DUNEDIN CITY COUNCIL | kaunihera a-rohe o Ōtepoti

8 August 2023

[redacted]

[redacted]

Kia Ora [redacted]

Local Government Official Information and Meetings Act 1987 Request (LGOIMA)

I refer to your request of 9 June 2023 and my subsequent e-mail extending the time to respond to your request. Please accept my apologies for the delay. In your request you asked for details about the Civic Centre, Wall Street Mall, Toitū, Moana Pool and the Dunedin Public Art Gallery.

Please find our response to your request below:

Information is included below on the emissions for DCC sites with significant emissions. The DCC's overall emissions inventory for the period July 2021 to June 2022 can be found on the Zero Carbon page of the DCC website (or directly using the following link): https://www.dunedin.govt.nz/__data/assets/pdf_file/0009/978264/greenhouse-gas-emissions-inventory-and-management-report-2021-22.pdf

MOANA POOL

Emissions

Moana Pool	Units	July 2020 to June 2021	July 2021 to June 2022	July 2022 to May 2023
Electricity consumption	kWh	2,420,383.31	2,420,383.31	2,356,013.11
LPG consumption	kWH	4,451,761.00	4,451,761.00	4,432,940.10
Electricity emissions	tCO2e	218.85	290.65	266.21
LPG emissions	tCO2e	1,440.01	968.50	838.83

EMISSIONS REDUCTION PLANS

The Moana Pool upgrade project is currently underway. The heat recovery system at Moana is being considered as part of that work. Improved heat recovery at Moana Pool would reduce (rather than completely displace) the use of LPG to heat water.

DCC CBD AREA FACILITIES

Emissions

Civic Centre	Units	July 2020 to June 2021	July 2021 to June 2022	July 2022 to May 2023
Electricity consumption	kWh	942,175.53	827,327.52	785,193.41
LPG consumption	kWH	1,636,196.00	1,711,049.00	1,541,225.40
Electricity emissions	tCO2e	95.54	99.35	94.29
LPG emissions	tCO2e	355.96	372.24	335.30

Toitū Early Settlers Museum	Units	July 2020 to June 2021	July 2021 to June 2022	July 2022 to May 2023
Electricity consumption	kWh	1,056,859.81	1,055,163.95	942,892.77
LPG consumption	kWH	305,034.00	308,169.00	292,450.33
Electricity emissions	tCO2e	107.17	126.71	113.23
LPG emissions	tCO2e	66.36	67.04	63.62

Dunedin Public Art Gallery	Units	July 2020 to June 2021	July 2021 to June 2022	July 2022 to May 2023
Electricity consumption	kWh	981,970.81	958,446.33	711,204.15
LPG consumption	kWH	1,187,930.00	1,158,853.00	980,921.20
Electricity emissions	tCO2e	99.58	115.10	85.41
LPG emissions	tCO2e	258.44	252.11	213.40

Wall Street Mall	Units	July 2020 to June 2021	July 2021 to June 2022	July 2022 to May 2023
Electricity consumption	kWh	2,088,136.01	2,036,210.29	1,805,826.79
LPG consumption	kWH	235,679.00	99,379.00	205,496.32
Electricity emissions	tCO2e	211.75	244.52	216.86
LPG emissions	tCO2e	51.27	21.62	44.71

Emissions Reduction Plans

Council staff have been investigating the energy load profiles of eight of our largest energy using facilities. Potentially changing the fuel type at these facilities is the subject of a future report to Council.

TAHUNA WASTEWATER TREATMENT PLANT

Emissions

Tahuna Wastewater Treatment Plant	Units	July 2020 to June 2021	July 2021 to June 2022	July 2022 to May 2023
Diesel stationary energy consumption	L	203,995.80	247,278.00	224,359.00
Diesel stationary energy emissions	tCO2e	543.39	660.00	598.83
Biological Wastewater treatment emissions*	tCO2e	3,591.05	3,591.05	3295.90

*Relates to methane and nitrous oxide emissions generated through wastewater treatment and discharge, and sludge/biosolids treatment and disposal.

Emissions Reduction Plans

DCC are investigating a variety of long term alternatives to manage biosolids (sludge) from wastewater treatment plants, such as using the biosolids as a resource rather than the current incineration/landfill approach, and/or utilising energy from sludges such as by anaerobic digestion and combustion of biogas to produce electricity and/or heat (which we currently do at Green Island Wastewater Treatment Plant).

Historical Plans/Decisions for Tahuna Wastewater Treatment Plant

Information on the historical plans for the Tahuna Wastewater Treatment Plant have been attached. The attached *Dunedin City Council – Wastewater Treatment and Disposal Options Study – Stage One – Issues and Options Scoping* document from 1991 includes an overview of the considerations at that point to inform decisions in the 1990s and early 2000s for wastewater treatment in Ōtepoti Dunedin.

The attached *Dunedin City Council – Tahuna Wastewater Treatment Plant – Application for renewal of air discharge permit* document from 2012 provides an overview of the significant upgrades to wastewater treatment infrastructure and wastewater discharge undertaken in the early 2000s.

These documents together give somewhat of an overview on the historical decisions and considerations at Tahuna wastewater treatment plant since the 1990s. Given the time that has passed, it is difficult to source all planning and decision-making documents dating back twenty to thirty years. As such, there is likely to be further documentation that DCC has been unable to retrieve at this time. Therefore pursuant to section 17(e) of LGOIMA that the document alleged to contain the information requested does not exist or despite reasonable efforts to locate it, cannot be found this part of your request is declined.

As we have declined some information you are advised that you have the right to seek a review by the Office of the Ombudsman.

Yours faithfully

Governance Support Officer

Dunedin City Council

Tahuna Wastewater Treatment Plant

Application for renewal of air discharge permit

Application and Assessment of Effects on the Environment

17 December 2012

DUNEDIN CITY COUNCIL
Kaunihera-a-rohe o Otepoti

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Appendices

1. Existing air discharge permit 2002.625
2. Dunedin City Council – Tahuna Wastewater Treatment Plant. Air Discharge Permit – Identification of Planning Considerations. Report No. 1278104628. Prepared by Golder Associates (NZ) Ltd. July 2012.
3. Tahuna Wastewater Treatment Plant. Assessment of Air Discharges Effects. Report No. 1278104628_003_R_Rev 1. Prepared by Golder Associates (NZ) Ltd. December 2012.
4. Selected photographs of Tahuna Wastewater Treatment Plant
5. Preliminary statement from KTKO Ltd/Te Runanga o Otakou
6. Newsletter distribution area

1. APPLICATION FORMS

1 Resource Consent Application

Otago Regional Council

(For Office Use Only)
Deposit Paid: $

This application is made under Section 88 of the Resource Management Act 1991.

Charges/Deposits

A deposit **must** accompany the application (see page **7** for amounts). The applicant will be invoiced for all costs incurred in processing this application that exceed the deposit.

Please complete the application in pen. For questions marked with an * you will find notes on page 4

1. ***Applicant(s) Details**

Applicant(s) name(s) in full: **DUNEDIN CITY COUNCIL**

OR Company Name (in full)
OR Names of Trustees (in full) if Applicant is a Trust
or Name of Incorporation

Postal Address **PO Box 5045**
Moray Place
Dunedin 9058

Street Address (not a P O box number) **10 Tahuna Road, Dunedin, 9013**

Phone Number Business **03 456 0516** Private **n/a**
Mobile **027 233 2996** Fax **03 455 5736**

Email Address **chenders@dcc.govt.nz**

2. Consultant/Contact Details (if not applicant)

Name of Consultant/ Contact Person:

Tony Dons, Tony Dons Limited

Postal Address **PO Box 6054**
Dunedin North
Dunedin 9059

Phone Number Business **03 464 0611** Private **n/a**
Mobile **0274 798 333** Fax **03 464 0613**

Email Address **tonydons@ihug.co.nz**

3. a) *Are there any current or expired resource consents relating to this proposal?

√ **Yes**

If yes, give Consent Number(s) and Description:

2002.625 Permit to discharge to air odours resulting from primary treatment of wastewater and products of combustion. Issued: 22 October 2004. Expiry: 30 June 2013

b) Has there been a previous application for this activity that was returned as incomplete?

√ **No**

c) Have you a pre-application lodged with Council for this activity?

√ **No**

4. The applicant is (tick one): √ **owner** □ leasee □ prospective purchaser of the land on which the activity occurs.

5. *Who is the owner of the land on which the activity occurs/is to occur? (only complete if applicant is not the landowner)

Name of landowner: **n/a**

Postal Address

Phone Numbers

Email Address

6. *Who is the occupier of the land on which the activity occurs/is to occur? (only complete if the applicant is not the land occupier)

Name of land occupier **n/a**

Postal Address

Phone Number

Email Address

7. *Who leases the land on which the activity occurs/is to occur? (only complete if land is leased and it is not leased to the applicant)

Name of land leasee **n/a**

Postal Address

Phone Number

Email Address

8. Tick the consents required in relation to this proposal:

Water

Take Surface Water Divert

Take Groundwater Dam

Discharge onto or into:

Land Water √ **Air**

Land Use:

Bore construction Bore alteration

Activities in or on beds of lakes or rivers or floodbanks

Disturbance of contaminated land

Coastal:

Activities in the coastal marine area (i.e., below mean high water spring tide)?

Where you have indicated that a consent is required, you must complete the appropriate Application Form before your application can be processed. Application Forms can be found on the Council's website: www.orc.govt.nz.

9. What is the maximum term of consent you are seeking? **35 years**

10.Territorial Local Authority in which activity is situated?

√ Dunedin City Council Queenstown Lakes District Council

Clutha District Council Waitaki District Council

Central Otago District Council

11. *Do you require any other resource consent from any local authority for this activity?

√ **No**

If Yes, please list:

Have these consents been applied for/issued? Yes No

If Yes, please give the date applied for or issued:

Notes on Application Form Details

1. **Applicant(s) Details**

A resource consent can only be held by a legal organisation or fully named individual(s). A legal organisation includes a limited company, incorporated group or registered trust. If the application is for a trust the full names of all trustees are required. If the application is not for a limited company, incorporated group or trust, then you must use fully named individual(s).

2. **Consultant/Contact Details**

If you are using a consultant/agent for this application put their details here. If you are not, leave question 2 blank.

3 **Previous Consent**

Do you currently have a resource consent to do the activity that you are applying to renew with this application? If so, please enter the permit number if known and a brief description including the date of issue and the expiry date.

5-7 **Landowner, occupier and leasee**

If you are not the landowner, land occupier or leasee of the land where the activity will be undertaken, you may be required to obtain their unconditional written approval to your application. On pg 6 there is a form that can be used.

11. **Additional Consents**

If you are carrying out earthworks or building work you may need other consents from either the ORC or your Territorial Local Authority.

Declaration

Before signing the declaration below, in order to provide a complete application have you remembered to:

Fully completed this Form 1 and the necessary Application Forms √

Attached the required deposit. (see pg 8 for amounts) √
Cheques payable to Otago Regional Council

Please note: your deposit may not cover the entire cost of processing your application. At the end of the application process you will be invoiced for any costs that exceed the deposit. Interim invoices may be sent out for applications, where appropriate.
If the required deposit does not accompany your application, staff will contact you on the number provided on this form to request payment and after 3 working days your application will returned if no further payment is made for the required deposit.

I/we hereby certify that to the best of my/our knowledge and belief, the information given in this application is true and correct.

I/we undertake to pay all actual and reasonable application processing costs incurred by the Otago Regional Council.

Name/s **CHRIS HENDERSON**
(BLOCK CAPITALS)

Signature/s
(or person authorised to sign on behalf of applicant)

Designation **Wastewater Treatment Manager** Date **18 December 2012**
(e.g., owner, manager, consultant)

Otago Regional Council Postal Address: 70 Stafford St, Private Bag 1954, Dunedin 9054

Written Approvals of Persons Likely to be Adversely Affected

I/We (Please print full name/s)_____ _____

of (Address) _____

have studied the proposal by (Applicant) _____

for a Resource Consent (Number) _____ to _____

_____

and give my/our written approval to the proposed activity/activities.

Signature/s_____ Date _____
(or person authorised to sign on behalf of affected party/parties)

Phone _____ Fax _____ Email _____

Please note: If this application is subsequently notified the above approval does not constitute a submission as required under Section 96 of the Resource Management Act 1991.

I/We (Please print full name/s)_____ _____

of (Address) _____

have studied the proposal by (Applicant) _____

for a Resource Consent (Number) _____ to _____

_____

and give my/our written approval to the proposed activity/activities.

Signature/s_____ Date _____
(or person authorised to sign on behalf of affected party/parties)

Phone _____ Fax _____ Email _____

Please note: If this application is subsequently notified the above approval does not constitute a submission as required under Section 96 of the Resource Management Act 1991.

I/We (Please print full name/s)_____ _____

of (Address) _____

have studied the proposal by (Applicant) _____

for a Resource Consent (Number) _____ to _____

_____

and give my/our written approval to the proposed activity/activities.

Signature/s_____ Date _____
(or person authorised to sign on behalf of affected party/parties)

Phone _____ Fax _____ Email _____

Please note: If this application is subsequently notified the above approval does not constitute a submission as required under Section 96 of the Resource Management Act 1991.

Consultation

Under Section 95E of the Resource Management Act 1991 (the Act) the Council will identify affected parties to an application and if the application is to be processed on a non-notified basis the unconditional written approval of affected parties will be required. Consultation with potentially affected parties and interested parties can be commenced prior to lodging the application.

Consultation may also be required with the appropriate Tangata Whenua for the area. The address of the local Iwi office is: Kai Tahu ki Otago Ltd, P O Box 446, Dunedin, Fax (03)477-0072, Phone (03) 477-0071, email: ktko@ngaitahu.iwi.nz. If you require further advice please contact the Otago Regional Council.

Good consultation practices include:

- Giving people sufficient information to understand your proposal and the likely effects it may have on them
- Allowing sufficient time for them to assess and respond to the information
- Considering and taking into account their responses

Information Requirements

In order for any consent application to be processed efficiently in the minimum time and at minimum cost, it is critical that as much relevant information as possible is included with the application**. Where an application is significantly incomplete, the Consent Authority may decide not to accept the application for processing.**

An application for a resource consent must include an Assessment of Effects as outlined in the Fourth Schedule of the Resource Management Act 1991 and reproduced below. The extent of detail required should be relative to the scale and significance of the potential adverse effects the activity may have on the receiving environment.

Resource Management Act 1991
FOURTH SCHEDULE—ASSESSMENT OF EFFECTS ON THE ENVIRONMENT

1. Matters that should be included in an assessment of effects on the environment –
Subject to the provisions of any policy statement or plan, an assessment of effects on the environment for the purpose of section 88(6)(b) should include:

(a) A description of the proposal.
(b) Where it is likely that an activity will result in any significant adverse effect on the environment, a description of any possible alternative locations or methods for undertaking the activity.
(c) Repealed, as from 7 July 1993, by s 225 Resource Management Act 1993 (1993 No 65).
(d) An assessment of the actual or potential effect on the environment of the proposed activity.
(e) Where the activity includes the use of hazardous substances and installations, an assessment of any risks to the environment which are likely to arise from such use.
(f) Where the activity includes the discharge f any contaminant, a description of:
(i) The nature of the discharge and the sensitivity of the proposed receiving environment to adverse effects; and
(ii) Any possible alternative methods of discharge, including discharge into any other receiving environment:
(g) A description of the mitigation measures (safeguards and contingency plans where relevant) to be undertaken to help prevent or reduce the actual or potential effect.
(h) An identification of those persons interested in or affected by the proposal, the consultation undertaken, and any response to the views of those consulted.
(i) Where the scale or significant of the activity's effect are such that monitoring is required, a description of how, once the proposal is approved, effects will be monitored and by whom.

2. **Matters that should be considered when preparing an assessment of effects on the environment –** Subject to the provisions of any policy statement or plan, any person preparing an assessment of the effects on the environment should consider the following matters:

(a) Any effect on those in the neighbourhood and, where relevant, the wider community including any socio-economic and cultural effects.
(b) Any physical effect on the locality, including any landscape and visual effects.
(c) Any effect on ecosystems, including effects on plants or animals and any physical disturbance of habitats in the vicinity.
(d) Any effect on natural and physical resources having aesthetic, recreational, scientific, historical, spiritual, or cultural, or other special value for present of future generations.
(e) Any discharge of contaminants into the environment, including any unreasonable emission of noise and options for the treatment and disposal of contaminants.
(f) Any risk to the neighbourhood, the wider community, or the environment through natural hazards or the use of hazardous substances or hazardous installations.

Set out below are details of the amounts payable for those activities to be funded by fees and charges, as authorised by s36(1) of the Resource Management Act 1991.

Resource Consent Application Fees (from 1 July 2012)

Note that the fees shown below are a **deposit** to be paid on lodgement of a consent application and applications for exemptions in respect of water metering devices. This deposit will not usually cover the full cost of processing the application, and further costs are incurred at the rate shown in the scale of charges. GST is included in all fees and charges.

Publicly Notified Applications: [3]	**$**
First application	5,000.00
Concurrent applications	225.00
Non Notified Applications and Limited Notified Applications: [3]	**$**
First application (except those below)	1,000.00
Concurrent applications [1]	50.00
Exemptions from water measuring Regulations	200.00
Bores	500.00
Gravel	500.00
Hearings	Per Note 2 below
Transfers and Certificates Deposits:	**$**
Transfer of Mining Privilege	100.00
Transfer – other	100.00
Priority Table	100.00
Section 417 Certificate	200.00
Certificate of Compliance	200.00
Section 125 – Extension of Term	100.00
All Other Costs	As per Scale of Charges

Scale of Charges:	**From 1 July 2012 $**
Staff time per hour:	
* Executive staff	235.00
* Senior Technical/Scientist	147.00
* Technical/Scientist	94.00
* Administration	77.00
Disbursements	Actual
Additional site notice	Actual
Advertisements	Actual
Vehicle use per kilometre	0.70
Travel and accommodation	Actual
Testing charges	Actual
Consultants	Actual

Notes

1. For additional permits in respect of the same site, activity, applicant, time of application, and closely related effect as the first application.

2. The deposit payable shall be 90% of the cost of a hearing as calculated by Council in accordance with information contained in the application file and using the scale of charges. The amount payable will be due at least 10 working days before the commencement of the hearing. If the amount is not paid by the due date, then the Otago Regional Council reserves the right under S36 (7) of the Resource Management Act to stop processing the application. This may include cancellation of the hearing.

   Should a hearing be cancelled or postponed due to the non payment of the charge, the applicant will be invoiced for any costs that arise from that cancellation or postponement.

   Following completion of the hearing process, any shortfall in the recovery of hearing costs will be invoiced, or any over recovery will be refunded to the applicant.

   Under Section 100A of the RMA, one or more submitters may make a request to have a resource consent application heard by one or more hearing commissioners who are not members of Council. In this case the applicant will pay the amount that Council estimates it would cost for the application to be heard had the request not been made, and the submitter(s) who made the request will pay, in equal shares, the cost of the application being heard that exceeds that amount payable by the applicant.

   Further, the applicant may request to have a resource consent application heard by one or more hearing commissioners who are not members of Council. In this case, the applicant will pay the full costs.

3. Where actual and reasonable costs are less than the deposit paid, a refund will be given.

Review of Consent Conditions

Following the granting of a consent, a subsequent review of consent conditions may be carried out at either request of the consent holder, or, as authorised under Section 128, as a requirement of Council. Costs incurred in undertaking such reviews will be payable by the consent holder at the rates shown in the Scale of Charges above.

Compliance Monitoring Charges (from 1 July 2012)

1. Performance Monitoring

The following charges will apply to the review of performance monitoring reports for all consent holders, except those listed in section 1.4 below. The charges shown are annual fixed fees per performance monitoring report or plan, and are inclusive of GST.

1.1 Discharge to Air Consent

	From 1 July 2012 *$*
Measurement of contaminants from a Stack report	38.50
Ambient air quality measurement of contaminants report	66.50
Management plans and maintenance records	33.50
Annual Assessment report	66.50

1.2 Discharge to Water, Land and Coast

		$
• Effluent Systems	Environmental Quality report	31.00
• Active Landfills	Environmental Quality report	38.50
	Annual Assessment report	87.00
	Management Plans	174.00
• Closed Landfills	Environmental report	23.00
	Annual Assessment report	23.00
	Management Plans	87.00
• Stormwater	Environmental Quality report	20.50
	Management Plans	87.00
• Industrial Discharges	Effluent quality report	28.00
	Environmental report	61.50
	Annual Assessment report	77.00
	Management Plans	174.00

1.3 Water Takes

Calibration data reports		13.00
Manual return of data per take		66.50
Datalogger return of data per take sent to ORC		23.00
Datalogger return of data per take collected by ORC	Collection costs +	23.00
Telemetry data per consent		33.50
Low flow monitoring charge*		
- Kakanui at McCones		327.00
- Unnamed Stream at Gemmels		1,431.00

*Charge for monitoring sites established by the ORC specifically to monitor consented activities in relation to river flows.

1.4 Set Fees for Specific Consent Holders

Performance monitoring fees as shown below will apply to the following consent holders:

Dunedin City Council	$15,890.00
Central Otago District Council	$5,409.00
Clutha District Council	$8,358.00
Queenstown Lakes District Council	$7,629.00
Waitaki District Council	$5,753.00
Oceana Gold	$53,043.00
Ravensdown	$5,742.00
Contact Energy	$4,262.00
Trustpower	$3,381.00
Pioneer Generation	$2,792.00

2. Audit

Audit work will be charged at half of the actual cost incurred, with the actual costs being calculated using the Scale of Charges.

3. Non-Compliance, Incidents and Complaints

Enforcement work on consent conditions, and remedying negative effects from permitted activities – Scale of Charges.

4. Consent Establishment Inspections

One off inspection by Council on establishment work carried out by consent holders – $150.00 (incl. GST), from 1 October 2010 - $155.00

Gravel Inspection and Management

Gravel extraction fee – $0.66 per cubic metre (incl. GST). Where more than 10,000 cubic metres of gravel is extracted within a prior notified continuous two month period, the actual inspection and management costs will be charged, as approved by the Director Corporate Services.

8 Discharge Permit Schedule To Discharge Contaminants To Air

(For Office Use Only)
Consent No.: _____

Please provide an accurate plan showing the location of the site, existing works or works to be constructed, property boundaries and neighbouring properties.

Part A: General

1. **Process Details**

(a) Please supply a detailed flow chart and description of the process that results in either a discharge to the atmosphere, or could potentially result in a discharge to air.

2. **Discharge Details**

(a) Describe the contaminant discharged and quantities:

Odour, aerosols and combustion contaminants. See AEE for further details.

(b) Has there been carried out, or do you have access to, any discharge, monitoring, or monitoring of impacts of the discharges? **Yes** √ No

(If yes, please supply a copy of the information obtained.)

(c) Has any meteorological data relevant to the site been obtained? **Yes** √ No

(If yes, please give details and, if possible, a copy/summary of the information obtained.)

(d) Describe the type of land use surrounding the site (eg. north, residential – closest 500m; south, industrial, etc):

Residential to north; recreational to west, east & south. Nearest residence 30 m from wastewater treatment plant site boundary but 100 m from wastewater treatment processes.

(e) What alternative methods of disposal or discharge have you considered?

See AEE

(f) How is the equipment controlling the discharge operated and maintained to prevent equipment failure, and what measures are implemented to ensure that the effects of any malfunction are remedied?

See AEE

(g) What, if any, monitoring do you carry out to ensure that the discharge does not have an adverse effect?

See AEE

(h) Please provide the following discharge information relevant to your process. (See overleaf)

See AEE

Air Discharge Permit Information

Combustion Processes (metric units should be used)

- Type of fuel, sulphur content, amount used.
- Describe combustion processes and details of boiler or heat unit.
- Maximum heat release rate (kilowatts, megawatts).
- Concentration of contaminants in discharge (mg/m^3).
- Height of discharge point (chimney(s)).
- Height of building the chimney is attached to.
- Describe fitting on top of chimney(s), cone, rain excluded, Chinaman's hat).
- Frequency of discharge (hours of operation).
- Describe air pollution control equipment.
- Velocity of flue gas (m/s).
- Monitoring system (for checking and recording discharge).
- Location of discharge points in relation to factory and boundaries.
- Condition of boiler or heat unit, chimney and details of last service.
- Insulation of chimney.

Quarries

- Describe quarrying process.
- Type of rock being mined.
- Open cast extraction capacity (tonnes/hour).
- Size reduction and screening capacity (tonnes/hour).
- Storage capacity (tonnes/hour).
- Dust control measures.
- Monitoring systems (for checking and recording dust emissions).
- Frequency of discharge (i.e., hours of operation).
- Quarry management plan.

Wood Processing Industries

- Describe the process.
- Describe air pollution control equipment (including height of discharge point(s), exhaust flow and velocity).
- Monitoring system (for checking and recording discharge(s)).
- Particulate emission test (to determine dust concentration and mass emission levels discharged from the vent, measured over three runs, with all wood sanding equipment working at the same time).
- Frequency of discharge (i.e., hours of operation).
- Location of discharge points in relation to the premises and neighbouring premises.

Chemical Manufacturing Blending Processes/Electroplating

- Describe the process.
- Describe air pollution control equipment including fan flow rates.
- Monitoring system (for checking and recording discharge).
- Frequency of discharge (i.e., hours of operation).
- Distance of discharge points from neighbouring premises.
- Raw material capacity of operation? or product rate.
- Height of discharge points.

Air Discharge Permit Information (continued)

Abrasive Blasting

- Describe the process and details of blasting chamber, blasting media used.
- Describe air pollution control equipment and height of discharge points, velocity of gases, fitting on top of vent(s).
- Particulate emission tests (to determine dust concentration and mass emission levels discharged from the vent, measured over three runs).
- Monitoring system (for checking and recording discharge).
- Frequency of discharge (i.e., hours of operation).
- Distance of discharge points from neighbouring premises.

Wool Scourers and Tanneries

- Describe the process.
- Describe air pollution control equipment and height of discharge point(s), fitting on top of vent(s).
- Monitoring system (for checking and recording discharge).
- Describe raw material capacity of operation.
- Frequency of discharge (i.e., hours of operation).
- Distance of discharge points from neighbouring premises.

Spray Painting Process

- Describe the process and details of spray painting booth.
- Describe air pollution control equipment and height of discharge point(s), velocity of gases, fitting on top of vent(s).
- Describe paints and solvents used (provide MSDS where available).
- Paint and solvent usage rates.
- Distance of discharge points from neighbouring premises.

Concrete Manufacturing Plants

- Describe the process.
- Give details of raw material capacity (tonnes/hour).
- Dust control measures.
- Hours of operation.
- Monitoring system (for checking and recording dust).

Foundries

- Describe the process, raw materials used, products made and equipment used.
- Give details of raw material capacity (tonnes/hour) and tonnes/hour product made.
- Hours of operation.
- Describe air pollution control equipment and height of discharge point(s), velocity of gases, fitting on top of vent(s).
- Monitoring system for discharges.

Air Discharge Permit Information (continued)

Rendering Process

- Describe the rendering process (high/low temperature, drying, etc.).
- Describe combustion process (if applicable, i.e., type of combustion process, fuel used, fuel combustion rate, contaminants released to air, exit velocity, concentration).
- Describe air pollution control equipment.
- Height and number of discharge point(s) and any fitting on top of vent(s).
- Hours of operation.
- Distance of discharge points from neighbouring premises.

Asphalt Production

- Describe the process, including dust control equipment.
- Give details of raw material capacity (tonnes/hour).
- Hours of operation.
- Monitoring systems.

Coffee Roasting Processes/Vegetable Frying Processes

- Describe roasting process (roast or frying cycle, maximum raw material capacity (kg/hr).
- Describe combustion process (if applicable, i.e., type of combustion processes, fuel used, fuel combustion rate).
- Describe air pollution control equipment.
- Height and number of discharge point(s) describe fitting on top of vent(s).
- Hours of operation.
- Monitoring system (for checking and recording discharge).
- Distance of discharge points from neighbouring premises.

Other Processes

- Describe the process.
- Describe air pollution control equipment.
- Hours of operation.
- Monitoring systems, for recording discharges.

Part B: Assessment of Effects on the Environment

Where your activity could have an effect on the environment an assessment of environmental effects is required in accordance with the Fourth Schedule of the Resource Management Act 1991.

1. Comment on all possible effects the discharge may have on the quality of the receiving air, persons living in the area and local plant and animal life:

See AEE

2. In the vicinity of the discharge are there any:	Yes	No
(a) Residential developments?	√	
(b) Production land (eg., crops, dairy farming)?		√
(c) Recreational activities carried out (eg sports grounds, parks etc)?	√	
(d) Sources of similar on other discharges to air?	√	
(e) Areas of particular aesthetic or scientific value (e.g., scenic views etc)?		√
(f) Areas or aspects of significance to Iwi?		√
(g) Commercial activities (eg. office blocks)?		√

If you have answered yes to any of the above, describe what effects your discharge may have and the steps you propose to mitigate these:

See AEE

8A Schedule
Discharge Permit
To Discharge Contaminants to Air From Combustion Processes

This form is to be used for applications seeking to discharge contaminants to air from combustion processes within the Otago Region including the Coastal Marine Area. For the purpose of this application, 'combustion processes' includes incinerators and boilers, but excludes domestic fires and outdoor burning.

(For Office Use Only)
Consent No.: _____
Job No: _____

PLEASE READ BEFORE COMPLETING THE APPLICATION FORM

In order for any consent application to be processed efficiently in the minimum time and at minimum cost, it is critical that as much relevant information as possible is included with the application. **If all the necessary information is not supplied with the application then Otago Regional Council may, under section 88 of the Resource Management Act 1991 (the Act) return your application, request further information or decline your application. This will lead to delays in the processing of your application and may increase processing costs.**

Form 1 and Schedule 8A, when properly completed, may provide an adequate "Assessment of Effects on the Environment" (AEE) where the adverse effects of a proposal are not significant. However, this can only be determined on application. The required detail for an AEE should reflect the scale and significance of the potential adverse effects the activity may have on the environment. If the size of your proposed activity or scale of its potential effects is significant, a report by a professional advisor in support of your application may be required. An AEE is required by the Act so that you and others can understand what happens to the environment when you discharge contaminants to air. When considering applications to discharge contaminants to air, the effects of the discharge on the receiving environment and iwi values must be assessed.

Details of information required in an AEE is included in the Fourth Schedule of the Act appended to Form 1: Resource Consent Application.

Once an initial assessment has been made of your application, we may request further information in accordance with Section 92 of the Resource Management Act 1991.

PART A: Description of the Proposed Activity

A.1 Please provide an accurate site plan showing:

(a) a description of the type of land use surrounding the site (eg. north, residential – closest 500m; south, industrial, etc);
(b) property boundaries and neighbouring properties;
(c) nearby buildings
(d) road access
(e) existing combustion facilities or those to be constructed;
(f) specific location of discharge point(s); and
(g) scale and north arrow.

A.2 Please provide a GPS location in NZTM 2000 (New Zealand Transverse Mercator) for each combustion facility

a. Name:	**Incinerator (biofilter)**	NZTM 2000: E	**1407799**	N	**4913514**
b. Name:	**Generator**	NZTM 2000: E	**1407734**	N	**4913579**
c. Name:		NZTM 2000: E		N	
d. Name:		NZTM 2000: E		N	
e. Name:		NZTM 2000: E		N	

A.3 (a) How many combustion facilities (e.g. boilers / incinerators etc) are present on the site?

Two combustion facilities: one emergency generator and one incinerator.

(b) How many combustion facilities does this application seek to consent?

One – biosolids incinerator. Emergency generator is a permitted activity and therefore a resource consent is not being sought for this activity.

A.4 What is the make, model and heat generation capacity (e.g. one megawatt) of each existing or proposed combustion facility?

Incinerator details:

Make **Dorr Oliver** Model **Fluidised bed** Capacity **1.25 tonnes/hr**

Please supply the manufacturer's specifications for each combustion facility

A.5 When was each combustion facility installed, or if the application is for a new combustion facility(s), when do you expect it to be commissioned?

Incinerator installed February 1981, rebuilt June 1996

A.6 Existing combustion facility(s) (*if you do not have an existing facility(s) please go to question A.6)*

(a) Please describe the physical condition of the combustion facility(s), including chimney/stack.

Incinerator is in good condition

(b) Please state the date of, and attach details from the last service on the combustion facility(s), including chimney/stack.

Incinerator is serviced annually; last serviced August 2012

A.7

Note the incinerator exhaust is discharged via a biofilter under normal operating conditions therefore not a chimney or a stack. Biofilter details are provided below.

(a) What are the dimensions of the chimney/stack?

Approximate length **115** metres and width **24** metres

(b) What is the height of the chimney from ground level? **2.5 metres (height of biofilter)**

(c) What is the height of the chimney above the adjoining building roof level? **0 metres**

(d) Please describe the insulation of the chimney/stack? **N/A**

(e) Please describe the cap on top of the chimney/stack? (e.g. cone, rain cap)

As stated above, the exhaust from the incinerator is discharged via a biofilter (discharged via Biofilters 1 & 2 with total area of 2,800 m^2). The discharge exhaust from the incinerator is mixed with other ventilation air and extracted to a biofilter. The incinerator stack is open to the atmosphere but has air drawn in under normal operation.

(f) What is the maximum height of adjoining and adjacent buildings to the discharge point?

HRAS building at 6 m

(g) Please attach photographs of the combustion facility(s) and chimney/stack. **See appendices.**

A.8 What type of fuel is used?

❒ Coal

What type of coal? (e.g. Ohai, Kai Point)
Please include with this application a chemical description of the coal used including the expected sulphur content

❒ Wood including pellets

❒ LPG or Natural Gas

❒ Diesel

√ Other *(please specify)*
The fuel for the incinerator is dewatered biosolids (approximately 30 wt. % dry solids). A small amount of diesel is burnt as a starter fuel when the incinerator is started up and as an ongoing fuel with combustion of HRAS biosolids.

A.9 How much of the fuel described above is used:

Biosolids Incinerator

(a) Per day **nominally 30 t**

(b) Per week **nominally 210 t**

(c) Per month **approximately 900 t**

(d) Per year **approximately 11,000 t**

A.10

What are the hours of operation of the combustion facility(s)?

Biosolids Incinerator

(a) Per day **24 hours per day** which times?

(b) Per week **7 days per week** which days? **Monday to Sunday**

(c) Per month which months?

A.11 Please supply a detailed flow chart and description of the process that results in either a discharge to air, or could potentially result in a discharge to air.

See AEE

A.12 If known, what contaminants are discharged and in what concentrations (mg/m^3)?

Biosolids incinerator (mg/m^3)

- **PM_{10} 0.7**
- **SO_2**
- **NO_x 272.5 (max measured since 2004)**
- **CO**

Other: Mercury 3.5×10^{-4} (trace level)

Dioxin 9.3×10^{-9}

A.13 Describe any existing or proposed air discharge pollution control measures (e.g. bag house, filters).

Biosolids incinerator: Described in the AEE

A.14 How is the equipment controlling the air discharge operated and maintained to prevent equipment failure, and what measures are implemented to ensure that the effects of any malfunction are remedied? *Please provide a maintenance plan for the combustion facility(s).*

This is detailed in the AEE

A.15 What is the estimated or known maximum velocity of the flue gas?

Biosolids incinerator: 0.006 metres/second (from biofilter when combined with other biofilter flows)

A.16 What monitoring, if any, do you carry out to ensure that the discharge does not have an adverse effect? *(please supply results of any monitoring undertaken)*

See AEE

A.17 Has any meteorological data relevant to the site been obtained? **See AEE**

No ❒

Yes ❒ *(If yes, please give details and, if possible, attach a copy of the information obtained to this application)*

A.18 Section 105 of the Resource Management Act 1991 requires consideration of alternatives to the discharge and the reasons for proceeding with your proposed choice.

(a) What alternative methods of disposal or discharge to air from your combustion facility(s) have you considered?

See AEE

(b) Justify why you have made the choice to proceed with the proposed activity described in this application.

See AEE

PART B: Assessment of Environmental Effects **See AEE**

B.1	**In the vicinity of the discharge are there any:**	**Yes**	**No**
(a)	Residential developments?	√	
(b)	Production land (e.g., crops, dairy farming)?		√
(c)	Recreational Areas (e.g. sports grounds, parks)	√	
(d)	Sources of other similar discharges to air?	√	
(e)	Areas of particular aesthetic or scientific value?		√
(f)	Areas or aspects of significance to Iwi?		√
(g)	Commercial activities and/or schools?	√	

B.2 List and describe all possible effects the discharge from your combustion facility(s) may have on:

(a) The receiving air quality

See AEE

(b) Persons living or working in the area

See AEE

(c) Local plant and animal life

See AEE

(d) Any of the features identified in B.1 that have not already been discussed

See AEE

PART C: Consultation **See AEE**

C.1 Please comment on any consultation undertaken with parties who may be interested in or potentially affected by your proposal to discharge contaminants to air (e.g., neighbours, Iwi).

2. Please provide any written approvals to the activity using Council's standard Form 1 - Resource Consent Application

PART D: Checklist

D.1 In order to provide a complete application, have you remembered to attach:

(a)	The fully complete Form 1 and this Schedule 8A	√
(b)	A site plan	√
(c)	Manufacturer's specifications for each combustion facility	√
(d)	Details of the last service (if applicable)	√

Last incinerator service (August 2012) included:

- **reline secondary cooling tower (Conveyor Specialists)**
- **refractory repair (Alan Eatwell)**
- **check combustion air flow supply (DCC)**
- **mechanical overhaul of biosolids feed screw and belt press (DCC)**
- **overhaul high pressure water supply (DCC)**
- **general inspection (DCC)**
- **repairs to steel outer shell (Action Engineering)**

(e)	Photographs of the combustion facility(s) and chimney	√
(f)	A chemical description of the coal used (if applicable)	**n/a**
(g)	A flow chart of the process that results in a discharge	√
(h)	The maintenance plan for the combustion facility(s)	√
(i)	The results of any monitoring undertaken	√
(j)	Any meteorological information relevant to the site	√
(k)	Written approvals obtained	**n/a**
(l)	Any appropriate additional information (e.g. photographs)	√

2 EXECUTIVE SUMMARY

The Dunedin City Council ("DCC") operates a municipal wastewater treatment plant at 10 Tahuna Road, Tainui, Dunedin and holds an existing air discharge permit (2002.625). The Tahuna WWTP forms a key part of the municipal wastewater infrastructure which the DCC maintains and operates pursuant to its obligation under the Local Government Act. The existing permit was granted in 2004 and expires on 30 June 2013. This application for renewal of the existing air discharge permit will be lodged with the Otago Regional Council ("ORC") by 31 December 2012 which is six months before the expiry.

This application and assessment of effects on the environment (AEE) provides information on the DCC and the Tahuna WWTP, existing and proposed resource consents, the Tahuna wastewater treatment process and its air discharges, effects of air discharges, mitigation of air discharges, assessment of alternatives, proposed monitoring, outcome of consultation, a statutory assessment and proposed consent conditions.

The DCC seeks a resource consent to authorise discharges to air from the Tahuna WWTP including odour and aerosols from the wastewater treatment process and combustion contaminants from the biosolids incinerator. Emissions from the emergency generator are permitted under Rule 16.3.4.1 of the Otago Air Plan and therefore do not require a resource consent. Consent is sought for a 35 year term.

After a substantial community consultation process the DCC decided to undertake a $110m upgrade of the Tahuna wastewater treatment process. This upgrade included an 1,100 m ocean outfall, removal of the wastewater discharge from Lawyers Head, provision of secondary treatment and UV disinfection and an upgrade and increase in biofilter odour control capacity. Secondary treatment includes fine screening, high rate activated sludge (HRAS) treatment and biological trickling filtration (BTF). These upgrade components are now required in terms of long term resource consents granted to the DCC. Construction of the upgrade is now completed.

The upgraded wastewater treatment system will generate additional biosolids which will enable greater volumes of biosolids to be transferred to Green Island for digestion and electricity generation. The DCC has decided, after review, that the best practicable option for disposing of biosolids is a combination of increased operating hours of the existing Tahuna WWTP incinerator, maximising the use of existing Green Island WWTP digesters to produce heat, gas and electricity and sending the residual biosolids to the Green Island landfill and subsequent collection of methane gas for electricity generation. This option will maximise the use of existing assets while being environmentally acceptable.

Golder Associates (NZ) Ltd carried out a technical assessment for this application and independently reviewed the original design and performance of the air emission containment and treatment system. Overall, Golder found that the treatment process enclosure, air extraction and biofilter treatment capacity represented best practice and was superior to comparable systems found throughout Australasia.

Golder considered that these emissions were unlikely to cause exceedance of the NES standard and would not cause measureable increases in airshed PM_{10} concentrations.

NO_2 emissions are predicted to meet the ambient air requirements specified by the NES, AAQG and RAAQG. Mercury emissions will also be well below the AAQG while dioxin emissions are estimated to be well below the relevant WHO and MfE guidelines and thus a negligible cancer risk.

Community consultation revealed a low level of concern regarding the granting of a replacement air permit for the Tahuna WWTP but did highlight that odour complaint recording needed improvement and that nearby odour levels also needed improvement. The local iwi, Te Runanga o Otakou, have no specific issues or concerns at this stage.

The statutory assessment showed that this application is not contrary to the purpose and principles of the RMA. The discharges to air from the Tahuna WWTP are consistent with the relevant objectives and policies of the RPS, Otago Air Plan and Otago Waste Plan and meet the requirements of the NES.

In conclusion, this application and assessment of effects on the environment provides the basis for the ORC to grant the DCC an air discharge permit for the Tahuna WWTP for a 35 year term.

ASSESSMENT OF EFFECTS on the ENVIRONMENT

3. Introduction

The Dunedin City Council ("DCC") operates a municipal wastewater treatment plant at 10 Tahuna Road, Tainui, Dunedin and holds an existing air discharge permit (2002.625). The Tahuna WWTP forms a key part of the municipal wastewater infrastructure which the DCC maintains and operates pursuant to its obligation under the Local Government Act. The existing permit was granted in 2004 and expires on 30 June 2013. This application for renewal of the existing air discharge permit will be lodged with the Otago Regional Council ("ORC") by 31 December 2012 which is six months before the expiry. Appendix 1 includes the existing air permit. Lodgement of this application with the ORC six months before the expiry date of the existing permit will allow the DCC to operate under the existing air permit until this application is finally determined.

The existing air permit authorises the "discharge to air of odours resulting from the primary treatment of wastewater and products of combustion for the purposes of operating a sewage sludge incinerator and treating sewage at the Tahuna Wastewater Treatment Plant". Construction of the wastewater treatment upgrade has been completed with commissioning underway in November-December 2012. The upgrade will enable wastewater to undergo secondary treatment and ultra violet (UV) disinfection.

The key features of the new wastewater treatment process will include:

- fine screening
- high rate activated sludge (HRAS)
- biological trickling filters (BTF)
- UV disinfection
- biosolids dewatering
- odour control biofilters
- biosolids incineration.

The new air permit will need to authorise all discharges to air from the upgraded treatment plant except those permitted under the Otago Air Plan (ORC, 2009).

The DCC already holds four "long term" permits issued by the ORC for various activities associated with the operation of the Tahuna WWTP. The granting of this air permit will complete the set of permits required for the long term operation of the upgraded wastewater treatment plant (WWTP).

This application is supported by two key reports prepared by Golder Associates (NZ) Limited. The first report identifies the planning considerations for this application ("Golder planning report") and is included in Appendix 2. The second report assesses the effects of air discharges from the Tahuna WWTP ("Golder technical assessment") and is included in Appendix 3.

4. Dunedin City Council and Tahuna Wastewater Treatment Plant

4.1 Dunedin City Council

The DCC was established under the Local Government Act to promote the social, economic, environmental and cultural wellbeing of the Dunedin district. One of its functions is to provide an effective and safe wastewater collection, treatment and disposal system. The residents of Dunedin have indicated to the DCC that they would like the system to be reliable, efficient, cost effective, odour-free and with minimal effects on the environment. These objectives determined the need for the upgrade to the Tahuna WWTP and will guide its future operation.

The Tahuna WWTP is the largest of Dunedin's eight wastewater treatment plants and services a population of about 83,000 which is two-thirds of Dunedin district's total population. The City Environment division of the DCC operates the Tahuna WWTP under the direct control of the Wastewater Treatment Manager.

4.2 Tahuna Wastewater Treatment Plant

The Tahuna WWTP is located on a 4.8 ha site at 10 Tahuna Road on land owned by the DCC and designated for wastewater treatment and disposal purposes. Figure 1 shows the location of the property titles that make up the Tahuna WWTP site. Wastewater treatment has occurred at this site since 1967 with the installation of comminutors. Primary treatment was commissioned at Tahuna in February 1981. The Musselburgh Pumping Station was commissioned in 1908 and upgraded in 1952.

The Tahuna WWTP has been continually modified in order to refine and improve the degree of wastewater treatment and odour control at the plant. The improvements have included the installation of fine screens at the Musselburgh Pumping Station and, as a result, the decommissioning of the comminutors at the Tahuna site in 2001. The original biofilters were commissioned at Tahuna in January 1991.

In 2004, the DCC was granted resource consents for the staged upgrade of the Tahuna WWTP. Stage 1, completed in 2009, removed the discharge from the Lawyers Head outfall and directed the discharge of treated wastewater through a newly-constructed 1,100 m long ocean outfall which runs directly south of the Tahuna WWTP. The Stage 1 upgrade also included provision for the disinfection of the primary wastewater through dosing with hypochlorite, and upgraded the odour control facilities at the WWTP, principally by replacing the old biofilters with Biofilters 1 and 2.

The DCC has now completed Stage 2 of the planned upgrade of the WWTP, which includes the provision of secondary treatment required to meet the more stringent wastewater discharge standards which are specified in the wastewater discharge permit. At the completion of the current upgrade, the DCC will have invested about $110 million to ensure that the standard of wastewater treatment and air emission control meets the community's aspirations and resource consent conditions.

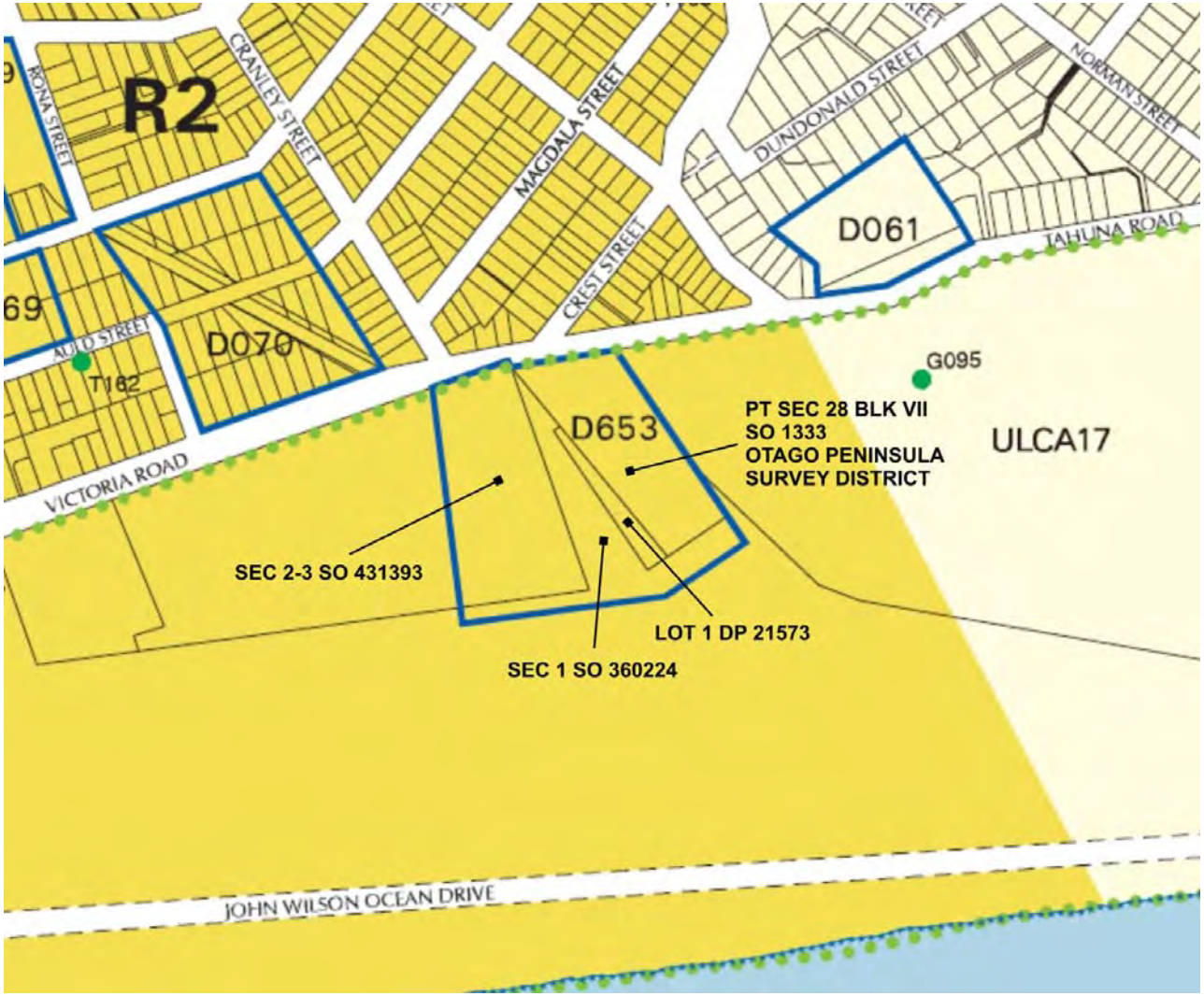

Figure 1: Property titles for the Tahuna WWTP site

4.3 Contribution of Tahuna Wastewater Treatment Plant to the Wellbeing of Dunedin

As discussed earlier, the collection, treatment and disposal of wastewater is a core function provided by the DCC. During 2001 – 2002, a 70-strong working party, including members of the public, DCC staff, neighbours, consultants and iwi met regularly to discuss options for improved wastewater treatment. The result of consultation and the consent process was a 2-stage upgrade which included an ocean outfall, an improvement in treatment from primary to secondary and UV disinfection. The upgrade also included improved odour control and increased reuse of wastewater biosolids at the Green Island WWTP to generate gas and electricity.

The key benefits of the upgrade to the Dunedin community are:

- the Stage 2 upgrade will result in the discharge of wastewater with lower levels of organic load, suspended solids and pathogens with a corresponding reduction in the potential adverse impacts on coastal water and its users;
- relocation of the discharge point from Lawyers Head to the ocean outfall results in improved dispersion and all but eliminating wastewater and odour effects at Lawyers Head;
- improved capture and treatment of wastewater treatment odour; and
- reuse of Tahuna biosolids at the Green Island WWTP to produce gas and to generate electricity.

5. Resource Consents

5.1 Existing Resource Consents

The DCC holds a number of resource consents associated with the Tahuna WWTP. These are listed in Table 1 and include the air discharge permit (2002.625), the subject of this application plus permits for the treated wastewater discharge to the Pacific Ocean through an 1,100 m ocean outfall and permits for the contingency discharge of treated wastewater at Lawyers Head. A separate air discharge permit (2002.626) authorises the discharge of odour from surge vents and portals associated with the wastewater discharge at Lawyers Head.

The existing air discharge permit for the Tahuna WWTP was granted for a relatively short period of 10 years because the future nature of the discharges to air from the Tahuna WWTP, and the treatment processes to be utilised, would not be known until decisions had been made in relation to the nature of secondary treatment and biosolids management that were going to be installed at the site. That assessment is now complete for both the wastewater and biosolids. In relation to biosolids management and treatment, the DCC has decided to dewater biosolids on site, incinerate about 50% on site, transport 30% directly to the Green Island WWTP digester and transport the final 20% to the Green Island landfill.

The existing air permit is subject to a number of conditions including:

Table 1: Tahuna Wastewater Treatment Plant – Existing Resource Consents

Consent No.	Purpose	Issued	Expiry
2002.621	Occupy coastal marine area with offshore outfall structures	22-10-2004	22-10-2039
2002.622	Erect structures, disturb foreshore and seabed for purpose of installing offshore outfall	06-10-2004	3 years & 6 months from commencement[1]
2002.623	Discharge 600 l/s (dry weather flow) and 4,000 l/s (wet weather flow) of treated wastewater to Pacific Ocean from offshore outfall	06-10-2004	30-06-2032
2002.624	Discharge 600 l/s (dry weather flow) and 4,000 l/s (wet weather flow) of treated wastewater to Pacific Ocean from twin outfalls at Lawyers Head for contingency disposal	06-10-2004	30-06-2032
2002.625	Discharge to air odours from primary treatment of wastewater and products of combustion for purpose of operating a sewage sludge incinerator and treating sewage at Tahuna WWTP	22-10-2004	30-06-2013
2002.626	Discharge contaminants to air, namely odour, from surge vent and portals associated with wastewater discharge at Lawyers Head	22-10-2004	30-06-2032

1 now expired

- no noxious, dangerous, offensive or objectionable odour effects outside WWTP property boundary;
- three yearly community odour assessment surveys;
- maintenance of complaint register and notification of ORC;
- adoption of best practicable option (BPO) to avoid or mitigate potential adverse effects from air discharges, particularly odour discharges;
- incinerator contaminant discharge limits;
- annual incinerator discharge monitoring;
- review of conditions by the consent holder;
- review of conditions by the consent authority.

The results of community odour surveys and incinerator monitoring are reported in detail in the Golder technical assessment appended to this application (Appendix 3). Community odour surveys were undertaken in 2005, 2008 and 2011 and showed some odour impacts close to the Tahuna WWTP but little impact further than 500 m from the plant. Incinerator discharge monitoring showed general compliance with incinerator discharge consent limits. Two minor exceedances were recorded for NO_x discharges and three exceedances were recorded for mercury discharges from 2005 – 2007. Recent mercury discharges have been well within the consent limits. Recent monitoring of biofilter discharges shows that discharging incinerator emissions through the biofilter noticeably reduces the discharges of contaminants to air.

The DCC has maintained a complaint register as required and this information is reviewed in the Golder technical assessment. However, during the community consultation undertaken for this application, it became apparent that odour complaint records were not complete, particularly for 2010, 2011 and 2012. The DCC acknowledges this deficiency and has improved its complaint recording system. One deficiency appeared to be that multiple complaints, made to the general DCC contact telephone number, about the same odour incident were not all recorded. The DCC accepts that all complaints should be recorded. The DCC will also include a category for "comments" about environmental performance, including odour emissions, so that this category of community feedback is also recorded. On occasions some residents wished to make a comment about WWTP operations rather than a formal complaint.

One of the conditions in the existing air discharge permit also requires the adoption of BPO to avoid or mitigate potential adverse effects from air discharges. The DCC regards the assessment of air emission and odour emission control and treatment options for the current WWTP upgrade to have been instrumental in satisfying this requirement to adopt BPO. The original assessment was undertaken by CH2M Beca and MWH and independently checked by Golder Associates (NZ) Ltd for this application. Further details on the achievement of BPO for odour control are included in the Golder technical assessment and later in this document.

5.2 Resource Consent Sought

This application is to renew existing air discharge permit 2002.625 issued by the ORC on 22 October 2004 and due to expire on 30 June 2013. The DCC seeks a

permit which will authorise all emissions to air from the Tahuna WWTP site including odour, aerosols and combustion contaminants from a biosolids incinerator. The emergency generator, established to ensure sufficient power for essential WWTP operations should the external power supply fail, meets the conditions of permitted activity Rule 16.3.4.1 (Otago Air Plan) and therefore does not need resource consent.

The overall status for this application for discharges to air from the Tahuna WWTP is **discretionary**. The Golder planning report and Section 12 of this document explains this in further detail.

The DCC has considered possible alternative locations and methods of this discharge to air as required in Schedule 4 of the RMA. Alternatives were considered during the design of the WWTP upgrade and during the independent technical assessment carried out for this application by Golder. The assessment included with this application has considered alternative methods of odour and particulate emission control and alternative biosolids disposal options. These are discussed later in this application.

The location of the discharges to air is determined by the location of the WWTP operation which in turn is determined by the location of the wastewater reticulation and the location of the ocean outfall. The assessment of options to upgrade the wastewater treatment plant confirmed that the upgrade should occur at the existing Tahuna WWTP. The rateable capital value of the Tahuna WWTP site is $14,860,000 as at 1 July 2010 while the replacement value of the WWTP is $165,000,000.

5.3 Term of consent

The DCC seeks a consent term of 35 years for this application. The DCC considers that a 35 year term is reasonable in this case because:

- RMA provides for a maximum term of 35 years;
- the DCC and the Dunedin community are entitled to long term security because of the substantial and ongoing investment in wastewater treatment at this site;
- air emission control and treatment capacity provided by the $110 million WWTP upgrade represents best practice for comparable WWTP systems;
- the upgrade will allow all emissions generally to meet relevant regional and national standards and guidelines;
- community consultation has indicated a low level of concern regarding the renewal of the air discharge permit although some nearby neighbours requested improvements in odour control and odour complaint record-keeping;
- iwi indicated “no specific issues/concerns” during preliminary consultation but they wished to be kept informed;
- this application meets all relevant statutory requirements;

- the DCC proposes a review condition which will allow for the ORC to review consent conditions during the term of the permit if the exercise of the permit causes adverse effects that require additional mitigation.

6. Description of Tahuna Wastewater Treatment Plant Operation

6.1 Overview

Wastewater arrives at the Tahuna WWTP from the Musselburgh Pumping Station which is approximately 0.5 kilometres northwest of the Tahuna WWTP. The raw inlet wastewater is made up primarily of municipal sewage with a small proportion of industrial waste. It is coarsely screened at the Musselburgh Pumping Station, prior to being finely screened at the Tahuna WWTP. The layout of the up-graded WWTP is shown in Figure 2. The wastewater treatment process at Tahuna includes the following key elements:

- fine screening of inlet wastewater
- grit removal and high-rate activated sludge (HRAS) process
- HRAS Effluent Discharge (HED) sump
- aerobic biological trickling filtration (BTF) and sump
- ultra-violet (UV) disinfection
- outfall flush chamber
- outfall pump station and Papatuanuku Junction Chamber (PJC)
- biosolids dewatering and incineration
- emergency generator
- four odour control biofilters and associated fans and ventilation system.

A flow diagram showing the wastewater treatment process is provided in Figure 3 and Appendix 4 provides selected photographs of the WWTP**.** As the wastewater reaches each successive stage of the treatment plant it becomes increasingly treated and therefore has a decreasing potential to create odour or pathogenic aerosols. The remainder of this section provides some details of the individual process stages. Further details are provided in the Golder technical assessment.

6.2 Screening

The Musselburgh Pumping Station supplies coarsely screened (25 mm) wastewater to the Tahuna WWTP. This inlet wastewater is then finely screened through three 2 mm screens to remove solids larger than 2 mm. The solids are screw conveyed from the screening building and discharged to skips. The air discharges from screening includes odourous gases, such as hydrogen sulphide (H_2S), and aerosols that may contain pathogens.

Figure 2: Tahuna WWTP site layout

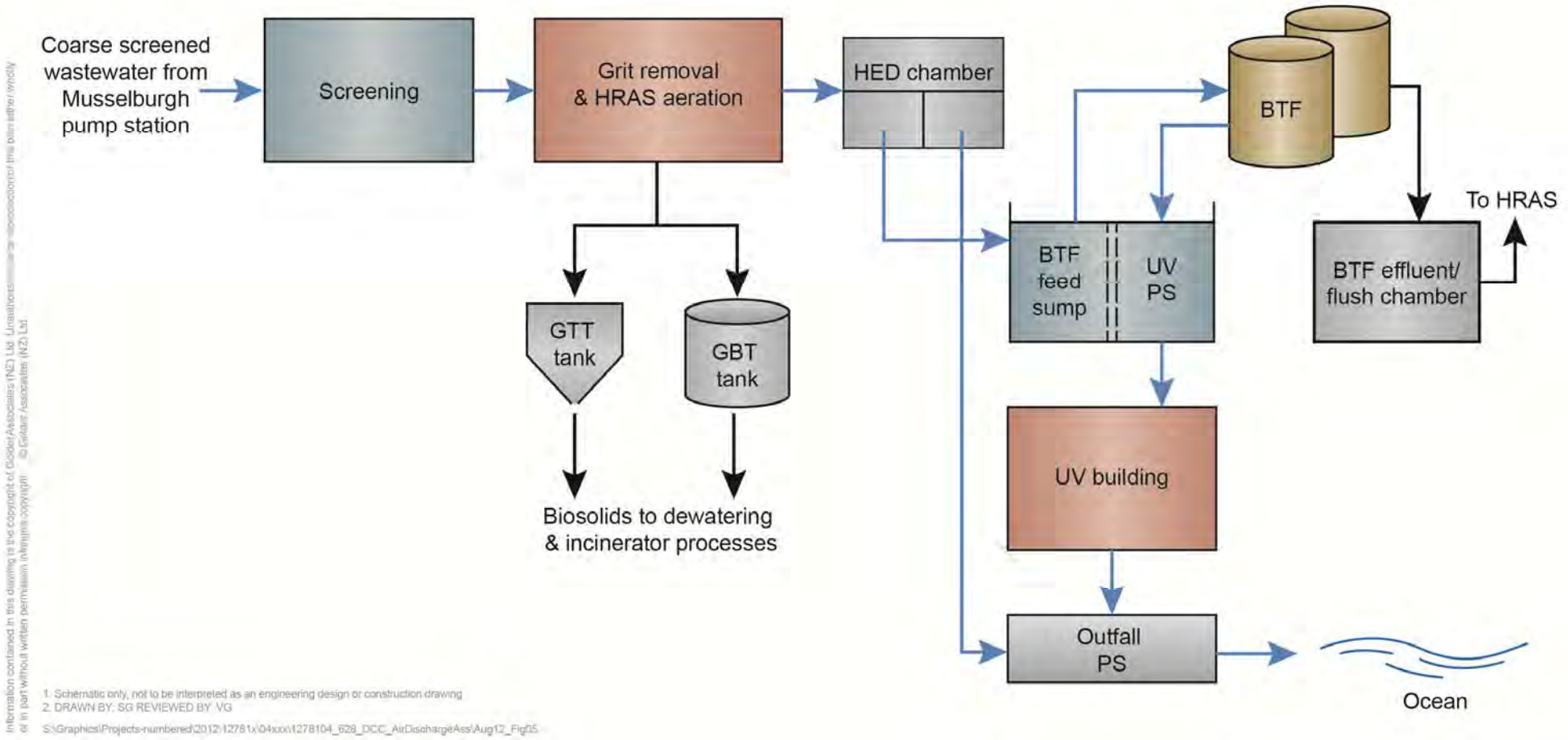

Figure 3: Tahuna WWTP process

6.3 High Rate Activated Sludge (HRAS)

The three existing primary sedimentation tanks have been retrofitted to become a high-rate activated sludge (HRAS) process. The HRAS tanks have an initial grit removal zone followed by a high rate aeration section and then a clarification zone. Fine bubble diffusers are used within the high rate aeration section of the tanks. The initial grit removal and aeration stages of the tanks are enclosed by covers that extend to the clarification stage of each tank. Air emissions are contained by targeted extraction of air from odour sources and are vented to the biofilter system. The clarification stage follows the aeration stage where the tank surface is uncovered. There is minimal odour from this section of HRAS tanks.

The HRAS effluent overflows via a covered weir into a covered effluent collection channel that runs along the end of each of the three HRAS tanks. The channel is also covered and ventilated to the biofilter system.

6.4 HED Chamber

The HED chamber receives the HRAS effluent as well as any by-pass flow (during high rainfall events) and directs up to 1.4 m^3/s to the two Biological Trickling Filters (BTFs). High rainfall flows pose a low odour potential.

6.5 Biological Trickling Filters (BTF)

The BTFs consist of two 37 m diameter covered tanks, each containing 4 m deep packed beds of plastic media. Effluent from the HRAS is recirculated through the beds and aerobic conditions are encouraged by the forced down-drafting of air. Biofilms develop on the plastic media which absorb and degrade further organic content within the wastewater. Unpleasant sewage odours and aerosols are produced by the BTFs but these are extracted from the lower levels of the BTFs and discharged to the new biofilter system (Biofilters 3 & 4).

6.6 BTF Sump

The BTF sump has several chambers which are all covered and extracted to a new biofilter treatment system.

6.7 Ultraviolet Disinfection

Disinfection of the treated wastewater prior to discharging to the ocean outfall will be carried out using submerged UV irradiation. Previously disinfection was via a chlorine contact tank. Odour associated with wastewater at this stage of the treatment process is expected to be relatively low and building air is vented directly to atmosphere.

6.8 Outfall Flush Tank

The outfall flush tank is filled over a period of two hours and has an estimated volume of 2,200 m^3. This volume is released to the ocean outfall over a 10 minute

period during night time hours when inlet flows are relatively low. Air that is displaced from the tank during filling is discharged through a carbon filtered air vent. The outfall flush tank is also extracted to the existing biofilter system.

6.9 Outfall Pump Station and Papatunuku Junction Chamber

Following UV disinfection, the treated wastewater flows to the Outfall Pump Station and Papatuanuku Junction Chamber (PJC) which discharges treated wastewater to the new ocean outfall. Air is extracted from the Outfall Pump Station and PJC to the existing biofilter system.

6.10 Wastewater Solids Processing

The upgrade of the WWTP and improved treatment will increase the volume of biosolids that need to be processed. The incineration of thickened biosolids from the gravity thickener tank (GTT) will continue, as will the use of the existing Dewa Belt Press and biosolids load out and export from the site. There will also be a new biosolids dewatering and storage system that allows for biosolids dewatering, load out and export from the site.

Dewatered biosolids that are exported from the site are sent to the Green Island WWTP or landfill for anaerobic digestion and subsequent biogas production. In both cases, biosolids are being used to generate electrical power for the Green Island WWTP with some exported to the national grid.

6.11 Biosolids Incineration

The existing biosolids incinerator is a Dorr Oliver fluidised bed system using sand as the solid fluidising medium that operates at a nominal combustion temperature of 830°C. Figure 4 provides a schematic of the incinerator system and downstream exhaust cooling stages. The nominal biosolids incineration rate is 30 tonnes/day of dewatered biosolids at around 25 wt. % DS (dry solids). The plant currently operates for approximately 16 hours per day, five days per week.

It is proposed that the hours of incinerator operation will increase to 24 hours per day, seven days per week, in order to process the increased volume of biosolids. The instantaneous biosolids feed rate to the incinerator will remain the same.

The incinerator is shut down for approximately four weeks per year for annual maintenance. During this period all biosolids are trucked to the Green Island landfill and Wastewater Treatment Plant.

The cooled incinerator exhaust stream discharges to Biofilters 1 & 2 extraction system. The incinerator exhaust stack normally operates at a vacuum indicating the combustion exhaust is being effectively extracted to the biofilter system and not discharging to atmosphere via the vertical duct. DCC alarms the stack vacuum to provide confirmation that incinerator emissions are not discharging directly to the atmosphere.

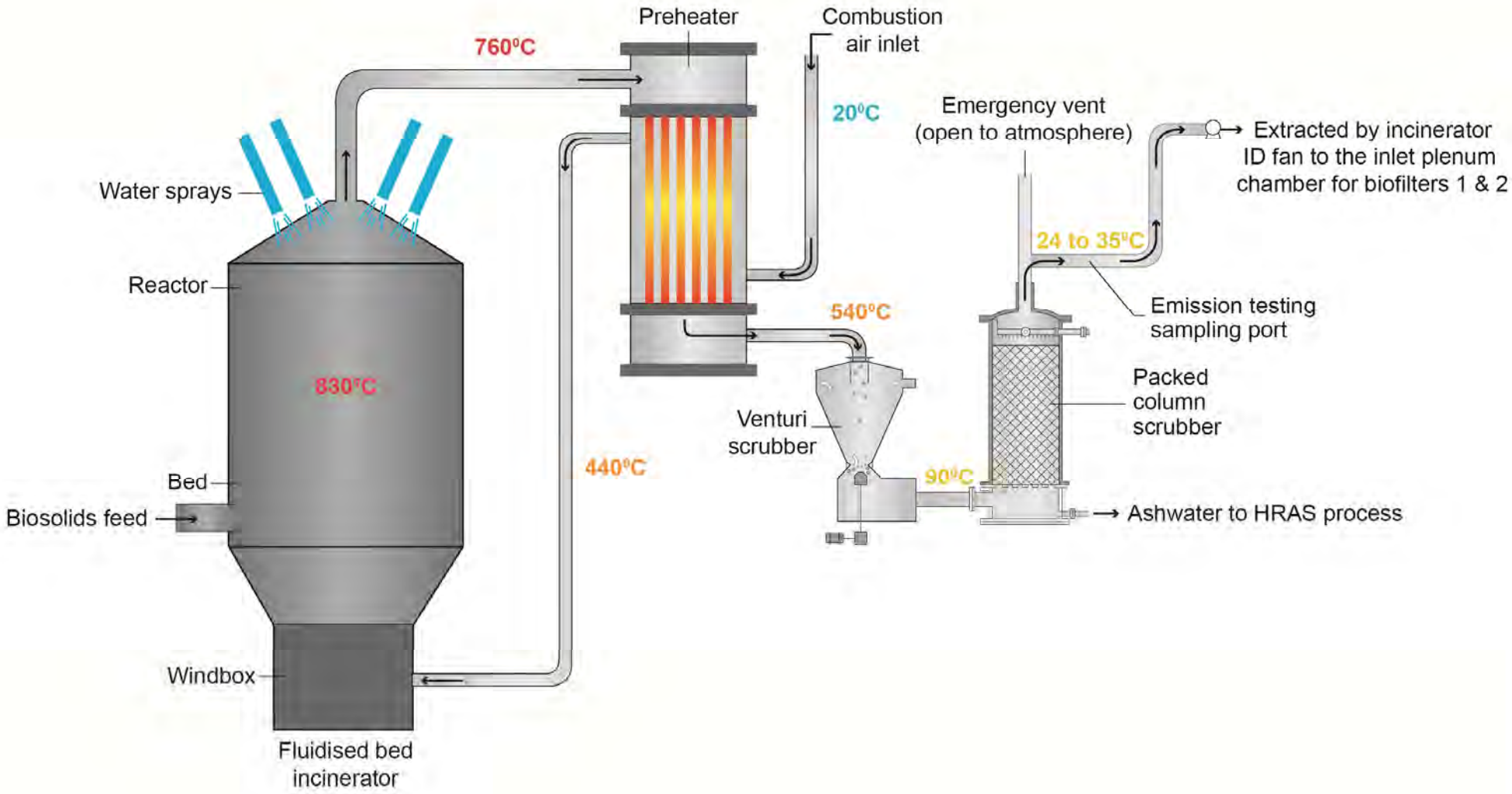

Figure 4: Biosolids incinerator plant schematic diagram

6.12 Solids Dispatch Building

The solids dispatch building adjoins the inlet sewage screening building and the new biosolids processing building. Biosolids collection trucks and smaller skip pick-up trucks periodically enter the building to remove loads of biosolids, or pick up and remove the skips from the site. The skips and biosolids hopper are a potential source of fugitive odour and mitigation of these is discussed in detail in the Golder technical assessment.

6.13 Biofilter Systems

There are four biofilter beds operating following the site upgrade (that is Biofilters 1 & 2 and Biofilters 3 & 4). The existing Biofilters 1 & 2 treat odorous air streams from sources that existed prior to the upgraded WWTP, including the screening area, the HRAS building and tanks. The 1400 m² southern biofilter bed (Biofilter 2) was commissioned in November 2007, while the 1400 m^2 northern biofilter bed was commissioned in May 2008 (Biofilter 1). They are relatively new and designed to treat up to 32 m³/s of contaminated air.

A new biofilter that has two isolated beds (Biofilters 3 & 4) has been constructed to treat the air from the new sources of odour resulting from the upgrade of the WWTP. These include the biosolids dewatering building, BTFs, BTF feed and flush sumps, UV channels and new biosolids storage tanks (GBT and TWAS). Biofilters 3 & 4 have a collective area of 1600 m^2 and media depth of 1.5 metres. These are designed to treat up to 25 m^3/s of contaminated air.

These biofilter systems are the main sources of air discharge from the WWTP site as all key air discharge sources are extracted and discharged via these systems.

6.14 Emergency Power Generation

In the event of interruption to the power supply to the site, an on-site standby electricity generator will provide power to essential services. The 1 megawatt (MW) diesel powered generator is sufficient to keep essential services operating, such as the odour control system and pumps, but would not support ongoing incineration as well. The emergency generator and incinerator would not operate at the same time. The generator requires periodic testing for one to two hours per month. The discharge of exhaust air from the generator will be infrequent and for short periods and will include PM_{10} and NO_2. The discharges to air from the standby diesel generator are a permitted activity under the Otago Air Plan.

7. Air Discharges from Tahuna Wastewater Treatment Plant

The key air discharges from the Tahuna WWTP are odour and combustion contaminants from the existing (1 & 2) and new (3 & 4) biofilters, emergency power generator combustion emissions and fugitive emissions. The key contaminants are odour, total suspended particulate (TSP), fine particulate (PM_{10}), nitrogen oxides (NO_x), mercury and dioxins. Sulphur dioxide emissions from the Tahuna WWTP are negligible and are not considered further. Discharges from the emergency generator meet the permitted activity requirements of the Otago Air Plan.

7.1 Biofilters

All of the treatment process discharges are extracted to the biofilters which predominantly treat odorous contaminants. The "typical" odour discharged from a correctly sized and operated biofilter is a musty, bark, earth type character that does not persist for more than 50 metres from the bed under most conditions. Odour emissions have been measured from the existing Biofilters 1 & 2 and are consistent with normal emissions from an effective biofilter.

Only Biofilters 1 & 2 receive combustion contaminants from the biosolids incinerator exhaust. Contaminant discharges from the incinerator and the existing Biofilters 1 & 2 have been measured. The contaminants included were total suspended particulate (TSP), nitrogen oxides (NO_X), mercury and dioxins. The average measured concentration of PM_{10} from the biofilters is well below the typical PM_{10} emission concentration from a solid fuel boiler fitted with a baghouse to control emissions. Furthermore, the measured dioxin discharge is well below the European Union directive for incineration of solid waste.

7.2 Fugitive Emissions

The wastewater treatment processes have air emissions extracted either directly from equipment or indirectly via building air extraction. Fugitive emissions of odour that have the potential to escape the air extraction systems are listed below.

- Emissions from trucks leaving the site with biosolids or screenings.
- Fugitive emissions from process buildings especially during windy conditions.
- Fugitive emissions from the incinerator building and associated biosolids belt press units.
- Fugitive emissions from the new biological trickling filters and associated feed and flush sumps.
- Wastewater pump stations and outdoor biosolids storage tanks.
- Air leaks from pressurised section of ducts supplying air to the biofilters, or from leaking fan seals.

8. Assessment of Effects on the Environment

This section is a summary of Sections 2, 6, 7 and 8 of the Golder technical assessment provided in Appendix 3.

8.1 Receiving Environment

8.1.1 Nearby Sensitive Activities

The WWTP is bounded by residential housing to the north and recreational land, including a bowling club, golf club, croquet club, scout hall and playing fields on its western, eastern and southern boundaries. Approximately 1,350 residences are located within 1,000 m of the site to the north of the WWTP. The nearest residence is approximately 30 m from the site boundary, but over 100 m from wastewater processes that are housed at the site. The surrounding residential area includes three schools. Other facilities within the area include the Dunedin Holiday Park, the Andersons Bay Cemetery, and the Andersons Bay Crematorium.

8.1.2 Background Air Quality

There are no other significant background sources of environmental or industrial odour within the area, except for the incoming wastewater system and Musselburgh Pumping Station which is well enclosed and its air extracted to an efficient biofilter system. There are moderate levels of combustion-derived air contaminants due to background sources. The background combustion sources include motor vehicle and domestic burning emissions.

8.1.3 Respirable Particulate Matter (PM_{10})

Measurements of PM_{10} have been made by the ORC at Macandrew Road in South Dunedin. The ORC operated a PM_{10} monitoring station at this location from May 2007 to April 2009. During this period there were three 24-hour measurements that exceeded 50 micrograms per cubic metre (µg/m³). Two occurred during the winter of 2007, being 63 µg/m^3 and 51 µg/m³, and the other occurred in the winter of 2008 with a value of 64 µg/m^3.

The annual average PM_{10} concentration over the period May 2007 to April 2009 was 19 µg/m³. No PM_{10} monitoring has been reported for the South Dunedin site since 2009. The Otago Air Plan, through the explanation to Policy 9.1.1, confirms that the Air Zone 2 (South Dunedin) airshed exceeds the NES air quality standard for PM_{10}. This airshed is a “polluted airshed” as defined by Regulation 17 of the NES.

8.1.4 Nitrogen Dioxide

The ORC conducted monitoring of NO_2 at its Central Dunedin monitoring site at Albany Street and found that NO_2 was much lower than the ambient air quality guideline (AAQG) of 100 µg/m³ (24-hour average).

8.2 Assessment Methodology

Golder completed a detailed independent technical assessment which is appended to this application (Appendix 3). The methodology used for this technical assessment included a review of odour and aerosol extraction design, extraction flow rates and

biofilter design and operation. Golder systematically checked extraction and treatment arrangements for each part of the wastewater treatment process.

Assessment of incinerator exhaust gases discharged through the biofilter was carried out using a dispersion modelling approach with a high resolution meteorological dataset and using monitoring data for incinerator and biofilter emissions. A dispersion modelling assessment for the emergency generator is also provided even though the generator discharges are a permitted activity under Rule 16.3.4.1 of the Otago Air Plan.

Golder assessed odour and combustion discharges against the relevant criteria such as the odour FIDOL factors (frequency, intensity, duration, offensiveness and location) for determining if odour emissions were likely to be "objectionable or offensive", and the NES, AAQG and RAAQG. These are detailed in Section 12 (statutory assessment) of this document and in the Golder technical assessment.

8.3 Odour Extraction and Biofiltration

Golder reviewed the specific air extraction points and flows associated with each processing and pumping stage of the wastewater treatment process. The effectiveness of the design for containing odour and aerosol emissions was assessed along with a review of extraction flows provided in the original design by Beca. The following areas of the WWTP were assessed in detail:

- Inlet sewage screening building
- HRAS building
- Biosolids dewatering building and biosolids tank
- Gravity tank thickener and building
- Biosolids incinerator and belt presses
- Dewa belt press
- New solids collection and despatch area
- Wastewater chambers and pump stations
- Biological trickling filters
- Biofilters

Overall, Golder found that the extent of process enclosure, air extraction rates and biofilter treatment capacity at the upgraded Tahuna WWTP represented best practice and that these systems would be superior to those typically found in comparable WWTP systems throughout Australasia. Generally, air extraction rates from targeted components of the wastewater treatment process e.g. screens, tanks, dewatering equipment and BTFs and from buildings are sufficient to ensure all odourous air is removed for biofilter treatment. If, as a result of process or environmental monitoring, additional extraction is required then Biofilters 3 & 4 have 4 m^3/s of spare capacity.

8.4 Assessment of Potential Odour Effects

Golder has assessed the historical, existing and future potential for odour effects by the use of community feedback, downwind assessments and odour control system review.

8.4.1 Complaint Records

The DCC has recorded 49 odour complaints in relation to the Tahuna WWTP since 2000. Feedback from a recent community meeting however indicated that some odour complaints during 2010, 2011 and possibly 2012 were not recorded. As a result of this feedback, the DCC has implemented measures to ensure the complaints recording system records all complaints that are received. Despite these recent limitations, the available complaint records since 2000 are useful and have been reviewed for this assessment.

An analysis of the complaints indicates the following:

- Complaints mainly occur from locations immediately adjacent to the WWTP, and predominantly from the golf course to the south of the plant.
- Approximately 35 % of complaints were not linked to a particular source or process condition upset.
- Prior to 2004, approximately 24 % of complaints received may have related to the operation of the biofilter. This has reduced to one complaint possibly relating to the biofilter since 2004. It is noted that the biofilters were refurbished between 2006 and 2008.
- Other complaints relate to effluent wells, biosolid conditions, maintenance issues, open plant doors, or other operational plant issues.
- Existing biofilter emissions do not appear to be causing odour complaints.
- Odour was noticed during commissioning in July 2012 when the TWAS and GBT tanks had no extraction.

8.4.2 Odour Surveys

Odour surveys are used to measure “population annoyance” from various sources of environmental odour. Information is collected via telephone, or face to face surveying of people who live or work in an area. The method is described in the Ministry for the Environment Good Practice Guide for Assessing and Managing Odour in New Zealand (MfE, 2003). Odour surveys were carried out during March 2005, March 2008, and March 2011.

In 2011, within 200 m of the plant, 44 % (± 15 %) of the population was annoyed by odours and attributed them to the WWTP. This estimate has a relatively large uncertainty because the sample size was small, but indicates a moderate odour effect close to the plant. As the distance of a residence from the site increases the percentage, “at least annoyed” decreases. Between 200 - 500 m there is a minor level of annoyance and for the area beyond 500 m the level of annoyance is within the background/control level.

8.4.3 Downwind Odour Assessments

Golder also made observations downwind of the current WWTP operation during June and August 2012. On both occasions no odours were discernible. In spite of

this, the DCC have procedures for undertaking routine boundary assessments to check for odour from the site. This includes monitoring ambient H_2S levels.

8.4.4 Future Odour Effects

Golder expects the operation of the upgraded WWTP and the associated targeted emissions extraction system to make a reduction in the potential for odour exposure off site. This relies upon the effective management of the air extraction and biofilter systems that have been installed as part of the WWTP upgrade. The effective management of these mitigation systems is underpinned by the use of an effective Air Discharge Management Plan (ADMP). Golder concluded that WWTP air emissions are likely to cause only minor effects on the surrounding community provided the ADMP is implemented and odour control systems are operated effectively.

8.5 Assessment of Combustion Air Discharges

The assessment of incinerator exhaust gases discharging through the biofilter has been carried out using dispersion modelling. Respirable particulate (PM_{10}), nitrogen dioxide (NO_2), mercury and dioxin exposures were assessed.

8.5.1 Respirable Particulate (PM_{10})

The maximum predicted offsite **24-hour** average PM_{10} GLC from the biofilter is 12 µg/m³, which is predicted to occur immediately to the southeast of the site and in a small area at the site boundary and on the adjacent golf course. This maximum concentration is predicted immediately adjacent to the biofilters. Golder considers that dispersion modelling is likely to have over predicted GLCs at this "near-field" location. Furthermore, people would not be exposed at this location for 24-hours which is the relevant averaging period for the NES.

Beyond the small area of impact to the south east corner of the site, the maximum GLCs quickly reduce to below 5 µg/m³. Within 150 m of the south east site boundary, the concentrations reduce to 3 µg/m³. To the north of the site over the residential area where people may be exposed for a 24-hour period, predicted GLCs are less than 2 µg/m³. Such low concentrations are not considered significant.

Allowing for a background concentration of 38 µg/m³ for 24-hour average PM_{10}, the cumulative PM_{10} GLCs due to combustion emissions from the biofilters are not likely to cause any significant change to background concentrations, nor are they likely to cause the NES for PM_{10} to be breached on high pollution days in Dunedin. Background concentrations of PM_{10} are sometimes above the RAAQG of 30 µg/m³, especially on cold still days. However, the site discharges are likely to make no measureable impact on ambient PM_{10} in the surrounding Tahuna area on such days. The only prospect of biofilter emissions causing a measurable increase in ambient PM_{10} is within a very localised and small area adjacent to the southern boundary. This will not cause measureable increases in airshed PM_{10} concentrations.

The maximum predicted **annual** average PM_{10} GLC from the biofilter is approximately 2.5 µg/m³, which occurs immediately to the southeast of the site over

the golf course. Concentrations over residential areas are typically less than 0.2 µg/m³.

Allowing for an annual background concentration of 19 µg/m³, the predicted cumulative impacts just exceed the AAQG of 20 µg/m³ over a highly localised part of the golf course to the south of the site and are just below the AAQG to the north over the residential area. Although the annual average background concentration of 19 µg/m³ is already very close to the AAQG, the contribution from the site, especially over areas where people are likely to be exposed, is very small and considered to be not significant.

8.5.2 Nitrogen Dioxide (NO_2)

The maximum predicted offsite **1-hour** average NO_2 GLC from the biofilter is 70 µg/m³, which is predicted to occur immediately over a small area at the southeast boundary of the site over the golf course. Beyond this small area of impact, the maximum 1-hour GLCs quickly decrease to below 30 µg/m³.

To the north of the site over the residential area where people may be exposed for a 1-hour period, predicted GLCs are less than 25 µg/m³. Allowing for a background of 29 µg/m³, the cumulative impact of NO_2 emissions from the biofilter will not approach the RAAQG of 130 µg/m³.

The maximum predicted offsite **24-hour** average NO_2 GLC from the biofilter is 24 µg/m³, which is predicted to occur in approximately the same location as for the maximum 1-hour GLC. People would not be exposed at this location for 24-hours (the relevant averaging period for the NES) and so impacts further away are more appropriate to consider. The GLCs at the residential area to the north are predicted to be less than 4 µg/m³. This is a small proportion of both the AAQG and the RAAQG. Allowing for a background of 29 µg/m³, the maximum offsite cumulative 24-hour GLCs will be just below the RAAQG of 60 µg/m³.

8.5.3 Ambient Mercury

The peak predicted annual average GLC of mercury is 0.002 µg/m³. This concentration is less than 1% of the AAQG for mercury of 0.3 µg/m³. This peak concentration occurs in the same localised area as the peak annual average PM_{10} concentration. Concentrations are predicted to be below 0.00014 µg/m³ in residential areas which is far below the AAQG.

8.5.4 Dioxins and Furans

The cancer potency from exposure to dioxins is estimated from the Lifetime Average Daily Dose (LADD) to dioxins and furans. The approach for calculating this and subsequent cancer risk is detailed in Appendix C of the Golder assessment. The cancer risk was found to be negligible. The potential for non-cancer effects due to inhalation is also extremely low when compared to guideline values.

Golder estimated annual average and maximum dioxin concentrations for areas where there are residential dwellings and found that the exposure value was well below the WHO guideline value and the MfE's unofficial guideline.

9. Assessment of Alternatives

9.1 Wastewater Treatment and Biosolids Disposal

As discussed earlier, the DCC is required to provide an effective and safe wastewater collection, treatment and disposal system for Dunedin City. Furthermore, the residents of Dunedin have indicated to the DCC that any wastewater treatment system should be reliable, efficient, cost-effective, odour-free and with minimal effects on the environment. The DCC also considers that it has a duty to maximise the use of existing assets and avoid any unnecessary capital expenditure on new assets. This is an important objective when considering alternatives.

The nature and location of air discharges associated with the Tahuna WWTP have been largely determined by the $110 million WWTP upgrade required by the community consultation and resource consent process which concluded in 2004. These decisions determined that an ocean outfall, secondary treatment and disinfection would be established at the Tahuna site. In 2009, the DCC determined after a Project Design and Development Process (PDDP) involving consultants and staff that High Rate Activated Sludge (HRAS), biological trickling filters (BTF), UV disinfection, digestion of biosolids and drying be implemented as the wastewater treatment methods. These options were chosen because they achieved wastewater discharge resource consent requirements, could be completed on time, had low power use and carbon footprints and were sustainable.

Subsequent to these decisions the DCC became aware that cost savings could be achieved because on-site biosolids digestion and drying were not necessary and that a more affordable and still environmentally acceptable option was to use existing assets for biosolids disposal. The DCC has an existing purpose-built biosolids incinerator at Tahuna WWTP which is capable of longer operating hours, an existing digester at the Green Island WWTP which is not operating at capacity because of reduced wastewater flows in the Green Island catchment. Furthermore, the Green Island landfill has remaining capacity if required.

It is noted that an inevitable consequence of improved treatment of wastewater at Tahuna results in a greater volume of biosolids that require cost-effective and environmentally acceptable disposal. It is thus not practicable for pre-upgrade biosolids management systems to accommodate the increased biosolids volume without some increase or change to operations. Ideally, the greatest practicable proportion of biosolids are reused to extract energy and to save some of the energy costs associated with operating wastewater treatment plants.

The DCC has undertaken a number of reviews of biosolids management as the composition and quantity of biosolids requiring disposal has become clearer. To some degree, the actual quantity and composition of biosolids requiring disposal will not be known until the upgraded WWTP is fully commissioned. At this stage however, the DCC considers that the best practicable option for disposing of the anticipated volume of biosolids from the upgraded Tahuna WWTP is a combination of:

- upgrade the existing Tahuna WWTP biosolids incinerator to operate 24 hours per day, 7 days per week to reduce as much biosolids as possible to a small quantity of residual ash. This option can accommodate about 50% of the anticipated volume of Tahuna biosolids;

- maximise the use of the existing Green Island WWTP digesters to process additional biosolids from Tahuna to produce heat, gas and electricity that can be used to offset energy costs at both the Green Island and Tahuna WWTPs. This option can accommodate about 30% of the anticipated volume of Tahuna biosolids;

- send the residual biosolids from Tahuna directly to the Green Island landfill where it will aid future methane gas production;

- pipe collected methane gas from the Green Island landfill to power a new gas electricity generator located at the Green Island WWTP.

The DCC anticipates that all the above options will be required to dispose of the anticipated volume of biosolids. One or two options on their own will not be sufficient. The DCC will maximise the use of the Tahuna incinerator and Green Island digesters to minimise the use of the remaining capacity of the Green Island landfill.

The DCC has also considered alternative technologies for biosolids disposal such as the STERM (Sludge Total Energy Recovery Module) sludge drying process, Pacific Pyrolysis and EFI Sludge Dryer. These options have been rejected at this stage because they are either not proven at full scale, not practical or too expensive. The DCC has also discounted land-based disposal of Tahuna WWTP biosolids because there is no identifiable use for biosolids land application in the local area, little suitable nearby land, potentially high transport costs, a requirement to treat biosolids before land application and potential odour and water contamination issues.

9.2 Air Emissions

This section considers the air emissions that result from the upgraded Tahuna WWTP and assesses the proposed air emission mitigation measures and alternatives. This is based on the independent technical assessment carried out by Golder.

9.2.1 Extraction of Air Emissions

9.2.1.1 Odour and Aerosols

The DCC have implemented targeted extraction of emission sources plus supplementary building extraction at the WWTP. This approach is more efficient than only extracting building air with lower air extraction rates and electricity costs. Building air ventilation is applied to the HRAS, GTT and Biosolids Handling buildings and significant spare capacity is available within the system for increased extraction of existing sources or application to new sources of air emissions if required.

9.2.1.2 Incinerator Exhaust Extraction

Incinerator exhaust at the Tahuna WWTP is scrubbed, cooled and treated in two upgraded biofilters. Golder considers this to be very good practice and represents BPO in this circumstance. The incinerator exhaust discharge stack may need an emergency weighted cap, but this does not appear necessary at this stage given continuous vacuum monitoring and controls in place. The measurement and monitoring of the vacuum in the discharge duct is an effective means to confirm that all incinerator exhaust air is discharging to atmosphere through the biofilter system.

9.2.2 Odour Removal

The Golder assessment of the design air loading rates and biofilter bed design showed that routine elimination of discernible WWTP odours and aerosols will occur through the two biofilter systems. The continued high treatment performance of these systems is important to ensure that the site does not produce objectionable odour effects offsite and therefore monitoring and maintenance programmes need to be robust. The DCC has accepted the recommendation that key monitoring and maintenance procedures for the air extraction systems and the biofilters are documented and that these procedures are included in an air discharge management plan (ADMP). This plan will be prepared by 28 February 2013.

9.2.3 Incinerator Exhaust

The mitigation of incinerator emissions has been assessed by considering the type of pollution control equipment, the management and monitoring of that equipment and finally the environmental monitoring that the DCC undertakes.

Golder considers that the fluidised bed incinerator at Tahuna is one of the most common biosolids incinerators used world-wide and that it is the best practicable option (BPO) for the incineration of wastewater biosolids. The fine screening of wastewater prior to biological treatment and the methods employed to rapidly cool and filter the exhaust gas ensures that the production of dioxins and furans are at very minor levels that create negligible potential health risk.

The DCC undertakes significant monitoring at all stages of the incineration process to ensure optimal performance of the incinerator and associated pollution control equipment.

Golder has assessed the incinerator design and control measures against the relevant United Nations Environment Programme document and found that the Tahuna WWTP biosolids incinerator is generally consistent with Best Available Technology (BAT) requirements as outlined by UNEP.

Golder also considers that the system at Tahuna includes the correct type of incinerator and regular monitoring to ensure good combustion and appropriate flue gas treatment.

Fine screening of the wastewater before it enters the plant ensures that hazardous waste products (such as plastics) are not contained in the biosolids burnt in the incinerator. Furthermore, exhaust gases from the Tahuna WWTP incinerator undergo treatment beyond that normally required for biosolids incinerators. This is

because the incinerator exhaust gases are extracted to the existing biofilter system, which helps to further reduce the contaminant concentrations.

In summary, the Tahuna WWTP biosolids incinerator achieves or exceeds the requirements of BPO.

9.2.4 Best Practicable Option for Odour Control

Golder considers that the Tahuna WWTP has a high level of odour control and that it achieves BPO for wastewater treatment plants. All parts of the Tahuna WWTP process are extracted at source and/or the buildings are extracted to biofilters for treatment. It is more common for aerobic processing plants at municipal WWTPs to be open to the atmosphere but this does not occur at the Tahuna WWTP.

10. Monitoring

The DCC undertakes considerable environmental monitoring and this has enabled a robust assessment of the effects on the environment for this application. The DCC also undertakes considerable process monitoring so that its wastewater treatment and air emissions control processes operate appropriately. The DCC proposes to continue much of this monitoring. The detail of the process monitoring will be included in the Air Discharge Management Plan (ADMP) while the incinerator/biofilter emission monitoring and environmental monitoring will be specified in the air discharge permit.

Process monitoring (relevant to air emissions) is expected to include annual checks on air extraction flows, air extraction effectiveness, incinerator discharge stack vacuum monitoring, biofilter operating parameters, biofilter back-pressure trends and biofilter bed composition.

Incinerator/biofilter emission monitoring will include annual testing for particulates, heavy metals, dioxins and furans as currently occurs. This monitoring reflects the existing resource consent conditions and is detailed in the proposed consent conditions in Section 14. Regarding odour monitoring, Golder considers that the standard practice of odour complaint monitoring, recording and reporting follow-up actions provides adequate environmental effects-based monitoring for this situation. Further odour annoyance surveys should not be required given the level of odour control equipment and processes being implemented. If formal community feedback were required in response to odour complaints, then diary programmes and direct consultation can be implemented.

Odour diaries are used by people in affected communities to record their daily exposure to odour and are useful for collecting information on the frequency and strength of odour impacts at various locations. Further details on this method are provided in the Ministry for the Environment Odour Assessment and Management Guideline (MfE, 2003).

11. Consultation

The DCC recognises that community consultation is part of good practice in preparing significant resource consent applications. This section of the application describes the objective of consultation and details the consultation undertaken and its outcome. A description of the consultation undertaken is also a requirement of an AEE prepared under the RMA.

The objective of consultation was to identify interested and affected parties, inform them of the consent application, determine the issues or concerns of these parties, attempt to resolve these issues or concerns and, where appropriate, seek written support. The consultation programme, in this case, reflected the localised nature of potential adverse effects and built on the community newsletters distributed to neighbours to inform them of progress with the WWTP upgrade.

The consultation programme included the following:

- preparation of a draft project plan for the preparation of the application including consultation;
- consulting ORC on the draft project plan;
- consulting KTKO (Kai Tahu ki Otago) as agent of Te Runanga o Otakou;
- distributing a newsletter to all properties within 500 m of Tahuna WWTP informing them of the air permit application and inviting them to a community consultation meeting;
- forwarding letters to specific parties informing them of the air permit application and inviting them to the community consultation meeting;
- arranging a community consultation meeting, providing background information and requesting written feedback.

11.1 Otago Regional Council

DCC representatives met ORC on 11 June 2012 and outlined the draft project plan. Key points raised by the DCC were:

- the existing permit authorises emissions from primary treatment of wastewater and incineration of biosolids;
- the upgrade to the secondary treatment will begin operating before the new air permit is granted;
- the existing permit requires BPO for air discharges which is one of the outcomes of the current $110 million upgrade;
- Golder Associates (NZ) will undertake the technical assessment and will independently review the air emission design work undertaken by MWH and Beca;
- DCC will undertake full consultation including the nearby residential community and key organisations and a newsletter will be distributed and a community consultation meeting held;
- DCC will apply for a 35 year term;

The ORC sought clarification that the incinerator will continue to operate. The DCC explained that the emissions from the incinerator were first treated by two scrubbers and then discharged to air via the biofilters. The ORC acknowledged that the biofilters were the best form of odour control in this situation.

The DCC clarified that the primary destination of biosolids was incineration with approximately 50% of biosolids incinerated and 30% trucked to Green Island WWTP. The digester at Green Island produced methane from biosolids which was then combusted to produce electrical power. The remaining 20% of biosolids was disposed to the Green Island landfill.

The ORC confirmed that few complaints had been received regarding air emissions at Tahuna. It was confident in odour management at Tahuna and would focus its assessment on emissions from biosolids incineration. The ORC explained that emission standards from incinerators have tightened. Particulate (PM_{10}) standards were also important even if breaches of the NES in Dunedin (Zone 2) only occurred 3 – 4 times per year. The ORC recommended PM_{10} emission limit was 50 mg/m^3. The particulate concentration emission limit in the existing Tahuna WWTP air discharge permit is 30 mg/m^3.

The ORC confirmed that alternatives to biosolids incineration should be assessed in the application and the DCC explained that it planned to review options for biosolids disposal in 2013 – 2014. Apart from digesting biosolids to produce gas and then electricity there were few practicable alternatives to incineration.

The ORC confirmed that KTKO should be consulted as iwi representatives and that the crematorium should be considered for consultation.

11.2 Iwi

The DCC consulted KTKO on 3 August 2012 and provided a summary statement, existing air discharge permit (2002.625) and three recent Stage 2 upgrade community newsletters. The DCC outlined the draft project plan and in particular explained the components of $110 million wastewater treatment upgrade; the technical assessment methodology; and the proposed permit term of 35 years.

The DCC explained the operation of the Biological Trickling Filter (BTF) and odour control biofilter and further explained the fate of wastewater treatment biosolids. Biosolids are incinerated on site or trucked to Green Island where they are either fed into the digester to produce gas and electricity, or discharged to the Green Island landfill. An option for the future is to establish a digester on site at Tahuna.

It was agreed that KTKO would provide a preliminary statement on issues identified with the application after consultation with Otakou Runanga (Edward Ellison). A preliminary statement, dated 6 September 2012, was provided and is included in Appendix 5.

The preliminary statement from KTKO stated that “Te Runanga o Otakou have no specific issues/concerns at this stage, but do request to be consulted and informed of

the proposal as it develops". The preliminary statement went on to state that "Te Runanga o Otakou are encouraged to note that the proposed treatment for air discharge has the intention of no odour discharge".

11.3 Community Newsletters

The DCC has distributed community newsletters on the WWTP upgrade since September 2006. In total, 13 newsletters have been distributed with four from September 2006 to April 2008 focusing on upgrading Biofilters 1 & 2 and nine newsletters from May 2010 to July 2012 focusing on the stage 2 wastewater treatment upgrade and construction of Biofilters 3 & 4. These newsletters were delivered to all properties within 500 m of the Tahuna WWTP. The newsletter distribution area was expanded in September 2011 to include all properties around the Musselburgh Pumping Station. The newsletters have been well received by the community who have appreciated being kept informed of progress with the upgrade.

The DCC distributed a further newsletter in early October 2012 notifying residents of the preparation of an application to renew the existing air discharge permit for the Tahuna WWTP. The newsletter also invited residents to a community consultation meeting on 24 October 2012 and explained that background information would be provided as well as an opportunity to complete feedback forms. This newsletter was delivered to 622 properties covering the same area as the wastewater treatment upgrade newsletters. This area is shown in Appendix 6.

The distribution area includes all properties within 500 m of the Tahuna WWTP, including nearby recreational facilities and additional properties around the Musselburgh Pumping Station. The three community odour surveys undertaken for the Tahuna WWTP showed that very few residents are annoyed by Tahuna WWTP odours further afield than 500 m from the WWTP. This result supports the adequacy of the newsletter distribution area.

A number of specific organisations were also posted or emailed a copy of the community newsletter. These organisations are as follows:

- KTKO Ltd
- Public Health South
- Chisholm Park Golf Club
- Dunedin Holiday Park
- Tainui Sports Society Bowls & Croquet
- Westpac Bowls Stadium
- Dunedin Crematorium
- Ocean Beach Scouts
- St Kilda Bowling Club
- St Kilda Brass Band
- Albion Cricket Club Inc.
- Dunedin Technical AFC
- Otago Regional Council
- Dunedin City Council, Environmental Health.

11.4 Community Meeting

The DCC arranged a community consultation meeting at the local golf club on 24 October 2012. Five community members attended with three local sports clubs represented. The DCC explained the consent application process, details of the WWTP upgrade, recent coastal water quality (bacterial) monitoring and odour complaint records since 2000. There was some discussion regarding odour levels and odour complaint recording. Attendees at the meeting explained that on occasions odour levels were unreasonable at nearby properties, particularly at recreational facilities.

Attendees also questioned the odour complaint records particularly for 2010, 2011 and 2012. It appears that more odour complaints have been made than the number recorded by the DCC. The DCC apologised for not recording all odour complaints and undertook to investigate the cause for this and to improve the reliability of complaint recording. The DCC also apologised again for the short period of particularly offensive odours that occurred in July 2012. These odours occurred during the early commissioning of part of the biosolids dewatering and storage facility. An apology had been included in the July 2012 community newsletter.

The community consultation meeting also received a presentation on the independent technical assessment prepared by Golder. This presentation described the assessment methodology, odour sources, odour control and treatment and results of community odour surveys. Operation of the odour control biofilter and biosolids incinerator were also explained. Questions were asked regarding odour masking sprays, truck reversing alarms, biosolids disposal and publication of monitoring results.

All attendees were provided with a background information booklet and were asked to complete a feedback form. Three feedback forms were completed which indicated that attendees found the consultation meeting helpful, supported the granting of the air discharge permit but requested an improvement in odour control and an improvement in odour complaint recording. Attendees also requested that odour complaint recording procedures were clarified.

11.5 Outcome of Community Consultation

During the preparation of this resource consent application, the DCC consulted with the ORC, KTKO and the local community through community newsletters and a community consultation meeting. This consultation built on existing communications with ORC and KTKO and on newsletters which had been distributed regularly to the surrounding community since 2006 on the Tahuna WWTP upgrade. The ORC acknowledged that biofilters were the best form of odour control for the Tahuna WWTP. The ORC also pointed out that it would focus its assessment on incinerator emissions and thought that the assessment of alternatives to biosolids incineration was important. The ORC confirmed its recommended PM_{10} emission limit of 50 mg/m^3.

The DCC consulted iwi by meeting KTKO and outlining the consent application project plan. A number of details of the Tahuna WWTP were explained. After

consulting Te Runanga o Otakou, KTKO provided a letter confirming that Te Runanga o Otakou did not have specific issues or concerns at that stage but wished to be kept informed.

Since 2006, the DCC has distributed 13 newsletters to the community, within 500 m of the WWTP, regarding the Tahuna WWTP upgrade. In October 2012, a newsletter regarding this consent application was distributed to 622 properties within 500 m of the WWTP. This newsletter notified residents of the consent application and included an invitation to a community consultation meeting at the local golf club. Invitations were also sent to 14 organisations. The meeting was attended by five residents and sports club representatives. Three feedback forms were completed which indicated support for the granting for the air discharge permit but requested an improvement in odour control and an improvement in odour complaint recording.

Overall, there appears to be a low level of concern from the community regarding the granting of a replacement air discharge permit for the Tahuna WWTP.

12. Statutory Assessment

12.1 Introduction

Previous sections of this application have described the wastewater treatment process at the Tahuna WWTP, identified the discharges to air, assessed the effects of these discharges on the air environment, reviewed mitigation and monitoring and described consultation undertaken by the DCC. This section summarises each relevant planning consideration and then provides comment indicating how that consideration is satisfied. The DCC commissioned Golder to identify the relevant planning considerations for this application. Their report is included in Appendix 2 and forms the basis for this section.

12.2 Resource Management Act 1991 (RMA)

12.2.1 Overview

The RMA, and associated statutory documents, identify the circumstances where resource consents are required for an activity, as well as establishing the 'thresholds' that must not be contravened by an activity. This section identifies the provisions of the RMA that were assessed in relation to the air permit application for the Tahuna WWTP.

12.2.2 Part 2 Considerations

Part 2 of the RMA outlines the purpose and principles of the RMA. Section 5 states:

"(1) The purpose of this Act is to promote the sustainable management of natural and physical resources.

(2) In this Act, "sustainable management" means 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 reasonably 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 use of the Tahuna site for wastewater treatment and the granting of this air discharge permit is consistent with the purpose of the RMA. Treatment of Dunedin's wastewater at Tahuna, including the improvements made during the current upgrade (i.e. secondary treatment and disinfection of the wastewater), will enable the wider Dunedin community to provide for their social, economic and cultural wellbeing and for their health and safety. The improved collection and treatment of odour discharges through the four new biofilters enables the sustainable use of the air resource and will avoid almost all adverse effects on the surrounding community. The air discharges to which this application relates are an unavoidable consequence of the operation of the WWTP. The DCC is required to maintain the wastewater system under the provisions of the Local Government Act.

The efficient operation of the biosolids incinerator and associated emission control equipment and subsequent discharge through the biofilters avoids adverse effects on the environment, including potential health effects. Continued use of the biosolids incinerator is an efficient use of an existing physical resource and is an essential component of the methods used to dispose of an increased quantity of biosolids created by the improved treatment of wastewater.

Given these control and treatment processes, the life-supporting capacity of Tahuna's air resource is safeguarded and thus also sustained for future generations.

Section 6 of the RMA identifies matters of national importance which shall be 'recognised and provided for' while section 7 identifies matters which 'shall be had regard to' under the RMA. With regard to the discharges to air from the Tahuna WWTP, while there are no section 6 matters relevant to the activity the following section 7 matters are considered to be of relevance:

"(a) kaitiakitanga:

(aa) the ethic of stewardship:

(b) the efficient use and development of natural and physical resources:

(c) the maintenance and enhancement of amenity values:

(f) maintenance and enhancement of the quality of the environment:"

In addition, section 8 of the RMA requires *"all persons exercising functions and powers"* under the RMA to take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).

The DCC has consulted KTKO as agent of Te Runanga o Otakou who have kaitiakitanga over the Tahuna area. Iwi have indicated no specific concerns over the granting of this air discharge permit but wish to be kept informed. The DCC conducted an extensive assessment of wastewater treatment options before deciding on the current wastewater treatment upgrade at Tahuna. Assessment criteria included affordability, environmental care, sustainability, energy efficiency, achievement of community wishes and air emission and odour control. Of particular importance were the reduction of wastewater effects on the coastal environment and the reduction of air emission and odour effects on the local community. The treatment plant upgrade will result in better control and treatment of odour emissions. Iwi were consulted by the DCC during the decision-making on preferred wastewater treatment options. Upgrading the existing Tahuna WWTP is an efficient use of physical resources. Also, given the control and treatment processes in place for the discharges to air from the Tahuna WWTP, amenity values and the quality of the environment will be maintained.

12.2.3 Section 15 Considerations

Section 15(1) of the RMA states that no person may discharge contaminants to air, from an industrial or trade premise (section 15(1)(c)), unless the discharge is expressly allowed by a national environmental standard or other regulations, a rule in a regional plan as well as a rule in a proposed regional plan for the same region (if there is one), or a resource consent.

Section 15(1) of the RMA is relevant to air discharges associated with biosolids incineration and fugitive emissions from the Tahuna WWTP. The plant is a municipal wastewater treatment facility, which is classified as an industrial or trade process under section 2 of the RMA. A resource consent is required for discharges of odour and the products of combustion from the incinerator from the Tahuna WWTP because no other national regulation or regional rule expressly provides for these discharges.

12.2.4 Sections 104 and 105 Considerations

12.2.4.1 Section 104 Considerations

For any resource consent application, section 104 of the RMA requires the consent authority, in making a decision on such an application, to consider the actual and potential effects of allowing the activity (section 104(1)(a)), the relevant provisions of any national environmental standards, other regulations, national policy statement, coastal policy statement, regional policy statement or proposed regional policy statement, plan or proposed plan (section 104(1)(b)) and any other matters considered relevant or necessary to consider (section 104(1)(c)).

The statutory planning provisions which are relevant to the Tahuna WWTP's discharges to air, and which have been addressed in this resource consent application are:

- **"*Resource Management (National Environment Standards for Air Quality) Regulations 2004*", as amended in June 2011, hereafter referred to as the NES.**
- **Regional Policy Statement for Otago (RPS);**
- **Regional Plan: Air for Otago (Air Plan); and**
- **Regional Plan: Waste for Otago (Waste Plan).**

In relation to the 'other matters' to be considered under section 104(1)(c), the following are relevant to the air discharges from the Tahuna WWTP.

- **The Ministry for the Environment's (MfE) *"Ambient Air Quality Guidelines"* (AAQG).**
- **Kai Tahu ki Otago's *"Natural Resource Management Plan"* (KTKO Plan). This Plan is an iwi resource management plan and therefore is of relevance to the discharges to air from the Tahuna WWTP.**

These matters are assessed later in this section of the application.

In addition, section 104(2A) requires the consent authority to "*… have regard to the value of the investment of the existing consent holder*". The value of the investment and the significance of the Tahuna WWTP to the Dunedin community are outlined in Section 4 of this application. The value of the investment in the Tahuna WWTP and the benefits to the Dunedin community and environment are significant. As discussed elsewhere in this application, the DCC has a responsibility to provide an effective and safe wastewater collection, treatment and disposal system for Dunedin City. As a result of an extensive consultation programme and resource consent process, the DCC was required to upgrade wastewater treatment at its Tahuna WWTP. The DCC has invested $110 million in achieving a new ocean outfall, secondary treatment and UV disinfection and improved odour control. The replacement value of the Tahuna WWTP is $165 million.

An inevitable consequence of improved wastewater treatment is the production of additional biosolids which need to be disposed of in an affordable and sustainable way. The DCC has reviewed the options for biosolids disposal and decided that it should maximise the use of existing assets and maximise the beneficial reuse of biosolids. These objectives are met by a combination of incineration at the Tahuna WWTP, digestion and electricity generation at Green Island WWTP and landfill of biosolids at Green Island with subsequent gas capture and electricity generation.

12.2.4.2 Section 105 Considerations

Section 105 outlines additional matters to which the consent authority must have regard when making decisions on applications for discharge permits. Section 105 requires:

- An assessment of the discharge and the sensitivity of the environment to adverse effects (section 105(1)(a));

- The reason for the proposed choice in relation to the discharge (section 105(1)(b)); and
- An outline of alternative discharge methods and locations (section 105(a)(c)).

The Golder technical assessment has examined the air discharges and proposed air emission controls and effects on the environment in some detail and concluded that adverse effects due to biosolids incinerator discharges to air, or fugitive discharges of odour or aerosols are likely to be minor. Both Golder and the DCC have assessed alternative discharge methods and locations and concluded that the upgrade being implemented is at least the BPO for wastewater treatment and air emission control. An assessment of alternatives is provided in section 9 of this document.

12.3 Statutory Planning Documents

12.3.1 National Environmental Standards

12.3.1.1 Overview

The NES is a high level statutory document, which subordinate plans, such as regional policy statements, regional plans and district plans cannot be inconsistent with. Compliance with the NES, which includes standards related to ambient concentrations for key air quality contaminants, is mandatory and consent authorities are required to refuse the grant of air discharge permits under specific requirements where compliance is not achieved.

The NES was promulgated in 2004. In 2009, the regulations relating to PM_{10} were reviewed to address concerns about the perceived stringency of the ambient standard, the lack of equity for industrial air pollution sources, and the difficulty in achieving the original target timeline of 2013. The NES was revised and the amended regulations came into force on 1 June 2011.

12.3.1.2 Standards

The standards specified in the NES which are relevant to the discharges assessed in this resource consent application are identified in Table 2.

In accordance with Regulation 14 of the NES, the ambient air quality standards, for any of the specified contaminants, apply at any place:

"a) that is an airshed; and
b) that is in the open air; and
c) where people are likely to be exposed to the contaminant."

The ORC has gazetted airsheds and they are specified within the Otago Air Plan. The Tahuna WWTP is located within an area classified as Air Zone 2. Air Zone 2 exceeds the NES standard for PM_{10} as outlined in Section 8.1.3 of this application. The ORC monitoring indicates that the NES standard for NO_2 is achieved.

Table 2: Relevant NES ambient air quality standards (NES Standards)

Contaminant	Averaging Period	Standard ($\mu g/m^3$)	Permissible Exceedance
PM_{10}	24 hr	50	One 24 hr period in a 12 month period
Nitrogen dioxide (NO_2)	1 hr	200	9 hrs in a 12 month period

12.3.1.3 Regulations 11 and 12

Regulation 11 of the NES prohibits the operation of an incinerator at schools or healthcare institutions unless a resource consent has been granted, while Regulation 12 of the NES prohibits the operation of high-temperature hazardous waste incinerators. The Tahuna WWTP is neither a school nor healthcare institution and therefore Regulation 11 is not relevant. However, the requirements of Regulation 12 are evaluated below.

The NES defines a 'high temperature hazardous waste incinerator' as follows:

> "*an incinerator that is designed and operated principally for burning hazardous waste at a temperature greater than 850 °C as measured –*
> *(a) near the inner wall of the incinerator; or*
> *(b) at another point in the combustion chamber where the temperature is likely to represent the temperature in the incinerator."*

In addition, the NES defines 'hazardous waste' as follows:

> "*waste that –*
> *(a) belongs to 1 or more of the categories in Annex I of the Basel Convention; and*
> *(b) has 1 or more of the characteristics in Annex III of that Convention".*

The DCC confirms that the incinerator operating combustion chamber temperature is maintained below 850^0C (i.e. at 830^0C) and also that the incinerator was not designed primarily for burning hazardous waste material but was designed for burning biosolids that are produced from the treatment of finely screened municipal wastewater. The DCC biosolids incinerator is thus not classified as a hazardous waste incinerator under Regulation 12. Furthermore, Golder's technical assessment has confirmed that the Tahuna dewatered biosolids are not classified as hazardous waste. Regulation 12 does not prohibit the operation of the Tahuna WWTP's incinerator.

12.3.1.4 Regulations 17, 20 and 21

PM_{10}

Regulation 17 relates to PM_{10} discharges and is therefore considered in relation to this resource consent application. The South Dunedin airshed is classified as a "polluted airshed" under Regulation 17 (4)(a) of the NES because the airshed has at least 12 months of meaningful PM_{10} data during the last five years and the average exceedances of the PM_{10} standard (50 $\mu g/m^3$) exceeded once per year.

Regulation 17 of the NES requires resource consent applications which are seeking to authorise the discharge of PM_{10} in any part of a polluted airshed to be declined in accordance with subsection (1) if the discharge to be expressly allowed by the consent would be likely, at any time, to increase the concentration of PM_{10} (calculated as a 24-hour mean under Schedule 1) by more than 2.5 micrograms per cubic metre in any part of a polluted airshed. There are exemptions to this requirement including under subsection (2) if the discharge is the same or less than that under an existing consent for the same activity on the site, or under subsection (3) if the emissions can be offset by PM_{10} reductions by the applicant elsewhere within the same airshed.

The South Dunedin airshed is a "polluted airshed" under Regulation 17 of the NES and thus the ORC must decline an application to discharge PM_{10} if the discharge is likely to increase 24 hour PM_{10} concentrations by more than 2.5 µg/m^3 in any part of the polluted airshed. The Golder technical assessment shows that total PM_{10} concentrations from biofilter discharges contribute up to 12 µg/m^3 on a small area of the adjacent golf course to the southeast of the WWTP site. In spite of this, ORC need not decline such an application if the proposed consent is for the same activity (Regulation 17(2)(a)) and the amount and rate of PM_{10} discharge to be allowed by the consent will be the same or less as those under the existing consent (Regulation 17(2)(b)).

DCC confirms that the proposed consent is for the same activity i.e. the proposed consent is for discharges to air from the operation of the existing biosolids incinerator after treatment by a biofilter. Although the incinerator will operate at the same rate, it will operate up to 24 hours per day, 7 days per week. In spite of the increased daily operating hours, the Golder technical assessment has shown that the very low level of particulate discharge from the biofilter, combined with the effect of the upgraded biofilters, will not result in an increase in the allowable PM_{10} discharge. Regulation 17 therefore does not require the discharge of PM_{10} being sought by this application to be declined.

Nitrogen oxides

Regulation 20 applies to resource consents for a number of contaminants, including NO_X. Under this regulation, a consent authority must decline an application for resource consent if the discharge is likely to cause the concentrations in the airshed (Air Zone 2) to exceed the NES Standards for oxides of nitrogen and if it is likely to be the principal source of this contaminant in the airshed.

Golder has modelled the discharge of NO_2 from the biofilters and found that after allowing for expected background concentrations that NO_2 emissions will comply with the 1 hour NO_2 NES of 200 µg/m^3.

Sulphur dioxide

Regulation 21 applies to resource consent applications which include SO_2 as a contaminant in the discharge. Under this regulation, a consent authority must decline an application for resource consent if the discharge is likely to cause the concentrations of SO_2 in the airshed (Air Zone 2) to exceed the specified NES Standard.

SO_2 discharges from the Tahuna WWTP are negligible so this regulation does not apply to this application.

12.3.2 Regional Policy Statement for Otago (RPS)

The RPS, which became operative in October 1998, provides an overview of resource management issues within the region. As such it establishes a framework for achieving integrated management of resources while also providing guidance for subordinate plans.

The matters of regional significance covered by the RPS include the manawhenua perspective, land, water, air, coast, built environment, biota, natural hazards, energy, wastes and hazardous substances as well as monitoring and review of the RPS and cross boundary issues.

Chapter 7 (Air) and Chapter 13 (Wastes and Hazardous Substances) of the RPS are relevant to any resource consent application for the discharges to air from the Tahuna WWTP. Objectives and policies that are assessed in this resource consent application are listed below.

Obj 7.4.1	To maintain and enhance Otago's existing air quality, including visual appearance and odour.
Pol 7.5.1	To recognise and provide for the relationship Kai Tahu have with the air resource in Otago.
Pol 7.5.2	To avoid, remedy or mitigate any discharges which have adverse effects on the air resource including effects on human health, the environment, visual impacts and odour.
Pol 7.5.3	To promote and encourage improvements to existing discharges in order to reduce the amount and toxicity of contaminants released.
Pol 7.5.5	To encourage the use of fuels and combustion processes that have minimum adverse effects on the environment.
Obj 13.4.1	To protect Otago's communities, environment and natural resources from the adverse effects of the waste stream.
Pol 13.5.1	To recognise and provide for the relationship Kai Tahu have with natural and physical resources when managing Otago's waste stream through: (a) Providing for the management and disposal of Otago's waste stream in a manner that takes into account Kai Tahu cultural values; …

The relevant requirements of the Regional Policy Statement for Otago are met as follows:

- **The upgraded WWTP will provide for an overall improvement in discharges by achieving improved control and treatment of odour discharges and ensuring the quality of other discharges are at least maintained.**
- **Iwi have been consulted during the preparation of this application and have no specific concerns at this stage.**

- **Golder has carried out an independent assessment of air discharge enclosure, extraction and treatment at the upgraded Tahuna WWTP and has concluded that they represent best practice and in many cases are the Best Available Technology and furthermore, the assessment has shown that the adverse effects of discharges will be no more than minor and thus effectively avoided.**
- **The Tahuna WWTP requires minimal importation of fuel as the incinerator uses biosolids.**
- **The Tahuna WWTP upgrade enables improved treatment of Dunedin's wastewater, a reduction in adverse effects on Dunedin's coastal environment and substantial reuse of wastewater biosolids.**
- **The Papatuanuku Junction Chamber acknowledges cultural concerns regarding this wastewater discharge by providing contact with "mother earth" before discharge to coastal water.**

12.3.3 Regional Plan: Air for Otago (Otago Air Plan)

12.3.3.1 Overview

The Otago Air Plan became operative in January 2003. Plan Change 1, relating to fire service training and building disposal, became operative in April 2008 and Plan Change 2 (National Environmental Standards) became operative in January 2009. The Otago Air Plan promotes the sustainable management of the region's air resource.

It is noted that as a result of the 2011 amendments to the NES with respect to PM_{10} discharges, the Otago Air Plan now contains provisions which are inconsistent with the amended NES. In this circumstance, the requirements of the NES take precedence over those of any regional plan except where the plan imposes stricter requirements.

12.3.3.2 Airsheds and Regional Ambient Air Quality Guidelines

The Otago Air Plan identifies various airsheds which are classified as Air Zone 1 to 3. The Tahuna WWTP is located within Air Zone 2 (South Dunedin). The explanation to Policy 9.1.1 identifies that PM_{10} concentrations within Air Zone 2 exceed the NES Standard.

Schedule 1 of the Otago Air Plan contains Regional Ambient Air Quality Guidelines (RAAQG) which specify the ambient air quality, for the range of contaminants identified, that the Otago Air Plan seeks to maintain for the region. This Schedule contains Otago Goal Levels, for a range of air quality parameters, which equate to 66% of the "MfE Levels" identified in Schedule 1 of the Otago Air Plan. The MfE Levels comprise a mixture of the NES Standards and AAQG (MfE 2002). The relevant RAAQGs are contained in Table 3.
Policy 8.1.1 identifies that the key driver of the RAAQGs is to maintain air quality if the Otago Goal Levels are met, and in circumstances where these levels are not met the ambient air quality is considered degraded and therefore the resource management response is to aim to enhance ambient air quality.

Table 3: Regional Ambient Air Quality Guidelines (RAAQG)

Contaminant	Otago Goal Levels ($\mu g/m^3$)	MfE Levels ($\mu g/m^3$)	Averaging Times
PM_{10}	35	50[1]	24 hrs
	-	20	Annual
NO_2	130	200[1]	1 hr
	60	100	24 hrs

1: permissible exceedance as provided for by the NES.

12.3.3.3 Relevant Objectives and Policies

The Otago Air Plan also contains objectives and policies that establish the management framework for activities that have the potential to affect the region's air resource. The relevant objectives and policies are listed below.

Obj 6.1.1 To maintain ambient air quality in parts of Otago that have high air quality and enhance ambient air quality in places where it has been degraded.

Obj 6.1.2 To avoid adverse localised effects of contaminant discharges into air on:

(a) Human health;
(b) Cultural, heritage and amenity values;
(c) Ecosystems and the plants and animals within them; and
(d) The life-supporting capacity of air.

Obj 6.1.3 To allow for the sustainable use of Otago's air resource.

Pol 7.1.1 To recognise and provide for the relationship Kai Tahu have with the air resource through procedures that enable Kai Tahu to participate in management of the air resource.

Pol 8.1.1 To have regard to the Otago Goal Levels[1] identified in Schedule 1 and comply with the Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxics) Regulations 2004 in managing the region's ambient air resource.

Pol 8.2.3 In the consideration of any application to discharge contaminants into air, Council will have:

(a) Particular regard to avoiding adverse effects including cumulative effects on:
  (i) Values of significance to Kai Tahu;
  (ii) The health and functioning of ecosystems, plants and animals;
  (iii) Cultural, heritage and amenity values;
  (iv) Human health; and
  (v) Ambient air quality of any airshed; and
(b) Regard to any existing discharge from the site, into air, and its effects.

Pol 8.2.4 The duration of any permit issued to discharge contaminants into air will be determined having regard to:
(a) The mass and nature of the discharge;
(b) The nature and sensitivity of the receiving environment; and
(c) Any existing discharge from the site, into air, and its effects.

Pol 8.2.5 To require, as appropriate, that provision be made for review of the conditions of any resource consent to discharge contaminants into air.

Pol 9.1.1 To reduce discharges of PM_{10} to comply with the ambient air quality standard for PM_{10} by 1 September 2013, in Air Zone 1 by following curved line paths to compliance, and in specified airsheds in Air Zone 2 by following straight line paths to compliance.

Pol 11.1.1 To avoid or mitigate any adverse effects on human health or amenity values resulting from the discharge of offensive or objectionable odour through the use of:
(a) Good management practices (including the use of codes of practice) and process technology that has an inherently low odour potential to ensure the amount of odorous contaminants generated by a process or activity is minimised;
(b) Appropriate control technologies to reduce the emission of odorous contaminants;
(c) Site planning mechanisms and other land use management techniques to reduce the potential for adverse off site effects; and
(d) Tools and techniques that provide an objective assessment of odour, such as olfactometry, odour dose response assessments and community surveys.

1: The explanation to Pol 8.1.1 identifies that the Otago Goal Levels reflect the level of contaminant which is to be aimed for where air quality is degraded. The aim is to ensure as much as possible of Otago's air resource is below these levels.

The relevant objectives and policies of the Otago Air Plan are met as follows:

- **Ambient air quality around the Tahuna WWTP will be at least maintained and for odour enhanced as a result of the upgrade of the Tahuna WWTP which includes improved containment, ventilation and treatment of air emissions.**
- **Adverse effects on human health, cultural, heritage and amenity values, ecosystems and the life supporting capacity of air are largely avoided, given the control and treatment measures adopted for all WWTP discharges to air thus also providing for the sustainability of the area's air resource.**
- **Other foreseeable uses of the nearby air resource are not precluded by this application.**
- **Use of the emergency generator will enable wastewater receipt, treatment and discharge as well as air emission control and treatment to continue even if there is a mains power interruption.**
- **Iwi have been consulted and have no specific concerns at this stage.**

- **The DCC has had regard to the RAAQG in terms of ambient air quality and management response. The Golder assessment shows that PM_{10} and NO_2 emissions from the Tahuna WWTP will not adversely affect the area's existing ambient air quality which in relation to both parameters are generally below the RAAQGs. The control and treatment processes utilised at the Tahuna WWTP will maintain ambient air quality.**
- **This application seeks a discharge permit for the discharge of air associated with a longstanding and important community service.**
- **The Golder technical assessment has shown that the requirements of the NES will be complied with.**
- **Discharges from the site will not create any measurable increase in ambient airshed concentrations of PM_{10}.**
- **The reasons for granting a long term permit have been outlined in this application.**
- **The DCC accepts provision should be made for review conditions in the permit.**
- **Incinerator operation and odour management have been assessed as using Best Available Technology in this case.**

12.3.3.4 Relevant Rules

Overview

The Otago Air Plan rules relating to discharges from incineration, combustion, waste management discharges and the discharge of PM_{10} are relevant to the Tahuna WWTP discharges to air. These rules have been assessed below.

Burning or incineration of specified materials (section 16.3.3)

Rule 16.3.3.1(prohibited activity) and 16.3.3.2 (discretionary activity) specify that the burning of sewage sludge and associated solids, or solids derived from liquid borne municipal, industrial or trade waste are prohibited unless they are burnt in an incinerator or crematorium, in which case they are a discretionary activity requiring resource consent.

Given that it is proposed to use an incinerator to incinerate sewage biosolids at the Tahuna WWTP, Rule 16.3.3.2 applies and resource consent for a discretionary activity is the subject of this application.

Products of combustion from fuel burning equipment

Rule 16.3.4.1(permitted activity) provides for the discharge of contaminants to air from fuel burning equipment. The diesel fired generator on the site complies with part (2) of this rule as it does not exceed a heat output of 5 MW and burns only oil with a sulphur content of less than 1 %.

The DCC will ensure that the emergency generator stack discharge complies with Schedule 6 so that the stack exceeds the required height and therefore the generator will meet all requirements for permitted activity status.

Waste management processes

Discharge of contaminants to air arising from waste management processes are addressed under Section 16.3.7 of the Otago Air Plan.

Rule 16.3.7.1 provides for discharges to air associated with the storage, transfer, treatment and disposal of liquid borne municipal waste as a permitted activity where the influent liquid waste does not exceed a BOD_5 of 850 kg per day and where a range of other standards are to be complied with.

This activity does not comply with the BOD_5 limit in Rule 16.3.7.1 and therefore the discharges to air from the Tahuna WWTP are not a permitted activity. A resource consent for a discretionary activity in accordance with Rule 16.3.7.3 has been applied for.

Discharges of PM_{10}

Section 16.3.15 of the Otago Air Plan contains rules relating to the discharge of PM_{10} where such discharges may be a component of an activity requiring resource consent as a discretionary activity in accordance with the other rules of the Otago Air Plan (i.e. in sections 16.3.1 to 16.3.14). As outlined above, the site is located in Air Zone 2 and at times exceeds the ambient NES standards for PM_{10}.

Rule 16.3.15.1 prohibits the discharge of PM_{10} to air if the activity is not provided for by any permitted or specific discretionary activity rules (Rules 16.3.1 to 16.3.14 and 16.3.15.2 to 16.3.15.5). As outlined within this section of the document, there are specific discretionary activity rules that apply to the discharges to air from the biosolids incinerator and permitted activity rules that apply to the diesel fired generator. Therefore Rule 16.3.15.1 (prohibited activity) does not apply to these activities.

Rule 16.3.15.2 provides for the discharge of PM_{10} as a discretionary activity in an airshed where the ambient air quality standard for PM_{10} is already breached and the discharge to be permitted is likely to significantly increase the concentration of PM_{10} in an airshed. Golder has shown that the discharge of PM_{10} will not significantly increase the concentration of PM_{10} in the airshed so this rule is not applicable. Rule 16.3.15.3 relates to discharges of PM_{10} where the applicant proposes offsets. Offsets are not proposed in this case.

Rule 16.3.15.4 relates to PM_{10} discharges before 1 September 2013 in airsheds where the ambient air quality for PM_{10} is not breached. The ambient air quality is breached in this airshed so this rule is not applicable. Rule 16.3.15.5 relates to discharges of PM_{10} after 31 August 2013 so this rule is also not applicable.

In summary, none of the rules in Section 16.3.15 require the need to seek consent for PM_{10} discharges from the Tahuna WWTP.

The discharges to air from the Tahuna WWTP require a discharge permit in accordance with the following rules of the Otago Air Plan:

- **Rule 16.3.3.2 (discretionary activity) which provides for the discharge of contaminants from incineration of sewage sludge and associated solids, or solids derived from liquid borne municipal, industrial or trade waste within an incinerator.**

- **Rule 16.3.7.3 (discretionary activity) which provides for the discharge of contaminants associated with the storage, transfer, treatment and disposal of liquid borne municipal waste not meeting the permitted activity standards of 16.3.7.1.**

The overall status for the resource consent application for the discharges to air from the Tahuna WWTP is discretionary.

12.3.4 Regional Plan: Waste for Otago

12.3.4.1 Overview

The Waste Plan became operative in April 1997. Since becoming operative there have been no notified Plan Changes or formal reviews. The Waste Plan seeks to provide an integrated management framework of all waste (i.e., liquid, solid, gaseous or radioactive) management activities within Otago. For this reason, the Waste Plan contains a policy framework, and where relevant related rules, covering manawhenua issues, waste minimisation, contaminated sites, hazardous substances and wastes, as well as landfills (i.e., including composting operations).

While the overall approach of the Waste Plan to minimise waste is considered relevant to this application, no particular rules within the Waste Plan are relevant to the Tahuna WWTP's discharges to air. While no rules are relevant, the waste minimisation objectives and policies of the Waste Plan are assessed as part of the resource consent application.

12.3.4.2 Relevant Objectives and Policies

The relevant objectives and policies are listed below.

Obj 4.3.2 To maximise the opportunities for the reuse, recycling and recovering of materials from the waste stream.

Pol 4.4.1 To recognise and provide for the relationship Kai Tahu have with natural and physical resources by:

(a) Acknowledging that future generations will inherit the results of good and bad waste management practices;

(b) Providing for the management of Otago's waste stream in a manner that takes into account Kai Tahu cultural values; and

(c) Maintaining consultation with Kai Tahu on issues relating to waste management.

Pol 4.4.2 To encourage, support and facilitate integrated waste management by (in order of priority):

(a) Minimising the effects on the environment by reducing the quantity and / or toxicity of material entering the waste stream.

(b) Reusing materials;

(c) Recycling materials, where practicable, that cannot be reused;

(d) Recovering resources from materials in the waste stream; and

(e) Disposing of the residual waste in an environmentally safe manner.

The relevant requirements of the Otago Waste Plan are met as follows:

- **The current upgrade of the Tahuna WWTP will enable enhanced treatment of Dunedin's wastewater, resulting in increased biosolids volumes. DCC's biosolids management approach aims to maximise the reuse of the energy in the biosolids through the production of methane and associated electricity generation at the Green Island WWTP's digester.**
- **The DCC has consulted local iwi during the Tahuna WWTP upgrade and during the preparation of this air permit application.**
- **The Tahuna WWTP upgrade will result in reduced effects of wastewater discharges and air emissions and in particular will reduce organic load, suspended solids and pathogens in the wastewater discharge. In addition, where capacity allows, the energy inherent in the biosolids is reused while the disposal of the remainder of the biosolids occurs in a manner that is environmentally safe.**

12.4 Other Considerations

12.4.1 Ambient Air Quality Guidelines

AAQGs (MfE 2002), like the NES Standards, are values for ambient concentrations of atmospheric contaminants that have been set as values for the protection of human health and the environment. Unlike the NES Standards, the AAQGs are not mandatory values. However, the AAQGs are used to assess the effects of discharges of contaminants to air and for this reason they are considered in this resource consent application.

The AAQGs that are applicable to the Tahuna WWTP's discharges to air are contained in the Table 4.

Table 4: MfE Ambient Air Quality Guidelines (AAQG)

Contaminant	Averaging Period	Guideline (µg/m^3)
PM_{10}	24 hr	50*
PM_{10}	Annual	20
NO_2	1 hr	200*
NO_2	24 hr	100
Mercury	Annual	0.33

* Indicates that there is a NES for this contaminant and averaging period. In such cases, although the AAQG and NES are the same, the NES Standard is used.

The Golder technical assessment has shown that the MfE AAQG for PM_{10}, NO_2 and mercury are complied with except that there is a small localised exceedance of the annual PM_{10} AAQG from biofilter emissions just to the south of the Tahuna WWTP. The mercury guideline is easily complied with as the predicted annual average concentration outside the Tahuna WWTP boundary being less than 1% of the guideline.

12.4.2 Ambient Dioxins

The Golder technical assessment estimated the cancer risk due to inhalation and found this to be very minor. This assessment was based on using monitored dioxin emission rates, dispersion modelling and finding that the exposure value was well below the WHO guideline and MfE's unofficial guideline.

12.4.3 Kai Tahu ki Otago – Natural Resource Management Plan

The KTKO Plan is an iwi management plan developed by the runaka who have kaitiaki within the Otago region. It identifies Kai Tahu ki Otago's management framework for the region's resources, including the air resource. Kai Tahu ki Otago includes the four Papatipu Runaka (i.e., Te Runanga o Moeraki, Kati Huirapa Runaka ki Puketeraki, Te Runanga o Otakou and Hokonui Runanga) and associated whanau and ropu (i.e., Moturata Taieri Whanau and Waikoau Ngai Tahu Runanga (S.O.) Incorporated) of the Otago Region.

Section 5.7 of the KTKO Plan contains the policy framework in relation to the 'Air and Atmosphere (Hau me te Hau Takiwa)' of the Otago Region as a whole.

The relevant objectives and policies identified in Section 5.7 of the KTKO Plan are listed below.

Obj 5.7.2(i)	Kai Tahu ki Otago sites of significance are free from odour, visual and other pollutants.
Obj 5.7.2(ii)	Kai Tahu ki Otago are meaningfully involved in the management and protection of the air resource.
Obj 5.7.2(iii)	The life-supporting capacity and mauri of air is maintained for future generations.
Pol 5.7.3.3	To require Cultural Assessments for any discharges to air including agrichemical.

The DCC has consulted KTKO on this application and has been advised that Te Runanga o Otakou have no specific issues or concerns at this stage but do request to be consulted further and kept informed. KTKO specifically noted that Te Runanga o Otakou are encouraged to note that the proposed treatment for air discharge has the intention of "no odour discharge". This reflects Objective 5.7.2(i). This also reflects the intention of the DCC. KTKO have requested a site visit once the WWTP upgrade is completed. The DCC will arrange this.

12.4.4 Dunedin City Council Plan

Under the Dunedin City District Plan (District Plan) the Tahuna WWTP site is designated for the purposes of "Waste Water Treatment Plant" and identified as D653 on Dunedin City Zone Map No. 51. While the Tahuna WWTP is designated, as a land use management tool, the designation does not apply directly to activities managed by regional councils, including activities such as the discharge of contaminants to air.

13. Discussion and Conclusions

The DCC operates a municipal wastewater treatment plant at 10 Tahuna Road, Dunedin, and holds an existing air discharge permit. This permit is due to expire on 30 June 2013 and the DCC will lodge this application for an air discharge permit for the discharges to air from the Tahuna WWTP with the ORC by 31 December 2012. This application and assessment of environmental effects (AEE) provides information on the DCC and the Tahuna WWTP, existing and proposed resource consents, the Tahuna wastewater treatment process and its air discharges, effects of air discharges, mitigation of air discharges, assessment of alternatives, proposed monitoring, outcome of consultation, a statutory assessment and proposed consent conditions. A number of key matters have been identified which are discussed below to support the conclusion that the ORC can grant a replacement air permit for a 35 year term.

The DCC has responsibility to provide an effective and safe wastewater collection, treatment and disposal system for Dunedin City. The Tahuna WWTP operates on a specifically designated site and treats the wastewater from about two-thirds of the population of Dunedin district. Wastewater treatment has occurred at this site since 1967. The DCC is required to maintain a wastewater treatment system pursuant to its responsibilities under the Local Government Act.

After a substantial community consultation process the DCC decided to undertake a $110m upgrade of the Tahuna wastewater treatment process. This upgrade included an 1,100 m ocean outfall, removal of the wastewater discharge from Lawyers Head, provision of secondary treatment and UV disinfection and an upgrade and increase in biofilter odour control capacity. Secondary treatment includes fine screening, high rate activated sludge (HRAS) treatment and biological trickling filtration (BTF). Provision was also made for contact with “mother earth” in the Papatuanuku Junction Chamber (PJC). These upgrade components are now required in terms of long term resource consents granted to the DCC and have been constructed.

The upgraded wastewater treatment system will generate additional biosolids which will enable greater volumes of biosolids to be transferred to Green Island for digestion and electricity generation. The DCC has decided, after review, that the best practicable option for disposing of biosolids is a combination of increased operating hours of the existing Tahuna WWTP incinerator, maximising the use of existing Green Island WWTP digesters to produce heat, gas and electricity and sending the residual biosolids to the Green Island landfill and subsequent collection of methane gas for electricity generation. This option will maximise the use of existing assets while being environmentally acceptable.

The DCC seeks a resource consent to authorise the discharge to air from the Tahuna WWTP including odour and aerosols from the wastewater treatment process and combustion contaminants from the biosolids incinerator. Emissions from the emergency generator are permitted under Rule 16.3.4.1 of the Otago Air Plan and therefore do not require a resource consent. Consent is sought for a 35 year term which is reasonable in this case because of the significant investment in the WWTP, the high level of air emission control and treatment, little community concern about the granting of the permit being sought by this application, because the application

meets all statutory requirements and because the WWTP provides an important societal and environmental service to Dunedin City.

A review of the environment surrounding the Tahuna WWTP revealed that there is a densely populated residential area immediately to the north of the WWTP and a number of recreational facilities to the west, east and south of the WWTP. The DCC is not aware of any nearby sites of particular significance to iwi. ORC monitoring of the South Dunedin airshed (Air Zone 2) has shown that PM_{10} concentrations have exceeded the NES on occasions in the past and according to Regulation 17 of the NES is now classified as a "polluted airshed". These matters have been taken into account in the preparation of this application.

Golder Associates (NZ) Ltd carried out a technical assessment for this application and independently reviewed the original design and performance of the air emission containment and treatment system. Overall, Golder found that the treatment process enclosure, air extraction and biofilter treatment capacity represented best practice and was superior to comparable systems found throughout Australasia. Furthermore, the odour extraction system has spare capacity for future adjustments if required. Golder recommended the preparation and implementation of an Air Discharge Management Plan (ADMP) to ensure that the air emission control system is operated at a high level at all times.

Golder carried out dispersion modelling of existing incinerator emissions discharging through the biofilter for respirable particulate (PM_{10}), nitrogen dioxide (NO_2), mercury and dioxin. Golder predicted an elevated 24 hour PM_{10} (up to 12 $\mu g/m^3$) in a small area of the golf course at the southeast boundary of the WWTP but much lower predicted levels (less than 2 $\mu g/m^3$) in the residential area to the north of the WWTP. Golder considered that these emissions were unlikely to cause exceedance of the NES standard and would not cause measureable increases in airshed PM_{10} concentrations.

NO_2 emissions are predicted to meet the ambient air requirements specified by the NES, AAQG and RAAQG. Mercury emissions will also be well below the AAQG while dioxin emissions are estimated to cause a negligible cancer risk and to be well below the relevant WHO and MfE guidelines. Golder recommends ongoing monitoring of air extraction systems, key biofilter parameters, incinerator operations and incinerator discharges but considers that ongoing community odour surveys are not necessary. Complaint monitoring, community consultation and, if required, diary programmes are sufficient for odour effects monitoring.

Community consultation revealed a low level of concern regarding the granting of a replacement air permit for the Tahuna WWTP but did highlight that odour complaint recording needed improvement and that nearby odour levels also needed improvement. The local iwi, Te Runanga o Otakou, have no specific issues or concerns at this stage but do request ongoing consultation. The DCC have kept the local community well informed on the WWTP upgrade by distributing regular newsletters and a specific newsletter was distributed on the air permit application and community consultation meeting. The three feedback forms completed at the

community consultation meeting expressed support for the granting of a replacement air permit.

The statutory assessment showed that this application is not contrary to the purpose and principles of the RMA. The overall status of this application for discharges to air from the Tahuna WWTP is discretionary. The discharges to air from the Tahuna WWTP are consistent with the relevant objectives and policies of the RPS, Otago Air Plan and Otago Waste Plan. Although the South Dunedin airshed exceeds the NES standard for PM_{10} and is classified under Regulation 17 of the NES as a "polluted airshed" this application is able to be granted because the proposed consent for the discharge of PM_{10} from the incinerator is for the same activity and that no increase in allowable PM_{10} discharge is proposed. The proposed discharge of PM_{10} will not create any measurable increase in ambient airshed PM_{10} and the proposed discharge of NO_2 meets the NES requirements. Mercury and dioxin discharges are also well within relevant guidelines.

In conclusion, this application and assessment of effects on the environment provides the basis for the ORC to grant the DCC an air discharge permit for the Tahuna WWTP for a 35 year term.

14. Proposed Consent Conditions

The DCC proposes the following resource consent conditions.

1. There shall be no discharge of odour as a result of exercising this permit that is noxious, dangerous, offensive or objectionable to the extent that it causes an adverse effect at or beyond the property boundary.

2. The Consent Holder shall advise the Consent Authority of every complaint it receives within one working day of receiving the complaint. The Consent Holder shall keep a register of every complaint. The register shall detail the name of the complainant, date, time and type of complaint, cause of complaint and action taken by the Consent Holder in response to the complaint. The register shall be made available to the Consent Authority upon request.

3. The Consent Holder shall notify the Consent Authority as soon as practicable of any plant malfunction or breakdown that results in an abnormal discharge.

4. The concentration of contaminants in the air discharge from the biosolids incinerator, prior to discharge to the biofilters, shall not exceed the following:

Particulate	30 mg/Sm^3
Sulphur dioxide	50 mg/Sm^3
Oxides of nitrogen	200 mg/Sm^3 as NO_2
Hydrogen chloride	10 mg/Sm^3
Hydrogen fluoride	2 mg/Sm^3
Mercury	0.1 mg/Sm^3
Total Cadmium and Thallium	0.1 mg/Sm^3
Total Antimony, Arsenic, Lead, Chromium, Cobalt, Copper, Manganese, Nickel and Vanadium	0.5 mg/Sm^3
Dioxins and Furans (PCDD/Fs)	0.1 $ngTEQ/Sm^3$

5. The Consent Holder shall measure the discharges from the biosolids incinerator to demonstrate compliance with the limits for each contaminant listed in condition 4. Measurements shall be undertaken at least once per year and shall comply with the following standard methods, or equivalent approved by the Consent Authority:

   USEPA method 5 for particulate;
   USEPA method 8 for sulphur oxides;

USEPA performance specification 2 for continuous monitoring of oxides of nitrogen;
USEPA method 14 for fluorides;
USEPA method 26 for hydrochloric acid;
USEPA method 29 for heavy metals;
USEPA method 23 for dioxins and furans.

Samples shall be collected downstream of the scrubber system and prior to entering the biofilter. As far as practicable all sampling and analysis shall be undertaken by an IANZ accredited laboratory or an ILAC equivalent. A minimum of three individual samples shall constitute a single test and compliance shall be measured against the arithmetic mean. The toxic equivalents for dioxins and furans (TEQ) shall be determined from WHO (1997) toxic equivalency factors and one half of the limit of detection shall be included in the TEQ calculations for those congeners below the detection limit. All results shall be corrected to 0^0C 101.3 kPA, dry gas and 11% oxygen. Results shall be measured as hourly averages with the exception of dioxins and furans, which shall be measured as three-hour averages.

If after three years of consistent compliance with the concentration of a contaminant specified in condition 4 of this consent, the Consent Holder may cease testing of that contaminant with the prior written approval of the Consent Authority.

6. (a) Within six months of the commencement of this consent, the Consent Holder shall prepare and forward to the Consent Authority an Air Discharge Management Plan (ADMP) for the effective and efficient operation of process air extraction and biofilter treatment systems at the Tahuna Wastewater Treatment Plant to ensure compliance with the conditions of this consent. The ADMP shall include:

    (i) definition of personnel roles and responsibilities;
    (ii) description of key contaminant-generating processes;
    (iii) description of the air contaminant extraction and biofiltration systems;
    (iv) monitoring parameters including frequency, draft trigger levels, and recommended actions;
    (v) maintenance programme for the air extraction and biofilter systems;
    (vi) contingency plans and responses to deal with abnormal events; and
    (vii) procedures for reviewing the ADMP.

    (b) The Consent Holder shall update the ADMP when there are any significant changes or upgrades to the Tahuna Wastewater Treatment Plant's operation. The need for such an update shall be assessed at least once every year and reported to the Consent Authority.

(c) The Consent Holder shall ensure that the ADMP is available for viewing by the Consent Authority and interested parties on request in writing or at such other time as is agreeable to all appropriate parties.

(d) The Consent Holder shall operate and maintain the Tahuna Wastewater Treatment Plant in accordance with the ADMP.

(e) The ADMP may be incorporated into another management plan, such as the Tahuna Wastewater Treatment Plant Operations and Management Manual, which may be required by the conditions of another resource consent.

(f) The ADMP should refer to relevant standard operating procedures, site repair and maintenance procedures and other relevant documentation.

7. The Consent Holder may apply to change or cancel any consent conditions as provided for in section 127 of the Resource Management Act 1991 where a change in circumstances has caused the conditions to become inappropriate or unnecessary.

8. The Consent Authority may in accordance with sections 128 and 129 of the Resource Management Act serve notice on the Consent Holder of its intention to review the conditions of this consent within three months of each anniversary date of this consent for the following purposes:

(a) to deal with any adverse effect on the environment which may arise from the exercise of this consent and which it is appropriate to deal with at a later stage, or which becomes evident after the date of commencement of the consent, or

(b) to adopt the best practicable option to remove or reduce any adverse effect on the environment, or

(c) to comply with the requirements of a relevant rule in an operative regional plan.

15. Abbreviations and Glossary

ABBREVIATIONS USED

AEE	Assessment of Effects on the Environment
AAQG	Ambient air quality guideline
ADMP	Air Discharge Management Plan
BAT	Best available technology
BOD	Biological oxygen demand
BPO	Best practicable option
BTF	Biological trickling filters
CO	Carbon monoxide
DCC	Dunedin City Council
DS	Dry solids
EWS	Electronic weather station
GLC	Ground level concentration
Golder	Golder Associates (NZ) Limited
GBT	Gravity belt thickener
GTT	Gravity tank thickener
HED	HRAS effluent discharge
HRAS	High rate activated sludge
H_2S	Hydrogen sulphide
ID	Induced draft
MfE	Ministry for the Environment
MoH	Ministry of Health
MPS	Musselburgh Pumping Station
NES	National Environmental Standards
NO_2	Nitrogen dioxide
NO_X	Oxides of nitrogen
PM_{10}	Fine particulate matter less than 10 microns in diameter
PS	Pumping station
ORC	Otago Regional Council
PJC	Papatuanuku Junction Chamber
RAAQG	Regional Ambient Air Quality Guideline

RE	Recycled effluent
RMA	Resource Management Act 1991
SLP	Straight line path
SO_2	Sulfur dioxide
SOER	Surface odour emission rate
STP	Standard temperature and pressure (0°C, 1 atmosphere pressure)
TSP	Total suspended particulate
TWAS	Thickened waste activated sludge
US EPA	United States Environmental Protection Agency
UV	Ultra-violet
WAS	Waste activated sludge
WWTP	Wastewater Treatment Plant

UNITS USED

°C	Degrees Celsius
µg/m³	Micrograms per cubic metre
g/s	Grams per second
K	Kelvin
kg/h	Kilograms per hour
kg/m³	Kilograms per cubic metre
kW	Kilowatt
m/s	Metres per second
m²	Square metre
m³	Cubic metre
mg/m³	Milligrams per cubic metre
mg/Nm³	Milligrams per normalised cubic metre (0°C, 1 atmosphere pressure and dry)
MJ/kg	Megajoule per kilogram
MJ/m³	Megajoule per cubic metre
MW	Megawatt
OU/m²/s	Odour unit per square metre per second – see SOER
OU/m³	Odour unit per cubic metre

OU/s	Odour unit per second
pg/m^3	Picogram per cubic metre
ppm	Parts per million

16. References

MfE 2002. Ambient Air Quality Guidelines. Prepared by the Ministry for the Environment, 2002

MfE 2003. Good practice guide for assessing and managing odour in New Zealand. Air Quality Report 36, ME:473, Ministry for the Environment, Wellington, June 2003.

ORC, 2009: Regional Plan: Air for Otago. Prepared by Otago Regional Council. 1 January 2003 and updated at 1 January 2009.

APPENDIX 1

Existing Air Discharge Permit 2002.625

Otago Regional Council

COUNTERPART

Consent No. 2002.625

DISCHARGE PERMIT

Pursuant to Section 105 of the Resource Management Act 1991, the Otago Regional Council grants to:

Name: Dunedin City Council

Address: 1 The Octagon, Dunedin

a permit to discharge to air odours resulting from the primary treatment of wastewater and products of combustion

for the purposes of operating a sewage sludge incinerator and treating sewage at the Tahuna Wastewater Treatment Plant

for a term of 10 years expiring on 30 June 2013 subject to the following conditions.

Location of activity: 10 Tahuna Road, Dunedin

Legal description: Part Sec 28, marked "A" Blk VII and Part Sec 128, Marked "B" Blk VII Otago Peninsula SD

Map Reference: NZMS 260 I44:176-752

Conditions:

1. There shall be no discharge of odour as a result of exercising this permit that is noxious, dangerous, offensive or objectionable beyond the boundary of the designation of the plant.

2. The consent holder shall carry out a community odour assessment survey during February and March at least once every three years and report the results to the Consent Authority within 3 months of the completion of the survey. The survey shall consult a random selection of people within a 1000 metre radius of the consent holder's activities. The design and extent of the survey shall comply with recognised good practice for community surveys and be to the satisfaction of the Consent Authority. The first survey shall be undertaken within 12 months of commencement of the consent.

3. The consent holder shall advise the Consent Authority of every complaint it receives within 1 working day of receiving the complaint. The consent holder shall keep a register of every complaint. The register shall detail the name of the complainant, date, time and type of complaint, cause of complaint and action taken by the consent holder in response to the complaint. The register shall be made available to the Consent Authority upon request

4. The consent holder shall adopt the best practicable option to avoid or mitigate any potential adverse effects on the environment arising from discharges from the consent holder's activities. This shall include, but not be limited to:

   (a) ensuring all significant odour sources are enclosed and ventilated to odour control equipment at all times;

   (b) preparing an operating and maintenance plan for the ventilation and biofilter systems within 6 months of the commencement of this consent that provides for regular monitoring of biofilter moisture, back-pressure, bed pH, and a programme for media replacement;

   (c) regular reviews of the effectiveness of ventilation and biofilter systems, with a view to continuous improvement in odour control.

5. The concentration of contaminants in the air discharge from the sewage sludge incinerator shall not exceed the following:

Particulate	30 mg/Sm^3
Sulphur dioxide	50 mg/Sm^3
Oxides of nitrogen	200 mg/Sm^3 as NO_2
Hydrogen chloride	10 mg/Sm^3
Hydrogen fluoride	2 mg/Sm^3
Mercury	0.1 mg/Sm^3
Total Cadmium and Thallium	0.1 mg/Sm^3
Total Antimony, Arsenic, Lead, Chromium, Cobalt, Copper, Manganese, Nickel and Vanadium	0.5 mg/Sm^3
Dioxins and Furans (PCDD/Fs)	0.1 $ngTEQ/Sm^3$

6. The Consent Holder shall measure the discharges from the sewage sludge incinerator to demonstrate compliance with the limits for each contaminant listed in condition 5. Measurements shall be undertaken at least once per year and shall comply with the following standard methods, or equivalent:

   USEPA method 5 for particulate;

   USEPA method 8 for sulphur oxides;

USEPA performance specification 2 for continuous monitoring of oxides of nitrogen;

USEPA method 14 for fluorides;

USEPA method 26 hydrochloric acid;

USEPA method 29 for heavy metals

USEPA method 23 for dioxins and furans

Samples shall be collected down stream of the scrubber system and prior to entering the biofilter. As far as practicable all sampling and analysis shall be undertaken by an IANZ accredited laboratory or an ILAC equivalent. A minimum of three individual samples shall constitute a single test and compliance shall be measured against the arithmetic mean. The toxic equivalents for dioxins and furans (TEQ) shall be determined from WHO (1997) toxic equivalency factors and one half of the limit of detection shall be included in the TEQ calculations for those congeners below the detection limit. All results shall be corrected to 0°C 101.3 kPA, dry gas and 11% oxygen. Results shall be measured as hourly averages with the exception of dioxins and furans, which shall be measured as three-hour averages.

7. The Consent Holder may apply to change or cancel any consent conditions as provided for in section 127 of the Resource Management Act 1991 three years after the commencement of this consent and within 3 months of each following anniversary of the consent where a change in circumstances has caused the conditions to become inappropriate or unnecessary.

8. The Consent Authority may in accordance with Section 128 and 129 of the Resource Management Act serve notice on the consent holder of its intention to review the conditions of this consent within three months of each anniversary date of this consent for the following purposes:

   (a) to deal with any adverse effect on the environment which may arise from the exercise of this consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent, or
   (b) to adopt the best practicable option to remove or reduce any adverse effect on the environment, or
   (c) to comply with the requirements of a relevant rule in an operative regional plan.

Issued at Dunedin this 22nd day of October 2004 pursuant to the Environment Court Order of Judge Smith of 7th September 2004.

Selva Selvarajah
Director Resource Management
c g:\sl2\j\dcc-robinson p.doc

APPENDIX 2

Dunedin City Council – Tahuna Wastewater Treatment Plant. Air Discharge Permit – Identification of Planning Considerations. Report No. 1278104628. Prepared by Golder Associates (NZ) Ltd. July 2012.

July 2012

DUNEDIN CITY COUNCIL - TAHUNA WASTEWATER TREATMENT PLANT

Air Discharge Permit - Identification of Planning Considerations

Submitted to:
Dunedin City Council
PO Box 5045
Moray Place
Dunedin 9058

Report Number. 1278104628

Distribution:

Dunedin City Council

REPORT

Golder Associates

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APPENDICES

APPENDIX A
Report Limitations

APPENDIX B
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Abbreviations and Glossary of Terms

AAQG	MfE's Ambient Air Quality Guidelines.
Air Plan	Regional Plan: Air for Otago
DCC	Dunedin City Council – who operate the Tahuna WWTP
District Plan	Dunedin City District Plan
GLC	ground level concentration
hr	hour
KTkO	Kai Tahu ki Otago. The four Papatipu Runanga and associated whanau and ropu of the Otago region
KTkO Plan	Kai Tahu ki Otago's Natural Resource Management Plan 2005
m	metre
MfE	Ministry for the Environment
mg/m^3	milligrams per cubic metre
MW	mega watt
NES	National Environmental Standards
NES Standards	means the ambient air quality standards specified in the NES. The NES standards that are of relevance to the Tahuna WWTP's discharges to air are contained in Table 1 of this document
NO_x	oxides of nitrogen
NO_2	nitrogen dioxide
ORC	Otago Regional Council
PM_{10}	Respirable particulate matter less than 10 microns in diameter
RAAQG	Regional Ambient Air Quality Guidelines. The RAAQG are contained in Schedule 1 of the Air Plan
RMA	Resource Management Act 1991
RPS	Regional Policy Statement for Otago
SO_2	sulfur dioxide
Tahuna WWTP	means the Tahuna wastewater treatment plant operated by DCC and for which a replacement air discharge permit is to be sought
TSP	total suspended particulate
Waste Plan	Regional Plan: Waste for Otago
WHO	World Health Organisation
WHO Guidelines	refers to WHO's *"Air Quality Guidelines Global Update 2005"* (WHO 2006)
$\mu g/m^3$	micrograms per cubic metre

1.0 INTRODUCTION

1.1 Background

Dunedin City Council (DCC) operates the Wastewater Treatment Plant located in the suburb of Tahuna in Dunedin. The Tahuna Wastewater Treatment Plant (Tahuna WWTP) treats the majority of the wastewater generated within Dunedin city itself, prior to discharge into the coastal marine area (via a 1.1 km outfall).

There are a number of discharges to air associated with the site. These discharges are currently authorised by an air discharge permit (Consent No. 2002.635) from Otago Regional Council (ORC). The discharge permit authorises the discharge to air of odours resulting from the treatment of wastewater and products of combustion associated with treating sewage and operating a biosolids incinerator. The discharge permit expires on 30 June 2013.

1.2 Purpose and Structure of this Document

To assist with the preparation of the resource consent application, this document[1] identifies the matters of relevance in preparing the various technical assessments and the resource consent application itself, namely the discharges to air from the Tahuna WWTP. The report identifies the pertinent information arising from the Resource Management Act 1991 (RMA), particularly Part 2 matters and section 104 and 105 considerations, as well as the relevant statutory planning documents (National Environmental Standards for Air Quality, Regional Policy Statement for Otago, Regional Plan: Air for Otago and the Regional Plan: Waste for Otago). In addition, where relevant, other considerations may also be identified, for example, the Ambient Air Quality Guidelines, the Kai Tahu ki Otago – Natural Resources Management Plan, the WHO Air Quality Guidelines and the Dunedin City District Plan. This document does not contain an assessment of the activity, namely the discharge of contaminants to air from the Tahuna WWTP, against the identified planning considerations.

Given the purpose of this document, Section 2.0 contains an overview of the sources and nature of contaminants being discharged to air from the Tahuna WWTP. The considerations arising from the Resource Management Act 1991 (RMA) are identified in Section 3.0 while Section 4.0 identifies the considerations arising from the relevant statutory planning documents. Section 5.0 of this document identifies considerations arising from relevant guidelines as well as the Kai Tahu ki Otago's Natural Resources Management Plan (KTkO Plan). A summary listing the key matters for consideration is contained in Section 6.0 of this document.

2.0 THE TAHUNA WASTEWATER TREATMENT PLANT – DISCHARGES TO AIR

The Tahuna WWTP treats raw municipal wastewater, which has been coarsely screened at the Musselburgh pumping station. The existing resource consent provides for the wastewater to undergo further screening at the Tahuna WWTP prior to primary treatment taking place with sediment being settled in the sedimentation tanks. The primary treated wastewater is periodically disinfected using chlorination prior to discharge to the coastal marine area via a new ocean outfall. The DCC are in the process of completing an upgrade to the Tahuna WWTP whereby the wastewater will pass through secondary treatment involving a high rate activated sludge and biological trickling filter and UV disinfection processes prior to discharge.

[1] This document is subject to the report limitations contained in Appendix A.

The primary wastewater biosolids generated by the existing process is dewatered and then incinerated in the plant's existing biosolids incinerator and it is proposed that the incineration of biosolids (albeit biosolids from the secondary processing of wastewater) will continue once the upgrade is completed. As part of the upgrade, additional biosolids treatment is proposed whereby a portion of biosolids will be thickened and dewatered prior to being removed from site to the Green Island Landfill or to the Green Island WWTP for digestion.

Localised process odour extraction, extracted building air and the cooled discharges from the incinerator exhaust are all passed through biofilters to remove odours, PM_{10} and other contaminants prior to discharging to air. A diesel fired generator has also been installed on site to provide a backup electricity supply during periods of power failure.

Given the nature of the Tahuna WWTP's operations, the main activities generating air emissions following the plant upgrade are considered to be the following:

- Fine screening and grit removal prior to treatment of the wastewater.
- Secondary treatment of the wastewater via a High Rate Activated Sludge (HRAS) system (aerobic treatment) and the subsequent operation of enclosed biological trickling filters (aerobic treatment).
- Biosolids collection/dewatering.
- Biosolids incineration.
- Biosolids dispatch and trucking off site to Green Island (the volume of biosolids that is not processed through the incinerator).
- Operation of a diesel-fired generator for the purpose of providing back up power to parts of the plant, including the pumps, and aerobic processing of the wastewater.
- Dispatch of solid materials (screenings) off site to the Green Island landfill.

While this is not an all-encompassing list of the activities taking place at the Tahuna WWTP, as already identified, these are considered to be the main sources of any air emissions arising from the plant. Other activities undertaken at the plant, such as use of aerosols within enclosed buildings, are very minor contributors to any discharges to air and accordingly not considered further within this document.

Given the nature of the above activities, the key discharges of contaminants to air from the Tahuna WWTP, which are to be assessed in the resource consent application, are as follows:

- Discharge of odour. The main potential sources of odour are from the wastewater and biosolids treatment, management and disposal systems.
- Contaminants from the discharge to air from combustion activities, including incineration of biosolids and operation of the diesel fired generator. These include nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and particulate matter less than ten microns in diameter (PM_{10}), as well as trace amounts of metals, dioxins and furans.

3.0 RESOURCE MANAGEMENT ACT 1991

3.1 Overview

The RMA and associated statutory documents, identify the circumstances where resource consents are required for an activity, as well as establishing the 'thresholds' that must not be contravened by an activity or else it is prohibited and a resource consent cannot be granted. Therefore this section of this document identifies the provisions of the RMA that will need to be assessed in relation to the resource consent application for the Tahuna WWTP.

3.2 Part 2 Considerations

Part 2 of the RMA outlines the purpose and principles of the RMA. Section 5 states:

> *"(1) The purpose of this Act is to promote the sustainable management of natural and physical resources.*
>
> *(2) In this Act, 'sustainable management' means 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 well-being and for their health and safety while*
>
> *(a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably 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."*

Section 6 of the RMA identifies matters of national importance which shall be 'recognised and provided for' while section 7 identifies matters which 'shall be had regard to' under the RMA. With regard to the discharges to air from the Tahuna WWTP, while there are no section 6 matters relevant to the activity the following section 7 matters are considered to be of relevance:

> *"(a) kaitiakitanga:*
>
> *(aa) the ethic of stewardship:*
>
> *(b) the efficient use and development of natural and physical resources:*
>
> *(c) the maintenance and enhancement of amenity values:*
>
> *(f) maintenance and enhancement of the quality of the environment"*

In addition, section 8 of the RMA requires *"all persons exercising functions and powers"* under the RMA to take into account to the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).

The resource consent application will need to assess whether, or not, the discharges to air from the Tahuna WWTP are consistent with the above Part 2 matters.

3.3 Section 15 Considerations

Section 15(1) of the RMA states that no person may discharge contaminants to air, from an industrial or trade premise (section 15(1)(c)), unless the discharge is expressly allowed by a national environmental standard or other regulations, a rule in a regional plan as well as a rule in a proposed regional plan for the same region (if there is one), or a resource consent.

Section 15(1) of the RMA is relevant to the Tahuna WWTP. Although the plant is a municipal wastewater treatment facility, under the RMA it is also classified as an industrial or trade process[2] given that it receives a raw material (i.e., wastewater), treats it and then dispatches it.

3.4 Sections 104 and 105 Considerations

3.4.1 Section 104 considerations

For any resource consent application, section 104 of the RMA requires the consent authority, in making a decision on such an application, to consider the actual and potential effects of allowing the activity (section 104(1)(a)), the relevant provisions of any national environmental standards, other regulations, national policy statement, coastal policy statement, regional policy statement or proposed regional policy

[2] Section 2 of the RMA.

statement, plan or proposed plan (section 104(1)(b)) and any other matters considered relevant or necessary to consider (section 104(1)(c)). These matters will need to be addressed within the resource consent application in order to ensure that the consent authority has sufficient information to determine whether the resource consent can be granted.

The statutory planning document provisions which are relevant to the Tahuna WWTP's discharges to air, and which must therefore be considered by the consent authority pursuant to section 104(1)(b) and which therefore must be addressed in the resource consent application, are identified in Section 4.0 of this document. The relevant statutory planning documents are:

- *"Resource Management (National Environment Standards for Air Quality) Regulations 2004"*, as amended in June 2011, hereafter referred to as the NES.
- Regional Policy Statement for Otago (RPS).
- Regional Plan: Air for Otago (Air Plan).
- Regional Plan: Waste for Otago (Waste Plan).

In relation to the 'other matters' that the consent authority must consider under section 104(1)(c), the matters considered to be of relevance to the air discharges from the Tahuna WWTP are:

- The Ministry for the Environment's (MfE) *"Ambient Air Quality Guidelines"* (AAQG). The provisions of relevance to the Tahuna WWTP's air discharges are identified in Section 5.0 of this document.
- The World Health Organisation's (WHO) *"Air Quality Guidelines Global Update 2005"* (WHO 2006), hereafter referred to as the 'WHO Guidelines'. The relevance of these guidelines to the Tahuna WWTP is discussed in Section 5.0 of this document.
- Kai Tahu ki Otago's *"Natural Resource Management Plan"* (KTkO Plan). This Plan is an iwi resource management plan and therefore is of relevance to the discharges to air from the Tahuna WWTP. The provisions of relevance to the resource consent application are identified in Section 5.0 of this document.

In addition, section 104(2)(A) requires the consent authority to *"…have regard to the value of the investment of the existing consent holder"*. This matter will therefore also need to be assessed in the resource consent application.

3.4.2 Section 105 considerations

Section 105 outlines additional matters to which the consent authority must have regard when making decisions on applications for discharge permits. Section 105 requires:

- An assessment of the discharge and the sensitivity of the environment to adverse effects (section 105(1)(a)).
- The reason for the proposed choice in relation to the discharge (section 105(1)(b)).
- An outline of alternative discharge methods and locations (section 105(1)(c)).

The assessment of effects on the environment, namely on the air resource of the area, will need to be addressed in the resource consent application. In addition, the resource consent application will need to contain an assessment of alternatives, in terms of discharge methods, locations and related reasons for those decisions, in order to address the matters identified in sections 105(1)(b) and (c) of the RMA.

3.4.3 Summary

To summarise, the resource consent application will need to address the following matters, as required by sections 104 and 105 of the RMA:

- An assessment of the actual and potential effects of the discharges to air.
- An assessment of the discharges to air in relation to the provisions of the relevant statutory plans developed under the RMA, namely the NES, RPS, Air Plan and Waste Plan.
- An assessment of the proposed discharges in relation to the AAQG and KTkO Plan.
- The value of investment associated with the Tahuna WWTP.
- An assessment of alternative discharge methods and locations including the reasons for the choices made.

4.0 STATUTORY PLANNING DOCUMENTS

4.1 Overview

This section of this document identifies the provisions of the relevant statutory planning documents that will need to be assessed in the resource consent application for the discharges to air from the Tahuna WWTP.

4.2 National Environmental Standards

4.2.1 Overview

In terms of the planning hierarchy, the NES is a high level statutory document, which subordinate plans, such as regional policy statements, regional plans and district plans cannot be inconsistent with. Compliance with the NES, which includes standards related to ambient concentrations for key air quality contaminants, is mandatory such that consent authorities are required to refuse the grant of air discharge permits under specific requirements where compliance is not achieved.

The NES was promulgated in 2004. In 2009, the regulations relating to PM_{10} were reviewed to address concerns about the perceived stringency of the ambient standard, the lack of equity for industrial air pollution sources, and the difficulty in achieving the original target timeline of 2013. In response, the NES was revised and the amended regulations came into force on 1 June 2011.

4.2.2 Standards

The standards specified in the NES which the resource consent application will need to assess compliance against are identified in Table 1. Within this document these standards are hereafter referred to as the 'NES Standards'.

Table 1: Relevant NES ambient air quality standards (NES Standards).

Contaminant	Averaging period	Standard (µg/m^3)	Permissible exceedance
PM_{10}	24 hr	50	One 24 hr period in a 12 month period
SO_2	1 hr	570	Not to be exceeded
SO_2	1 hr	350	9 hrs in a 12 month period
Nitrogen dioxide (NO_2)	1 hr	200	9 hrs in a 12 month period

In accordance with Regulation 14 of the NES, the ambient air quality standards, for any of the specified contaminants, apply at any place:

"a) that is an airshed; and

b) that is in the open air; and

c) where people are likely to be exposed to the contaminant."

The Otago Regional Council (ORC) has gazetted airsheds and they are specified air sheds within the Air Plan. The Tahuna WWTP is located within an area classified as Air Zone 2. The implications of this classification in relation to PM_{10} concentrations (i.e., a polluted airshed) are discussed in Section 4.2.4 below.

Compliance with the NES Standards in the airshed, as a result of the Tahuna WWTP discharges to air, will be need to assessed as part of the resource consent application.

4.2.3 Regulations 11 and 12

Regulation 11 of the NES prohibits the operation of an incinerator at schools or healthcare institutions unless a resource consent has been granted, while Regulation 12 of the NES prohibits the operation of high-temperature hazardous waste incinerators. The Tahuna WWTP is neither a school or healthcare institution and therefore Regulation 11 is not relevant. However, the requirement of Regulation 12 may need further evaluation as assessed below.

The NES defines a 'high temperature hazardous waste incinerator' as follows:

"an incinerator that is designed and operated principally for burning hazardous waste at a temperature greater than 850 °C as measured –

(a) near the inner wall of the incinerator; or

(b) at another point in the combustion chamber where the temperature is likely to represent the temperature in the incinerator."

In addition, the NES defines 'hazardous waste' as follows:

"waste that –

(a) belongs to 1 or more of the categories in Annex I of the Basel Convention; and

(b) has 1 or more of the characteristics in Annex III of that Convention".

It is understood that the Tahuna WWTP incinerator operates at less than 850 °C (i.e., at 830 °C) and if this is the case then the incinerator does not fall under the definition of a high temperature incinerator. It is important that the technical assessment and resource consent applications assesses whether or not the temperature limit specified in Regulation 12 is complied with.

In addition, the technical assessment and resource consent applications will need to assess whether the biosolids constitutes a hazardous waste in accordance with the definition provided in the NES, namely Annexes I and III of the Basel Convention.

If it is determined that the incinerator does not fall under the definition of a high temperature incinerator, or it is not a 'hazardous waste incinerator', then Regulation 12 would not apply to the incinerator at the Tahuna WWTP and therefore the NES does not prohibit the operation of the incinerator at the Tahuna WWTP. However, if this is not the case, then the prohibition associated with Regulation 12 will need to be revisited.

4.2.4 Regulations 17, 20 and 21

4.2.4.1 Overview

The applicability or otherwise, of Regulations 17, 20 and 21 of the NES will need to be assessed in relation to the Tahuna WWTP discharges to air. For this reason, a brief overview of the requirements of these regulations is contained in the following section of this document.

4.2.4.2 PM_{10}

Regulation 17 relates to PM_{10} discharges and therefore needs to be considered in relation to the resource consent application. PM_{10} concentrations within Air Zone 2 (South Dunedin), within which the Tahuna WWTP is located, exceed the NES Standards as identified in the explanation to Policy 9.1.1 of the Air Plan (refer to Section 4.4 of this document). However, Regulations 16 and 17 of the amended NES provide an amended approach to determining if an airshed is polluted after 1 September 2012. The technical assessment and resource consent application will need to assess with the Air Zone 2 (South Dunedin) is still identified as a polluted airshed under these regulations.

Regulation 17 of the NES requires resource consent applications which are seeking to authorise the discharge of PM_{10} in any part of a polluted airshed to be declined in accordance with subsection (1) if the discharge to be expressly allowed by the consent would be likely, at any time, to increase the concentration of PM_{10} (calculated as a 24-hour mean under Schedule 1) by more than 2.5 micrograms per cubic metre in any part of a polluted airshed. There are exemptions to this requirement including under subsection (2) if the discharge is the same or less than that under an existing consent for the same activity on the site, or under subsection (3) if the emissions can be offset by PM_{10} reductions by the applicant elsewhere within the same airshed.

Fuller consideration of Regulations 16 and 17 will need to be covered in the resource consent application documentation. This will include an assessment of whether or not the airshed is actually a 'polluted airshed' and then whether any PM_{10} emissions are such that the resource consent would have to be declined under subsection (1), or whether subsections (2) or (3) are applicable regarding existing resource consents and offsetting enabling the consent to be granted.

4.2.4.3 Nitrogen oxides

Regulation 20 applies to resource consents for a number of contaminants, including NO_X. Under this regulation, a consent authority must decline an application for resource consent if the discharge is likely to cause the concentrations in the airshed (Air Zone 2) to exceed the NES Standards for oxides of nitrogen and if it is likely to be the principal source of this contaminant in the airshed.

Given the provisions of Regulation 20, compliance with the NES Standard for NO_2, will need to be assessed in the resource consent application in order to determine whether the discharge permit can or cannot be granted.

4.2.4.4 Sulfur dioxide

Regulation 21 applies to resource consent applications which include SO_2 as a contaminant in the discharge. Under this regulation, a consent authority must decline an application for resource consent if the discharge is likely to cause the concentrations of SO_2 in the airshed (Air Zone 2) to exceed the specified NES Standard.

Given the provisions of Regulation 21, compliance with the NES Standard for SO_2 will need to be assessed in the resource consent application in order to determine whether the discharge permit can or cannot be granted.

4.2.5 Summary

To summarise, the applicability or otherwise of Regulation 12 will need to be evaluated more fully in the resource consent application in terms of whether or not the operation of the Tahuna WWTP biosolids incinerator is prohibited. This assessment will principally need to be placed in the context of whether the Tahuna WWTP is a 'high temperature' and 'hazardous waste' incinerator or not.

The resource consent application documentation will also need to assess, in relation to the NO_2 and SO_2 concentrations contained within the Tahuna WWTP's discharges to air, whether the ambient air quality in Air Zone 2 will continue to comply, or not, with the specified NES Standards as a result of the discharges.

In respect of PM_{10}, as the discharge is within an airshed where the NES Standards for PM_{10} are exceeded, consideration will need to be given to the provisions of Regulations 16 and 17 as to whether the airshed is classified as a polluted airshed under Regulations 16 and 17 and whether resource consent can be granted.

If compliance with the relevant NES Standards cannot be achieved then it will be necessary to assess whether or not the consent authority can or cannot grant the discharge permit given the requirements of Regulations 17, 20 and 21.

4.3 Regional Policy Statement for Otago

The RPS, which became operative in October 1998, provides an overview of resource management issues within the region. As such it establishes a framework for achieving integrated management of resources while also providing guidance for subordinate plans.

The matters of regional significance covered by the RPS include the manawhenua perspective, land, water, air, coast, built environment, biota, natural hazards, energy, wastes and hazardous substances as well as monitoring and review of the RPS and cross boundary issues.

Chapter 7 (Air) and Chapter 13 (Wastes and Hazardous Substances) of the RPS are relevant to any resource consent application for the discharges to air from the Tahuna WWTP. Objectives and policies that will need to be assessed in the resource consent application are contained in Table 2.

Table 2: RPS – Relevant objectives and policies.

Objectives and policies	Description
Obj 7.4.1	To maintain and enhance Otago's existing air quality, including visual appearance and odour.
Pol 7.5.1	To recognise and provide for the relationship Kai Tahu have with the air resource in Otago.
Pol 7.5.2	To avoid, remedy or mitigate any discharges which have adverse effects on the air resource including effects on human health, the environment, visual impacts and odour.
Pol 7.5.3	To promote and encourage improvements to existing discharges in order to reduce the amount and toxicity of contaminants released.
Pol 7.5.5	To encourage the use of fuels and combustion processes that have minimum adverse effects on the environment.
Obj 13.4.1	To protect Otago's communities, environment and natural resources from the adverse effects of the waste stream.
Pol 13.5.1	To recognise and provide for the relationship Kai Tahu have with natural and physical resources when managing Otago's waste stream through: (a) Providing for the management and disposal of Otago's waste stream in a manner that takes into account Kai Tahu cultural values; ...

As the above policy framework is self-explanatory, the implications for the resource consent application have not been summarised any further within this section of this document.

4.4 Regional Plan: Air for Otago

4.4.1 Overview

The Air Plan became operative in January 2003. Plan Change 1, relating to fire service training and building disposal, became operative in April 2006 and Plan Change 2 (National Environmental Standards) became operative in January 2009. The Air Plan promotes sustainable management of the region's air resource.

It is noted that as a result of the 2011 amendments to the NES with respect to PM_{10} discharges, the Air Plan now contains provisions which are inconsistent with the amended NES. In this circumstance, the requirements of the NES take precedence over those of any regional plan except where the plan imposes stricter requirements (section 43B of the RMA and Regulation 28 of the NES).

4.4.2 Airsheds and regional ambient air quality guidelines

The Air Plan identifies various airsheds which are classified as Air Zone 1 to 3. The Tahuna WWTP is located within Air Zone 2. The explanation to Policy 9.1.1 identifies that PM_{10} concentrations within Air Zone 2, including Air Zone 2 (South Dunedin), exceed the NES Standards and therefore the airshed associated with this discharge is likely to be considered a 'polluted airshed').

Schedule 1 of the Air Plan contains Regional Ambient Air Quality Guidelines (RAAQG) which represent the ambient air quality, for the range of contaminants identified, that the Air Plan seeks to maintain for the region. This Schedule contains Otago Goal Levels, for a range of air quality parameters, which equate to 66% of the "MfE Levels" identified in Schedule 1 of the Air Plan. The MfE Levels comprise a mixture of the NES Standards and AAQG (MfE 2002). The relevant RAAQGs are contained in Table 3.

Table 3: Regional Ambient Air Quality Guidelines.

Indicator	Otago Goal Levels (µg/m^3)	MfE levels (µg/m^3)	Averaging times
PM_{10}	35	50	24 hrs
	-	20	Annual
SO_2	330	500	10 minutes
	230	350[1]	1 hr
	380	570	1 hr
	80	125	24 hrs
	-	50	Annual
NO_2	130	200[1]	1 hr
	60	100	24 hrs

Note: [1] Permissible exceedance as provided for by the NES Standards. Refer to Table 1 of this document.

The manner in which the Otago Goal Levels are to be used, when making decisions under the RMA, is outlined in the explanation to Policy 8.1.1. The key driver is to maintain air quality if the Otago Goal Levels are met, and in circumstances where these levels are not met the ambient air quality is considered degraded and therefore the resource management response is to aim to enhance ambient air quality. The overall aim is to ensure as much of Otago as possible has ambient contaminant concentrations below the Otago Goal Levels. It is also noted in the explanation to Policy 8.1.1 that the Otago Goal Levels are concerned with ambient air quality and thus the cumulative impacts of discharges. Accordingly, it is generally inappropriate to apply them directly to set emission limits or determine resource consent monitoring requirements for individual discharges.

4.4.3 Relevant objectives and policies

The Air Plan also contains objectives and policies that establish the management framework for activities that have the potential to affect the region's air resource. The relevant policy framework is contained in Table 4.

Table 4: Air Plan – Relevant objectives and policies.

Objectives and policies	Description
Obj 6.1.1	To maintain ambient air quality in parts of Otago that have high air quality and enhance ambient air quality in places where it has been degraded.
Obj 6.1.2	To avoid adverse localised effects of contaminant discharges into air on: (a) Human health; (b) Cultural, heritage and amenity values; (c) Ecosystems and the plants and animals within them; and (d) The life-supporting capacity of air.
Obj 6.1.3	To allow for the sustainable use of Otago's air resource.
Pol 7.1.1	To recognise and provide for the relationship Kai Tahu have with the air resource through procedures that enable Kai Tahu to participate in management of the air resource.
Pol 8.1.1	To have regard to the Otago Goal Levels identified in Schedule 1 and comply with the Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxics) Regulations 2004 in managing the region's ambient air resource.
Pol 8.2.3	In the consideration of any application to discharge contaminants into air, Council will have: (a) Particular regard to avoiding adverse effects including cumulative effects on: (i) Values of significance to Kai Tahu; (ii) The health and functioning of ecosystems, plants and animals; (iii) Cultural, heritage and amenity values; (iv) Human health; and (v) Ambient air quality of any airshed; and (b) Regard to any existing discharge from the site, into air, and its effects.
Pol 8.2.4	The duration of any permit issued to discharge contaminants into air will be determined having regard to: (a) The mass and nature of the discharge; (b) The nature and sensitivity of the receiving environment; and (c) Any existing discharge from the site, into air, and its effects.
Pol 8.2.5	To require, as appropriate, that provision be made for review of the conditions of any resource consent to discharge contaminants into air.
Pol 11.1.1	To avoid or mitigate any adverse effects on human health or amenity values resulting from the discharge of offensive or objectionable odour through the use of: (a) Good management practices (including the use of codes of practice) and process technology that has an inherently low odour potential to ensure the amount of odorous contaminants generated by a process or activity is minimised; (b) Appropriate control technologies to reduce the emission of odorous contaminants; (c) Site planning mechanisms and other land use management techniques to reduce the potential for adverse off site effects; and (d) Tools and techniques that provide an objective assessment of odour, such as olfactometry, odour dose response assessments and community surveys.

In addition to the above objectives and policies, Policy 9.1.1 also may be relevant to the Tahuna WWTP's discharges to air application. This policy aims to reduce PM_{10} discharges so as to meet the NES standard for PM_{10}, using the straight line path for Air Zone 2, by 1 September 2012. However, the 2011 amendments to the NES removed the requirement to use straight line and curved line paths for achieving compliance with the standards by September 2013. Rather the amended NES now proposes a modified regime based around polluted airsheds (refer to Regulations 16 and 17) and an effective extended timeframe of 1 September 2020 for compliance with the NES standards. Given the direction now provided by the NES, it is considered it is not appropriate to consider Policy 9.1.1 in relation the discharges from the Tahuna WWTP. However, given that the outcomes sought by this policy could be considered to be more stringent than the current NES requirements, it is important to be aware that ORC may consider that this policy still applies. It is recommended clarification be sought from ORC on the current application of this policy, given the recent amendments to the NES.

Policy 9.1.2 relates to the offsetting the discharge of PM_{10}. This policy has similarities with the approach provided for in Regulation 17(3) of the NES, but is nevertheless different. Given that the NES now provides this direction regarding PM_{10} reductions, it is considered it is not appropriate to consider Policy 9.1.2 in relation to the PM_{10} discharges from the Tahuna WWTP.

4.4.4 Applicable rules

4.4.4.1 Overview

The Air Plan rules relating to discharges from incineration, combustion (i.e., the diesel generator), waste management discharges and the discharge of PM_{10} are relevant to the Tahuna WWTP discharges to air. These rules have been assessed below.

4.4.4.2 Burning or incineration of specified materials (section 16.3.3)

Rule 16.3.3.1 (prohibited activity) and 16.3.3.2 (discretionary activity) specify that the burning of sewage sludge (i.e., biosolids) and associated solids, or solids derived from liquid borne municipal, industrial or trade waste are prohibited unless they are burnt in an incinerator or crematorium, in which case they are a discretionary activity requiring resource consent. Given that it is proposed to use an incinerator to incinerate biosolids at the Tahuna WWTP, Rule 16.3.3.2 applies and resource consent will need to be sought for a discretionary activity.

4.4.4.3 Products of combustion from fuel burning equipment

Rule 16.3.4.1 (permitted activity) provides for the discharge of contaminants to air from fuel burning equipment. The diesel fired generator on the site complies with part (2) of this rule as it does not exceed a heat output of 5 MW and burns only oil with a sulfur content of less than 1 %. In addition, it is understood that the DCC intend to ensure that condition (a) of the permitted activity rule which requires that in the case of equipment installed after 1998, any associated chimney must comply with Schedule 6 (Determination of Chimney Heights), will be complied with. Therefore, the discharges to air from the diesel fired generator are a permitted activity in accordance with Rule 16.3.4.1 and a resource consent does not need to be sought for this component of site discharges.

4.4.4.4 Waste management processes

Discharge of contaminants to air arising from waste management processes are addressed under Section 16.3.7 of the Air Plan.

Rule 16.3.7.1 provides for discharges to air associated with the storage, transfer, treatment and disposal of liquid borne municipal waste as a permitted activity where the influent liquid waste does not exceed a BOD_5 of 850 kg per day and where a range of other standards are to be complied with. As the activity does not comply with the BOD_5 limit the discharges to air from the Tahuna WWTP are not permitted by Rule 16.3.7.1. Therefore, a resource consent for a discretionary activity is required in accordance with Rule 16.3.7.3.

4.4.4.5 Discharges of PM_{10}

Section 16.3.15 of the Air Plan contains rules relating to the discharge of PM_{10} where such discharges may be a component of an activity requiring resource consent as a discretionary activity in accordance with the other rules of the Air Plan (i.e., in sections 16.3.1 to 16.3.14). As outlined in Section 4.4.2 of this document, the site is located in Air Zone 2, which under the Air Plan and possibly the NES is classified as a polluted airshed due to PM_{10} at times exceeding the ambient air quality standards for PM_{10}. Taking these exceedences into account, Rules 16.3.15.1 to 16.3.15.3 are likely to be relevant.

Rule 16.3.15.1 prohibits the discharge of PM_{10} to air if the activity is not provided for by any permitted activity rule or specific discretionary activity rules (Rules 16.3.1 to 16.3.14 and 16.3.15.2 to 16.3.15.5). As outlined within this section of the document, there are permitted and specific discretionary activity rules that apply to the discharges to air from the waste incinerator and the diesel fired generator (the potential sources of PM_{10}) and therefore Rule 16.3.15.1 (prohibited activity) does not apply to these activities.

Pending the outcome of the technical assessment, an assessment will need to be made as to whether there are any emissions of PM_{10} that trigger the resource consent application also being considered under Rule 16.3.15.2 (discretionary activity), particularly given that this is an existing discharge. It is considered that if Rule 16.3.15.2 does not apply as result of PM_{10} discharges arising from the site, then an assessment of the remaining rules within this section of the Air Plan will need to be considered.

Pending the outcome of the technical assessment, and a determination as to what rules, if any, apply in respect of the PM_{10} rules in the Air Plan, the application will still need to be assessed against the NES as discussed in Section 4.2.3 above.

4.4.4.6 Summary

The discharges to air from the Tahuna WWTP require a discharge permit in accordance with the following rules of the Air Plan:

- Rule 16.3.3.2 (discretionary activity) which provides for the discharge of contaminants from incineration of sewage sludge (i.e., biosolids) and associated solids, or solids derived from liquid borne municipal, industrial or trade waste within an incinerator
- Rule 16.3.7.3 (discretionary activity) which provides for the discharge of contaminants associated with the storage, transfer, treatment and disposal of liquid borne municipal waste not meeting the permitted activity standards of 16.3.7.1
- Pending the outcome of the technical assessment, a discretionary activity resource consent may be required in accordance with Rule 16.3.15.2

The discharges to air from the diesel fired generator are a permitted activity (Rule 16.3.4.1) and a resource consent does not need to be sought for this component of the site discharges.

The overall status for the resource consent application for the discharges to air from the Tahuna WWTP is discretionary.

4.4.5 Summary of Air Plan provisions

To summarise, the key considerations arising from the Air Plan in relation to the discharges to air from the Tahuna WWTP are as follows:

- The Tahuna WWTP is located with Air Zone 2 (South Dunedin). The PM_{10} concentrations within Air Zone 2 exceed the NES Standards and therefore the airshed is considered a polluted airshed (as identified in the explanation to Policy 9.1.1).

- In relation to the policy framework for the Air Plan, the following matters will need to be addressed within the resource consent application. These are:
  - Compliance with the NES Standards (Policy 8.1.1)
  - Compliance with the RAAQGs contained in Schedule 1 of the Air Plan and which include Otago Goal Levels set at 66% of the AAQG or NES Standards. The Otago Goal Levels are to be *"had regard to"* in relation to managing the region's air resource (Pol 8.1.1). It can be inferred from the policy framework of the Air Plan, and related explanations, that if the Otago Goal Levels are not complied with then the ambient air quality could be considered degraded and therefore subject to being enhanced (Obj 6.1.1). If the Otago Goal Levels are achieved, then it can also be inferred that the existing ambient air quality is to be at least maintained, even if it is not ultimately enhanced (Obj 6.1.1).
  - The adverse effects of the Tahuna WWTP discharge on human health, heritage and amenity values, ecosystems (i.e., including plants and animals) and the life-supporting capacity of the air will need to be assessed (Obj 6.1.2, Obj 6.1.3, Pol 8.2.3 and Pol 8.2.4). In addition, the mechanisms (e.g., good management practice, control technologies etc.) for avoiding or mitigating any adverse effects on human health or amenity values, or objectionable odour, will need to be identified in circumstances where there are adverse effects, or potential adverse effects (Pol 11.1.1).
  - Kai Tahu relationship with the air resource, and values of significance, as identified through consultation (Obj 6.1.2 and Pol 8.2.3).
- Rules 16.3.3.2, and 16.3.7.3 (discretionary activities) relating to the discharges from the incinerator and waste management processes trigger the need to apply for an air discharge permit for the Tahuna WWTP. The discharges to air from the diesel fired generator are a permitted activity (Rule 16.3.4.1) and resource consent is not required for this component of the site's discharges. In addition, following completion of a technical assessment, it will be necessary to determine whether resource consent is required in accordance with Rule 16.3.15.2 (also discretionary) or whether other rules in section 16.3.15 of the Air Plan apply. Notwithstanding this, overall the application will be for a discretionary activity.

4.5 Regional Plan: Waste for Otago

4.5.1 Overview

The Waste Plan became operative in April 1997. Since becoming operative there have been no notified plan changes or formal reviews.

The Waste Plan seeks to provide an integrated management framework of all waste (i.e., liquid, solid, gaseous or radioactive) management activities within Otago. For this reason, the Waste Plan contains a policy framework, and where relevant related rules, covering manawhenua issues, waste minimisation, contaminated sites, hazardous substances and wastes, as well as landfills (i.e., including composting operations).

While the overall approach of the Waste Plan to minimise waste is considered relevant to this application, no particular rules within the Waste Plan are relevant to the Tahuna WWTP's discharges to air. While no rules are relevant, the relevant objectives and policies of the Waste Plan still necessitate assessment as part of the resource consent application.

4.5.2 Relevant objectives and policies

The relevant objectives and policies in the Waste Plan are contained in Table 5.

Table 5: Waste Plan – Relevant objectives and policies.

Objectives and Policies	Description
Section 4 – Waste Minimisation	
Obj 4.3.2	To maximise the opportunities for the reuse, recycling and recovering of materials from the waste stream.
Pol 4.4.1	To recognise and provide for the relationship Kai Tahu have with natural and physical resources by: (a) Acknowledging that future generations will inherit the results of good and bad waste management practices; (b) Providing for the management of Otago's waste stream in a manner that takes into account Kai Tahu cultural values; and (c) Maintaining consultation with Kai Tahu on issues relating to waste management.
Pol 4.4.2	To encourage, support and facilitate integrated waste management by (in order of priority): (a) Minimising the effects on the environment by reducing the quantity and / or toxicity of material entering the waste stream. (b) Reusing materials; (c) Recycling materials, where practicable, that cannot be reused; (d) Recovering resources from materials in the waste stream; and (e) Disposing of the residual waste in an environmentally safe manner.

As the above policy framework is self-explanatory, the implications for the resource consent application have not been summarised any further within this section of this document.

5.0 OTHER CONSIDERATIONS

5.1 Overview

This section identifies the provisions of 'other matters'[3] that will need to be assessed in the resource consent application for the Tahuna WWTP's air discharges.

5.2 WHO Air Quality Guidelines

In 2006, the World Health Organisation (WHO) published a global update to its SO_2 guidelines (WHO 2005). This update contains guidelines for 10 minute and 24 hr average SO_2 concentrations. In the update, the 10 minute guideline remains at 500 µg/m^3 while the 24 hour guideline has been reduced to 20 µg/m^3 with an interim target of 50 µg/m^3. The 24 hour WHO Guideline is lower than the AAQG of 120 µg/m^3, discussed in Section 5.3 of this document, which was based on the previous WHO guidelines.

A review of the background information has clarified that the WHO 24-hour guideline relates principally to one Hong Kong study where the reduction in fuel oil sulfur levels resulted in a reduction of airshed wide 24-hour SO_2 levels, and a subsequent reduction in population mortality rates (Environ Medical Services Ltd

[3] Under section 104(1)(c) of the RMA.

2008). The spatial and temporal patterns of ambient 24-hour SO_2 within Hong Kong are very different to New Zealand airsheds. In New Zealand, peak 24-hour SO_2 levels occur close to industrial sites and are not representative of average levels, and are also not usually representative of the wider airshed.

In addition to the spatial and temporal issues raised above, there also appears to be significant uncertainty about whether SO_2 is the contaminant of concern, or whether the mix of the contaminants is more important with SO_2 acting as a proxy for these contaminants in the Hong Kong study (Environ Medical Services Ltd 2008).

Based on the above, Golder considers it premature to use the 24-hour WHO guideline to assess this application or any localised GLC impacts from industrial sites in New Zealand. This is particularly so when assessing the modelling results of localise SO_2 GLCs close to an industrial point source, as opposed to a concentration that is representative of a wider airshed. Internationally, guidelines are applied to the latter concentrations rather than localised impacts. At this time, the revised WHO guideline has not been formally adopted by the MfE. Accordingly, this guideline has not been used for assessing potential health effects associated with this application, as it is not considered effects based.

Golder considers there is significant uncertainty regarding the health benefits of complying with the new WHO guidelines when applying these to localised peak impacts near industrial sites that are relatively infrequent (Environ Medical Services Ltd 2008). On this basis, it is considered that there would not be a need to assess site discharges against the WHO guidelines for SO_2 as part of the applications for resource consent.

Finally, other WHO guidelines do not need to be assessed in relation to the Tahuna WWTP, as they have been assessed, and where relevant, incorporated into the AAQG and NES Standards.

5.3 Ambient Air Quality Guidelines

The AAQGs (MfE 2002), like the NES Standards, are values for ambient concentrations of atmospheric contaminants that have been set as values for the protection of human health and the environment. Unlike the NES Standards, the AAQGs are not mandatory values. However, the AAQGs are used to assess the effects of discharges of contaminants to air and for this reason they will need to be considered in the resource consent application.

The AAQGs that will be applicable to the Tahuna WWTP's discharges to air are contained in Table 6.

Table 6: Relevant AAQGs.

Contaminant	Averaging period	Guideline (µg/m^3)
PM_{10}	24 hr	50*
PM_{10}	Annual	20
SO_2	1 hr	350*
SO_2	24 hr	120
NO_2	1 hr	200*
NO_2	24 hr	100
Mercury	Annual	3.3×10^{-1}

Note: * Indicates that there is an NES Standard for this contaminant and averaging period. In such cases, although the AAQG and NES Standards are the same, for assessment purposes, the NES Standard should be used.

5.4 Kai Tahu ki Otago – Natural Resource Management Plan

The KTkO Plan is an iwi management plan developed by the runaka who have kaitiaki within the Otago region. It identifies Kai Tahu ki Otago's[4] management framework for the region's resources, including the air resource.

Section 5.7 of the KTkO Plan contains the policy framework in relation to the 'Air and Atmosphere (Hau me te Hau Takiwa)' of the Otago Region as a whole. The KTkO Plan identifies the Tahuna WWTP as being within the Otago Harbour Catchment although the policy framework associated with the Otago Harbour Catchment does not address air discharge. Although not relevant to the matters outlined in this document, it is also noted that point source wastewater discharge from the Tahuna WWTP is identified under the Coastal Environment Section of the KTkO Plan.

The relevant objectives and policies identified in section 5.7 of the KTkO Plan are contained in Table 7.

Table 7: Kai Tahu ki Otago – Relevant objectives and policies.

Objectives and policies	Description
Section 5.7 – Air and Atmosphere (Hau me te Hau Takiwa) for the Otago Region	
Obj 5.7.2(i)	Kai Tahu ki Otago sites of significance are free from odour, visual and other pollutants.
Obj 5.7.2(ii)	Kai Tahu ki Otago are meaningfully involved in the management and protection of the air resource.
Obj 5.7.2(iii)	The life-supporting capacity and mauri of air is maintained for future generations.
Pol 5.7.3.3	To require Cultural Assessments for any discharges to air including agrichemical.

As the above policy framework is self-explanatory, the implications for the resource consent application has not been summarised any further within this section of this document. It is noted that Policy 5.7.3.3 identifies that Kai Tahu will require a Cultural Impact Assessment to be completed. The need for such an assessment should be determined through consultation with Kai Tahu.

5.5 Dunedin City District Plan

While not a matter for consideration as part of the applications to discharge contaminants to air, it is noted that under the Dunedin City District Plan (District Plan) the site is designated for the purposes of "Waste Water Treatment Plant" - identified as D653 on Dunedin City Zone Map No. 51. The requirements of the RMA for undertaking works on a designated site apply to works undertaken on the site, that is (subject to conditions attached to the designation), land use activities can proceed without the need for a resource consent, although an Outline Plan must be provided to the DCC prior to works commencing. While the Tahuna WWTP is designated, as a land use management tool, the designation does not apply to activities managed by regional councils, including activities such as the discharge of contaminants to air.

[4] Kai Tahu ki Otago, as identified in Section 1.5 of the KTkO Plan, is the four Papatipu Runaka (i.e., Te Runanga o Moeraki, Kati Huirapa Runaka ki Puketeraki, Te Runanga o Otakou and Hokonui Runanga) and associated whanau and ropu (i.e., Moturata Taieri Whanau and Waikoau Ngai Tahu Runanga (S.O.) Incorporated) of the Otago Region.

6.0 SUMMARY

A key matter to be confirmed during the early phases of this resource consent process is whether or not the operation of the Tahuna WWTP incinerator is prohibited. This assessment will principally need to be placed in the context of whether the Tahuna WWTP incinerator is a 'high temperature' and a 'hazardous waste incinerator'.

In accordance with section 15(1) of the RMA and rules contained within the Air Plan, DCC will need to lodge a resource consent application for the discharges to air from the Tahuna WWTP at least six months prior to the expiry of the current discharge permit (Consent No. 2002.635). The overall activity status of the application is discretionary under the Air Plan.

The discharges to air from the diesel fired generator are a permitted activity (Rule 16.3.4.1) and resource consent is not required for this component of the site's discharges. The discretionary activity rules within the Air Plan that trigger the need to seek the air discharge permit are:

- Rule 16.3.3.2 (discretionary activity), which provides for the discharge of contaminants from incineration of sewage sludge (i.e., biosolids) and associated solids, or solids derived from liquid borne municipal, industrial or trade waste within an incinerator.
- Rule 16.3.7.3 (discretionary activity), which provides for the discharge of contaminants associated with the storage, transfer, treatment and disposal of liquid borne municipal waste not meeting the permitted activity standards of 16.3.7.1.
- Pending the outcome of the technical assessment, a discretionary activity resource consent may be required in accordance with Rule 16.3.15.2. If it is considered that this rule does not apply, an assessment of whether or not any of the other rules in section 16.3.5 of the Air Plan applies will need to be undertaken.

Given that a resource consent application must be lodged with the ORC, the key matters that will need to be addressed within the various technical assessments and resource consent application, that arise from the RMA and associated planning documents are, in no particular order, as follows:

- Consideration of the relevant matters from Part 2 of the RMA.
- The value of investment associated with the Tahuna WWTP.
- An assessment of alternative discharge methods and locations including the reasons for the choices made both previously and in relation to the ongoing operations of the Tahuna WWTP (i.e., this should include an assessment of alternative mitigation measures).
- Confirm whether or not the incinerator is a high temperature hazardous waste incinerator and therefore whether or not Regulation 12 of the NES prohibits the operation of the incinerator.
- Compliance with the NES Standards, AAQGs and Otago Goal Levels in the airshed (i.e., Air Zone 2). The standards and guidelines that are relevant to the Tahuna WWTP discharges to air are identified in Tables 1, 3 and 6 of this document. If these standards and / or guidelines cannot be complied with, then it is necessary to consider the following:
  - If the NES Standards cannot be complied with then it will be necessary to evaluate whether the discharge permit can be granted under the NES.
  - If the Otago Goal Levels are not complied with then the airshed quality will be considered degraded. Accordingly, enhancement of air quality, may be required through this resource consent process (refer to Section 4.4 of this document).

- An assessment of the actual and potential effects of the discharges to air, particularly in relation to the life-supporting capacity of the air, Kai Tahu values, ecosystems, human health, heritage and amenity values as well as ambient air quality of the Air Zone 2. Mechanisms to avoid, remedy and mitigate adverse effects (e.g., different treatment options, implementation of best practice approaches, waste minimisation concepts, future monitoring etc.) should also be identified.

7.0 REFERENCES

DCC 2006. Dunedin City District Plan. Prepared by Dunedin City Council, July 2006.

Environ Medical Services Ltd 2008. Review of the World Health Organisation's Guideline for 24-Hour Sulfur Dioxide - Implications for New Zealand, A report prepared by Environ Medical Services Ltd, August 2008.

European Environment Agency 2006a. Basel Convention, Annex I, Categories of wastes to be controlled. Retrieved from http://scp.eionet.europa.eu/definitions/annexes/baseli. Accessed 2 July 2012.

European Environment Agency 2006b. Basel Convention, Annex III, List of hazardous characteristics. Retrieved from www.http://scp.eionet.europa.eu/definitions/annexes/baseliii. Accessed 2 July 2012.

KTkO 2005. Natural Resource Management Plan. Prepared by Kai Tahu ki Otago, 2005.

MfE 2002. Ambient Air Quality Guidelines. Prepared by the Ministry for the Environment, 2002.

ORC 1997. Regional Plan: Waste for Otago. Prepared by Otago Regional Council, April 1997.

ORC 1998. Regional Policy Statement for Otago. Prepared by Otago Regional Council, October 1998.

ORC 2009. Regional Plan: Air for Otago. Prepared by Otago Regional Council, January 2003 and updated January 2009.

Resource Management Act 1991. Retrieved from http://www.legislation.govt.nz/act/public/1991/0069/latest/whole.html. Accessed 18 June 2012.

Resource Management (National Environmental Standards for Air Quality) Regulations 2004. SR 2004/309 (2004/433, 2005/214 and SR 2011/103). Incorporates the 2004, 2005 and 2011 amendments.

WHO 2006: Air Quality Guidelines Global Update 2005 – Particulate matter, ozone, nitrogen dioxide and sulfur dioxide. Prepared by the World Health Organisation, Geneva.

APPENDIX A

Report Limitations

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APPENDIX B

Annexes I and III of the Basel Convention

Basel Convention, Annex I, Categories of wastes to be controlled

Waste Streams	
Y1	Clinical wastes from medical care in hospitals, medical centers and clinics
Y2	Wastes from the production and preparation of pharmaceutical products
Y3	Waste pharmaceuticals, drugs and medicines
Y4	Wastes from the production, formulation and use of biocides and phytopharmaceuticals
Y5	Wastes from the manufacture, formulation and use of wood preserving chemicals
Y6	Wastes from the production, formulation and use of organic solvents
Y7	Wastes from heat treatment and tempering operations containing cyanides
Y8	Waste mineral oils unfit for their originally intended use
Y9	Waste oils/water, hydrocarbons/water mixtures, emulsions
Y10	Y10 Waste substances and articles containing or contaminated with polychlorinated biphenyls (PCBs) and/or polychlorinated terphenyls (PCTs) and/or polybrominated biphenyls (PBBs)
Y11	Waste tarry residues arising from refining, distillation and any pyrolytic treatment
Y12	Wastes from production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish
Y13	Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives
Y14	Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on man and/or the environment are not known
Y15	Wastes of an explosive nature not subject to other legislation
Y16	Wastes from production, formulation and use of photographic chemicals and processing materials
Y17	Wastes resulting from surface treatment of metals and plastics
Y18	Residues arising from industrial waste disposal operations
Wastes having as constituents:	
Y19	Metal carbonyls
Y20	Beryllium; beryllium compounds
Y21	Hexavalent chromium compounds
Y22	Copper compounds
Y23	Zinc compounds
Y24	Arsenic; arsenic compounds
Y25	Selenium; selenium compounds
Y26	Cadmium; cadmium compounds

Y27	Antimony; antimony compounds
Y28	Tellurium; tellurium compounds
Y29	Mercury; mercury compounds
Y30	Thallium; thallium compounds
Y31	Lead; lead compounds
Y32	Inorganic fluorine compounds excluding calcium fluoride
Y33	Inorganic cyanides
Y34	Acidic solutions or acids in solid form
Y35	Basic solutions or bases in solid form
Y36	Asbestos (dust and fibres)
Y37	Organic phosphorus compounds
Y38	Organic cyanides
Y39	Phenols; phenol compounds including chlorophenols
Y40	Ethers
Y41	Halogenated organic solvents
Y42	Organic solvents excluding halogenated solvents
Y43	Any congenor of polychlorinated dibenzo-furan
Y44	Any congenor of polychlorinated dibenzo-p-dioxin
Y45	Organohalogen compounds other than substances referred to in this Annex (e.g. Y39, Y41, Y42, Y43, Y44)

Basel Convention, Annex III, List of hazardous characteristics

UN Class Code Characteristics

H1	Explosive An explosive substance or waste is a solid or liquid substance or waste (or mixture of substances or wastes) which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such speed as to cause damage to the surroundings.
H3	Flammable liquids The word "flammable" has the same meaning as "inflammable." Flammable liquids are liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (for example, paints, varnishes, lacquers, etc., but not including substances or wastes otherwise classified on account of their dangerous characteristics) which give off a flammable vapour at temperatures of not more than 60.5 C, closed-cup test, or not more than 65.6C, open-cup test. (Since the results of open-cup tests and of closed-cup tests are not strictly comparable and even individual results by the same test are often variable, regulations varying from the above figures to make allowance for such differences would be within the spirit of this definition.)
H4.1	Flammable solids Solids, or waste solids, other than those classed as explosives, which under conditions encountered in transport are readily combustible, or may cause or contribute to fire through friction.
H4.2	Substances or wastes liable to spontaneous combustion Substances or wastes which are liable to spontaneous heating under normal conditions encountered in transport, or to heating up on contact with air, and being then liable to catch fire.
H4.3	Substances or wastes which, in contact with water emit flammable gases Substances or wastes which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.
H5.1	Oxidizing Substances or wastes which, while in themselves not necessarily combustible, may, generally by yielding oxygen cause, or contribute to, the combustion of other materials.
H5.2	Organic Peroxides Organic substances or wastes which contain the bivalent-O-O- structure are thermally unstable substances which may undergo exothermic self-accelerating decomposition.
H6.1	Poisonous (Acute) Substances or wastes liable either to cause death or serious injury or to harm health if swallowed or inhaled or by skin contact.
H6.2	Infectious substances Substances or wastes containing viable micro organisms or their toxins which are known or suspected to cause disease in animals or humans.
H8	Corrosives Substances or wastes which, by chemical action, will cause severe damage when in contact with living tissue, or, in the case of leakage, will materially damage, or even

	destroy, other goods or the means of transport; they may also cause other hazards.
H10	Liberation of toxic gases in contact with air or water Substances or wastes which, by interaction with air or water, are liable to give off toxic gases in dangerous quantities.
H11	Toxic (Delayed or chronic) Substances or wastes which, if they are inhaled or ingested or if they penetrate the skin, may involve delayed or chronic effects, including carcinogenicity.
H12	Ecotoxic Substances or wastes which if released present or may present immediate or delayed adverse impacts to the environment by means of bioaccumulation and/or toxic effects upon biotic systems.
H13	Capable, by any means, after disposal, of yielding another material, e.g., leachate, which possesses any of the characteristics listed above.

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APPENDIX 3

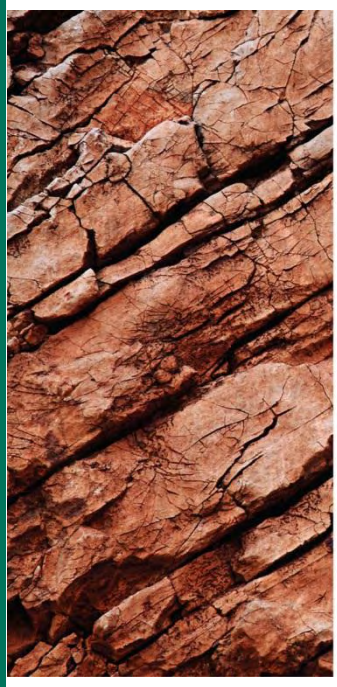
Tahuna Wastewater Treatment Plant. Assessment of Air Discharges Effects. Report No. 1278104628_003_R_Rev 1. Prepared by Golder Associates (NZ) Ltd. December 2012.

December 2012

TAHUNA WASTEWATER TREATMENT PLANT

Assessment of Air Discharge Effects

Submitted to:
Dunedin City Council
PO Box 5045
Civic Centre
50 The Octagon
Dunedin 9016



Report Number: 1278104628_003_R_Rev1

REPORT

Golder Associates

ABBREVIATIONS AND UNITS

°C	Degrees Celsius
µg/m³	Micrograms per cubic metre
AAQG	Ambient air quality guideline
ADMP	Air Discharge Management Plan
BPO	Best Practicable Option
BAT	Best Available Technology
AEE	Assessment of Effects on the Environment
BOD	Biological oxygen demand
BTF	Biological trickling filters
CO	Carbon monoxide
DCC	Dunedin City Council
DS	Dry solids
EWS	Electronic weather station
g/s	Grams per second
GBT	Gravity belt thickener
GLC	Ground level concentration
Golder	Golder Associates (NZ) Limited
GTT	Gravity tank thickener
H_2S	Hydrogen sulfide
HED	HRAS effluent discharge
HRAS	High rate activated sludge
ID	Induced draft
K	Kelvin
kg/h	Kilograms per hour
kg/m³	Kilograms per cubic metre
kW	Kilowatt
m/s	Metres per second
m²	Square metre
m³	Cubic metre
MfE	Ministry for the Environment
mg/m³	Milligrams per cubic metre
mg/Nm³	Milligrams per normalised cubic metre (0°C, 1 atmosphere pressure and dry)
MJ/kg	Megajoule per kilogram
MJ/m³	Megajoule per cubic metre
MoH	Ministry of Health
MPS	Musselburgh Pump Station

MW	Megawatt
NES	National Environmental Standards
NO_2	Nitrogen dioxide
NO_X	Oxides of nitrogen
ORC	Otago Regional Council
$OU/m^2/s$	Odour unit per square metre per second – see SOER
OU/m^3	Odour unit per cubic metre
OU/s	Odour unit per second
pg/m^3	Picogram per cubic metre
PJC	Papatuanuku Junction Chamber
PM_{10}	Fine particulate matter less than 10 microns in diameter
ppm	Parts per million
PS	Pumping station
RAAQG	Regional Ambient Air Quality Guideline
RMA	Resource Management Act 1991
RE	Recycled effluent
SLP	Straight line path
SO_2	Sulfur dioxide
SOER	Surface odour emission rate
STP	Standard temperature and pressure (0°C, 1 atmosphere pressure)
TSP	Total suspended particulate
TWAS	Thickened waste activated sludge
US EPA	United States Environmental Protection Agency
UV	Ultra-violet
WAS	Waste activated sludge
WWTP	Wastewater Treatment Plant

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1.0 INTRODUCTION

1.1 Overview

Dunedin City Council (DCC) operates the Tahuna Wastewater Treatment Plant (WWTP) located in the suburb of Tahuna in Dunedin. The WWTP treats the majority of the wastewater generated within Dunedin City itself, prior to discharge into the coastal marine area via a 1.1 kilometre (km) outfall.

The DCC is applying for a replacement resource consent to authorise the discharge of contaminants into the atmosphere from the total site. The WWTP is being upgraded to provide secondary treatment and ultra-violet (UV) disinfection of the wastewater before its discharge via the ocean outfall. The discharges to air from the site mainly comprise odour, aerosols and to a lesser extent combustion gases.

This report[1] provides an independent assessment of the potential air quality effects of emissions to air from the operation of the upgraded WWTP, including emissions from a biosolids incinerator and a standby diesel-fired electrical generator.

1.2 Background

The WWTP is located off Tahuna Road in Dunedin, approximately 300 m north of St Kilda Beach and immediately adjacent to residential dwellings (Figure 1).

Wastewater from the wider Dunedin City area is piped to the Musselburgh Pump Station, where it passes through a coarse screen (25 mm) before being pumped to the Tahuna WWTP.

DCC holds a resource consent for the discharge of contaminants into air from the WWTP (Consent No. 2002.625), which was granted by the Otago Regional Council (ORC) on 22 October 2004. This consent expires on 30 June 2013. The consent provides for discharges to air of odours resulting from the primary treatment of wastewater including products of combustion.

DCC is applying for a replacement of its air discharge permit, which will include changes to the treatment of wastewater and biosolids that occur as part of the upgrade.

1.3 Scope and Assessment Approach

This report is an independent assessment of the potential air discharge effects resulting from the operation of the upgraded WWTP. It has been prepared in conjunction with a statutory and planning regulations review (Golder 2012), which identifies relevant rules and regulations that this air quality assessment addresses.

This report addresses the main air discharge issue for the site, namely odour. It also addresses combustion contaminants resulting from biosolids incineration and the operation of a standby diesel-fired electrical generator. The main combustion contaminants include nitrogen dioxide (NO_2), and fine particulate matter less than ten microns in diameter (PM_{10}). The potential effects of these main contaminants, as well as the minor discharge of dioxins and mercury are all assessed.

A qualitative assessment due to pathogen exposure risk beyond the WWTP site boundary is also provided.

Dust emissions from the operation of the WWTP are expected to be negligible and are therefore have not been included in the scope of this assessment.

This assessment considers the recent history of community feedback regarding odour effects (via complaint records and odour annoyance surveys) and assesses the likely improvement in air quality that the up-graded WWTP system would achieve relative to the existing/historical plant. This approach places emphasis on

[1] This report is subject to Golder's standard report limitations which are provided in Appendix A.

establishing the effectiveness of fugitive emission containment and subsequent treatment, which is achieved through a review of odour extraction and biofilter systems at the site. The assessment also includes air dispersion modelling of emissions from the biofilters and generator to assess the potential effects of combustion contaminant discharges to air.

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TITLE | TAHUNA WASTEWATER TREATMENT PLANT SITE LOCATION

NOVEMBER 2012

PROJECT | 1278104628

1

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2.0 RECEIVING ENVIRONMENT

2.1 Nearby Sensitive Activities

The WWTP is bounded by residential housing to the north and recreational land, including a bowling club, golf club, croquet club, scout hall and playing fields on its western, eastern and southern boundaries. These facilities are labelled in Figure 2.

A densely populated residential area (approximately 1,350 residences) is located within 1,000 m to the north of the WWTP. The nearest residence is approximately 30 m from the site boundary, but over 100 m from wastewater processes that are housed at the site.

The surrounding residential area includes two schools to the north-west of the site. These are Tahuna Normal Intermediate (150 m away) and Musselburgh School is (380 m away). Tainui School is located approximately 190 m northeast of the site. There are also several churches in the area.

Other community facilities within the area but not so close to the WWTP site include the Dunedin Holiday Park, which is approximately 500 m west of the site, the Anderson Bay Cemetery, which is approximately 500 m from the eastern boundary of the WWTP and the Anderson Bay Crematorium which is approximately 1,000 m from the eastern boundary of the WWTP.

2.2 Background Air Quality

2.2.1 General

There are no other significant background sources of environmental/industrial odour within the area, except for the incoming sewerage system and Musselburgh pump station (MPS). However, the pump station is well enclosed and its air is extracted to an efficient biofilter system, so these other sources are not significant within the area of the WWTP. The area surrounding the WWTP will be subject to natural odours associated with the ocean and beach, but these are not expected to have any potential for cumulative effects with odours that escape the WWTP odour control system.

There are moderate levels of combustion-derived air contaminants due to background sources. However, these are not expected to be significant at the WWTP. The background combustion sources include motor vehicle and domestic burning emissions. Degradation of air quality due to the surrounding commercial sector is expected to be low as there are no heavy industrial activities within the surrounding area.

Background concentrations of PM_{10} and NO_2 are discussed in the following sections.

2.2.2 Respirable particulate matter

Measurements of PM_{10} have been made by the ORC at several locations in the Otago region using automated Beta-Attenuation monitors and high volume samplers. The nearest PM_{10} monitoring station to the Tahuna WWTP was located at Macandrew Road in South Dunedin, and operated from May 2007 to April 2009. Throughout this period, there were three 24-hour measurements that exceeded 50 micrograms per cubic metre (µg/m³). Two occurred during the winter of 2007, being 63 µg/m^3 and 51 µg/m³, and the other occurred in the winter of 2008 with a value of 64 µg/m^3.

The annual average PM_{10} concentration over the period May 2007 to April 2009 was 19 µg/m³. No PM_{10} monitoring has been reported for the South Dunedin site since 2009.

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TITLE KEY SENSITIVE RECEPTORS NEAR TAHUNA WWTP

NOVEMBER 2012

PROJECT 1278104628

2

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2.2.3 Nitrogen dioxide

ORC conducted monitoring of NO_2 at its Central Dunedin monitoring site at Albany Street using a mixture of passive sampling and wet chemistry monitoring between 1998 and 2004. The maximum 24-hour average reported was 30 µg/m³ (ORC 2005) which is much lower than the ambient air quality guideline (AAQG) of 100 µg/m³ (24-hour average) (see Section 5.0). Golder is not aware of any more recent monitoring that ORC has undertaken of NO_2 in Dunedin.

2.3 Meteorology and Terrain

The Tahuna WWTP is situated on relatively flat land (see Figure 1) adjacent to the coast. The land to the north of the site is situated on relatively flat terrain that generally extends to the Otago Harbour. Lawyers Head and the Otago Peninsula lie immediately to the east of the site.

The typical wind pattern at the location of the Tahuna WWTP is indicated by the wind rose in Figure 3. This wind rose has been generated by wind data measured by the National Institute of Atmospheric Research (NIWA) at the Musselburgh electronic weather station (EWS), which is located close to the Tahuna WWTP.

The data presented in Figure 3 covers the period of 30 June 2009 until 30 June 2012. It indicates that the strongest winds are from the west to southwest. Light winds (0.5 to 2.1 m/s), which result in poor dispersion for low level odour sources, mainly occur from the north. These light winds are likely to result from local cold air drainage flows from the hilly areas of HighCliff that occur during calm evening and morning periods.

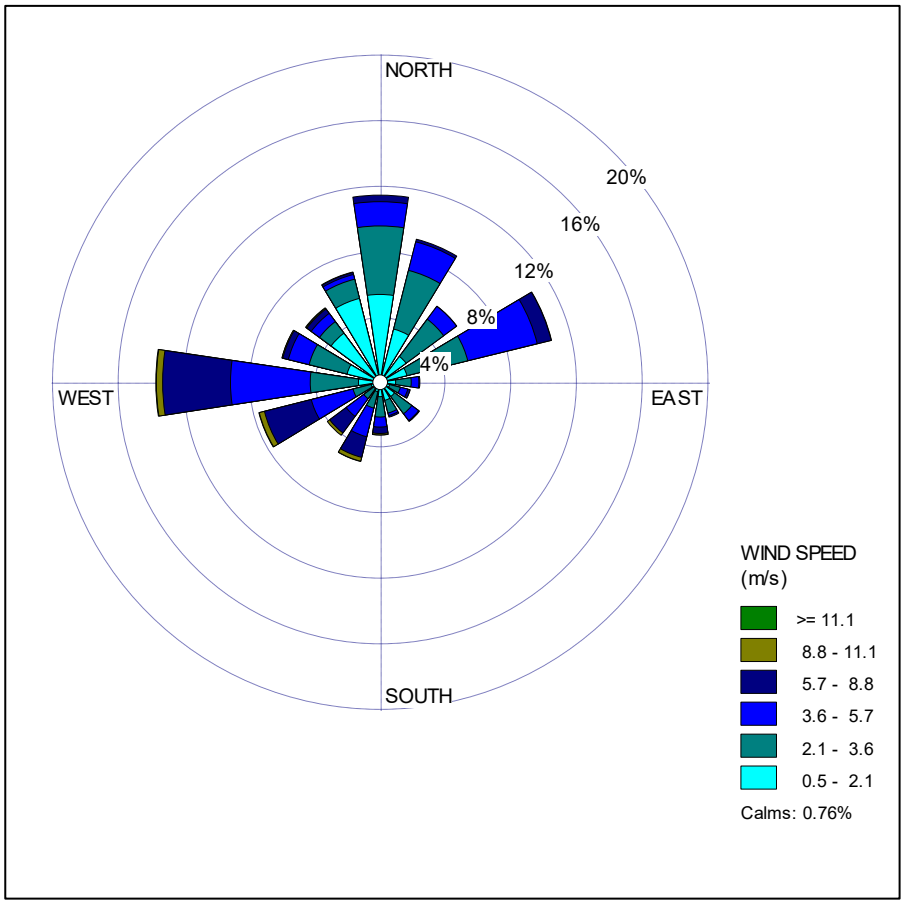

Figure 3: Wind rose for the Musselburgh EWS (30 June 2009 to 30 June 2012) (National Climate Database).

The wind rose also indicates that the WWTP site is situated in an ideal location with respect to the least frequent wind directions, which are from the east to southeast. Residential areas are only downwind of the site during these infrequent wind conditions.

3.0 PROCESS DESCRIPTION

3.1 Wastewater Treatment Stages

3.1.1 General

The raw inlet wastewater is made up primarily of municipal sewage with a small proportion of industrial waste. It is coarsely screened at the Musselburgh pumping station, which is approximately 0.5 km northwest of the Tahuna WWTP, prior to being finely screened at the Tahuna WWTP.

The layout of the up-graded WWTP is shown in Figure 4. This includes treatment processes and interconnection sumps prior to discharging treated wastewater to ocean, which are listed as follows:

- fine screening of inlet coarsely screened wastewater
- grit removal and high-rate activated sludge (HRAS) process
- HRAS Effluent Discharge (HED) sump
- aerobic biological trickling filtration (BTF) and sump
- ultra-violet (UV) disinfection
- Outfall flush chamber
- Outfall pump station and Papatuanuku junction chamber
- Biosolids dewatering and incineration.

The overall upgraded WWTP includes fine screening, HRAS using fine bubble diffusers, two parallel BTFs and UV disinfection prior to discharge. A schematic flow diagram showing the connections between the above stages is provided in Figure 5. As the wastewater reaches each of the successive treatment plant stages it becomes increasingly treated and therefore has a decreasing potential to create odour or pathogenic aerosols.

The remainder of this section provides a more detailed description of the individual process stages described in Figure 5, as well as stages involved in biosolids dewatering and incineration.

3.1.2 Screening

The Musselburgh pumping station supplies coarsely screened wastewater (that is to 25 mm) to the WWTP site. This inlet wastewater is then finely screened through three 2 millimetre (mm) screens to remove solids (plastics, and other materials) larger than 2 mm. These are screw conveyed from the screenings building and discharged to a sealed skip. The three screens are Subo contrashear units that operate in parallel and, along with a flow by-pass screen, are all housed in an enclosed screenings building. The enclosed conveyors from each Subo screen and by-pass screen, transfer screened material through to enclosed skips that are located within the adjoining building (solids storage and dispatch room). The containment of odours and aerosols from the screening stage is described in detail in Section 6.0.

The air discharges from screening includes odorous gases, such as hydrogen sulphide (H_2S), and aerosols that would contain pathogens.

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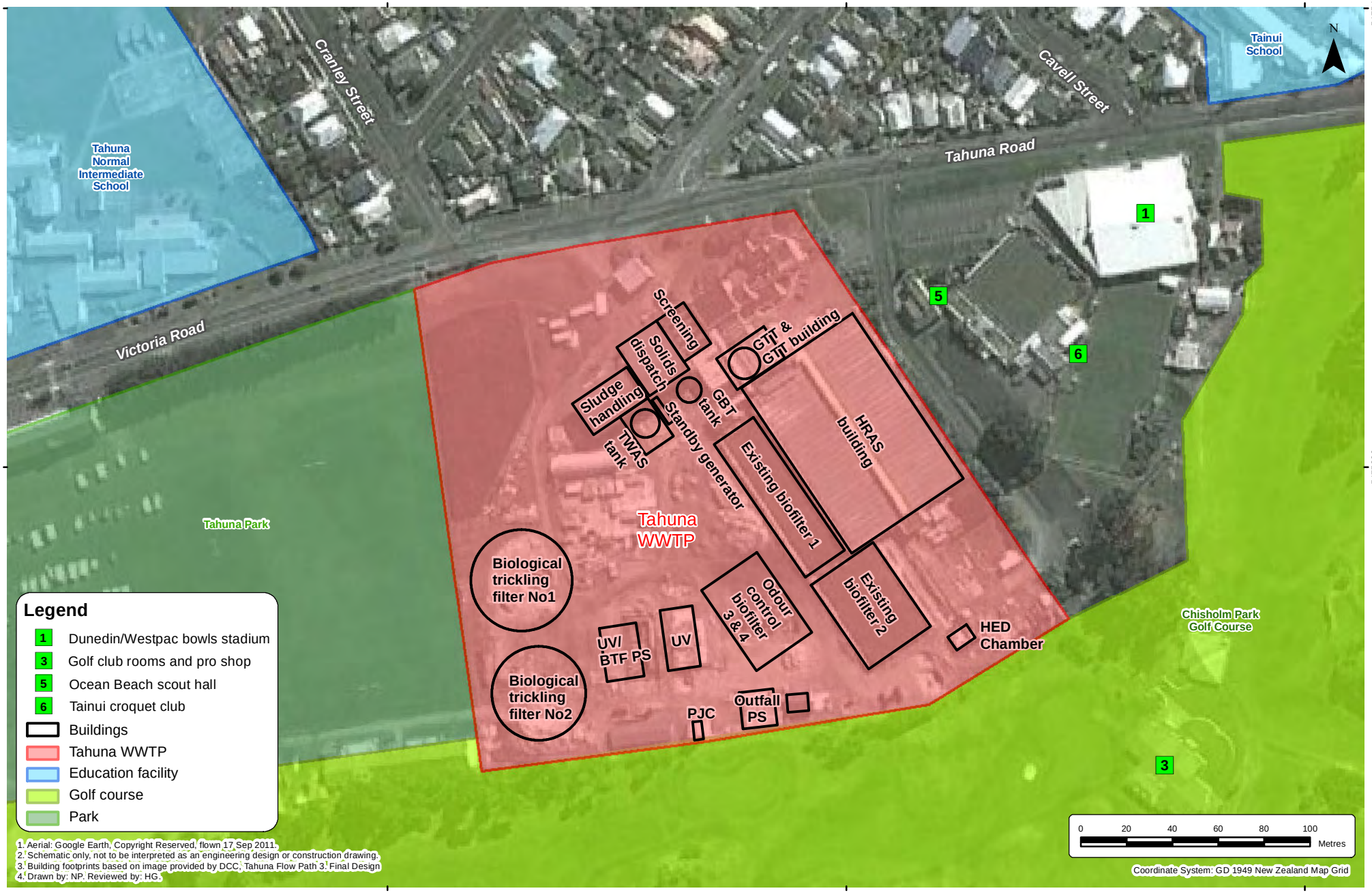

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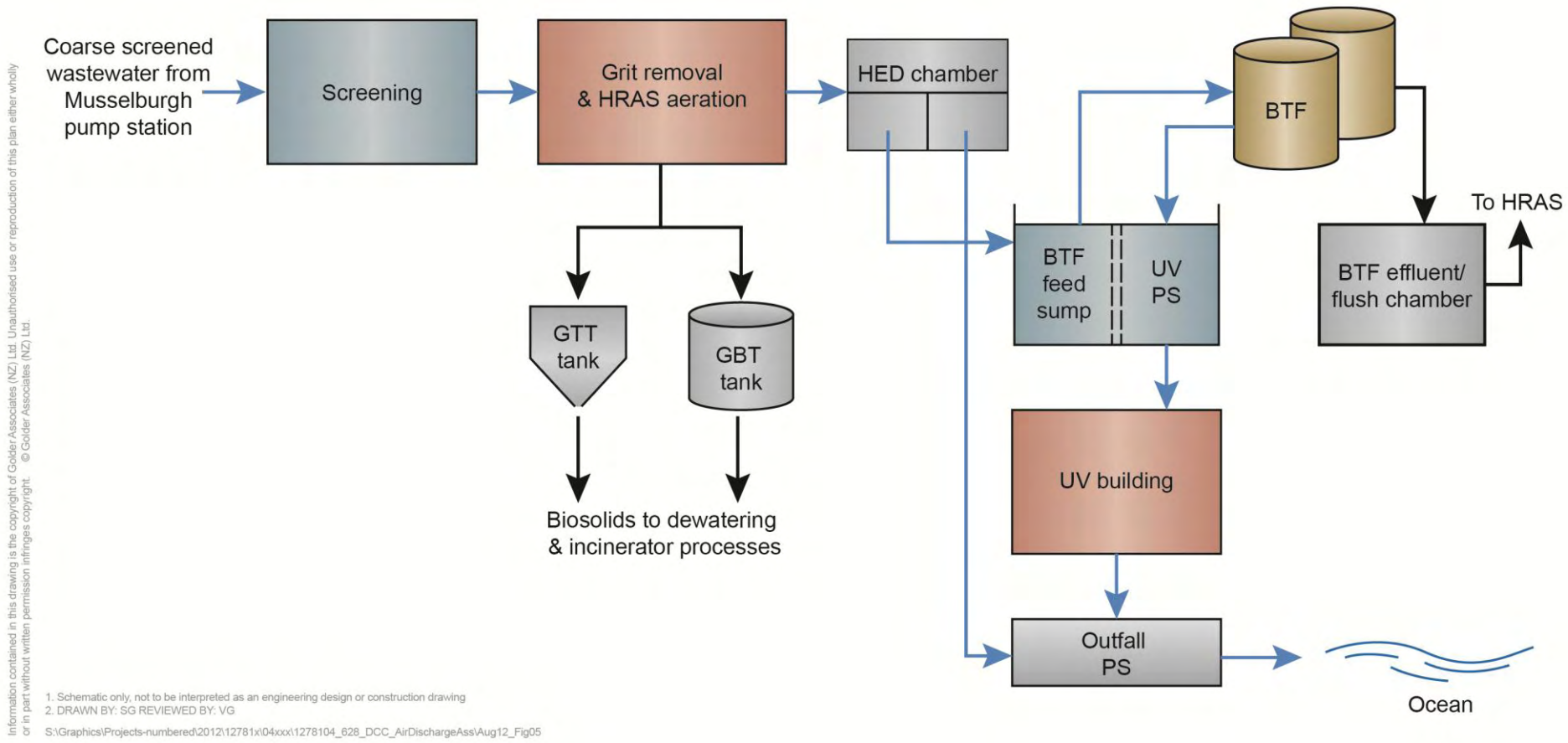

Figure 5: Wastewater treatment process flow schematic diagram.

3.1.3 High rate activated sludge

The three 16 m wide by 75 m long primary sedimentation tanks have been retrofitted to become a high-rate activated sludge (HRAS) process.

The HRAS tanks have an initial grit removal zone followed by a high rate aeration section and then a clarification zone. Fine bubble diffusers are used within the high rate aeration section of the tanks.

The nominal population loading of 125,000 population equivalents (PEs) is expected to result in an average biological oxygen demand (BOD) loading of 20,000 kg/day. Given a typical BOD reduction within the HRAS of 65 % and oxygen transfer efficiency of 30 % for fine bubble diffusers, an estimated aeration air supply rate of 1 cubic metre per second (m^3/s) is calculated for each of the three HRAS tanks (3 m^3/s in total). The DCC has confirmed that the design total flow rate of air is approximately 1.3 m^3/s into each HRAS tank (approximately 4 m^3/s in total).

Because the aeration stage will strip volatile and odorous compounds from the wastewater, the initial grit removal and aeration stages of the tanks are enclosed by covers that extend to the clarification stage of each tank. These air emissions (including odorous gases, aerosols and associated pathogens) are contained by a targeted extraction of air from within the enclosed head space. The extracted air and associated contaminants are vented to a biofilter system.

The clarification stage follows the aeration stage, where the tank surface is uncovered. In this quiescent stage, solids removal (flotation and sedimentation) occurs. These solids are collected by top and bottom surface scrapers and are pumped to the waste active sludge dewatering and handling system. There is minimal odour from this section of HRAS tank, as the wastewater is quiescent and has been stripped of odour by the proceeding aeration stage.

The HRAS effluent overflows via a covered weir into a covered effluent collection channel that runs along the end of each of the three HRAS tanks. This channel generates some turbulence and associated odour and aerosol discharges. For this reason, the channel also has its air space extracted and ventilated to a biofilter system. The effluent is then pumped to the HED sump.

The HRAS tanks are designed to process wastewater at a rate of 1.4 m^3/s, but can treat up to approximately 2.8 m^3/s before excessive biomass wash out occurs. Excess flow above these ranges is diverted around the HRAS system and re-joins the HRAS effluent flow in the collection channel. High wastewater flows into the plant are associated with high rainfall events, are relatively diluted and flush through the Dunedin City sewer system relatively quickly. Such flow conditions have minimal potential to cause any odour when passing through the WWTP. Any flow that is diverted around the HRAS is screened and has its odour and aerosol emissions extracted by inlet channel extraction system.

The partially-treated wastewater from the HRAS has less potential to generate odour compared to inlet coarsely screened wastewater. However, the turbulence within the HED sump still has the potential to generate odours and aerosols that will contain various pathogens. Therefore, the air from the sump is extracted to a biofilter as discussed in Section 6.0 (Odour Extraction and Biofiltration).

3.1.4 HED chamber

The HED chamber receives the HRAS effluent as well any HRAS by-passed flow (during high rainfall events) and directs up to 1.4 m^3/s to the two 37 m diameter Biological Trickling Filters (BTFs). During normal wastewater flow conditions (below 1.4 m^3/s), the HED sump directs the total flow to the BTFs (as described in Section 3.1.5). Excess flow above 1.4 m^3/s is diverted directly to the outfall pump station and bypasses the BTFs. The DCC has advised that approximately 95 % of inlet flows are less than 1.4 m^3/s and therefore would not bypass the BTFs. Under very high flows the HED sump is designed to direct the additional flow above 4 m^3/s directly to the Lawyers Head outfall (note the highest flow measured to date is 3.7 m^3/s). These flows are not expected and would nevertheless be very dilute, posing a low odour potential.

3.1.5 Biological trickling filters

The BTFs consist of two 37 m diameter tanks, each containing packed beds of plastic media that are approximately 4 m deep. Effluent from the HRAS is recirculated through the beds and aerobic conditions are enhanced by the forced down-drafting of 7 m^3/s of air per BTF (14 m^3/s in total). Biofilms develop on the

plastic media and which absorb and degrade further organic content within the wastewater. The inner layers of the biofilm are typically anaerobic despite the presence of air flow across the outer surface of the biofilms. Consequently, unpleasant secondary sewage odours and aerosols are produced by the BTFs but will be extracted with the single pass of fresh air from the top of the BTFs and then discharged to the new biofilter system.

To control the build-up of biofilms, the BTFs are flushed on a daily basis with high recirculating flows. During this flushing period, the stream containing washed-off biofilm, is returned to the HRAS system. This enables the washed off biofilm to be recovered to the HRAS biosolids handling system.

Because of the possible generation of unpleasant odours within the BTFs they will be covered and this combined with downward flow of air through the each bed at 7 m^3/s allows these odours to be contained and ventilated to a new biofilter system.

3.1.6 BTF sumps

The BTF sump has several chambers including that receiving effluent from the HED chamber, a BTF recirculation sump, and BTF discharge to the UV building sump. The BTF flush sump pumps the flushed-off biomass-laden streams back to the HRAS. The BTF sump and BTF flush sumps are all covered and their head space air is directly extracted to a new biofilter treatment system.

3.1.7 Ultraviolet disinfection

Disinfection of the BTF treated wastewater prior to discharging to the outfall will be carried out using UV irradiation. Previously disinfection was via a chlorine contact tank, which will now be used as the outfall flush tank (described in Section 3.1.7 below).

Since the wastewater is disinfected at this point, pathogens present in the wastewater would exist at low levels relative to earlier stages of the treatment process.

Odour associated with the wastewater at this stage of the treatment process is expected to be relatively low by the time this exits the BTFs. However, the pump station that lifts the wastewater up to the UV plant building and the channels that collect UV treated effluent will have air extracted and discharged to the new biofilter system. The UV building air is expected to contain only minor levels of odour and is vented directly to atmosphere.

3.1.8 Outfall flush tank

The outfall flush tank is filled over a period of two hours and has an estimated volume of 2,200 m^3. This volume is released to the ocean outfall over a 10 minute period during night time hours when inlet flows are relatively low. The increase in flow allows the ocean outfall to be purged out and cleared of any solids/algae build-up and air on a daily basis. Air that is displaced from the tank during filling is discharged through a carbon filtered air vent. The outfall flush tank's head space is also extracted to the existing biofilter system and described in Section 6.0.

3.1.9 Outfall Pump Station and Papatuanuku Junction Chamber

Following UV disinfection, the treated wastewater flows to the Outfall Pump Station and Papatuanuku Junction Chamber (PJC) which discharge treated wastewater to the new ocean outfall line.

The treated wastewater will be turbulent as it is flows into pump station and into the PJC, which could generate aerosols and some odour. However, the potential for this to cause adverse effects would generally be low due to the high level of treatment by these final stages. Nevertheless, the air is extracted from the Outfall pump station and head of the PJC to the existing biofilter system.

3.2 Solids Processing Overview

3.2.1 General

Prior to the plant upgrade, the sewage was screened for fine material at Musselburgh and the grit removal/HRAS system shown in Figure 4 only involved limited grit removal and primary solids settling. The primary wastewater biosolids generated were then thickened, dewatered and then incinerated.

With the upgrade of the WWTP, the production of secondary biosolids from the HRAS and BTFs will increase the volumes of biosolids that need to be processed at the site. A schematic of the solids handling processes following the upgrade is described in Figure 6.

The incineration of thickened biosolids from the gravity thickener tank (GTT) will continue, as will the use of the existing Dewa Belt Press and biosolids load out and export from the site. However, this belt press can be supplied with thickened biosolids from either the new thickened waste activated sludge (TWAS) tank or the GTT as currently occurs. There will also be a new biosolids dewatering and storage system that allows for biosolids dewatering, load out and export from the site.

Dewatered biosolids that are exported from the site are intended to be sent to the Green Island WWTP or landfill for anaerobic digestion and subsequent biogas production (via the landfill or an anaerobic biosoilds digester). In both cases, biosolids are being used to generate power that drives the Green Island WWTP with some exported to the national grid.

A certain level of biosolids exported from the site is necessary to remove incinerator ash, but is also desirable for optimising the power generation at the DCC's Green Island biogas production facility. The upgrade allows Tahuna WWTP biosolids to be utilised for power generation via biogas produced by the Green Island biogas plant, from gas generated and extracted from the Green Island landfill.

More detailed descriptions are provided below of the biosolids thickening and storage and the two main biosolids processing routes; that is, dewatering and load out versus dewatering and incineration.

3.2.2 Biosolids thickening and storage

The primary and secondary biosolids streams are pumped from the HRAS tanks to the existing Gravity Tank Thickener (GTT) and the Gravity Belt Thickener (GBT) tank. The latter provides a buffer ahead of the new gravity belt thickeners, which then discharges thickened HRAS biosolids to the TWAS tank. Therefore, the new GBT tank and the gravity belt thickeners it supplies parallels the function of GTT that currently thickens the HRAS biosolids. However, the latter discharges thickened biosolids directly to further dewatering stages, rather than to storage. The gravity belt thickeners work by distributing the biosolids over a perforated belt and discharge thickened biosolids to the TWAS tank for storage before further processing. Supernatant from the belt thickeners and the GTT returns to the HRAS inlet.

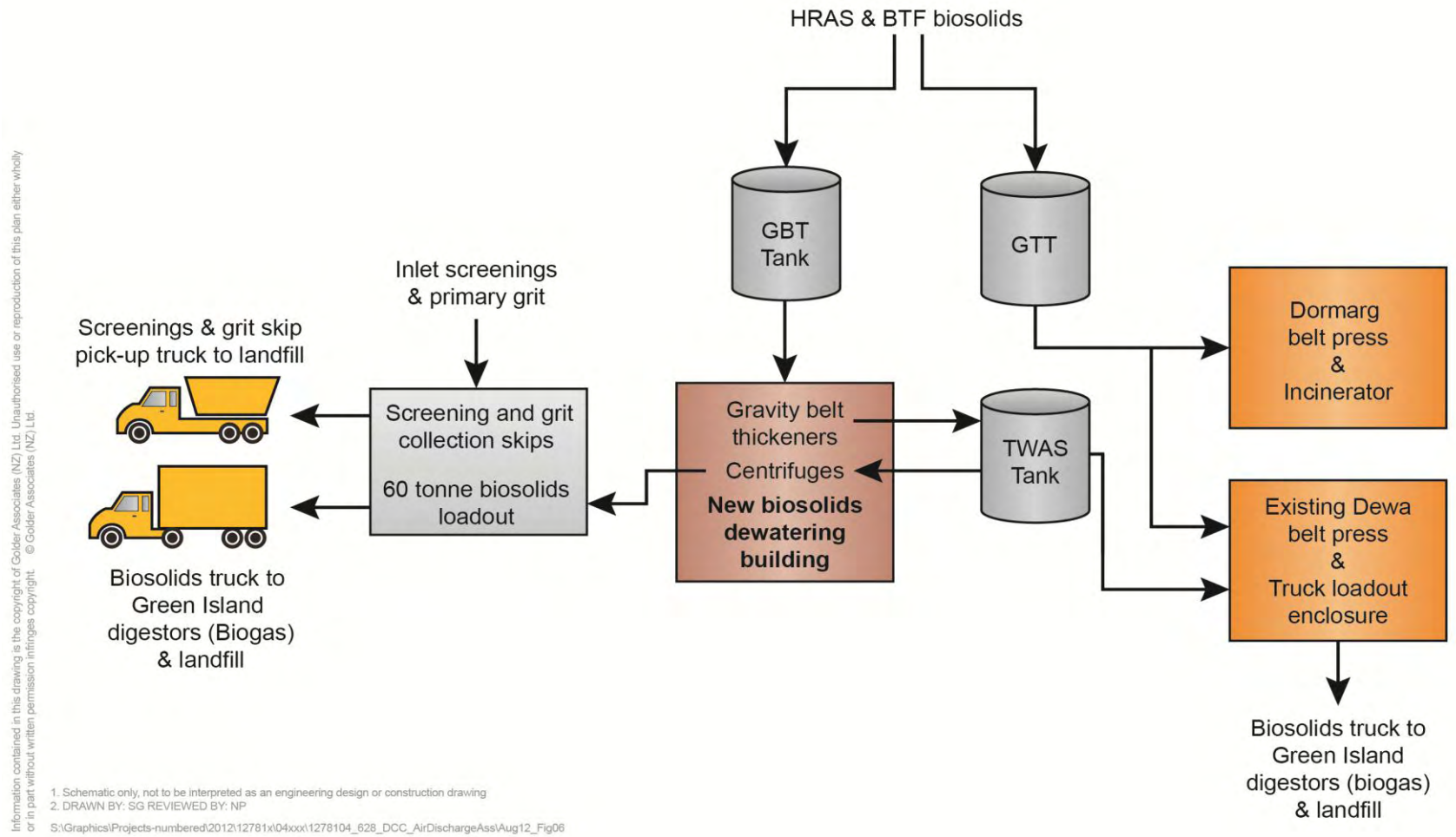

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Figure 6: Solids process flow schematic diagram.

3.2.3 Biosolids dewatering and load out

The thickened biosolids from GTT can be dewatered and exported off site using the existing Dewa Belt Press and truck load out system. The thickened biosolids that will be stored in the TWAS tank will mostly be processed by the two new centrifuge dewatering units. The dewatered biosolids from the centrifuges will be screw conveyed to a 60-tonne overhead storage hopper located within the solids dispatch building. The system will also be configured so TWAS tank biosolids can also be dewatered and loaded out via the existing Dewa Belt Press and truck load out system.

Biosolids removal trucks would arrive at the site at an average rate of 2 to 3 trucks per day, carrying an approximate load of 7 m^3 of dewatered biosolids (at 25 % DS). The loading of dewatered biosolids into each truck will displace a similar volume of air from the truck's own storage container.

All of the above biosolids thickening, storage, dewatering, and biosolids storage and load out systems have the potential to produce sewage type odour, especially during and following storage of biosolids in the large TWAS tank. The control of this odour potential is discussed in Section 6.0 (Odour Extraction and Biofiltration).

3.2.4 Biosolids dewatering and incineration

Belt pressing of biosolids and their incineration has been operated at the site for many years and it is proposed to continue with this option in parallel with a new biosolids dewatering system.

3.2.4.1 Dewatering prior to incineration

The incinerator at the site is enclosed within its own building that includes separate enclosures that house two Dormarg belt presses. The Dormarg belt presses would continue to be fed thickened biosolids from the GTT tank. However, with the change in nature of the thickened biosolids due to the new HRAS operation, it is anticipated that either the use of an auxiliary fuel (diesel) or else further drying of the biosolids will be required to ensure that combustion of the biosolids remains autothermic and stable.

3.2.4.2 Incineration

The biosolids incinerator is a Dorr Oliver fluidised bed system using sand as the solid fluidising medium that operates at a nominal combustion temperature of 830°C. Figure 7 provides a schematic of the incinerator system and downstream exhaust cooling stages.

The system's nominal biosolids incineration rate is 20 tonnes/day of dewatered biosolids at around 30 wt. % DS. The plant operates for approximately 16 hours per day, five days per week. Previously, about one third of biosolids from the GTT was dewatered via the Dewa Press and then loaded out to the Green Island landfill.

It is proposed that the hours of incinerator operation would increase to 24 hours per day, seven days per week, in order to accommodate the increased biosolids production associated with the HRAS system. The instantaneous biosolids feed rate to the incinerator would remain the same. The increased operating period would accommodate the increased amount of biosolids produced with the operation of the fully commissioned HRAS system and continues to provide a less expensive option compared to trucking dewatered biosolids off-site.

The incinerator is shut down for approximately four weeks per year for annual maintenance. Half of this period is required for cooling down and reheating the reactor prior to and following the maintenance work. During this period all biosolids are trucked to Green Island (Green Island Landfill and Wastewater Treatment Plant).

The incinerators exhaust discharge temperature is reduced to approximately 760°C by the injection of water above the fluidised bed. The exhaust gas is then further cooled to approximately 540°C by passing it through a combustion air heat exchanger (recuperator). This transfers heat into the incoming combustion air supply, which is preheated from ambient up to 440°C. The exhaust gas then undergoes a very rapid cooling stage (540°C to 90°C within a fraction of second) as it contacts a pressurised water spray within a Venturi scrubber. This step also removes solids and ash from the exhaust gas stream.

The exhaust stream is further cooled to approximately 30°C by passing through a packed tower counter flow water scrubber, which also helps remove particulates from the air stream.

The cooled exhaust stream discharges via a vertical duct that has a tee connection to Biofilters 1 & 2 extraction system. The vertical duct is open to atmosphere and has a small flow of air drawn into it as the duct is operated under a small vacuum. It is noted that a hinged cap could be installed at the end of the stack as required. This would pull shut during normal operation by the vacuum that is maintained within the duct.

Under normal operation the incinerator exhaust stack operates under a vacuum as it is directly connected to the suction side of a dedicated ID fan, which then pushes this stream into the plenum chamber that is extracted by the large 110 kW fans that supply Biofilters 1 & 2.

The incinerator exhaust stack normally operates at a vacuum of around -3 mm water gauge indicating the combustion exhaust is being effectively extracted to the biofilter system and not discharging to atmosphere. DCC alarm the stack vacuum so loss of vacuum within the duct generates a warning to operators and otherwise provides confirmation that incinerator emissions are not discharging directly to atmosphere. This vacuum is currently recorded, trended and displayed to the operators.

Further comment on this arrangement is provided in Section 7.0 (Mitigation).

3.2.5 Solids dispatch building

The solids dispatch building walls adjoin the inlet sewage screening building and the new biosolids handling building. It contains a large overhead hopper for storage of dewatered biosolids and dedicated enclosed skips that receive washed grit and screenings. Biosolids collection trucks and smaller skip pick-up trucks periodically enter the building to remove loads of biosolids, or pick up and remove the skips from the site. It is standard operating procedure to ensure that only one door is opened at a time so to avoid any through draft occurring, thereby minimising any fugitive emissions.

The skips and biosolids hopper are a potential source of fugitive odour both during storage, loading and transfer off site. The mitigation of these is discussed in Section 7.0.

3.3 Biofilter Systems

There will be four biofilter beds operating following the site upgrade (that is Biofilters 1 & 2 and Biofilters 3 & 4). The existing Biofilters 1 & 2 treat odorous air streams from sources that existed prior to the upgraded WWTP, including the screening area, the HRAS building and tanks. The 1400 m² southern biofilter bed was commissioned in November 2007, while the 1400 m^2 northern biofilter bed was commissioned in May 2008, so both are relatively new and are designed to treat up to 32 m³/s of contaminated air.

A new biofilter that has two isolated beds (Biofilters 3 & 4) has been constructed to treat the air from the new sources of odour resulting from the upgrade of the WWTP, including the biosolids dewatering building, BTFs, BTF feed and flush sumps, UV channels and new biosolids storage tanks (GBT and TWAS). Biofilters 3 & 4 have a collective area of 1,600 m^2 and media depth of 1.5 m. These are designed to treat up to 25 m^3/s of contaminated air.

These biofilter systems are the main sources of air discharge from the WWTP site as all key air discharge sources are extracted and discharged via these systems. The nature of these final emissions to air is described in Section 4.0 (Nature of Discharges). Furthermore, the design and operation of these systems is detailed in Section 6.0 (Odour Extraction and Biofiltration).

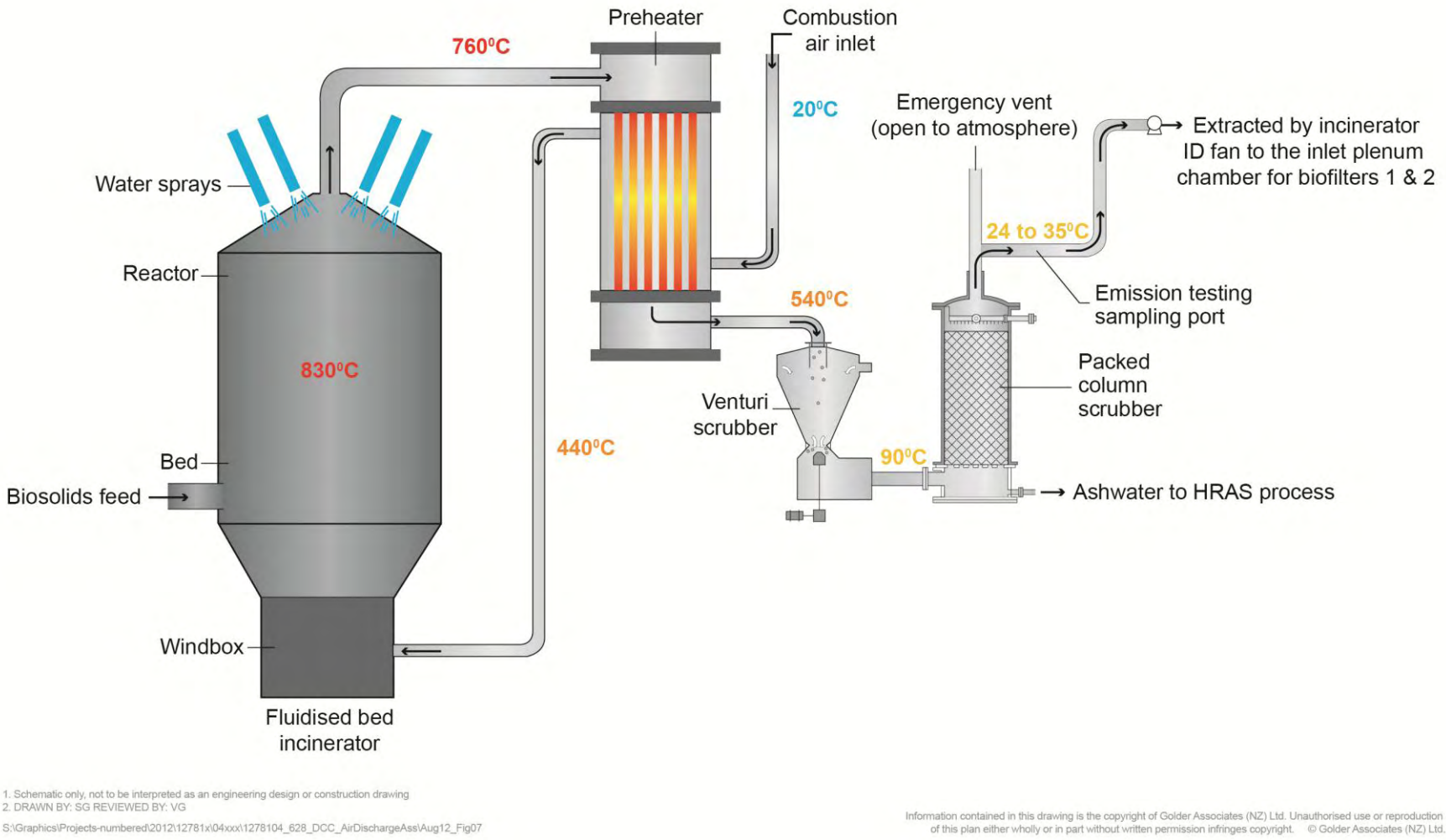

Figure 7: Biosolids incinerator plant schematic diagram.

3.4 Emergency Power Generation

In the event of interruption to the power supply to the site, an on-site electricity standby generator will provide power to essential services. The 1 megawatt (MW) diesel powered generator is adequate in size to keep operating essential services and plant such as the odour control system and pumps. The generator would require periodic operation of approximately one to two hours per month to ensure it is within an operational condition. The discharge of exhaust air from the generator would therefore be infrequent and for short periods. For this assessment, the potential ambient concentrations of PM_{10} and NO_2 during the operation of the diesel generator at capacity have been modelled for scenarios of a discharge stack height, of 10 m and 15.3 m above ground level. A stack height of 15.3 m is 3.5 m above the tallest building ridgeline that is within than five times this height from the generator. This incremental height difference results in the operation of the standby diesel generator being classified as a permitted activity under the ORC Plan (Golder, 2012).

4.0 NATURE OF AIR DISCHARGES

4.1 Introduction

This section details the discharges to air from the processing of the wastewater at the WWTP. Individual processes and/or processing buildings as well as the incinerator have their emissions extracted to the site's biofilters for removal of odour and other contaminants. Therefore the existing and new biofilter beds are the main source of air discharge from the site. The discharge to air from the standby generator is also discussed.

The other source of air discharge can result from fugitive emissions of odour and aerosols that may escape the odour extraction systems at the WWTP site. Potentially this can occur from processes within the WWTP buildings, various sumps, BTFs and odour transfer ducts themselves. This potential is reduced to a minor level by the effective targeting of air discharge sources by directly connecting these to the odour extraction and control systems at the site. For example the BTFs are covered and have large air streams pull downwards through their beds and discharge through the beds of Biofilters 3 & 4. Given effective extraction of these and all other potential air discharge sources and their effective treatment through the site biofilters, only minor levels of air contaminant discharge would result from fugitive emission sources.

Given the targeted extraction of all potential sources of significant air contaminant discharge, the various biofilter surfaces are the only significant source of air discharge flow; that is, the existing and new biofilters 1 & 2 and 3 & 4. The nature of fugitive emission discharges is discussed in general terms, but their significance relies on the performance of the air extraction systems that supply the site biofilters – this key aspect of this assessment is discussed in Section 6.0 (Odour Extraction and Biofiltration).

4.2 Biofilters

4.2.1 Odour character

All of the discharges on-site are extracted to the biofilters that predominantly treat odorous contaminants. The "typical" odour discharge from a correctly sized and operated biofilter is a musty, bark, earth type character that does not persist for more than 50 m from the bed under most conditions. The biofilter contains bark and soil products containing micro-organisms that breakdown the organic, odorous compounds discharged into it and this results in the unpleasant character of these compounds being eliminated from the discharge.

Odour emissions have been measured from the existing Biofilters 1 & 2 by Watercare Services Limited (Watercare) on several occasions. Watercare (2011) indicated that the odour had a character consistent

with light to moderate earthy/vegetation or light to moderate chemical odour. Odour emission test results from Watercare (2009) are summarised in Table 1.

Golder considers the measured emission levels in Table 1 are consistent with normal emissions from an effective biofilter and notes that using dispersion modelling to estimate impacts of these emissions produces relatively meaningless information due the character of the discharge as described above.

Table 1: Odour test results for Biofilters 1 & 2 (Watercare 2009).

Parameter Description	Parameter Value	Comments
Biofilter odour surface concentration	<1,000 OU/m^3	Neutral character with a low intensity
Gas flow to each biofilter†	17 m^3/s	Approximate assumption for flow
Surface odour emission rate	12 OU/m^2/s	Low odour flux value

† Gas flow rate provided in a personal communication between Sue Bennett of MWH and Dominic Hitchen, 19 March 2009, regarding emissions testing in Watercare (2009).

4.2.2 Combustion contaminants

Only Biofilters 1 & 2 receive combustion contaminants within the inlet air stream to their beds as a result of the biosolids incinerator exhaust. Contaminant discharges from the incinerator and the existing Biofilters 1 & 2 were measured by Watercare (2011). The test results are given in Appendix B and summarised in Table 2.

The contaminants included in the monitoring by Watercare were total suspended particulate (TSP), nitrogen oxides (NO_X), mercury and dioxins. For the purposes of assessing combustion contaminants from the biofilter, TSP concentrations are treated as being in the PM_{10} size fraction, which is a valid assumption given that particulate emissions will be derived from the incinerator combustion process.

NO_X is largely composed of nitric oxide (NO) and to a lesser degree the more toxic nitrogen dioxide (NO_2). For the purpose of this assessment, it is assumed that NO_2 comprise 15 % of the NO_X emissions, which is a conservative assumption for an external combustion device such as an incinerator.

It is useful to note that the average measured concentration from the biofilters of PM_{10} (0.7 milligrams per cubic metre – mg/m^3) is well below the typical PM_{10} emission concentration (typically 20-50 mg/m^3) from a solid fuel boiler fitted with a baghouse to control emissions. Additionally, the measured dioxin discharge concentration of 0.0093 nanograms International Toxicity Equivalent (iTEQ) per cubic metre (ng iTEQ/m^3) is well below the European Union directive for burning of solid waste (EU 2000) of 0.1 ng iTEQ/m^3.

Increasing the operational hours of the incinerator from 16 to 24 hours/day has been accounted in the dispersion modelling assessment by assuming constant emissions for all hours of the year. In real terms, it is expected that NO and NO_2 emissions would increase in proportion to the increased operating hours. However, PM_{10} emissions are unlikely to change significantly irrespective of whether or not the incinerator is operating – the measured TSP discharge concentration of 0.7 mg/m^3 is very low. It is also expected that in absolute terms, that PM_{10} emissions from the up-graded Biofilter beds 1 and 2 would have reduced from levels that occurred prior to the up-grade because the improved quality of the media and subsequent level of air filtering.

Calculated mass emission rates for each of the contaminants from the existing biofilter beds are provided in Table 2. They are based on the assumption that the combined flow of air from the various emission sources is split evenly to each biofilter, resulting in an air flow to each biofilter of 17 m^3/s.

Other discharge parameters used for the purposes of the dispersion modelling assessment are given in Table 2.

Table 2: Summary of contaminant emissions – Biofilters 1 & 2.

Name	Average measured concentration (mg/m³)	Comment	Total emission rate (mg/s)
PM_{10}	0.7	Low compared to typical industrial air discharges from Baghouse or ESP systems	22.4
NO_x ‡	272.5	Measured levels	8.0
NO_2	40.9†	Measured levels	1.2
Mercury	3.5×10^{-4}	Trace level	1.2×10^{-2}
Dioxin	9.3×10^{-9}	10 times lower than European directive	3.2×10^{-7}

‡ Maximum measured emission rate since 2004.
† NO_2 emitted as 15 % of NOx

4.3 Emergency Power Generator

Discharge and emission parameters for the standby generator are based on a typical 1 MW (electrical output) diesel-fired generator. The generator is housed within a 6.1 m long container that is 2.6 m tall at a location shown in Figure 4. Contaminant and combustion flow calculations for the diesel-fired generator are summarised in Appendix F.

The stack parameters and exhaust flow characteristics used in this assessment are given in Table 3. The current exhaust stack is expected to have a diameter of approximately 300 mm. The assessment has been undertaken based on two different assumed stacks heights of 10 m and 15.3 m above ground level. Note following the assessment, that Golder recommends the 15.3 m stack height be adopted.

The key contaminant emissions associated with the combustion of diesel are PM_{10} and NO_X. Typical manufacturer PM_{10} and NO_X emission specifications for a 1 MW diesel fired generator are 0.2 grams per kilowatt hour (g/kWh) and 16.75 g/kWh respectively. This corresponds to a PM_{10} and NO_X mass emission rate of 0.056 g/s and 4.65 g/s respectively.

For the purpose of this assessment, NO_2 emissions are assumed to comprise 15 % of the total NO_X emission, which is typical for a diesel fired generator. Accordingly, a NO_2 mass emission rate of 0.7 g/s is calculated.

The relevant discharge and emission parameters for the 1 MW diesel fired generator are provided in Table 3.

Table 3: Discharge parameters for the 1 MW emergency power generator.

Parameter	Value
Efflux velocity	27.1 m/s
Efflux temperature	473 K
Stack diameter	0.3 m
Stack height	10 m and 15.3 m
NO_2 emission rate	0.7 g/s
PM_{10} emission rate	0.056 g/s

4.4 Fugitive Emissions

The wastewater treatment processes have air emissions extracted either directly from equipment or else indirectly via building air extraction. Fugitive emissions of sewage type odour that have the potential to escape the site's air extraction systems could result from various sources that are listed below.

- Emissions from trucks leaving the site with biosolids or screenings
- Process buildings fugitive emissions (including the HRAS, biosolids dewatering, screening building, biosolids and screenings storage building), especially during windy conditions
- Fugitive emissions from incinerator building and associated biosolids belt press units
- Fugitive emissions from the new biological trickling filters and associated feed and flush sumps
- Wastewater pump stations, and outdoor biosolids storage tanks
- Air leaks from pressurised section of ducts supplying air to the biofilters, or from leaking fan seals.

The mitigation measures to minimise the fugitive odour and aerosol emissions from the above list of potential sources is discussed in Section 6.0 (Odour Extraction and Biofiltration).

5.0 ASSESSMENT CRITERIA

5.1 Odour Assessment

Under the Resource Management Act (1991) the main concern with odour is whether it causes an effect that is considered to be “objectionable or offensive”. Whether an odour has an objectionable or offensive effect will depend on a number of features of the odour exposure which are collectively known as the FIDOL factors:

- Frequency is how often an individual is exposed to odour
- Intensity is the strength of the odour
- Duration is the length of a particular odour event
- Offensiveness/character relates to the ‘hedonic tone’ of the odour, which may be pleasant, neutral or unpleasant
- Location refers to the type of land use and nature of human activities in the vicinity of an odour source (MfE 2003a)

When determining whether an odour is offensive or objectionable, it is usually insufficient for an odour to simply be detected beyond the boundary of a site. The odour must also be of sufficient intensity, duration, character, and frequency to cause an adverse effect. The various tools used to assess the combined effects of the various FIDOL factors and whether or these are likely to objectionable following the upgrade are discussed in Section 8.0 (Assessment of Potential Odour Effects).

5.2 Combustion Products Assessment Criteria

5.2.1 Introduction

The following regulations and guidelines have relevance to this application regarding assessment criteria:

- The Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxics) Regulations 2004 (the NES)
- The Ambient Air Quality Guidelines (AAQGs) (MfE/MoH, 2002)
- Regional Ambient Air Quality Guidelines (RAAQG) contained in the RPA

- World Health Organization (WHO).

The assessment criteria used for this study are discussed below. A number of different averaging periods are cited. This is due to the varying health effects that are being protected by the guidelines. Shorter averaging periods normally protect against acute health effects that may be felt quickly such as respiratory difficulty, while longer averaging periods protect against effects that are more long-lasting such as the risk of acquiring asthma or suffering reduced ability to be active.

While the AAQGs are not mandatory, the NES are, and their requirements over-ride those of any regional plan except where such a plan imposes stricter requirements.

Further to the above guidelines, the dioxin cancer potency guidelines are briefly discussed below and in more detail in Appendix C.

5.2.2 National Environmental Standards

The planning report prepared by Golder (Golder 2012) details the parts of the NES that relate to the Tahuna WWTP. The following provides a brief summary of the standards that are directly pertinent to this air quality assessment. Section 5.2.7 discusses Regulation 12 which relates to the operation of the biosolids incinerator.

The NES (air quality) Regulations were published in 2004. The Regulations are mandatory and include standards related to the ambient concentrations of SO_2, NO_2, CO, PM_{10}, and ozone (O_3). They include concentration limits, maximum numbers of allowable exceedances, and monitoring methods. The NES time averaging periods are 1-hour for SO_2, NO_2 and O_3, 8-hour for CO, and 24-hour for PM_{10}.

Regulation 14 of the NES, (MfE, 2004a) sets out the locations that ambient air quality standards apply, as follows:

"14 Application of standards

(1) The ambient air quality standard for a contaminant applies at any place –

(a) that is in an airshed; and

(b) that is in the open air; and

(c) where people are likely to be exposed to the contaminant.

(2) However, if the discharge of a contaminant is permitted by a resource consent, the ambient air quality standard for the contaminant does not apply to the area that the resource consent applies to."

"Airsheds" include parts of the region of a regional council that are specifically gazetted as an airshed, and any remaining areas of the region that are not gazetted. This means that the standards apply in all areas of New Zealand, in the open air, wherever people may be exposed over the relevant time averaging period. The main exception is that if the discharge is authorised by a resource consent, then the standards do not apply on the site to which that consent applies.

Therefore, the key areas for this assessment in terms of NES compliance are the residential and recreational areas around the Tahuna WWTP site. As discussed earlier in this report, the site lies within the South Dunedin Airshed.

The South Dunedin Airshed is a polluted airshed. Regulation 17 relates to resource consent applications that in a polluted airshed must be declined if it is likely that, at any time, to increase the concentration of PM_{10} (calculated as a 24-hour mean) by no more than 2.5 $\mu g/m^3$ in any part of a polluted airshed. Exemptions to this requirement are as follows:

- if the discharge is same or less than that under an existing consent for the same activity on-site
- if the emissions can be offset by PM_{10} reductions by the applicant elsewhere in the airshed

Regulation 20 relates to nitrogen oxides. It states the consent authority must decline an application for a resource consent if it is likely that the airshed (in this case Dunedin South) is likely to exceed the relevant NES for this contaminant.

The NES criteria applicable to this application are shown in Table 4.

5.2.3 National Ambient Air Quality Guidelines

The AAQGs have very similar limits to the NES, but also include guidelines additional to those in the NES, namely, 24-hour NO_2 (100 µg/m^3) and an annual PM_{10} guideline of 20 µg/m^3. Compliance with the AAQGs is similar in intent to that of NES. However, AAQGs are not linked to specific airsheds, or regulations which could require a regulatory authority to decline a consent application if there is non-compliance. The AAQGs that are applicable to this application are shown in Table 4.

5.2.4 Regional Ambient Air Quality Guidelines

The RAAQGs are included in Schedule 1 of the RPA and are mostly specified as “Otago Goal Levels” and set at 66 % of the equivalent NES or AAQG values.

5.2.5 Dioxin guidelines

The cancer potency from exposure to dioxins is estimated from what is termed the Life time Average Daily Dose (LADD) to dioxins and furans. Whereas the potential for chronic health effects is assessed by a similar term called the Tolerable Daily Intake (TDI). These exposure terms have the same units of picograms[2] of International Toxicity Equivalent (iTEQ) per day per kg of body weight (i.e., pg-iTEQ/kg-bw/day). For chronic health effect assessments, the TDI value can be compared to the recommended World Health Guideline values of 1 to 4 pg-iTEQ/kg-bw/day. The New Zealand Ministry for Health has an unofficial guideline of 1 pg-iTEQ/kg-bw/day (MfE 2001). This is further discussed in Appendix C. The LADD is also assessed in terms of the probability of the occurrence of cancer.

5.2.6 Summary of relevant standards and guidelines

A summary of the relevant standards and guidelines for assessing the potential effects from combustion discharges is provided in Table 4.

Table 4: Summary of standards and guidelines relevant to this application.

Pollutant	Averaging period	Guideline/ Standard (µg/m^3)	Notes
PM_{10}	24-hour	50 35	NES – permitted excess one 24 hour period in 12 months. RAAQG
PM_{10}	Annual	20	AAQG
NO_2	1-hour	200 130	NES – permitted excess 9 hours in 12 months (9th highest). RAAQG
NO_2	24-hour	100 60	AAQG RAAQG
Mercury	Annual	3.3 x 10^{-1}	AAQG
Dioxin	Annual	-	Acceptable incremental risk of increased cancer rates in the population of <1 in 1,000,000. Tolerable daily intake 1 pg TEQ/kg body weight/day.

[2] Note that a picogram is equal to 0.000000000001 grams, or 1 x 10^{-12} grams

5.2.7 Waste incinerators under the National Environmental Standards

Regulation 12 of the NES prohibits the operation of high-temperature hazardous waste incinerators. It defines a high temperature hazardous waste incinerator as follows:

> *"an incinerator that is designed and operated principally for burning hazardous waste at a temperature greater than 850 °C as measured –*
>
> *(a) near the inner wall of the incinerator; or*
> *(b) at another point in the combustion chamber where the temperature is likely to represent the temperature in the incinerator."*

In addition, the NES defines 'hazardous waste' as follows:

> *"waste that –*
>
> *(a) belongs to 1 or more of the categories in Annex I of the Basel Convention; and*
> *(b) has 1 or more of the characteristics in Annex III of that Convention."*

Therefore, when considering whether or not the DCC's incinerator operation at Tahuna could be defined as a 'high-temperature hazardous waste incinerator' under the NES, the following was accounted for:

- The incinerators operating temperature.
- The principal purpose of the incinerator as designed.
- Whether or not the dewatered biosolids may be deemed to be hazardous under Annex I and then Annex III of the Basel Convention. Consideration of Annex III criteria is only necessary if hazardous waste criteria are met in Annex I, as some of the criterion within both Annexes need to be met for a waste stream to be defined as Hazardous.

With respect to the first two considerations listed above, the incinerator operating combustion chamber temperature is maintained below 850 °C (i.e., at 830 °C) and secondly it is not principally designed for burning hazardous waste material, but is designed for burning biosolids that are produced from the treatment of finely screened municipal wastewater. Given this, then the incinerator operation would not be defined as a hazardous waste incinerator under Regulation 12 of the NES.

Notwithstanding the above findings it is useful to consider whether or not the biosolids themselves might be classed as hazardous waste under Regulation 12. This required a review of Annexes I and III of the Basel Convention. Biosolids derived from the treatment of municipal wastewater is not listed as one of the categories of hazardous waste in Annex I. While it is likely the biosolids will contain trace levels of some metals listed in Annex I, these are not likely to be elevated above normal background levels given the low level of any industrial wastewater discharge to the Dunedin City sewerage system and use of coarse and fine screening of the wastewater before biological treatment stages.

Given the above, it is concluded that the dewatered biosolids produced at the Tahuna WWTP do not represent hazardous waste as defined in Annex I of the Basil convention. Annex III therefore does not need to be considered. The Ministry for the Environment appears to have reached a similar view with reference to the Hazardous Substances and New Organisms (HSNO) Act (MfE 2003b). This document states that *"biosolids or their constituents are unlikely to trigger any of the hazardous property criteria."*

In conclusion, the Tahuna WWTP is not a 'high-temperature' incinerator, nor is it designed for the purpose of 'high-temperature' hazardous waste incineration. Furthermore, the dewatered biosolids are not considered to be classed as a hazardous waste under the Basel Convention. Therefore, the NES does not prohibit the operation of Tahuna WWTP's biosolids incinerator.

6.0 ODOUR EXTRACTION AND BIOFILTRATION

6.1 Introduction

This section reviews the specific extraction points and flows associated with various processing and pumping stages of the WWTP. It also assesses the effectiveness of the proposed design for containing odour and aerosol emissions. Design extraction flow rates for the WWTP that are assumed for this assessment are specified by Beca (2010), whereas volumes of plant items including tanks, screens and other processing equipment have specified by Flo-Dry (2006). These values have also been cross-checked against Golder's own calculations and further information provided by the DCC.

6.2 Inlet Sewage Screening Building

A schematic diagram of the sewage screening building and odour extraction points is shown in Figure 8. The three main Subo screens sit within the sewage inlet channels that are covered. Each screen has a volume of approximately 16 m^3 and is fully enclosed, which allows their emissions of odour and aerosol to have targeted extraction of 0.6 m^3/s. This equates to entire screen air volume being fully extracted within around 25 seconds (i.e., 135 volume changes per hour). Therefore, these key sources of raw sewage odour would be highly controlled and there would be little or no opportunity for fugitive contaminant emission.

The respective dewatering/discharge conveyors attached to all screens (including the by-pass screen) also receive targeted air extraction with a total air flow of 0.2 m^3/s. This provides a high rate of air change within the conveyor enclosure, providing effective aerosol and odour containment given the degree these systems are sealed. The screening building is also indirectly ventilated via the screens that are themselves exposed to the extraction of 0.8 m^3/s of air above the covered inlet effluent channel (discussed in Section 6.2).

Given the above, the potential for fugitive emission into the screening building environment would be very low. The overall targeted extraction of over 2.0 m^3/s would ultimately ventilate the building air at a rate that equates to approximately 4 building volume changes per hour (room volume estimated to be 1,680 m^3). Given the well-sealed state of this building enclosure, any fugitive emission that escapes into this building from the screens or conveyor system (which should be minor) is further mitigated by the overall extraction flow that is applied to this building.

The overall building extraction is important as the sewage screening building can receive sewage that is relatively odorous, especially during low flow periods and warm weather. Furthermore, the aerosols from this stage of the WWTP have the greatest pathogenic potential so having some redundancy in the level of extraction is ideal given the closer proximity of this component of the WWTP to residential dwellings (due north of the screening building).

Finally, air emissions from the by-pass screen are only directly targeted by the extraction of air from its discharge conveyor, which extracts around 11 air volume changes per hour from this screen enclosure. This screen is also indirectly ventilated via the extraction of air from the effluent inlet channel to the HRAS system. Given this screen would operate in higher flows that are associated with low odour potential then this level is considered to be adequate, but if necessary, there is capacity within the overall system to directly target this screen with a larger extraction flow as per the other screens.

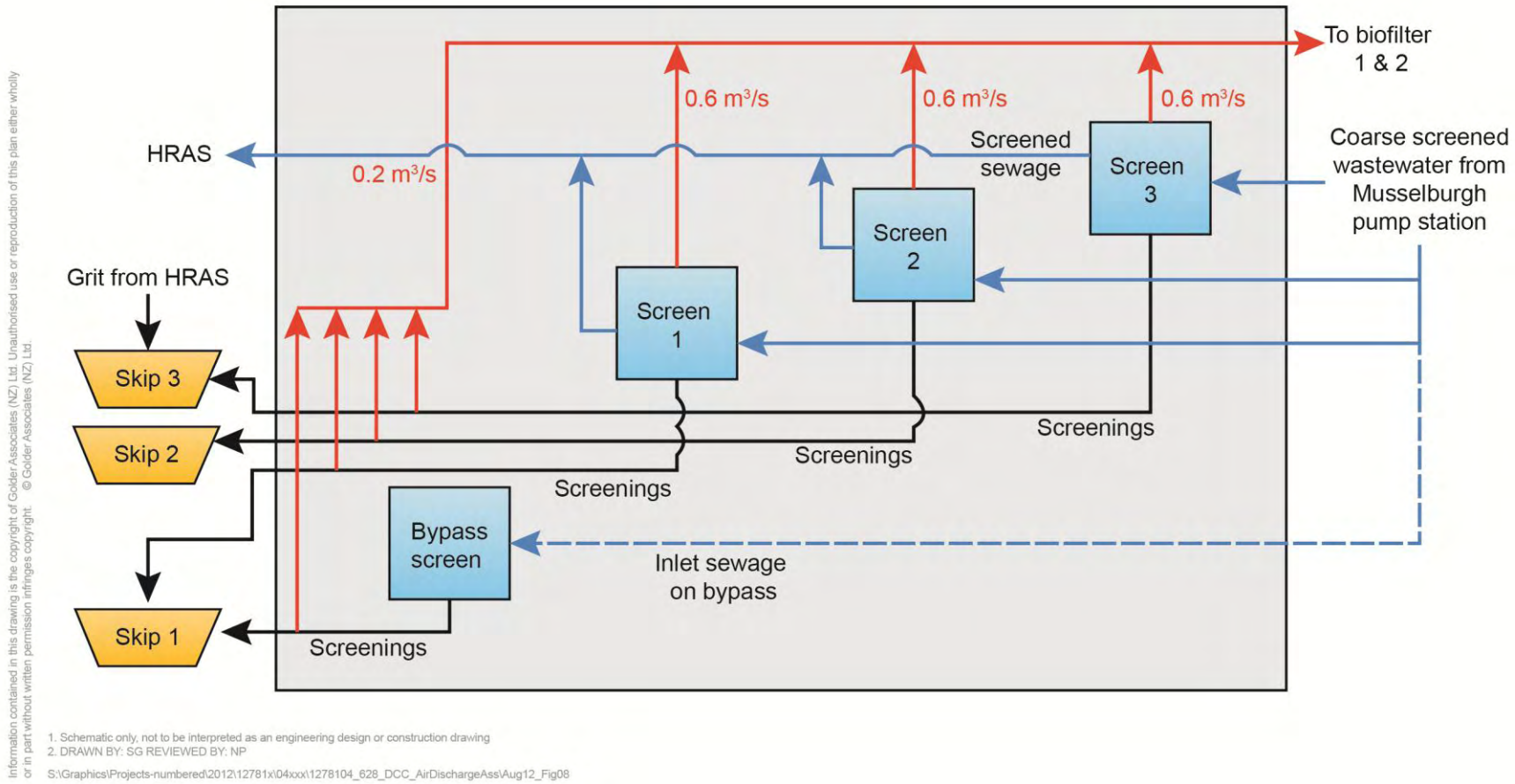

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Figure 8: Schematic of odour extraction system for the sewage screening plant.

6.3 HRAS Building

6.3.1 General

A schematic diagram of the targeted odour extraction system within the HRAS building is shown in Figure 9. Historically, the loss of fugitive emissions from this area of the WWTP may have been one of most significant sources of fugitive odour emission. However, the use of a mix of targeted emissions extraction and general building air extraction has now been installed as described below.

6.3.2 Aeration zone

The introduction of high rate aeration within the initial stages of the HRAS tank and targeted emissions extraction system shown in Figure 9 is a key feature of the upgrade that is likely to significantly improve the control of odour from this source. The input of air to the high rate aeration zones of the HRAS tank is approximately 4 m^3/s. This flow discharges beneath the covered section of the HRAS, which receives a total design air extraction rate of 5.4 m^3/s (i.e., 4.6 m^3/s + 0.8 m^3/s). The net extraction flow of air into the covered section of the HRAS is therefore around 1.4 m^3/s (i.e., 5.4 m^3/s – 4 m^3/s). This differential flow would extract approximately five volume changes per hour from the head space of the covered section of the three HRAS tanks. The end of the covered section of HRAS tank is mostly blanked off.

Given the HRAS system sits in an enclosed building and is not subject to external wind conditions, five volume air changes per hour should be sufficient to contain the odour emissions associated with aerated section of the HRAS process. This is important as the odour associated with the discharged aeration air is likely to be significant if not well controlled. DCC has advised that their experience to date is that the system works well and that is confirmed by Golder's observations.

6.3.3 Clarification zone

The quiescent settling zone of the HRAS tanks is not covered and therefore is not directly targeted for emissions extraction. However, this area of the tank is not expected to generate significant odour because of the initial stripping of volatiles and odours in the covered HRAS section and also because of the absence of any effluent turbulence.

6.3.4 Effluent channel

The HRAS tank has the wastewater discharge over a weir structure and into the effluent collection channel, which results in significant turbulence and therefore odour and aerosol release. To counter this, the effluent channel is enclosed, as indicated in Figure 9, and has targeted air extraction at a design rate of 4.5 m^3/s. This means an air extraction rate in excess of 100 volume changes per hour from the enclosed effluent channel, so fugitive emissions would not be able to escape this stage.

6.3.5 Building ventilation

Fresh air is pumped into the HRAS building at an approximate rate of 2 m^3/s, which is countered by a general building air extraction rate of 6 m^3/s (giving a net hydraulic ventilation rate of 4 m^3/s). This net flow plus the net extraction flows from the covered sections of the HRAS tanks (4.5 + 5.4 m^3/s) gives a total net HRAS ventilation rate of 14 m^3/s. The total ventilation rate would achieve approximately 1.5 building air changes per hour from the HRAS building, which confirms that the successful control of odour and aerosol emission from the HRAS building relies on target source extraction. Furthermore, the 6 m^3/s of building air extraction provides opportunity for increased targeted extraction if this is found to be necessary (i.e., by reducing the building air extraction rate and using this instead for targeted extraction).

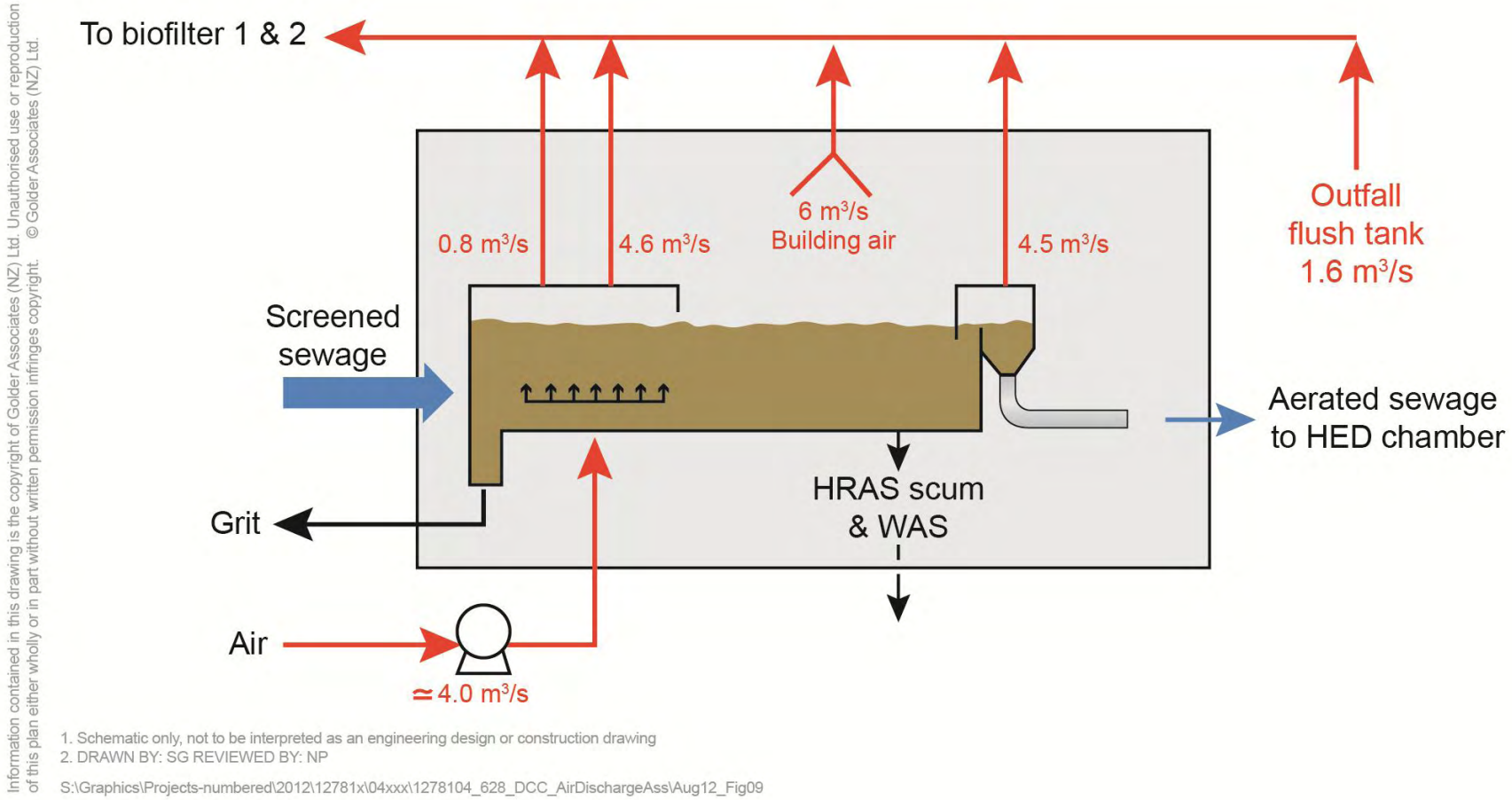

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Figure 9: Schematic of targeted air emissions extraction system for the HRAS building.

6.3.6 Outfall flush tank

The outfall flush tank has a targeted extraction of its head space that connected to the HRAS building extraction system. Given the design extraction of 1.6 m^3/s and volume of 2,200 m^3, this would equate to around 2.5 volume changes per hour of ventilation, which is considered adequate given the wastewater at this stage in the treatment process should have a low odour potential. Also, the breathing vent on this tank contains a large carbon filter for treated of displacement air. In practice, the tank is filled very gradually over approximately two hours and therefore minimal filtered displaced air and therefore minimal odour is expected to result from this source.

6.3.7 Annual monitoring

The HRAS is one of the largest potential sources of odour and aerosol emission within the WWTP site and therefore periodic monitoring of the targeted air extraction system effectiveness via measurement of extraction flows, vacuums and H_2S levels is recommended to be performed on an annual basis. It is noted that air flow checks will be undertaken on commissioning of the fully upgraded WWTP.

6.3.8 Discussion

Golder's observations of the target extraction system for one of the commissioned HRAS tanks indicated there to be effective control of emissions from the covered high rate aeration section and end sections of the HRAS tank. There is scope to direct more of the building air extraction capacity (around 2-3 m^3/s) towards the covered section of the HRAS tanks and increase this ventilation rate to 10 to 15 volume changes per hour. This would result in a significant decrease in the potential for fugitive odours and aerosols escaping the high rate aeration section of the HRAS. Currently there appears to be sufficient ventilation of the aerated section of the HRAS. Therefore, there is significant redundancy built into the existing extraction system design, which would allow for future modifications and improvements to the system if these are ever required.

6.4 Biosolids Dewatering Building and Biosolids Tanks

6.4.1 General

The upgraded WWTP is conservatively estimated to produce an average of 8.6 tonnes/day of biosolids (DS basis). These solids are drawn off the HRAS system at around 0.5 % to 1 % DS, producing 900 to 1,800 m^3/day of dilute biosolids that are thickened and dewatered down to around 34 tonnes of dewatered biosolids at 25 % DS. The new biosolids dewatering building and processes will usually receive and process around 40 % to 50 % of HRAS biosolids via the GBT tank, which is then thickened and stored within the TWAS tank. The overall processes and associated odour extraction points are shown in Figure 10.

6.4.2 Building ventilation

The new biosolids dewatering and biosolids load out buildings are connected to each other and therefore share the latter building's air extraction rate of 4 m^3/s. It is estimated that 50 % of this building air extraction rate that is situated above the biosolids load out hopper would effectively ventilate the new solids dewatering building. Processes within dewatering building have combined targeted extraction flows of approximately 1 m^3/s. Consequently, the building would be ventilated at approximately 3 m^3/s, which would impart a ventilation rate in the order of 4 volume changes per hour to the biosolids processing building (room volume is 2,700 m^3).

6.4.3 Biosolids storage time

The centrifuge dewatering units within this building dewater some of the biosolids stored within the large TWAS tank. These biosolids are likely to be highly odorous on occasion, because of the retention time of thickened biosolids (at around 3 % to 4 % DS) within the TWAS tank. It is estimated that thickened biosolids storage times have the potential to exceed several days, based on the capacity of the TWAS tank (1,000 m^3), and the production of thickened biosolids from the gravity belt presses (around 150 m^3/day to 200 m^3/day at 3 % to 4 % DS).

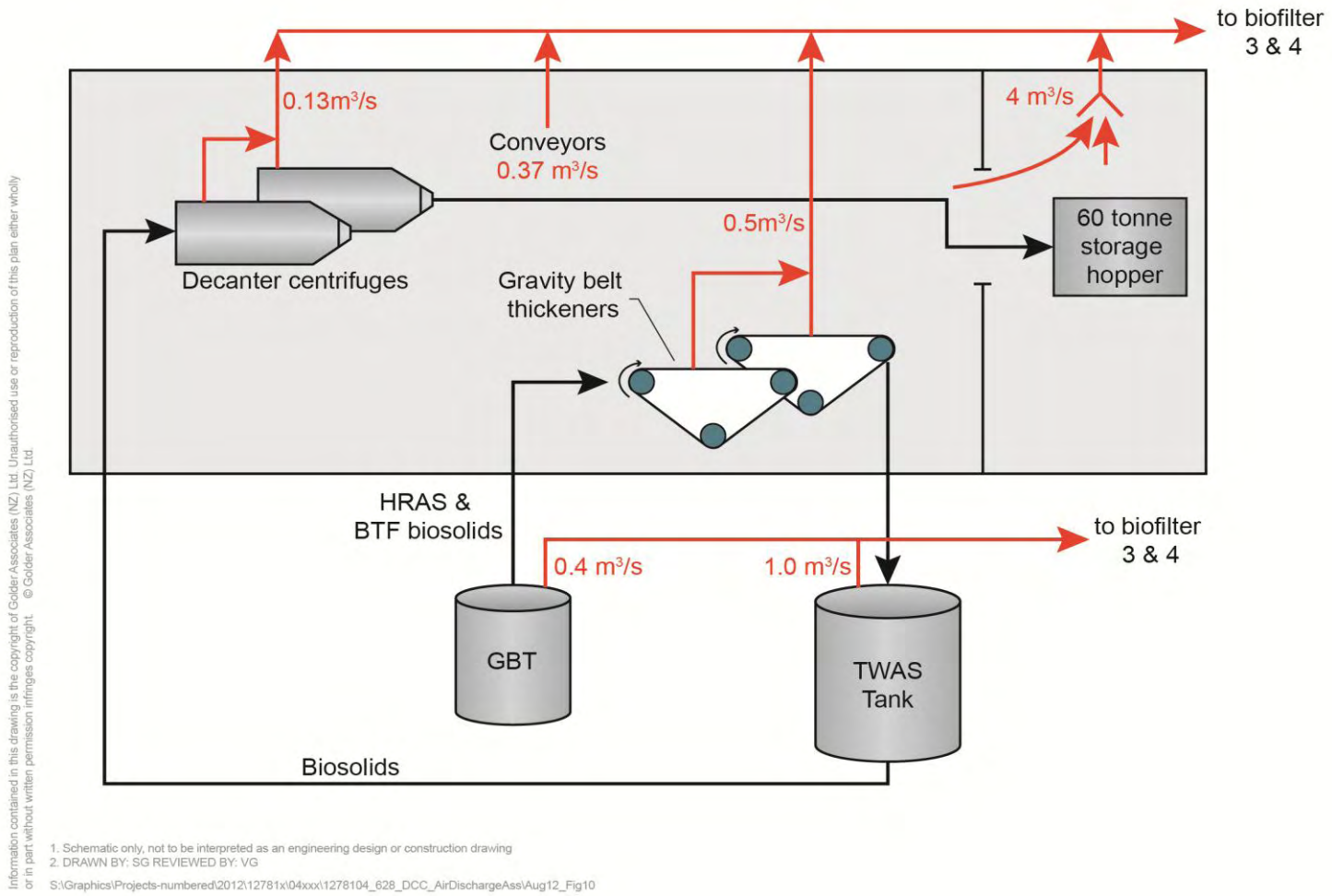

Figure 10: Schematic diagram of targeted air emissions system for the biosolids dewatering building and storage.

Because of a high odour potential associated with the thickened biosolids, a high level of targeted air extraction on the TWAS tank, centrifuges and downstream conveyance and storage of dewatered biosolids exiting the TWAS tank is considered necessary to ensure objectionable odours are not produced offsite. The adequacy of this extraction is discussed below.

6.4.4 Targeted process emissions extraction

The two gravity belt thickeners, two biosolids dewatering centrifuges and all conveyors have targeted air extraction to contain their respective emissions.

The application of 0.06 m^3/s of targeted air extraction from each of the six conveyors (0.37 m^3/s in total) is specified by Beca (2011) to achieve a design ventilation rate of 10 volume changes/hr. As for the conveyors, the targeted extraction rates for the two gravity belt thickeners (0.25 m^3/s each) is specified to achieve a design ventilation rate of 10 volume changes/hr. This degree of head space ventilation should ensure very good containment of fugitive emissions from these sources.

The design extraction rate for the centrifuges (0.11 m^3/s per unit) seems too low given the potential of these units to generate odour. Unlike the conveyors and gravity belt thickeners, the centrifugal action of these units generates a pressurised air discharge that will contain odours and aerosols. Therefore, a larger design extraction rate may be necessary to contain these emissions effectively.

6.4.5 Targeted tank ventilation

The TWAS tank (1,000 m^3) and GBT tank (300 m^3) both have targeted air extraction rates at 1.0 m^3/s and 0.4 m^3/s respectively. These flows would ensure that fugitive emissions from these tanks would be very low. This is because the volumetric loading rates of thickened and HRAS biosolids streams into these tanks would less than 1/10th of the volumetric extraction rate of air from these tanks. Therefore, air displacement due to biosolids loading (the main potential source of fugitive odour emission) would be mitigated by the targeted air extraction from these tanks. This is important for both tanks, especially the TWAS tank that stores thickened waste activated biosolids prior to dewatering.

6.4.6 Annual monitoring

The centrifuge air extraction performance and other equipment within the biosolids dewatering building will be checked following the commissioning of the upgraded WWTP, and this is recommended to be undertaken annually.

6.4.7 Discussion

As with the HRAS building, there is redundancy built into the building air extraction capacity of 4 m^3/s that is shared between the biosolids load-out building and the biosolids dewatering building. As such, there is significant redundancy within the extraction system design to increase the target extraction of any existing or new process equipment if desired in the future.

6.5 Gravity Tank Thickener and Building

6.5.1 General

As with the HRAS and new biosolids dewatering process building, the Gravity Thickener Tank (GTT) and its associated building enclosure have a mixture of target emissions extraction and general building air extraction. This is shown in Figure 11.

6.5.2 Building extraction

The GTT building adjoins the HRAS, screening and other areas of the main WWTP building complex. It has building air ventilation that is estimated to be approximately 1 m^3/s. This room also has some fresh air force ventilated into it from the blower room. Therefore, the effective net ventilation rate of this room is likely to be low. Accordingly, the control of air emissions from the GTT room will be largely dependent upon the targeted extraction of air from the GTT tank.

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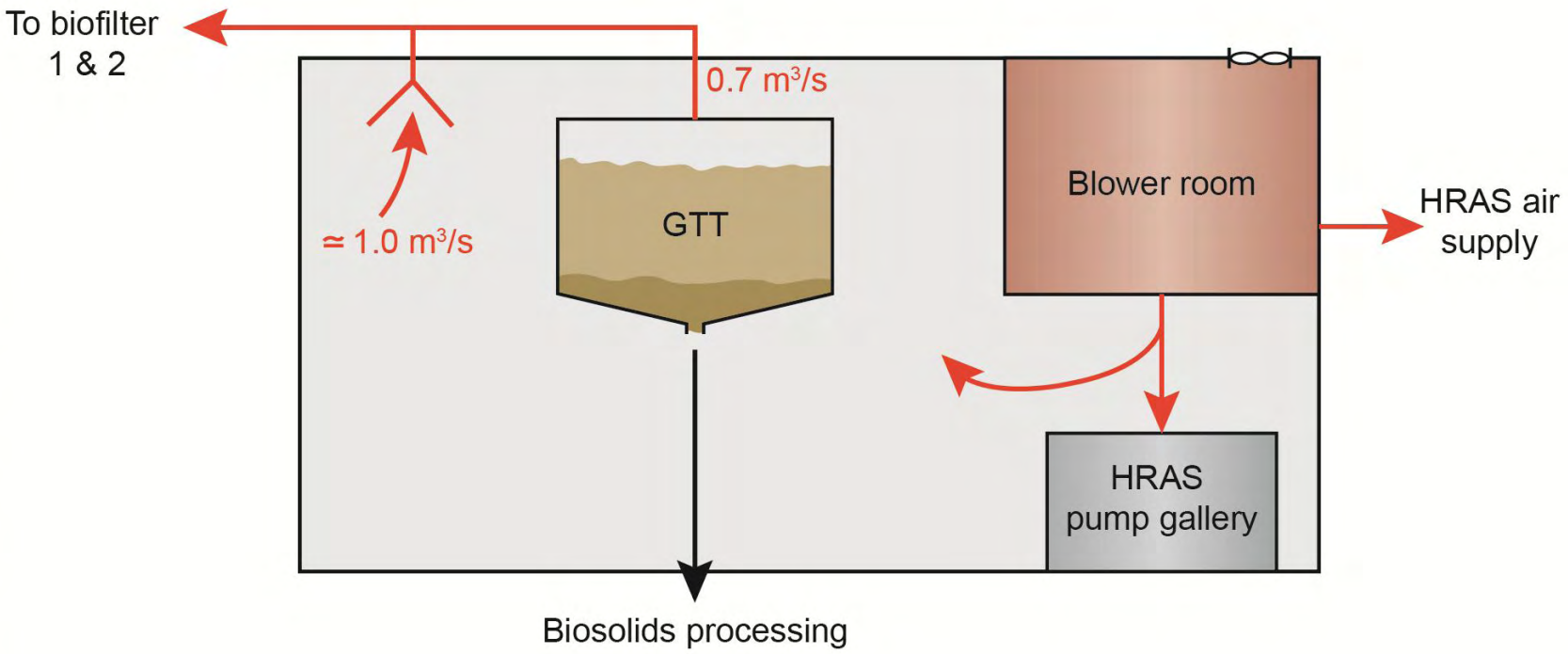

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Figure 11: GTT, blower room and pump gallery buildings odour control diagram.

6.5.3 Targeted extraction

The 12.5 m diameter GTT is covered and has an effective head space volume of approximately 250 m^3. Given targeted design air extraction rate of 0.7 m^3/s the GTT head space would be ventilated at a rate of 10 volume changes per hour. This rate is relatively high and should be sufficient to contain fugitive emissions from the GTT surface.

6.5.4 Monitoring

The monitoring of air flows extracted from the GTT and GTT room should also be included in the list of items to be checked following the WWTP commissioning and as part of routine annual monitoring practices.

6.6 Biosolids Incinerator and Belt Presses

6.6.1 General

The rate of thickened biosolids supplied to the incinerator and its belt presses will remain unchanged, but increased operation hours from 16 hours/day to 24 hours/day for up to seven days a week is being considered. This would increase the annual average rate of biosolids dewatering and incineration. The thickened biosolids would continue to be supplied by the existing GTT, but dewatering may only achieve 25 % DS due to the change in the source of the biosolids from primary to secondary generation. According to the DCC biosolids incineration would increase from 5.8 tonnes/day (dry basis) to about 7.1 tonnes/day (dry basis). This indicates approximately 150-200 tonnes/day of wet biosolids (at 3 % - 4% DS) being supplied by the GTT to the incinerator's Dormarg belt press dewatering system and 25 - 30 tonnes/day of biosolids at 25 % DS being processed by the incinerator.

6.6.2 Targeted emissions extraction

There are two main targeted extraction points within the room that houses the biosolids incinerator and Dormarg belt presses (having a volume of approximately 200 m^3) that generate the incinerator dewatered biosolids (shown in Figure 12). These are the enclosures that house the belt presses and the incinerator exhaust air flow.

The cooled and scrubbed incinerator exhaust air is extracted via its own ID fan and discharge duct at a nominal rate of 1.5-2 m^3/s, which discharges into the inlet plenum for Biofilters 1 and 2. A similar air flow rate (albeit smaller) is drawn from within incinerator building and into the incinerator as combustion air.

The designed targeted extraction flow from the two belt press enclosures is 0.25 m^3/s each, and these enclosures are approximately 25 m^3. Accordingly, these would have a ventilation rate of 36 volume changes per hour. This is a high extraction rate, which is important as the thickened biosolids from the GTT and supernatant discharge from the belt presses are likely to be odorous.

6.6.3 Building ventilation rate

The combination of targeted extraction of the two belt pressure enclosures and the demand for combustion air would ventilate the incinerator room at over 30 volume changers per hour and therefore impose a very high level of fugitive emission containment within this building.

6.6.4 Discussion

The high air ventilation rates imposed on the belt press enclosures and the incinerator room (both above 30 volume changes per hour) should ensure minimal opportunity for fugitive emissions from the biosolids incinerator building.

6.7 Dewa Belt Press

6.7.1 General

The Dewa press receives thickened biosolids from the GTT and dewaters these before discharging them to a truck. Unlike the new biosolids handling building the dewatered biosolids are not stored, but loaded directly into a waiting biosolids truck that sits within the load out enclosure while being steadily loaded. This system currently loads out two to three 7-tonne loads of wet biosolids at 25 % DS per day, and would be able to continue at this rate in the future. However, depending upon the performance of the new biosolids handling system, it may process less biosolids.

Dewatered biosolids at around 25 % DS are discharged from this press and screw conveyed up and into a waiting truck. The conveyor discharge and truck are relatively open and so the overall building ventilation rate would be important in determining the extent of fugitive emissions control. The building has targeted extraction points as shown in Figure 13 (extraction to Biofilters 1 & 2).

6.7.2 Targeted extraction

The Dewa press is estimated to have a free volume less than 50 m^3, and would therefore be ventilated at over 60 volume changes per hour given its design targeted extraction of 0.9 m^3/s. The truck load out volume is approximately 160 m^3, and would therefore be ventilated at 30 volume changes per hour given its design targeted extraction of 1.4 m^3/s.

6.7.3 Building extraction

The overall building extraction rate for the Dewa press room and load out enclosure is considered to be important, as dewatered biosolids on the conveyor and from the discharge to the truck are not directly targeted and contained. Given the total building volume of about 1,000 m^3, the press and load out target extraction rates (total of 2.3 m^3/s) would result in this building being ventilated at 8 volume changes per hour. The building is designed so that the truck load-out bay is fully enclosed and therefore enhancing the control of fugitive emissions from the sludge dewatering and truck load-out areas.

6.7.4 Monitoring

The Dewa dewatering press and truck load-out area is currently relatively open, but planned building modifications will allow these areas to be more fully enclosed. Proposed monitoring following commissioning and as part of annual monitoring of extraction systems should also include these Dewa press building and associated truck load-out bay.

6.8 New Solids Collection and Dispatch Area

6.8.1 General

The solids dispatch building allows for entry of trucks for biosolids load out and to pick up skips that contain screenings and washed grit. This contains the grit washers and skips that are gradually filled with screenings and washed grit, as well as the new 60 tonne dewatered biosolids hopper that would receive dewatered biosolids from the centrifuges. The centrifuges operate in the new biosolids handling building that adjoins and is open to the solids dispatch building.

Because the solids dispatch building sits between the GTT and sewage screening rooms (on its eastern side) and the new biosolids handling building to the west, the building air extracted from this building at a design rate of 4 m^3/s is likely to be pulled through from these other buildings. For example, it is estimated that 2 m^3/s of building air will be extracted from the biosolids dewatering building as a result of the building air extracted from the solids dispatch building (see Section 6.3.2). This would mitigate fugitive odour emissions into the solids dispatch area during the loading out of trucks while access doors are kept closed.

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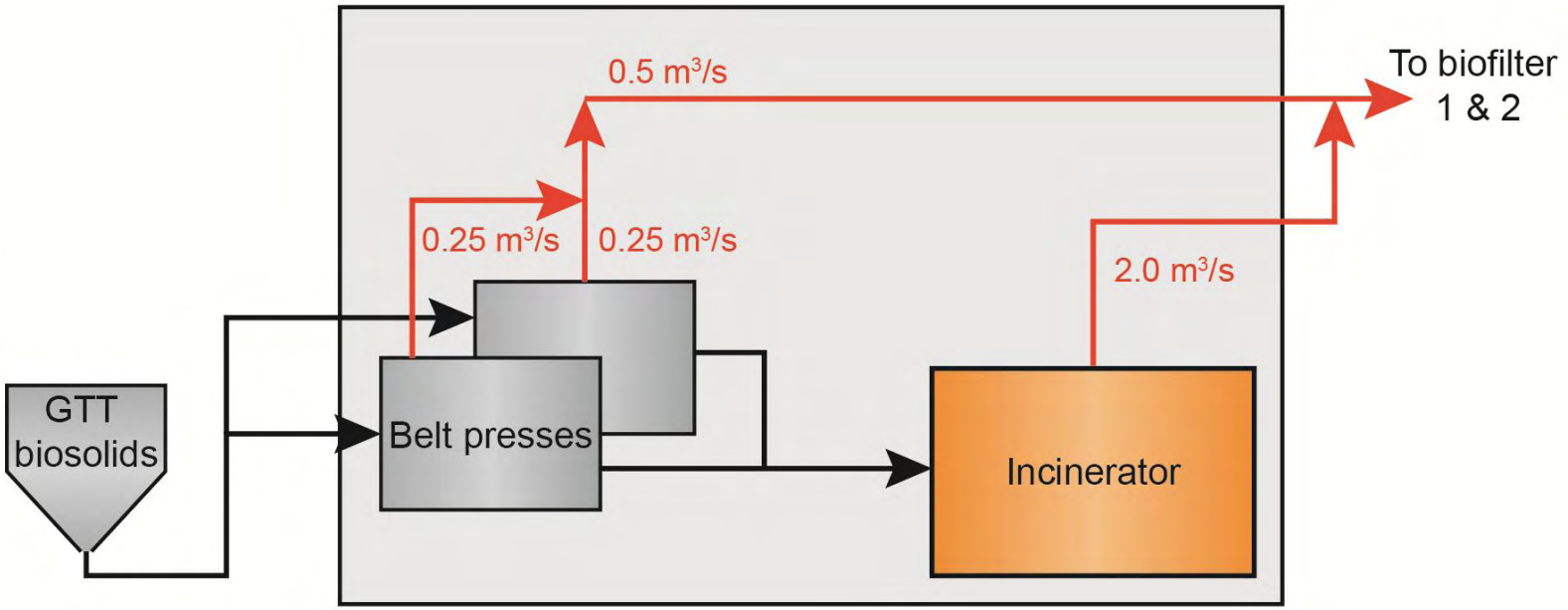

1. Schematic only, not to be interpreted as an engineering design or construction drawing
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Figure 12: Biosolids incinerator and belt press room odour control diagram.

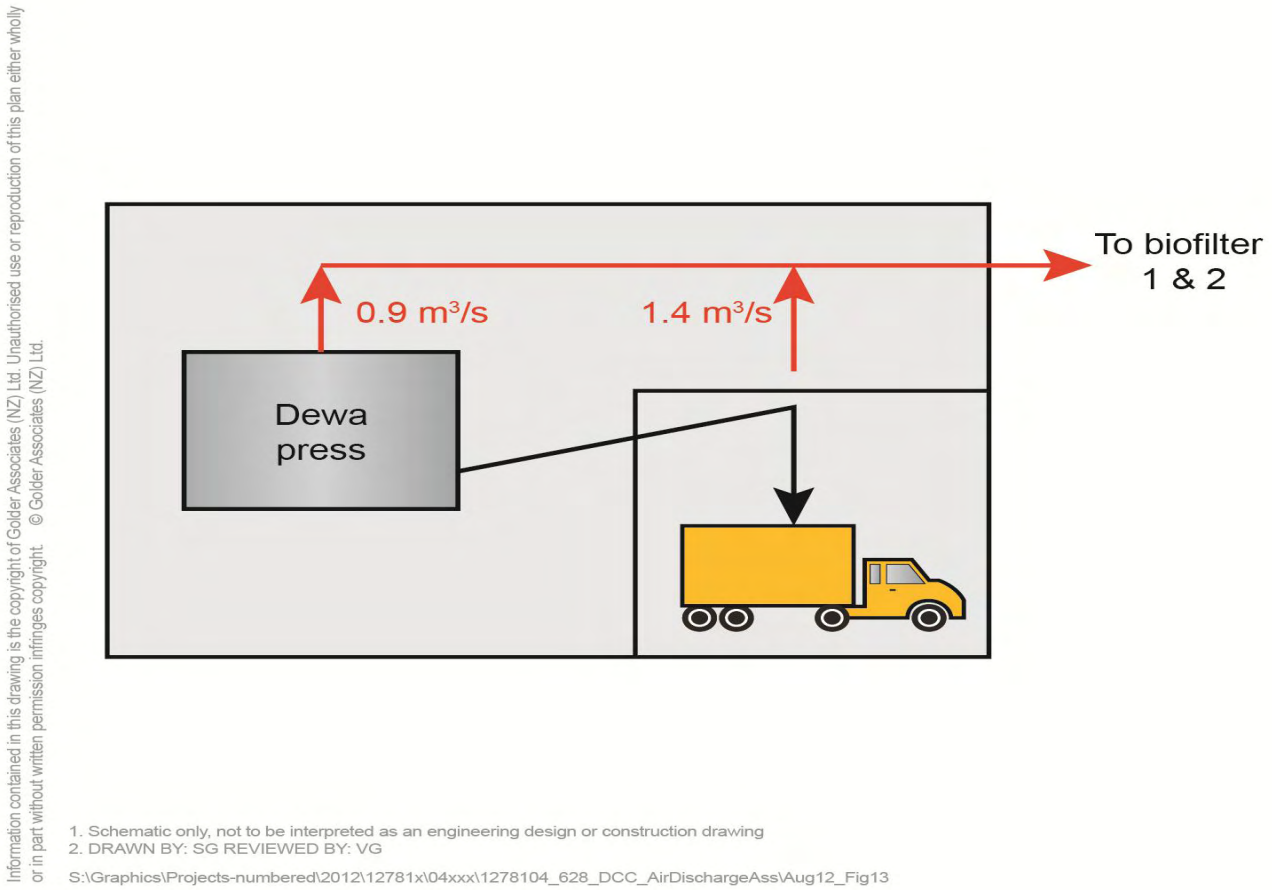

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Figure 13: Existing Dewa belt press and truck load-out enclosure odour control diagram.

As discussed in Section 3.2.5 it is standard operating procedure to ensure that only one door is opened at a time to allow for truck entry and exits so there is no through draft. However, during the actual loading cycle both doors should be closed to minimise the risk of fugitive odour emissions.

6.8.2 Truck movements

As noted above, the solids dispatch building is enclosed but will have truck access doors open periodically to allow for biosolids load out from the 60 tonne hopper as well as the picking up of skips. Given the anticipated operation of the biosolids incinerator and assuming no load out of biosolids from the Dewa belt press system, there would be four truck movements per day (5 days/week) required to remove 28 tonnes of dewatered biosolids from the site each week. This can be compared to the situation prior to the WWTP upgrade being completed, where two truck movements per day (5 days/week) occurred. The picking up and removal of skips by smaller pick-up truck would be less frequent at approximately three movements per week.

6.8.3 Targeted emissions extraction system

The emissions extraction system that targets the biosolids storage hopper, skips and grit washers is described in Figure 14, which shows that all the storage vessels are directly extracted. The skips and grit washers have volumes of approximately 9 m^3 and 4 m^3 respectively. Therefore, given the design extraction rates in Figure 14 of 0.06 and 0.03 m^3/s respectively, these items are ventilated at rates in excess of 20 air volume changes per hour.

The biosolids load out hopper's effective volume of approximately 50 m^3 would be extracted at a rate of nine volume changes per hour based on the specified design extraction rate. By comparison, the Beca design report (2011) lists this item as having a design extraction rate of 10 volume changes per hour.

However, following a review of its extraction ducting that includes a 200 mm diameter connection to the hopper and a 150 mm diameter connection to its inlet conveyor, a higher extraction air flow of 0.25 m^3/s is expected – giving the hopper an effective ventilation rate closer to 18 volume changes per hour, which should ensure very effective containment of emissions.

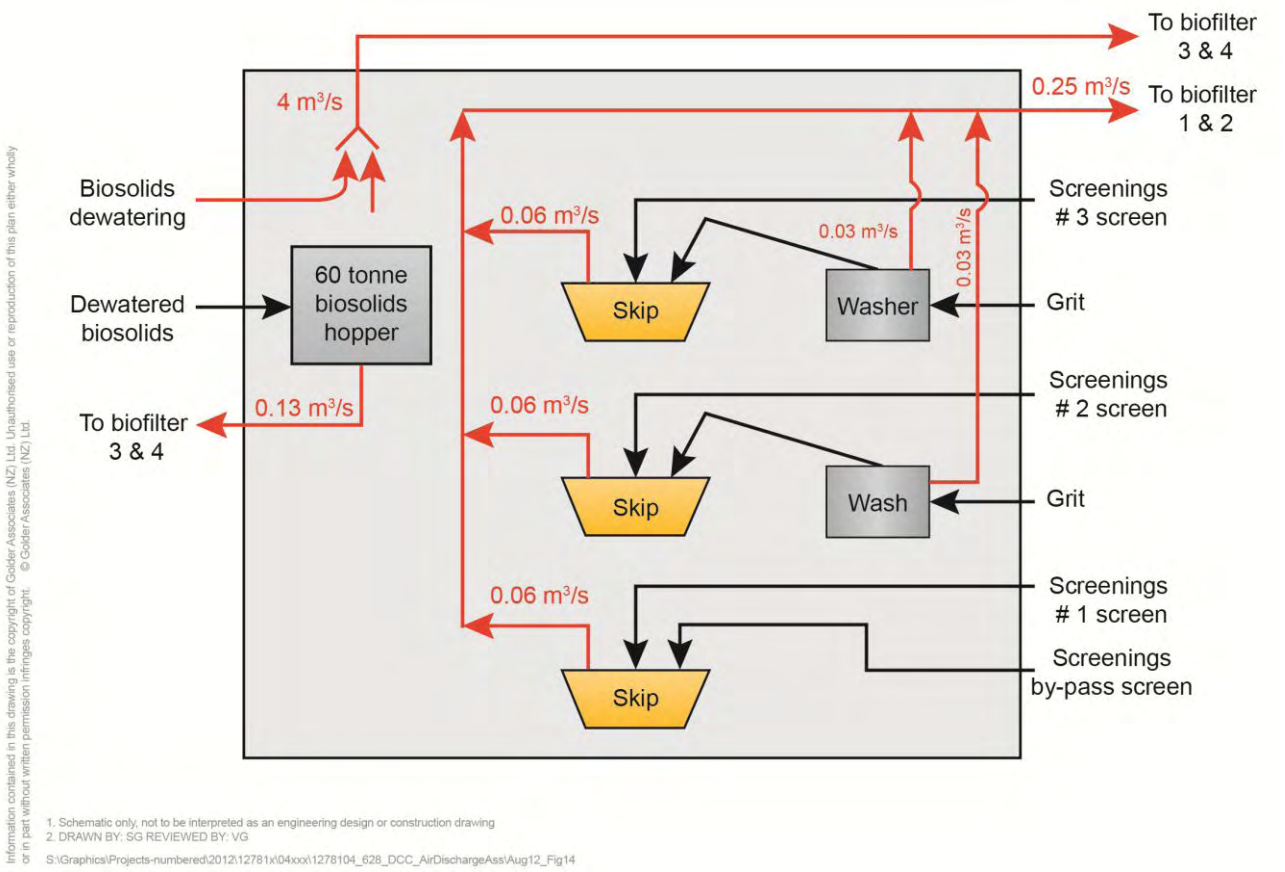

Figure 14: Solids storage and dispatch area odour control diagram.

6.8.4 Discussion

The ventilation rates for skips, grit washers and the 60 tonne hopper should ensure fugitive air emissions from these are well controlled. As long as access doors are only opened for truck entry and exits then there would be minimal opportunity for fugitive emissions of odour from the solids dispatch building, as they would only need to be opened for several minutes at a time.

The discharge of 7 tonnes of wet biosolids into a truck will result in short term fugitive odour emissions into the solids dispatch building. However, these are likely to be contained as long as access doors are kept shut during loading operations.

6.9 Wastewater Chambers and Pump Stations

There are a number of wastewater chambers, sumps and pump stations between the HRAS and the final ocean outfall that are potential sources of aerosol and odour emission. They decrease in environmental significance as the wastewater is progressively treated. These pumping chambers are all enclosed and subjected to targeted air extraction in order to contain these potential fugitive emissions. In descending

order of significance in terms of odour potential, these chambers and their target extraction flows are listed as follows:

- HED pump station – 0.42 m^3/s, 10 volume changes/hr
- BTF flush chamber – 0.3 m^3/s, 10 volume changes/hr
- BTF pump station – 0.67 m^3/s, 10 volume changes/hr
- UV lift pump station – 0.67 m^3/s, 10 volume changes/hr
- UV discharge channel – 0.4 m^3/s, 10 volume changes/hr
- Outfall pump station and Papatuanuku Junction Chamber – 1.3 m^3/s,

All the above sources have design volume specific ventilation rates of 10 volume changes/hr; except for the outfall pump station and PJC Junction, which is estimated to have a lower value of approximately 8 volume changes/hr.

The above ventilation rates are relatively high given these chambers are all tightly sealed and therefore fugitive emissions would be effectively eliminated from these potential sources.

6.10 Biological Trickling Filters

6.10.1 General

The two 37 m diameter biological trickling filters (BTFs) each have a single pass air flow of 7.0 m^3/s, which is drawn down through the BTFs packed beds to the new biofilter system. The empty volume of bed filters is approximately 9,000 m^3. When accounting for the wet media volume, then these units have an estimated effective free air volume of 6,000 to 7,000 m^3. Therefore, their specific air ventilation rate is three to four volume changes per hour.

The low ventilation rate of the BTFs validates the decision by the DCC to fully cover the BTFs to ensure that fugitive aerosol and odour emissions are effectively contained. If they were open, windy conditions would be able to suck odours and aerosols from the top of these units and result in a significant source of odour and aerosol discharge.

The BTF covers provide a high degree of sealing from windy conditions and vents for air entry are relatively small in area. Therefore, the BTFs would normally operate under sufficient vacuum (i.e., greater than –10 pascals (Pa) draft) such that they would not be prone to release of fugitive emissions during windy conditions. Windy conditions could otherwise act to pull air out of the BTFs by lowering the effective vacuum under which the BFTs operate. The BTF covers have dampers that control the entry of fresh air into the beds and these effectively help avoid the ability of air to escape from the BTFs to atmosphere.

6.10.2 Monitoring

It is recommended that normal operating vacuum of the BTFs be checked as part of the WWTP commissioning programme and as part of routine annual monitoring of odour extraction systems at the site.

6.11 Biofilters

6.11.1 General

There are effectively two biofilter systems proposed for the treatment of all air discharges that are extracted from the WWTP processes and the incinerator (i.e., the existing and new biofilters). Each system has two independent beds that are operated in parallel and therefore the existing system is referred to as Biofilters 1 & 2 and the new system as Biofilters 3 & 4.

Biofilters typically remove 99.9 % or more of inlet odorous compounds such as H_2S and effectively remove 100 % of the discernible process odour that they treat when designed and operated to good practice. However, combustion contaminants such as NO_2 can have low to moderate removal efficiencies. Appendix B provides the summary of emission testing results from existing Biofilters 1 & 2 from 2007 until 2011. The first column of the table details the resource consent requirements. For all of the contaminants measured (total suspended particulate, mercury, total cadmium and thallium, total other trace metals, and dioxins and furans), the concentrations were well below those levels permitted by the resource consent.

6.11.2 Design loading rates

The important design criteria for biofilters include flow bed loading rate (m^3_{air}/hr per m^3_{media}) and bed pressure drop (water gauge mm-H_2O). For treatment of odorous ambient air streams from wastewater plants, Golder recommends different maximum loading rates based on the use of bark or bark-soil/compost based beds. For bark beds, we recommend a maximum loading rate of 20 to 30 m^3_{air}/hr per m^3_{media} for treating ambient wastewater treatment emissions. However, higher loading rates of 35 to 40 m^3_{air}/hr per m^3_{media} can be loaded to typical soil-bark beds and compost-bark bed designs.

Further comment on the two biofilter systems and their design loadings follows.

6.11.3 Biofilters 1 and 2

Biofilters 1 & 2 have been up-graded in recent years and use a graded bark bed with a media volume of 3,360 m^3 (i.e., 2 x 1,400 m^2 beds at 1.2 m deep). Previously the bed media resulted in some air flow channelling, which reduces the performance in terms of odour and contaminant removal efficiency. For the new beds, a maximum air loading rate of 30 m^3_{air}/hr per m^3_{media}, is considered appropriate. Given the bed dimensions then this allows for a design flow of approximately 28 m^3/s to be supplied to Biofilters 1 & 2. Figure 15 summarises all of the input sources of air emission (including odour, aerosols, and combustion products) that are treated by this system and indicates a total design flow of 29 m^3/s. This is within 4% of the recommended design value, and is therefore considered to be acceptable.

6.11.4 Biofilters 3 and 4

Biofilters 3 & 4 are proposed to have a mix of graded bark, compost and sea shells for the bed media and have a total media volume of 2,400 m^3 (i.e., 2 x 800 m^2 beds each 1.5 m deep). Given the recommended maximum air loading rate of 40 m^3_{air}/hr per m^3_{media} for this specific application, we recommend this system be loaded with a maximum flow of 27 m^3/s.

Figure 16 summarises all of the input sources of air emission (including odour, and aerosols) that are treated by this system and indicates a total design flow of 23 m^3/s, which is 4 m^3/s below the recommended design flow. This spare capacity is available to treat dryer emissions and other sources should dewatered biosolids drying be required ahead of the incinerator, or for any existing source for which increased extraction is required.

7.0 ASSESSMENT OF COMBUSTION AIR DISCHARGES

7.1 General Approach

The assessment of incinerator exhaust gases discharging through the biofilter and combustion emissions from the standby diesel generator has been carried out using dispersion modelling.

The dispersion modelling approach allows for the prediction of contaminant concentrations over a wide area. The modelling approach is schematically illustrated in Figure 17 and requires the following three main stages:

- Source configuration and emissions data
- Meteorological, terrain and land use data

- Evaluation of the predicted impacts and cumulative effects against ambient guideline

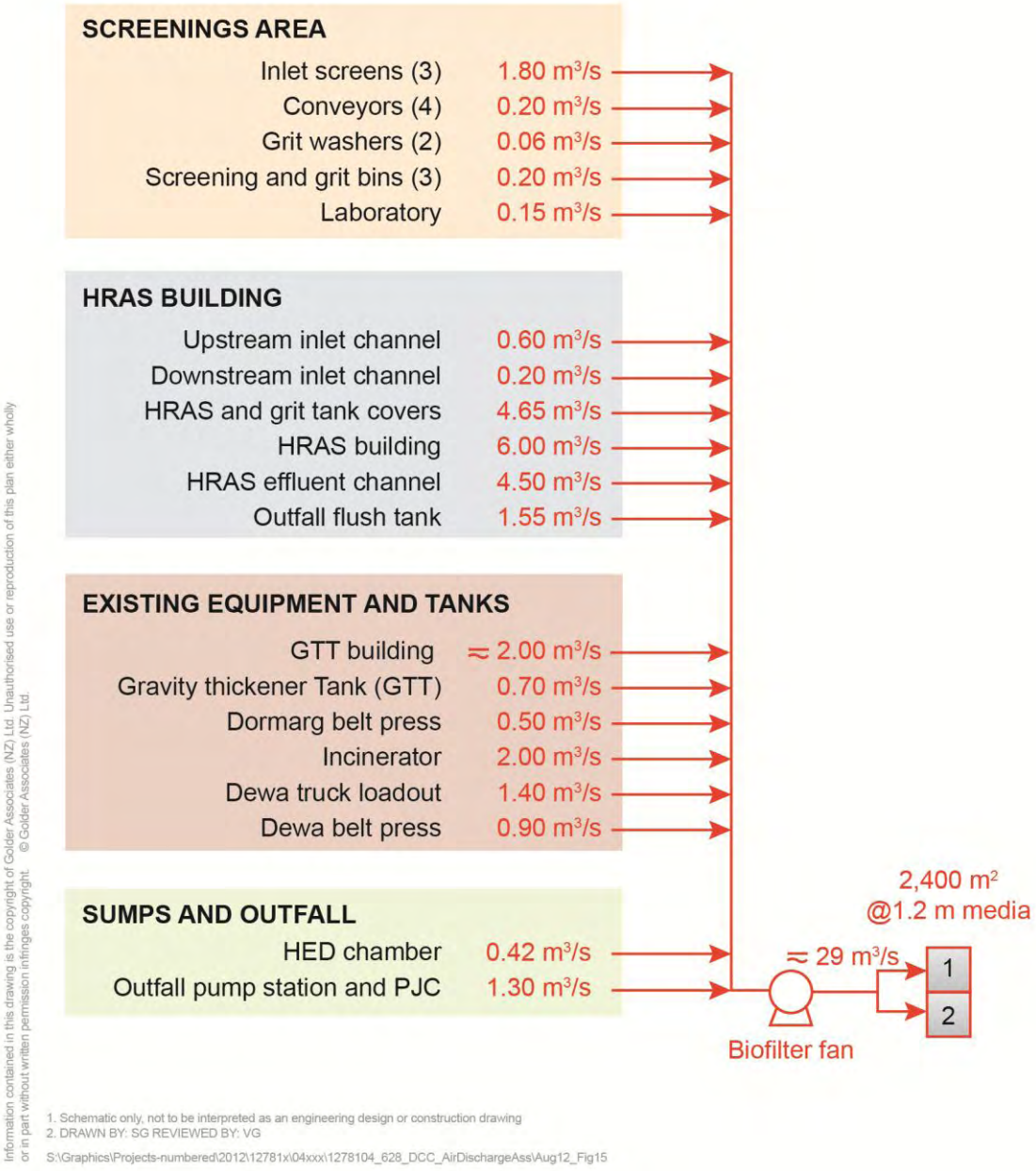

Figure 15: Sources extracted to biofilter 1 and 2.

Source specifications were provided by DCC and emissions were determined based on monitoring data from Watercare (2009, 2011) for the biofilter and through the use of a combustion calculation (Appendix F) for the standby diesel generator (see Section 4.2). Golder has used this information to set up the CALPUFF dispersion model to predict contaminant GLCs.

A three-dimensional high-resolution meteorological dataset for the area surrounding the Tahuna WWTP was also developed using the CALMET meteorological model in order to run the CALPUFF model. Further details on these two models are provided in Appendices D (CALMET) and E (CALPUFF).

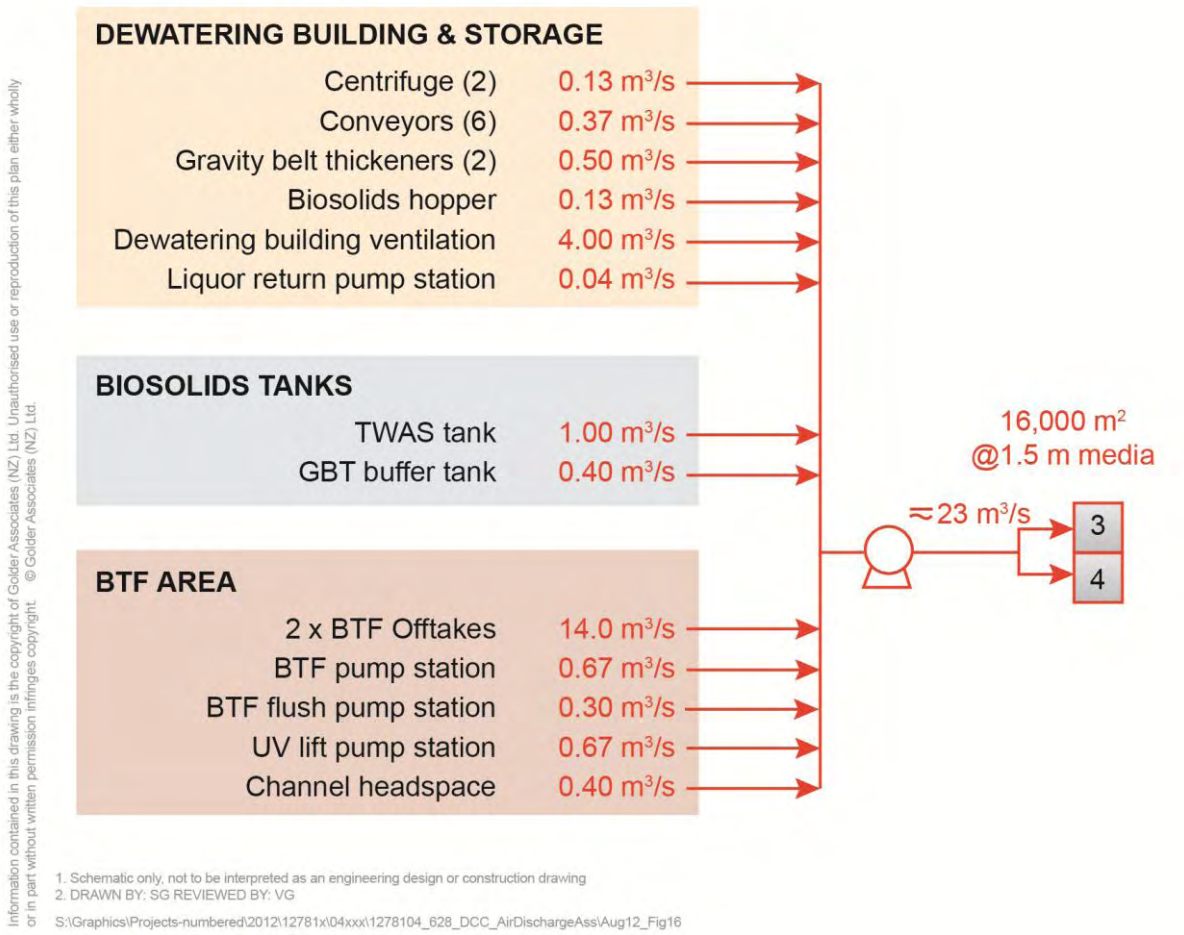

Figure 16: Sources extracted to biofilter 3 and 4.

It is important to stress that the relationship between predicted GLCs and actual monitoring results needs to be considered when assessing against the assessment criteria. Even when accounting for the modelling system's inherent propensity to overstate short term maximum air quality impacts, the assumption of continuous maximum applied for emission rates adds a significant additional level of conservatism to the model predictions.

7.2 Dispersion Modelling Results

7.2.1 Biofilters

7.2.1.1 Respirable particulate (PM_{10})

The maximum predicted offsite 24-hour average PM_{10} GLC from the biofilter is 12 µg/m³ (site emissions only), which is predicted to occur immediately to the southeast of the site and in a small area at the site boundary and on the golf course (see Figure 18). This maximum concentration is predicted immediately adjacent to the biofilters. GLCs at this 'near field' location are likely to be over-predicted by the modelling. Furthermore, people would not be exposed at this location for 24-hours (the relevant averaging period for the NES) and so impacts further away are more appropriate to consider.

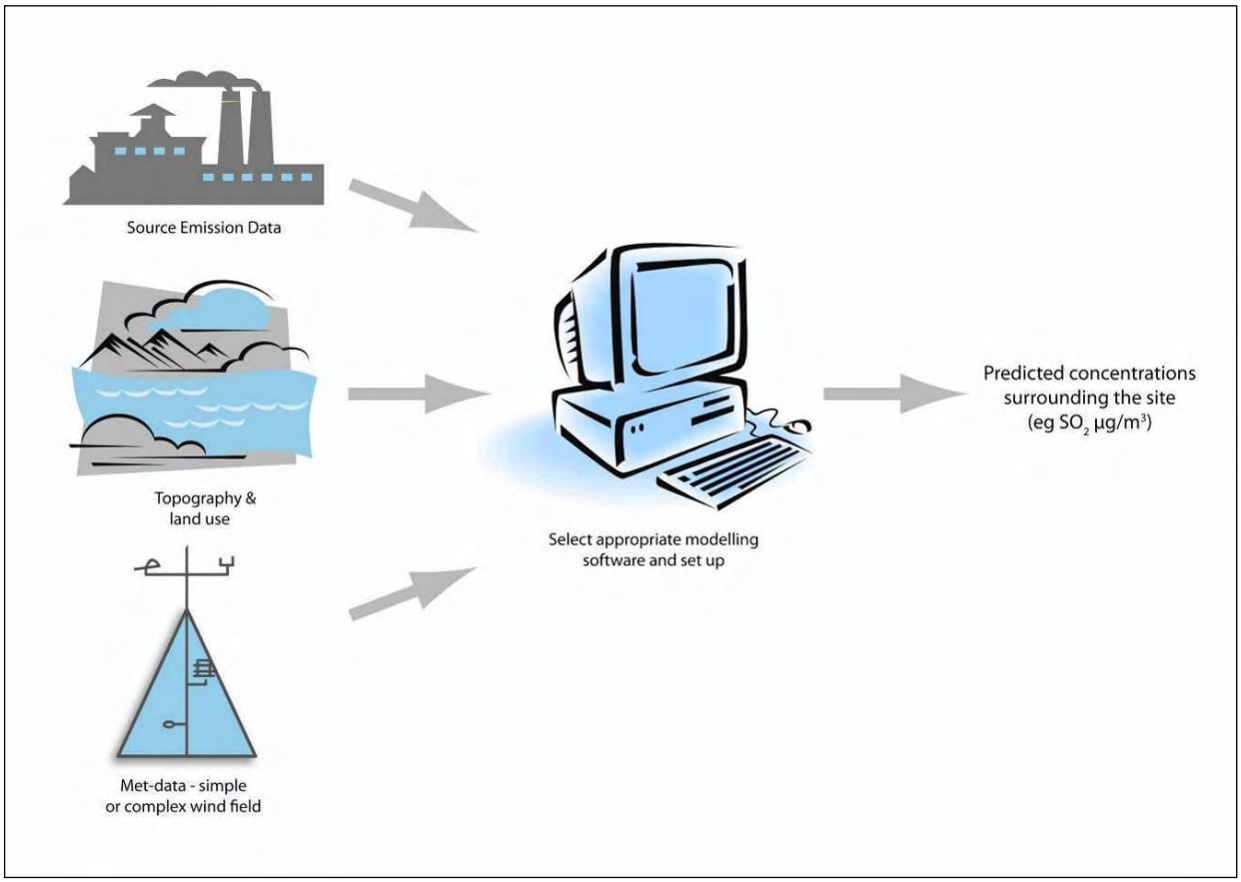

Figure 17: Schematic of dispersion modelling process.

Beyond the small area of impact that is opposite the south east corner of the site, the maximum GLCs quickly reduce below 5 µg/m³. Within 150 m of the southeast site boundary, the concentrations reduce to 3 µg/m³. To the north of the site over the residential area where people may be exposed for a 24-hour period, predicted GLCs are less than 2 µg/m³ (see Figure 18). Such low concentrations are not considered significant, especially given that such concentrations are below the limit of detection for most ambient PM_{10} monitoring methods.

Allowing for a background concentration of 38 µg/m³ for 24-hour average PM_{10} (double the annual average PM_{10} concentration mentioned in Section 2.2.2), the cumulative PM_{10} GLCs due to combustion emissions from the biofilters are not likely to cause any significant change to the background. They are also not likely to cause the NES for PM_{10} to be breached on high pollution days in Dunedin. Background concentrations of PM_{10} are sometimes above the RAAQG of 30 µg/m³, especially on cold still days. However, the site discharges are likely to make no measureable impact on ambient PM_{10} in the surrounding Tahuna area on such days. The only prospect of the biofilter emissions causing a measurable increase in ambient PM_{10} is within a very localised and small area adjacent to the sites southern boundary. This will not create an airshed management issue.

The maximum predicted annual average PM_{10} GLC from the biofilter is approximately 2.5 µg/m³, which occurs immediately to the southeast of the site over the golf course. Concentrations over residential areas are typically less than 0.2 µg/m³. This is shown as a contour plot in Figure 19.

When allowing for an annual background concentration of 19 µg/m³, predicted cumulative impacts just exceed the AAQG of 20 µg/m³ over a highly localised part of the golf course to the south of the site and are just below the AAQG to the north over the residential area. Although the annual average background concentration of 19 µg/m³ is already very close to the AAQG, the contribution from the site, especially over

areas where people are likely to be exposed, is very small and is not considered significant. A summary of peak 24-hour and annual concentrations at different sensitive locations are given in Table 5.

Table 5: Summary of maximum PM_{10} GLC for sensitive locations – biofilter emissions only.

Averaging period	Maximum off-site GLC (µg/m³)	Location of maximum off-site GLC	Maximum residential location GLC (µg/m³)	Assessment criteria (µg/m³)
24-hour maximum	12	Southeast site boundary	2	50 NES† 35 RAAQG
Annual	2.5	Southeast site boundary	0.2	20 AAQG

Note: † permitted excess one 24-hour period in 12 months.

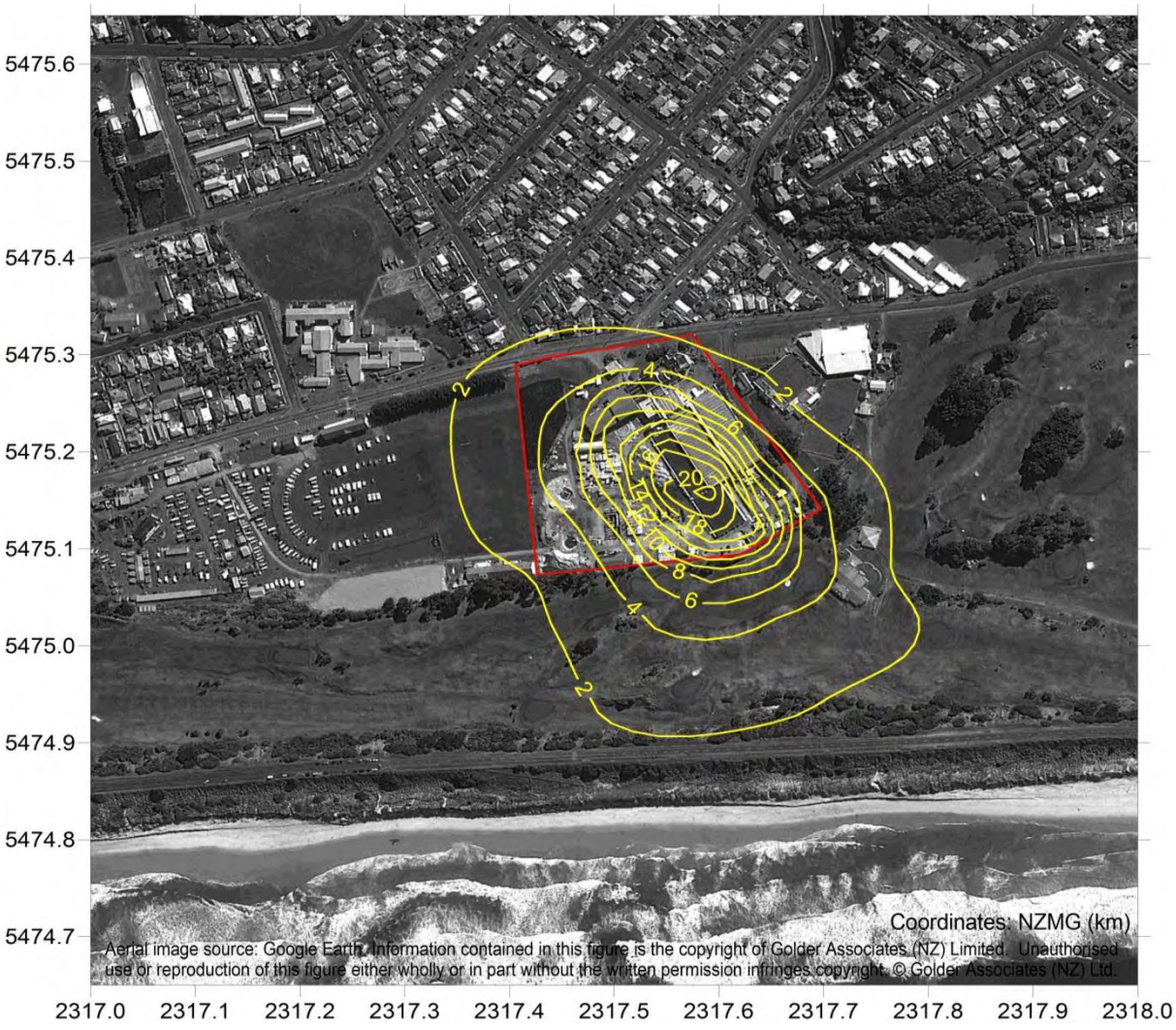

Figure 18: Predicted maximum 24-hour average PM_{10} ground level concentrations for the existing biofilters at the Tahuna WWTP. Yellow contours are in units of µg/m³; the red outline indicates the site boundary.

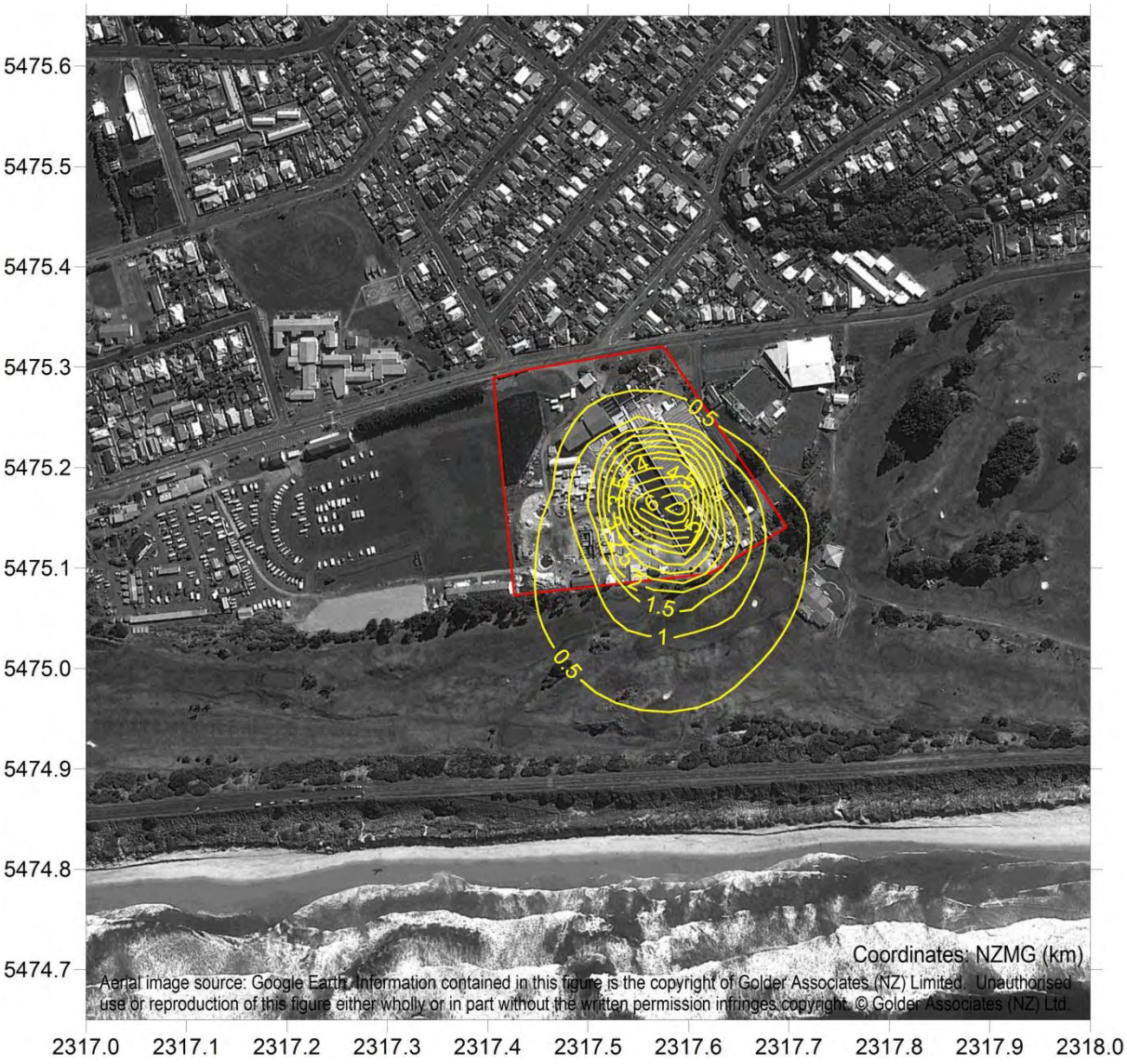

Figure 19: Predicted annual average PM_{10} ground level concentrations for the existing biofilters at the Tahuna WWTP. Yellow contours are in units of µg/m³; the red outline indicates the site boundary.

7.2.1.2 Nitrogen dioxide (NO_2)

The maximum predicted (modelled 99.9th percentile) offsite 1-hour average NO_2 GLC from the biofilter is 70 µg/m³ (biofilter emissions only), which is predicted to occur immediately over a small area at the southeast boundary of the site over the golf course (see Figure 20).

Beyond the small area of impact opposite the southeast corner of the site, the maximum 1-hour GLCs quickly decrease to below 30 µg/m³. To the north of the site over the residential area where people may be exposed for a 1-hour period, predicted GLCs are less than 25 µg/m³. This is shown as a contour plot in Figure 20. Allowing for a background of 29 µg/m³, it is clear that the cumulative impact of NO_2 emissions from the biofilter and background levels will not approach the RAAQG of 130 µg/m³.

The maximum predicted offsite 24-hour average NO_2 GLC from the biofilter is 24 µg/m³ (biofilter emissions only), which is predicted to occur in approximately the same location as for the maximum 1-hour GLC (Figure 21. People would not be exposed at this location for 24-hours (the relevant averaging period for the NES) and so impacts further away are more appropriate to consider.

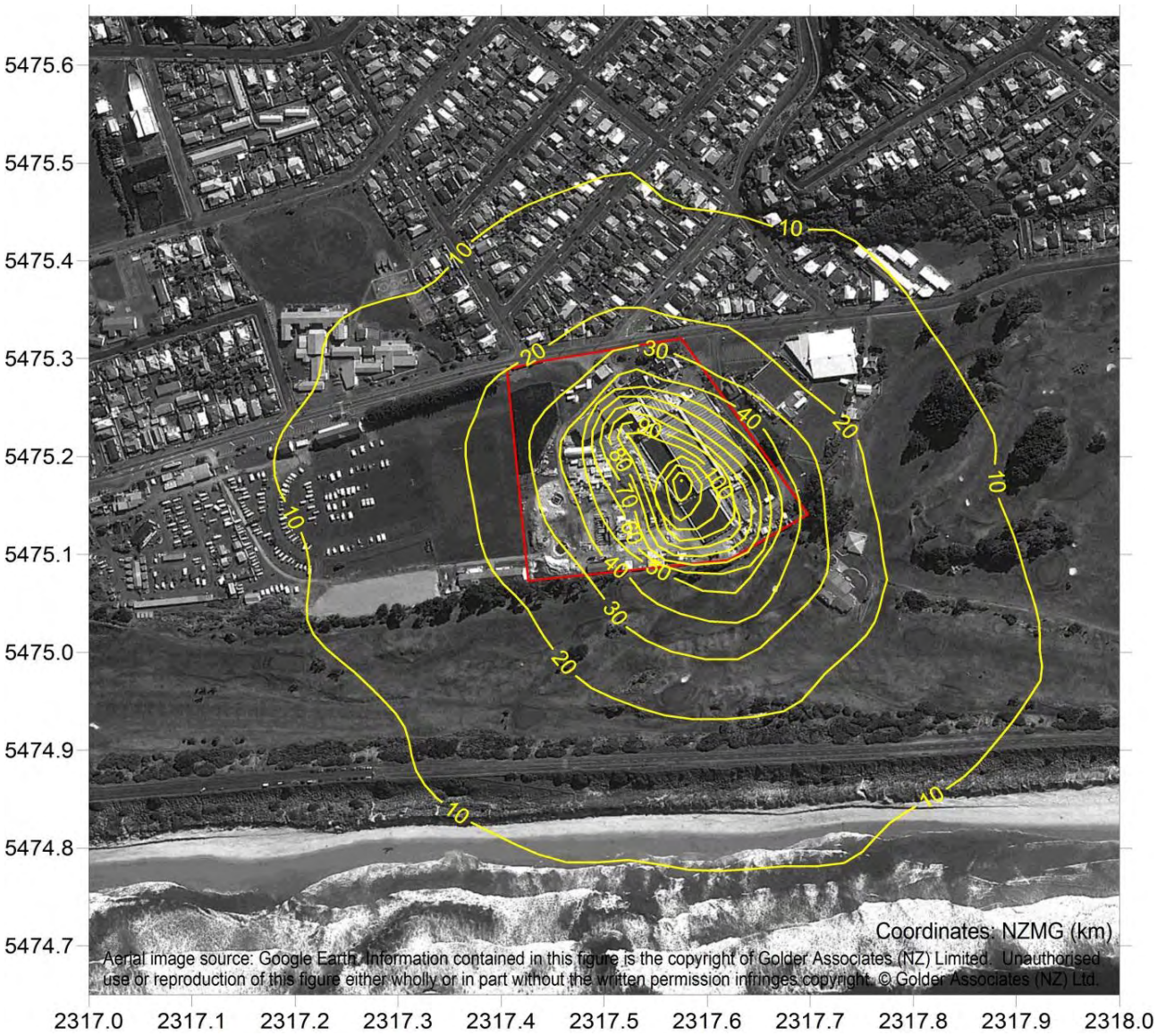

Figure 20: Predicted maximum (modelled 99.9th percentile) 1-hour average NO_2 ground level concentrations for the existing biofilters at the Tahuna WWTP. Yellow contours are in units of µg/m³; the red outline indicates the site boundary.

The GLCs at the residential area to the north are predicted to be less than 4 µg/m³. This is a small proportion of both the AAQG and the RAAQG. Allowing for a background of 29 µg/m³, the cumulative 24-hour GLCs will be just below the RAAQG of 60 µg/m³.

A summary of the NO_2 GLCs is given in Table 6.

7.2.1.3 Ambient mercury

The peak predicted annual average GLC of Mercury is 0.002 µg/m³. This concentration is less than 1 % of the AAQG for mercury of 0.3 µg/m³. This peak concentration occurs in the same localised area as the peak annual average PM_{10} concentration (not shown). Concentrations are predicted to be below 0.00014 µg/m³ in residential areas.

Table 6: Summary of maximum NO_2 GLC for sensitive locations – biofilter emissions only.

Averaging period	Maximum off-site GLC (µg/m³)	Location of maximum off-site GLC	Maximum residential location GLC (µg/m³)	Assessment criteria (µg/m³)
1-hour maximum (modelled 99.9th)	70	Southeast site boundary	25	200 NES† 130 RAAQG
24-hour maximum	24	Southeast site boundary	4	100 AAQG 60 RAAQG

Note: † permitted excess 9 hours in 12 months.

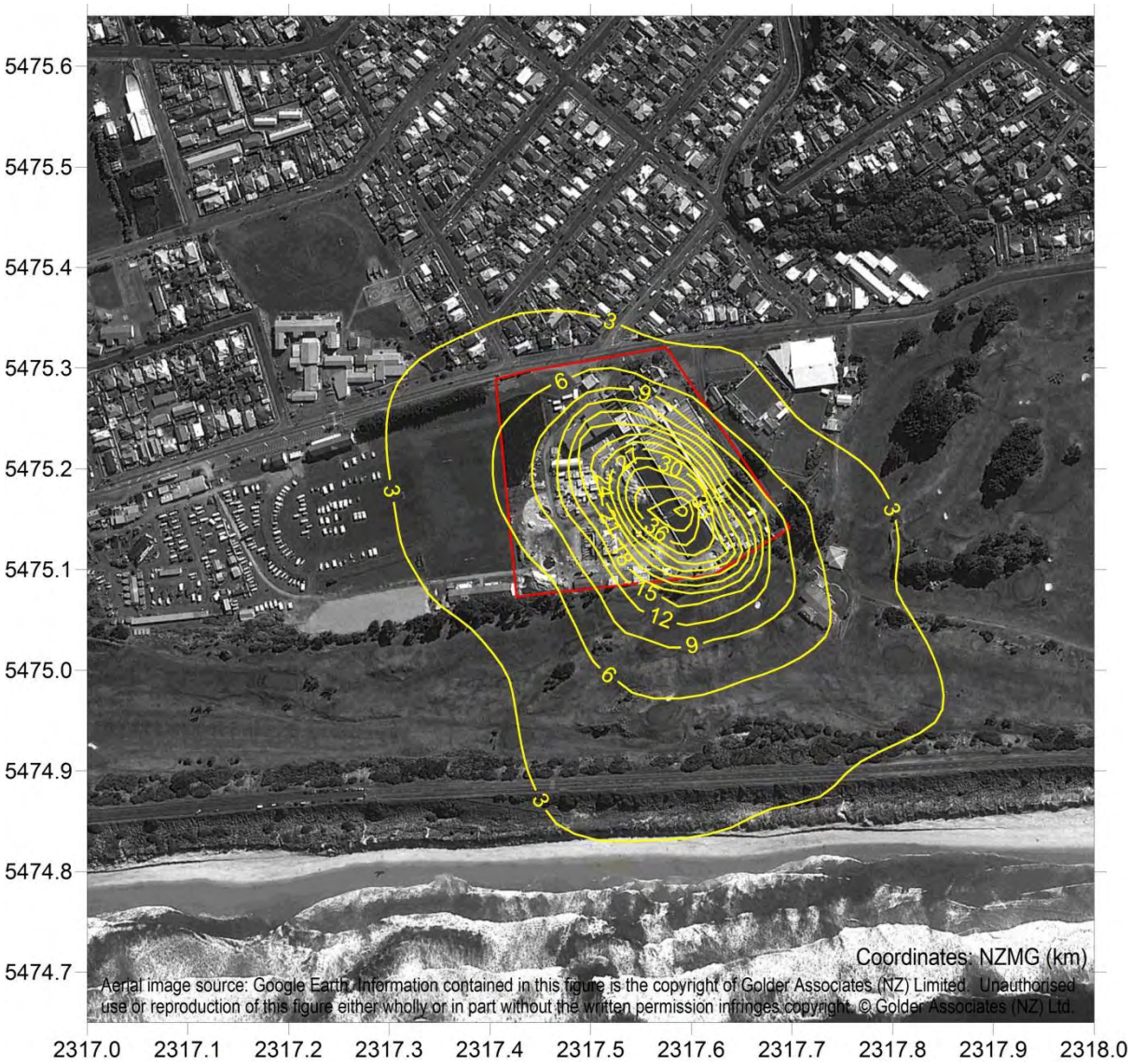

Figure 21: Predicted annual average NO_2 ground level concentrations for the existing biofilters at the Tahuna WWTP. Yellow contours are in units of µg/m³; the red outline indicates the site boundary.

7.2.1.4 Ambient TEQ-dioxin

The cancer potency from exposure to dioxins is estimated from what is termed the Lifetime average daily dose (LADD) to dioxins and furans. The approach for calculating this and subsequent increased cancer risk is detailed in Appendix C. The resultant estimated cancer risk due to inhalation is found to be very minor as detailed below.

Annual exposure concentration

Dispersion modelling based predictions of the long term average ambient concentration of TEQ-dioxin due to emissions from biofilter 1 and 2 has been completed when assuming historically measured discharge rates (shown in Table 2). Given the average TEQ-dioxin emission rate of 3.2×10^{-7} mg/s from biofilter 1 and 2, the associated maximum annual average concentration over the residential area to the north of the site is predicted to be 2.8×10^{-9} µg I-TEQ/m^3. This equates to a concentration of 2.8×10^{-3} pg I-TEQ/m^3. Given this exposure concentration and the values for average body weight, inhalation rate, contact time and exposure time over 70 years (see Appendix C) a LADD value of 4.9×10^{-5} pg I-TEQ/kg-bw/day is calculated. This is also an estimate of the maximum TDI value that is predicted for this proposal. This exposure value is well below the WHO guideline value of 1 to 4 pg-iTEQ/kg-bw/day and the MfE's unofficial guideline of 1 pg-iTEQ/kg-bw/day.

The dioxin emissions from the standby generator are not considered here due to their intermittent nature.

Inhalation health risk

The predicted increased cancer risk (known as LADD x q_1) is calculated to be 7×10^{-8}, which is less than 1 in 10 million. This level of incremental risk is one to two orders of magnitude below the probabilities of 10^{-6} to 10^{-5} which are generally considered to be an acceptable range (see the discussion in Section 5.2.4). Therefore, the cancer risk is considered negligible.

The potential for non-cancer effects due to inhalation is also extremely low when comparing the estimated TDI value of 4.9×10^{-5} pg/kg/day to the guideline value of 1.0 pg/kg/day, as the health guideline TDI value is over 20,000 times above the estimated worst case prediction.

7.2.2 Standby diesel generator

7.2.2.1 Respirable particulate (PM_{10})

PM_{10} was modelled for the standby diesel generator for two stack height scenarios: 10 m and 15.3 m (the latter being the height needed to comply with the relevant permitted activity rule in the Regional Plan). A summary of the predicted concentrations for the 10 m and 15.3 m stack height scenarios is given in Table 7 and Table 8 respectively. The maximum predicted 24-hour offsite PM_{10} GLC for the 10 m stack height is 6 µg/m³ and for the 15.3 m stack is 4 µg/m³. For both scenarios, the location of these maximum predicted offsite GLCs occurs immediately north of the site and over Victoria Road. These values decrease by approximately a third over the residential area further north of the site.

The maximum predicted annual average PM_{10} GLCs are 0.6 µg/m³ for the 10 m stack and 0.5 µg/m³ for the 15.3 m stack and occur at the eastern boundary of the site. These concentrations decrease by approximately 50 % at the nearest residential properties north of the site.

Contour plots of the maximum 24-hour and annual PM_{10} GLCs are given in Figure 22 and Figure 23 for the 15.3 m stack height scenario.

It should be noted that the annual averages PM_{10} GLCs resulting from the generators emissions would be well below those predicted by the modelling. This is because the modelling assumes constant operation by the generator, which in reality will only operate occasionally and then for short periods of time (i.e., to provide backup supply during power cuts and for routine checks of its operation).

Table 7: Summary of maximum PM_{10} GLC for sensitive locations – standby diesel generator with a stack height of 10 m.

Averaging period	Maximum off-site GLC (µg/m³)	Location of maximum off-site GLC	Maximum residential location GLC (µg/m³)	Assessment criteria (µg/m³)
24-hour maximum	6	North site boundary	4	50 NES† 35 RAAQG
Annual	0.6	East site boundary	0.3	20 AAQG

† permitted excess one 24-hour period in 12 months.

Table 8: Summary of maximum PM_{10} GLC for sensitive locations – standby diesel generator with a stack height of 15.3 m.

Averaging period	Maximum off-site GLC (µg/m³)	Location of maximum off-site GLC	Maximum residential location GLC (µg/m³)	Assessment criteria (µg/m³)
24-hour maximum	4	North site boundary	2.5	50 NES† 35 RAAQG
Annual	0.5	East site boundary	0.2	20 AAQG

† permitted excess one 24-hour period in 12 months.

It is also for this reason that the generator is unlikely to contribute in a significant way to cumulative effects of PM_{10} (that is, from the biofilter and background sources). Additionally, the peak impacts of the generator are not predicted to occur in the same location as those arising from the biofilter.

7.2.2.2 Nitrogen dioxide (NO_2)

As with $PM_{10,}$ NO_2 was modelled for the standby diesel generator for stack heights of 10 m and 15.3 m. A summary of the predicted NO_2 GLCs for the 10 m and 15.3 m stack height scenarios is given Table 9 and Table 10 respectively.

The maximum predicted 1-hour (99.9^{th} percentile) offsite NO_2 GLC for the 10 m stack height is 140 µg/m³ and for the 15.3 m stack is 80 µg/m³. For both scenarios, the maximum offsite GLCs occur at the northern site boundary. These GLCs decrease to approximately 80 µg/m³ for the 10 m stack height scenario and 60 µg/m³ for the 15.3 m stack height scenario over the residential area further north of the site.

The maximum predicted 24-hour offsite PM_{10} GLCs are 60 µg/m³ for the 10 m stack height and 50 µg/m³ for the 15.3 m stack height. The maximum 24-hour GLCs for both scenarios occurs at the northern site boundary. These GLCs decrease to approximately 50 µg/m³ for the 10 m stack height scenario and 35 µg/m³ for the 15.3 m stack height scenario over the residential area further north of the site.

Contour plots of the maximum 1-hour and 24-hour NO_2 GLCs are given in Figure 24 and Figure 25 for the 15.3 m stack height.

The cumulative effects of NO_2 for the diesel generator, biofilter and background are unlikely to exceed the assessment criteria as the generator will only operate occasionally for short periods of time. In addition, the maximum offsite GLCs for the generator and biofilter emissions occur in different locations, with the maximum GLC from the generator occurring to the north of the site, and the maximum GLC from the biofilter occurring to the south of the site.

As discussed earlier in relation to PM_{10} impacts, it is unlikely that NO_2 emissions from the generator would contribute to in a significant way to cumulative effects of NO_2.

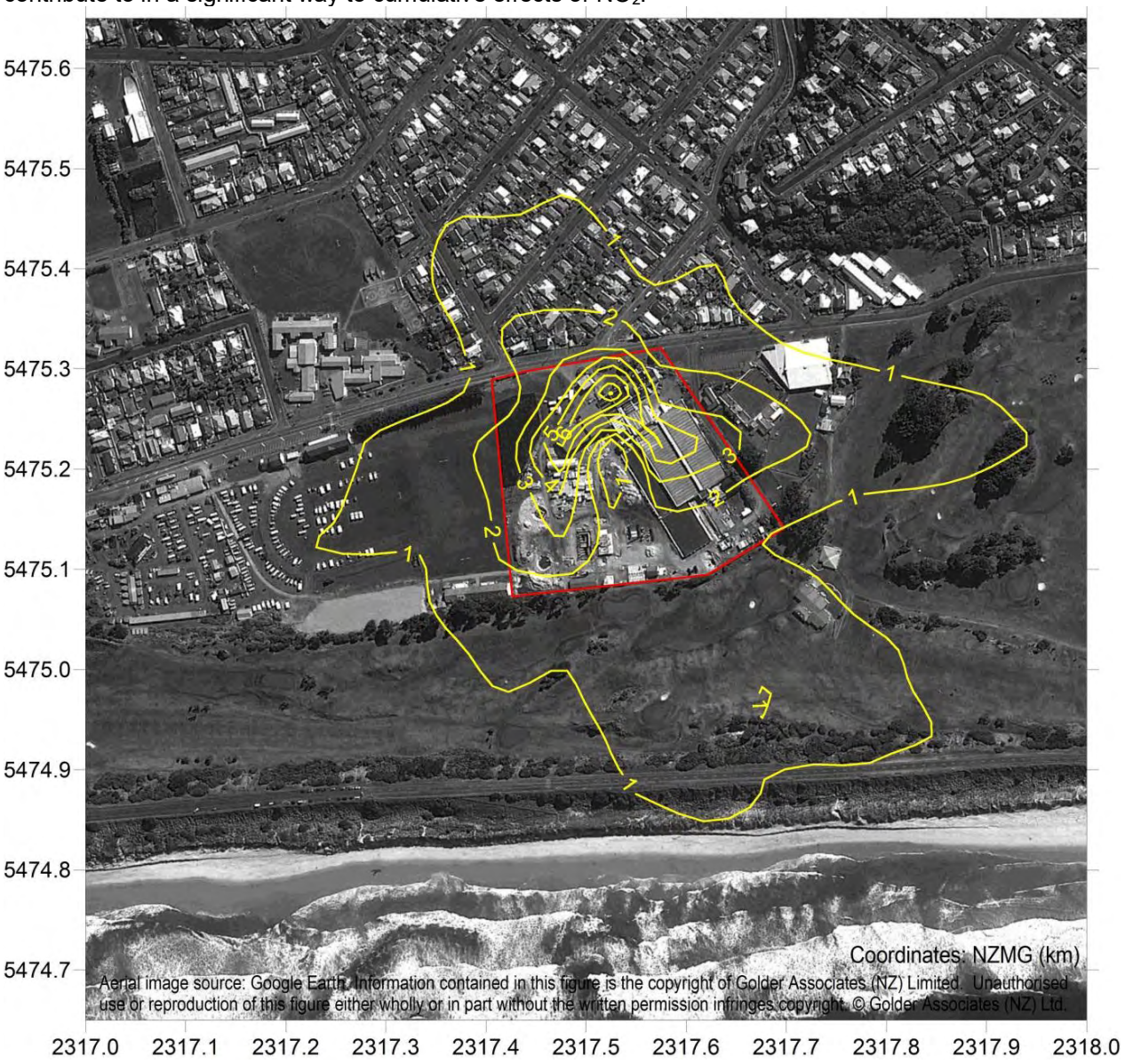

Figure 22: Predicted maximum 24-hour average PM_{10} ground level concentrations for the standby diesel generator with a stack height of 15.3 m at the Tahuna WWTP. Yellow contours are in units of µg/m³; the red outline indicates the site boundary.

Table 9: Summary of maximum NO_2 GLC for sensitive locations – standby diesel generator with a stack height of 10 m.

Averaging period	Maximum off-site GLC (µg/m³)	Location of maximum off-site GLC	Maximum residential location GLC (µg/m³)	Assessment criteria (µg/m³)
1-hour maximum (modelled 99.9th)	140	North site boundary	80	200 NES† 130 RAAQG
24-hour maximum	60	North site boundary	50	100 AAQG 60 RAAQG

Note: † permitted excess 9 hours in 12 months.

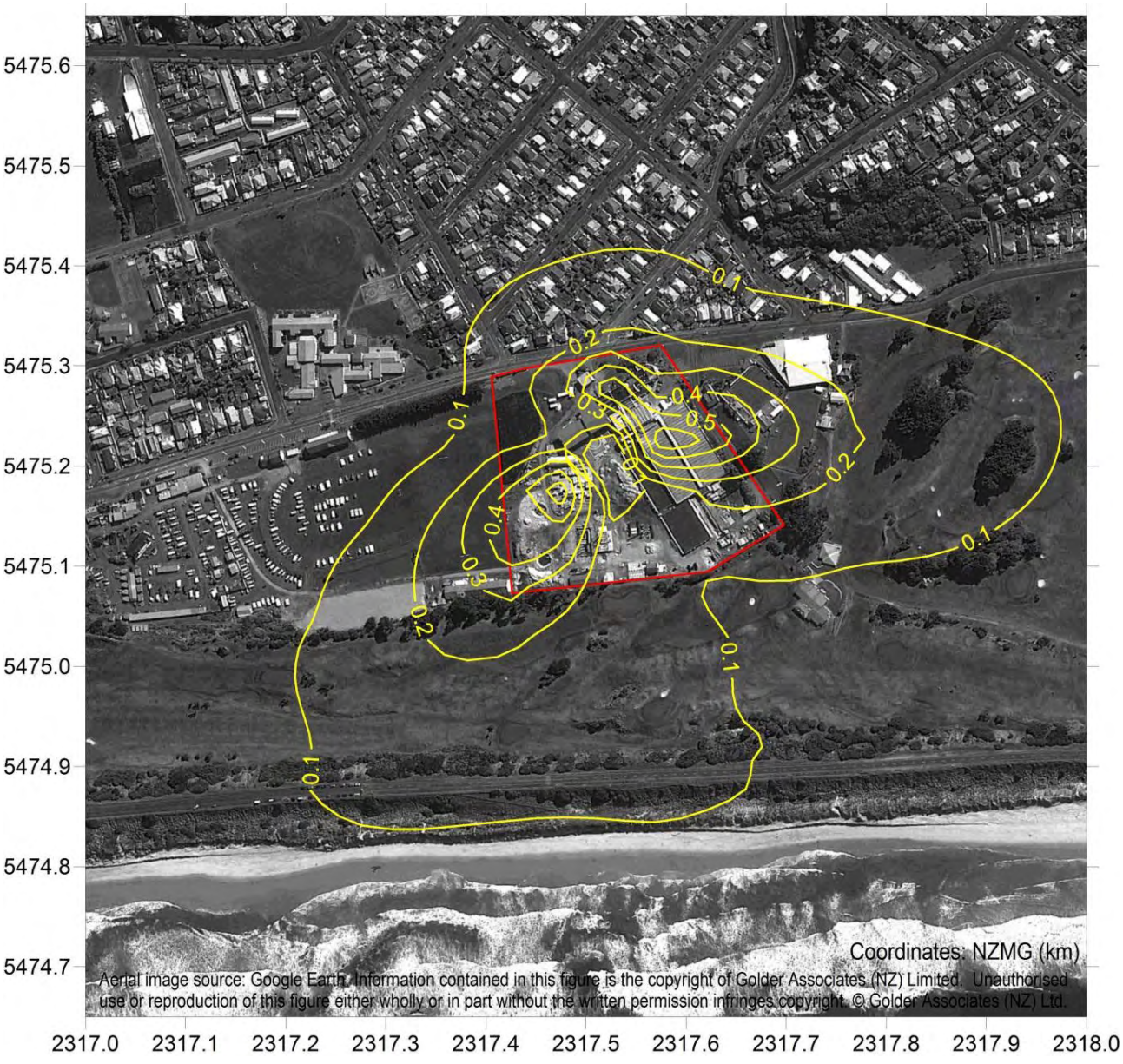

Figure 23: Predicted annual average PM_{10} ground level concentrations for the standby diesel generator with a stack height of 15.3 m at the Tahuna WWTP. Yellow contours are in units of µg/m³; the red outline indicates the site boundary.

Table 10: Summary of maximum NO_2 GLC for sensitive locations – standby diesel generator with a stack height of 15.3 m.

Averaging period	Maximum off-site GLC (µg/m³)	Location of maximum off-site GLC	Maximum residential location GLC (µg/m³)	Assessment criteria (µg/m³)
1-hour maximum (modelled 99.9th)	80	North site boundary	60	200 NES† 130 RAAQG
24-hour maximum	50	North site boundary	35	100 AAQG 60 RAAQG

Note: † permitted excess 9 hours in 12 months.

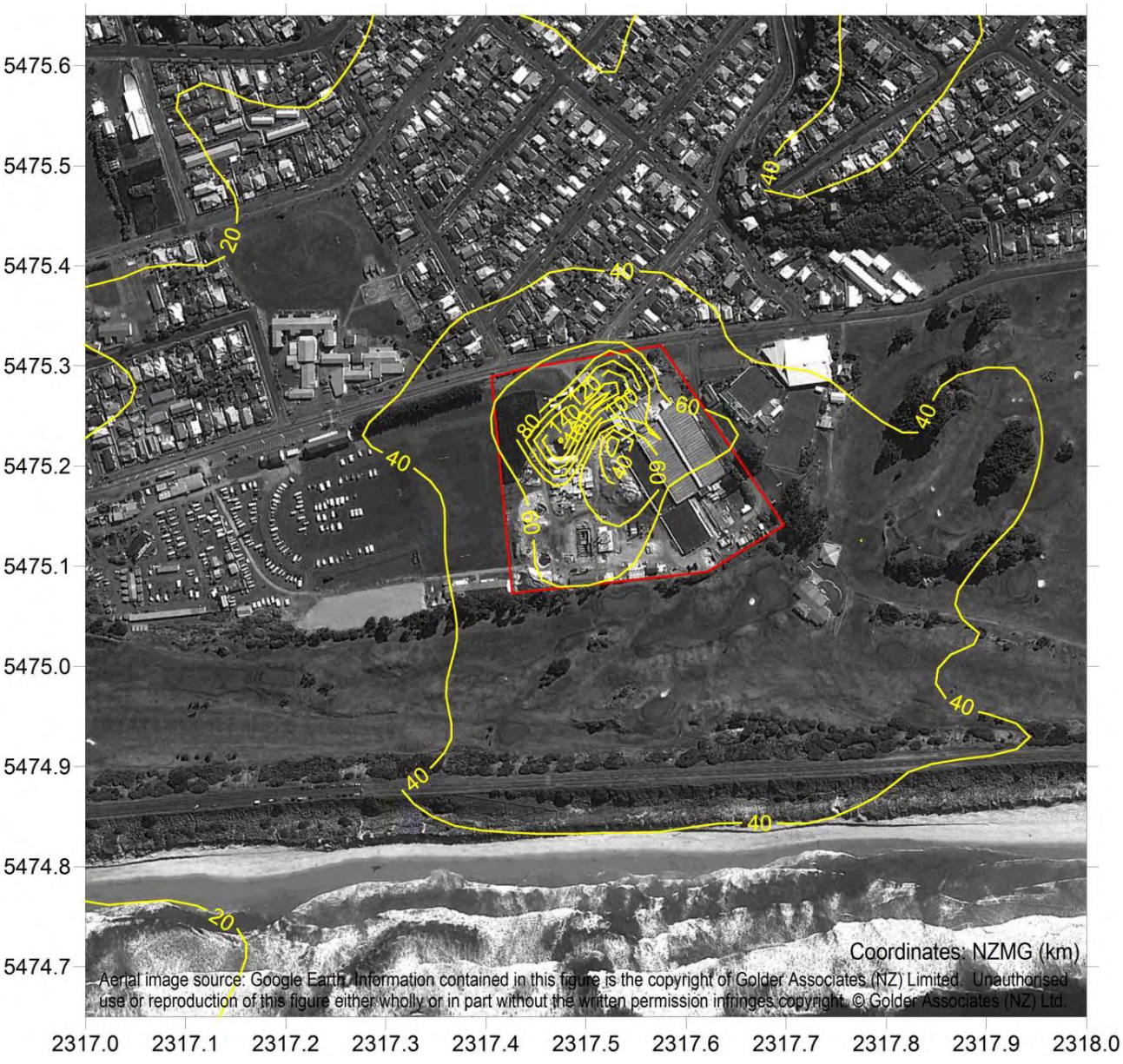

Figure 24: Predicted maximum (modelled 99.9th percentile) 1-hour average NO_2 ground level concentrations for the standby diesel generator with a stack height of 15.3 m at the Tahuna WWTP. Yellow contours are in units of µg/m³; the red outline indicates the site boundary.

7.3 Summary

The modelling results for the biofilter and standby diesel generator predict that all off site GLCs of PM_{10}, NO_2 and mercury would be below the relevant assessment criteria at locations where people are likely to be exposed and when taking into account likely background concentrations.

There is a small area in the corner of the golf course where 24-hour average PM_{10} concentrations are slightly above the RAAQG for PM_{10}, however people are not expected to be exposed at this location for a 24-hour period. The cancer and inhalation risk arising from dioxin discharges is also predicted to be well below the assessment criteria.

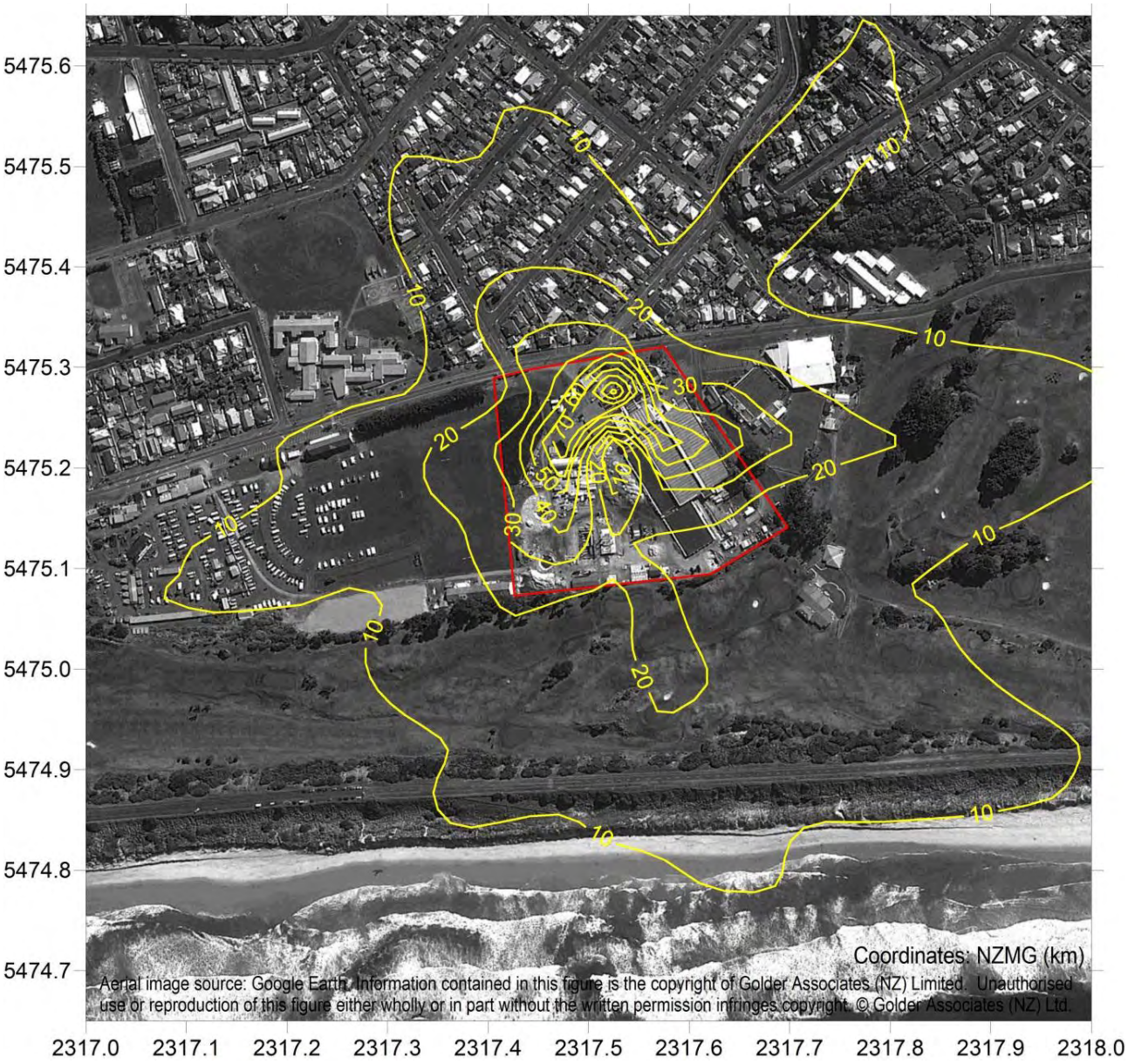

Figure 25: Predicted annual average NO_2 ground level concentrations for the standby diesel generator with a stack height of 15.3 m at the Tahuna WWTP. Yellow contours are in units of µg/m³; the red outline indicates the site boundary.

The maximum PM_{10} and NO_2 GLCs for the diesel generator and biofilter occur in different offsite locations. Additionally, the generator operates infrequently for maintenance purposes or during power outages. For these reasons, it is unlikely that emissions from the generator would result in cumulative effects that would lead to exceedences of the assessment criteria.

Two sets of GLCs have been presented for the standby diesel generator stack height; 10 m and 15.3 m. It is understood from the DCC that a stack height of 15.3 m is required for the top of the stack to be 3.5 m above nearby building ridgelines. This clearance results in the operation of the diesel-fired generator being a permitted activity under the ORC Plan. Both the 10 m and 15.3 m stack height scenarios result in predicted GLCs for NO_2 and PM_{10} that are well below the relevant ORC and NES target values. However, the GLCs from the 15.3 m high stack scenario are approximately two thirds of those predicted to occur from the 10 m high stack height scenario. Furthermore, whilst the 10 m height option results in PM_{10} GLCs that are lower than the various regulatory targets, they are still sufficiently high to be problematic given the airshed is polluted (refer Section 5.2.2).

Golder recommends that the DCC installs a stack for the diesel-fired generator that is 15.3 m above ground level, or any minor variation to this height, as it is necessary to ensure that the top of the stack is at least 3.5 m higher than the highest building roof ridgeline that is on the site.

8.0 ASSESSMENT OF POTENTIAL ODOUR EFFECTS

8.1 Introduction

In this section the historical, existing and future potential for odour effects are assessed by use of the following information:

- Community feedback (historical effects)
- Downwind assessment (existing effects)
- Odour control system review (future effects)

Community feedback information is available in the form of odour complaint records and odour annoyance surveys that the DCC has implemented periodically to monitor the impact of odours from the WWTP on the wider community. Because the WWTP has been progressively upgraded over the last 12 months, the results of these surveys as well as complaint record information will largely relate to historical effects of odour on the surrounding community, rather than existing effects. Existing effects are expected to have decreased over the last 12 months with the installation and operation of improved odour extraction systems within the HRAS building and associated tanks. However, there have been some releases of odour during the commissioning of plant. Nevertheless, this information provides a useful benchmark to help ascertain future odour effects following the completed WWTP upgrade.

An assessment of existing odours downwind of the WWTP provides a useful snapshot of the potential for existing odour emissions to cause effects, and these investigations are used as a means to confirm that the implementation of controls to the HRAS and screening buildings has effectively contained odours from these areas. Finally the review of existing and proposed upgrades to the odour extraction and biofiltration systems is the primary means used to assess the potential for odour effects following the WWTP upgrade and is benchmarked against community feedback information.

8.2 Community Feedback

8.2.1 Complaint records

The DCC has recorded 49 odour complaints in relation to the Tahuna WWTP since 2000. Feedback received from a recent community meeting (held on the 24th October 2012 at the Tahuna Golf Club), and the DCC's subsequent investigations, has confirmed that some odour complaints during 2010, 2011 and possibly 2012 were not recorded. Now that the DCC is aware of the issue, it is understood DCC are implementing measures to ensure their complaints recording systems does record all complaints that are received. Despite these recent limitations, the available complaint records since 2000 are still useful and have been reviewed for this assessment. From this analysis, it appears that the frequency of complaints received in recent years is probably lower than that typically occurring around ten years ago. There have been four complaints recorded to date during 2012 and there is the prospect that some other complaints have been lodged but not recorded. This aside, an increased complaint level is expected this year as a result of the commissioning of the up-graded WWTP. Neighbours had been advised of the prospect of additional odours during commissioning through regular community newsletters.

An analysis of the complaints indicates the following:

- Complaints mainly occur from locations immediately adjacent to the WWTP, and predominantly from the golf course to the south of the plant.
- Approximately 35 % of complaints were not linked to a particular source on site or process condition upset.
- Prior to 2004, approximately 24 % of complaints received may have related to the operation of the biofilter. This has reduced to one complaint possibly relating to the biofilter since 2004. It is noted that the existing biofilters were refurbished between 2006 and 2008.
- Other complaints relate to effluent wells, biosolid conditions, maintenance issues, open plant doors, or other operational plant issues.
- Existing biofilter emissions do not appear to be causing odour complaints.
- Odour was noticed during commissioning when the TWAS GBT tanks had no extraction – July 2012.

8.2.2 Odour surveys

Odour surveys are used to measure "population annoyance" from various sources of environmental odour on communities. Information is collected via telephone, mail out or face to face surveying of people who live or work in an area. The method is described by the MfE's Good Practice Guide. Odour surveys were carried out by Tony Dons Ltd on behalf of the DCC to assess the community response to the Tahuna WWTP odour emissions during March 2005, March 2008, and March 2011. In 2011, the surveying technique was modified such that face-to-face interviews were conducted for residents living within 500 m of the site.

A summary of proportion of the population that reported being "at least annoyed" is shown in Table 11 from 2005 to 2011. In 2011, within 200 m of the plant, 44 % (± 15 %) of the population was annoyed by odours and attributed them to the WWTP. This estimate has a relatively large uncertainty because the sample size was small (45) but it still indicates a moderate odour effect close to the plant. This result was not statistically different to the percentage "at-least annoyed" results for 2008 of 31 % (± 15 %) and the 2005 responses (36 % ± 15 %).

As expected, the distance of residence from the site increases the percentage, "at least annoyed" decreases. Previous control surveys have shown that in regions with no significant odour sources, that 5 to 15 % of the population reported being "at least annoyed" by odour (MfE 2003a). This is considered the 'background level'. Beyond 500 m, all values were within the background level (Tony Dons Ltd 2011).

The population that was "at least annoyed" was further asked to describe the primary odour. These are shown in Table 12. Within 200 m, the odour was most commonly described as having a sewage odour,

which is consistent with nominating WWTP as the primary source of odour. These descriptions are consistent with fugitive emissions from the WWTP that escape the odour extraction and biofiltration system.

The relationship of the different levels of annoyance to the percentage of “at least annoyed” results from the survey is shown in Figure 26. This shows that within 200 m of the WWTP, there is a moderate level of annoyance. Between 200 - 500 m there is a minor level of annoyance and for the region beyond 500 m and as a whole, the level of annoyance is within the background/control level.

Table 11: Proportion of population from Community Odour Surveys in 2005, 2008 and 2011 who reported being "at least annoyed" by odours and nominated Tahuna WWTP (Tony Dons Ltd 2011).

Distance from WWTP	Northwest quarter			Northeast quarter			Combined		
	2005	2008	2011	2005	2008	2011	2005	2008	2011
0-200 m	19 % ± 17 %	33 % ± 24 %	33 ± 20 %	48 % ± 21 %	29 % ± 19 %	54 ± 20 %	33 % ± 14 %	31 % ± 15 %	44 ± 15 %
200-500 m	25 % ± 15 %	12 % ± 11 %	15 ± 10 %	20 % ± 12 %	13 % ± 12 %	20 ± 11 %	22 % ± 10 %	13 % ± 8 %	17 ± 7 %
500-1,000 m	7 % ± 5 %	7 % ± 6 %	2 ± 4 %	7 % ± 5 %	5 % ± 6 %	7 ± 7 %	7 % ± 4 %	6 % ± 4 %	4 ± 4 %
0-1,000 m (combined)	13 % ± 6 %	12 % ± 6 %	13 ± 6 %	16 % ± 6 %	12 % ± 6 %	20 ± 7 %	14 % ± 4 %	12 % ± 4 %	17 ± 5 %

The uncertainty range is given as the 95% confidence interval.

Table 12: Proportion of population from Community Odour Surveys in 2005, 2008, and 2011 who reported being "at least annoyed" by odours versus description of odour (Tony Dons Ltd 2011).

Distance from WWTP	Sewage			Sulphur/rotten eggs			Putrid			Other*			Don't know		
	2005	2008	2011	2005	2008	2011	2005	2008	2011	2005	2008	2011	2005	2008	2011
0-200 m	17 % ± 11 %	25 % ± 14 %	31 % ± 14 %	5 % ± 7 %	0 % ± 0 %	16 % ± 11 %	5 % ± 7 %	0 % ± 0 %	0 % ± 0 %	7 % ± 8 %	3 % ± 6 %	4 % ± 6 %	5 % ± 7 %	3 % ± 6 %	0 % ± 0 %
200-500 m	10 % ± 7 %	8 % ± 7 %	15 % ± 7 %	4 % ± 4 %	3 % ± 4 %	3 % ± 3 %	0 % ± 0 %	5 % ± 5 %	1 % ± 2 %	11 % ± 7 %	5 % ± 5 %	1 % ± 2 %	1 % ± 2 %	0 % ± 0 %	0 % ± 0 %
500-1,000 m	6 % ± 4 %	6 % ± 4 %	4 % ± 4 %	1 % ± 1 %	1 % ± 2 %	2 % ± 3 %	2 % ± 2 %	1 % ± 2 %	2 % ± 3 %	6 % ± 4 %	2 % ± 3 %	4 % ± 4 %	0 % ± 0 %	1 % ± 2 %	0 % ± 0 %
0-1,000 m (combined)	9 % ± 3 %	10 % ± 4 %	13 % ± 4 %	2 % ± 2 %	1 % ± 1 %	5 % ± 3 %	2 % ± 2 %	2 % ± 2 %	1 % ± 1 %	8 % ± 3 %	3 % ± 2 %	3 % ± 2 %	1 % ± 1 %	1 % ± 1 %	0 % ± 0 %

The uncertainty range is given as the 95 % confidence interval.

*The ”Other” odour description was not broken down to the lesser descriptors in the Tony Dons Ltd (2011) report.

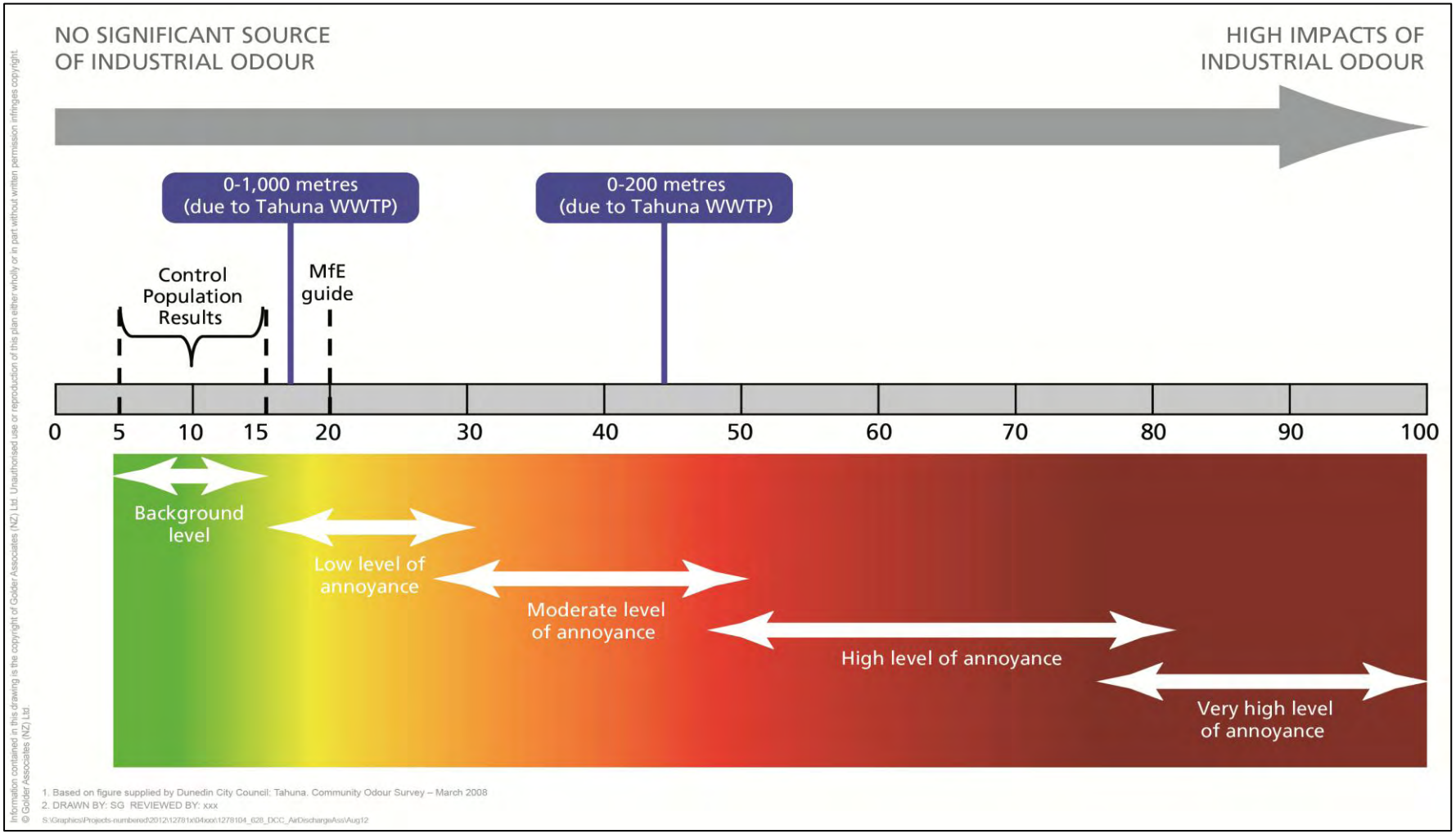

Figure 26: Summary of the percentage of "at least annoyed" results for 2011 in relation to the level of annoyance.

8.2.3 Summary of community feedback

The absence of odour complaints being lodged during the last few years from people living or undertaking recreation within 200 m of the WWTP site does not confirm that only minor odour effects have been caused in recent years. This is because the annoyance survey results for these closest areas to the WWTP indicates at least a moderate level of odour effect on people living or working within 200 m of the WWTP.

The absence of odour complaint in recent years is likely to be a result of a significant improvement in air quality due to upgrades undertaken to the odour control system and resulting tolerance of the local community to the current levels of odour from the WWTP. However, the odour annoyance survey results indicate that odour impacts up until 12 months ago were still more than minor (i.e. well above 20 % at least annoyed). The description of odours provided by residents during odour annoyance surveys indicates that fugitive odour emissions from the WWTP (which escape the odour extraction systems) is largely responsible for this moderate level of odour annoyance and associated adverse effect.

The above assessment of odour effects relates to the period leading up to March 2011. The existing odour effects following further improvements to the extraction of HRAS fugitive odours is likely to have further diminished odour effects. However, it is clear that the extensive up-grading of odour controls within the final up-graded WWTP could achieve a substantial reduction in existing odour impact levels. This potential outcome is discussed below.

8.2 Downwind Odour Assessments

Golder has made observations downwind of the current WWTP operation during June and August 2012. On 16 June 2012 a strong cold southerly wind was blowing and no odours were discernible. On 26 August 2012 no discernible odours were noticed during a steady onshore breeze and fine weather conditions. It will be appropriate to routinely assess downwind odours once the upgraded WWTP is fully commissioned (scheduled for November 2012) and when all processes and air discharge mitigation systems are in operation. To this end, the DCC have procedures for undertaking routine boundary assessments to check for odour emanating from the site and this includes monitoring ambient H_2S levels. This monitoring is considered good practice and should be undertaken on a daily basis.

8.3 Future Odour Effects

The operation of the upgraded WWTP and associated targeted emissions extraction system is expected to make a significant reduction in the potential for odour exposure off site. This relies upon the effective management of the air extraction and biofilter systems that have been installed as part of the WWTP upgrade. The effective management of these mitigation systems is underpinned by the use of an effective air discharge management plan. Given the implementation of this plan and effective management and review of the air emission mitigation systems proposed and largely implemented by the DCC, it is concluded that the WWTP air emissions are likely to cause only minor effects on the surrounding community.

9.0 MITIGATION

9.1 Extraction of Air Emissions

9.1.1 Odour and aerosols

The strategy for effective air emissions control is discussed in this section. The targeted extraction of emission sources is the important design feature to continue at the WTTP. This represents an important departure from the approach of trying to control odours and aerosols by the extraction of building air. That

approach requires much larger air flows and subsequent biofilter and fan sizes, which would be impractical for this site.

The proposed targeted air extraction approach is more energy efficient because the overall air extraction rates and subsequent fan electricity costs are reduced to a level that is feasible. This aside, there are substantial levels of building air ventilation applied to the HRAS, GTT and Biosolids Handling buildings that provide significant redundancy within the system allowing for increased extraction of existing sources or application to new sources of air emissions.

9.1.2 Extraction system monitoring

Day to day monitoring of air extraction systems is generally not required as these operate consistently for long periods. However, annual checks upon the total air flows and the effectiveness of air extraction systems is recommended and will be implemented as part of the commissioning of the upgraded WWTP. For future annual checks on the extraction systems, it is recommended that these include the measurement of draft vacuums (mm-water gauge or Pa) near the point of connection to plant items, as well as air flow rates within the main air extraction manifolds that service different areas of the WWTP.

9.1.3 Incinerator exhaust extraction

The scrubbing, cooling and biofilter treatment of the incinerator's exhaust is considered to be very good practice and representing the BPO in this circumstance. The incinerator exhaust discharge stack could have an emergency weighted cap, but this does not appear necessary given the vacuum monitoring and controls in place. The measurement and monitoring of the vacuum within this duct is an effective means to confirm all incinerator exhaust air is discharging to atmosphere via the biofilter system. This system would enable the monitoring and reporting of temporary events (if occurring) where discharges of incinerator exhaust go directly to atmosphere and by-pass the biofilter. These events are expected to be negligible, but it would be appropriate to provide improved monitoring of these events.

9.1.4 Conclusion and recommendation

It is considered that odour and aerosol emissions from the WWTP process and pumping stages will be contained to a very high level that results in minor releases to atmosphere. This is based on the following:

- Analysis in Section 6.0 of all the targeted air extraction points as specified for each source of air emission.
- General building air extraction design flows.
- Routine monitoring and annual review of the air extraction system performance.

Regarding the incinerator exhaust it is reasonable to conclude that the process of cooling and biofiltration represents at least the BPO for this site (see Section 9.3.5). The current discharge duct vacuum monitoring combined with a weighted cap (to allow emergency releases to air) is an appropriate system that is likely to ensure negligible emissions of air contaminants to the atmosphere.

9.2 Odour Removal

9.2.1 Introduction

The design air loading rates and biofilter bed design detailed in Section 6.11 indicate the routine elimination of discernible WWTP odours and aerosols which would occur through the two biofilter systems. The continued high treatment performance of these systems is important to ensure the site does not produce objectionable odour effects offsite and therefore their monitoring and maintenance programmes need to be robust. It is therefore important that the site documents key monitoring and maintenance procedures for maintaining the performance of both the air extraction systems and the maintenance of biofilter performance, and that these be embodied into an air discharge management plan (ADMP). The ADMP should be reviewed annually and have operating targets set for flows, extraction vacuums, and biofilter operating

parameters that can be subject to change based on experience at the site over time. Biofilter parameters that could be specified in a draft ADMP are discussed and recommended below.

9.2.2 Biofilter operating parameters

Recommended draft bed operating parameter ranges for use in an air discharge management plan (ADMP) are listed below. These are not absolute ranges that must be met, but are indicative of ranges where the biofilter beds will operate optimally and sustainably over time. Some of these will be naturally met given the nature of the sources (i.e., ambient air).

- Biofilter system back pressure <100 – 150 mm water gauge (weekly)
- Biofilter media back pressure <50 mm water gauge (weekly)
- Biofilter inlet air temperature <35 ^{o}C for more than 99% of time (weekly)
- Biofilter bed pH pH 5 or higher (top 2/3 layer) and pH 4 or higher (Bottom 1/3 layers) (3 monthly)
- Biofilter bed moisture: 50 wt. % to 65 wt. % (monthly during summer, 3 monthly for other seasons)

9.2.3 Biofilter bed monitoring & maintenance

Biofilter media gradually break down over time and turn into compost, therefore monitoring of back pressure trends and bed composition on annual basis is recommended so that the bed replacements can be planned well ahead of the time they are required.

Annual investigations of the media are recommended as follows:

- Measurement of biological activity (faecal coliforms/gram)
- Coarse size analysis using sieve tray tests down to 75 microns
- Assessment of fines below 75 microns for total carbon and carbon: nitrogen ratio
- H_2S discharge concentrations from surface
- Flow distribution evenness
- Moisture content spatial variation.

9.3 Incinerator Exhaust

9.3.1 General

This section of the report discusses how the potential for adverse environmental effects from the incinerator will be mitigated by DCC. There are three general forms of effects mitigation to consider, including the type of pollution control equipment, the management and monitoring of that equipment to ensure that efficient operation is maintained and finally the environmental monitoring that is implemented at the site. These aspects of mitigation are discussed in more detail below.

9.3.2 Pollution control equipment

The ‘fluidised bed’ type of incinerator is one of the most common municipal biosolids waste incinerators used world-wide and can be considered best practicable option (BPO) for the burning of waste biosolids. Further discussion of BPO is given in Section 9.3.5 below.

The production of dioxins and furans are a significant concern from hazardous waste incinerators. However, the DCC incinerator is not designed as such a system, and neither does it incinerate hazardous waste. Further to this, the fine screening of wastewater prior to biological treatment and the methods employed to rapidly cool the exhaust gas (from 540 ^{o}C to 90 ^{o}C) and then filter this ensures that the production of dioxins and furans (that can otherwise result of de novo dioxin formation) are at very minor levels that create a negligible potential health risk.

The formation of dioxin is limited when the exhaust stream is subjected to rapid cooling. This is primarily achieved by the venturi scrubber, which quenches the exhaust stream to reduce the temperature.

9.3.3 Performance monitoring

There is significant monitoring undertaken at all stages of the process to ensure optimal performance of the incinerator and the successive pollution control equipment. The incinerator and the scrubber cooling water are checked hourly. More detail on the checks undertaken is given in the following sections.

9.3.3.1 Incinerator monitoring

To ensure good combustion performance, temperatures and pressures are monitored at various zones inside the incinerator. The combination of the temperature/pressure across the incinerator with the fluidising airflow, and excess oxygen which is also monitored, ensures the incinerator can be controlled to operate within optimal performance limits.

9.3.3.2 Recuperative heat exchanger monitoring

The water sprays at the top of the incinerator control the temperature of the exhaust gas to protect the heat exchanger from excessive temperatures. To ensure the water sprays are effectively working, the inlet and outlet temperature of the heat exchanger are monitored at least hourly while the incinerator is in operation.

9.3.3.3 Packed scrubber monitoring

The packed scrubber cooling water system is checked at least once per shift with the pump pressure, inlet and outlet water temperature and flow rate recorded. The temperature of the scrubber inlet and the exhaust are also recorded to ensure that the temperature of the air going to the biofilters is cool enough for treatment by the biofilter.

9.3.4 Maintenance

The upgrade has meant that annual and routine maintenance, such as replacing seals and cleaning, can be more easily undertaken. This is due to the increased options for biosolids reuse and disposal.

9.3.5 Best practicable option

BPO, as defined by section 2 of the RMA, is the best method for preventing or minimising adverse effects on the environment while considering nature of discharges (including sensitivity of receiving environment), pollution control technology available, and financial considerations of the technology choice.

With regard to the incinerator's design and measures to control its emissions, consideration has been given to the United Nations Environment Programme (UNEP) 2008 document that provides guidance for what it considers is the best available technique (BAT) for waste biosolids incineration. BAT can be taken to mean the benchmark for the best technology/measure available for controlling emissions. A comparison of the Tahuna WWTP biosolids incinerator with UNEP (2008) indicates that the system is generally consistent with BAT requirements. Key points from this comparison are as follows:

- **Incinerator type**: The incinerator operating at the Tahuna WWTP is a purpose built fluidised bed incinerator. This design of incinerator is described by UNEP (2008) as being "well demonstrated for the thermal treatment of sewage biosolids".
- **Good combustion**: There is extensive regular monitoring of the incinerator and the auxiliary process control equipment to ensure the incinerator is operating at its optimum.

- **Flue gas treatment**: the addition of the Venturi scrubber and the packed scrubber are effective in the treatment of the flue gas. The Venturi scrubber ensures a rapid decrease in temperature that minimises the formation of dioxins via de novo synthesis. It also helps removes ash and particulate matter from exhaust. The acidic packed scrubber effectively removes chlorides, fluorides, and mercury.

Fine screening of the wastewater before it enters the plant ensures that hazardous waste products (such as plastics) are not contained in the biosolids burnt in the incinerator. This helps to minimise the formation of hazardous contaminant emissions from the incinerator.

Exhaust gases from the Tahuna WWTP incinerator undergo further treatment beyond that normally required for biosolids incinerators. This is because the incinerator exhaust gases are extracted to the existing biofilter system, which helps to further reduce the contaminant concentrations.

In summary, it is considered that the Tahuna WWTP biosolids incinerator achieves or exceeds the requirements of BPO, when taking into account the following matters:

- The sensitivity of the receiving environment is high, which necessitates a high level of emission control.
- The incinerator is designed as a purpose built system, which is generally consistent with BAT for a biosolids incineration.
- The incinerator has a high degree of emission control measures, which are at least consistent with BAT requirements.

9.3.6 Performance monitoring

Annual monitoring of the incinerator has been undertaken since 2002 and of the biofilter since 2007. The results of significant pollutants, such as particulate, heavy metals, dioxins and furans, are measured at low levels. The monitoring results are summarised in Appendix B.

9.4 Environmental Monitoring

For this application, the standard practice of odour complaint monitoring, recording and reporting actions is considered to provide adequate environmental effects-based monitoring. Further odour annoyance surveys should not be required given the level of odour control being implemented and that if formal community feedback were to be required in response to odour complaints, then diary programmes and direct consultation should be implemented.

9.5 Best Practicable Option for Odour Control

The Tahuna WWTP has a high level of odour control which is considered BPO for wastewater treatment plants. It is common for the aerobic processing plant at municipal WWTPs to be open to the atmosphere, whereas all parts of the Tahuna WWTP process are extracted at source and/or the buildings are extracted to biofilters for treatment.

10.0 CONCLUSIONS

The main conclusions from this assessment are listed as follows:

- The extent of process enclosure, air extraction rates and treatment capacity at the DCC's upgraded Tahuna WWTP are considered to represent best practice and these systems would be superior to those typically found within comparable municipal WWTP systems throughout Australasia.

- The measures for mitigation of odour and incinerator emissions represent the BPO when accounting for the sensitivity of the receiving environment, which is evidenced by the close proximity of residential and recreational land uses to the site.
- The BPO for mitigating air discharges in this instance often requires the BAT to be implemented, and this is the case for this proposal.
- There is significant redundancy within the current air extraction and treatment systems that allows for future modification and refinement to the target air emissions extractions systems at the site.
- There is a number of plant items for which the effectiveness of the targeted extraction systems is recommended for routine annual monitoring, following the initial round of flow checks that is scheduled for the commissioning of the upgraded WWTP.
- It is important that an air discharge management plan (ADMP) is developed to ensure that the air emissions extraction and treatment systems continue to work effectively and sustainably over the longer term. An ADMP that is transparent and reviewed annually is the most effective means to ensure effective operation of mitigation systems in the longer term.
- Given the proposed air emission controls associated with the upgraded Dunedin City Council WWTP at Tahuna, the potential for adverse effects due to biosolids incinerator discharges to air, or fugitive discharges of odour and aerosols (which includes pathogens) from the processing of raw sewage are likely to be minor.

11.0 REFERENCES

Beca 2010. DCC: Tahuna Wastewater Treatment Plant Upgrade – Stage 2. Contract No.3250 – Volume 2. Part 1 Civil and structural specifications. Technical Specification 3002: Odour Control System. CH2M Beca and MWH, May 2010.

EU 2000. Directive 2000/76/EC of the European Parliament and the Council of 4 December 2000 on the incineration of waste. EN official journal of the European communities 28.12.200 L 332/91-111

Flo-Dry 2006. Tahuna Wastewater Treatment Plant Upgrade – Odour Control Design report. Flo-Dry Engineering Ltd. January 2006

Golder 2012. Dunedin City Council - Tahuna Wastewater Treatment Plant: Air discharge permit – identification of planning considerations. Report prepared by Golder Associates (NZ) Limited for Dunedin City Council., July 2012.

K2 2007. Dunedin City Council Tahuna Water Pollution Control Plant: emission assessment of sludge incinerator and biofilter. K2 Environmental, Christchurch, December 2007.

Metcalfe and Eddy 1991. Wastewater engineering: treatment, disposal, and reuse. Third Edition. Revised by Tchobanoglous G, Burton, F. McGraw-Hill International Editions, Singapore, 1991.

MfE 2012. New Zealand waste list. Waste category 19 – wastes from waste management facilities, off-site waste water treatment plants and the preparation of drinking water and water for industrial use. Ministry for the Environment, Wellington. [Downloaded from http://www.mfe.govt.nz/issues/waste/content.php?id=25&code=19 on 2 August 2012]

MfE 2003a. Good practice guide for assessing and managing odour in New Zealand. Air Quality Report 36, ME:473, Ministry for the Environment, Wellington, June 2003.

MfE 2003b. Guidelines for the Safe Application of Biosolids to Land in New Zealand. Ministry for the Environment, Wellington, August 2003.

MfE 2001. An action plan for reducing discharges of dioxin to air. ME number 411.

ORC 2007a. Air Emission Inventory Dunedin, Mosgiel and Alexandra 2005. Otago Regional Council. ISBN 1 877265 62 4.

ORC 2007b. Regional plan: Air for Otago. Incorporating Operative Plan Change 1; & Decisions on submissions received to Proposed Plan Change 2 (National Environmental Standards). Otago Regional Council.

ORC 2007c. Ambient Air Quality in Otago: particulate matter monitoring results. Otago Regional Council

ORC 2008. Ambient Air Quality in Otago: particulate matter (PM_{10}) monitoring results. Otago Regional Council.

ORC 2009. Regional Plan: Air for Otago. Operative version updated to 1 January 2009. Otago Regional Council, Dunedin, January 2009.

Tony Dons Ltd 2011. Dunedin City Council Tahuna Community Odour survey. Tony Dons Limited, in association with Golder Associates (NZ) Limited, , 31 May 2011.

UNEP 2008. Guidelines on best available techniques and provisional guidance on best environmental practices relevant to Article 5 and Annex C of the Stockholm Convention on persistent organic pollutants. Section V.A: Guidance/guidelines by source category: source categories in Part II of Annex C. Part II source category (a) waste incinerators. Published by the Secretariat of the Stockholm Convention on Persistent Organic Pollutants, United Nations Environment Programme, Geneva, Switzerland, May 2007.

Watercare 2009. Dunedin City Council: Emissions testing – Tahuna Water Pollution Control Plant. Prepared for DCC Tahuna Water Pollution Control Plant by Laboratory Services – Air Quality Group, Watercare Services Limited, Auckland, 18 March 2009.

Watercare 2012. Dunedin City Council: Tahuna Water Pollution Control Plant – Emission assessment of the sludge incinerator and biofilter November 2011. Watercare Laboratory Services Limited – Air Quality Group, Auckland, 12 January 2012.

APPENDIX A

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APPENDIX B

Incinerator and Biofilter Monitoring Results

1.0 INTRODUCTION

K2 Environmental Ltd and Watercare Laboratory Services (Watercare) have conducted emissions testing on the incinerator and the biofilter and the results are summarised within this Appendix.

The testing methods used were as follows:

USEPA Method 1	Sample and velocity transverse method
USEPA Method 2	Measurement of velocity
USEPA Method 3	Gas analysis for determination of dry molecular weight
USEPA Method 4	Moisture content determination
USEPA Method 5	Particulate emissions
USEPA Method 7E	Nitrogen oxides by instrument analysis
USEPA Method 8	Sulphur dioxide and sulphuric acid mist
USEPA Method 23	Dioxins and furans
USEPA Method 26A	Hydrogen chloride and hydrogen fluoride
USEPA Method 29	Determination of metal emissions

Watercare states that they employed the following deviations from USEPA method 5:

- USEPA state standard conditions as 20 ^{o}C and 101.3 kPa. Watercare standardise conditions to 0 ^{o}C and 101.3 kPa.
- Watercare employ a minimum sampling distance from the interior wall of the stack of 0.05 m to avoid surface effects.

2.0 INCINERATOR DISCHARGE MONITORING RESULTS

Table 1: Summary of results for sludge incinerator discharge (K2 2007, Watercare 2012).

Contaminant	Consent Condition	2002	2004	2005	2006	2007	2008	2009	2010	2011	Mass emission rates (based on 2011 testing)
Total suspended particulate (mg/m^3)	30	12	2.8	3.4	2.1	2.1	2.7	2.3	2.9	2.2	0.011 kg/hr
Sulfur dioxide (mg/m^3)	50	23	<1.3	2.3	1.4	<0.87	1.9	3.9	1.56	0.27	0.001 kg/hr
Oxides of nitrogen (mg/m^3)	200	**219**	11	75	180	**210**	194	185	131	**232**	
Hydrogen chloride (mg/m^3)	10	0.72	<2.8	0.86	<0.48	<0.52	0.14	0.20	0.79	0.23	<LOD
Hydrogen fluoride (mg/m^3)	2.0	-	-	-	-	<0.026	<0.083	<0.05	<0.15	<0.58	<LOD
Mercury (mg/m^3)	0.10	0.012	0.077	0.11	0.13	**0.18**	0.07	0.09	0.09	0.05	
Total cadmium and thallium (mg/m^3)	0.10	0.0002	0.00024	0.0013	0.00037	0.0007	0.00002	0.00004	0.0001	0.0001	
Total other trace metals (mg/m^3)	0.50	0.014	0.012	0.34	0.092	0.048	0.0081	0.015	0.056	0.01	
Dioxins and furans: blank not subtracted (pg/m^3)	100	-	4.7	5.4	5.3	6.6	24.2	6.2	4.7	3.6	

Notes: < LOD The analyte in the sample is less than the blank. Figures in **bold** indicate the result was above the resource consent limit

Table 2: Trace metals and metalloids from sludge incinerator (average concentration of three runs measured November 2011) (Watercare, 2012).

Contaminant	Detection limit (µg/m³)	Concentration (µg/m³)
Arsenic	0.03	0.15
Antimony	0.25	1.5
Cadmium	0.01	0.15
Cobalt	0.01	0.17
Chromium	0.22	0.48
Copper	0.68	1.74
Lead	0.25	2.95
Mercury	0.06	53.80
Manganese	0.13	2.03
Nickel	0.15	2.78
Thallium	0.13	< LOD
Vanadium	0.25	< LOD

3.0 BIOFILTER DISCHARGE MONITORING RESULTS

Table 3: Summary of results for biofilter 2007 - 2011 (Watercare 2012).

Analyte	Consent condition	2007	2008	2009	2010	2011
Total suspended particulate (mg/m^3)	30	<0.24	0.7	1.5	0.2	<LOD
Mercury (mg/m^3)	0.10	0.0011	0.0002	0.0002	0.0002	0.00005
Total cadmium and thallium (mg/m^3)	0.10	0.00067	<LOD	0.00004	0.00004	0.0001
Total other trace metals (mg/m^3)	0.50	0.15	0.0057	0.0186	0.0150	0.002†
Dioxins and furans: blank not subtracted (pg/m^3)	100	2.5	22.9	6.3	5.6	3.1

Notes: † excludes manganese concentrations. <LOC The analyte in the sample is less than the blank.

Table 4: Trace metals from biofilter (average concentration of three runs measured November 2011) (Watercare 2012).

Analyte	Detection limit (µg/m³)	Analyte concentration (µg/m³)
Arsenic	0.03	< LOD
Antimony	0.25	< LOD
Cadmium	0.01	0.01
Cobalt	0.01	0.09
Chromium	0.22	0.25
Copper	0.68	< LOD
Lead	0.25	0.38
Mercury	0.06	0.05
Manganese	0.13	**
Nickel	0.15	1.05
Thallium	0.13	< LOD
Vanadium	0.25	< LOD

Notes: ** ICPMS report indicates very high concentration of potassium and manganese. The trace metals sampling train (USEPA Method 29) consists of two impingers containing 100 mL each of $H2O_2/HNO_3$ absorbing solution and two impingers containing 100 mL each of acidified KMnO4 absorbing solution. It was suspected that the $H2O_2/HNO_3$ absorbing solution, which is analysed for manganese, was accidentally contaminated with acidified KMnO4 solution. The high concentration of potassium confirms the accidental contamination. All three results are therefore considered invalid and not reported (Watercare 2012).

APPENDIX C

Dioxins and Furans

1.0 DEFINITION OF I-TEQ DIOXINS

Dioxins are a group of chemicals consisting of polychlorinated dibenzo-p-dioxins (PCDDs, dioxins) polychlorinated dibenzofurans (PCDFs, furans) and polychlorinated diphenols (PCBs). Dioxins are released to the environment in very small amounts through industrial and domestic activities including the incineration of waste. As dioxins are a complex mix of congeners, to assess potential environmental and health risks associated with dioxins, individual toxicity factors for the individual congeners are used. The total toxicity of a particular group of dioxins is calculated by multiplying the individual mass of the dioxins by their international toxicity factor. These results are then summed together. This results in a cumulative International Toxicity Equivalent (I-TEQ) and is typically reported as picograms (pg) of I-TEQ[1]. Using the I-TEQ is a common regulatory measure to determine the environmental and health risk of exposure to the group of chemicals known as dioxins.

2.0 METHODOLOGY FOR INHALATION PATHWAY RELATED HEALTH RISK

The cancer potency from exposure to dioxins is estimated from what is termed the "Life time Average Daily Dose" (LADD) to dioxins and furans. Whereas the potential for chronic health effects is assessed by a similar term called the Tolerable Daily Intake (TDI). These exposure terms have the same units of picograms of TEQ per day per kg of body weight (i.e., pg-TEQ/kg-bw/day). For chronic health effects assessments the TDI value can be compared to the recommended World Health Guideline values of 1 to 4 pg-TEQ/kg-bw/day. The New Zealand Ministry for Health has an unofficial guideline of 1 pg-TEQ/kg-bw/day (Dioxin Action Plan MfE, 2002).

Therefore for the inhalation pathway, these exposure values are a function of the following factors:

- Long term ambient concentration
- Average adult body weight (assumed to be 70 kg by convention)
- The amount of air we breathe a day (typical value of 13 m^3/day can be assumed)
- Fraction of time spent in exposed location (68% to 73% of time at home assumed)
- Long term exposure duration (9 years for residential scenarios and 30 years for rural)
- Average Life time (70 years assumed by convention).

To calculate an LADD or TDI due to the inhalation of dioxin exposure for the incinerator emissions (discharged via the biofilter) it is necessary to calculate the highest long-term exposure concentration of I-TEQ dioxin using the atmospheric dispersion modelling results.

The LADD (pg/kg/day) = Annual average concentration (μg I-TEQ/m^3) /body weight (kg)*Air breathed (m^3/day)*Time at home (73%)*Percentage of lifetime at that location (9 years/70 years)

[1] Note that a picogram is equal to 0.000000000001 grams, or 1 x 10^{-12} grams.

3.0 INCREASED CANCER RISK

When assessing the individual risk of dioxins causing cancer due to long term exposure, the LADD value is multiplied by a "risk factor or slope factor (q_1^*)". It should be noted that a more complex calculation is required for risks of 10^{-2} or higher.

For this assessment, the risk of cancer effects due to exposure to dioxins due to inhalation (R) is estimated using the equation; R = LADD * q_1^*. For a high-end conservative risk assessment, the draft US EPA dioxin reassessment report is currently recommending that q_1^* be set at 1.4 * 10^{-3} kg-bw.day/pg. This value is based upon a revision of the US EPA's official slope factor of at 1.6 * 10^{-4} kg-bw.day/pg that indicates a cancer potency that is ten times lower than the proposed new value. Golder has used this slope factor for a number of inhalation based cancer risk assessments since it was established in consultation with the New Zealand Ministry for the Environment (comms with S Buckley, MfE, 6th March 2002).

The increased Cancer Risk is calculated as LADD (pg/kg/day) * q_1 (kg-bw.day/pg).

APPENDIX D

CALMET Model Configuration

1.0 METEOROLOGICAL MODELLING - CALMET

The CALMET model (version 6) was used to provide hourly, three-dimensional meteorological fields as input to the CALPUFF dispersion model. Wind and temperature, for instance, are not expected to be spatially uniform in the relatively complex terrain surrounding the Tahuna WWTP. Essentially, CALMET blends surface-based observation data and vertical profiles from nearby climate stations and accounts for the effects of terrain on the windflow.

The CALMET domain covers an area of 8 km from east to west and 6 km from north to south, with the southwest corner of the domain located at NZMG (km) 2313:5473 (as shown in Figure 1 of this Appendix). The domain has a number of significant topographical features that influence the meteorology of the area in the vicinity of the Tahuna WWTP, which have been accounted for in the modelling. These include the low lying area of St Kilda and the Otago Harbour to north of the site, St Clair and St Kilda beaches to the south of the site, Lawyers head and the Otago Peninsula to the East, and Forbury Hill (159 m) to the west.

A high grid resolution of 50 m has been used to resolve these features in conjunction with LIDAR data supplied by DCC. There are ten vertical levels, with a maximum height of 3,200 m above the local ground level. The model was run for each hour between 1 December 2000 and 1 December 2001. This year is considered to be a representative year and has been used for several other air quality assessments made in the Dunedin area.

Surface and meteorological data for the CALMET model was derived the national climate database (CliDB), which includes scalar average wind speeds as required by CALMET. Further information on the CALMET configuration is contained in Section 2.0

2.0 CALMET MODEL PARAMETERS

This section contains information to describe CALMET set-ups. The Table captions correspond to the Input Group headings in the CALMET parameter file.

The following tables provide details of user-specified parameters for generating an hourly, three-dimensional meteorological dataset with CALMET. Parameters not mentioned here should be assumed to take default values, or they relate to a particular feature of the model that is not used.

Table 1: Run control.

Parameter	Value
Start date/time	1 December 2000 00:00
Finish date/time	1 December 2001 00:00
Time zone	UTC+1200
Time step	3600 s

Table 2: Map projection.

Parameter	Value
Map projection	Tangential Transverse Mercator (TTM)
Datum region	WGS-84
Projection origin	49.906S, 170.489E
False origin *(NZMG coordinates)*	(2315.000, 5475.000) km

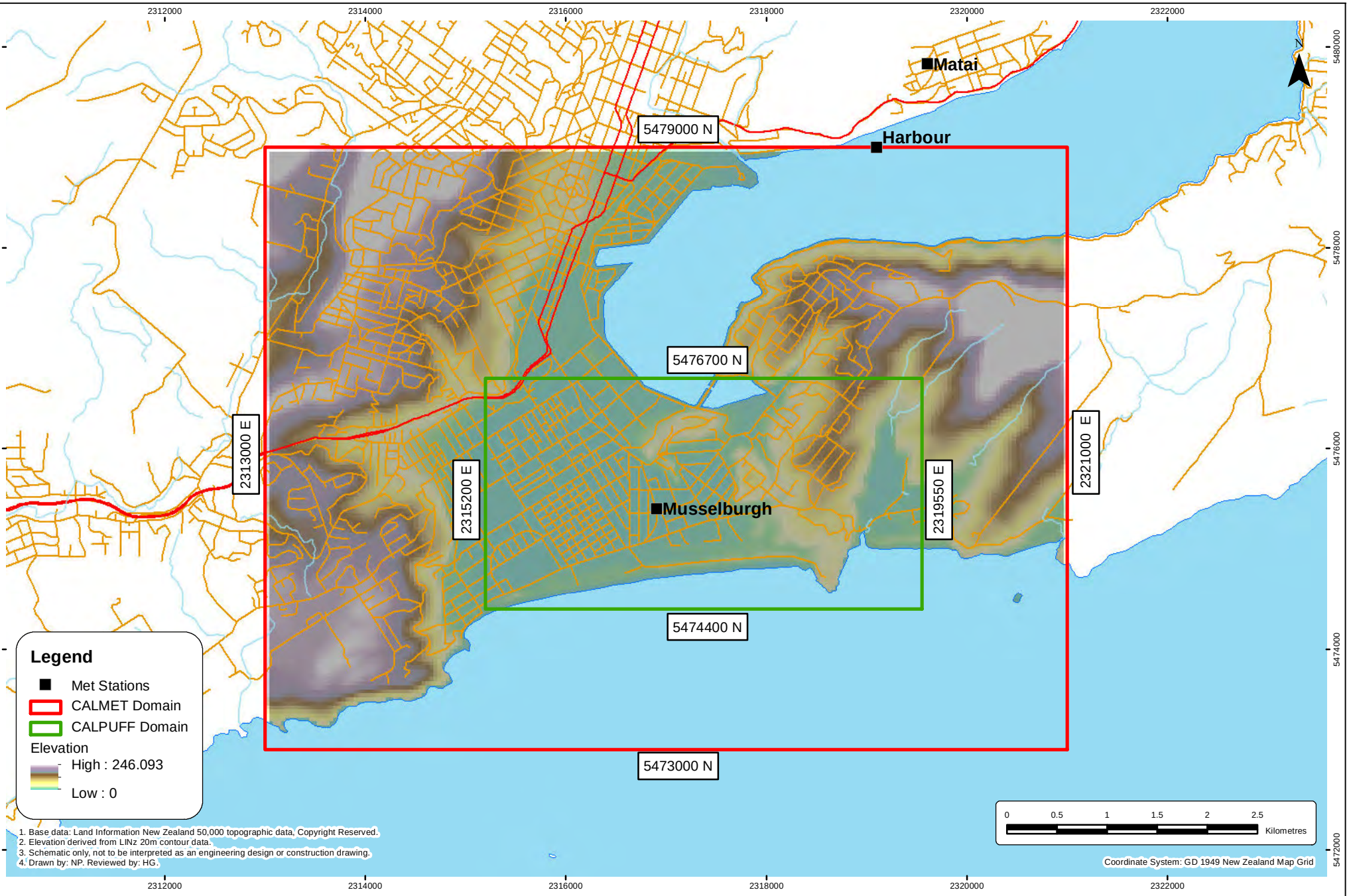

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Table 3: Grid control.

Parameter	Value
SW corner of grid cell (1,1)	(2313, 5473) km
Grid dimensions	160 x 120 grid cells at spacing 0.05 km
Vertical grid, number of layers	10
Cell-face heights for vertical grid (m)	0, 20, 40, 80, 160, 260, 430, 710, 1200, 2000,3200

Table 4: Wind field options.

Parameter	Value
Extrapolation of surface wind observations	-4; similarity theory used; layer 1 data at upper air stations ignored
Layer-dependent biases	-1, 8x0
Vertical extrapolation of surface winds (RMIN2)	-1.0; extrapolate all surface stations
Maximum radius of influence of met. data	RMAX1 = RMAX2 =1 km; RMAX3 = 10 km
Relative weighting of first-guess field and observations	R1 = R2 = 0.35 km
Radius of influence of terrain features	TERRAD = 2 km
Surface station to use for surface temperature	# 1 (Matai)
Upper-air station to use for the domain-scale lapse rate	# 1 (Invercargill Aero)

Table 5: Surface meteorological stations.

Name	Source and ID	X (km, NZMG)	Y (km, NZMG)	Time zone	Anem. Ht.
Matai	Watercare, 10001	2319.605	5479.830	-12	10 m
Harbour	Unknown, 10002	2319.100	5479.000	-12	10 m
Musselburgh	CliDB, 15752	2316.905	5475.400	-12	10 m
Dunedin Aero	CliDB, 7339	2292.500	5471.900	-12	10 m

Notes: The station ID is as used by CALMET. For National Climate Database (CliDB) stations the ID is the agent number.

Table 6: Upper-air meteorological station parameters.

Name	Source and ID	X (km, NZMG)	Y (km, NZMG)	Time zone
Invercargill Aero	CliDB, 5814	2150.800	5411.000	-12

Table 7: Input and output filenames.

Description		Filename(s)
Model Description		Version 6.211 Level 060414 Use CALPUFF PRO 6.0.3.06
CALMET run split into 16 x 23-day periods	input-parameter files	.\Periodnn.INP nn = 01, 02, …, 16
	binary output files	.\Periodnn.MET nn = 01, 02, …, 16
	listing files	.\Periodnn.LST nn = 01, 02, …, 16
Geographical file		geo_160_120_LIDAR.dat
Surface meteorological file		.\Dunedinsurf.dat
Upper-air meteorological file		.\Invc2001.up

3.0 DATA PRE-PROCESSING

3.1 Geographical Data

Terrain and land-use data were extracted from Golder's in-house database and converted to the CALMET input format in the file named geo_160_120_FINAL.dat. The meteorological domain has dimensions 8 x 6 km, consisting of 160 x 120 grid cells of size 50 x 50m.

3.2 Upper-Air Data

Upper-air data consist of 12-hourly soundings from Invercargill airport at standard and 'significant' levels above the surface, downloaded from the NIWA Climate Database (CliDB). These data are used in the calculation of three-dimensional aspects of the meteorology at Dunedin, such as the temperature profile and boundary-layer height. Vertical wind profiles are extrapolated upwards above the local surface observations in Dunedin by CALMET, limited by the temperature profile at Invercargill. The data are converted into the CALMET input format, in the file invc2001.up.

3.3 Surface Observations

CALMET requires surface-based meteorological parameters, usually obtained from weather and climate stations. The parameters are wind speed and direction, temperature, relative humidity, surface pressure, cloud cover, cloud ceiling height and rainfall rate. At every hour, every parameter must be available from at least one station. The following data have been used to create the surface-data input to CALMET, in the file named DunedinSurf.dat. Time series of all parameters were compared between sites, to ensure no unrealistic outlying data were present.

Matai Wind speed and direction

Harbour Wind speed and direction, temperature, relative humidity, rainfall

Musselburgh EWS Wind speed and direction, temperature, relative humidity, rainfall, pressure

Dunedin Aero AWS Cloud cover and ceiling height – if more than one layer, that with the highest cloud cover is used; if no cloud data for a particular hour, clear sky is assumed.

APPENDIX E

CALPUFF Model Configuration

1.0 INTRODUCTION

Dispersion modelling was undertaken using CALPUFF Version 6, which incorporates the PRIME building downwash algorithm.

Information regarding the CALPUFF set up for this assessment is provided in Section 4.0. In addition to modelling the ground level concentrations (GLC) at discrete receptor locations, the CALPUFF model was also set up to predict GLCs over a fine grid of receptors evenly spaced at 50 m intervals over an area of 4 km (east-west) by 2 km (north-south) surrounding the Tahuna WwTP. This is shown as the CALPUFF model domain in Appendix D.

For any dispersion model, hourly-averaged conditions can lead to over-prediction of GLCs. This is partly because the wind direction is assumed constant for each hour, and pollutants therefore arrive at the same location for the full period. To account for this, the Ministry for the Environment has recommended that the 1-hour average 99.9th percentile value of the modelled ground level concentration be reported as the predicted maximum predicted 1-hour average ground level concentration (MfE 2004). For predicted GLCs with longer averaging periods (i.e., 24 hour and annual), the maximum modelled values at any location are considered to provide the best estimate of the probable maximum that will occur for the contaminant emission rates assumed.

The assumption of continuous maximum contaminant emission rates by the dispersion model adds further conservatism to the highest estimated 99.9 percentile 1 hour GLCs and longer term GLCs. By comparison, the most probable 1 hour maximum GLC is less affected by continuous contaminant emission assumption. As a consequence of this, it is concluded that there is little risk that the predicted GLCs in this report, as evaluated from modelling results, will actually be higher than stated. The main risk is that the extent of contaminant GLCs, due to the site emissions, has been excessively overstated by the modelling assessment and maximum continuous emission assumptions.

In this report, maximum 1-hour predictions are based on the 99.9 percentile modelled value. It follows that the modelled 99.8 percentile prediction could be used to infer the most probable 99.9 percentile GLC for that location. 24-hour averages are based on the maximum value. CALPUFF does not directly predict GLCs with averaging periods less than 1-hour.

CALPUFF version 6.4 was run from 1 December 2000 to 1 December 2001. Most standard options were used, including the PRIME building-wake algorithm and the ‘pdf’ formulation for dispersion under convective conditions. Concentrations of TSP, mercury and dioxin were calculated at a number of discrete receptors, and on a grid with 50 m spacing.

2.0 GENERIC CALPUFF PARAMETERS

A fuller list of parameters used in the CALPUFF runs is given in the following tables. Parameters not mentioned below should be assumed to take default values, or they relate to a particular feature of the model that is not used.

Table 1: CALPUFF start and end times.

Parameter		Value	
Start date/time		00:00	1 December 2000
End date/time		00:00	1 December 2001
Base time zone	XBTZ	-12 (NZST)	
Time step	NSECDT	3600 s	

Table 2: Pollutant specifications.

Parameter		Value
Number of chemical species	NSPEC	4
Number of emitted species	NSE	4
Species; modelled; emitted; deposited?		Odour Yes; Yes; No Mercury Yes; Yes; No Dioxin Yes; Yes; No PM_{10} Yes; Yes; No
Chemical mechanism	MCHEM	0 (No chemistry)
Dry deposition	MDRY	0 (No dry deposition)
Wet deposition	MWET	0 (No wet deposition)

Table 3: Technical options.

Parameter		Value
Dispersion coefficient calculation	MDISP	2 use micrometeorological variables
Back-up calculation	MDISP2	3 PG for rural; MP for urban
PDF for dispersion under convective conditions	MPDF	1 (On)
Building downwash	MBDW	2 PRIME algorithm
Check parameters for regulatory settings		No (they are USEPA-specific)
Minimum σ_v over land (default 0.5 m/s)		0.2 (TRC recommendation)

Table 4: Map projection (parameters should match CALMET).

Parameter	Value
Map projection	Tangential Transverse Mercator (TTM)
Datum region	WGS-84
Projection origin	49.906S, 170.489E
False origin ***(use NZMG coordinates)***	(2315, 5475) km

Table 5: Grid control (parameters should match CALMET Runs E and F).

Parameter		Value
SW corner of grid cell (1,1)		(2313, 5473) km
CALMET grid dimensions	NX x NY; DGRIDKM	160 x 120 points at spacing 0.05 km
Vertical grid, number of layers		10
Cell-face heights for vertical grid (m)		0, 20, 40, 80, 160, 260, 430, 710, 1200, 2000, 3200

Table 6: Grid control (subset of CALMET grid points used by CALPUFF).

Parameter		Value
CALPUFF computational grid range E-W		45 to 132 out of NX=160
CALPUFF computational grid range S-N		29 to 72 out of NY=120
Use of gridded receptors?		Yes
Receptor grid range E-W		46 to 131
Receptor grid range S-N		30 to 71
Receptor grid nesting	MESHDN	1 (grid spacing 50 m)

Table 7: Discrete receptors.

Parameter		**Value**	
Number of receptors		27	
ID	X (km)	Y (km)	Ground Elev. (m)*
1	2317.243	5475.218	2
2	2317.709	5475.307	4
3	2317.745	5475.121	7
4	2317.722	5475.372	5
5	2317.303	5475.290	2
6	2317.766	5475.397	8
7	2317.063	5475.206	1
8	2317.032	5475.366	1
9	2317.553	5475.338	3
10	2317.616	5475.354	3
11	2317.478	5475.330	2
12	2317.646	5475.494	12
13	2317.498	5475.447	1
14	2317.375	5475.312	2
15	2317.389	5475.375	1
16	2317.583	5475.454	5
17	2317.452	5475.553	1
18	2317.657	5475.366	4
19	2317.144	5475.118	3
20	2316.803	5475.236	1
21	2317.436	5475.957	3
22	2317.977	5475.927	13
23	2316.956	5475.113	12
24	2318.081	5475.455	19
25	2317.861	5475.629	37
26	2317.205	5475.578	1
27	2317.726	5475.097	7

Note: * above mean sea level

3.0 AREA SOURCE PARAMETERS

Table 8: Summary of area source parameters assumed for dispersion modelling.

Parameter		**Value**
Name		**Biofilter 1**
Total Area		1400 m²
Height		2.2 m
Elevation		4.6 m
Sigma z		1.5 m
Segment 1	Vertex x co-ordinates (XVERT)	2317.545, 2317.558, 2317.54, 2317.526
	Vertex y co-ordinates (YVERT)	5475.228, 5475.209, 5475.196, 5475.215
Segment 2	Vertex x co-ordinates (XVERT)	2317.558, 2317.572, 2317.553, 2317.540
	Vertex y co-ordinates (YVERT)	5475.209, 5475.190, 5475.177, 5475.196
Segment 3	Vertex x co-ordinates (XVERT)	2317.572, 2317.586, 2317.567, 2317.553
	Vertex y co-ordinates (YVERT)	5475.190, 5475.170, 5475.158, 5475.177
Name		**Biofilter 2**
Total Area		1400 m²
Height		2.2 m
Elevation		4.6 m
Sigma z		1.5 m
Segment 1	Vertex x co-ordinates (XVERT)	2317.592, 2317.600, 2317.575, 2317.568
	Vertex y co-ordinates (YVERT)	5475.173, 5475.163, 5475.146, 5475.157
Segment 2	Vertex x co-ordinates (XVERT)	2317.600, 2317.609, 2317.585, 2317.575
	Vertex y co-ordinates (YVERT)	5475.163, 5475.150, 5475.133, 5475.146
Segment 3	Vertex x co-ordinates (XVERT)	2317.609, 2317.617, 2317.593, 2317.585
	Vertex y co-ordinates (YVERT)	5475.150, 5475.138, 5475.121, 5475.133

APPENDIX F

Standby Generator Combustion Calculation

COMBUSTION CALCULATIONS

26/Sep/12
1278104628: 1MW diesel generator
Operating conditions 9.5%vol (dry) CO2

Fuel: Diesel
Ultimate analysis (%wt, DAF basis)

Carbon	88.559	% dry basis
Hydrogen	11.440	% dry basis
Oxygen	0.0	% dry basis
Nitrogen	0.0	% dry basis
Sulphur	0.0010	% dry basis
Fuel moisture content:	0.1	%(as recieved basis)
Ash content:	0.1	%(as recieved basis)
DAF portion:	0.99850	kg/kg fuel (as received basis)

Air Requirements

Theoretical O2 required:	102	moles per kg of dry fuel	DRY
Excess air:	65.0	%	**(vol% CO2 = 9.46 %)**
Total O2 required:	169.0	moles per kg of dry fuel	**(vol% O2 = 8.5 %)**

Burner Details

Power Output:	1000	kW	(aggeko Spec sheet prime power)
@MCR:	100.0	%	(percentage of Max. Combustion Rate)
Effective power Output:	1000	kW	
Efficiency:	37%		
As rcvd fuel CV:	45700	kJ/kg	Based on Mobil specifications
Equivalent Stack diameter:	0.3	m	basede on the 12in rain cap
heat produced by combustion:	2695	kW	
heat loss:	1695	kW	
estimate of convective heat loss:			(heat loss due to convection= h*A*dT w here; h = overall heat transfer coefficient A = area of boiler surface dT = temp. difference)
max. burning rate:	**0.0590**	**kg "as received" /s**	
	0.21	t/hr	
density	0.834	kg/L	
max. burning rate:	0.071	L/s	
	254.593	L/hr	Maximum fuel burning rate (aggeko Spec sheet)

Stack Properties

NB: Radiative and conductive heat loss will also occur, but will be negligible compared to convective losses

Temp:	473	K
wet POC: (value from POC sheet)	32.5	m3/ kg DAF fuel
volumetric flow rate:	1.91	m3/s
Stack x-sectional area:	0.07	m2
Efflux velocity:	**27.06**	**m/s**

dry flow rate @ STP (POC sheet):	17.48	Nm3/ kg DAF fuel
	1.0	Nm3/sec
	3,705	Nm3/hour
WET flow rate @ STP (POC sheet):	18.8	Nm3/ kg DAF fuel
	1.1	Nm3/sec
	3,977	Nm3/hour

SO_2 emission rate	0.0012	g/s	no retention in ash
	0.0	kg/hr	no retention in ash
Nox emission factor	**16.75**	**g/kWh**	from specs supplied 16.75 g/kWh
NOx emission rate	**4.653**	**g/sec**	using prime power
NO2 emission rate (15%)	**0.70**	**g/sec**	
PM_{10} emission factor	**2.00E-01**	g/kWh	from specs supplied 0.2 g/kWh
PM_{10} emission rate	**0.056**	g/s	using prime power
PM_{10} emission rate	**0.20**	**kg/hr**	

NB "N" = standard atmospheric conditions and zero humidity
"DAF" = dry ash free basis

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APPENDIX 4

Selected Photographs of Tahuna Wastewater Treatment Plant

DCC: Tahuna Wastewater Treatment Plant (18 October 2012)

Wastewater Screens

High Rate Activated Sludge (HRAS)

Biological Trickling Filters (BTF)

Biological Trickling Filters (BTF) – internal view

Ultraviolet Disinfection (UV)

Biosolids Dewatering

Dewatering Equipment

Biosolids Storage Hopper

Biosolids Incinerator

Odour Control Biofilters

Emergency Generator

APPENDIX 5

Preliminary Statement from KTKO Ltd/ Te Runanga o Otakou

KTKO LTD
consultancy

6 September 2012

Tony Dons Ltd
P O Box 6054
Dunedin North
DUNEDIN 9056

Attn: Tony Dons

Preliminary Statement – Dunedin City Council : Waste and Waste Services

Proposed Renewal of Air Discharge Permit for Tahuna Wastewater Treatment Plant, Dunedin

From the information provided in regards to the above proposal, Te Rūnanga o Ōtākou have no specific issues/concerns at this stage, but do request to be consulted and informed of the proposal as it develops.

It is understood that the Tahuna Wastewater Treatment Plant is nearing completion and Te Rūnanga o Ōtākou are encouraged to note that the proposed treatment for air discharge has the intention of no odour discharge.

Would also like to thank you for the invitation of a site visit, perhaps this could be arranged once the Tahuna Wastewater Treatment Plant upgrade has been completed.

Please note that this reply is made without prejudice. The Runanga reserves the right to reconsider its position in light of additional information and/or research.

Thank you for seeking our feedback at this early stage and encourage consultation throughout the development of the above proposal.

Nahaku noa
na

Chris Rosenbrock
Manager

cc Te Rūnanga o Ōtākou

G:\KTKO\Resource Consents\2012 Resource Consents\(3057)Tahuna WWTP,Dn-Tony Dons Ltd(DCC)disch to air.docx

Level 1, 258 Stuart Street, PO Box 446, Dunedin, New Zealand
Phone 03 477 0071 • Cell 027 424 6372 • Fax 03 477 0072
Email info@ktkoltd.co.nz

APPENDIX 6

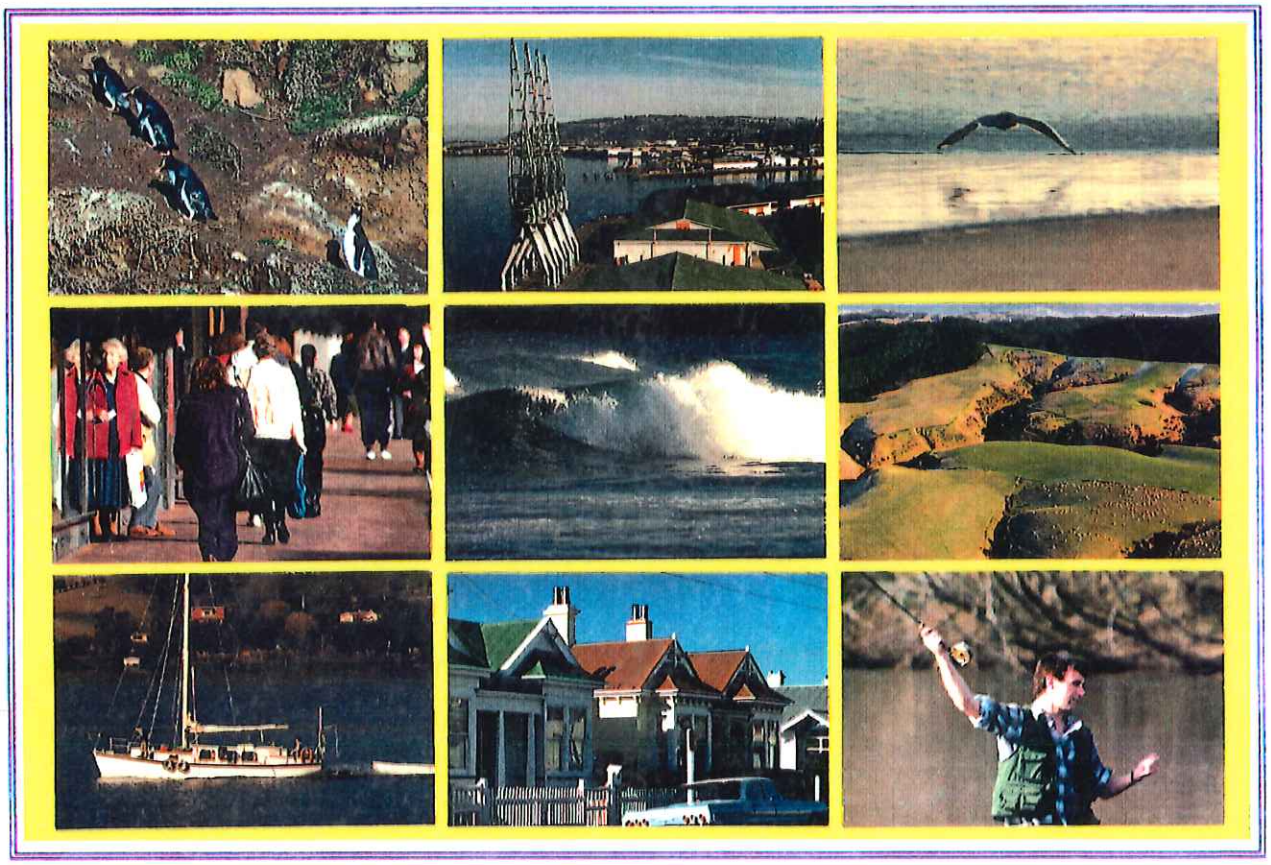
Newsletter Distribution Area

DCC Tahuna Wastewater Treatment Plant: Air permit consultation
Invitation Delivery Area – 10/11 October 2012

DUNEDIN CITY COUNCIL

WASTEWATER TREATMENT AND DISPOSAL OPTIONS STUDY

STAGE ONE



ISSUES AND OPTIONS SCOPING

Main Report

Royds Garden

BECA STEVEN

AUGUST 1991

Terry Dodd

PREFACE

TO THE READER

Please don't be daunted by the size of this report. It is important to you because it is the first major report in the Dunedin City Wastewater Treatment and Disposal Options Study. It sets the scene for the consideration of the major works which the Council may face over the next decade in its commitment to improving the environmental quality of Dunedin City and its environs. The title describes its primary function which is the scoping of the issues and the options which the Council and the citizens of Dunedin will now review.

This preface is intended to be your guide to the best way to approach this report so that, in the end, you will understand it and derive the greatest benefit from it.

SUMMARY REPORT

The section following this preface is the Summary Report. This has been bound at the front of the Main Report to encourage you to read the Summary first. It contains all the important material and the conclusions from the main report. It is also written in easy-to-understand style, so that those readers for whom "wastewater engineering" is a strange and new topic will be able to quickly get a grasp of this subject. The buff coloured pages of the Summary Report are also a good reference point to come back to, perhaps after you have tackled the main report. You may then refresh your memory on the issues, catchment options and total schemes which are presented in this report.

MAIN REPORT

The Main Report comprises 14 Parts which are presented in a logical sequence to lead you, the reader, through the general features of wastewater treatment and disposal to the specifics of the present Dunedin situation and then to the possible wastewater management options for Dunedin in the future. The best way to understand the format of the main report is to see the sections as falling into the following categories.

The first three parts are introductory. Part 1.0 describes **the purpose of the Options Study** and this Stage 1 Report. Part 2.0 covers **the basics of wastewater treatment and disposal**, including the purpose and components of a sewerage system and the composition of wastewater. The management of residuals such as sludge, screenings, noise and odour is also introduced. Part 3.0 contains the description of the **existing sewerage schemes** in Dunedin and their impacts. It is an important section to read as you need to have a thorough knowledge of what the City has now so that you may appreciate the options for future change.

The next two parts cover the important general interest topics of **trade waste discharges** (Part 4.0) and **environmental and planning law** (Part 5.0). These are followed by two parts which introduce to the reader the two main points of the Stage 1 Report, that is the **"Issues"** (Part 6.0) and the **"Options"** (Part 7.0). These two sections describe the **scoping of the issues and options.**

The next four parts describe and develop the background information which is required in the building up of technically feasible treatment and disposal options. Part 8.0 covers the **objectives of treatment** and the **reasons for different levels of effluent quality.** The **basic data** for sizing future treatment plants and pipelines is determined by **estimates of population.** These are developed for Dunedin in Part 9.0. Following this, Part 10.0 is a major part of the report with 12 sub-sections which cover the many **components of a wastewater scheme.** As these form the "building blocks" used later in the report, this part should not be missed out. The fourth one in this grouping is Part 11.0 which describes the **basis of the cost estimates.**

The final three parts form the heart of the Main Report. Part 12.0 presents the **future options** on the basis of four main catchments, and these are then grouped into **Representative Total Schemes** in Part 13.0. A large proportion of the Summary Report is drawn from these two parts of the Main Report. The final section, Part 14.0 charts out the next phases of the study as Council progresses through the **consultation and decision-making processes.**

ACKNOWLEDGEMENTS AND ADVISORS

The Royds Beca Joint Venture acknowledge the input of the following personnel and advisors:

- Staff of the Dunedin City Council, and in particular Messrs J P Brimble, T E Buchanan, B B Turner and D L Robinson of the Drainage and Refuse Department Operations and Service Group, and Mr W J Henderson of City Consultants.
- The Working Parties established by the Council.
- Messrs W H Cockerill and N Harwood of Octa Associates Ltd.

Consultants

Royds Beca Joint Venture consisting of:

- Royds Garden Ltd, Consulting Engineers & Planners, Dunedin
- Beca Steven Ltd, Consulting Environmental Engineers, Christchurch, (A Division of Beca Carter Hollings and Ferner)

Subconsultants

Mr B Duncan, Bruce Wallace Partners Ltd, Consulting Engineers, Auckland (land treatment and disposal)

Dr B Robertson, B Robertson and Associates, Environmental Consultant

International Reviewer

Mr I Law, Camp Scott Furphy Pty Ltd, Environmental Engineers and Scientists, Melbourne, Australia.

Front cover layout and photographs by Graeme Withell.

Dunedin City Council

Wastewater Treatment and Disposal Options Study

Stage 1 Report "Issues and Options Scoping"

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A. Wastewater Treatment Technology
B. Existing Sewerage Schemes - Details

Summary Report

DUNEDIN WASTEWATER TREATMENT AND DISPOSAL OPTIONS STUDY

STAGE 1

ISSUES AND OPTIONS SCOPING SUMMARY REPORT

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This report has been prepared for the Dunedin City Council by the environmental engineering consultants Royds Beca Joint Venture. The assistance of the staff of the City Council is gratefully acknowledged. The input to date from the various community interest groups is acknowledged, and has been accommodated in the Stage 1 Study reports.

More information about the Wastewater Treatment and Disposal Options Study may be obtained from:

Mr Trevor Buchanan
Manager, Drainage and Refuse
Dunedin City Council
PO Box 5045
DUNEDIN Fax (03) 474-3789

1.0 PURPOSE OF STUDY

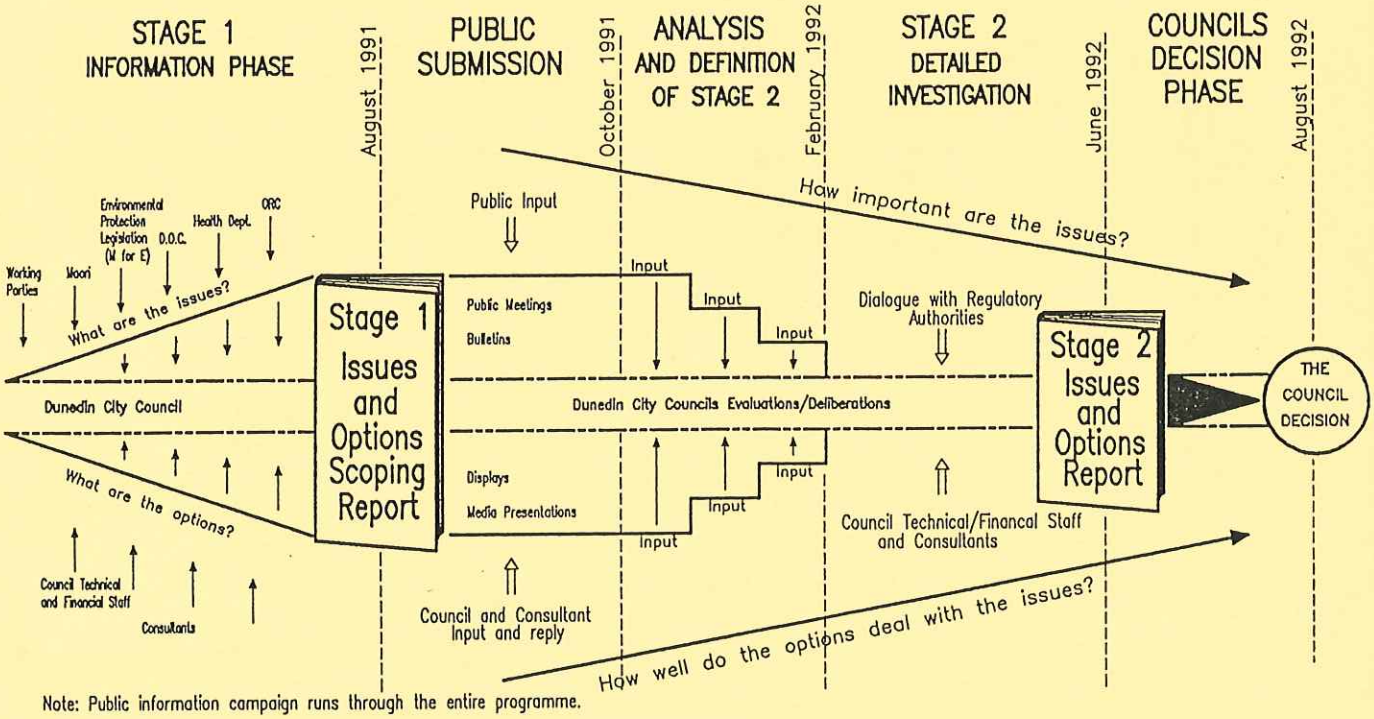
The current local and national political environment is such that the Dunedin City Council believes that future legislation will require a continuing higher standard of environmental protection, resulting in the need for improvements in wastewater treatment and disposal. The community is also making it clear that it considers that some of the city's wastewater treatment and disposal systems are now in need of upgrading to meet these increased environmental standards.

1.1 STUDY OBJECTIVES

The Wastewater Treatment and Disposal Options Study will:

- provide the citizens of Dunedin with information to assist in providing informed input into the decision making process on future upgrading of the treatment and disposal facilities.
- identify issues associated with the upgrading of wastewater treatment and disposal facilities.
- determine an evaluation framework for assessing technically feasible options against the wider identified issues.
- identify a range of technically feasible options for future wastewater treatment and disposal improvements and assess associated capital and annual operating costs.
- evaluate in detail a selected number of the options for wastewater treatment and disposal upgrading against the wider issues. Note: a separate study for Mosgiel is in progress.
- present the decision process for selection of the preferred option(s).
- lead to the adoption of an integrated plan for upgrading the city's wastewater treatment and disposal facilities which is environmentally acceptable and affordable.

The following diagram illustrates the procedures being followed for this study.



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2.0 INTRODUCTION

The Dunedin City Council is investigating options for upgrading wastewater treatment and disposal systems for the City.

At present the Council operates 12 separate systems, some of which will likely not meet future environmental standards required by the new Resource Management Act and related plans.

Some of the systems operated by the Council are believed to meet these standards, given that they involve high levels of treatment, and either disposal to land (Waikouaiti/Karitane, Warrington, Seacliff) or to water in an acceptable manner (Middlemarch).

The major systems subject of this study are centred in four historic catchments, namely:

- **the harbour basin** (HB) - involving secondary schemes at Port Chalmers, Burkes/St Leonards, Broad Bay/ Portobello, and Company Bay/ Macandrew Bay, with harbour discharges.

- **Musselburgh** (MC) - involving the main Tahuna treatment plant and Lawyers Head outfall, as well as (for the purposes of this study) the small Ocean Grove scheme.

- **Green Island** (GIC) - involving the Kaikorai milliscreen plant and Waldronville outfall, this scheme also treating industrial wastes from Mosgiel/Wingatui.

- **Mosgiel/Taieri** (MTC) - involving a secondary treatment plant for Mosgiel wastes, and disposal to the Taieri River.

A detailed Issues and Options Scoping Report has been prepared which identifies issues and key decision factors, and presents a range of technically feasible options.

Council's approach at all stages in the process leading up to selection of preferred options for future wastewater management is to ensure that community preferences are given full consideration and weight in the decision-making process.

The involvement of the public, Maori and special interest groups is a key component of the project. The Council has implemented a programme including working parties, news releases, and the opportunity for wider public involvement.

This Summary Report identifies and discusses the issues which will affect the choice of a scheme, including:

- protection of public health;
- environmental impacts;
- cultural values;
- estimated costs; and
- the effects on local communities of pipelines, treatment plants and outfalls.

2.1 PROJECT OBJECTIVES

The primary objective for upgrading the sewage collection, treatment and disposal system for Dunedin area is:

- **To select and implement the best practicable option for sewage collection, treatment and disposal in the greater Dunedin area.**

Explanation

The preferred best practicable option will be the one which best balances the sometimes competing and conflicting factors in a way which minimises overall negative effects and maximises community acceptance.

The following summarises the factors which are relevant to the need for the widest possible scoping of options. They range from Local Government reorganisation to the rising concern worldwide for the environment and serve to illustrate the starting point for this fundamentally important part of the options study. Solutions must be identified which match the community's aspirations and expectations.

a) Local Government Reorganisation

Following the reorganisation of local government, nine former local bodies became amalgamated within the new Dunedin City. This offers an opportunity to overview wastewater treatment and disposal on a broad scale, and where practicable rationalise these systems to the mutual benefit of the

environment and the citizens.

b) Existing Water Rights and Existing Use Consents

Some of the existing treated sewage discharges operate on "existing use consents" (which under the Resource Management Act expire in 10 years) and some others operate under short term water rights recently issued pending the Council's investigations and decisions regarding upgrading.

c) State of Legislation

The Resource Management Act is now law; this new legislation changes the basic way we need to think about resource and environmental management. Certain provisions, and in particular those relating to coastal management and receiving water quality requirements, necessitate a review of existing systems of wastewater treatment and disposal in Dunedin.

d) Community Perceptions and Aspirations

The community at large has become increasingly aware of environmental issues over the past decade - what were once fully accepted methods for wastewater treatment and disposal are now questioned and debated to a far greater extent.

e) The Wider Environment

The combination of b), c) and d) above, as well as the "greening" of society in general, has required a reconsideration of priorities in the environmental field. Public health and economics are still important issues, but not exclusively so, and concepts such as "intrinsic values", "sustainability", and "clean and green image" are also vital considerations.

f) Council's Objectives and Plans

These include the most important matter of protection of public health and also the issue of economics and affordability. Both Council's Annual and Strategic Plans accordingly address these issues.

3.0 WASTEWATER COLLECTION, TREATMENT AND DISPOSAL

This section provides general information applicable to all wastewater treatment and disposal systems.

3.1 COMPOSITION OF WASTEWATER

3.1.1 General

Wastewater is 99.9 per cent water, derived from various sources, including:

- toilets, baths, showers, sinks, dishwashers, and washing machines;
- washings and liquid wastes from hotels, restaurants, shops, offices, stores and laundries;
- groundwater which gets in through broken pipes;
- industrial liquid wastes, which are called "trade wastes", and other liquids which are discharged into the sewers.

Besides water, the main components of wastewater are: debris and inert materials, organics, nutrients, micro-organisms (including pathogens), oil and grease, and toxins.

3.1.2 Inert Material

Sewers carry a wide range of inert materials, eg, grit, wood and plastic, most of which are non-biodegradable.

3.1.3 Organics

Organic materials in wastewater include bio-degradable materials such as carbohydrates, proteins and fats. Faecal wastes contain a high proportion of organics, much of it in solid form.

Biochemical Oxygen Demand (BOD) is used as the measure of the amount of oxygen micro-organisms use in reducing the organic content of the wastewater. Effluents with high BOD can harm shallow waterways and harbours by reducing the oxygen available to fish and other aquatic life.

3.1.4 Nutrients

Wastewater contains small concentrations of the primary nutrients phosphorus and nitrogen either as organic forms (ie, as living or dead micro-organisms and plants) or inorganic forms (ammonia and nitrate).

High concentrations of nitrogen and phosphorous in effluents can promote algal blooms and serious waterweed obstruction in waterways and harbours.

3.1.5 Micro-organisms

Every day, people excrete millions of harmless bacteria. One of these harmless bacteria, faecal coliforms, is used as an indicator of harmful micro-organisms, pathogens.

Because not everyone in Dunedin is healthy, a variety of pathogens regularly occur in wastewater, including:

- bacteria (such as bacillary dysentery);
- viruses (such as hepatitis, polio, ear and throat infections, gastroenteritis, and meningitis); and
- protozoa (such as Giardia).

The type and number of pathogens in wastewater depends on the particular illnesses from which people in the community are suffering.

3.1.6 Oil and Grease

Wastewater contains a range of organic substances, including mineral and vegetable fats, oils and waxes.

3.1.7 Toxins

Toxins are a diverse group of organic and inorganic substances. They include for example phenols, metals, herbicides, acids, and cyanide. They are not usually present in domestic sewage, but can occur in industrial liquid wastes. In Dunedin, the discharge of these materials is in part controlled at source through trade waste bylaws.

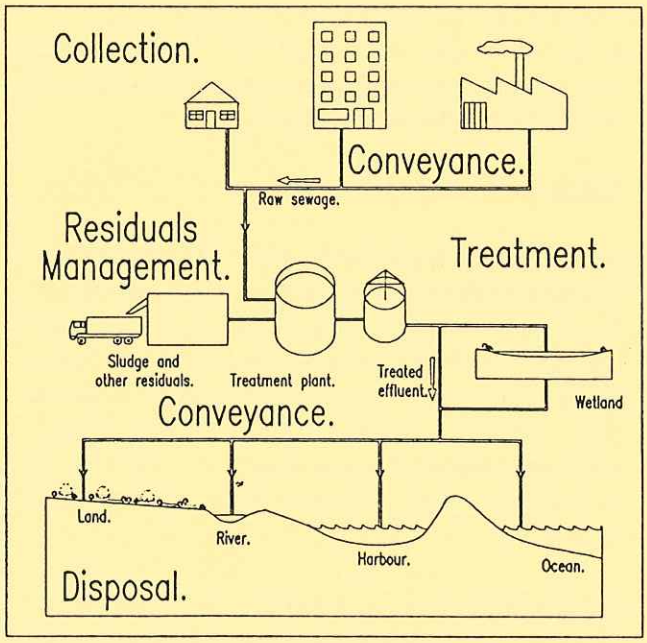
If toxins are present in sufficient quantities or concentrations in wastewater they can be hazardous within the collection sewers and treatment plants, both to the operators and equipment; they can inhibit or poison biological treatment processes; and they can pass through treatment processes to detrimentally affect the environment.

3.2 WASTEWATER SYSTEMS

3.2.1 Components

The basic components of any particular wastewater systems are:

- collection
- conveyance
- treatment
- effluent disposal
- residuals management



3.2.2 Collection and Conveyance

The collection and conveyance component is the network of pipes and pumping stations necessary to convey wastewater to treatment and disposal facilities, as well as from treatment plants to effluent discharge locations.

3.2.3 Treatment

Wastewater treatment protects public health and the environment by removing some constituents from the incoming wastewater and breaking down others to produce a liquid effluent, and

solids (as sludge).

There is a wide range of wastewater treatment technology which can achieve different levels of treatment. The levels of treatment are commonly referred to as:

- Preliminary
- Primary
- Advanced Primary
- Secondary; and
- Tertiary

There are two other main treatment processes which can be combined with these treatment levels: disinfection and nutrient removal.

Preliminary

Preliminary treatment involves the removal of large solids, grit, and excess fats. Milliscreening is a preliminary treatment process, and is used at the Green Island treatment plant.

Primary

In a primary treatment plant, wastewater first receives preliminary treatment, then passes into large sedimentation tanks where the flow of the sewage is slowed down to enable the floatable greases and scums to rise to the surface, where they can be scraped off, and the heavier settleable materials to be collected after settling as sludge. The Tahuna plant uses primary treatment.

Advanced primary treatment can be employed to provide greater removal of solids, oils and grease if required. Processes include addition of chemicals and pressurised air.

Secondary

There are various processes used in secondary treatment. Natural biological processes are used to remove much of the organic content, as well as many of the pathogens.

In oxidation ponds, algae provide the oxygen for bacteria which feed on the organic content of the sewage, while solids settle out to the bottom of the ponds where anaerobic decomposition takes place. Examples in Dunedin are Middlemarch, Warrington, and Waikouaiti/ Karitane.

During the activated sludge process, the primary-treated effluent flows into large aeration tanks where it is mixed with a brownish liquid called "activated sludge", that serves as a culture medium for the micro-organisms which feed on organic content of the sewage, and break it down. Aerated lagoons use activated sludge principles operated in large open lagoons. Examples in Dunedin of activated sludge plants are Ocean Grove, Burkes/ St Leonards, and Broad Bay/Portobello.

In trickling or biological filtration rotating arms, that look like a large rotary clothes line, distribute primary treated effluent over graded rocks or plastic media. A slime layer containing useful micro-organisms grows over these rocks. These organisms convert the organic content in the wastewater to settleable solids. These are later collected along with slime layers that have broken away from the filter media leaving the clarified treated effluent. Examples in Dunedin are Mosgiel, Port Chalmers, and Company Bay/Macandrew Bay.

The relatively new biological aerated filter (BAF) process undertakes the biological treatment in a sand bed process. It offers a particularly compact plant arrangement.

Tertiary

Tertiary treatment further improves effluent quality particularly by the removal of additional fine suspended solids, nutrients and other undesirable matter (eg, pathogens). A variety of techniques can be used including sand filtration, dual media (sand and anthracite) filtration or oxidation ponds. Tertiary treatment can also be provided in wetlands. Disinfection is also a tertiary process, with use of ultraviolet light (uv) becoming common. A recently-developed microfiltration technique is currently being evaluated as a means of providing high removals of fine solids, including micro-organisms.

3.2.4 Effluent Disposal

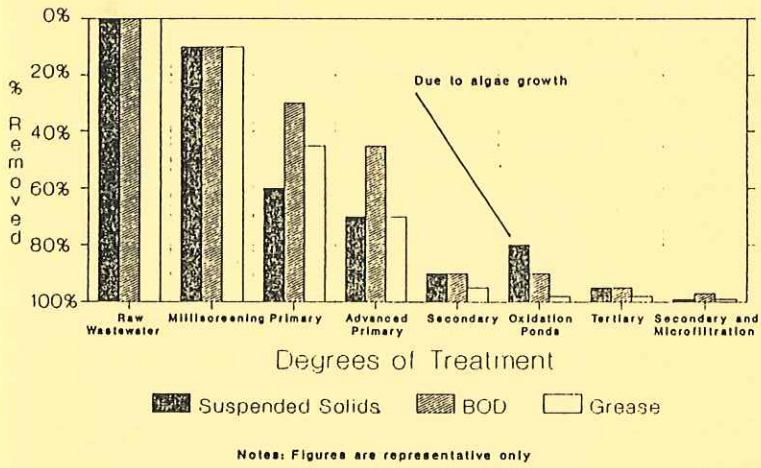
The final stage of a sewerage system is disposal. This can either be into water or onto land. The present discharges from the four historic catchments occur into Otago Harbour, the ocean, and the Taieri River.

Virtually all the sewerage systems of coastal towns and cities in New Zealand rely on marine

disposal for final disposal of their effluent. In the past, when many communities discharged raw wastewater, reliance on natural marine purification was total. Now more and more of these communities treat their wastewater to some extent, and dependence on natural processes in the receiving water is decreasing.

Nevertheless, there is always an area around the outfall, known as the "mixing zone". It can be unsafe to swim or to take shellfish within this area because of the presence of the effluent field (unless the effluent itself is treated to bathing water or shellfish-taking standards).

Pollutant Levels Remaining in the Domestic Wastewater Stream Following Various Degrees of Treatment



3.2.5 Residuals

Residuals are the non-liquid by-products from the wastewater treatment processes. They include odours, noise, sludges, air emissions and screenings (largely of inert material).

These must be properly managed in order to avoid detrimental environmental impacts. For example, sludge management is a complex and particularly important matter.

4.0 EXISTING SYSTEMS AND IMPACTS

The existing systems in the four historic catchments subject to this study are shown in the figure below, and were briefly described in the Introduction above. Environmental impacts associated with these schemes are:

- **harbour basin** - nutrient enrichment around some outfalls, particularly Sawyers Bay. Some water quality deterioration, at times due to inadequate performance of treatment plants coupled with short shallow outfalls, in particular bacteriological increases.

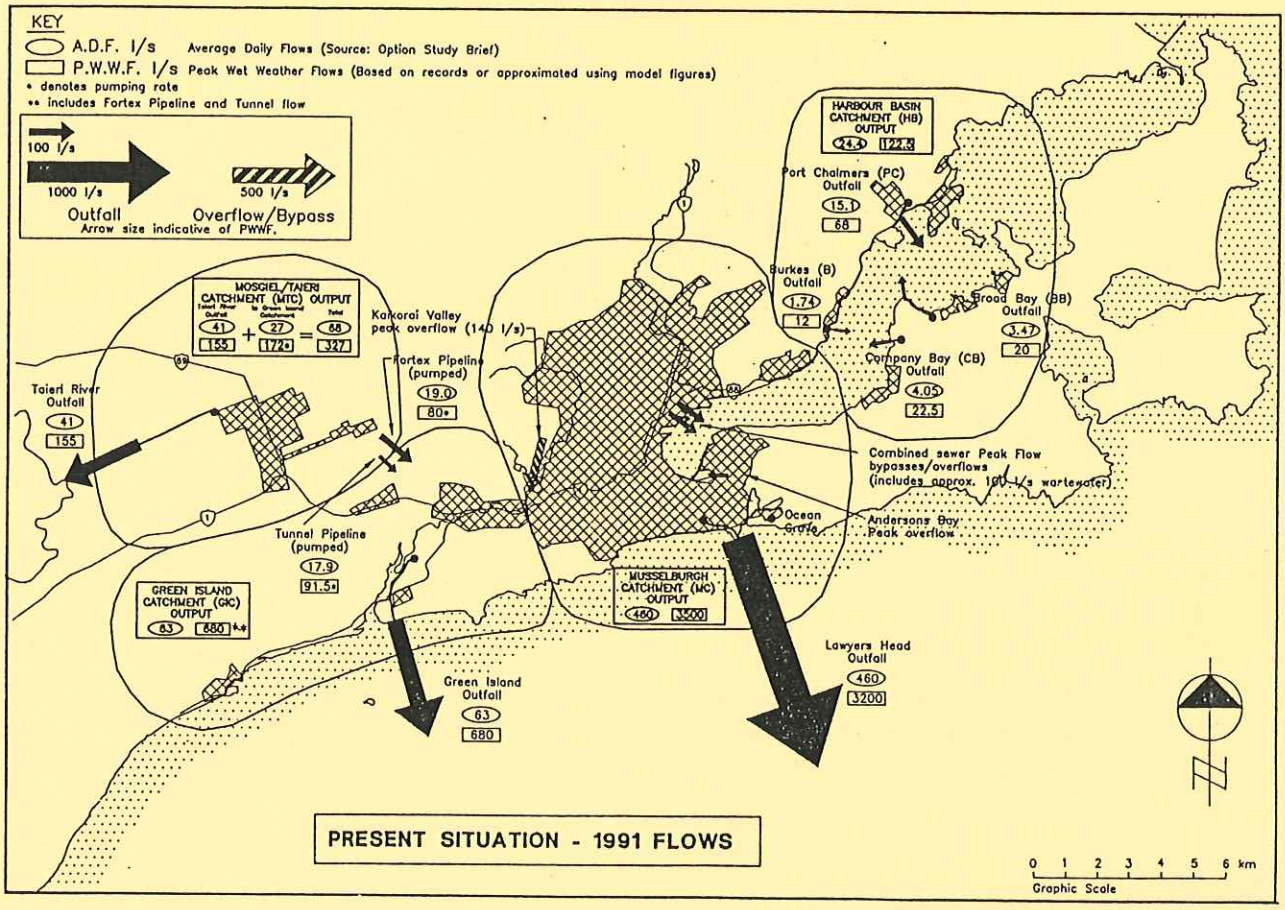
  Public perceive harbour water to be polluted with sewage, particularly after heavy rain when major stormwater/sewage overflows discharge. Limited available data do not indicate general harbour-wide pollution, but do confirm problems in localised areas.

- **Musselburgh** - solids accumulations and grease lines on beaches, particularly when Tahuna treatment plant not fully operational. Bacteriological contamination of main bathing beaches above accepted public health standards frequently occurs. Discharge visible at Lawyers Head, with accompanying odours at times.

- **Green Island** - some exceedance of accepted bathing water public health standards, including at the popular surfing location at Blackhead. Occurrence of pinhead grease on beaches at times.

- **Mosgiel** - bacteriological contamination of the Taieri River in the vicinity of the outfall above accepted public health standards for contact recreation. Concerns with regard to protection of trout fishery, although recent results show an improvement.

Other relevant factors associated with the existing schemes are discussed below.



4.1 CAPACITY LIMITS

Based on data from the 1991 Census and extrapolated population projects to the year 2051, three population growth scenarios have been included in this study. These are:

- a maximum projected growth rate of 1% increase compounded every 5 years.
- a nil growth rate - this is the scenario used for design at this stage.
- a minimum projected growth rate of 1% decrease compounded every 5 years.

4.2 CONTRIBUTION OF TRADE WASTES

Trade wastes make a major contribution to wastewater flows and strength in the Musselburgh and Green Island catchments particularly. For these areas:

- whilst the actual domestic population of the Musselburgh catchment is approximately 80,000, trade waste volumes are equivalent to a further 20,000 people, and strength of these wastes is equivalent to 80,000-200,000 people (based on solids, BOD, or oil and grease data).
- for the Green Island area, the actual domestic population is approximately 11,000, whereas trade waste volumes are equivalent to a further 36,000 (including Fortex). Trade waste strength is equivalent to a population of 138,000-320,000 people based on solids, BOD, or oil and grease data.

This study considers this important matter in some detail, including the proportions of and options for the recovery of trade waste charges pertaining to the treatment and disposal of these wastes by the Council.

4.3 CONDITION OF EXISTING SYSTEMS

Some components of the existing systems will require replacement or rehabilitation. Much of the conveyance network is very old, while some components of the older treatment plants are nearing the end of effective working lives in the next 20-30 years. This study offers an opportunity to consider these matters in a

coordinated way in the long-term planning framework.

4.4 CULTURAL CONCERNS

4.4.1 Maori View

In the traditional Maori view there are a number of tapu associated with water and hygiene in relation to food. This has implications for the disposal of sewage into any source of river or sea foods. It is deeply objectionable on traditional spiritual grounds for the Maori to mix waters that have been contaminated by human wastes with waters from which food is gathered. In this context the discharge of effluent to Otago Harbour is a concern.

4.4.2 Non-Maori (Caucasian) View

The Caucasian culture also has concerns regarding water and hygiene, but not expressed in such spiritual ways as the Maori response. Water is important to society as a source of recreation; for swimming, boating, water skiing, diving and fishing; as well as commercial activities and potable use.

For recreation to be satisfying, it is necessary for it to be safe and relaxing. Consequently, recreation on and around water requires that the water be clean and hygienic. Some assurance is needed that the water does not contain harmful levels of contamination.

4.5 RESOURCE MANAGEMENT ACT

The Resource Management Act has just been passed. This legislation changes the way we need to think about the environment and how we use it. The concept of sustainable management of natural resources is a cornerstone of the Act which requires consideration of the social, economic and cultural well-being of communities while also:

- sustaining the potential of natural and physical resources to meet the reasonably foreseeable needs of future generations.

- safeguarding the life-supporting capacity of air, water, soil and ecosystems.

- avoiding, remedying or mitigating any adverse effects on the environment caused by our activities.

This legislation will play a major role in determining the directions for wastewater treatment and disposal in Dunedin, including reconsideration of the existing status of licences for current treatment plant sites and discharges.

5.0 FUTURE OPTIONS : KEY ISSUES

In order for community preferences for future wastewater schemes to be determined, it is important that the wide range of issues that will impact on that process are clearly identified and the nature of each understood.

These key issues may be grouped for convenience into the following categories:

- public health
- social, cultural and community impacts
- environmental impacts
- available technology and reliability
- ability to stage scheme development
- costs, financing and affordability
- legal and planning issues
- resource management legislation changes and DoC coastal policy
- regional and national considerations
- the future for industry and employment
- waste minimisation and re-use

All of these key issues must be appraised and dealt with in a logical manner, in order to develop solutions required to meet demands for upgrading of the existing wastewater schemes.

Critical questions which normally arise during discussion of wastewater schemes include:

- what's the problem with the existing systems?
- what are our options (including doing nothing)?
- is there any potential for contamination of a drinking water supply?
- is the water safe to bathe in or collect fish and shellfish from?
- will the discharge be visible?
- will ecological values be detrimentally affected?
- will the treatment plant be noisy or create odour?
- how much does it all cost?
- can we build it and pay for it in stages?

- what can we do in the short term to avoid discharge of wastewater into the harbour and how will this influence the longer term choices?
- can we afford to do it? or not to do it?
- what happens during power failures?
- can the effluent be disposed of onto land?

These and other issues (some 18 in total) are discussed in the major Issues and Options Scoping Report, and are taken into account in developing a series of technically feasible scheme options, based on building up component parts into schemes. It must be noted however that public input is essential to both confirm these issues, and/or to add or delete others from the decision process.

6.0 SCOPING OF OPTIONS

The main objective of this study is the identification of a range of technically-feasible options for the treatment and disposal of the wastewaters from the major urban areas of Dunedin City and environs.

The study has started with a "clean slate" and has not assumed that any one particular solution or method is favoured from the outset. As a consequence there is a very large number of possible combinations amongst treatment and disposal options for the four historic catchments.

In order to more rationally discuss these options, a method was devised to more easily present options - a **Catchment Output Concept**, that is how many disposal options there are spread over the four catchments, using disposal to either land or water (or effluent reuse).

The existing situation provides the starting point for this concept system. Each of the four historic catchments by and large treats and disposes of its own wastewater (the only transfer between catchments being some Mosgiel/Wingatui wastewaters to the Green Island system). This then represents four catchment outputs, and is termed **Concept Level 4.**

From this state, where there are four essentially isolated wastewater catchments, we can start considering transfer of wastewater from one catchment to another, and thereby reduce the number of Concept Levels. For example, if all of the wastewater from the harbour basin was transferred into the Musselburgh catchment for treatment and disposal, we have a **Concept Level 3** situation.

Concept Level 2 schemes involve two intercatchment transfers, and two major treatment and disposal schemes.

A Concept Level 1 scheme involves bringing all of the wastewater generated within the City into one catchment, for "centralised" treatment and disposal.

The discussion of possible options below follows this catchment output concept.

7.0 SCHEME COMPONENTS : OPTIONS

7.1 GENERAL

In developing future wastewater scheme options, it is useful to initially consider technically feasible options for each component of a scheme, and then group these in various combinations to arrive at total scheme options.

7.2 CONVEYANCE

There are a large number of options for conveying to treatment plant sites, and from these sites to discharge locations. Included in the options are new pipelines, tunnels, pipelines across the harbour, renovation of existing sewers, and associated pump stations.

For the majority of the scheme options, conveyance components represent a high proportion of the overall capital costs.

The Stage I study confirms that the Musselburgh Pumping Station and the Green Island treatment plant site should remain as the main wastewater collection and conveyance "nerve centres" in these two catchments.

7.3 TREATMENT AND DISPOSAL INTERRELATIONSHIPS

7.3.1 Treated Effluent Standards

The amount of treatment of wastewater necessary prior to disposal will depend largely on the capacity of land or receiving waters to assimilate the treated wastewater. Refer to sections below for a discussion of treatment

processes and upgrading options.

Land Disposal

For Dunedin, sufficient land areas not in water supply catchments, of suitable topography and assimilative characteristics have been identified south of Brighton and on the Peninsula (Okia Flat) which could be used for the disposal of all or part of expected effluent volumes.

The prime requirements for effluent quality in land disposal systems are control over levels of solids, oil and grease, toxins, and macro-ions important in soil structure and chemistry (Ca, Mg, Ca, K, N).

The 1973 Department of Health Guidelines require that effluent must be at least at a secondary treatment level or from oxidation ponds.

River Disposal

It is unlikely that the discharge of further treated effluent to the Taieri River can be contemplated.

There is no other river of sufficient size in the City area to accommodate large volumes of treated wastewater.

Harbour Disposal

The harbour is probably less sensitive to nutrient enrichment than local rivers. As a consequence sophisticated treatment processes to ensure very low levels of these are probably not required, although secondary treatment will be necessary. Of importance will be to ensure that the effluent is not aesthetically noticeable or offensive, and that levels of pathogenic micro-organisms and toxins do not detrimentally affect harbour waters and their users.

Preliminary information from the ongoing Otago Harbour Planning Study indicates however that many people perceive harbour water quality to be poor, largely as a result of the discharges of treated wastewater from the four harbour basin schemes, major wet weather overflows, and industrial wastes. There have been calls to remove all such discharges, in order to enhance harbour ecological and recreational values. These views will require further consideration in this ongoing study.

Coastal Disposal

Discharge of wastewater effluent to coastal waters is a common practice in New Zealand.

The open coastal environment is known to be a nutrient-deficient system, and consequently the discharge of BOD and nutrients is regarded as less of an issue than, for example, the discharge of pathogens, toxins, or high concentrations of solids, oil and grease.

As a consequence it has been the practice in the past to discharge a lower quality effluent into the sea than would be normally acceptable for inland or enclosed waters. Public opinion however is starting to influence and change this practice, whether on technical or aesthetic grounds. At this stage a number of options are proposed. For those involving ocean discharge, most have outfalls that provide good separation distances from the shoreline.

7.3.2 Treatment Plant Processes

The basic forms of wastewater treatment have been described in section 3.2.3 above. The decision as to which specific process will be used will depend upon the matching of disposal option and associated effluent quality, as well as economic and siting constraints.

Section 7.4 below presents a brief description of some of the options available for upgrading existing treatment plants, in particular Tahuna and Green Island. It should be noted that all of the treatment plants in the harbour basin and at Mosgiel involve secondary biological treatment, and can be readily upgraded to improve performance consistently if required, as well as extended to incorporate further levels of treatment which might be necessary (disinfection, nutrient removal).

For the option of a major new treatment plant at Southdale Road (see below), a secondary biological filtration process is proposed, with or without uv disinfection. There is also an option of retaining the existing Tahuna primary plant as the first part of a split-site secondary facility.

7.3.3 Treatment Plant Sites

A number of treatment plant sites have been identified for the purposes of this study. Many of them involve use of existing sites, given that

a significant number of available future options involve retaining existing, possibly upgraded treatment facilities.

Potential new sites for treatment plants have been considered at:

- Southdale Road behind Smaills Beach
- Kaikorai Valley near Townleys Road (but not favoured)
- site within the land disposal area identified south of Brighton

7.4 UPGRADING EXISTING PLANTS

Several of the options discussed in the Issues and Options Scoping Report involve significant upgrading of treatment processes at the two major Dunedin plants, Tahuna and Green Island. This is in recognition of the fact that all other treatment plants in the four historic catchments are of a secondary standard already, whereas these two are primary and preliminary respectively.

In summary, the upgrading options discussed are:

- Musselburgh Pumping Station
  - upgrading including fine screening and, in some options, grit removal
- Tahuna
  - upgrade performance of existing plant to full primary
  - upgrade to advanced primary (3 methods considered)
  - upgrade to secondary treatment using biological aerated filters (BAF) or other methods, with or without uv disinfection
  - upgrading to tertiary treatment using secondary (above) and subsequent microfiltration. This could enable use of the existing Lawyers Head outfall.

- Green Island
  - upgrade the preliminary (milliscreening) process to advanced primary as originally planned (2 methods, as well as an option using lime disinfection)
  - upgrade to full secondary treatment, with or without disinfection, using a number of different processes.

Sections 8 and 9 below present options for catchment schemes and representative total schemes, including these upgrading options.

7.5 DISPOSAL

7.5.1 General

Options presented in detail in the Issues and Options Scoping Report involve:

- land disposal for all or part of the wastewater flow
- use of existing, probably modified outfalls
- construction of new outfalls into the harbour and offshore
- consideration of re-use technologies

7.5.2 Land Disposal

No site exists in the greater Dunedin area for rapid infiltration of treated effluent into sand or gravel layers. Consequently a slower rate of application is considered, where treatment and disposal is achieved by slow filtering of the effluent through the surface soil mantle. Some uptake of moisture and nutrients by a suitable tree crop will also occur.

Large areas of land in and around Dunedin were not considered because they are within drinking water supply catchments. Similarly, areas of land known to suffer instability were also excluded, as were large parts of the Peninsula because of topography and runoff potential. The Taieri Plains are not suitable because of high water tables and other issues including land ownership, and nitrogen enrichment of connected streams and lakes.

This left two areas identified as potential land disposal sites:

- the Okia Flat on the Otago Peninsula. Such an area (50 ha) could serve as a land disposal site for all treated effluent generated within the harbour basin.

- a large area of land (3600-5000 ha) south of Brighton, possibly in the coastal forest, could be used to dispose of all wastewaters generated in Dunedin (from

all 4 catchments).

7.5.3 Disposal to Water

Options for outfalls for disposal of treated effluent to water are:

- a long (1600 m) marine outfall directly offshore from the Tahuna treatment plant. This outfall would replace the existing Lawyers head outfall, and would involve retaining the Tahuna treatment plant in upgraded or extended form.

- shorter marine outfalls off Tahuna (600 m and 1100 m) with higher levels of treatment.

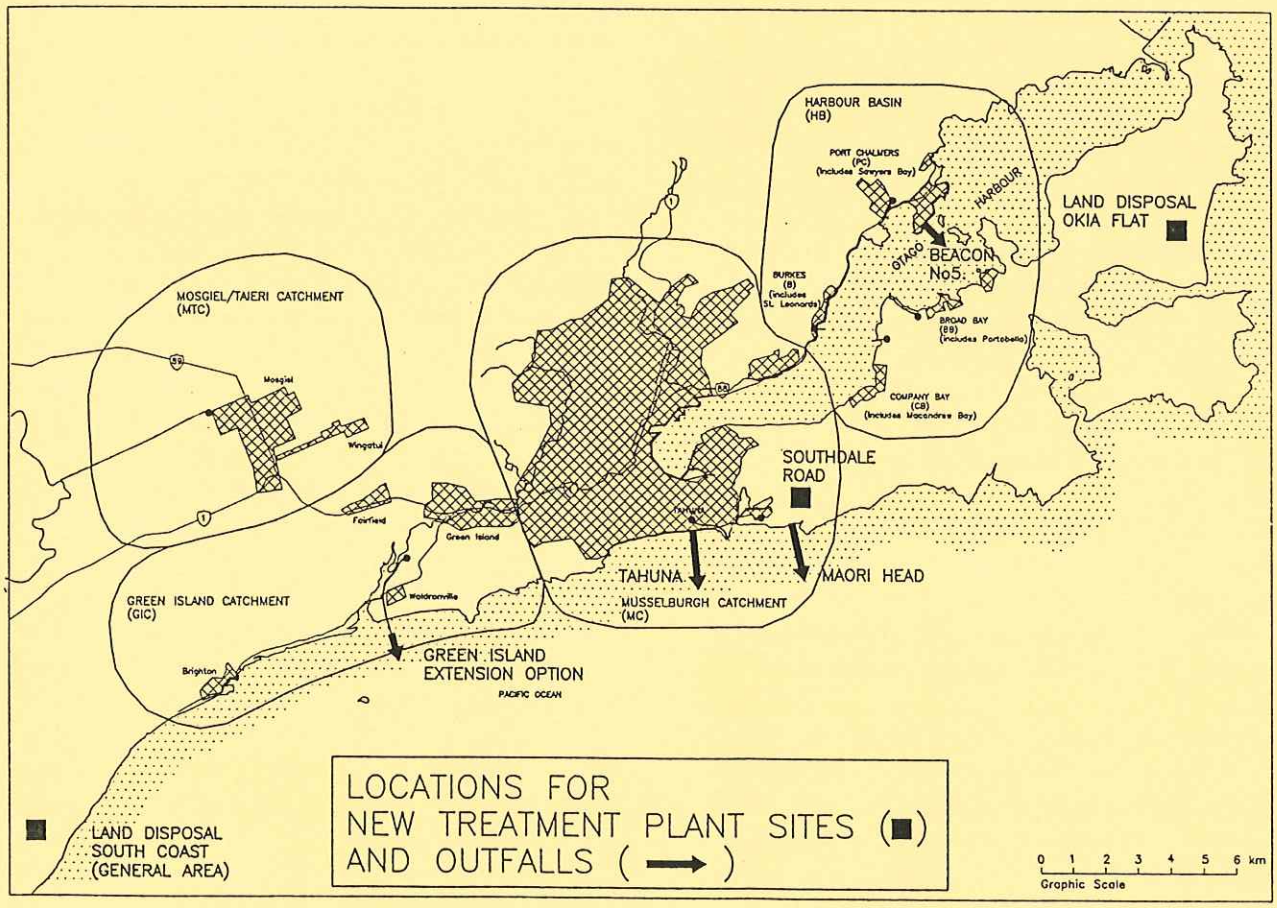
- a long (1100 m) marine outfall off Maori head (near Smaills Beach). This could involve either retaining the Tahuna treatment plant as above, or a new plant at Southdale Road.

- an extension of 600 m to the existing Waldronville outfall, giving 1100 m in total.

Note: The length of these outfalls, required to ensure appropriate protection of public health and environmental values is related to the quality of effluent discharged, and will be confirmed during Stage II investigations.

- in the main harbour channel, near Beacon No 5, Sawyers Bay. This new outfall would replace the existing Sawyers Bay outfall, extending into deeper water in the main shipping channel. This outfall could also be used for disposal of other treated harbour basin effluents, with linking of some or all of these schemes by pipelines to the one discharge location.

- other options involve use of existing, probably modified outfalls, for example linking some of the harbour basin outfalls, or continued use of Lawyers Head.



7.6 RESIDUALS MANAGEMENT

This includes the management of odours, noise, sludges, air emissions and screenings. Techniques incorporated in the scoping of options include:

- Musselburgh Pumping Station: automated efficient grit and screenings removal

- Tahuna Treatment Plant options: increased incinerator performance and an additional parallel sludge dewatering system. Sludge driers have been considered. Completion of the ongoing odour and noise control systems is also included.

- appropriate sludge and other residuals systems for options of treatment at Southdale Road, and treatment associated with a south coast land disposal scheme. Anaerobic digestion and sludge drying have been considered as options for this.

- Green Island: automated solids screening and sludge dewatering systems, with facility for lime stabilisation also being considered.

- harbour basin plants: if these remain in use, rationalisation of sludge management, including a mobile dewatering plant.

Overall, high regard needs to be paid to odour prevention and treatment, noise suppression, and control of any air emissions. Estimates have accordingly allowed for these.

7.7 RE-USE AND WASTE MINIMISATION

The Issues and Options Scoping Report reviews possible re-use technologies for effluent and byproducts. It also includes consideration of minimising domestic sewage, wet weather flows, trade waste flows and pollutant loadings.

The conclusion is reached that while there are both re-use and minimisation technologies available that could be economic, they are unlikely to greatly affect the options and schemes under consideration as scoped in the report. More review is needed in Stage 2.

7.8 RELIABILITY, RISK AND FLEXIBILITY

These issues are of increasing importance in wastewater management as treatment plants and disposal systems must be appropriately assessed from the outset. Flexibility relates to the number of process trains, spare capacity and back up systems that treatment plants and other parts of the system have, and their ability to allow processes to remain fully operative when for example one process train of 3 or 4 is out of use. This has been allowed for in the options considered.

8.0 CATCHMENT OPTIONS

In the following two sections, for ease of reference in figures and tables, the four historic catchments will be referred to in abbreviated form, namely:

- HB = harbour basin
- MC = Musselburgh catchment
- GIC = Green Island catchment
- MTC = Mosgiel/Taieri catchment

Section 6 above introduced the concept approach being taken in this first stage of identifying technically-feasible options, using "catchment output levels". This enables the reader to get a broad view of the very complex situation in Dunedin, and consider potential options for development in general before becoming immersed in details.

This section presents some of the range of options for schemes within each of the four historic catchments - some of these will be carried forward in Section 9 below into representative total schemes for the City.

No value judgement has been made on which options are more environmentally sound or least costly, or favoured for any other reason. The main Issues and Options Scoping Report presents a large number of options for consideration, and the aim in this Summary Report is to present a lesser range of options which reflects the variety and scale discussed in the main report.

8.1 EXPLANATION OF ESTIMATED COSTS

Costs are all stated in millions of dollars ($M), exclusive of GST, and are preliminary cost estimates only based on present day costs. **In this respect any figures within 5% of each other should be considered the "same" and those within 10% of each other should be considered "similar".**

Capital Cost is money expended to build the system.

Annual Operating and Maintenance (O&M) Costs are the nett additional (or reduced) costs over (or below) existing operating costs required to run the treatment and disposal schemes.

Capitalised O&M Costs is the above defined estimated O&M total represented in present day values (so it can be added to the capital cost) for 25 years of scheme operation assuming a 6% difference between interest rates and inflation. The inclusion of this in total costs allows more meaningful comparison to be made across the range of low capital/high O&M schemes and high capital/low O&M schemes.

Total Cost is the total of the capital and the capitalised O&M costs.

8.2 HARBOUR BASIN (HB)

There are 11 options presented in the main report for the harbour basin. They range from the simplest of upgrading the four treatment plants and moving the Company Bay discharge to Grassy Point, as well as a new outfall for Port Chalmers; to more fundamental changes such as shifting all the discharges out of the harbour to either land disposal at Okia Flat or into the Musselburgh catchment.

There are a large number of "intracatchment" transfer pipelines possible in the harbour basin and it is there that much of the capital expenditure lies.

One of the rationalisations made in setting out the options was that if uv disinfection of harbour discharges was required or adopted in principle then it would apply to all such discharges, not just a single plant or two.

The following 5 options are a selection of those that show the full range of estimated costs, and also includes those used in representative total schemes presented in Section 9.0 below.

Option HB1a

- Upgrade all 4 treatment plants to ensure more consistent performance.
- Link Company Bay discharge to Grassy Point outfall and provide new Port Chalmers outfall

Key Environmental Features

- Improves harbour water quality in general by consistently higher quality effluent.
- Removes localised pollution problems in Sawyers Bay and Company Bay areas
- Does not significantly reduce nutrient load to harbour in total, but discharges effluent into better flushed areas.
- Retains existing four sewage treatment plants with associated environmental impacts.

Cost Estimates		$M
Capital		3.69
O & M pa	0.12	
Capitalised O&M		1.59
TOTAL		5.28

Option HB1b

- as per Option HB1a with uv disinfection on all discharges

Key Environmental Features

- Improves harbour water quality by consistently higher quality effluent.
- Removes localised pollution problems in Sawyers Bay and Company Bay areas
- Does not significantly reduce nutrient load to harbour in total, but discharges effluent into better flushed areas.
- Retains existing four sewage treatment

plants with associated environmental impacts.

- Provides significantly reduced bacteriological and pathogen load to harbour

Cost Estimates		$M
Capital		3.89
O & M pa	0.15	
Capitalised O&M		1.94
TOTAL		5.83

Option HB4

- Burkes wastewater conveyed back to Musselburgh catchment.
- Other three plants remain,with land disposal at Okia Flat on the Peninsula

Key Environmental Features

- Removes all four treated wastewater discharges from the harbour basin.
- Decommission Burkes plant with associated local environmental improvements.
- Land disposal impacts associated with use of Okia Flat (full environmental impact investigation needed to provide scheme acceptance)

Cost Estimates		$M
Capital		11.9
O & M pa	0.20	
Capitalised O&M		2.52
TOTAL (rounded)		14.4

Options HB5

- Conveys all wastewater to Musselburgh Catchment and decommission the existing four plants.

Key Environmental Features

- Removes all four discharges from the harbour basin.
- Decommission the four treatment plants with associated local environmental improvements.
- Raises questions of conveyance pipeline risks and reliability in the harbour bed itself in scheme HB5b (the lower cost one) compared to HB5a which has all pipelines in road and rail reserves.

Sub-Option HB5a

- By pipelines in roads/rail reserves.

NOTE : The additional treatment capacity for the Musselburgh Catchment is not allowed for in these estimates but is included in the total representative schemes.

Cost Estimates		$M
Capital		13.5
O & M pa	(0.24)	
Capitalised O&M		(3.11)
TOTAL (rounded)		10.4

Sub-Option HB5b

- By pipelines partly in harbour.

NOTE: As for HB5a above.

Cost Estimates		$M
Capital		9.23
O & M pa	(0.28)	
Capitalised O&M		(3.63)
TOTAL		5.60

Note: this sub-option is used in total representative schemes involving the HB5 option.

Note: ( ) indicated a negative value, ie, a credit

8.3 MUSSELBURGH CATCHMENT (MC)

There are 20 options presented in the detailed Stage 1 report for this, the largest of the four major catchments. In contrast to the Harbour Basin, the main question here is not the intracatchment transfers but the different degrees of treatment, the two possible treatment plants sites (Tahuna and Southdale Road) and three potential coastal discharge locations (Tahuna, Maori Head and Lawyers Head).

Amongst this range of alternatives, a large number of combinations can be developed. Some perhaps do not make a lot of sense but they are, nonetheless, technically feasible by definition, although ultimately none is carried forward to a representative total scheme.

The following 12 options are a selection of those that show the full range of estimated costs, range of treatment standards and outfall locations and lengths, and also includes those used in representative total schemes presented in section 9.0 below. All options include appropriate upgrading of the Musselburgh Pumping Station.

Those options and representative total schemes adopting a Maori Head ocean outfall, and also a Southdale Road treatment plant site, provide a range of staging options that could have particular advantage from a financing and implementation stand point. This combination also gives good future flexibility.

Option MC1a

- Upgrade Tahuna to full primary treatment.
- Discharge remaining at Lawyers Head (denoted **marginal** in representative total schemes).

Key Environmental Features

- Some improvement at beaches around Lawyers Head particularly with grease lines and solids, but not of bacteriological/pathogen levels.
- Disadvantages of continued use of Lawyers Head discharge point as some shoreline and beaches will continue to contain some proportions of treated effluent.
- Totally relies on treatment plant performance to maintain sea water standards.
- Uses upgraded Tahuna treatment plant with associated siting considerations.

Cost Estimates		$M
Capital		10.0
O & M pa	0.80	
Capitalised O&M		10.2
TOTAL		20.2

Option MC1d

- Upgrade Tahuna to secondary treatment and uv disinfection.
- Discharge remaining at Lawyers Head

Key Environmental Features

- Significant improvement of water quality around Lawyers Head and associated beaches, including bacteriological/pathogenquality,meeting bathing standards.
- Question of perception of use of Lawyers Head even for a disinfected secondary effluent. Sea water at adjacent shoreline and beaches will still have same proportion of effluent but of a much higher standard.
- No shoreline separation of the discharge.
- Totally relies on treatment plant performance to maintain sea water quality standards.
- Uses extensively upgraded Tahuna treatment plant with associated siting considerations. Need to handle greater amounts of sludge and other residual byproducts.

Cost Estimates		$M
Capital		44.0
O & M pa	2.5	
Capitalised O&M		32.0
TOTAL		76.0

Option MC1e

- Upgrade Tahuna to tertiary treatment, including disinfection.
- Discharge remaining at Lawyers Head.

Key Environmental Features

- Greater improvement again over MC1d with tertiary effluent, therefore beaches and shoreline very well protected.
- Probably lesser concern with aesthetics of using existing Lawyers Head outfall, but nearby shoreline and beaches will still contain some proportions of treated effluent as for MC1a and MC1e.
- No shoreline separation of the discharge.
- Totally relies on treatment plant performance to maintain sea water quality standards.
- Tahuna treatment plant site retained with even more extensive upgrading than for MC1d and also even greater sludge production than for MC1d above.

Cost Estimates		$M
Capital		109
O & M pa	5.5	
Capitalised O&M		70.3
TOTAL (rounded)		**179**

Option MC2a

- Upgrade Tahuna to full primary plant
- New 1,600m ocean outfall off Tahuna

Key Environmental Features

- Significant improvement of water quality at shoreline and on beaches, should meet bathing standards at beaches.
- Potential for movement of full primary treated effluent further afield from ocean discharge zone.
- Good shoreline separation (1600 m)
- Effluent discharge field should barely be visible from air.
- Uses an upgraded Tahuna treatment plant with associated siting considerations as for MC1a.
- Less reliance on treatment plant performance for maintenance of sea water quality at shoreline through buffering effect of separation distance.

Cost Estimates		$M
Capital		40.4
O & M pa	1.05	
Capitalised O&M		13.4
TOTAL		**53.8**

Option MC2c

- Upgrade Tahuna to secondary treatment
- New 1,100m ocean outfall off Tahuna

Key Environmental Features

- Significant improvement in sea water quality at shoreline over scheme MC2a. Will meet bathing standards at all beaches.
- Little likelihood of environmental effects beyond immediate effluent discharge mixing zone in the ocean.
- Adequate shoreline separation (1100 m)
- As for MC1d with extensively upgraded Tahuna treatment plant with associated siting considerations including greater amounts of sludge and other residuals byproducts.
- Still has a reasonable degree of reliance on treatment plant performance to maintain shoreline water quality.

Cost Estimates		$M
Capital		63.1
O & M pa	2.45	
Capitalised O&M		31.3
TOTAL		**94.4**

Option MC3a

- Upgrade Tahuna to full primary
- New 1,100m ocean outfall off Maori Head

Key Environmental Features

- Generally all as for MC2a but with greater distance from main Dunedin beaches, therefore meeting bathing standards.
- Investigations needed to ensure no adverse ecological effects of effluent field moving up coast as will occur for most of time.
- Good shoreline separation of effluent discharge location.

Cost Estimates		$M
Capital		42.4
O & M pa	1.18	
Capitalised O&M		15.1
TOTAL		57.5

Option MC3d

- Upgrade Tahuna to secondary treatment and uv disinfection
- New 1,100m ocean outfall off Maori Head

Key Environmental Features

- Generally all as for MC2c as far as Tahuna plant upgrade is concerned, and discharge of secondary treated effluent into the ocean - but added advantages of:
  - disinfected secondary effluent giving bacteriological and pathogen protection.
  - Maori Head outfall more distant from main Dunedin beaches
  - good shoreline separation of effluent discharge location.

Cost Estimates		$M
Capital		76.4
O & M pa	2.88	
Capitalised O&M		36.8
TOTAL (rounded)		113

Option MC3e

- Upgrade Tahuna to tertiary treatment, including disinfection
- New 1,100m ocean outfall off Maori Head

Key Environmental Features

- Most unlikely to be any measurable environmental effects on sea water quality or environmental values associated with effluent discharge.
- An extremely high effluent quality coupled with ocean outfall.
- Tahuna site extensively upgraded and large amounts of sludge and other residuals to be dealt with, all with plant siting considerations as per scheme MC1e.

Cost Estimates		$M
Capital		141.4
O & M pa	5.88	
Capitalised O&M		75.2
TOTAL (rounded)		217

Option MC4a

- New Southdale Road secondary treatment plant
- New 1,100m ocean outfall off Maori Head

Key Environmental Features

- All disposal impacts of a secondary effluent out the 1100 m Maori Head outfall the same as MC3d above.
- Environmental considerations associated with establishing a new treatment plant site and associated residuals management at a Southdale Road site.

- Decommissions existing Tahuna plant.

Cost Estimates		$M
Capital		78.5
O & M pa	1.45	
Capitalised O&M		18.5
TOTAL (rounded)		**97.0**

Option MC4b

- As for MC4a with uv disinfection

Key Environmental Features

- All disposal impacts of a secondary effluent out the 1100 m Maori Head outfall the same as MC3d above.
- Environmental considerations associated with establishing a new treatment plant site and associated residuals management at a Southdale Road site.
- Decommissions existing Tahuna plant.
- Less impacts on receiving sea water because of disinfection of effluent resulting in less bacteriological/pathogen impact on the receiving sea water.

Cost Estimates		$M
Capital		81.50
O & M pa	1.85	
Capitalised O&M		23.6
TOTAL (rounded)		**105**

Option MC4c

- Retain Tahuna as is, with some upgrade, and pipe to .....
- ... New Southdale Road secondary stage treatment plant
- New 1,100m ocean outfall of Maori Head

Key Environmental Features

- Same general low level of environmental impacts of secondary treated effluent discharge as for schemes MC4a.
- Retain use of Tahuna Plant for primary treatment and associated siting considerations.
- Environmental considerations associated with establishing a new treatment plant site and associated residuals management at Southdale Road.

Cost Estimates		$M
Capital		74.4
O & M pa	2.35	
Capitalised O&M		30.0
TOTAL (rounded)		**104**

Option MC4d

- As for MC4c with uv disinfection at the Southdale Road secondary treatment stage

Key Environmental Features

- Same general low level of environmental impacts of secondary treated effluent discharge as for schemes MC4a with:
  - less impacts on receiving sea water because of disinfection of effluent resulting in less bacteriological/pathogen impact on sea water.
- Retain use of Tahuna Plant for primary treatment and associated siting considerations.
- Environmental considerations associated with establishing a new treatment plant site and associated residuals management at Southdale Road.

Cost Estimates		$M
Capital		77.4
O & M pa	2.65	
Capitalised O&M		33.9
TOTAL (rounded)		**111**

8.4 GREEN ISLAND CATCHMENT (GIC)

There are 12 options presented for this catchment, much less than for Musselburgh catchment because the main emphasis here is on the degree of treatment and, to a lesser extent, the need to increase the length of the existing outfall (a 600m extension is included in the options). There are no alternative treatment plant nor outfall locations considered.

There is a range of options for both advanced primary and secondary treatment processes, which are introduced in Part 7.4 above and more fully elaborated on in the detailed Stage 1 Scoping Report.

The following 7 options are a selection of those that show the full range of estimated costs, range of treatment standards and the two coastal outfall lengths of existing (at 500 m) and an extension of 600 m to give a total of 1100 m.

These estimated costs all exclude further treatment of Fortex's trade waste discharge, the detailed report discusses this.

Option GIC1a

- Upgrade existing plant to advanced primary treatment using floatation/ sedimentation
- Use existing coastal outfall

Key Environmental Features

- Improvement of ocean and shoreline water quality, in particular with regard to grease and solids.
- Little improvement in discolouration effects of discharge when viewed from air.
- Provides limited shoreline separation.
- Retains existing but upgraded Green Island treatment plant with associated environmental considerations.

Cost Estimates		$M
Capital		2.0
O & M pa	0.55	
Capitalised O&M		7.03
TOTAL		9.03

Option GIC1b

- Upgrade existing plant to advanced primary using dissolved air floatation (DAF)
- Use existing coastal outfall

Key Environmental Features

- As for GIC1a but with higher grease and solids removal, therefore further improvement in ocean and shoreline water quality.

Cost Estimates		$M
Capital		3.8
O & M pa	0.75	
Capitalised O&M		9.59
TOTAL (rounded)		13.4

Option GIC1c

- Upgrade existing plant to advanced primary treatment plant with some disinfection by high lime process
- Use existing coastal outfall

Key Environmental Features

- Improvement of ocean and shoreline water quality, in particular with regard to grease and solids.
- Little improvement in discolouration effects of discharge when viewed from air.
- Provides adequate shoreline separation.
- Retains existing but upgraded Green Island treatment plant with associated environmental impacts.
- Reduction in numbers of bacteria discharged to environment, with related improvement to water quality (depending on degree of disinfection)

Cost Estimates		$M
Capital		3.0
O & M pa	0.75	
Capitalised O&M		9.59
TOTAL (rounded)		12.6

Option GIC1d

- Upgrade existing plant to secondary treatment by anaerobic contact plus aerobic stages and including uv disinfection
- Use existing coastal outfall

Key Environmental Features

- Significant improvement to ocean shoreline water quality including lower bacteriological and pathogen levels through disinfection.
- Significant degree of protection of environmental values (including aesthetics).

Cost Estimates		$M
Capital		7.6
O & M pa	0.75	
Capitalised O&M		9.59
TOTAL (rounded)		17.2

Option GIC2a

- As for Option GIC1a with 600 m extension to the existing coastal outfall.

Key Environmental Features

- More significant improvement over GIC1a but with same treatment plant considerations.
- Much longer shoreline separation than presently.
- Potential for contamination of waters around Green Island requires detailed investigation.
- Same treatment plant impacts as GIC1a.

Cost Estimates		$M
Capital		9.80
O & M pa	0.55	
Capitalised O&M		7.03
TOTAL (rounded)		16.8

Option GIC2c

As for Option GIC1c with 600 m extension to the existing coastal outfall.

Key Environmental Issues

- Greater improvement in ocean and shoreline water quality compared with GIC1c.
- Potential for some contamination of waters around Green Island, dependent on degree of disinfection required detailed investigation.
- Much longer shoreline separation than presently.
- Same treatment plant considerations as GIC1c.

Cost Estimates		$M
Capital		10.8
O & M pa	0.75	
Capitalised O&M		9.59
TOTAL (rounded)		20.4

Option GIC2d

As for Option GIC1d with 600 m extension to the existing coastal outfall.

Key Environmental Issues

- Substantial improvement of shoreline water quality
- Significantly greater protection of environmental values (including aesthetics)
- Much longer shoreline separation than present.
- Same treatment plant and increase sludge production impacts as for GIC1d.

Cost Estimates		$M
Capital		15.4
O & M pa	0.75	
Capitalised O&M		9.59
TOTAL (rounded)		25.0

8.5 MOSGIEL/TAIERI CATCHMENT (MTC)

This Stage 1 study brief has not required options to be investigated for upgrading the Mosgiel discharge into the Taieri River, or alternative disposal means for this catchment alone. A separate study is addressing this. This study has however considered conveying all wastewater out of this catchment to the adjoining Green Island catchment or beyond.

The option reviewed therefore is conveyance of all wastewater to the Green Island catchment. This is denoted as scheme MTC1. The estimated costs are:

Key Environmental Issues

- Removal of effluent from Taieri River, with associated improvement in all aspects of environmental impact.
- Decommissioning of all, or part, of the existing Mosgiel treatment plant with consequent removal of all or some site impacts.

Cost Estimates		**$M**
Capital		5.56
O & M pa	(0.233)	
Capitalised O&M		(2.98)
TOTAL		2.58

Further consideration of partial conveyance to GIC, for example dry weather flow only and leaving the balance of wet weather flows to be intermittently treated and otherwise disposed of into the Taieri River or elsewhere, has not been evaluated at this stage as policy decisions would be required.

8.6 LAND DISPOSAL

Whilst not a "catchment" option, it is appropriate to separately identify the option of conveying all Dunedin wastewater (including that from Mosgiel) and pumping it to a single treatment facility and land disposal site south of Brighton. This option is presented in Section 9 below, as Scheme 1/II.

Similarly, the option of conveying treated effluent from the 3 major harbour basin plants (not Burkes) to a land disposal site at Okia Flat is identified in Section 8.2 above (Option HB4).

Land disposal and land treatment including other options, is discussed in detail in the main report.

9.0 REPRESENTATIVE TOTAL SCHEMES

The catchment options presented above in Section 8 are all for a single catchment and are therefore essentially Concept Level 4 options, because each catchment has its own treatment and disposal system. Some options, particularly a number of the Musselburgh ones, can be enlarged in size to accept wastewater from other catchments for some of the concept level 3, 2 and 1 representative total schemes.

In order to develop the range of concept levels 3, 2 and 1 combinations, transfers of flows between catchments must occur.

In this section various catchment options are combined to form some 17 representative total schemes. The philosophy and mechanism of combining these has been to group them on as common a basis as possible. Such bases include for example using all primary or advanced primary treatment plants with long coastal outfalls, or all secondary plants and adequate shoreline separation, or high quality effluent discharged at the shoreline, or a single land disposal scheme for all four catchments, and so on.

It must be fully appreciated however that there are many more ways in which the various catchment options can be grouped to give representative total schemes. Furthermore there are also a number of staging options available where one scheme may be implemented in some cases for example by moving from one concept level to another, and also one representative total scheme to another. The staging options are introduced in the detailed report and will be further developed for the shortlisted catchment options and schemes in the Stage 2 investigations.

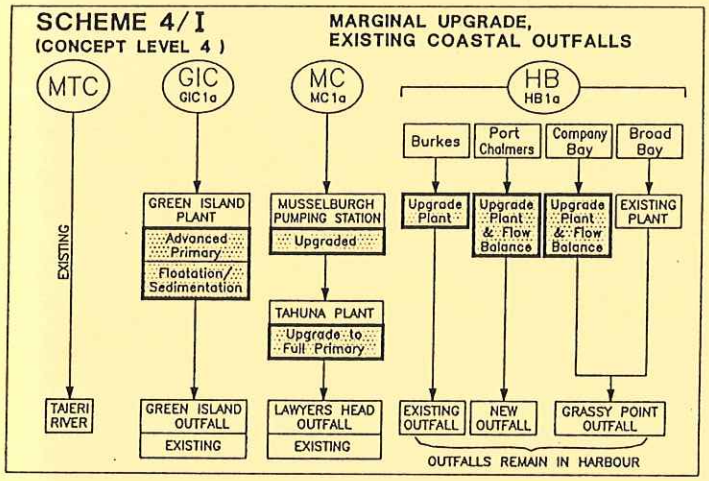
The following summarises the representative total scheme components and the estimated costs. The detailed Stage 1 report further breaks down these estimated costs on a

catchment basis, and also gives the pro-rata amounts that can be attributed to the trade waste discharges. These range from 5% to 40% of the capital and operating costs of some schemes; being highest for the schemes with high levels of treatment and lowest for schemes which are substantially conveyance and disposal only.

The estimated costs given exclude for the further treatment of Fortex's trade waste. This is discussed in the detailed report.

REPRESENTATIVE TOTAL SCHEMES

CONCEPT LEVEL 4 (4 OUTPUTS) - SCHEMES 4/I TO 4/VII

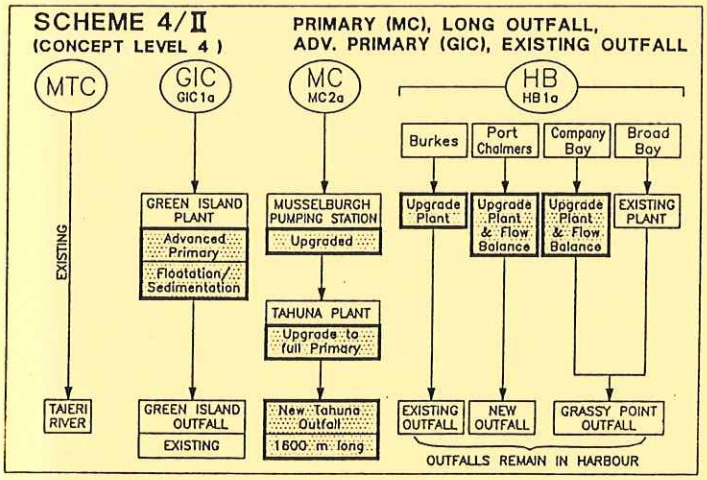


Scheme 4/I

Key Environmental Issues

Combination of those for catchment options Harbour Basin HB1a page 14, Musselburgh Catchment MC1a page 16, Green Island Catchment GIC1a page 20, with Mosgiel remaining as existing.

		Cost Estimate $M
Capital Cost		
- Conveyance	1.69	
- Treatment	13.7	
- Disposal	0.35	
Total Capital (rounded)		15.7
O&M pa	1.47	
Capitalised O&M		18.8
TOTAL		34.5

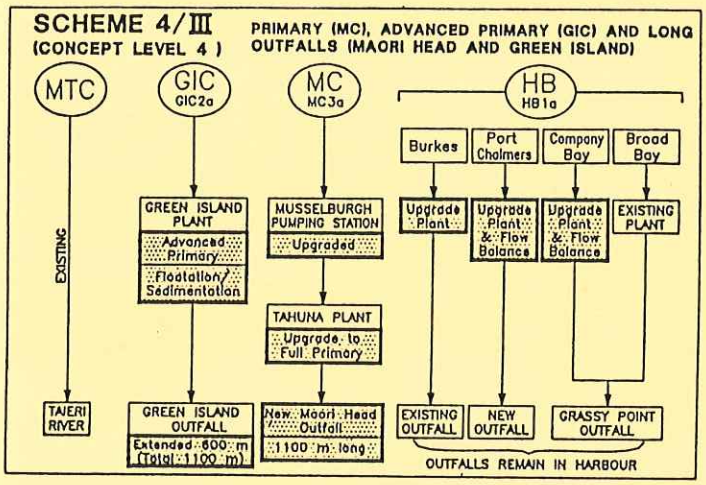


Scheme 4/II

Key Environmental Issues

Combination of those for catchment options Harbour Basin HB1a page 14, Musselburgh Catchment MC2a page 17, Green Island Catchment GIC1a page 20, with Mosgiel remaining as existing.

		Cost Estimate $M
Capital Cost		
- Conveyance	5.59	
- Treatment	13.7	
- Disposal	26.9	
Total Capital (rounded)		46.2
O&M pa	1.72	
Capitalised O&M		22.0
TOTAL		68.2

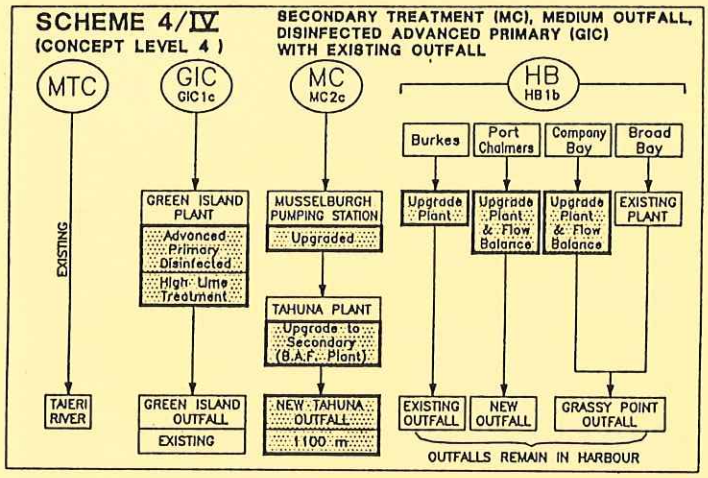


Scheme 4/III

Key Environmental Features

Combination of those for catchment options Harbour Basin HB1a page 14, Musselburgh Catchment MC3a page 18, Green Island Catchment GIC2a page 21, with Mosgiel remaining as existing.

		Cost Estimate $M
Capital Cost		
- Conveyance	15.9	
- Treatment	13.7	
- Disposal	26.4	
Total Capital (rounded)		56.0
O&M pa	1.85	
Capitalised O&M		23.7
TOTAL		79.7

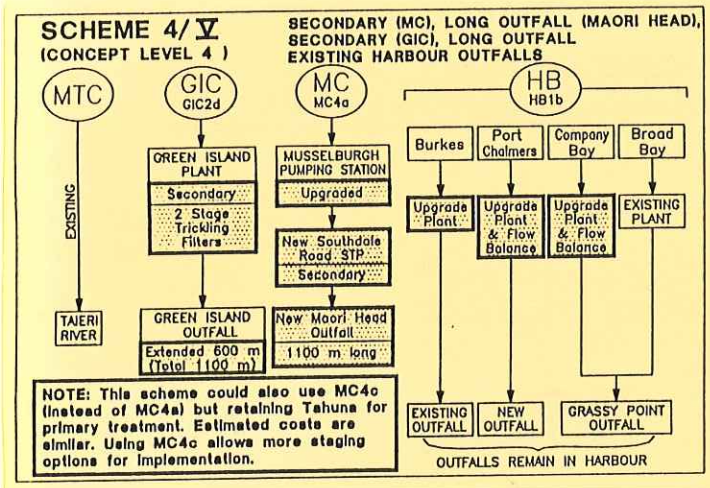


Scheme 4/IV

Key Environmental Features

Combination of those for catchment options Harbour Basin HB1b page 14, Musselburgh Catchment MC2c page 17, Green Island Catchment GIC1c page 20, with Mosgiel remaining as existing.

		Cost Estimate $M
Capital Cost		
- Conveyance	5.59	
- Treatment	45.9	
- Disposal	18.6	
Total Capital (rounded)		70.1
O&M pa	3.32	
Capitalised O&M		42.8
TOTAL (rounded)		113

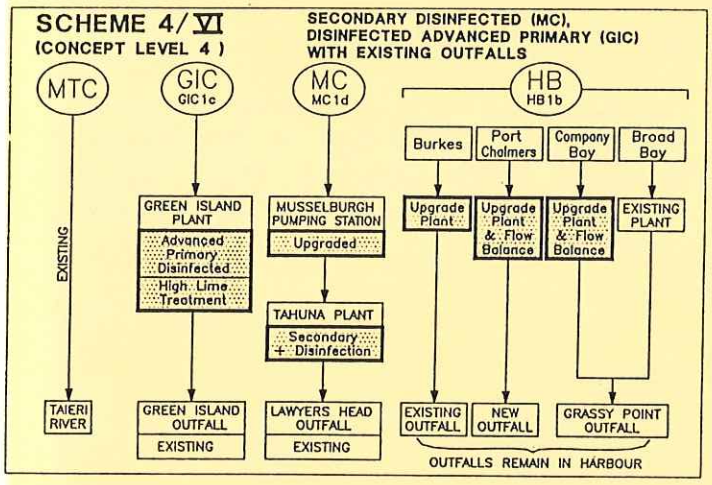


Scheme 4/V

Key Environmental Features

Combination of those for catchment options Harbour Basin HB1b page 14, Musselburgh Catchment MC4a page 18, Green Island Catchment GIC2d page 21, with Mosgiel remaining as existing.

		Cost Estimate $M
Capital Cost		
- Conveyance	20.0	
- Treatment	51.5	
- Disposal	26.4	
Total Capital (rounded)		97.9
O&M pa	2.35	
Capitalised O&M		30.0
TOTAL (rounded)		128

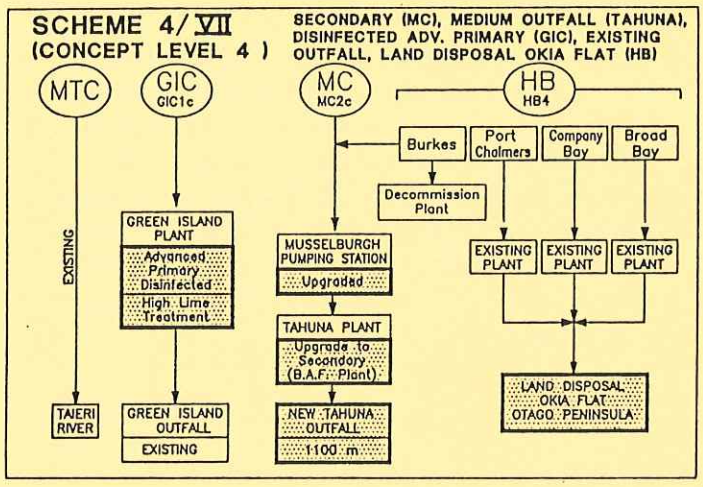


Scheme 4/VI

Key Environmental Features

Combination of those for catchment options Harbour Basin HB1b page 14, Musselburgh Catchment MC1d page 16, Green Island Catchment GIC1c page 20, with Mosgiel remaining as existing.

		Cost Estimate $M
Capital Cost		
- Conveyance	1.69	
- Treatment	48.9	
- Disposal	0.35	
Total Capital (rounded)		50.9
O&M pa	3.40	
Capitalised O&M		43.5
TOTAL		94.4



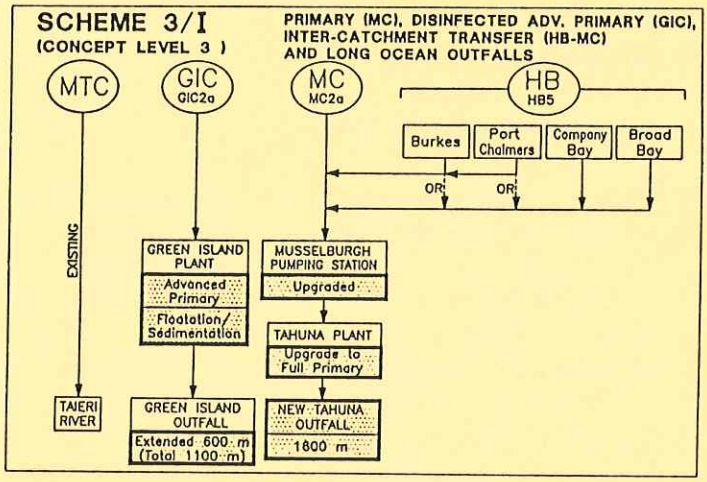
Scheme 4/VII

Key Environmental Features

Combination of those for catchment options Harbour Basin HB4 page 15, Musselburgh Catchment MC2c page 17, Green Island Catchment GIC1c page 20, with Mosgiel remaining as existing.

		Cost Estimate $M
Capital Cost		
- Conveyance	15.0	
- Treatment	44.0	
- Disposal	19.0	
Total Capital		78.0
O&M pa	3.40	
Capitalised O&M		43.4
TOTAL (rounded)		121

CONCEPT LEVEL 3 (3 OUTPUTS) - SCHEMES 3/I TO 3/IV

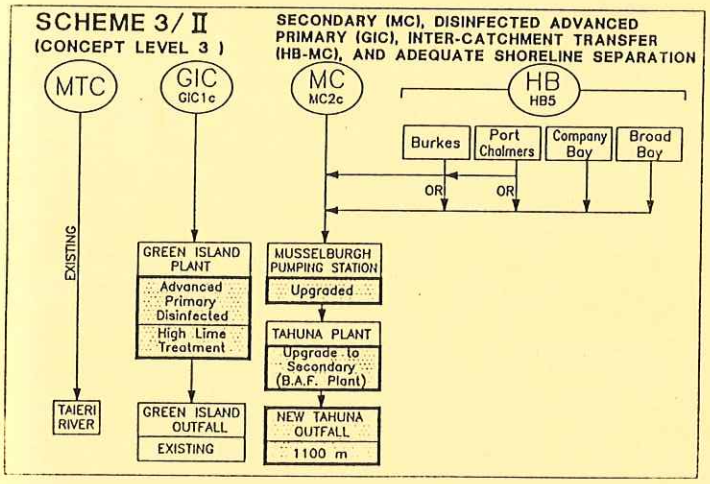


Scheme 3/I

Key Environmental Features

Combination of those for catchment options as follows but with the intercatchment transfers, discharges and treatment requirements correspondingly larger than the base catchment option: Harbour Basin HB5b page 15, (sewage effluent discharges removed from harbour), Musselburgh Catchment MC2a page 17, Green Island catchment GIC2a page 21, with Mosgiel remaining as is.

		Cost Estimate $M
Capital Cost		
- Conveyance	13.1	
- Treatment	12.5	
- Disposal	34.3	
Total Capital		59.9
O&M pa	1.37	
Capitalised O&M		17.4
TOTAL		77.3

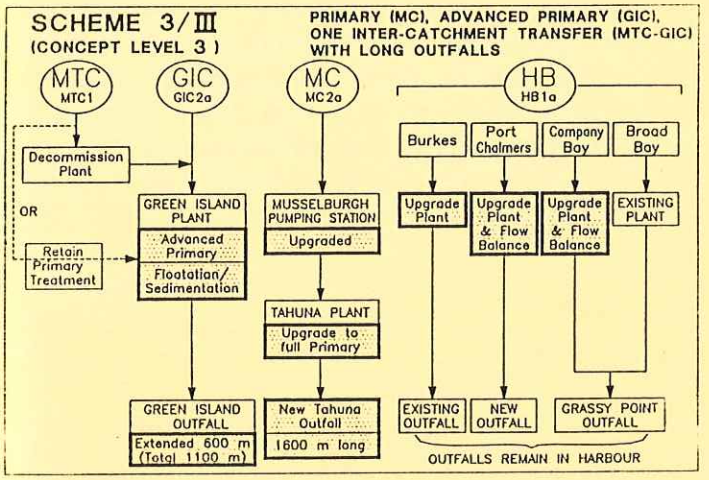


Scheme 3/II

Key Environmental Features

Combination of those for catchment options as follows but with the intercatchment transfers, discharges and treatment requirements corresponding larger than the base catchment option: Harbour Basin HB5b page 15, (sewage effluent discharges removed from harbour), Musselburgh Catchment MC2c page 17, Green Island catchment GIC1c page 20, with Mosgiel remaining as is.

		Cost Estimate $M
Capital Cost		
- Conveyance	13.1	
- Treatment	44.8	
- Disposal	18.2	
Total Capital		76.1
O&M pa	3.02	
Capitalised O&M		38.6
TOTAL (rounded)		**115**

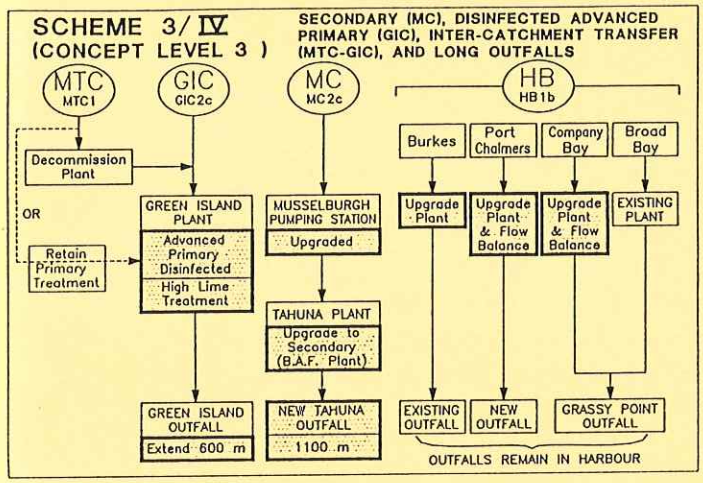


Scheme 3/III

Key Environmental Features

Combination of those for catchment options as follows but with the intercatchment transfers, discharges and treatment requirements corresponding larger than the base catchment option: Harbour Basin HB1a page 14, Musselburgh Catchment MC2a page 17, Green Island catchment GIC2a page 21, Mosgiel/Taieri Catchment (MTC1) with removal of effluent discharge to Taieri River.

		Cost Estimate $M
Capital Cost		
- Conveyance	11.2	
- Treatment	16.4	
- Disposal	34.6	
Total Capital		62.2
O&M pa	1.99	
Capitalised O&M		25.5
TOTAL		**87.7**



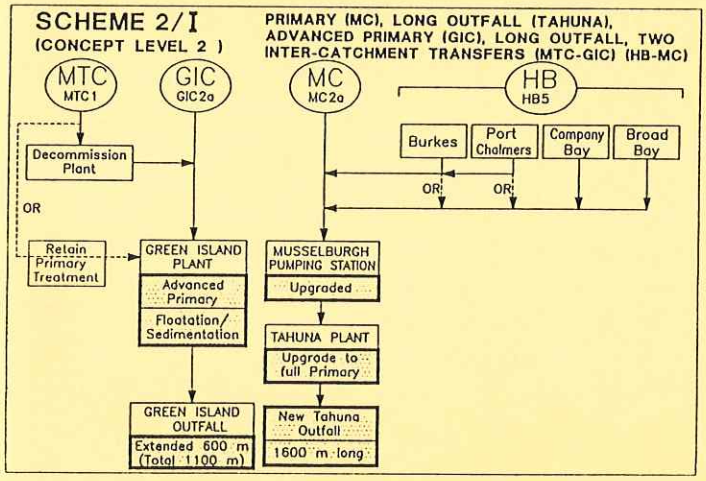
Scheme 3/IV

Key Environmental Features

Combination of those for catchment options as follows but with the intercatchment transfers, discharges and treatment requirements corresponding larger than the base catchment option: Harbour Basin HB1b page 14, Musselburgh Catchment MC2c page 17, Green Island catchment GIC2c page 21, Mosgiel/Taieri Catchment (MTC1) with removal of effluent discharge to Taieri River.

		Cost Estimate $M
Capital Cost		
- Conveyance	11.2	
- Treatment	47.9	
- Disposal	26.4	
Total Capital		85.5
O&M pa	3.72	
Capitalised O&M		47.5
TOTAL		**133**

CONCEPT LEVEL 2 (2 OUTPUTS) - SCHEMES 2/I TO 2/IV

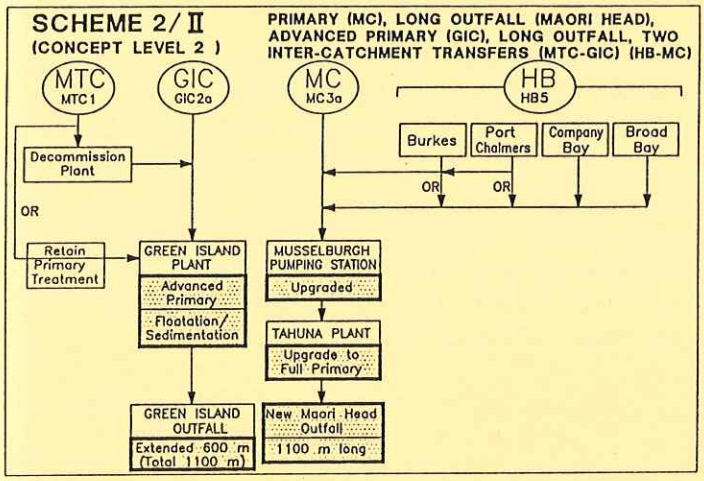


Scheme 2/I

Key Environmental Features

Combination of those for catchment options as follows, but with the intercatchment transfers, discharge and treatment requirements correspondingly larger than the base catchment options for the Musselburgh and Green Island Catchments. Removal of Harbour Basin discharge (HB5b page 15) and Mosgiel/Taieri River discharge (MTC1 page 22) with Musselburgh Catchment MC2a page 17 and Green Island Catchment GIC2a page 21.

		Cost Estimate $M
Capital Cost		
- Conveyance	18.7	
- Treatment	14.2	
- Disposal	34.3	
Total Capital		67.2
O&M pa	1.64	
Capitalised O&M		20.8
TOTAL (rounded)		**88.0**



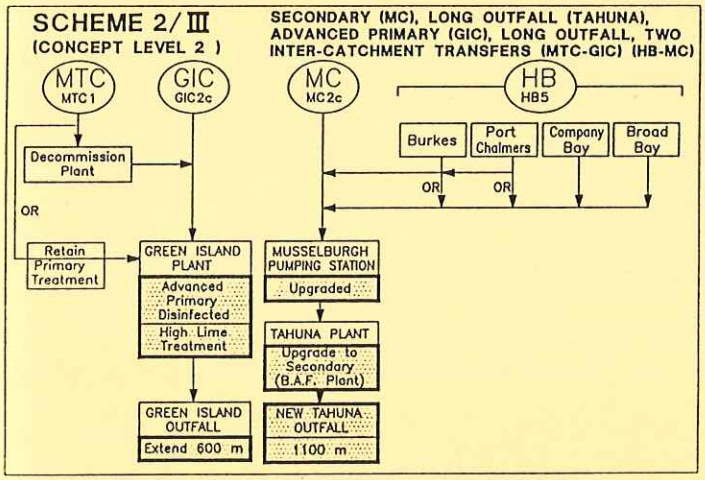
Scheme 2/II

Key Environmental Features

Combination of those for catchment options as follows, but with the intercatchment transfers, discharge and treatment requirements correspondingly larger than the base catchment options for the Musselburgh and Green Island Catchments. Removal of Harbour Basin discharge (HB5b page 15) and Mosgiel/Taieri River discharge (MTC1 page 22) with Musselburgh Catchment MC3a page 18 and Green Island Catchment GIC2a page 21.

Cost Estimate $M

Capital Cost		
- Conveyance	29.1	
- Treatment	14.2	
- Disposal	26.0	
Total Capital		69.3
O&M pa	1.77	
Capitalised O&M		22.5
TOTAL		**91.8**



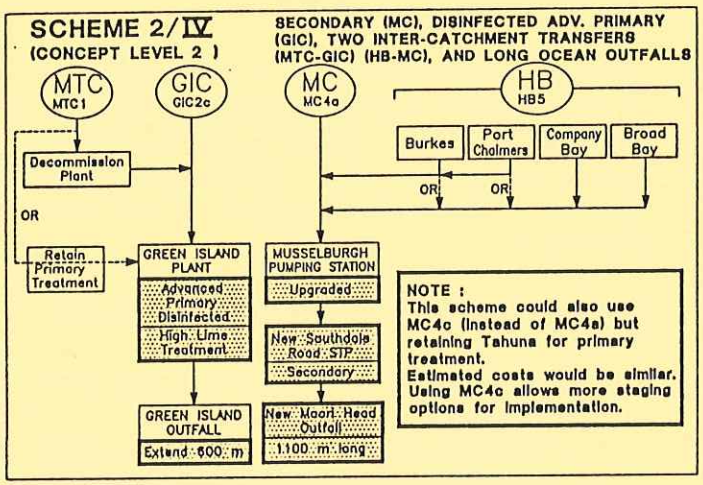
Scheme 2/III

Key Environmental Features

Combination of those for catchment options as follows but with the intercatchment transfers, discharge and treatment requirements correspondingly larger than the base catchment options for the Musselburgh and Green Island Catchments. Removal of Harbour Basin discharge (HB5b page 15) and Mosgiel/Taieri River discharge (MTC1 page 22) with Musselburgh Catchment MC2c page 17 and Green Island Catchment GIC2c page 21.

Cost Estimate $M

Capital Cost		
- Conveyance	18.7	
- Treatment	46.8	
- Disposal	26.0	
Total Capital		91.5
O&M pa	3.39	
Capitalised O&M		43.3
TOTAL (rounded)		**135**



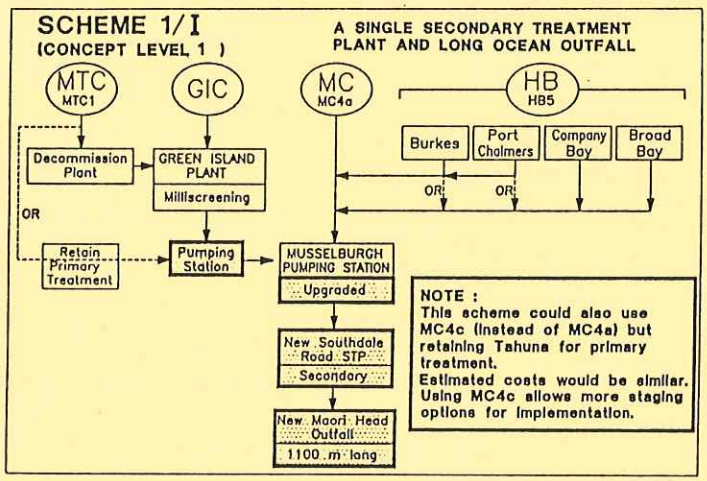
Scheme 2/IV

Key Environmental Features

Combination of those for catchment options as follows but with the intercatchment transfers, discharge and treatment requirements correspondingly larger than the base catchment options for the Musselburgh and Green Island Catchments. Removal of Harbour Basin discharge (HB5b page 15) and Mosgiel/Taieri River discharge (MTC1 page 22) with Musselburgh Catchment MC4a page 18 and Green Island Catchment GIC2c page 21.

	Cost Estimate $M	
Capital Cost		
- Conveyance	33.1	
- Treatment	47.5	
- Disposal	26.0	
Total Capital		107
O&M pa	2.34	
Capitalised O&M		29.9
TOTAL (rounded)		137

CONCEPT LEVEL 1 (1 OUTPUT) - SCHEMES 1/I AND 1/II

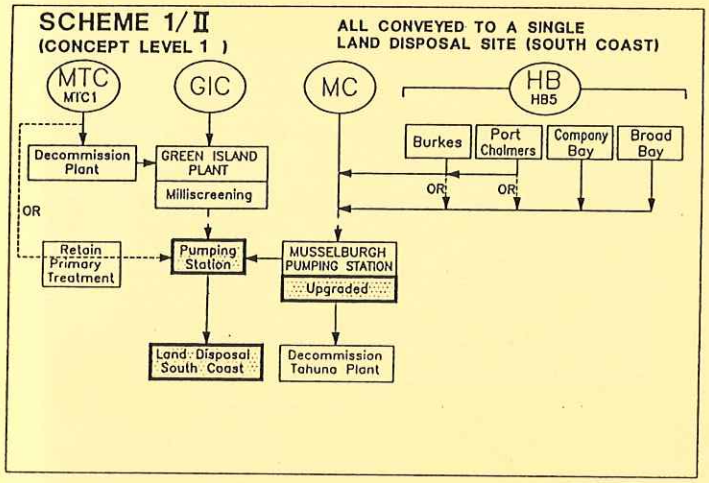


Scheme 1/1

Key Environmental Features

Removes discharge of treated effluent from harbour basin (option HB5b page 15) Mosgiel discharge to Taieri River (option MTC1 page 22), Green Island catchment discharge to ocean off Waldronville Beach. Has one secondary treatment plant at Southdale Road and one ocean outfall off Maori Head option MC4a - refer page 18 for features.

	Cost Estimate $M	
Capital Cost		
- Conveyance	55.4	
- Treatment	58.0	
- Disposal	22.2	
Total Capital (rounded)		136
O&M pa	3.33	
Capitalised O&M		44.0
TOTAL (rounded)		180



Scheme 1/II

Key Environmental Features

Removes all direct discharges of treated effluent to natural water, namely the Harbour Basin, the Taieri River and the Musselburgh and Green Island Catchment ocean discharges. This removes environmental impacts of all such discharges.

Impacts of a large land disposal system namely

- some restrictions on access to the land at times
- effluent seepage and possibly runoff considerations as only 10 to 20% of the effluent is actually lost by the land disposal process; the rest finds its way to underground and surface natural waters.
- any land ownership impact
- impacts of siting of treatment facilities in the land disposal area, and disposal of sludges

		Cost Estimate $M
Capital Cost		
- Conveyance	109	
- Treatment	58	
- Disposal	98	
Total Capital		265
O&M pa	7.79	
Capitalised O&M		99.6
TOTAL (rounded)		**365**

This information and cost data are summarised on page 35.

10.0 EVALUATION AND DECISION PROCESS

The selection of the most appropriate overall wastewater treatment and disposal schemes for the greater Dunedin area is one of the most important decisions the Dunedin City Council will ever have to make. There are long term consequences of the selection which will impact on all ratepayers and which will influence the future potential of the area. The scheme options selected will have a major influence on:

- use of natural waters and possibly land
- the enhancement of the environment
- the satisfying of cultural values
- the discretionary spending ability of ratepayers
- possible effects on some industries
- town and country planning

Because these influences are significant and long term in nature, Council is most aware that it is essential that it not only chooses the best practicable option, but is also able to demonstrate that it has done that to the satisfaction of both its ratepayers and those charged with overseeing such decisions in the interest of the general public.

Planning the decision process is no less important than planning the construction of any

scheme option. The establishment, review and approval of a process leading to option selection will give those responsible for that decision a much greater degree of security that their objectives have been met.

The Stage 1 study resulting in the Issues and Options Scoping Report is one of the first and key foundation blocks to the logical stepwise decision process Council is following.

Following the public submission phase, and Council's analysis of this input, the Stage 2 brief will be prepared. It is anticipated that a shortlisting of a limited number of catchment options and representative total schemes (as presented in the Stage 1 reports or otherwise selected) will occur.

Environmental impact assessment and approvals will be required later on, these now requiring to meet the provisions of the Resource Management Act. The Stage 2 investigations will further scope environmental impact assessment in more detail.

Implementation considerations, including project funding and staging of options, are also important matters to be advanced during Stage 2 of the study.

Also an important part of more detailed investigations into particular options are matters of operation and maintenance, performance evaluation, and risks and reliability considerations.

Information in the Issues and Options Scoping Report (and summarised here) both identifies and discusses a number of factors that will become evaluation criteria during the ongoing decision process. These criteria include:

- **legal aspects**
  eg, Resource Management Act, planning

- **the issues**
  ie, what are they? how important are they?

- **matters of principle**
  ie, is the issue a matter of general principle or the domain of a special interest group?

- **estimated costs**
  ie, what will it cost? who pays for it? can the community afford it? what about industry

- **negotiability**
  ie, can the issue be negotiated?

11.0 COUNCIL'S PROGRAMME

Key dates in the Council's programme are:

- 27 August 1991 - Council receive the Stage 1 Issues and Options Scoping Report.

- 28 August 1991 - Council make the Stage 1 Issues and Options Scoping Report and Summary Report publicly available.

  - Council invite public submissions on the Stage 1 Report.

- 19 October 1991 - End of period for public submissions to Council

- November 1991 to February 1992 - Council considers the public submissions and Stage 1 Report and defines the Stage 2 Study.

- mid February 1992 - Commencement of the Stage 2 Study.

- mid June 1992 - Completion of the Stage 2 Study.

- July 1992 - Council's deliberations and acceptance of the most appropriate total scheme, and formulation of a capital works programme accordingly.

- August 1992 - Council adopts reports and capital works budgets.

12.0 CONCLUSIONS

- The existing Dunedin wastewater treatment and disposal systems are characterised by a wide range of technologies, effluent qualities and associated environmental impacts. Furthermore they are geographically widespread.

- It is appropriate to approach the study on the basis of the four existing historic wastewater catchments, namely the Harbour Basin, Musselburgh, Green Island and Mosgiel/Taieri.

- There are a wide range of issues involved, from very localised ones to those of a city-wide and "global" perspective. It is imperative that the issues are all identified and thoroughly evaluated in relation to the treatment and disposal options, before decisions are made.

- Trade wastes, the wastewater discharge from industry, represent an important issue, particularly in the two main catchments, Musselburgh and Green Island. In addition, trade waste discharges into the Port Chalmers and Mosgiel schemes are of significance. The scoping report identifies proportions of trade waste, and discusses their treatment and disposal (and associated costs)

- The importance of appropriate management of residuals (particularly sludges and odours) is highlighted as part of the overall perspective.

- Waste minimisation and reuse of effluent and byproducts is a matter requiring further consideration during ongoing investigations.

- Community involvement, including special interest groups and statutory authorities, is a fundamental part of the decision making process.

- The investment the City already has in wastewater schemes is very substantial and options that maximise the use of existing treatment and disposal facilities are identified.

- Practicable options are available for the upgrading of treatment performance at all existing plants and sites. Tahuna, for example, offers a number of options of full primary, advanced primary, secondary and tertiary treatment.

- Further monitoring and testing of existing wastewaters is required in order to more fully quantity flows and quality, for the purposes of more detailed design and options evaluation. Some pilot plant studies particularly at Green Island would be appropriate.

- The scoping study has identified a limited number of new sites for treatment, (particulary one in Southdale Road) and also a limited number of ocean outfall locations (principally off Tahuna and Maori Head).

- Options for land disposal have been looked at on both a large and small scale. Despite the many siting restraints of hilly topography, soil types, potential instability, landuse and ownership, and environmental protection, two feasible schemes have been identified. One is for a large scheme catering for all, or part of, Dunedin's wastewater, based on coastal land south of Brighton. The other is a scheme that could accommodate harbour basin wastewater at the Okia Flat on the Peninsula.

- From over 100 technically feasible catchment options, the 40 selected for presentation in the Stage 1 scoping study cover the full range of treatment types and effluent standards as well as disposal methods and sites. They also cover the full range of estimated costs.

- From looking at individual catchments by themselves, the progression is then made to linking catchments together. Four catchments become three, three become two, and two become one, giving a commensurate number of disposal locations, or outputs.

- Grouping of various catchment options (individually or linked) leads to many

total possible schemes for the Dunedin area as a whole. In the stage 1 scoping study some 17 of these have been presented as **representative total schemes**. These have been selected in a methodical way to give some consistency in standards of wastewater treatment and methods and locations of disposal. A number of other groupings are also possible.

- Representative total schemes presented cover the estimated capital cost range from $15 million to $265 million. Additonal (or decreased) annual operating and maintenance costs and total costs are also presented together with proportions for trade waste. The comparison of estimated capital costs with total costs shows that in some instances the higher capital cost option is the lower total cost option.

- All representative total schemes, and many of the individual catchment options, provide a number of different ways scheme implementation can be staged over time, thus allowing various funding options to be also considered as well as providing future flexibility.

- In all catchment options and total representative schemes except those denoted marginal, the majority of estimated costs are for the various Musselburgh catchment upgrades.

- For a number of the representative total schemes, and others that can be formulated, the estimated costs are "similar" and this should assist decisions being made on other than costs grounds.

- Matters of affordability and funding are being separately reported on by the Dunedin City Council.

REPRESENTATIVE TOTAL SCHEMES SUMMARY TABLE

Scheme No	Description	Estimated Costs ($M)[7]				
		Capital 1	O&M pa[6] 2	Capitalised O&M[6] 3	TOTAL[8] (Rounded) 1 3 = 4	Compliance With Bathing Water Quality Standards at Shoreline[9,10]
	Concept Level 4 Schemes (4 Outputs)[4]					
4/I	Marginal upgrade-existing outfalls[1]	15.7	1.47	18.8	34.5	local exceedance
4/II	Full primary (MC) and long coastal outfall (off Tahuna), advanced primary (GIC) and existing coastal outfall (off Waldronville)[1]	46.2	1.72	22.0	68.2	MC - normal GIC - partial
4/III	Full primary (MC) and long coastal outfall (off Maori Head), advanced primary (GIC) and long coastal outfall (off Waldronville[1]	56.0	1.85	23.7	79.7	normal
4/IV	Secondary (MC)and medium outfall (off Tahuna) and disinfected advanced primary (GIC) with existing outfall (off Waldronville)[2]	70.1	3.32	42.8	113	good
4/V	Secondary (MC-Southdale Road) and long coastal outfall (off Maori Head) and secondary (GIC) and existing outfall (off Waldronville)[2]	97.9	2.35	30.0	128	MC- good GIC - normal
4/VI	Secondary disinfected (MC) Lawyers Head discharge and advanced primary disinfected (GIC) existing outfall (off Waldronville)[2]	50.9	3.40	43.5	94.4	good but no shoreline separation
4/VII	Secondary (MC), medium coastal outfall (off Tahuna), advanced primary disinfected (GIC), and existing outfall, and land disposal (Okia Flat) of harbour basin (excl Burkes)	78.0	3.40	43.4	121	good
	Concept Level 3 Schemes (3 Outputs)					
3/I	Full primary (HB+MC) and long coastal outfall (off Tahuna), advanced primary (GIC) and long coastal outfall (off Waldronville)[3,4]	59.9	1.37	17.4	77.3	normal
3/II	Secondary (HB+MC) medium coastal outfall and disinfected advanced primary (GIC) existing outfall (off Waldronville)[3,4]	76.1	3.02	38.6	115	good
3/III	Full primary (MC) and long coastal outfall (off Tahuna), advanced primary (GIC+MTC) and long coastal outfall (off Waldronville)[1,5]	62.2	1.99	25.5	87.7	normal
3/IV	Secondary (MC) and medium coastal outfall (off Tahuna,) advanced primary disinfected (GIC+MTC) and long coastal outfall (off Waldronville)[1,5]	85.4	3.72	47.5	133	good
	Concept Level 2 Schemes (2 Outputs)[3,5]					
2/I	Full primary (HB+MC) and long coastal outfall (off Tahuna), advanced primary (GIC+MTC) with long coastal outfall (off Waldronville)	67.2	1.64	20.8	88.0	normal
2/II	Full primary (HB+MC) and long coastal outfall off Maori Head, advanced primary (GIC+MTC) with long coastal outfall (off Waldronville)	69.2	1.77	22.5	91.7	normal to good
2/III	Secondary (HB+MC) medium length Tahuna outfall and disinfected advanced primary (MTC+GIC) and long coastal outfall (off Waldronville)	91.5	3.39	43.3	135	good
2/IV	Secondary (HB+MC) and long coastal outfall (off Maori Head), disinfected advanced primary (MTC+GI) and long coastal outfall (off Waldronville)	107	2.34	29.9	137	good
	Concept Level 1 Scheme (1 Output)[3,5]					
1/I	All secondary treatment (HB+MC+GIC+MTC), to a single long coastal outfall (off Maori Head)	136	3.44	44.0	180	good
1/II	All secondary treatment (HB+MC+GIC+MTC) to a single land disposal scheme (South Coast Site)	265	7.79	99.6	365	land disposal scheme so not applicable

Notes:

1. Including option HB1a : all HB plants upgraded as required to secondary and to two harbour outfalls (Beacon No 5 and Grassy Point)
2. Including option HB1b : as for HB1a but with disinfection
3. Including option HB5a : all HB to MC via harbour bed crossings
4. MTC treatment as is, with existing discharge into Taieri River
5. Including Option MTC1 : MTC conveyed to GIC
6. O&M (operational and maintenance) costs are the nett increase or decrease (in brackets) to run the treatment and disposal scheme over that at present.
7. Refer to Part 8.1 page 14 for explanation of basis of estimated costs.
8. Total = Capital + Capitalised O&M.
9. Increasing compliance ranked - marginal, partial, normal, good.
10. For Musselburgh Catchment and Green Island Catchment ocean discharge options only.

Part 1.0

Purpose and Scope

PART 1.0 : PURPOSE AND SCOPE

1.1 INTRODUCTION

The Council's stated position is as follows:

"The current local and national political environment is such that the Dunedin City Council believes that future legislation will require a continuing higher standard of environmental protection, resulting in the need for improvements in wastewater treatment and disposal. The community at large is also making it clear that it considers that some of the city's wastewater treatment and disposal systems are now inadequate in their ability to meet these increased environmental standards.

Council acknowledges these concerns and is implementing this study which will consider the city's future needs for wastewater treatment and disposal in a climate of increased environmental awareness. The study, which follows on from an initial review undertaken in 1990, will give the city an environmentally acceptable, integrated and cost effective solution to its wastewater treatment and disposal issues.

This is not an isolated instance of the Council's regard to these issues but is part of a proactive environmental improvement programme initiated by Council and identified as a major issue in its Strategic Plan.

Other facets of this ongoing programme include:

- the adoption and enforcement of city-wide trade waste bylaws.
- the continuation of a programme to separate the central city combined sewer system in conjunction with a programme to minimise stormwater discharge and infiltration to the foul sewer system.
- a major programme of sewer renewal.

This Options Study should send signals to the citizens of Dunedin that in delivering the best possible services at an affordable price, Council is determined to play its part in preserving the environment, which is seen by the city as a major recreational and economical resource."

1.2 OBJECTIVES

The Council's objectives are that the Wastewater Treatment and Disposal Options Study will:

- provide the citizens of Dunedin with information to allow informed input into the decision making process on future upgrading of the treatment and disposal facilities.
- identify issues associated with the upgrading of wastewater treatment and disposal facilities.
- determine an evaluation framework for assessing technically feasible options against the wider identified issues.
- identify a range of technically feasible options for future wastewater treatment and disposal improvements and assess associated capital and annual operating costs.

- evaluate in detail a selected number of the options for wastewater treatment and disposal upgrading against the wider issues.
- present the decision process for selection of the preferred option(s).
- lead to the adoption of an integrated plan for upgrading the city's wastewater treatment and disposal facilities which is environmentally acceptable and affordable.

The following diagram illustrates the procedures being following from the Information Phase through the Decision Process Phase and finally arriving at the Decision.

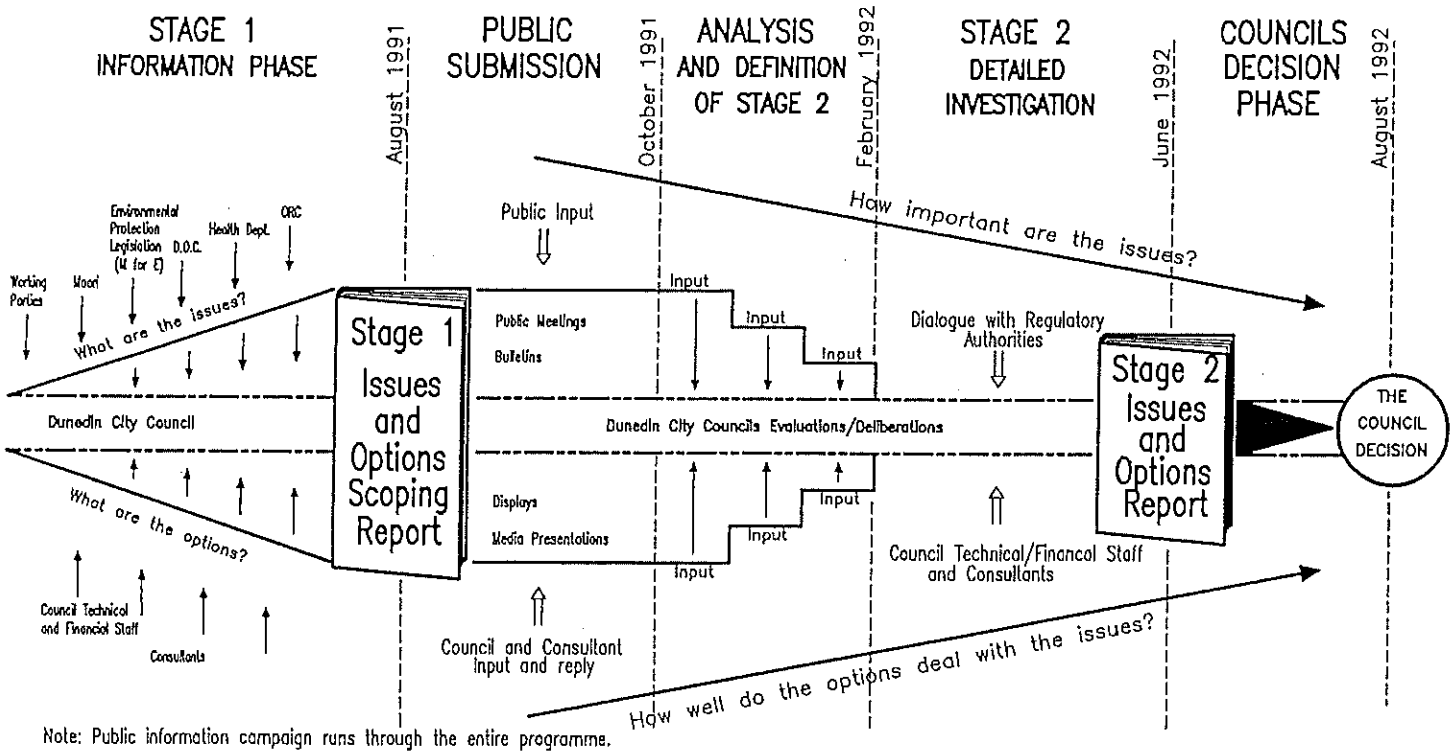


FIG 1.2.1

This Stage 1 Report is designed to provide a broad overview to the general public on the technical, social, cultural, financial and environmental consequences of all of the options which have been examined. The response and input from the general public including special interest groups is considered by Council as an essential step in the further development of wastewater treatment and disposal options.

The Stage 1 Summary Report has been compiled to give a less technical summary to this Main Report and the associated Appendices Report.

The Stage 1 Summary Report and this Main Report as they are received by Council will become documents for general public comment and submissions. These reports will be presented to the public to receive comment across the full spectrum of social, environmental (including odour and noise), planning and cost (residential and commercial customer consequences) issues for each of the options considered.

1.3 RELEVANT FACTORS

The following summarises the factors which are relevant to the need for the widest possible scoping of options. They range from Local Government reorganisation to the rising concern worldwide for the environment and serve to illustrate the starting point for this fundamentally important part of the options study. Solutions must be identified which match the communities aspirations, expectations and ability to pay.

a) Local Government Reorganisation

Following the reorganisation of local government, nine former local bodies became amalgamated within the new Dunedin City. This offers an opportunity to overview wastewater treatment and disposal on a broad scale, and where practicable rationalise these systems to the mutual benefit of the environment and the citizens.

b) Existing Water Rights and Existing Use Consents

Some of the existing treated sewage discharges operate on "existing use consents" (which under the Resource Management Act expire in 10 years) and some others operate under short term water rights recently issued pending the Council's investigations and decisions regarding upgrading.

c) State of Legislation

There is now a Resource Management Act; this new legislation changes the basic way everyone thinks about resource and environmental management. Certain provisions, and in particular those relating to coastal management and receiving water quality requirements, necessitate a review of existing systems of wastewater treatment and disposal in Dunedin.

d) Community Perceptions and Aspirations

The community at large has become increasingly aware of environmental issues over the past decade - what were once fully accepted methods for wastewater treatment and disposal are now questioned and debated to a far greater extent.

e) The Wider Environment

The combination of b), c) and d) above, as well as the "greening" of society in general, has required a reconsideration of priorities in the environmental field. Public health and economics are still important issues, but not exclusively so, and concepts such as "intrinsic values", "sustainability", and "clean and green image" are also vital considerations.

f) Council's Objectives and Plans

These include the most important matter of protection of public health and also the issue of economics and affordability. Both Council's Annual and Strategic Plans accordingly address these issues.

1.4 STRUCTURE OF THE OPTIONS STUDY

The Options Study is programmed into several phases as detailed below:

1.4.1 Stage 1 of the Options Study

The Stage 1 Study, subject of this report, has identified wastewater treatment and disposal options available and relevant to Dunedin's current and projected future situation. The various scenarios developed and presented in the Stage 1 report indicate a range of possible effluent quality and disposal options, including land disposal of effluent. Sludge management is also being considered in detail. The existing constraints of the main treatment plants must be recognised and considered.

The description of each option includes the following:

- how the system integrates with existing plant, including currently proposed modifications.
- the range of effluent quality that can be expected or be necessary and relevant to existing or modified outfalls or a land disposal system.
- the indicative capital and operating costs.
- whether the upgrading proposals in the 1991/92 Annual Plan for Musselburgh Pumping Station and Tahuna and Green Island Treatment plants should proceed.

1.4.2 Adoption of the Stage 1 Options Study Report

The report will be received by Council and public submissions will be invited.

The public submissions on the Stage 1 report will be considered with the report by Council, who will then make decisions regarding the adoption of the report and the direction of Stage 2 of the Options Study.

1.4.3 Stage 2 of the Options Study

Following authority to proceed with the Stage 2 report, the selected treatment and disposal options confirmed by Council will be studied in greater depth.

The following information will result for each of the options:

- refined cost estimates for capital and operating costs.
- treatment plant and disposal location and configuration including land area, building and town planning requirements, and requirements of environmental legislation.
- the quality of effluent at various stages of treatment and means of disposal of effluent and sludge.
- plant technical and operational details including staffing requirements, energy usage, odour and noise control, efficiency and reliability of operation, compatibility with existing plant, and compatibility with existing plant control systems, potential suppliers and locations world wide where similar plants are operating satisfactorily.
- confirmation or otherwise that capital works currently proposed by Council for the 1992/93 year are consistent with the proposed longer term options and can proceed.

- operator training requirements.

- an implementation (or co-ordination) programme.

The Stage 2 report is to be completed by June 1992. This will be considered by Council with the intention of confirming and implementing a Capital Works Programme.

1.5 PUBLIC PARTICIPATION

To achieve the objective of providing for full public participation in the decision making process, a 2 step approach has been adopted. The project management structure has been designed to incorporate ongoing input from various groups and organisations through working parties. This will then be complemented by the provision for general public input during the period between Stages 1 and 2.

There are three working parties:

- regulatory organisations
- tangata whenua
- specific interest groups

These groups have been involved throughout Stage 1 of the study, and have had an appropriate input into the identification and evaluation of issues associated with wastewater treatment and disposal for the city (refer part 6.0 below).

Part 2.0

Wastewater Basics

PART 2.0 : WASTEWATER BASICS

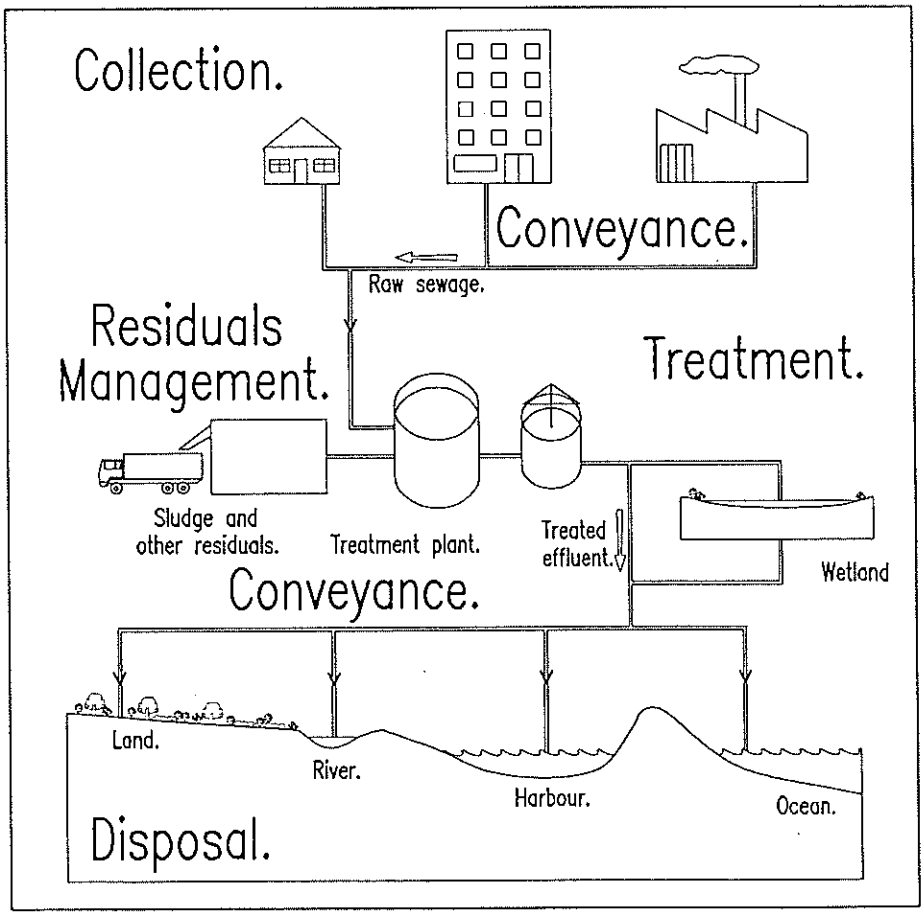
2.1 INTRODUCTION

The following section provides an explanation of many of the commonly-used technical terms and processes in the field of wastewater treatment and disposal. Further details of specific treatment technologies and processes are found in Appendix A.

2.2 KEY DEFINITIONS AND TERMINOLOGY

The following key definitions are set out in this part of the report as they need to be well understood in respect of the following parts of the report. A more comprehensive listing of abbreviations and a glossary are included at the end of this report.

- **sewage** — toilet and other waterborne wastes derived from domestic dwellings and non-industrial sources (office buildings, etc)
- **trade wastes** — those liquid wastes discharged by industries that produce contaminated wastewater as a result of their processes. These industries are commonly called "wet" industries.
- **wastewater** — the total mix of sewage and trade wastes
- **wastewater collection and disposal system (sewerage system)** — the system of pipes, pump stations, treatment and disposal facilities which convey wastewater. These are the components of a sewerage scheme as shown in the following diagram.



- **treated effluent** — the term used to describe the final liquid effluent from any particular wastewater treatment process. This effluent requires disposal by some means. It is usual to qualify the term by referring to the degree of treatment or process type, such as "secondary treated effluent" or "activated sludge effluent".

- **residuals** — residuals are all those non-liquid effluents and by-products from the wastewater treatment processes, and include odours, noise, sludges, screenings, and air emissions. These must also be properly managed in order to avoid detrimental or negative environmental impacts.

- **treatment** — The processing of wastewater using physical, biological or chemical means to remove all constituents that will have a harmful effect on public health or the environment at the point of discharge. The degree of treatment required is dependent on the receiving environment and the method of disposal.

- **disposal** — The point at which effluent is discharged from man-made facilities and enters the natural environment.

- **outfall** — A pipe or structure which discharges wastewater or effluent in receiving waters.

- **flow Definitions**

ADWF	-	Average daily dry weather flow
PWWF	-	Peak wet weather flow
MWWF	-	Maximum wet weather flow

2.3 PURPOSE OF SEWERAGE SYSTEMS

There are three primary purposes for the water-based wastewater collection and disposal system as we know it:

- to protect public health, by removing human waste and other contamination from places where people live;

- to provide a means of removal and transport of the large quantities of wastewater produced in offices, hotels, industries, public buildings, restaurants, industries (trade waste), etc;

- to provide for the ultimate treatment and disposal of effluent to the environment in a manner which avoids nuisance and public health problems, maintains aesthetic and cultural values, and does not detrimentally affect ecological and other values.

2.4 COMPOSITION OF WASTEWATER

A waterborne sewerage system uses a very large volume of water to convey a small quantity of solid and liquid wastes. A typical design dry weather flow for a sewerage system is of the order of 225 to 275 litres per person per day, and it is generally found that the total content of suspended, dissolved and colloidal solids is such that sewage is in fact 99.9% water.

However, although sewage is dilute, it is also an unstable, offensive mixture of dissolved and suspended solids, containing human wastes with the potential for disease transmission. The challenge of sewage treatment is therefore to remove that small proportion of solids and other materials, or at least the part that is detrimental to the environment or public health.

Wastewater consists of all the faeces and urine from the people using the particular sewerage system; the water from their baths, showers, sinks, domestic waste disposal machines, basins, dishwashers, washing machines and gully traps; washings and liquid wastes from hotels, restaurants, shops, offices, stores, laundries and industries; and any other liquids which people pour into or allow to enter the sewers.

There are many ways to categorise the components of sewage but the conventional sanitary engineering practice is to distinguish between:

- debris and inert materials;
- organic materials;
- nutrients;
- pathogens;
- oil and grease, and;
- toxins

These terms are defined as follows:

2.4.1 Debris and Inert Materials

Sewers carry a surprising range of inert materials including sand, gravel, combs, toothbrushes, panti-hose, teabags, drinking straws, cigarette butts, pieces of wood, condoms, panty shields, sanitary napkins, pins, rubber goods, plastic bags, disposable nappies and a variety of plastic items of all colours and shapes. Sewers should not be used for the disposal of a number of these items as often they are non-biodegradable, many float and it is unacceptable to discharge them into the environment. Debris and inert materials can cause blockages in sewers. They may also cause damage to wastewater treatment processes, and must be removed.

2.4.2 Organic Materials

Organic materials in sewage are biodegradable materials (some as solids, some in solution) such as carbohydrates (eg, sugar, sucrose, fructose, milk, glucose, starches and cellulose), proteins (eg, meat, bacteria, cheese) and fats (eg, butter, animal fats, cooking oils, body oils, soaps). In order to simplify the description of organic material it is convenient to describe the organic content of sewage by reference to two standard tests:

- 5-day Biochemical Oxygen Demand (BOD_5), and;
- Suspended Solids (SS). The term Non Filterable Residue can also be used (NFR)

The most widely used parameter of organic pollution applied to both wastewater and surface water is the 5-day BOD (BOD_5). This determination involves the measurement of the dissolved oxygen used by micro-organisms in the biochemical oxidation of organic matter. A typical value for domestic sewage is 220-250 g/m^3 of BOD_5.

Suspended solids are those retained on a 0.5 micron filter (after first removing the debris described above). A typical domestic sewage suspended solids value is also 220-250 g/m^3.

2.4.3 Nutrients

Sewage contains the primary nutrients phosphorus and nitrogen in small concentrations, either in organic forms (ie, as living or dead micro-organisms and plants) or inorganic forms (orthophosphate, ammonia and nitrate). Typical nutrient concentrations for sewage are 30 g/m^3 of nitrogen and 6 g/m^3 of phosphorus. Approximately two-thirds of the nitrogen is in the form of ammonia, with most of the residual being organic nitrogen. Large effluent discharges can cause problems in rivers and in enclosed harbours (due to nutrient enrichment) but not in the ocean. The ocean is usually short of nutrients and large scale mixing rapidly reduces nutrient concentrations to background levels.

2.4.4 Pathogens

Pathogens are disease causing organisms that are discharged by infected human beings. The range of pathogens present at any time directly reflects the level of public health prevailing in the contributing population. Examples of such pathogens are Salmonella, enteroviruses, and micro-organisms causing skin, ear and eye infections.

Because the incidence of pathogens in sewage is so small, other more common micro-organisms present in large numbers are used to measure the potential presence and degree of removal of pathogens from sewage.

These are called indicator organisms and at present faecal coliforms, which are in abundance in numbers in the gut of warm blooded animals and are not themselves harmful, are usually used for this purpose.

2.4.5 Oil and Grease

The term "oil and grease" as commonly used includes the fats, oils, waxes and other related constituents found in wastewater. Fats and oils are contributed to domestic sewage in soap, butter, lard, margarine, and vegetable fats and oils. They give rise to blockages in sewers and pumping stations, create difficulties in treatment plants and, under calm conditions, may produce a film on the ocean surface near the outfall. A high proportion of oil and grease should be removed prior to the disposal of effluent to the ocean in order to minimise the risk of aesthetic and environmental nuisance. In this report oil and grease levels given are determined by the standard total grease test.

2.4.6 Toxins or Potentially Harmful Materials

Toxins refer to that great range of organic, chemical and inorganic substances which, if present in sufficient quantities or concentrations, will poison or harm life or affect people eating seafood in which they have accumulated. Examples of toxins include phenols, heavy metals (eg, zinc, chromium, cadmium, lead, etc) herbicides, acids and cyanide. Particularly hazardous ones include for example the chlorinated hydrocarbons such as pesticides, PCBs, etc.

In wastewater treatment it is important to appreciate that the heavy metals accumulate to a large extent (around 80%, but varies with process and metal type) with the solid materials and sludges, while many of the liquid metals like herbicides and hydrocarbons, for example, accumulate with the oils and greases. These phenomena are important in considering the effects of various types of treatment on toxins.

2.5 WASTEWATER TREATMENT AND DISPOSAL TERMINOLOGY

Wastewater treatment has been traditionally categorised under certain headings, and these categories tend to be still used today, although with new technologies available some of the distinctions become blurred, and several misconceptions have arisen because of this. There are trends nowadays to move away from use of these terms, and in fact refer to the effluent from a specific treatment process (eg, "activated sludge plant effluent" rather than "secondary"). These traditional categories are:

- **preliminary treatment** — The removal of large solids, grit, and other problematic material (eg, excess fats) which might otherwise interfere with downstream processes and/or damage equipment. Milliscreening, barscreens, comminutors and grit channels, for example, are usually considered as preliminary treatment processes;

- **primary treatment** — The removal of floating and settleable material particularly by a variety of means, but normally by physical processes such as sedimentation and floatation tanks. There are additional methods of enhancing the removal of these solids, often by use of chemicals or air, called **Advanced Primary Treatment**;

- **secondary treatment** — The removal of dissolved nutrients, organic matter (BOD_5) and non-settleable solids by a variety of means, including biological and chemical processes. The biological processes involve concentrated growth of micro-organisms either on fixed surfaces (eg, trickling filters) or in suspension, (eg, activated sludge plants);

- **tertiary treatment** — Further treatment to remove specific elements which may be of concern (eg, more nutrients, trace metals, bacteria, solids, organics) by an array of processes (including disinfection);

- **disinfection** — A process designed to reduce the number of micro-organisms in a particular effluent, including use of chlorination, UV light, and ozone. It is usual to refer to a disinfected [stage of treatment] effluent, such as a "disinfected secondary effluent".

- **marine treatment** — The use of the marine environment to dilute and treat sewage by natural processes to harmless otherwise acceptable levels. This treatment system also includes the final disposal of the effluent. Such processes include dilution, dispersion, biological breakdown, and micro-organism die-off.

- **effluent disposal** — Is the discharging of the treated effluent from any treatment process, either to a receiving water such as a river, lake or ocean, or onto land.

- **residuals management** — The residuals from sewage treatment processes refer to those by-products produced (other than the liquid effluent), such as sludges, odours, noise, and air

emissions. All of these residuals require appropriate management to ensure in particular that treatment plants do not become an environmental or social detriment.

- **sludge** — Sludge is the by-product which is drawn off the bottom of sedimentation tanks, when the liquid in a treatment stage is allowed to settle. Various processes can then be used to stabilise and/or dewater the sludges prior to re-use or disposal.

- **scum** — Floatable grease and oils.

2.6 EFFLUENT DISPOSAL

There are four principal options for the disposal of effluent, namely:

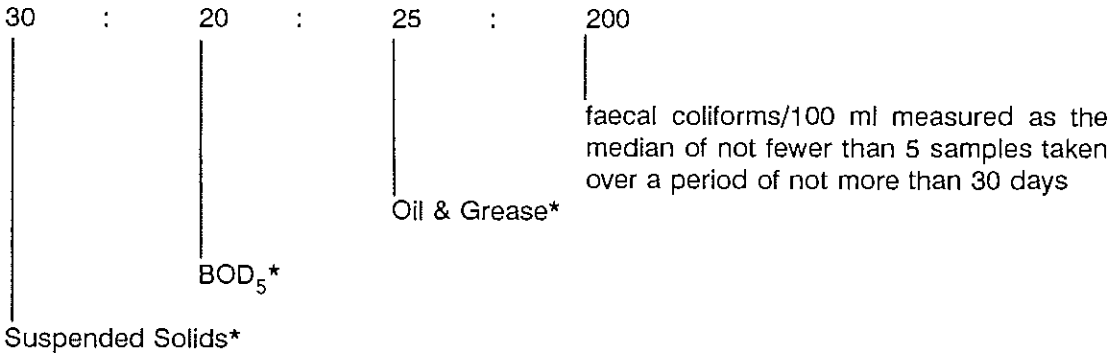
- inland waters (rivers, lakes)
- ocean or coastal waters
- harbour or estuarine waters
- land

Each of these has its own particular features and limitations which must be taken into account when they are being evaluated for the disposal of effluent. One of the principal considerations is establishing the level of compatibility between the standard of treatment and the means of disposal. The four options listed do not necessarily require the same type or standard of treatment; this "balancing" act is the goal of an issues and options study such as the one being undertaken by the Dunedin City Council.

2.6.1 Effluent Standard Definition

When discussing various wastewater treatment and disposal options, a standard means of defining acceptable effluent quality is to use the following notation:

eg, for a "high-quality disinfected secondary effluent" an acceptable standard might be 30:20:25:200, which represents



* All concentrations (except for faecal coliforms) are expressed in g/m^3 measured as 30-day averages of daily samples; 90% of the results should not exceed 1.5 x the stated average value.

2.6.2 Inland Waters

Background

Historically, most human communities have developed alongside bodies of fresh water, be they rivers, lakes, estuaries, or natural harbours. The ready availability of fresh water for sustenance and the removal or disposal of the waste from the community has made these locations ideal. However, as such urban communities have developed, there has been a growing conflict between the uses to which the bodies of fresh water have been put.

Overseas, many of the large rivers and lakes bounded by cities have become grossly polluted and massive endeavours are now underway to reverse these problems. In New Zealand, while the problems in evidence elsewhere are not on the same scale, there is widespread concern about the discharge of untreated or inadequately treated wastewater to our rivers and lakes. The fears and concerns of the public extend from visual pollution, to enteric micro-organisms or pathogens (bacteria and viruses), to nutrient enrichment (or eutrophication), and to toxic chemicals (heavy metals and organic compounds such as pesticides). Lake Rotorua and the Waikato, Waimakariri and lower Clutha Rivers are cases in point where such issues have been raised.

Effluent Standards

In comparison with ocean discharges of effluent, higher levels of treatment are often required for river and lake outfalls because of lower available dilutions for the effluent discharge, coupled with various river water uses and the likely proximity to urban communities. This may for example require a disinfected secondary effluent in some cases, in others a secondary effluent which has had nutrients removed or even, in the extreme case, a tertiary effluent which has had nutrients removed and is disinfected.

Up to the 1970's the effluent standards for discharge to rivers were often set by what is known as the UK Royal Commission Standards of 30:20 (30 g/m^3 suspended solids (SS), 20 g/m^3 biochemical oxygen demand (BOD_5)). This was achievable by the secondary treatment technology and equipment available at the time, and was considered to represent a reasonable balance between treatment cost and environmental/public health impact in the majority of instances. Increasing population and increased use of water lead to increased volumes of sewage, which together with increased environmental standards, has required improved effluent standards in some instances. These improved standards have led to improved and additional treatment processes being available nowadays.

Much of this new technology is designed to remove wastewater contaminants previously not considered necessary, or indeed sufficiently known about - eg, nutrients.

Waters of many New Zealand rivers and lakes have been classified under the Water Pollution Regulations (1963) or the Water and Soil Conservation Act 1967. Effluent discharged from treatment plants to inland waters would need to be of a quality that is compatible with water quality standards corresponding to the classification of these waterways. The dilution or assimilation capacity of the rivers is an important factor in the determination of effluent quality standards.

Flow rates in almost all New Zealand rivers vary seasonally and it is therefore necessary to base effluent quality standards on the assessed average minimum low flow-rate, that is, the worst case dilution capacity of the watercourse in question.

Part 8 of this report discusses these matters in more detail.

Disposal Structures

Exposed sewage pipes poking out into rivers and lakes from their banks and discharging a coloured blend of wastewater into the flow are slowly becoming features of the past. There are still instances where singlepoint discharges are actually required and are designed as such (e.g. to enhance dilution or reduce the formation of a fish barrier from a particular pollutant) but they are now submerged with their outfall pipe buried or built into a structure such as a bridge pier, groyne or abutment. More common, however, for modern river or lake discharges are submerged multiport diffusers which extend fully or partially across the riverbed or for a certain distance along the river or lake bank. The jets of effluent discharge from the ports at a fairly high velocity and mix with the natural waters (the process is called jet entrainment) to form a very much diluted stream within a relatively short distance of the diffuser.

2.6.3 Ocean or Coastal Waters

Background

As with inland waters discussed above, many communities which developed in a coastal location did so because of the food which could be harvested from the sea and the apparent ease with which the sea absorbed the waste produced by the population. Discharge of wastewater effluent to coastal waters is a common practice worldwide and in New Zealand (as elsewhere) the standard of effluents discharged varies considerably.

Both in the past and, to some extent, the present society's acceptance of wastewater disposal to coastal waters has been based on the perception that the oceans are so vast that the amount of sewage discharged to them is relatively insignificant. In many cases, scientific evidence has been produced to show that such discharges have had over a long time no adverse effects at all on the marine flora and fauna in the vicinity of outfalls. However, the converse has also been shown at some locations and as analytical skills and techniques used by environmental and biological investigators have increased so too have the doubts and concerns of the public and experts about the level of treatment required for ocean discharge of wastewater. The increased level of flow at particular sites is also a major factor giving rise to this concern.

Modern New Zealand society is now more in tune with the cultural and spiritual values of the Maori people (the tangata whenua) who have traditionally had a close relationship with their land and water resources and view the whole environment as an integrated whole. Water and its uses is especially closely linked with physical and spiritual elements. These sentiments apply equally to the freshwater and coastal environment, but have received more attention and focus in the latter case.

Contamination of coastal and ocean food harvesting and fishing areas by wastes, particularly of human origin, is culturally offensive to Maori people. While it is easy to rationalise this attitude from a public health point of view (i.e. it is very good practice and commonsense), this is also a simplistic stance as it ignores the total cultural/spiritual nature of this Maori tradition.

It is important, therefore, to ensure that seafood resources are protected from the effects of marine effluent discharge and other types of pollution. This does not mean that ocean outfalls cannot be used at all, but that the location of the outfall and the level of treatment must be carefully evaluated in relation to the natural resources so that they are not compromised by the discharge.

Objectives

The three principal objectives of an ocean outfall are:

(a) to provide a rapid and substantial dilution of the discharged effluent with seawater;
(b) to separate the discharged effluent from people using the coast and nearshore waters for swimming, diving, surfing or seafood collection: this is called "shoreline separation"; and
(c) for the discharge to have minimal impact on marine life and the ocean.

Generally, a long ocean outfall is necessary to meet these objectives (i.e. an outfall greater than 1000m long); such outfalls have been built at Gisborne, Napier, and Hastings and are also proposed at Wellington (into Cook Strait) and at Auckland (to the Tasman Sea). But with a higher quality effluent (e.g. as at New Plymouth) a somewhat shorter outfall can prove satisfactory if the principle of shoreline separation does not need to be adhered to.

The over-riding objective for an ocean discharge is to establish the level of treatment onshore which will enable the three objectives listed above to be met offshore.

Effluent Standards

The open coastal environment is known to be a nutrient-deficient system, and consequently the discharge of sewage-derived organic matter is regarded as less of an issue than, for example, the discharge of pathogenic micro-organisms, toxins, or high concentrations of grease and fat.

As a consequence it has been the practice in the past to discharge a lower quality of effluent into the sea than would be normally acceptable for inland or enclosed waters. Public opinion, however, is starting to affect this practice, whether on technical or aesthetic grounds.

The natural purification processes that take place in ocean waters (known as marine treatment in the technical arena) allow effluent levels to be set on a parameter by parameter basis. Accordingly, these specific parameters are targeted when the design and operation of treatment processes are being considered. Some of the new treatment technologies are particularly suited to this approach.

For example, as introduced above, it is acknowledged that BOD_5 discharged into a sufficiently deep and mobile coastal water is of little significance. On the other hand solids (suspended solids), greases, (and other floatable material), colour, toxins and pathogenic micro-organisms are pollutants of priority (or concern) that need to be targeted in deciding on the treatment.

There are moves in the USA, where secondary treatment for ocean discharge is all but mandatory, to readdress this present position and look to a more rational and cost efficient treatment process for ocean discharge. This balancing of the interrelationship between outfall length and appropriate effluent standard is commonly addressed in "issues and options" studies such as this.

Part 8 of this report discusses these matters in more detail.

Disposal Structures

Refer Section 10.6.4 below.

2.6.4 Harbour or Estuarine Waters

Background

Harbours and estuaries form the boundary between inland waters and coastal waters. As a consequence they both play an important role as the transition zone between these two disparate environments, and are often regarded as extremely sensitive because of the wide fluctuations in conditions which can exist (the freshwater/saline water interchange, sediment and pollutant sinks, etc.) In these water bodies the terrestrial, freshwater and marine environments meet to form a complex, dynamic interface system.

The ability of a harbour or estuary to absorb the various impacts of multiple uses, including those derived from the existence of urban development, without persistent ecological or aesthetic degradation varies considerably both from place to place, as well as from location to location within each harbour or estuary. There are also many natural processes in action, eg, flood flows, closure of estuaries due to sand movement, transport of silts and debris which will adversely impact on a harbour or estuary.

The influence of water volume and tidal flushing plays a major role in determining whether or not a particular harbour or estuary could be used for the disposal of treated sewage.

It is unfortunate, however, that in many parts of New Zealand these sensitive environments (particularly estuaries rather than major harbours) have been subjected to a variety of uses which, when coupled with the fact that upstream pollution also contributes, has resulted in severe degradation of water quality, ecological values and therefore a reduction in possible other uses of the system (recreation, food gathering, etc).

Resource use conflicts in harbours and estuaries arise mainly between those activities that require high water quality (such as fisheries and recreation) and other activities for which water quality is relatively unimportant and which may even lead to its degradation (waste discharges, port activities).

Effluent Standards

A harbour or estuary is, from a technical point of view, probably less sensitive to nutrient enrichment than inland waters or lakes, and as a consequence there is often less need to provide sophisticated sewage treatment systems to ensure very low levels of BOD_5, nitrogen and phosphorus - this of course will depend on estuarine or harbour dynamics versus the volumes of effluent to be disposed of.

Of critical importance is to ensure that any effluent discharge is neither aesthetically noticeable nor offensive, and that levels of pathogenic micro-organisms and toxins do not detrimentally affect receiving waters and their users (including shellfish resources, sediments etc).

In some areas of New Zealand (Tauranga for example), the tidally-timed discharge of disinfected secondary effluent has been occurring for many years, whereas in other areas (Nelson, Christchurch, Auckland) the use of oxidation pond treatment has been preferred. Given that the nature of the specific estuary or harbour in question varies considerably, it is impossible to derive a generalised effluent standard for such locations and each must be specifically investigated.

Part 8.0 of this report discusses these matters in more detail.

Disposal Structures

Refer above for Inland Waters.

2.6.5 Land Disposal

Background

There is nothing new about disposal of sewage to the land, although the terms "land based treatment" and "land disposal" have a much higher profile now than a few years ago. Before water borne sewerage systems became widespread, cesspits and pit privies were commonly used. Septic tanks and seepage fields are another example of small scale land disposal of sewage which are still in use serving isolated small communities or households.

In the modern world with significant volumes of water comprising the sewage flow, application of effluent to land can still be an effective process for disposal of treated effluent.

Some of the effluent applied to land will be lost to the atmosphere through evapotranspiration. The remainder will percolate through the soil and may ultimately enter natural waters, either ground water or surface water.

Objectives and Methods

The main objectives in discharging effluent on to the land may be one or more of the following:

- to provide a means of treatment for improving effluent quality (by overland flow, and flow through wetlands) prior to final disposal which may be to ground water, lakes, rivers or sea water;
- to provide a means of effluent disposal for cultural reasons and/or environmental, practical or economic reasons;
- to provide a benefit by irrigation to supply moisture and nutrients for plant growth, e.g. trees in a forest or crops;
- to recharge ground waters, i.e. effluent re-use.

In considering any scheme for disposal to land involving more than one main objective, the principal objective to be achieved should be clearly established as each objective may have conflicting requirements.

Effective and economic land disposal of effluent is extremely dependent on the characteristics of the land that is available, its area, topography, soils and geology and the climate of the region.

Some of the methods of disposal to land are described briefly below, in the two main use categories of wetland treatment and effluent irrigation. In Part 10.7 the specific investigations and application in Dunedin are discussed.

Wetland Treatment

Strictly speaking this is a land treatment technology, involving secondary and tertiary treatment processes. Use of both natural and constructed wetlands is now being established as an innovative and cost effective alternative to further treat or polish effluents before final discharge to natural receiving waters. It has particular application where the discharge is into sensitive waters. The treatment processes that take place in these systems include filtration, settlement,

microbiological action, absorption, evaporation, and nutrient intake.

Wetlands can either be natural wetlands (e.g. marshes, swamps, bogs) or constructed wetland systems. Constructed systems may range from creation of a marsh in a natural setting to intensive construction involving earthmoving, grading, impermeable barriers or erection of containers such as tanks or trenches. They are both 'surface flow' and 'subsurface flow' systems.

In all cases the volume coming out of the wetland is about the same as that going in. Use of a wetland is therefore not a disposal method but a treatment method.

Some wetland treatment schemes are now in place in Northland and other schemes are planned or in construction throughout New Zealand.

Effluent Irrigation

Irrigation of effluent can be achieved by several different methods depending on the topography and soils of available land.

Rapid infiltration is used on soils with high permeability such as sands and gravels. Disposal is by percolation down to the water table.

Slow rate irrigation is used where soils are less permeable. Disposal is by percolation and evapotranspiration. Loading rates are related to water balance, permitted groundwater quality and acceptable application rates for constituents in the effluent such as nitrogen and dissolved salts (calcium, sodium, magnesium). Application can be by either sprinkler or border dyke flood irrigation depending on the topography of the available land. Ground cover can vary but for management reasons trees are preferred because of the all-year round growing season and long rotation (years) between harvests.

Overland flow can be used on relatively flat ground with soils of low permeability. The effluent flows across the ground and whilst some is lost by percolation, the majority is lost by evapotranspiration. Depending on the size of land area available and the season of the year, runoff can occur. This can be intercepted in cut-off trenches and discharged to a natural watercourse perhaps via a wetland to provide final purification.

Land disposal systems have both benefits and disadvantages. They can result in benefits such as an eventual financial return from forest crops, the use of what might otherwise be poor or low value land, and an effluent disposal system culturally acceptable to the tangata whenua. However, there are some risks such as disease of trees, pollution of surface and groundwater, and the buildup of undesirable constituents in the soils, which may result in irreversible changes in the soil structure affecting its ability to support growth. A system's efficiency is affected by climatic conditions (rainfall, temperature, sunshine and wind) all of which are variable from season to season and from one year to the next. Capital costs to establish a successful land disposal system, particularly if application is by sprinklers, are very high as can be ongoing energy costs in pumping and distributing the effluent.

Potential danger from aerosols could occur with wind transporting viruses and pathogens outside of the land application area. The more technical aspects of land disposal options for Dunedin are further discussed in Part 10.7.

Effluent Standards

For effluent applied to the land, there are no standards comparable to those which pertain to discharge to natural waters. The evaluation of whether or not the effluent is suitable for land disposal depends very much on constraints imposed by the soil and groundwater or ultimate

receiving water. It is important that the effluent be treated to remove any solids which may block the reticulation and distribution laterals or sprinklers if this type of system is to be used. Thus the prime treatment goal is solids removal rather than a reduction in organic strength (BOD_5), coliforms or other wastewater constituents.

The Department of Health does have a set of guidelines on the standard of effluent appropriate for land disposal, and the ensuing uses of that land, but these are somewhat dated (1973). Certainly, however, these guidelines and the input of the Department are appropriate on a case-by-case basis.

Part 8 of this report discusses these matters in more detail.

2.7 RESIDUALS MANAGEMENT

Residuals management refers to the management of those residuals (or by-products) arising out of wastewater treatment processes. These residuals include:

- sludge
- screenings
- ash
- odour
- noise
- air emissions

Each of these is discussed in the following sections. As with the selection of wastewater treatment processes, it is too early in the project to determine the most appropriate residuals management procedure for each treatment plant type and site.

In view of the objectives for sludge management, it is appropriate to hold the decision of the procedure to be followed until as late as reasonably possible in the Councils' programme. This is an area of wastewater treatment that is attracting much attention internationally, with many innovative and developing processes and sludge reuse technologies being researched and implemented. Some will have particular attraction in respect of this project.

2.7.1 Sludge Management

Introduction

Sludge treatment and disposal has unfortunately in the past not always been as well planned for or managed as it should have been and accordingly much attention is now being paid to this very important, often expensive and complex part of wastewater treatment. The sludge treatment and disposal is a major component, say in the order of 40% of the operating costs, for a larger wastewater treatment facility.

The objectives of sludge management that are appropriate to this project are:

- to adopt relatively simple, flexible and where possible multiple sludge treatment and disposal/reuse options.

- to reuse or otherwise dispose of the sludge or end products arising from its treatment in an environmentally safe manner which protects public health and the ecosystem, and.

- to acknowledge the reuse potential of municipal sludge and adopt practices that allow reuse as may economically and otherwise be desirable.

- dispose of sludge in an energy efficient manner.

Sludge Quantities

Sludge amounts increase as the degree of treatment becomes higher, that is, as more incoming solid matter and organic growth material are removed. For example, secondary treatment processes, which remove BOD_5, convert BOD_5 to biological sludges and other products (water, carbon dioxide, etc).

Figure 2.7.1 shows the increasing amount of sludge (given in dry solids) that would be produced with the various levels of treatment. The sludge produced is wet (varying between 2% and 5% solids) and particularly unstable. Therefore it needs treatment to stabilise it or otherwise to be made innocuous by incineration or other methods as are introduced below. Chemical dosing, to aid flocculation or phosphorus removal from the wastewater being treated, will increase the sludge quantity substantially and can make dewatering and reuse more difficult.

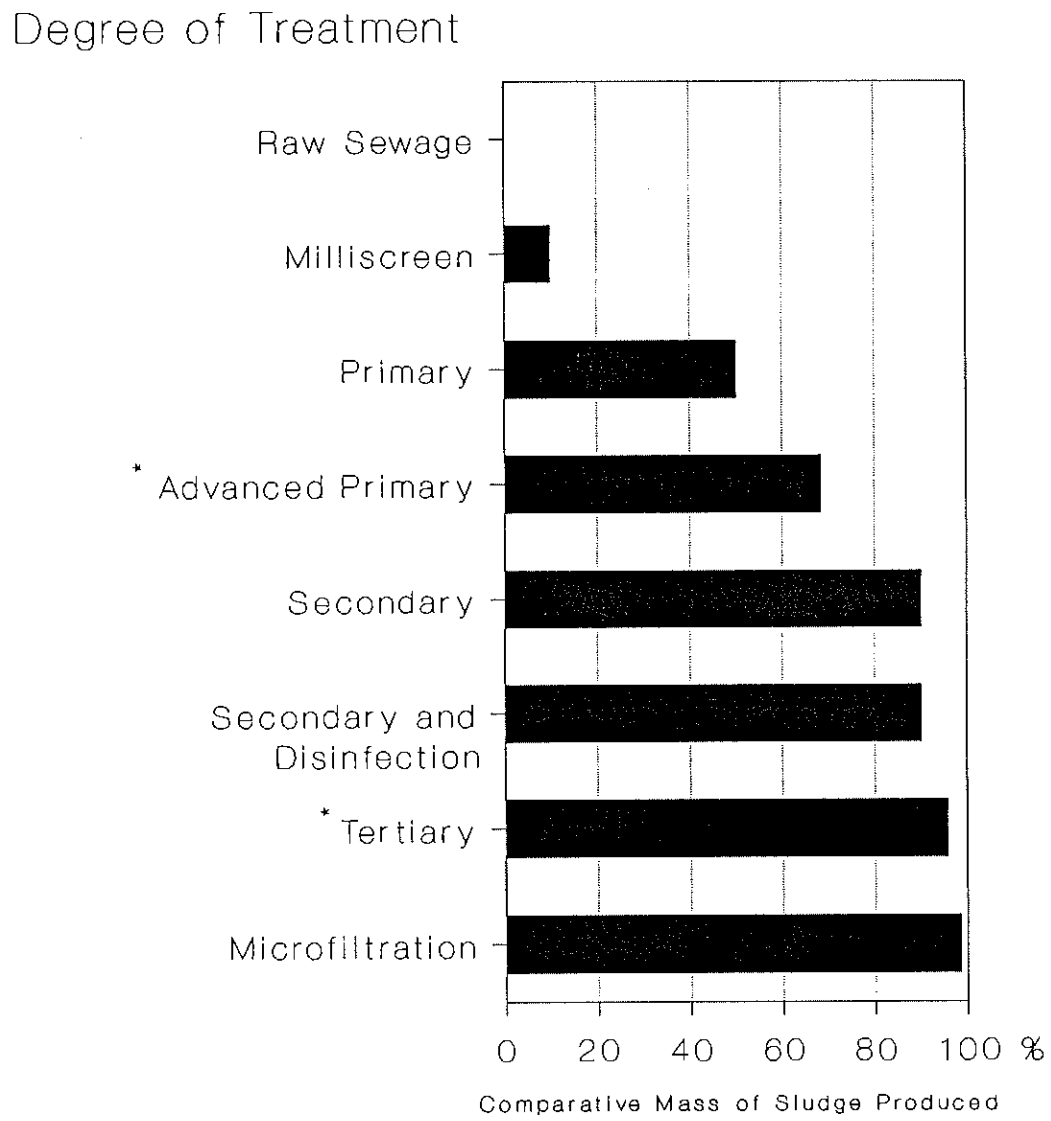
Sludge Management Issues

Particular issues and questions that need to be evaluated include:

- what level of treatment is needed, and what is the quantity and nature of the sludge produced?

- the implications of undertaking secondary treatment for a coastal (ocean) discharge where this may not be needed from a water quality standpoint (as is the case for BOD_5 removal) and where the secondary process produces much more sludge to manage and also costs more to run and/or consumes more energy.

Organic Sludge Production For Various Treatment Options



* If chemical dosing is used, sludge quantities (chemical plus organic) can be appreciably greater than "natural" organic sludge, depending on dose rates.

Figure 2.7.1

- the level of heavy metals that may accumulate in the sludges from the treatment process and the implications of such levels of metals with respect to trade waste discharges (through trade waste bylaw limits) and for sludge disposal or reuse options.

- the degree to which the sludge management objectives are met.

Sludge Processing Methods

Figure 2.7.2 shows diagrammatically some sludge treatment, conveyance, handling and disposal/reuse possibilities that are available.

These include:

- anaerobic digestion with thickening, dewatering and trucking dewatered, stabilised sludge (in a cake form) to a landfill or long term storage for reuse;

- pumping wet sludge to a remote site for dewatering and disposal there, or lime or other stabilisation before disposal;

- incineration at the treatment plant site with ash disposal to landfill; and

- sludge drying to 50% dry solids or 90% dry solids with disposal or reuse of the dried sludge pellets.

Sludge drying to 90% dry solids is an emerging technology. The treatment would provide a reusable sludge or soil-enhancing material in the form of a dry sludge pellet. The pellets could be used immediately as the temperature needed to dry the sludge is sufficient to kill potentially harmful (pathogenic) micro-organisms. For other possibilities, including the drying to 50% dry solids, storage of sludge for some years is necessary before reuse. Such procedures must be in accordance with the NZ Department of Health's guidelines on the disposal of sludge onto land. In addition to setting limits for control of potentially harmful micro-organisms, these procedures also set levels on the amounts of metals and other toxins that can be put onto land.

In respect to sludge disposal and reuse, it must be realised that, even after many of the available forms of treatment (including anaerobic digestion), sludge can be a health risk and even with landfilling, for example, appropriate co-disposal and other procedures, such as restricted access, should be undertaken.

Developing and innovative sludge management technologies which could be proven and commercially viable by the time the sludge management decisions need to be made include:

- oil-from-sludge
  Heating (by pyrolysis), cooling and condensing process to produce oil and dried sludge char. Currently being trialled at Malabar, Sydney, Canada and New York.

- co-incineration with solid waste

- microwaving of sludge
  Drying and killing pathogenic micro-organisms in a microwaving system

- in-vessel pasteurisation

- in-line enclosed composting plants

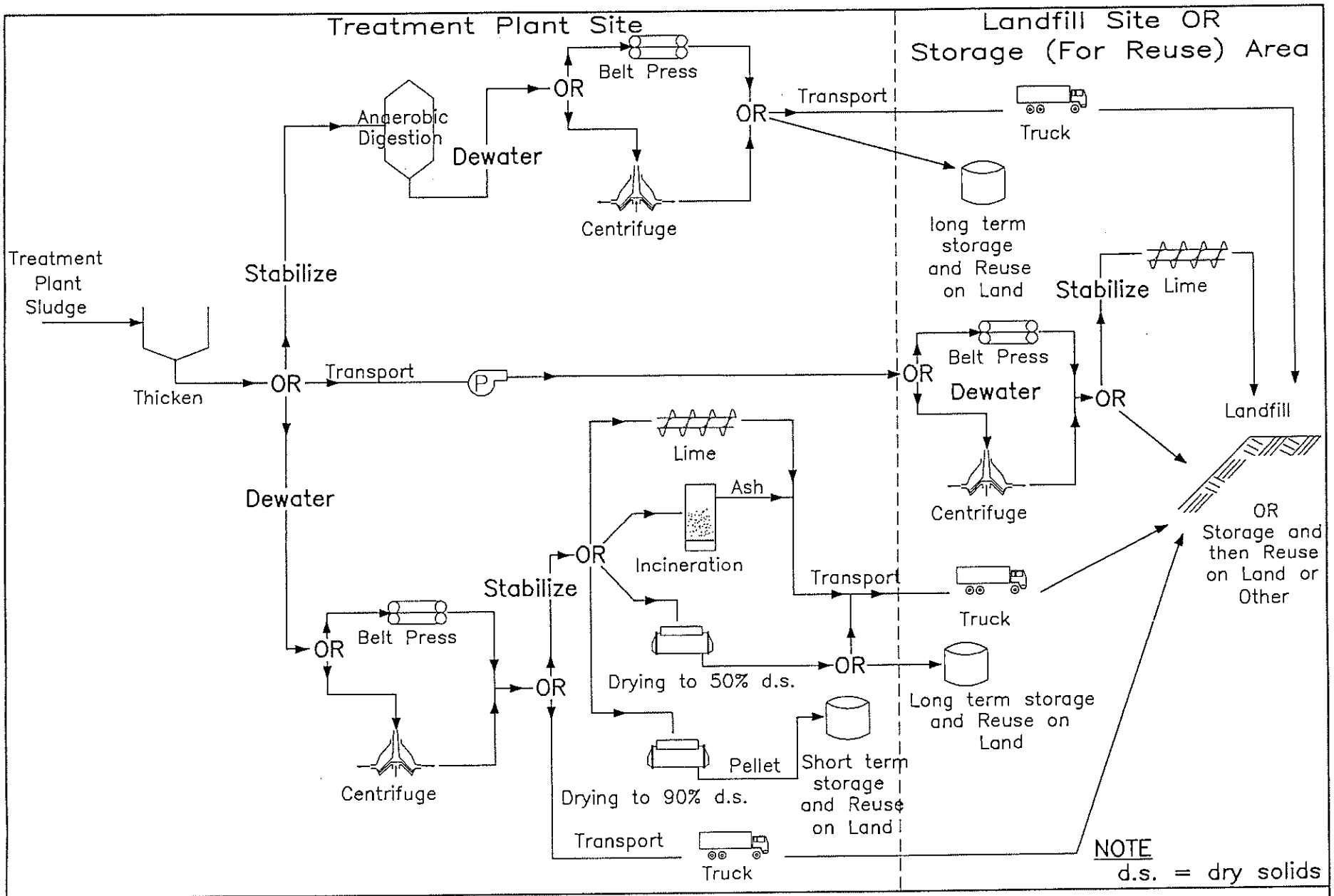


Figure 2.7.2 Typical Sludge Management Options

- smelting of sludge to make aggregate
  For use in roads, bricks, paving blocks, ceramic pipes, etc
- stabilisation with kiln dust
- below-ground aqueous-phase oxidation (Vertech process)
- other processes

Land disposal of wet sludge is also a possibility providing the appropriate land area and management techniques are applied. Sludge use with afforestation is practised in large scale municipal plants in Seattle and elsewhere. The Christchurch City Council is considering this method of disposal for Christchurch's sludge, and planning and water right applications for trials are presently in progress.

More remote sites offer on-site treatment and disposal options for sludge management which are expected to be at significantly lower operating costs than for a confined site. For example, Wellington City Council propose to pump (wet) sludge from a treatment plant site near the Wellington airport to the Happy Valley landfill (8 km away) for subsequent treatment (anaerobic digestion) and dewatering prior to co-disposal in the landfill.

In developing likely options for sewage sludge management, it is clear from the above discussion that a number of considerations and constraints must be taken into account during decision-making, in particular those relating to the treatment plant location and siting aspects.

Factors such as energy use versus energy gain, capital and operating costs, and availability of final disposal options (eg, landfill) must also be weighed up.

2.7.2 Screenings and Ash Disposal

Screenings

Prior to 1980 it was common in NZ wastewater treatment plants to reduce the size of solids by macerating (comminuting) the waste stream at the inlet to the plant. However, the size-reduced rags and plastics could still form strings or balls, particularly when combined with fat and hair, leading to troublesome blockages in sludge processing equipment further along the process system.

Since 1980, it has become accepted practice to remove solids intact, by bar screens or milliscreens at the plant inlet. The screenings are collected by a screw or belt conveyor, sometimes dewatered by a press, and dumped in a bin for conveyance to a landfill for co-disposal.

One screenings incinerator has been installed at the Hutt Valley milliscreening plant.

Ash Disposal

Ash disposal from sludge incinerators needs appropriate attention as the ash may contain heavy metals from the sludges which may be released under certain conditions to contaminate the environment in which the ash has been disposed. Appropriate handling procedures within a landfill, eg, lime precipitation of heavy metals may be necessary.

2.7.3 Odour Control

Introduction

Sewage conveyance and treatment processes can be a source of objectional odours as, unfortunately, a number of case histories in New Zealand and elsewhere have shown.

Of particular concern and obviously of interest to those people who may live, work, or recreate in the vicinity of the treatment plant is the matter of odour potential.

Odour prevention, control and treatment are therefore all very important parts of a treatment plant siting, design and operation.

Suitable objectives pertaining to particular treatment plant sites will therefore need to be set. The overall objective will be to ensure that no odour nuisance arises outside the treatment plant boundary or buffer zone. There are established specifications and procedures for setting and monitoring odour detection and control limits and these would be applied in this project to particular sites.

Potential Sources of Odour

Generally, odour related to wastewater treatment processes tends to come from:

(a) formation of anaerobic conditions
(b) stripping of volatile compounds out of solution

The most common smell resulting is that of hydrogen sulphide, which is characterised as the smell of rotten eggs. However, other organic sulphide and amine compounds can occur to produce nuisance combinations of odours.

Although all unit processes within a wastewater treatment plant have potential for odour generation, the greatest potential impact relates to areas handling untreated wastewater and/or solids handling, ie, screenings and sludge areas.

Odour Prevention

Odour emissions can be prevented by appropriate attention to the design, detailing, operation and maintenance of potential odour generation elements of the plant. The procedures to control odour generation are:

- minimise turbulence of wastewater
- minimise turbulence and exposure of sludge flows to the atmosphere
- cover and ventilate all areas with potential for odour generation. This would include all head works, primary sedimentation tanks, biological filters, scum and sludge handling facilities. The sludge handling facilities should also incorporate air locks.
- for areas with a lower potential for any odour generation (eg, secondary treatment tanks) design and construct the plant with the facility for retrofitting covers, ventilation, and odour treatment if conditions change, or if proven necessary.
- provision of appropriate sealing and airlocking of rooms/facilities.

- provision of adequate ventilation and odour treatment plant, with appropriate duplication and/or standby plant.

- operation and maintenance programmes to provide for planned and regular cleaning and flushing of all surfaces, and the removal of any slime or sludge build ups, ie, a high standard of house keeping.

- location of ventilation air discharges in relation to site topography and climatic (wind) conditions.

Ventilation and Odour Treatment

Ventilation rates for all covered processes and enclosed buildings, are selected to provide:

- a safe and inoffensive working environment for staff working within the enclosure

- adequate odour control

- adequate humidity and corrosion control

- prevention of public nuisance

Odour treatment may be effected by either contact with an oxidising chemical, absorption onto carbon particles or biochemical absorption in a biofilter.

A number of odour treatment systems have been developed and proven. The most commonly used systems are:

a. absorption on activated carbon
b. absorption/conversion in biological soil or compost filters
c. oxidation in packed towers or spray mist towers by:

    - ozone
    - hypochlorite
    - chlorine dioxide
    - hydrogen peroxide
    - uv-generated ozone
    - other specialised chemicals (activated carbon)
    - or some combination of these

Activated carbon has not proved to be cost effective due to its high capital cost, the need to use wet scrubbers and physical fouling of the carbon particles by fat and grease carried over in the ventilated air stream.

Soil biofilters are an economical form of odour treatment, but require larger site areas. The recently commissioned soil biofilter at the Tahuna WPCP has a 900 mm deep bark/soil bed to reduce area requirements.

Oxidation in spray mist towers by hypochlorite solution is a successful technology used in the USA. However the European "standard", to achieve a high degree of odour removal is a 3 stage media filled scrubber with acid, alkali and hypochlorite stages in various combinations to suit the odours present on each site.

An integral part of residuals management is to appropriately treat ventilation discharge prior to release to the atmosphere.

2.7.4 Noise

Noise level standards would be set for treatment, pumping and any other items of plant to ensure appropriate low noise levels at specified locations such as working areas within a treatment plant, and the treatment plant boundary fence. District Scheme zoning conditions (or other) would need to be complied with.

The potential for noise disturbance from operating plants to residents and nearby workers is readily contained within acceptable limits. Choice of design and equipment, fitting silencers, and housing noisy equipment such as pumps and compressors in insulated structures, suitably isolated and screened within the working environment, are routine practices. The noise controls for the Tahuna soil filter fanhouse is a good example of what can be achieved.

During construction, noise control is more difficult. Nevertheless, there are standards recommended, contained in NZS 6803P:1984, "The Measurement and Assessment of Noise from Construction, Maintenance and Demolition Work". The recommended limits are set out in Table 2.7.1 below:

Table 2.7.1 : Recommended Upper Limits for Levels of Construction Work Noise Received in Residential Areas

Time Period	Noise Level (dBA)								
	Weekdays			Saturdays			Sundays and Public Holidays		
	L_{10}	L_{95}	Lmax	L_{10}	L_{95}	Lmax	L_{10}	L_{95}	Lmax
0630-0730	60	45	70	..	..	..	..	..	..
0730-1800	75	60	90	75	60	90	..	..	..
1800-2000	70	55	85	..	..	..	..	..	..
2000-0630	..	..	..	..	..	..	..	..	..

.. At these times the relevant provision of NZS 6802:1977 Assessment of Noise in the Environment shall apply. This may mean that no noisy construction work can take place during these hours.

Note: L_{10} is the noise level which is equalled or exceeded for 10% of the time.

L_{95} is the background noise level which is taken as that level equalled or exceeded for 95% of the observation time.

Construction noise could be an issue for short periods, particularly during excavation and spoil transport, and heavy metal fabrication. Working conditions, suitable equipment and time of working can be prescribed for all work having a potential to generate noise and dust.

2.7.5 Air Emissions

These could for example include boiler stack emissions, anaerobic digestion gas flare off (if this system is used), sludge incineration emissions, sludge drying equipment emissions, and others.

In all cases the provisions of the Clean Air Act and now the Resource Management Act would need to be followed and the best practicable method adopted for treatment of emissions. Examples include tall emission stacks, treatment by filters, scrubbing or soil filters, etc.

It should be noted that with increasing attention being paid to sludge incineration in a number of countries (particularly Japan and Europe where pressure on land is severely limiting) the air emissions standards are becoming increasingly stringent and accordingly the complexity and cost of the air pollution control equipment of sludge (and refuse) incineration has increased.

Part 3.0

Existing Dunedin Sewerage Systems and Impacts

PART 3.0 : EXISTING DUNEDIN SEWERAGE SYSTEMS AND IMPACTS

3.1 HISTORICAL OVERVIEW

This history of Dunedin's existing sewerage schemes stems from the late 1800s with the development of the central Dunedin City and Port Chalmers areas, both of which had combined (foul sewage and stormwater) sewerage systems installed with raw sewage discharged direct into the harbour. The history of the development of sewerage schemes throughout the wider Dunedin City area is that a number of individual local authorities have undertaken their own developments as time has progressed, and as public health needs and environmental concerns and demands have required. As far as sewage treatment is concerned the first plants were installed in the early 1960s, with all major plants now in use being constructed throughout the 1970s and 1980s.

While it is outside the scope of this study to provide a detailed historic overview it is appropriate, and necessary in many cases, to at least review the more recent history of treatment plants and disposal schemes (and associated approvals), as they have a direct bearing on options being evaluated.

Accordingly, in the following sections of this part of the report an historic perspective is given for each of the existing sewerage schemes. Furthermore in section 10.2.2 a historical review is given of the drainage system, and in section 11.1 a summary is included of the age of the various treatment plants. Appendix B includes additional details on the existing sewerage schemes.

3.2 SEWERAGE SCHEMES AND CATCHMENTS

The City Council currently operates 12 sewerage schemes, at:

- Waikouaiti-Karitane
- Seacliff
- Warrington
- Port Chalmers
- Burkes-St Leonards
- Tahuna
- Ocean Grove
- Company Bay-Macandrew Bay
- Portobello-Broad Bay
- Green Island
- Mosgiel
- Middlemarch

The following map (Figure 3.2.1) shows the location of each treatment plant and effluent discharge point. Also shown on this map are the locations of the major combined stormwater-sewage discharges into the upper harbour basin. At times of heavy rainfall, the capacity of some sewers and the Musselburgh Pump Station is exceeded, resulting in a mixture of stormwater runoff and wastewater overflowing into the harbour. The number of these outfalls has recently been reduced as the programme to separate stormwater from sewage in the central Dunedin area proceeds.

It is both useful and realistic to consider the main study area as comprising four major sewer catchments, although within these four these are obviously sub-catchments of significant importance, particularly around Otago Harbour. These catchments are shown in Figure 3.2.2.

MIDDLEMARCH
TAIERI RIVER OUTFALL
MOSGIEL
GREEN ISLAND WATER POLLUTION CONTROL PLANT
WALDRONVILLE OUTFALL
DUNEDIN
MUSSELBU
PUMPING S
DOSLI Map Licence No. 1991/59. Crown Copyright Reserved.

This study does not consider the northern schemes of Warrington, Seacliff, Karitane and Waikouaiti, nor the Middlemarch scheme. Furthermore the Mosgiel scheme is considered only to the extent of its possible further integration with the other main catchments, particularly the Green Island catchment.

The specific details of wastewater flows and quality from the four historic catchments, subject of this study, are provided in Part 9 of this report.

3.2.1 Harbour Basin (HB)

The Harbour Basin Catchment is the most easterly one of the four and presently encompasses four sub-catchments:

- Port Chalmers including Sawyers Bay
- Burkes including St Leonards
- Company Bay including Macandrew Bay
- Broad Bay including Portobello

The population of this catchment is presently estimated at 6,123 and this is not predicted to rise over the planning period adopted for this study. As can be seen from the map in Figure 3.2.2, the population is widespread with generally low density other than at community centres, with few industrial wastewater sources except around Port Chalmers/Sawyers Bay.

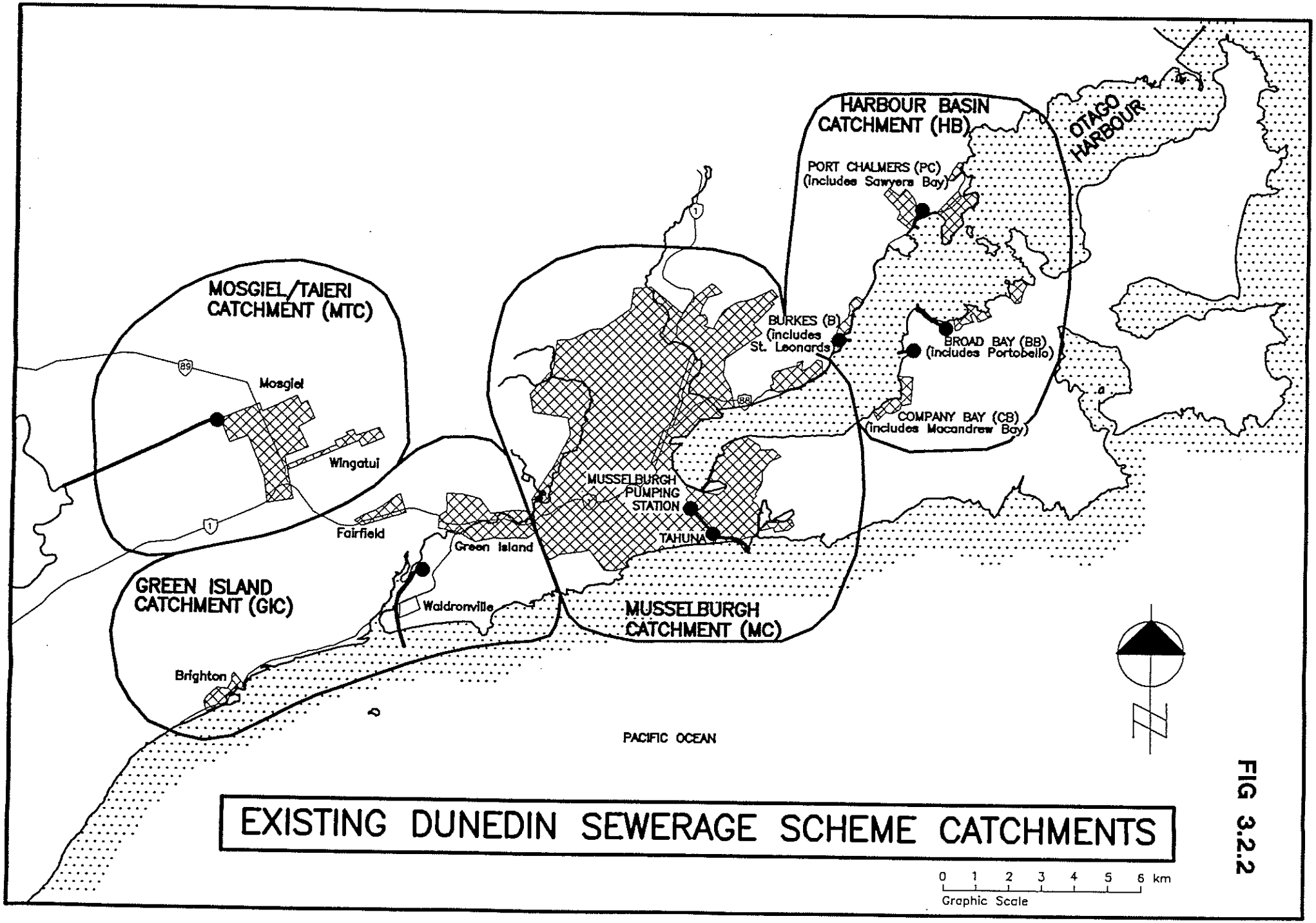
There are four separate treatment plants in the Harbour Basin catchment each with its own outfall to the harbour. The reason for grouping the four subcatchments under the same heading is principally because they all discharge effluent to the harbour and secondly because of their relative proximity to each other.

3.2.2 Musselburgh Catchment (MC)

The largest catchment both on a volume and area basis is the main city catchment. This is designated the Musselburgh Catchment. Practically all the sewage is collected at the Musselburgh pumping station for conveyance to the Tahuna Water Pollution Control Plant. This catchment stretches from Ravensbourne in the east to the upper sections of the Kaikorai Valley in the west, taking in the northernmost City suburbs of Wakari and North-East Valley, the seaside suburbs of St Clair and St Kilda, and the south side of Otago Harbour as far around as The Cove. For the purposes of this study, the small Ocean Grove catchment and separate treatment scheme is also included.

The population of this catchment is presently estimated at 81,027 and this is not expected to rise over the planning period adopted for this study. As can be seen from the map in Figure 3.2.2, the population is widespread with generally uniform density typical of New Zealand urban areas. There are quite a number of industrial wastewater sources.

The topographical nature of this catchment is varied, ranging from very flat sub-catchments around the harbour fringe through to the steeper hill sub-catchments which ring the central city area. The Main Interceptor Sewer (MIS) runs from the North East Valley to the Musselburgh Pumping Station.



EXISTING DUNEDIN SEWERAGE SCHEME CATCHMENTS

FIG 3.2.2

3.2.3 Green Island Catchment (GIC)

This is the second largest of the four catchments both in terms of area and of sewage volume. It is, essentially, the industrial catchment of Dunedin including as it does the major part of the Kaikorai Valley and Green Island industrial estates. As an extension of the traditional catchment boundaries, the Green Island Outfall at Waldronville also accepts treated effluent from the Fortex Meatworks near Mosgiel, tradewastes from two other Mosgiel wet industries (Alltex International Yarns and Euro NZ Scours Ltd) and sewage from Wingatui. These wastes are conveyed to the Green Island Basin through the Tunnel pipelines.

This catchment is of similar type to the Harbour Basin catchment in that it is quite wide-ranging and takes in several communities such as Fairfield, Brighton, and Waldronville which are remote from its major central core.

This feature is reflected in the population density which ranges from normal urban development to rural settlements. The population of this catchment is presently estimated at 11,100 and this is not predicted to rise significantly over the planning period adopted for this study. However, of any area within greater Dunedin this is the area which could expand in terms of both domestic and industrial loadings. As can be seen from the map in Figure 3.2.2, the population centres are widespread and there are numerous industrial wastewater sources, some particularly large with strong waste loads.

3.2.4 Mosgiel/Taieri Catchment (MTC)

This catchment is complicated in that while it has distinctive catchment boundaries a lot of the wastes generated within it are conveyed to the Green Island Catchment for treatment and/or disposal (see above). The balance of the sewage and tradewastes are treated on the outskirts of Mosgiel with the secondary effluent discharging to the Taieri River. The inclusion of this catchment in the study is limited to those cases where the balance of the wastewater now being treated and going to the Taieri River is instead transferred to another catchment for ultimate disposal.

The population of this catchment is presently estimated at 13,500 and this is not predicted to rise significantly over the planning period adopted for this study. The Mosgiel area, however, does have the potential to expand, with new urban housing developments opening up. Increased wet industry is limited by lack of treatment and disposal capacity for these wastes at the Mosgiel plant, and would likely have to be transferred into the Green Island catchment. As can be seen from the map in Figure 3.2.2, the population centre is fairly compact, with several outlying small housing clusters also being serviced by the Mosgiel sewerage system.

3.3 TAHUNA PLANT AND LAWYERS HEAD OUTFALL

Of the 12 systems, the Tahuna plant discharges the greatest daily volume of treated sewage and sludge to the environment. The scheme serves Central Dunedin.

3.3.1 History

This scheme presently encompasses the Tahuna Water Pollution Control Plant and the Lawyers Head outfall, the latter having been in use since 1908.

From 1908 to 1981 (when the Tahuna Plant was commissioned) raw, and later comminuted (shredded), wastewater was continuously discharged from Lawyers Head.

As a consequence of the commissioning of the plant in 1981 a significant reduction in the discharge of gross solids, floating material and other wastewater pollutants being discharged into

the ocean at Lawyers Head has been achieved. This has resulted in a substantial improvement in the environmental quality at Lawyers Head and nearby beach shorelines.

3.3.2 Treatment Plant

The treatment plant is located in Tainui close to Lawyers Head. It is situated in a residential area and is readily visible to residents with the nearest residence being situated approximately 30m from the plant.

The plant discharges primary treated wastewater to the sea. The plant provides comminution, screening and primary sedimentation. The sewage sludge is incinerated and ash discharged to sea, although some, in a dewatered form, is trucked to the Green Island landfill. Incinerator gases are passed through a recently installed soil filter and the residual gases are released to the atmosphere. Further odour control upgrading is proposed. The wastewater discharge is licensed under an existing use notification and formal water right conditions do not exist. Limited information exists on its environmental impact.

At times there has been some carryover from the plant of neutrally buoyant plastics and other materials and these have been observed on the immediately adjacent beaches from time to time. The recent installation of mesh screens at the Tahuna Plant has substantially reduced the discharge of these materials during normal operation.

Recent improvements (April 1991) in sludge dewatering and handling capacity have resulted in the continuous operation of 3 sedimentation tanks rather than previously where only 2 sedimentation tanks were used. This has resulted in an increase in the removal of solids and grease thus reducing further the amounts of these materials being discharged at Lawyers Head. The previously characteristic "grease lines" that appeared from time to time in the past within the intertidal zone on Tomahawk Beach (DCC weekly inspection data and photographs) have also in consequence been reduced.

Distinctive sewage odour was common near the plant and adjacent areas, and still is at Lawyers Head. Complaints, at particular times of the year, from nearby residents have been extensive, and therefore recently a soil filter has been incorporated into the plant to address the problem. Since its commissioning minimal odour is now experienced from the plant site.

Bypass: By design the plant is bypassed in times of very heavy rain and at such times the screening apparatus for removing neutrally buoyant plastics etc is bypassed. The effluent still passes through coarse screening at the Musselburgh Pumping Station. This leads to the appearance of plastics of sewage origin and other particulate matter on city beaches, particularly Tomahawk. Wet weather flow also leads to the entry of stormwater into the foul sewer system and subsequent entry by overflow to the Otago Harbour from the combined sewer system. This is being reduced under the Council's present programme.

At certain times of the year maintenance requirements mean that only 2 sedimentation tanks can operate. This time is kept to around 2 weeks per year. However, during this period sedimentation is lower and the suspended solids concentrations are greater in the effluent. The plant is bypassed for up to one week per year for annual maintenance and cleaning of the sludge thickener. Coarse screened sewage is discharged to the sea at Lawyers Head during this period resulting in an increase in floating material including plastics, increased solids and greases plus other pollutants.

3.3.3 Outfall

The effluent is discharged to the sea (via two outlets - one on each side of Lawyers Head) at the base of the cliffs at Lawyers Head. There is no outfall or diffuser - it is a shoreline point

discharge at the extremities of a small peninsula. While there is good initial dilution subsequent dilution is more limited. The effluent field is almost always visible from the top of the cliffs at Lawyers Head and a smell of sewage is noticeable.

3.3.4 Effluent Quality

Effluent quality is monitored for a limited range of parameters by DCC, including: faecal coliforms, suspended solids, grease and heavy metals. These results show:

- faecal coliform concentrations are typical of primary effluent (approximately $2x10^7$ per 100 ml).
- concentrations of heavy metals, grease, suspended solids and BOD are relatively low.

3.3.5 Environmental Impacts

Recreational Use :

The extensive beach, rocky shore and coastal waters in the vicinity of the outfall are used for recreation.

Swimming: Shoreline waters in all the beach areas to the north and south are used for swimming. Perceived pollution, rips and poor access limit the number of swimmers at Tomahawk. However, usage is greatest at Smaills, St Kilda and St Clair beaches. Surf lifesaving clubs operate at St Kilda and St Clair. Water is taken from the sea at St Clair to fill the St Clair salt water pool during summer months.

Surfing: Smaills, St Kilda and St Clair beaches are popular surfing beaches close to Dunedin. Dunedin is one of those few cities where good surf-breaks are situated within the city boundaries and the St Clair beach is often used for surf championships. Usage is dependent on swell and wind conditions. At times the presence of sewage in the water (predominantly grease, odour and taste) is reported by surfers, particularly during NE swell conditions. Tomahawk Beach and Lawyers Head are also good surf breaks but their use is restricted because of sewage pollution. All of these beaches are also used by windsurfers.

Skin-Diving: The rocky reef areas in the outfall vicinity especially around St Clair, Tomahawk Reef, Bird Island and Maori Point are popular for food collection and sight-seeing. Sewage pollution (particulate, odour and taste) has been occasionally reported by divers at all these locations.

Wading, Fishing, Shellfish Collection and Fossicking: The intertidal area at Lawyers Head, St Clair, Tomahawk Reef, Bird Island and Maori Point is used by people to collect food (generally seaweeds and mussels) and for sightseeing. Fishermen regularly fish from the rocks at St Clair and Maori Point.

Picnicking/Walking/Sitting: All of the beaches are used extensively for these more passive forms of recreation.

Commercial Use :

Fishing: The coastal area is fished commercially, primarily for crayfish but it is also trawled for wetfish.

Rafting: A commercial rafting company operate a coastal tour facility from Mid-Beach near St Clair.

Wastewater Movement Following Discharge :

The buoyant effluent discharged from the shoreline outfall is diluted as it flows north or south with the inshore current. The predominant current is considered to be up the coast. Monitoring of faecal coliforms in seawater by DCC indicates the following:

- the effluent field can be carried with the inshore current both north and south of the outfall area. Predominantly the effluent field is carried northward up the coast.
- the direction of the inshore current seems to be dependent on a combination of the wind strength and direction, plus the swell height and direction.
- a strong NE wind does not necessarily turn the current to flow south if a large southerly swell is occurring. Likewise a strong NE swell can turn the current to flow south in southerly wind conditions.
- the effluent field frequently reaches the surf zone at Tomahawk Beach and on occasions at St Kilda Beach. At times it reaches both beaches.
- the effluent field can extend to St Clair Beach during NE swell and wind conditions - but at present monitoring has only extended to mid-beach between St Kilda and St Clair (monitoring has just been commenced at St Clair).

Water Quality and Other Impacts:

Monitoring of faecal coliform concentrations at beaches to the north and south of the outfall have been undertaken by DCC at weekly intervals for a number of years. Sampling sites have included Tomahawk Beach (2 sites), Lawyer's Head and Mid-Beach (or Moana Rua). Analysis of the data indicates the following features:

- during the period July 1990 to June 1991 the faecal coliform concentration at mid-beach (ie. Moana-Rua, 3km south of the outfall) exceeded currently-accepted bathing water bacteriological criteria of 200 MPN/100ml in 32 of the 45 weekly samples. At Lawyer's Head, in the small bay immediately to the south of the outfall, the level was exceeded in 35 of the 45 weekly samples.

- FC concentrations were greatest in the beaches to the south on 13 occasions out of the 45 weekly samples.
- in the previous year (July 1989 to June 1990) the faecal coliform concentration at mid-beach (ie. Moana-Rua, 3km south of the outfall exceeded 200 MPN/100ml in 18 of the 45 weekly samples. At Lawyer's Head, in the small bay immediately to the south of the outfall, criteria were exceeded in 25 of the 45 weekly samples.
- FC concentrations were greatest in the beaches to the south on 8 occasions out of the 45 weekly samples in the 1989-1990 year..
- FC concentrations at St Clair Beach exceeded 200 MPN/100ml in 2 samples out of 14 (Otago Regional Council 1990 data). These criteria were exceeded only during NE wind and swell conditions.

The impact of other sources of faecal coliform contamination such as stormwater, however, also needs to be considered when addressing causes.

The guideline criteria for FC concentration in shellfish harvesting waters (ie. 14 MPN/100ml) was exceeded in 41 out of 46 weekly samples taken during the period June 1990-91 at Mid-Beach.

No analyses on shellfish quality have been performed but based on the results from the mussel testing at Blackhead some contamination of local shellfish would be expected in adjacent rocky shore areas. Similarly, no survey of the existing ecology has been undertaken. In the immediate outfall vicinity both rocky and sandy intertidal and subtidal communities of marine aquatic biota would be expected. Sediments have not been sampled but the rugged inshore coastline indicates that in-shore accumulation of contaminants would be unlikely.

While open coastal waters are generally nutrient deficient there has been concern expressed that the effluent field may be contributing nutrients to the Peninsula estuaries to the north of the outfall (ie. Hoopers and Papanui Inlets). Both are relatively poorly flushed, are closed at times, and are exhibiting signs of extensive eutrophication. Hoopers Inlet is closest to Lawyers Head, approximately 14 km north east . Dilution of the effluent field over this distance is likely to be high and consequently it is unlikely that the cause of the eutrophication is from this source.

3.4 OCEAN GROVE SCHEME

Of the 12 systems the Ocean Grove land disposal scheme is small in terms of daily volumes of wastewater discharged. Its average dry weather flow (ADWF) is 0.4% of that from the largest plant, Tahuna.

In the early 1960s development of the then township area reached a point that a reticulated sewerage scheme was required for maintenance of public health and sound sanitation.

3.4.1 Treatment Plant

The treatment plant was established in the early 1960s and is located on the coast in the sandhills at the back of Ocean Grove. It is not visible from residences in the area but is situated only 50m from the nearest residence.

The plant discharges secondary treated domestic sewage to a small pond/groundwater disposal area. The plant treats the sewage using a comminutor and a Pasveer Ditch (extended aeration activated sludge). Excess sludge is dried in beds and land-filled. Odour and noise problems do not occur. The plant meets its design performance standards as confirmed by effluent monitoring data.

Because the discharge is licensed under an existing use notification, formal water right conditions do not exist. As a consequence, limited information exists on its environmental impact.

3.4.2 Land Disposal System

The effluent is discharged into a small pond that is in contact with groundwater. Consequently the effluent does not accumulate on-site but drains away towards Tomahawk Beach located 100m to the east. A local resident indicates that the small pond discharges to an underground stream. The plant and disposal area are fenced and well-sign posted to inform the public of potential health risks.

3.4.3 Environmental Impacts

The sandhill area that receives the effluent discharge has a potentially high use for recreation. It is situated on a city beach that at present is polluted with effluent from the Tahuna treatment plant. Because of this masking effect, the impact of the Ocean Grove system on this environment is therefore difficult to characterise.

3.4.4 Note:

For the purposes of the rest of this report, the Ocean Grove Scheme will be considered as part of the Musselburgh Catchment.

3.5 GREEN ISLAND PLANT AND WALDRONVILLE OUTFALL

Of the 12 systems the Green Island scheme is the second largest in terms of daily volumes of wastewater discharged. Its average dry weather flow (ADWF) is 14% (to 27% with Fortex included) of that from the largest plant, Tahuna. This wastewater is discharged to the open sea behind Waldronville.

The system encompasses one "centralized scheme" to service a number of communities (combined population approximately 11,100) and significant industrial (trade waste) discharges.

In summary the scheme serves:

The Green Island Community
The Fairfield Community
The Waldronville Community
The Brighton/Ocean View Community
The Wingatui and Gladstone Communities
The Green Island trade wastes
The future provision for Fairfield area trade wastes
The Woolscour and Textile manufacturing trade wastes from Mosgiel
The Fortex discharge which uses the outfall only at present.

Extra capacity is available should other inputs be included (eg part of the Kaikorai Valley catchment of the former Dunedin Drainage and Sewerage Board Scheme) and has provision for further domestic, commercial and trade waste discharges.

3.5.1 History

Prior to 1989, raw domestic sewage and untreated/uncontrolled trade wastes were discharged from the Green Island area onto the Waldronville Beach at about the low tide area. Photographs and beach monitoring record this most unattractive and unsatisfactory position.

In addition:

- Waldronville's treated effluent was discharged into the Kaikorai Estuary.
- Fairfield's treated effluent was discharged into Abbots Creek and thence the upper Kaikorai Estuary. In its latter years this plant was well overloaded.
- Brighton and the Ocean View area did not have a reticulated sewerage scheme. The on site disposal systems that operated at that time created the potential for public health problems.
- Wingatui and the Gladstone Road area of the Upper Taieri plains did not have a reticulated sewerage system. The many ineffective on site septic tanks and other disposal systems resulted in major effluent disposal problems within the community.
- Some Mosgiel industries were having difficulties meeting discharge requirements with consequent deterioration of the Taieri River.

The Green Island scheme replaced or eliminated the need for three discharges into inland or estuary water, reduced the pollution load into the Taieri River and eliminated the need for a disposal system for Brighton. It has also substantially cleaned up the Waldronville Beach and adjoining coastline.

A major impact of the scheme, therefore, is that it has provided enhanced public health protection, sizeable measures of environmental improvement and protection, and also general community wellbeing including the ability for trade-waste-producing industries to continue operation and in fact further establish in the area.

In the following discussion further impacts of the scheme are discussed in some detail. These should be considered in the light of the above.

3.5.2 Treatment Plant

The treatment plant is located on the eastern margin of the Kaikorai Estuary just downstream from the Green Island landfill site. Approvals for the plant and discharge were granted on the understanding that a two stage system, an "Advanced Primary Treatment Plant", would be provided. Stage 1 would incorporate grit removal and milliscreening to 1.0mm size and Stage 2, high rate sedimentation and entrained (or dissolved) air floatation. Unfortunately, the second stage was not constructed principally because of the closure of the Burnside Freezing Works. As a consequence removal of settleable solids and grease is not as effective as originally planned.

The plant is visible to residents on the opposite side of the estuary at Fairfield. The nearest resident is situated approximately 500m distance from the plant.

Screenings are landfilled on-site (drying beds, screenings to landfill and leachate to wastewater treatment). Screenings have not been monitored for their potential hazard to the environment.

Odour emanating from the Fortex connection, immediately downstream of the wastewater treatment plant, is a problem at times. Fortex is presently fine-tuning its treatment systems to improve the situation and the Council are considering odour control at the pipeline junction.

Commissioning problems with the plant arose as a result of trade waste breaches. Washover of the milliscreens caused by blinding with trade-wastes was a major problem. The cause has since been identified and at present is being controlled by further pre-treatment of the offending trade waste. At times of washover, screens were by-passed and raw sewage discharged to the sea. This was occurring for 1-3 hrs on a daily basis but does not now occur. Assisting industry to implement a solution was part of the commissioning process undertaken by Council.

3.5.3 Outfall and Diffuser

The mixture of milliscreened and Fortex meatworks (treated) effluent is discharged to the sea behind Waldronville via a 500m outfall to beyond the surf zone. The final 70m consists of a diffuser discharging into 5-7m of water via 12 (of the 30 available) ports. Monitoring of diffuser performance in 1991 showed that the initial dilution of the waste, where it first reached the surface under calm conditions, was not less than 58 times. Water right conditions require a minimal initial dilution of 24 times. Of concern, however, is the periodic burying of many of the diffuser ports and the operation of a limited number only. In the period June to October 1990 much of the diffuser was buried by sand. Again in June this year the diffuser was partly buried and only 5 ports were open. These ports were those which had risers installed on them last year. Such conditions have reduced diffuser efficiency over that originally designed. Further modifications are possible to improve performance both in terms of avoiding sand blockages and in improving hydraulic characteristics.

3.5.4 Effluent Quality

Effluent quality is monitored regularly for a wide range of parameters. The concentrations and loadings of these parameters are controlled by water right limits. Limits are based on international criteria for the protection of sensitive marine organisms. The results of the 1990 effluent monitoring indicate compliance with all water right conditions except:

- suspended solids (effluent mean of 950 g/m^3 compared with water right limit of 600) which are exceeded on almost all occasions during weekdays.

- fats and grease have no numerical water right limit but are included in the general narrative condition requiring that the discharge shall not cause particulate floating or particulate deposited to be visible outside a zone of 250m radius from the centrepoint of the diffuser. However, this condition is not monitored to an extent sufficient to characterise compliance. Effluent concentrations of fats, grease and oils (mean of 462 g/m^3) are high relative to many other sewage discharges (typical urban effluent post milli-screening is 50-60 g/m^3). Fats and grease are sometimes apparent as a slick on the water surface and can be carried for large distances (well outside the 250 m radius). They have been seen at Blackhead and near Green Island.

3.5.5 Environmental Impacts

Aquatic Biota :

In terms of the aquatic environment occupied by the effluent field the aquatic biota are the most affected, and three broad areas of habitat are important:

- rocky substrate including a wide range of inter and subtidal plants and animals,
- sandy substrate, which includes the major area of benthic sediments within the outfall vicinity (this harsh environment has few inhabitants) and
- water column, which is inhabited by a diverse range of plants and animals.

Recreational Use :

The extensive beach, rocky shore and coastal waters in the vicinity of the outfall are used for recreation.

Surfing: Blackhead, situated 2 km to the NE of the outfall, is a popular surfing beach close to Dunedin. It is reputed to be one of the best surf-riding breaks in the South Island. In the past it has been the venue for both the South Island and NZ Surf Championships. Usage is dependent on swell and wind conditions. At times the presence of sewage in the water (predominantly grease, odour and taste) is reported by surfers. In the past, complaints were more common and they related to grease particles and animal and human faeces in addition to those mentioned above.

Skin-Diving: The rocky reef areas in the outfall vicinity especially around Blackhead and Green Island are used for food collection and sight-seeing. Sewage pollution (particulate, odour and taste) have been reported by divers at Blackhead. No aquatic ecological impact assessment has been undertaken for Green Island (a small island 2.5 km offshore), but a survey of marine bird-life was undertaken for pre-water right investigations.

Swimming: Shoreline waters in the area are used for swimming but usage is generally low. Perceived pollution, rips and limited access are known deterrents.

Wading, Fishing, Shellfish Collection and Fossicking: The intertidal area at Blackhead is used by small numbers of people to collect food (generally algae and mussels) and for sightseeing. Fishermen regularly fish from the rocks at Blackhead. At times canoeing and other boating activities are undertaken in the area.

Picnicking/Walking/Sitting: The beach is used for these passive forms of recreation. It is less popular than inner city beaches. Health risk may be associated with particulate matter, such as "pinhead" grease washed up on the beach at times. The position, as previously outlined, has substantially improved over the former raw sewage discharge onto the beach at the low tide level. At times, naturally occurring marine algal detritus is washed up onto the beaches in the area and can be mistaken for sewage material.

Commercial Use :

Fishing: The coastal area (particularly near Blackhead and Green Island) is fished commercially, primarily for crayfish. Crayfish live, feed and spawn on the rocky reef areas near Blackhead. Wetfish species are caught closer to the outfall by trawl nets dragged over the soft sediments. The majority of these species are capable of spawning in the outfall area and therefore it is likely that their microscopic pelagic larvae, which are extremely sensitive to pollution, will be present in the surface waters at times.

Rafting: A commercial rafting company operates a coastal tour facility from Mid-Beach near St Clair. Their tour path includes the Blackhead area.

Wastewater Movement Following Discharge :

The buoyant effluent discharged from the diffuser ports is diluted by surrounding seawater prior to reaching the surface (58:1 times at present when all ports are open) and is diluted further as it flows north or south with the inshore current. The predominant current is up the coast (generally around 4-6 cm/s or about 0.1 knots).

Although detailed monitoring has not been undertaken there is some evidence to indicate that "the effluent at times causes the alteration of the turbidity or colour of the receiving water to a conspicuous extent when viewed from land" (water right condition 7).

The existing data indicates the following features:

- the effluent field can be carried with the inshore current both north and south of the outfall area.
- the direction of the inshore current seems to be dependent on a combination of the wind strength and direction, plus the swell height and direction.
- a strong NE wind does not necessarily turn the current to flow south if a large southerly swell is occurring. Likewise a strong NE swell can turn the current to flow south in southerly wind conditions.
- the effluent field enters the surf zone of Blackhead Beach for a portion of the time. At times it moves onto beaches to the south.

Water Quality and Other Impacts :

Monitoring of faecal coliform concentrations at beaches to the north and south of the outfall have been undertaken by DCC at weekly intervals for a number of years. Sampling sites have included Westwood Beach, Kaikorai Estuary mouth, Beachlands (2 sites), and Blackhead (2 sites).

- during the period December 1989 to December 1990 the faecal coliform concentration at Blackhead (2000m NE of the outfall) exceeded 200 MPN per 100ml in 21 of the 46 weekly samples. A more rigorous analysis of the results would be required to assess how often the standards were not met. Factors such as inputs from other sources (eg. Blackhead Stream and Kaikorai Estuary) would need to be included. At Westwood Beach (2 km SW of the outfall) criteria were exceeded in 8 of the 46 weekly samples.
- in the previous year (February to March 1989) the faecal coliform concentration at Blackhead exceeded 200 MPN per 100ml in 4 of the 12 samples. At Westwood Beach criteria were exceeded in 3 of the 12 samples.
- in the period 1978-81 (when raw sewage was discharged onto the beach at Waldronville) the FC count at Blackhead exceeded 200 MPN per 100ml on 17 out of 37 occasions.
- high FC concentrations were found in Kaikorai Estuary on most sampling occasions. The likely cause was from bird droppings and catchment runoff.

NZ criteria for FC concentration in shellfish harvesting waters (ie. 14 MPN/100ml) was exceeded in 38 out of 46 weekly samples taken at Blackhead during the period December 1989 to December 1990. In March-April 1989 it was exceeded 10 out of 15 samples.

Analysis of contaminants present in mussels taken from Blackhead on one occasion each year since 1988 indicate the following;

- no significant heavy metal contamination (ie. cadmium, chromium, copper, lead, nickel and zinc),
- no contamination with enteroviruses or Salmonella
- faecal coliform concentrations in mussels (range 400-35,000 FC per 100g) exceed the New Zealand Department of Health (1985) guideline for FC allowable in shellfish (ie. 230 FC per 100g).

The possible contributions from other sources would need to be examined before causes were accurately identified.

Mussels from Brighton also exceeded guidelines in 1990 (860 FC per 100g) - possibly the result of local runoff and stream inputs.

An ecological survey of the intertidal rocky shore at Blackhead (and a perceived control site at Brighton) has been undertaken bi-annually since 1988. Comparisons of the results show no readily identifiable differences in either species composition or abundance which cannot be explained by natural variables.

Sediments have been sampled from transects located parallel to the outfall pipe at 250m and 2km on either side of the pipe. On each transect samples were taken from mid-tide, low-tide, 450m offshore and 700m offshore. Analyses showed no evidence of a build-up in organic carbon or nitrogen in these samples (since March 1989), as predicted in the initial water right investigations.

3.6 PORT CHALMERS PLANT AND SAWYERS BAY OUTFALL

Of the 12 systems the Port Chalmers scheme is the fourth largest in terms of daily volumes of wastewater discharged. Its average dry weather flow (ADWF) is 3% of that from the largest plant, Tahuna. The effluent is discharged to the Otago Harbour at Sawyers Bay.

The Port Chalmers scheme serves the catchments of Port Chalmers, Careys Bay, Sawyers Bay and Roseneath. There are proposals that Deborah Bay will also be connected to the scheme soon. Trade wastes from the Container Port, a tannery, fish processors (and in the past a woolscour) also utilise the plant.

3.6.1 History

Prior to 1970 the Port Chalmers area had combined sewers which discharged through a number of outfalls at the harbour edge. This was of particular concern in that the discharge was in the confines of a food exporting port area. In the early 1970s a programme of separating the combined sewers began. Foul sewer lines were laid to convey sewage to a new secondary treatment plant in Sawyers Bay. Sawyers Bay was reticulated in the 1960s with treatment to a "Pasveer Ditch". The new two stage biological secondary plant was built on this site. When installed this was one of the most advanced treatment concepts existing in New Zealand at that time.

The extensive programme undertaken by the Port Chalmers Borough Council also involved new reticulated sewerage schemes being installed in Careys Bay and Roseneath in the early 1970's.

3.6.2 Treatment Plant

The treatment plant was established in 1975-79 and is located in Sawyers Bay. It is situated in an industrial area and is visible to residents. The nearest resident is situated approximately 300m distance from the plant.

The plant discharges secondary treated industrial and domestic sewage to the sea and sewage sludge to landfill. The plant provides primary and secondary sedimentation and biological filtration. Water rights for the discharge are presently under review. Suspended solids and BOD concentration limits on the existing short term right are exceeded for the majority of the time. Limits are not applied to any other parameters.

Sludges are treated on-site (anaerobically digested, gas used for heat and remaining solids landfilled locally) and some odour problems have been noted. Sludge composition has not been monitored but it is likely that it contains elevated chromium levels.

The plant is at present not consistently meeting design BOD_5 and suspended solids effluent concentrations. The input of high strength tannery wastes is the major cause. During heavy rain overloading occurs.

3.6.3 Outfall

The outfall was constructed in 1970 to meet the then necessary approvals. The effluent is discharged to Sawyers Bay via a shoreline outfall that discharges to the intertidal zone. No diffuser is present . As such dilution with receiving waters is not actively encouraged. The effluent field is generally visible in the bay as greyish brown discoloration at all stages of the tide.

3.6.4 Effluent Quality

Effluent quality has been monitored recently for a wide range of parameters by DCC. Compared with typical urban sewage after secondary treatment the Port Chalmers effluent had elevated concentrations of BOD_5, suspended solids, grease, nitrogen and phosphorus. Concentrations of the heavy metals chromium, cadmium and lead were also elevated relative to other municipal discharges in New Zealand. However, in comparison to heavy metal concentrations in the Green Island discharge only chromium was higher in the Port Chalmers effluent.

3.6.5 Environmental Impacts

Aquatic Biota :

A wide range of biota use the Sawyers Bay area. They include birds, shellfish, fish, algae, phytoplankton, zooplankton and a wide range of benthic organisms. Overabundant growth of seaweed in the bay indicated that nutrient inputs were excessive and the bay was eutrophic. The majority of sediments in Sawyers Bay were of the fine-mud type, organically enriched, and anoxic. In summer they released hydrogen sulphide. These muddy sediments were concentrated around the outlets of the two main input streams and the sewage outfall and extended as a thick blanket out into much of the bay. The communities present in these sediments were dominated by pollution-tolerant, small burrowing polychaete worms.

In comparison to the high diversity of species in Otago Harbour "mud communities" that were relatively isolated from point sources of pollution, those in the Sawyers Bay were low, which indicated that the community was exposed to some form of stress. Species diversity was very low in the immediate vicinity of the outfall.

Recreational Use :

Sawyers Bay is a relatively enclosed coastal bay within the upper harbour basin. It is surrounded by both residential and industrial land. The bay is used for boating, swimming, fishing, wind-surfing, picnicking, fossicking, etc. A variety of Otago schools also use the bay extensively for canoeing and boating experience, using the facilities of the Port Chalmers School. Its potential is somewhat under-utilised as a result of the very noticeable signs of sewage pollution (odour, taste, and visual) and muddy organic rich sediments in the area.

Wastewater Movement Following Discharge :

There is minimial dilution of the effluent once it is discharged into the bay/onto mudflats at low tide. At high water the effluent field is concentrated in the northern quarter of Sawyers Bay. As the tide goes out it spreads further south.

Water Quality and Other Impacts :

Sawyers Bay shows elevated levels of plant nutrients (both nitrogen and phosphorus), suspended solids, faecal coliforms and at times grease. Heavy metal concentrations of the water were all below international criteria for the protection of sensitive marine biota.

Nitrogen is expected to be the plant nutrient that is in shortest supply in the Bay. The input in the sewage effluent is likely to be exacerbating the nuisance weed growth problem. Annual sewage loadings of nitrogen to the bay are estimated to be approximately 6 to 10 times greater than the combined loadings from streams and land runoff in the catchment. Sulphide concentrations were often higher in the Bay water than in the effluent indicating its eutrophic nature. It is to be noted that the quality in the Bay has improved since the 1970's when the tannery discharged independently of the sewage plant.

Faecal coliform (FC) concentrations in isolated pockets of shellfish (cockles) close to the outfall (4300 per 100g) greatly exceeded the New Zealand Department of Health (1985) guideline for FC allowable in shellfish (ie. 230 FC per 100g). FC concentrations in the more extensive cockle beds further away from the outfall also exceeded these criteria.

NZ criteria for FC concentration in shellfish harvesting waters (ie. 14 MPN/100ml) was exceeded at all sites sampled in Sawyers Bay.

Unlike the relatively low levels of metals recently measured in the water column, the sediments of the bay showed significant contamination. Heavy metal analyses of the sediments in the past (early 1980) in Sawyers Bay indicate very high levels of chromium and elevated levels of other metals (probably from industrial point source discharges to the bay). More recent analyses have been performed but results have not yet been processed.

3.7 PORTOBELLO - BROAD BAY SCHEME

Of the 12 systems the Portobello - Broad Bay scheme is small in terms of daily volumes of wastewater discharged. Its average dry weather flow (ADWF) is 0.6% of that from the largest plant, Tahuna. The effluent is discharged to the Otago Harbour at Grassy Point.

3.7.1 Treatment Plant

The treatment plant was established in the late 1980s. It is located in Camp Rd and is relatively isolated from residential areas.

The plant discharges secondary treated domestic sewage to the sea and sewage sludge to the Tahuna Plant. The plant provides secondary treatment by the extended aeration activated sludge process. The effluent is subsequently held in a tank to allow for ebb tide discharge only.

Water rights for the discharge require that the effluent not exceed 20 g/m^3 BOD_5, 30 g/m^3 suspended solids and 1 x 10^6 per ml faecal coliforms (geometric mean of 5 consecutive fortnightly samples). Recent monitoring data indicates that these levels are consistently met and only occasionally exceeded.

Sludges are treated on-site (aerobically digested) and remaining solids trucked to the Tahuna Plant. No odour problems are apparent. Sludge composition has not been monitored but is not expected to contain potentially hazardous chemicals.

3.7.2 Outfall

The effluent is discharged to the eastern channel at Grassy Point via a 100m long outfall. The end section consists of a 6m long diffuser with 5 ports discharging at a depth of approximately 4m. The effluent field is not generally visible in the harbour. Unlike Sawyers Bay, Grassy Pt is exposed and well flushed. Contaminants are not expected to accumulate in the area.

3.7.3 Effluent Quality

Effluent quality has been monitored since commencement of discharge for a range of parameters by DCC. The Portobello effluent was similar to that of typical urban sewage after secondary treatment.

3.7.4 Environmental Impacts

Aquatic Biota :

A wide range of biota use the Grassy Point area. They include birds, some shellfish, fish, algae, phytoplankton, zooplankton and a wide range of benthic organisms.

Recreational Use :

The receiving environment has aesthetic appeal and is used at times for windsurfing, boating, fossicking and collecting seaweed.

Wastewater Movement Following Discharge :

The buoyant effluent discharged from shoreline outfall is diluted to some extent as it flows out into the harbour. Without receiving water data only the pre-commissioning predictive data is available. It indicated that most of the effluent would enter the eastern channel but at times some may move into the Broad Bay area. It is unlikely that bathing standards would be exceeded at Broad Bay as a result of the discharge.

Water Quality and Other Impacts :

The water right requires extensive monitoring at 2 monthly intervals of the receiving environment. This includes sampling for BOD, SS, FC, TP and TN at 6 sites in the vicinity of Grassy Point and more work is needed to determine the effect on the environment.

Faecal coliform samples taken from shoreline sites at Grassy Pt indicated that bathing standards were almost always met but shellfish harvesting criteria were often exceeded. At Raynbird Pt

(about halfway between the Company Bay outfall and Grassy Pt) criteria are exceeded more often.

Abundant accumulation and growth of seaweed at Grassy Pt has been noted but possibly this may have always occurred. It decays in the intertidal area and creates an odour problem to passing motorists. Ecological surveys have not been undertaken in the area but it is expected that both sand and rocky shore communities would be present.

3.8 COMPANY BAY - MACANDREW BAY SCHEME

Of the 12 systems the Company Bay - Macandrew Bay scheme is small in terms of daily volumes of wastewater discharged. Its average dry weather flow (ADWF) is 0.8% of that from the largest plant, Tahuna. The effluent is discharged to the Otago Harbour at Company Bay.

This scheme serves the Company and Macandrew Bay catchments.

3.8.1 Treatment Plant

The treatment plant is located near the outfall in Company Bay. It is situated in a well populated residential area and is easily visible to residents. The nearest resident is situated approximately 100m distance from the plant.

The plant discharges secondary treated domestic sewage to the Otago Harbour and sewage sludge to the Tahuna Plant. The sewage is treated in a primary sedimentation tank, a biological filter and a secondary sedimentation tank. This plant has served the needs of the community well for over 20 years. The plant has become overloaded as a result of stormwater inputs.

Because the discharge is licensed under an existing use notification, formal water right conditions do not exist. As a consequence, limited information exists on its environmental impact.

Sludges are treated on-site (anaerobically digested) and remaining solids trucked to the Tahuna Plant. Odour problems are sometimes apparent.

3.8.2 Outfall

The effluent is discharged to Company Bay via a 100m shoreline outfall that discharges to the intertidal zone. No diffuser is present . As such, dilution with receiving waters is not actively encouraged.

3.8.3 Effluent Quality

Effluent quality has been monitored for many years for a range of parameters by DCC. Compared with typical urban sewage after secondary treatment the Company Bay effluent was poor. BOD concentrations were generally in the 60-100 g/m^3 range, SS in the 50-80 g/m^3 range and FCs $1x10^6$ to $1x10^7$ per 100ml.

3.8.4 Environmental Impacts

Aquatic Biota :

No survey has been undertaken but it is expected that a wide range of biota use the Company Bay area. They include birds, some shellfish, fish, algae, phytoplankton, zooplankton and a wide range of benthic organisms.

Recreational Use :

The receiving environment has aesthetic appeal and is used at times for windsurfing, boating, fossicking, collecting seaweed. Its use is perhaps restricted by the obvious concrete outfall structure.

Water Quality and Other Impacts :

Because of the limited receiving water monitoring data it is difficult to determine the present impact of the effluent on the receiving environment. Faecal coliform samples taken from shoreline sites at Company Bay indicated that bathing standards were often exceeded and shellfish harvesting criteria always exceeded. At Raynbird Pt (about halfway between the Company Bay outfall and Grassy Pt) criteria were also exceeded but not as often.

3.9 BURKES - ST LEONARDS SCHEME

Of the 12 systems the Burkes - St Leonards scheme is small in terms of daily volumes of wastewater discharged. Its average dry weather flow (ADWF) is 0.3% of that from the largest plant, Tahuna. The effluent is discharged to the Otago Harbour at Burkes.

This scheme serves the Burkes and St Leonards catchments.

3.9.1 Treatment Plant

The treatment plant was established in 1971 and is located near the main road in Burkes. It is situated in a residential area and is easily visible to residents. The nearest resident is situated approximately 100m distance from the plant.

The plant discharges secondary treated domestic sewage to the Otago Harbour and sewage sludge to the Tahuna Plant. The plant treats the sewage using contact stabilisation (a variation of the activated sludge process). The plant is overloaded in terms of meeting its design BOD and SS criteria.

Water rights for the discharge are presently under review. Suspended solids and BOD limits on the existing short term right are exceeded at times. Limits are not applied to any other parameters.

Sludges are trucked to the Tahuna Plant. Odour problems are not apparent.

3.9.2 Outfall

The effluent is discharged to the Otago Harbour via a shoreline outfall that discharges just beyond the intertidal zone into shallow water near the main channel. No diffuser is present. As such dilution with receiving waters is not actively encouraged.

3.9.3 Effluent Quality

Effluent quality has been monitored recently for some parameters by DCC. Compared with typical urban sewage after secondary treatment the Burkes effluent was poor. BOD concentrations were generally in the 20-90 g/m^3 range, SS in the 20-100 g/m^3 range and FCs $1x10^5$ to $6x10^6$ per 100ml. However, recent monitoring subsequent to plant operation changes do show improvements to generally comply with Water Rights.

3.9.4 Environmental Impacts

Aquatic Biota :

No survey has been undertaken but it is expected that a wide range of biota use the Company Bay area. They include birds, some shellfish, fish, algae, phytoplankton, zooplankton and a wide range of benthic organisms.

Recreational Use :

The receiving environment has aesthetic appeal and nearby areas are used at times for picnicking, windsurfing, boating, fossicking and swimming.

Wastewater Movement Following Discharge :

The buoyant effluent discharged from shoreline outfall is diluted to some extent as it flows out into the harbour, and is expected to be carried with the tide in many directions. The area of discharge is well flushed.

Water Quality and Other Impacts :

Because of the absence of receiving water monitoring data it is difficult to determine the present impact of the effluent on the receiving environment. Its small volumes, however, would indicate that any contamination would likely be localised.

3.10 MOSGIEL PLANT AND TAIERI RIVER OUTFALL

Of the 12 Dunedin City sewage systems presently under review the Mosgiel scheme is the third largest in terms of daily volumes of wastewater discharged. Its average dry weather flow (ADWF) is 8% of that from the largest plant, Tahuna. It discharges to the lower Taieri River just below the Silverstream confluence.

3.10.1 History

In the late 1800s evidence of significant water pollution from human sewage and the Woollen Factory at Mosgiel has been recorded. In the early 1900s a drainage scheme and septic tank and field tile treatment system was built. In 1921 the Woollen Mills effluent was connected to the sewer. In 1928 30% of householders were still using the pail closet system involving the regular removal of night soil but by 1937 most residences were connected. In 1958 a new sewerage system was commissioned with outfalls to the Taieri River and Silverstream. Since this time many changes to the original scheme have been made. This has included plant extensions in the 1980s and additional control of trade wastes (including the removal of some by alternative discharge through the tunnel pipeline into the Green Island system).

Complaints of alleged sewage pollution of the Silverstream and the Taieri River were common between 1950 and 1980. In more recent years the pollution of the Silverstream from such sources has been virtually eliminated. Attempts by the Mosgiel Borough Council to improve the situation in the Taieri River were often hampered with delays imposed on it by central government. Consequently, complaints of pollution of the Taieri River arising out of the nature of the sewage discharge persisted throughout the early 1980s. On many occasions tests showed that the Borough was exceeding water right limits. A significant improvement and fall in the number of complaints occurred after 1985.

3.10.2 Treatment Plant

The Mosgiel treatment plant was established in the mid 1970s and extended in the 1980s. It includes secondary treatment (biological) but discharges to a receiving environment where dilution and assimilation of wastes is relatively poor.

The treatment plant is located within the residential area of Mosgiel on the banks of the Silverstream. It is visible to residents in the area with the nearest resident being situated approximately 50m distance from the plant.

The plant discharges treated sewage (industrial and domestic) to the Taieri River and sludge to the Green Island landfill. The plant provides primary sedimentation, biological filtration and secondary clarification of inputs. The major industrial input is from a tannery. Water rights for the discharge are presently under review.

Sludges are treated on-site (centrifuge drying beds, dry sludge to landfill and leachate to wastewater treatment) and some odour problems are apparent. Odour occasionally emanating from the wastewater treatment plant is known to be of concern to local residents.

3.10.3 Outfall and Diffuser

The effluent is discharged to the Taieri River via a 16m (3 port) gravity-fed diffuser just below the confluence with the Silverstream.The hydraulic characteristics of the existing diffuser could be improved to achieve greater initial dilutions. Once discharged the effluent is diluted in the Taieri River but the distance it travels before it becomes fully mixed with the river is at present unknown (but is likely to be less than 700m).

3.10.4 Effluent Quality

Effluent quality is monitored regularly for a wide range of parameters. The concentrations and loadings of these parameters are controlled by water right limits. Limits are primarily based on international criteria for the protection of sensitive freshwater organisms.

Monitoring results indicate that prior to 1986 water right limits were regularly exceeded for most parameters. Subsequent results confirmed a general improvement in effluent quality. The incidence of non-compliance since 1986 (out of a total of 119 sampling occasions unless otherwise stated) was as follows:

- total daily loads of Cr - exceeded on 2 occasions
- total daily load of BOD exceeded on one occasion
- CN concentration limit - exceeded on 10 occasions (out of '19)
- sulphide concentration limit - exceeded on 39 occasions (not exceeded during last half of 1990)
- Cu concentration limit - exceeded twice till Oct 1989 then exceeded on 8 occasions to Dec 1990.
- phenol concentration limit - exceeded on one occasion in 1986 (out of 19)
- Cd - not exceeded till 1990 then exceeded 6 times in that year
- Ni - not exceeded till 1990 then exceeded 5 times in that year.

3.10.5 Environmental Impacts

Recreational Use :

Humans currently use or have in the past used the Taieri River for food gathering (aquatic plants, fish and shellfish), recreation (bathing, fishing, boating, sightseeing, water skiing), water supply (irrigation and stock and human drinking water), aesthetics, scientific study, and dilution and degradation of wastewaters (eg urban stormwater, treated human sewage and industrial waste waters, milking shed washwaters and agricultural runoff). Because the Lower Taieri Plain is itself well-populated and is also close to the city of Dunedin the incidence or potential incidence for such uses is relatively high. In more recent times the use by humans below the Mosgiel sewage discharge for food gathering, fishing, bathing and drinking has diminished as a consequence of the discharge.

Water Quality and Other Impacts :

To meet NZ water quality criteria for bathing during low flows (at the point where the effluent is fully mixed with the river) the effluent faecal coliform (FC) levels would need to be reduced by two orders of magnitude . Monitoring of receiving water during low flows prior to 1987 indicated that bathing criteria were not met as far down the river as Henley. However, FC concentrations in the river in the period January 1987 to June 1988 at all sites below the discharge point were less than or slightly exceeded bathing criteria. Oddly, no such declining trend was found for effluent concentrations. No river monitoring was carried out subsequent to June 1988.

Enteroviruses are expected to have a variable presence in the effluent but have not been monitored. River sampling undertaken in 1984 detected enteroviruses up to 4km downstream in the water column and sediments on most occasions and up to 19.5 km downstream on one occasion. Faecal coliform numbers were high in all samples. Enterovirus and faecal coliform numbers were at least ten times greater in sediments than in overlying water.

The lower Taieri River is inhabited by various plants and animals, including those sensitive to pollution (eg. salmonids and planktonic crustaceans) and is also used recreationally.

A survey of fish and benthic macro-invertebrates during the prolonged low flow period in 1985 (flows around 3 cumecs) indicated a change in biota to more pollution-tolerant forms below the point of effluent entry. The cause of this change could not be confirmed because of the wide range of other potential variables (eg. substrate composition, flow, effect of other inputs in the vicinity). Observations (Otago Catchment Board) at this time indicated slime bacterial and algal growths and sulphide deposits were also present on sediment surfaces below the sewage input. A more recent survey (undertaken during low flows in January 1991) of upstream and downstream sites found no readily identifiable differences in either species composition or abundance which cannot be explained by natural variables. This indicates that existing impacts of the sewage effluent on aquatic biota are likely to be minimal.

Accumulation of potentially toxic metals in the river sediments as a result of effluent contaminants settling onto the bed of the river was investigated in a brief study in May 1987. Monitoring results indicate that the effluent may have slightly raised the sediment concentrations of zinc, nickel, chromium, copper and lead. However, because the difference in concentrations between upstream and downstream sites was not likely to be significant except perhaps for zinc, and because of the large number of other relevant variables, a change in concentration as a result of the effluent could not be confirmed. A comparison with other sediment studies indicated that measured concentrations were still in the general "unpolluted" category.

In terms of eutrophication potential, algal growth in the Taieri River is theoretically limited by nitrogen. This is significant in that the Mosgiel sewage effluent has a relatively high inorganic nitrogen to phosphorus ratio (approx 15:1) and therefore has the potential to stimulate plant growth in the river, perhaps to excessive levels. Eutrophication symptoms (eg. high bacterial and algal growths on river-bed and anoxic sediments) would then be apparent.

A survey of benthic algal and bacteria in January 1991 was carried out to check the eutrophication effects at low flows (< 6l/s). The results showed a clean river-bed with no symptoms of eutrophication. The situation during prolonged low flows needs further assessment.

Part 4.0

Trade Waste Discharges

PART 4.0 : TRADE WASTE DISCHARGES

4.1 INTRODUCTION

Trade waste discharges are those of a non-domestic sewage nature that arise from industrial processes.

The four largest sewerage schemes in the Dunedin City Council area each have industrial wastewaters - that is trade wastes, discharged into them. These are:

- the Musselburgh Catchment System - (that is, the former Dunedin Drainage and Sewerage Board System (DD&SB)
- Green Island Drainage Basin System (now referred to as the Green Island scheme)
- Mosgiel Sewerage System
- Port Chalmers Sewerage System

The number, relative size and importance of trade wastes into each system are discussed.

Under the previous Local Body structures the five separate authorities (included Silverpeaks County Council) each dealt with trade wastes in a different way and consequently there are presently in place different administration systems, charging systems, trade waste bylaws and agreements. The Dunedin City Council is presently reviewing the important issue of trade waste bylaws, controls and methods of charging.

As part of this issues and options scoping study it is both necessary and appropriate that the matter of trade waste is covered at least to the extent that:

(i) The amount and nature of trade waste is presently identified, and as far as possible future predictions made.

(ii) the implications for wastewater treatment and disposal options are identified,and associated additional capital and annual operating and maintenance costs are identified in the estimates.

(iii) the possible implications for water rights (future discharge permits) are appreciated.

(iv) the need for new consolidated trade waste bylaws and agreements are appreciated.

(v) industries, and the community at large are made aware of the sizeable trade waste discharges and associated issues.

(vi) the industrial dischargers themselves become involved in their specific issues along with the other specialist interest groups and the community as a whole.

The volume, flow rate, suspended solids, grease and organic strength (Biochemical Oxygen Demand (BOD_5) are the principal parameters of interest in this study.

It should be appreciated, however, that whilst it is outside the scope of this study to investigate the potential harmful (hazardous/toxic) substances part of trade waste management, the issue must be appropriately acknowledged and recorded that relevant management systems and scheme concepts are available to ensure necessary controls.

4.1.1 Trade Waste Definition and Legislation

The original trade waste legislation was contained in the Water Pollution Act 1953. In 1971 these provisions were transferred to the Water and Soil Conservation Act and in 1979, the trade waste provisions were moved to the Local Government Act 1974 and now appear as sections 488-496 of that Act. It is under this Act that the Green Island and Mosgiel Trade Waste Bylaws and specific agreements were formulated. The Port Chalmers agreements were formulated under the Water and Soil Conservation Act provisions.

The Dunedin Drainage and Sewerage Board Act also has powers relating to trade waste control.

Section 489 of the Local Government Act interpretation defines "Domestic Sewage", "Trade Wastes", "Trade Premises", "Trade Waste Bylaws" and "Wastes" as follows:

"Domestic sewage" means liquid wastes (including matter in solution or suspension therein) discharged from premises used solely for residential purposes, or wastes of the same character discharged from other premises; but does not include any solids, liquids, or gases that may not lawfully be discharged into sewerage drains controlled by a local authority:

"Trade premises" means any premises used or intended to be used for carrying on any trade or industry; and includes any land or premises wholly or mainly used (whether for profit or not) for agricultural or horticultural purposes:

"Trade wastes" means any liquid, with or without matter in suspension or solution therein, that is or may be discharged from trade premises in the course of any trade or industrial process or operation or in the course of any activity or operation of a like nature; but does not include condensing water, surface water, or domestic sewage:

"Trade wastes bylaws" means bylaws made under the authority of section 491 of this Act or deemed to be trade wastes bylaws pursuant to section 498 (2) of this Act:

"Waste" includes any matter that, when added to or mixed with any natural water, will contaminate the water so as to change the physical or chemical condition thereof in such a manner as to—

(a) Make the water unclean, noxious, or impure; or

(b) Be detrimental to the health, safety, or welfare of persons using the water; or

(c) Render the water undrinkable to farm animals; or

(d) Be poisonous or harmful to animals, birds, or fish around or in the water.

These definitions nowadays need to be interpreted widely with respect to a "trade premise" in order that discharges such as laundries, laboratories, etc, may be classed as "trade waste". A more appropriate definition nowadays is "commercial activities that contribute amounts of wastewater" different in nature from domestic sewage.

4.1.2 Reasons and Goals for Trade Waste Control

It is appropriate to briefly state these here, as a number form an integral part of this issues and options scoping study.

Before summarising these reasons and goals it is important to appreciate that regulation and control of trade waste is nowadays taking a much more important role. Regulation is now being seen as an important aspect of environmental management as well as a means of cost recovery on a user pays basis.

Discharges from local authority sewerage systems to the environment are becoming increasingly scrutinised and it can be expected that more stringent conditions will be imposed on water rights, particularly with regard to effluent parameters normally associated with trade waste discharges

(toxins, high grease, etc). The Resource Management Act will overlap with the Local Government Act as far as trade waste discharges are concerned and can be expected, through instruments and plans that will be made under it, to force some higher standards for discharges, particularly to coastal waters. In terms of the Musselburgh Catchment the new Act will require standards presently not in place.

The reasons for trade waste controls include:

- safety of personnel working in the sewerage system - and the public generally
- compliance with 'water rights' (future 'discharge permits')
- minimal degradation of the sewerage system (eg, corrosion control)
- secure performance of the wastewater treatment plant and other parts of the sewerage system (eg, potentially harmful materials affecting biological treatment systems)
- maintaining quality of the final treated effluent discharge with minimal effect on the receiving environment, be it land, inland, estuary or coastal waters.
- residuals management control by controlling potentially harmful compounds that accumulate in sludges (eg, heavy metals), contaminants in air emissions, ash and odour control.
- the need for local authorities to be able to plan for, construct and successfully operate sewerage facilities to accept, convey, treat and dispose of trade wastes
- The need for Councils to be able to recover from trade waste dischargers the costs of receiving, treating and disposing of their trade wastes. The amount of recovery up to the full pro-rata "fair cost" as allowed for under the Act is dependent upon Council's decisions and resolutions (refer following section).

In the future, increased attention will be paid to minimising trade waste discharges by the use of new "clean" technologies and greater emphasis on waste minimisation and resource reuse. These principles are encompassed in the Resource Management Act with the principal purpose being sustainable management of resources.

4.1.3 Trade Waste Charging

While there are a number of charging systems presently in use in New Zealand, and likely to be more, there is statutory authority under the Local Government Act for three types of charges relating to trade wastes. These can cover both the capital and annual operating and maintenance costs - they are:

(a) charges relating to the treatment of trade waste by the local authority.

(b) charges relating to the treatment, reception and disposal of excess sewage from trade premises, where those charges relate to the excess volume of sewage over that normally discharged from other premises with substantially the same rateable value as the trade premises. These charges must be based upon the reasonable costs of receiving, treating and disposing of an equivalent amount of domestic sewage of an equivalent strength.

(c) a general power to prescribe "licence fees" to recover the reasonable costs incurred by the council in respect of the granting of consents or services given or inspections made.

The implications for the larger trade waste discharging industries of the costs involved in new Council treatment and disposal facilities, particularly treatment facilities that undertake a high degree of treatment, are likely to be very significant and accordingly need full evaluation and discussion/agreement with industry before decisions are made.

These issues can also be complex. Questions are likely to be raised as the study is progressed, questions such as - should the community at large meet part of the (potential) trade waste charge, or should trade waste dischargers meet their full proportions? How should such an issue be addressed if the selected scheme incorporates a higher degree of treatment (eg, secondary treatment) and/or longer sea outfall length that has been the result of the communities wants, whereas a lesser degree of treatment and/or shorter outfall length would be sufficient from public health and water quality view points. Furthermore what about Council policies in attracting new (and indeed retaining existing) industry that has significant trade waste discharges?

4.2 DUNEDIN'S TRADE WASTE DISCHARGES

The following provides a summary of the existing known main trade waste dischargers and their approximate combined magnitude in each of the four historic catchments that are being used in this study.

The combined magnitudes are approximate only, particularly for the Musselburgh Catchment, as sufficient monitoring has not yet been completed to more accurately assess the trade waste discharge levels.

In order to gain a better understanding of the relative magnitude of the present trade waste discharges the technique of comparing them to equivalent domestic population is used. For this report four bases are used as the first three will almost definitely be relevant to some of the likely future upgrading of treatment and disposal, and the fourth, Biochemical Oxygen Demand (BOD_5) if a secondary treatment system is adopted (or at least one designed on a BOD_5 basis).

The bases are:

(a) a volume or hydraulic domestic population equivalent : where the daily trade waste volume is divided by the equivalent volume (270 litres) a person contributes per day to the sewerage system. This is a simplified approach as it does not take into account the discharge patterns and duration over the 24 hour day.

(b) a suspended solids domestic population equivalent : where the daily trade waste suspended solids mass is divided by 70 g (the amount attributed to a person per day) to give the trade waste population equivalent on this basis.

(c) a total grease domestic population equivalent : where the daily trade waste grease mass is divided by 12.5 g (the amount attributed to a person per day) to give the trade waste population equivalent on this basis. This is taken to be the same as oil and grease in this report.

(d) an organic strength or biochemical oxygen demand (BOD_5) population equivalent where the daily trade waste BOD_5 mass is divided by 75 g (the amount attributed to a person per day) to give the trade waste population equivalent on this basis.

The assessed domestic population equivalents of existing trade waste discharges relative to existing domestic population are summarised in Table 4.2.1.

TABLE 4.2.1 : ASSESSED DOMESTIC POPULATION EQUIVALENTS OF EXISTING TRADE WASTE DISCHARGES RELATIVE TO EXISTING DOMESTIC POPULATION (Refer to Part 4.2 for basis of calculation)

Catchment	Volume or Hydraulic Basis			Suspended Solids Basis			Total Grease Basis			Organic Basis (ie, Biochemical Oxygen Demand (BOD_5))		
	Actual* Domestic Population	Trade Waste Domestic Equivalent Population	Total Domestic Population	Actual* Domestic Population	Trade Waste Domestic Equivalent Population	Total Domestic Population	Actual* Domestic Population	Trade Waste Domestic Equivalent Population	Total Domestic Population	Actual* Domestic Population	Trade Waste Domestic Equivalent Population	Total Domestic Population
Harbour/Port Chalmers	3,127	(+15%) 420	3,547	3,127	(+30%) 940	4,067	3,127	(+30%) 940	4,067	3,127	(+30%) 940	4,067
Musselburgh (main) Catchment	65,571 14,906 80,477 use 80,000	(+20%) 20,000	approx 100,000	80,000	(+125%) 100,000	180,000	80,000	(+250%) 200,000	280,000	80,000	(+213%) 170,000	250,000
Green Island Catchment (GIC) (includes Mosgiel Industry Discharge)	11,100 use 11,000	8,000	19,000	11,000	74,000	85,000	11,000	200,000	211,000	11,000	77,000	88,000
Fortex Discharge (agreement 7,500 m^3/d allowance)		28,000	28,000		64,000[a]	64,000[a]		120,000[a]	120,000[a]		90,000[a]	90,000[a]
TOTAL GIC	11,000	36,000	47,000	11,000	138,000	149,000	11,000	320,000	331,000	11,000	167,000	178,000
Mosgiel Plant Catchment	10,300	(+16%) 1,750	12,050	10,300	(+16%) 1,750	12,050	10,300	(+16%) 1,750	12,050	10,300	(+16%) 1,750	12,050
GRAND TOTAL ALL CATCHMENTS IN TRADE WASTE	105,004 use 104,427	58,170	162,597	104,427	240,690	345,117	104,427	522,690	627,117	104,127	339,690	449,117

* Reference Table 3.4 - Working Paper 4A (Musselburgh Catchment excludes Ocean Grove)

Notes

On further implementation of trade waste controls and charges, it could be expected that some volumes and pollutant loads would reduce through in-factory process control and pretreatment.

+% = increase in % over actual domestic population.

Refer to Pie diagrams for Musselburgh and Green Island Catchments.

(a) Based on assumed concentrations of suspended solids of 600 g/m^3 (GI Water Right limit), total grease 200 g/m^3 and BOD_5 900 g/m^3.

The relative importance of the four parameters used to compare trade waste with the domestic usage are:

(a) volume or hydraulic basis : for sizing of conveyance pipes and pumping, much of a treatment plant, and outfalls and/or land disposal areas. It must be noted that the peak discharge rates (eg, litres per second) are the most important rather than the daily volumes, and these peak rates are not well represented by this basis - on further assessment of options peak flow rates will need to be reviewed, as well as daily volumes.

(b) suspended solids basis : For primary, advanced primary and secondary treatment plants including sludge management and disposal.

(c) total grease basis : For primary, and more particularly advanced primary treatment as the latter is specifically targeted at removal of this floatable material along with further suspended solids. Also secondary treatment.

(d) organic strength basis : Biochemical Oxygen Demand (BOD_5). For secondary and tertiary treatment particularly where the treatment design basis is on BOD_5. Also in the extra sludge generated by removal of BOD_5.

It is important here to again record that secondary treatment specifically to remove BOD_5, particularly the soluble portion, for discharge to the ocean is not normally required. This raises the question of costs of this versus other impacts (eg, treatment cost implications, energy use, extra sludge treatment and disposal) when they are taken into account in a total environmental approach to wastewater management.

Parts 9.3.4 and 9.3.5 below present specific details on the contribution of trade wastes to effluent flows and quality generated in the four main catchments. No allowances are made for future increase in possible trade waste discharges, nor for any reductions from better housekeeping or industry's own pretreatment and discharge reduction nor changing to alternative cleaner technologies.

The following therefore is a summary of industries and trade wastes presently in each catchment together with some comment on future possibilities.

4.2.1 The Harbour Basin Catchment - Port Chalmers Plant

The only plant accepting trade waste is the Port Chalmers Plant. This two stage secondary (biological) treatment plant was previously designed, and trade waste agreements put in place by the former Port Chalmers Borough Council, to accept pretreated discharge from:

- the Sawyers Bay tannery
- the (former) Walter Taylor woolscour
- the Container Port container wash water

At the present time some five trade waste agreements are in force, with three trade waste discharges actually occurring from:

- the Sawyers Bay tannery
- the Sawyers Bay fish factory (excluding the digestor supernatant effluent which is discharged elsewhere)
- the Container Port washwater

They jointly represent approximately 15% of the average daily volume and 30% of the wastewater load. Approximately 27.5% of the existing annual operating cost of the treatment plant is recovered by way of trade waste charges.

The Ravensdown Fertiliser Plant at Ravensbourne discharges its trade effluent after pretreatment directly into the harbour off the company's wharf. These discharges are covered by operative water rights issued by the Otago Regional Council.

4.2.2 The Musselburgh Catchment

This is the main city catchment which incorporates the former Dunedin City Council and St Kilda Borough Council areas and is served by the Tahuna Water Pollution Control Plant and the Lawyers Head sea outfall.

Council are presently considering implementing trade waste bylaws to cover the catchment and also alternative charging scenarios.

While no formal trade waste bylaw is in operation a trade waste application system has been in place for 4 years and some 70 forms have since been completed.

Presently three specific agreements and associated trade waste charges are in force, these being with the Ferrier Woolscour, the Dunedin Hospital (kitchen discharge) and the DCC Water Department for washwater from the Mt Grand treatment plant.

Analysis of wastewater arriving at the Tahuna Water Pollution Control plant confirms that there is a very significant total trade waste discharge in this catchment particularly in terms of:

(a) BOD_5 at about 70% higher than normal domestic strength (ie, 420 g/m^3 average compared to around 250 g/m^3)

(b) Suspended solids at about 25% higher than normal domestic strength (ie, 315 g/m^3 average compared with around 240 g/m^3)

(c) Total grease at about 80% higher than normal domestic strength (ie, 90 g/m^3 average compared to around 50 g/m^3)

It is noted however that comparing the effects of trade waste discharges by a concentration basis can be misleading if there is some diluting effect from groundwater inflow for example.

Analysis of DCC Water Department water supply records in the late 1989 early 1990 periods indicated there were then some 31 industries using over 10,000 m^3 of water per year that could be assessed as trade waste discharges under the Local Government Act definition and taking into account knowledge of their particular industry. In total the estimates then prepared suggested that these industries were contributing about some 3 million m^3 of the 16 million m^3 (dry weather) flow volume received at the Tahuna plant annually. That is about 19%, but for simplicity say 20%.

Of these 31 industries the significant contributors, particularly in terms of suspended solids, total grease, and organic (BOD_5) loadings are likely to be within the following groupings.

• woolscour	all three components
• fish processing factories	particularly total grease (ie, fish oil which is measured as total grease under the standard grease test) and BOD_5

•	drink production (eg, brewing, distilling, soft drink, milk, coffee)	BOD_5 and total grease
•	food production eg, Potato chips/products; bakeries, chocolate, hospital and other kitchen wastes, general food production and preparation	Solids and BOD_5

4.2.3 The Green Island Catchment

Historically the former Green Island Borough Council area was known to contain the main wet trade waste discharging industries with the former Burnside Freezing Works (up to 11,000 m^3/day at peak discharges of up to 300 l/s), the abattoir (now the Alliance Burnside Meat Processing Plant) the tannery (now Clutha Leathers) and a number of smaller industries.

Conveniently, at the time of formulation of the Green Island Drainage Basin Wastewater Scheme, three Mosgiel industries confirmed their wish to use the scheme as did the owners of two proposed industrial areas within the Silverpeaks County Council area, namely the Walton Park Sand Company area adjacent to SH 1 and the DCC landfill area.

The acceptance of use of the Green Island scheme for these discharges was partly instrumental in the formulation of the Silverpeaks Tunnel Pipeline conveying domestic and trade wastes from the Mosgiel/Upper Taieri Plains area.

More recently the Fortex Meat Processing Plant's trade waste has been conveyed through to and discharges into the Green Island scheme immediately below the existing treatment (milliscreening) stage 1 plant. The Company's allowance is to discharge up to 7,500 m^3/day of trade waste meeting specified standards.

The existing major sources of industrial waste in the Green Island region are:

- Clutha Leathers (tannery at Green Island)
- Alliance Group (meatworks/abattoir at Burnside)
- Primary Producers Co-operative Society Ltd (coolstore and possibly a future animal skin treatment/tannery operation: located at Burnside)

The existing major sources of industrial waste from the Mosgiel region are:

- Fortex Ltd (meat processing works located at Silverstream to the west of Mosgiel township)
- Alltex International Yarns (woollen mills/wool processing factory located in Mosgiel)
- Euro New Zealand Scours Ltd (woolscour in Mosgiel)

Other existing industrial waste discharges not listed above include a livestock saleyards, two piggeries, a tannery and a bottle washing plant.

While the closure of the Burnside Freezing Works caused a significant decrease in the trade waste volume and strength this has now been replaced by the new Fortex discharge with an allowance of 7,500 m^3/day compared to the former Burnside Freezing Works of up to 11,500 m^3/day. The Burnside freezing works, however, discharged over 8 to 10 hours whereas Fortex can be discharged over 24 hours per day, with a maximum discharge flow rate allowance of around 90 l/s.

The trade waste discharges from these industries, and any others, are covered by the (former) Green Island Borough Council's Trade Waste Bylaw No 11 (effective 1 February 1987) and a number of specific agreements with industry that are also pursuant to the Local Government Act provisions.

The present trade waste dischargers meet some 40% of the present annual operating and maintenance costs of the scheme. Capital replacement has been taken account of with the major discharges in the specific trade waste agreements.

During the investigations into, and formulation of, the Green Island Drainage Basin Wastewater Scheme, the former Green Island Borough, Mosgiel Borough and Silverpeaks County Councils were most aware of the significance of trade waste discharges relative to the domestic population and the cost implications for the industrial discharges in these three former local authorities areas.

Presently about 40% of the daily volume (week days when Alliance meat processing and other main industries are working) of the 5,500 m^3 passing through the treatment (milliscreening plant) is trade waste. The Fortex agreement allows for up to 7,500 m^3/day of trade waste (meeting present agreement levels) to be discharged into the outfall system, that is, an increase of 136% over the existing treatment plant discharge. To date Fortex have discharged around 5,000 m^3/day only.

As expected with these high strength organic wastes the Green Island discharge has:

(a) suspended solids levels that are significantly higher than domestic sewage (average concentration 1,086 g/m^3 compared to domestic of around 240 g/m^3 - that is 4.5 times more concentrated).

(b) total grease of an average concentration of around 470 g/m^3 compared to domestic of 50 g/m^3, that is, some 9.4 times more concentrated.

(c) an organic strength measured as BOD_5 of around 1,200 g/m^3 concentration (estimated) compared to typical domestic of around 250 g/m^3, that is some 4.8 times more concentrated.

The increased strength and associated mass loadings resulting from these trade wastes discharges are not only of considerable significance in the effluent discharge, but also in the further treatment considerations.

The original concept for the Green Island treatment plant was to have an advanced primary treatment phase using entrained or dissolved air flotation following the milliscreening. This treatment was to target removal of the floatable fats/grease and other solids materials.

Such a proposal will be continued through the options study, as one of the treatment options. In this case of an appropriate "advanced primary treatment" the trade waste costs can be apportioned to flow, suspended solids and total grease loadings, with industry paying a large proportion of capital and operating costs if Council requires full pro-rata cost apportionment.

If, however, a secondary (biological) wastewater treatment plant is required the possible cost implications to industry are likely to be very considerable, particularly for a system designed on a BOD_5 basis and for which large quantities of sludge are produced.

Furthermore, if effluent disinfection is required, the influence of the trade wastes will mean that UV disinfection is unlikely to be very effective. Chlorination (a non favoured disinfection

means) would also be of limited effectiveness as well as costly. Instead, a high lime treatement process is included in the options. Effective shoreline separation through outfall length extension is seen as a more appropriate procedure if micro-biological levels of the shore/wave interface are deemed to be of prime importance.

4.2.4 The Mosgiel/Taieri Catchment

The Mosgiel plant is a secondary treatment plant discharging effluent to the Taieri River. The water right (presently under review) has limits on BOD_5, suspended solids, ammoniacal nitrogen and certain heavy metals and potentially harmful compounds.

In September 1979 the (former) Mosgiel Borough Council enacted their trade waste bylaw No 25. This reflected the (former) water right limits in the prohibited wastes part.

In the early 1980's the (former) Mosgiel Borough Council had 4 principal trade waste discharges, namely:

- the (ex) Mosgiel Woollen Mills
- the (Mosgiel) Woolscour
- the tannery (formerly Tomkins, then Knights)
- a (small) fellmongery since closed down

Difficulties with the three remaining industries meeting the Trade Waste Bylaw limits, coupled with other factors, resulted in the (Silverpeaks) Tunnel Pipeline coming into being with the trade wastes from the first two (and capacity for the third) then being conveyed into the Green Island Drainage Basin System.

The tannery, with a significantly reduced trade waste discharge, continues to discharge into the Mosgiel system. More recently the Invermay Agricultural Research Centre discharges from its abattoir and allied processing operations have been connected into the Mosgiel system. These are the two principal trade waste discharges presently being made into the Mosgiel system, the latter being relatively small and spasmodic.

The trade waste discharge presently accounts for approximately 15% to 20% of the flows and loadings. For simplicity this is taken as 16%.

The limits on the water right severely restrict any new large trade waste discharge that has significant BOD_5, suspended solids, grease, ammoniacal nitrogen or toxic components.

4.3 PRESENT TRADE WASTE CONTROLS AND BYLAWS - SUMMARY

The following summarises the present position as introduced above. The Dunedin City Council is presently giving attention to the matter of trade wastes throughout all catchments and has recently appointed a trade waste officer.

Harbour Catchment - Port Chalmers Scheme

- A number of specific trade waste agreements are in existence which set the limits on a range of pollutants and other parameters and also set out the charging basis.

- There is no general trade waste bylaw in existence; instead the former Port Chalmers Borough Council prepared separate agreements with each industry as that was more appropriate.

Musselburgh Catchment (Tahuna WPC Plant and Lawyers Head Discharge)

- Three charging agreements are in place
- A trade waste application form system is in place for new developments
- The Council is in the process of adopting the Green Island Trade Waste Bylaw No 11 for the Musselburgh catchment area, as an interim measure.
- Regular monitoring for some industries

Green Island Catchment

- The Green Island Borough Council : Trade Waste Bylaw No 11 has been in force since February 1987. In addition there are a number of "By Agreement" trade waste dischargers that have agreements which include specific requirements on their discharges and basis of charges.
- The Water Rights for this scheme set a range of limits on certain contaminants which are reflected back through into the trade waste bylaw and specific agreements.
- Regular monitoring takes place of trade waste discharges and treated effluent discharged to sea.

Mosgiel/Taieri Catchment

- The Mosgiel Borough Council : Trade Waste Bylaw : Trade Waste Bylaw No 25 has been in force since September 1979.
- The water right conditions (presently under review) are reflected through into the trade waste bylaw.
- Regular monitoring takes place of the trade waste discharges and the treated effluent discharge to the Taieri river.

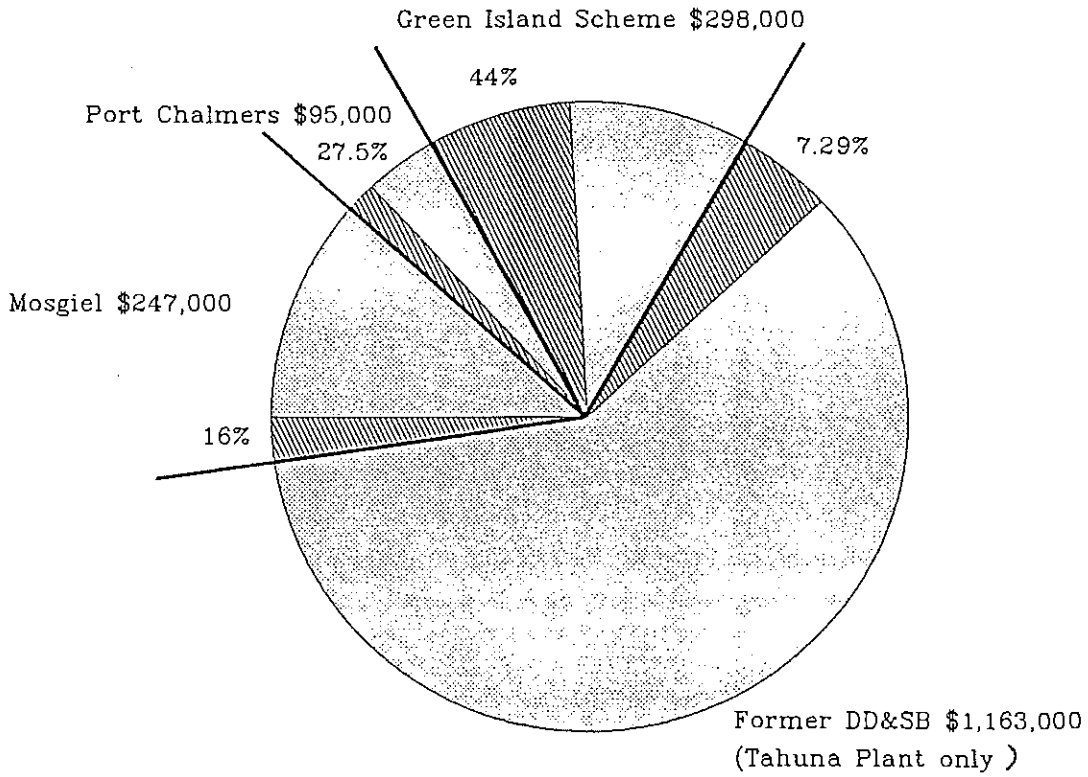
4.4 FUTURE REQUIREMENTS AND OPTIONS FOR MANAGEMENT

Management of trade wastes must be undertaken by an integrated approach to water rights, trade waste bylaws and any specific agreements, and the implementation and operation of these.

At the time of printing the Dunedin City Council has indicated a preference for uniform annual charges for residential ratepayers and appropriate trade waste charges for other users in the 1992/93 financial year.

Figure 4.4.1 shows the percentage of annual operating and maintenance costs for the four main catchments which were recovered via trade waste charges (to April 1990).

Annual Operating and Maintenance Cost Treatment and Disposal Only (see note) Situation at April 1990



Present "user pays" trade waste recovery as percentage of total annual operating and maintenance cost for each of the four treatment and disposal schemes.

This does not include conveyance or loan/finance charges, except for the Mosgiel System.

In the Green Island and Port Chalmers System capital replacement has been separately dealt with under the specific agreements.

FIGURE 4.4.1

Part 5.0

Environmental Considerations, Legislation and Planning

PART 5.0 : ENVIRONMENTAL CONSIDERATIONS, LEGISLATION AND PLANNING

5.1 INTRODUCTION

The following is a brief discussion of the relevant legislation and regulations which will be of importance in this study. It must be noted, however, that much of this legislation has been consolidated into the Resource Management Act, which is effective from 1 October 1991. A detailed discussion of the provisions of this Act also follows.

5.2 CONSENTS REQUIRED UNDER EXISTING LEGISLATION

Existing Use Right : these are existing discharge use rights notified, under the Water & Soil Conservation Act (1967), prior to 1969. These discharges currently do not require a Water Right. However, there will be a 'sunset' clause on all existing use rights such that within 10 years new Water Right consents must be applied for.

Water Rights : a right to discharge waste into natural water or onto land must be obtained from the Regional Council pursuant to section 21 of the Water and Soil Conservation Act 1967. Conditions may be imposed on any right specifying effluent quantity and quality, discharge location, and defined standards of receiving water quality which must be met. The right can also require monitoring of the discharge and receiving waters (including ecological values).

The water rights process involves public notification, objections, and hearings, and parties to this process (including the applicant) can appeal to the Planning Tribunal and High Court.

Land Use Consents : the use of land for the establishment of sewage treatment plants will require the consent of the Dunedin City Council pursuant to the provisions of the Town and Country Planning Act 1977, unless specific land zonings already exist in the District Scheme.

The City Council would have to make a requirement upon itself to have a particular site designated for the purposes required, and, following public notification and objections, a planning hearing would be held. As with the water rights procedures, a right of appeal to the Planning Tribunal and High Court exists.

Provisions of the Town and Country Planning Act also enable the City Council to control "objectionable elements" such as noise, smoke, smells, effluent, vibrations, and other noxious or dangerous elements associated with the operation of any particular land use, in this instance a sewage treatment plant (section 77 of the Act).

Harbour Use : the Otago Regional Council has much of the harbour floor vested in it by virtue of the Harbours Act 1950, and consequently has a licensing role for any proposed use of this area. There is, however, a Bill before Parliament, promulgated by DoC, which

seeks to revest these lands back in the Crown, for management by DoC and regional councils under the provisions of the Resource Management Act (see below).

The City Council also has a role in licensing uses of foreshore lands, by virtue of it having vested in it certain former Harbour Board lands and recreational facilities above mean high water mark.

User of Seabed/Foreshore : under the **Harbours Act 1950**, control of the use of the foreshore and seabed is vested in the Minister of Conservation, unless the area in question is within a defined commercial port, whereupon the Minister of Transport is the decision-making authority. The Act covers any activity which crosses in, on or over the seabed below mean high water mark, and consequently the construction of any pipeline across the harbour or out to sea will require such approval.

Preservation of Historic Places :

authority from the Historic Places Trust is required where works may interfere with historic or archaeological sites, via the **Historic Places Act 1980.**

Treaty of Waitangi : any decisions made with regard to the upgrading or construction and operation of sewerage systems must take into account the principles of the Treaty of Waitangi, particularly Article 2 and its guarantees of undisturbed management of their forest, fisheries, and other possessions treasured by the Maori. Various pieces of legislation as well as significant legal decisions support this, including:

- **The Conservation Act 1988**
- **The Environment Act 1988**
- Court of Appeal decisions within the **Water and Soil Conservation Act 1967**

The **Town and Country Planning Act 1977**, Section 3, also states that a matter of national importance to be given due weight by local and regional planning agencies is:

> "The relationship of the Maori people and their culture and traditions with their ancestral land".

The Treaty of Waitangi Act 1975 provides for the observance of these principles, and established the Waitangi Tribunal, which is empowered to make recommendations on claims relating to the practical application of the Treaty and any inconsistencies therein.

Public Health and Nuisances :

the **Health Act 1950** is the controlling statute in New Zealand with regard to ensuring protection of public health, and controlling nuisances and offensive practices which might detract from good public health. In conjunction with provisions in the

Local Government Act 1974, the Otago Area Health Board and the City Council health inspectorate will have an input into any decisions made on providing appropriate sewerage facilities for the city.

5.3 THE RESOURCE MANAGEMENT ACT

At the time of preparation of this report the new Resource Management Act has been passed, and it will come into force on 1 October 1991.

Certain key elements include:

1. coastal protection and a separate coastal policy, as a national priority, with licensing of activities either by the regional council (coastal permits) or the Minister of Conservation (restricted coastal activities).
2. the concept of sustainable management of resources
3. the concept of best practicable options in relation to discharge of contaminants or emission of noise, but now optional rather than mandatory.
4. the control of discharges of contaminants into or onto land, air, or water.

Of interest and relevance within the Act are the following:

- the definitions of "discharge" and "contaminant", taken in their widest sense, mean that there is probably very little in the way of substances, energy or heat that is not a contaminant.

- the discharge of any contaminant into water or onto the land is prohibited, unless permitted by a rule within a regional plan, or by a discharge consent.

- a key mechanism for controlling and managing discharges to the environment will be the use of management plans. Regional and district management plans will be prepared which address the control of discharges, and define performance standards for these where they are going to be permitted under management plans through regional and district rules.

- whilst not a generally enforceable duty, Section 17 requires everyone to avoid, remedy or mitigate any adverse effect on the environment arising from their activities. This duty can be enforced by use of abatement notices or enforcement orders, which can require the cessation of an activity actually licensed by a discharge consent if that activity was seen to be causing some form of detrimental impact on the environment, possibly even if it was predicted at the time of licensing.

- section 107 of the Act prevents a consent authority from granting a discharge permit for contaminants into water if effects such as visible oils or grease films, objectionable odours, a conspicuous change in the colour or visual clarity, or significant adverse effects on aquatic life, are likely to occur. This provision would, in effect, prohibit shallow, untreated wastewater outfall to oceans, rivers and lakes, and is of considerable significance in the New Zealand context where such outfalls are still reasonably common. Section 107 allows exceptions only if the discharge is of a temporary, or exceptional nature, and the effects on the environment justify granting the exception. There is some question, however, as to whether or not this section covers discharges to the ocean ("coastal permits" rather than "discharge permits" as referred to in the section), although it certainly does for those designated as a restricted coastal activity (s 119).

- the Act requires regional policy statements to be prepared, but the only regional plan that is mandatory is a regional coastal plan, which must be prepared within two years of the coming into effect of the Act.

- an important provision is the option to adopt the best practicable option to prevent or minimise adverse effects of discharges. Every person who discharges a contaminant may be required to adopt "best practicable options" (BPO). "Best practicable option" is currently proposed to be defined in relation to a discharge of a contaminant or an emission of noise, as measuring the best method for preventing or minimising the adverse effects on the environment having regard, among other things, to:

  (a) The nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and

  (b) The financial implications, and the effects on the environment, of that option when compared with other options; and

  (c) The current state of technical knowledge and the likelihood that the option can be successfully applied:

  It must be noted here however that the BPO concept will not be universally mandatory except for noise control, but that it should be available as a supplementary or alternative technique in circumstances where in the setting of standards, a more preferable technique is unsuitable or impracticable. There is, however, a provisoin enforcing a duty to consider alternative means of minimising or preventing environmental damage, which it could be said, is as powerful a tool as mandatory BPO implementation.

- environmental impact assessment will become an integral part of the process of issuing consents. With one of the main underlying philosophies of the Resource Management Act being "sustainable management" of natural and physical resources, as well as the concept of integrated consideration of consents, it is likely that, for any particular waste treatment and disposal situation, all options must be considered and the option giving the lowest net negative environmental impact identified.

- existing water rights continue in force, although there are powers for a regional council to bring any unsatisfactory or non-complying discharges into line, including:

  - a "sunset" clause on all existing rights such that within 10 years of the coming into force of the Act new consents must be applied for.

  - provisions for review of consents in certain circumstances.

Another interesting development is the question of the use of economic instruments as a tool for the allocation and management of resources. These concepts are currently being investigated further.

5.4 DEPARTMENT OF CONSERVATION - DRAFT COASTAL POLICY

In preparation for meeting his responsibilities under the Resource Management Act, the Minister of Conservation has asked his Department for a draft national coastal policy, which was circulated recently for public comment. This document contains a number of policies which have a direct bearing on Council's marine discharge options, namely:

- Plans and decisions by Regional Councils shall prevent new discharges of untreated human waste, and all discharges of untreated human waste shall cease within ten years of the adoption of the regional coastal plan (i.e. within a maximum period of 12 years of the coming into force of the Act). (Refer Policy 5.2.3)

The definition of "treated" pertaining to human waste is given as "land-based secondary treatment" or higher level.

Interestingly, the policy for industrial waste discharges is not so preclusive, stating that:

- with respect to industrial waste, ["treated"] means treated to neutralise or destroy any hazardous substances and to render harmless any biological contaminants.

If such an approach to domestic sewage was also taken, the restrictive prohibition of anything other than "land-based secondary treatment" or better would be removed, and therefore appropriate attention could be given to treating and removing sewage parameters of environmental concern on a case-by-case basis.

Whilst this is a draft policy, the intentions of the Minister are clearly to improve discharges to the coastal environment of the kind currently occurring at Lawyers Head and Green Island.

It should be noted here that the Resource Management Bill Review Committee concluded that the coastal management structure proposed by the Act is unsatisfactory in that it fails to separate coastal space allocation and regulatory functions within DoC; it also contains conflicting objectives which lead to accountability problems. As a consequence, the whole question of consideration of the draft coastal policy must be viewed with some uncertainty, despite the fact that the Review Committee recommended the interim retention of the existing unsatisfactory coastal management provisions in the Act pending major policy review and debate.

5.5 STATUS OF EXISTING SCHEME FACILITIES

5.1 Introduction

This section reviews each of the treatment plant sites and effluent discharges in the primary area of interest for the study, with regard to planning zones, site designations, water rights, and any other relevant statutory permits which are held or may be required.

It should be noted here that in past years, when a subsidy for sewerage schemes was obtained from the Department of Health, a requirement of the Minister (prior to authorising subsidy payment) was that all relevant statutory consents were in place for the scheme/proposed scheme. As a consequence all of the "modern" (ie, post 1969) treatment and disposal systems in the Dunedin City area are appropriately licensed. This is covered in detail below.

As with any use of a site/land for wastewater treatment purposes, it should be noted that Section 77 of the Town and Country Planning Act requires that objectionable elements are kept to a minimum, including noise, odours, vibration, or detraction from amenities.

5.5.2 Musselburgh Catchment

The Musselburgh catchment involves four components of relevance to this paper:

- Musselburgh pumping station
- Tahuna treatment plant
- Lawyers Head outfall

- Ocean Grove scheme

There are also a number of emergency overflows and combined sewer discharges requiring consideration.

Musselburgh Pumping Station

The site of the pump station is located alongside Culling Park, in the former Borough of St Kilda. The site is appropriately designated for purposes undertaken (wastewater screening, grit removal, pumping), within an underlying zone of Residential A.

The site is of sufficient size to allow upgrading of preliminary wastewater treatment facilities in conformity with the site designation.

Tahuna Treatment Plant

The site of the treatment plant appears in the current District Scheme part of the Recreation 18 (Golf Course) zone located within the District Scheme for the Chisholm Park facility, and adjacent to the Ocean Beach Domain Board land to the south and west. The site was appropriately designated within the previous District Scheme, but during the formal review of that scheme in 1982, the designation was not redrawn. As a consequence, the plant site falls within the provisions of the Town and Country Planning Act pertaining to existing uses (section 90), as a non-conforming use of the site. This section, however, provides for appropriate recognition of uses of land existing prior to the coming into operation of the District Scheme. The consideration of the designation should be undertaken within the new District Plan process.

The site is constrained, and any upgrading or extension of treatment facilities would require to be limited virtually to the existing site.

The Tahuna treatment plant also has a Clean Air Act licence for the emissions from the sludge incinerator. This licence contains conditions requiring:

- that any odour generated is harmless and inoffensive at the plant boundary
- certain limits to be met for particulate matter, toxic metal particulares, and smoke density

This license expires on 31 March 1992.

Lawyers Head Outfall

The discharge from Lawyers Head of up to 219,350 m^3/day of wastewater is currently licensed in perpetuity as a notified existing use pursuant to s 21(2) of the Water and Soil Conservation Act 1967. As a consequence, there are no effluent quality or environmental standards which are required to be maintained (or monitored).

Any significant increase in discharge volume above that notified, or change in discharge location, invalidates the notification, and a water right (or discharge consent under the terms of the Resource Management Act) is required to be obtained.

It should be noted that the Resource Management Act requires that such notification expires 10 years from the date of commencement of the Act (2001). There are, however, other provisions in the new Act which allow the Regional Council to review the current existing use notification for the purposes of:

- dealing with any adverse environmental effect arising from exercise of the notification
- requiring the City Council to adopt a best practicable option to reduce or remove such environmental effects/impacts
- enabling water quality standards to be met, following preparation of a regional coastal plan (mandatory, within two years of commencement of the Act, 1 October 1991).

As a consequence, there is no long-term security of the existing right to continue discharging wastewater at Lawyers Head, as indeed with any water right (with regard to conditions and restrictions).

Ocean Grove Scheme

This treatment plant site is appropriately designated within the District Scheme, with an underlying Residential A zone. The site has ample room for installation of further treatment stages if required/desired.

The discharge of treated effluent to land within the site, and presumably the treatment of sludge by dewatering in similar sand country, is licensed as an existing use notification under the Water and Soil Conservation Act, and consequently only the volume of effluent is limited(340 m^3/d).

Other Discharges

Other discharges within the Musselburgh catchment currently licensed as notified existing uses under the Water and Soil Conservation Act are:

1. emergency overflow, Bauchop St
2. emergency overflow, Halsey St
3. emergency overflow, Jervois St
4. emergency overflow, Mason St

It should be noted that two of these overflows (Jervois and Mason) have since been discontinued.

Similar comments to those above (pertaining to Lawyers Head) apply to these notifications, with the exception of consideration of the irregular, "emergency" nature of these discharges.

There does not appear to be any form of licence for the sewer overflow into Andersons Bay.

5.5.3 Green Island Catchment

Two major components of the Green Island Drainage Basin are relevant to consider here, namely:

- the Green Island milliscreening plant and ancillary operations
- the Waldronville outfall

Milliscreening Plant

The Green Island milliscreening plant adjoins the Kaikorai estuary downstream from the main Dunedin landfill, and is appropriately zoned as "Proposed GI Borough Sewage Treatment Works" within the former Silverpeaks County Council District Scheme. The site has an underlying Rural G zoning.

Ancillary operations carried out on site involve the dewatering and landfilling of screenings, which activities are appropriately licensed by water right (No 2792), which expires on 1 April 1999. The only requirement of this right is that the landfilling site be lined and bunded with impervious material, and appropriately drained, in order to minimise movement of leachate into the Kaikorai estuary or underlying groundwater.

The site is sufficiently large to allow extension/upgrading of treatment facilities, but any extension offsite is constrained to the westerly quarter by the zoning of the estuary as Coastal Protection and Wildlife. The Council intends to purchase farmland to the south and east of the site as a buffer for the plant site.

Waldronville Outfall

The Waldronville outfall is licensed by Water Right No 2790, expiring in 1999. This right contains a large number of special conditions limiting the quality of the discharge, its quantity, and requiring comprehensive monitoring of effluent and receiving environment (including bacteriology, ecology, and sediment chemistry).

The right allows a total wet weather discharge volume of 75,000 m^3/d, reducing to 25,000 m^3/d in dry weather. Current dry weather discharge volumes are in the order of 15,000 m^3/d (including the Fortex trade waste).

Emergency Discharges

Water rights are held for all emergency overflows within the Green Island Drainage Basin scheme, including for Brighton and Waldronville township pump stations, the Wingatui area, and onto Waldronville beach in the event of a failure of the main outfall.

5.5.4 Port Chalmers Scheme

The Port Chalmers treatment plant and Sawyers Bay outfall service the former Borough area.

Treatment Plant

The plant site is appropriately designated for activities carried out, within an underlying Industrial Zone.

There is sufficient area of land available on the site to allow for appropriate upgrading or extension of treatment facilities if needed (including various tertiary treatment processes), albeit with some slight difficulty.

Sawyers Bay Outfall

The current discharge of treated effluent into Sawyers Bay is licensed by Water Right No 2808, which expires on 1 November 1991. This right limits the basic effluent parameters of BOD_5 and SS (20 and 30 g/m^3 respectively), and requires that a comprehensive environmental impact study

is carried out during the term of the right (being done), including characterising effluent quantities and quality, receiving environment and associated impacts, and carrying out a beneficial uses study.

The exact status of licensing for the outfall structure itself has yet to be confirmed - normally it would require an approval under the Harbour Act as a seabed/foreshore structure, and it is known that the Otago Harbour Board issued a requirement that the end of the outfall be appropriately signposted (presumably for navigation purposes). Certainly any extension of the existing outfall would require an appropriate coastal licence/consent under the Resource Management Act 1991.

Emergency Outfalls

Water rights are held for a number of emergency discharges/overflows in the Port Chalmers catchment, including at:

1. Downes Road, Blanket Bay - pump station overflow
2. the treatment plant site
3. into Mussel Bay - pump station overflow
4. into Careys Bay - pump station overflow
5. Peninsula Beach Road - pump station overflow
6. Bellevue Place - pump station overflow
7. George Street, Koputai Bay - pump station overflow

5.5.5 Burkes Scheme

Treatment Plant

The small treatment plant site is appropriately designated for the purpose of sewage treatment, with an underlying Residential A zoning. The site is only partially developed, and consequently any extensions to or upgrading of effluent treatment facilities would not be seriously constrained.

Outfall

The current discharge into the harbour beyond the railway embankment is licensed by Water Right No 3805, which expires on 1 April 1993. The right limits the basic effluent parameters of BOD_5 and SS to 20 and 30 g/m^3 respectively from 30 April 1992, and requires that by this time the Council shall have implemented measures to both ensure that these restrictions are met, and to reduce the occurrence of excessive infiltration by stormwater which hydraulically overloads the plant and markedly reduces treatment efficiencies.

The exact status of licensing of the outfall is unknown, but any extension of it will require consent under the Resource Management Act 1991.

5.5.6 Portobello-Broad Bay

Treatment Plant

The treatment plant site is currently not designated within the District Scheme, although apparently a requirement to designate the site for public works was issued under S 118 of the Town and Country Planning Act.

The site has an underlying Rural A zone, and is small, being a cut into the surrounding hill. Expansion of the site could be difficult, depending upon the nature of the plant development and hydraulics.

Outfall

The discharge from this scheme occurs into the harbour off Grassy Point, and is licensed by Water Right No 2647 which expires on 1 October 1994. The right limits the basic effluent parameters of BOD_5 and SS (20 and 30 g/m^3 respectively), and requires comprehensive monitoring of effluent quantity and quality, and associated environmental quality (including water and shellfish). The discharge is limited to a period around high tide and the outgoing tide. Currently approximately 300 m^3/day is discharged compared with the volume licensed of 500 m^3/day.

The outfall was approved by the Minister of Transport under the Harbours Act provisions relating to seabed structures.

Other Discharges

All emergency discharges and pump station overflows are appropriately licensed by water rights.

5.5.7 Company Bay-Macandrew Bay

Treatment Plant

The plant site is appropriately designated for the purposes undertaken, within an underlying Residential A zone in Company Bay. Expansion or upgrading of treatment facilities would be able to be accommodated, particularly if the disused sludge drying beds are removed.

Outfall

The discharge from the outfall into Company Bay is licensed as a notified existing use in terms of s 21(2) of the Water and Soil Conservation Act, and as a consequence only effluent volume is limited - this is set at 2,000 m^3/day, well in excess of current discharge volumes estimated at 350 m^3/day.

The exact status of licensing for the outfall is yet to be confirmed, but as with Sawyers Bay the former Otago Harbour Board required it to be appropriately signposted.

Other Discharges

There would appear to be no further licenses or discharge rights/authorisations for any pump station overflows or other emergency discharges associated with this scheme.

5.5.8 Mosgiel

Treatment Plant

The site of the Mosgiel treatment plant is appropriately designated, within an underlying Residential 1 zone. The site is bounded in part to the east by the Silverstream Recreation Reserve and to the north and west by rural land. There is sufficient spare capacity on the site for upgrading of effluent treatment systems to some degree.

Discharge to Taieri River

The treated effluent from the Mosgiel plant is discharged to the Taieri River, such discharge licensed by Water Right No 3189. This right, expiring in June 1993, contains conditions limiting 15 effluent parameters, and requires appropriate monitoring of effluent quantity and quality as well as the carrying out of an environmental impact study (including public consultation) prior to August 1992.

Other Discharges

It appears that appropriate water rights are held for emergency discharges and pump station overflow for the Mosgiel system, including a major outfall bypass discharge into the Silverstream.

Part 6.0

Issues Identification

PART 6.0 : ISSUES IDENTIFICATION

6.1 INTRODUCTION

In order that a decision process can be followed logically it is important that all the relevant issues that must be assessed in the process are clearly identified, and the nature of each well understood.

In this report some 18 issues have been identified. In doing so the authors are most aware that different people, groups and organisations will identify different issues. Furthermore, there is likely to be a wide difference in the assessment and relative importance and weight of these different issues. For this reason the Council has established working parties with membership covering various interests, as a means of further clarifying and weighting all of the issues associated with this project.

In view of the above it is stressed that the issues identified and discussed here are not necessarily exclusive, nor is the discussion necessarily complete or definitive.

The approach taken in the text is to introduce and generally discuss the possible issues and then finish that discussion by stating more specifically what the particular issue may be with specific regard to this project.

It is expected, in fact is likely to be necessary, that during Stage 2 of the project some issues will be dealt with in more detail, with more specific information accordingly being required.

Likewise, environmental impact investigations and reporting phases will address specific impacts from a preferred sewerage scheme or schemes once these have been determined.

6.2 ISSUES SCOPING

6.2.1 Public Health

Introduction

In the following discussion public health issues are discussed in terms of hazards to health from pollutants in wastewater. These pollutants are pathogenic micro-organisms such as viruses and bacteria, and potentially harmful chemicals. The importance and different significance of these in domestic sewage and trade wastes will be highlighted. The present situation is analysed in terms of the health risks for different proposed or possible effluent discharge locations.

These are not the only issues that could be considered part of "health". Wider issues, such as the community's healthy or unhealthy perception of itself and its environment, are also most important.

Domestic Sewage

Domestic sewage is a public health hazard because it contains bacteria, viruses and other micro-organisms that can cause disease. Such pathogens are contained in the faeces of diseased individuals, and can cause disease when:

- contaminated water is drunk or swallowed;
- body contact occurs with contaminated water, causing skin, eye or ear infection;
- contaminated shell-fish are eaten.

Contact with contaminated water in urban environs generally occurs through recreational use of river, harbour or sea, rather than through the potable water supply.

Disease can also be spread by eating shell-fish, particularly taken from contaminated water. Filter feeding shellfish which concentrate micro-organisms including pathogens, possible diseases include viral gastro-enteritis, Shigella, Salmonella and hepatitis A. Bony fish are not considered to be a hazard, in terms of pathogens, as long as they are cleaned well to avoid passing surface adhering pathogens to other food.

Therefore, the principal aim of domestic sewage treatment and disposal from a public health point of view, is to minimise the number of disease-causing micro-organisms discharged into the environment to which the public have ready access.

Industrial Wastewater (Trade Waste)

Potential risks to public health from industrial wastewater are:

- micro-organisms causing disease;
- toxic chemicals.

From present knowledge it appears that industrial wastewater in Dunedin is not a significant public health risk in terms of spread of disease by bacteria and viruses. The most common cause of sewage-related disease is the Norwalk virus, and this appears to be exclusively of human origin. Industrial waste may contain some bacterial pathogens, such as Salmonella. There is also a potential danger from shell-fish contaminated with these bacteria.

Industrial wastewater may be hazardous to human health because of toxic chemicals. These chemicals may be ingested by fish or shell-fish, which in turn when eaten cause harm to humans. As a general rule the chemicals will harm the fish before they harm the humans that eat them. Effluent standards are therefore based usually on prevention of harm to marine life.

Because of control of industrial effluents by trade waste bylaws, industrial wastewater is almost certainly not a public health hazard at current measured levels of parameters in the discharge.

Summary

The issues related to public health may therefore be summarised as follows:

- protection of drinking water sources
- protection of recreational waters
- protection of shellfish growing waters
- protection of the environment from damage by toxic chemicals.
- odour and air pollution protection from treatment operations and residuals management, including aerosols
- noise control

6.2.2 Physical Environmental Impacts

Present Situation

The present impacts of wastewater discharges to local waters, the harbour and coastline mean a number of major issues require resolution. Some of the issues identified include:

1. The discharge of effluent to the coast including:

   - the problems associated with the visibility of the discharges
   - the problem of wastes and scums, including fats and greases discharged from an outfall near to the shore. Because the treatment of waste in some instances is minimal, fats and grease are washed to shore at times, where it is visible as pinhead particles on the beach.
   - the potential for accumulation of toxic sediments around an outfall because of the discharge of heavy metals.
   - the potential for bioaccumulation of toxic components in marine life around an outfall because of the discharge of heavy metals.
   - the contamination of water and shellfish by pathogenic micro-organisms

2. The issues associated with discharge of effluent, whether treated or not, into the harbour, and its effect on water quality and other issues.

3. The issues associated with the discharge of treated effluent into the Taieri River.

The quantifiable and "known" impacts associated with the current schemes were discussed in detail in Part 3 above.

Upgraded Sewerage Scheme or Schemes

With regard to upgrading options for Dunedin, general environmental considerations may be considered under the following headings:

1. Pipeline Conveyance Routes

When considering the construction of new pipelines and associated facilities (pump stations etc) it is necessary to take account of any significant terrestrial ecological values which might be found on the proposed route, such as rare or endangered species or communities. Detrimental effects on such values must be avoided or minimised.

Appropriate runoff control measures during pipeline construction will be required, to prevent or minimise the discharge of silt-laden water to local waterways or the harbour, thereby minimising the affects on ecological and aesthetic values.

Planning for emergencies, including pump station overflows during power outages, pipeline blockage, etc will be a significant factor in determining pipeline route - it can be these types of occurrences which cause environmental damage, rather than routine operation of the system.

2. Land-based Activities

The use of any form of land-based activity including treatment involves consideration of the site under the Town & Country Planning Act, and a number of significant and related utility and ancillary issues must be addressed, including matters of national, regional, maritime and district importance. A number of these are addressed more specifically below.

Consideration must be given to such issues as:-

- compatibility with adjacent and nearby development
- odours and clean air
- visual appearance and aesthetics
- traffic
- social issues
- affordability and economics
- Maori issues
- exposure to coastal weather, salt water/air
- land use, actual and potential
- construction activity impacts

and as well further investigations into a number of technical issues and public input as to perceptions of the issues, is desired.

3. Treatment Plant Sites

Land availability, public acceptance, and environmental values associated with proposed sites must be balanced in order to arrive at a site or sites which do not compromise to an unacceptable degree the relevant values outlined above.

Most if not all wastewater treatment processes produce solids and sludges (called residuals), and the treatment and disposal of these is a key element in wastewater management, one which often plays a significant role in selection of final options. Consideration needs to be given to the final destination of any treated sludges (eg, local landfill, reuse onto land) and the associated environmental effects.

All elements, including the views expressed by the public and special interest groups will have to be integrated, weighted and evaluated before the Council makes a final decision.

6.2.3 Effluent Disposal

An issue which invariably arises in respect of any wastewater management proposal is the means of effluent disposal.

In the Dunedin area, disposal of large volumes of treated effluent to land is probably a less likely scenario, given the topography and the unavailability of suitable areas. As a consequence, disposal of any final effluent will likely be to the ocean, the harbour, or a local river, although land disposal is certainly not precluded at this stage.

The most significant environmental effects associated with effluent disposal to water are:

- aesthetics (visibility, colour and clarity, odours, floating grease etc)
- bacteriological pollution of bathing or shellfish collection waters
- nutrient enrichment of riverwaters and associated weed or slime growth
- potential contamination of any water supply sources.

If the effluent contains a significant volume of trade wastes consideration must also be given to potential effects of toxic materials (for example trace metals, chlorinated organic compounds etc) on the ecology of the receiving waters and edibility of any aquatic food organisms.

Associated with effluent disposal to waterways, particularly the ocean, is the effect of outfall construction on the ecology of the area - whilst temporary in nature, these effects can be relatively severe, particularly if blasting or trenching is involved. Social and cultural considerations also apply.

Summary

The major issues related to physical environmental impacts may therefore be summarised as follows:

- the acceptability or not of the current treatment and disposal system impacts (including emergency/maintenance discharges to the harbour);
- the choice of final effluent disposal system based on a number of environmental factors;
- the choice of treatment plant locations with particular reference to effects on local population and environment, including during construction;
- the impacts of construction of possible new conveyancing pipelines, tunnels and pump stations (including overflows).

6.2.4 Social and Cultural Impacts

Social Impacts and Public Awareness

Most legislation governing or related to the treatment and disposal of wastewaters allows for a degree of public input. The Resource Management Act also provides for extended public input, particularly at the proactive, forward planning stage as well as the traditional role of objection to finite proposed developments or activities.

Recent trends indicate a growing acceptance by the public at large of its role in being involved in the selection of appropriate options based on its perceptions and its environmental views and requirements. As a consequence, public surveys of the acceptability of a range of wastewater scheme options is nowadays relatively commonplace. Similarly, evaluation of scheme options must nowadays include social impact assessment, including economic considerations such as community costs and the ability of communities to pay for the schemes.

The growing general environmental and cultural awareness of the public at large will play an increasingly important role in the management of wastewater treatment and disposal in New Zealand, with considerable increase in public involvement in the project planning and consent decision-making stages.

Environmental awareness has grown significantly over the past few years, particularly overseas, to the extent where it now can play a role in national and international politics. One result of this movement is a re-evaluation of currently accepted wastewater treatment and disposal practices from an environmental perspective; giving the environmental consideration a great deal more weight than in the past, when economic and engineering factors were dominant. Concepts such as "sustainability" and "intrinsic value" have become part of the equation.

Public Perception

There appears to be a strong public perception that "tertiary" or "full treatment" or "land based" treatment systems are to be preferred. It should be noted here that the term "land based treatment" is often used inappropriately and can lead to confusion. A milliscreen plant can be

described as or included in the term land based treatment. Land disposal is a separate issue. Care must be taken with the use of these terms.

Contrary to this approach is a recent move in the USA, (where secondary treatment is mandatory regardless of discharge location) to consider the characteristics of the body of water into which the effluent is discharged. Wastewaters are treated to remove (as the prime aim) those components of environmental and public health concern, eg fats and grease and solids for marine discharges via long outfall, and micro-organisms and nutrients for river discharges. This current trend could thereby result in a re-acceptance of primary or advanced primary treatment prior to marine discharge in some situations.

Both approaches have been voiced in New Zealand of late, and will require careful consideration and balancing within a public acceptance/education/input process during option selection ("scoping", as the process is often known). These approaches will also have to be taken into account in final decision making and consent processes.

Affordability

A prime concern in any discussion of wastewater management options is the question of affordability - can the community concerned pay for the selected option? This is specifically addressed in Section 6.2.13 below.

Summary

The main issues related to social and cultural impacts are summarised as follows:

- the need to consider and evaluate public perceptions
- the affordability of any particular sewerage option
- the effects of increasing public awareness of environmental matters on selection of any particular scheme
- the "balance" and "trade offs" of social and cultural consideration against scientific and technical matters, including economics and affordability.

6.2.5 The Maori Perspective

The whole question of recognition of Maori cultural interests has been significantly reinforced and strengthened by certain Court of Appeal decisions in recent years. It is now accepted that these interests must be addressed in any scoping, impact assessment, and consent decision-making processes relating to wastewater treatment and disposal.

It is a generally-held belief that there are certain tenets within the sphere of Maori culture which cannot be compromised, for example the position that no type of human waste, no matter how well treated, can be discharged to water. In the past this has lead to confusion as well as the establishment of irreconcilable differences between parties. Recent experience in the North Island however has clearly indicated that compromises can be reached, resulting in treatment and disposal systems acceptable to both cultures, albeit sometimes as a first or interim stage towards a longer-term solution. The development of the use of wetlands treatment and disposal is an example of land-based treatment.

The Resource Management Act makes specific reference to the Treaty of Waitangi, which must be considered in any decision made under the Act (Section 8). Regardless of the various

interpretations of this clause, and suggestions of possible "outs", the fact remains that the Court of Appeal decisions establish precedents that will ensure that Maori cultural issues are taken into account in the decision making process.

At this stage it is believed that the main issue concerning the Maori relates to ensuring that good quality effluent is discharged in a location such that important food resources are not contaminated - the Council is currently liaising with the relevant iwi and groupings to further define this issue.

A separate issue, also requiring consideration, is the presence of burial sites and other culturally sensitive locations, and the potential for these to be disturbed by the physical works. This will also be the subject of consultation.

6.2.6 Recreation

There is a natural human reaction to view with repugnance anything which is foul or dirty. It is clear from statements from those who use the coast for recreation that they have always been aware the sea is polluted but the desire to partake in their sport often overrode any concern they had. The issue today has a much higher public profile as people are more concerned about the environment.

As well as the philosophical reaction to pollution above, particular issues impacting on recreation are listed as follows:

- health
- visual
- tourism and cultural promotion
- district scheme
- vitality of sporting clubs

6.2.7 Community Impacts

A sewerage scheme is an essential community service and the way in which it is provided can affect a community in a number of ways. Some of the concerns in the region include:

- benefits, including those to recreation from reducing pollutants in the harbour and coastal waters.

- planning for the future so the location and type of sewerage system allows the potential for urban growth to be realised and keeps land use options open.

The long term planning of the area includes the timing and scale of urban development, competing land uses and the provision and availability of infrastructure. As urban development continues it will be essential that the components of any system can handle the anticipated flows and loadings. To some extent it is possible that the provision of sewerage can dictate the direction of growth. The question as to how far the provision of an essential service (sewerage) should be allowed to control the direction of urban development needs to be addressed.

The areas of current and potential urban growth need to be taken into consideration when planning the upgrading of the sewerage systems for Dunedin. Similarly, other issues requiring consideration are:

- providing a flexible system that can respond to future developments in technology and changes in the economic situation.

- the location of treatment facilities in urban areas. People are reluctant to have facilities "close to where they live".

The social effects of a sewerage system on the wider community can involve a social stigma associated with having treatment facilities close to urban areas. The community is also affected by the construction of new sewers/pipelines through residential areas even though the impacts are usually temporary and can be minimised with good management and consultation. Other community impacts involve aesthetic considerations such as the visual effects of collection, treatment and disposal system.

Often, a critical question to be answered is "who makes the decisions and who pays"? This includes issues such as how the future community and the environment are represented. Externalities should be considered. These allow for situations where the costs and benefits of a decision are imposed on groups or individuals who had no part in the decision and involve values such as bequest (the worth of endowing future generations with a natural resource), option (the value placed on ensuring that the option to use an environmental amenity is retained) and existence (the value of knowing a resource exists). These values introduce the concepts of resource stewardship and sustainable resource management referred to in the new Resource Management Act.

Summary

While difficult to summarise the issues of community impacts can be stated as:

- Many of the impacts on the community are neither totally positive nor negative.
- There will inevitably be conflict with a situation where reducing the harmful effect on the community in one area may increase the perceived harmful effect somewhere else.
- The issue of conflict resolution involves compromise and trade-offs to develop a system that has general consensus.
- The actual compromises to be made are a community issue which will have some influence on the key decision factors and the final decision.

6.2.8 Industry

Industry is an important part of the infrastructure, social climate and well-being of the Dunedin area. Issues, therefore, that relate not only to the ongoing viability of existing industry but also to the establishment of new industry are important and must accordingly be well appreciated and appropriately treated in the selection and implementation of an upgraded sewerage scheme for Dunedin.

Specific issues that can have an effect on industry include:

- the level of rates or charges for all or just specific industry costs.
- the effects trade waste costs may have an industry.
- the implementation of trade waste bylaw requirements on industrial discharges, such requirements being set by the need to meet certain water right contaminant levels or maintain suitable low levels of toxins (for example in sludges that may otherwise be reused).

- the inclusion or not of trade waste discharges into the sewerage system, as for example requirements for one particular scheme may exclude the possible discharge of any trade wastes with specific contaminants.

These issues, along with the Council costs, however they may be determined in the future, can be very important issues not only for the continued viability of existing industry, but also for the attraction and establishment of new industry to the Dunedin area.

Part 4 above discusses the trade waste situation in Dunedin.

6.2.9 Public Relations and Acceptance

The community's willingness to improve the current situation and to pay to do so, including the cost of capital works, maintenance and ongoing operating expenses, is measured differently from its ability to pay. Similarly, industry will determine how much it is capable of paying towards a new scheme and if the levies that are struck go beyond what it is prepared to pay.

Although the community may recognise the need for improved collection and treatment facilities for sewage they are generally reluctant to accept these facilities in close proximity to where people live. Careful consideration must be given to the location of the actual treatment and disposal facilities, and especially the physical separation of these from areas of present and future habitation where practicable. If, because of sound practical reasons, a facility is to be sited closer to a residential area than ideal, the immediate community must be satisfied that certain aspects (eg, noise, odours) are dealt with in an acceptable manner, to provide an acceptable solution.

The role of the media in the dissemination of information to the community is important. In order that informed conclusions are reached the community relies on full and unbiased reporting by the news media. This relies in turn on full disclosure of information on a regular basis from the Council to the public either directly or indirectly. Public acceptance of any proposal is marred if decisions are taken without public participation and consultation. This not only relates to specific interest groups but also to the private citizen.

6.2.10 Available Technology

An important issue in the formulation of scheme options and in their evaluation is that of available technology and its compatibility with Council's objectives.

Assessment of available technology is considered in all principal parts of a scheme, namely:

- conveyance
- treatment
- disposal
- residuals management

The types of issues that arise in assessment of technology include:

- capital intensive systems versus operating cost intensive.
- future flexibility in treatment processes, for example the ability to be upgraded, retrofitted or otherwise modified to perform higher (or changed) treatment efficiencies.
- high technology plants versus medium and lower level technology.
- modular extension possibility of treatment plants, wastewater pumping system upgrades.

- emergency provisions, standby capacity in plants and resulting operating flexibility.
- technically feasible and well proven treatment and disposal systems compared with unproven and/or developing technology.
- life of equipment and systems.

6.2.11 Reliability, Spare Capacity and Emergencies

Following on from above, important design and operational considerations for sewerage schemes involve a range of decisions, each of which has an influence on the overall reliability, spare capacity and ability to accommodate emergencies.

The issues of pipeline reliability, emergencies and spare capacity have important consequences for any discharges not only in terms of costs and operating procedures but also in potential impacts. Likewise are the issues for treatment facilities in respect to the location, type, amount of standby capacity, and procedures that can be implemented during emergency conditions.

The interrelationship of treatment plant site and conveyance routes and distances are also important issues in evaluating scheme options particularly because alternative arrangements are possible with some of the scheme options.

Treatment Plant Reliability and Emergency Discharges

A sewage treatment plant is a mechanically and energy intensive facility that, like any process operation, is subject to breakdown and malfunction. Part 10 of this report covers these matters in detail, including outfall reliability and risks associated with other aspects of this topic.

6.2.12 Staging of Schemes

The possibility of staging the implementation of the selected scheme, or schemes, could have a number of advantages including those introduced below. In assessing the acceptance of any staging programme for the selected scheme, or schemes, the advantages would need to be weighed up against the implications/disadvantages of not completing the total scheme(s) in a "once off" programme.

The options for scheme staging will principally depend on what scheme or schemes are selected and the time frame over which it is decided to implement them.

Options could include:

- staging of treatment first and outfall later
- staging of an outfall first and treatment later
- staging a treatment plant by progressively adding further stages of treatment, eg, primary treatment first, secondary later and if needed finally tertiary of one type or another
- sludge management technology introduction may be staged.

Advantages of staging are likely to include the following, but again each option would need to be evaluated on its own merits and the weighting of advantages versus impacts/negative features assessed in the decision process.

- stage financial requirements over a longer period of time. This would reduce the need for loans and may even allow a financing scenario where expenditure could be matched in some affordable units more in line with annual rating income.

- better use of construction resources

- allow evaluation of treatment and/or outfall(s) before the final stages of the total project are completed, thereby possibly allowing refinement and consequent cost savings in the final stages.

- allow a programme of "pollution reduction over time" to be more closely balanced to expenditure.

- allow later use of further developing/innovative technology for parts of the project.

- allow improvement and reliability to be made over a longer period with consequent costs.

The "trade offs" and weighting of any staged programme will require careful assessment in any decision process evaluation. In sections 10.12 and 10.14 staging of schemes is discussed, while in part 13.0 a list is given of the parts of each representative total scheme which could be staged.

6.2.13 Cost and Financing

In making decisions as to the selected scheme, or schemes, the Council must take into account the communities' ability to pay, that is, the affordability aspect. This is being addressed in the community participation programme.

While the subject of individual costs, charges and rates will be the subject of separate financial information, it is appropriate in this report to at least raise the types of issues that are likely to need addressing both in scheme selection and "user charge" methods of paying for the scheme or schemes selected.

In scheme selection such issues arise as:

- The overall (estimated) capital cost

- The overall (estimated) ongoing operating (including maintenance) cost

- Asset replacement considerations, those taking into account differing worklife expectations of the various sewerage scheme components (eg, pumps versus conveyance pipes, etc).

- The balance of capital and operating costs, for example once spent capital costs are fixed, while annual operating costs are ongoing and generally rise with inflation.

- The financial methods used to analyse costs and in particular the procedures looking at present worth and the capitalisation of annual operating costs.

- The possibilities of staging parts of the scheme or schemes.

- The loans Council is presently servicing for drainage and sewerage and the present levels of rating for these and other services.

- The implications on all commercial and industrial establishments of new rates/charges for the upgraded sewerage.

- The potentially complex issue of trade waste charges and different methods of Council's recovery of these in terms of the Local Government Act. For example, should the community at large meet part of the trade waste charge, or should trade waste dischargers meet their full proportions? How should such an issue be addressed if the selected scheme incorporates a higher degree of treatment and/or longer outfall lengths that has been the result from the communities' wants, whereas a lesser degree of treatment and/or shorter outfall length would be sufficient from strictly public health and water quality viewpoints?

- Any extra costs, and who pays them, that may be necessary in order that the project better fits other possible needs/issues such as the ranking high in terms of fostering the "Clean Green New Zealand Image" future, or that it more closely meets the "Sustainability of Natural and Physical Resources".

  These issues are introduced below in Section 6.2.15 and 6.2.16. In terms of resource sustainability issues such as the desirability of sludge reuse arise, and the likely extra costs of it compared with, for example, conventional landfill disposal.

- The issues of estimate reliability, asset life and maintenance factors and total project through life.

While the majority of the above issues, and undoubtedly others, will have an effect on the total capital and operating costs of the project, the other principal components of "costs and financing" is the way in which the community pays, including rating and/or user charges.

6.2.14 Relevant Planning Schemes and Policies, and Legislative Requirements

The siting of any treatment plant on land that does not have a suitable designation or zoning will require notified planning approval under the Town & Country Planning Act or a scheme change for a new designation.

Consideration must also be given to time frame differences in utilising an existing, fully licensed site compared with gaining relevant statutory approvals for a new site.

6.2.15 The "Clean Green New Zealand" Image

The 'Clean Green New Zealand' image is very important in the promotion of New Zealand in the international arena. This image has been promoted in the marketing of primary produce and processed goods as well as in the development of the tourist industry.

The maintenance of this image, which has commercial as well as philosophical value, depends on New Zealand retaining its resources of clean water and air and protecting these for the future.

With such an image to foster and protect, the discharge of inappropriately-treated wastewater to the environment is an obvious inconsistency.

The enhancement of the "Clean Green New Zealand Image" is therefore an issue that is likely to be of some importance in the selection of the upgraded sewerage facilities for Dunedin, particularly given recent moves to promote it as a wildlife and "scenic splendour" centre for

tourism. The Peninsula and Otago Harbour are recognised as important parts of this local "image".

6.2.16 Sustainability of Natural and Physical Resources

As introduced in Part 5 above, one of the cornerstones of future environmental and resource management in New Zealand, under the provisions of the Resource Management Act, is the concept of sustainability of natural and physical resources. Whilst development is also provided for, a critical consideration in any decision process will be whether or not a particular resource use compromises the ability of the environment as a life-supporting system, including consideration of the needs of future generations.

Specific issues and discussions associated with treatment and disposal of wastewater include:

- sustainability of the effluent receiving environment, eg, aquatic ecology.
- minimising energy use and then only use a renewable resource
- reuse of residuals (byproducts) where appropriate, eg, sludge reuse, waste heat reuse.

6.2.17 Harbour Study

Otago Harbour is a focal point of the city, and is home for numerous water and land based activities. There are concerns over a number of issues associated with the harbour and these uses, including:

- pollution (real or perceived)
- access to the water
- potential for further recreational uses
- appearances, visibility of structures including outfalls

Whilst many of these issues were referred to in preceding sections, the ongoing Otago Harbour Planning Study provides an opportunity to consider them as a specific amalgam independently of this study at the appropriate time.

Section 8.2 presents a brief summary of the preliminary findings of the harbour study to date.

6.2.18 Integrated Environmental and Holistic Approach

Too often in the past sewerage projects have been decided principally on a single issue such as the effluent disposal location or the type of treatment plant.

In working through the decision process and evaluating the various, and often competing issues, it is both necessary and important that not only an integrated environmental approach is taken to scheme or schemes selection, but also that the overall approach is an holistic one. Examples where this approach apply are:

- Integrated pollution control approach considering the "cross media effects" of air, land and water.

  In wastewater treatment this means that in transferring a contaminant from one medium to another (eg, from "in solution" to "a solid sludge") the effects of this in terms of associated environmental impacts must be considered and the solution giving the lowest net negative environmental impact identified. An integrated environmental approach

must be one of the considerations when comparing different options for treatment and disposal of suspended solids (SS) and Biological Oxygen Demand (BOD_5).

- The penalties of higher degrees of treatment particularly in energy intensive plants.
- The balance of "toxicity and risk" and therefore appropriate effluent standards.
- Resource conservation and reuse.
- Land use.
- The advantages and disadvantages of land disposal of effluent, ie, the advantages for afforestation on the one hand and the problem of greenhouse gas emissions from forests on the other.
- other issues that are relevant to the specific case being evaluated.

It is now recognised that planning and implementation of any sewerage scheme nowadays involves, of necessity, the basic philosophy/approach as outlined above. Driving forces which play a role are:

- sustainability
- the Resource Management Act
- practicability
- affordability

To ignore an integrated, "total environment" approach is to place the decision process and subsequent outcomes in some jeopardy.

6.3 EVALUATION AND WEIGHTING

Some 18 general issues were identified above as being relevant to the consideration of wastewater treatment and disposal for Dunedin. It must be noted, however, that public input is an essential ingredient to both confirm these issues, and/or to add or delete others from the decision process.

All of the key issues must be appraised and dealt with in a logical manner, in order to develop solutions required to meet demands and community aspirations for upgrading of the existing wastewater schemes.

The selection of the most appropriate overall wastewater treatment and disposal schemes for the greater Dunedin area is one of the most important decisions the Dunedin City Council will ever have to make. There are long term consequences of the selection which will impact on all ratepayers and which will influence the future potential of the area. The scheme options selected will have a major influence on:

- use of natural waters and possibly land
- the enhancement of the environment
- the satisfying of cultural values
- the discretionary spending ability of ratepayers
- possible effects on some industries
- town and country planning

Because these influences are significant and long term in nature, Council is most aware that it is essential that it not only chooses the best practicable option, but is also able to demonstrate that it has done that to the satisfaction of both its ratepayers and those charged with overseeing such decisions in the interest of the general public.

Planning the decision process is no less important than planning the construction of any scheme option. The establishment, review and approval of a process leading to option selection will give those responsible for that decision a much greater degree of security that their objectives have been met.

Four broad groups can be identified within the community which will provide differing inputs into the decision-making process:

- local residents, who are or may be materially affected by the construction and operation of scheme components nearby;
- the surrounding local community, who may feel intruded upon by any new developments;
- special interest groups, who may seek to comment on a development from a particular, often single-issue perspective; and
- the wider community, including ratepayers and the Maori community, who express much broader, more general comments in relation to the issue.

The Council has established three working parties, to assist it during all parts of the decision-making process. These are made up of:

- special interest groups
- the tangata whenua
- regulatory agencies

These parties have provided an initial scoping of issues, and have commenced more detailed consideration, weighting and evaluation of these. Preliminary results of this exercise to date are:

- few if any additional issues were identified beyond the range presented in Part 6.2 above;
- as expected, local resident and community representatives placed emphasis on matters of direct relevance to them, such as problems with odours and noise;
- similarly, industry representatives saw costs and affordability as important, and recreationalists saw the protection of ecological systems and useable fisheries as important
- an initial analysis of feedback from the working parties shows that the "top 5" issues of general importance to all were public health protection, protection of ecosystems, protection of useable fisheries, active recreational pursuits, and the effects of and problems with trade wastes.

Further detailed evaluation and weighting of issues will occur after the public participation stage of the project, and also during Stage 2 wherein certain more-favoured options are investigated and developed further.

Part 7.0

Scoping of Options

PART 7.0 : SCOPING OF OPTIONS

7.1 INTRODUCTION

The main objective of this study is the identification of a range of technically feasible options for the treatment and ultimate disposal of the municipal wastewater from the major urban areas of Dunedin City and its environs. This is not such a simple task as might first be imagined because of the widespread nature of urban development in Dunedin, stretching as it does from Port Chalmers in the East to Mosgiel and Brighton in the West, and the number and variety of the existing sewerage systems.

The study has started with a "clean slate" and has not assumed that any one particular solution or methodology is favoured at the outset. As a consequence of this approach, there is a large number of possible permutations and combinations amongst the treatment and disposal options for the different catchments. Royds Beca identified as many of these as possible and then applied a "systems approach" to firstly ensure that the range of options was comprehensive, and secondly to reduce this multitude of choices to a logical and understandable format. From this conceptual schemes summary it was then possible to choose a number of technically feasible options for refinement and cost estimation.

This part of the report describes the process of scoping or defining the extent of these options; the way in which they were reduced in number to give a more reasonable range for further consideration, and then, ultimately, the rationale for grouping the options into "Representative Total Schemes" (see Part 13.0). In Part 12.0 a summary of the appropriate individual catchment options is given.

7.2 HISTORIC CATCHMENTS

The basic approach of breaking the study area into four major catchments, which was first described in Section 3.2, forms the very basis of the catchment options scoping (refer also to Figure 3.2). For completeness, they are:

- Musselburgh Catchment (MC)
- Green Island Catchment (GIC)
- Mosgiel/Taieri Catchment (MTC)
- Harbour Basin (HB)
  comprising
  - Port Chalmers/Sawyers Bay (PC)
  - Burkes/St Leonards (B)
  - Company Bay (CB)
  - Broad Bay (BB)

References below to catchments and subcatchments will generally be by their abbreviations.

7.3 THE DECISION PROCESS

7.3.1 Introduction

When new interrelationships for effluent treatment and disposal within and amongst the four catchments are developed, it quickly becomes apparent that there are too many different options for them all to be sensibly covered, even at a very preliminary scoping level of detail. At the same time, it is necessary to ensure that no important option is overlooked in the development of schemes which are to be carried through this first stage for refinement and cost estimation.

The solution to what would otherwise be a complicated and confusing collection of almost 100 options is to take a CONCEPTUAL SYSTEMS approach to the problem which is based on common elements (or "concepts") in the range of identified options. Therefore, while a specific option may not be adopted, another option which is similar in concept to it may be adopted instead.

7.3.2 Catchment Output Concepts

The common element which was chosen was the number of CATCHMENT OUTPUTS; that is, how many disposal options there were spread over the four main catchments. The outputs could be either to WATER (ocean, harbour or river) or to LAND (including re-use). In enumerating the outputs no distinction was made between the actual "water" body into which discharge was made nor whether disposal to "land" is by irrigation or for re-use such as aquifer recharge.

The present situation provided the starting point in this conceptual systems methodology. Although there are in fact a total of 8 outfalls, all to water, these can be reduced conceptually to just four CATCHMENT OUTPUTS, one from each of the main catchments under consideration. These are shown in Figure 7.3.1. The ocean discharge at Lawyers Head and discharge to land at Ocean Grove are considered as just one Output, while the four individual outfalls in the harbour are grouped together as one Output to the harbour.

Shown alongside the present situation in Figure 7.3.1 is a simplified representation of the CONCEPT LEVEL 4 model. There are no intercatchment transfers and each catchment treats and disposes its own wastewater in isolation from the other three.

Starting at Concept Level 4, the number of catchment outputs is decreased by one each time to develop another three Catchment Output Concepts:

CONCEPT LEVEL 3:	three outputs to water and/or land with one intercatchment transfer required (4 separate cases)
CONCEPT LEVEL 2:	two outputs to water and/or land with two intercatchment transfers required (5 separate cases)
CONCEPT LEVEL 1:	one output only to water and/or land with three intercatchment transfers required (2 separate cases)

There are some Intermediate Level cases where there might be a limited transfer of effluent from one catchment to the next such as happens at present from MTC to GIC.

STAGING potential in scheme implementation by moving from one concept level to another, or within a particular concept level is likely to be an important issue in assessing various options.

7.3.3 Initial Key Decisions

Early in the investigations Royds Beca has concluded that in developing the models the following options were not viable, consequently they have been eliminated from those being considered and accordingly shown in Figure 7.3.1.

CATCHMENT OUTPUT CONCEPTS : (BASED ON HISTORIC CATCHMENTS)

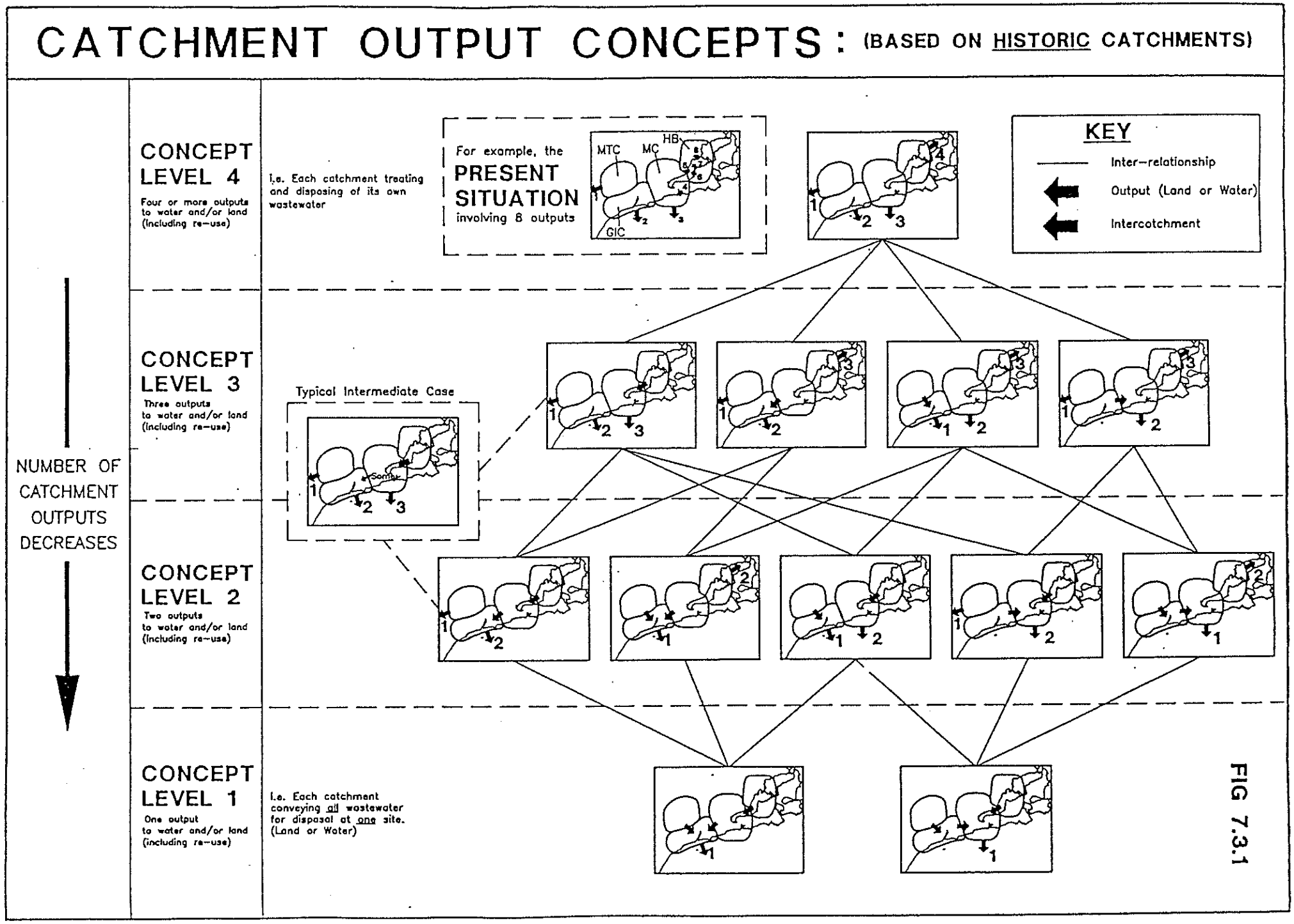


FIG 7.3.1

(i) That the Harbour Basin does not offer a sensible solution for the disposal of all Dunedin's wastewater.

(ii) That the Mosgiel/Taieri catchment likewise does not offer a sensible solution for the disposal of all Dunedin's wastewater.

Notwithstanding the above, particularly (ii), the possibility of effluent reuse cannot be discounted, certainly for the longer planning period, and this is similarly considered as a potential output. The Taieri Plains offers some potential for ground water recharge. This is discussed in Part 10.0 - Reuse of Effluents and Byproducts.

Another initial key decision the study team have made, is that the Musselburgh Pumping Station complex should logically remain as the "collection/nerve" centre of the Musselburgh Catchment. Relocation of this and the consequent incoming trunk sewer conveyance would be a very large task with significant disruption, and would involve significant cost.

Similarly the existing Green Island Wastewater Treatment Plant Site acts as a focus for the incoming conveyance lines from the Green Island Valley, Brighton/Waldronville, Tunnel Pipeline from Mosgiel area and the Fortex area. Accordingly, most of the options for the catchment and others joining it, will retain this site as the key collection and treatment focus point.

A further consideration in the options scoping, and more particularly in the options concepts themselves for the Musselburgh catchment is that the remaining combined sewer wet weather overflows into the top end of the Harbour are to be eliminated within the 10 year period.

Furthermore, high wet weather flows (through rain/stormwater) into the Kaikorai Valley catchment are also to be investigated with the objective of reducing the wet weather flows.

7.4 GROUPING OF OPTIONS

7.4.1 Catchment Options

As previously introduced there are large numbers of technically feasible scheme options. The number is large because of the many variables which include:

(i) The number of catchments and linking of all or parts of one or more catchments to another, this item gives the number of sewerage schemes.

(ii) The options available for each sewerage scheme component, eg, treatment plant sites, new conveyance routes, new and existing effluent disposal sites.

(iii) Quality of effluent/type of treatment.

(iv) Disposal means/location be it land, sea, harbour or inland waters.

(v) For coastal outfalls the location/length/quality interrelationship.

Options for each catchment can conveniently be grouped under the headings: conveyance, treatment and disposal, which are three most basic parts of any particular sewerage scheme (see Part 10.0). Some of the options which are considered as Catchment Options are listed below.

Conveyance Options:

(i) Harbour Basin - (HB)

- linking of some existing outfalls with consequent elimination of some
- provision of new outfalls
- connection of some schemes to Musselburgh catchment
- connection of all the HB to the MC and also land disposal alternatives.

The above encompass options of laying pipelines both in existing road and rail reserves and within the harbour itself.

(ii) Musselburgh Catchment (MC)

- linking Tahuna plant to new coastal outfall options
- linking the Musselburgh Pumping Station to a new treatment plant site and thence to a new ocean outfall - either directly or via Tahuna site
- conveyance out of this catchment to the GIC for subsequent or further treatment and disposal

(iii) Green Island Catchment (GIC)

- conveyance back into the MC for subsequent treatment and disposal
- conveyance with the wastewater from other catchments for subsequent land disposal

(iv) Mosgiel/Taieri Catchment (MTC)

- Conveyance of all, or part, back to the GIC
- Options for subsequent conveyance from the GIC in combination with other catchment flows.

Treatment Options

(i) Harbour Basin (HB)

- Retention of all or some of these plants with appropriate upgrading at the sites but in all cases such upgrading will be within the existing plant boundaries.

- Decommissioning of some or all the plants but with retention for pumping and subsequent flow balancing/emergency storage.

(ii) Musselburgh Catchment (MC)

- The existing Tahuna plant with a range of upgrading/extension and retro-fit options.

- A new treatment plant site to serve this catchment and under a number of options, also other catchments.

(iii) Green Island Catchment (GIC)

- Upgrade/extension of the existing plant

(iv) Mosgiel/Taieri Catchment (MTC)

- No new treatment plant sites are being considered

(v) Associated with land disposal systems, some treatment and effluent storage facilities within the land disposal area being considered.

Outfalls Options

(i) Harbour Basin (HB)

- various options including linking of some outfalls, such as provision of a new Port Chalmers outfall with options of it also serving other schemes

- options eliminating one, two, three and all four outfalls

(ii) Musselburgh Catchment (MC)

- new coastal outfalls of various lengths and various locations including one between Lawyers head and St Kilda ("Tahuna"), and one off Maori Head - the site included in the investigation in the 1960's)

- retention of the existing Lawyers Head outfall for various options

(iii) Green Island Catchment (GIC)

- retaining of existing ocean outfall (500 m long) with diffuser modifications

- extension of existing ocean outfall

(iv) Mosgiel/Taieri Catchment (MTC)

- no new outfall options are being considered within the MTC as part of this study

(v) Land Treatment and Disposal

- area of land disposal of all or part of the HB or similar effluent volumes on a site

- areas for land disposal of all Dunedin's wastewater

Note:
land treatment and/or land disposal options for Mosgiel effluent in the Taieri catchment do not form part of this study.

The discussion above introduces in a general way the grouping and range of options being considered from the point of view of various component parts of the wastewater treatment and disposals options review.

Part 10.0 sets out in detail the components making up each scheme, including discussion on the associated effluent standards, treatment plant types and arrangement and the associated residuals management options.

The components developed in Part 10.0 are then carried forward into Part 12.0 where they are combined to show "Catchment Options" for each of the four main catchments.

7.4.2 Representative Total Schemes

The catchment options in Part 12.0 are essentially CONCEPT LEVEL 4 options because each catchment has its own treatment and disposal scheme.

In order to develop Concept Level 3, 2 and 1 combinations, transfer of flows between catchments must occur. This further development is covered in Part 13.0 where specific catchment options are pulled together to form REPRESENTATIVE TOTAL SCHEMES. The philosophy and mechanism for these schemes is more fully explained in Part 13.0.

Part 8.0

Treated Effluent Quality Objectives

PART 8.0 : TREATED EFFLUENT QUALITY OBJECTIVES

8.1 TREATMENT STANDARD AND DISPOSAL INTERRELATIONSHIP

Wastewaters and domestic sewage are by and large water; water which must be appropriately treated before it can be safely returned to the hydrological cycle by discharge onto land or into natural water. The degree of treatment required depends on a number of issues and critical factors, including:

- the ability of the receiving water or land to absorb, assimilate and treat the polluting components of the discharge.
- the uses and environmental values associated with the receiving water or land.
- public health matters, (the primary reason for our waterborne sewerage systems in the first place).

There is therefore a need for decision-makers and the public to fully understand the interrelationships between these factors.

With regard to Dunedin, most of the treated wastewater is likely to continue to be discharged to either a local river (the Taieri), the harbour or coastal waters. Wetlands are a form of treatment, not ultimate disposal, and discharge from wetlands must occur somewhere; the possibility of land disposal is discussed further below.

With regard to river discharges, lower available dilutions coupled with various river water uses and often the proximity of urban communities means that higher levels of treatment are often required. This may, for example, require a disinfected secondary effluent in some cases, in others a secondary effluent which has had nutrients removed or even in the extreme case a tertiary effluent which has had nutrients removed and is disinfected. Control of toxins is also necessary for the protection of sensitive ecological values such as fisheries.

The current discharge from the Mosgiel treatment plant to the Taieri River has been the subject of recent investigations and debate (during the renewal process for the water right - refer Section 3.10 above), and it is believed as a result of this that there would be some opposition to discharging increased volumes of treated effluent into the Taieri.

A discharge to the harbour could probably technically be of a slightly lesser standard, say a disinfected "secondary" effluent given greater initial dilutions available. However, a study to determine the sensitivity of the harbour waters to increased nutrient loading could be required before a final effluent standard was selected. The high recreational use of the harbour requires stringent control of aesthetic components of any discharge, as well as pathogenic micro-organisms.

A coastal discharge could, if located appropriately, take advantage of the significantly greater dilutions in the nutrient-poor sea water, and hence treatment to remove BOD and nutrients is not required. Parameters of major importance are generally the aesthetic components (colour, floatables, oil and grease, solids, etc) and public health concerns (particularly with regard to pathogens in bathing and shellfish collection waters). There is also a need to consider the potential for bioaccumulation of toxins, such as trace metals and organics, in shellfish taken for human consumption. In some instances partially disinfected "primary" effluent may be able to be discharged, although the Department of Conservation (DoC) policies on discharges to coastal waters (refer Part 5.4 above) must be considered here.

A prime requirement in establishing appropriate receiving water/discharge locations is often the need for "shoreline separation". This involves separation of the users of shoreline waters and associated areas of ready access from the potential risk to public health associated with the effluent. The outfall lengths derived in this report, and associated effluent quality characteristics, are designed as essential for ensuring continued protection of public health, including during periods of emergency shutdowns and failures, wherever practicable. Shorter outfalls with higher levels of treatment cannot be considered to provide either the same security of public health protection or aesthetic standards (including perceived).

Whilst dilutions and mixing capabilities are significantly greater in the marine environment than in freshwater, there is still a requirement to consider potential detrimental effects on marine ecology from toxins, particularly persistent chemicals such as trace metals.

A discharge to land requires sufficient treatment to ensure that the absorptive and "polishing" capabilities of the soil are not detrimentally affected. This requires good removal of solids, oil and grease, and an appropriate consideration of concentrations of macro-ions (Mg, Ca, Na, K, N) and toxic elements. The potential public health risk associated with either public access to the site, aerosols from the spray operation (if used), or from use of underlying groundwater must also be addressed, and in this regard the Dept of Health's 1973 Guidelines would need to be adhered to. These require that effluent must be at least at a secondary treatment level or oxidation pond prior to land disposal.

One of the important considerations in any discussion of options for disposal of effluent is to ensure that the relevant limitations of the receiving environment are comprehensively understood. By appreciating these factors it is possible, and nowadays becoming appropriate practice, for these pollutants of priority to be the target of the treatment process while those of lesser concern need not be the specific target. This allows selection of treatment processes for ocean discharge, for example, which aim at removal of suspended solids and greases but not the more expensive biological secondary treatment processes to remove BOD_5.

While the type and degree of treatment for each option is largely dependant on the effluent disposal location, there are common requirements for all treatment processes. These include:

- robust treatment processes that can demonstrate proven performance and reliability.
- use of an appropriate degree of technology
- economy of operation in terms of personnel, materials and energy (operating costs), as well as consideration of capital costs
- ability to handle at least to a limited extent toxic discharges
- a sufficient degree of flexibility and redundancy built into the plant to handle peak flows, breakdowns and maintenance
- appropriate attention to environmental requirements in relation to residuals management, visual aspect and operator compatibility
- facility for expansion, preferably in a staged or modular way, when future planning requirements dictate.

8.2 HARBOUR BASIN STUDY

To quote the first Otago Harbour Planning Study Newsletter (March 1991):

> "**Why** do the Study?
>
> Otago Harbour is a focal point of Dunedin City and is home for numerous water based and land related activities. The harbour is experiencing increasing pressures and has been the subject of much public discussion in recent times.

There have already been a number of studies undertaken focusing on various issues related to the harbour but the concerns remain.

There is concern over pollution within the harbour from a number of sources which many feel has resulted in a lowering of the harbour water quality, especially in the harbour which is subject to relatively heavy recreational use. That level of recreational use is increasing with an increasing strain being placed on the present facilities. However, access to the water is constrained around much of the harbour's shoreline. Reclamations have been proposed in various areas in order to improve access and to provide more land for development purposes. Commercial port activities occur throughout much of the harbour while the land uses in the surrounding catchment area impact on all of the activities and uses. Underlying it all are natural physical processes and biological communities which are an integral part of the entire harbour.

The purpose of this study is to look at the harbour, its uses and its conflicts. Ultimately the study will result in a planning and management framework within which all harbour uses can occur with the minimum of conflicts."

Obviously, therefore, much of the information and understanding gained during the study will be of considerable relevance to this Wastewater Treatment and Disposal Options Study, in particular that from the following Harbour Study Working Groups:

- Pollution
- Cultural and Social
- Ecosystems and Physical Systems
- Recreation

There is apparently not a lot of reliable or directly comparable information available to present a comprehensive picture of the status of water quality in the harbour, and even less on the quality of edible seafoods. Areas of concern identified however are:

- poorer water quality at times in the upper harbour due to poor flushing and long residence times. The contribution of the Leith, stormwater, sewage overflows, general land runoff, and port/industrial activities to water and sediment contamination is of note. Industrial spills into the harbour or lower Leith are also of considerable concern.

- Sawyers Bay is known to be suffering from nutrient enrichment (eutrophication), and sediments show signs of considerable but historic contamination by trace metals. Other small bays receiving effluents similarly show eutrophication problems.

- existing sewage discharges are believed to contribute up to 30% of nutrients entering the harbour, although this requires confirmation/further investigation.

- public perception of water quality is worse than available data would tend to indicate, particularly for the upper harbour. These perceptions however are strongly felt.

- recreational use of the harbour is a key feature of the city, and there are strong pressures to increase both the diversity and extent of recreational activities.

- certain parts of the harbour have significant ecological values associated with them (eg, Aramoana salt flats, the Taiaroa Head area), as well as the fact that the entire harbour itself is unique as an example of a sheltered, shallow-water marine inlet in southern cool temperate waters.

- there are strong Maori cultural values associated with the harbour, and in particular concerns are often expressed about contamination of shellfish (cockle) resources by both domestic sewage and industrial wastes (including by contaminated sediments redistributed by dredging).

As a consequence any consideration of retaining discharges of treated effluent into the harbour, via either the existing or new outfall systems, will need to address these general concerns as well as the specific environmental factors associated with any particular proposed option.

8.3 SUMMARY

In summary, the key objectives in setting effluent quality standards are:

- to ensure continued or enhanced public health protection, including consideration of the concept of adequate shoreline separation.

- to maintain or enhance receiving water quality (if discharge occurs to this medium) such that uses made of it are able to be carried out safely, and in an aesthetically-acceptable manner. In this regard, adherence to currently-accepted standards for shellfish collection, contact recreation, and fisheries protection waters is of considerable importance.

- to ensure that the environmental and public health effects of any land disposal system (if discharge occurs to this medium) are not unacceptable, including protection of surface water and underlying groundwater from contamination.

- to meet the requirements of both the Resource Management Act and the DoC National Coastal Policy (refer sections 5.3 and 5.4 above), particularly with regard (in the former) to the minimum water quality standards to be met beyond a zone of reasonable mixing (section 107).

As a consequence, options for the disposal of effluent from catchment or overall schemes which are described below have included a preliminary assessment of the likely standard of effluent required to satisfy these objectives. These standards, however, may be changed based, for example, on the aspirations of the community and special interest groups for a particular receiving environment.

Part 9.0

Population Flows and Loadings

PART 9.0 : POPULATION FLOWS AND LOADINGS

9.1 DESIGN PERIODS

For the Stage 1 concept design the following design periods have been adopted: 10 years hence, 30 years hence, and 60 years hence, ie, years 2001, 2021, 2051.

These time frames are generally consistent with wastewater scheme planning in New Zealand. While these periods have been used, it is important to appreciate they are not "set in concrete", particularly at this early stage of Council's consideration of upgrading programme. Ongoing refinement must be part of the overall programme.

The 10 year projection has been adopted for the initial commissioning stage of new treatment facilities.

A 20 year design life has been adopted for major wastewater treatment facilities. This period is sufficient to cover loan repayments (ie, 10 year projection plus 20 year design life is 30 years hence). The construction items listed are all relatively easily renewed or extended allowing commitment of capital expenditure to be optimised in a first phase construction.

A 60 year design life has been adopted for major sewers, tunnels, pump station structures and the marine outfall(s). Each of these items would be a major works causing significant disruption during construction and not easily or cheaply upgraded.

9.2 DEMOGRAPHIC AREAS AND POPULATION PREDICTIONS

In order to scope the wastewater treatment and disposal options for each of the historic catchments and build up representative total schemes it is necessary, as part of this Stage 1 study, to assess both population projections (on a catchment basis), possible changes in trade waste discharges and any expected changes in water use and associated wastewater generation.

The Council's brief included information on demographic predictions. This information has been further worked up as a part of the study. Council's planning department has provided further information.

9.2.1 Demographic Areas

The Dunedin City comprises the following population areas:

Waikouaiti Coast
West Harbour/Port Chalmers
Northern Suburbs
Central Area/Dunedin North
Western Suburbs
Southern Area/St Kilda
Andersons Bay - Peninsula
Green Island Basin
Mosgiel
Taieri/Saddle Hill
Strath Taieri

9.2.2 Current Population Projections

The demographic predictions detailed in this section are based on the 1986 census, and allow for an increase of the total city population (covered by the areas described below in table 3.1), of 2,175 people as reported for the 1991 census. Details of how this increase is distributed are not yet available, but have for the purposes of expediency been applied on a pro-rata basis, (ie, 1986 census) to Waikouaiti Coast, Central Area/Dunedin North and Strath Taieri. It is expected that details of the distribution of the increase on 1986 census figures will be available in August 1991 and any major discrepancies between the assumption and actual could be taken into account.

The generated 1991 population figures are presented in Table 9.2.1.

TABLE 9.2.1 : 1991 Population Distribution

Area	1991
Waikouaiti Coast	3,400
West Harbour/P C	5,300
Northern Suburbs	9,800
Central Area/Dunedin North	12,100
Western Suburbs	25,700
Southern Area/St Kilda	21,000
Andersons Bay/Peninsula	12,700
Green Island Basin	11,100
Mosgiel	10,300
Taieri/Saddle Hills	3,200
Strath Taieri	800
	115,400

Notes: a. pro-rata factor $\frac{(115{,}400 - 16{,}300)}{(113{,}200 - 16{,}300)} = 1.028$

b. Factor applied to update 1986 populations for each area to 1991 populations.

c. Areas except Waikouaiti Coast, Central Area and Strath Taieri have no increases.

d. Information given in the "Options Study Brief" has been used for 1986 populations and as basis for extrapolation.

As described above, projections of the city's population for the years 2001, 2021, 2051 are to be considered, and population projections for these years are shown below.

Population Increases

The bases of population changes (as advised by DCC) over the design periods are as follows:

- Case 1 - Maximum growth projection at 1% increase compounded every five years.
- Case 2 - Medium growth projection at 0%
- Case 3 - Minimum growth projection at 1% decrease every five years.

A summary of the population projections at each design stage for medium and high growth cases is presented in the following table 9.2.2.

TABLE 9.2.2 : Suburban Population

	Medium Growth Projection 2001 to 2051 (ie, 1991 population)	High Growth Projections		
		2001	2021	2051
Mosgiel Taieri/Saddlehill	10,300 3,200 13,500	10,500 3,300 13,800	10,900 3,400 14,300	11,600 3,600 15,200
Green Island Basin	11,100	11,300	11,800	12,500
Kaikorai Valley	14,906	15,254	15,834	16,820
City Basin	65,571	72,896	75,581	79,863
Port Chalmers/Sawyers Bay	3,127	3,186	3,304	3,540
Burkes/St Leonards	583	594	616	660
Company Bay/Macandrew Bay	1,397	1,430	1,485	1,573
Broad Bay/Portobello	1,016	1,040	1,080	1,144
TOTAL	111,200	119,500	124,000	131,300

Historic Catchment Areas

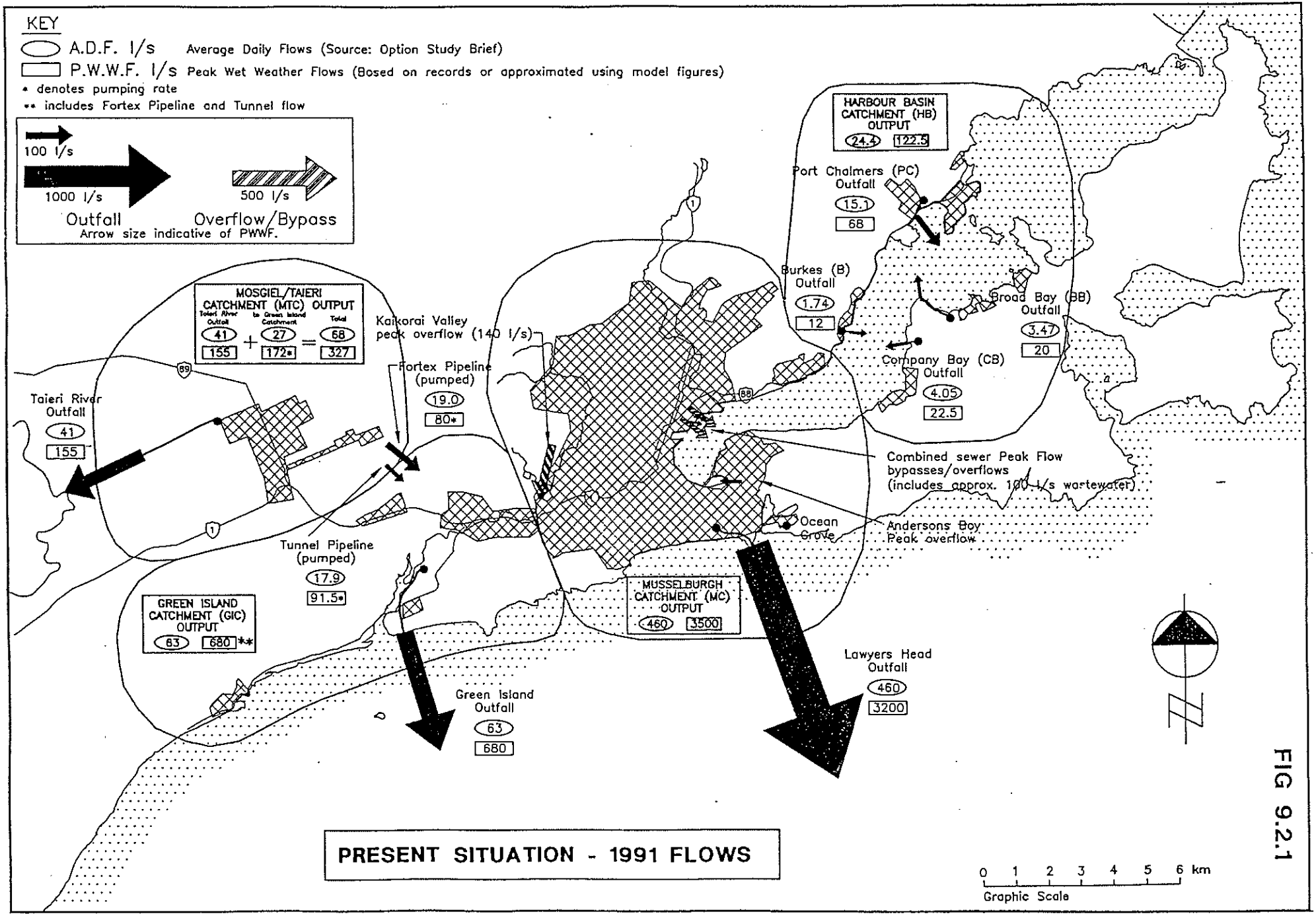
The following catchment areas are considered in this study. These have been previously introduced in Part 3.2 and shown in Figure 3.2.2.

- Musselburgh (MC)
- Green Island (GIC)
- Harbour Basin (HB)
- Mosgiel/Taieri (MTC)

Each catchment area comprises one or more natural drainage catchments. The current flows discharged from each of the four historic catchments are shown in Figure 9.2.1. Adopting the medium growth projection, the population in the four catchments is estimated as in Table 9.2.3.

TABLE 9.2.3 :

Catchment	Population 2001 to 2051
Musselburgh	80,477
Green Island	11,100
Harbour Basin	6,123
Mosgiel/Taieri	13,500
TOTAL	111,200


KEY
A.D.F. l/s Average Daily Flows (Source: Option Study Brief)
P.W.W.F. l/s Peak Wet Weather Flows (Based on records or approximated using model figures)
* denotes pumping rate
** includes Fortex Pipeline and Tunnel flow
100 l/s
1000 l/s
500 l/s
Outfall
Overflow/Bypass
Arrow size indicative of PWWF.
HARBOUR BASIN CATCHMENT (HB) OUTPUT
24.4
122.5
Port Chalmers (PC) Outfall
15.1
68
Burkes (B) Outfall
1.74
12
Broad Bay (BB) Outfall
3.47
20
Company Bay (CB) Outfall
4.05
22.5
MOSGIEL/TAIERI CATCHMENT (MTC) OUTPUT
Taieri River Outfall
41
155
to Green Island Catchment
27
172*
Total
68
327
Kaikorai Valley peak overflow (140 l/s)
Fortex Pipeline (pumped)
19.0
80*
Taieri River Outfall
41
155
Combined sewer Peak Flow bypasses/overflows (includes approx. 100 l/s wastewater)
Ocean Grove
Andersons Bay Peak overflow
Tunnel Pipeline (pumped)
17.9
91.5*
MUSSELBURGH CATCHMENT (MC) OUTPUT
460
3500
GREEN ISLAND CATCHMENT (GIC) OUTPUT
63
680**
Lawyers Head Outfall
460
3200
Green Island Outfall
63
680
PRESENT SITUATION - 1991 FLOWS
0 1 2 3 4 5 6 km
Graphic Scale
FIG 9.2.1

9.3 FLOWS AND LOADINGS

9.3.1 Estimation of Wastewater Flows

Approach

There are two aspects of flow estimation, namely estimating current flow rate characteristics and extrapolating these into the future.

Current Flow Rate Characteristics

The useful flow rates are as follows: (a day = 24 hours)

Average Daily Dry Weather Flow (ADWF)

The average flow on a dry day. Measurements should preferably be taken on the third of three consecutive dry days. The average daily dry weather flow should be identified as "summer" or "winter".

Generally, this is the normal flow rate for wastewater treatment plant design.

Peak Wet Weather Flow (PWWF)

The peak wet weather flow rate is the peak rate of flow on a wet day. The rainfall on the day concerned should be stated.

The flow rate is the peak pumping rate required (with an appropriate safety factor).

The above flow characteristics can be either estimated by modelling, using known populations and standard flow factors, industrial and commercial areas and standard wastewater generation rates, and standard infiltration and inflow rates, or obtained from actual flow monitoring data. The latter method is preferable.

For the study area, it is considered appropriate to first look at building up flow information by modelling methods and comparing these data with recorded flow information for each catchment.

Sources of Wastewater

The principal sources of wastewater are:

- domestic discharges
- commercial discharges
- industrial discharges
- inflow and infiltration
- stormwater

Flow Factors : Domestic

Trends in wastewater discharge are probably reflected by trends in water usage, outside summer months (when a significant proportion of water is used for irrigation).

City water records over the last five years have been reviewed but show no specific trends. It would be necessary to do a study on water demands by a selected, stable, wholly domestic catchment to determine whether there are significant trends.

For the purpose of this study, it is proposed that the following gross flow factors are used. These should be further considered and refined as the study proceeds, and confirmed prior to final design of the actual facilities.

TABLE 9.3.1 : Domestic Flow Factors

Design Period	Flow Factor l/p d
2001	270
2021	290
2051	320

Flow Factors : Commercial Discharges

Because land zoned commercial may not be actively used, a per employee wastewater generation rate of 200 l/d is proposed (ie, 200 l/p d).

It is anticipated that commercial usage will remain fairly constant.

Flow Factors : Industrial Discharges

The industrial discharge flow factor allows for relatively 'dry' industries, and does not allow for large 'wet' industries such as a tannery or freezing works. Allowances are accordingly included for these large existing trade waste flows and loadings.

Inflow and Infiltration

A base inflow and infiltration rate has been used in the domestic flow factor.

The only secure way of determining peak inflow and infiltration rates is by flow measurement. Where such information is not available, standard peaking factors may be adopted.

Stormwater

Stormwater enters the wastewater system in a number of different ways.

The most common is through infiltration of groundwater into foul sewer systems through joints of pipes, etc, and the inflow of stormwater from illegal connections to foul sewers. These contributions to wastewater flows are taken into account in the infiltration and inflow factors built into domestic flow rates. However, stormwater also enters the Musselburgh Catchment wastewater system by intentional (legal) inflows of stormwater runoff into the foul sewer by combined sewers.

The effect of the contribution of stormwater runoff on peak flows observed at Musselburgh pumping station, and the estimate of the proportion of wastewater from the combined sewer catchments bypassed during peak flows, is discussed in this section.

Combined Sewers

Stormwater runoff is purposefully directed to the Musselburgh catchment main intercepting sewer (MIS) via some combined sewers still in use in the Dunedin City Basin.

The main areas include the following sub-catchments:

i)	York/Haddon Place	-	stormwater conveyed to foul sewer main and some combined sewers (also includes contribution from a natural water catchment)
ii)	Pitt Street	-	stormwater conveyed to sewer main and some combined sewers
iii)	Hanover Street	-	combined sewer
iv)	St Andrew Street	-	combined sewer

An estimated 140 l/s of this overflows into the Kaikorai Stream near Townleys Road in Kaikorai Valley where flows from that (former DD&SB) catchment gravitate through to the St Clair area.

A figure of approximately 300 l/s of wastewater is being bypassed from the Musselburgh system during peak flows (this excludes overflowing in the Surrey Street area).

Musselburgh Catchment Peak Wet Weather Flows

Because of the various bypasses and overflows in the Musselburgh system acting at times of peak flows, it is difficult to quantify the present day peak wet weather flows from the flow data available.

The component of wastewater in bypassed flows has been estimated to gain an understanding of the magnitude of bypassed wastewater.

From this evaluation it is proposed to use a PWWF = 3100 l/s for present peak flows, for options evaluation, for the case of totally separated sewers (ie, all remaining combined sewers separated) and no bypassing of wastewater from the Musselburgh system.

Peaking Factors

A peaking factor is the ratio of the peak wet weather flow (PWWF) to the average daily dry weather flow (ADWF).

For the two main catchments of Musselburgh and Green Island, individual peaking factors will be applied to each wastewater source as follows for calculation of model flows:

Peaking Factors for Main Catchments (MC and GIC)

Source	Peaking Factor
Domestic	6
Commercial	2
Industrial	4

For the smaller predominantly or entirely domestic catchments, peaking factors will be applied as follows:

Peaking Factors for Minor Catchments

Mosgiel	3.8
Port Chalmers	4.5
Company Bay	5.6
Broad Bay	5.75
Ocean Grove	6.2
Burkes	6.5

Catchment Design Flows

Based on the population projections (medium growth case) and flow factors given above, catchment flows can be developed for average dry weather and peak wet weather cases.
Table 9.3.2 presents the average dry weather flows (ADWF) estimated for each catchment for each design case, using the modelling assumptions above.

TABLE 9.3.2 : Medium Growth Projections
Average Dry Weather Flows (ADWF) in litres per second

Catchment	Variables			Average Dry Weather Flows (ADWF)							
	1991 to 2051 Population	District Scheme Industrial Area (ha)	Total Employment Figures	Domestic l/s			Commercial l/s	Industrial l/s	Totals l/s		
				2001 270 l/p d	2021 290 l/p d	2051 320 l/p d	200 l/p d	45 m^3/ha d	2001 l/s	2021 l/s	2051 l/s
Mosgiel Domestic (Part MTC)	13,500	-	2,600	42.2	45.3	50.0	6.0	-	48.2	51.3	56.0
Mosgiel Industrial (Part MTC)	-	92.0	-	-	-	-	-	47.9	47.9	47.9	47.9
Green Island Basin (Part GIC)	11,100	85.1	1,700	34.7	37.3	41.1	3.9	44.3	82.9	85.5	89.3
Kaikorai Valley (Part MC)	14,906	32.5	2,030	46.6	50.0	55.2	4.7	16.9	68.2	71.6	76.3
City Basin (Part MC)	65,571	291.0	34,378	204.9	220.1	242.9	79.6	151.6	436.1	451.3	474.1
Port Chalmers (PC)	3,127	10.8	630	9.8	10.5	11.6	1.5	5.6	16.9	17.6	18.7
Burkes (B)	583	-	-	1.8	2.0	2.2	-	-	1.8	2.0	2.2
Company Bay (CB)	1,397	-	50	4.4	4.7	5.2	0.1	-	4.5	4.8	5.3
Broad Bay (BB)	1,016	-	112	3.2	3.4	3.8	0.3	-	3.5	3.7	4.1
Ocean Grove (Part MC)	550	-	-	1.7	1.8	2.0	-	-	1.7	1.8	2.0
TOTALS	111,750	511.4	41,500	349.3	375.1	414	96.1	226.3	711.7	737.5	776.4

Key: l/s = litres per second
l/p d = litres per person per day
m^3/ha d = cubic metres per hectare per day

Note: Mosgiel industry figures exclude Tunnel pipeline and Fortex flows

9.3.2 Summary of Suggested Design Flows and Loadings for the Stage 1 Options Study

Peak wet weather flows are calculated from the ADWF flows using the peaking factors established earlier. There are shown in Table 9.3.3 the flow rates recommended for adoption for option evaluations.

TABLE 9.3.3: Recommended Catchment Flow Rates

Catchment	ADWF l/s			PWWF l/s		
YEAR :	2001	2021	2051	2001	2021	2051
Musselburgh (MC)						
Total Catchment	506	524	553	3,250	3,400	3,650
Subcatchments:						
Dunedin City Basin	436	451	474	2,750	2,860	3,070
Kaikorai Valley	68.2	71.6	76.8	490	520	565
Ocean Grove	1.7	1.8	2.0	15	15	16
Green Island (GIC)						
Total Catchment	261	264	268	779	804	839
Subcatchments:						
GI Drainage Basin	82.9	85.5	89.3	600	625	660
Tunnel Pipeline (pump rate)	91.5	91.5	91.5	91.5	91.5	91.5
Fortex Pipeline* (pump rate)	87	87	87	87	87	87
Mosgiel/Taieri (MTC)						
Total Catchment	96	99	104	375	387	405
Subcatchments:						
Mosgiel Domestic	48.2	51.3	56.0	183	195	213
Mosgiel Industries (excl Tunnel Pipelines)	47.9	47.9	47.9	192	192	192
Harbour Basin Catchments: (HB)						
Total Catchments	26.7	28.1	30.3	133	140	152
Subcatchments:						
Port Chalmers	16.9	17.6	18.7	76	79	84
Burkes	1.8	2.0	2.2	12	13	14
Company Bay	4.5	4.8	5.3	25	27	30
Broad Bay	3.5	3.7	4.1	20	21	24
TOTAL CITY	889.7	915.1	955.3	4537	4731	5046

Note: * Could be increased to around 100 l/s by Fortex with DCC agreement - refer Fortex/DCC agreement.

9.3.3 Discussion on the Use of Recommended Catchment Flow Rates

Musselburgh - These figures are based on total future separation of combined sewers and no bypassing of wastewater. Model figures have been recommended for ADWF, however, PWWF figures are based on a 'recorded' 1991 PWWF of 3,100 l/s, and extrapolated for the years 2001, 2021 and 2051 to allow for increasing water use.

Green Island - Model figures are recommended for ADWF for Green Island Basin, however, PWWF figures are based on extrapolation of recorded peaks.

Both the Fortex and Tunnel pipeline flows are fixed as per the trade waste agreements

Mosgiel/Taieri - Mosgiel industry figures are based on the whole industrial district scheme area for Mosgiel with an industrial flow factor applied to give model figures.

These figures do not allow for the setting up of any new 'wet' industries in Mosgiel however, only establishment of relatively 'dry' industries in the district.

Harbour Basin - Model figures are recommended for both ADWF and PWWF for the Harbour Basin catchments, however for the consideration of flows for design of conveyance systems, for the smaller flow numbers, pipe sizes are more likely to be determined by pumping rate characteristics.

9.3.4 Contribution of Trade Wastes to Flows and Quality

Raw wastewater quality is monitored at the Tahuna, Green Island, Port Chalmers, Mosgiel and Company Bay wastewater treatment plants. Trade waste monitoring is also undertaken at selected industries.

Part 4 of this report further elaborates on the significance of trade waste loadings particularly BOD_5, Suspended Solids and grease loadings. Also refer Section 9.3.5 below.

The contribution of the various trade wastes to the flows and quality of wastewater generated within the four historic catchments is best described in terms of population equivalent. This information is presented in Part 4, and shown diagrammatically in Figure 9.3.1.

9.3.5 Wastewater Quality Data Use

For treatment plant design purposes, the principal quality parameters will depend on the treatment plant type and design basis being used. These include BOD_5, suspended solids (SS) concentration, and grease concentrations of the raw wastewater.

Normal domestic sewage values for BOD_5 and SS are:

- BOD_5 200-290 g/m^3
- SS 200-290 g/m^3

The recorded concentrations at Tahuna are between 30% and 50% higher than normal domestic sewage (depending on which parameter is considered). Refer also to Part 4.2 - Trade Wastes.

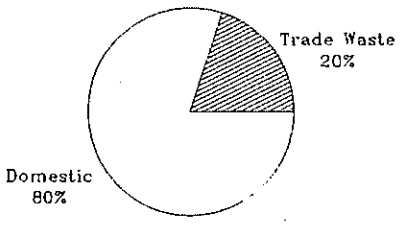
For Green Island the concentrations are 3-4 times higher than normal domestic sewage for SS and BOD_5 and on average 9 times higher for grease, as is expected for this catchment - a result of the type and significance of discharge of the 'wet' industries in this catchment.

These figures are elaborated on in Part 4.0 of this report.

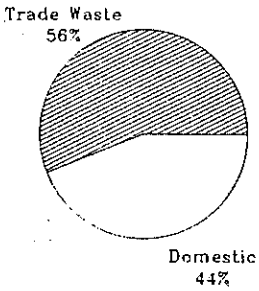
Mosgiel and Port Chalmers figures generally fall within normal domestic sewage values.

Figure 9.3.1 Contribution of Tradewaste to Wastewater Flows and Strengths, Based on Population Equivalents For Present Flows and Loadings

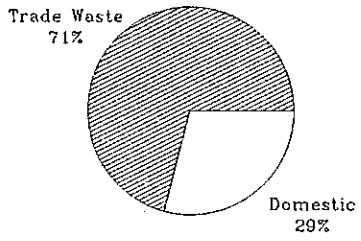
Musselburgh Scheme



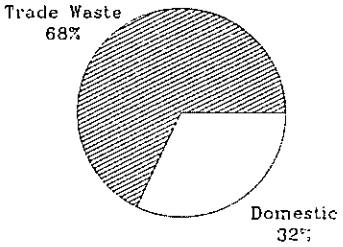
Daily Volume
(excludes wet weather flows)



Suspended Solids

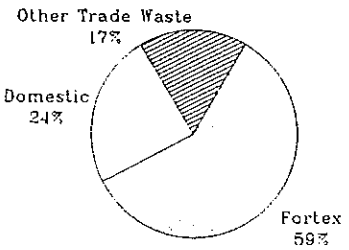


Total Grease

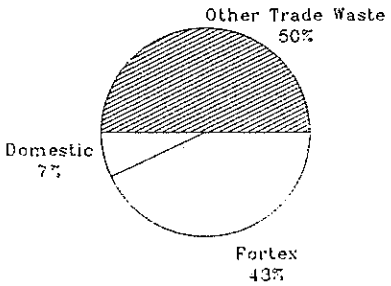


BOD_5

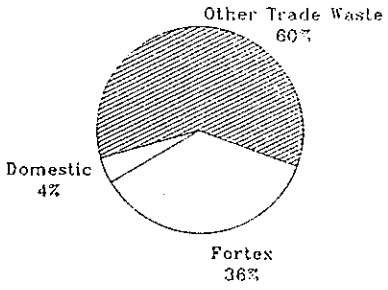
Green Island Scheme



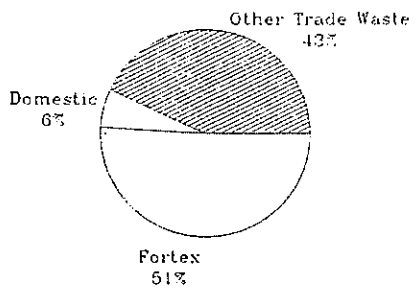
Daily Volume
(excludes wet weather flows)



Suspended Solids



Total Grease



BOD_5

The following initial design values are proposed:

TABLE 9.3.5 : Recommended Initial (Concept) Design Quality Parameters (as may be relevant to particular concept design)

Catchment	Quality Parameters					
	BOD_5 (g/m^3)*		SS (g/m^3)**		Total Grease (g/m^3)***	
	average	max	average	max	average	max
Musselburgh	420	580	320	420	100	200
Green Island	1000	1500	1100	1700	500	1600
Mosgiel	280	430	230	420	50	90
Port Chalmers	240	260	200	220	50	90
Company Bay	310	420	250	350	50	90
Other Catchments	250	320	250	320	50	90

Note: Mass loadings have also been established for key criteria.
*BOD_5 = Biochemical Oxygen Demand (a measure of organic strength)
**SS = Suspended Solids, also called Non Filterable Residue (NFR)
***Total Grease = Oil and Grease in this report. Refer Part 2.4.5.

9.3.6 Monitoring

There should be further continued monitoring of both wastewater flow rates and wastewater qualities.

A review of current monitoring facilities and procedures, and a subsequent monitoring programme would assist in:

- identifying further instrumentation and procedures required
- securing a good data base for later stage evaluation and design
- maintenance programming
- indicating system loading aberrations which may lead to more effective control of loading inputs.

For Stage 2 work and further refinement of treatment design it is imperative more information is obtained for the Musselburgh and Green Island Catchments for SS, total grease and BOD_5.

Part 10.0

Components of the Wastewater Schemes

PART 10.0 : COMPONENTS OF THE WASTEWATER SCHEMES

10.1 INTRODUCTION

In Part 2.3 the purpose and components of a sewerage scheme are introduced, namely:

- collection
- conveyance
- treatment
- disposal
- residuals management

A complete sewerage scheme, and in this project the parts being focused on of treatment and disposal, incorporates the integration of all these components. This integration is generally in the order as listed above although in some existing schemes and options under consideration conveyance is likely to be required throughout the scheme linking, for example, both collection and treatment and treatment and disposal facilities.

In this Stage 1 scoping report, the method of discussing individual components of treatment and disposal options is followed as many of the components are common to a number of different catchment options and total representative schemes.

This discussion reviews, at least in a scoping format, the technical, physical, location, construction and operational components that are linked together in various ways to make up the many catchment options and representative total schemes. The discussion also includes a lead in, as is appropriate in a scoping report such as this, to matters such as operation and maintenance, reliability, risk and redundancy, and effluent and residuals reuse.

It is stressed, in reviewing these components of the catchment options and representative total schemes and linking them together in various ways, that firstly only technically feasible and secondly the more logical combinations have been presented.

Where technologies are innovative, or in a developmental stage, the discussion is noted accordingly.

In this part of the report estimated costs are tabulated for many of the components discussed. The basis of these cost estimates is set out in Part 11.0.

10.2 COLLECTION AND CONVEYANCE

10.2.1 Introduction

One of the most important and yet most frequently overlooked areas in the field of wastewater management is the sewage collection and conveyance system. Because it is buried out of sight it is not as obvious as treatment plants or points of disposal, but its role in transporting sewage and wastewater from their sources to treatment plants or disposal points must not be undervalued.

Any development of the existing Dunedin sewerage system to provide a new treatment plant or relocated outfalls or land disposal schemes will require adjustments to the existing sewers to deliver flows from the present system to these new facilities, which may be in a different catchment or even outside the four main city catchments. The new system could involve both "intra - catchment" conveyance changes and "inter - catchment" changes. Intra- indicates conveyance within each catchment, while Inter- signifies that the conveyance is between

catchments. This conveyance development has to also consider any staged implementation for various elements of the schemes which could be adopted.

In this section, the historical development of the present collection and conveyance system is summarised because it is important to recognise the constraints which existing infrastructure imposes on any future development.

The major new pumping stations, gravity sewers and rising (pumping) mains which would be needed for the intracatchment options and intercatchment schemes are presented with cost estimates.

10.2.2 Drainage System Description

Historical

Prior to 1898, Dunedin City comprised the area between what is known as the Town Belt (a strip of native bush reserve running around the first ridges) and the Harbour, and it was surrounded by a number of autonomous Boroughs, e.g. Maori Hill, Roslyn, Mornington, South Dunedin and Caversham. The drainage from the Boroughs passed through the City and pollution of the Otago Harbour was a continuing problem. Agreement between the City, the Boroughs and the Otago Harbour Board proved impossible to reach and in 1898 the matter was referred to arbitration. Following this the Dunedin Drainage and Sewerage Board (DD&SB) was formed in 1900 to provide for the proper drainage of the Greater Dunedin area, generally defined as the existing Dunedin City and the adjoining Boroughs. (see Figures 10.2.1 and 10.2.2). It should be noted that these figures exclude Waikouaiti, Karitane, Seacliff and Warrington, although they are covered by the Greater Dunedin area.

Work on the main city system, which is basically unchanged today, commenced in 1903 and comprised the Main Intercepting Sewer (MIS) extending along the then Harbour foreshore (picking up the main lines running through the City) from the Water of Leith to Musselburgh Pumping Station, rising mains from the Musselburgh Pumping Station to a high point at Tahuna Road (adjacent to the present Water Pollution Control Plant commissioned in 1981) and a gravitational outfall from this point to sea outfall at Lawyers Head, discharge being at the high tide level. The original selection of Lawyers Head was apparently on a very cursory basis, but sewage has been discharged from there since May 1908.

The natural topography and physical features of the Board's district limited the area which could be served by the main system and up until the amalgamation of West Harbour (1963) and the Peninsula (1967) with the City, all development within the DD&SB area had been provided with sewerage except for isolated scattered housing on the fringes of the City areas. Independently of the main city system, sewerage systems were developed in adjacent communities such as Mosgiel, Green Island, Fairfield, Wingatui, and Harbour Basin communities.

Present Day

With the amalgamation in 1989 of neighbouring local authorities (Boroughs and Councils) to form the enlarged Dunedin City Council, the function of the DD&SB was absorbed by that Council, but the sewerage reticulation systems have remained separate as they were prior to amalgamation.

Musselburgh Catchment [MC] (Fig. 10.2.1)

The majority of the central urban area drains by gravity into the Main Intercepting Sewer (MIS) which then gravitates to the Musselburgh Pumping Station. The nominal capacity of this station, which is really the hub of the Musselburgh Catchment, is 4550 l/s. The only areas not draining to the MIS are:

- St Kilda 900mm dia. sewer which gravitates direct to Musselburgh.
- Andersons Bay : 600mm dia. trunk gravitating direct to Musselburgh.
- two small subcatchments which are pumped either directly or indirectly to the MIS (Ravensbourne and The Cove).

Present development within the area is on a 'separate' system but a part of the central city area is still 'combined' and at times of heavy rainfall the flow from this area is diverted to the Harbour. A programme of separation is underway and within 10 years all foul sewage will flow to Musselburgh Pumping Station. At present the ratio of wet weather:dry weather flow is 6:1 and higher even with much of the central area diverted to the Harbour. This indicates a substantial inflow of stormwater from private connections.

Other Catchments [GIC, HB, MTC] (see Figures 10.2.1 and 10.2.2)

The only other subcatchments which gravitate to treatment plant sites are Green Island, Sawyers Bay and Seacliff, the latter not being included in this section of the study.

All other subcatchments within the three major catchments of Green Island, Harbour Basin and Mosgiel/Taieri have pumped reticulation systems. These separate areas are:

Green Island Catchment
Brighton, Waldronville, Fairfield, Wingatui, Fortex and the two Mosgiel industries.

Harbour Basin
Macandrew Bay, Company Bay, Broad Bay, Portobello, Burkes/St Leonards, Port Chalmers (with the exception of Sawyers Bay which gravitates).

Mosgiel/Taieri Catchment
Mosgiel, Taieri Plains Industries.

10.2.4 The Collection Reticulation

The total length of the reticulation is approximately 1500km, with a maximum flow path of approximately 11km. Fifty percent of the reticulation is 150mm or less in diameter and the age of the system is generally in excess of 60 years. Because post-1945 subdivisional development in the Dunedin area occurred predominantly outside the main city area, a relatively high proportion of the sewers in this central area can be expected to be greater than 50 years old, perhaps some 75% of all sewers being in this category.

Since this report is mainly concerned with the larger size conveyance lines, which are generally in sound condition, there is need only to note that the Council has instituted a drainage inspection, maintenance and renewal programme to ensure all sewers and mains in the city are and remain servicable. Additionally, Council has very recently approved a programme of inspection for illegal and other stormwater discharges to the foul sewer system.

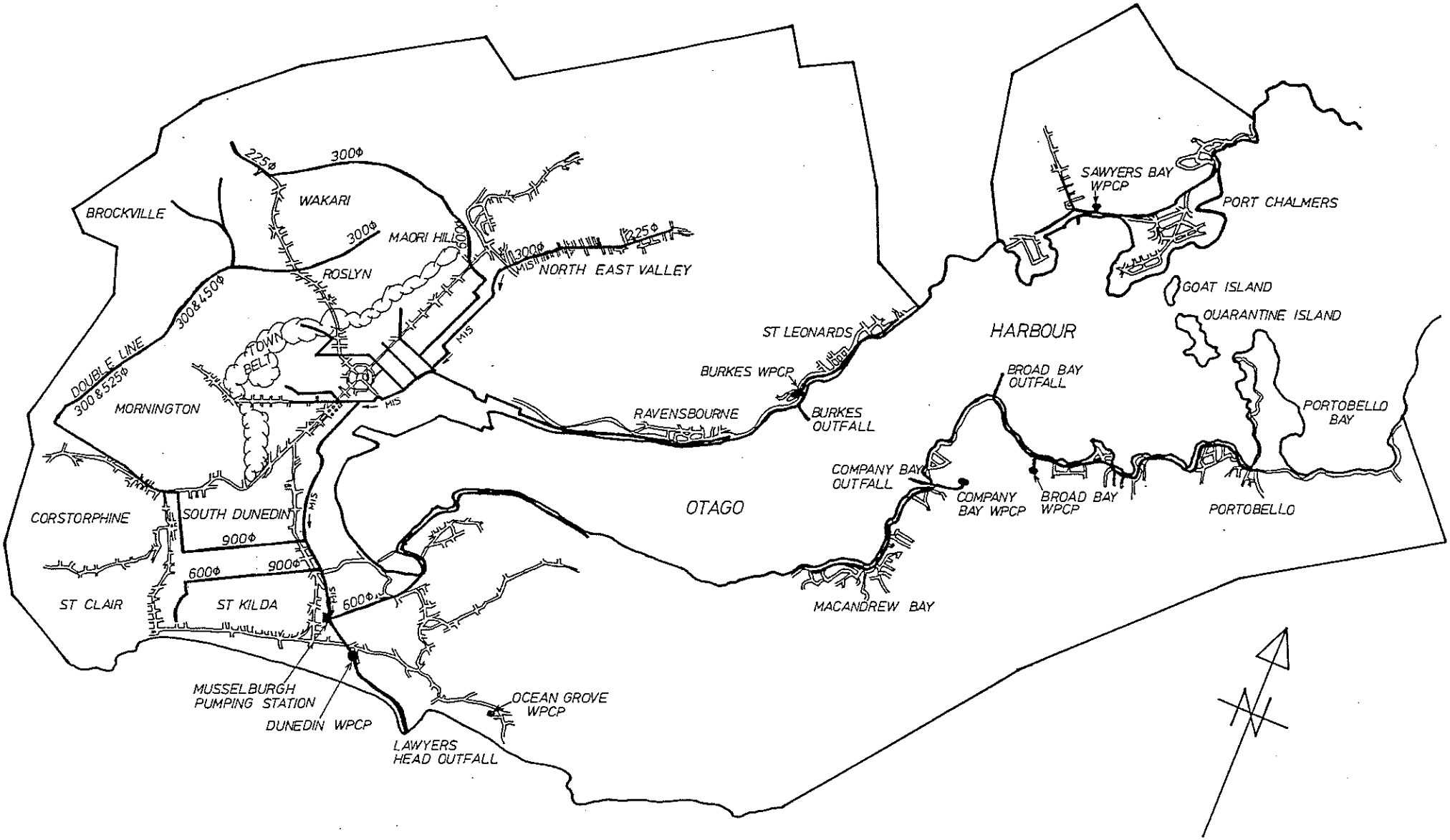


FIGURE 10.2.1

D.C.C. CITY WORKS DRAINAGE	SCALE 1:50 000	DATE 12 APRIL 1990
METROPOLITAN DUNEDIN TRUNK FOUL SEWERS	DRAWN D.L. ROBINSON	F-820
	TRACED MJS	
	CHECKED	
	APPROVED	

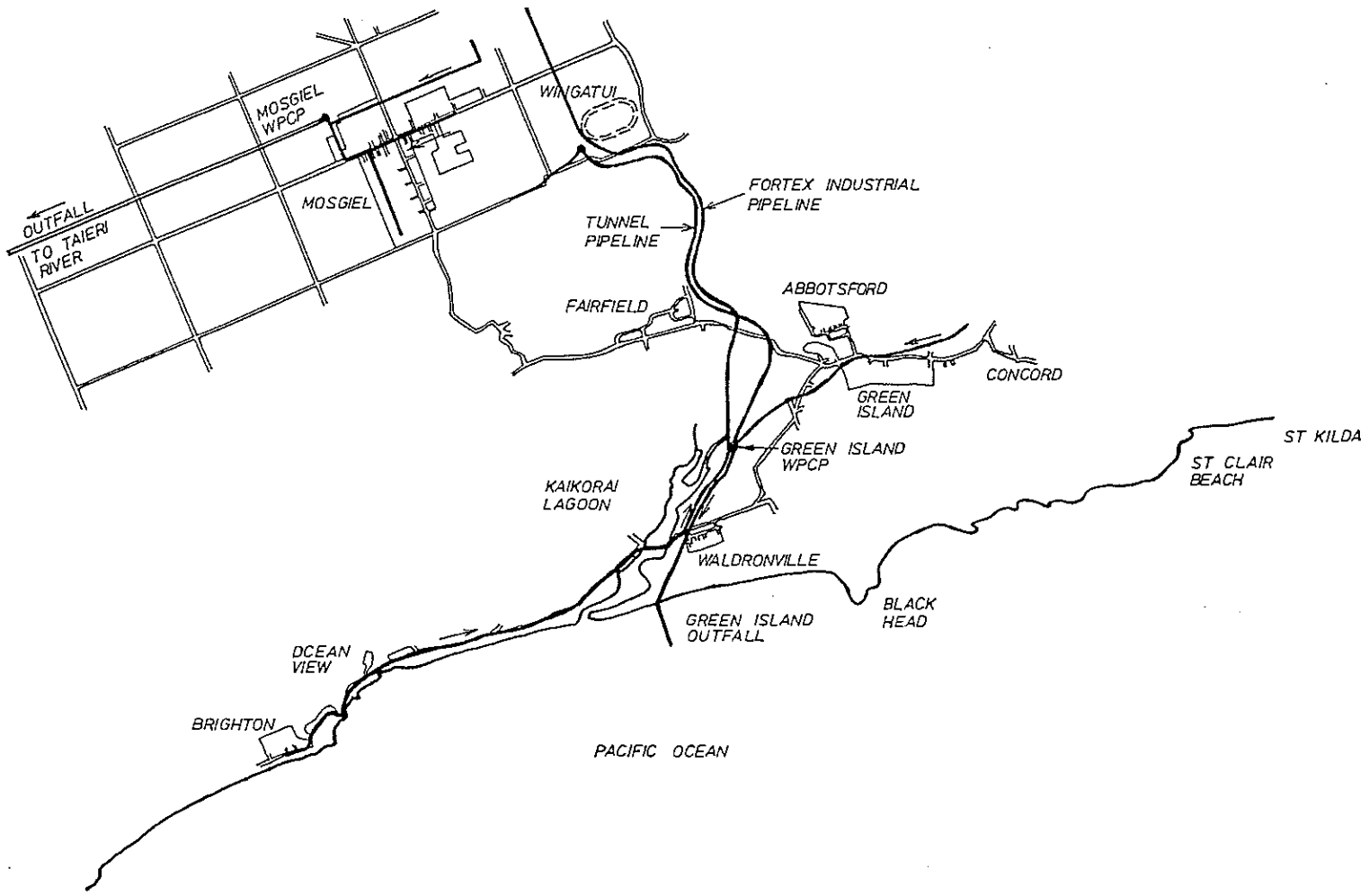


FIGURE 10.2.2

DESIGNED		SCALE 1:63360		MOSGIEL AND GREEN ISLAND DRAINAGE SCHEMES TRUNK FOUL SEWERS	DRAWING No 820/2
DRAWN	MJS	FOR ISSUE			SHEET No 2 of 2
TRACED	MJS	DRAWING STATUS			ISSUE A B C D E F G
CHECKED	D.L.R.	NOTE: CONTRACTOR SHALL VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK			DATE ISSUED
APPROVED	D.L.R.				

10.2.5 New Collection and Conveyance Systems

In planning and estimating costs for new sewers, rising mains and pumping stations the following assumptions have been made:

Routes - where possible pipes will be laid in roads, road reserve, council easements, or railway reserve.

Tunnel options - where routes involve high static lift over hills, the alternative of dedicated tunnelled pipelines has been identified.

Pipe material - generally concrete (rubber ring jointed) for low to medium head pipelines over 400mm diameter; concrete lined mild steel for high head pipelines over 400mm diameter; uPVC (plastic) or HDPE (high density polyethylene) pipelines under 400mm diameter (in pressure and sewer grades).

Cost estimates - these have been based on actual pipe costs plus pipelaying rates estimated by Royds Beca and a specialist local contracting company, with allowances made for different ground conditions, difficult routes, pipe size and total length.

Pumping Stations - Smaller pumping stations serving subcatchments, assume two - pump configuration (duty/standby) with submersible sewage pumps.

Larger pumping stations pumping long distances or between catchments, assume wetwell/dry well configuration and variable speed drive pumps.

Emergencies/overflows - assume no standby generation of power in new stations; small pump station will have 100% backup; larger pump stations will have 50-100% backup depending on the total number of pumps installed; Musselburgh pumping station does not yet have standby power generation capacity but has diesel engine driven pumps.

10.2.6 Intra-catchment conveyance

The following section describes new pipeline links which have been identified. They are shown schematically in Figures 10.2.4 to 10.2.7 for each of the four major catchments. Cost estimates for Linkups which are included in "Catchment Options" or "Representative Total Scheme" are also given.

Harbour Basin Catchment (HB)

Each of the existing treatment plants can be linked to the others or to the Grassey Point outfall or a new outfall near Beacon #5 (Port Chalmers Peninsula), this position subject to confirming studies. The links are generally pumping mains, laid either in the roads reserve, railway reserve or in the harbour bed. Diameters vary depending on whether there is one or more subcatchment flows being conveyed from place to place. A schematic diagram of some of the HB intra-catchment links appears as Figure 10.2.3.

Those links which are relevant to costed options or schemes are given below in Table 10.2.1. In some instances, there is more than one choice of route between two or more treatment plants but to tabulate all such alternative routes would only lead to confusion. For instance, it is estimated to be significantly cheaper to transfer Burkes to Port Chalmers (B to PC) via two cross harbour links (B to GP and then GP to PC) than to lay a new landline in road/rail reserves. However, the latter choice enables easy connection of future sewers into the trunk sewer as residential or industrial development occurs along the route, which is not possible with a B to CB cross harbour link. There may also be some doubts on technical grounds about the

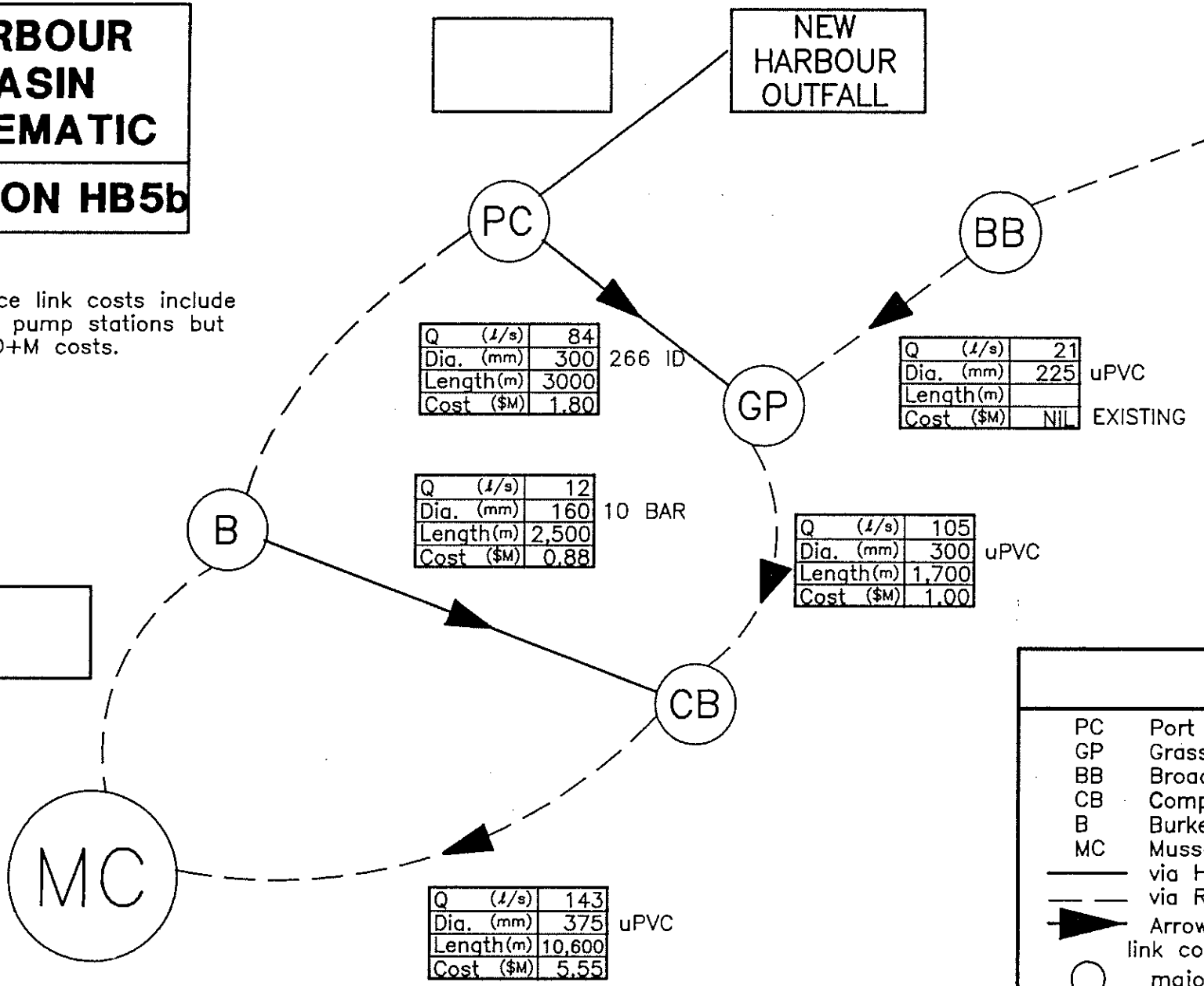
construction feasibility and long term security of a small bore cross harbour pipeline on the Burkes/Company Bay alignment where it crosses the training walls and the main shipping channel. Similar logic applies to the preference for transferring Burkes to the Musselburgh Catchment (B to MC) in Option HB4 while conveying the other three plants from the Harbour Basin to Okia for land disposal.

For the transfer of all the harbour basin plants back to the Musselburgh Catchment (Option HB5), which should be considered as an inter - rather than an intra-catchment conveyance, there are two route combinations the choice of which could be made on the grounds of cost or technical preference. They are shown as HB5a and HB5b and are more fully described in the section on **Inter-Catchment Conveyance.**

HARBOUR BASIN SCHEMATIC

OPTION HB5b

NOTE :
Conveyance link costs include additional pump stations but exclude O+M costs.



CONVEYANCE OPTION CAPITAL COST SUMMARY	
LINK	COST ($M)
PC – NEW HARBOUR OUTFALL	
BB – OKIA LAND DISPOSAL	
PC–B	
PC–GP	1.80
BB–GP	existing
GP–CB	1.00
B–CB	0.88
B–MC	
CB–MC	5.55
TOTAL	9.23

KEY

PC	Port Chalmers
GP	Grassy Point
BB	Broad Bay
CB	Company Bay
B	Burkes
MC	Musselburgh Catchment
———	via Harbour Bed
— — —	via Road/Rail reserve
▶	Arrow indicates conveyance link costed and flow direction
○	major conveyance terminus

Royds Beca

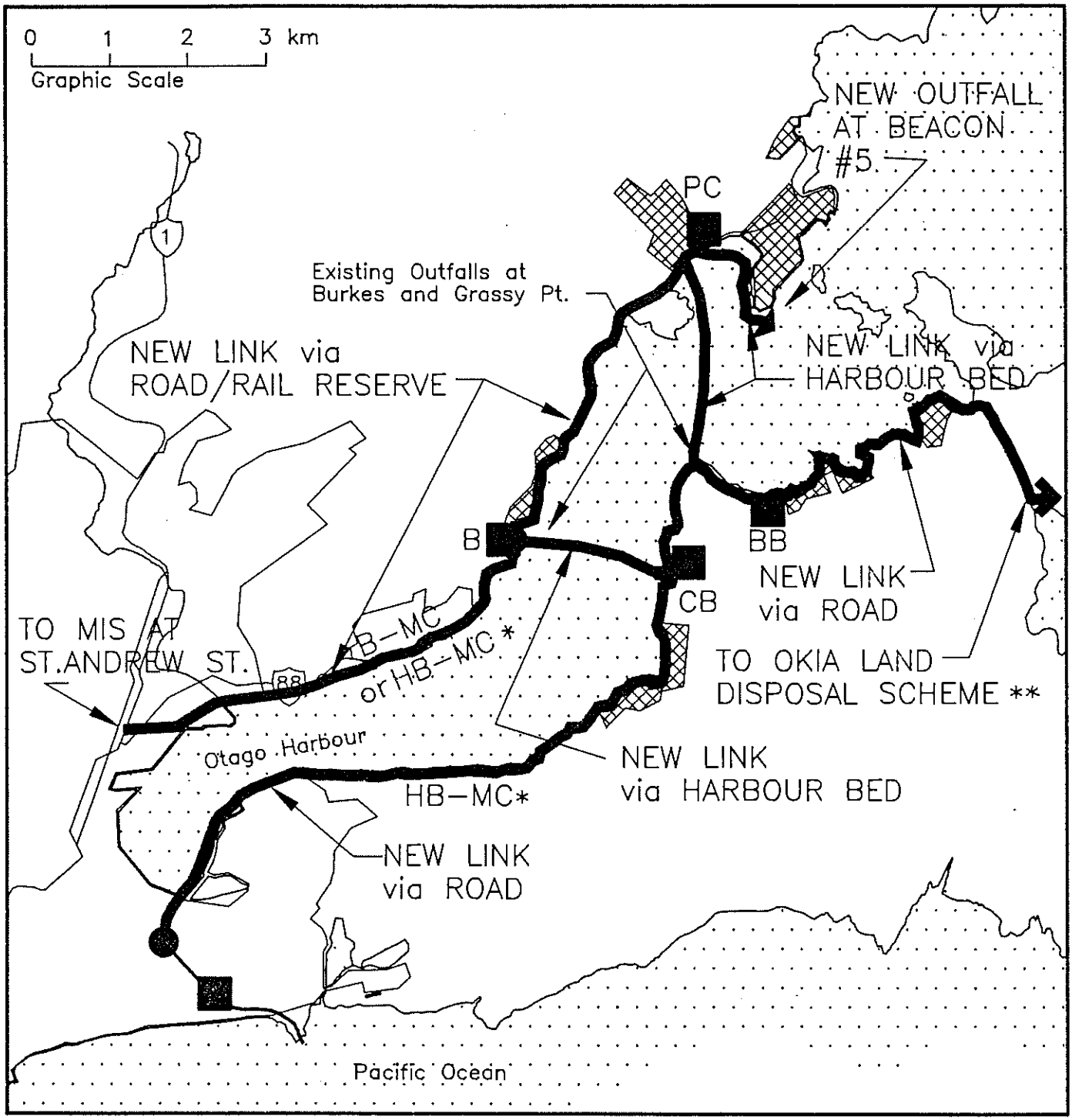
A joint venture with Royds Garden Ltd. and Beca Steven.

DUNEDIN CITY COUNCIL
WASTEWATER TREATMENT AND DISPOSAL OPTIONS STUDY
CONVEYANCE OPTIONS – CAPITAL COSTS OF CONVEYANCE LINKS

HARBOUR BASIN OPTION HB5b

SCALES: nts

DRAWING No. FIG 10.2.3



* Refer to inter-catchment links shown on Figure 10.2.8

** Refer to Land Disposal Map FIG 10-7-1

HARBOUR BASIN CATCHMENT

TABLE 10.2.1 HARBOUR BASIN CONVEYANCE LINK ESTIMATES (excludes outfall costs)

Links[1]	Design Flow (l/s)	Pipe Dia. & Type[2] (mm)	Length (approx) (m)	Capital Estimate ($M)	O & M Estimate ($ p.a.)	Option or Scheme
CB to GP	30	225 uPVC	1700	0.84	6000	HB1a
PC to B# 5	84	250 HDPE	1200	0.85	15000	and
				1.69	21000	HB1b
B to PC	14	150 uPVC	5200	2.65	17000	HB2a
CB to GP	30	225 uPVC	1700	0.83	6000	and
GP/BB to PC	47	250 HDPE	3000	1.90	15000	HB2b
PC to B# 5	131	350 HDPE	1200	1.00	15000	
				6.38	53000	
B to MC	14	150 uPVC	6000	2.80	17000	HB3a
CB to GP	30	225 uPVC	1700	0.83	6000	and
PC to B# 5	84	250 HDPE	1200	0.85	15000	HB3b
				4.48	38000	
B to MC	14	150 uPVC	6000	2.80	17000	HB3c
CB to GP	30	225 uPVC	1700	0.83	6000	and
GP/BB to PC	47	250 HDPE	3000	1.90	15000	HB3d
PC to B# 5	119	350 HDPE	1200	1.00	15000	
				6.53	53000	
B to MC	14	150 uPVC	6000	2.80	17000	HB4
PC to GP	84	300 HDPE	3000	1.80	16000	
CB to GP	30	225 uPVC	1700	0.83	6000	
GP to BB	98	2/225 uPVC	1000	0.66	10000	
BB to Okia	119	300 uPVC	12000	5.00	47000	
				11.09	96000	
By road/rail reserve route						HB5a
PC to B	84	300 uPVC	5200	3.40	26000	
B to MC	98	300 uPVC	6000	4.53	42000	
BB/GP to CB	21	150 uPVC	1700	0.83	7000	
CB to MC	47	225 uPVC	10600	4.77	33000	
				13.53	108000	
By harbour bed route						HB5b
PC to GP	84	300 HDPE	3000	1.80	16000	
BB/GP to CB	105	300 uPVC	1700	1.00	11000	
B to CB	12	160 HDPE	2500	0.88	6000	
CB to MC	143	375 uPVC	10600	5.55	34000	
				9.23	67000	

Notes: [1] B = Burke/St Leonards; PC = Port Chalmers; CB = Company Bay; BB = Broad Bay; GP = Grassy Point; B# 5 = Beacon #5 new outfall.
[2] uPVC pipe size is Nominal Bore; HDPE pipe size is Outside Diameter
uPVC = unplasticised polyvinylchloride pipe
HDPE = high density polyethylene pipe

Musselburgh Catchment (MC)

Unlike the Harbour Basin there are very few intra-catchment transfers. Most occur "downstream" of the Musselburgh Pumping Station, and are required to either link this pumping station to a new treatment plant and/or outfall option at Southdale Road/ Maori Head respectively or to link the Tahuna Plant to the latter facilities. Another shorter one links the Tahuna Plant and a new Tahuna outfall. These conveyance links are summarised in Table 10.2.2.

Ocean Grove

While this 1960's small plant in the Musselburgh catchment continues to operate well with reasonable operating costs, further consideration should be given to decommissioning it and conveying the wastewater to the Musselburgh catchment system. It is understood that the Council's Drainage Engineering Department have previously looked into this matter. A detailed analysis of capital versus operating costs may further assist in this decision, particularly if the same trend comes through as for the harbour basin plants. That is, with decommissioning and savings in operating costs,commensurate sums of capital may be expended if a total cost approach is taken.

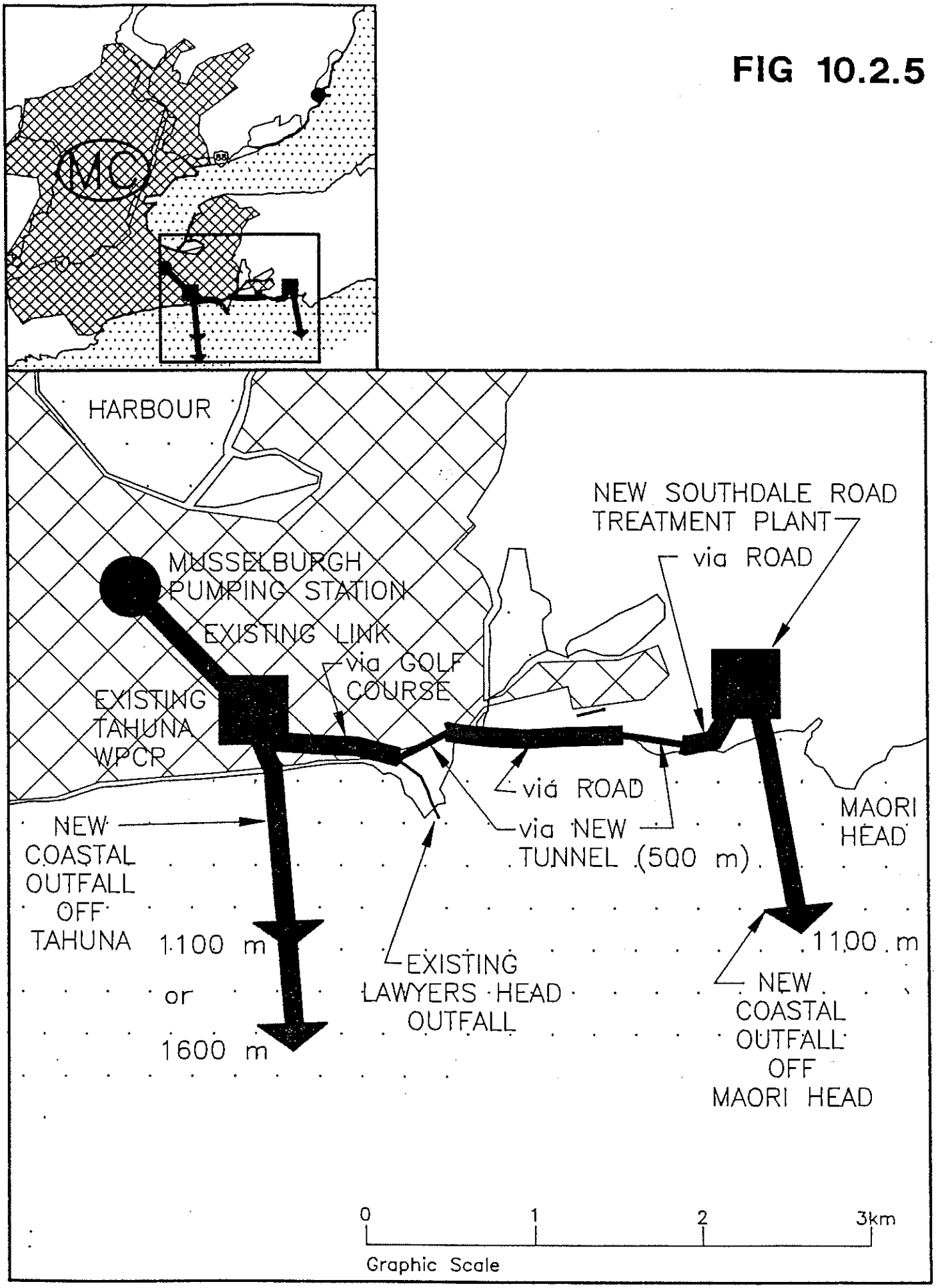
If a Maori Head outfall, with or without a Southdale Road treatment plant site is adopted, the conveyance of either effluent initially, then untreated wastewater into the trunk line passing through or nearby Ocean Grove would be possible.

If appropriate this should be further developed in the Stage 2 Study.

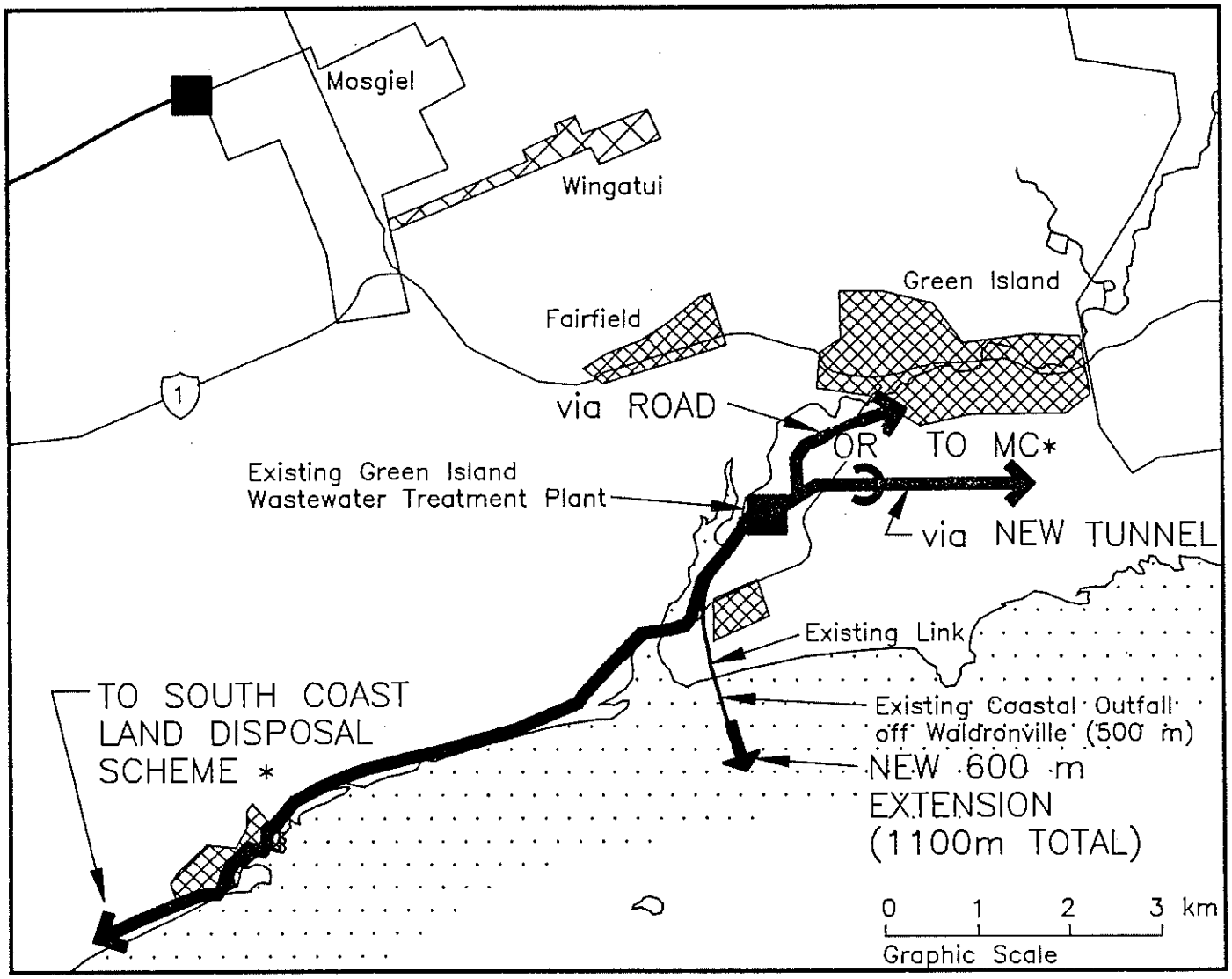
Green Island Catchment (GIC)

There are very few new intra-catchment conveyance links required for Green Island. The only one which is obvious could in fact, almost be called an "inter" catchment link, but it is included here for completeness. It is: Kaikorai Valley rerouted into Green Island Catchment rather than through the old railway tunnel to Musselburgh (see Table 10.2.3). Most of the options within the Green Island Catchment involve treatment upgrades or outfall modifications, not changes or additions to the existing conveyance system.

FIG 10.2.5



MUSSELBURGH CATCHMENT



* Refer to inter-catchment links shown on Figure 10.2.8

GREEN ISLAND CATCHMENT

TABLE 10.2.2
MUSSELBURGH CATCHMENT CONVEYANCE LINK ESTIMATES (excludes outfall costs)

Links[1]	Design Flow (l/s)	Pipe Dia. & Type[2] (mm)	Length (approx) (m)	Capital Estimate ($M)	O & M[3] Estimate ($ p.a.)	Option or Scheme
TP to TO	3850	1350 RCRRJ	350	3.9	163,000	MC2a/f
MPS to SR SR to MH	3850 3850	1350 SWP 1350 RCRRJ	4300 350	14.3 3.9 18.2	333,000 163,000 496,000	MC4a/b
TP to SR SR to MH	3850 3850	1350 SWP 1350 RCRRJ	3700 350	14.8 3.9 18.7	337,000 163,000 500,000	MC4c/d
TP to MH	3850	1350 SWP	3300	14.2	326,000	MC3a/e

Notes: [1] MPS = Musselburgh Pumping Station; TP = Tahuna Plant; TO = Tahuna outfall; SR = Southdale Road; MH = Maori Head outfall
[2] RCRRJ = reinforced concrete rubber ring jointed pipe; SWP = spiral welded pipe;
[3] Musselburgh Catchment pumping costs included in treatment costs not these conveyance costs.

TABLE 10.2.3
KAIKORAI VALLEY OVERFLOW TO GREEN ISLAND CATCHMENT CONVEYANCE LINK ESTIMATES

Links[1]	Design Flow (l/s)	Pipe Dia. & Type[2] (mm)	Length (approx) (m)	Capital Estimate ($M)	O & M Estimate ($ p.a.)	Option or Scheme
Kaikorai Valley to GIC	140	400 uPVC	500 m	0.48	1,200	Refer Part 10.2.6

Notes: [1] GIC = Green Island Catchment
[2] uPVC = unplasticised polyvinyl chloride pipe

Musselburgh Catchment - Kaikorai Valley Flows and Overflows

The issue of connecting all or part of the historic Musselburgh catchment's Kaikorai Valley flows into the Green Island catchment is a matter that has been addressed in the past and most recently in 1988. At that time, the then Dunedin Drainage and Sewerage Board worked through the matter in some detail with the then Green Island Borough Council. Reports in March 1988 from Royds Garden Ltd, consulting engineers to the former Green Island Borough Council, and the Dunedin City Council in September 1989 cover the matter in detail. They should accordingly be included as support information to this scoping report.

In summary, it is recorded that:

(i) the assessed wet weather peak overflow to the Kaikorai Stream is 140 l/s. The existing Green Island trunk system has capacity at present to accommodate this although some upgrading of the pumping and milliscreening plant at the Green Island treatment facility would be required. If this 140 l/s was used, however, it would take up the majority of the 200 l/s approximately spare capacity in the Green Island trunk sewer system. This spare capacity was part of the 300 l/s previously allocated to the former Burnside Freezing Works but now retained by the Council (formerly Green Island Borough Council, now Dunedin City Council).

(ii) estimates included in this report have not allowed for the additional mechanical plant required at the existing Green Island treatment plant to accommodate this additional 140 l/s. Very approximately, the estimated capital cost would be about $300,000 for an additional milliscreen, main pump, and ancillary works.

(iii) the Green Island trunk main system is not large enough to take the full flow from the Musselburgh catchment's Kaikorai Valley flow. It was never designed for it. Very substantial upgrading with a new main sewer would be required.

(iv) to connect to the Musselburgh catchment Kaikorai Valley termination point where the wastewater flows through the old rail tunnel to St Clair, to the top end of the Green Island trunk main conveyance system was previously estimated by Dunedin City Council Engineers to cost $300,000 to $400,000 (September 1989 basis). This would allow the 140 l/s discharge to be made plus other capacity available when the Green Island system can allow it. For example it is likely that for dry weather all the Musselburgh catchment would be accommodated in the Green Island system, but not when there is any substantial wet weather flow.

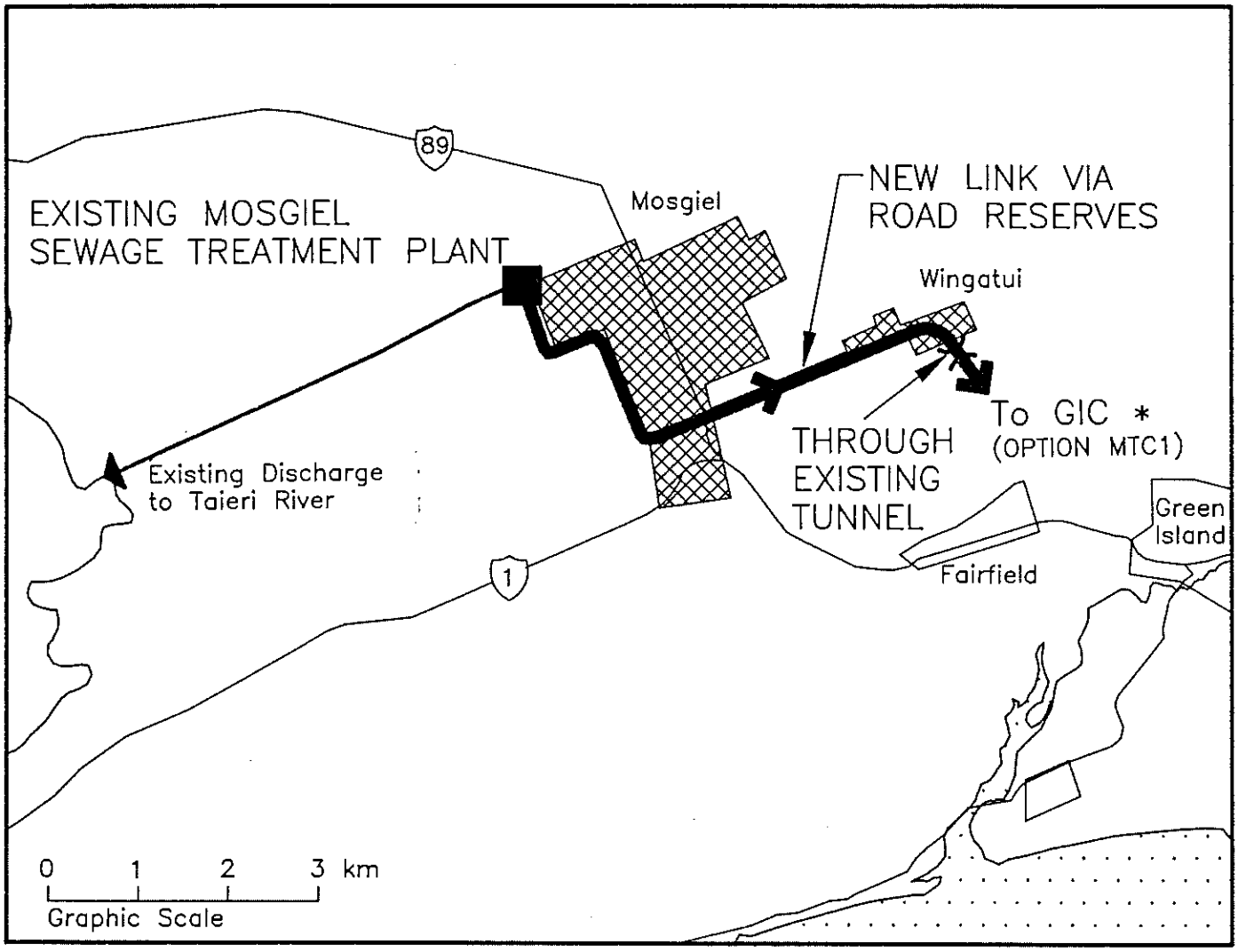
(v) therefore, from (ii) to (iv) above a very approximate estimated capital cost is $600,000 to $700,000 to take the flows from Kaikorai Valley through the Green Island system on an "as available flow" basis, with a limit probably around 150 to 200 l/s maximum.

(vi) allowing this as set out in (iv) and (v) above, however, would take spare capacity for industry or other development, in fact capacity that was previously allocated to industry (Burnside Freezing Works).

In this study the question has also arisen as to the capacity of an upgraded Tahuna treatment plant to take the harbour basin catchment flows. The rationale here is that if the Tahuna site has limited potential, then if an equivalent amount of the Kaikorai subcatchment was diverted into the Green Island catchment, this may allow connection of the harbour basin to the Tahuna plant.

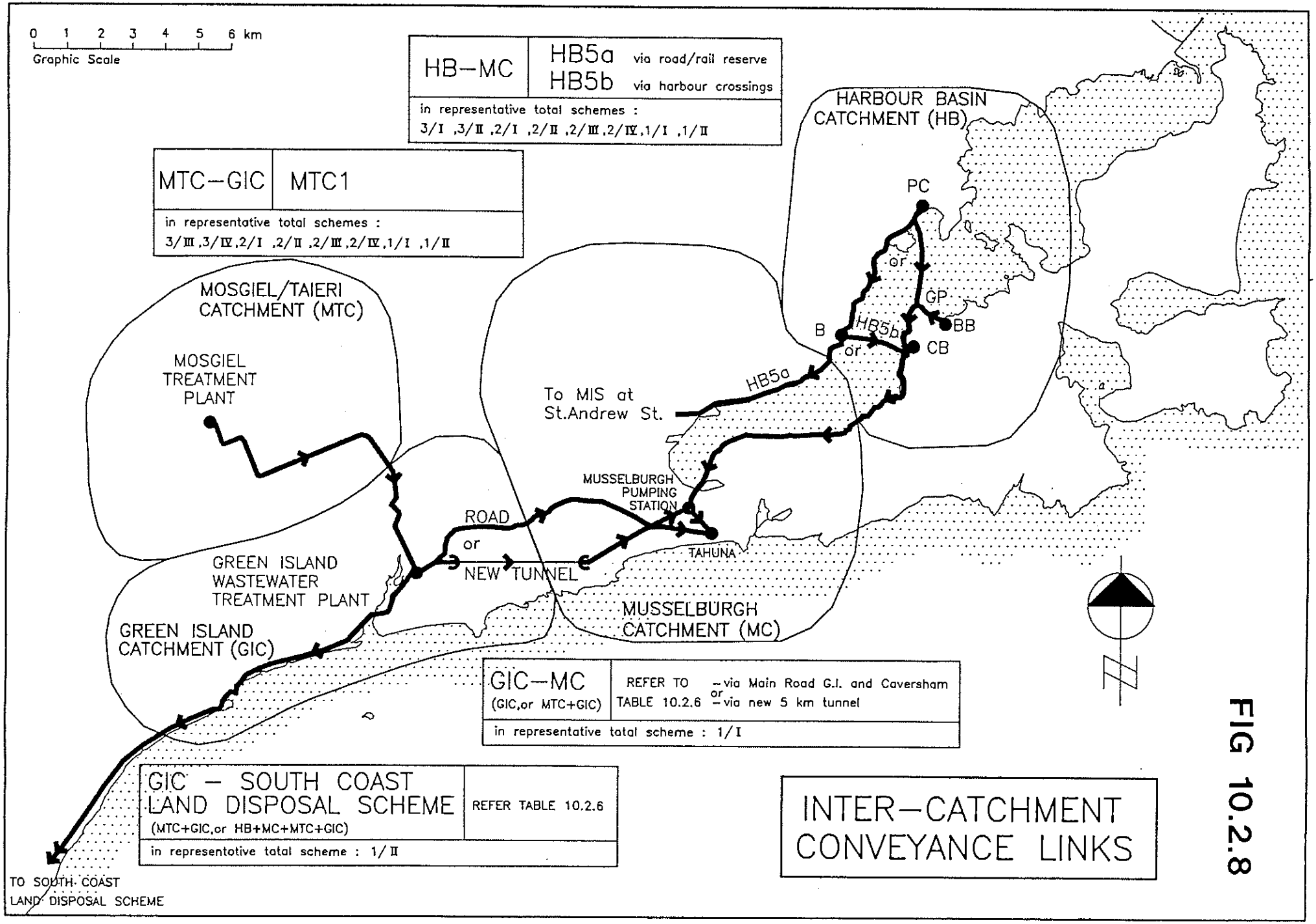
This report (Part 10.4 and Parts 12.0 and 13.0) confirms that it is possible to upgrade the Tahuna plant and Musselburgh pumping station for all retro-fitting and upgrading options considered to also include the harbour basin on the year 2021 treatment design basis. The question raised is, therefore, not an issue in this respect, and accordingly does not alter the previous discussion.

More detailed assessment of this Kaikorai Valley matter may be appropriate in the Stage 2 study. Regardless of this, Royds Beca support the approach of undertaking investigations into the reticulation system to reduce the illegal and other wet weather flows as far as that is practical and economic.



* Refer to inter-catchment links shown on Figure 10.2.8

MOSGIEL/TAIERI CATCHMENT


0 1 2 3 4 5 6 km
Graphic Scale
HB–MC
HB5a via road/rail reserve
HB5b via harbour crossings
in representative total schemes :
3/I ,3/II ,2/I ,2/II ,2/III ,2/IV ,1/I ,1/II
MTC–GIC
MTC1
in representative total schemes :
3/III ,3/IV ,2/I ,2/II ,2/III ,2/IV ,1/I ,1/II
HARBOUR BASIN CATCHMENT (HB)
MOSGIEL/TAIERI CATCHMENT (MTC)
MOSGIEL TREATMENT PLANT
PC
or
GP
BB
B
HB5b
or
CB
HB5a
To MIS at St.Andrew St.
MUSSELBURGH PUMPING STATION
ROAD
or
NEW TUNNEL
TAHUNA
GREEN ISLAND WASTEWATER TREATMENT PLANT
GREEN ISLAND CATCHMENT (GIC)
MUSSELBURGH CATCHMENT (MC)
GIC–MC
(GIC,or MTC+GIC)
REFER TO TABLE 10.2.6
–via Main Road G.I. and Caversham
or
–via new 5 km tunnel
in representative total scheme : 1/I
GIC – SOUTH COAST LAND DISPOSAL SCHEME
(MTC+GIC,or HB+MC+MTC+GIC)
REFER TABLE 10.2.6
in representotive total scheme : 1/II
TO SOUTH COAST LAND DISPOSAL SCHEME
INTER–CATCHMENT CONVEYANCE LINKS
FIG 10.2.8

10.2.7 Inter-Catchment Conveyance

The major likely conveyance development would be the transfer of wastewater or effluent from one catchment to an adjacent one for treatment and or disposal. This could occur if Council adopted any of the Schemes above Concept Level 4, that is Concept Levels 3, 2, or 1. These would require one, two or three intercatchment transfers respectively.

These possible transfers are covered below in categories determined by the catchments which are linked together. They are shown schematically in Figure 10.2.8.

Harbour Basin to Musselburgh Catchment (HB to MC)

There are three options which require the transfer of some or all of the Harbour Basin flows to the Musselburgh Catchment. They are:

- Burkes to MC (part transfer) (B to MC)
- All Harbour Basin to MC via road/rail reserve routes along north and south sides of the harbour (HB5a)
- All Harbour Basin to MC via cross-harbour bed routes and then along south-side harbour road reserve (HB5b)

TABLE 10.2.4

Link[1]	Route	Capital Estimate ($ M)	O & M Estimate ($ M p.a.)	Option or Scheme
B to MC	road/rail reserves	2.80	0.017	HB3a/3d HB4
HB to MC	road/rail reserves	13.16	0.017	HB5a
HB to MC	harbour bed road reserve	8.75	0.067	HB5b

Notes: [1] B = Burkes: MC = Musselburgh Catchment; HB = Harbour Basin

Ravensdown Fertiliser Co-Operative Ltd

The Ravensdown Fertiliser Co-operative Ltd have 7 operative water rights for various discharges into the Otago Harbour, adjacent to their fertiliser works in Ravensbourne.

Early in this study it was identified that if the Burkes Plant was to be decommissioned and that wastewater conveyed through Ravensbourne to the Musselburgh catchment, then it would be opportune to consider also conveying some parts of the fertiliser works' discharge along the same route should that be found desirable. Also, if the Harbour Study indicated that some of the fertiliser wastewater would be better not discharged into the harbour then the above option would again be relevant for consideration.

During the study the 7 water rights have been reviewed. The assessment shows that the right for the smallest discharge is for scrubber effluent up to 51,000 litres per hour (14 l/s) the next 60 l/s then 94 l/s and higher to unspecified amounts of stormwater. By comparison, the design PWWF for Burkes is only 14 l/s. This indicates that to convey, treat and discharge such relatively large flows, should they be continuous, would require a much larger conveyance system back to a suitable point in the main catchment (compare the estimated costs for the Burkes to

Musselburgh catchment link in Table 10.2.4).

Additional detailed knowledge of the quantity, flow rate and quality of the various operations of the fertiliser works would be necessary before a realistic assessment could be made. This is outside the scope of the Stage 1 Study. It should be included in Stage 2 if it fits into the ongoing investigation programme, and the company should then be involved in such considerations.

University of Otago's Portobello Marine Laboratory

If all Council's sewage discharges were to be removed from the harbour, there would be some consistency in also considering the removal of the discharge from the Portobello Marine Laboratory, should it be found economic to do so. Council would need to make provision for acceptance of the Marine Laboratory effluent into the Portobello - Broad Bay sewerage system. It could be possible, for example, to convey just septic tank effluent rather than the raw sewage itself, if that was acceptable to the Council. While this matter is raised for completeness in considering the harbour basin conveyance matters, further consideration of it is outside the scope of the study.

Because these links are more conveniently considered under the intra-harbour basin conveyance alterations, the details and cost estimates have been presented in Table 10.2.1 and are only summarised in Table 10.2.4 below.

Musselburgh Catchment (with or without the Harbour Basin) to Green Island Catchment (MC to GIC)

There are two alternatives for the transfer of all the flows from Musselburgh Catchment through to Green Island. (See Table 10.2.5)

The first route option is to pump from a new Musselburgh pumping station via a 6km rising main up Caversham Valley to the existing Caversham Tunnel and then through a 5km gravity sewer down Main South Road Green Island to the existing treatment plant.

A second route option is to pump from a new Musselburgh pumping station via a rising main along Richardson/Coughtrey/Sandringham Streets to a 5km long tunnel starting at Norfolk Street in St Clair and exiting at Brooklyn Street, Green Island.

Within the broad scope of this Stage I study, there is little difference in costs if any (or all) of the Harbour Basin plant flows are transferred to Green Island through either of these new MC to GIC inter-catchment links. However, there are the extra costs of first linking the HB into the MC by either of the two routes presented in Table 10.2.4 above.

TABLE 10.2.5 :
MUSSELBURGH CATCHMENT TO GREEN ISLAND CATCHMENT CONVEYANCE LINK ESTIMATES

Links[1]	Design Flow (l/s)	Pipe Dia. Material[2] (mm)	Length (approx) (m)	Capital Estimate ($M)	O & M[3] Estimate ($ M p.a.)	Option or Scheme
MC to GIC via Caversham & Main Road	3650	1350 CLMS & RCRRJ	10,700	30.0	0.785	Scheme 1/II
MC to GIC via new 5km tunnel	3650	1350 CLMS & RCRRJ	9,100	29.0	0.783	Schem 1/II

Notes: [1] MC = Musselburgh Catchment; GIC = Green Island Catchment
[2] CLMS = concrete lined mild steel pipe; RCRRJ = reinforced concrete rubber-ring jointed pipe
[3] Excludes Musselburgh Catchment pumping.

Green Island Catchment (with or without Mosgiel/Taieri Catchment) to the Musselburgh Catchment (GIC to MC)

These options are complementary to those routes given above for MC to GIC, but contain several important differences.

These are:

- a new pumping station will be required in Green Island Catchment.
- the inclusion of Mosgiel flows into the GIC flows would be a significant increase in volume (compared with HB flows included into the MC flow for transfer to GIC).
- the roles of rising main and gravity sewer described in the previous section through tunnels and along major arterial road routes would be reversed.

The details and cost estimates in Table 10.2.6 below cover the options of transfer by either route, both with and without the Mosgiel/Taieri Catchment flows (that is, four options in total). (The cost of the Mosgiel to Green Island link is shown as a separate item (in Table 10.2.7), and is included in the relevant (later) subtotals, but not in table 10.2.6).

TABLE 10.2.6
GREEN ISLAND CATCHMENT TO MUSSELBURGH CATCHMENT CONVEYANCE LINK ESTIMATES

Links[1]	Design Flow (l/s)	Pipe Dia.[2] (mm)	Length (approx) (m)	Capital Estimate ($M)	O & M[3] Estimate ($ M p.a.)	Option or Scheme
GIC to MC (excl MTC) via Main Road, GI & Caversham	839	900 CLMS + RCRRJ	10,700	18.6	0.255	
GIC to MC via new 5km tunnel (excl. MTC)	839	900 CLMS + RCRRJ	9,100	21.7	0.215	
MTC + GIC to MC via Main Road, GI & Caversham	1,060	900 CLMS + RCRRJ	10,700	19.1	0.335	Scheme 1/I
MTC + GIC to MC via new 5km tunnel	1,060	900 CLMS + RCRRJ	9,100	22.2	0.275	Scheme 1/I

Notes: [1] MC = Musselburgh Catchment; GIC = Green Island Catchment; MTC = Mosgiel Taieri Catchment
[2] CLMS = cement lined mild steel pipe
RCRRJ = reinforced concrete rubber ring jointed pipe
[3] O&M costs shown are addtional to existing costs

Mosgiel/Taieri Catchment to Green Island Catchment (MTC to GIC)

There is an option of bringing the balance of the wastewater generated in Mosgiel to Green Island through a third inter-catchment pipeline (the others are the Tunnel Pipeline and the Fortex Pipeline).

A new pipeline would be routed through the existing railway tunnel; there will be sufficient space for this when NZ Rail relays the twin tracks in a centralised single track as is planned. It would then follow the same route as the existing two pipelines from the tunnel southern exit to the Green Island plant.

The details and cost estimates of this single link are summarised in Table 10.2.7. The flows in question are: Mosgiel domestic and commercial area sewage and the balance of the industrial flows, all of which are currently conveyed to the Mosgiel Treatment Plant.

Stage 2 of this study should consider the option of bringing only the base dry weather flow through to Green Island and treating surplus wet weather flow in the modified treatment plant prior to discharge to the Taieri River. Acceptance of this alternative would be a policy decision contingent on approval for a river discharge under such conditions.

A further matter for possible consideration in Stage 2 is the rationalization of use of the two pipelines already in place and use of the private reserve capacity of 9 l/s which exists in the Tunnel Pipeline.

TABLE 10.2.7
MOSGIEL/TAIERI CATCHMENT TO GREEN ISLAND CATCHMENT CONVEYANCE LINK ESTIMATES

Links[1]	Design Flow (l/s)	Pipe Dia. Material[2] (mm)	Length (approx) (m)	Capital Estimate ($M)	O & M Estimate ($M p.a.)	Option or Scheme
MTC to GIC	405	400 PVC	12,000	5.56	0.120	Option MTC1 Schemes 3/III to 1/II

Notes: [1] MTC = Mosgiel/Taieri Catchment; GIC = Green Island Catchment
[2] uPVC = unplasticised polyvinylchloride pipe

Green Island Catchment to South Coast Land Disposal Scheme

For consideration of land disposal at the South Coast site (shown on figure 10.7.1) two different sized conveyance links between the Green Island catchment and the South Coast site have been considered:

(i) for Mosgiel/Taieri Catchment and Green Island Catchment wastewater flows to the South Coast, and
(ii) for all the wastewater generated in all four catchments to the South Coast.

The details and cost estimates of each of these single links are summarised in tables 10.2.8 and 10.2.9 respectively.

TABLE 10.2.8
GREEN ISLAND CATCHMENT (INCLUDING MOSGIEL/TAIERI CATCHMENT) TO SOUTH COAST LAND DISPOSAL (GIC + MTC to SC) CONVEYANCE LINK ESTIMATES

Links[1]	Design Flow (l/s)	Pipe Dia. Material[2] (mm)	Length (approx) (m)	Capital Estimate ($M)	O & M Estimate ($M p.a.)	Option or Scheme
GIC+MTC to SC	1,060	900 CLMS + RCRRJ	21,500	45.0	1.15	None

Notes: [1] MTC = Mosgiel/Taieri Catchment; GIC = Green Island Catchment; SC = South Coast land disposal scheme
[2] CLMS = concrete lined mild steel pipe; RCRRJ = reinforced concrete rubber-ring jointed pipe

TABLE 10.2.9
GREEN ISLAND CATCHMENT (INCLUDING ALL FOUR CATCHMENTS) TO SOUTH COAST LAND DISPOSAL (MC + HB + GIC + MTC TO SC) CONVEYANCE LINK ESTIMATES

Links[1]	Design Flow (l/s)	Pipe Dia. Material[2] (mm)	Length (approx) (m)	Capital Estimate ($M)	O & M[3] Estimate ($M p.a.)	Option or Scheme
MC+HB+ GIC+MTC to SC	4,200	1,350 CLMS + RCRRJ	21,500	65.0	3.10	Scheme 1/II

Notes: [1] MC = Musselburgh Catchment; HB = Harbour Basin;
MTC = Mosgiel/Taieri Catchment; GIC = Green Island Catchment;
SC = South Coast land disposal scheme
[2] CLMS = concrete lined mild steel pipe; RCRRJ = reinforced concrete rubber-ring jointed pipe
[3] Include Musselburgh Catchment pumping and Green Island Catchment pumping

10.3 TREATMENT SITES

10.3.1 Introduction

There are currently eight treatment plant sites within Dunedin City and the Otago Harbour environs plus the treatment plant at Mosgiel, giving a total of nine. These are:

- Tahuna (comminution, primary treatment and sludge incineration)
- Musselburgh (coarse 50mm gap screening and pumping)
- Ocean Grove (secondary treatment, extended aeration activated sludge land disposal)
- Green Island (pumping and milliscreening - 1mm gap)
- Mosgiel (secondary treatment - trickling filter)
- Broad Bay (secondary treatment - extended aeration activated sludge)
- Port Chalmers (secondary treatment - trickling filter)
- Company Bay (secondary treatment - trickling filter)
- Burkes/St Leonards (secondary treatment - contact stabilisation activated sludge)

The Ocean Grove site is not considered further. In due course it should be connected into the Musselburgh catchment and options are available depending on the scheme finally chosen. This should be further reviewed in Stage 2. The flows are so small they are of little significance in this respect in this Stage 1 Study.

This section reviews these sites as they are at present and whether, or how, they might be extended in the future. It also investigates other possible sites for new treatment plants such as the Southdale Road valley behind Smaills Beach, the Kaikorai Valley near PPCS site at Burnside and the Brighton-Kaikorai coastal margin. There is very little spare land which would be considered suitable within the urban area of Dunedin City and it seems obvious that the existing sites are those which would be looked at first for expansion.

10.3.2 Existing Sites

The treatment plant at Tahuna covers a large portion of the site which was originally Reserve land. It is bounded by Tahuna Road to the north, Golf Links to the south, Chisholm Park Recreation Reserve to the east and the Ocean Beach Domain Reserve to the west. The potential for expansion of this 1.8 hectare site is extremely limited. The main opportunities for enhancing the treatment plant lie either in retrofitting different process plant or in building upwards or downwards from the existing structures. If expansion was to occur, a first direction could involve relocation of some of the stables used by the Otago A & P Society. However such site expansion is not seen as necessary in the short to medium term. The proximity of both residential and recreational neighbours to the plant implies that the treatment processes must continue to be fully enclosed to ensure that nuisances do not occur from odour, noise and plant lighting.

Musselburgh

As with Tahuna, the Musselburgh Pump Station is surrounded by residential properties and recreational reserves (playing fields). The pumping station is fully housed in a substantial structure but noise complaints have been received, mainly due to exhausts when the diesel-powered standby pumps are operating. The vertical bar screens are outside this building, but they too have covers which reduce the potential for noise and odour problems. Beneath the ground on both sides of the building and forebay there is a network of buried pipes entering and leaving the facility; these make extension of the facilities difficult but not impossible.

The main need at Musselburgh is to expand the ability to screen out gross solids and remove grit from the incoming flow before it reaches the pump wet wells. Since it is at this point that all the wastewater from the main Dunedin Catchment is collected for onpumping to Tahuna, the installation of at least fine screening in the forebay is a straightforward proposition. Provision could also be made to collect and automatically pump out the grit which accumulates in the forebay. It is also essential that air extracted from the wet wells be treated using a soil biofilter on the site.

Green Island

As this is one of the more recently completed treatment plants, the need for extra land for future extension or staged expansion was anticipated by the Green Island Borough Council (now amalgamated with the Dunedin City Council) and there is an appropriate area of land available and zoned for just that purpose. Furthermore, the City Council has purchased one site and intends to purchase another block of land adjoining the plant site to act as "buffer zones" which would enlarge the total site area from 8.8 hectares to 12 hectares. Of the existing 8.8ha site, about 3.5ha only is considered suitable for treatment facilities because of the uneven topography. The Kaikorai Lagoon acts as a sensitive boundary to the north and west. The Green Island plant could be expanded with ease within the site boundaries to include dissolved air flotation and sedimentation as originally planned, or similar in-tank processes. Larger scale treatment processes such as lagoons would prove difficult to accommodate on the existing site without extensive earthworks (excavation and reclamation). Furthermore, uncovered treatment processes are likely to lead to nuisance odours because of the industrial discharges and the local drift pattern under calmer conditions. Consequently, covered treatment processes with odour treatment of extracted air are considered essential on this site.

Mosgiel

It is not anticipated that expansion or enhancement of this plant needs to be covered under the terms of reference of this Stage 1 study.

Broad Bay

This is the most recently built treatment plant in Dunedin and is located on a steep 2.2 hectare site sculpted from the hillside. The size of the site allows for adequate buffer zones on each side, although there is as yet no residential development which encroaches on any boundary. Because of the local topography there is little scope for expansion of the treatment plant without attendant earthworks to extend the level platform on which the existing structures have been built. There is a possibility that the use to which these tank structures are put could be changed to suit a different treatment process or conveyance requirement.

Port Chalmers

This secondary treatment plant comprises eleven structures all fairly well confined to a 1 ha site behind Sawyers Bay. The site is well hidden from the main road and there are few residential properties in the immediate vicinity. Most neighbouring properties are used for industrial purposes. Expansion of this plant would be difficult, without the purchase by the Council of one or more of the adjacent properties. Rather than expand the plant, it would be more logical to retrofit new treatment processes either within the present tank structures or between them within the existing boundaries.

Company Bay

This small treatment plant occupies a site above Company Bay and is overlooked by several residential properties which are its only neighbours. The site is more spacious than the other three harbour catchment sites and there is the potential for the plant to be extended if required. If the effluent from this plant is to be improved, the site could easily accommodate either a new process plant (with full or partial demolition of the existing facilities) or retrofitted plant improvements. The disused sludge drying beds could provide a suitable space for extra facilities.

However, given its location and the limited population which it serves, it is possible that the plant will not be altered, (it may even be decomissioned) with the contributory flows being diverted to another catchment, either within the harbour basin or outside it.

Burkes/St Leonards

This is the smallest of the harbour catchment plants, both in site area and the population served. The site is compact, located as it is between the main Port Chalmers Road and the treeclad hills which lie behind it. Should it be decided to modify the treatment process to improve the quality of the effluent which is discharged into the harbour, it is likely that the area presently occupied by the sludge drying beds could be used. Sludge would be tankered off site.

However, as with the Company Bay Plant, this plant's location and small contributory population it may be appropriate to transfer contributory flows either elsewhere in the harbour basin or to the main city catchment could be desirable. Options are reviewed in this report.

10.3.3 Other Possible Sites

Southdale Road Area

One of the options which has been identified as the site for a new outfall is off Maori Head with the outfall terminus at Smaills Beach. Behind this beach is a valley up which runs Southdale Road. The lower, or beach, end of the valley is relatively flat land between the two ridges which flank the valley. This area would form a good treatment plant site and comprises some 4.5 hectares in readily usable area and a total of 15ha if a stepped site is formed. There are four permanently occupied dwellings off Southdale Road, three of which would be neighbours of any

treatment plant built there, while the fourth is more remote as it is situated much further up the valley. There is also a fishing club lodge at the beach end of the valley which is used by club members at weekends and more frequently during the fishing season.

The Southdale Road site is only separated by a single ridge from Ocean Grove and Tomahawk Beach, which represent the easternmost suburbs of Dunedin on this side of the peninsula. This ridge creates the impression of the site being geographically remote, yet the site could be reached by a new tunnelled rising main either from Tahuna or Musselburgh pumping station. There is certainly sufficient area to build a secondary treatment plant for the total sewage flow from the city (a concept output level one scheme), possibly even to the extent of sludge treatment and landfill disposal of the dewatered product in some of the minor gullies which flank the main valley.

The site is currently zoned rural and would require negotiated purchase by the Council and rezoning for sewage treatment plant purposes.

Kaikorai Valley

There is presently an overflow problem with the former Dunedin City system at the lower end of the Kaikorai Valley system, near Townleys Road, where up to 140 l/sec overflows to the Kaikorai Stream at times of heavy flow.

One possible option to this may be construction of a wet weather overflow treatment plant using a chemical treatment system such as alum addition and continue to discharge the treated overflow into the Kaikorai Stream. A site on presently vacant industrial zoned land adjacent to Kaikorai Valley Road and Townleys Road could be available if such an option was adopted.

It is considered, however, that such an option, while technically feasible albeit expensive, is not the appropriate way to solve this overflow problem. Instead, measures such as reducing the wet weather flow as Council have just embarked on investigating, and/or coupling part of the flow to the Green Island and/or upgrading facilities to Musselburgh catchment are the more appropriate measures. This matter has accordingly been addressed in more detail in Part 10.2.

Kaikorai Estuary to Brighton Coastal Area

While there may be possible new sites in this area, and the earlier investigations in the 1970's by the former Green Island Borough Council did address them (refer those reports), the study to date indicates that for the representative options being considered a new site is not needed in this general location. Instead, concentration of facilities at the existing Green Island catchment treatment site is the appropriate procedure particularly with a larger site available as is introduced above.

Large scale open aerated lagoons or oxidation pond options within or near the Kaikorai Estuary have not been considered appropriate as was also the case during the former Green Island Borough Council's investigations in the 1970's.

Site for Treatment as Part of Land Disposal

In Part 10.7 the south coast land disposal option is discussed. For this option a secondary treatment plant would be constructed as part of the land disposal scheme.

Initial concepts used for estimates are that this plant would either be a Dual Powered Aerated Lagoon or Biological Filtration System. Either would be sited at an appropriate location within or adjacent to the 5,000 ha area needed as would the effluent storage basin(s).

For Dual Powered Lagoons a site of around 15 ha would be required while for a Trickling Filter Plant, 3 hectares would be adequate.

The Harbour Basin land disposal option using Okia Flat on the Otago Peninsula, requires an effluent storage basin on this site. The treatment will remain at the existing Harbour Basin plants (refer Part 10.7).

Sites for Sludge Disposal

It is outside the scope of this report to address these when they are part of appropriately designated and managed co-disposal landfills. Where, however, a single use dedicated sludge landfill is encompassed in an option this matter needs review. While this is a possibility with a Southdale Road site and South Coast Land Disposal scheme it is similarly too early to discuss any such options in detail. Sludge reuse is an option of particular interest and should be considered further in the Stage 2 Study.

10.4 TREATMENT PROCESSES

10.4.1 Tahuna - Existing Treatment Processes and Limitations

The main treatment processes at Tahuna include:

- comminution, which reduces the size of solids to pass through a 6mm gap drum screen.

- primary sedimentation is achieved in three tanks 75m long, 16m wide, 3m deep with relatively long retention times of 6 hrs at present average flow of 500 l/s and 1.2 hrs at design peak flow of 2500 l/s. Travelling bridge scrapers move the sludge and scum to the inlet end of the tanks where it is removed at a relatively low concentration of about 0.3% solids by Yardmaster centrifugal pumps. The sludge contains sand and grit due to absence of separate removal. At the outlet weirs, 10mm mesh screens have been fitted to trap neutrally buoyant rags and plastics. These screens are cleaned manually.

  Solids capture rate at 40-50% is lower than the 60-75% achieved by other primary sedimentation tanks in NZ, which are pre-aerated.

- primary sludge is transferred to a single gravity thickener 12.7m diam. by 6.8m deep, and is thickened to a concentration between 5 and 10% solids. If the thickener is out of service beyond 24 hrs, the primary sedimentation tanks must be bypassed.

- sludge dewatering to 30-35% solids is achieved by two filter belt presses (0.8 m wide belts) with polymer dosing which has been recently introduced.

- sludge incineration in a single fluidised bed combustor reduces the organic solids to ash which is conveyed off site in the main effluent flow. Incineration operation is limited to two shifts per day, 5 to 6 days per week. Additional sludge not incinerated is dewatered by a filter belt press and trucked to landfill.

- sodium hypochlorite is generated on site by PEPCON electrolytic cells from seawater pumped from the Upper Harbour. Hypochlorite is dosed in the main influent channels to the sedimentation tanks and on the sludge thickener surface to control odours.

- all treatment processes are housed in buildings and ventilation air is extracted to a recently constructed soil biofilter for odour treatment - total air flow of $21m^3$/sec. The incinerator exhaust after cooling by water scrubbers, is also conveyed to the soil biofilter.

10.4.2 Tahuna - Current DCC Upgrading Proposals

The brief requires a review of the following proposals.

(a) Replacement of the existing comminutors with screening devices, the prime objective being removal of light semi-buoyant materials, greater than 2mm in size. The screened material would be collected, dewatered and landfilled.

(b) Some form of entrained air system associated with the sedimentation tanks to incease percentage of solids removal.

(c) Increasing effective weir length of sedimentation tanks. This may mean alterations to the existing sludge/scum collection system.

(d) Increasing incinerator output by increasing fluidising blower size. Blower purchased, to be installed and operational by July 1991 (25% greater capacity)

(e) Re-install the ash collection system using hydrocyclones.

(f) Continued odour and noise control programme e.g.

- Replacement of scrubber water cooling tower
- Ecolo deodorisers - extend installation
- Noise attenuation on ventilation fan intakes
- Activated carbon filters on incinerator room roof fans
- Increase height of incinerator stack
- CO combustion control rather than the present O_2 control

Comments on each proposal follow in the discussion of total treatment upgrading options.

10.4.3 Tahuna - Pre-Treatment Options Evaluation (including Musselburgh Pump Station).

Pretreatment involves screening to remove rags and plastics and grit removal. The latter is normally achieved in conjunction with pre-aeration in a hopper bottom tank with a spiral roll flow pattern induced by the air injection. The spiral flow keeps organic matter in suspension but sand and grit settle out and are washed into the hoppers.

In section 10.4.4, the likely benefit of pre-aeration is discussed. The pre-aeration tank would need to be sited at Tahuna so that the floc would not be disturbed by pumping as would occur if the pre-aeration/grit removal tank was positioned at the inlet to the Musselburgh Pump Station.

Fine screening (1-6mm gap) could be retrofitted at the Musselburgh Pump Station quite economically to replace the existing coarse bar screens (50mm gap). While screening could be installed at Tahuna, the limited space available and competing uses for that space, suggest that Musselburgh is the preferred location for fine screening. It would be possible to install fine screens at the outlet from the existing Tahuna tanks to overcome the debris problem in the effluent. However, the technology is now available to install fine screening before the plant, which not only produces a better effluent quality but also protects the equipment in the Musselburgh Pump Station and the Tahuna Plant.

Until five to ten years ago, it was standard practice to reduce the size of solids at the plant influent with Comminutors, Barminutors or bar screens in conjunction with disintegrators. It was intended that the reduced size of solids would allow settlement with sludge and co-processing with the sludge. However, the cutting or shredding action of the size reduction equipment

tended to create strings of rag and plastic which, when combined with grease, formed balls and blockages in equipment. Furthermore, the size reduction equipment invariably had high maintenance costs.

There has been a noticeable increase in plastic strip items in wastewater over recent years, which can pass through traditional bar screens and disintegration devices.

Consequently, the preferred practice now is to remove rags and plastics intact, from the flow and to dispose by burial or incineration. A number of different screening technologies are now available which can remove the inert material efficiently with minimal operation and maintenance requirements eg.

- milliscreens, rotating horizontal drum; gap 0.5 to 3mm; pumped inlet
- Suboscreens, rotating horizontal drum in gravity flow channel, 1 to 6mm gap.
- step screens, inclined stairs which lift solids out of flow by an oscillating action 3 to 12mm gap.
- aquaguard screens, plastic mesh with integral rake 6 to 30mm gap.

In Europe, the current standard is the use of 6mm Aquaguard screens or equivalent at the inlet to secondary plants. Inert materials are virtually completely removed by such screens. A 6mm Suboscreen has recently been installed at Invercargill and solids removal performance is good. Further evaluation of alternative screening arrangements would be undertaken early in the Stage 2 study. The screen gap would depend on the type of treatment upgrading adopted. If primary treatment only was to be continued then a gap size of 1-2 mm could be chosen but if the "protection" of secondary treatment was available then 3 to 6 mm gap screens could be favoured.

10.4.4 Tahuna - Primary Sedimentation Upgrading Options

Process Evaluation

At present the solids removal rate in the Tahuna primary sedimentation tanks is lower than that achieved in other NZ treatment plants despite the Tahuna tanks generally having comparable or greater retention times and surface areas than these other plants (see Table 10.4.1.)

TABLE 10.4.1 Primary Sedimentation Tank Performance

Plant/Tank Outlet Method	Year (i)	BOD_5 g/m^3 Raw	BOD_5 g/m^3 PE (ii)	% BOD_5 removal	SS g/m^3 Raw	SS g/m^3 PE (ii)	% SS removal
Manukau/ submerged launders	81/82	350	225	36	287	77	73
	86/87	387	225	42	396	77	80
		352	208	41	319	65	80
Christchurch/ submerged launders	81/82	208	163	22	147	45	70
	86/87	228	174	24	213	48	77
	88/89	270	189	30	161	42	74
Invercargill/ multiple notched weir troughs	88/89	174	114	35	175	69	60
Hamilton/multiple notched weir troughs	88/89	198	126	36	226	84	63
North Shore/ end wall weir	86/87	297	205	31	273	74	73
	88/89	299	194	35	251	54	79
Tahuna/end wall weir	1991	420	302	28	320	180	44

Notes: (i) Annual averages except for Tahuna which are results of limited sampling from March to June 1991 - 11 samples.
(ii) PE is primary effluent
(iii) All tanks except Tahuna have pre-aeration systems.

Normal design expectations are 30-35% BOD_5 removal and 60% SS removal. Other NZ plants perform to or exceed these removal rates. A "Full Primary" performance for Tahuna could be up to 40% BOD_5 and 75% SS removal based on operating results elsewhere yielding effluent qualities of 250 g/m^3 BOD_5 and 100 g/m^3 SS (annual averages).

At the Christchurch plant, there can be relatively more primary tanks in service than required for summer low flows. Solubilisation of solids could be occurring due to longer retention times which would explain the remarkably low NFR concentration but poorer BOD_5 removal. Soluble BOD_5 testing would be required to prove this contention.

The high strength of Tahuna influent wastewater is demonstrated in the table, with only the Manukau plant being comparable. However the Manukau solids removal performance is dramatically superior, almost double that of Tahuna, despite known uneven flow distribution across the ten tanks at Manukau.

Only North Shore and Tahuna have end wall weirs, with the other plants having notched weirs or submerged launders extending over the final 25% of the tank area to prevent localised stream currents.

However, the North Shore tanks have solids removal rates of 73 to 79% compared to 44% for Tahuna. A preliminary conclusion is that the pre-aeration tanks, which precede all primary tanks in the table except Tahuna, could have a significant effect in flocculating and conditioning solids for more effective settlement.

Thus the entrained air (or pre-aeration) concept which has been under consideration by the DCC (refer to section 10.4.2), is likely to be more effective than revising the outlet weirs alone. However, the poor settleability of particular industrial waste solids could account for the lower removal performance (eg, woolscour effluent caused poor primary tank solids removal performance at Invercargill prior to 1985, even with the "benefit" of pre-aeration).

These detailed design considerations will require further investigation in Stage 2 of the Study. Some factors may require pilot plant testing and the investigations would include;

- likely effectiveness of pre-aeration
- modifications to outlet weir
- inlet flow distribution within and between the tanks
- flow patterns within each tank and pattern of solids deposition
- presence of seawater or particular industrial wastewater which could be affecting solids settlement
- adequacy of sludge scraper mechanism

Retrofit Considerations

Modifications to improve the hydraulic characteristics of the tanks, if found to be required, will be relatively straightforward, possibly involving;

- further baffling of inlet ports to create even flow distribution
- longitudinal or extra transverse weirs at the outlet end of the tanks.

Provision of a pre-aeration tank prior to the existing sedimentation tanks would be more difficult and the obvious position would be in the comminution building once the comminutors were replaced by fine screens at MPS. Aeration of the influent channels alone would provide less than 5 minutes retention time which has been found to be ineffective elsewhere.

The pre-aeration tanks at the plants described in Table 10.4.1, typically have average retention times from 15 to 30 minutes. For a 5m depth, the tanks need to be 20m x 10m approx which would occupy the complete comminution building. A new inlet structure upstream of the comminution building and channel around the building would be required to allow reconstruction work to proceed within the building. Such an exercise would be complicated but not impossible. At least two parallel tanks would be provided to allow one to be taken out of service at average flows. The tanks would have hopper bottoms to trap sand and grit which would be automatically pumped out to a conventional hydrocyclone and grit washer (refer to Figure 10.4.1).

It would be possible to have a beam grid and plate covers over the pre-aeration tanks to support sludge dewatering belt presses (or centrifuges) or rotary drum type sludge driers.

The superstructure is substantial and supports a gantry crane suitable for maintenance of such mechanical equipment. Air would be extracted from under the covers and conveyed to the biofilter for odour treatment.

Other possible spaces for the preaeration tanks would be in the yard where the cooling towers are positioned at present, which is a more restricted space or converting the sludge thickener tank. A full evaluation of these options would be undertaken during Stage 2 to determine the most cost effective in the light of what effluent quality is to be achieved and the sludge quantities produced.

10.4.5 Tahuna "Advanced Primary" Processes

Process Evaluation

Chemically Assisted Sedimentation (CAS/Fig 10.4.1)

CAS is a well established process in water and wastewater treatment. The process essentially consists of the addition of chemicals to increase the removal of suspended solids and floatables (oil and grease) in the sedimentation of wastewater. The chemicals destabilise the solids and grease which are formed into "flocs" which settle or float more quickly than by conventional sedimentation. The treatment normally consists of (i) rapid mixing of the chemicals into the flow, (ii) up to about 20 minutes for "floc" formation in a flocculation tank, and (iii) settling over a period of 1 to 2 hours at average flows in a sedimentation tank. Overall removal efficiencies of up to 80% (SS), 40% (BOD_5) and 80% (O&G) can be achieved.

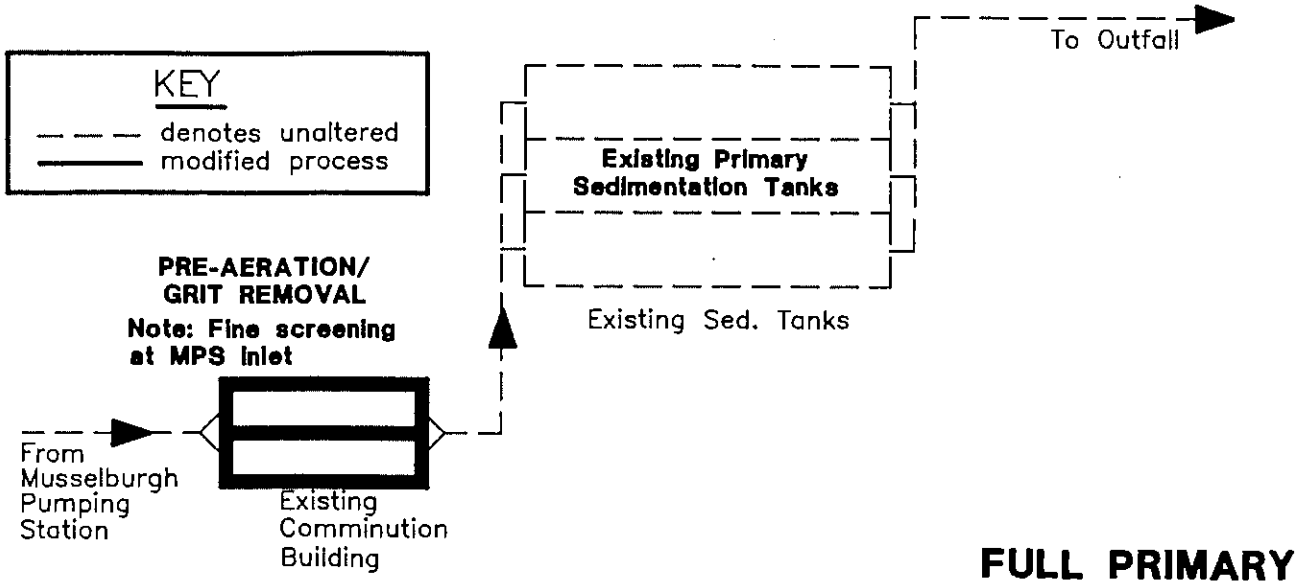
Chemicals normally used are liquid alum about 300 g/m^3, in conjunction with polyelectrolyte dosed at 1 g/m^3. Lime is sometimes used and while not so efficient as a coagulent, if high dose rates are used creating pH 10.5 and greater, significant bacterial reductions can be achieved. The chemicals dosed into the effluent result in higher sludge quantities for disposal and a reduction in heat available.

Primary Sedimentation Plus CAS (Fig 10.4.1)

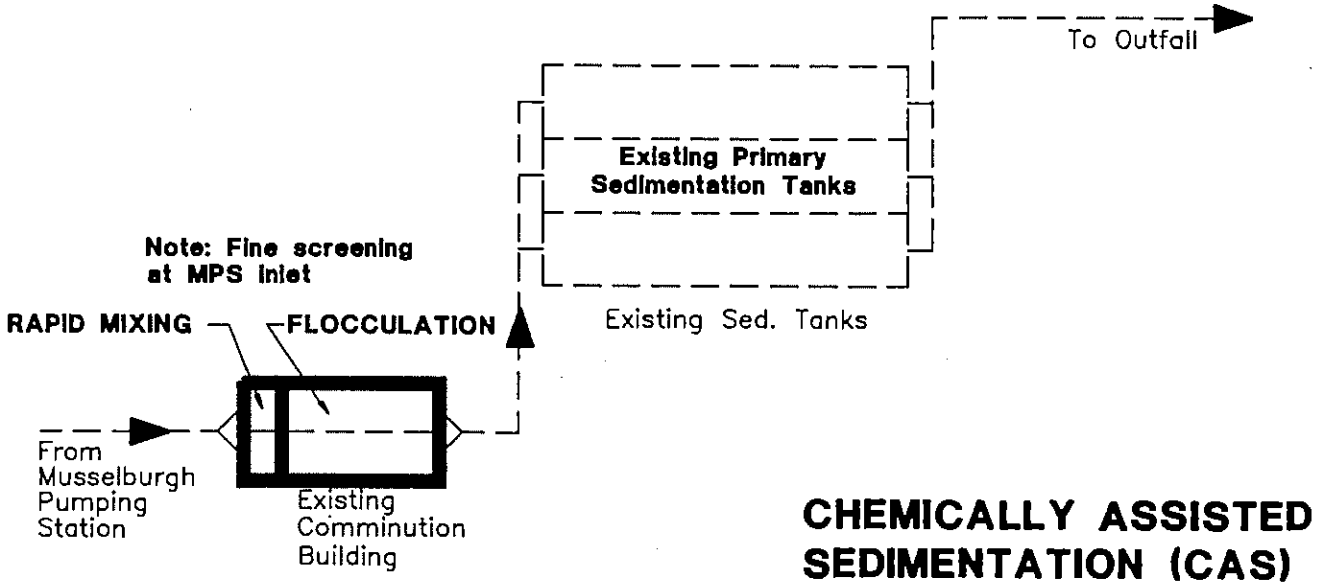
Current pilot studies at Sydney have indicated that significant reductions in chemical coagulant usage result from settling the sewage before chemically dosing and resettling. This option is the same as the preceding CAS option, with the addition of Full Primary Treatment ahead of it. Removal efficiencies are also the same as for CAS.

TAHUNA TREATMENT UPGRADING OPTIONS

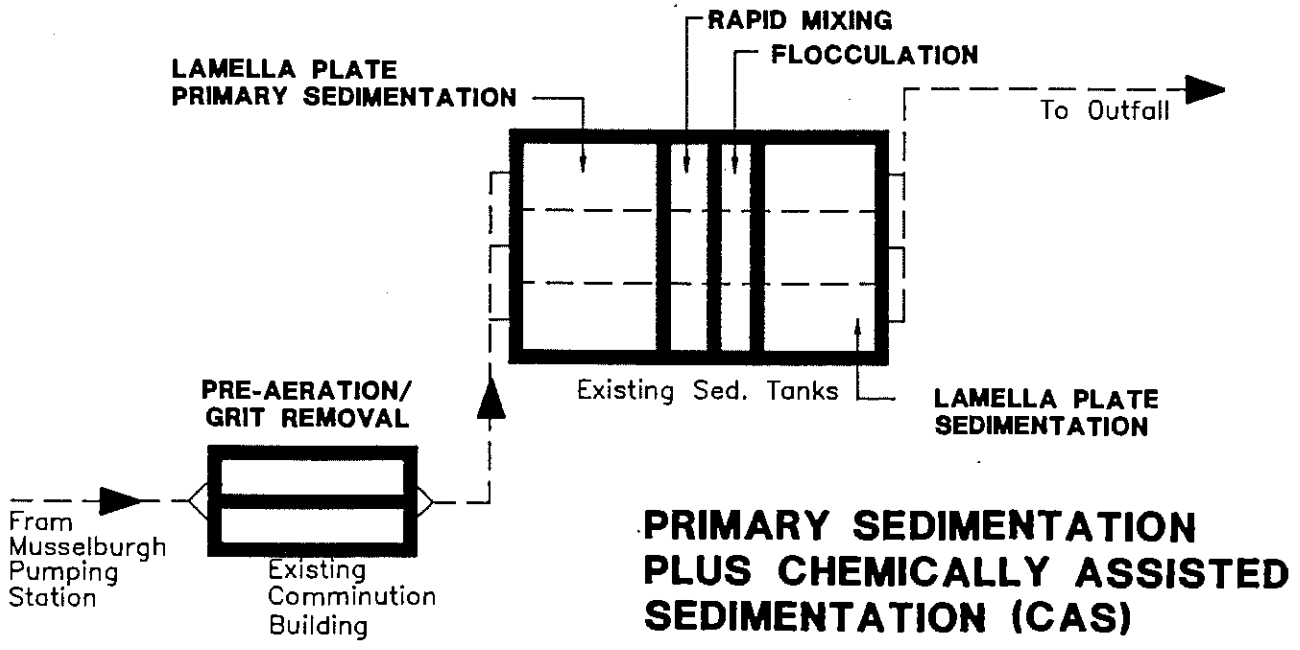
Fig 10.4.1



FULL PRIMARY



CHEMICALLY ASSISTED SEDIMENTATION (CAS)



PRIMARY SEDIMENTATION PLUS CHEMICALLY ASSISTED SEDIMENTATION (CAS)

Dissolved Air Floatation (D.A.F./Fig 10.4.2)

DAF is a well established process in water treatment and tradewaste treatment particularly for effluents with high oil and grease contents and only more recently in municipal wastewater treatment practice, specifically in waste activated sludge thickening. There has been very little work done on the application of DAF to the treatment of municipal wastewater itself. The experience of DAF equipment suppliers is concentrated mainly on the treatment of water, wastewater sludge and trade wastes. Because of the developing nature of this process and the wide degree of performance achieved with different manufacturers at different installations, it is considered to be as much an art as it is a science. Consequently, much of the technical information relating to the process tends to be "tied up" with patents and the like.

The DAF process comes in various forms. The "conventional" form is where up to 30% of the plant effluent is saturated with air at high pressure, and recycled for mixing with the raw flow at the DAF plant inlet. As the mixed flow enters the flotation tank, which is at atmospheric pressure, most of the air is released as micro bubbles which float to the surface bringing much of the grease and suspended solids with it. DAF would be preceded by high rate sedimentation probably a lamella plate separator. Overall removal efficiencies of up to 80% (SS), 40% (BOD_5) and 80% (O&G) could be expected.

Magnetite Assisted Sedimentation (Sirofloc - Fig 10.4.2)

This process derives from the use of magnetite in the treatment of water for potable purposes, which process is in commercial operation in Australia and is proposed for Dunedin plants. The Sirofloc process as applied to wastewater treatment has been under development by the CSIRO Australia for about 4 years, and a small sewage pilot plant has been in operation for the last 9 months at Lower Plenty in Victoria. A small pilot plant has also been installed at the Malabar S.T.P. Sydney.

Briefly, the process requires the addition of acid to the sewage flow to lower the pH, then the addition of magnetite and ferric sulphate. Colloidal matter in the sewage absorbs to the magnetite in the flocculating phase. After passing through permanent magnets which increases flocculation of the laden magnetitite, the flow passes into the sedimentation tanks where the magnetite sludge quickly settles by gravity. Clarified effluent from the sedimentation tanks is neutralised normally by lime, before discharge to the receiving waters.

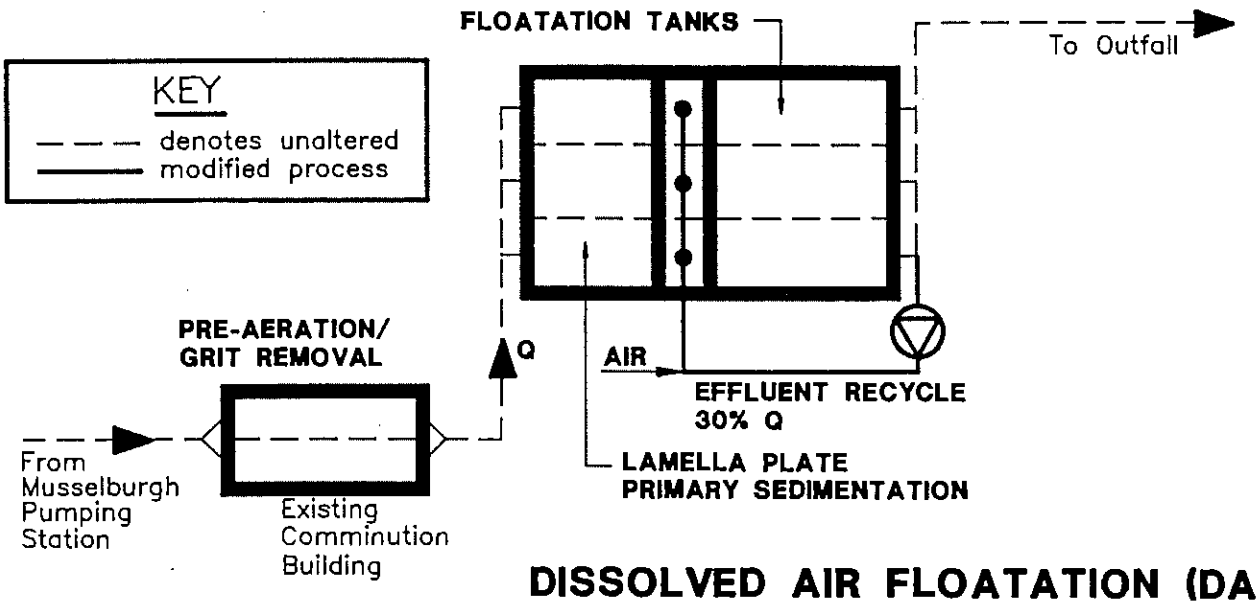
Regeneration of the magnetite for re-use involves raising the pH of the magnetite sludge with alkali, washing with sewage and separating the magnetite in drum separators. Developers of the process claim that over 99% of magnetite is re-claimed. Overall removal efficiencies of up to 88% (SS), 84% (BOD_5) and 80% (O&G) have been claimed. These efficiencies are high and are subject to confirmation by pilot and tank scale studies at Malabar, Sydney.

A-stage High Rate Activated Sludge (Fig 10.4.2)

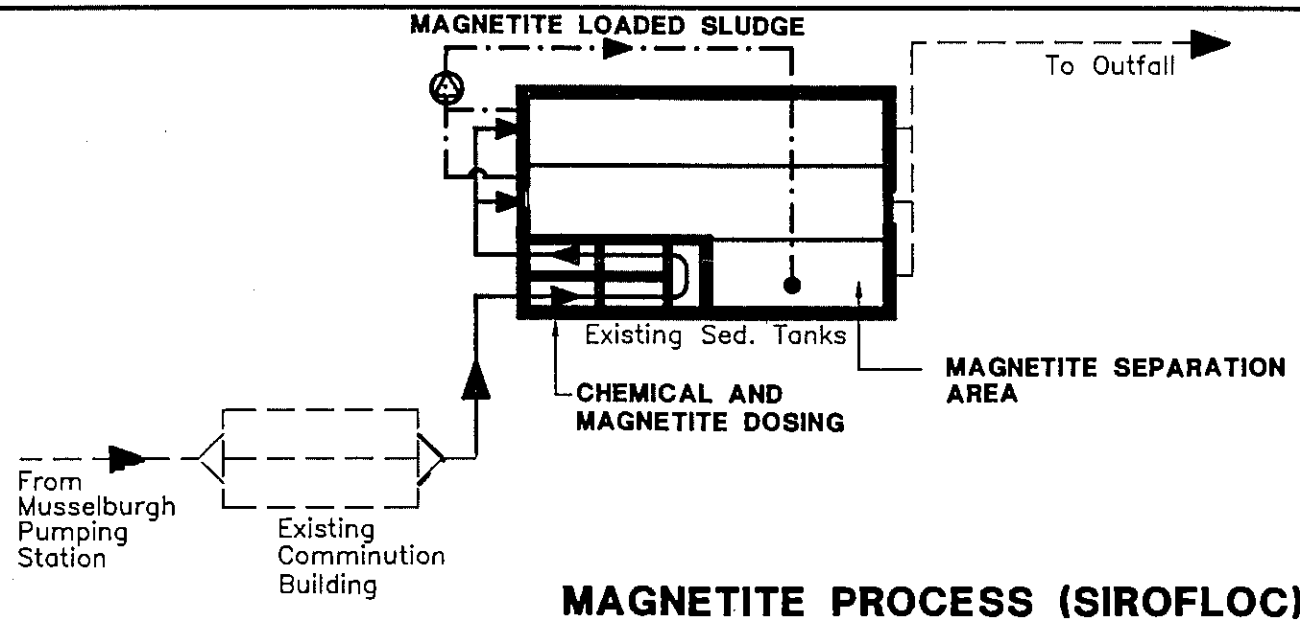
This process can be based upon the conventional pre-aeration/grit removal tank (retention time of 30 to 60 minutes at average flow) with the added feature of recycling of sludge settled in the primary tanks. The process has been proved at small and large scale plants in Europe over the past decade. It is normally used in conjunction with a B-stage lightly loaded activated sludge process to produce final effluent qualities less than BOD_5 10:SS10. The overall concept is known as the AB process.

TAHUNA TREATMENT UPGRADING OPTIONS

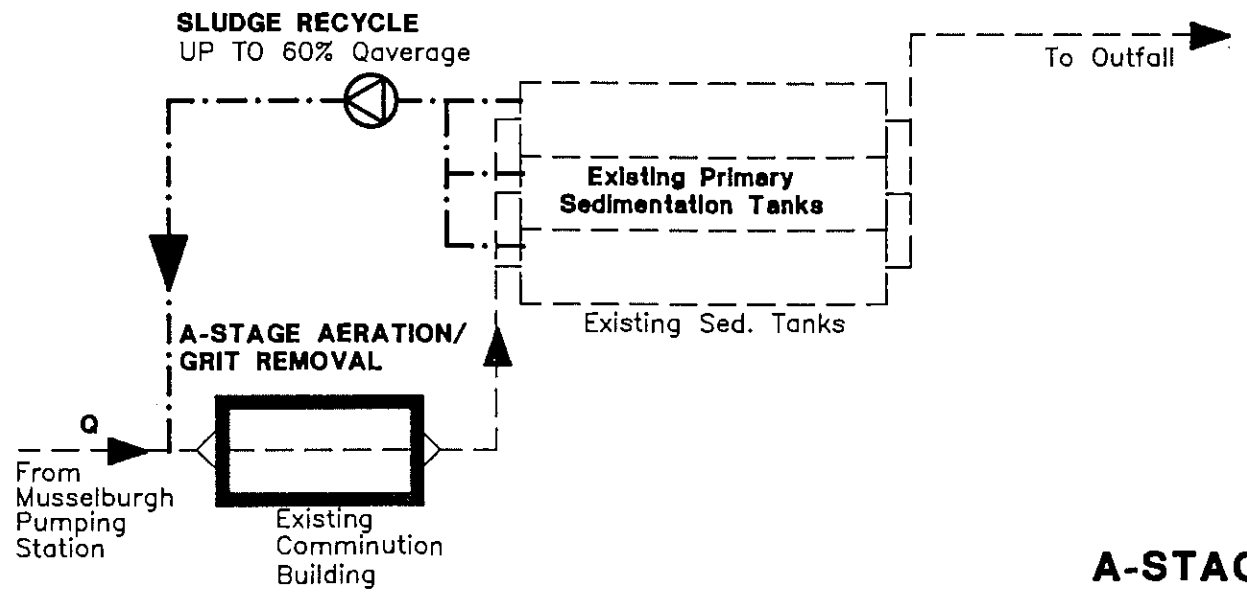
Fig 10.4.2



DISSOLVED AIR FLOATATION (DAF)



MAGNETITE PROCESS (SIROFLOC)



A-STAGE

Recycling of the sludge to the aerated chamber "activates" the solids and significant increases in BOD_5 removal can be achieved by adsorbing finer colloidal solids onto the floc. Suspended solids removal is proportionally increased. Overall removal rates after settling, achieved elsewhere are 50-60% BOD_5, 70-80% SS and 70% O&G which are comparable with the other "advanced primary" processes. The A-stage process should not be considered as a high rate secondary process as only a single stage of treatment is provided compared to the two or more stages inherent in conventional secondary treatment.

Additional BOD_5 and solids are removed without the addition of chemicals at the expense of providing sludge recycling of up to 60% of average flow. The cost of recycle pumping would be significantly lower than the purchase cost of chemicals. As for all the advanced primary processes extra sludge will be produced due to higher removal rates of solids and adequate sludge processing must be provided.

Effluent quality variability is likely to be higher from an A-stage process than a chemical dosed process but monthly averages would be comparable. The process has been used in municipal plants in Europe, with high tradewaste loads. Hence, in comparison with the other advanced primary processes, it has the significant advantages of being proven, avoids chemical dosing and has a lower energy requirement. The A-stage process should be evaluated in detail in the Stage 2 study.

10.4.6 Tahuna Biological Secondary Treatment

Process Evaluation

The Biological Aerated Filter (BAF) process represents only one example of the available biological secondary treatment processes. It is the most compact of all the fully proven processes by a substantial margin. While it was found to be more expensive on a "green field" site in Wellington, it appears capable of being retrofitted into the existing primary sedimentation tanks together with lamella plate separators preceding the BAF cells. This feature is likely to provide a sufficient cost advantage over other forms of secondary treatment which would require additional structures and probable expansion of the site mainly due to the space required for secondary clarifiers.

This concept is a biological process which combines oxidation and removal of stabilised suspended matter in the one reactor. Its compact size together with absence of secondary clarifiers makes it particularly suitable for sites with restricted area.

The process consists of an aerobic fixed film reactor operating with a submerged, granular bed. The granular media provides a matrix on which a high concentration of biomass can grow. Process air is added through injection pipes located about 300mm above the bottom of the granular bed. The bottom 300mm below the air injection level serves as a final filter, thus eliminating the need for secondary clarifiers. In physical construction, each BAF cell resembles a conventional rapid gravity sand filter.

Like rapid gravity sand filters, BAF cells require periodic backwashing. Typically this takes place every 18-36 hours (depending on the plant load), taking about 25 minutes for each cell. Sludge from the backwash water is usually settled out in Lamella Plate sedimentation tanks, the overflow of which is recycled through the BAF plant. Removal efficiencies of up to 93% (SS), 93% (BOD_5) and 98% (O&G) could be expected.

Effluent quality would be very reliable at average flows and the space constraints would dictate the maximum flow during wet weather above which effluent quality would deteriorate. A peak flow of 3000 l/s could be possibly treated without too much deterioration in effluent quality. For extreme flows up to 4500 l/s, which is the peak hydraulic capacity of the plant, bypass of 1500 l/s

would be required assuming the MPS had been upgraded to this capacity. Such events would be infrequent and fine screening would be a pre-condition for the bypass.

Retrofit Considerations

A possible layout for the lamella plate separator plus BAF process is shown in Fig 10.4.3 There is sufficient space in the existing sedimentation building for the BAF cells and the main consideration to be investigated in Stage 2, is the practicality of installing the backwash and process air pipework within the existing spare, double storey channels between each sedimentation tank.

It would be necessary to keep the lamella separator as high as possible to provide sufficient head across the BAF cells. This would require some increase in tank wall height.

A new 2 or 3 storey services building would be constructed beside the former chlorine contact tank at the south end of the sedimentation tank hall. This would house process and backwash air blowers, backwash water pumps, power distribution and control equipment and compact odour treatment units additional to the existing biofilter.

Other retro-fit options that require consideration in the Stage 2 Study are Rotating Biological Contactors (RBC's or Biodiscs) that could fit into the existing tanks after lamella separators or MEMBIO units which are very high rate biological reactors being trialled in Australia at present by the manufacturers of the MEMTEC microfiltration units.

10.4.7 Tahuna Tertiary and Disinfection Treatment

Process Evaluation

Chlorination has been the traditional method for disinfection of effluents treated to better than full primary standard. However, the effects of organo-chlorine compounds are a concern and ultra violet light (UV) disinfection systems have been gaining rapidly increasing acceptance particularly in North America.

In NZ, previous studies have demonstrated that while UV disinfection has a higher capital cost, its running cost is lower than chlorination and UV has a lower total cost (capital plus operating).

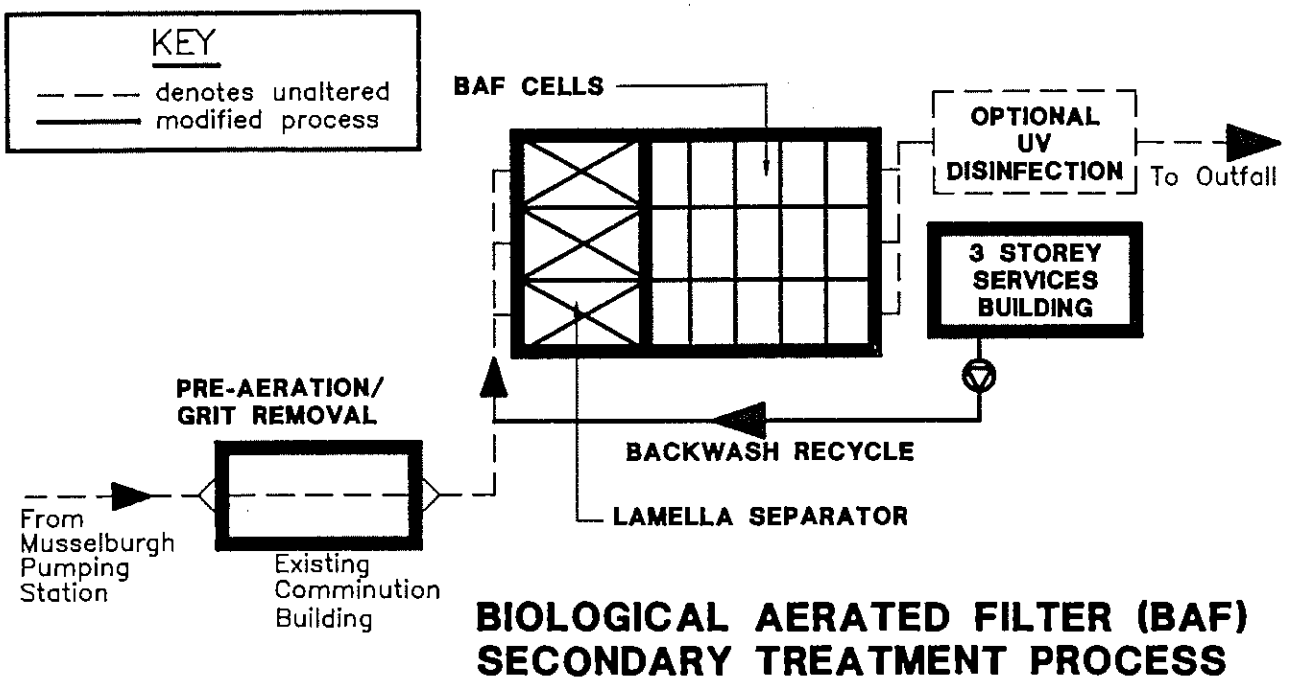
UV disinfection is a physical process involving the transfer of electromagnetic energy (in the form of light) from a source (typically at present a low pressure mercury vapour lamp) to the genetic material of organism cells. The radiation destroys genetic material disabling cellular ability to replicate resulting in the death of the cells and consequently the organism.

The principal advantages of UV disinfection are the absence of any toxic residuals or chemical intermediates (which could harm sensitive species in receiving waters); and the inherent safety of the systems for operators. Other factors supporting the use of UV disinfection include: cost effective installation and operation, comparable pathogen killing ability, and ease of operation and maintenance.

The effectiveness of the process relates to the degree of exposure of organisms in the wastewater to the UV light. The process is therefore most effective on wastewaters with low solids contents, ie, relatively high quality treated wastewater. Significant kills can still be achieved in lower quality wastewaters. However, efficiency is reduced and residual levels of pathogens cannot be further reduced. Thus UV disinfection of secondary effluent prior to discharge to the environment is the typical application.

TAHUNA TREATMENT UPGRADING OPTIONS

Fig 10.4.3



BIOLOGICAL AERATED FILTER (BAF) SECONDARY TREATMENT PROCESS

Another method of disinfection is ozone dosing which is used in large overseas plants. Ozone is an unstable gas so must be produced on site by passing an oxygen containing gas through an electric field. The ozone must then be dissolved in water for 5-10 minutes for disinfection to occur. Ozone is generally more effective than chlorine at equivalent concentrations but this varies with pH and composition of the wastewater. After disinfection, the ozone in the gases from the treated wastewater must be destroyed. Ozone has more commonly been used to replace chlorine in drinking water where its advantage is the lack of a chemical residual. However, in wastewater this can lead to a rapid growth of micro-organisms immediately following treatment. Studies in NZ have shown that ozone systems are more expensive than UV disinfection. For this study, UV disinfection has been adopted as the preferred process.

An alternative approach to disinfection is the virtually complete removal of solids together with bacteria, by a microfiltration process such as MEMCOR which is presently being developed in Australia.

Membrane technology has been utilised for over 20 years in commercial and medical fields where fine separation and concentration has been required. The most commonly used have been reverse osmosis (RO) for desalination of salt water and ultrafiltration (UF) in the food and medical industries for separation of protein and larger molecules.

MEMTEC's crossflow microfiltration (CMF) is claimed to have improved the traditional microfiltration membrane systems by 300% yielding throughput rates 30 times UF and 300 times RO at an operating pressure of 400 kPA (UF 800 kPa and RO 1400 kPa).

A compressed gas cleaning method is used by MEMTEC in place of liquid methods and this feature is claimed to be the reason for the improved throughputs.

The following removal performance data is claimed for MEMCOR microfiltration.

	Total Coliform /100ml	Faecal Strep /100ml	Enterovirus $TCID_{50}$	BOD_5 g/m^3	Turbidity NTU Units	TOT P g/m^3
Feed	8.5x10p4	$4.0x10^2$	10^2-10^6	1-18	6-37	2.5-4.4
Filtrate	Nil to trace	Nil to trace	No virus detected	1-7	0.6-2	1.8-7.9
Average % Removal	Near complete	Near complete	Near complete	83	92	22

Retrofit Removals

UV disinfection which consists of arrays of lamps submerged in gravity flow channels, could readily fit in the former chlorine contact chamber at the south end of the main building. The present series flow arrangement would be converted to parallel flow channels with isolating gates to each channel. A superstructure over a least part of the area would be required to allow removal and cleaning of the lamps under all weather conditions.

A MEMCOR installation would require about $5000m^2$ and pressure pumping would be needed to force the effluent through the membrane. Consequently a 2 storey arrangement could be feasible and necessary if the site is not to be extended. Including the contact tank, about $3000m^2$ is spare at the south end of the site not allowing for additional services buildings required for a BAF process which could be housed elsewhere with difficulty.

10.4.8 Tahuna - Summary of Treatment Upgrading

The relationship of costs to increasing level of treatment as indicated by removal of suspended solids, is shown in Figure 10.4.4.

At this preliminary review stage an upgrading strategy for Tahuna and Musselburgh would encompass: - (refer also to Table 10.4.2)

- an investigation programme including laboratory scale and pilot plant testing of some of the following improvements.
- fine screening (1-3mm gap) at Musselburgh replacing the existing 50mm gap bar screens together with automated removal of grit which accumulates in the forebay.
- if an improved effluent which could be discharged from a long ocean outfall was the preferred option then the Tahuna comminution building would be converted to combined pre-aeration/grit removal tanks with an extra bypass channel around the comminution building. The pre-aeration process, along with possible alterations to inlet ports and outlet weirs, could increase performance to "full primary" treatment.
- if a better effluent quality was the choice, then the A-stage and CAS processes would be studied in some detail at Stage 2, as being the most proven of the "advanced primary" processes.
- if biological secondary treatment coupled with a shorter ocean outfall was decided upon, then the BAF processes would be studied, in detail in Stage 2, particularly the retrofit arrangements. The very short retention MEMBIO process, which is currently being trialled in Sydney, could also be evaluated.
- UV is likely to be the preferred disinfection process.
- tertiary treatment is likely to be considered only in conjunction with continued discharge from Lawyers Head.

TABLE 10.4.2
COMPARISON OF TREATMENT PROCESS OPTIONS FOR TAHUNA - TO SERVE MUSSELBURGH CATCHMENT ONLY

Treatment Process	Discharge Location	Effluent Quality (Average) g/m^3			/100 ml	Estimated Treatment Costs[i] $M	
		SS	BOD_5	O&G	FC	Capital	pa O&M[ii]
(Influent)		(320)	(420)	(92)			
Existing Plant	Lawyers Head	180	300	55	10^7	-	1.8[iii]
Full Primary with pre-aeration, fine screening and grit removal	Long Ocean Outfall	100	270	40	10^7	10.0	0.8
Advanced Primary							
CAS	Long Ocean	60	180	25	10^6	14.0	1.8
A Stage	Outfall	80	180	30	10^6	12.0	1.0
Sirofloc Process (Magnetite)	Long Ocean Outfall	50	100	25	$5x10^5$	15.0	2.4
Secondary							
BAF	Short Ocean Outfall	20	20	2	$5x10^5$	41	2.2
BAF + UV disinfection	Short/Medium Outfall or Lawyers Head	20	20	2	$2x10^2$	44	2.5
Tertiary							
BAF + Memcor	Short Outfall or	1	5	1	Nil to	109	5.5
Membio + Memcor	Lawyers Head				trace	188	5.7

Notes: (i) All cost estimates include sludge processing and disposal and other residuals management and Musselburgh pumping station upgrade.
(ii) O&M costs shown for upgrading options are nett additional to existing costs.
(iii) Includes Musselburgh Pump Station at ($0.5M/yr)

10.4.9 Southdale Road - New Treatment Plant Option

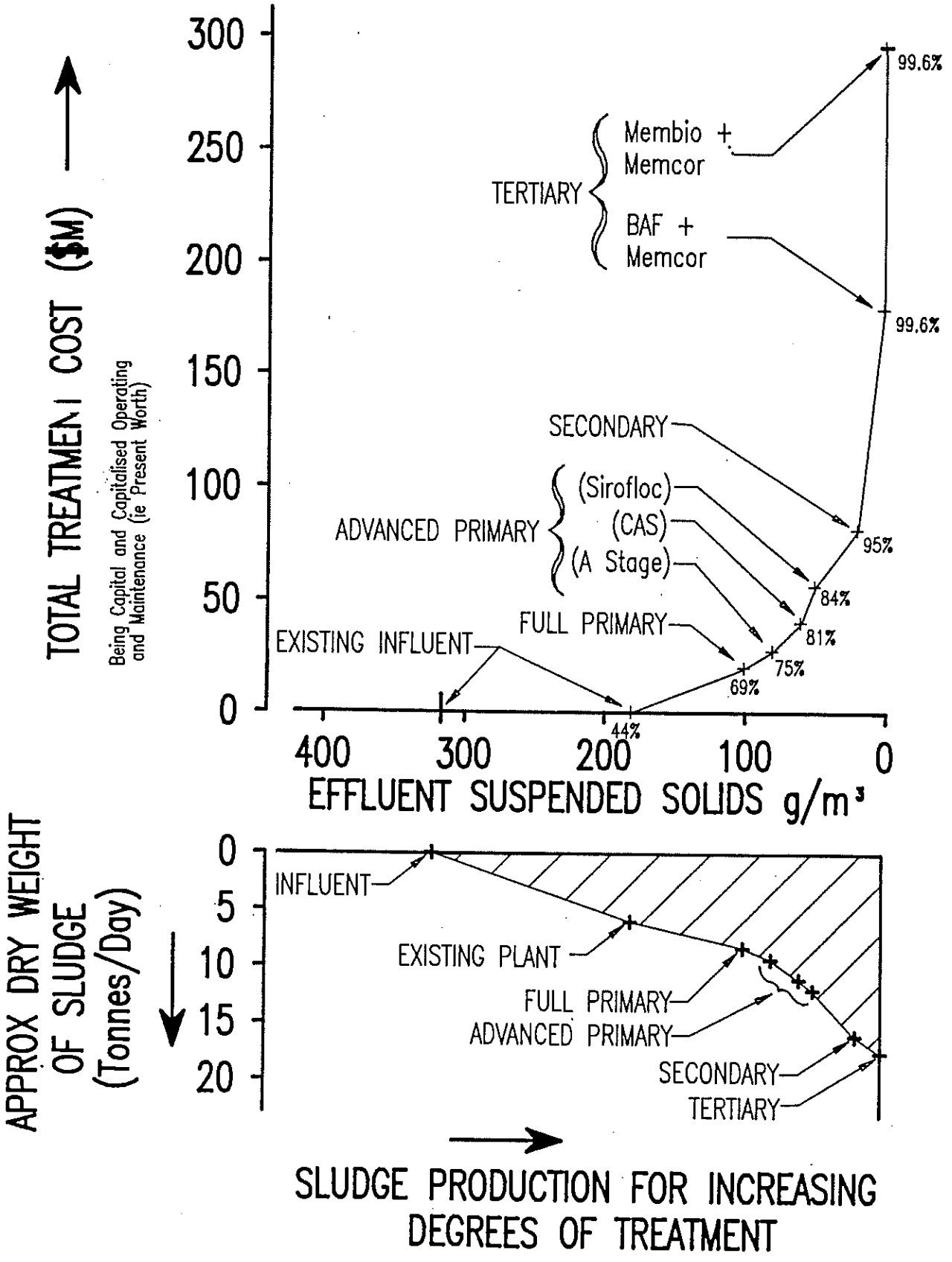
Because of suitable conditions for an ocean outfall off Maori Head and the possible availability of sufficient flat land adjacent to Southdale Road in Smaills Valley, consideration has been given to the provision of a treatment plant at this location. The plant would handle all the Musselburgh catchment flows up to about 3500 l/s with the excess being diverted to Lawyers Head during peak flow events. Design flows would be higher if inter-catchment transfers were adopted. The site is of sufficient size to take all four catchments (a Concept Level One Scheme) if a trickling filter plant is used.

If major earthworks were undertaken it would be possible to construct the dual power level lagoon type of secondary treatment which is likely to have the lowest capital cost. However,the dramatic impact of the earthworks on the valley, and the potential for possible odour release from the uncovered aerated lagoons make this option unfavourable in comparison with processes which can be covered and occupy less space.

ESTIMATED COST Vs SUSPENDED SOLIDS LEVELS IN EFFLUENT, TAHUNA WPCP

Existing and Upgrading Options for Musselburgh Catchment
Percentages Indicate Average Solids Removed

FIG 10.4.4



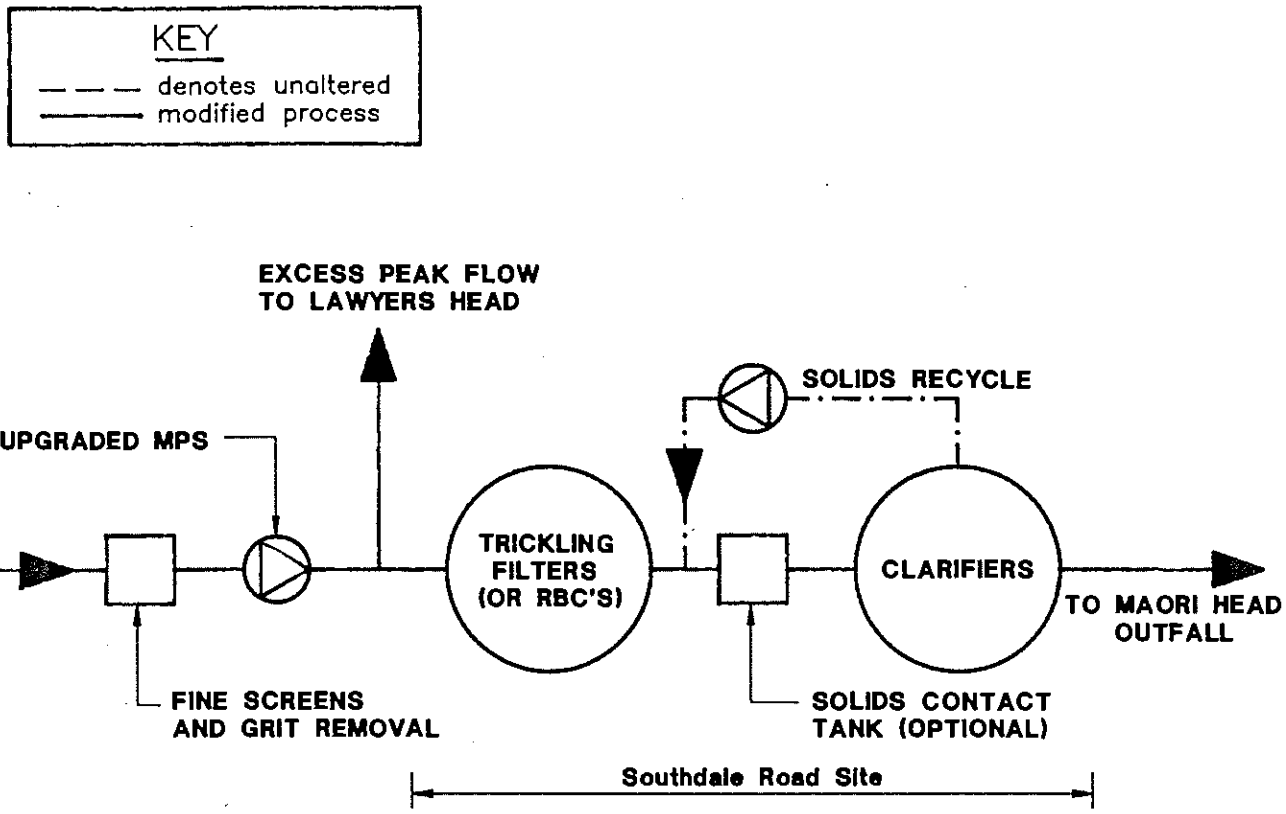
Of the proven secondary treatment processes,a trickling filter plant is likely to have a near lowest overall cost for the above average strength influent. An effluent quality of about 50:50 could be achieved by trickling filters suitable for discharge from the Maori Head outfall. The outfall length is likely to be a minimum of 1100 m to discharge into the long shore current which does not return to the coast in the immediate vicinity. Hence from a benefit/cost stand point, a better effluent quality is not necessarily needed, eg, secondary treatment plus disinfection. If required, though, the trickling filter process can be economically upgraded with the addition of a solids contact tank to produce an effluent quality of about 20:20. The rotating biological contactor (RBC) process could also be evaluated for this site. Activated sludge plants offer other alternatives but at higher costs.

It is likely that at least a secondary treatment plant would be constructed at Southdale Road should this location be favoured. That is, primary treatment only would not be duplicated at Southdale Road if replacing that at Tahuna.

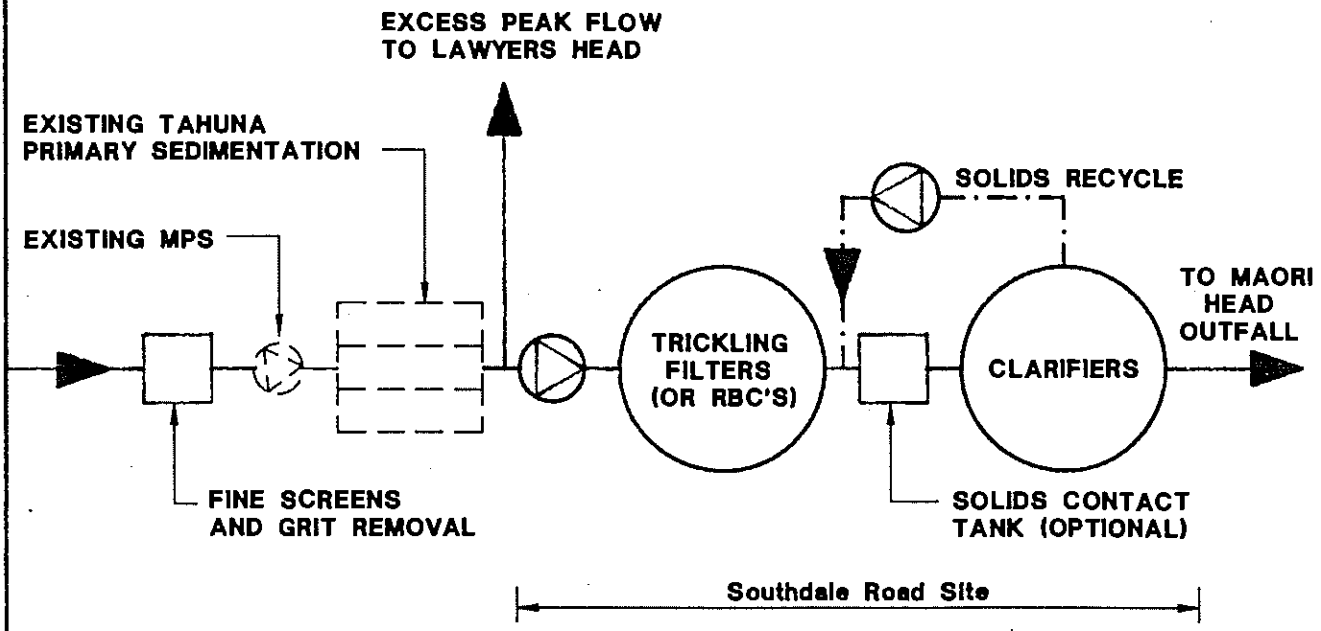
It could be possible to apply milliscreened effluent direct to trickling filters at Southdale Road, eliminating the need for prior primary sedimentation at Tahuna. Screens with 1 or 2 mm gap would be installed at Musselburgh Pump Station and the pump discharge conveyed direct to Southdale Road. The Tahuna plant could then be converted to other uses. Refer to Figure 10.4.5 for basic option schematics. Refer also to Table 10.4.3 for references to scheme options.

SOUTHDALE ROAD TREATMENT PLANT SCHEMATICS

Fig 10.4.5



TRICKLING FILTER SECONDARY TREATMENT



TAHUNA PRIMARY PLUS SECONDARY AT SOUTHDALE ROAD

TABLE 10.4.3 : SECONDARY TREATMENT OPTIONS FOR A SOUTHDALE ROAD TREATMENT PLANT

Scheme/Catchment Served	Treatment Process and Site	Effluent Quality (average) g/m^3 /100 ml				Estimated Treatment Costs[1] $M	
		SS	BOD_5	O&G	FC	Capital	Annual O&M[i] [ii]
Musselburgh Catchment MC4a	Secondary trickling filter (TF) at Southdale Road	50	50	5	10^6	42.0	0.9
Musselburgh Catchment MC4b	Above with UV disinfection	50	50	5	10^3	45.0	1.3
Musselburgh Catchment plus Harbour Basin (HB) extended MC4a	Secondary trickling filter (TF) at Southdale Road	50	50	5	10^6	42.5	0.95
Musselburgh Catchment plus Harbour Basin (HB) extended MC4b	Above with UV disinfection	50	50	5	10^3	45.5	1.40
All Four Catchments further extended MC4a	Secondary trickling filter (TF) at Southdale Road	50	50	5	10^6	58.0	1.8
All Four Catchments further extended MC4b disinfection	Above with UV disinfection	50	50	5	10^3	62.0	2.4
Musselburgh MC4c	Primary at Tahuna plus TF at Southdale Road	50	50	5	10^6	37.5	1.3
Musselburgh MC4d	as for MC4c + UV disinfection	50	50	5	10^3	40.5	1.55

Musselburgh + HB MC4c extended	Primary at Tahuna plus TF at Southdale Road	50	50	5	10^6	38.0	1.35
Musselburgh + HB MC4d extended	as for MC4c + UV disinfection	50	50	5	10^3	41.5	1.65
All four catchments MC4c extended	Primary at Tahuna plus TF at Southdale Road	50	50	5	10^6	60.0	3.0
MC4d extended	as for MC4c + UV disinfection	50	50	5	10^3	65.0	3.6

Notes: (i) O&M costs are nett additional over existing costs which are $1.8 M pa for Tahuna plus Musselburgh pump station.

(ii) New pumping at Musselburgh or Tahuna included in conveyance component.

10.4.10 Green Island - Existing Treatment Processes and Limitations

Approximately 5,500m^3/day of wastewater is treated at the Plant. Industrial trade wastes make up about 40% of the flow and include those wastes brought to the plant from Wingatui and Mosgiel via the Tunnel Pipeline. The Fortex Meat Processing Plant at North Taieri also discharges up to a further 7,500m^3/day to the outfall, downstream of the existing treatment plant. Fortex has an on-site wastewater treatment system. This increases the outfall flow to about 75% trade waste.

A constant velocity channel on the incoming sewer is used to settle out grit and sand which is periodically removed by an excavator. The wastewater is pumped up to 1mm milliscreens to remove solids, prior to discharge to the Pacific Ocean via the 500m long Waldronville outfall. Screenings from the plant are landfilled onsite.

Overwashing of milliscreens previously occurred due to trade waste solids in excess of approximately 330 l/s at a suspended solids of 2500g/m^3. Tighter enforcement of Trade Waste Bylaws is ongoing to ensure that industrial wastewater meets required standard.

The effluent discharge is visible as a slick at times. Seagulls gather over the outfall ports which may indicate that some solids are possibly still passing through the system or re-aggregating within the discharge/outfall line downstream of the milliscreens. Another indicator of the effluent discharge is the deposit of pin head grease on the Waldronville beaches at times, possibly caused by the coagulation of emulsified fats when the warm effluent strikes the significantly colder sea-water.

10.4.11 Green Island - Previous Upgrading Proposals

The original treatment plant concept involved the following post milliscreening operations which were not implemented when the Burnside Freezing Works was closed. This resulted in a considerable decrease in available funds, requiring plant costs to be reduced as far as practicable. Accordingly only the Stage 1 milliscreening plant was constructed.

- clarification of all wastewater by use of advanced primary treatment in high rate floatation/sedimentation tanks which include entrained air floatation to assist solids removal.

- dewatering of sludge using finer (0.2mm aperture) milliscreens and sludge conditioning by lime addition.

- collection and pressing (to reduce the water content) of the screenings.

- collection and drainage of float material.

- disposal of all solid waste products (eg. grit, screened and pressed solids, dewatered, limed sludge, and float material) by sanitary landfill on the treatment plant site.

- future recovery of decayed solid waste products from the sanitary landfill area for recycling.

10.4.12 Green Island - Advanced Primary Treatment Upgrading Options

(Refer to Figure 10.4.6)

Floatatation/Sedimentation (FS)

The existing grit removal channels and 1mm gap milliscreens provide appropriate pretreatment for any subsequent treatment processes.

As was proposed earlier, it is reaffirmed that because the wastewater has a high grease content, any "sedimentation" process should incorporate air floatation to coagulate the finer grease particles into a scum which can be removed from the surface. This has also been referred to as the "entrained air" option in the past.

Conventional coarse bubble pre-aeration, as described for Tahuna in section 10.4.4, could remove a proportion of the grease but the high input grease concentration requires the special feature of fine bubble aeration to achieve a higher removal percentage. Expected removal rates are 70% for SS, 40% for BOD_5 and 70% for O&G. Pilot plant testing would be desirable to confirm this.

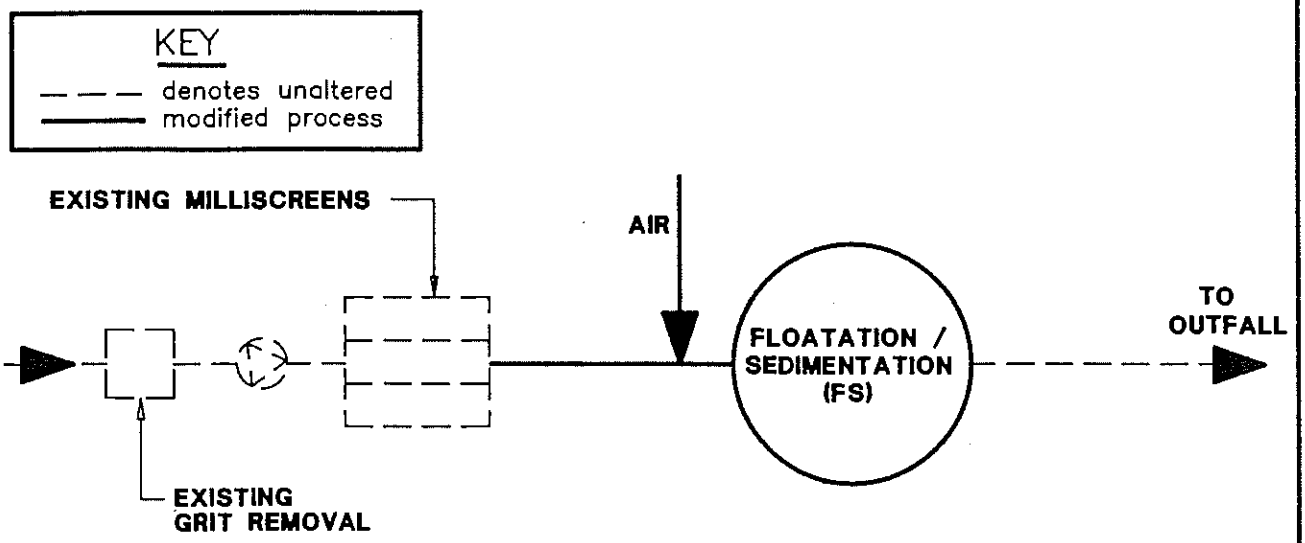
The screened wastewater from the milliscreens would gravitate to the high rate floatation/sedimentation tanks - two circular concrete tanks approximately 25 metres in diameter (or rectangular equivalent). Each would have a mechanically operated rotating "top float" removal device and a "bottom sludge" removal scraping device.

The special feature of the tanks would be the submerged air entraining devices fixed near the inlet. These devices will significantly improve the removal of floatable material and in particular grease, due to the formation of fine air bubbles. A detention period of 45 minutes at average dry weather flows is proposed compared to 2 hours or longer for conventional primary sedimentation.

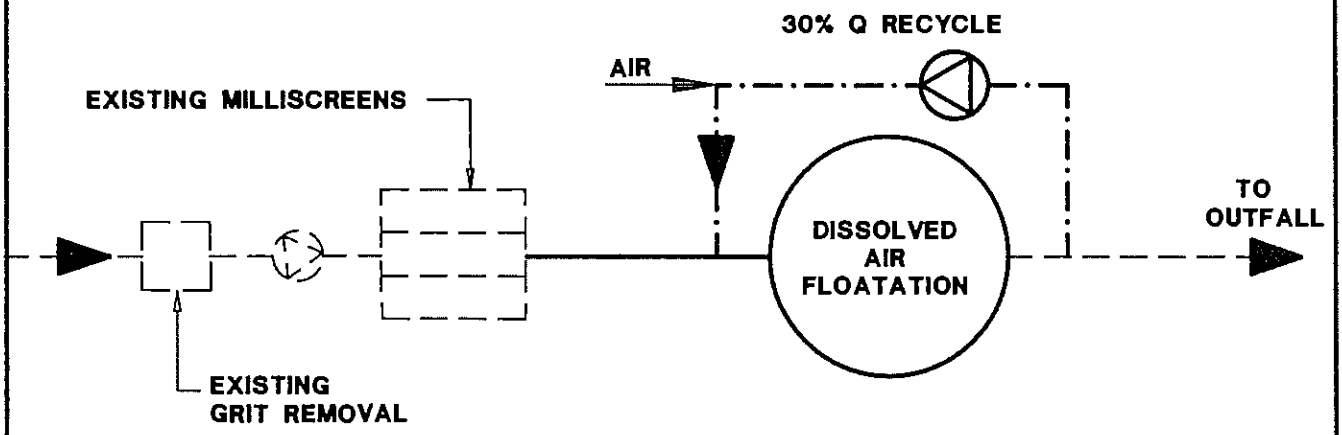
The "float" and "bottom sludge" could be difficult to dewater in a belt press due to the high grease content but a centrifuge could be used based on their widespread use in the wool scour industry. Centrifuge reliability would be satisfactory due to the prior grit removal and milliscreening. The dewatered cake could be landfilled directly or stabilised by lime dosing if found to be putrescible.

GREEN ISLAND
ADVANCED PRIMARY TREATMENT
UPGRADING OPTIONS

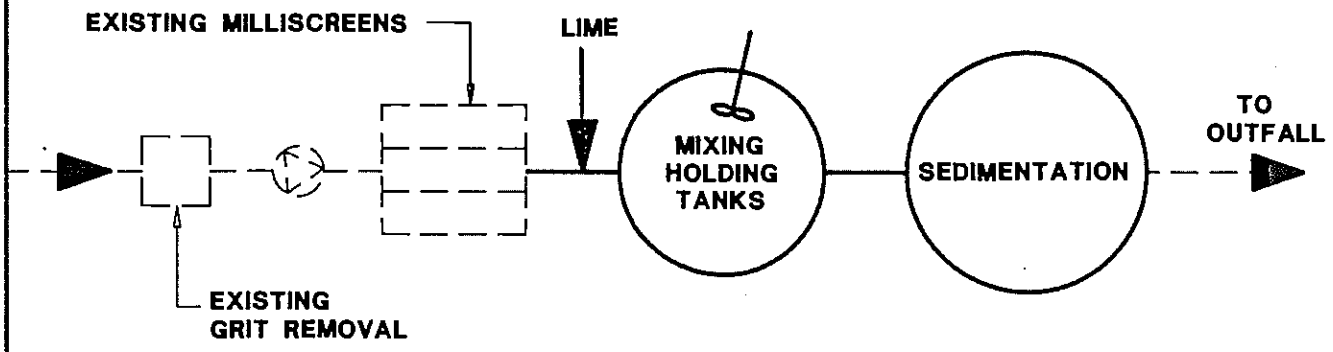
Fig 10.4.6



FLOATATION / SEDIMENTATION



DISSOLVED AIR FLOATATION (DAF)



HIGH LIME + SEDIMENTATION

Dissolved Air Floatation (DAF)

As outlined for the Tahuna plant in section 10.4.5, DAF is not normally used for municipal wastewater but the process has been extensively used for trade wastes with high grease and fat contents.

Because about 30% of the flow must be recycled and pressurised along with air injection, the operating costs would be significantly higher than the process described above. However, improved solids and grease removal percentages can be expected. The physical size of the DAF tanks would be similar to the FS process.

Expected removal rates for DAF are about 75% for SS, 60% for BOD_5 and 80% for O&G.

These percentage removals could be further increased by adding of polyelectrolyte chemicals and/or two stage DAF, but at higher costs.

High Lime plus sedimentation

If the effluent is dosed with lime to pH10.5 to 11.0 and retained fully mixed in a tank for 2 to 4 hours, disinfection can be achieved with Faecal Coliforms reducing from 10^7 to below 10^3.

At the same time, the lime can act as a coagulant and, if allowed to settle, a lime sludge can be withdrawn. Such a sludge would be pre-stabilised due to the lime content or would require a minor supplemental dose to achieve full stabilisation.

There are conflicting reports on the dewaterability of a lime sludge and local trials would be required.

Expected removal rates are about 70% for SS, 55% for BOD_5 and 70% for O&G.

10.4.13 Green Island - Secondary Treatment

(Refer to Figure 10.4.7)

Anaerobic Contact Process

As opposed to aerobic secondary treatment in which the oxygen biochemical demand (BOD_5) of the waste is satisfied by supplying oxygen, anaerobic treatment processes take place in a tank or lagoon completely devoid of oxygen.

Stabilisation of the waste is achieved by different sets of bacteria, the first breaking down complex organics to volatile acids (acetic and proprionic mainly) and the second group converting the volatile acids to biogas (methane 65%, carbon dioxide 35%).

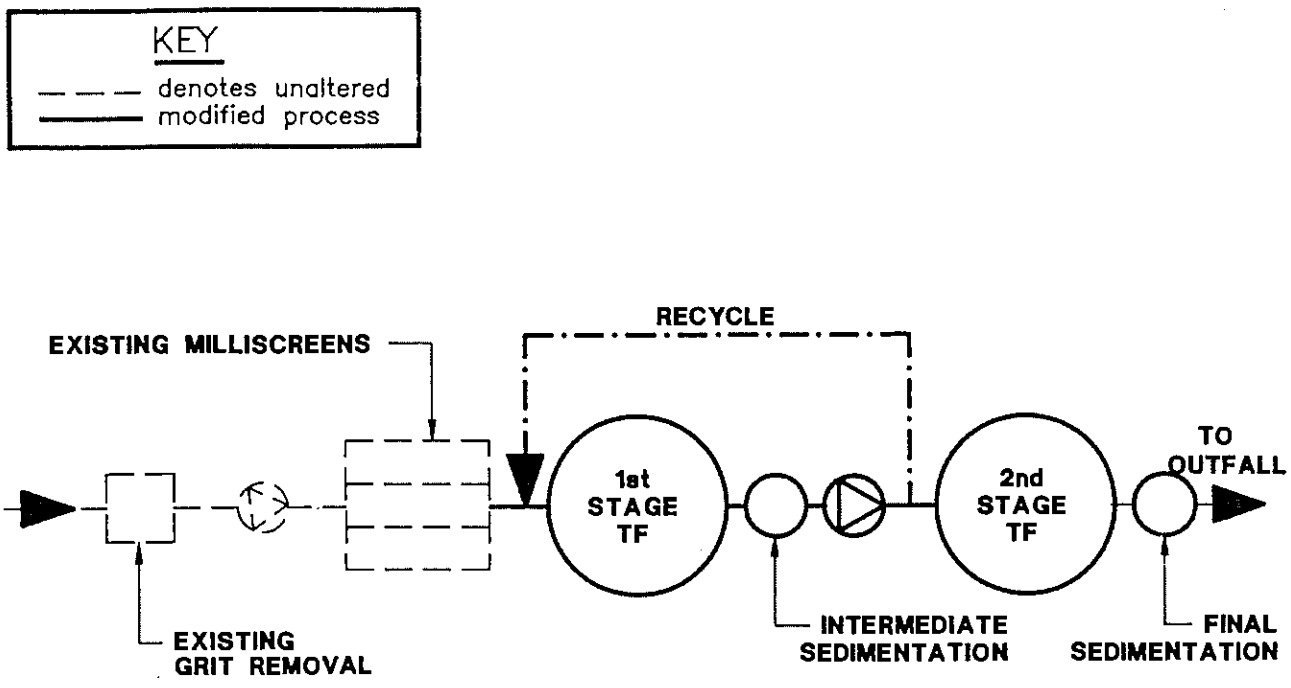
Anaerobic processes only function above 15^oC and more rapid reaction rates are achieved up to 35^oC. Consequently, the process is more suited to the higher strength (BOD_5 greater then 1000 g/m^3) and warmer effluents produced by some industries. In NZ, successful anaerobic treatment is practised in the meat, wool scour and dairy industries.

If the temperature and feed strength criteria are satisfied, anaerobic treatment has these advantages over aerobic processes.

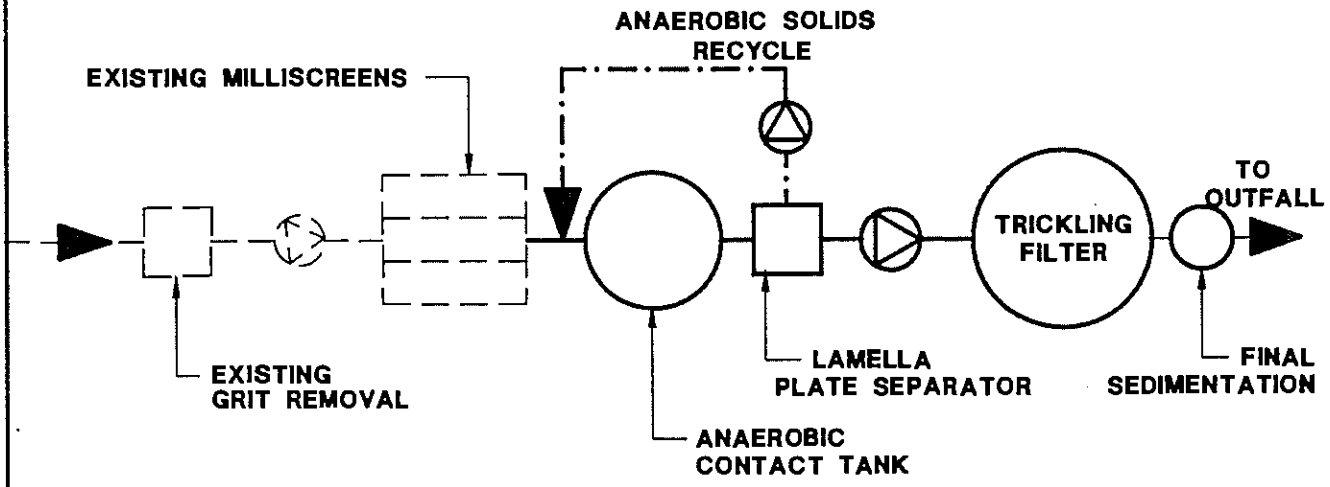
- no high power input required for aerators
- production of a useable fuel as biogas which could be used in boilers or engines.

GREEN ISLAND SECONDARY TREATMENT UPGRADING OPTIONS

Fig 10.4.7



TWO STAGE TRICKLING FILTERS (TF)



ANAEROBIC CONTACT PLUS AEROBIC TRICKLING FILTERS

- sludge production rate about 20% that of aerobic processes resulting in reduced sludge disposal costs.

- high loading rates per unit of reactor volume.

Balancing these significant advantages are the need to monitor the process more thoroughly to avoid upsets and to cover the tanks to contain odours. In some locations in NZ, it has been found that anaerobic lagoons can be used if covered by a scum blanket which acts as a biofilter for treatment of odours. Because of the reasonably close proximity of urban and other development, and the often still air inversion layer effects in the Kaikorai estuary area, covered tanks with full odour control systems would be incorporated.

A number of high rate anaerobic treatment processes have been developed over the past 15 years but will not be discussed in this study. The anaerobic contact process is the mostly widely used in NZ, after simple anaerobic lagoons, with at least five major examples.

The distinguishing feature of the anaerobic contact process is the use of an external clarifier to separate the biomass and return it to the reactor. Sludge separation is made more difficult by biogas buoying of solids and temperature/density currents. Consequently vacuum degasification or air stripping devices are used to remove the biogas prior to the clarifier.

Alternatively, lamella plate separators can be used which deflect biogas up the underside of each inclined plate allowing solids to settle on and slide down the upper surface of the plate, unhindered by the rising gas bubbles.

Expected treatment performance after the anaerobic clarifier would be about 80% for SS, 85% for BOD_5 and 90% for O&G which result in a final effluent quality about 180:180:90. An effluent quality better than 50:50:50 could be achieved if a trickling filter or aerated lagoon was installed after the anaerobic process. This anaerobic/aerobic concept has been used for the cost estimates.

Two stage Aerobic Trickling Filters (ie, Biological Filtration)

In order to obtain the required removal percentages from the high influent strength wastewater, two stages would be required for any biological secondary treatment process.

The trickling filter is well proven for higher strength wastewaters and requires significantly less energy to operate than suspended growth, activated sludge processes even with double stage pumping.

Four towers, each of approximately $1500m^3$ media capacity, 19.5m diam and 5m plastic media height, would be required. Two parallel trains would operate with two towers in series and interstage pumping. The first stage would be loaded at 4 kg BOD_5/m^3/day and 50 to 60% BOD_5 removal could be expected. The second stage loading would be 1.6 kg BOD_5/m^3/day in order to achieve an 80% BOD_5 reduction resulting in final effluent qualities about 90 g/m^3 for SS and BOD_5 and 50 g/m^3 for O&G.

The towers would be covered and ventilation air extracted to a soil biofilter for odour control.

10.4.14 Green Island - Summary of Treatment Upgrading

The relationship of costs to increasing level of treatment, as indicated by removal of suspended solids, is shown in Figure 10.4.8.

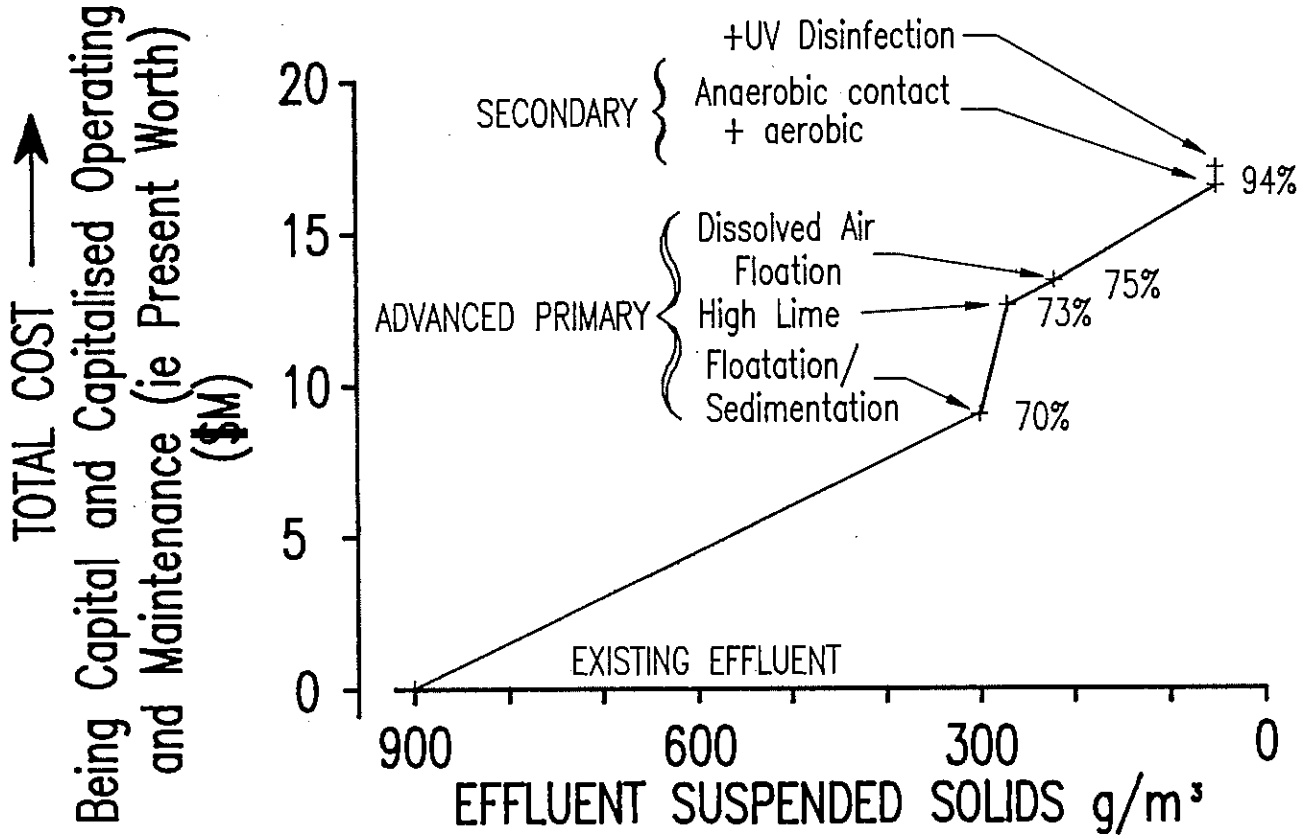
At this Preliminary assessment stage, an upgrading strategy for Green Island could encompass (refer also to Table 10.4.4)

- existing grit removal and 1mm milliscreens would be appropriate pre-treatment for any subsequent treatment process.
- a significant improvement in effluent quality could be achieved by proceeding with the original concept of advanced primary teatment using high rate floatation/sedimentation tanks after the milliscreens. The fine bubble aeration devices should achieve substantial removal of grease and fat as a float on the surface of the tanks.
- if control of microbiological pollution was sought, then the most appropriate process would be dosing with lime to pH 10.5 or 11.0 to achieve disinfection. In addition, lime coagulation would occur and additional removal of solids would take place in a clarifier.
- if biological secondary treatment was required, then further consideration should be given to the anaerobic contact process which can remove most of the high strength load in an efficient manner.
- if required, an aerobic secondary stage could be added to obtain an effluent quality of about 50:50 ($SS:BOD_5$).
- an alternative secondary treatment concept would be two stage trickling filters with intermediate and final clarification producing an effluent quality of about 90:90.
- UV disinfection could be added after secondary treatment but while results on a 50:50 effluent would be better than for a 90:90 effluent the inherent colour and other components due to the meat works will limit the effectiveness of UV disinfection.
- treatment upgrading should be considered along with the option of extending the 500 m long outfall.

ESTIMATED COST Vs SUSPENDED SOLIDS LEVELS IN EFFLUENT

FIG 10.4.8

Existing and Upgrading Options for Green Island Catchment (Excluding Fortex)
Percentages Indicate Average Solids Removed



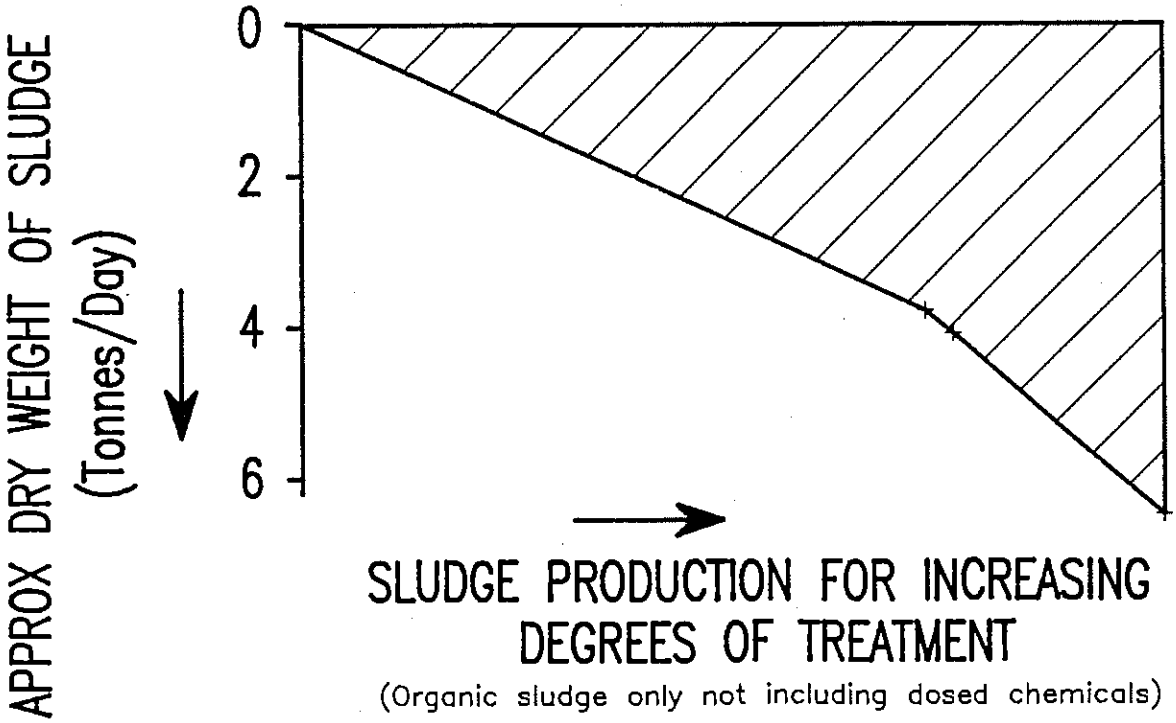


TABLE 10.4.4 :
COMPARISON OF TREATMENT PROCESS OPTIONS FOR GREEN ISLAND

Treatment Process	Discharge Location	Effluent Quality (Average) g/m^3			/100 m	Estimated Treatment Costs[(i)]	
		SS	BOD	O&G		Capital [(i)]	pa O&M[(i)]
Existing Milliscreen	Existing Outfall (500 m)	900	1200	470	10^7	-	0.5[(ii)]
Advanced Primary Floatation/ Sedimentation (Entrained Air)	Existing or Long Outfall (1100 m)	300	700	150	10^6	2.0 (3.9)	0.55 (1.10)
Dissolved Air Floatation	Existing or Long Outfall (1100 m)	220	500	100	10^6	3.8 (6.6)	0.75 (1.50)
High Lime + Sedimentation	Existing Outfall	270	600	130	10^3	3.0 (5.4)	0.75 (1.50)
Secondary 2-Stage Trickling Filters	Existing or Long Outfall	90	90	50	10^6	7.6 (13.2)	0.85 1.60)
Anaerobic Contact + Aerobic	Existing Outfall	50	50	30	10^6	9.0 (15.3)	0.65 (1.30)
+ UV Disinfection	Existing Outfall	50	50	30	10^3	9.5 (16.0)	0.70 (1.40)

Notes: (i) Capital and O&M costs estimates are for nett additional processes and include sludge processing and disposal and other residuals management. The flow versus strength data is very limited to date and hence cost estimates are uncertain. Totals in brackets include Fortex.

(ii) Includes Green Island catchment pumping.

10.4.15 Harbour Basin - Port Chalmers Treatment Plant

Existing Processes and Limitations

The domestic sewage and industrial wastes (85% and 15% by volume respectively) are treated in a secondary treatment plant situated in the suburb of Sawyers Bay, prior to disposal through a short outfall into the edge of the adjacent Sawyers Bay.

High strength tannery wastes are pre-treated by primary sedimentation and application over a "roughing" biological filter designed to reduce the organic strength of these wastes to a level closer to that of domestic sewage. The effluent from this pre-treatment system, which can be recirculated over the roughing filter, then joins the main (domestic) sewage flow at the primary sedimentation stage.

Low strength industrial wastes and domestic sewage (from the population of approximately 3000), are treated by primary sedimentation followed by secondary treatment using biological stone media trickling filters and secondary sedimentation.

Solids (sludge) and scums collected within the system are anaerobically digested with gas produced used to heat the digesters. The resulting inert sludge is then consolidated, airdried on open beds and disposed to landfill. Whilst making up only 15% (approximately) of the total waste flow by volume, trade wastes handled at Port Chalmers represent approximately 30% of the strength of that influent.

The plant has not been consistently meeting the existing water right conditions. Thus, if the plant remains at this location an upgrade will be essential to meet the water right and a longer outfall will be necessary to achieve effluent dilution. However, the tanning operation at Sawyers Bay is likely to reduce primary tanning and hence less high strength wastewater will be received by the plant. Tanning operation reduction is planned to occur before the end of 1991.

Some odour complaints have been received occasionally. These are usually connected with sludge transfer to the digester or sludge on the sludge drying beds.

Upgrading Proposals

It is suspected that primary effluent can be bypassed to the outfall through a common pump well and simple modifications are planned to overcome this problem.

With the reduced load on the plant when the tanning operation is scaled down, a better effluent quality should be achieved which complies with the Water Right.

However, if the influent load remains high and/or the final effluent quality exceeds the Water Right, additional treatment capacity will be needed. Rather than providing extra treatment units in parallel, a more reliable effluent quality will be achieved by retrofitting a "solids contact" tank after the trickling filters. The overall concept is known as the Trickling Filter/Solids Contact process (TF/SC). It has been found to be economical and very stable in a number of full scale plants in the USA and is the process recently adopted for the Wellington Wastewater Treatment Plant.

An aerated short retention tank (less than 30 minutes) is provided immediately after the trickling filter. Secondary clarifier sludge is recycled to the solids contact tank which acts as a suspended growth activated sludge process.

The main benefit of the process is the accumulation of finer colloidal solids into the floc resulting in final effluent qualities better than 20:20. Enhanced performance can be achieved by using a flocculator clarifier to ensure low solids in the effluent. An assessment of the detailed modifications required would be carried out in the Stage 2 study.

Even if the outfall is extended to the main Harbour Channel, discharge on the outgoing tide may be a desirable objective. An effluent holding tank would be required to store the six to eight hours of flow between discharge cycles. This is likely to require some extra pumping. This tank would be aerated to promote further treatment as occurs with the Broad Bay holding tank.

The estimate to upgrade this plant has allowed for the solids contact, and effluent holding tanks, and the extended outfall to the main channel.

UV disinfection would be an appropriate method if reduced microbiological concentrations are required in the future. This is included in the estimates as an additional upgrade.

10.4.16 Harbour Basin - Burkes Treatment Plant

Existing Treatment Processes

This small compact secondary plant handles a population of 550. The plant is a variation of the activated sludge process, called contact stabilization, and discharges continuously into the Otago Harbour. A high rate of dilution occurs at the edge of the well flushed main channel. Sludge produced is aerobically digested and then tankered to the Tahuna plant for incineration or dewatered on-site in drying beds.

The plant is from time to time subject to hydraulic washout of the activated sludge by uncontrolled excessive inflows of stormwater into the sewerage system.

Upgrading Proposals

The most effective way of overcoming the hydraulic washout problem would be a flow balancing tank at the inlet to the plant (assuming stormwater inflow cannot be remedied in a cost effective manner).

Present average flow is about 2 l/s and if maximum flow through the secondary treatment compartments is restricted to 4 l/s, the excess up to the design peak wet weather flow of 12 l/sec ie. a net 8 l/s would need to be stored in the balancing tank.

Deciding on the volume of storage would require an investigation into the frequency and magnitude of peak flows. As a starting point a storage volume of $300m^3$ has been assumed which would enable a ten hour duration peak flow to be stored. If 6m deep, a tank of 8m diam. would be required. The balancing tank could be positioned over the existing sludge drying beds. Sludge would be tankered off site to Tahuna or another facility with upgraded sludge handling capability.

If an ebb tide discharge was required, the peak flow balancing tank could be used for holding of effluent with changeover of automatic actuated valves based on inlet flow sensing.

The estimate for upgrading allows for the balancing tank.

UV disinfection would be an appropriate method of reducing microbiological concentrations if this was a future requirement. Like Port Chalmers, this is seen as an additional upgrade.

Consideration is given in Part 10.2, (Conveyance) to options where this plant is abandoned completely and wastewater transferred to either the Port Chalmers or Musselburgh catchments.

10.4.17 Company Bay Treatment Plant

Existing Treatment Processes and Limitations

The plant is located on the rural edge of the suburb of Company Bay. Domestic sewage from Company Bay and Macandrew Bay communities is comminuted and then pumped into a primary sedimentation tank (actually half a Clarigestor unit which removes 60% of solids) and thence over a trickling filter. The filter effluent passes to the other half of Clarigestor, where biological

solids are removed prior to discharge into the harbour at the centre of Company Bay via a short outfall.

Sludge from two settling chambers passes into the bottom of the Clarigestor tank, where it undergoes anaerobic digestion. Excess digested sludge is withdrawn and tankered to the Tahuna plant for disposal, whereas previously it was air dried to open beds onsite. This, however, created significant odour problems and has been discontinued.

On occasions the plant becomes hydraulically overloaded by stormwater diluting the sewage and causing large flows through the clarigestor. These higher than design flows cause solids in the final sedimentation tank to be re-suspended and carried into the outfall.

The end of the short outfall is just below low water in the middle of Company Bay. Effluent initial dilution is poor and likely to recirculation in the bay. However, monitoring shows generally acceptable counts of faecal coliform bacteria in the shore-line harbour water when compared with 200FC/100ml bathing water standard.

Upgrading Proposals

If the treatment plant is retained then provision of a separate secondary clarifier with optimised features for that purpose and a solids contact tank would ensure better effluent quality reliability. The concept is the same as proposed for Port Chalmers (Trickling Filter/Solids Contact - TF/SC).

The clarigestor would be used solely for primary sedimentation and excess secondary sludge would be recycled to the clarigestor for co-settling and sludge stabilisation.

Having two separate clarifiers would allow one to be taken out of service while still maintaining treatment to a reasonable standard.

An effluent holding tank would be installed to allow for ebb tide discharge over a four hour period. The cost estimates allow for the TF/SC process and the effluent holding tank.

An additional allowance is made for UV disinfection if this to be adopted.

In section 10.2 (Conveyance), the options for decommissioning of this plant and conveyance of the wastewater to either Grassy Point, Port Chalmers Outfall or the Mussellburgh catchment are discussed.

10.4.18 Broad Bay Treatment Plant

The domestic sewage from approximately 1,000 persons in the suburbs of Portobello and Broad Bay, is pumped into a concentric circular tank, in which it undergoes secondary treatment by the extended aeration activated sludge process. After removal of bioliogical solids in a clarifier the effluent passes to a holding tank. The tank discharge is time controlled such that effluent enters the harbour waters only during outgoing tides over a period of 4 hours. The effluent travels 2km to the outfall which is located 120m off the end of Grassy Point and initially dilutes into 6m water depth at the middle of the eastern channel. The cross channels which convey the effluent to the main harbour channel (by tidal outflow) are located adjacent to the discharge site.

Upgrading Proposals

This plant produces a reliable effluent quality about the 25:25 standard and no major treatment upgrading would be required.

UV disinfection would be effective on the present effluent quality and a separate allowance for this upgrade is shown in the cost estimates.

10.4.19 SUMMARY OF HARBOUR BASIN UPGRADING OPTIONS AND ASSOCIATED COST ESTIMATES

Without any firm direction from the harbour study that is still in progress, the above upgrading options for the harbour basin are formulated on the premise that with a consistent effluent standard of around 30 g/m^3 suspended solids and 30 g/m^3 BOD_5 and with effluent being discharged into well flushed parts of the harbour, including ebb tide storage, then this could be an acceptable standard from a water quality viewpoint. Statistical definitions are, however, required for effluent standards, rather than absolute limits. This is discussed in Part 10.10.

If, however, microbiological standards are also considered to be of prime importance even after allowing for mixing zones within the receiving waters, and this may be the case with the significant boating and other recreational use in the harbour, then effluent disinfection using UV light irradiation is the appropriate additional treatment process contemplated.

Estimates have accordingly allowed for this.

Table 10.4.5 summarises the cost estimates for upgrading options for remaining in the harbour basin (HB), as discussed above.

TABLE 10.4.5 : Summary of Harbour Basin Upgrading Options and Cost Estimates

Ugrade/ Allowance in Estimates	Capital Cost Estimates $M				O&M Cost Estimates pa $M				Included in Harbour Basin Option Numbers	Included in Represent-ative Total Schemes
	PC	B	CB	BB	PC	B	CB	BB		
Treatment upgrades to meet 30/30 (SS/BOD_5) effluent includes ebb tide discharge system for PC & CB	0.78	0.36	0.46	0.05	0.040	0.010	0.020	0.003	HB1a	1/I to 1/VI inclusive
Extra for UV Oisinfection	0.07	0.04	0.04	0.05	0.01	0.004	0.007	0.007	HB1b	1/I to 1/VI inclusive if UV disinfectio n

Finally, it is recorded that while the above stance has been taken in consideration of upgrading existing harbour discharges, it is acknowledged that no options have been included that look at nitrogen removal treatment. Wile the issue of eutrophication has been raised in the harbour study and nitrogen has been suggested to be the limiting nutrient (rather than phosphorus), there is as yet no firm evidence to suggest that such extensive treatment measures are needed if the discharges remain into the harbour. This approach taken is on the proviso that providing well treated secondary effluent (maybe with disinfection) is discharged into well flushed parts of the harbour, then treatment for nitrogen removal is unlikely to be required.

The Council awaits the outcome of the harbour study to confirm whether or not the approach taken by Royds Beca in this Stage 1 scoping report is appropriate, or if in fact nitrogen removal is needed regardless of the discharge locations.

It is hoped by Council that if this option needs to be evaluated as an alternative to the above upgrading options and/or the option of conveyance out of the harbour basin, then this is clearly established as an outcome of the harbour study just as soon as possible. This should be before the terms of reference for the Stage 2 options study are finalised.

If nitrogen removal is required then the option identified by Royds Beca as the one most likely to be the preferred environmentally, is to convey all harbour basin secondary treated discharges to the Port Chalmers plant site where the tertiary nitrogen removal treatment would be located, with discharge out the new outfall. The new outfall as previously proposed is into the main channel out past Beacon No 5, with ebb tide discharge control as previously discussed.

However, the options of conveying Harbour Basin wastewater to the Musselburgh Catchment or to land disposal are likely to have similar overall costs and to require detailed investigations in Stage 2.

10.5 RESIDUALS MANAGEMENT

10.5.1 Introduction

The general principles and options for residuals management have been outlined in section 2.7. For each of the treatment sites under consideration, the relevant residuals management methods will be discussed in the following sections.

The residuals (or by-products) arising from the treatment of wastewater include:

- sludge
- screenings and grit
- ash
- odour
- noise
- air emissions

10.5.2 Musselburgh Pump Station

The operations proposed for this site are the continuation of pumping and the removal of screenings and coarse grit from the flow at the inlet to the pumps.

Large objects are removed at present by the 50mm gap coarse bar screens but are then disintegrated and returned to the flow. Fine screens (1-3mm gap) are proposed to replace the existing coarse screens to remove the plastic strip items in particular. However, due to the large gravity flow catchment upstream of the MPS, the larger organic solids will be removed with the inert debris. Such organic solids would cause the screenings to be offensive and putrescible if held on site for a period.

Consequently, a disintegration or washing of the screenings would be required, followed by dewatering by an inclined drainer screw or small milliscreen. Further dewatering would take place in a screw press or equivalent before feeding into a covered skip for transport to a controlled landfill.

Burial in a restricted access landfill is seen as the most satisfactory method of screenings disposal. Plastics now form a significant proportion of screenings. Incineration of screenings would require special features to avoid an air emission problem.

Enclosed screw conveyors can now be used for screenings handling to avoid spillage which can occur with belt conveyors. In addition, the enclosed tube can be vented to an odour treatment system which is likely to be a soil biofilter handling extract air from the wet well and forebay areas as well. Removable covers would be fitted over the screens for odour confinement.

If disintegration is continued, these units would be fitted with noise control hoods. Measures are also being taken to reduce the noise created by the diesel engine exhausts which are above acceptable levels at present. It is planned to install standby diesel generation sets to replace the diesel engine pump drives. The standby power sets will be housed in a properly designed soundproofed room. The substantial superstructure of the pump station itself provides inherent noise control but some attention to details such as double glazing of windows may be required.

Grit accumulates in the forebay area particularly during peak flow events. This grit has to be manually removed at present to prevent jamming of the coarse bar screens. Some types of fine screen could remove the 3 to 4mm size grit which is the dominant fraction. If a fine screen is selected which couldn't handle the grit successfully, then grit traps could be installed with submersible pumps, for automatic removal of the grit. Such pumps would have hardened steel

casings for this duty. A conventional grit washer with an inclined screw conveyor would be used to dewater the grit. For odour control and aesthetic reasons the grit washer would be installed inside a small building which could also house the reception facilties for septic tank and grease pit tanker discharge.

To summarise, future residuals management improvements at Musselburgh should concentrate on the automation and enhanced efficiency of screening and grit removal. These operations already occur on site to some extent. Multiple mechanical equipment items should be provided to ensure continued processing when one unit is out of action for servicing.

10.5.3 Tahuna Treatment Plant

While the treatment processes at Tahuna have been covered, odour and noise emissions have caused complaints from time to time. The odour emissions have substantially abated following the commissioning in early 1991 of a large soil biofilter for odour treatment of the extract air.

The sludge incinerator at Tahuna is the only one in NZ although there are many installations overseas. Particular operating problems have had to be overcome to achieve the present reliable operation. However, the processing of sludge is reliant on a single sludge thickener which if out of service for more than 24 hours, means that the primary sedimentation tanks have to be bypassed to avoid accumulation of the sludge. If the single incinerator is out of service, sludge can still be dewatered on a belt press for cartage off site to landfill. However, there is no spare belt press capacity, particularly when major maintenance is required.

Consequently, in future upgrading of the plant, priority must be given to provision of multiple sludge processing units for reliability and alternative methods of sludge processing in emergencies.

Parallel sludge thickening could be achieved by gravity belt thickeners which are similar in construction to the existing belt presses but are capable of higher throughputs. Vertical screw type thickeners are also now available which occupy much less space. With the fine screening and grit removal proposed for other improvements, centrifuges could be reconsidered for both sludge thickening or dewatering duties if space restrictions dominate.

The present sludge handling capability is marginal due to the limited hours of incinerator operation overnight to avoid a noise nuisance after 11.00pm. If the noise emission points are controlled, then 24 hour operation would be possible with extra operating costs resulting from additional shift staffing levels. As the treatment standard is improved, the sludge volume will be significantly increased. The capital cost of a second incinerator would be high and alternatives such as rotary drum sludge driers and raw sludge dewatering with or without lime stabilisation need to be considered. The preliminary cost estimates have allowed for sludge driers with appropriate multiple equipment items for reliability.

Rotary drum driers are used in meat industry rendering plants in NZ and have been recently introduced for sewage sludge drying overseas. A 90% dry solids sludge pellet is produced which is stable and could be used immediately or stored for later reuse. The temperatures achieved by the drier ensure destruction of the microbiological contaminants. Control of odours would be essential.

Normally, the driers are direct fired using natural gas or LPG, the latter being the only available option in Dunedin. The operating cost could be perhaps reduced by exchanging the incinerator exhaust heat to the inlet air for the drier. At present, a water scrubber is used to cool the incinerator exhaust. The second stage cooling water is close circuited with water to air open cooling towers and is the source of chlorine odours stripped from the cooling water.

The drier exhaust air, like the incinerator exhaust at present, could be diluted by the main building air extract air and fed to a soil biofilter for odour control. In this way, combustion products and odour emissions can be controlled.

As a general principle, local covers should be provided over processes which release odour. This measure ensures better confinement of odours and results in an improved working environment within the plant. If these processes are left unconfined in a building, the extract ventilation rate must be increased and the handling and treatment of large air volumes becomes costly.

To summarise, the current proposals to increase the sludge incinerator throughput by providing a larger fluidising air blower should proceed, together with the hydrocyclones for ash removal. Planning should commence for additional parallel sludge thickening and dewatering equipment to ensure reliability of sludge processing.

The odour and noise control programme as currently envisaged should also proceed, involving:

- extended installation of Ecolo deodorisers (chemical oxidising spray)
- noise attenuation of fans to allow 24 hr incinerator operation
- activated carbon filters on incinerator room roof exhaust fans
- carbon monoxide incinerator combustion control in addition to than the present excess oxygen control.

With the success of the diversion of incinerator exhaust to the soil biofilter, there is little need to increase the height of the incinerator stack. Replacement of the incinerator exhaust water scrubbing cooling tower could be deferred until a detailed study of the sludge drying option is undertaken.

10.5.4 Southdale Road Treatment Plant

Treatment processes on this site other than final clarifiers would have fibreglass hoods over each tank. Extract air would be subject to odour treatment, eg, a soil biofilter or chemical scrubber.

Sludge processing could be either by anaerobic digestion in closed tanks with sludge being composted or trucked to a landfill after dewatering, or by rotary drum driers to produce a 90% dry solids pellet for reuse. Alternatively, lime stabilisation of raw or digested sludge could be considered. The preliminary cost estimates have allowed for the anaerobic digestion option.

Noise producing equipment would be housed in buildings or provided with local covers to avoid noise intrusion in this semi-rural area.

10.5.5 Green Island

At present the screenings are buried on site for decomposition and possible later mining as a humus source. Some natural dewatering takes place by drainage. Upgrading measures would involve a screw press for screenings dewatering to allow for ease of handling and disposal.

A significant increase in solids will result when a floatation/sedimentation process is installed and these solids will require dewatering by a centrifuge in view of the high fat content which could cause problems for a belt press. These solids could then be lime stabilised to prevent release of odours, and landfilled or applied to arable land as an organic supplement.

Extract air from the plant is presently discharged via a stack. At the junction manhole downstream of the plant where the Fortex pipeline joins the plant outlet pipe, noticeable odours are released. The current proposal to install a soil biofilter to treat these odours is appropriate

and provision should be made to extend the biofilter to handle extract air from existing and future processes on the site.

The preliminary cost estimates have allowed for screenings and sludge dewatering and line stabilisation.

10.5.6 Harbour Basin Plants

Generally the plant operations have already been modified to reduce impacts on the local environment eg. ceasing of sludge drying at Company Bay. If these plants are retained in service, then further attention to detail should be pursued to ensure that residuals management have negligible adverse impacts and these solutions generally have low costs.

To provide greater flexibility for sludge processing at the remote plants, a trailer mounted centrifuge for sludge dewatering would save on sludge disposal tanker costs. If the dewatered cake is lime stabilised it could be diverted direct to a landfill thereby reducing the demand on the Tahuna incinerator. The mobile dewatering rig could also be used as an emergency back-up for Tahuna, Green Island and Mosgiel plants. This concept has not been included in the preliminary estimates.

10.6 OUTFALLS FOR EFFLUENT DISPOSAL

10.6.1 Introduction

One of the options for the final disposal of effluent from any of the Dunedin treatment plants is a new ocean outfall, or outfalls, or modifications to existing outfalls.Currently there exist two ocean outfalls (Tahuna and Green Island) and four harbour outfalls (Sawyers Bay, Burkes, Company Bay and Grassy Point) serving Dunedin City. In addition there is also the outfall from the Mosgiel treatment plant to the Taieri River. This section reviews the options along the southern coast and the harbour for new outfall locations. Preferably, an outfall site should be backed by a wide, flat construction area to allow for pipe assembly; the beach and nearshore seabed should be relatively stable and gently rather than steeply sloping; and the eventual disposal point, or diffuser location, should be clear of headlands or other coastal geological features which might interfere with the natural ocean currents sweeping the discharged effluent away from the outfall point.

The geographical limits on the southern coastline have been taken as Brighton to the south and Andersons Reef to the north (just east of Maori Head). In the harbour it is considered that any new outfall to the main channel must lie seaward of a line joining the Broad Bay and Sawyers Bay treatment plants. It is believed that any outfall on the city side of this line would not achieve adequate discharge flushing. This leaves little choice of location for a new harbour outfall other than out from Beacon #5 on the Port Chalmers Peninsula, or between there and the container port area.

10.6.2 Potential Ocean Outfall Sites

The sites which are covered below are shown on Figure 10.6.1

Brighton-Kaikorai Estuary Mouth

This stretch of coastline is physically suitable for an outfall, either short or long, but has several significant detracting elements which cause it to be dropped as an option.

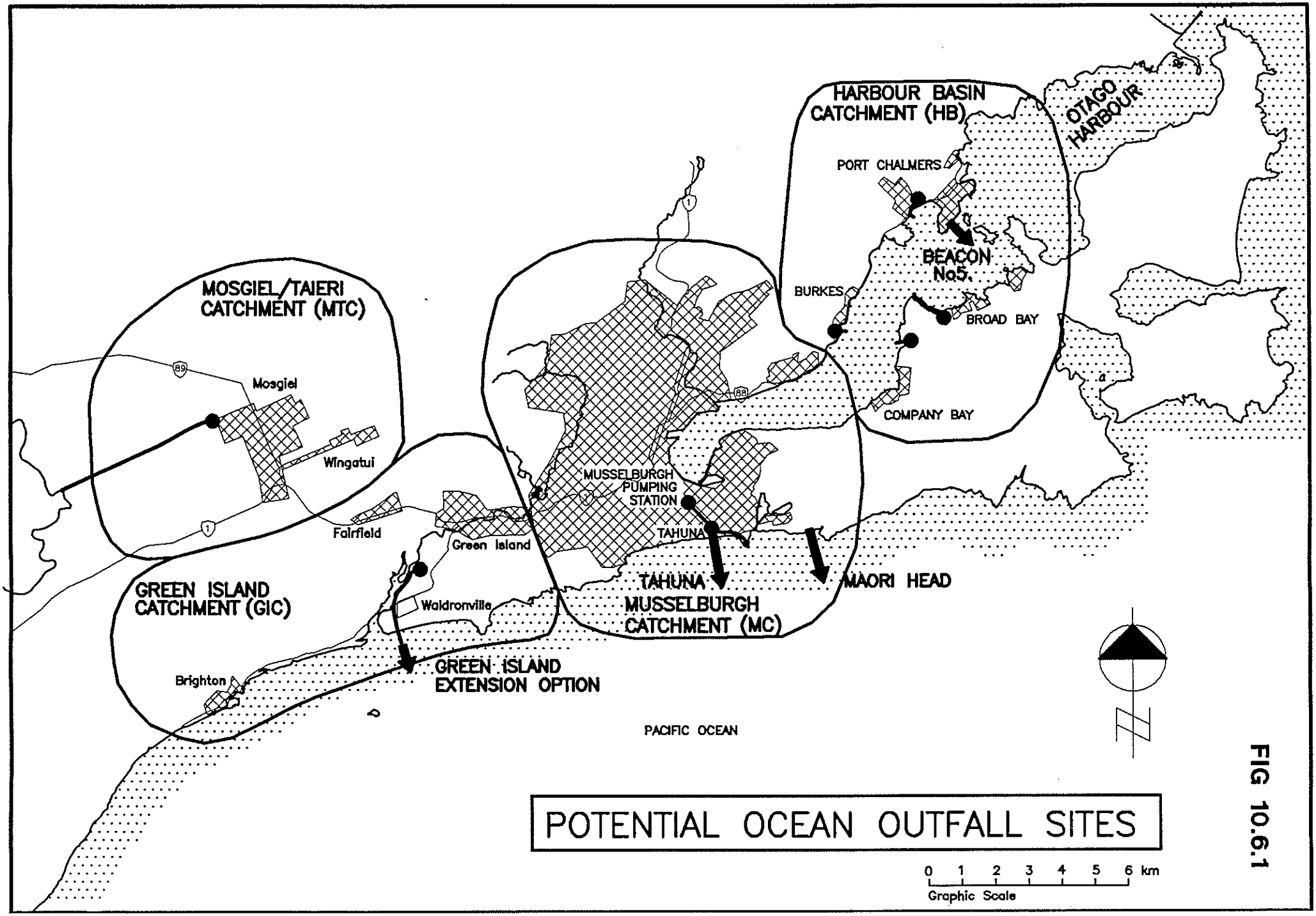

HARBOUR BASIN CATCHMENT (HB)
OTAGO HARBOUR
PORT CHALMERS
BEACON No.5.
BURKES
BROAD BAY
COMPANY BAY
MOSGIEL/TAIERI CATCHMENT (MTC)
Mosgiel
Wingatui
Fairfield
Green Island
MUSSELBURGH PUMPING STATION
TAHUNA
GREEN ISLAND CATCHMENT (GIC)
Waldronville
Brighton
TAHUNA MUSSELBURGH CATCHMENT (MC)
MAORI HEAD
GREEN ISLAND EXTENSION OPTION
PACIFIC OCEAN
N
POTENTIAL OCEAN OUTFALL SITES
0 1 2 3 4 5 6 km
Graphic Scale

FIG 10.6.1

These are:
- the beach is popular with surfers and beachcombers
- effluent may be swept back into the Kaikorai estuary
- there is limited back area behind the beach
- effluent from a long outfall would be swept onto Green Island by the prevailing upcoast currents

Kaikorai Estuary Mouth-Black Head

This length of coastline includes the existing Green Island outfall and was the site of the original Waldronville beach outfall. While it is acknowledged as being a very hostile and active stretch of coast, it is also very physically suitable for an outfall. The existing outfall can be extended probably up to 1000m (another 550m) from the duneline. There is a reef at 800m but this is unlikely to cause construction difficulties. This would address the problems at present which are sand buildup at the diffuser and some pinhead grease being washed back to the beach. The latter may also be remedied by adding an advanced primary stage to the screening plant, as originally conceived.

Since there is already an outfall in place on this length of coast, there seems to be no point in locating a new outfall anywhere else between the two defined limits.

Black Head

This headland has been considered as an outfall location at the time of the Green Island investigations and the same reasons are still valid for not selecting it as an option, with some reasons now even stronger.

They are:
- it is a pristine ecological area
- it is near a popular surfing area and is popular with fossickers
- there is a strong gyre (eddy current) which could sweep effluent from a short outfall at Black Head south back along the Waldronville Beach
- the quarrying operation poses difficulties (short and long term) to the structural integrity of a pipeline to any outfall at Black Head
- there are coastal stability problems just south of Black Head
- conservation of Black Head has become the focus of community concerns
- the geology of Black Head would make tunnelling very difficult

Black Head-Forbury Head (Cargill Castle)

This length of coastline is backed by a continuous line of high cliffs from which it would be impossible to launch or build an outfall. Access for construction and plant to beach level is near impossible. The only apparent option is a tunnelled outfall from back behind the cliffs, but it is believed that the limestone is massively fractured and would not be suitable for the driving of a shaft and tunnel. While this outfall construction technique is used overseas it has not been carried out in New Zealand and would need mobilisation of offshore specialist plant.

Forbury Head-Lawyers Head

The two most popular Dunedin Beaches, St Clair and St Kilda, comprise this length of coastline. At the northern most end is the existing outfall from the Tahuna Plant. Although the seabed conditions are generally very similar for this sector of the coast, the most suitable location for a new outfall is in the vicinity of the Tahuna Plant, most likely to the east where the beach is

backed by John Wilson Ocean Drive and the golf course. There is no real constraint on outfall length which would be determined by the level of treatment and oceanographic studies.

Lawyers Head

The greatest advantage which Lawyers Head has as an outfall location is that there is an existing tunnel for the Tahuna discharge. While the quality of the present discharge has been criticised, it could be treated to a much higher standard which may be acceptable to discharge through the existing outfall with little modification. Lawyers Head is, therefore, retained as an outfall location option. Regardless of effluent quality Lawyers head does not permit "shoreline separation" should the need for such separation be a key decision factor.

Lawyers Head-Maori Head

There are two beaches between these prominent headlands from which a new outfall could be built, namely Tomahawk Beach and Smaills Beach. The first is more accessible and has suffered a lot from the proximity of the Lawyers Head outfall. The preference is, therefore, to choose Smaills Beach as the launching point for an outfall which would extend obliquely out beyond Maori Head to reach the strong longshore current which sets to the east most of the time. Another advantage of this site is that one of the possible sites for a new treatment plant is up the valley behind Smaills Beach, along Southdale Road.

East of Maori Head/Andersons Reef

In the mid 1960's a study was carried out as to the suitability of Andersons Reef as the site for an outfall; in the end it was not recommended. There was no certainty that effluent would not be carried back onto Smaills Beach. Certainly access to the shoreline is difficult and construction of an outfall would have been a challenge although construction was not a consideration at that time. The coastline east of Maori Head is also rugged and would pose severe difficulties in piping effluent to an outfall and in construction of an outfall. For practical engineering reasons, therefore, it is considered that there is no reason to consider any locations up the coast from Maori Head for a new outfall.

10.6.3 Potential Harbour Outfall Sites

Of the four existing harbour outfall sites, only the one at Grassy Point can be considered adequate when evaluated on the grounds of shoreline separation and good dilution, given that discharge is only made on the outgoing tide. Two of the other three outfalls are either very close to the shore into inter-tidal shallows or into poorly flushed inlets (or both). Burkes discharges into the edge of the main channel and consequently reasonable dilutions could be expected. Any outfall for effluent to the harbour should ideally be to the east of Port Chalmers, preferably only on the ebb tide to allow the effluent to be swept well down the harbour by the outgoing tidal stream before the tide turns.

The locations assumed for harbour outfalls in this study are at Grassy Point (existing) or at the west end of the Port Chalmers Peninsula (Beacon #5). Alternatively, the existing outfalls should be modified as follows:

- Burkes outfall extended to the main dredged shipping channel
- Company Bay outfall rerouted around to Grassy Point
- Sawyers Bay outfall extended across the Bay to Beacon #5 (the main channel) or between there and the Port Chalmers Container Terminal.

10.6.4 Outfall Design and Construction

An ocean outfall may be any length from a few metres (discharging at or just below mean tide level) to several thousand metres long, the latter often discharging into water depths of 50-100m or more depending on the bathemetry. Shoreline discharges such as that at Lawyer's Head are not usually described as outfalls, the generic term mainly being applied these days to purpose-designed offshore structures such as the one at Waldronville for the Green Island Scheme.

There are three main sections to an outfall (see Figure 10.6.2):

(a) the landline section of pipe from the treatment plant or outfall pumping station to the coastline terminus of the outfall;
(b) the seabed section of pipe (either buried beneath or laid on the seafloor) from the shoreline out to sea; and
(c) the diffuser section which is a section of pipe with many small holes or ports in it from which effluent is discharged (this may also be buried beneath, laid on, or supported above the seafloor).

The location of an outfall and the distance which it must extend from the coastline are determined by a number of factors, namely:

- public and cultural acceptance of the site
- the effluent standard
- public health and water classification requirements
- geography of the locality
- construction feasibility, cost and risk
- longterm security of the pipelines
- construction impacts
- dilution, dispersion and mixing available
- prevailing currents
- offshore seabed profile and material
- wind and wave patterns

Generally, a diffuser is located in sufficient water depth and is so designed to achieve an appropriate initial dilution of the effluent within the mixing zone around it. The effluent is mainly freshwater and is therefore less dense than the receiving saltwaters; the buoyant plume rises from the diffuser ports, entraining clean seawater on the way up. Currents then convey the mixture away from the outfall and further dispersive mixing takes place in the wider ocean reaches.

Construction of outfalls is a major challenge for marine contractors, and it is generally acknowledged that this type of project which covers the interface between the land and the ocean is of high contractural risk. Not withstanding this, there are some very competent outfall contractors in New Zealand who over the last decade have successfully built offshore pipelines using a variety of materials and techniques. The choice of material for an outfall pipeline depends on a number of factors ranging from economics to feasibility of construction, the latter factor often being determined by the physical constraints of a specific site. Material choice is also inherently associated with the method of construction. Some materials which have been used are: steel, concrete, ductile iron, High or Medium density polyethylene (HDPE or MDPE), fibreglass, uPVC or a combination of two or more of these.

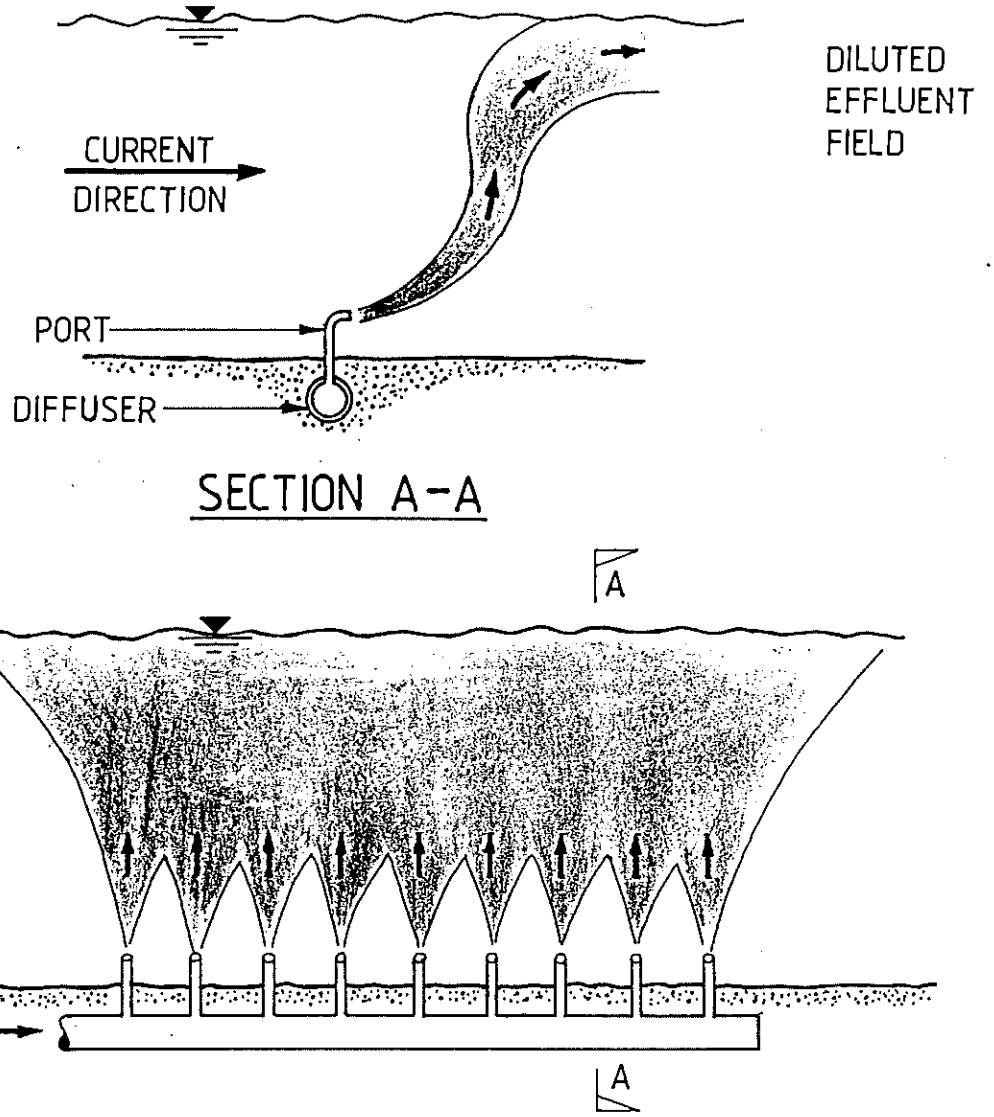


FIGURE 10.6.2 SEA OUTFALL DETAILS.

Construction techniques vary widely, but essentially involve the pipeline either then being laid piece-by-piece or preassembled into discrete but manouverable units and joined together on the seabed. It is quite common for engineers to design the outfall pipeline as it will be required in its final configuration but not specify a particular construction method as specialist outfall contractors are in the best position to know the most appropriate and/or innovative techniques.

10.6.5 Outfall Size and Length

Ocean Outfalls

In estimating the costs for various ocean outfalls at the sites defined in 10.3.1 above, the following assumptions have been made as to pipe material, weightcoating, sizing criteria, initial dilution, pipe burial, diffuser design, and construction details.

Pipe material	: spiral welded steel pipe lengths (concrete lined)
Weightcoating	: prefabricated reinforced concrete, factory applied
Sizing criteria	: velocity at average daily flow > 0.4 m/s
	: velocity at peak design flow < 3.0 m/s
Initial dilution	: average of >100 if not treated to full secondary standard
	: average of >50 if treated to full secondary standard
Pipe burial	: fully buried through the surf zone to water depth of 5m MSL
Diffuser design	: multiport type (50 - 100m long) with horizontal ports
Construction method	: full staging for short outfalls (< 600m)
	: "bottom-pull" method for long outfalls (> 600m) but with staging through the surf zone for greater security of construction.

The one exception to the assumptions given above is the possible extension of the Green Island outfall at Waldronville Beach. This was constructed as twin 800mm diameter HDPE pipes secured to a continuous, articulated concrete base, and there is no good reason why this method, or a similar one, could not be used to extend the twin pipelines further out to sea.

The outfall sizes considered for Dunedin are relatively large, ranging from 1300 mm ID to 1600 mm ID, a range which brackets the new outfall proposed for Wellington City at 1283mm ID. The outfalls for Timaru City and New Plymouth City are 1000mm ID and 900mm ID respectively. With the concrete weightcoat thickness of 100-150mm, the outside dimension of the outfalls considered ranges from 1550 mm to 1950 mm diameter.

It is difficult to accurately assess the length of outfall required at the various sites until a comprehensive oceanographic and environmental study has been carried out. Because of the complex mass-water movements which occur in the coastal waters between Brighton and Taiaroa Head at the entrance to Otago Harbour due to tides, winds, waves and currents, the prediction of the fate of effluent discharged from an outfall off this coast is also very complicated. Many techniques have been used including dye and drogue release, drift cards, physical models, and mathematical or computer models. Common to all these methods, is the length of time required for the planning, fieldwork, current metering, wave observation, data analysis, model calibration and verification. An outfall investigation programme for a new Dunedin outfall could easily take 1 to 2 years, maybe more as seasonal patterns need to be clearly established.

To accelerate the process for this Stage 1 report, the following assumptions were made for outfall lengths. They were based both on local knowledge gained from observations of the effluent field movement from the existing outfalls and on the perception that an outfall which extended beyond the line of the prominent headlands of Black Head, Lawyers Head and Maori Head was more likely to be in the zone of influence of offshore ocean currents rather than of inshore gyres or eddies caused by these headlands (see Figure 10.6.1). This is particularly

applicable to an outfall off the Tahuna Beach, in the western lee of Lawyers Head which extends over 500m from an imaginary line joining St Kilda and Tomahawk Beaches. Similar logic applies to the Green Island outfall, with Black Head casting a pronounced "shadow" over the Waldronville Beach from the viewpoint of inshore coastal water movements.

The preliminary outfall lengths selected for cost estimation are given in Table 10.6.1. They are related both to the specific site (and the considerations outlined above) and the standard of effluent being considered for discharge through them. That is, a primary effluent must be discharged further from the shoreline than a secondary effluent which, in turn, must be discharged further out than a disinfected effluent. While the distances may seem rather arbitrary, they are similar in magnitude to outfall lengths at other New Zealand locations.

Harbour Outfalls

For the purpose of this report it has been assumed that outfall pipes into the harbour will be continuous HDPE pipes dredged, jetted or ploughed into the harbour bed. They will be secured with concrete weights and have multiport diffusers, although the initial dilutions given above would be difficult to achieve in the shallower harbour waters. They would be sized on the same velocity basis as given above.

10.6.6 Cost Estimation for Outfalls

Although it is relatively easy to estimate the material costs of the actual pipeline, there are many more, greater unknown costs involved in putting that pipeline in place. Generally, these costs are determined by the following factors: perceived risk, site exposure to the seas, outfall diameter and length, water depth, weather patterns and construction season (and hence downtime), availability of specialist plant, and the construction method chosen by the contractor or dictated by the site.

For the purpose of scoping options and costs in this report, the experience gained in other outfall projects, investigations, and reports around New Zealand has been drawn on to give best estimates of cost for possible ocean outfalls of various diameter and length, summarised in Table 10.6.1 below. Within the cost estimate for each of the ocean outfall options is a nominal sum of $300,000 for oceanographic and outfall studies.

Harbour outfalls are detailed in Table 10.6.2 . Within the cost estimate for each of the harbour outfall options is a nominal sum of $100,000 for hydrographic and outfall studies in Otago Harbour. This is probably a generous figure and accordingly needs refining if these options are to be considered in the Stage 2 study. The outcome of the Harbour Study and Sawyers Bay Study should assist here.

TABLE 10.6.1
OCEAN OUTFALL OPTIONS AND COST ESTIMATES

OUTFALL SITE	Length (m)	Diameter (mm ID)	Design Flow (l/s peak)	Cost Estimate ($ million)	OPTION
TAHUNA	600 1100 1600	1300 1300 1300	3800 3800 3800	10.0 18.2 26.5	MC2e/f MC2b/c/d MC2a/b
MAORI HEAD	1100	1300 1400 1500 1600	3800 4490 4640 5050	18.2 19.5 21.0 22.5	MC3a/4f
GREEN ISLAND	plus 600	twin 730	840 1250	7.8 7.8	GIC2a/e

TABLE 10.6.2
HARBOUR OUTFALL OPTIONS AND COST ESTIMATES

OUTFALL SITE	Length (m)	Diameter[1] (mm)	Design Flow (l/s peak)	Cost Estimate ($ million)	OPTION
BEACON #5	150	250 HDPE	84	0.350	HB1a/b & HB3a/b
	150	350 HDPE	119	0.450	HB3c/d
	150	350 HDPE	131	0.450	HB2a/b

10.7 LAND TREATMENT AND DISPOSAL OPTION

10.7.1 Possible Techniques

The various techniques available for the treatment of wastewater and/or the disposal of treated effluent using land are described in Part 2.6 of this report and more specific relevant details of the techniques are provided as follows:

Treatment and Disposal Techniques

(a) Rapid Infiltration (RI)

The soil type required is free draining sands and gravels. The groundwater table should be at least 2.5 m below ground level. Pre-treatment of the applied wastewater is mainly directed at the removal of suspended solids. Achievable application rates range from 1000 to 10,000 m^3/ha/day.

(b) Slow Rate Irrigation (SRI)

Treatment and disposal is achieved by the filtering and infiltrating of the applied pre-treated wastewater into and through the surface soil mantle. Most soil types are applicable. The groundwater table should be at least 2.0 m below ground level. Large land areas are involved and the land must be planted in a suitable crop. In the NZ situation, for year round application of effluent, the appropriate crop is forest trees. Typical application rates range from 25 to 115 m^3/ha/day depending on the vertical infiltrative capacity of the soil, the site topography and the particular tree species.

The required standard of treatment is that equivalent to a secondary effluent or to a good oxidation pond effluent or better. Department of Health (1973) recommendations require a secondary effluent or oxidation pond effluent for domestic systems, although nowadays each case is reviewed on its merits. Buffer zones, scheme management and control of public access are important issues in the respect of public health protection.

The soil treatment of the effluent can achieve virtual total removal of most of the residual pollutants. A significant exception is nitrate. This is because the principal removal process is plant uptake and this achieves only about 25% or less removal of the applied nitrogen in the effluent.

Treatment Techniques

(a) Wetlands

Both surface flow and subsurface flow constructed wetlands can achieve good removal of suspended solids and BOD when loaded with a wastewater which has been pre-treated to aerated pond effluent standard or better. However, neither method has been found to be efficient in the removal of nutrients. Typical nutrient removals achieved with full scale plants operating in New Zealand are:

Total nitrogen	-	20 to 30%
Total phosphorus	-	0 to 10%

The systems achieve faecal coliform removals of only about one order of magnitude.

The typical design application rate for wetlands is about 800 m^3/ha/day. Flat land is required.

(b) Overland Flow

This treatment technique has not been used on a large scale in New Zealand. It is generally considered that the treatment standards achieved by the method can be more efficiently done by other means. Evenly graded land areas of gentle slope are required. A typical application rate is about 500 m^3/ha/day.

10.7.2 Suitability for Dunedin

Site Appraisal

A detailed appraisal has been made of the land within reasonable vicinity of Dunedin City (Refer to Figure 10.7.1). This appraisal has established the following:

- there is no land area of sufficient size available with the appropriate soil type for Rapid Infiltration systems (RI) for the entire wastewater from the four catchments.

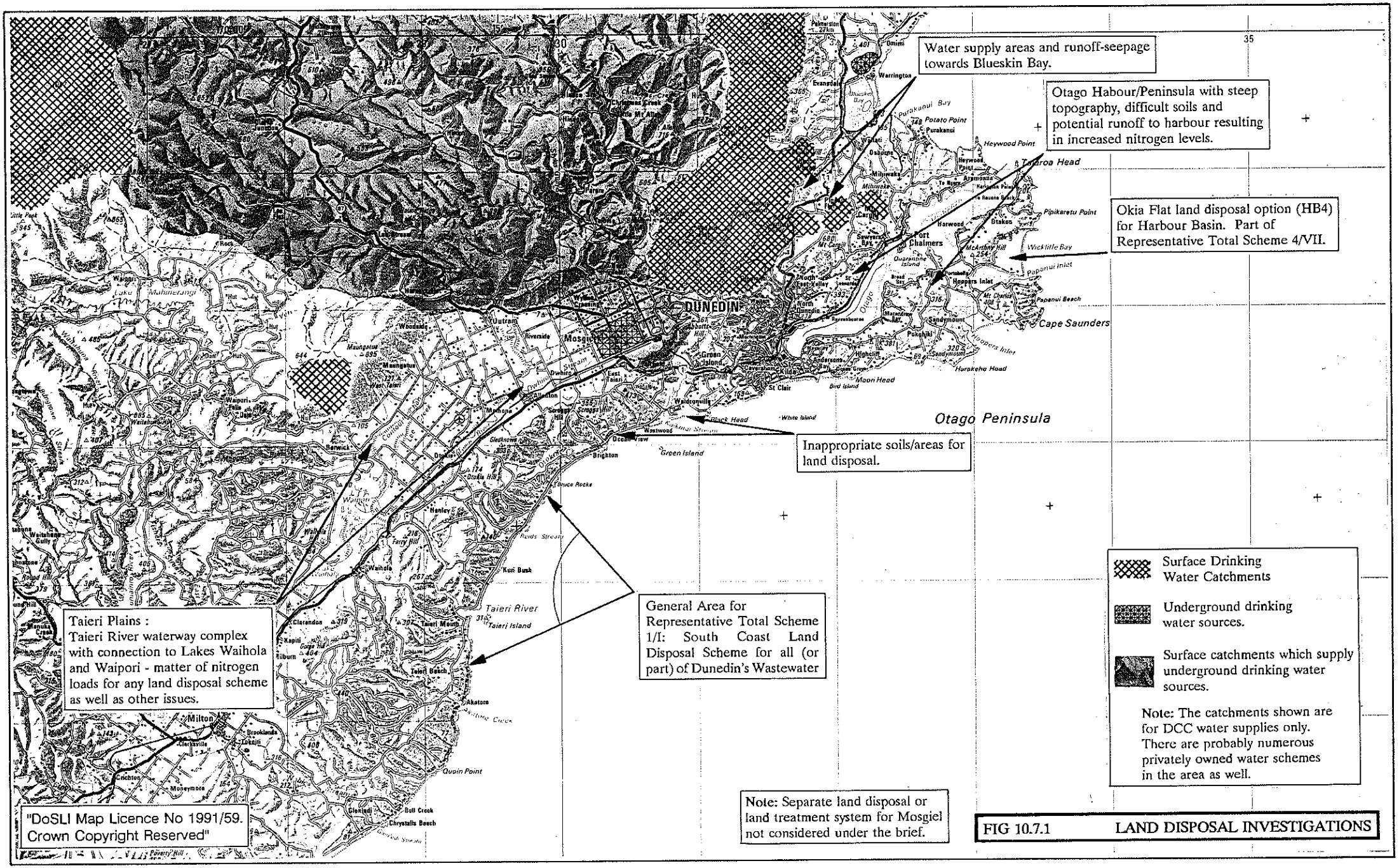


FIG 10.7.1 LAND DISPOSAL INVESTIGATIONS

- large areas of land generally to the west of Dunedin are excluded from use for land disposal because they are drinking water supply catchments.

- the geology of the area is relatively complex and this is reflected in the very variable nature of the surface soils as indicated by the existing mapping and by field observation.

- the Taieri Plain is unsuitable as an SRI site because of the:

  (i) fragmented nature of the land ownership
  (ii) high groundwater level and poor soil infiltrative capacity
  (iii) the potential impact of elevated nitrogen levels in the groundwater and on the Taieri River and Lakes Waihola/Waipori wetland complex (increased nitrate can assist in eutrophication).
  (iv) potential for damaging overseas markets if something went wrong on this highly productive land.

- coastal areas south of Dunedin to Brighton are excluded from consideration because of their known potential for land instability. Other areas are also not desirable from this aspect.

- the Otago Peninsula is not suited to large scale SRI because of its generally steep topography, history of slope instability, small land holdings and because of the Dunedin City town planning restriction on blanket tree planting.

- the slopes of the north western side of the Harbour, and similarly those of Mount Cargill and other areas going northwards including those draining to Blueskin Bay are similarly unsuitable. This is because of:

  (i) the steep topography.
  (ii) the wide variation of soil types
  (iii) the potential impacts of elevated nitrogen levels in the Harbour and Blueskin Bay.
  (iv) the water catchment issue previously discussed.

10.7.3 Concepts of Land Disposal and Treatment Relative to the Options Available

In view of the findings of the site appraisal it is appropriate to review the concepts of just how various options may fit into the total picture of all options, and how options involving for example land disposal and/or treatment of the effluent from only part or a single catchment may be viewed relative to others. The following discussion raises these issues.

Land Disposal

- In evaluating all possible technically feasible schemes it is appropriate that a single land disposal scheme to cater for all wastewater from the four catchments (Harbour Basin, Musselburgh, Green Island and Mosgiel/Taieri) be investigated. Such an option has been identified, although extensive investigation would be required to confirm its performance. This single land disposal scheme is a Concept Level One scheme (refer Part 7.3) and is labelled Representative Total Scheme No 1/II. It would be located in the South Coast (forest) areas as discussed below.

  This scheme could be reduced in size to cater for just the Green Island catchment, or this plus the Mosgiel/Taieri catchment. In fact this is likely to be a more practicable scheme in terms of dewatering a suitable area.

Such a scheme would, however, be more expensive in terms of the limited population it served, this principally because of the long conveyance distance (25 to 30 km or more) from the existing Green Island plant. Estimated costs for this disposal option for the Green Island catchment, with or without the Mosgiel Taieri Catchment, have not been determined but can be if required. Again, this scheme, like the Okia Flat land disposal option, caters only for part of the total Dunedin wastewater. Furthermore it raises the issue of the appropriateness of land disposal of only part of the areas wastewater effluent when in such a case, as for Scheme HB4, most would otherwise be disposed of to the ocean. If, however, such a south coast scheme was adopted the existing Green Island outfall could remain in use for discharge of suitable treated trade wastes eg, Fortex and others that could be separately conveyed to it.

- Other land disposal schemes have also been investigated for all or part of a single catchment.

  One option that has been identified is to use the Okia Flat on Otago Peninsula. This is discussed below. It is included as Harbour Basin Option HB4 when secondary treated effluent from the Port Chalmers, Broad and Company Bay plants would be conveyed to this site, with the storage basin located at Okia Flat. Burkes would be conveyed back into the Musselburgh catchment.

- The detailed appraisal which has been carried out has established that except for the possible option which is described in 10.7.4 below there are no areas of suitable land within practical vicinity of Dunedin, considering classification and occupancy, which are large enough to serve the four catchments.

  Land treatment and disposal of wastewater to serve a city as large as Dunedin would be a major project requiring very thorough operational management and restricting land use controls. A scheme of such a scale has not been found to be practicable anywhere else in New Zealand and it is only in a very few locations overseas that appropriate circumstances of land type and use together with climatic conditions have rendered such a system to be viable for a city. The operational management considerations which are quite restrictive mean that it is also not practically feasible to utilise a large number of small blocks of land scattered throughout the region to serve Dunedin. Even in promulgating such a proposal there would be major difficulties in obtaining statutory approvals and resolving land use conflicts. It also would be substantially more costly than a project utilising one single large area. For these reasons the concept of small land disposal areas serving parts of catchments is not a technically feasible option.

New Zealand is dependent on primary industry for its economic stability. The use of agricultural land for disposal of wastewater would require stringent controls to ensure the protection of public and stock health.

Land Treatment

The issue that arises here is that if there was a land treatment option available for any particular catchment, or groupings of catchments, would it offer advantages, from a benefit/cost viewpoint over other forms of "in tank" treatment to achieve whatever the desired effluent standard is that the land treatment scheme was installed to achieve? The answer is probably no in view of the receiving capacity the ocean provides for those options based on ocean disposal. There would, however ,probably be some advantages for harbour discharge effluents if suitable wetland sites for example were available, but they are not within reasonable distance.

For staging of a scheme for Mosgiel, wetland treatment, or even overland flow, may be an appropriate polishing method for the existing secondary effluent and accordingly sites near the

Taieri river or elsewhere in the plains areas may be available. A wetland only has limited micro-biological reduction compared to UV disinfection for example, and is known to increase concentrations of ammonia and reduce dissolved oxygen levels in an effluent.

It is, however, outside the scope of this brief to consider Mosgiel's wastewater other than joining to the other catchment or catchments.

10.7.4 Land Disposal Options

Possible Slow Rate Irrigation (SRI) Site

For the entire Dunedin areas (ie, the 4 main catchments) - Total Representative Scheme XVI (Concept Output level 1).

An SRI system must accommodate wet winter flows. The estimated maximum wastewater flow for a wet week in the year 2050 for the whole of Dunedin's all four catchments is 895,000 m^3 and this is equivalent to an average flow of 128,000 m^3/d. Because of the constraints outlined in Part 10.7.2 above the availability of SRI sites capable of providing for this full Dunedin flow are very limited. However for the purpose of options comparison the following site has been identified as the most appropriate for such a scheme.

Coastal land to the north and south of the Taieri River south of Brighton: this possible land may include part of the Otago Coast forest. The soils in the area are generally yellow-brown earths of poor infiltrative capacity. To accommodate the total Dunedin flow a nett irrigation area of about 3,600 ha would be required. This is based on an average application rate of 25 mm of effluent per week applied on a cycle basis of one application per 7 days. To allow for buffer zones and the provision of a standby block for forest management purposes a gross area of 5000 ha is required. During rain and snow storm events the irrigation of effluent to the land is not possible. To allow for this situation the disposal system must include the provision of effluent storage ponds at the irrigation site. A minimum of about 7 days storage would be required. To serve the whole of Dunedin storage ponds totalling about 900,000 cu.m capacity are needed.

The estimated cost of the land disposal and effluent storage component is $98M, with an estimated annual operating and maintenance cost of $2.8 M.

Screened (or primary settled) wastewater would be conveyed to the land disposal area and an appropriate secondary type treatment plant established in this area. Preliminary considerations are based on Dual Powered Aerated Lagoons and High Rate Biological Filtration options well sited within or near to the land disposal area. Sludge disposal could also be by land disposal within the area and/or landfilling in a dedicated sludge landfill.

Estimated costs have allowed for the above typical treatment requirements.

It must be emphasised that at this stage of the study the option is presented as nothing more than a possibility and the cost and technical feasibility is not at all proven. Should the option be pursued further in the next stage of investigation, this would require the setting up of detailed site investigations to determine the precise areas, the type of application system and buffer controls, management systems and particularly the soil, water, vegetation aspects. Such detailed investigations, including some on site trials would be needed before the scheme could be confirmed as "technically feasible" and the reliability/risk assessment of its performance established. At the completion of this later study which would likely have a duration of several seasons it may well be found that there is insufficient suitable land to accommodate the total wastewater flow.

Possible Slow Rate Irrigation (SRI) Based on Use of Okia Flat - Otago Peninsula

For Harbour Basin Option HB4

The Okia Flat, Otago Peninsula has been identified as a proposed recreation area by the Dunedin City Council. The surface soil of the flat is a fine grained sand of apparently good infiltrative capacity. There are possibly about 50 ha of land available at this site which could be planted in a suitable tree crop and utilised for SRI. The site capacity could be about 70 m^3/ha/day.

This area appears sufficient to take the existing (and likely reasonable future) wastewater loading from the Harbour Basin catchment with or without the Burkes discharge.

The scheme would entail conveyance of Port Chalmers secondary treated effluent across the harbour to join the Company Bay and Portobello/Broad Bay secondary treated effluent which would then be pumped conveyed to Okia Flat over the low saddle into the Papanui inlet area.

While the soil type at Okia Flat well suits this type of system, there are many operational and environmental issues that would need to be thoroughly investigated before such a scheme could be deemed to be acceptable. These would include the matter of any seepage back into Papanui Inlet, which is a valuable shellfish area, the seepage into the ocean and any effects on Victory Beach, the issue of marine life including the yellow-eyed penguins in the areas, any loss of recreation use and other issues.

Estimated costs of Harbour Basin options (refer Part 12.2) put this option into perspective relative to conveying all wastewater out of the Harbour Basin to the Musselburgh catchment.

An effluent storage pond of about 2 days capacity would be required as part of the system. The estimated cost of the actual land disposal scheme including the storage pond is $0.75 M and annual operating cost of $40,000 pa.

It must be noted that only a preliminary assessment has been made of the above two sites. If these options are favoured for further consideration, much more detailed investigation would be necessary before the feasibility could be confirmed.

Wetland Sites

To serve all of Dunedin a wetland of 160 ha nett area would be required. The only area of flat land of this size available in the vicinity of Dunedin is the Taieri Plain. The effluent from the wetland would not be suitable for discharge to the Taieri River unless additional treatment processes were applied to remove nutrients, pathogens and other residual pollutants which may be of concern. A wetland for Mosgiel wastewater by itself on the Taieri Plains may, however, be an appropriate upgrade option if needed. Consideration of this is outside the Stage 1 study brief.

Previous discussion in Part 2.6.5 also relates to wetland systems.

10.8 REUSE OF EFFLUENTS AND BY-PRODUCTS : WASTE MINIMISATION

10.8.1 General

In Part 6.0, which deals with Issues Identification, the issue of reuse is raised not only in an economic framework as a means to reduce operating costs, but also in terms of sustainability of natural and physical resources, the "green image" and the waste minimisation, reuse and recycle philosophy.

Reuse and recycling, as integral parts of waste minimisation are all important community issues nowadays, and accordingly in planning new wastewater management schemes the options assessment must include evaluation of reuse technologies.

In this Stage 1 report the approach taken, consistent with the project formulation and programme, is to scope the reuse options that may be available and comment how various treatment and disposal options being considered include, or could be adapted to include these. In Stage 2 reuse techniques can then be further investigated as part of those catchment options and Total Representative Schemes that are shortlisted for further development and review.

Before scoping the reuse technologies that are available and could be compatible with various wastewater treatment options and disposal options for Dunedin, it should be appreciated that the extra costs to reuse suitably treated effluent and byproducts (sludge, waste heat, etc) outside the treatment plant itself are normally greater than the income that such reuse technologies can attract. With changing cost structures and the likely development of "economic instruments" in waste disposal fields it is likely that reuse technologies will become more financially viable. Other decision factors should, however, be taken into account as well as economics in evaluating reuse possibilities.

As an example of the above, recent studies in Auckland looked at a scheme to supply 30,000 m^3/day of non-potable water from the Manukau sewage treatment plant to the Wiri-Newmarket industrial area. An estimated cost of 79 cents/m^3 to produce the non-potable water in this way was compared with the then present Auckland bulk water price of 67 cents/m^3. By contrast Dunedin City's present industrial bulk water price can be as low as 16 cents/m^3 depending on demand.

10.8.2 Reuse Techniques Presently in Place

The present Dunedin sewerage schemes incorporate the following reuse technologies.

- the Waikouaiti/Karitane sewerage scheme makes some reuse of the irrigation and low level fertiliser value in growing Pinus radiata trees as part of the land disposal scheme.
- the Port Chalmers and Mosgiel sewage treatment plants both use biogas provided from the anaerobic sludge digestors as the principal energy source, by burning it to keep the digestors heated.
- the Tahuna plant uses some of the waste heat from the sludge incinerator to provide heated water for general plant heating.

10.8.3 Reuse of Effluents

In theory, if all the effluent could be reused by recycling there would be no effluent for disposal. There are, however, many considerations that must be fully evaluated in any effluent reuse option. These considerations include:

- technical considerations. While "state of the art" technology does exist they are usually more innovative and unproven than other options.
- economics. The cost of effluent reuse would far exceed the present cost of water in Dunedin, and the use of high levels of technology generally involve substantial capital and operating costs.
- demand, reliability and variation. The demand for reused effluent is usually variable and difficulties result in matching supply and demand.

- reliability of the effluent reuse system

- social attitudes. Policies and practices in wastewater reuse options must be guided by public opinion. For example, findings from USA indicate that the greater the proposed contact with reused wastewater the more unfavourable the proposal was viewed.

- public health risks. There have been many investigations, including extensive epidemiological research into the question of risks from various effluent reuse procedures. It is outside the scope of this report to review these except to record that there are some concerns with some reuse options and regulations. Management and monitoring are all key parts of reuse technologies - for example, there are the Department of Health's guidelines for the land disposal of effluent.

- Maori cultural and spiritual values. These are introduced in Part 6.0 (Issues Identification).

Potential reuse applications in the Dunedin area can be broadly divided into:

- industrial reuse
- agriculture and afforestation
- aquaculture
- potable water
- groundwater recharge

These groups are briefly discussed below.

Industrial Reuse

This could include cooling water, non-potable water and possibly materials transport.

While the present industrial trade waste volumes are reasonably large in both the Green Island and Musselburgh catchments, initial investigations as part of this study have not shown any significant option that would be both technically and economically viable and meet necessary public health requirements.

This comment relates to reusing effluent from Council's sewerage schemes, not to industry's own reuse procedures which by contrast can be economic and sound practice to, for example, reduce nett discharge volumes, hence likely trade waste charges.

Furthermore, it should be appreciated that much of the present trade waste volumes are from food processing industries and hence potable water is required. Also, there are no industries using large quantities of cooling water close by the treated effluent sources.

Agriculture and Afforestation

In general these could include dryland crop irrigation, pasture irrigation, afforestation, energy crop irrigation, hydroponics, wetland crop irrigation and recharge of groundwater.

The land disposal options using afforestation are discussed in Part 10.7. In respect to reuse of effluent it must be appreciated, however, that in the type of systems proposed only 10 to 20% of the effluent volume would be reused or lost through plant/tree growth and evapotranspiration; the remainder percolates through the soil matrix, reaching natural surface or groundwater. Some use is made of the nutrients although the majority of the nitrogen stays in the effluent itself.

From an economic view point and siting limitations (including environmental restraints) there are not seen to be any extensive effluent reuse options for the major Dunedin volumes. The siting factors discussed in Part 10.7 relating to land disposal generally apply to reuse considerations as well. There may however be appropriate options for all or part of Mosgiel's effluent, but consideration of these is outside the scope of this study. Additionally there may be some limited applications where relatively small quantities could be used where the effluent standard is appropriate for the reuse proposed. Such possibilities should be further considered in the Stage 2 study when the shortlisted scheme options are reviewed in more detail.

Aquaculture

While aquaculture is increasing in NZ, there appears little advantage, and many disadvantages in using treated effluent for this in the New Zealand scene. Furthermore, aquaculture is not a consumptive use of water.

Hydroponics

While the availability of effluent which contains nutrients may appear an attractive source of food for hydroponics, the effluent nutrient levels are low and can be somewhat variable, and trade waste contaminants could be unacceptable.

Furthermore, volumes of effluent used would in all probability be small, again making this possible reuse technology a complementary one to disposal, not a substitute for it.

Potable Water

Reuse of sewage effluent for potable water is in the planning stages in several countries, with recharge to underground aquifers being the most common of the technologies being considered. In some countries, principally the water short countries of South Africa and Israel, these technologies are becoming well developed.

In recent studies in Auckland it has been concluded that "for public health and economic reasons [that] sewage effluent cannot be considered for production of potable water at this time".

In this Dunedin project, investigations to date would support this conclusion, and even more so in respect of the economic considerations, as Dunedin's potable water supply costs are considerably less than Auckland's.

Groundwater Recharge of the Taieri Plains

Notwithstanding the above comments with respect to potable water, the Stage 1 study has reviewed the possiblity of artificial recharge of these aquifers by appropriately treated effluent. Accordingly, therefore, this is recorded as a technical possibility for some effluent, may be that from the Mosgiel system for example. Even for Mosgiel, however, it is most unlikely to be a sensible option economically where other options, including conveying to the Green Island catchment are considered.

It is not seen, however, as very feasible for the total effluent volumes from the four Dunedin catchments, nor would it be economic or come into the afforability equation part of this project.

Any scheme would need extensive investigation and the question of public health, and stock health would be high on the agenda of such an investigation.

10.8.4 Treated Sludge Reuse

Sludge is often seen as a valuable resource particularly with its organic, nutrient and trace level composition. While it does have these components and is substantially organic, its fertiliser value is relatively low and is better described as a soil conditioner.

The two key limitations with sludge reuse are:

(i) public health considerations, with pathogenic microorganisms that can accumulate in sludges

(ii) heavy metal levels that can be quite high if certain trade wastes are discharged into the sewerage system, for example the chromium from chrome tanneries.

In New Zealand the Department of Health's 1984 guidelines set limits on storage times and application rates before sludge treated in different ways can be used. Internationally there have been extensive investigations into sludge reuse technologies, and for use on land the setting of appropriate limits and management requirements.

Balanced against the above are the advantages of reuse techniques including composting, use of treated wet sludge, dry sludge and other land disposal reuse technologies. While they are available for Dunedin, the costs of reuse could outweigh the other methods of disposal. These procedures are introduced in Part 2.7 (refer Figure 2.7.2) and discussed in terms of the options in Parts 10.4 and more specifically 10.5. The option of sludge drying to 90% dry solids is one technology that could have particular merit for the Musselburgh catchment as waste heat from the existing sludge incinerator could assist in the drying process. The dried sludge pellets could be used as a soil enhancing material. The pellets could be used immediately as the temperature is sufficient to kill potentially harmful (pathogenic) micro-organisms. Health and other approvals would, however, be required. This sludge drying option is included in these reviews.

Generation of biogas from anaerobic sludge digestion is a commonly-used technology and as previously indicated is part of the Port Chalmers and Mosgiel Sewage Treatment Plants. The options presented in this report include the sludge management option of anaerobic digestors for a new Southdale Road plant for the Musselburgh and possibly other catchments, and for the Green Island secondary treatment option of contact anaerobic stabilisation. In both these schemes there would be some surplus of gas from the treatment plants' own needs, particularly with the larger system for the Musselburgh catchment. This surplus could be reticulated to a nearby user, eg, energy use of industry, or converted to CNG for vehicle fuel or other use or used to drive a gas fired generator to produce electricity to feed into the Dunedin grid. While such gas uses would provide some income, this would not be sufficiently large to substantially change the relativity of the estimated preliminary operating and maintenance costs presented in this scoping report. These issues can be further processed in the Stage 2 study where preferred options are further evaluated.

Biogas generation from the sludge in a dedicated sludge landfill or in Dunedin's main co-disposal landfill is again another potential reuse technology and one of some interest in future landfill considerations for Dunedin. It is however outside the scope of this report to consider this further now.

Sludge smelting is a "high tech" reuse technology being developed in Japan and also USA particularly where there is very limited, or no, space available for sludge disposal. Bricks, pipes, and aggregates are being made from the smelted sludge.

Sludge-to-oil is a technology in the later stages of commercial development and is being trialled in USA, Canada and Australia.

Incinerator ash can be used for filling and for sub-bases, etc for road construction. The major concern here in ash reuse however is the potential release to the environment of heavy metals that have been accumulated in the ash.

Waste heat use is also a product reuse technology. As previously recorded this is used to some extent at the Tahuna plant, and there is potential for further use of waste heat from the incinerator both within and outside the plant area. One option which has merit and should be further investigated is to use waste heat from the existing sludge incinerator at Tahuna as a heat source for sludge drying at the same plant (refer Section 10.5).

10.8.5 Minimisation of Wastes at Source

The above discussion principally relates to the reuse of treated effluent and other byproducts.

In the hierarchy of waste minimisation the first level is always reduction in the waste production itself. In wastewater this covers two areas of:

(i) reduction in the actual volumes and flows of wastewater - ie, the water part

(ii) reduction at source in pollutant loads and concentration levels

Each of these are discussed relevant to the Dunedin situation.

(i) Reduction in volumes and flows of wastewater

(a) domestic sewage - people need a minimum amount of water for basic sanitation, and figures in New Zealand put this between 90 and 120 litres per head per day. The difference between this and the normal level of around 250 litres (range 225 to 275) is brought about by our life style and clean way of living. Automatic washing machines and dishwashers are, for example, common place. Sink unit garbage grinders (wastemasters) are slowly increasing in use, and these can add to a household water use by 5 to 10%. There is also a slow general upward trend in household water use as standards of living and use of modern appliances increase. Such an increase has been allowed for in the initial scoping studies - refer Part 9.0.

One of the factors that has a bearing on domestic sewage production is the water supply pressure at the point of use as higher pressures add to water use. In this respect much of Dunedin has reasonably high pressures because of the hilly topography.

Notwithstanding the above, a decrease in water use resulting in a decrease in domestic sewage production could be affected by such measures as:

- a high price for water and/or household water metering
- reduction in supply pressures
- dual flush WC's
- extra charges on sink unit garbage grinders or banning these
- better controls on automatic devices such as automatic flushing urinals
- overall public education

It is outside the scope of this report to investigate these in detail and what effect various measures may have. It is noted, however, that in Christchurch and Auckland, where water supply shortages are becoming a problem, domestic water supply reductions of around 20% are expected, more in the peak garden watering

times. The reduction in actual domestic sewage volumes generated is not known but 5% could be quite achievable while 10% would, it is suggested, be difficult. Regardless of this, however, facilities like dual flush toilets have considerable merit. They are now a requirement in new buildings in Auckland.

The important issue for the sewerage scheme however is the total volumes and peak flows. Any small reduction in base domestic sewage volumes and flows will not have a very significant effect on the size of new facilities, especially those such as conveyance that need to be designed on a peak flow rate. They would, however, reduce operating costs and to a small extent sizing of some treatment and disposal facilities. A land disposal area would fall into this category and a direct type of proportion in land area requirements would follow, eg, a 5% volume reduction equates to 5% less land area if the same design basis is used.

The difficulty, however, in sewerage schemes is the base infiltration and inflow that gets into the pipes and manholes, etc, from groundwater and wet weather flow. This increases the peaking factors in the older systems in particular. These reach six times (or higher) the average dry weather flows.

These matters are discussed in some depth in Part 9.0. The key issue here is that the conveyance and part of the treatment systems must be large enough to take these peak flows.

With these peaking factors it is evident that even with 10% drop in the base domestic sewage there is not a large effect on the peak flows.

The more appropriate way to reduce the size of the parts of the sewerage scheme is therefore to reduce the entry of stormwater and groundwater and other unwanted inflows. In this respect Council has its combined sewer programme well in hand and is in the process of appointing staff to investigate illegal and other rainwater entry to the foul sewerage systems.

The results of these programmes are likely to have much greater effect in reducing wastewater volumes and flows, hence the size of facilities needed than a reduction in the base domestic sewage volumes.

(b) trade waste volume reduction - industry often has available to it water conservation methods, in-factory recycling and alternative technologies that can in many cases result in substantial reductions in volumes of trade wastes. Furthermore, flow balancing at the industry itself can reduce the peak discharge patterns. Also, techniques can be used such as night time discharge when domestic sewage flows are low.

As industry usually pays both water supply and trade waste charges it can be to their economic advantage to reduce the water use and hence discharges. Experience elsewhere has shown these reductions can be very significant in some situations. The overall effects need to be considered, in terms of total volumes of wastewater and more particularly for much of a sewerage scheme's requirements peak flow rates. Information on trade waste volumes in this report allow an initial assessment to be made.

(ii) Reduction in pollution load

While there is little that can be achieved in the domestic area to reduce the mass load of pollutants, especially suspended solids, BOD_5, oils and greases; limits on sink garbage grinders (10% increase in pollutant load) and effective grease and fat traps at food premises, etc, do help.

Trade waste discharge is, however, different and often very significant reductions in a whole range of pollutants can be made by in-factory process changes, good housekeeping and pre-treatment at the industry itself before discharge to Council's sewerage system. Like the volume issue, trade waste controls and charges often have the effect of reducing such pollutant mass loads and concentrations. In this respect it is noted that in the Auckland Regional Council area the new trade waste management procedures require adoption of "clean" techniques that minimise trade waste production whenever this is practicable. There is therefore considerable scope for some reduction in pollutant loads such as suspended solids, BOD_5 and oils and grease and also reduction and in some cases total elimination of the toxins or potential harmful compounds. Reference is made to Part 4.0 Trade Wastes.

10.9 OPERATION AND MAINTENANCE

In any wastewater management scheme it is most important that matters of operation and maintenance are fully considered from the outset of any investigations and that these are carried through into concept design, detailed design, construction and onto the ongoing operation and maintenance.

While this Stage 1 scoping report discusses treatment technologies and possible plant configurations, it does not, however, develop or discuss in any detail the matters of operation and maintenance. These are to follow and are accordingly part of the Stage 2 brief.

Specific matters that will then be further developed and evaluated include:

- the level of technology available for particular options, particularly for example in control systems (high versus lower technology)
- actual labour and other operating requirements, including number and type of personnel
- needs for training and retraining of operations personnel
- working conditions and the "human engineering" factors
- asset management and maintenance features
- any effects of operational procedures on the immediate proximity of the conveyance, treatment and disposal facilities
- monitoring requirements and programmes

In Part 11.2 annual operating and maintenance costs are discussed.

10.10 RELIABILITY, RISK AND FLEXIBILITY

Of increasing importance in wastewater management are the interrelated issues of reliability, risk and flexibility. While all these issues need increasing attention paid to them in the ongoing stages of this study, and particularly during the detailed design, construction and operating stages, it is appropriate to at least introduce them here. They include, for example:

(i) reliability of the treatment process

The reliability of treatment processes to meet specified, standards. This depends on many factors which include:

- the inherent treatment capacity of the plant, including the ability to handle peak loadings compared to design loadings, plant redundancy, standby capacity and other features.
- the operation of the plant
- inflow conditions particularly peak flow and pollutant load variations, and for plant with biological treatment processes, the ability to handle discharges containing toxic compounds.
- biological process upsets
- extreme climatic variations
- natural catastrophes (earthquake, etc)
- industrial disputes
- plant malfunction (eg, automation of a control system)
- power failure

(ii) flexibility of the conveyance, treatment and disposal systems

flexibility of the conveyance, treatment and disposal systems relates to the number of process trains and plant units that make up the system. In particular it applies to pumping systems and treatment plants. For example in large treatment plants it is normal practice nowadays to have 3 or 4 identical parallel process trains to handle the wastewater flows.

With this type of arrangement if, for example, one process train is out of use for maintenance or unexpected failure then, providing the basic design allows and operation is appropriate, the remainder of the plant will continue to function to a known predetermined level.

By contrast, the Tahuna plant, for example, has no flexibility in the sludge thickening facility, and when this unit is out of use, for other than about 1 day, the plant is bypassed by the screened but otherwise untreated wastewater.

(iii) effluent reliability

effluent reliability is of importance in all treatment options, but particularly so for those where a high degree of treatment is required. This must be taken into account in setting effluent standards and in monitoring plant performance.

To illustrate this, reference is made to extensive overseas studies that have investigated the statistical reliability in effluent quality from actual operating treatment plants.

Frequency distributions of effluent sample test results obtained indicate that a skewed distribution is typical. An example is shown in Figure 10.10.1 for records of suspended solids observation in an activated sludge plant effluent. The mean is in the range 10-15 g/m, but excursions of up to 100 g/m^3 were recorded. (NB: 1 g/m^3 = 1 mg/l)

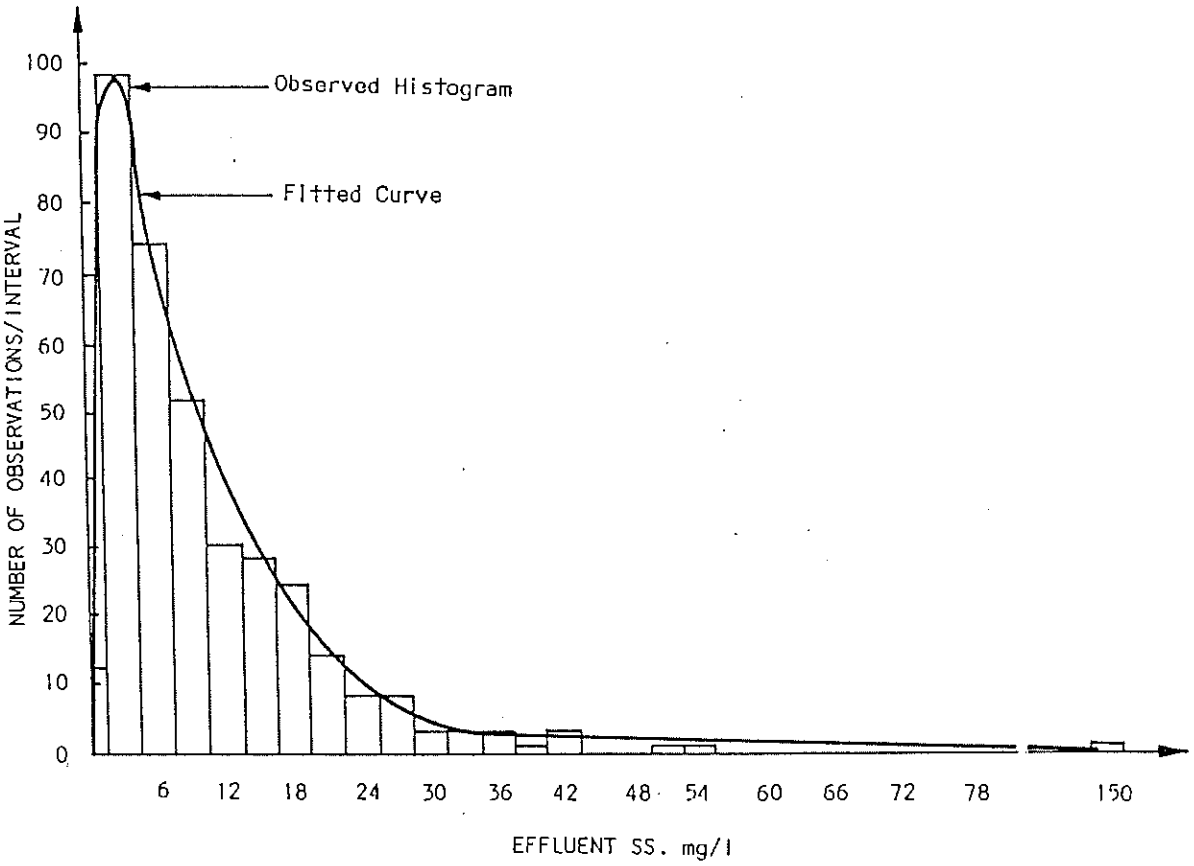


FIGURE 10.10.1 DISTRIBUTION OF SS IN EFFLUENT SAMPLES

The skewed distribution is because samples cannot be less than zero SS but excursions in plant performance can result in high levels of SS. The pattern for BOD_5 is similar.

A practical example of this is in results taken from data from 14 large treatment plants in the USA. If the mean plant performance observed was 50 g/m^3 BOD_5 and SS then the effluent excursions of the following magnitude could be expected in effluent quality:

1 day in 100, 130 g/m^3 BOD/SS would be exceeded
1 day in 1000, 175 g/m^3 BOD/SS would be exceeded

The determination of the appropriate method of described treatment plant effluent quality standards should take into account the impact of excursions on receiving water. The frequency of excursions into harmful concentrations should be limited, but it should be remembered that extremely high levels of reliability are expensive.

With the higher strength wastewaters in the Musselburgh and particularly the Green Island catchments, these statistical variations must also be accommodated, particularly where fluctuating and changing industrial tradewaste discharges are common place.

(iv) outfall risk and reliability

The history of outfall and submarine pipeline construction in New Zealand has shown that mishaps resulting in structural damage are most likely during construction. Failure of such a structure following satisfactory completion of construction is extremely rare.

Risk of delay, damage and mishap is an integral part of offshore construction, and provided that this is recognised at all stages of project development risk can be minimised through thorough investigation, conservative design, and careful construction management and supervision. The experience of designer and contractor plays a significant part in this process. The philosophy of outfall construction must be to "do it once and do it right", as there is never the same opportunity to plan and programme the second time around.

Provided an outfall structure has been carefully designed and constructed to suit its environment it can be expected to comprise a reliable, low maintenance component of a wastewater treatment system.

However, it is recommended and prudent, given the value of this component of the wastewater treatment scheme, that regular inspection of an outfall be made to establish the occurrence of any damage, any unusual changes in seabed condition that could initiate damage, and to ensure that diffuser ports have not become blocked by effluent, marine growth or sediment movement. The build-up of marine growth on exposed sections of pipeline can result in additional loading on the structure and may require removal. Inspection should be made at least on an annual basis.

Wastewater and cooling water outfalls are known to have been operating on the New Zealand coastline for 25 years and overseas for longer periods, without any signs of deterioration.

(v) conveyance systems, risks and reliability

While buried pipelines normally pose low risk, that is, they are inherently reliable, there are issues to be considered particularly in the Dunedin area where areas of potential land instability are known. Pumping systems risk and reliability generally follows that similar to treatment plants.

(vi) land disposal systems

These need their own special assessment of risk and reliability,as while there are good examples both in New Zealand and overseas, there are also some failures and concerns. The very complex natural system of soil, vegetation, hydrogeology, climate and the overall eco-system balance must be well understood in the scheme design and management. Experience shows just how important management is to the on-going long term reliability of land disposal schemes.

10.11 FUTURE CHANGES AND TECHNOLOGY DEVELOPMENTS

10.11.1 Future Changes

In any wastewater treatment system, concept and design parameters are established that take into account certain predicted future changes.

A number of factors can influence the accuracy of the design assumptions.

These include:

- population increases (or decreases) over those allowed for in the initial design.
- industrial (tradewaste) loading changes both in terms of flow rates and wastewater volumes and qualities (although the latter can be reasonably controlled by tradewaste bylaws and agreements). This is particularly relevant in the Dunedin area with such major examples as the closure of the former Burnside Freezing Works and more recently the new substantial (and largest) trade waste discharge from Fortex - these both affecting the Green Island catchment. Furthermore, there are examples of the proposed new tannery and chicken abattoir in the Musselburgh catchment that have been announced as this report was being drafted.
- effects of ageing sewers and other facilities resulting in increased infiltration, wet weather flows, etc.
- positive effects, ie, flow reduction by renewal/upgrading sewers and reduction in illegal stormwater connection.
- increased demands for higher quality effluents and higher environmental standards at treatment plants (eg, aesthetics, noise, odour abatement provisions, etc).
- developments, both in new treatment and residuals management technologies and refinements to those existing, that result in more efficient operation. Developments in sludge utilisation techniques are likely to continue. This important issue is further discussed below.
- new legislation and new approval standards reflecting society's changing needs and aspirations.

The above listing of possible future changes is not unique to the Dunedin area, nor are all of these likely to occur. The important point in the evaluation of options is to be aware that future changes do occur in any scheme, and that the scheme initially selected should as far as practicable, and acceptable cost-wise, be planned and have facility to accommodate these changes.

10.11.2 Wastewater Treatment and Residuals Management Technology

International developments and trends that have relevance in this project include the following. A number of these are reflected in the treatment technologies and total scheme options reviewed in this Stage 1 report.

- increasing focus on a "total integrated approach to wastewater treatment and disposal" that not only considers the treatment concepts but also the treatment plant environment itself, the effluent disposal environment and the sludge management aspects. This is introducted in Part 6.2 Issues Identification.

Such an integrated approach brings in all aspects of land, air, and water and is consistent with the new Resource Management Act.

- increased public awareness and interest in environmental issues with consequence expectations for higher degrees of wastewater treatment and for utilisation of sludges.

- the shift from marine disposal of preliminary and some primary treated effluents towards more land based treatment giving higher effluent standards does not account for all of the environmental effects outlined above.

- technical acceptance of the principles of marine treatment in appropriate situations.

- the influence of power (electricity) cost rises on the annual operating costs of the more energy intensive types of treatment. These include the activated sludge range of plants and particularly those with low loadings and longer detention required for the higher effluent qualities. This issue is obviously to the fore at present with power price increases being promised.

  For example, in Western Europe and USA the increasing cost of power has over the last decade seen increased development and usage of biological filtration. This increase also results from the new, more effective range of plastic media used in this process.

- the on-going development and refinement of activated sludge technology resulting in more efficient systems and in some cases more compact plants, including in particular new process arrangements (last 10 to 15 years) of "deep shaft", "two stage treatment", "high rate biosorption", and "intermittent batch" systems.

- developments of two stage biological plants where reasonably high effluent qualities (20:30 or better)are needed and/or the influent strength is considerably higher than domestic strength through trade wastes as is the case in the Green Island catchment in particular. These developments use both combinations of biological filtration and activated sludge stages, and two-stage activated sludge.

- developments and increasing application in both aerobic (oxygen present) and anaerobic (oxygen devoid) biological treatment processes that incorporate the principle of biological flocs being suspended in and onto a media. For example, in the aerobic group is the submerged aerated biological filter process for which the biological aerated filter (BAF) process offers a retrofit option to convert the Tahuna plant to a secondary biological treatment plant (refer Part 10.4).

- the improvements in secondary clarifier (secondary settling tank) design and operation for both activated sludge and biological filtration plants that have resulted in improved performance and hence higher quality effluents.

- improved biological (trickling) filter design and associated solids contact (TF/SC) process. In the USA this BF/SC development is in many cases giving higher benefit/cost for this type of new plant than activated sludge plants.

- the increasing acceptance and use of UV disinfection of effluents as an environmentally acceptable method. The most common level of disinfection being provided (and frequently guaranteed) is a 200 FC/100 ml limit for a 20:30 (BOD:SS) secondary treated effluent.

- in contrast to the above the use of chlorination as a disinfection process is of mounting environmental concern.

- increasing realisation that sludge treatment and disposal has been inadequately investigated. Accordingly, a total sludge management approach is now required, and standby systems with 100% redundancy are being adopted.

- increasing awareness and implementation of sludge utilisation technologies (includes composting, land application, energy production, smelting to a clinker for reuse in aggregate, the conversion of sludge to oil, etc).

- increasing use of sludge pumping from the wastewater treatment plants to other (often central) sludge treatment and/or disposal facilities situated away from the wastewater treatment plan. This technology is in particular being used in large densely populated cities (eg, Tokyo, Manchester) and now proposed in Wellington.

10.11.3 Flexibility for the Future

In section and detailed design of new treatment plants and systems, including the retro-fitting of existing plants, it is important that adequate attention is paid to provision of flexibility for the future. While it is not always possible to know what new technological developments or changing flows and loads may result in the future within the life of the treatment plant, such flexibility as far as it can be incorporated, is often a valuable asset.

In terms of this Stage 1 study, it is comforting to find that all existing treatment plants have a good degree of flexibility allowing retro-fitting and addition of new processes to the basic plants themselves. For example, as discussed in Part 10.4, the existing Tahuna plant can be retro-fitted for a full primary, advanced primary, secondary or tertiary treatment system. Similarly for the Stage 1 Green Island milliscreening plant which was designed and partly constructed for the Stage 2 advanced primary system, although other treatment arrangements can also be added in.

10.12 CONSTRUCTION CONSIDERATIONS INCLUDING STAGING

10.12.1 Construction Consideration

In evaluating the various catchment options and how they may be grouped to arrive at Representative Total Schemes, it has been necessary to also assess construction techniques and requirements. This has also included assessment of how new facilities (treatment, conveyance and disposal) can be constructed and then commissioned while at the same time leaving the present systems functioning as key parts of the present sewerage schemes. In all options considered this is possible although with the Tahuna retro-fit options some short periods of partial and total plant closure would likely to be required. These matters will be reviewed in more detail and reported on in the Stage 2 report.

Constructability is another important consideration in the options identification and development. The land based work included in all options would be readily constructable using techniques and plant commonly available and would be well within the scope of some local contracting firms. The coastal outfall construction is more specialized and would almost definitely require bringing plant and equipment into the region as is discussed in Part 10.6. Methods of procurement and construction are further discussed in Part 14.4 where Scheme Implementation is discussed.

10.12.2 Staging of Scheme Construction

In part 6.2 "Issues Identification" staging of schemes as a possible method of implementation is introduced and the staging scenarios that are likely to be available are outlined. These are not repeated here.

The staging options include not only the way in which a particular catchment option maybe staged (eg, outfall first, treatment later or vice versa), but also how the options from the 3 or 4 catchments included in the particular total scheme may be staged relative to each other. This allows a progressive staging towards a final scheme by working through levels of staging within a particular catchment, then inter catchment and moving for example from a Concept Output Level 4 Total Scheme to a Concept Level 2 or 1 Total Scheme.

In part 13 where the Representative Total Schemes are discussed, a summary is included in what components and catchment options could be staged in various ways. In Part 14.4 staging is further discussed as part of an introduction to Implementation Considerations and an example given of how a staging model can be built up incorporating a number of components, catchment options and concept output levels to finally arrive at a particular Total Scheme.

Thus Council may select a concept level scheme (3,2 or 1) as being its goal in a certain time frame, but not necessarily try to achieve the goal in one large single-step project. Associated infrastructure planning and urban development would be undertaken in conformity with the stated long-term goal for the City's wastewater system.

Part 11.0

Cost Estimates

PART 11.0 : COST ESTIMATES

11.1 PRESENT COSTS AND SCHEME LIFE

In any study of future options for upgraded treatment and disposal, it is necessary to review as part of a total evaluation, the cost and remaining useful life of the existing facilities. This by itself is an involved exercise and in its entirety is outside the scope of this Stage 1 Report.

As the Council's programme progresses and catchment options and representative total schemes are shortlisted for further more detailed evaluation through the Stage 2 programme, items of cost and life that need to be included in such an evaluation are:

- annual operating and maintenance costs both existing and future
- equipment replacement provisions
- capital repayment status of the facilities, eg, debt free, remaining loans
- condition survey
- economic life
- residual life costs of the facilities
- costs to decommission facilities

Two key items of relevance are age of facilities and present annual operating and maintenance costs. The following table 11.1.1 summarises these.

The total annual operating and maintenance costs can be compared to those given in this report for upgraded scheme options and representative total schemes. These new figures include operating costs as may be appropriate to those schemes. Increases, or decreases, can therefore be determined. These cost differences are not specifically tabulated in this report.

TABLE 11.1.1 : Treatment Plant Age and Current Operation and Maintenance (O&M) Annual Costs

	1990/91 Year* Treatment Annual Operating and Maintenance Expenditure $Million pa	Years Facility Has Been In Operation
Tahuna	1.290	10
Broad Bay	0.090	4
Company Bay	0.035	(approx) 24
Port Chalmers	0.182	part 25, part 19 part 17
Burkes	0.044	20
Sub total harbour basin plants	0.351	
Green Island	0.321	outfall 3 treatment 1.5
Mosgiel	0.353	part 17 (approx) part 9 (approx)

* Source - Dunedin City Council
(excludes GST, August 1990 dollars, excludes loan repayment costs)

11.2 BASIS OF COST ESTIMATES

This report includes the estimated costs in the following categories:

Capital Cost — the money expended to construct the components of the options and total wastewater treatment and disposal schemes.

Operating and Maintenance Costs (O&M) pa — the nett additional (or reduced) costs over (or below) existing annual operating and maintenance costs to run the wastewater treatment and disposal schemes. They exclude any annual capital loan repayment amounts.

In order to represent costs in various ways and to allow more valid 'total cost' comparison of the various sewerage scheme options, other analytical techniques are used in the estimated cost data presentation. These are:

Capitalised Operating and Maintenance (O&M) Costs — This is the estimated above defined annual O&M cost represented in present day values (so it can be added to the capital cost) for 25 years of scheme operation and maintenance, assuming a 6% difference between interest rates and inflation (Present day value - annual O&M x 12.78).

The inclusion of this in total costs allows more meaningful comparison to be made across the range of low capital/high O&M schemes and higher capital/lower O&M cost schemes.

While the 6% difference may not be totally appropriate to the time of writing this report, historic evidence does show this is an appropriate figure when considering a 25 year time frame. A sensitivity analysis can however be undertaken to see the effects of taking other figures and time periods. The basis used in this report is consistent with that taken in a number of other major wastewater project options investigations in NZ recently.

Asset Replacement Cost — this is a factor that can be built into the cost estimates for each component part of the options and schemes which takes account of the differing life expectations of the components. This factor is not incorporated into the estimated costs in this report. Instead it is suggested this is a refinement that should be built into the cost estimates and analysis in the Stage 2 investigations. The use of this factor is further discussed below.

Estimated Total Cost — as used in the Report is therefore the summation of the estimated capital cost, and the capitalised operating and maintenance cost as defined above. For clarity, the columns are numbered in cost tables to show the items that add up to give the total cost.

In the Stage 2 report staged implementation and the Asset Replacement Costs will also be entered into the totals. The fact that they are not in the Stage 1 report should not affect the first level of cost evaluation at this stage of the project.

In using the various analytical techniques available to combine the impacts of capital and operating costs on the rates, it should be appreciated that all of these techniques rely on the assessment of the true interest rate to apply over the life of the project, and the reliability of this assessment is difficult to determine. The impact (and potential error) is highest on components with high operating costs.

There is a degree of risk in predicting future costs today and this should be taken into account. Capital costs, by comparison, are not affected by events after construction.

Most wastewater scheme components are not unique to any particular installation. Historical data is available for most technologies. This enables indicative operating and maintenance costs, and component lives, to be assessed at the evaluation stage for comparison purposes. With this information, the total impact of capital plus operating and maintenance expenditure can be determined.

Component and option selection therefore is based on the total cost of the item, that is the combination of capital plus operating and maintenance costs. A simple way of comparing alternatives, as introduced above, is to reduce annual costs over a period to a single capital cost by the application of appropriate economic factors. This "capitalised" operating and maintenance cost is then added to the capital cost to give the total cost. Total costs for component alternatives can then be compared. This is generally sufficient for component selection. A more rigorous analysis which reduces all costs to impacts on rates can also be made using similar techniques.

In comparing estimated costs it must be fully appreciated that the figures given are estimates only, not actual or even tendered costs, and even then a number of them are of a preliminary nature only. This applies in particular to some of the coastal outfall estimates as they are more difficult than other items to estimate with a high degree of certainty.

Accepting therefore that they are estimates, the following interpretation should be placed on the figures when making comparisons between various scheme options.

Any figures that are within 5% of each other should be considered "the same".

Those within 10% of each other should be considered "similar".

The basis on which cost estimates have been made are:

- unless otherwise stated costs are given in millions of dollars, $M
- all estimates are exclusive of GST
- all estimates are based on a CCI (Construction Cost Index) of 3,500

The assumed CCI figure of 3,500 is predicted to be reached between March and June 1992 and accordingly this fits well into Council's Stage 2 programme. The last published CCI was March 1991 at 3,410, the forecast for June 1991 being 3,420.

- The capital cost estimates include

  - a 17.5% preliminary and general (P&G) on base capital estimates
  - a 10% engineering/design and 15% contingency on top of the base estimate and P&G
  - preliminary allowances for site investigations, eg, foundations, soils, oceanographies for outfalls, land disposal investigations
  - land purchase costs for new sites, etc
  - compensation allowances that may be appropriate
  - environmental impact assessment and reporting
  - gaining necessary statutory approvals but this does not allow for protracted hearings and other statutory procedures

- Annual Operating and Maintenance Costs (O&M pa) - as previously specified this is the nett additional (or reduced) costs over (or below) existing operating costs to run the treatment and disposal schemes.

  - Power (10 cents/kWh)
  - Staffing across the board ($50,000 pa per person, including staff overheads
  - Sludge trucking to landfill at Green Island as at present
    current rate $38 per tonne dewatered sludge cake (includes disposal cost of $13/tonne)
  - Maintenance at 4% pa of mechanical and electrical capital cost estimate
    0.25% of civil/structures capital cost estimate
  - Consumables - as appropriate

  These maintenance allowances do not include for a replacement or depreciation allowance. It is proposed that in Stage 2 such allowances will be included in the Asset Replacement Cost assessment as introduced here.

- Capitalised Operating and Maintenance (O&M) Cost
  annual (O&M) x 12.78 = Capitalised O&M (ie, present worth of the annual O&M cost for 25 years at a 6% difference in interest rates and inflation).

- Estimated Total Cost = capital cost + capitalised O&M cost (as discussed above)

- All cost estimates, unless otherwise shown, do not include an allowance for the further treatment of the Fortex trade waste discharge, nor for the land disposal scheme.

Asset Life and Replacement Factors

In the Stage 2 options and total scheme evaluation and estimate refinements this cost factor should be included in the assessment.

The elements comprising the various schemes range from sophisticated treatment plants to concrete lined tunnels. These elements have widely differing life expectancies which is not reflected in the maintenance and operating costs. A factor can be built into the costing for each element which takes account of the differing life expectancies and places a value on this.

The elements could be grouped into four categories of life expectancy as follows:

Treatment plants/pumping stations	35 years
Outfalls	40 years
Pipelines	60 years
Tunnels	100 years

The value for treatment plants/pumping stations is a weighted average of the different life expectancies of mechanical and electrical plant and civil works such as concrete tanks and buildings.

The effect of introducing asset life and replacement factors into the total cost assessment at the time of the Stage 2 evaluation will result in the schemes with a high proportion of the capital cost in mechanical equipment being more expensive on a total cost assessment than those schemes with a high proportion of the scheme capital cost being in tunnels and pipelines, and to a lesser degree, outfalls.

11.3 OPERATION AND MAINTENANCE COST FACTORS

Municipal facilities are funded by rates, generally through a loan arrangement, although the trend nowadays is to finance as much as possible out of rates revenue to reduce the gearing which has resulted from years of high inflation and high loan interest rates. The annual rate covers both the financing of the capital expenditure (through loan repayments) and the costs for operating and maintaining facilities. There is therefore an optimum balance between capital cost and operating and maintenance cost to minimise the impact on rates.

The various components of a wastewater treatment and disposal scheme all have different ratios of capital and operating costs. Each must therefore be considered separately.

Treatment plants, for instance, have a high operating cost through staff, energy, and maintenance requirements when compared to the trunk sewer, where operating cost is limited to some cleaning and repair work. Components which have higher operating costs require more intensive analysis into the optimal balance for process selection.

The degree of treatment reflects directly on the operating and maintenance costs and the two largest items are often energy and sludge treatment and disposal. For example a secondary biological plant requires energy for the biological treatment and requires treatment and disposal of the increased amounts of sludge produced.

In times of high true interest rates, it is difficult to justify "on paper" high levels of capital expenditure in order to reduce annual operating and maintenance costs. The life of the facility must be taken into account, however, as it is possible these economic circumstances will not prevail for too long into the future, and the average true interest rate may be lower than present rates.

Similarly, the expected life of various components can be assessed to arrive at the best value for money. A cheaper item, which might require replacement each 15 years could be a more economic choice than a more expensive item which would last 30 years.

As introduced above, an important operating cost can be that for energy. Costs for pumping large flows and quantities of wastewater to a more elevated and distant site (such as the south coast land disposal scheme) and nett energy costs of various treatment options therefore have an important influence on the total operating cost of various scheme options. The extra energy usage can have impacts at remote sites, eg, contributing to the need for electricity generation facilities.

The major energy use in treatment is for secondary treatment and this is very dependent on the process used and whether or not it is preceded by primary sedimentation which lowers the energy cost, particularly for any activated sludge option, but at the expense of the higher capital cost of providing primary sedimentation itself. These energy use factors will be evaluated in the Stage 2 study including the opportunity to recover energy as biogas from the sludge digest.

11.4 TRADE WASTE CONSIDERATIONS

Part 4.0 introduces trade waste discharges, reviews the present discharges into the four catchments, discusses why trade wastes need to be considered in this study and provides comparative information on the relative magnitude of trade wastes relative to the actual populations.

This information highlights the significantly greater load of suspended solids, total grease and BOD_5 (organic strength) in the Green Island and Musselburgh catchments than comes from the domestic population. This is shown on Table 9.3.6 and Figure 9.3.1.

The information from this table and the pie diagrams has then accordingly been used on a percentage basis to apportion out the trade waste proportion of the various component parts of the representative total schemes being considered. This information is given on the summary tables in Part 13.0 where both % and the actual dollar proportion of the estimated cost is given.

In terms of the Local Government Act, a Council can charge trade waste dischargers up to the full pro-rata usage they make of a system for both capital and operation and maintenance. This is elaborated on in Part 4.0.

Charges for treatment can include for trade waste quality as well as quantity. The quality components will depend on the nature of the treatment and sludge systems used - for example on

- a suspended solids base for solids removal such as in primary and advanced primary plants

- a total grease basis for the grease removal, handling and disposal, especially for example in advanced primary particularly dissolved air flotation (DAF), plants.

- BOD_5 for secondary treatment.

Also there is the joint consideration of sludge treatment and disposal of solids and solids produced from secondary treatment where BOD_5 removed is converted to sludges.

The volume or flow rate of wastewater is also one of the charging components and in a more hydraulic based plant (eg, milliscreening and primary sedimentation), makes up the major part of the charges.

The conveyance peak flow rate is usually the appropriate charge as it is for outfalls - for land disposal the daily volume is the more appropriate item.

In the tables given in Part 13.0 for Representative Total Schemes the estimated use for conveyance is very approximate only as this relates to a peak flow basis and these calculations have not bee undertaken, instead the daily volume has been used and an allowance downwards made of the relative proportion of that. Otherwise the percentages shown in the pie diagrams in Part 9.0 for the Musselburgh and Green Island catchments have been used.

As required, figures are shown in the Green Island catchment treatment options for both the inclusion and exclusion of Fortex's trade waste discharge as part of the Green Island treatment.

While these pro-rata cost estimates are prepared, it is stressed that the information given is simply the pro-rata cost split, which gives a guide to the amount the Dunedin City Council could charge, in accordance with the Local Government Act, if Council decided to adopt this principal of full cost apportionment.

Under the Act an allowance needs to be made, however, for the equivalent domestic sewage contribution from the property and this would reduce the esitmate cost proportions, the extent depending on the rating procedures used for sewerage rates.

11.5 AFFORDABILITY AND FUNDING

Affordability and funding are the subjects of a separate report by the Dunedin City Chief Executive to the Dunedin City Council.

Part 12.0

Catchment Options for Wastewater Treatment and Disposal

PART 12 : CATCHMENT OPTIONS FOR WASTEWATER TREATMENT AND DISPOSAL

12.1 INTRODUCTION

Part 7.0, Scoping of Options, introduced the conceptual approach which has been taken in this study of first identifying and isolating technically feasible options in four categories of "catchment output levels". As a planning method, this approach enables the reader to initially stand back from a very complex situation and get a broad overview of the Dunedin wastewater scene and its potential development before becoming immersed in the details. The latter step must be taken because, while the solution (or solutions) may seem very clear or straightforward at the higher plane of the "catchment output concepts", in reality any one option or scheme (a combination of options) is a sensible collation of several components namely; conveyance, treatment and disposal.

Therefore, following on from the evaluation and estimation of the components in Part 10.0, these parts of a sewerage system can now be grouped in various ways to form technically feasible treatment and disposal options. In the first instance, these options are presented in this part of the report as Concept Level 4, that is, on the basis of each individual catchment with no "intercatchment" transfers. Logically, they are referred to as "catchment options" and they form the building blocks for the representative total schemes which are promulgated in the next chapter, Part 13.0.

In summary, this report is using the components from Part 10.0 to build up the catchment options of this chapter. Some of these options are then carried forward into the total schemes which follow.

In this process, no value judgements are made on which option is environmentally more sound, or least costly, or favoured for a particular reason, because it is hoped that the tabulated catchment options cover the field and provide Council with a comprehensive range from which to choose those for further investigation in the Stage 2 study.

The concentrated form of tabular presentation has been chosen deliberately so that all options for each catchment are presented together, including the costs (capital, O&M and total) for all the components.

The "conveyance" parts are generally straightforward but there is a variety of treatment processes and, in some instances, outfall lengths recorded for each catchment.

To complement the tabulated information, a pictorial representation of the relevant catchment is included with conveyance routes, treatment plant sites and outfall locations all marked.

12.2 HARBOUR BASIN

(refer Figure 10.2.4 and Tables 12.2.1, 12.2.2)

There are 11 options presented for the Harbour Basin. They range from the simplest, of upgrading the four treatment plants, moving the Company Bay discharge to Grassy Point, and providing a new Port Chalmers outfall; to more fundamental changes such as shifting all the discharges out of the harbour to either land disposal at Okia Flat or the Musselburgh catchment.

There are a large number of "intracatchment" transfer pipelines possible in the Harbour Basin (see section 10.2.6) and it is there that much of the estimated capital expenditure lies.

One of the rationalisations made in setting out the options was that if disinfection of harbour outfalls was required or adopted in principle then it would apply to all such discharges not just one or two plants. A significant conclusion is that the capitalised O&M cost savings resulting from the decommissioning of all the harbour basin treatment plants, equates to the capital cost of a conveyance transfer to the Musselburgh Catchment.

There will be a slight increase in operating costs due to the harbour basin flow and sludge load. However, this will be relatively minor at about a 5% increase at the Tahuna Plant on an average flow basis.

Due to the lag effect of longer conveyance times, the daily peak flows from the harbour basin catchments will not coincide with those from the Musselburgh Catchment. Thus the effect on treatment capacity at Tahuna will be negligible other than for extra sludge processing.

If some of the existing tankage at the Harbour Basin plants is retained for flow balancing during peak wet weather events, the need to bypass storm flows into the harbour could be reduced along with impact of storm flows on the Musselburgh Catchment.

TABLE 12.2.1 : HARBOUR BASIN (HB) CATCHMENT OPTIONS SUMMARY SCHEDULE

Option [A]		Disposal		Treatment			Report Ref. Part [D]	Included in Representative Total Scheme
		Type	Details	Site	Effluent Standard[B] SS/BOD/O&G/FC	Process		
HB1a	B PC CB BB	outfall outfall outfall outfall	as is new new[C] as is	all at existing plant sites	secondary 30/30/5/10^6	all plants upgraded as required (see text)	10.4.15 to 19	4/I to 4/VI 3/III, 3/IV,
HB1b		outfalls	as HB1a above	as HB1a	above but with 30/30/5/10^2-10^3	disinfection	10.4.15 to 19	-
HB2a	B PC CB BB	single harbour outfall	at Port Chalmers	all at existing plant sites	secondary 30/30/5/10^6	all plants upgraded as required (see text)	10.4.15 to 19	-
HB2b		single outfall	as HB2a above	as HB2	above but with 30/30/5/10^2-10^3	disinfection	10.4.15 to 19	-
HB3a	B	convey	sewage to	MC and	decommission	the plant	10.4.15 to 19	-
	PC CB BB	outfall outfall outfall	new new[C] as is	all at existing plant sites	secondary 30/30/5/10^6	all plants upgraded as required (see text)		
HB3b	B	convey	sewage to	MC and	decommission	the plant	10.4.15 to 19	-
	PC CB BB	outfall outfall outfall	new new[B] as is	all at existing plant sites	secondary with disinfection 30/30/5/10^2-10^3	all plants upgraded as required (see text)		
HB3c	B	convey	sewage	to MC	and decommission	the plant	10.4.15 to 19	-
	PC CB BB	single harbour outfall	at Port Chalmers	all at existing plant sites	secondary 30/30/5/10^6	all plants upgraded as required (see text)		
HB3d	B	convey	sewage	to MC	and decommission	the plant	10.4.15 to 19	-
	PC CB BB	single harbour outfall	at Port Chalmers	all at existing plant sites	secondary with disinfection 30/30/5/10^2-10^3	all plants upgraded as required (see text)		
HB4	B	convey	sewage	to MC	and decommission	the plant	10.7	4/VII
	PC CB BB	land disposal	Okia Flat	existing	secondary (no change)	no change		
HB5a	all	convey	sewage	to MC and	(via road/rail decommission	reserve route) the plants	10.2.6	[E]
HB5b	all	convey	sewage	to MC route) and	(via harbour decommission	crossings the plants	10.2.6	3/I, 3/II 2/1, 2/II, 2/III, 2/IV 1/I, 1/II

[A] B = Burkes/St Leonards; PC = Port Chalmers; CB = Company Bay; BB = Broad Bay/Portobello

[B] Effluent averages - variation would occur about these averages
SS = Suspended Solids, BOD5 = Biochemical Oxygen Demand, O&G = Oil and Grease, FC = Faecal Coliforms (all in g/m3 except FC as number per 100 ml)

[C] effluent would be conveyed from Company Bay to the Grassy Point outfall

[D] Also harbour outfalls part of 10.6

[E] Could have HB5a option in representative schemes shown for HB5b (instead of HB5b) at additional estimated capital cost - see text

TABLE 12.2.2 :
HARBOUR BASIN (HB) OPTIONS ESTIMATED COSTS SUMMARY ($ M)

Option	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital (rounded) 1+2+3=4	O & M pa 5	Capitalised O & M 6	TOTAL (rounded) 4+6
HB1a	1.69	1.65	0.35	3.69	0.12	1.59	5.28
HB1b	1.69	1.85	0.35	3.89	0.15	1.94	5.83
HB2a	4.0	1.65	0.45	6.10	0.15	1.93	8.03
HB2b	4.0	1.85	0.45	6.30	0.18	2.29	8.59
HB3a	4.48	1.29	0.35	6.12	0.12	1.59	7.71
HB3b	4.48	1.45	0.35	6.28	0.15	1.89	8.17
HB3c	6.53	1.29	0.45	8.27	0.14	1.78	10.1
HB3d	6.53	1.45	0.45	8.43	0.16	2.08	10.5
HB4	11.1	Nil	0.75	11.9	0.20	2.52	14.4
HB5a	13.5	Nil	Nil	13.5	(0.24)	(3.11)	10.4
HB5b	9.23	Nil	Nil	9.23	(0.28)	(3.63)	5.60

Note: ( ) indicates a negative value, ie, a credit

12.3 MUSSELBURGH CATCHMENT

(Refer Figure 10.2.5 and Tables 12.3.1, 12.3.2)

There are 20 options presented for this, the largest of the four major catchments. In contrast to the Harbour Basin, the main question here is not the intracatchment transfers but the different degrees of treatment, the two possible treatment plants sites (Tahuna and Southdale Road) and three potential coastal discharge locations (Tahuna, Maori Head and Lawyers Head).

Amongst this range of alternatives, a large number of combinations of options can be developed. Some perhaps do not make as much sense as others but they are, nonetheless, technically feasible by definition, although ultimately none is carried forward to a representative total scheme.

Separation of the discharge from the shoreline can be achieved by a coastal outfall either at Tahuna or Maori Head. An outfall off Maori Head provides flexibility both in where treatment is undertaken and the staging of treatment upgrading. As an example, the existing Tahuna primary treatment plant could be retained initially but at a later stage, treatment facilities could be constructed at Southdale Road and the Tahuna plant then decommissioned.

If a Tahuna outfall is constructed, there are a number of practicable options available for upgrading of treatment within the confines of the existing Tahuna site. These are outlined in part 10.4.

TABLE 12.3.1 : MUSSELBURGH CATCHMENT (MC) OPTIONS SUMMARY SCHEDULE

Option	Disposal		Treatment[D]			Report Ref. Part[E] Below and Table 10.4.2	Includedin Representative Total Scheme
	Type	Details	Site	EffluenStandard SS/BOD/O&G/FC[B]	Process[C]		
MC1a	outfall	as is[A]	Tahuna	full primary 100/270/40/10^7	upgrade existing	10.4.4 & 10.6	4/I
MC1b	outfall	as is[A]	Tahuna	advanced primary 80/80/30/10^6	upgrade existing	10.4.5	-
MC1c	outfall	as is[A]	Tahuna	secondary 20/20/2/5x10^5	BAF	10.4.6	-
MC1d	outfall	as is[A]	Tahuna	secondary + disinfection 20/20/2/2x10^2	BAF + UV	10.4.6	4/VI
MC1e	outfall	as is[A]	Tahuna	tertiary 1/5/1/nil	proprietary	10.4.7	-
MC2a	outfall	Tahuna 1600m	Tahuna	full primary 100/270/40/10^7	upgrade existing	10.4.4	4/II, 3/I,3/III 2/I
MC2b	outfall	Tahuna 1600m	Tahuna	advancedprimary 80/80/30/10^6	upgrade existing	10.4.5	-
MC2c	outfall	Tahuna 1100m	Tahuna	secondary 20/20/2/5x10^5	BAF	10.4.6	4/IV,4/VII, 3/II,3/IV, 2/III
MC2d	outfall	Tahuna 1100m	Tahuna	secondary + disinfection 20/20/2/2x10^2	BAF + UV	10.4.6	-
MC2e	outfall	Tahuna 600m	Tahuna	secondary + disinfection 20/20/2/2x10^2	BAF + UV	10.4.6	-
MC2f	outfall	Tahuna 600m	Tahuna	tertiary 1/5/1/nil	proprietary	10.4.7	-
MC3a	outfall	Maori Hd 1100m	Tahuna	full primary 100/270/40/10^7	upgrade existing	10.4.4	4/III 2/II
MC3b	outfall	Maori Hd 1100m	Tahuna	advancedprimary 80/80/30/10^6	upgrade existing	10.4.5	-
MC3c	outfall	Maori Hd 1100m	Tahuna	secondary 20/20/2/5x10^5	BAF	10.4.6	-
MC3d	outfall	Maori Hd 1100m	Tahuna	secondary + disinfection 20/20/2/2x10^2	BAF + UV	10.4.6	-
MC3e	outfall	Maori Hd 600m	Tahuna	tertiary 1/5/1/nil	proprietary	10.4.7	-
MC4a	outfall	Maori Hd 1100m	Southdale Road	secondary 50/50/5/10^6	trickling filter	10.4.9	4/V, 2/IV,1/I
MC4b	outfall	Maori Hd 1100m	Southdale Road	secondary + disinfection 50/50/5/10^3	trickling filter + UV	10.4.9	-
MC4c	outfall	Maori Hd 1100m	Tahuna Southdale	primary + secondary 50/50/5/10^6	upgrade + trickling filter	10.4.3 + 10.4.9	-
MC4d	outfall	Maori Hd 1100m	Tahuna & Southdale	as MC4c + disinfection 50/50/5/10^3	as MC4c + UV	10.4.3 10.4.9	-

[A] Existing Lawyers Head outfall

[B] Effluent averages - variation would occur about these averages
SS = Suspended Solids, BOD_5 = Biochemical Oxygen Demand, O&G = Oil and Grease, FC = Faecal Coliforms (all in g/m^3 except FC as number per 100 ml)

[C] BAF = Biological Aerated Filter (Secondary Treatment), UV = Ultra Violet Light Disinfection
Proprietary = BAF + Memcor (Membrane Filtration - Refer Table 10.4.2)

[D] All include appropriate Musselburgh Pumping Station Upgrade

[E] Refer also relevant part of 10.6 - Outfalls

TABLE 12.3.2 : MUSSELBURGH CATCHMENT (MC) OPTIONS ESTIMATED COSTS SUMMARY ($ million)

Option	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital (rounded) 1+2+3=4	O & M pa 5	Capitalised O & M 6	TOTAL (rounded) 4+6
MC1a	Nil	10.0	Nil	10.0	0.8	10.2	20.2
MC1b	Nil	12.0	Nil	12.0	1.0	12.8	24.8
MC1c	Nil	41.0	Nil	41.0	2.2	28.1	69.1
MC1d	Nil	44.0	Nil	44.0	2.5	32.0	76.0
MC1e	Nil	109.0	Nil	109.0	5.5	70.3	179
MC2a	3.9	10.0	26.5	40.4	1.05	13.4	53.8
MC2b	3.9	12.0	26.5	42.4	1.25	16.0	58.4
MC2c	3.9	41.0	18.2	63.1	2.45	31.3	94.4
MC2d	3.9	44.0	18.2	66.1	2.75	35.2	101
MC2e	3.9	44.0	10.0	57.9	2.75	35.2	93.1
MC2f	3.9	109.0	10.0	123	5.75	73.5	197
MC3a	14.2	10.0	18.2	42.4	1.18	15.1	57.5
MC3b	14.2	12.0	18.2	44.4	1.38	17.6	62.0
MC3c	14.2	41.0	18.2	73.4	2.58	33.0	106
MC3d	14.2	44.0	18.2	76.4	2.88	36.8	113
MC3e	14.2	109.0	18.2	141.4	5.88	75.2	217
MC4a	18.3	42.0	18.2	78.5	1.45	18.5	97.0
MC4b	18.3	45.0	18.2	81.5	1.85	23.6	105
MC4c	18.7	37.5	18.2	74.4	2.35	30.0	104
MC4d	18.7	40.5	18.2	77.4	2.65	33.9	111

12.4 GREEN ISLAND CATCHMENT

(Refer Figure 10.2.6 and Tables 12.4.1, 12.4.2)

There are 12 options presented for this catchment, much less than for Musselburgh catchment because the main emphasis here is on the degree of treatment and to a lesser extent, the need to increase the length of the existing outfall, although options include a 600 m extension. There is no alternative treatment plant site nor outfall location considered.

There is a range of both advanced primary (some with an element of disinfection) and secondary treatment processes which are more fully described in Section 10.4. The treatment processes have to be suitable for the higher strength wastewater resulting from the major trade waste discharges in this catchment. In particular, oil and grease concentrations are high and specific removal methods of these floatable contaminants must be provided.

Assuming that the outfall is not substantially lengthened, then an important objective of upgraded treatment would be to reduce the microbiological and pathogen contaminants. Disinfection of effluents such as at Green Island, which have higher solids content and colour, can be difficult or ineffective if using chlorination or uv light methods.

However, the high lime process can be effective both for disinfection and coagulation of solids. If practiced with final clarification, a significantly improved effluent quality could be achieved with comparable total costs to other processes which do not achieve disinfection. Being a naturally occurring compound, lime does not have significant impacts on the receiving water.

TABLE 12.4.1 : GREEN ISLAND CATCHMENT (GIC) OPTIONS SUMMARY SCHEDULE

Option	Disposal		Treatment			Report[C] Ref.	Included in Representative Total Scheme
	Type	Details	Site	Effluent Standard[B] SS/BOD_5/O&G/FC	Process		
GIC1a	outfall	as is[A]	existing	advanced primary 300/700/150/10^6	floatation/ sedimentation	10.4.12	4/I, 4/II
GIC1b	outfall	as is[A]	existing	advanced primary 220/500/100/10^6	Dissolved air floatation (DAF)	10.4.12	-
GIC1c	outfall	as is[A]	existing	advanced primary 270/600/130/10^3	highlime	10.4.12	4/IV, 4/VI, 4/VII 3/II
GIC1d	outfall	as is[A]	existing	secondary 50/50/50/10^6	2-stage trickling filters	10.4.13	-
GIC1e	outfall	as is[A]	existing	secondary 50/50/30/10^6	anaerobic contact + aerobic stage	10.4.13	-
GIC1f	outfall	as is[A]	existing	secondary 50/50/30/10^3	anaerobic contact + aerobic stage + uv disinfection	10.4.13	-
GIC2	1100m outfall	extra 600 m	existing	as is	milliscreening	10.4.10	-
GIC2a	1100m outfall	extra 600 m	existing	advanced primary 300/700/150/10^6	floatation/ sedimentation	10.4.12	4/III, 3/I, 3/III 2/I, 2/II
GIC2b	1100m outfall	extra 600 m	existing	advanced primary 220/500/100/10^6	dissolved air floatation (DAF)	10.4.12	-
GIC2c	1100m outfall	extra 600 m	existing	advanced primary 270/600/130/10^3	highlime	10.4.12	2/III, 2/IV 3/IV
GIC2d	1100m outfall	extra 600 m	existing	secondary 50/50/50/10^6	2-stage trickling filters	10.4.13	4/V
GIC2e	1100m outfall	extra 600 m	existing	secondary 50/50/30/10^3	anaerobic contact + aerobic stage	10.4.13	-
GIC2f	1100m outfall	extra 600 m	existing	50/50/30/10^6	anaerobic contact + aerobic stage + uv disinfection	10.4.13	-

[A] the outfall would not be extended but there would be minor diffuser modifications.
[B] preliminary estimates of average effluent quality - considerable variability could be expected. in g/m^3 except FC as number per 100 ml)
[C] Also relevant parts of Section 10.6 dealing with Green Island (Waldronville) outfall.

TABLE 12.4.2 :
GREEN ISLAND CATCHMENT (GIC) OPTIONS ESTIMATED COSTS SUMMARY ($M)

Option	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital (rounded) 1+2+3=4	O & M pa 5	Capitalised O & M 6	TOTAL (rounded) 4+5
GIC1a	Nil	2.0	Nil	2.0	0.55	7.03	9.03
GIC1b	Nil	3.8	Nil	3.8	0.75	9.59	13.4
GIC1c	Nil	3.0	Nil	3.0	0.75	9.59	12.6
GIC1d	Nil	7.6	Nil	7.6	0.75	9.59	17.2
GIC1e	Nil	9.0	Nil	9.0	0.65	8.31	17.3
GIC1f	Nil	9.5	Nil	9.5	0.70	8.95	18.5
GIC2	Nil	Nil	7.8	7.8	0.32	4.10	11.9
GIC2a	Nil	2.0	7.8	9.8	0.55	7.03	16.8
GIC2b	Nil	3.8	7.8	11.6	0.75	9.59	21.2
GIC2c	Nil	3.0	7.8	10.8	0.75	9.59	20.4
GIC2d	Nil	7.6	7.8	15.4	0.75	9.59	25.0
GIC2e	Nil	9.0	7.8	16.8	0.65	8.31	25.1
GIC2f	Nil	9.5	7.8	17.3	0.70	8.95	26.2

12.5 MOSGIEL/TAIERI CATCHMENT

(Refer Figure 10.2.7 and Tables 12.5.1, 12.5.2)

This Stage 1 study brief has not required options to be investigated for upgrading the Mosgiel discharge into the Taieri River, or alternative disposal means for this catchment alone. A separate report is addressing this. This study has, however, considered conveying all wastewater out of this catchment to the adjoining Green Island catchment or beyond.

Further consideration of partial conveyance to GIC, for example dry weather flow only and leaving the balance of wet weather flows to be intermittently treated and otherwise disposed of into the Taieri River or elsewhere, has not been evaluated at this stage as policy decisions would be required.

TABLE 12.5.1 : MOSGIEL/TAIERI CATCHMENT (MTC) OPTIONS SUMMARY SCHEDULE

Option	Disposal	Treatment	Report Ref. Part	Included in Representative Total Scheme
MTC1	Convey all wastewater to GIC		10.27	3/III - 1/II

TABLE 12.5.2 :
MOSGIEL/TAIERI CATCHMENT (MTC) OPTIONS SCHEDULE ESTIMATED COSTS SUMMARY ($ M)

Option	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital (rounded) 1+2+3 = 4	O & M pa 5	Capitalised O & M 6	TOTAL (rounded) 4+6
MTC1	5.56	Nil	Nil	5.56	(0.233)	(2.98)	2.58

Note : ( ) = negative value, ie, a credit

Part 13.0

Representative Total Wastewater Treatment and Disposal Schemes

PART 13.0 : REPRESENTATIVE TOTAL WASTEWATER TREATMENT AND DISPOSAL SCHEMES

13.1 INTRODUCTION

There are several ways in which Council can reach a decision on wastewater treatment and disposal for the greater Dunedin area. One way is to pick several of the individual catchment options from Part 12.0 of this report and address these in an order of priority for each of the four catchments. The priority afforded to any catchment, and to the options in that catchment, would depend on the issues which are identified in the public consultation process. For example, the overriding concern of the community could be to improve or remove the harbour outfall discharges, in which case Council would pick up some of the HB options outlined in Section 12.2. This might not mean that other wastewater options in the other three catchments are ignored, but that they are given a lower priority. On the other hand, the community may come through with strong views on the need to improve or renew the Lawyers Head outfall, at the expense of any other improvements in GIC, HB or MTC. Council's options for the Musselburgh catchment, and for Tahuna and Maori Head are covered in Section 12.3. Alternatively, community concerns may focus on one other major treatment plant and outfall, Green Island, expressing the strong opinion that this plant be upgraded to the treatment level originally anticipated for this plant, ie, advanced primary. If community perceptions and feelings are strong enough, the Green Island Catchment option could be developed at the exclusion of, or in isolation from, any changes in the other catchments.

Similarly, if land disposal for the Harbour Basin was strongly preferred, this option presented in Part 12.0 (along with other land disposal schemes) could be further developed.

While the four selected outcomes of the public consultation phase given above are possible in theory, they are very unlikely to occur in practice. Because of the wide geographical spread of the options, there will be a widespread and vocal divergence of views as to what options should be given priority. Thus, it is probable that Council will make its preferred choice from a list of "schemes" which best address the concerns raised in each catchment and by the Dunedin community at large.

The 17 representative total schemes which are described in this part are, therefore, an amalgam of different catchment options which have been grouped on the basis of a particular selection criteria. It should be acknowledged that the list of 17 is by no means an exhaustive one because the large number of catchment options can be combined in very many ways.

However, the 17 schemes do give a comprehensive range of choices for Council and public to consider at the end of this Stage 1 study. They include examples of each of the catchment output concept levels as shown on Figure 7.3.1 and summarised below in Table 13.1.1.

TABLE 13.1.1

Concept Level	No of Schemes	Scheme Name
4	7	4/I, 4/II, 4/III, 4/V, 4/VI, 4/VII
3	4	3/I, 3/II, 3/III, 3/IV
2	4	2/I, 2/II, 2/III, 2/IV
1	2	1/I, 1/II
	17	

Within the following subsections 13.2 to 13.5, which refer to concept levels 4 through to 1, the representative total schemes are summarised briefly, shown schematically and geographically, and the capital and O&M cost estimates are summarised in tabular form. The latter tables are firstly resented as "total costs" for the scheme in each catchment and under the headings of the three components, conveyance, treatment and disposal. The second summary schedule shows the proportion of these total costs which may be attributable to trade waste discharges under the hypothetical charging regime used for the purposes of this report.

Of the 44 catchment options which were presented in Tables 12.2.1 to 12.51, there are 15 which are carried forward into this section. For ease of reference, the relevant individual catchment options are summarised below in a similar tabular form.

NOTE: All O&M costs shown are additional to those existing.

TABLE 13.1.2 :
REPRESENTATIVE TOTAL SCHEMES CATCHMENT OPTIONS SUMMARY SCHEDULE

Option F	Disposal		Treatment[D]			Report Ref. Part[E] Below and Table 10.4.2	Includedin Represent-ativeTotal Scheme
	Type	Details	Site	EffluenStandard SS/BOD/O&G/FC[B]	Process[C]		
MC1a	outfall	as is[A]	Tahuna	full primary 100/270/40/10^7	upgrade existing	10.4.4 & 10.6	4/I
MC1d	outfall	as is[A]	Tahuna	secondary + disinfection 20/20/2/2x10^2	BAF + UV	10.4.6	4/VI
MC2a	outfall	Tahuna 1600m	Tahuna	full primary 100/270/40/10^7	upgrade existing	10.4.4	4/II, 3/I,3/III 2/I
MC2c	outfall	Tahuna 1100m	Tahuna	secondary 20/20/2/5x10^5	BAF	10.4.6	4/IV,4/VII, 3/II,3/IV, 2/III
MC3a	outfall	Maori Hd 1100m	Tahuna	full primary 100/270/40/10^7	upgrade existing	10.4.4	4/III 2/II
MC4a	outfall	Maori Hd 1100m	Southdale Road	secondary 50/50/5/10^6	tricklingfilter	10.4.9	4/V, 2/IV,1/I
MTC1	convey	all	wastewater	to GIC		10.2.7	3/III-1/II
GIC1a	outfall	as is[G]	existing	advancedprimary[H] 300/700/150/10^6	floatation/ sedimentation	10.4.12	4/I,4/II
GIC1c	outfall	as is[G]	existing	advancedprimary[H] 270/600/130/10^3	highlime	10.4.12	4/IV,4/VI, 4/VII, 3/II
GIC2a	1100m outfall	extra 600 m	existing	advancedprimary[H] 300/700/150/10^6	floatation/ sedimentation	10.4.12	4/III, 3/I,3/III, 2/I,2/II
GIC2c	1100m outfall	extra 600 m	existing	advancedprimary[H] 270/600/130/10^3	highlime	10.4.12	2/III,2/IV, 3/IV
GIC2d	1100m outfall	extra 600 m	existing	secondary[H] 50/50/50/10^6	2-stage trickling filters	10.4.13	4/V
HB1a B PC CB BB	outfall outfall outfall outfall	as is new new[I] as is	all at existing plant sites	secondary 30/30/5/10^6	all plants upgradedas required(see text - Part 12.0)	10.4.15 to 19	4/Ito 4/VI, 3/III,3/IV
HB4 B	convey	sewage	to MC	and decommission	the plant	10.7	4/VII
PC CB BB	land disposal	Okia Flat	existing	secondary (no change)	no change		
HB5a	all	convey	sewageto and	MC (via road/rail decommission	reserveroute) the plants	10.2.6	[J]
HB5b	all	convey	sewageto and	MC (via harbour decommission	crossingsroute) the plants	10.2.6	3/I,3/II, 2/I,2/II, 2/III,2/IV, 1/I,1/II

[A] Existing Lawyers Head outfall
[B] Effluent averages - variation would occur about these averages
SS = Suspended Solids, BOD_5 = Biochemical Oxygen Demand, O&G = Oil and Grease, FC = Faecal Coliforms (all in g/m^3 except FC as number per 100 ml)
[C] BAF = Biological Aerated Filter (Secondary Treatment), UV = Ultra Violet Light Disinfection
Proprietary = BAF + Memcor (Membrane Filtration - Refer Table 10.4.2)
[D] MC options include appropriate Musselburgh Pumping Station Upgrade
[E] Refer also relevant part of 10.6 - Outfalls
[F] MC = Musselburgh Catchment; B = Burkes/St Leonards; PC = Port Chalmers; CB = Company Bay; BB = Broad Bay/Portobello
[G] The outfall would not be extended but there would be minor diffuser modifications.
[H] Preliminary estimates of average effluent quality - considerable variability could be expected.
[I] effluent would be conveyed from Company Bay to the Grassy Point outfall
[J] could have HB5a option in representative schemes shown for HB5b (instead of HB5b) at additional estimated capital cost - see text - Part 12.0.

TABLE 13.1.3 :
REPRESENTATIVE TOTAL SCHEMES CATCHMENT OPTIONS ESTIMATED COSTS SUMMARY ($ M)

Option	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital (rounded) 1+2+3=4	O & M pa 5	Capitalised O & M 6	TOTAL (rounded) 4+6
MC1a	Nil	10.0	Nil	10.0	0.8	10.2	20.2
MC1d	Nil	44.0	Nil	44.0	2.5	32.0	76.0
MC2a	3.9	10.0	26.5	40.4	1.05	13.4	53.8
MC2c	3.9	41.0	18.2	63.1	2.45	31.3	94.4
MC3a	14.2	10.0	18.2	42.4	1.18	15.1	57.5
MC4a	18.3	42.0	18.2	78.5	1.45	18.5	97.0
GIC1a	Nil	2.0	Nil	2.0	0.55	7.03	9.03
GIC1c	Nil	3.0	Nil	3.0	0.75	9.59	12.6
GIC2a	Nil	2.0	7.8	9.8	0.55	7.03	16.8
GIC2c	Nil	3.0	7.8	10.8	0.75	9.59	20.4
GIC2d	Nil	7.6	7.8	15.4	0.75	9.59	25.0
HB1a	1.69	1.65	0.35	3.69	0.12	1.59	5.28
HB4	11.1	Nil	0.75	11.9	0.20	2.52	14.4
HB5a	13.5	Nil	Nil	13.5	(0.24)	(3.11)	10.4
HB5b	9.23	Nil	Nil	9.23	(0.28)	(3.63)	5.60
MTC1	5.56	Nil	Nil	5.56	(0.233)	(2.98)	2.58

Note: ( ) = negative value, ie, a credit

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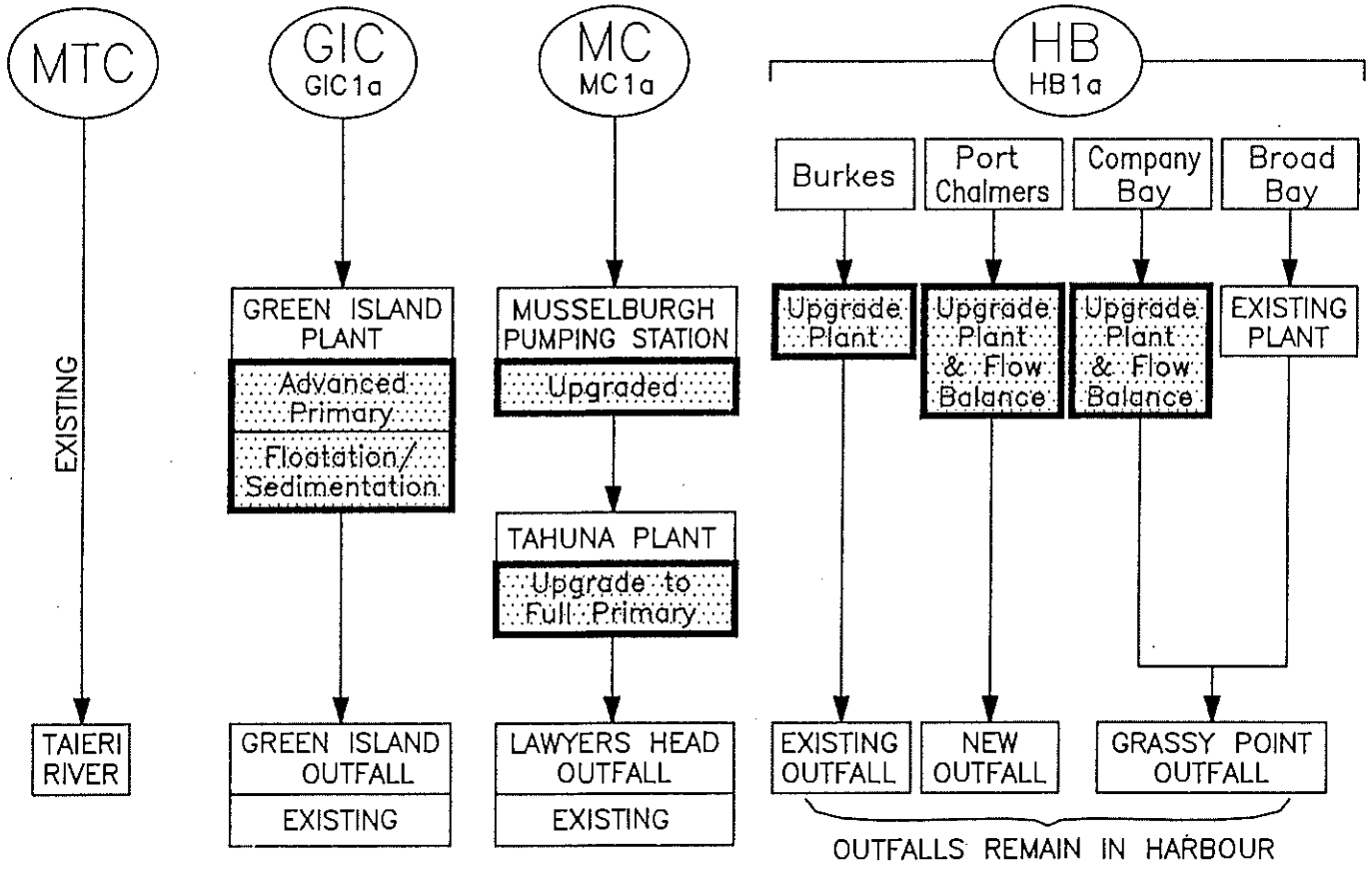
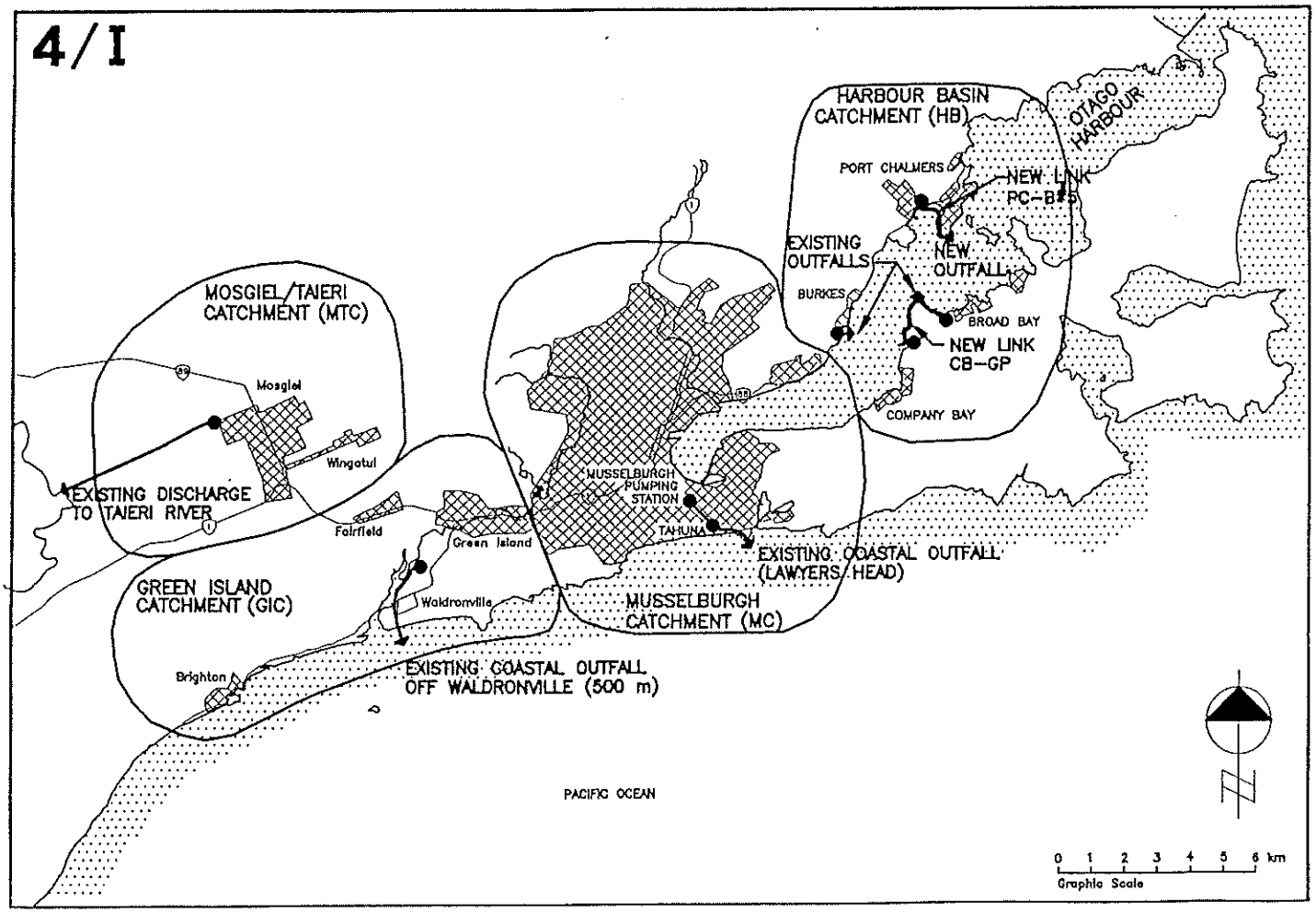
SCHEME 4/I
(CONCEPT LEVEL 4)

MARGINAL UPGRADE, EXISTING COASTAL OUTFALLS





13.2 CONCEPT LEVEL FOUR SCHEMES - 4/I TO 4/VIII

SCHEME 4/I

Key Environmental Issues

HB1a

- Improves harbour water quality in general by consistently higher quality effluent.
- Removes localised pollution problems in Sawyers Bay and Company Bay areas.
- Does not significantly reduce nutrient load to harbour in total, but discharges effluent into better flushed areas.
- Retains existing four sewage treatment plants with associated environmental impacts.

MC1a

- Some improvement at beaches around Lawyers Head particularly with grease lines and solids, but not of bacteriological/pathogen levels.
- Disadvantages of continued use of Lawyers Head discharge point as some shoreline and beaches will continue to contain some proportions of treated effluent.
- Totally relies on treatment plant performance to maintain sea water standards.
- Uses upgraded Tahuna treatment plant with associated siting considerations.

GIC1a

- Improvement of ocean and shoreline water quality, in particular with regard to grease and solids.
- Little improvement in discolouration effects of discharge when viewed from air.
- Provides limited shoreline separation.
- Retains existing but upgraded Green Island treatment plant with associated environmental considerations.

MTC

- Mosgiel remains as existing.

SCHEME 4/I

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEDULE ($ M)

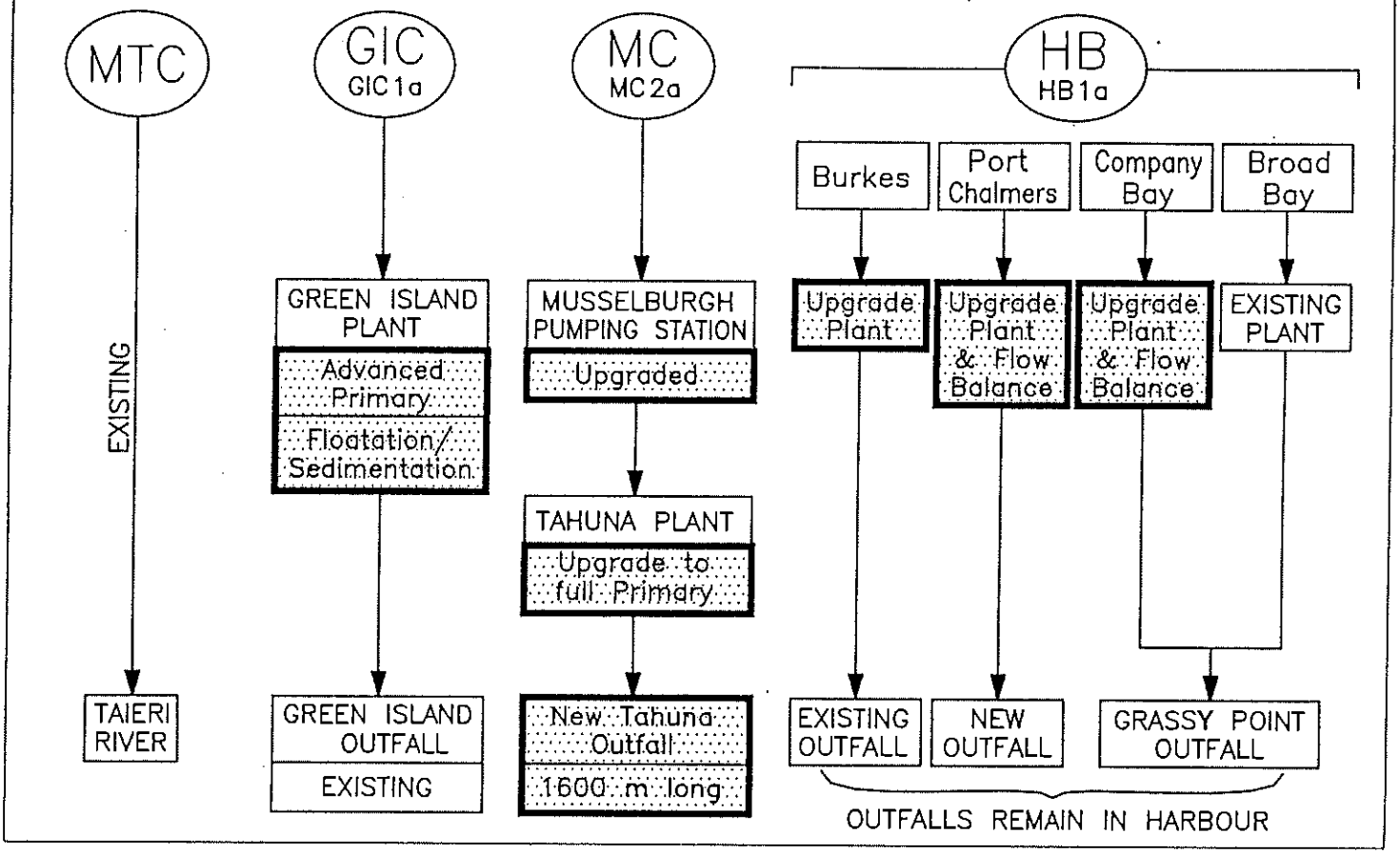
Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB)	1.69	1.65	0.350	3.69	0.124	1.59	5.28
Musselburgh (MC)	Nil	10.0	Nil	10.0	0.80	10.2	20.2
Green Island (GIC)	Nil	2.00	Nil	2.00	0.55	7.03	9.03
Mosgiel (MTC)	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)	1.69	13.7	0.350	15.7	1.47	18.8	34.5

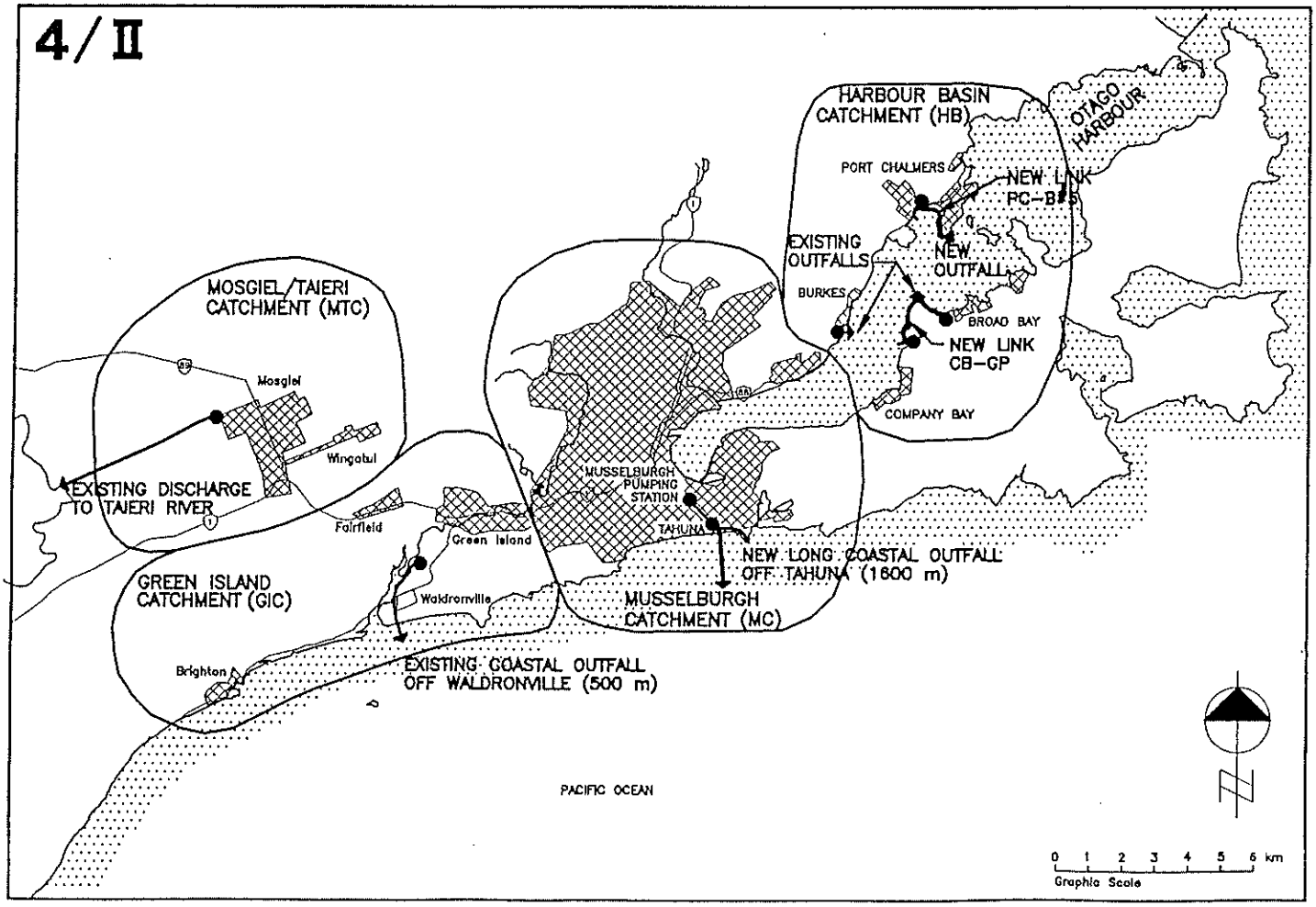
TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB	%	10	40	10		10		
	$	0.17	0.66	0.04	0.87	0.012	0.15	1.02
MC	%		40			50		
	$	Nil	4.00	Nil	4.00	0.400	5.11	9.11
GIC	%		40			60		
	$	Nil	0.80	Nil	0.80	0.330	4.22	5.02
MTC	%							
	$	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)		0.17	5.46	0.04	5.67	0.742	9.48	15.2

SCHEME 4/II
(CONCEPT LEVEL 4)

PRIMARY (MC), LONG OUTFALL, ADV. PRIMARY (GIC), EXISTING OUTFALL





SCHEME 4/II

Key Environmental Features

HB1a

- Improves harbour water quality in general by consistently higher quality effluent.
- Removes localised pollution problems in Sawyers Bay and Company Bay areas.
- Does not significantly reduce nutrient load to harbour in total, but discharges effluent into better flushed areas.
- Retains existing four sewage treatment plants with associated environmental impacts.

MC2a

- Significant improvement of water quality at shoreline and on beaches, should meet bathing standards at beaches.
- Potential for movement of full primary treated effluent further afield from ocean discharge zone.
- Good shoreline separation (1600 m).
- Effluent discharge field should barely be visible from air.
- Uses an upgraded Tahuna treatment plant with associated siting considerations as for MC1a.
- Less reliance on treatment plant performance for maintenance of sea water quality at shoreline through buffering effect of separation distance.

GIC1a

- Improvement of ocean and shoreline water quality, in particular with regard to grease and solids.
- Little improvement in discolouration effects of discharge when viewed from air.
- Provides limited shoreline separation.
- Retains existing but upgraded Green Island treatment plant with associated environmental considerations.

MTC

- Mosgiel remains as existing.

SCHEME 4/II

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEDULE ($ M)

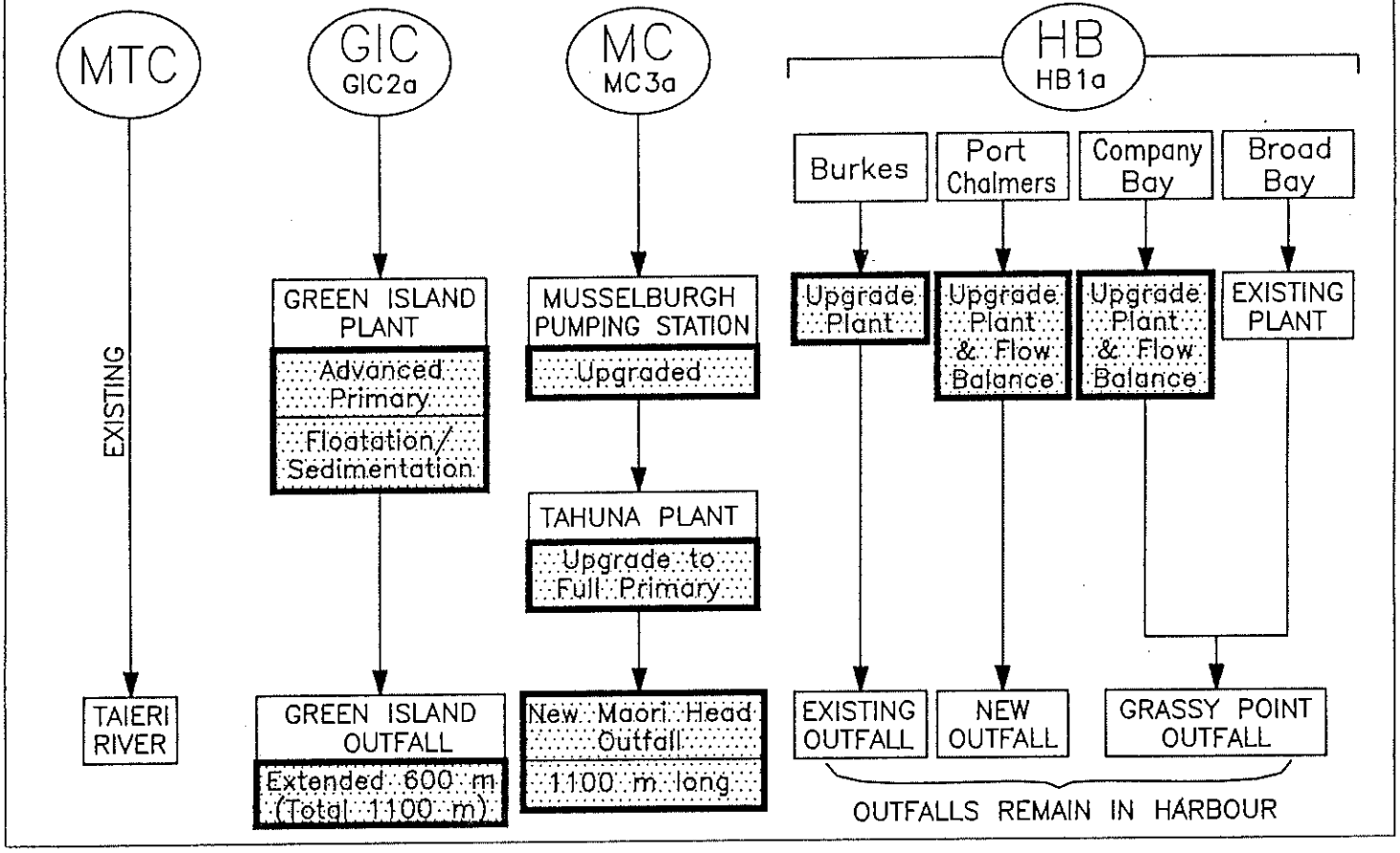
Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB)	1.69	1.65	0.35	3.69	0.124	1.59	5.28
Musselburgh (MC)	3.90	10.0	26.5	40.4	1.05	13.4	53.8
Green Island (GIC)	Nil	2.00	Nil	2.00	0.55	7.03	9.03
Mosgiel (MTC)	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)	5.59	13.7	26.9	46.2	1.72	22.0	68.1

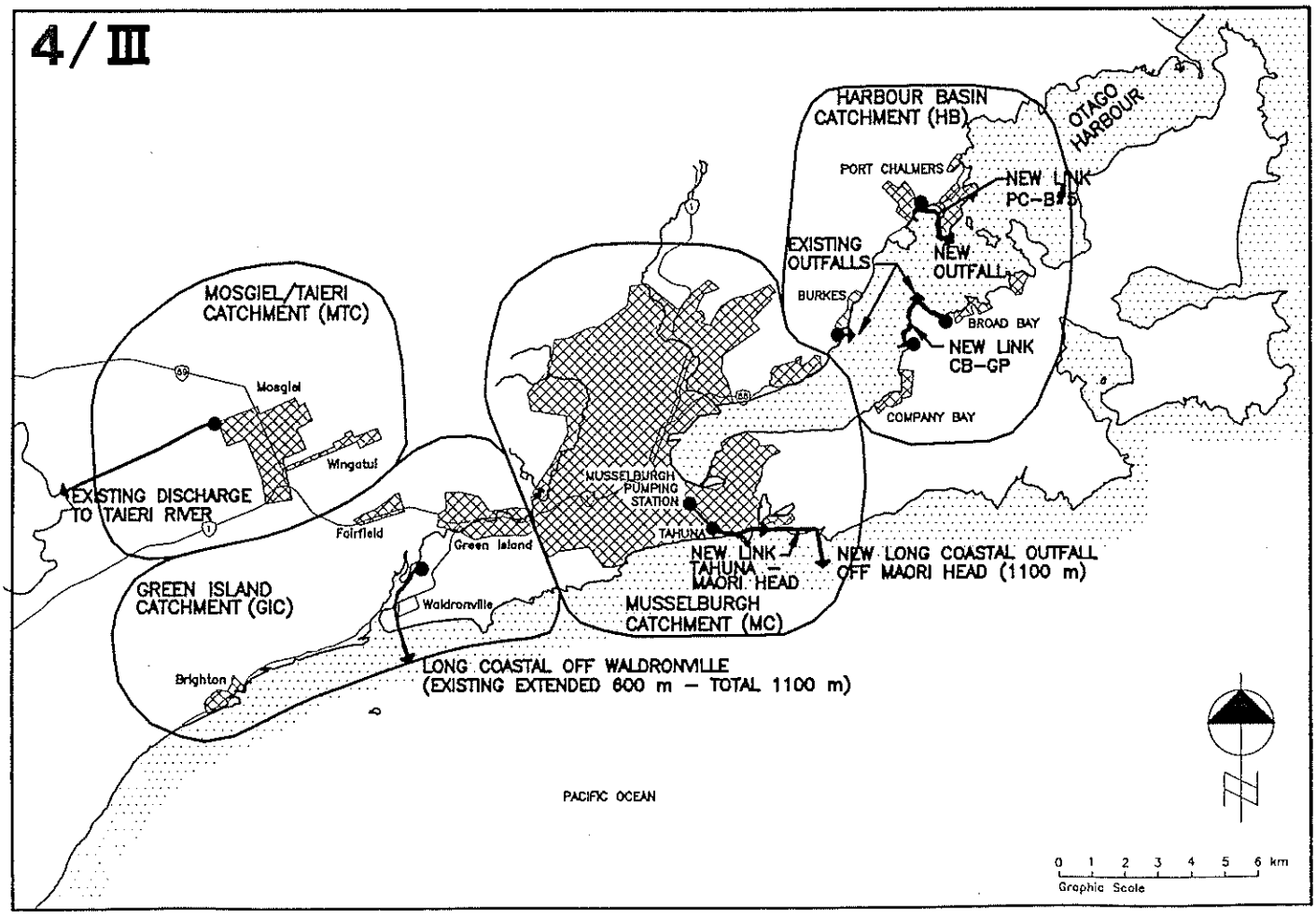
TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB	%	10	40	10		10		
	$	0.17	0.66	0.04	0.87	0.012	0.15	1.02
MC	%	10	40	10		50		
	$	0.39	4.00	2.65	7.04	0.525	6.71	13.8
GIC	%		40			60		
	$	Nil	0.80	Nil	0.80	0.330	4.22	5.02
MTC	%							
	$	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)		0.56	5.46	2.69	8.71	0.867	11.1	19.8

SCHEME 4/III
(CONCEPT LEVEL 4)

PRIMARY (MC), ADVANCED PRIMARY (GIC) AND LONG OUTFALLS (MAORI HEAD AND GREEN ISLAND)





SCHEME 4/III

Key Environmental Features

HB1a

- Improves harbour water quality in general by consistently higher quality effluent.
- Removes localised pollution problems in Sawyers Bay and Company Bay areas.
- Does not significantly reduce nutrient load to harbour in total, but discharges effluent into better flushed areas.
- Retains existing four sewage treatment plants with associated environmental impacts.

MC3a

- Generally all as for MC2a but with greater distance from main Dunedin beaches, therefore meeting bathing standards.
- Investigations needed to ensure no adverse ecological effects of effluent field moving up coast as will occur for most of time.
- Good shoreline separation of effluent discharge location.

GIC2a

- More significant improvement over GIC1a but with same treatment plant considerations.
- Much longer shoreline separation than presently.
- Potential for contamination of waters around Green Island requires detailed investigation.
- Same treatment plant impacts as GIC1a.

MTC

- Mosgiel remains as existing.

SCHEME 4/III

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEDULE ($ M)

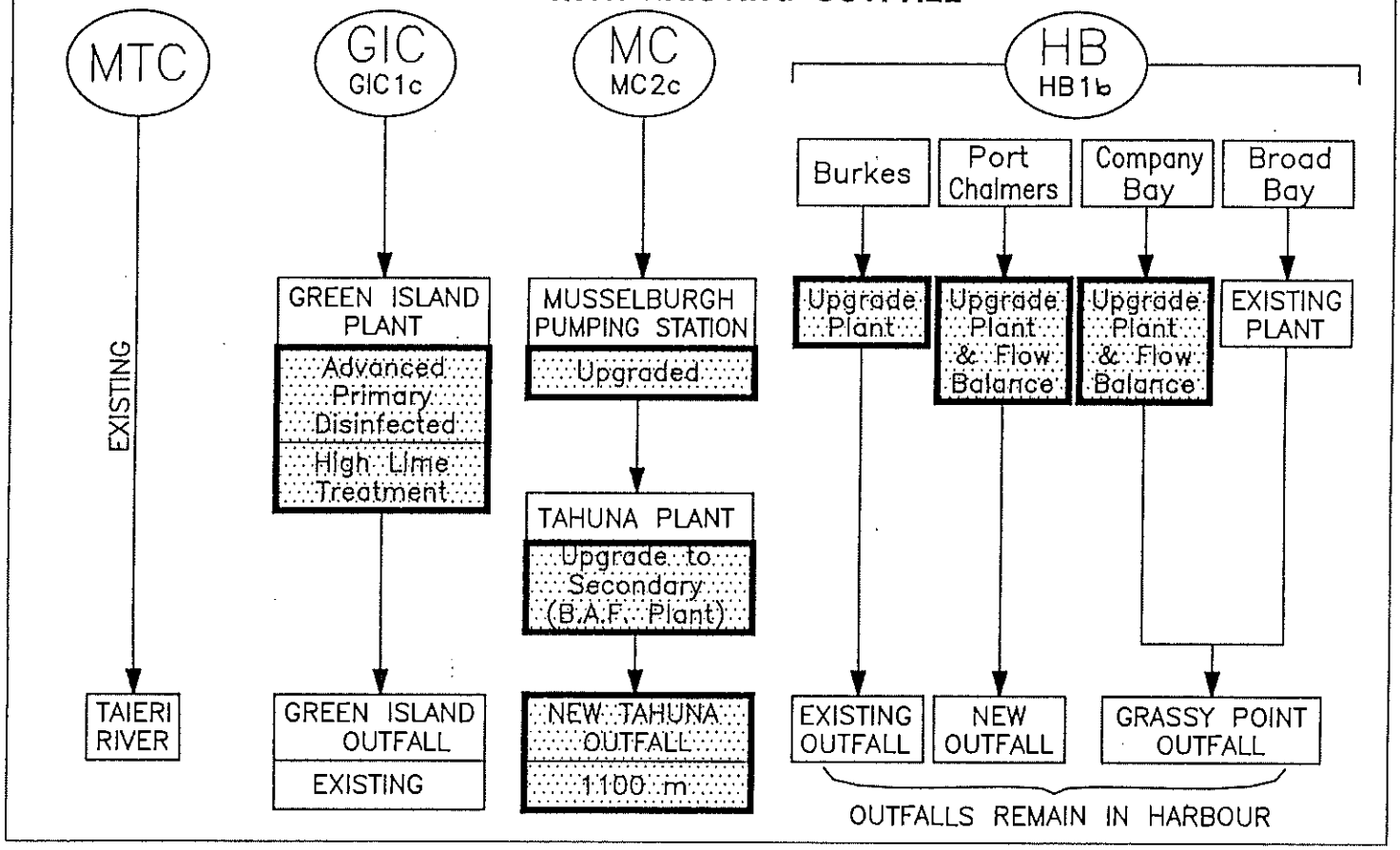
Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB)	1.69	1.65	0.35	3.69	0.124	1.59	5.28
Musselburgh (MC)	14.2	10.0	18.2	42.4	1.18	15.1	57.5
Green Island (GIC)	Nil	2.00	7.80	9.80	0.55	7.03	16.8
Mosgiel (MTC)	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)	15.9	13.7	26.4	55.9	1.85	23.7	79.6

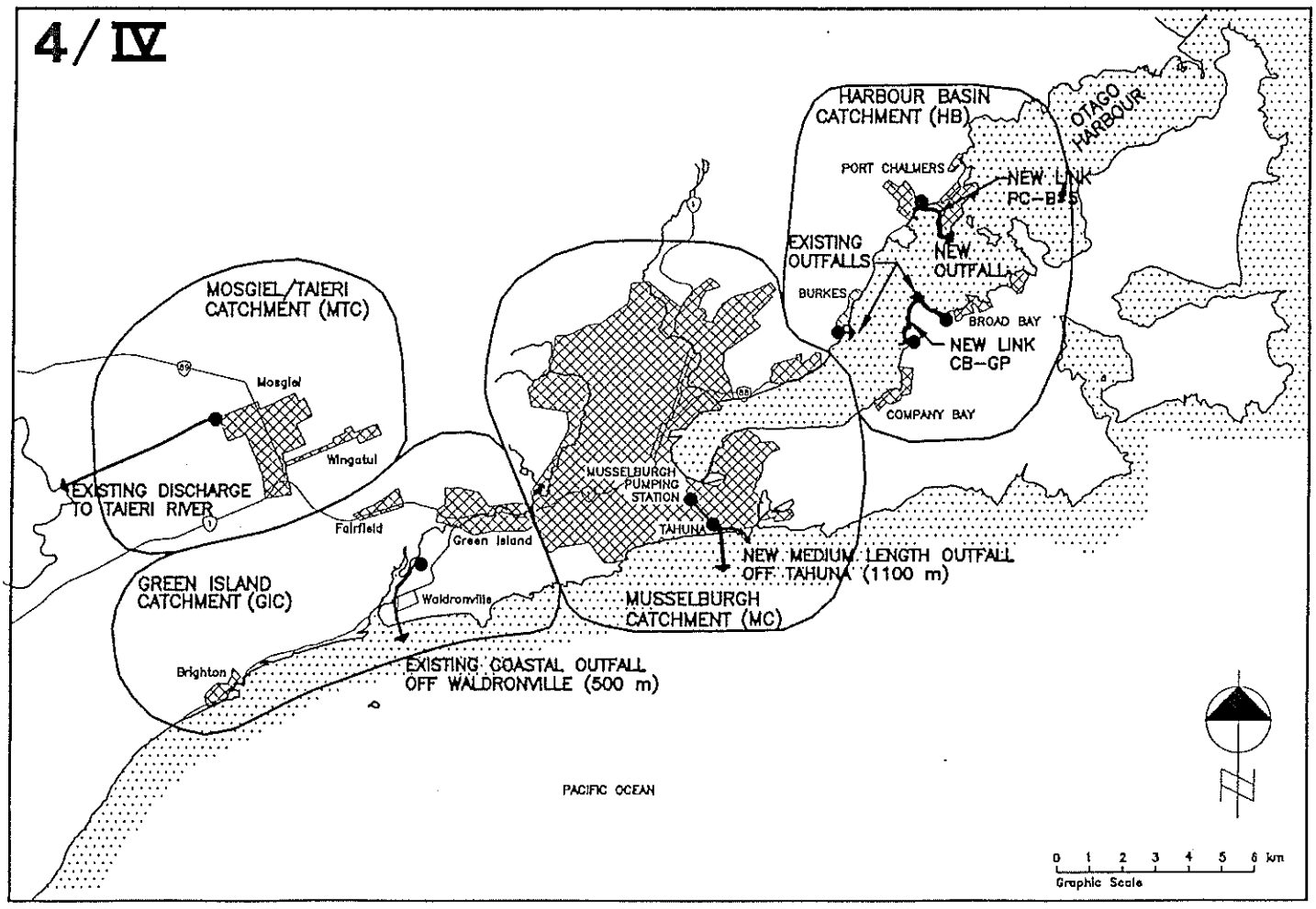
TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB	%	10	40	10		10		
	$	0.17	0.66	0.83	1.66	0.012	0.15	1.81
MC	%	10	40	10		50		
	$	1.42	4.00	5.42	10.8	0.590	7.54	18.3
GIC	%		40	10		65		
	$	Nil	0.80	0.80	1.60	0.358	4.58	6.18
MTC	%							
	$	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)		1.59	5.46	7.05	14.1	0.960	12.3	26.4

SCHEME 4/IV
(CONCEPT LEVEL 4)

SECONDARY TREATMENT (MC), MEDIUM OUTFALL, DISINFECTED ADVANCED PRIMARY (GIC) WITH EXISTING OUTFALL





SCHEME 4/IV

Key Environmental Features

HB1b

- Improves harbour water quality in general by consistently higher quality effluent.
- Removes localised pollution problems in Sawyers Bay and Company Bay areas.
- Does not significantly reduce nutrient load to harbour in total, but discharges effluent into better flushed areas.
- Retains existing four sewage treatment plants with associated environmental impacts.
- Provides significantly reduced bacteriological and pathogen load to harbour.

MC2c

- Significant improvement in sea water quality at shoreline over scheme MC2a. Will meet bathing standards at all beaches.
- Little likelihood of environmental effects beyond immediate effluent discharge mixing zone in the ocean.
- Adequate shoreline separation (1100 m).
- As for MC1d with extensively upgraded Tahuna treatment plant with associated siting considerations including greater amounts of sludge and other residuals byproducts.
- Still has a reasonable degree of reliance on treatment plant performance to maintain shoreline water quality.

GIC1c

- Improvement of ocean and shoreline water quality, in particular with regard to grease and solids.
- Little improvement in discolouration effects of discharge when viewed from air.
- Provides adequate shoreline separation.
- Retains existing but upgraded Green Island treatment plant with associated environmental impacts.
- Reduction in numbers of bacteria discharged to environment, with related improvement to water quality (depending on degree of disinfection).

MTC

- Mosgiel remains as existing.

SCHEME 4/IV

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEDULE ($ M)

Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB)	1.69	1.85	0.35	3.89	0.15	1.94	5.83
Musselburgh (MC)	3.90	41.0	18.2	63.1	2.42	31.3	94.4
Green Island (GIC)	Nil	3.00	Nil	3.00	0.75	9.59	12.6
Mosgiel (MTC)	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)	5.59	45.9	18.6	70.0	3.32	42.8	113

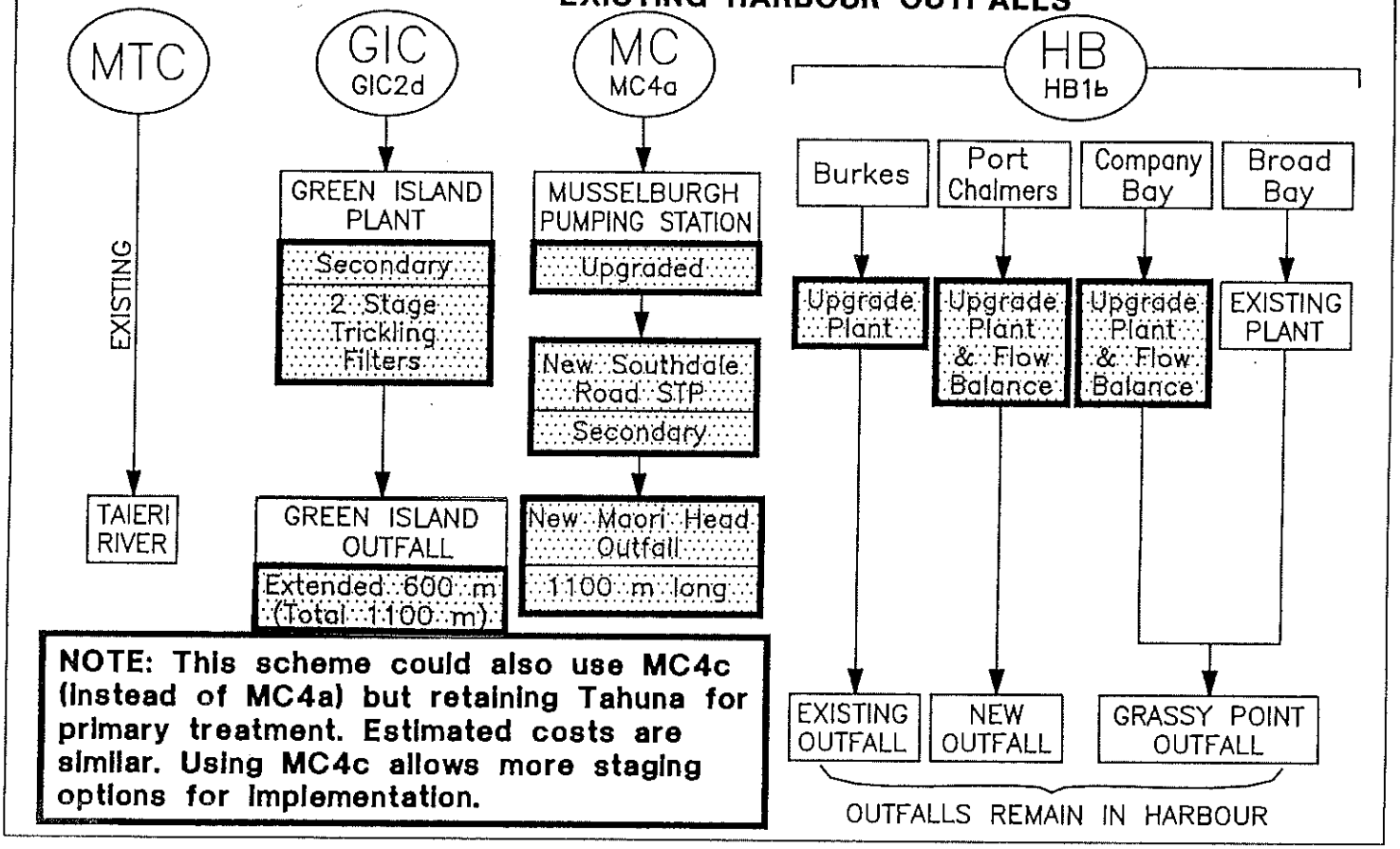
TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB	%	10	40	10		10		
	$	0.17	0.74	0.04	0.95	0.015	0.19	1.14
MC	%	10	40	10		50		
	$	0.39	16.4	1.82	18.6	1.210	15.5	34.1
GIC	%		40			65		
	$	Nil	1.20	Nil	1.20	0.488	6.24	7.44
MTC	%							
	$	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)		0.56	18.3	1.86	20.8	1.713	21.9	42.7

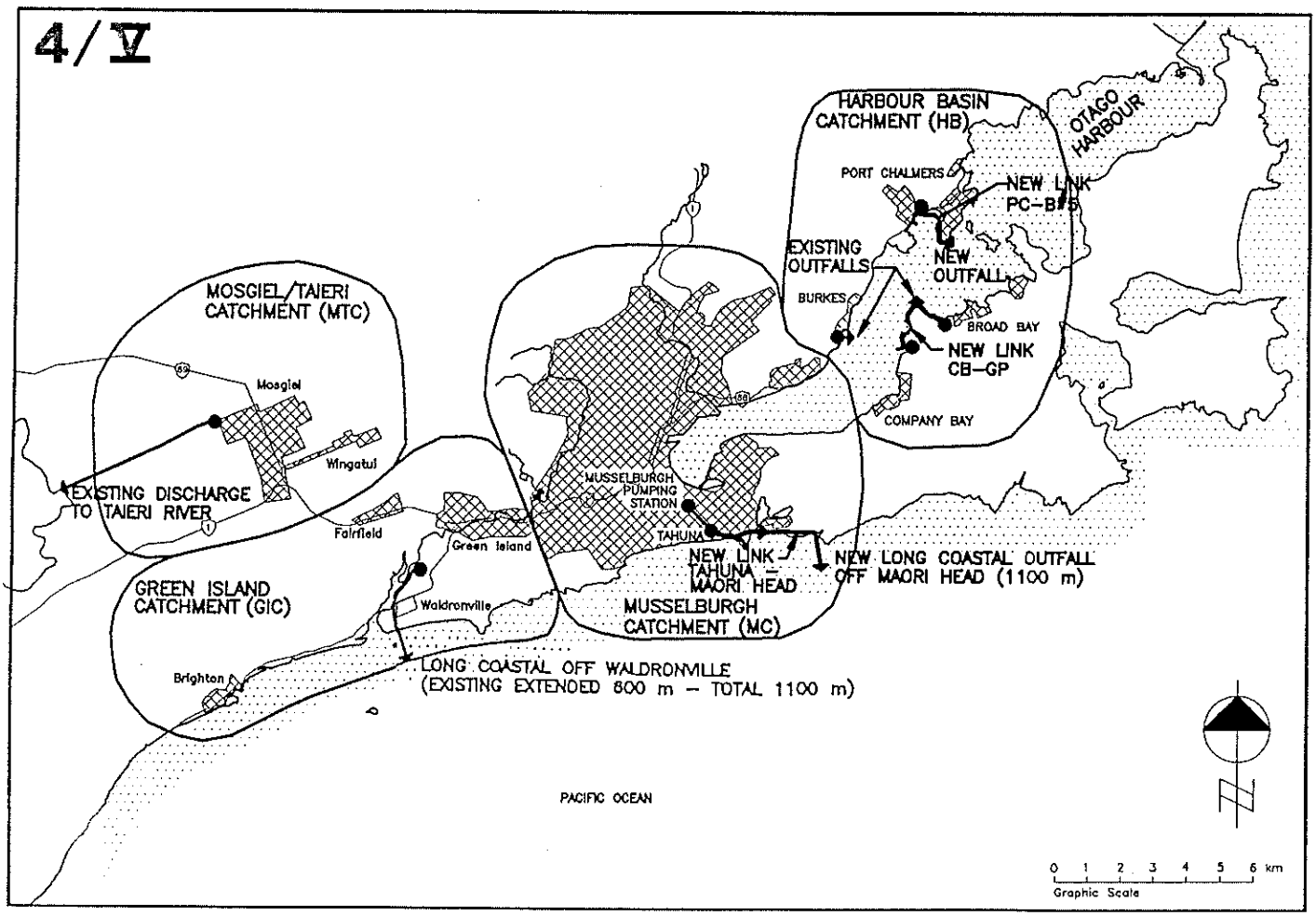
SCHEME 4/V

(CONCEPT LEVEL 4)

SECONDARY (MC), LONG OUTFALL (MAORI HEAD), SECONDARY (GIC), LONG OUTFALL EXISTING HARBOUR OUTFALLS



NOTE: This scheme could also use MC4c (instead of MC4a) but retaining Tahuna for primary treatment. Estimated costs are similar. Using MC4c allows more staging options for implementation.



SCHEME 4/V

Key Environmental Issues

HB1b

- Improves harbour water quality in general by consistently higher quality effluent.
- Removes localised pollution problems in Sawyers Bay and Company Bay areas.
- Does not significantly reduce nutrient load to harbour in total, but discharges effluent into better flushed areas.
- Retains existing four sewage treatment plants with associated environmental impacts.
- Provides significantly reduced bacteriological and pathogen load to harbour.

MC4a

- All disposal impacts of a secondary effluent out the 1100 m Maori Head outfall the same as MC3d above.
- Environmental considerations associated with establishing a new treatment plant site and associated residuals management at a Southdale Road site.
- Decommissions existing Tahuna plant.

GIC2d

- Substantial improvement of shoreline water quality.
- Significantly greater protection of environmental values (including aesthetics).
- Much longer shoreline separation than present.
- Same treatment plant and increase sludge production impacts as for GIC1d.

MTC

- Mosgiel remains as existing.

SCHEME 4/V

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEDULE ($ M)

Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB)	1.69	1.85	0.35	3.89	0.15	1.94	5.83
Musselburgh (MC)	18.3	42.0	18.2	78.5	1.45	18.5	97.0
Green Island (GIC)	Nil	7.60	7.80	15.4	0.75	9.59	25.0
Mosgiel (MTC)	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)	20.0	51.5	26.4	97.8	2.35	30.0	128

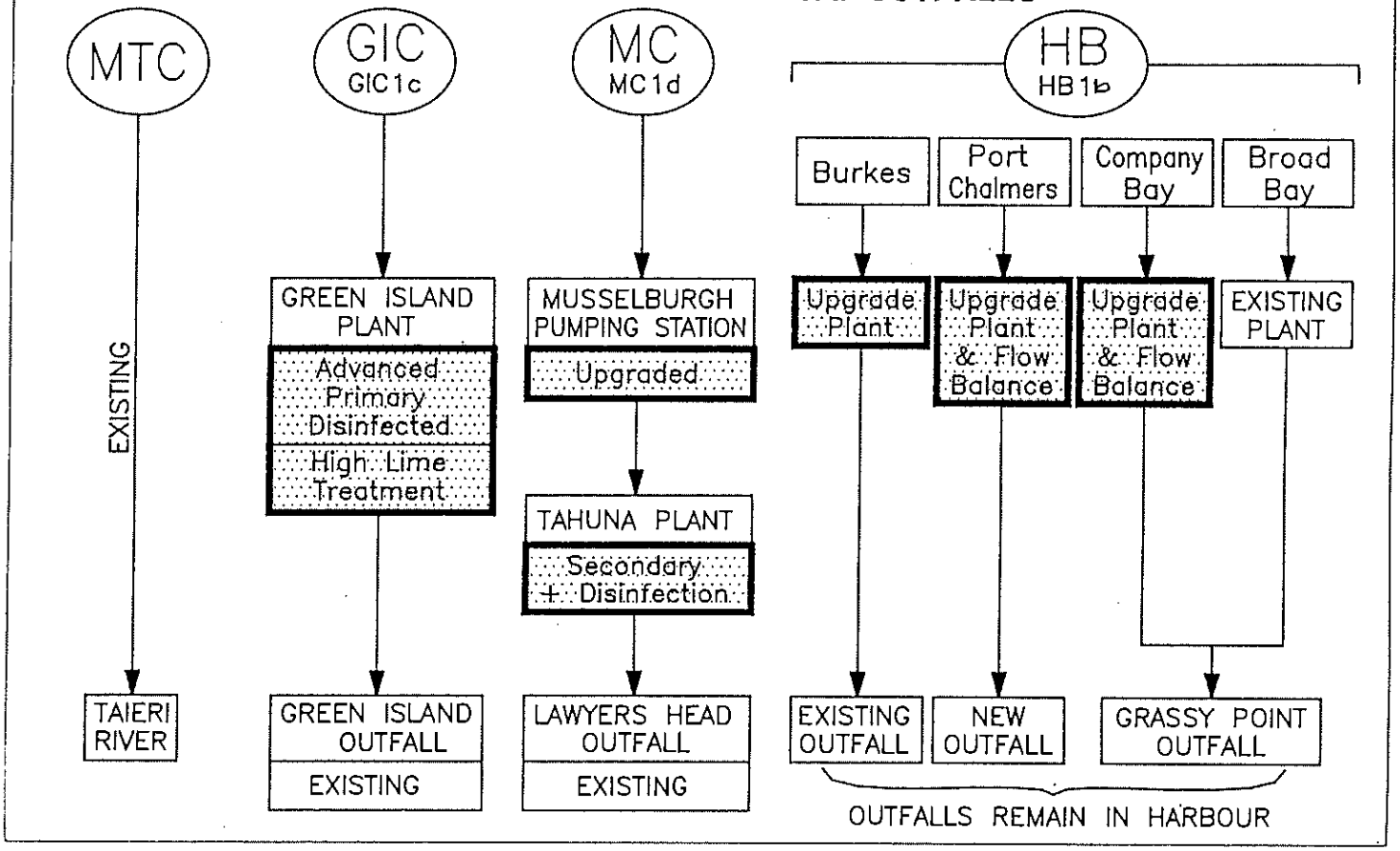
TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

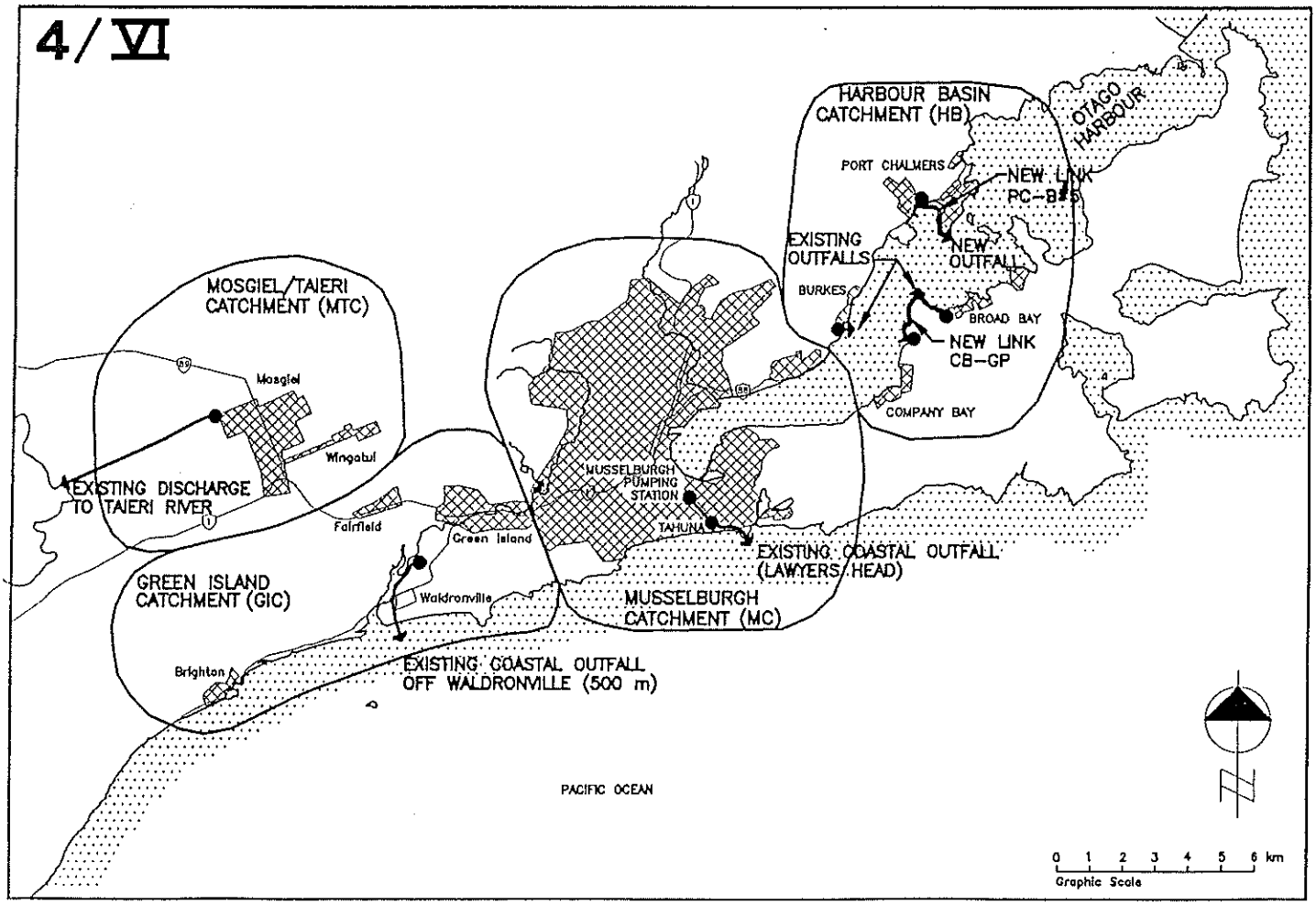
Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB	%	10	40	10		10		
	$	0.17	0.74	0.04	0.94	0.015	0.19	1.14
MC	%	10	40	10		50		
	$	1.83	16.8	1.82	20.5	0.725	9.27	29.8
GIC	%		40	10		65		
	$	Nil	3.04	0.78	3.82	0.488	6.24	10.1
MTC	%							
	$	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)		2.00	20.6	2.64	25.3	1.23	15.7	41.0

SCHEME 4/VI

(CONCEPT LEVEL 4)

SECONDARY DISINFECTED (MC), DISINFECTED ADVANCED PRIMARY (GIC) WITH EXISTING OUTFALLS





SCHEME 4/VI

Key Environmental Features

HB1b

- Improves harbour water quality in general by consistently higher quality effluent.
- Removes localised pollution problems in Sawyers Bay and Company Bay areas.
- Does not significantly reduce nutrient load to harbour in total, but discharges effluent into better flushed areas.
- Retains existing four sewage treatment plants with associated environmental impacts.
- Provides significantly reduced bacteriological and pathogen load to harbour.

MC1d

- Significant improvement of water quality around Lawyers Head and associated beaches, including bacteriological/ pathogen quality, meeting bathing standards.
- Question of perception of use of Lawyers Head even for a disinfected secondary effluent. Sea water at adjacent shoreline and beaches will still have same proportion of effluent but of a much higher standard.
- No shoreline separation of the discharge.
- Totally relies on treatment plant performance to maintain sea water quality standards.
- Uses extensively upgraded Tahuna treatment plant with associated siting considerations. Need to handle greater amounts of sludge and other residual byproducts.

GIC1c

- Improvement of ocean and shoreline water quality, in particular with regard to grease and solids.
- Little improvement in discolouration effects of discharge when viewed from air.
- Provides adequate shoreline separation.
- Retains existing but upgraded Green Island treatment plant with associated environmental impacts.
- Reduction in numbers of bacteria discharged to environment, with related improvement to water quality (depending on degree of disinfection).

MTC

- Mosgiel remains as existing.

SCHEME 4/VI

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEDULE ($ M)

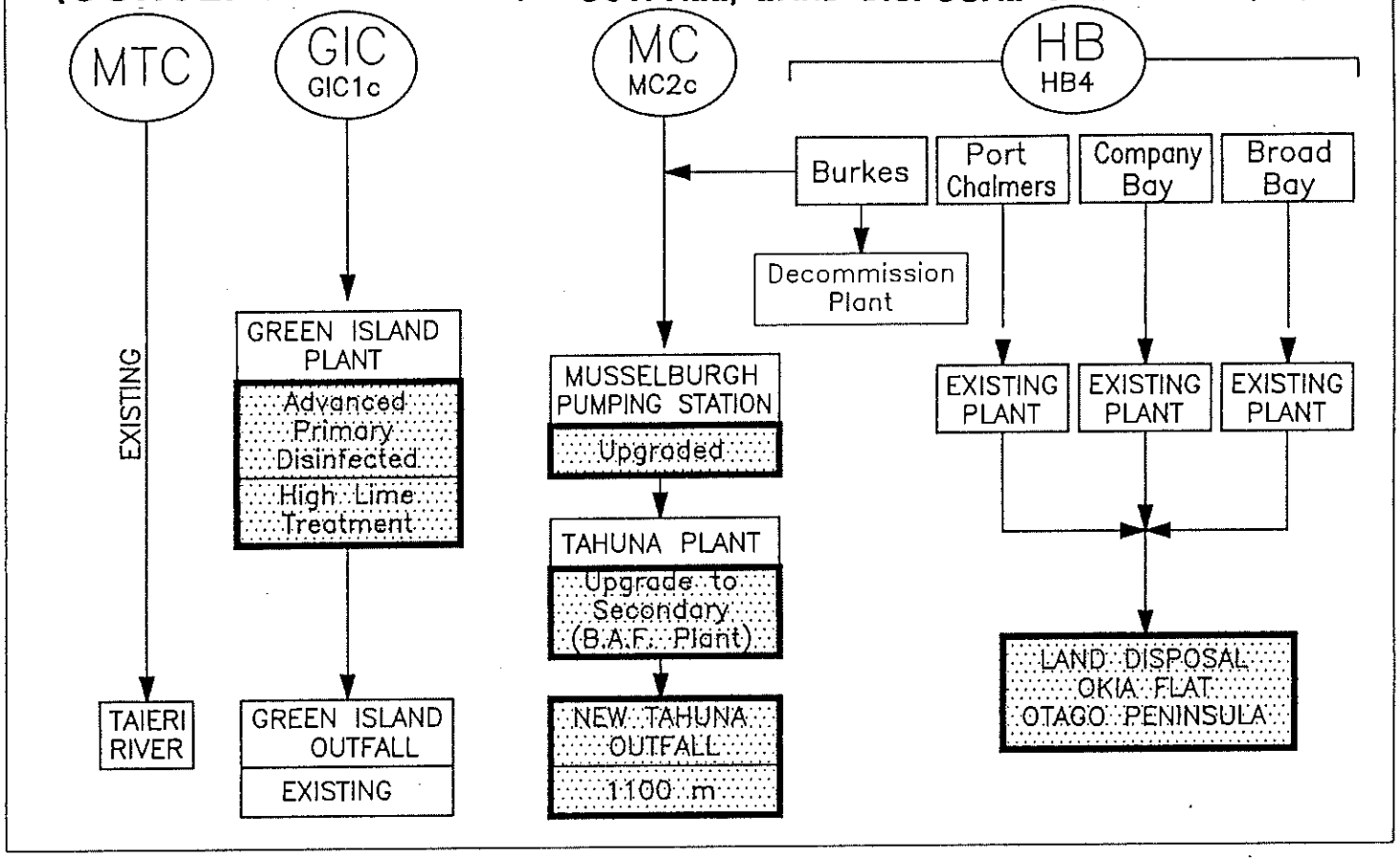
Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB)	1.69	1.85	0.35	3.89	0.15	1.94	5.83
Musselburgh (MC)	Nil	44.0	Nil	44.0	2.50	32.0	76.0
Green Island (GIC)	Nil	3.00	Nil	3.00	0.75	9.59	12.6
Mosgiel (MTC)	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)	1.69	48.9	0.35	50.9	3.40	43.5	94.4

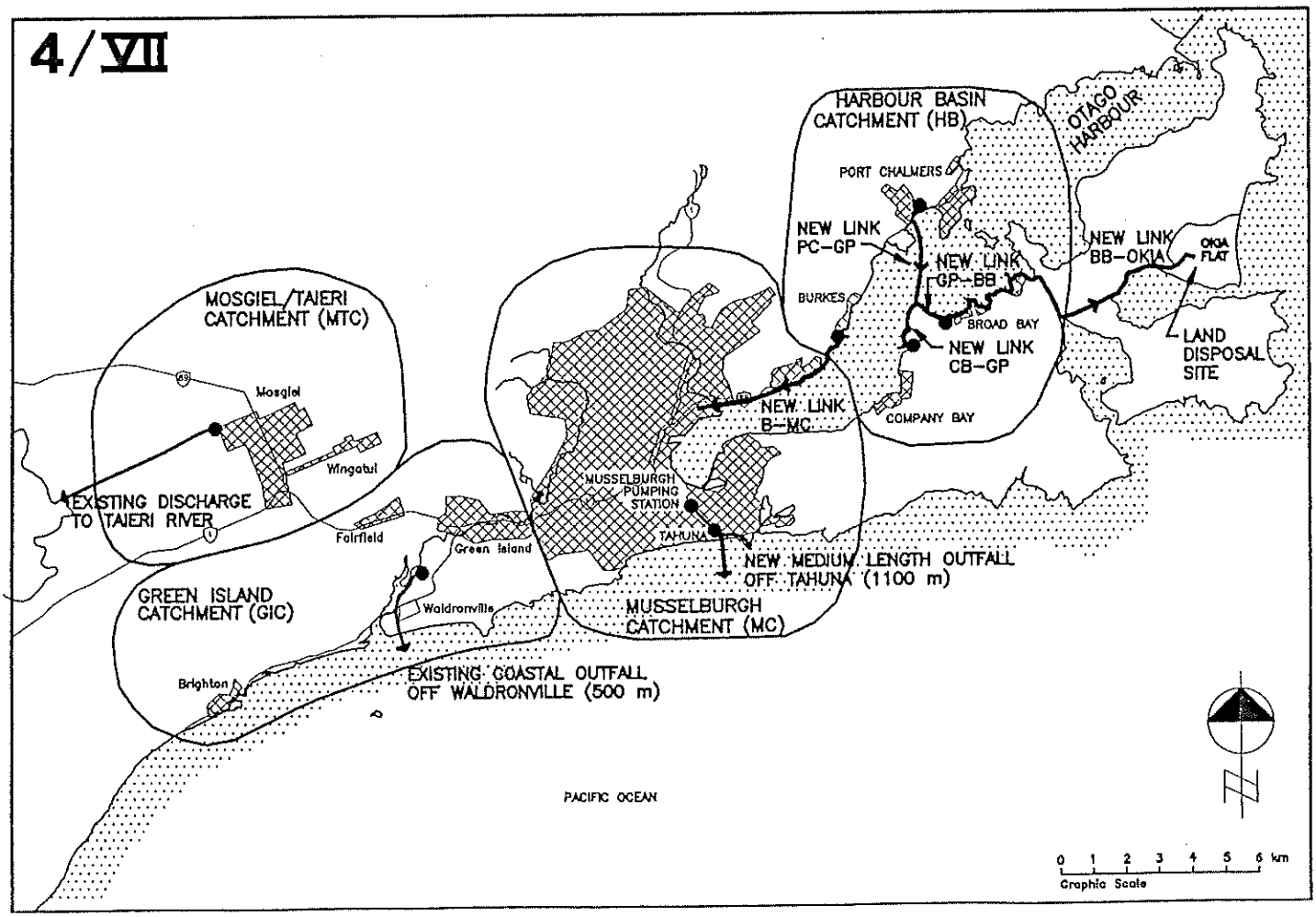
TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB	%	10	40	10		10		
	$	0.17	0.74	0.04	0.95	0.015	0.19	1.14
MC	%	10	40	10		50		
	$	Nil	17.6	Nil	17.6	1.25	16.0	33.6
GIC	%		40			65		
	$	Nil	1.20	Nil	1.20	0.488	6.24	7.44
MTC	%							
	$	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)		0.17	19.5	0.04	19.8	1.753	24.4	42.2

SCHEME 4/VII
(CONCEPT LEVEL 4)

SECONDARY (MC), MEDIUM OUTFALL (TAHUNA), DISINFECTED ADV. PRIMARY (GIC), EXISTING OUTFALL, LAND DISPOSAL OKIA FLAT (HB)





SCHEME 4/VII

Key Environmental Features

HB4
- Removes all four treated wastewater discharges from the harbour basin.
- Decommission Burkes plant with associated local environmental improvements.
- Land disposal impacts associated with use of Okia Flat (full environmental impact investigation needed to provide scheme acceptance).

MC2c
- Significant improvement in sea water quality at shoreline over scheme MC2a. Will meet bathing standards at all beaches.
- Little likelihood of environmental effects beyond immediate effluent discharge mixing zone in the ocean.
- Adequate shoreline separation (1100 m).
- As for MC1d with extensively upgraded Tahuna treatment plant with associated siting considerations including greater amounts of sludge and other residuals byproducts.
- Still has a reasonable degree of reliance on treatment plant performance to maintain shoreline water quality.

GIC1c
- Improvement of ocean and shoreline water quality, in particular with regard to grease and solids.
- Little improvement in discolouration effects of discharge when viewed from air.
- Provides adequate shoreline separation.
- Retains existing but upgraded Green Island treatment plant with associated environmental impacts.
- Reduction in numbers of bacteria discharged to environment, with related improvement to water quality (depending on degree of disinfection).

MTC
- Mosgiel remains as existing.

SCHEME 4/VII

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEDULE ($ M)

Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB)	11.1	Nil	0.75	11.9	0.20	2.52	14.4
Musselburgh (MC)	3.9	41.0	18.2	63.1	2.45	31.3	94.4
Green Island (GIC)	Nil	3.0	Nil	3.0	0.75	9.59	12.6
Mosgiel (MTC)	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)	15.0	44.0	19.0	78.0	3.40	43.4	121

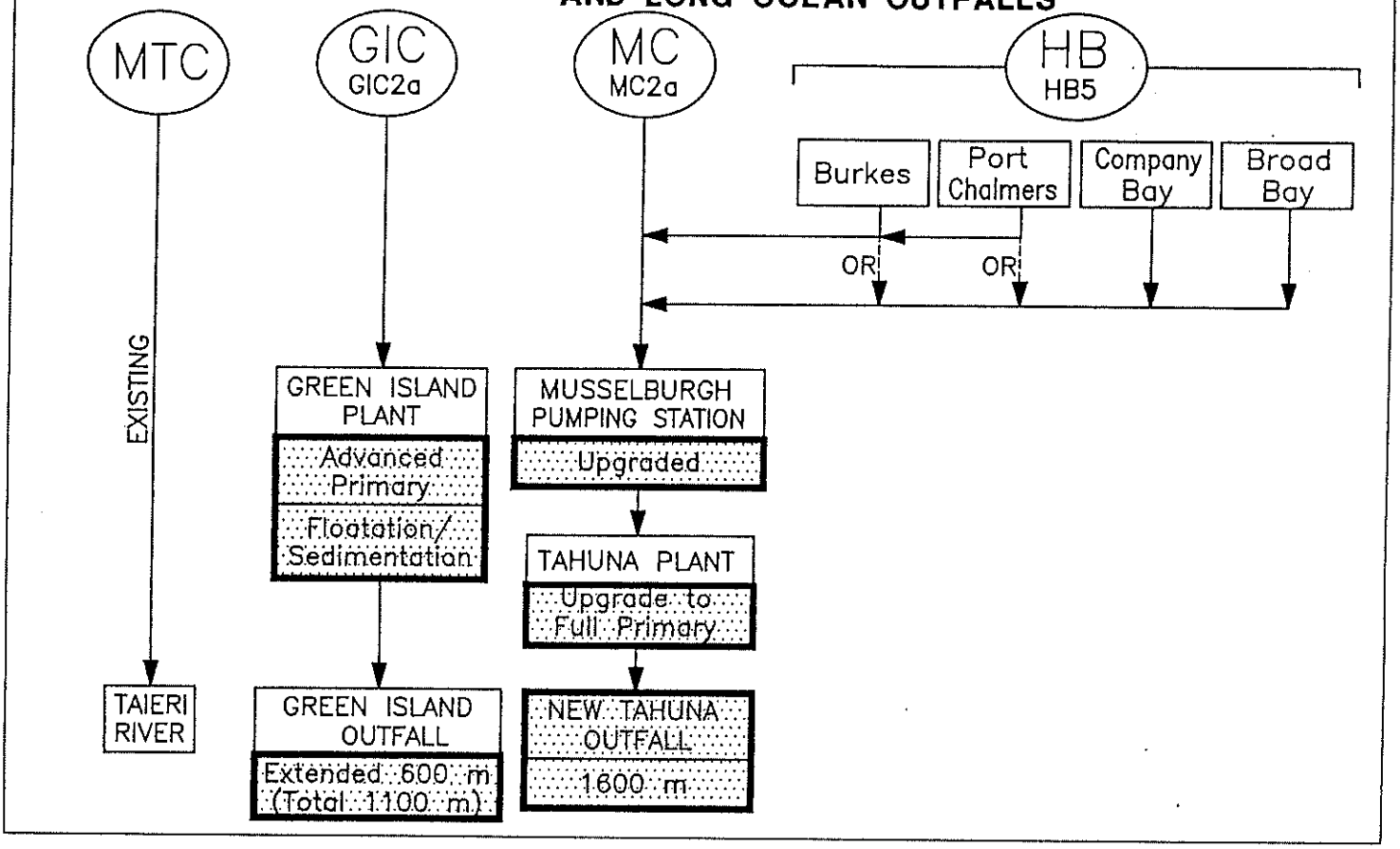
TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

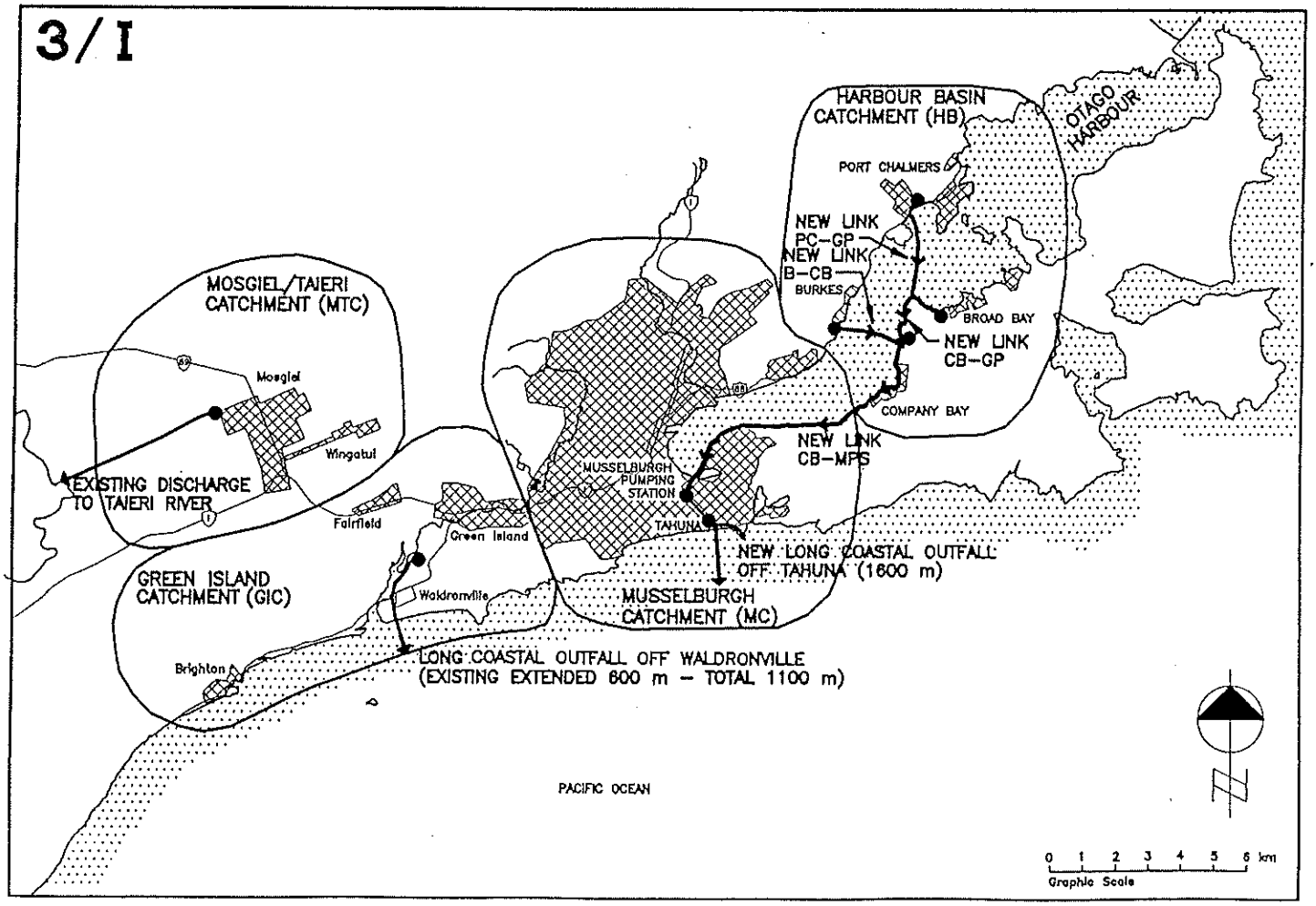
Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB	%	10	40	10		20		
	$	1.11	Nil	0.08	1.19	0.040	0.51	1.70
MC	%	10	40	10		50		
	$	0.39	16.4	1.82	18.6	1.225	15.7	34.3
GIC	%		40			65		
	$	Nil	1.20	Nil	1.20	0.488	6.24	7.44
MTC	%							
	$	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)		1.50	17.6	1.90	21.0	1.75	22.4	43.4

SCHEME 3/I

(CONCEPT LEVEL 3)

PRIMARY (MC), DISINFECTED ADV. PRIMARY (GIC), INTER-CATCHMENT TRANSFER (HB-MC) AND LONG OCEAN OUTFALLS





13.3 CONCEPT LEVEL THREE SCHEMES - 3/I TO 3/IV

SCHEME 3/I

Key Environmental Features

HB5b

- Removes all four discharges from the harbour basin.
- Decommission the four treatment plants with associated local environmental improvements.
- Raises questions of conveyance pipeline risks and reliability in the harbour bed itself in scheme HB5b (the lower cost one) compared to HB5a which has all pipelines in road and rail reserves.

MC2a

- Significant improvement of water quality at shoreline and on beaches, should meet bathing standards at beaches.
- Potential for movement of full primary treated effluent further afield from ocean discharge zone.
- Good shoreline separation (1600 m).
- Effluent discharge field should barely be visible from air.
- Uses an upgraded Tahuna treatment plant with associated siting considerations as for MC1a.
- Less reliance on treatment plant performance for maintenance of sea water quality at shoreline through buffering effect of separation distance.

GIC2a

- More significant improvement over GIC1a but with same treatment plant considerations.
- Much longer shoreline separation than presently.
- Potential for contamination of waters around Green Island requires detailed investigation.
- Same treatment plant impacts as GIC1a.

MTC

- Mosgiel remains as existing.

SCHEME 3/I

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEDULE ($ M)

Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB) Musselburgh (MC)	13.1	10.5	26.5	50.1	0.82	10.4	60.5
Green Island (GIC)	Nil	2.00	7.8	9.80	0.55	7.03	16.8
Mosgiel (MTC)	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)	13.1	12.5	34.3	59.9	1.37	17.4	77.3

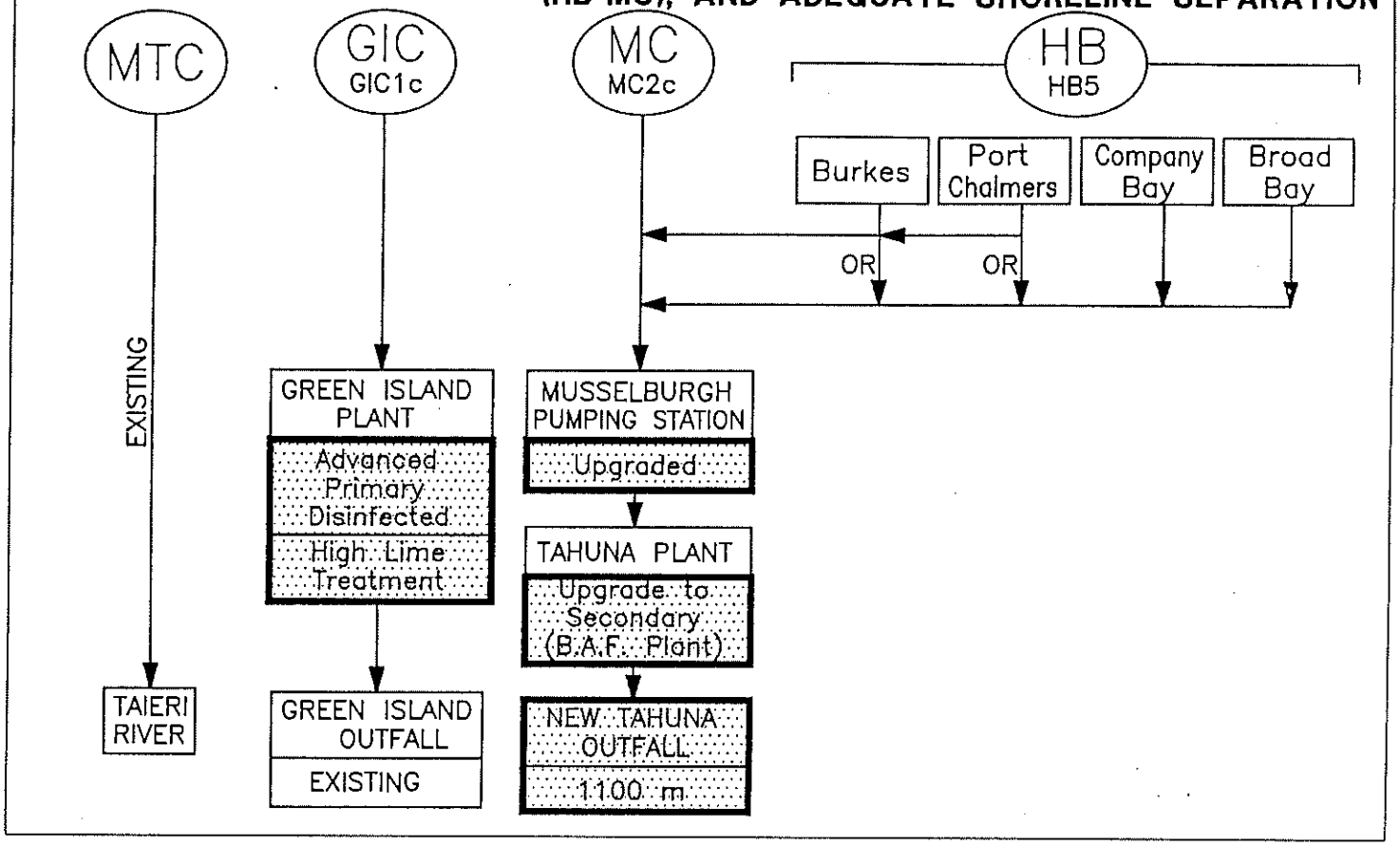
TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

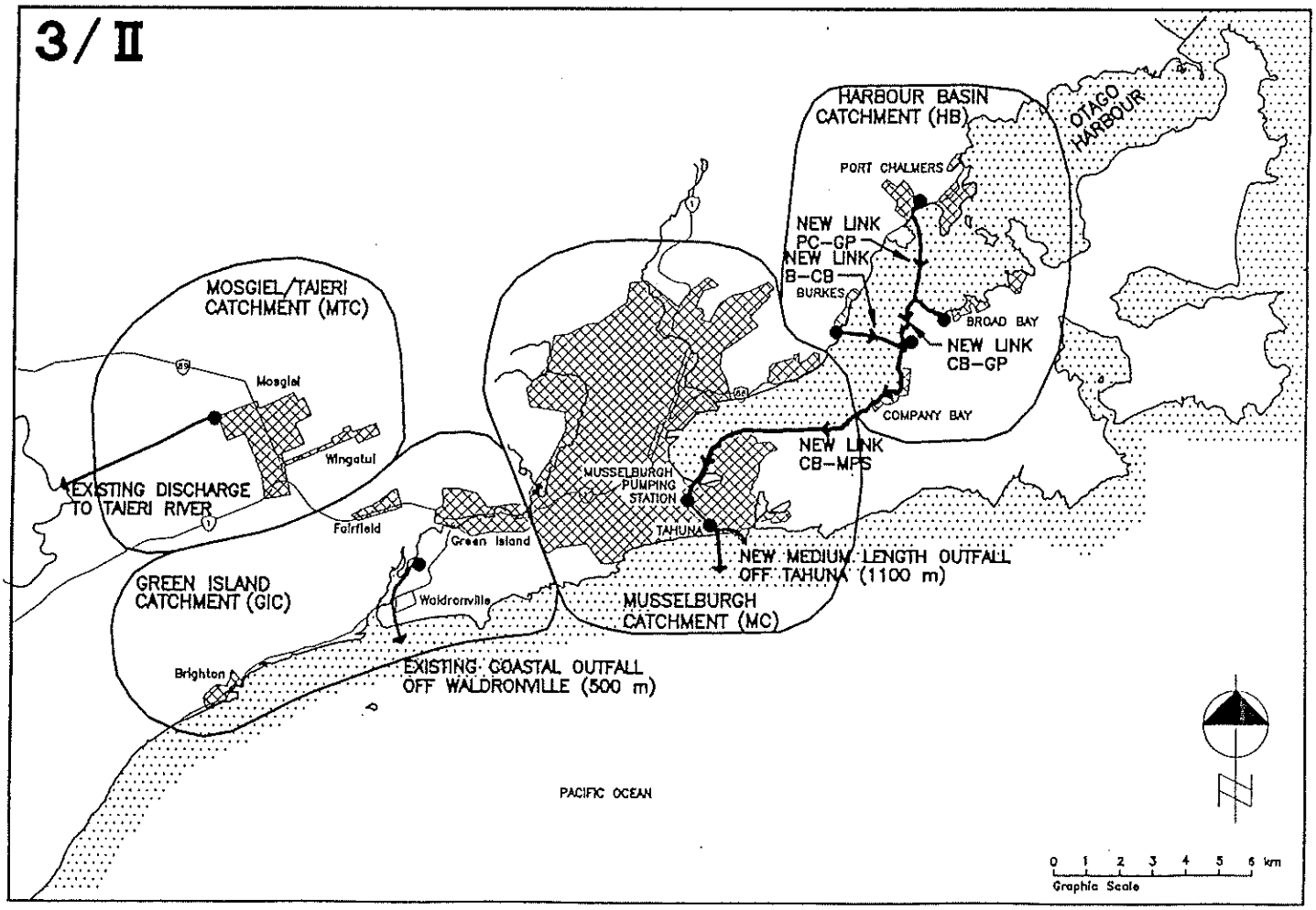
Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB	%	10	40	10		50		
MC	$	1.31	4.20	2.65	8.16	0.410	5.24	13.4
GIC	%		40	10		65		
	$	Nil	0.80	0.78	1.58	0.358	4.58	6.16
MTC	%							
	$	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)		1.31	5.00	3.43	9.74	0.768	9.82	19.6

SCHEME 3/ II

(CONCEPT LEVEL 3)

SECONDARY (MC), DISINFECTED ADVANCED PRIMARY (GIC), INTER-CATCHMENT TRANSFER (HB-MC), AND ADEQUATE SHORELINE SEPARATION





SCHEME 3/II

Key Environmental Features

HB5b

- Removes all four discharges from the harbour basin.
- Decommission the four treatment plants with associated local environmental improvements.
- Raises questions of conveyance pipeline risks and reliability in the harbour bed itself in scheme HB5b (the lower cost one) compared to HB5a which has all pipelines in road and rail reserves.

MC2c

- Significant improvement in sea water quality at shoreline over scheme MC2a. Will meet bathing standards at all beaches.
- Little likelihood of environmental effects beyond immediate effluent discharge mixing zone in the ocean.
- Adequate shoreline separation (1100 m).
- As for MC1d with extensively upgraded Tahuna treatment plant with associated siting considerations including greater amounts of sludge and other residuals byproducts.
- Still has a reasonable degree of reliance on treatment plant performance to maintain shoreline water quality.

GIC1c

- Improvement of ocean and shoreline water quality, in particular with regard to grease and solids.
- Little improvement in discolouration effects of discharge when viewed from air.
- Provides adequate shoreline separation.
- Retains existing but upgraded Green Island treatment plant with associated environmental impacts.
- Reduction in numbers of bacteria discharged to environment, with related improvement to water quality (depending on degree of disinfection).

MTC

- Mosgiel remains a existing.

SCHEME 3/II

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEDULE ($ M)

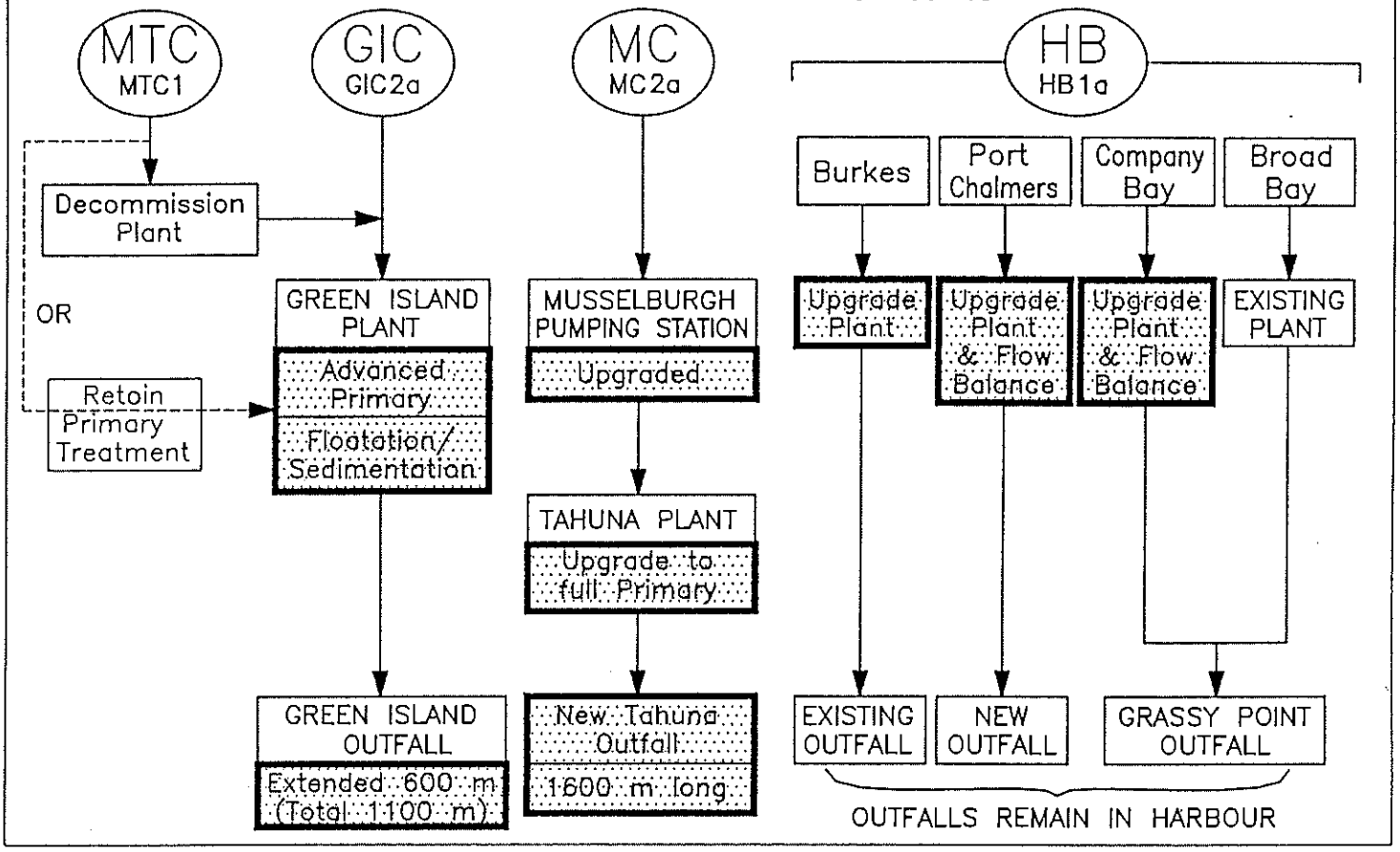
Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB) Musselburgh (MC)	13.1	41.8	18.2	73.1	2.27	29.0	102
Green Island (GIC)	Nil	3.00	Nil	3.00	0.75	9.59	12.6
Mosgiel (MTC)	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)	13.1	44.8	18.2	76.1	3.02	38.6	115

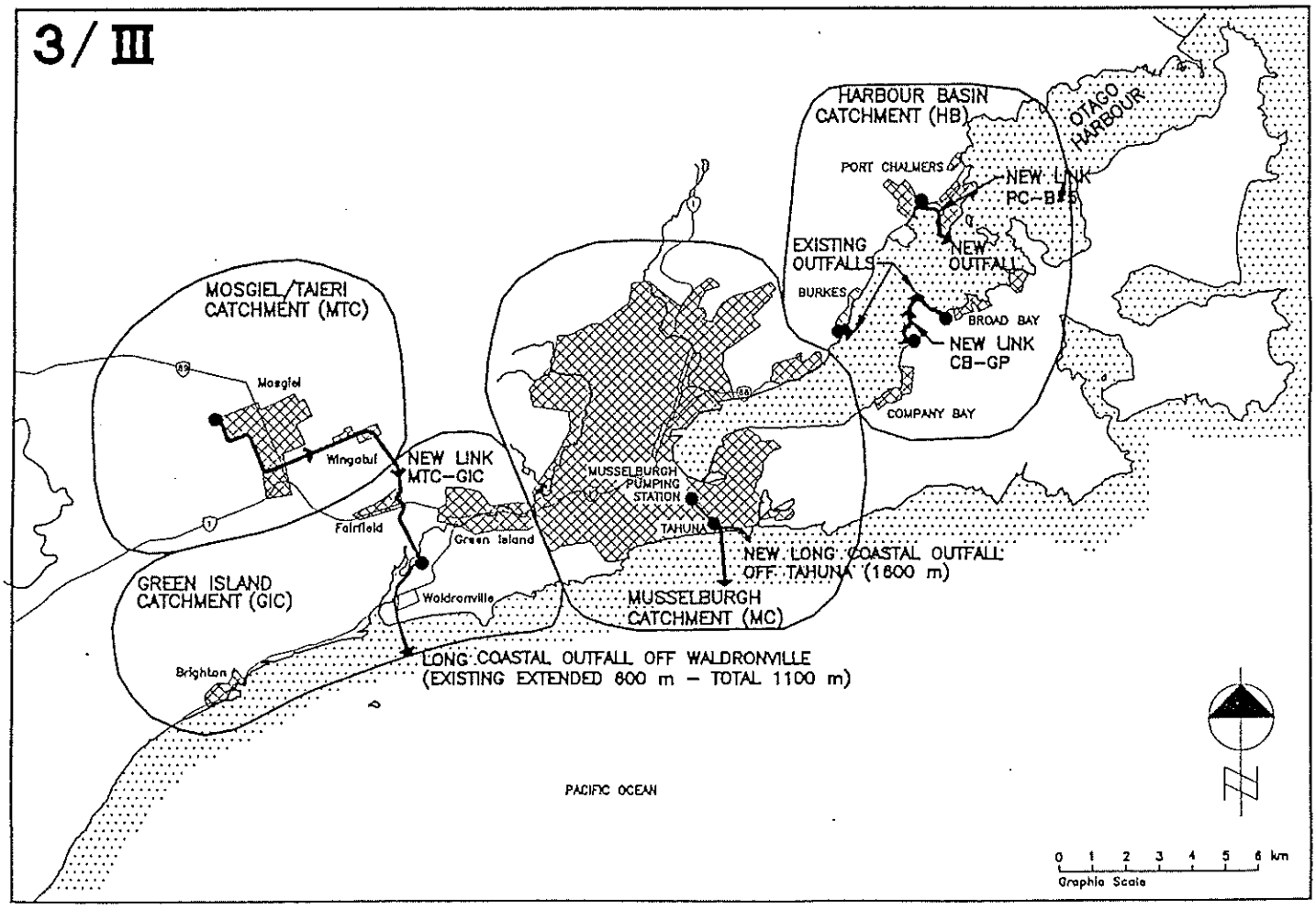
TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB	%	10	40	10		50		
MC	$	1.31	16.7	1.82	19.8	1.135	14.5	34.3
GIC	%		40			65		
	$	Nil	1.20	Nil	1.20	0.488	6.24	7.44
MTC	%							
	$	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL (rounded)		1.31	17.9	1.82	21.0	1.623	20.7	41.7

SCHEME 3/III
(CONCEPT LEVEL 3)

PRIMARY (MC), ADVANCED PRIMARY (GIC), ONE INTER-CATCHMENT TRANSFER (MTC-GIC) WITH LONG OUTFALLS





SCHEME 3/III

Key Environmental Features

HB1a

- Improves harbour water quality in general by consistently higher quality effluent.
- Removes localised pollution problems in Sawyers Bay and Company Bay areas.
- Does not significantly reduce nutrient load to harbour in total, but discharges effluent into better flushed areas.
- Retains existing four sewage treatment plants with associated environmental impacts.

MC2a

- Significant improvement of water quality at shoreline and on beaches, should meet bathing standards at beaches.
- Potential for movement of full primary treated effluent further afield from ocean discharge zone.
- Good shoreline separation (1600 m).

- Effluent discharge field should barely be visible from air.
- Uses an upgraded Tahuna treatment plant with associated siting considerations as for MC1a.
- Less reliance on treatment plant performance for maintenance of sea water quality at shoreline through buffering effect of separation distance.

GIC2a

- More significant improvement over GIC1a but with same treatment plant considerations.
- Much longer shoreline separation than presently.
- Potential for contamination of waters around Green Island requires detailed investigation.
- Same treatment plant impacts as GIC1a.

MTC1

- Removal of effluent from Taieri River, with associated improvement in all aspects of environmental impact.
- Decommissioning of all, or part, of the existing Mosgiel treatment plant with consequent removal of all or some site impacts.

SCHEME 3/III

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEDULE ($ M)

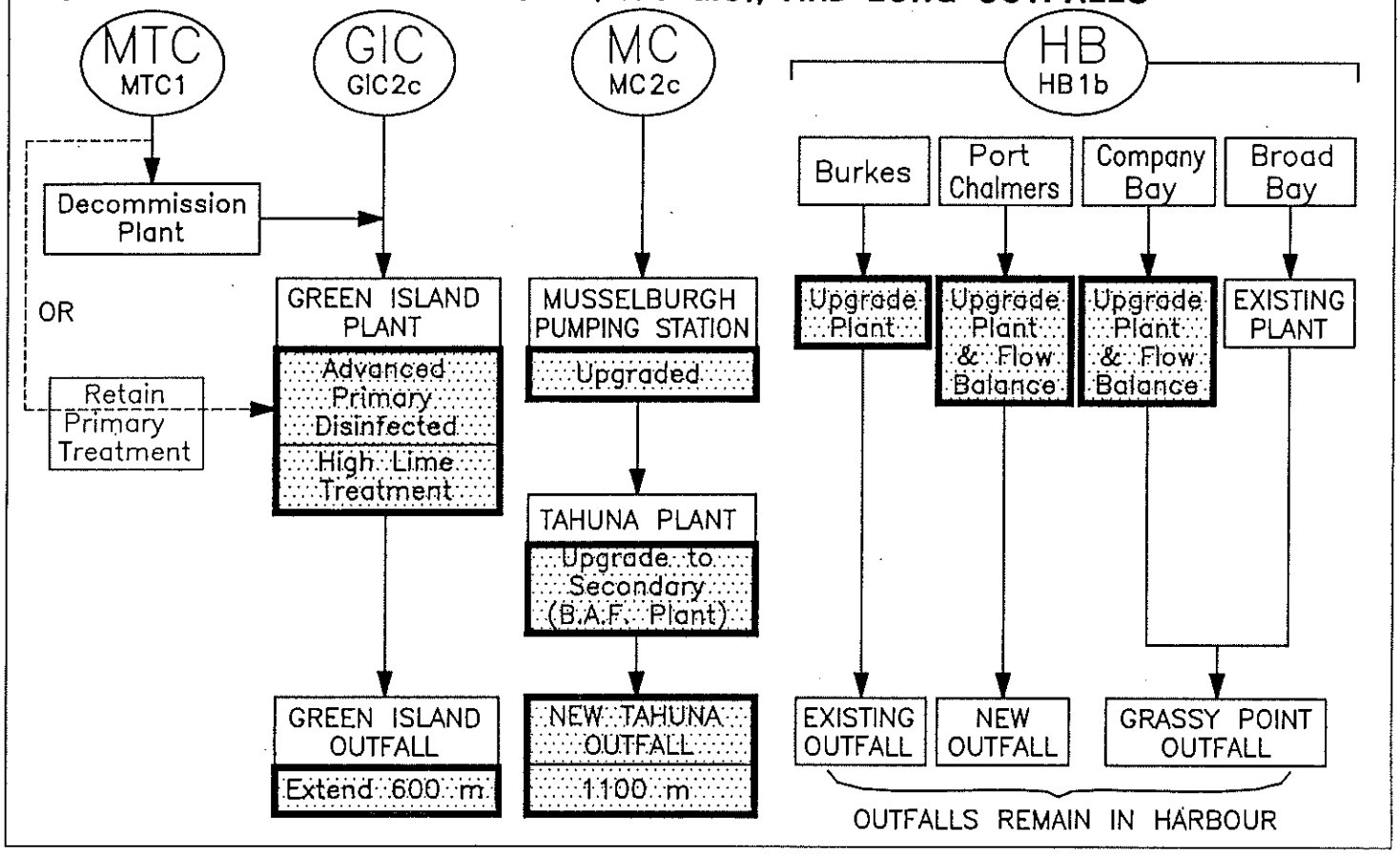
Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB)	1.69	1.65	0.350	3.69	0.12	1.59	5.28
Musselburgh (MC)	3.90	10.0	26.5	40.4	1.05	13.4	53.8
Green Island (GIC) Mosgiel MTC	5.56	4.70	7.80	18.1	0.82	10.5	28.6
TOTAL (rounded)	11.2	16.4	34.7	62.2	1.99	25.5	87.7

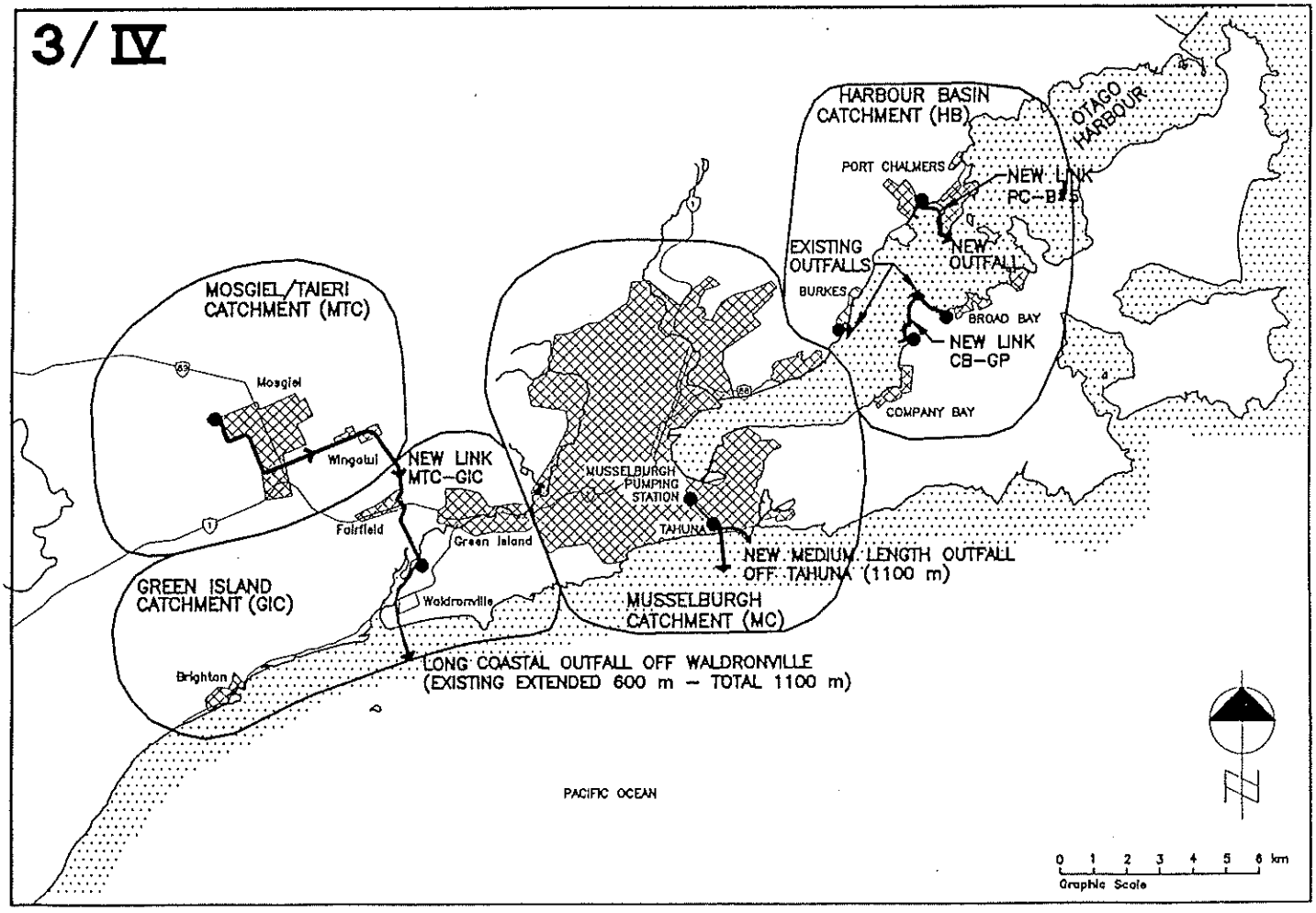
TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB	%	10	40	10		10		
	$	0.17	0.66	0.04	0.87	0.012	0.15	1.02
MC	%	10	40	10		50		
	$	0.39	4.0	2.65	7.04	0.525	6.71	13.8
GIC	%	10	40	10		45		
MTC	$	0.56	1.88	0.78	3.22	0.369	4.72	7.94
TOTAL (rounded)		1.12	6.54	3.47	11.1	0.906	11.6	22.8

SCHEME 3/IV (CONCEPT LEVEL 3)

SECONDARY (MC), DISINFECTED ADVANCED PRIMARY (GIC), INTER-CATCHMENT TRANSFER (MTC-GIC), AND LONG OUTFALLS





SCHEME 3/IV

Key Environmental Features

HB1b

- Improves harbour water quality in general by consistently higher quality effluent.
- Removes localised pollution problems in Sawyers Bay and Company Bay areas
- Does not significantly reduce nutrient load to harbour in total, but discharges effluent into better flushed areas.
- Retains existing four sewage treatment plants with associated environmental impacts.
- Provides significantly reduced bacteriological and pathogen load to harbour.

MC2c

- Significant improvement in sea water quality at shoreline over scheme MC2a. Will meet bathing standards at all beaches.
- Little likelihood of environmental effects beyond immediate effluent discharge mixing zone in the ocean.
- Adequate shoreline separation (1100 m).
- As for MC1d with extensively upgraded Tahuna treatment plant with associated siting considerations including greater amounts of sludge and other residuals byproducts.
- Still has a reasonable degree of reliance on treatment plant performance to maintain shoreline water quality.

GIC2c

- Greater improvement in ocean and shoreline water quality compared with GIC1c.
- Potential for some contamination of waters around Green Island, dependent on degree of disinfection required detailed investigation.
- Much longer shoreline separation than presently.
- Same treatment plant considerations as GIC1c.

MTC1

- Removal of effluent from Taieri River, with associated improvement in all aspects of environmental impact.
- Decommissioning of all, or part, of the existing Mosgiel treatment plant with consequent removal of all or some site impacts.

SCHEME 3/IV

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEDULE ($ M)

Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB)	1.69	1.85	0.350	3.89	0.15	1.94	5.83
Musselburgh (MC)	3.90	41.0	18.2	63.1	2.45	31.3	94.4
Green Island (GIC) Mosgiel (MTC)	5.56	5.00	7.80	18.4	1.12	14.3	32.7
TOTAL (rounded)	11.2	47.9	26.4	85.4	3.72	47.5	133

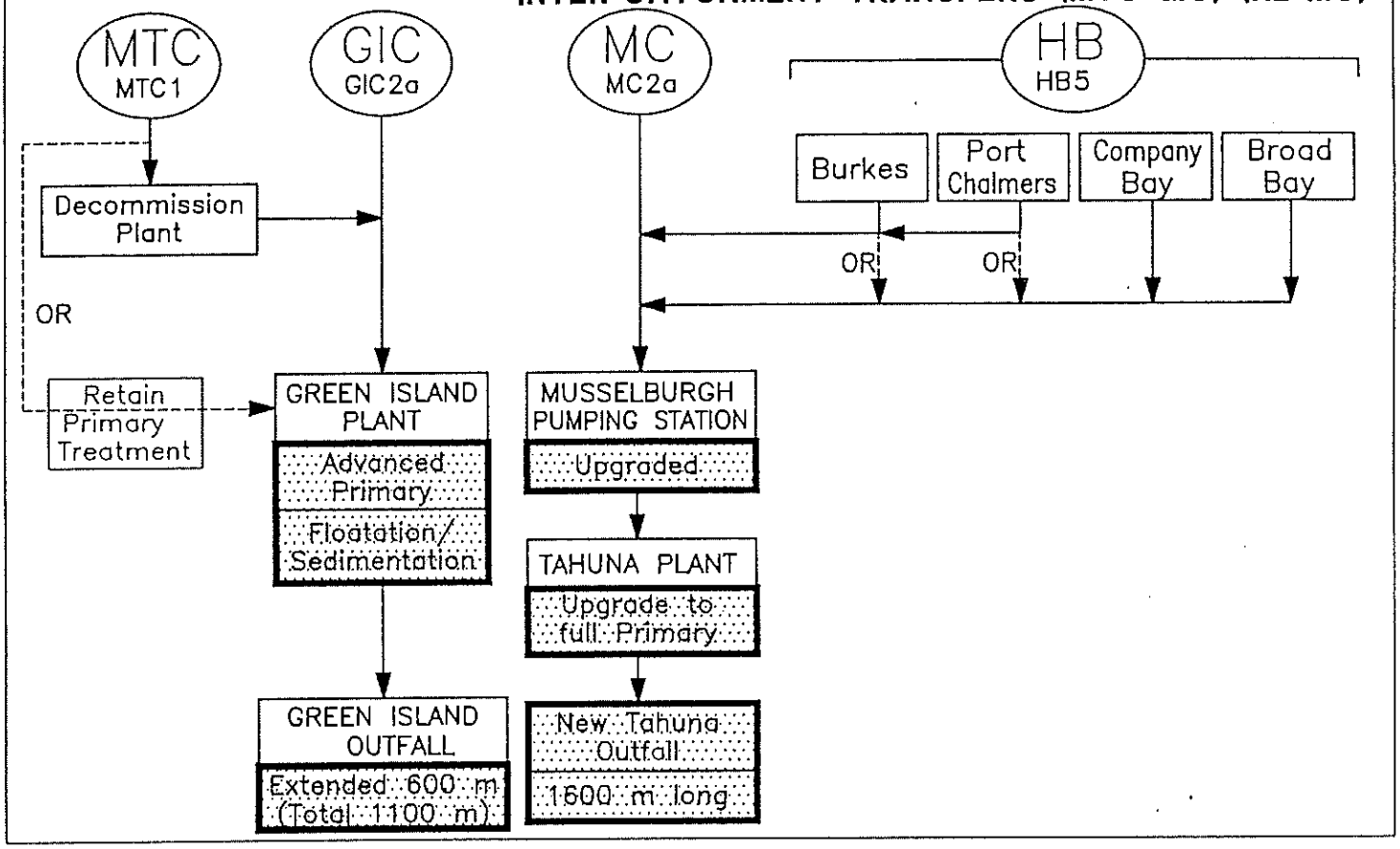
TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

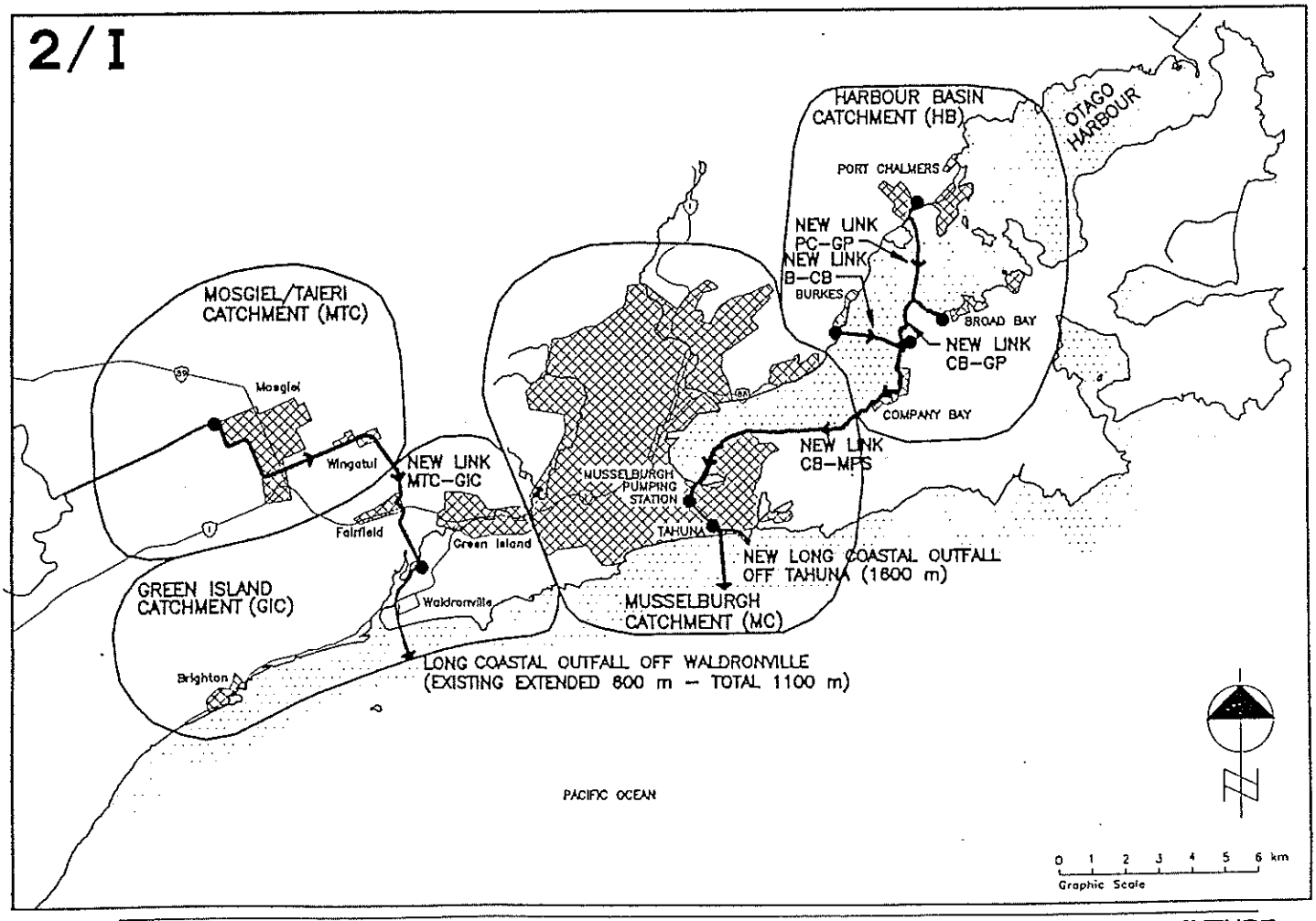
Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB	%	10	40	10		10		
	$	0.17	0.74	0.04	0.94	0.015	0.19	1.14
MC	%	10	40	10		50		
	$	0.39	16.4	1.82	18.6	1.225	15.7	34.3
GIC	%	10	40	10		45		
MTC	$	0.56	2.00	0.78	3.34	0.504	6.44	9.78
TOTAL (rounded)		1.12	19.1	2.64	22.9	1.744	22.3	45.2

SCHEME 2/I

(CONCEPT LEVEL 2)

PRIMARY (MC), LONG OUTFALL (TAHUNA), ADVANCED PRIMARY (GIC), LONG OUTFALL, TWO INTER-CATCHMENT TRANSFERS (MTC-GIC) (HB-MC)





13.4 CONCEPT LEVEL TWO SCHEMES - 2/I TO 2/IV

SCHEME 2/I

Key Environmental Features

HB5b

- Removes all four discharges from the harbour basin.
- Decommission the four treatment plants with associated local environmental improvements.
- Raises questions of conveyance pipeline risks and reliability in the harbour bed itself in scheme HB5b (the lower cost one) compared to HB5a which has all pipelines in road and rail reserves.

MTC1

- Removal of effluent from Taieri River, with associated improvement in all aspects of environmental impact.
- Decommissioning of all, or part, of the existing Mosgiel treatment plant with consequent removal of all or some site impacts.

MC2a

- Significant improvement of water quality at shoreline and on beaches, should meet bathing standards at beaches.
- Potential for movement of full primary treated effluent further afield from ocean discharge zone.
- Good shoreline separation (1600 m).
- Effluent discharge field should barely be visible from air.
- Uses an upgraded Tahuna treatment plant with associated siting considerations as for MC1a.
- Less reliance on treatment plant performance for maintenance of sea water quality at shoreline through buffering effect of separation distance.

GIC2a

- More significant improvement over GIC1a but with same treatment plant considerations.
- Much longer shoreline separation than presently.
- Potential for contamination of waters around Green Island requires detailed investigation.
- Same treatment plant impacts as GIC1a.

SCHEME 2/I

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEMES ($ Million) - all values have been rounded up to 2 significant figures

Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB) Musselburgh (MC)	13.1	10.5	26.5	50.1	0.82	10.4	60.5
Green Island (GIC) Mosgiel (MTC)	5.56	3.70	7.80	17.1	0.82	10.4	27.5
TOTAL (rounded)	18.8	14.2	34.3	67.2	1.64	20.8	88.0

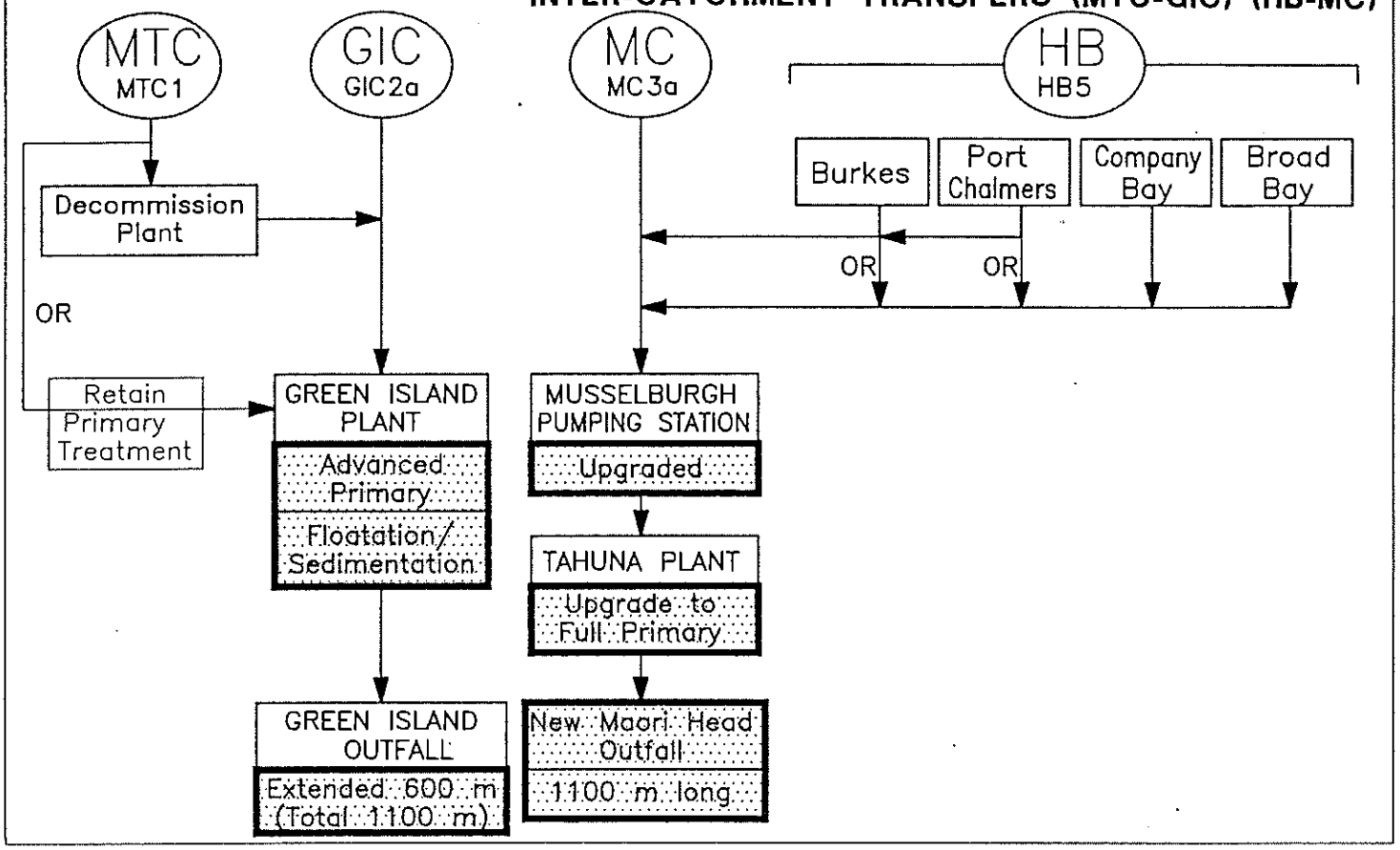
TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB	%	10	40	10		50		
MC	$	1.31	4.20	2.65	8.16	0.410	5.24	13.4
GIC	%	10	40	10		45		
MTC	$	0.56	1.48	0.78	2.82	0.369	4.72	7.54
TOTAL (rounded)		1.87	5.68	3.43	11.0	0.779	9.96	20.9

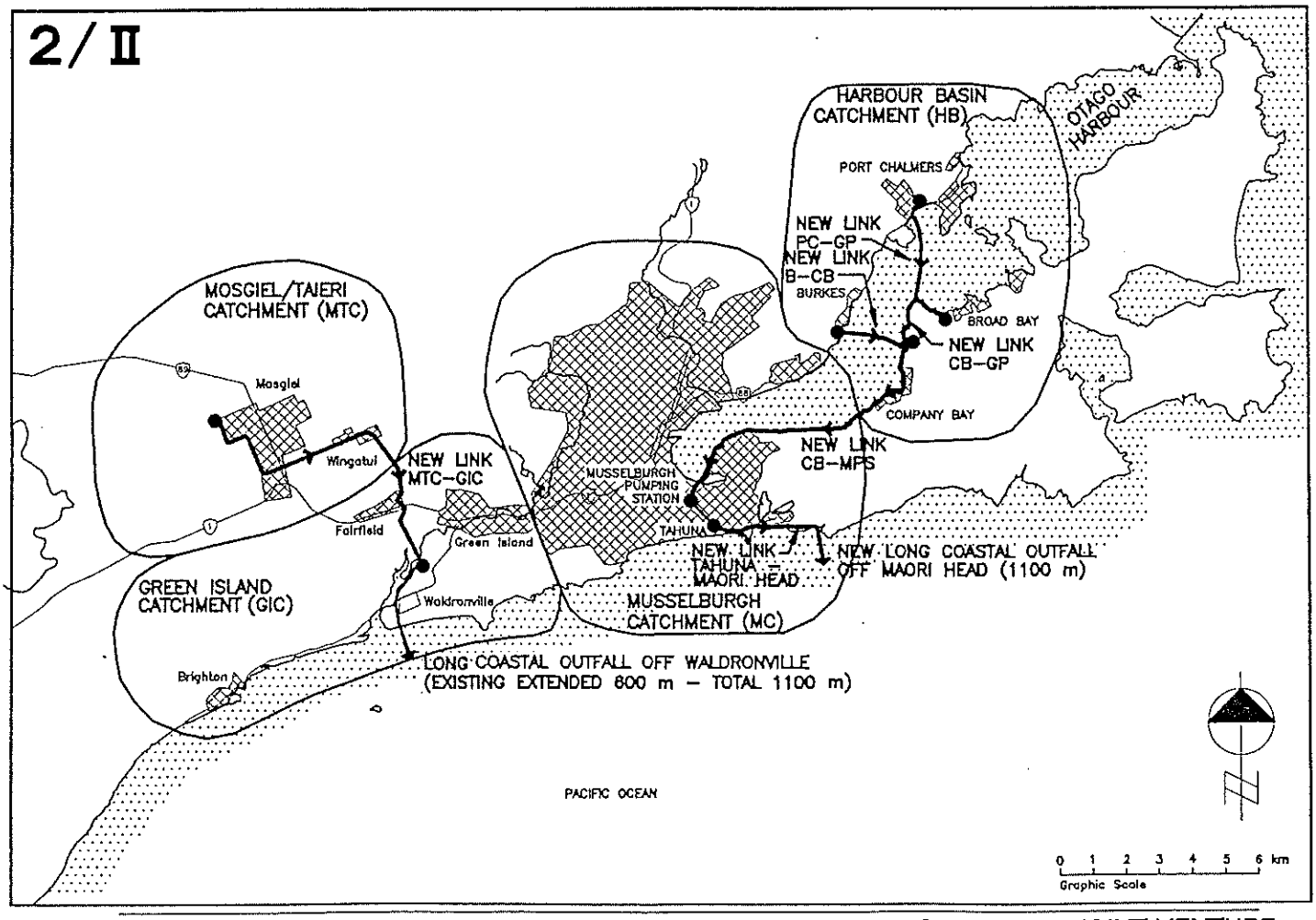
SCHEME 2/ II

(CONCEPT LEVEL 2)

PRIMARY (MC), LONG OUTFALL (MAORI HEAD), ADVANCED PRIMARY (GIC), LONG OUTFALL, TWO INTER-CATCHMENT TRANSFERS (MTC-GIC) (HB-MC)



2/ II



SCHEME 2/II

Key Environmental Features

HB5b
- Removes all four discharges from the harbour basin.
- Decommission the four treatment plants with associated local environmental improvements.
- Raises questions of conveyance pipeline risks and reliability in the harbour bed itself in scheme HB5b (the lower cost one) compared to HB5a which has all pipelines in road and rail reserves.

MTC1
- Removal of effluent from Taieri River, with associated improvement in all aspects of environmental impact.
- Decommissioning of all, or part, of the existing Mosgiel treatment plant with consequent removal of all or some site impacts.

MC3a
- Generally all as for MC2a but with greater distance from main Dunedin beaches, therefore meeting bathing standards.
- Investigations needed to ensure no adverse ecological effects of effluent field moving up coast as will occur for most of time.
- Good shoreline separation of effluent discharge location.

GIC2a
- More significant improvement over GIC1a but with same treatment plant considerations.
- Much longer shoreline separation than presently.
- Potential for contamination of waters around Green Island requires detailed investigation.
- Same treatment plant impacts as GIC1a.

SCHEME 2/II

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEDULE ($ M)

Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB) Musselburgh (MC)	23.5	10.5	18.2	52.2	0.95	12.1	64.3
Green Island (GIC) Mosgiel (MTC)	5.56	3.70	7.80	17.1	0.82	10.4	27.5
TOTAL (rounded)	29.1	14.2	26.0	69.3	1.77	22.5	91.8

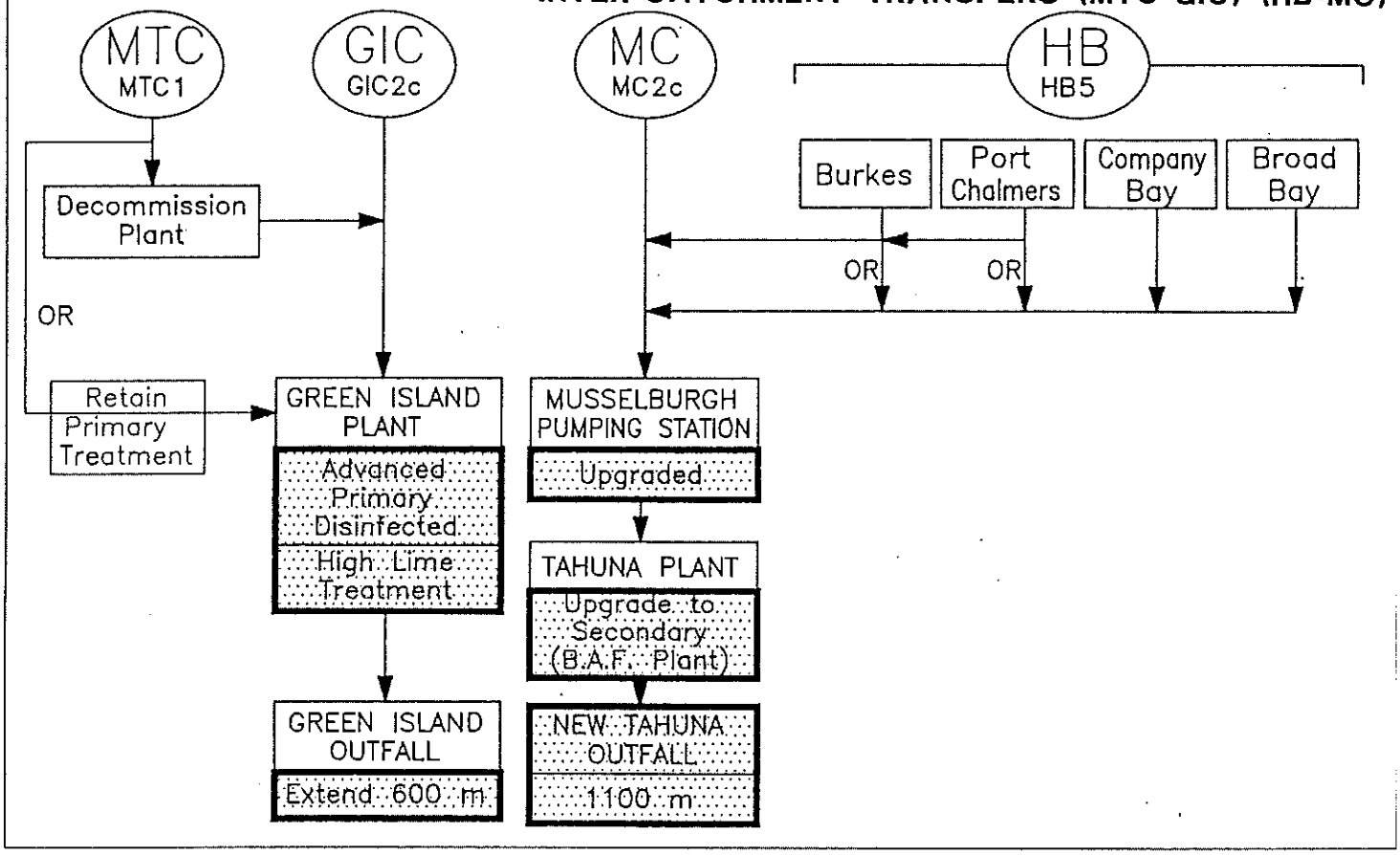
TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

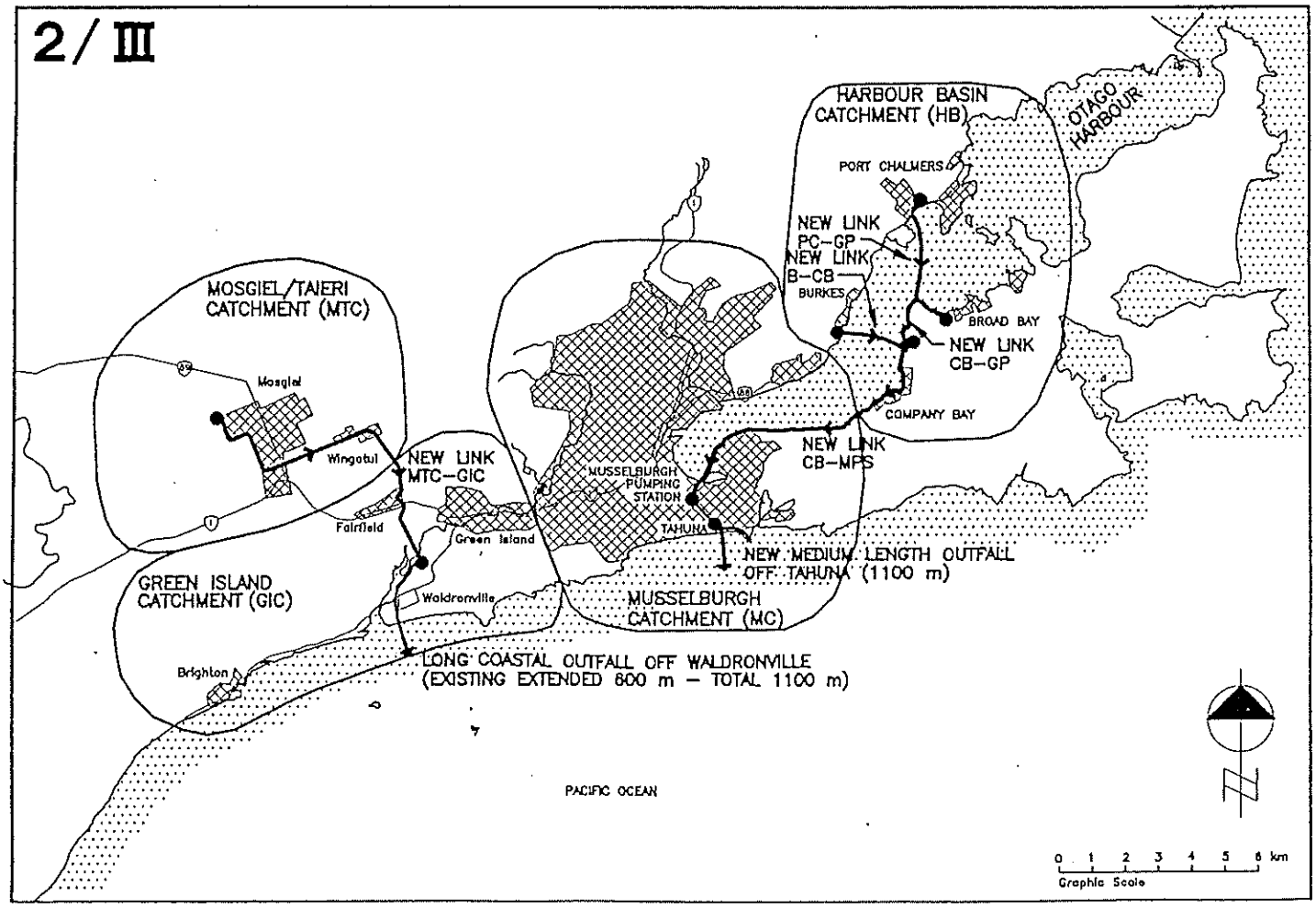
Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB	%	10	40	10		50		
MC	$	2.35	4.20	1.82	8.37	0.475	6.07	14.4
GIC	%	10	40	10		45		
MTC	$	0.56	1.48	0.78	2.82	0.369	4.72	7.54
TOTAL (rounded)		2.91	5.68	2.60	11.2	0.844	10.8	21.9

SCHEME 2/III

(CONCEPT LEVEL 2)

SECONDARY (MC), LONG OUTFALL (TAHUNA), ADVANCED PRIMARY (GIC), LONG OUTFALL, TWO INTER-CATCHMENT TRANSFERS (MTC-GIC) (HB-MC)





SCHEME 2/III

Key Environmental Features

HB5b
- Removes all four discharges from the harbour basin.
- Decommission the four treatment plants with associated local environmental improvements.
- Raises questions of conveyance pipeline risks and reliability in the harbour bed itself in scheme HB5b (the lower cost one) compared to HB5a which has all pipelines in road and rail reserves.

MTC1
- Removal of effluent from Taieri River, with associated improvement in all aspects of environmental impact.
- Decommissioning of all, or part, of the existing Mosgiel treatment plant with consequent removal of all or some site impacts.

MC2c
- Significant improvement in sea water quality at shoreline over scheme MC2a. Will meet bathing standards at all beaches.
- Little likelihood of environmental effects beyond immediate effluent discharge mixing zone in the ocean.
- Adequate shoreline separation (1100 m).
- As for MC1d with extensively upgraded Tahuna treatment plant with associated siting considerations including greater amounts of sludge and other residuals byproducts.
- Still has a reasonable degree of reliance on treatment plant performance to maintain shoreline water quality.

GIC2c
- Greater improvement in ocean and shoreline water quality compared with GIC1c.
- Potential for some contamination of waters around Green Island, dependent on degree of disinfection required detailed investigation.
- Much longer shoreline separation than presently.
- Same treatment plant considerations as GIC1c.

SCHEME 2/III

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEDULE ($ M)

Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB) Musselburgh (MC)	13.1	41.8	18.2	73.1	2.27	29.0	102
Green Island (GIC) Mosgiel (MTC)	5.56	5.00	7.80	18.4	1.12	14.3	32.7
TOTAL (rounded)	18.7	46.8	26.0	91.5	3.39	43.3	135

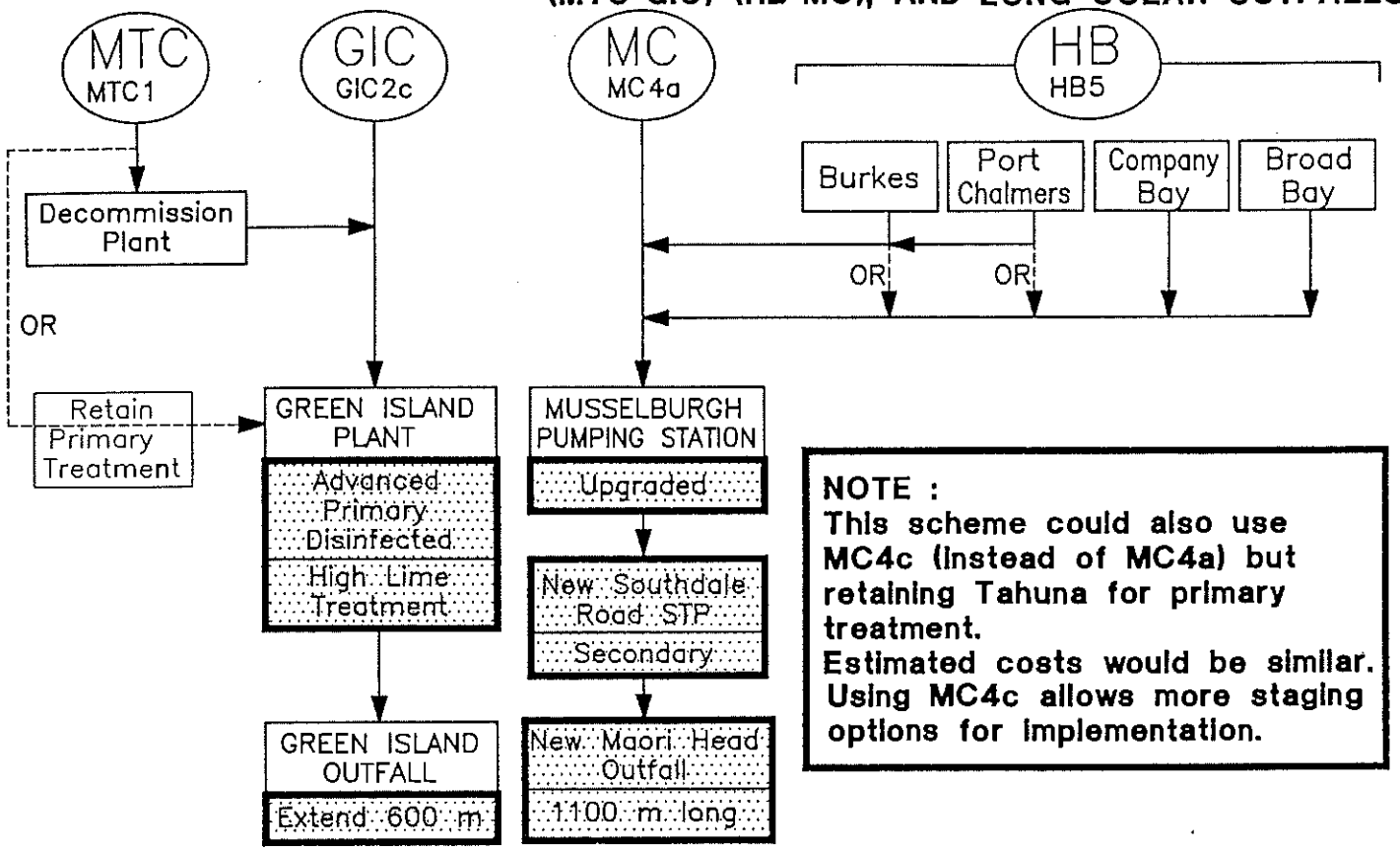
TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB	%	10	40	10		50		
MC	$	1.31	16.7	1.82	19.8	1.135	14.5	34.3
GIC	%	10	40	10		45		
MTC	$	0.56	2.00	0.78	3.34	0.504	6.44	9.78
TOTAL (rounded)		1.87	18.7	2.60	23.2	1.64	20.9	44.1

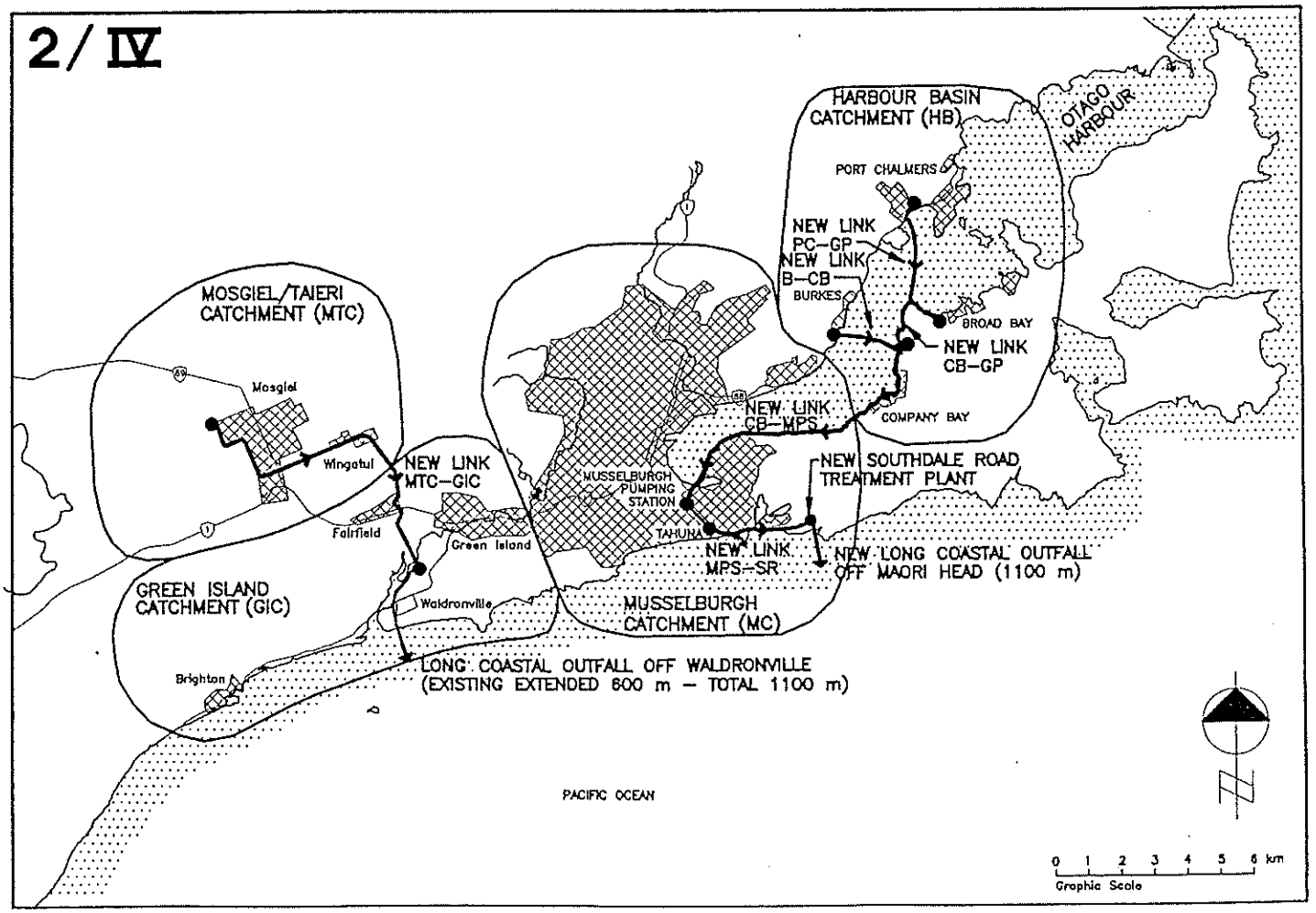
SCHEME 2/IV

(CONCEPT LEVEL 2)

SECONDARY (MC), DISINFECTED ADV. PRIMARY (GIC), TWO INTER-CATCHMENT TRANSFERS (MTC-GIC) (HB-MC), AND LONG OCEAN OUTFALLS



NOTE :
This scheme could also use MC4c (instead of MC4a) but retaining Tahuna for primary treatment.
Estimated costs would be similar.
Using MC4c allows more staging options for implementation.



SCHEME 2/IV

Key Environmental Features

HB5b

- Removes all four discharges from the harbour basin.
- Decommission the four treatment plants with associated local environmental improvements.
- Raises questions of conveyance pipeline risks and reliability in the harbour bed itself in scheme HB5b (the lower cost one) compared to HB5a which has all pipelines in road and rail reserves.

MTC1

- Removal of effluent from Taieri River, with associated improvement in all aspects of environmental impact.
- Decommissioning of all, or part, of the existing Mosgiel treatment plant with consequent removal of all or some site impacts.

MC4a

- All disposal impacts of a secondary effluent out the 1100 m Maori Head outfall the same as MC3d above.
- Environmental considerations associated with establishing a new treatment plant site and associated residuals management at a Southdale Road site.
- Decommissions existing Tahuna plant.

GIC2c

- Greater improvement in ocean and shoreline water quality compared with GIC1c.
- Potential for some contamination of waters around Green Island, dependent on degree of disinfection required detailed investigation.
- Much longer shoreline separation than presently.
- Same treatment plant considerations as GIC1c.

SCHEME 2/IV

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEDULE ($ M)

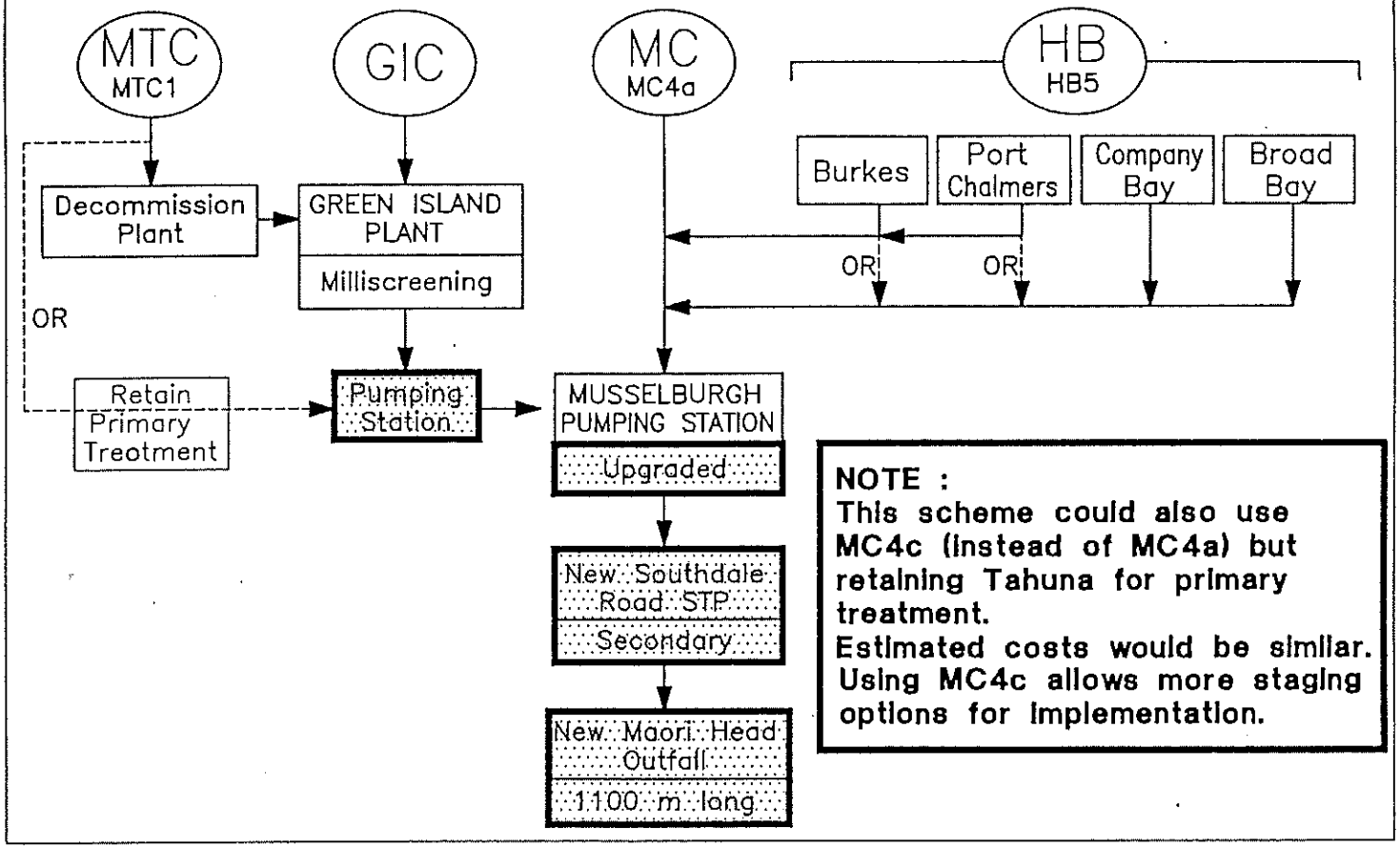
Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB) Musselburgh (MC)	27.5	42.5	18.2	88.2	1.22	15.6	104
Green Island (GIC) Mosgiel (MTC)	5.56	5.00	7.80	18.4	1.12	14.3	32.7
TOTAL (rounded)	33.1	47.5	26.0	107	2.34	29.9	137

TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

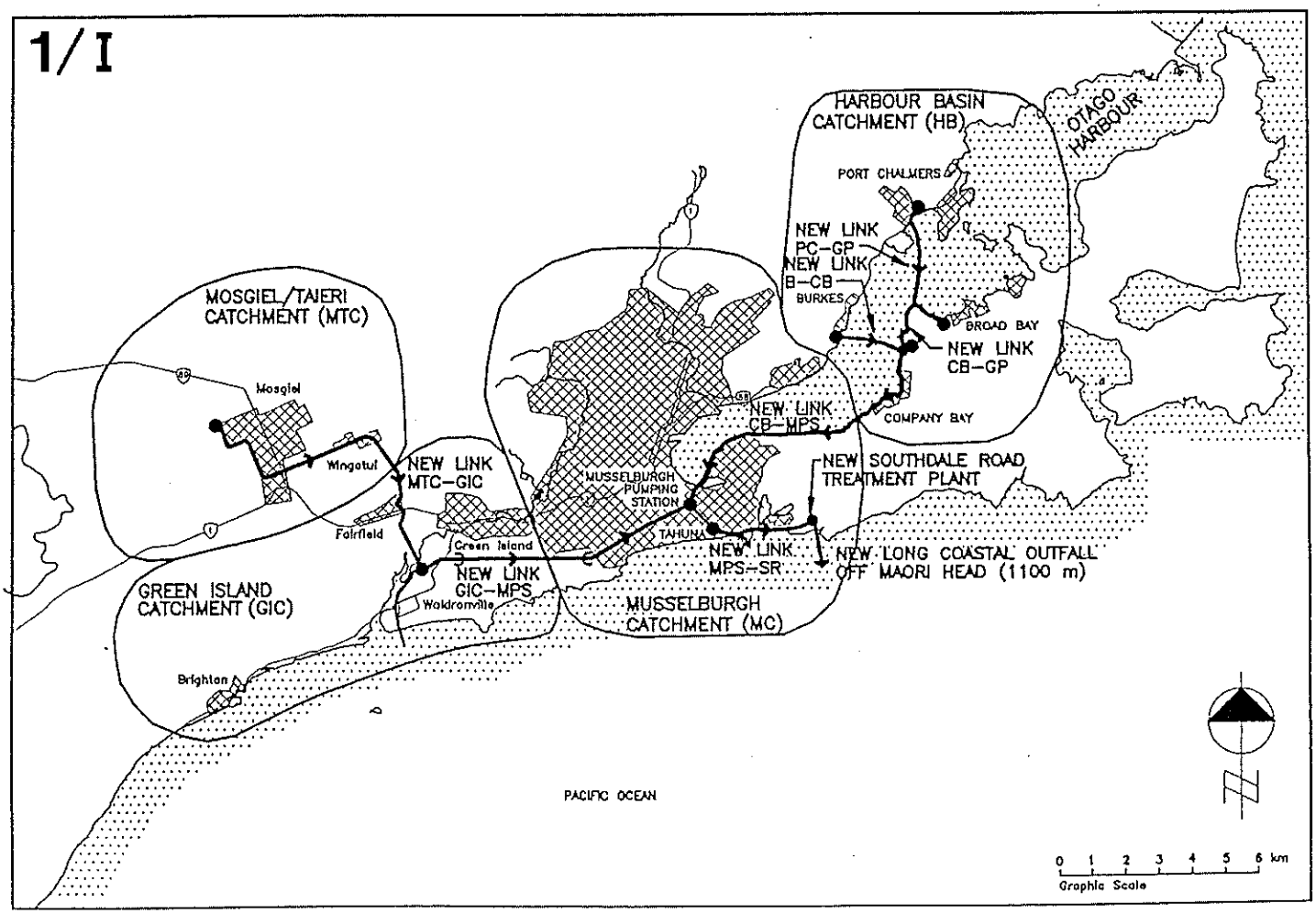
Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB	%	10	40	10		50		
MC	$	2.75	17.0	1.82	21.6	0.610	7.80	29.4
GIC	%	10	40	10		45		
MTC	$	0.56	2.00	0.78	3.34	0.504	6.44	9.78
TOTAL (rounded)		3.31	19.0	2.60	24.9	1.11	14.3	39.2

SCHEME 1/I
(CONCEPT LEVEL 1)

A SINGLE SECONDARY TREATMENT PLANT AND LONG OCEAN OUTFALL



NOTE :
This scheme could also use MC4c (instead of MC4a) but retaining Tahuna for primary treatment.
Estimated costs would be similar. Using MC4c allows more staging options for implementation.



13.5 CONCEPT LEVEL ONE SCHEMES - 1/I TO 1/II

SCHEME 1/I

Removes discharge of treated effluent from harbour basin, Mosgiel discharge to Taieri River, Green Island catchment discharge to ocean off Waldronville Beach. Has one secondary treatment plant at Southdale Road and one ocean outfall off Maori Head.

Key Environmental Features

HB5b

- Removes all four discharges from the harbour basin.
- Decommission the four treatment plants with associated local environmental improvements.
- Raises questions of conveyance pipeline risks and reliability in the harbour bed itself in scheme HB5b (the lower cost one) compared to HB5a which has all pipelines in road and rail reserves.

MTC1

- Removal of effluent from Taieri River, with associated improvement in all aspects of environmental impact.
- Decommissioning of all, or part, of the existing Mosgiel treatment plant with consequent removal of all or some site impacts.

MC4a

- All disposal impacts of a secondary effluent out the 1100 m Maori Head outfall the same as MC3d above.
- Environmental considerations associated with establishing a new treatment plant site and associated residuals management at a Southdale Road site.
- Decommissions existing Tahuna plant.

SCHEME 1/I

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEDULE ($ M)

Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB) Musselburgh (MC) Green Island (GIC) Mosgiel (MTC)	55.4	58.0	22.2	136	3.44	44.0	180
TOTAL (rounded)	55.4	58.0	22.2	136	3.44	44.0	180

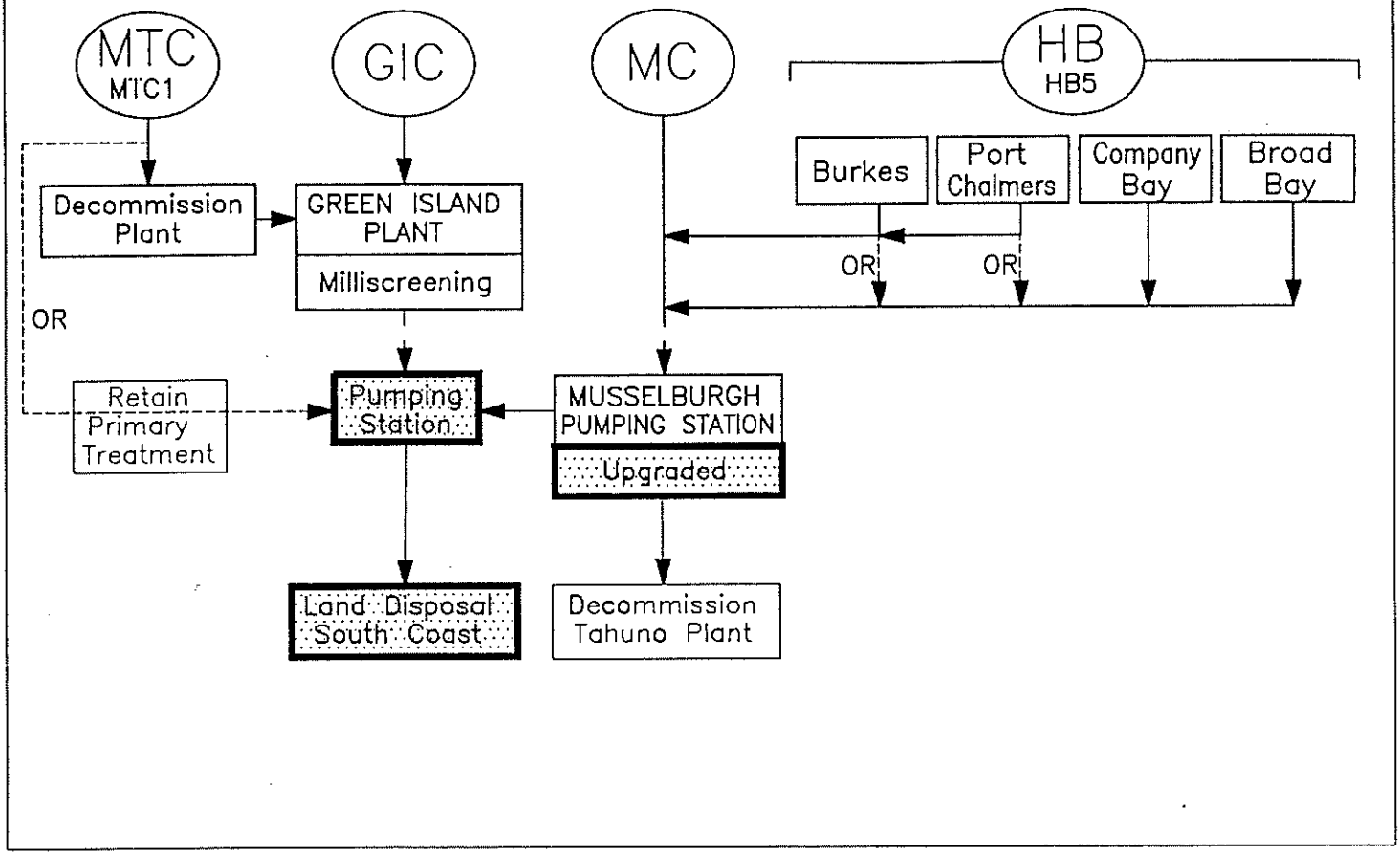
TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

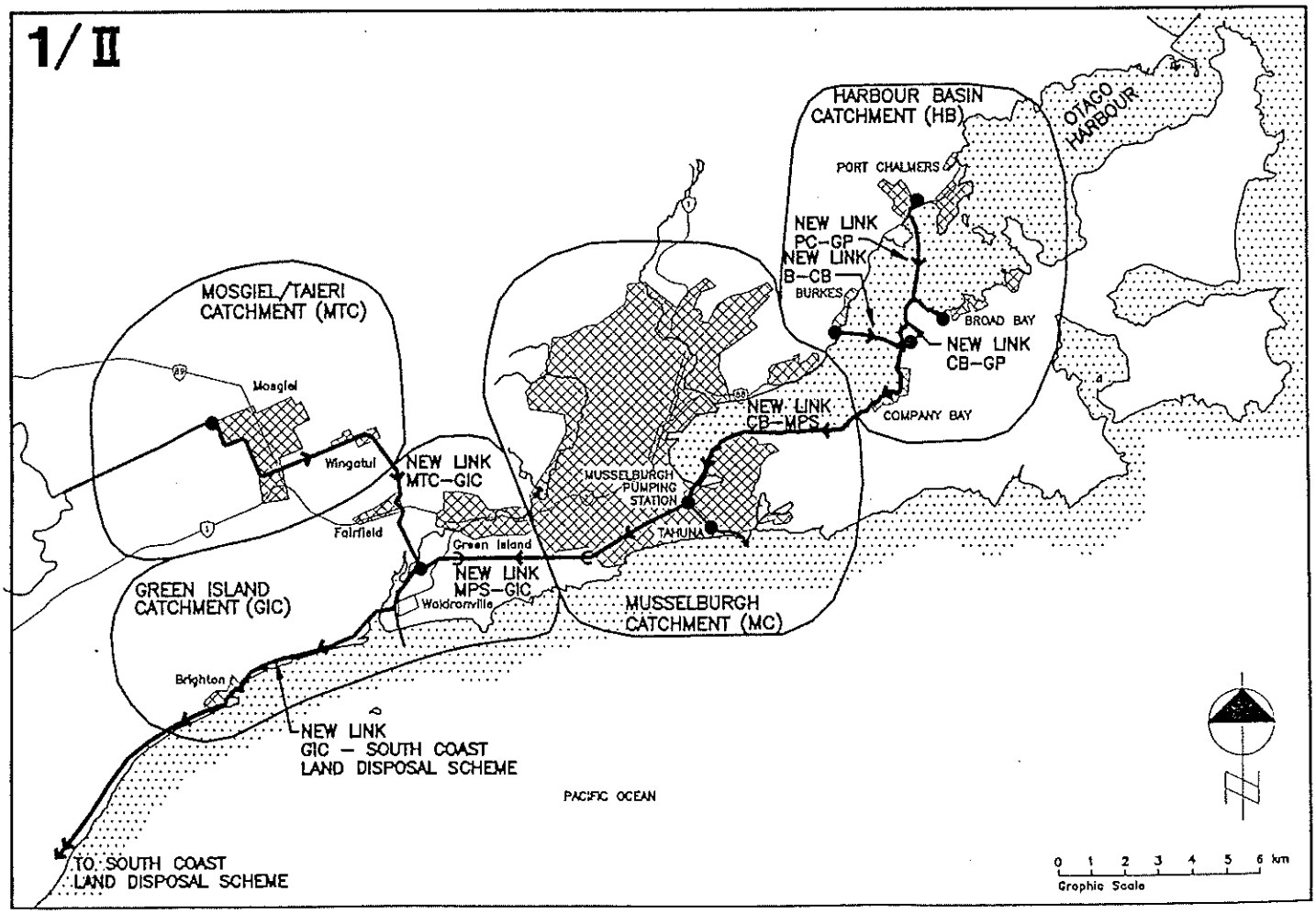
Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB MC	%	10	40	10		50		
GIC MTC	$	5.54	23.2	2.22	31.0	1.72	22.0	53.0
TOTAL (rounded)		5.54	23.2	2.22	31.0	1.72	22.0	53.0

SCHEME 1/II

(CONCEPT LEVEL 1)

ALL CONVEYED TO A SINGLE LAND DISPOSAL SITE (SOUTH COAST)





SCHEME 1/II

Key Environmental Features

Removes all direct discharges of treated effluent to natural water, namely the Harbour Basin, the Taieri River and the Musselburgh and Green Island Catchment ocean discharges. This removes environmental impacts of all such discharges.

Impacts of a large land disposal system namely:

- some restrictions on access to the land at times.
- effluent seepage and possibly runoff considerations as only 10 to 20% of the effluent is actually lost by the land disposal process; the rest finds its way to underground and surface natural waters.
- any land ownership impact
- impacts of siting of treatment facilities in the land disposal area, and disposal of sludges.

SCHEME 1/II

TOTAL SCHEME ESTIMATED COSTS SUMMARY SCHEDULE ($ M)

Catchment	Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3 = 4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
Harbour (HB) Musselburgh (MC) Green Island (GIC) Mosgiel (MTC)	109	58.0	98.0	265	7.79	99.6	365
TOTAL (rounded)	109	58.0	98.0	265	7.79	99.6	365

TRADEWASTE PROPORTION OF ESTIMATED COSTS FOR TOTAL SCHEME SUMMARY SCHEDULE ($ Million)

Catchment		Conveyance Capital 1	Treatment Capital 2	Disposal Capital 3	Subtotal Capital 1+2+3=4	O&M pa 5	Capitalised O&M 6	TOTAL 4+6 (rounded)
HB MC	%	10	40	10		20		
GIC	$	10.9	23.2	9.80	43.9	1.56	19.9	63.8
MTC								
TOTAL (rounded)		10.9	23.2	9.80	43.9	1.56	19.9	63.8

REPRESENTATIVE TOTAL SCHEMES SUMMARY TABLE

Scheme No	Description	Estimated Costs ($M)[7]				
		Capital 1	O&M pa[6] 2	Capitalised O&M[6] 3	TOTAL[8] (Rounded) 1 3 = 4	Compliance With Bathing Water Quality Standards at Shoreline[9,10]
	Concept Level 4 Schemes (4 Outputs)[4]					
4/I	Marginal upgrade-existing outfalls[1]	15.7	1.47	18.8	34.5	local exceedance
4/II	Full primary (MC) and long coastal outfall (off Tahuna), advanced primary (GIC) and existing coastal outfall (off Waldronville)[1]	46.2	1.72	22.0	68.2	MC - normal GIC - partial
4/III	Full primary (MC) and long coastal outfall (off Maori Head), advanced primary (GIC) and long coastal outfall (off Waldronville[1]	56.0	1.85	23.7	79.7	normal
4/IV	Secondary (MC)and medium outfall (off Tahuna) and disinfected advanced primary (GIC) with existing outfall (off Waldronville)[2]	70.1	3.32	42.8	113	good
4/V	Secondary (MC-Southdale Road) and long coastal outfall (off Maori Head) and secondary (GIC) and existing outfall (off Waldronville)[2]	97.9	2.35	30.0	128	MC- good GIC - normal
4/VI	Secondary disinfected (MC) Lawyers Head discharge and advanced primary disinfected (GIC) existing outfall (off Waldronville)[2]	50.9	3.40	43.5	94.4	good but no shoreline separation
4/VII	Secondary (MC), medium coastal outfall (off Tahuna), advanced primary disinfected (GIC), and existing outfall, and land disposal (Okia Flat) of harbour basin (excl Burkes)	78.0	3.40	43.4	121	good
	Concept Level 3 Schemes (3 Outputs)					
3/I	Full primary (HB+MC) and long coastal outfall (off Tahuna), advanced primary (GIC) and long coastal outfall (off Waldronville)[3,4]	59.9	1.37	17.4	77.3	normal
3/II	Secondary (HB+MC) medium coastal outfall and disinfected advanced primary (GIC) existing outfall (off Waldronville)[3,4]	76.1	3.02	38.6	115	good
3/III	Full primary (MC) and long coastal outfall (off Tahuna), advanced primary (GIC+MTC) and long coastal outfall (off Waldronville)[1,5]	62.2	1.99	25.5	87.7	normal
3/IV	Secondary (MC) and medium coastal outfall (off Tahuna,) advanced primary disinfected (GIC+MTC) and long coastal outfall (off Waldronville)[1,5]	85.4	3.72	47.5	133	good
	Concept Level 2 Schemes (2 Outputs)[3,5]					
2/I	Full primary (HB+MC) and long coastal outfall (off Tahuna), advanced primary (GIC+MTC) with long coastal outfall (off Waldronville)	67.2	1.64	20.8	88.0	normal
2/II	Full primary (HB+MC) and long coastal outfall off Maori Head, advanced primary (GIC+MTC) with long coastal outfall (off Waldronville)	69.2	1.77	22.5	91.7	normal to good
2/III	Secondary (HB+MC) medium length Tahuna outfall and disinfected advanced primary (MTC+GIC) and long coastal outfall (off Waldronville)	91.5	3.39	43.3	135	good
2/IV	Secondary (HB+MC) and long coastal outfall (off Maori Head), disinfected advanced primary (MTC+GI) and long coastal outfall (off Waldronville)	107	2.34	29.9	137	good
	Concept Level 1 Scheme (1 Output)[3,5]					
1/I	All secondary treatment (HB+MC+GIC+MTC), to a single long coastal outfall (off Maori Head)	136	3.44	44.0	180	good
1/II	All secondary treatment (HB+MC+GIC+MTC) to a single land disposal scheme (South Coast Site)	265	7.79	99.6	365	land disposal scheme so not applicable

Notes:

1. Including option HB1a : all HB plants upgraded as required to secondary and to two harbour outfalls (Beacon No 5 and Grassy Point)
2. Including option HB1b : as for HB1a but with disinfection
3. Including option HB5a : all HB to MC via harbour bed crossings
4. MTC treatment as is, with existing discharge into Taieri River
5. Including Option MTC1 : MTC conveyed to GIC
6. O&M (operational and maintenance) costs are the nett increase or decrease (in brackets) to run the treatment and disposal scheme over that at present.
7. Refer to Part 8.1 page 14 for explanation of basis of estimated costs.
8. Total = Capital + Capitalised O&M.
9. Increasing compliance ranked - marginal, partial, normal, good.
10. For Musselburgh Catchment and Green Island Catchment ocean discharge options only.

Part 14.0

Progress Towards Development of Council's Objective

PART 14.0 : PROGRESS TOWARDS DEVELOPMENT OF COUNCIL'S OBJECTIVE

14.1 COUNCIL'S DECISION PROCESS AND PROGRAMME

The selection of the most appropriate overall wastewater treatment and disposal schemes for the greater Dunedin area is one of the most important decisions the Dunedin City Council will ever have to make. There are long term consequences of the selection which will impact on all ratepayers and which will influence the future potential of the area. The scheme options selected will have a major influence on:

- use of natural waters
- the enhancement of the environment
- the satisfying of cultural values
- the discretionary spending ability of ratepayers
- possible effects on some industries
- town and country planning

Because these influences are significant and of a long term nature, Council is most aware that it is essential that it not only chooses the best practicable option, but is also able to demonstrate that it has done so to the satisfaction of both its ratepayers and those charged with overseeing such decisions in the interest of the general public.

The Council is most aware that it must therefore be as certain as possible that the scheme selected is that which best meets its own objectives. In the past, a common approach has often been to select an option on the basis of one or two parameters and then test that selection by arguing it through the various approvals forums, usually by utilising legal principles. More recent evaluation of the results of that process has indicated the options have frequently been found to have shortcomings once they are constructed and operating. By that stage, very large amounts of money have usually been spent, and there is an understandable reluctance to either admit to problems, or to spend additional funds on correcting them.

Pressure from both the community and from regulatory bodies has encouraged the use of more sophisticated techniques for option selection so that those responsible for the selection can be as certain as possible that what has been selected is the best practicable option.

A fundamental part of any option selection is the scrutiny which the selection will be subject to. This scrutiny will be both informal and formal, and is likely to extend past the option selected to how it was selected. Informal scrutiny may be by members of the public, particularly those directly affected (and who have rights of objection in the approvals process). Formal scrutiny may be by an independent audit. Similar to a financial audit, the selection audit will evaluate not only the final selection but also the procedure used to reach it (the audit trail).

Planning the decision process is no less important than planning the construction later in the project. The establishment, review and approval of a process leading to option selection will give those responsible for that decision a much greater degree of security that their objectives have been met. A decision process breaks the option selection down from a single very large step into a series of smaller steps. These smaller steps are building blocks to the option selection. Each of the small steps can be more readily and reliably considered and evaluated than can the single large step. The reliability of each is therefore greater, and it can be scrutinised using its own set of criteria.

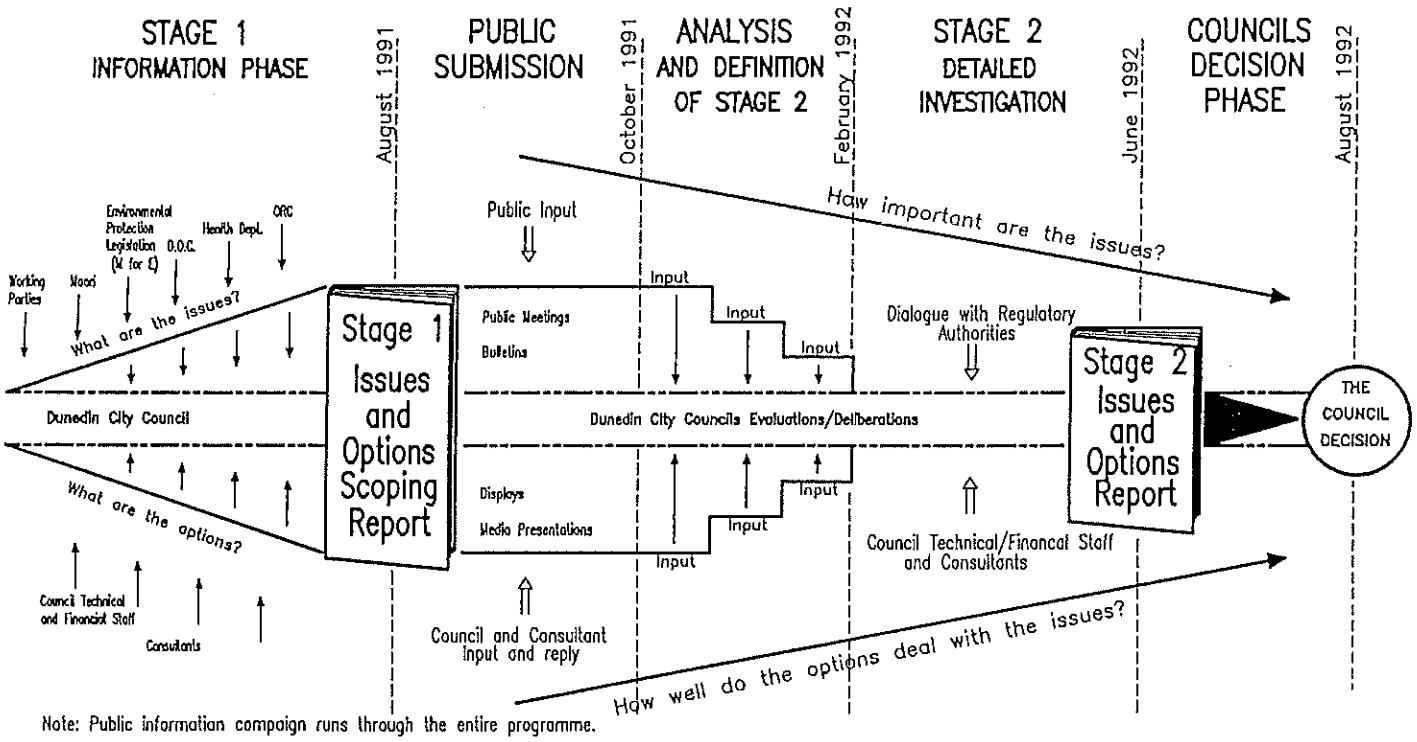
The Stage 1 study, resulting in this Issues and Options Scoping Report, is one of the first and key foundation blocks to the logical stepwise decision process Council is following.

The process which integrates the basic elements of the decision process, namely:

- the project objective
- the key decision factors
- the issues, and
- the evaluation criteria

had already been initiated by Council's formulation of its Strategic and Annual Plans and the commencement of this Wastewater Treatment and Disposal Study. The input from this Stage 1 along with that from the three Working Parties also forms the early part of the decision process, as will the forthcoming phase of input from ratepayers, the general public and community at large.

Figure 1.2.1 (included again here), gives a diagrammatic representation of Councils Decision process and programme.



The key dates of the immediate programme , subject to Council confirmation, are:

- 27 August 1991 - Council receives the Stage 1 Issues and Options Scoping Report.
- 28 August 1991 - Council make the Stage 1 Issues and Options Scoping Report and Summary Report publicly available.
- 28 August 1991 - Council invite public submissions on the Stage 1 Report.
- 19 October 1991 - End of period for public submissions to Council
- November 1991 to February 1992 - Council considers the public submissions and Stage 1 Report and defines the Stage 2 Study.
- mid February 1992 - Commencement of the Stage 2 Study.
- mid June 1992 - Completion of the Stage 2 Study
- July 1992 - Council's deliberations and acceptance of the most appropriate total scheme and formulation of a capital works programme accordingly.
- August 1992 - Council adopts reports and capital works budgets.

14.2 STAGE 2 OF THE OPTIONS STUDY

In parts 1.4.2 and 1.4.3 the lead into and scope of the Stage 2 study is discussed. It is important to appreciate that the detailed scope of the Stage 2 study will be determined from the outcome of this Stage 1 report, following public submissions, consultations and Council's considerations.

The information to be further investigated and developed for the Stage 2 study for those shortlisted schemes is summarised in Part 1.4.3 of this report. Furthermore throughout this report, and particularly in Part 10, a number of specific topics are noted as being important ones to be further developed as part of the Stage 2 study providing they are relevant to the shortlisted schemes being further investigated.

14.3 ENVIRONMENTAL IMPACT ASSESSMENT AND APPROVALS

Whatever scheme option is selected, approvals will be required. These will be under the provisions of the Resource Management Act, as well as some present legislation. Part 5.0 introduces environmental considerations, legislation and planning.

These approvals will require a full environmental impact assessment to be made of the selected scheme option. This will include the identification of issues and options (as are set out in a scoping format in this report) and the key elements of the decision process phase. It is necessary to demonstrate in the environmental impact assessment that the optimum selection has been made from an impact point of view. The decision process phase is therefore a key part of the environmental impact assessment. The Fourth Schedule to the Resource Management Act provides details of what should be considered in any EIA.

This report gives an initial environmental scoping of some of the issues.

This report, however, is not an environmental impact assessment, and should not be used in isolation to assess environmental impact.

As introduced in Sections 6.2, 10,12, 13 and 14.4 of this report, an important consideration relates to staging. Staging of scheme implementation may prove to be in the best interests of both the ratepayers and the environment. The environmental, public health, cultural, and other impacts will therefore vary over the implementation period as components of the scheme are progressively constructed and brought into operation. It is imperative that additional approvals are able to be obtained at an appropriate time.

This will provide the Council and ratepayers with the security required to embark on a project of this scale. Council must be secure in the knowledge that the content of the project is accurately defined before commitment to capital expenditure. If this is not done, there is risk of changes being required later in the implementation period, with added cost.

14.4 IMPLEMENTATION CONSIDERATIONS INCLUDING STAGING

The following considerations will need to be addressed before or during the implementation of the scheme to ensure that the objectives continue to be met. These considerations are introduced in this report and will be further developed in the Stage 2 report as Council's programme progresses.

14.4.1 Ownership

'Privatisation' is currently fashionable, and it has application in most local government asset management considerations. The Council may need to decide, prior to construction, whether or not they choose to own the whole of the project, part, or any of the project at all. This decision is likely to be based on economic factors prevailing at the time, but there are important considerations which will need to be taken into account including the on-going operation and performance requirements of any scheme.

The prime example of one economic factor is the value of money. There have been recent well-publicised offers of investment in infrastructure (particularly water and wastewater systems) in New Zealand by large overseas organisations. These offers have been stated to include concessional financing arrangements. Whilst these arrangements may have benefit in certain cases, they must be carefully evaluated to ensure the lifetime cost to the ratepayers is optimised. A tradeoff of low investment rates against guaranteed purchase (from one supplier) is not likely to be the optimum solution as a commercial profit must be generated and exchange rate risks must be covered somewhere in the system.

Ownership of the project by a commercial organisation could include just the treatment plant, or could also include the conveyance and disposal components. Inclusion of the conveyance and disposal components is less common because of their interrelationship with other Council assets (eg, they are usually located in streets).

Private ownership will not necessarily mean reduced costs to the ratepayer.

14.4.2 Project Funding

Project funding considerations will be heavily influenced by ownership and staging considerations. If the project (or part of it) was to be in commercial ownership, the need for capital is reduced. The owner would raise the required capital on the finance market and these costs would be included in the costs charged for the service.

A number of local authorities have high current debt levels, which have high servicing requirements because of high interest rates. There is a general trend towards debt retirement where possible, particularly of long term debt. If interest rates reduced substantially, and could be fixed, the alternative of raising the required capital for the project by way of a loan or loans would be attractive. If interest rates remain high, the alternative of staging the project is likely to be more attractive. This involves constructing scheme components sequentially over a period and funding a portion at least from cash flow. This process can be assisted by asset sales if appropriate.

14.4.3 Procurement and Construction

A number of alternatives exist for carrying out the physical construction of the project works particularly for treatment plants. These are separate from the staging considerations noted elsewhere in this report. Examples of alternatives are:

- design and build (turn-key)

  A contract is entered into for design and construction of the facility to meet set performance criteria.

- design, build, operate and transfer

  A contract is entered into for design, construction and one or more years of operation of the facility before its ownership is transferred to the local authority. This enables the performance of the plant to be evaluated before ownership, and this factor taken into account on transfer.

- design and tender

  The owner designs the plant and calls competitive tenders for construction.

- process tender

  The owner calls for tenders for the process components, but designs the remainder of the plant and calls competitive tenders for construction. Wellington is an example of this process.

The design and tender process is the most common option in New Zealand, with the first two being more usual in developing countries and to a lesser extent in the USA and Europe. The process tender is a development of the design and tender alternative where commercial considerations have been decided to be the best way to select the optimum process.

14.4.4 Post-Implementation Considerations

Operation and Maintenance

Even though ownership of the project might be found best to remain with the Council, there are alternatives available for operation and maintenance.

Operation and maintenance by contract has been common in Europe (particularly France) and to a lesser extent the USA, for a number of years. It is now gaining recognition in New Zealand, but there is little history yet available. By the time final decisions are made by Council, there may be New Zealand case studies, and experienced contractors, available, to enable a comparison between this method and the Council carrying out operations and maintenance utilising its own staff.

Performance Evaluation

Ongoing performance evaluation, is an effective way of ensuring optimum performance of the project over the long term. This evaluation can cover:

- plant operating efficiency (cost of operating together with effluent standards achieved)
- the operation and maintenance strategy
- the ownership strategy
- the funding strategy

A regular review enables decisions to be taken to ensure scheme performance is continually optimised. The importance of direct Council control to ensure value for money to ratepayers, and compliance with the various operating approvals, (eg, discharge permits under the new Resource Management Act) must be to the fore in ongoing performance evaluation.

14.4.5 Staging of Implementation

Part 6.2 introduces the issue of staging and sets out the range of staging considerations that are likely to be relevant to this Dunedin project. Staging is then further discussed as part of construction considerations in Part 10.12.

For the representative total schemes set out in Part 13, a summary listing is given of how the components of options, and the various catchment options that make up the total scheme, can be staged. Furthermore, other parts of this report, particularly those dealing with economics and affordability, integrate the considerations of staging from a financial view point.

The above reference back to earlier parts of this report is given in order to set the background, and give some emphasis to the matter of staging. Staging is likely to be an important issue from a community acceptance and cost affordability stance on scheme selection and implementation.

While it is outside the scope of this Stage 1 report to evaluate and present various staging and associated financial models for these representative total schemes, it is appropriate to list those consideratons which would be taken into account when staging options are developed in the Stage 2 study. These are:

- Council policy
- availability of finance
- community priorities/concerns
- Water Rights and other legal issues
- outfall versus treatment options
- staging treatment plant upgrades
- catchment basin priorities
- progression from one concept level output representative total scheme to another.

Abbreviations and Glossary

ABBREVIATIONS AND GLOSSARY

ADWF	-	Average daily dry weather flow
B	-	Burkes
Bacteria	-	Group of ubiquitous microscopic organisms, mostly unicellular
BAF	-	Biological aerated filter
BB	-	Broad Bay-Portobello
Benthic organisms	-	Referring to organisms living in or on the sediments of aquatic habitats
Biota	-	The flora and fauna of an area
Bloom	-	An unusually large number of organisms per unit of water, usually algae, made up of one or a few species
BOD_5	-	5 day biochemical oxygen demand, a measure of the organic matter content of water or wastewater by the quantity of oxygen consumed by micro-organisms in breaking it down
BPO	-	Best practicable option
CAS	-	Chemically assisted sedimentation
CB	-	Company Bay
CCI	-	Construction Cost Index
Cd	-	Cadmium
CMF	-	Crossflow microfiltration
CN	-	Cyanide
CO	-	Carbon monoxide
Cr	-	Chromium
Criteria (water quality)	-	Scientific data evaluated to derive the recommended limits for water uses
Cu	-	Copper
d	-	day
DAF	-	Dissolved air floatation
dBA	-	A measure of sound intensity
DCC	-	Dunedin City Council
DD & SB	-	Dunedin Drainage and Sewerage Board
Disinfection	-	A process designed to reduce the number of micro-organisms in a particular effluent, including use of chlorination, UV light, and ozone. It is usual to refer to a disinfected (stage of treatment) effluent, such as a "disinfected secondary effluent".
Disposal	-	The point at which effluent is discharged from man-made facilities and enters the natural environment.
DoC	-	Department of Conservation
Domestic Sewage	-	See part 4.1.1

Effluent	-	A complex waste material (eg, liquid industrial discharge or sewage) which may be discharged into the environment.
Effluent Disposal	-	Is the discharging of the treated effluent from any treatment process, either to a receiving water such as a river, lake or ocean, or onto land.
Existing Use Right	-	See part 5.2
Eutrophic	-	Abundant in nutrients and having high rates or productivity frequently resulting in oxygen depletion below the surface layer of a water body.
Eutrophication	-	The process of enrichment of rivers, lakes or other water bodies with nutrients (especially nitrogen and phosphorus). Usually overabundant aquatic plant growth occurs, dissolved oxygen in the water is depleted, and the diversity of animal communities may be reduced.
Faecal coliforms	-	A group of bacteria which are normally abundant in the intestinal tracts of warm blooded animals and are indicators of the contamination of water by the faeces of these animals.
FC	-	Faecal Coliforms
FS	-	Floatation/sedimentation
Flow Definitions	-	ADWF : Average daily dry weather flow
	-	PWWF : Peak wet weather flow
	-	MWWF : Maximum wet weather flow
g	-	Grams
GIC	-	Green Island Catchment
GP	-	Grassy Point
GST	-	Goods and services tax
g/m^3	-	Grams per cubic metre (parts per million)
ha	-	Hectare
Harbour Use	-	See part 5.2
HB	-	Harbour basin catchment
HDPE	-	High density polyethylene
H_2S	-	Hydrogen sulphide
ID	-	Internal diameter
Intertidal	-	Between low-water and high-water mark
Invertebrates	-	Animals lacking dorsal column of vertebrae or a notochord
km	-	Kilometre
l	-	Litres
Land Use Consents	-	See part 5.2
l/d	-	Litres per day
l/pd	-	Litres per person per day
l/s	-	Litres per second

m	-	Metre
Marine treatment	-	The use of the marine environmental to dilute and treat sewage by natural processes to harmless otherwise acceptable levels. This treatment system also includes the final disposal of the effluent. Such processes include dilution, dispersion, biological breakdown, and micro-organism die-off.
MC	-	Musselburgh Catchment
MDPE	-	Medium density polyethylene
MIS	-	Main Intercepting Sewer
ml	-	Millilitre
MPN	-	Most probable number (of bacteria)
MTC	-	Mosgiel/Taieri Catchment
MWWF	-	Maximum wet weather flow
m^2	-	Square metres
m^3	-	Cubic metres ($1m^3$ = 1,000l)
m^3/d	-	Cubic metres per day
m^3/s	-	Cubic metres per second ($1m^3/s$ = 1,000l/s)
m/s	-	Metres per second
N	-	Nitrogen
Natural Water	-	The definition of water in the Water and Soil Conservation Act 1967 applied to all forms of naturally occurring water; including surface water in rivers, streams, lakes, swamps, groundwater, sea water, steam, ice and snow. Water under the control of a public authority or water in a reservoir, pipe, tank, race or cistern is not natural water.
NE	-	North East
NFR	-	Non filterable residue
Ni	-	Nickel
Nitrogen	-	An odourless, invisible, chemically inactive gas that forms about 80% of the atmosphere. It is an essential macronutrient for plants and so is used in fertilisers.
Nutrient	-	An element or compound essential for the growth and development of like forms. The major plant nutrients are nitrogen and phosphorus but there are also a number of minor nutrients which are required in small quantities.
OD	-	Outside diameter
Organic	-	Containing or combined with carbon
Outfall	-	A pipe or structure which discharges wastewater or effluent in receiving waters
O_2	-	Oxygen
O & G	-	Oil and grease = total grease under standard test
O & M	-	Operation (operating) and maintenance
P	-	Phosphorus
Pathogen	-	An organism capable of eliciting disease symptoms in another organism
Pb	-	Lead
PC	-	Port Chalmers

Peaking factor	-	$\frac{\text{PWWF}}{\text{ADWF}}$
Pelagic	-	Term applied to organisms which inhabit the open water of a sea or lake
Periphyton	-	The organisms attached to submerged plants
pH	-	A measure of acidity/alkalinity (scale 1-14) (most acidic neutral most alkaline) (pH = 1 pH = 7 pH = 14)
Phosphorus	-	Element. It is found in nature only in the combined state, mainly as phosphate rock. It is used in fertilisers, detergents and matches and is essential to life.
Phytoplankton	-	The plant portion of the plankton
Plankton	-	Plants (phytoplankton) and animals (zooplankton), usually microscopic, floating in aquatic systems
Preliminary Treatment	-	The removal of large solids, grit, and other problematic material (eg, excess fats) which might otherwise interfere with downsteam processes and/or damage equipment. Milliscreening, barscreens, comminutors and grit channels, for example, are usually considered as preliminary treatment processes.
Primary Treatment	-	The removal of floating and settleable material particularly be a variety of means, but normally by physical processes such a sedimentation and floatation tanks. There are additional method of enhancing the removal of these solids, often by use of chemicals or air, called **Advanced Primary Treatment.**
PWWF	-	Peak Wet Weather Flow
P & G	-	Preliminary and General
RBC	-	Rotating Biological Contactors (biodiscs)
Residuals	-	Residuals are all those non-liquid effluents and by-products from the wastewater treatment processes, and include odours, noise, sludges, screenings, and air emissions. These must also be properly managed in order to avoid detrimental or negative environmental impacts.
Residuals Management	-	The residuals from sewage treatment processes refer to those by-products produced (other than the liquid effluent), such as sludges, odours, noise, and air emissions. All of these residuals require appropriate management to ensure in particular that treatment plants do not become an environmental or social detriment.
RI	-	Rapid Infiltration
RO	-	Reverse Osmosis
Scum	-	Floatable grease and oils
Secondary Treatment	-	The removal of dissolved nutrients, organic matter (BOD_5) and non-settleable solids by a variety of means, including biological and chemical processes. The biological processes involve concentrated growth of micro-organisms either of fixed surfaces (eg, trickling filters) or in suspension, (eg, activated sludge plants).

Sewage	-	Toilet and other waterborne wastes derived from domestic dwellings and non-industrial sources (office buildings etc)
Sewerage System	-	See "wastewater collection and disposal system"
Sludge	-	Sludge is the by-product which is drawn off the bottom of sedimentation tanks, when the liquid in a treatment stage is allowed to settle. Various processes can then be used to stabilise and/or dewater the sludges prior to re-use or disposal.
SH1	-	State Highway 1
SS	-	Suspended Solids
SRI	-	Slow Rate Irrigation
Suspended Solids	-	Small particles of solids distributed through water
Tertiary Treatment	-	Further treatment to remove specific elements which may be of concern (eg, more nutrients, trace metals, bacteria, solids, organics) by an array of processes (including disinfection)
Trade Wastes	-	Those liquids wastes discharged by industries that produce contaminated wastewater as a result of their processes. These industries are commonly called "wet" industries. See also part 4.1.1
TF/SC	-	Trickling filter/solids contact
TN	-	Total Nitrogen
TP	-	Total Phosphorus
Trade Premises	-	See part 4.1.1
Trade Wastes Bylaws	-	See part 4.1.1
Toxicity	-	The inherent potential or capacity of a material to cause adverse effects in a living organism
Turbidity	-	The cloudiness in a liquid caused by the presence of finely divided, suspended material
Treated Effluent	-	The term used to describe the final liquid effluent from any particular wastewater treatment process. This effluent requires disposal by some means. It is usual to qualify the term be referring to the degree of treatment or process type, such as "secondary treated effluent" or "activated sludge effluent".
Treatment	-	The processing of wastewater using physical, biological or chemical means to remove all constituents that will have a harmful effect on public health or the environment at the point of discharge. The degree of treatment required is dependent on the receiving environment and the method of disposal
UF	-	Ultrafiltration
uPVC	-	Unplasticised polyvinyl chloride
UV	-	Ultra Violet light
Virus	-	A sub-microscopic agent infecting plants, animals and bacteria, and unable to reproduce outside the tissues of a host

Waste	-	See part 4.1.1
Wastewater	-	The total mix of sewage and trade wastes
Wastewater Collection and disposal system (sewerage system)	-	the system of pipes, pump stations, treatment and disposal facilities which convey wastewater. These are the components of a sewerage scheme as shown in the following diagram.
Water Quality	-	An indication of the extend to which the condition of water rise considered suitable for, or meets the expectations that people may have of it, for any particular use.
Water Rights	-	See part 5.2
Wetland	-	An intermittently or permanently wet area, shallow water or a land/water margin, inhabited by plants and animals that are adapted to living in wet conditions
WPCP	-	Water pollution control plant
Zooplankton	-	The animal portion of the plankton
Zn	-	Zinc