

Grace Ockwell

From: [REDACTED]
Sent: Monday, 17 March 2014 02:24 p.m.
To: officialinformation@dcc.govt.nz
Subject: Local Government Official Information request - 407881

Categories: LGOIMA

[REDACTED] has submitted a LGOIMA request - 407881.

Below are the details of the request

Request details:

Hi, I am currently in my fourth year at the University of Otago studying the Bachelor of Surveying degree. My Environmental Engineering paper requires a research report on the 'context of zero waste in New Zealand at a organisational level.' I am currently interested in how DCC is capturing methane gas from the Green Island landfill and using this to create energy in order to help achieve zero waste. I was wondering if you could send me as much information as you can about this project. Information such as objectives, outcomes, progress and any reports which relate to this. This would greatly help me focus my research on the Green Island landfill and how the DCC is using this to help achieve zero waste. Thank you for your time and I look forward to hearing back from you.

File attachment

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Name

Email address

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Grace Ockwell

From: Ian Featherston
Sent: Thursday, 3 April 2014 10:34 a.m.
To: [REDACTED]
Cc: Grace Ockwell
Subject: RE: Local Government Official Information request - 407881
Attachments: Document1.doc; Document3~0.doc; Document4.doc; Document21~0.doc; Gas collection Memo Dec 08.doc; Gas collection report to ISCOM 20-07-07.doc; Landfill Gas Collection Review MWH 2005.pdf; Letter to ORC - GILF gas collection update May 2008.doc; Solid Waste Annual Plan Workshop Report (2).doc

Categories: LGOIMA

Hi [REDACTED]
Attached are the reports associated with the gas collection and destruction at the Green Island Landfill

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 Civic Centre
 Dunedin

From: William Clifford

Date: 28 September 2005

Reference: 801/010596-05

Attention: Iain Satterthwaite

Project: Green Island Landfill: Landfill Gas Collection Review

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William Clifford

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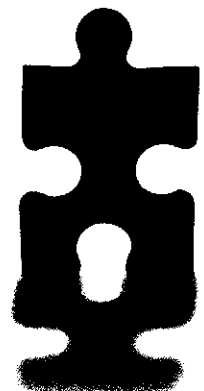


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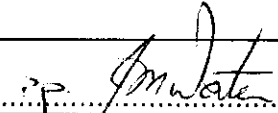
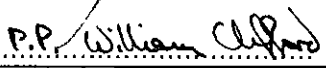
Green Island Landfill Landfill Gas Collection Review *Final Report*

September 2005



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Dunedin City Council

Green Island Landfill Landfill Gas Collection Review Final Report

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1. Introduction

1.1 Purpose

In 2004 regulations relating to the emission of methane from landfills came into force. Green Island Landfill will require a gas collection system unless closed before October 2007.¹ Based on previous landfill gas assessments undertaken for the Dunedin City Council (the Council) and on the requirements of the new regulations, MWH has been asked to review landfill gas collection at Green Island Landfill. The objective of this review is the development of an overall work plan for landfill gas collection implementation.

1.2 Scope

The scope of this review includes:

- Landfill site characterisation in terms of filling patterns, age of fill, cover, land use, land use status and landfill migration mitigation features
- Landfill gas collection concepts
- Landfill gas preliminary risk assessment
- Landfill gas collection implementation programme.

1.3 Background

1.3.1 Landfill Gas

Landfill gas (LFG) is produced as an end product of anaerobic biological decomposition. Although it comprises mainly methane and carbon dioxide, it may also contain small amounts of other gases, including volatile organic compounds. The typical composition of LFG is given in Table 1.3.1. The density of LFG varies with composition and may be slightly heavier or lighter than air.

Table 1.3.1: Typical constituents found in LFG (Source- CAE Landfill Guidelines)

Component	Percent (dry volume basis)
Methane	45 - 60
Carbon Dioxide	40 - 60
Nitrogen	2 - 5
Oxygen	0.1 - 1.0
Sulphides, Disulphides, Mercaptans etc.	0 - 1.0
Hydrogen	0 - 0.2
Carbon Monoxide	0 - 0.2
Trace Constituents	0.01 - 0.6

¹ Refer to MWH, *Impact of the National Environmental Standards for Landfill Gas*, November 2004.

The potential effects of LFG are as follows:

- **Flammability** – methane is explosive when mixed with air in concentrations between 5 and 15% methane. There is a risk of fire or explosion due to gas migration and collection in confined spaces
- **Asphyxiation** – LFG can act as an asphyxiate by displacing or diluting air, so that the oxygen concentration is reduced in confined spaces. The NZ Workplace exposure Standards state that the concentration of oxygen in air should be maintained at or above 19.5% v/v under normal atmospheric pressure
- **Toxicity** – Some of the constituents in LFG (e.g. CO₂, H₂S, VOCs) could have toxic effects if present in high enough concentrations. However trace gases do not normally present a problem after atmospheric dilution. LFG can also have detrimental effects on soils and vegetation within the completed landfill and adjacent sites
- **Odour** – The odorous compounds associated with LFG include ketones, esters, amino volatile fatty acids, hydrogen sulphide, and mercaptans. The offensiveness of the odour of LFG is reduced as the waste enters the methanogenic biodegradation stage (2-4 years after waste placement). Hence odours are not generally a significant issue with LFG from closed landfills
- **Greenhouse Gas Effects** – The major constituent of LFG is methane, which is considered to have twenty-one times greater greenhouse gas effects than carbon dioxide.

Landfill gas production generally peaks within the first two years of waste decomposition, and then tapers off, continuing in many cases for periods up to 25 years or more.²

1.3.2 Existing Gas Collection System

A gas collection system was constructed at Green Island Landfill in 1995 as part of a commercial venture to utilise gas as an energy source. The system was extended over the next three years. It is understood that the gas yield was insufficient to provide an economic return and so the venture was terminated in September 1999. Most of the LFG collection system is still in place, although its condition is unknown.

² Tchobanoglous et al., *Integrated Solid Waste Management: Engineering Principles and Management Issues*, McGraw-Hill, 1993.

2. Legislation and Guides

2.1 Resource Management (National Environment Standards) Regulations 2004

The Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins, and Other Toxics) Regulations 2004 was enacted on 6 September 2004. The regulations that relate to controls on greenhouse gas emissions from landfills came into force on 8 October 2004 and have been reported on previously³. (A copy of the relevant sections can be found in the previous report.)

The regulations define a landfill as “a site where waste is disposed of by burying it, or placing it upon land or other waste.” The regulations do not apply to cleanfills.

Regulation 25 states that “regulations 26 and 27 apply to a landfill if:

- (a) *the landfill---*
 - (i) *has a total capacity of not less than 1 million tonnes; and*
 - (ii) *contains not less than 200 000 tonnes of waste; and*
 - (iii) *is or is likely to be accepting waste; and*
- (b) *the waste in or to be included in the landfill is likely to consist of 5% or more (by weight) of matter that is putrescible or biodegradable.*

However, regulations 26 and 27 do not apply to a landfill until 8 October 2007 if the landfill---

- (a) *has a total capacity of not less than 1 million tonnes of waste; and*
- (b) *on 8 October 2004---*
 - (i) *contains not less than 200 000 tonnes of waste; and*
 - (ii) *is accepting waste; and*
- (c) *does not operate a gas collection system.”*

The total airspace that the Green Island Landfill is proposed to occupy has been estimated as approximately 5 million m³. Using an allowance of 20 percent by weight as cover material and an in situ density of waste of 0.8 tonnes/m³, this volume equates to a waste mass of approximately 3 million tonnes. The estimated quantity of waste placed in the landfill up to December 2003 is approximately 1.5 million tonnes.⁴

The Green Island Landfill has a capacity greater than the specified limit of 1 million tonnes, is accepting waste and does not have an operational gas collection system (although it does have a decommissioned landfill gas collection system over part of the landfill). Therefore, the regulations will be relevant to the Green Island Landfill from 8 October 2007.

Once effective, a National Environmental Standard (NES) overrides any rule in a Regional Plan, unless the relevant rule is more stringent than the NES. For existing uses, the NES will be implemented through a review of the conditions of the relevant consent. The RMA Section 128 states that, when a relevant NES has been made, a consent authority may review the conditions of any water, coastal or discharge permit.

³ MWH November 2004, *Green Island Landfill: Impact of the National Environment Standard for Landfill Gas*

⁴ *Financial Implication of Zero Waste Policy*, May 2004, MWH.

A review of the conditions of the discharge to air consent for Green Island Landfill by the Otago Regional Council has shown that the consent holders “shall take all practicable steps to collect the landfill gas generated from refuse less than 12 years old...”⁵

Regulation 26 states that “No person may allow the discharge of gas to air from a landfill”. However this “does not apply if the landfill has a system for the collection of gas from the landfill---

- (a) *that is designed and operated to ensure that any discharge of gas from the surface of the landfill does not exceed 5 000 parts of methane per million parts of air; and*
- (b) *in which the gas is---*
 - (i) *flared in accordance with regulation 27; or*
 - (ii) *used as a fuel or for generating electricity.*

Complying with Condition (a) above will be influenced by the landfill cover design and the method of monitoring discharge of gas from the surface of the landfill. Typically, methane concentrations in landfill gas will be 55%, with the remainder being predominantly carbon dioxide. A collection system will remove much of this gas but the remainder will be discharged through the surface. If the landfill gas discharged from a landfill is measured without entrained air, the concentration of methane will be greater than 5,000 ppm⁶.

Regulation 27 provides details of the required system if the gas collected is destroyed by flaring. This includes requirements for both the principal flare and the backup flare. These requirements are included in Appendix D of this report.

2.2 Guides

2.2.1 User Guide to Regulations

The Ministry for the Environment has prepared a draft users guide to the Regulations⁷, which includes a sampling protocol for Instantaneous Surface Monitoring (ISM) at Landfills. The ISM technique of monitoring, although subject to a number of variables, provides a qualitative assessment of landfill gas (LFG) emissions from a landfill surface as measured by methane in parts per million.

Information gathered from the monitoring allows decisions to be made on modifications that will reduce odour emissions and enhance methane gas collection in a gas extraction system.

Instantaneous surface monitoring of landfill gas is also performed to determine the need for a LFG gas control system and is also used to verify if the landfill gas collection and control system is operating correctly. It can also be used to identify locations on the landfill where more detailed emission monitoring is required.

In the protocol, it is noted that both the United States Environmental Protection Agency and South Coast Air Quality Management Board recommend that ISM is conducted quarterly on sites where active gas collection and control systems have been installed.

⁵ Consent No.: 94524

⁶ ppm means ‘parts per million’

⁷ MfE November 2004, The Users Guide to Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins, and Other Toxics) Regulations 2004

2.2.2 Other Guides

Other guides referred to in this report are the Landfill Guidelines (CAE, 2000), A Guide to the Management of Closing and Closed Landfills In New Zealand (MfE, 2001), Waste Management Paper No. 27 Landfill Gas (DOE, 1991) and Waste Management Paper 26B Landfill Design, Construction and Operational Practice (DOE, 1995).

Waste Management Paper No. 27 states that "A control system should be considered effective if the concentration of flammable gas from the landfill never exceeds 1% by volume and the concentration of carbon dioxide, from the landfill, never exceeds 1.5% by volume in any sub-surface probe or borehole outside the area of influence of the gas control system or the area of the wastes".

3.1.2 Site Definition

The legal descriptions of the site are recorded in Table 3.1.

Table 3.1: Legal Description of Green Island Landfill Site

Certificate of Title	Cadastral Reference	Comment
CT 11B/1241	Part Section 45 and Section 46,47, Green Island Bush Survey District Section 54,63, Block VII Dunedin and East Taieri Survey District	Designated Landfill Area Part of Landfill Operation Area
CT 11B/1241	Section 119, Block VII Dunedin and East Taieri Survey District	Designated Landfill Area Outside Landfill Operation Area
CT 11C/1275	Section 120 and Part Section 53, Block VII Dunedin and East Taieri Survey District Closed Road intersecting Part Section 86, 87, 98, 102, 103, Block V Lower Kaikorai Survey District	Designated Landfill Area Outside Landfill Operation Area
CT 16D/1194	Part Section 86, 87, 98, 99, 100, 101 and Section 102, 103, Block V Lower Kaikorai District	Designated Landfill Area Outside Landfill Operation Area
CT 12D/571	Lot 1 DP 20826	Designated Landfill Area Outside Landfill Operation Area
CT 15C/1017	Sec 1 SO 24040	Designated Landfill Area Outside Landfill Operation Area
CT 7C/934	Part Section 44, 156, Green Island Bush Survey District	Designated Landfill Area Landfill Operation Area
CT 7C/934	Part Section 38, 39, 40, Green Island Bush Survey District	Designated Landfill Area Outside Landfill Operation Area
CT 12C/261	Part Lot 4 DP 4550	Designated Landfill Area Outside Landfill Operation Area
CT 12C/262	Lot 1 DP 20582	Designated Landfill Area Landfill Operation Area
CT 15A/266	Section 81, Block VII Dunedin and East Taieri Survey District	Designated Landfill Area Landfill Operation Area
CT 15C/1016	Section 1, SO 24047	Designated Landfill Area Landfill Operation Area
CT 368/19	Part Sec 45, Green Island Bush District	Designated Landfill Area Landfill Operation Area
CT 11B/1241	Section 55, 65	Not Designated Landfill Area Landfill Operation Area

An aerial photograph of the site and a drawing showing the site, site boundaries, and land ownership are included in Appendix A. The landfill footprint, as shown in the Appendix A, is the focus of this review.

3.2 Land Use and Operations

Land use within the landfill footprint can be divided into three main areas:

- a) The area closed to waste disposal. This includes the transfer station, resource recovery areas, and the area to the east and south of the station. The indicative area is 11 hectares
- b) The area within which there is active waste disposal. This is confined to the western section of the landfill and lies within the Lift 2 bunds, as shown in drawings in Appendix B. The indicative area is 16 hectares
- c) The area where the landfill footprint may be extended in the future (compare the Final Landform drawings in Appendix A). The indicative area is 5 hectares.

Approximately 6 hectares lie within the site but outside the landfill footprint. This area consists of lagoons, screening, access routes etc.

3.3 Waste

3.3.1 Filling History

Green Island landfill was first opened to receive industrial waste in 1954. By the late 1970s it had become "the main landfill for all of Dunedin, taking in an average of 58,000 tonnes of refuse annually."⁸ Appendix B contains drawings showing the location and age of the waste at Green Island Landfill. Surveys of the landfill face were carried out in 1964, 1967, 1971, 1975, 1977, and 1979 (see drawing in Appendix B). Based on the information on the drawing, and given the overlapping of faces from one survey to the next, it would be reasonable to infer that waste was placed in multiple shallow lifts. Since 1991, annual surveys have shown the progression of the landfill face.

By 1990⁹ the area now closed to waste disposal was filled to the Lift 1 level (RL ~ 106 m to 107). Thus, waste in this area has an age greater than 15 years and up to 50 years. (Note: 15-year-old waste is likely to be generating LFG at between 50 and 75% of its maximum generating capacity. 30-year-old waste is likely to be generating LFG at 25% or less of its maximum generating capacity).¹⁰ By the end of 2001, Lift 1 was complete.

Since 2002 a second lift of waste is being placed over older waste, as shown in the drawings in Appendix B.

The depth of waste in Lift 1 varies from 4.5 m at the eastern side of the site to 8 m on the western side.¹¹ The depth of waste in the second lift is typically 8 m.

⁸ BECA STEVEN, *Environmental Impact Assessment of the Existing Green Island Landfill*, 1992.

⁹ Royds Garden 1990, Green Island Waste Management Centre Conceptual Development

¹⁰ Figures based on the example in MIE, *A Guide to the Management of Closing and Closed Landfills in New Zealand*, 2001, p.89.

¹¹ Based on bore log data in *Possible Development of Green Island Tip and Environs* (Patterson & Pitts, 1981) and on the 1993 and subsequent surveys of the site.

3.3.2 Waste Quantities and Composition

Estimates of waste quantities disposed of at the site have been reported¹². The composition of waste that was disposed of in the Green Island Landfill up to the 1990s was not monitored.

Between October 1996 and June 1997 detailed information regarding quantities of municipal solid waste, sludge and inert material was recorded by the Council.

This was analysed¹³ for waste composition, which was reported as follows:

Municipal solid waste:	18.2%
Sludge:	4.2%
Inert Material:	77.6%

Waste types and quantities received at the landfill are monitored and reported to the Council by the landfill operator. SWAP¹⁴ analyses are carried out periodically and forwarded to the MfE for inclusion in its database. Special waste received and disposal locations are monitored and recorded by the landfill operator¹⁵.

Table 3.3.1 contains information on the quantities of sludge disposed of at Green Island Landfill between 2000 and 2005. The dry solids content of the sludge (other than from the Tahuna Wastewater Treatment Plant) is not known. Sludge from the Tahuna Wastewater Treatment Plant is expected to be approximately 20% dry solids.

Table 3.3.1: Quantities of Sludge Disposed at Green Island Landfill

Year	Council (tonnes)	Industry (tonnes)
2000/01	7,173	6,107
2001/02	5,846	6,828
2002/03	5,939	6,424
2003/04	6,287	11,932
2004/05	6,921	9,002

3.4 Physical Characteristics

3.4.1 Geology

Investigations by Royds Garden (1990) and Beca Steven (1991) indicated that the landfill is situated over alluvium. They found

“soft silt and clayey silt underlying interbedded and discontinuous layers of soils ranging from clayey silts and sandy silts to uniform sands, which is typical of estuarine deposits. The depth of the alluvium was found to be irregular and varied from as little as 2 m to more than 10 m. Below this, bedrock of the Abbotsford Formation was found.”¹⁶

¹² Royds Garden September 1993, Study of Landfill Gas Generation and Control

¹³ SCS – Wetherill Environmental, *Landfill Gas Collection System Improvements: Green Island Landfill, Dunedin*, Draft, August 1997.

¹⁴ MfE 2000 Solid Waste Analysis Protocol

¹⁵ DCC Contract No. 2572

¹⁶ BECA STEVEN, *Environmental Impact Assessment of the Existing Green Island Landfill*, 1992.

The 1992 Environmental Impact Assessment report states that:

“the permeability of the upper alluvial sediments is greater than the permeability of the underlying marine sediments. The average permeability at depths above 4m was approximately 4×10^{-6} m/s. The average permeability at depths greater than 4 m was approximately 6×10^{-7} m/s.”¹⁷

As the quantity of waste in the landfill increases, consolidation of the underlying alluvium and a reduction in its permeability will result.

3.4.2 Bunds

In 1998 the Council commissioned a report on perimeter bund construction and staging.¹⁸ It is understood that perimeter bunds for Lift 1 were constructed by capping landfill, while Lift 2 bunds were constructed with cleanfill and clay.¹⁹ As-built details of the capping and bunds have not been located.

3.4.3 Groundwater

Groundwater levels are monitored on a regular basis. However, there is only one bore located within the landfill. Information from this bore MW9 (see Appendix B for location) indicates that the water table has risen from 6 m below the top of Lift 1 (RL 104) to 4 m below the top of Lift 1 (RL 106).²⁰ This rise is shown in Figure 3.4.1. A report that reviews resource consent compliance comments that “some scatter apparent in the various data sets may be attributable to incorrect data input.”²¹

The rise in the water table may be a localised or a general effect. Final groundwater levels within the landfill have been predicted²². Initially this was RL 104. Subsequently, after computer modelling, this was revised to RL 105 for waste with an average permeability of 10^{-4} m/s. However, dependent on the resultant permeability of the waste, the groundwater level within the landfill could be RL 109 for waste with an average permeability of 10^{-5} m/s or RL 121 for waste with an average permeability of 10^{-6} m/s.

¹⁷ BECA STEVEN, *Environmental Impact Assessment of the Existing Green Island Landfill*, 1992.

¹⁸ BECA CARTER HOLLINGS & FERNER, *Green Island Landfill Perimeter Bund Construction and Staging Report*, 1998.

¹⁹ Pers. Comm. with David Hanan, Delta.

²⁰ Data from Delta's monitoring results.

²¹ MWH, *Green Island Landfill: Review of Monitoring Information*, April 2004.

²² Beca Carter Hollings & Ferner, *Green Island Landfill Perimeter Bund Construction and Staging Report*, 1998

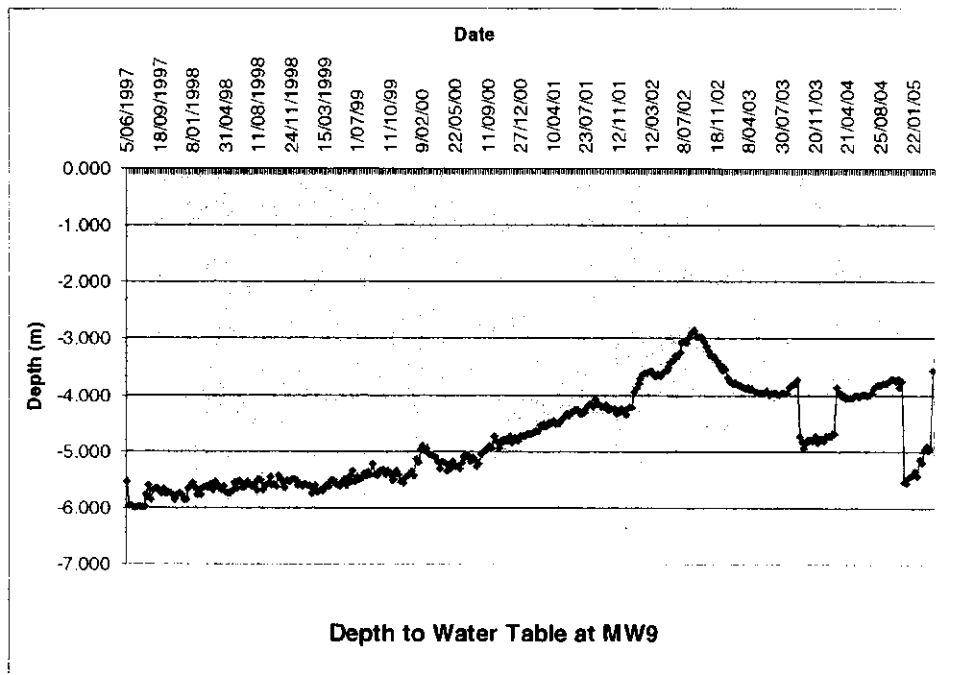


Figure 3.4.1: The Trend in Groundwater Levels at MW9, Green Island Landfill

Surface drainage is limited on the site (see section 3.4.4) and there is no subsurface drainage system within the landfill. This may be compounding the issue of rising water levels within the landfill.

Reasonable estimates for the permeabilities of the various materials in the landfill are shown schematically in figure 3.4.2.²³

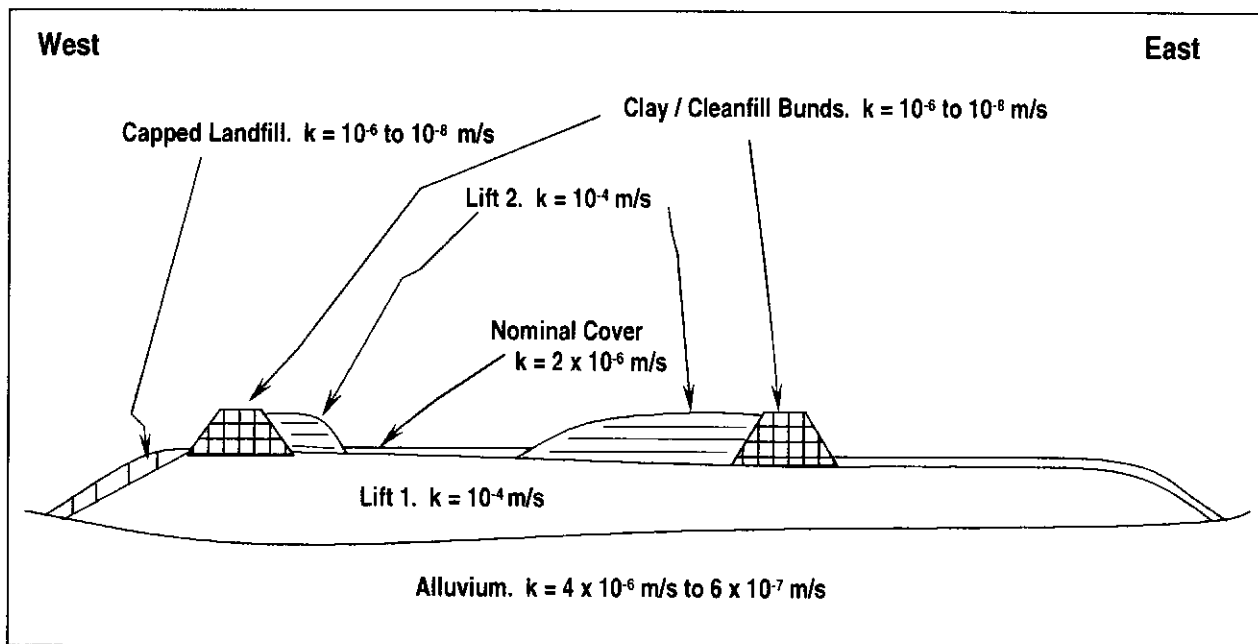


Figure 3.4.2: Schematic Cross-Section through Landfill Showing Typical Permeability Rates

²³ Data taken from BECA STEVEN, *Environmental Impact Assessment of the Existing Green Island Landfill*, 1992 and MWH, *North Taieri Landfill: Estimates of Leachate Generation*, 2005.

3.4.4 Surface Water

Surface water on the landfill is managed as indicated on Drawing G03 in Appendix B. A recent development, not shown on the drawing, is the formation of a drainage path from the operational area, through a cutting in the Lift 2 bund near its western most extremity, and to the perimeter stormwater channel. Surface water drainage is inhibited by the generally flat topography of the completed Lift 1 surface, particularly in the operational area.

A visual inspection of the landfill in May 2005 by MWH showed that there was a pond of water on the surface of Lift 2. The location of the pond was approximately at the July 2004 landfill face, as shown in a drawing (Sheet G12) in Appendix B.

3.4.5 Topography

The topography of the site is illustrated by Drawing G03 in Appendix B. Generally Lift 1 has been finished at a level of approximately RL 107 m, with side slopes of 3.5H: 1V. Lift 2 is being formed at a finished level of approximately RL 111 m to RL 112 m, with side slopes of 3.5H: 1V.

Two alternative final landforms are included in the Green Island Landfill Management and Development Plan²⁴. One includes an extension over the sewer at the southern end of the site while the other excludes this extension. Drawings (G09 and G10) showing these proposed landforms are in Appendix B.

3.4.6 Cover

At present, approximately 30 to 40% of the operational area of the landfill site has been filled to Lift 2 level with either waste or bund material. The remaining operational area is at Lift 1 level and has been covered with up to 300 mm of compacted material.²⁵ On top of this cover there are compost windrows, whiteware, tyres, and waste cars in places. Elsewhere, pits for the disposal of sludge and other hazardous wastes have been constructed.

Regarding the placement of intermediate cover, the operator's Operations Plan states that:

'Intermediate cover' will be applied to all landfill side slopes that will not receive additional waste for 30 days or more. 'Intermediate cover' will be placed to a minimum thickness of 300 mm (including daily cover which may already be in place)... When filling operations begin again, the 'intermediate cover' will be stripped from the surface and stockpiled and the underlying waste shall be penetrated.²⁶

Anecdotal information indicates that the intermediate cover at lift 1 level is thin in places. The extent of thin cover is not known. Thin cover will result in increased rain infiltration and more rapid gas emissions.

Regarding final cover, the operator's Operations Plan states that:

"When waste reaches final level grade, the 'final cover' shall be applied. The 'final cover cross section', from top to bottom is:

- 200mm Topsoil combined with compost

²⁴ MWH 2004

²⁵ Pers. Comm. with David Hanan, Delta.

²⁶ DELTA, *Operations Plan and Quality Control Forms*, September 2004.

- A minimum cover of 500mm low permeability clay cleanfill compacted to 'allowable bearing pressure' 100 kPa and a permeability of less than 10^{-7} m/s.

The 'final cap cover' will minimise erosion, surface water infiltration, and reduce leachate and gas generation."

Monitoring information (see section 3.6) indicates that final cover around the edge of the landfill over Lift 1 waste is failing to contain landfill gas.

Recommended practice (MfE, 2001) is that the final landfill cap comprises 300mm subgrade overlying waste, 600 mm compacted barrier layer ($k < 1 \times 10^{-7}$ m/s), and 150 mm topsoil layer. The total depth of cover excluding topsoil is 900 mm compared with a total depth of cover excluding topsoil given in the Operations Plan of 700 mm (assuming intermediate cover remains in place prior to final cover).

3.5 Existing Landfill Gas Collection System

3.5.1 Description

A gas collection system was installed in 1995 as part of a commercial venture to utilise gas as an energy source. This consisted of horizontal reticulation at typically 2 metres below ground level covering an area of 6.3 hectares. 4 collector mains were laid to bring the gas to a purification plant at the eastern side of the landfill. Between September 1996 and August 1999 vertical wells were installed over another area of the site.

Drawings in Appendix D show the reticulation and the purification plant. The area covered is approximately 7 ha, or indicatively 40% of the operational area of the site.

3.5.2 Performance

The estimated quantity of LFG recoverable was estimated prior to the installation of wells²⁷. At a 60% recovery rate, the total energy content was estimated at 403 GJ/day (147,000 GJ/yr). This indicates a recoverable energy content from the reticulated area of approximately 64,000 GJ/yr.

A report by SCS – Wetherill Environmental²⁸ contains a summary of the gas collection system performance for July 1997. (This system consisted of the horizontal wells called Fields 1, 2, and 4 and the vertical well field 3 - see Appendix D). The average collected/untreated gas flow for the month was 294 m³/hr. Overall methane content was 48%. According to the report, "after adjustments for collection efficiency, methane losses, and downtime, delivery potential was estimated at approximately 52,000 GJ/yr in 1997". This potential is equivalent to 1.65 MW.

The gas recovery venture was terminated in September 1999 for reasons which included the gas yield being insufficient to provide an economic return.

²⁷ Royds Garden September 1993, Study of Landfill Gas Generation and Control

²⁸ SCS – Wetherill Environmental, *Landfill Gas Collection System Improvements: Green Island Landfill, Dunedin*, Draft, August 1997

3.5.3 Current Condition of Collection System

The current condition of the gas collection system is not known. Part of the vertical well field has been demolished.

3.6 Methane Monitoring

Resource Consent no. 94524 stipulates that “monitoring for methane and carbon dioxide and oxygen shall be undertaken monthly using portable gas detectors at the site...near to the boundary at Clariton Ave.” Historical results of this monitoring can be found in Appendix E. In another report, MWH reviewed these results and found that “significant concentrations of methane were recorded in...1994 and 1995, particularly at monitoring point G1. These have subsequently reduced with methane concentrations being undetectable since the start of 2003. This may indicate that the area of the landfill adjacent to these bores was producing significant quantities of landfill gas prior to 2003 but has subsequently reduced. The current monitoring points near to the Clariton Avenue neighbours only indicate the presence of landfill gas and give no indication of the rate of production.”²⁹ It is noted that the MfE guidelines quote the UK Department of the Environment Waste Management Paper No. 27, which recommends that CH₄ concentrations should be less than 1% at the landfill boundary.³⁰ This value has not been exceeded at the monitoring points since 2001.

In March 2005, the Council commissioned EnviroWaste Services Ltd. to carry out instantaneous surface monitoring for methane at Green Island Landfill. According to the report “over the majority of the landfill, the surface methane emission levels were less than 0.05%. Methane levels in the completed part of the landfill were below 1% and in the active area there were five locations where the methane was 1% or greater.” It is worth noting that methane levels of 10,000 ppm (the maximum reading of the instrument) were recorded outside the landfill footprint (locations Q and V).³¹

²⁹ Taken from MWH, *Green Island Landfill: Review of Monitoring Information*, April 2004.

³⁰ MfE, *Guide for the Management of Closing and Closed Landfills in New Zealand*, Wellington, May 2001.

³¹ ENVIROWASTE, *Instantaneous Surface Monitoring for Methane at Green Island Landfill Dunedin*, March 2005.

4. Issues

4.1 Alternative to Meeting NES Requirements

One of the first issues to be considered is whether there are any alternatives to meeting the NES requirements. While the standard applies to landfills designed to accept over 1 million tonnes of waste throughout their design life (and thus applies to Green Island Landfill), it does not apply to landfills that are closed before 8 October 2007.

4.2 Meeting NES Requirements

4.2.1 Overview

Clause 26 of the NES states:

- (1) *No person may allow the discharge of gas to air from a landfill.*
- (2) *Subclause (1) does not apply if the landfill has a system for the collection of gas from the landfill-*
 - a) *that is designed and operated to ensure that any discharge of gas from the surface of the landfill does not exceed 5000 parts of methane per million parts of air;*
and
 - b) *in which the gas is -*
 - i. *flared in accordance with regulation 27; or*
 - ii. *used as a fuel or for generating electricity.*

(Underlining by MWH).

Issues associated with meeting the NES requirements can be divided into those relating to the necessary "system for the collection of gas" and those relating to surface emissions not exceeding "5,000 parts of methane per million parts of air."

Considering first the methane emission limit, issues to consider include:

- (i) Age of Waste
- (ii) Potential Activity of Waste
- (iii) Migration of Gas
- (iv) Migration of Liquid
- (v) Rain Infiltration and Cover
- (vi) Operations
- (vii) Type of Waste.

Regarding the collection system, associated issues include:

- (i) Extent of Collection System
- (ii) Type of Collection System

4.2.2 Age of Waste

Typically, "significant gas generation can be expected to continue for a period which is likely to be at least 15 years after the last deposit of waste".³² Thus for older waste, such as the waste located in the closed landfill section at Green Island, it is reasonable to expect little or no gas generation. EnviroWaste's instantaneous surface monitoring results for methane (March 2005) support this.

4.2.3 Potential Activity of Waste

Excavations of older waste in the 1990s showed that materials had undergone little decomposition due to the relatively dry conditions.³³ However, this was not evident when the LFG system was installed in 1995. Thus, while presently there are low methane emission levels over the older waste, it is not clear whether this is due to dry conditions and stalled decomposition, or due to relatively complete decomposition of the waste. Nevertheless, the methane monitoring (see section 3.6) indicates that much of the waste decomposition in the closed section of the landfill has ceased.

4.2.4 Exposure Routes

Normally, landfill gas is released to the atmosphere by both convective flow and diffusion.³⁴ Lateral migration of gas occurs where there is a "thin layering method of filling with heavy compaction and the use of daily cover materials." Perched water tables also reduce vertical gas flow.³⁵ The "characteristics of the cover material and the surrounding soil" also influence the extent of lateral gas migration.³⁶

At Green Island it is not unreasonable to expect the facilitation of lateral gas migration given the lack of bunds at the Lift 1 level. The use of cleanfill and landfill to construct bunds can also be expected to allow the lateral migration of gas outside the landfill footprint.³⁷ (Builders' rubble is often used to encourage the movement of landfill gas.³⁸)

Vertical gas migration can be expected where the internal pressure of the landfill exceeds atmospheric pressure. The lack of a final cap over much of the operational area of the landfill will also facilitate the vertical movement landfill gas.

Buried services/trenches or building foundations on a landfill may provide LFG migration conduits. Drawing G02 and G05 in Appendix B show the locations of services and possible migration routes via conduits.

The likely escape route for LFG is through cracks in the landfill surface/cover material and via diffusion through the surface of the landfill.

³² Department of the Environment, *Waste Management Paper No 27: Landfill Gas*, London, 1989.

³³ ROYDS GARDEN, *Study of Landfill Gas Generation and Control: Green Island Landfill*, September 1993.

³⁴ Tchobanoglous et al., *Integrated Solid Waste Management: Engineering Principles and Management Issues*, McGraw-Hill, 1993.

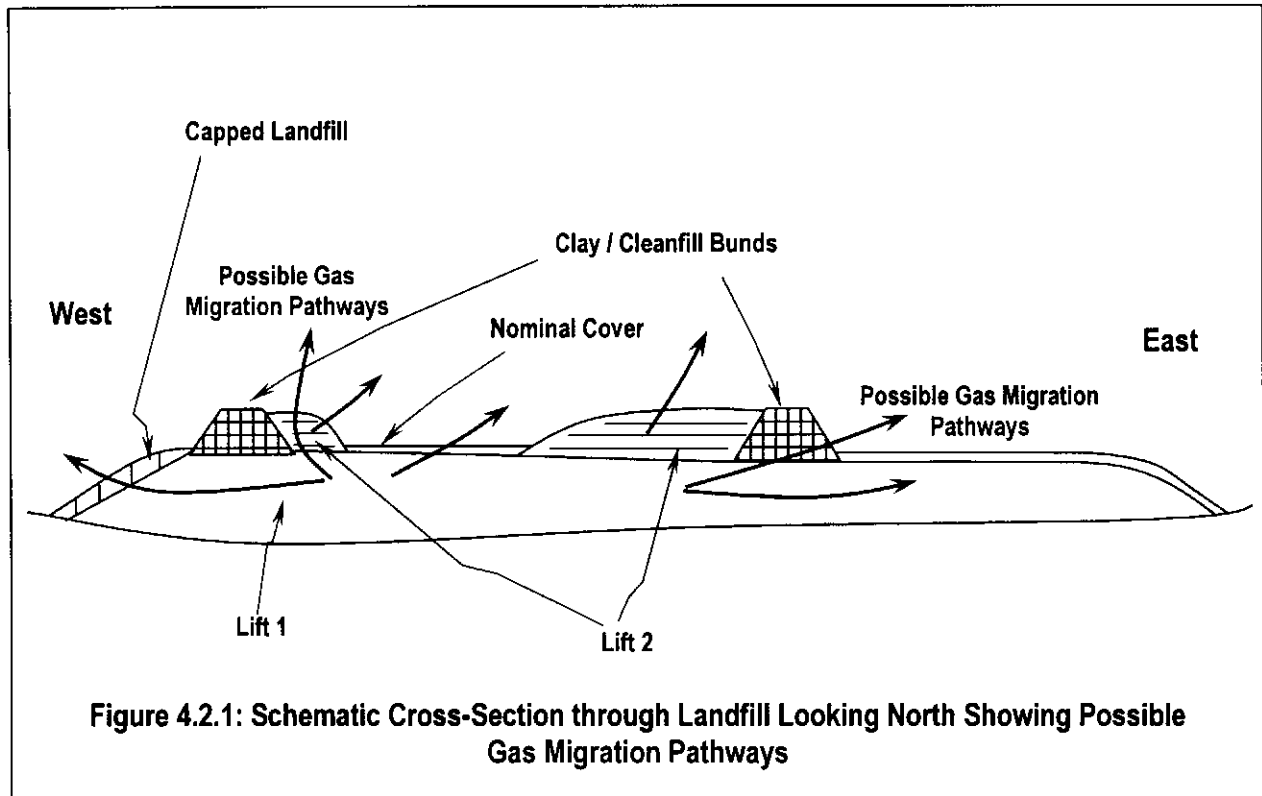
³⁵ Department of the Environment, *Waste Management Paper No 27: Landfill Gas*, London, 1989.

³⁶ Tchobanoglous et al., *Integrated Solid Waste Management: Engineering Principles and Management Issues*, McGraw-Hill, 1993.

³⁷ See section 3.6 where high methane levels were recorded outside the bund perimeter.

³⁸ Department of the Environment, *Waste Management Paper No 27: Landfill Gas*, London, 1989.

Figure 4.2.1 conceptually shows some of the main gas migration routes.



Receptors which may be affected by the migration of LFG from the landfill are as follows:

- Active users of the landfill
- Users of buildings on the closed area the landfill (buildings have been designed to facilitate passive release of gas)
- Vegetation on or near the landfill.

4.2.5 Migration of Liquid

Sludge waste has been placed at Lift 1 and Lift 2 levels. It is planned that sludge will be placed at Lift 3 level in the future. Some sludge has a high liquid content. It is feasible that this liquid waste could seep either through or under the current bunds, leading to the generation of methane outside the operational landfill area.

4.2.6 Rain Infiltration and Cover

LFG generation is enhanced with higher moisture content of waste. Moisture levels within the landfill will increase with increased rainfall infiltration and with groundwater rise. At present there is reported to be 300 mm of cover on the Lift 1 waste and Lift 2 waste in the operational area (see section 3.4.6). Rainfall infiltration will be higher with such thin cover compared to final cover. The upward extension of the landfill, along with thin cover, may be facilitating the rise in groundwater levels (see Section 3.4.1 and Figure 4.2.2). Both these factors

may contribute to a flow of groundwater contaminated with leachate (with LFG generating potential) away from the operational area. This could trigger LFG generation in areas that until now have indicated little or no LFG.

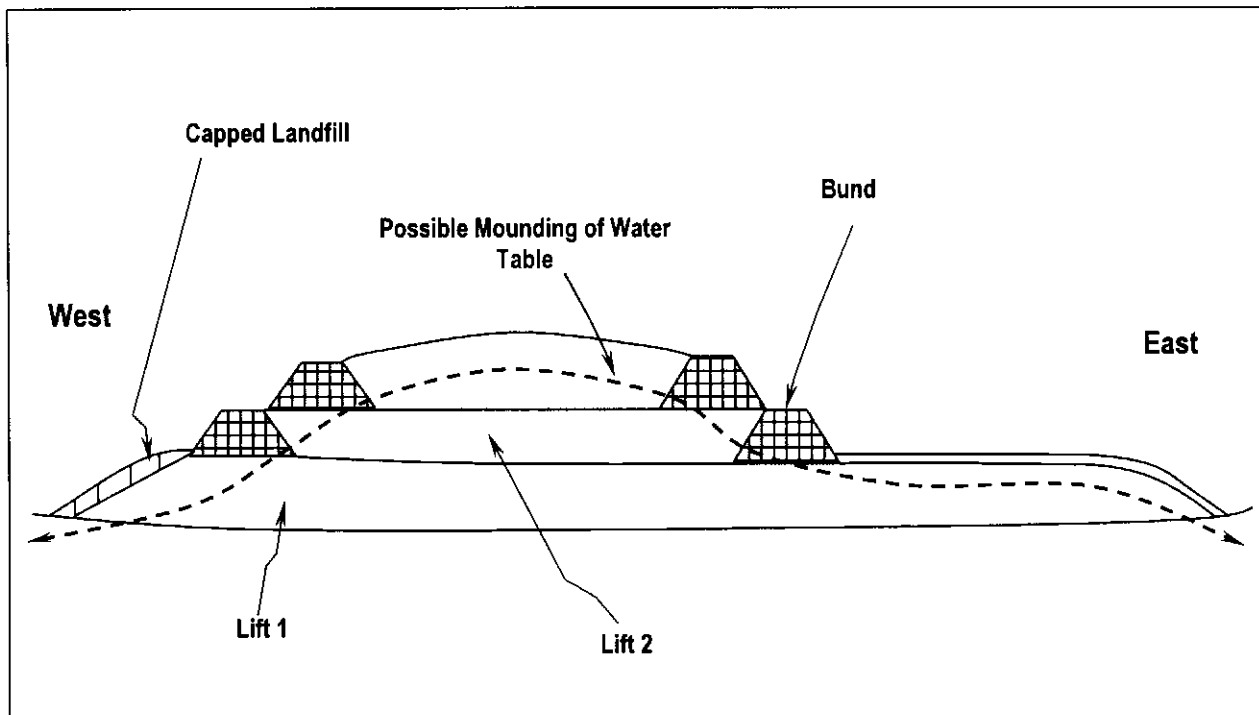


Figure 4.2.2: Schematic Cross-Section Showing Groundwater Mounding Concept

Related to this, the containment of gas within the landfill is contingent on an effective cover that does not allow its vertical migration into the atmosphere.

4.2.7 Operations

DELTA Utilities Services Ltd. operates and manages the Green Island Landfill. In its *Operations Plan and Quality Control Forms*, DELTA addresses the issue of landfill gas, describes the health and safety issues, and states that "access will not be permitted down any well, manhole etc without proper training and certification". The Operations Plan does not include a landfill filling plan or reference to LFG collection.

4.2.8 Extent of LFG Reticulation

Recognising that a system for the collection of gas is required by the NES regulations, an important issue that needs to be addressed is the extent of the collection system. The NES uses the "not greater than 5,000 ppm of methane from the surface" condition as a tool to ensure that an appropriate collection system is constructed. Thus one must be able to delineate where there is or would be emissions of greater than 5,000 ppm due to the lack of gas collection reticulation.

The results from the instantaneous surface monitoring of methane emissions (see section 3.6 above) indicate that reticulation may not be required over the closed eastern area of the landfill site due to low methane levels. However, as the report from EnviroWaste points out, "the methane levels recorded are an indication of the levels on the day for that time of the year and the weather conditions on the day. Methane levels will vary for

different times of the year and weather patterns.”³⁹ Thus regular surface monitoring of methane emissions would help to clarify the extent of reticulation required.

More importantly however, it is apparent from the issues identified previously that effective containment of waste, liquid and gas is required to ensure that gas emissions are controlled.

4.2.9 Type of Collection System

The issue of the type of gas collection to be installed can be considered under the following elements:

- (i) Vertical or horizontal pipes
- (ii) Cover
- (iii) Boundaries
- (iv) Existing Gas Collection System.

4.2.9.1 Horizontal or Vertical pipes

In general gas collection systems are made up of either vertical or horizontal pipes. Normally horizontal pipes are used where the depth of waste is shallow. Where waste is deep, vertical pipes are used. Thus, the filling regime (e.g. waste piled high in one section or spread out over the entire site) will influence the type of system installed.

4.2.9.2 Cover

The type of cover used will influence the effectiveness of the gas collection system. The following factors would affect the design and effectiveness of the collection system:

- Cover depth
- Cover material used
- Cover construction (e.g. density, permeability)
- Desiccation of cover and cracking.

4.2.9.3 Boundaries

At the boundaries to the gas collection system, it is necessary to ensure that gas does not move laterally outside the collection system. Effective barriers such as impermeable bunds or perimeter wells may be required.

4.2.9.4 Existing Gas Collection System

While the condition of the existing collection system is not known, it may be feasible to incorporate some or all of it into a new system. The location of the collection system is shown in Appendix D. Depending on its condition, the collection system could be:

- Used as is
- Upgraded or rehabilitated
- Damaged beyond repair.

³⁹ ENVIROWASTE, *Instantaneous Surface Monitoring for Methane at Green Island Landfill Dunedin*, March 2005.

4.3 Planning a LFG Collection System

4.3.1 Overview

Notwithstanding the issues associated with physically constructing an effective gas collection system at Green Island, programming and planning matters need to be considered in order to meet the NES October 2007 deadline. Issues to be considered are:

- LFG collection system development plan
- Carbon Credits.

In May 2005 Council and MWH representatives visited the Palmerston North Awapuni landfill with representatives of the Palmerston North City Council. A landfill gas collection and flaring system has recently been installed at the Awapuni landfill and the carbon credits for the collected LFG have been sold to an overseas interest. The purpose of the visit was to learn from the Palmerston North experience.

4.3.2 Development Plan

Matters identified during the visit to the Awapuni Landfill that need to be addressed to Green Island Landfill are reported as follows.

- Planning – determine extent of site from which to gather landfill gas, determine means of compliance with NES in terms of permissible gas discharge concentration, decide on method of gas collection, decide where to install wells or other collection facilities, consider any beneficial use of landfill gas and reasons of final decision
- Design – selection of gas collection reticulation, sealing landfill so that it contains gas and inhibits ingress of air when negative pressure is applied to gas collection reticulation
- Construction – drilling bores in waste, groundwater at shallow depth, working in with landfill operator
- Operating landfill gas collection system: air ingress, monitoring gas flow, measured gas flow different to that estimated during design stage, known gas losses, results of any landfill gas monitoring such as that provided by instantaneous surface monitoring following the MfE procedure
- Landfill Operation – any landfill operation modifications to minimise landfill gas collection costs or optimise gas collection.

4.3.3 Carbon Credits

In order to receive carbon credits, the Council would need to prove additionality.⁴⁰ As the Council will be required by law to collect the methane from Green Island landfill, (and is already required to do so as a condition of a resource consent) proving additionality will be difficult. Preliminary investigations indicate that carbon credits would only be available for grid electricity displacements from a gas engine. Assuming grid displacements similar to the Palmerston North landfill of 5,000 tonnes of CH₄ per year, the value to the Council

⁴⁰ Additionality: the extent to which something happens as a result of an intervention that would not have occurred in the absence of the intervention.

of carbon credits would be approximately \$75,000 per annum (based on a sale price of NZ\$15 per tonne of CO₂ equivalent).⁴¹

4.4 Interface with Operators

4.4.1 Delta

Delta Utility Services Ltd. is under contract to the Council to operate the Green Island Landfill until 2010. Any development of a LFG collection system will necessitate interfacing with the operator. Nevertheless the Contract Documents (SC 16.1 of the First Schedule to the General Conditions of Contract) state:

“The Principal envisages a change of circumstances during the term of the Contract as set out below. Changes involving major capital works may be carried out by “separate contractors” as per Clause 5.5. The Contractor shall not be entitled to additional costs resulting from minor disruptions to the Contract Works caused by the activities of Separate Contractors nor shall the activities of Separate Contractors be treated as a Variation pursuant to clause 5.5. The changes of circumstances the Principal envisages include but are not limited to the following:

...

- Possible reactivation of the landfill gas collection system to control / reduce emissions or to use gas beneficially and to comply with the possible introduction of a National Environmental Standard for Landfill Gas Collection and Destruction.

...

The Principal also envisages changes in:

- methodologies
- legal requirements
- performance outcomes.”

It is clear that the Council is not under any obligation to engage Delta in the development of a LFG collection system. However should “major” disruptions to Delta’s activities occur, there could be additional costs incurred under the present contract.

At present, the Contractor has no detailed filling plan. Such a plan will need to be prepared before an LFG collection and control system can be developed.

4.4.2 Other Landfill Operators

The activities of the other landfill operator in the Dunedin area may be an issue as they could affect Green Island Landfill operations, e.g. changes in their filling rates or disposal charges.

⁴¹ Note: Palmerston North Landfill accepts typically 100,000 tonnes of waste per annum, more than double the amount accepted at Green Island Landfill.

5. Options

5.1 Introduction

Section 5 considers the options of closing Green Island Landfill before 2007 and the implementation of a landfill gas collection system. This section also considers an implementation plan and contractual options for realising the plan.

5.2 Alternative to LFG System

A possible alternative to meeting the NES regulations of installing LFG collection and flaring system could be to close the landfill operation prior to the applicable regulation coming into effect in October 2007.

Installing a LFG collection system would be a substantial financial investment⁴². This report identifies issues that may need to be addressed in order to meet the NES regulations and, if addressed, would result in other costs, which would not be required if the landfill were closed. For example, the migration of leachate outside the operational footprint and the associated generation of LFG may require a large gas collection system or a leachate cut-off system that separates the operational footprint and the closed part of the landfill. Such a system should not be required if the landfill were closed.

However, whether or not to install a gas collection system can be looked at strategically in terms of the Council's operative Waste Management Plan.

Given this Plan, the continued operation of the Green Island landfill should be demonstrated to be environmentally and economically sustainable. There are significant environmental and economic issues with the current Green Island landfill. A demonstration can be effectively achieved by a comparison with alternatives. A mechanism of exploring alternatives could be the expression of interest process. Ideally, before embarking on such a process, the Council would confirm its residual waste management objectives, residual waste management principles, and any other criteria for deciding on a way forward. This is being dealt with currently in the development of Council's new Waste Management Strategy.

Such a demonstration would establish some certainty about the Council's options whereas currently there is too much that is unknown for a comparative evaluation of environmental and economical sustainability in terms of demonstrable alternatives.

5.3 Landfill Gas Management System

5.3.1 Overview

The objectives of a landfill gas management system⁴³ comprise:

- a containment system which will retain gas within the site and prevent off site migration
- a system for landfill gas collection and utilisation or flaring with adequate backup facilities

⁴² MWH November 2004, Impact of the National Environmental Standard for Landfill Gas

⁴³ MOE 1995 WMP 26B Landfill Design, Construction and Operational Practice

- a separate system to control landfill gas migration at the site perimeter which can operate independently of the gas collection from within the body of the waste
- gas monitoring boreholes outside the boundary of waste
- use of safe practices to avoid hazardous concentrations of gases within the temporary or permanent working areas of the site.

5.3.2 Containment System

The extent of a LFG containment system is considered in terms of broad options as follows.

Containment System over Landfill Footprint

This option would include the construction of a landfill gas collection system over the operational and closed areas of the landfill. It may be possible to utilise some of the existing collection system. Horizontal collection pipes would be required at each of the 3 lifts. Construction in the operational area of the landfill could be progressed in stages in tandem with the filling.

Containment System in the Operational Area Only

This option would require the construction of an LFG collection system within the operational area. As above, it may be possible to utilise some of the existing collection reticulation and stage the construction of new reticulation in tandem with the filling.

Containment System in the Active Section, with Peripheral Controls for Lateral Gas Migration and Groundwater in Problematic Areas

This option is similar to the previous, except that additional measures would be taken to ensure that migration of LFG beyond the operational landfill area does not occur. In this option the construction of perimeter extraction wells would intercept LFG, preventing its movement through to the closed section of landfill or to the atmosphere. Subsoil drains would also limit the possible mounding of the water table.

Given the results of LFG monitoring to date, the age of the waste in the closed area of the landfill, and the potential for gas migration from the operational landfill area to the closed landfill area, the third option would appear the appropriate one.

5.3.3 LFG Collection System⁴⁴

Three types of systems will be needed to control the lateral migration of LFG.

- passive venting in the closed area of the landfill
- barriers to contain gas within the operational area of the landfill
- pumping to extract gas from the operational area of the landfill.

⁴⁴ MOE 1995 WMP 26B Landfill Design, Construction and Operational Practice

The main components of the pumping system are:

- gas wells or drains in the waste
- pipework leading from the wells to the pumps, typically of smooth bore HDPE piping with fusion jointed welds and designed to drain condensate to low points to drain or back to the wells to drain
- condensate traps to remove condensed liquid from the system and designed to drain back to the wells or elsewhere into the waste
- pumps which remove the gas from the waste, which are generally centrifugal compressors
- landfill gas flare or utilisation plant.

Factors that will need to be considered in the design of the gas collection system include:

- forces both vertical and lateral on burying collection infrastructure generated as the waste compacts, degrades and settles
- loss of performance of the gas extraction system as a result of the build up of silt, chemical precipitates and biomass (small diameter pipes < 150 mm are reported to become unserviceable within 3 or 4 years of construction)
- the rise of groundwater / leachate within the waste, noting that vertical wells only extract LFG effectively from unsaturated waste and are reported not to be effective in wet sites
- the reduced permeability of degraded waste, accumulation of condensate and the physical displacement of pore water which can result in the build up of groundwater / leachate within gas wells to the detriment of their performance.

Factors that will need to be considered in the design of the flare include:

- the estimated quality and quantity of LFG likely to be generated
- the potential malodorous or hazardous trace components in the LFG, which is not possible to predict and which should be investigated during plant commissioning and repeated once a year thereafter
- the efficiency of the LFG flare and need for supplementary fuel
- the location of the flare so as to mitigate the visual impact of the flare and the effects of exhaust emissions.

A LFG collection system installation would be planned in conjunction with a landfill filling plan. A conceptual filling plan has been proposed previously⁴⁵. Assuming a pattern as outlined in Appendix F, the optimal method of gas collection would be placement of horizontal pipes in each cell as it is filled.

A detailed filling plan is required in order to plan a LFG collection system. The plan will be influenced by the:

- rate of intake of waste
- location and condition of the existing gas collection system
- gas collection method.

⁴⁵ BECA STEVEN, *Environmental Impact Assessment of the Existing Green Island Landfill*, 1992

The filling plan should address:

- cell dimensions
- the direction of filling
- the possibility of filling vertically prior to horizontally
- cover placement, material and design.

Given the contractual arrangement with Delta to 2010, the filling plan will need to be developed in conjunction with Delta.

In the absence of a filling plan it is difficult to devise gas collection concepts. Therefore, for the purposes of this review, a conceptual filling plan has been developed. It is located in Appendix F.

5.3.4 Control of LFG Migration

Control of LFG migration off the site is currently achieved by the Lift 1 cover material and the subsequent lift bunds. The leachate collection trench around much of the landfill footprint provides a barrier to and a passive collection system for any LFG that migrates through the soil beneath the landfill footprint.

Monitoring indicates that LFG is migrating through the Lift 1 cover material on the western side of the operational area.

Future activities will include installing a LFG barrier to separate the operational area from the closed area and sealing of LFG migration pathways through the Lift 1 cover material.

5.3.5 LFG Monitoring at Site Boundary

LFG monitoring at the site boundary occurs at locations near Clariton Avenue (Appendix E). The LFG monitoring programme should be revised to include regular monitoring at fixed locations around the landfill perimeter and periodic instantaneous surface monitoring (ISM) following a planned procedure (Appendix G).

5.3.6 Safe Operational Practices

The Operators operations plan will need updating to address LFG matters including safe operational practice and LFG monitoring as part of the overall implementation of the LFG collection system.

5.4 LFG Collection System Implementation Plan

To arrive at the optimal solution before the 2007 deadline, a proactive implementation plan is required. Implementation plan options are outlined in Tables 5.5.1 and 5.5.2.

Option 1, Table 5.5.1, involves the Council managing a step-by-step development of the LFG system. This option may more readily involve the development of the LFG system in consultation with the landfill operator, Delta.

Option 2, Table 5.5.2, involves the Council gathering information about the existing LFG system and then contracting out the planning and development of the LFG system. This option would involve the Council going to the market in order to assess interest in various development options which take account of the current option, the condition of the existing LFG system, carbon credit potential and landfill fill planning.

A possible risk with each option is a change in incoming waste quantities and types. Such changes could result from the method of sludge treatment selected for the upgraded Tahuna sewage treatment plant, changes in the operation of the Envirowaste landfill (e.g. early closure), and commissioning of a new, private landfill. Assessing certainty of incoming waste types and quantities may better be investigated through Option 2.

Table 5.5.1: LFG Collection System Implementation Plan – Option 1

	Action	Indicative Time Required (months)
Planning	Check condition of the existing LFG collection system	2 - 3
	Update Landfill Operations Plan so as to include a filling plan	2
	Develop the LFG collection and control system design	3
	Prepare report for ORC and MfE	1 - 2
Implementation	Develop & agree Contract arrangements	2 - 4
	Construct the LFG collection system	6
	Commission the LFG collection system	1

Table 5.5.2: LFG Collection System Implementation Plan – Option 2

Stage	Action	Indicative Time Required (months)
Planning	Existing LFG collection system	
	• Prepare condition assessment procedure and programme for	1
	• Check condition of the existing LFG collection system	2
	Landfill Operation	
	• Update Landfill Operations Plan so as to include a filling plan	2
	Assess Procurement Options	
	• Prepare a registration of interest document	1
	• Seek registrations and evaluation options	2
Implementation	• Select preferred option	1
	• Prepare report for ORC and MfE	1
	Procurement	
	• Develop & agree Contract arrangements	2 - 6
	• Construct the LFG collection system	6
	• Commission the LFG collection system	1

The total indicative time to plan and implement gas collection is estimated at 17 to 23 months. Overlap between some of the actions should be possible. However, it is likely that construction would best be undertaken during the earthworks construction season which generally is from October to March. It is apparent though that the time scale is tight given that the deadline for having a collection system operational is some 26 months away.

5.5 Procurement Options

Procurement options can be considered broadly as:

- working with the incumbent landfill operator, Delta, to plan, develop and operate a LFG system
- going to the market for proposals to plan, develop and operate the LFG based on the current landfill operation
- going to the market for ideas about the planning, development and operation of the LFG, then selecting the basis on which the Council wishes to proceed and either negotiating with a preferred provider or seeking proposals on the basis of a preferred solution.

For the second and third option, it is considered necessary to be specific about the contractual arrangements that the Council has with Delta and the options that Council will consider with respect to its contract with Delta.

As noted in the previous section, there are significant potential factors that could influence the future LFG production at the Green Island Landfill. Ideally, these risk factors would be taken account of when developing a basis for calling proposals for Option 2 and any acceptance of a proposal would involve an agreed risk allocation between the provider of a LFG solution and the Council. Alternatively, with Option 3, these risk factors should be better clarified during a market inquiry (e.g. registration of interest process) and then negotiation would be based on proposals sought with the benefit of any knowledge or innovation offered by the market.

6. Risks

6.1 Overview

The NES places a requirement on the Council to collect LFG in accordance with specified performance requirements. In this section risks in meeting these performance requirements are identified. Suggestions for further monitoring are made in order to understand the likelihood of occurrence of the identified risk and actions are proposed to mitigate the risks.

Identified risks are:

- gas migration through bunds / capped landfill
- rising water table
- gas migration through top surface of the operational area
- migration of sludge waste / leachate / gas from the operational area into the closed landfill area.

6.2 Gas Migration through Bunds / Capped Landfill

Section 3.6 summarises the results from recent surface methane monitoring at the site. High concentrations of methane were detected outside the perimeter bund / capped landfill at several locations.

Regular monitoring of LFG emissions (Appendix G) would help to clarify the extent of gas migration through the bunds.

Depending on the monitoring results, mitigation measures include:

- placement of extra cover
- excavation and sealing of cracks
- installation of perimeter gas wells.

6.3 Water Table

Poor surface water drainage, a lack of subsoil drainage, and the upward extension of the landfill may be facilitating the rise in groundwater levels (Section 3.4.3). This could lead to the emission of gas in the closed section of the landfill.

The installation of additional bores along the boundary between the closed and operational landfill area would help to better understand leachate levels and LFG migration within the landfill.

Mitigation measures along the boundary include a combination of the:

- construction of a cut-off wall within lift one
- installation of sub-soil drainage for LFG collection and leachate drainage
- placement of extra cover
- improvement of surface water runoff.

6.4 Gas Migration through the Top Surface

Irregular cover may be facilitating the vertical migration of methane through to the atmosphere. This is apparent from recent surface methane monitoring, as summarised in Section 3.6.

Regular monitoring of LFG emissions would help to clarify the extent of gas migration through the top surface of the landfill.

Mitigation measures include establishing a filling plan that results in better containment of LFG and an integrated LFG collection system.

6.5 Migration of Sludge Waste / Leachate

Given the large quantities of liquid waste disposed of in Green Island Landfill, it is possible that this could lead to high BOD leachate migration to the closed section of the landfill or to outside the bunds. This risk will increase as the landfill extends upwards and if sludge is disposed in Lifts 2 and 3.

Mitigation measures include

- those in 6.3 and 6.4 above
- limiting the placement of liquid waste to specific areas of the site
- controlling the moisture content of waste delivered to the site.

7. Conclusions

The main conclusions of the review are that:

- the NES regulations require that LFG is collected from Green Island landfill unless the landfill were closed
- the LFG monitoring programme needs to be upgraded forthwith so as to include regular monitoring along the complete boundary of the landfill footprint, which can be facilitated largely through existing infrastructure, and to include periodic Instantaneous Surface Monitoring following a protocol similar to that in Appendix G
- improvements in the LFG containment provisions at the landfill are expected to be required and these improvements are expected to include remediation of the final cover of the Lift 1 around the landfill perimeter and a LFG / leachate migration control system along the interface between the close and operational landfill areas
- the results from the upgraded LFG monitoring programme will assist with the design of the LFG containment improvements
- the existing LFG collection system should be investigated in terms of its suitability for further use as part of the new LFG collection system, with the investigation methodically inspecting and recording the condition of the wells, condensate sumps and other pipelines and updating the as-built records
- the disposal of liquid and high moisture content waste at the landfill should be reviewed with an objective of better controlling or prohibiting the disposal of such waste
- methods of controlling groundwater / leachate rise within the landfill need to be investigated with the investigation considering a LFG collection system that effects control by collecting and disposing of the collected leachate to the leachate disposal system
- LFG collection options need to be investigated in conjunction with landfill filling plan options
- a landfill filling plan needs to be finalised after appropriate investigations (as outlined above) and the plan should maximise the re-use of installed LFG collection wells and optimise the installation of new LFG collection wells in terms of resultant capital costs, cash flow and efficiency of LFG collection
- a preliminary LFG management system needs to be designed after giving effect to the above conclusions, with the design involving estimation of LFG character (generation rate, recovery rate, and quality) and preparation of cost estimates
- an overall plan for addressing the above measures in terms of detailed activities, timetable and budget costs is needed, and the plan will need to be updated from time to time during the course of developing the LFG management system
- discussions should be initiated with the landfill operator, Delta, about a LFG collection management system and Delta's role in the development of such a system
- liaison with the Ministry for the Environment and the Otago Regional Council should be maintained and their acceptance of Council plans should be sought at appropriate stages.

A further conclusion is that the Council should confirm its residual waste management objectives, residual waste management principles, residual waste disposal strategy, and other related criteria before finalising a way forward with implementing a LFG collection system. These matters have the potential to influence significantly the landfill filling plan and the resultant implementation of a LFG collection system. It is noted that these matters are being addressed currently as part of the development of Council's new Waste Management Strategy.

Finally, three broad approaches to procuring services for the development and operation of a LFG collection system were proposed as:

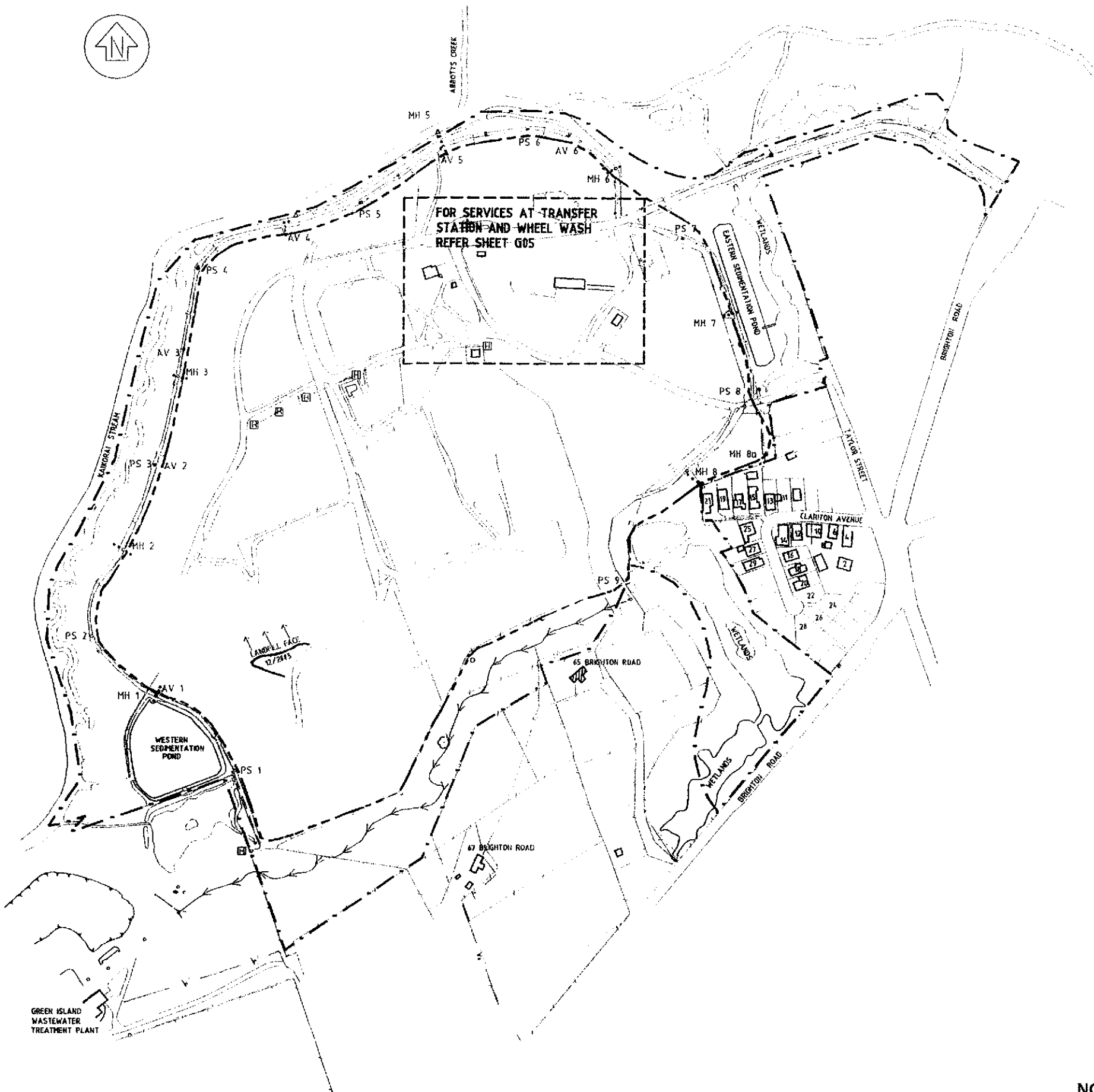
- working with the incumbent landfill operator, Delta, to plan, develop and operate a LFG system
- going to the market for proposals to plan, develop and operate the LFG based on the current landfill operation
- going to the market for ideas about the planning, development and operation of the LFG, then selecting the basis on which the Council wishes to proceed and either negotiating with a preferred provider or seeking proposals on the basis of a preferred solution.

It is considered that the third option is the preferred one because the first stage could be initiated whilst essential information about the condition of the existing LFG system is gathered and the Council's waste management strategy is being finalised and the second stage would proceed potentially with the benefit of market knowledge and ideas for innovation.

Appendix A – Aerial Photograph of Site and Drawings

LEGEND

- FENCE
- - - - - EXTENT OF LANDFILLED AREA
- - - - - LANDFILL OPERATION AREA
- LANDFILL DESIGNATION D656
DUNEDIN CITY COUNCIL DISTRICT PLAN
- SEWER LINE
- > STORMWATER DITCH
- WATER PIPES
- TELECOM LINES
- ELECTRICITY
- POWER LINES
- RISING MAIN
- MANHOLES
- HYDRANTS
- LEACHATE COLLECTION SYSTEM:**
- PS PUMP STATION
- MH MAN HOLE
- AV AIR VALVE



ORIGINAL SIZE A1
DO NOT SCALE - IF IN DOUBT, ASK

NOT FOR CONSTRUCTION

REV	AMENDMENTS	DATE CHECKED	DATE APPROVED

TAB/DWG : Layout1 / 866116-18 G02.dwg
 SERVER : DUNEDIN (NZDUN2511)
 XREFS : KBASEPLAN 2004

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SURVEYED	J.R PHIPPS	12/93
DESIGNED		
DRAWN	M.A BECHT	05/04
CHECKED		
APPROVED		



LANDFILL MANAGEMENT & DEVELOPMENT PLANS
GREEN ISLAND LANDFILL
SERVICES PLAN

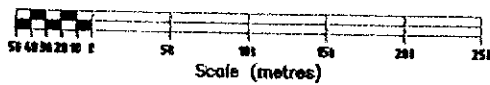
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Job No.	006116-18	Sheet No.	G02
Rev.			A

LEGEND

- FENCE
- - - - - EXTENT OF LANDFILLED AREA
- LANDFILL OPERATION AREA
- LANDFILL DESIGNATION D656
DUNEDIN CITY COUNCIL DISTRICT PLAN
- - - - - SEWER LINE
- STORMWATER DITCH
- EASTERN SEDIMENTATION POND CATCHMENT
(CLEAN LANDFILL RUN OFF)
- WESTERN SEDIMENTATION POND CATCHMENT
(ACTIVE SURFACE RUN OFF)
- CLEAN WATER STORMWATER CATCHMENT
- CLEAN WATER STORMWATER CATCHMENT VIA STORMWATER
INTERCEPTOR DITCH
- TRANSFER STATION STORMWATER CATCHMENT
REFER SHEET G05
- LEACHATE SYSTEM CATCHMENT
- LANDFILL STORMWATER RUN OFF CATCHMENT
(ROAD SURFACE RUN OFF)
- LEACHATE COLLECTION SYSTEM

NOTE

REFER PLAN 6116 W/ SHEET G06 FOR DETAILS ON THE LEACHATE COLLECTION SYSTEM



ORIGINAL SIZE A1
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REV	4/8/2005	INITIAL	DATE	INITIAL	DATE

TAB/DWG : Layout1 / 06116-18 G03.dwg
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Name	Date
SURVEYED DESIGNED DRAWN CHECKED APPROVED	J.R.PHELPS 12/03 M.A.BECHT 09/04



LANDFILL MANAGEMENT & DEVELOPMENT PLANS
GREEN ISLAND LANDFILL
STORMWATER AND CONTOUR FLOW PLAN

FOR REVIEW	
Date Drawn	16.09.2004
SCALES (A1)	1:2500 (A3) 1:5000
Job No.	006116-18
Sheet No.	G03
Rev.	A

LEGEND

- FENCE
- - - - - EXTENT OF LANDFILLED AREA
- - - - - LANDFILL OPERATION AREA
- LANDFILL DESIGNATION D658
DUNEDIN CITY COUNCIL DISTRICT PLAN
- - - - - SEWER LINE
- → → → → STORMWATER DREN



ORIGINAL SIZE A3 DO NOT SCALE - IF IN DOUBT, ASK

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REV	DESCRIPTION	INITIAL	DATE

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DESIGNED		
DRAWN	M.A. BECHT	09/04
CHECKED		
APPROVED		



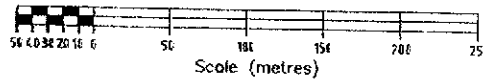
LANDFILL MANAGEMENT & DEVELOPMENT PLANS
GREEN ISLAND LANDFILL

**OPTION 1 - FINAL LANDFORM WITHOUT
 EXTENSION OVER SEWER**

FOR REVIEW	
Date Stamp	16.09.2004
Scale (A1)	1:2500 (A3) 1:5000
Job No.	006116-18
Sheet No.	G09
Rev.	A

LEGEND

- FENCE
- - - - - EXTENT OF LANDFILLED AREA
- - - - - LANDFILL OPERATION AREA
- LANDFILL DESIGNATION D658
DUNEDIN CITY COUNCIL DISTRICT PLAN
- - - - - SEWER LINE
- → → → → STORMWATER DITCH



ORIGINAL SIZE A1
DO NOT SCALE - IF IN DOUBT, ASK

REV	AMENDMENTS	INITIAL	DATE	INITIAL	DATE

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DRAWN	
CHECKED	
APPROVED	



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LANDFILL MANAGEMENT & DEVELOPMENT PLANS
 GREEN ISLAND LANDFILL

OPTION 2 - FINAL LANDFORM WITH
 EXTENSION OVER SEWER

FOR REVIEW	
Date Stamp	16.09.2004
Job No.	006116-18
Sheet No.	G10
Rev.	A
SCALES (A1)	1:2500
SCALES (A3)	1:5000

Appendix B – Location and Age of Waste

LANDFILLING RECORDS SHOWING TIPPING FACES

AND ASSOCIATED DATES

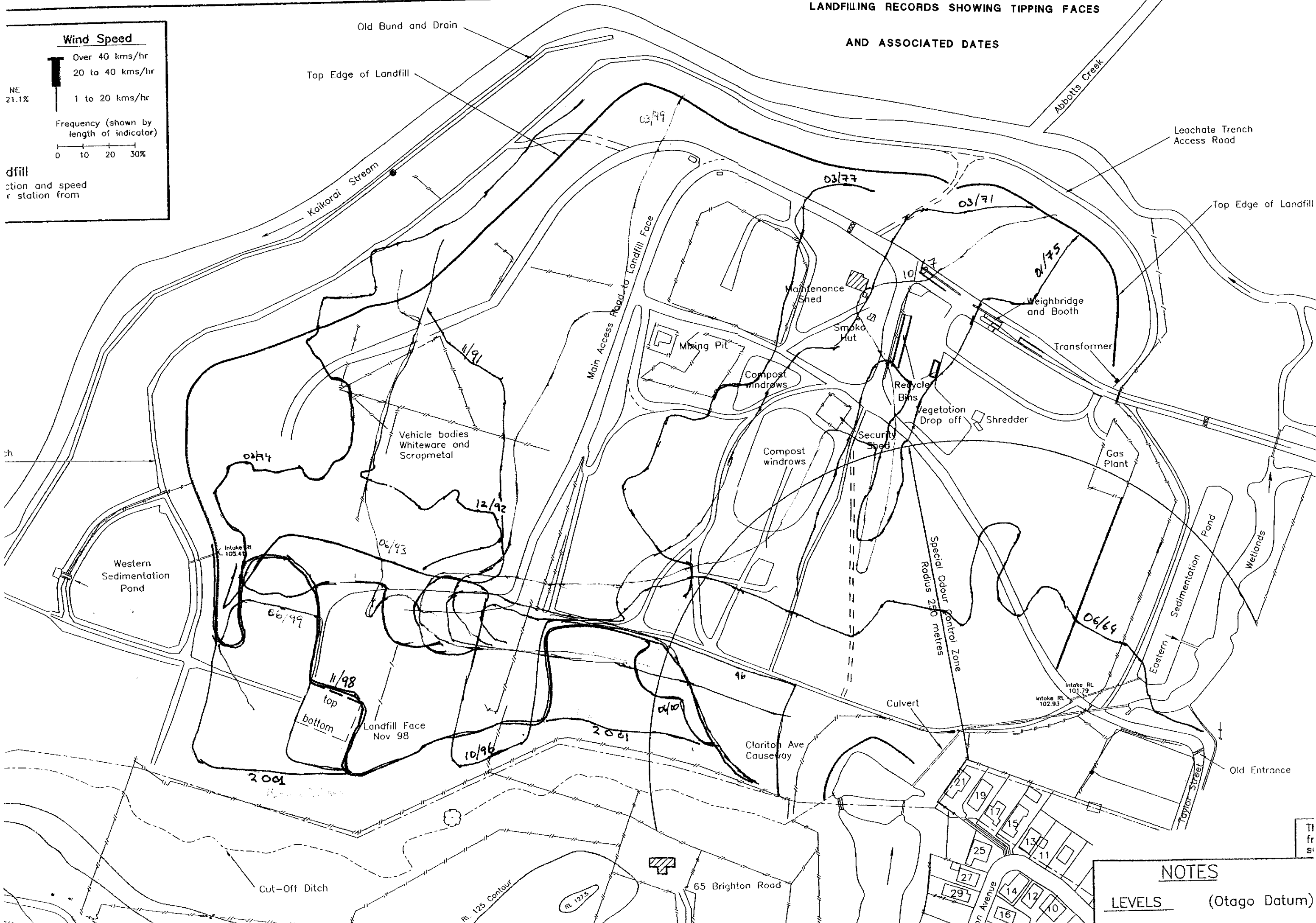
Wind Speed

Over 40 kms/hr
 20 to 40 kms/hr
 1 to 20 kms/hr

NE 21.1%

Frequency (shown by length of indicator)
 0 10 20 30%

dfill
 ction and speed
 r station from











NOTES

LEVELS (Otago Datum)

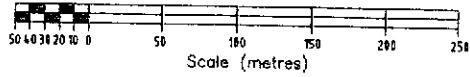
ORIGINAL SIZE A1
DO NOT SCALE - IF IN DOUBT, ASK

LEGEND

-  FENCE
-  EXTENT OF LANDFILLED AREA
-  LANDFILL OPERATION AREA
- LANDFILL DESIGNATION D658
DUNEDIN CITY COUNCIL DISTRICT PLAN
-  TOP OF LIFT 1
-  BASE OF LIFT 2
-  TOP OF LIFT 2
-  BASE OF LIFT 3
-  TOP OF LIFT 3



*landfill face progression
(Source: D Hanan)*



REV	AMENDMENTS	INITIAL	DATE	INITIAL	DATE
		CHECKED		APPROVED	

TAB/DWG : Layout1 / 006116-19 12.dwg
 SERVER : DUNEDIN (NZDUN2501)
 XREFS : XBASEPLAN 2004, XLIFTS

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DESIGNED		
DRAWN	M.A.BECHT	02/04
CHECKED		
APPROVED		



GREEN ISLAND LANDFILL
 CURRENT FILLING SEQUENCE

NOT FOR CONSTRUCTION

Scale Sheet	PRELIMINARY		
Date Stamp	27.04.2004		
SCALES (A1)	1:2500	(A3)	1:5000
No. 006116-19	Sheet No. 12	Rev. F	

Appendix C – NES Requirements

Regulation 27 states

"(1) If gas collected at a landfill is destroyed by flaring,---

- (a) the system for the principal flare or flares must---*
 - (i) comply with the requirements in subclause (2); or*
 - (ii) achieve at least the same effect as the system in subclause (2); and*
- (b) the system for the backup flare must---*
 - (i) comply with the requirements in subclause (3); or*
 - (ii) achieve at least the same effect as the system in subclause (3).*

(2) The system for a principal flare must---

- (a) have a flame arrestor; and*
- (b) have an automatic backflow prevention device, or an equivalent device, between the principal flare and the landfill; and*
- (c) have an automatic isolation system that ensures that, if the flame is lost, no significant discharge of unburnt gas from the flare occurs; and*
- (d) have a continuous automatic ignition system; and*
- (e) have a design that achieves a minimum flue gas retention time of 0.5 seconds; and*
- (f) be designed and operated so that gas is burned at a temperature of at least 750oC; and*
- (g) have a permanent temperature indicator; and*
- (h) have adequate sampling ports to enable emission testing to be undertaken; and*
- (i) provide for safe access to sampling ports while any emission tests are being undertaken.*

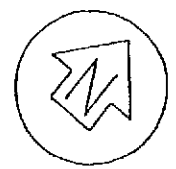
(3) The system for a backup flare must have---

- (a) a flame arrestor; and*
- (b) an automatic backflow prevention device, or an equivalent device, between the backup flare and the landfill; and*
- (c) an automatic isolation system that ensures that, if the flame is lost, no significant discharge of unburnt gas from the flare occurs; and*
- (d) a continuous automatic ignition system.*

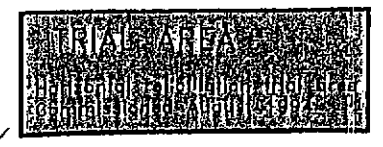
(4) A principal flare must be operated at all times unless it has malfunctioned or is shut down for maintenance.

(5) A backup flare must be operated if, and only if, a principal flare is not operating.

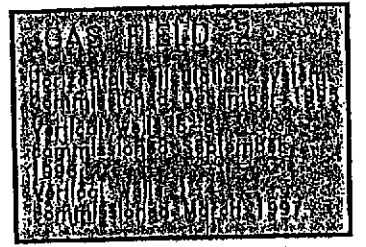
Appendix D – Gas Collection, 1995 to 2000, Gas Collection Network, 2000



GAS FIELD 4
 Horizontal collection system
 Commissioned December 1995
 Vertical wells 67-71
 Commissioned March 1999



WELL DESCRIPTION AND NAME	DATE COMMISSIONED	CONNECTED TO GAS COLLECTOR'S MAINS (1,2,3,4)
Horizontal Area 1	Dec 1995	1
Horizontal Area 2	Dec 1995	2
Horizontal Area 4	Dec 1995	4
Vertical Well Area 2		
Wells 5-8	Sept. 1996 (modified) March 1999	3 2
Wells 1-4	March 1997 (modified) March 1999	3 2
Well 74		2
Vertical Well Area 3		
Wells 11-13	Sept. 1996	3
Wells 9-10, 14-16	March 1997	3
Wells 17-40	March 1997	3
Wells 41-64	Nov. 1997	3
Wells 65-66	June 1998	3
Wells 72-73	August 1999	3
Vertical Well Area 4		
Wells 67-71	March 1999	4



Discarded pipes

Connects to underground field West

Connects to underground field East

Purpose break to underground pipe

Connects to field 2 west

Connects to field 2 east

Connects into underground field

Typical Proposed sludge pits

Gas Plant shut down 29/9/99

GAS FIELD 3
 Vertical wells 11-13 commissioned September 1996.
 Vertical wells 9-10, 14-40 commissioned March 1997
 Vertical wells 41-64 commissioned November 1997
 Vertical wells 65-66 commissioned June 1998
 Vertical wells 72-73 commissioned August 1999

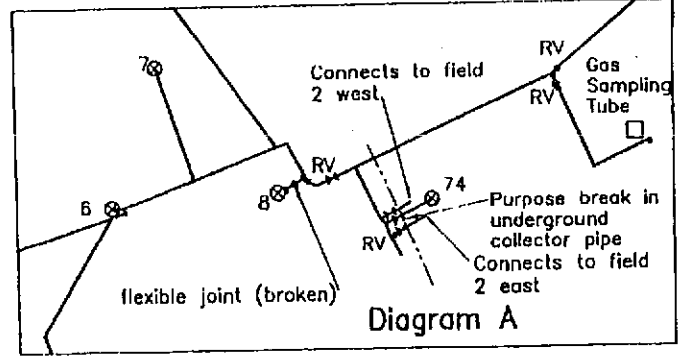
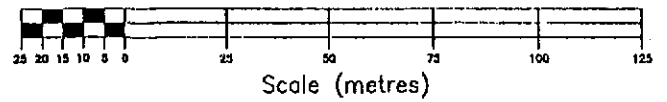
Field 2 connected to Field 4 collector pipe 26/8/99, due to Field 2 collector pipe broken or blocked in some way. Therefore gas from Field 2 has contributed to the Field 4 gas after the change over date.

GAS FIELD 1
 Horizontal collection system
 Commissioned December 1995
 Ring main vertical collector
 commissioned June 1998

4 x 180mm ϕ HDPE
 GAS COLLECTOR MAINS (1,2,3,4)
 Collects gas from 4 locations, which may be a combination of both horizontal and vertical wells.
 Citigas 'import' gas data refers to the 4 locations as 'fields'

LEGEND

HORIZONTAL COLLECTOR PIPE (u/g)	---
UNDERGROUND GAS COLLECTOR MAIN	---
VERTICAL GAS WELL COLLECTION PIPE (u/g)	---
VERTICAL GAS WELL COLLECTION PIPE	---
VERTICAL GAS WELL	⊙
RING MAIN VERTICAL COLLECTOR	⊙
GAS FIELD MARKER POST	⊞
REGISTRATION MARKS	•
SYPHON POINT	+
CONTROL VALVE	⊞



DESIGNED	DRAWN	JOB MANAGER VERIFICATION	APPROVED FOR ISSUE	CADFILE	SURVEYED	CO-ORDINATE SYSTEM	CO-ORDINATE DRAWN	SCALE (A2)	NOTES	AMENDMENT	DATE
J. Doorey	MB & HDR	U.D.P.	[Signature]		3/00			1:1250	CONTRACTOR SHALL VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK	A	
					4/00					B	
					4/00					C	
					7/00					D	
										E	

CITY CONSULTANTS Engineers & Surveyors

DCC DUNEDIN CITY COUNCIL

GREEN ISLAND LANDFILL

GAS COLLECTION NETWORK

JOB NO. 5524/518

SHEET No. 2 of 4

ISSUE	A	B	C	D	E
DATE ISSUED	17 April 2000				

Appendix E – Gas Monitoring Results

Green Island Landfill - Gas Monitoring Results

Atmosphere Normal = CH4 0%, CO2 0%, O2 20.9%

G1, G2, G3

Interval	Position	G1					G2				
	Date	CH4	CO2	O2	H2S ppb	Pressure (mb)	CH4	CO2	O2	H2S ppb	Pressure (mb)
	25/02/1994		16.0	1.0			0.0	4.0	16.0		
10	7/03/1994		7.8	11.8		1002	0.0	4.3	16.4		1002
7	14/03/1994		16.2	2.2		1007	0.0	3.0	18.1		1006
8	22/03/1994		7.9	5.4		1025	0.0	4.1	14.5		1025
6	28/03/1994	0.0	0.0	20.6		1021	0.0	2.2	17.7		1021
9	6/04/1994		13.9	0.7		1018	0.0	1.6	17.7		1020
5	11/04/1994		16.0	4.3		1012	0.0	0.8	16.8		1013
7	18/04/1994		13.5	6.1		1003	0.0	3.2	17.7		1008
8	26/04/1994	0.0	8.5	9.6		1027	0.0	1.7	18.5		1026
6	2/05/1994		11.5	10.2		1012	0.0	2.9	17.7		1015
7	9/05/1994		10.8	9.3		1016	0.0	2.4	18.3		1015
7	16/05/1994		7.8	10.8		984	0.0	1.2	19.9		982
7	23/05/1994	0.0	8.1	12.2		996	0.0	1.5	18.9		996
7	30/05/1994	0.0	0.0	?		1008	0.0	0.0	?		1008
9	8/06/1994		1.9	18.7		1014	0.0	1.3	19.1		1015
9	17/06/1994						0.0	0.6	19.7		1006
4	21/06/1994		2.1	18.6		1004	0.0	0.2	20.4		1004
6	27/06/1994	0.0	0.0	20.6		1006	0.0	0.0	20.5		1004
8	5/07/1994		0.1	20.1		1021	0.0	0.1	20.1		1021
6	11/07/1994		0.0	20.5		1001	0.0	0.3	19.8		1002
7	18/07/1994		1.9	17.5		1006		0.3	19.9		1006
4	22/07/1994		2.3	16.8		1027	0.0	1.9	18.2		1027
12	3/08/1994		2.1	17.8		1002	0.0	0.0	20.6		1003
5	8/08/1994		4.5	13.7		984	0.0	1.6	18.9		984
8	16/08/1994	0.0	0.0	20.7		1012	0.0	0.1	20.4		1012
6	22/08/1994		8.5	6.9		1013	0.0	0.0	20.4		1011
7	29/08/1994		8.3	6.1		1004	0.0	0.3	20.0		1004
7	5/09/1994		8.0	8.9		1002	0.0	0.4	19.2		998
7	12/09/1994		0.1	20.4		1006	0.0	0.9	19.0		1006
14	26/09/1994	0.0	0.0	20.4		993		0.0	20.4		993
14	10/10/1994	0.0	0.0	20.6		1000	0.0	0.4	19.7		998
7	17/10/1994	0.0	0.2	20.3		1003	0.0	1.5	19.1		1004
8	25/10/1994	0.0	5.4	10.8		1018	0.0	1.7	18.9		1018
8	2/11/1994	0.0	0.3	20.1		1020	0.0	1.5	19.0		1019
26	28/11/1994	0.0	0.9	19.4		1006		2.4	17.1		1006
3	1/12/1994	0.0	0.0	20.2		1015	0.0	2.7	18.1		1017
74	13/02/1995	0.0	3.1	16.7		1023	0.0	3.1	17.9		1023
64	18/04/1995	0.0	3.1	17.4		1019	0.0	1.2	19.7		1020
134	30/08/1995		7.2	8.4		1001	0.0	1.8	18.8		1001
44	13/10/1995	0.0	2.3	20.3		1012	0.0	3.2	23.5		1013
7	20/10/1995	0.0	0.0	20.4		998	0.0	0.0	20.4		998
14	3/11/1995		8.2	4.7		1012	0.0	2.6	17.2		1011
10	13/11/1995		2.6	16.4		1013	0.0	1.6	19.2		1013
72	24/01/1996		10.0	3.9		1012	0.0	1.9	18.3		1012
476	14/05/1997	0.0	1.4	17.3		980	0.0	2.6	16.9		979
13	27/05/1997		0.0	18.9		1013		0.0	19.1		1013
31	27/06/1997		0.4	21.7		1021	0.0	2.3	19.7		1020
46	12/08/1997	0.0	0.4	21.3		995	0.0	0.3	21.7		995
43	24/09/1997	0.0	2.9	20.4		1032	to access pipe				
41	4/11/1997	0.0	1.7	20.3		1007	0.0	1.9	19.8		1007
35	9/12/1997	0.0	2.6	17.9		1008		0.4	20.5		1013
45	23/01/1998	0.0	3.3	14.7		1014	0.0	0.9	20.2		1014
47	11/03/1998	0.0	6.2	13.6		1010	0.0	2.7	17.9		1014
27	7/04/1998	0.0	3.9	17.4		1021	0.0	1.3	19.2		1022
10	17/04/1998	0.0	5.1	14.8		1013	0.0	1.5	19.0		1012
35	22/05/1998	0.0	6.0	10.5		1007	0.0	0.9	20.1		1007
39	30/06/1998	0.0	5.6	14.3		1001	0.0	1.2	18.9		1001
31	31/07/1998	0.0	4.7	15.9		1009	0.0	0.5	19.0		1009
28	28/08/1998	0.0	3.7	15.2		1022	0.0	0.9	18.7		1022
28	25/09/1998		2.6	16.6		1021	0.0	0.5	18.7		1022
39	3/11/1998	0.0	4.7	11.9		1012	0.0	1.0	18.1		1012
35	8/12/1998	0.0	6.2	11.9		994	0.0	1.5	17.8		994
31	8/01/1999	0.0	4.7	14.4		1008	0.0	1.9	17.0		1007
28	5/02/1999	0.0	3.4	16.5		1024	0.0	1.6	19.6		1025

Green Island Landfill - Gas Monitoring Results

Atmosphere Normal = CH4 0%, CO2 0%, O2 20.9%

G1, G2, G3

Interval	Position		G1				G2					
	Date		CH4	CO2	O2	H2S ppb	Pressure (mb)	CH4	CO2	O2	H2S ppb	Pressure (mb)
166	21/07/1999		0.0	6.9	12.4		1001	0.0	1.6	18.9		1002
288	4/05/2000		0.0	5.2	12.8		1017	0.0	1.2	18.9		1017
45	18/06/2000		0.0	0.2	20.4		1014	0.0	0.3	20.4		1013
99	25/09/2000		0.0	5.0	15.4		1002	0.0	0.1	20.9		1002
38	2/11/2000		0.0	2.0	12.7		1001	0.0	1.0	19.5		1005
36	8/12/2000		0.0	0.0	20.4		993	0.0	0.0	20.4		993
49	26/01/2001		0.0	0.0	20.6		1000	0.0	0.4	19.7		998
28	23/02/2001		0.0	0.2	20.3		1003	0.0	1.5	19.1		1004
21	16/03/2001		0.0	5.4	10.8		1018	0.0	1.7	18.9		1018
35	20/04/2001		0.0	0.3	20.1		1020	0.0	1.5	19.0		1019
21	11/05/2001		0.0	0.9	19.4		1006	0.0	2.4	17.1		1006
35	15/06/2001		0.0	0.0	20.2		1015	0.0	2.7	18.1		1017
28	13/07/2001		0.0	3.1	16.7		1023	0.0	3.1	17.9		1023
612	17/03/2003		0.0	5.3	16.4	1	1027	0.0	1.1	20.5	1	1026
8	25/03/2003		0.0	4.6	18.3	0	1028	0.0	2.3	18.8	0	1028
7	1/04/2003		0.0	5.6	16.7	0	1020	0.0	2.7	19.3	0	1020
7	8/04/2003		0.0	4.9	17.5	0	1013	0.0	2.3	19.5	0	1013
6	14/04/2003		0.0	4.1	18.2	1	1025	0.0	2.8	19.1	1	1025
16	30/04/2003		0.0	4.2	18.4	1	1031	0.0	1.8	20.2	1	1031
6	6/05/2003		0.0	5.6	16.7	1	1020	0.0	1.9	20.3	1	1021
8	14/05/2003		0.0	3.6	19.5	1	1025	0.0	1.3	20.9	1	1024
5	19/05/2003		0.0	3	18.5	1	1012	0.0	1.6	18.8	1	1012
7	26/05/2003		0.0	3.5	17.9	1	1024	0.0	2.1	18.5	1	1025
10	5/06/2003		0.0	4	18.3	1	1018	0.0	1.9	19.3	1	1017
11	16/06/2003		0.0	4	18.1	2	1005	0.0	1.9	19.6	2	1005
8	24/06/2003		0.0	4	16.9	1	996	0.0	1.8	19.3	1	995
7	1/07/2003		0.0	4.1	17.8	0	1007	0.0	1.7	19.4	0	1007
8	9/07/2003		0.0	4.2	18.1	0	1024	0.0	1.6	18.7	0	1024
7	16/07/2003		0.0	4	17.1	1	1006	0.0	1.9	19.1	1	1006
8	24/07/2003		0.0	4.4	18.4	1	1034	0.0	1.9	19.8	1	1034
6	30/07/2003		0.0	4.6	17.2	1	1016	0.0	2.1	19.1	1	1016
5	4/08/2003		0.0	4.8	17.4	1	1025	0.0	2.3	19	1	1025
7	11/08/2003		0.0	5.2	16.4	2	1024	0.0	2.4	19.1	2	1025
14	25/08/2003		0.0	5.2	16.7	1	1024	0.0	2.4	18.9	1	1023
7	1/09/2003		0.0	5.6	15.7	1	1005	0.0	1.9	19.1	1	1006
7	8/09/2003		0.0	5.8	16.1	1	1009	0.0	3	18.8	1	1009
10	18/09/2003		0.0	5.6	16.2	0	979	0.0	3.1	18.6	0	979
13	1/10/2003		0.0	5.8	16.4	1	999	0.0	3	18.3	1	999
7	8/10/2003		0.0	5.8	15.6	1	1019	0.0	3.5	17.4	0	1019
9	17/10/2003		0.0	5.5	16	0	1020	0.0	3.5	18.1	0	1020
12	29/10/2003		0.0	7.2	13.9	1	1008	0.0	4.4	16.9	1	1008
12	10/11/2003		0.0	5.8	17.4	0	1009	0.0	3.6	18.2	0	1009
16	26/11/2003		0.0	6.9	15.8	0	1011	0.0	4.2	18.3	0	1011
5	1/12/2003		0.0	5.5	16.8	0	1015	0.0	3.6	16.8	0	1015
7	8/12/2003		0.0	5.2	18.2	0	1024	0.0	3.3	19.1	0	1024
7	15/12/2003		0.0	4.9	16.7	0	1004	0.0	2.2	19.5	0	1004
31	15/01/2004		0.0	4.7	16.2	0	1006	0.0	2.2	18.5	0	1006
5	20/01/2004		0.0	5.2	16.7	0	1028	0.0	2.2	19.5	0	1028
6	26/01/2004		0.0	4.3	17	0	1020	0.0	2.5	18.6	0	1020
9	4/02/2004		0.0	5.8	15	0	1013	0.0	3	18.7	0	1013
6	10/02/2004		0.0	4.8	16.7	0	1008	0.0	2.4	18.2	0	1008
6	16/02/2004		0.0	5	17.2	0	993	0.0	2.5	18.2	0	993
7	23/02/2004		0.0	3.9	17.6	0	1004	0.0	1.7	19	0	1004
16	10/03/2004		0.0	4.3	16.3	0	997	0.0	2.1	18.7	0	997

Green Isla

Atmosphere NoG4 = Gas monitoring points adjacent to Clariton Ave Neighbours

Interval	Position Date	G3					G4				
		CH4	CO2	O2	H2S ppb	Pressure (mb)	CH4	CO2	O2	H2S ppb	Pressure (mb)
	25/02/1994	0.0	0.0	20.0							
10	7/03/1994	0.0	0.0	20.5		1003	0.0	0.1	20.4		1003
7	14/03/1994	0.0	0.0	20.6		1007	0.0	0.0	20.4		1008
8	22/03/1994	0.0	0.3	20.5		1025	0.0	0.0	20.6		1025
6	28/03/1994	0.0	0.0	20.4		1020	0.0	0.0	20.4		1020
9	6/04/1994	0.0	0.0	20.4		1018	0.0	0.0	20.4		1018
5	11/04/1994	0.0	0.0	20.7		1012	0.0	0.0	20.6		1011
7	18/04/1994	0.0	0.0	20.4		1003	0.0	0.1	20.5		1005
8	26/04/1994	0.0	2.4	18.6		1027	0.0	0.0	20.5		1027
6	2/05/1994	0.0	2.7	18.0		1011	0.0	0.8	20.0		1013
7	9/05/1994	0.0	2.4	18.3		1018	0.0	1.8	18.8		1015
7	16/05/1994	0.0	3.7	17.2		985	0.0	0.7	19.9		984
7	23/05/1994	0.0	2.4	18.2		996	0.0	0.0	20.3		997
7	30/05/1994	0.0	1.6	?		1008	0.0	0.0	20.3		1009
9	8/06/1994	0.0	0.1	20.2		1014	0.0	0.1	20.1		1013
9	17/06/1994	0.0	0.0	20.7		1006	0.0	0.0	20.7		1006
4	21/06/1994	0.0	0.0	20.8		1005	0.0	0.0	20.8		1004
6	27/06/1994	0.0	0.0	20.5		1006	0.0	0.0	20.5		1006
8	5/07/1994	0.0	0.0	20.4		1020	0.0	0.0	20.4		1022
6	11/07/1994	0.0	0.0	20.5		999	0.0	0.0	20.6		1001
7	18/07/1994		0.0	20.4		1007	0.0	0.0	20.4		1008
4	22/07/1994	0.0	0.0	20.5		1026	0.0	0.0	20.5		1026
12	3/08/1994		0.0	20.8		1003	0.0	0.0	20.8		1003
5	8/08/1994	0.0	0.0	20.4		985		0.1	20.3		988
8	16/08/1994	0.0	0.0	20.6		1010	0.0	0.0	20.3		1012
6	22/08/1994	0.0	1.9	18.2		1011	0.0	0.6	18.4		1011
7	29/08/1994	0.0	0.0	20.5		1005	0.0	0.0	20.5		1005
7	5/09/1994	0.0	0.0	20.8		998	0.0	0.8	19.4		1000
7	12/09/1994	0.0	0.0	20.4		1006	0.0	0.0	20.3		1006
14	26/09/1994		0.0	20.4		992	0.0	0.0	20.1		993
14	10/10/1994	0.0	2.8	17.2		1001		2.1	16.7		999
7	17/10/1994	0.0	0.9	18.2		1005	0.0	1.3	18.9		1003
8	25/10/1994	0.0	2.2	17.1		1019	0.0	2.7	15.5		1018
8	2/11/1994	0.0	2.9	16.8		1019	0.0	3.0	15.9		1018
26	28/11/1994	0.0	2.6	17.2		1007	0.0	1.6	18.0		1006
3	1/12/1994	0.0	3.0	17.0		1015	0.0	5.4	12.1		1014
74	13/02/1995	0.0	3.5	17.3		1025	0.0	8.9	11.2		1025
64	18/04/1995	0.0	2.8	17.3		1019	0.0	7.0	10.2		1020
134	30/08/1995	0.0	0.0	20.8		1002	0.0	2.3	17.7		1002
44	13/10/1995	0.0	2.8	23.1		1013	0.0	2.8	22.4		1013
7	20/10/1995	0.0	0.0	20.5		998	0.0	0.0	20.8		998
14	3/11/1995	0.0	0.0	20.5		1011	0.0	0.0	20.6		1011
10	13/11/1995		0.0	20.7		1013	0.0	0.4	20.1		1013
72	24/01/1996	0.0	0.0	20.2		1013	0.0	4.6	12.8		1012
476	14/05/1997	0.0	0.0	18.1		979	0.0	0.0	18.1		979
13	27/05/1997		0.0	19.3		1017		0.0	19.4		1013
31	27/06/1997		0.0	20.8		1020		0.0	20.6		1023
46	12/08/1997	0.0	0.0	22.7		995		0.0	22.3		991
43	24/09/1997		0.0	22.3		1030		0.0	22.4		1030
41	4/11/1997		0.0	21.8		1006		1.6	19.4		1006
35	9/12/1997		0.0	22.3		1013	0.0	0.6	21.2		1013
45	23/01/1998		0.0	21.0		1014	0.0	0.0	21.4		1009
47	11/03/1998		0.0	20.4		1014	0.0	1.7	19.7		1015
27	7/04/1998		0.3	20.3		1023	0.0	2.6	17.8		1022
10	17/04/1998	0.0	0.0	20.6		1009	0.0	3.5	16.5		1008
35	22/05/1998	0.0	0.0	20.7		1007	0.0	3.4	16.1		1007
39	30/06/1998	0.0	0.0	20.2		1001	0.0	2.3	18.1		1001
31	31/07/1998		0.0	20.6		1009	0.0	1.6	18.7		1009
28	28/08/1998	0.0	0.0	19.9		1022	0.0	2.9	18.2		1023
28	25/09/1998	0.0	0.0	19.3		1022	0.0	0.3	18.9		1022
39	3/11/1998	0.0	0.0	19.3		1013	0.0	3.7	14.3		1013
35	8/12/1998	0.0	0.2	19.1		998	0.0	3.9	15.3		998
31	8/01/1999	0.0	0.0	18.6		1008	0.0	3.1	15.9		1008
28	5/02/1999		1.8	19.1		1024	0.0	2.8	16.9		1024

Green Isla

Atmosphere No G4 = Gas monitoring points adjacent to Clariton Ave Neighbours

Interval	Position Date	G3				G4					
		CH4	CO2	O2	H2S ppb	Pressure (mb)	CH4	CO2	O2	H2S ppb	Pressure (mb)
166	21/07/1999						0.0	2.3	17.3		1001
288	4/05/2000	0.0	0.0	20.6		1016	0.0	0.0	20.7		1017
45	18/06/2000	0.0	0.0	20.6		1012	0.0	0.0	20.7		1013
99	25/09/2000	0.0	0.0	21.1		1002	0.0	0.0	20.5		1002
38	2/11/2000	0.0	0.0	17.4		1042	0.0	0.0	14.5		1010
36	8/12/2000		0.0	20.4		992	0.0	0.0	20.1		993
49	26/01/2001	0.0	2.8	17.2		1001	0.0	2.1	16.7		999
28	23/02/2001	0.0	0.9	18.2		1005	0.0	1.3	18.9		1003
21	16/03/2001	0.0	2.2	17.1		1019	0.0	2.7	15.5		1018
35	20/04/2001	0.0	2.9	16.8		1019	0.0	3.0	15.9		1018
21	11/05/2001	0.0	2.6	17.2		1007	0.0	1.6	18.0		1006
35	15/06/2001	0.0	3.0	17.0		1015	0.0	5.4	12.1		1014
28	13/07/2001	0.0	3.5	17.3		1025	0.0	8.9	11.2		1025
612	17/03/2003	0.0	0.1	21.3	1	1026					1
8	25/03/2003	0.0	2	19.1	0	1029					0
7	1/04/2003	0.0	1.2	20.7	0	1020					0
7	8/04/2003	0.0	0.2	21.1	0	1013					0
6	14/04/2003	0.0	1.8	19.5	1	1025					1
16	30/04/2003	0.0	0.8	20.4	1	1031	0.0	2.6	19.4	1	1031
6	6/05/2003	0.0	0.6	20.7	1	1022	0.0	2.3	19.8	1	1020
8	14/05/2003	0.0	1.2	20.4	1	1024	0.0	2.3	20.3	1	1025
5	19/05/2003	0.0	1.6	19.1	1	1012	0.0	2	19.5	1	1012
7	26/05/2003	0.0	0.2	21.1	1	1024	0.0	2.3	19.3	1	1025
10	5/06/2003	0.0	2.2	21.4	1	1017	0.0	2.2	19.6	1	1018
11	16/06/2003	0.0	0.1	21.5	2	1006	0.0	3	19.2	2	1005
8	24/06/2003	0.0	0.1	21.3	1	995	0.0	2.3	20.1	1	995
7	1/07/2003	0.0	0	21.4	0	1007	0.0	1.1	20.7	0	1007
8	9/07/2003	0.0	0.2	21.2	0	1024	0.0	1.3	20.4	0	1024
7	16/07/2003	0.0	0.1	21.3	1	1006	0.0	1.1	20.5	1	1006
8	24/07/2003	0.0	0.2	21.1	1	1035	0.0	1.7	20	1	1035
6	30/07/2003	0.0	0.2	21.1	1	1016	0.0	2.4	19.1	1	1016
5	4/08/2003	0.0	0.2	21.3	1	1026	0.0	2.8	19.2	1	1026
7	11/08/2003	0.0	2.3	18.8	2	1025	0.0	3.7	18.1	2	1026
14	25/08/2003	0.0	0.1	18.9	1	1024	0.0	0.4	21.4	1	1023
7	1/09/2003	0.0	0.1	21.3	1	1005	0.0	0.3	21.2	1	1006
7	8/09/2003	0.0	0.1	21.3	1	1010	0.0	0.1	21.3	1	1010
10	18/09/2003	0.0	0.1	21	0	979	0.0	2.4	19.4	0	979
13	1/10/2003	0.0	0.2	21	1	999	0.0	3	19	0	999
7	8/10/2003	0.0	0.2	21	0	1019	0.0	3.2	18.6	0	1019
9	17/10/2003	0.0	0.2	21.4	0	1020	0.0	3.2	18.9	0	1020
12	29/10/2003	0.0	0.1	21	1	1008	0.0	3.1	19.2	1	1008
12	10/11/2003	0.0	0.1	21	0	1009	0.0	3	18.8	0	1009
16	26/11/2003	0.0	0.1	20.8	0	1011	0.0	3.5	19.1	0	1011
5	1/12/2003	0.0	0.2	20.6	1	1015	0.0	3.2	18.8	0	1015
7	8/12/2003	0.0	3	19.2	0	1024	0.0	3.1	19.3	0	1024
7	15/12/2003	0.0	2.8	18.9	0	1004	0.0	2.6	19.4	0	1004
31	15/01/2004	0.0	1.3	19.5	0	1006	0.0	2	19.2	0	1006
5	20/01/2004	0.0	1.1	20	0	1028	0.0	2.3	19.4	0	1028
6	26/01/2004	0.0	1.3	19.3	0	1020	0.0	2.1	19	0	1020
9	4/02/2004	0.0	0.2	20.6	0	1013	0.0	3.2	18.1	0	1013
6	10/02/2004	0.0	1.9	18.9	0	1008	0.0	2.9	18.5	0	1008
6	16/02/2004	0.0	1.3	19.5	0	993	0.0	1.3	19.8	0	993
7	23/02/2004	0.0	1.4	19.3	0	1004	0.0	1.4	19.6	0	1004
16	10/03/2004		1.2	19.3	0	997	0.0	1.9	19	0	997

Appendix F – Filling Pattern: Concept Design

F.1 Assumptions

- a) Liquid Waste Acceptance Criteria are implemented such that sludge must be dry before being placed in the landfill and liquid industrial waste is not accepted.
- b) Assume an average of 60,000 m³ of waste placed in the landfill per annum.
- c) Assume final landform excludes extension over the sewer.

F.2 Cell Construction Technique

- a) Waste is placed in cells up to 30 m wide.
- b) Waste is compacted at a slope of 5:1 (H:V).
- c) For Lift 2, waste is placed in 2 No. 4 m sublifts.
- d) For Lift 3, waste is placed in order to form final landform (without extension over sewer)
- e) All waste is placed in cells (ie no special waste pits other than asbestos pit).

F.3 Plan Area

F.3.1 Lift 2

For each cell, assume a depth of waste of 8 m, and a cell width of 30 m. Thus assume cell length of 250 m per annum.

Based on the sketch of a possible filling pattern, there is space for up to 12 years of waste at Lift 2.

F.3.2 Lift 3

For each cell, assume an average depth of 6 m, and a cell width of 30 m. Thus assume, cell length of 333 m per annum.

Based on the sketch of a possible filling pattern, there is space for up to 10 years of waste at Lift 3.

Appendix G – LFG Monitoring Programme

Instantaneous Surface Monitoring at Green Island Landfill

Methodology

Instantaneous Surface Monitoring (ISM) at Green Island Landfill shall be conducted in accordance with the MfE ISM Protocol for landfills.

Route

For the purpose of ISM, drawing Z10596-05-G001 shows three main areas at Green Island Landfill:

1. Active Operational Landfill Area
2. Closed Landfill Area
3. Perimeter of the Active Landfill

Active Operational Area

The active operational area, as shown in drawing Z10596-05-G001, is the area within the Lift 2 and 3 bunds. Instantaneous Surface Monitoring within this area shall be done on a 30 m by 30 m grid, as per the MfE ISM protocol.

Instantaneous Surface Monitoring shall also be done at the locations listed in section 0.

Closed Landfill Area

The closed landfill area, as shown in drawing Z10596-05-G001, includes the public part of the landfill.

Instantaneous Surface Monitoring within this area shall be at the locations listed in section 0.

Perimeter of the Active Landfill

This area is shown in drawing Z10596-05-G001 includes the leachate trench line and the batter slopes.

Instantaneous Surface Monitoring within this area shall be at the locations listed in section 0.

The exact locations of the monitoring points shall be recorded with the aid of a GPS. A GPS of accuracy ± 1 m Hz is required. The Datum is to be in terms of NZGD 2000. The Origin of coordinates in terms of Trig A North Taieri, 800,000mN, 400,000mE.

Recording

The MfE ISM Protocol sets out the information that shall be recorded before, during, and after instantaneous surface monitoring.

The exact locations of the monitoring points shall be recorded with the aid of a GPS. A GPS of accuracy $\pm 1m$ Hz shall be required. The Datum shall be in terms of NZGD 2000. The Origin of coordinates shall be in terms of Trig A North Taieri, 800,000mN, 400,000mE.

Methane gas readings shall be recorded at the locations listed in the table below.

Area	Name	Comment
Active Operational Area	30 m x 30 m grid	As per MfE ISM Protocol
	Along Stormwater Ditch	As indicated on Drg Z10596-05-G001. Recording at least every 30 m.
	MW9 - borehole	As indicated on Drg Z10596-05-G001
Closed Area	Manholes	As shown in Drg 006116-18-G05
	FS1	
	FS2	
	FS3	
	SW1	
	SW2	
	SW3	
	SW4	
	Mudtanks	As shown in Drg 006116-18-G05
	MT1	
	MT2	
	MT3	
	MT4	
	MT5	
	MT6	
	MT7	
	MT8	
	MT9	
	Lampholes	As shown in Drg 006116-18-G05
	LH1	
LH2		
Other	As shown in Drg 006116-18-G05	
2 No. GT (Gully Trap)		
3 No. Branch Tee Connections		
WW2		

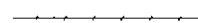

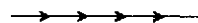

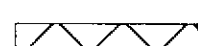



Area	Name	Comment
Landfill Perimeter	Bore holes	As shown in Drg 006116-19-G08A
	MW1A	
	MW1B	
	MW2A	
	MW2B	
	MW3A	
	MW3B	
	MW4A	
	MW4B	
	MW5A	
	MW5B	
	MW6A	
	MW6B	
	MW7A	
	MW7B	
	MW8A	
	MW8B	
	Pump Stations	As shown in Drg 006116-19-G08A
	PS1	
	PS2	
	PS3	
	PS4	
	PS5	
	PS6	
	PS7	
	PS8	
	PS9	
	Air Valves	As shown in Drg 006116-19-G08A
	AV1	
	AV2	
	AV3	
	AV4	
	AV5	
	AV6	
	Leachate Manholes	As shown in Drg 006116-19-G08A
	MH1	
	MH2	
	MH3	
	MH4	
	MH5	
	MH6	
	MH7	
	MH8	

Area	Name	Comment
	MH8A	
	Along Lift 1 batter slopes	Recording at least every 30 m
	Toe	
	Mid-height	
	Top	
	Along Lift 2 batter slopes	Recording at least every 30 m
	Toe	
	Mid-height	
	Top	
	Along Lift 3 batter slopes	Recording at least every 30 m
	Toe	
	Mid-height	
	Top	

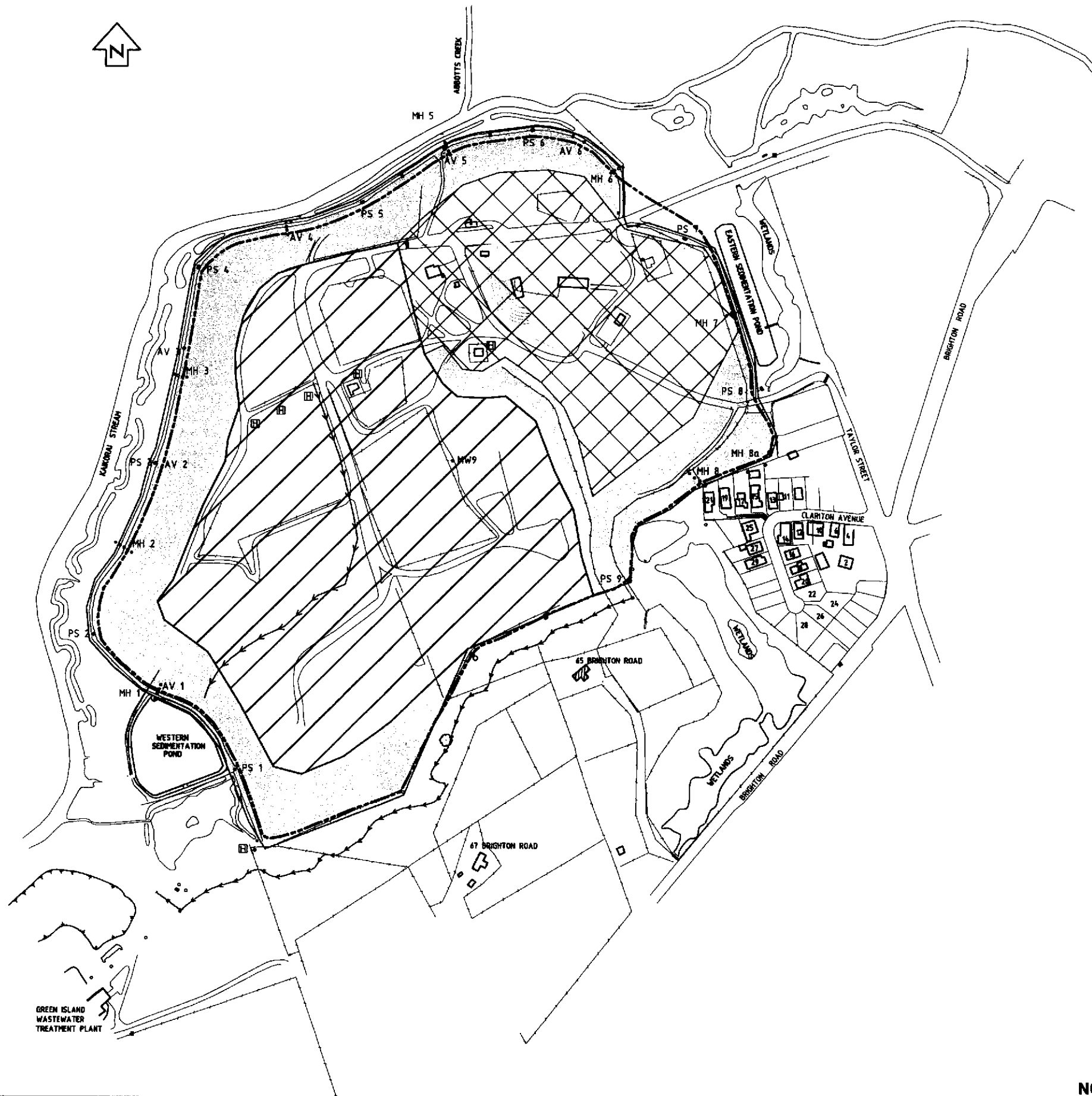
ORIGINAL SIZE A1
DO NOT SCALE - IF IN DOUBT, ASK

200
150
100
50
0
50
100
150
200

LEGEND

-  FENCE
 -  EXTENT OF LANDFILLED AREA
 -  STORMWATER DITCH
 -  ACTIVE OPERATIONAL AREA
 -  CLOSED AREA
 -  ACTIVE LANDFILL PERIMETER
 -  MANHOLES
 -  HYDRANTS
- LEACHATE COLLECTION SYSTEM**
- PS PUMP STATION
 - MH MAN HOLE
 - AV AIR VALVE

NOTE:
MW9 AND STORMWATER DITCH LOCATIONS
ARE SHOWN INDICATIVELY



NOT FOR CONSTRUCTION

REV	AMENDMENTS	INITIAL	DATE	INITIAL	DATE
		CHECKED		APPROVED	

TAB/DWG : Layout1 / Z10596-05-G001.dwg
 SERVER : DUNEDIN \RZDUN2597
 XREFS : XBASEPLAN 2004

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FIELDBOOK		
Name	Date	
SURVEYED	J.R. PHIPPS	12/03
DESIGNED	W.M. LILFORD	09/05
DRAWN	J.H. KIRKWOOD	09/05
CHECKED		
APPROVED		

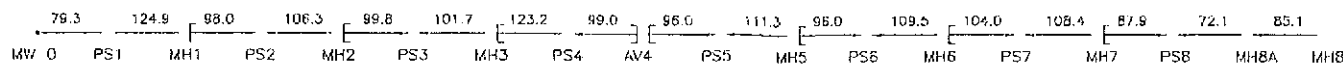
MWH

DUNEDIN CITY COUNCIL
Kaitiaki Takekōwhiri

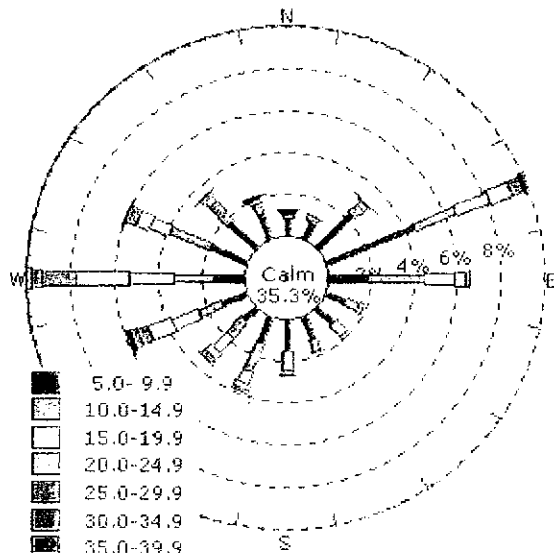
**GREEN ISLAND LANDFILL
 LANDFILL GAS COLLECTION REVIEW**

LFG MONITORING

WORKING PLOT		
Date	31/08/2005	
Scale	(A1) 1:2500	(A3) 1:5000
Job No.	Z10596-05	Plot No.
		Rev.
	G001	A



LEACHATE DRAIN DISTANCES AND CAPS



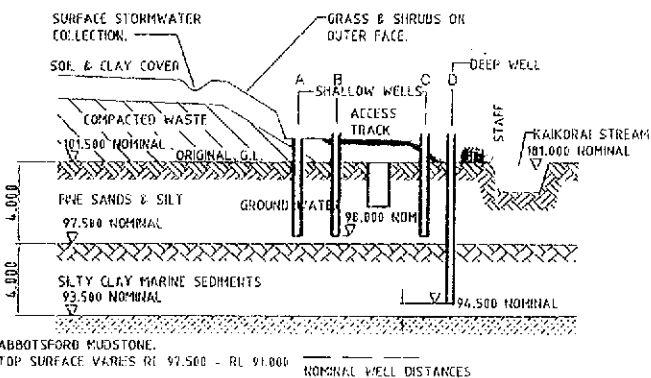
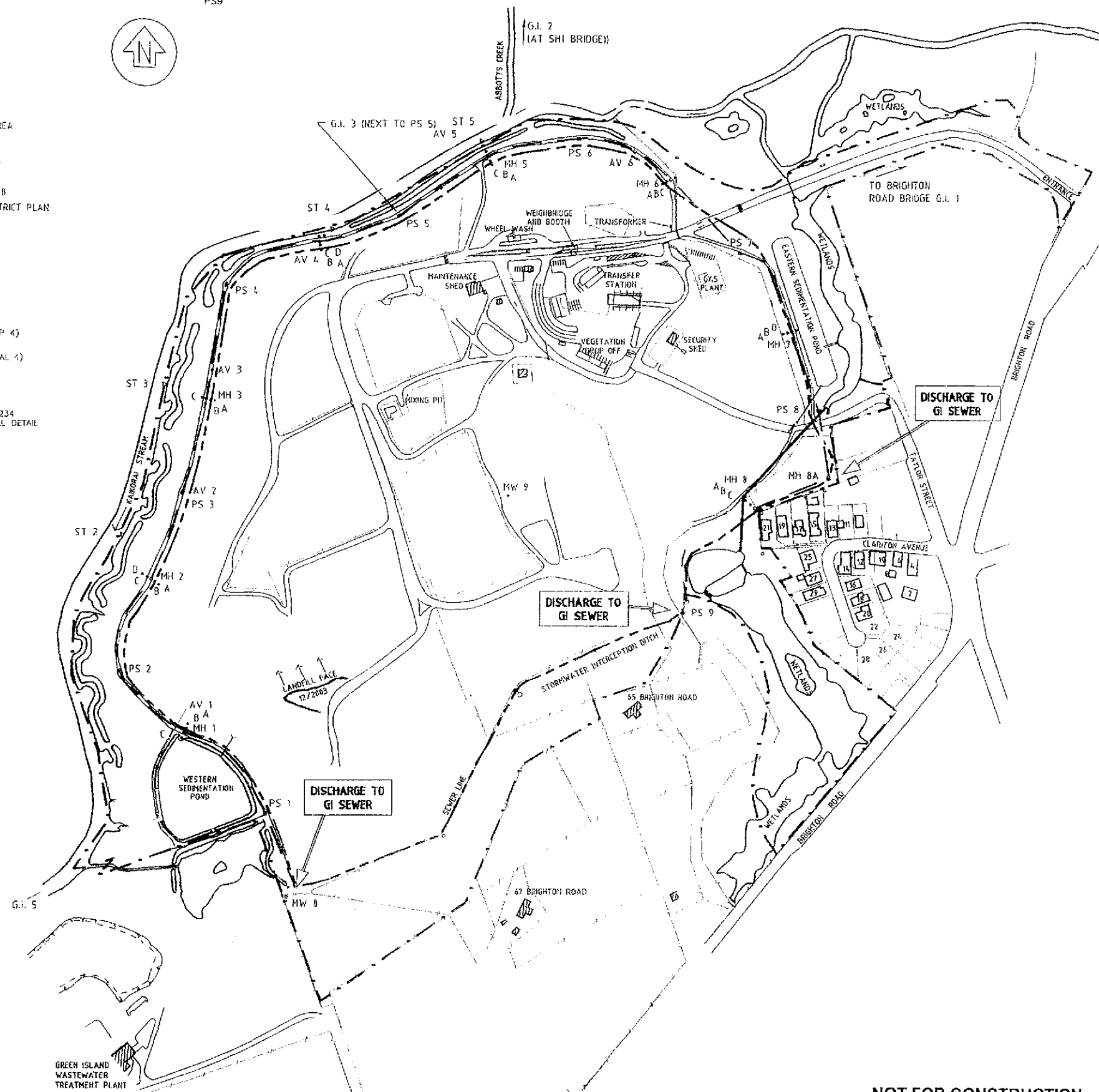
WINDROSE DATA FOR GREEN ISLAND LANDFILL (km/hr)
FOR PERIOD 01/01/03 TO 31/12/03

LEGEND

- FENCE
- EXTENT OF LANDFILLED AREA
- LANDFILL OPERATION AREA
- LANDFILL DESIGNATION D65B
- DUNEDIN CITY COUNCIL DISTRICT PLAN
- SEWER LINE
- STORMWATER DITCH

- PS PUMP STATION (TOTAL 9)
- MH MANHOLE (TOTAL 6)
- AV AIR VALVE (TOTAL 6)
- MW MONITORING WELL (SHALLOW 24, DEEP 4)
- ST STAFF (TOTAL 4)
- GI KAIKORAI STREAM SAMPLING POINT (TOTAL 4)

NOTE REFER TO CITYCONS DRAWING 5526/234
LEACHATE MONITORING FOR ADDITIONAL DETAIL



TYPICAL CROSS SECTION
LEACHATE TRENCH AND MONITORING WELLS
NTS

Green Island Leachate Collection System - Monitoring Wells

Pump Stations							Manholes			Air Valves		
Station	Lid Top	Inlet 1	Inlet 2	Pump Inlet	Pump Level	Out	Station	Lid Top	Inlet 1	Inlet 2	Station	Lid Top
PS 1	102.34	96.89	96.90	97.85	99.36	99.16	MH 1	102.57	99.09	99.07	AV 1	102.38
PS 2	102.42	99.05	98.07	98.36	98.54	99.34	MH 2	102.35	98.97	99.02	AV 2	102.44
PS 3	102.51	99.01	98.97	98.48	99.45	99.25	MH 3	102.57	98.87	98.93	AV 3	103.07
PS 4	102.43	98.85	98.02	98.35	99.30	99.10	MH 4	102.49	99.09	99.08	AV 4	102.74
PS 5	102.43	98.14	98.13	98.30	98.56	99.30	MH 5	102.33	98.90	98.86	AV 5	102.53
PS 6	102.47	98.16	98.15	98.30	98.61	99.41	MH 6	102.96	99.33	99.32	AV 6	102.73
PS 7	103.12	98.87	98.04	98.85	99.32	99.12	MH 8A	103.60	100.36	100.40		
PS 8	103.79	99.36	98.48	98.43	99.78	99.59	MH 8	105.02	102.00			
PS 9	105.87	100.17		99.06	100.65	103.49						

Monitoring Wells and Stream Staffs

Station	Distance from Drain	Top	Bottom	Depth	Classification	Ground Level	Landfill Surface	Station	Distance from Drain	Top	Bottom	Depth	Classification	Ground Level	Landfill Surface
MW 0	-	102.55	97.85	4.8	Shallow	102.44	N/A	MW 4A	9.0	104.00	98.50	5.5	Shallow	103.81	104.3
MW 1A	10.5	102.45	97.84	4.6	Shallow	102.27	103.0	MW 4B	3.6	103.00	98.30	4.7	Shallow	102.79	103.2
MW 1B	5.2	102.45	97.84	4.6	Shallow	102.40	N/A	MW 4C	5.4	102.90	98.28	4.7	Shallow	102.79	N/A
MW 1C	6.2	102.43	97.83	4.6	Shallow	102.22	N/A	MW 4D	5.2	102.98	92.49	10.5	Deep	102.76	N/A
MW 2A	10.0	102.57	97.57	4.8	Shallow	102.28	103.0	ST 4	9.7	103.0			Staff	101.4	N/A
MW 2B	4.8	102.42	97.62	4.8	Shallow	102.19	102.5	MW 5A	9.9	103.08	98.57	4.52	Shallow	102.98	N/A
MW 2C	5.1	102.49	97.68	4.8	Shallow	102.26	N/A	MW 5B	5.3	103.09	98.57	4.52	Shallow	102.89	N/A
MW 2D	11.1	102.51	92.51	10.0	Deep	102.16	N/A	MW 5C	5.6	103.07	98.55	4.52	Shallow	102.47	N/A
ST 2	47.4	103.0			Staff	101.0	N/A	ST 5	17.2	104.0			Staff	101.15	N/A
MW 3A	9.7	103.00	98.48	4.52	Shallow	102.83	103.7	MW 6A	10.0	102.82	98.47	4.35	Shallow	102.78	103.2
MW 3B	5.1	103.02	98.50	4.52	Shallow	102.76	N/A	MW 6B	4.8	102.72	98.37	4.35	Shallow	102.42	N/A
MW 3C	4.6	103.05	98.42	4.63	Shallow	102.65	N/A	MW 6C	4.9	102.71	98.36	4.35	Shallow	102.31	N/A
ST 3	47.0	103.0			Staff	101.1	N/A	MW 7A	9.7	103.27	98.28	4.99	Shallow	103.13	N/A
								MW 7B	4.8	103.28	98.29	4.99	Shallow	103.04	N/A
								MW 7D	5.3	103.23	96.16	7.07	Deep	102.87	N/A
								MW 6A	12.8	105.43	98.33	7.10	Shallow	105.28	N/A
								MW 8B	5.7	105.44	98.34	7.10	Shallow	105.23	N/A
								MW 8C	4.5	105.44	98.34	7.10	Shallow	105.37	N/A
								MW 9	Min 250	108.74	94.24	15.50	Deep	109.48	N/A

NOT FOR CONSTRUCTION

TAB/DWG : Layout1 / 06016-18 G08.dwg SERVER : DUNEDIN (HZDUN2501) XREFS : XBASEPLAN 2004		FIELDBOOK SURVEYED DESIGNED DRAWN CHECKED APPROVED		Name Date M.A. BECHT 09/04				LANDFILL MANAGEMENT & DEVELOPMENT PLANS GREEN ISLAND LANDFILL LEACHATE COLLECTION SYSTEM AND ENVIRONMENTAL MONITORING SYSTEM		Scale Date FOR REVIEW 16.09.2004	
COPYRIGHT © These drawings shall only be used for the purpose for which they were accepted. Any reuse is prohibited and no part of this document may be reproduced or distributed without the written permission of MWH NZ Ltd.		REV AMENDMENTS INITIAL DATE CHECKED INITIAL DATE APPROVED		SCALES (A1) 1:2500 (A3) 1:5000 Job No. 006116-19 Sheet No. G08 Rev. A		NOT FOR CONSTRUCTION		Scale Date FOR REVIEW 16.09.2004		Scale Date FOR REVIEW 16.09.2004	

TO: Infrastructure Services Committee
FROM: Solid Waste Team Leader
MEETING DATE: 30 January 2006
SUBJECT: **GREEN ISLAND LANDFILL GAS COLLECTION SYSTEM**

SUMMARY

This report provides an update on progress on development and implementation of a gas collection system at the Green Island Landfill.

IMPLICATIONS FOR:

- | | |
|-------------------------------------|----|
| (i) Policy: | No |
| (ii) Approved Annual Budget: | No |
| (iii) LTCCP/ Funding Policy: | No |
| (iv) Community Boards: | No |

RECOMMENDATION

That the report is noted.

INTRODUCTION

In accordance with the Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxins) Regulations 2004, the Council is required to install a gas collection system at the Green Island Landfill by October 2007. The current Annual Plan has a budget of \$180,000 for this financial year and \$3.420m for 2006/07 to implement the project.

BACKGROUND

As well as being required to collect gas under the Resource Management Regulations, the Council is also obliged to collect it under Otago Regional Council consent no 94524, clause 5, issued in November 1995 which states:-

"The consent holders shall take all practicable steps to collect the landfill gas generated from refuse less than 12 years old at the commencement of this consent and to minimise the emission of landfill gas to atmosphere."

In 1995 a scheme was implemented to collect gas and feed it to Dunedin's reticulation for sale to domestic and industrial users but due to insufficient quantities of gas collected, the project did not prove to be financially viable and the collection system was mothballed in 1995. Recent inspections have determined that what remains of it is largely unusable.

DISCUSSION

In December 2005, a landfill consultant, David Tucker was appointed to manage the project. Works carried out by David to date include implementing a programme of instantaneous surface gas monitoring and supervising the preparation of a Registration of Interest (ROI) document.

Staff intend advertising for registrations of interest in early February 2006. ROI will invite registration from parties interested in bidding for:-

- A landfill gas collection and flaring system – the benchmark solution
- A landfill gas collection and flaring system with development of a scheme for beneficial use of the gas.

Possible uses of the gas include collection and distribution as a fuel and generation of electricity.

The Committee is reminded that the Council has a long term contract with Delta for the management of its waste management facilities and detailed discussions are taking place with the contractor with respect to the content of the ROI and operational practices at the Green Island Landfill. Any changes in operational practices necessary to maximise gas generation and collection could have contractual and hence financial implications. The Committee will be advised of any such implications in due course.

CONCLUSION

Progress is being made in the landfill gas collection project for the Green Island Landfill. An ROI is being prepared which will be advertised in early February. Staff will report further on the outcomes of this stage and options for the progressing the project after conclusion of the ROI process.

Prepared by:

Approved for submission by:

Iain Satterthwaite
SOLID WASTE TEAM LEADER

Tony Avery
GENERAL MANAGER CITY ENVIRONMENT

Date report prepared: 18 January 2006

TO: EMT

FROM: Water & Waste Services Manager

MEETING DATE: 2 May 2006

SUBJECT: **GREEN ISLAND LANDFILL GAS COLLECTION -
REGISTRATION OF INTEREST**

SUMMARY

This report outlines the outcomes of the registration of interest process for gas collection at the Green Island Landfill and proposes a way forward to ensure completion of the project by October 2007. Registrations of interest closed on 24 March 2006.

IMPLICATIONS FOR:

- | | |
|-------------------------------------|---|
| (i) Policy: | No |
| (ii) Approved Annual Budget: | No |
| (iii) LTCCP/ Funding Policy: | No |
| (iv) Community Boards: | Yes – Community Boards have an interest in developments at the landfill |

RECOMMENDATION

It is recommended that the Council proceed with inviting tenders from the following for the design and construction of a gas collection and flaring system at the Green Island Landfill:

- Delta Utility Services Ltd
- Envirowaste Services Ltd
- Transfield Worley Ltd
- Waste Solutions Ltd

INTRODUCTION

The Council is required by the National Environmental Standard Relating to Certain Air Pollutants, Dioxins and Other Toxins Regulations 2004 to install a landfill gas collection system at Green Island by October 2007. \$3.6M dollars was included in the 2005/06 Annual Plan for these works. In November 2005 a consultant was appointed to project manage the process.

In February 2006, Registrations of Interest (ROI) were sought for design and construction of a gas collection and flaring system for the landfill. The ROI closed on 24 March 2006.

DISCUSSION

Registrations were received from seven companies as follows:

- Beca Carter Limited
- Transfield Worley Limited
- Waste Solutions Limited
- Delta Utility Services Limited
- Envirowaste Services Limited
- United Group Limited
- Works Construction Limited

A summary of the documents received is attached to this report.

A panel comprising of senior staff and the Consultant evaluated the submissions received and recommend that tenders be invited from a short list of four companies, being:

- Delta Utility Services Limited
- Transfield Worley Limited
- Envirowaste Services Limited
- Waste Solutions Limited

One of the main reasons for discounting the other three submitters is that they did not produce a letter of co-operation from Delta Utility Services Ltd which was a requirement of the ROI. Delta are currently managing the landfill on the Council's behalf under contract through to June 2010, which can be extended at the Council's discretion through to 2013. Any major disruption to their operations can result in a claim from Delta resulting in a variation to the contract.

The letter of co-operation does not negate the possibility of a variation to the contract as the level of any possible disruption will not be known until design and construction proposals have been received and reviewed but it does indicate a willingness for the parties to work together. Any possible financial implications to the Delta contract will be considered prior to any contract being placed for the gas collection system.

Additional reasons for discounting the other three are as follows:

- Beca Carter
 - Did not provide details of their construction capability and have no operations experience
 - Only offered investigation and design services although the ROI called for construct also
- United Group
 - Appear to have no experience in landfill gas projects
- Works
 - Appear to have limited technical and operations experience in landfill gas
 - Lacked the required detail

CONCLUSION

Staff and consultant are pleased with the response to the ROI. They would now like to proceed with inviting tenders for the design and construction of a gas collection and flaring system from four of the submitters as discussed above.

Prepared by:

Approved for submission by:

Iain Satterthwaite
SOLID WASTE TEAM LEADER

John Mackie
WATER & WASTE SERVICES MANAGER

Approved by: Tony Avery
GENERAL MANAGER CITY ENVIRONMENT

Date report prepared: 20 April 2006

TO: Infrastructure Services Committee
FROM: Water and Waste Services Manager
MEETING DATE: 30 July 2007
SUBJECT: **GREEN ISLAND LANDFILL GAS COLLECTION**

SUMMARY

Stage 1 Investigations have been completed at the Green Island Landfill for the gas management project. Whilst there may be potential to beneficially use the gas, this will only become apparent as infrastructure is put in place and more testing is carried out. As such it is proposed to adopt a minimised system for gas extraction and flaring in the short term.

IMPLICATIONS FOR:

- | | |
|--|----|
| (i) Policy: | No |
| (ii) Approved Annual Budget: | No |
| (iii) LTCCP/ Funding Policy: | No |
| (iv) Activity Management Plans: | No |
| (v) Community Boards: | No |

RECOMMENDATIONS

It is recommended that this report is noted.

INTRODUCTION

In accordance with the Resource Management (National Environmental Standard Relating to Certain Air Pollutants, Dioxins and Other Toxins) Regulations 2004 (NES), the Council is obliged to implement a gas collection and flaring system at the Green Island Landfill by October 2007.

In September 2006, Envirowaste Services Ltd was awarded a contract to carry out investigations at the landfill to determine the potential for gas generation and identify a solution for complying with the NES. This report details the outcomes of the investigations and outlines the way forward.

As well as having to comply with the NES, the Council is required, through a condition of the Green Island landfill consents, to collect landfill gas and minimise its emissions to the atmosphere.

A gas collection system was installed at the landfill in the 1990s in an effort to use the gas beneficially but the quantities of gas that were predicted were never realised, the project did not prove financially viable and the scheme was abandoned. With the introduction of the NES, a gas collection system has to be installed.

DISCUSSION

Key recommendations from the investigations report include the following:

- A staged landfill construction methodology should be implemented.
- The first stage of landfilling should be expedited to allow for installation of gas collection wells as soon as practical.
- Installation of a gas control system should be based on a minimised concept until sufficient proving of the gas yield has been achieved to determine whether the gas can be beneficially used.
- Upgrading of the existing cover and implementation of operational practices to facilitate safe gas extraction should be carried out.
- A leachate drainage system should be installed within the operational area to reduce the potential for ongoing increases in leachate levels.

Financial implications of implementing the recommendations are as follows:

1. Minimised Gas System

	Construction	Operation pa
Initial development	\$1,000,000	\$74,000
Completed	\$2,000,000 (additional)	\$134,000

2. Optimised Gas System

The consultants also looked at an optimised situation for gas extraction which would make beneficial use of the gas, either as a fuel or to generate electricity.

The estimated costs are:

	Construction	Operation pa
Initial development	\$1,000,000	\$74,000
Completed	\$8,700,000	\$-16,000

The negative annual operation costs for the completed system allows for the realisation of revenue from the generation of electricity, ie the system is estimated to make a small return in beneficially using the gas. The costs include estimates for connecting the Green Island

wastewater treatment plant (where gas is being utilised/flared), and a possible extraction system at the Fairfield landfill (does not include construction costs of the system at Fairfield), and it assumes the gas from these additional sources is supplied free of charge.

3. Upgrading the Cover

Short term - estimated costs \$3.1 – 4.4m
Long term - estimated costs \$2.8 – 3.9m (additional to short term)

The Consultants indicate short term as being three years and long term will be through to planned closure of the landfill.

Both leachate control and upgrading of the cover are recommended by the Consultants to respectively facilitate gas collection and to reduce the risk of fires occurring within the landfill which is a potential risk during the gas extraction operations.

4. Leachate Collection System

The Green Island Landfill has a perimeter leachate collection system which was installed in the 1990s to prevent the escape of leachate. To improve the collection of leachate, limit the build up of leachate and facilitate gas collection, the Consultants have recommended installation of a leachate collection system within the operational area, the estimated cost of which is \$2m with an annual operating cost of about \$75,000.

In implementing a gas system, consideration has to be given to the current contract that the Council has with Delta for management of its solid waste facilities. This contract runs through to June 2010 with an option to extend for a further three years.

As it stands, the contract does not include the operation and maintenance of a gas collection system together with installation of infrastructure as landfilling progresses. Further, changes in operational practices, particularly in terms of leachate control and application of cover material to waste, may be necessary to facilitate gas collection and flaring. Any changes to the current contract will necessitate variations which will incur additional costs.

Accordingly, Delta were given an opportunity to review the investigations report and provide feedback. Delta agreed that the minimised gas system was appropriate in the short term and whilst agreeing with the reports findings that cover needs to be upgraded for operation of a positive landfill gas collection system, they believed that it could be staged over a longer period. They pointed out that some of the work was already included in the current contract and as such, total costs would be about \$4m spread over 16 years. With regard to the leachate collection system, Delta agreed that installation of one within the operational area would be appropriate but that savings, as yet unquantified, could be made by introducing modifications to the system proposed by the Consultants, mainly by reducing the depth at which the collection pipework would be installed.

OPTIONS

To comply with the NES and the Green Island landfill consents, the Council is obliged to implement a gas collection system. It should be noted that the owner of the Fairfield landfill on the other side of the Kaikorai Estuary is also under the same obligation and has been undergoing a similar process. The owner is currently Envirowaste who has been conducting the investigations at Green Island landfill. Therefore, in terms of options, the Council has a limited choice; either to implement the minimised system or go for the optimised solution.

The Consultants do not recommend the latter, which staff and the landfill operator concur with. The optimised system should only be considered as more data is obtained on the quantities of gas available. Further, the Council has only budgeted about \$5m through to 2016/17, so the optimised system is unaffordable.

What the budget did not allow for was expenditure on additional leachate collection or upgrade of the cover at the landfill. Both items would incur capital and operational

expenditure but should be included in an operations contract as ongoing development of a landfill.

Due to the nature of landfill development and in order to minimise disruption to operations the following has already been effected:

- The landfill operator has adopted the staged construction recommended by the Consultant
- Four production wells (two of which were test wells) have been installed in the Stage 1 filling area.
- Cover material (clay, sand and soil) is now being accepted free of charge at the landfill in order to encourage customers to bring unsuitable material that is free of deleterious matter.

In the meantime staff are considering options to the purchase of a flare that is fully compliant with the NES, as it will be unnecessary until sufficient infrastructure is in place and sufficient gas is being generated to justify the expenditure.

Options being considered are:

- Use of the flare that was mothballed following the abandonment of the 1990s scheme.
- Piping the gas through to the existing flare at the Green Island wastewater treatment plant.

Concurrently with consideration of these options the Council's Energy Manager is investigating the feasibility of beneficially using the landfill gas, together with waste gas from the wastewater treatment plant to generate power.

Budgets

\$2.2m is budgeted for installation of the gas collection system in 2007/08. There is a further \$2.5m budgeted through to 2016/17 for phased expansion of the system. There is sufficient funds available in 2007/08 to cover initial development of the minimised system together with some upgrade of cover and installation of leachate drains. However, both the capital and operations budgets will be reviewed to reflect the findings of the Consultants and the landfill operators response.

CONCLUSION

Investigations have been completed at the Green Island landfill which is the latest stage in the process to implement a gas collection and flaring system necessary to comply with the NES.

Staff are of the opinion that the minimum option should be implemented in order for the Council to meet its obligations. Works are underway to achieve this and the Regional Council are also being consulted to ensure they are satisfied with the process that is being adopted.

Prepared by:

Approved for submission by:

Iain Satterthwaite
SOLID WASTE TEAM LEADER

John Mackie
WATER AND WASTE SERVICES MANAGER

Approved by: Tony Avery
GENERAL MANAGER CITY ENVIRONMENT

Date report prepared: 11 July 2007

TO: Infrastructure Services Committee
FROM: Water and Waste Services Manager
MEETING DATE: 30 July 2007
SUBJECT: **GREEN ISLAND LANDFILL GAS COLLECTION**

SUMMARY

Stage 1 Investigations have been completed at the Green Island Landfill for the gas management project. Whilst there may be potential to beneficially use the gas, this will only become apparent as infrastructure is put in place and more testing is carried out. As such it is proposed to adopt a minimised system for gas extraction and flaring in the short term.

IMPLICATIONS FOR:

- | | |
|--|----|
| (i) Policy: | No |
| (ii) Approved Annual Budget: | No |
| (iii) LTCCP/ Funding Policy: | No |
| (iv) Activity Management Plans: | No |
| (v) Community Boards: | No |

RECOMMENDATIONS

It is recommended that this report is noted.

INTRODUCTION

In accordance with the Resource Management (National Environmental Standard Relating to Certain Air Pollutants, Dioxins and Other Toxins) Regulations 2004 (NES), the Council is obliged to implement a gas collection and flaring system at the Green Island Landfill by October 2007.

In September 2006, Envirowaste Services Ltd was awarded a contract to carry out investigations at the landfill to determine the potential for gas generation and identify a solution for complying with the NES. This report details the outcomes of the investigations and outlines the way forward.

As well as having to comply with the NES, the Council is required, through a condition of the Green Island landfill consents, to collect landfill gas and minimise its emissions to the atmosphere.

A gas collection system was installed at the landfill in the 1990s in an effort to use the gas beneficially but the quantities of gas that were predicted were never realised, the project did not prove financially viable and the scheme was abandoned. With the introduction of the NES, a gas collection system has to be installed.

DISCUSSION

Key recommendations from the investigations report include the following:

- A staged landfill construction methodology should be implemented.
- The first stage of landfilling should be expedited to allow for installation of gas collection wells as soon as practical.
- Installation of a gas control system should be based on a minimised concept until sufficient proving of the gas yield has been achieved to determine whether the gas can be beneficially used.
- Upgrading of the existing cover and implementation of operational practices to facilitate safe gas extraction should be carried out.
- A leachate drainage system should be installed within the operational area to reduce the potential for ongoing increases in leachate levels.

Financial implications of implementing the recommendations are as follows:

1. Minimised Gas System

	Construction	Operation pa
Initial development	\$1,000,000	\$74,000
Completed	\$2,000,000 (additional)	\$134,000

2. Optimised Gas System

The consultants also looked at an optimised situation for gas extraction which would make beneficial use of the gas, either as a fuel or to generate electricity.

The estimated costs are:

	Construction	Operation pa
Initial development	\$1,000,000	\$74,000
Completed	\$8,700,000	\$-16,000

The negative annual operation costs for the completed system allows for the realisation of revenue from the generation of electricity, ie the system is estimated to make a small return in beneficially using the gas. The costs include estimates for connecting the Green Island

wastewater treatment plant (where gas is being utilised/flared), and a possible extraction system at the Fairfield landfill (does not include construction costs of the system at Fairfield), and it assumes the gas from these additional sources is supplied free of charge.

3. Upgrading the Cover

Short term - estimated costs \$3.1 – 4.4m
Long term - estimated costs \$2.8 – 3.9m (additional to short term)

The Consultants indicate short term as being three years and long term will be through to planned closure of the landfill.

Both leachate control and upgrading of the cover are recommended by the Consultants to respectively facilitate gas collection and to reduce the risk of fires occurring within the landfill which is a potential risk during the gas extraction operations.

4. Leachate Collection System

The Green Island Landfill has a perimeter leachate collection system which was installed in the 1990s to prevent the escape of leachate. To improve the collection of leachate, limit the build up of leachate and facilitate gas collection, the Consultants have recommended installation of a leachate collection system within the operational area, the estimated cost of which is \$2m with an annual operating cost of about \$75,000.

In implementing a gas system, consideration has to be given to the current contract that the Council has with Delta for management of its solid waste facilities. This contract runs through to June 2010 with an option to extend for a further three years.

As it stands, the contract does not include the operation and maintenance of a gas collection system together with installation of infrastructure as landfilling progresses. Further, changes in operational practices, particularly in terms of leachate control and application of cover material to waste, may be necessary to facilitate gas collection and flaring. Any changes to the current contract will necessitate variations which will incur additional costs.

Accordingly, Delta were given an opportunity to review the investigations report and provide feedback. Delta agreed that the minimised gas system was appropriate in the short term and whilst agreeing with the reports findings that cover needs to be upgraded for operation of a positive landfill gas collection system, they believed that it could be staged over a longer period. They pointed out that some of the work was already included in the current contract and as such, total costs would be about \$4m spread over 16 years. With regard to the leachate collection system, Delta agreed that installation of one within the operational area would be appropriate but that savings, as yet unquantified, could be made by introducing modifications to the system proposed by the Consultants, mainly by reducing the depth at which the collection pipework would be installed.

OPTIONS

To comply with the NES and the Green Island landfill consents, the Council is obliged to implement a gas collection system. It should be noted that the owner of the Fairfield landfill on the other side of the Kaikorai Estuary is also under the same obligation and has been undergoing a similar process. The owner is currently Envirowaste who has been conducting the investigations at Green Island landfill. Therefore, in terms of options, the Council has a limited choice; either to implement the minimised system or go for the optimised solution.

The Consultants do not recommend the latter, which staff and the landfill operator concur with. The optimised system should only be considered as more data is obtained on the quantities of gas available. Further, the Council has only budgeted about \$5m through to 2016/17, so the optimised system is unaffordable.

What the budget did not allow for was expenditure on additional leachate collection or upgrade of the cover at the landfill. Both items would incur capital and operational

expenditure but should be included in an operations contract as ongoing development of a landfill.

Due to the nature of landfill development and in order to minimise disruption to operations the following has already been effected:

- The landfill operator has adopted the staged construction recommended by the Consultant
- Four production wells (two of which were test wells) have been installed in the Stage 1 filling area.
- Cover material (clay, sand and soil) is now being accepted free of charge at the landfill in order to encourage customers to bring unsuitable material that is free of deleterious matter.

In the meantime staff are considering options to the purchase of a flare that is fully compliant with the NES, as it will be unnecessary until sufficient infrastructure is in place and sufficient gas is being generated to justify the expenditure.

Options being considered are:

- Use of the flare that was mothballed following the abandonment of the 1990s scheme.
- Piping the gas through to the existing flare at the Green Island wastewater treatment plant.

Concurrently with consideration of these options the Council's Energy Manager is investigating the feasibility of beneficially using the landfill gas, together with waste gas from the wastewater treatment plant to generate power.

Budgets

\$2.2m is budgeted for installation of the gas collection system in 2007/08. There is a further \$2.5m budgeted through to 2016/17 for phased expansion of the system. There is sufficient funds available in 2007/08 to cover initial development of the minimised system together with some upgrade of cover and installation of leachate drains. However, both the capital and operations budgets will be reviewed to reflect the findings of the Consultants and the landfill operators response.

CONCLUSION

Investigations have been completed at the Green Island landfill which is the latest stage in the process to implement a gas collection and flaring system necessary to comply with the NES.

Staff are of the opinion that the minimum option should be implemented in order for the Council to meet its obligations. Works are underway to achieve this and the Regional Council are also being consulted to ensure they are satisfied with the process that is being adopted.

Prepared by:

Approved for submission by:

Iain Satterthwaite
SOLID WASTE TEAM LEADER

John Mackie
WATER AND WASTE SERVICES MANAGER

Approved by: Tony Avery
GENERAL MANAGER CITY ENVIRONMENT

Date report prepared: 11 July 2007

2 May 2008

Consents Manager
Otago Regional Council
Private Bag 1954
DUNEDIN

Attention Chris Shaw

Dear Chris

GREEN ISLAND LANDFILL – GAS COLLECTION

Further to my letter of 20 December 2007, I write to provide the Regional Council with an update on progress in implementing a landfill gas collection and flaring system at the Green Island Landfill.

Progress is as follows:

- ⇒ Stage 1 (of 5 stages) is continuing with respect to the installation of gas extraction wells. To date, four wells have been installed. Construction is currently underway for another five wells. It is considered that installation of further wells will not be necessary until 2009 at the earliest.
- ⇒ In order to facilitate efficient gas collection and obtain sufficient gas yield, options for controlling the level of leachate within the landfill are being evaluated following extensive research and investigations by our Consultant and the landfill Contractor.
- ⇒ Due to the limited installation of infrastructure to date, the Council is not currently considering installation of a flare that is fully compliant with the National Environmental Standard for Gas Emissions, until there is sufficient gas yield to justify such expenditure.
- ⇒ Instead, installation of the pencil flare that was originally used for the gas investigations is being arranged. Thus, it is intended that the necessary consent application(s) will be submitted to the Regional Council with the intention of flaring gas by July / August this year.

As stated in previous correspondence, at this stage and in our opinion, the most practical option for flaring the gas extracted from this site is to initially install this 'backup' flare. This appears to be the most suitable option in the short term (with an upgrade to an NES – Air compliant flare intended to occur when filling has reached a stage when more production wells can be installed, which is anticipated to be sometime in 2009).

Please do not hesitate to contact the undersigned should you have any queries.

Yours sincerely

Iain Satterthwaite
WASTE WATER TREATMENT MANAGER

TO: Jim Harland, Chief Executive Officer

FROM: Ian Featherston, Solid Waste Manager

DATE: 5 December 2008

**SUBJECT: GREEN ISLAND LANDFILL GAS COLLECTION SYSTEM
UPDATE**

SUMMARY

The Green Island landfill is required to install a flare to destroy the methane produced during the landfilling operation, under the National Emissions Standards for air quality.

A separate consent to flare the gas is yet to be applied for but will be actioned early in 2009 so as to be running by about August 2009, as reported in the ORC letter attached.

The pipes have been installed for the first stage of filling and a backup flare has been built to prove the field before the final NES compliant flare is built.

Commissioning of the backup flare is programmed for 9-13 February 2009.

The ORC is being kept informed of progress of the installation of the backup flare while a consent application is being prepared.

BACKGROUND

At the July 2007 ISCOM meeting, a report on the Green Island landfill gas collection management was presented with the conclusion that the implementation of a flaring system was necessary to comply with the national environmental standards.

The minimum option was decided on with the budget of \$2.2M in 2007/08 allocated and \$2.5M budgeted through to 2016/17 for the phased expansion of the system.

The report also indicated the need to improve the cover in areas of the landfill to enable better collection of landfill gas and also improvements to the leachate collection system. These have been spread across the next ten years.

Gas collection wells were starting to be installed in 2007/08 with a programmed installation phased in over the following years.

DISCUSSION

Progress to Date

Stage 1

Stage 1 had 17 wells identified to be installed for filling. In 2007/08 eight wells had been installed and by November 2008 the remaining seven wells had been put in.

The Envirowaste designed well heads are to be installed over the next two months by the landfill operator, Delta.

As there has been some doubt as to how much gas will be collected, to design a compliant flare would be a risk so the ORC was approached with the idea of initially installing a small pencil flare to establish gas volumes so that an NES compliant flare could be designed and built. The ORC agreed with this approach.

Correspondence with the ORC is attached, they have been kept informed of progress to date.

The non-compliant flare has been completed and is undergoing tests at the Hampton Downs landfill in Auckland, by Envirowaste Services.

The connective pipework for the first four wells is being priced and the power supply to the security compound where the flare is to be placed is to be installed in January. The attached timeline shows the planned programme.

The initial flare will be operational by the end of February 2009 and within two months the gas flows should be established to enable the design and construction of a compliant flare to start in June. This will be tight timing to meet the August 2009 target date.

Over the next 12 months, the other seven wells will be filled around and should be connected up to the system as the landfilling progresses in a southwest direction to complete the stage 1 filling programme.

A resource consent application is to be submitted on the basis that an initial non-compliant flare is first installed to prove the field so that a final compliant flare can be sized correctly once the tenders for the compliant flare have been received.

Funding

The initial budget of \$2.2M for the 2007/08 year was not spent as better installation costs were achieved using the landfill operator, and the project ran behind. This has been reduced from the \$5.5M over the ten years back to the \$3.0M originally planned.

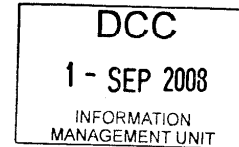
With the change in Solid Waste Managers there have been further delays in getting the project moving. This has now been rectified with more regular meetings and project monitoring being carried out.

Ian Featherston
Solid Waste Manager

Our reference:
94524

28 August 2008

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



Attention: Iain Satterthwaite

Dear Iain

Gas flaring at Green Island Landfill

After discussing the issues with yourself and Martin this afternoon, this letter is to confirm that the proposal, as detailed by you, and outlined in your letters dated 11/7/2007, and 17/8/2007 is acceptable.

It has been determined that the approach proposed by the DCC, namely to first install a partially compliant flare, and then install a fully compliant flare is similar to the approach accepted by the Otago Regional Council in several other consents as a multi step process to achieve compliance with NES 2004/309, and that the suggested time frame of having a fully compliant flare installed by August 2009 is also acceptable.

The Otago Regional Council would appreciate it greatly if you could keep the Council informed of future developments, and progress made, and looks forward to your continued co-operation in this matter.

Yours sincerely



Sean Leslie
Compliance Officer – Discharges.

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Mission Statement: "To promote the sustainable development and enhancement of Otago's resources"
70 Stafford Street, Private Bag, Dunedin. Telephone (03) 474-0827. Facsimile (03) 479-0015



**GREEN ISLAND GAS SYSTEM ESTIMATE
ROUGH ORDER OF COST FOR TEMP SYSTEM**

Initial Cost to end December 2008						Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
BY ESL	Elements to consider	Unit	Rate	Amount										
1. Temp flare	All up price			46,000					46,000					
2. installation and training	All up price			10,000					10,000					
3. Design advise	Estimate for connecting seven wells			3,000		3,000								
BY DELTA														
1. Power supply	10kw, say 50m run u/g, some under road	LS		12,000			12,000							
2. Fenced compound for flare	15m of 1.8m fence (\$50/m) plus 2 x 1.5m gates (say \$800)		15m x \$50 plus \$800	1,550			1,550							
3. Wellheads	7 wellheads	7	500	3,500			3,500							
4. Pipework	110mm dia, connection, waraths, straps	450m	\$35	16,750			16,750							
5. Welding PE		80 no	35	2,800			2,800							
6. Road crossing	from condensate chamber to flare	10	80	800			800							
7. Condensate chamber	1m dia manhole say 3m deep	LS		10,000			10,000							
	Total			106,400										
	Allow 20% contingency			21280						21280				
	Total Nov - Dec 2008			127,680										

						Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Additional Cost Jan 2009 to Apr 2009														
Additional pipework	Assume another 4 wells will be completed	200m	35	7,000						7,000				
Additional wellheads		4	500	2,000						2,000				
	Contingency 20%			1800						1800				
	Total cost Jan 09 - Apr 09			10,800										
	Total Project Nov '08 to Apr '09			138,480										
Resource Consent			\$10,000						10000					
Gas field reaching equilibrium														
Measure gas flow rates			\$20,000								20000			
Tender compliant flare			\$10,000						10000					
Manufacture Compliant Flare														
Install new Compliant Flare			\$400,000											400000
					Month Total	3,000	47,400	0	76,000	32,080	20,000	0	0	400,000
					Cum Total	3,000	50,400	50,400	126,400	158,480	178,480	178,480	178,480	578,480

19 May 2009

Otago Regional Council
Private Bag 1954
Dunedin 9054

Attention: Sean Leslie

Dear Mr Leslie

Last week I spoke to you on the issue of the gas flare at the Green Island landfill.

So far the gas collection system has installed 16 wells of which four have been connected to the flare and are producing gas. The rest will be connected as they have the final capping clay and soil installed.

The gas is being flared at present through the back-up flare while we establish the ongoing gas volumes generated from the field.

We have received tenders for an NES compliant enclosed flare, however during this process we were approached by a company prepared to utilise the gas from the landfill and combine it with the methane produced at the Green Island Wastewater Treatment Plant. This proposal is in the process of being considered by us and our Energy Manager.

The impact for the DCC is that the NES compliant flare costs would be significantly reduced if we were able to divert the money being spent on destroying the methane and put it into an energy recovery facility.

With this in mind and having spoken to Sean, we would be asking for the ORC to consider if the gas from the Green Island landfill collection system is utilised rather than destroyed, could the current backup flare be used instead of purchasing a larger NES compliant flare.

I look forward to your reply. If you have any questions please call me on 474 3447.

Yours faithfully

Ian Featherston
Solid Waste Manager

TO: Council Annual Plan Workshop

FROM: Solid Waste Manager

MEETING DATE: 20 January 2010

SUBJECT: **SOLID WASTE KERBSIDE RECYCLING, LANDFILL GAS COLLECTION CAPEX, ENVIROSCHOOLS FUNDING**

SUMMARY:

The Kerbside Recycling rate will need to be increased from the current \$34.90 per household to \$66.00 or \$50.00 per household, depending on the contract term of 3 or 7 years respectively. The full cost of the service will not be charged until the 2011/12 year, estimated at \$97.00 to \$65.00 per household.

The Landfill Gas Collection Capital Expenditure requirement can be deferred due to the pending feasibility study and report from the Energy Manager.

Enviroschool funding from 2010/11 onwards is being funded from the external revenue from the Waste Levy paid by the Ministry for the Environment to Territorial Authorities.

IMPLICATIONS FOR:

- | | |
|--|----|
| (i) Policy: | No |
| (ii) Approved Annual Budget: | No |
| (iii) LTCCP/ Funding Policy: | No |
| (iv) Activity Management Plans: | No |
| (v) Community Boards: | No |

RECOMMENDATIONS

1. That the report "Solid Waste - Kerbside Recycling, Landfill Gas Collection Capex, Enviroschools Funding" be received.

BACKGROUND

During the October 2009 budget review for 2010/11, EMT asked for further reports on the rating issues related to the Kerbside Recycling decision, Landfill Gas Collection CAPEX, and EnviroSchools funding for 2010/11 and beyond.

DISCUSSION

Kerbside Recycling:

The Council decided to tender the kerbside collections services on a base level fortnight service of two bins, one for glass and one for plastics and cans, paper and cardboard folded as currently done. Refuse is the Council user pays black bag weekly collection

Budget Impact.

	Approved 09/10	Draft 10/11	Draft 11/12	Draft 12/13	Draft 13/14
LTCCP	\$1,440,700	\$1,435,700	\$1,430,700	\$1,420,700	\$1,420,700
Option Fii) 3yr term		\$2,730,271	\$4,015,714	\$4,156,264	\$4,301,733
- deficit/+surplus		-\$1,294,571	-\$2,585,014	-\$2,735,564	-\$2,881,033
Option Fii) 7yr term		\$2,067,886	\$2,690,942	\$2,785,125	\$2,882,605
- deficit/+surplus		-\$632,185	-\$1,260,242	-\$1,364,425	-\$1,461,904

The 2010/11 year is a combination of the first 6 months rated at the current rate of \$34.90 per household, and the last 6 months based on the Option C costs of \$70 per household, averaging at \$53.00 per household for the 2010/11 year.

Since the council has decided on Option Fii) at an estimated cost of \$97 per household, there is a deficit of \$1,294,571 in the 2010/11 year and \$2,585,014 deficits going forward based on the 3 + 3 year term contract prices.

For the 7 year term contract there is a smaller deficit of -\$632,185 in 10/11 and -\$1,260,242 going forward 11/12

The impact on the 2010/11 is shown below, depending on the term of the contract.

Table of Rate per household

	Approved 09/10	Contract Term	Draft 10/11	Draft 11/12	Draft 12/13	Draft 13/14
Kerbside Recycling Rate (incl. GST)	\$34.90	3 yr	\$66	\$97	\$100	\$104
		7 yr	\$50	\$65	\$67	\$70
Increase from 09/10		3 yr	+\$31	+\$62	+\$65	+\$69
		7 yr	+\$15	+\$30	+\$32	+\$35

Until the Tender prices come in and a decision is made on the final term of the contract, the impact on rates can only be estimated, but it is likely that the 7 year term will result in the lowest rates impact.

By the end of March 2010 we should be able to give a better estimate of the service cost.

The revised timeline for the project is as follows:

January 2010	Tender Documents Developed 4 weeks
February 2010	Advertise tender 6-8 weeks
Mid March 2010	Tender closed
Mid to end March	Assess tenders
April 2010	EMT Tender approval
19 April 2010	ISCOM Award tender
November 2010 – Feb 2011	Collection service start date depending on tender award.

Landfill Gas Collection Capex.

The Green Island Landfill has been required to install a methane gas collection system under the (National Environmental Standard Relating to Certain Air Pollutants, Dioxins and Other Toxics) Regulations 2004 (NES).

\$2.4M was budgeted in the Capital plan in 2008/09 of which only \$0.6M was spent last year. There was a carry forward of \$0.5M to the 2009/10 year and the amount reduced to \$1.5M for the installation of a compliant flare.

During the year a proposal to utilise the sewerage sludge and methane gas from the landfill to generate electricity at the Green Island WWTP and use the hot exhaust gases for further processing of woodchips was proposed by the DCC Energy Manager.

This proposal to divert the gas to a waste to energy plant (rather than flaring it) was accepted by the Otago Regional Council which saves the capital expenditure on a larger compliant full destruction flare and enables the diversion of the funds to the waste to energy project.

The project is currently being developed and a feasibility study and report is being prepared by the Energy Manager for consideration early 2010.

The capital expenditure requirement for installing further gas wells is estimated to be \$300,000 in the current year and the balance of the \$1.5M could be earmarked for the waste to energy project.

Enviroschools Funding

In the 2009/10 year the Government funding was cut to \$10,000 and the \$30,000 shortfall was funded from the Waste Levy paid back to councils from the Ministry for the Environment. From 2010/11 it is proposed that the Enviroschools programme be fully funded from the Waste Levy which will not require any rates contribution.

Year	Community Services Rate	EfS (Govt Funding)	Waste Levy	Total
08/09	\$52,000	\$40,000	\$0	\$92,000
09/10	\$52,000	\$10,000	\$30,000	\$92,000
10/11	\$0	\$0.00	\$92,000	\$92,000
11/12	\$0	\$0.00	\$92,000	\$92,000

The Enviroschools Foundation is now signing a \$1million contract with MfE to transition into a new phase of Enviroschools development. The contract will run until 30 June 2010 and enable Enviroschools to continue to grow the school network and to work on many new aspects of the programme.

CONCLUSION

The impact on the Kerbside Recycling Rate for the 2010/11 year is estimated to be and increase between \$15 to \$31 per household, depending on the contract term.

Capital Expenditure on the Landfill Gas Collection System will be less than budgeted; however the expenditure is to be deferred until the outcome of the waste to energy project feasibility study and report from the Energy Manager.

Enviroschools funding will be sourced from external funding from the Waste Levy, therefore will not be funded from rates.

Prepared by:

Approved by:

Ian Featherston
SOLID WASTE MANAGER

John Mackie
MANAGER, WATER AND WASTE SERVICES

Approved for submission by:

Tony Avery
GENERAL MANAGER CITY ENVIRONMENT

Date report prepared: 23 December 2009