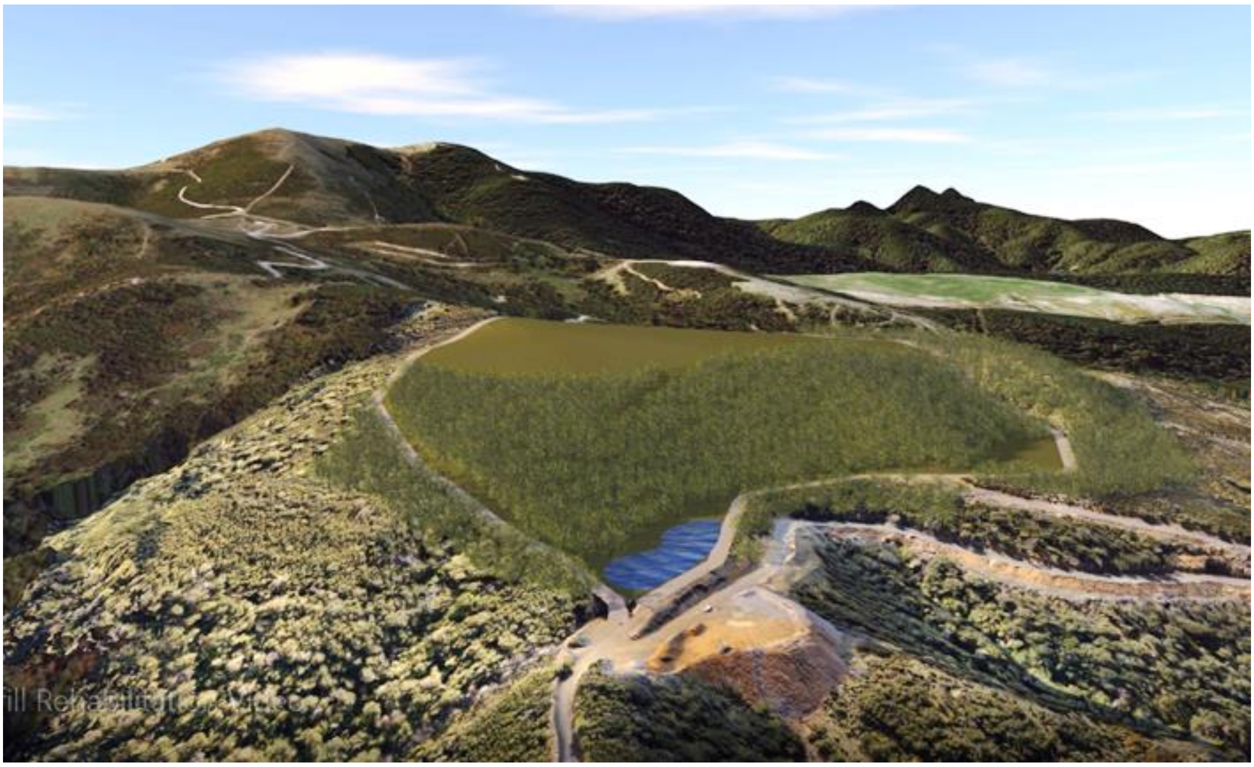
Appendix 5

Woodstock Landfill

Engineering Technical Report Addendum 1



INDIGENOUS REGENERATION *through* INNOVATIVE LANDFILL PRACTICE

February 2022

DOCUMENT OWNER	
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Document Name:	Woodstock Landfill Engineering Report – Addendum 1

DOCUMENT CONTROL				
Issue	Date:	Prepared	Reviewed	Approved for Issue
1	21/2/22	Martin Pinkham	Darryn Shepherd	Darryn Shepherd

This Addendum is to be read in conjunction with Appendix 5 Engineering Report of Application

4.4 Lining System

4.4.1 Description (this Addendum replace all of Section 4.4.1)

The purpose of a landfill lining system is to contain any leachate within the landfill and prevent it from entering the underlying soils or groundwater. It provides a low permeability containment system on which leachate is collected and removed from the landfill.

For a landfill, as proposed for Woodstock Landfill, the WasteMINZ Technical Guidelines describe the following two lining systems for a Class 1 landfill, comprising from top to bottom:

Type 1 lining system

- *Leachate drainage material, with underlying cushion geotextile to protect the geomembrane;*
- *1.5 mm HDPE geomembrane;*
- *600 mm compacted clay with a coefficient of permeability k < 1 x 10^{-9} m/s. Or*

Type 2 lining system

- *Leachate drainage material, with underlying cushion geotextile to protect the geomembrane;*
- *1.5 mm HDPE geomembrane;*
- *Geosynthetic clay liner (GCL);*
- *600 mm compacted clay with a coefficient of permeability k < 1 x 10^{-8} m/s.*

or

- *Leachate drainage material, with underlying cushion geotextile to protect the geomembrane;*
- *1.5 mm HDPE geomembrane;*
- *Geosynthetic clay liner (GCL);*
- *300 mm compacted clay with a coefficient of permeability k < 1 x 10^{-9} m/s.*

These two lining systems are considered to be equivalent to each other.

For the Woodstock Landfill it is proposed to use the Class 1 Type 2 Option 2 liner system for the base of the landfill and on the sidewall of the toe bund, comprising:

- Leachate drainage material, with underlying cushion geotextile to protect the geomembrane;
- 1.5 mm HDPE geomembrane;
- Geosynthetic clay liner (GCL);
- 300 mm compacted clay with a coefficient of permeability k < 1 x 10^{-9} m/s.

This system is considered to be at least equivalent to the liner systems detailed in the WasteMINZ Guidelines. Details of the proposed liner are shown on Drawing C2 in Appendix 2.

All components of the lining system work together to contain leachate within the landfill and prevent leachate seepage. The combined system functions as follows:

- For there to be any leakage through a lining system there must be a driving head (depth) of leachate. An effective drainage system above the main containment layers drains the leachate away before a significant depth of leachate can form above the containment layers, thus limiting the potential for any leakage;
- The primary containment layer is one of the liner systems as detailed above. This primary layer is essentially impermeable. There is low risk that the sheet is damaged during construction, and this is mitigated by strict construction quality assurance (QA) procedures;

- The Geotechnical Report in Appendix 3 and Hydrogeological Report in Appendix 4 identify that the underlying geology is a very low permeability massive and competent greywacke.
- There is generally an inwards hydraulic gradient of the existing groundwater which would further reduce the potential for leakage.

Any potential seepage through a defect in the HDPE liner system, which sits directly on top of the GCL. would swell up in the event that moisture came through the HDPE. The seepage would then have to travel through the very low permeability 300 mm compacted clay layer before it flows out of the lining system.

The time of travel through the system depends on the actual permeability achieved for the compacted clay. During this slow travel time contaminants in the leachate adhere to the clay particles and are removed from the liquid that may eventually seep from the bottom of the liner system, thereby significantly reducing the contaminant concentration.

Soils investigations undertaken to date indicate that suitable clay soils are generally available on site, both within the general footprint area and elsewhere on the wider site, to meet the compacted clay liner objectives. The laboratory test results for these clays indicate a permeability of 2.5×10^{-10} m/s. The availability of these materials for the lining system construction will depend on:

- The amount of disturbance to potential low permeability soil layers near the surface during vegetation clearance operations;
- The degree of contamination of near surface clay soils by roots;
- The ability to stockpile low permeability soils excavated from the footprint for later use.

Drawing D5 in Appendix 2 Drawings Issue 2 (Attachment 8) shows the location and estimated quantities of readily available low permeability clay resources on the site, which is more than 60,000 cubic metres. It is understood that further deposits of clay are readily available in the local vicinity.

Figure 4.3 below are the test results from two samples of the low permeability clay resources on the site. During the construction phase an appropriate quality assurance programme will be developed to ensure that the clays used for the liner and the cap comply with the minimum permeability specifications.

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 20/2802

Date: 22 November 2020

TEST REPORT – CONSTANT HEAD PERMEABILITY

Client Details:	**Woodstock Quarries Ltd 39 Stott Drive, RD1, Darfield**	**Attention:**	**D. Shepherd**
Job Description:	**Woodstock Quarries Ltd – Lining Investigations**		
Sample Description:	**Clayey SILT with minor sand**	**Client Order No:**	**N/A**
Sample Source:	**Middle Quarry / New Road (cs)**	**Sample Depth:**	**≈ 2.0m (cs)**
Date & Time Sampled:	**3-Nov-20 (cs)**	**Sampled By:**	**D. Shepherd (cs)**
Sample Method:	**NZS 4407:2015, Test 2.4.2 (pit or bank) (cs)**	**Date Received:**	**5-Nov-20**

CONSTANT HEAD PERMEABILITY TEST IN A TRIAXIAL CELL – ASTM D5084-16a			
Cell Pressure: (kPa)	**570**	**Compaction:**	**NZ Standard**
Saturation Back Pressure: (kPa)	**500**	**Solid Density: (t/m^3)**	**2.65 (assumed)**
Effective Confining Pressure: (kPa)	**70**	**Temperature During Test: (^{o}C)**	**20.7**
Saturation by Pore Pressure Response: (B Value)	**0.99**	**Permeant Liquid Used:**	**De-aired Tap Water**

Sample Status:	**Initial**	**Final**
Sample Dimensions: (mm)	**104.9 ϕ x 115.5**	**104.9 ϕ x 113.6**
Bulk Density: (t/m^3)	**2.08**	**2.12**
Water Content: (%)	**17.1**	**17.1**
Dry Density: (t/m^3)	**1.78**	**1.81**
Saturation By Calculation: (%)	**93**	**98**
Void Ratio: (*e*)	**0.49**	**0.46**
Constant Head: (kPa)	**30 kPa**	**50 kPa**
Hydraulic Conductivity: (k_{20})	**2.7 x 10^{-10} m/s**	**2.5 x 10^{-10} m/s**

General Notes:

- ***Information contained in this report which is Not IANZ Accredited relates to the sample description based on NZ Geotechnical Society Guidelines 2005, the client supplied information (cs) and sampling.***
- ***This report may not be reproduced except in full.***

Tested By: N.P. Danischewski **Date: 11 to 20-Nov-20**

Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

ACCREDITED IANZ TESTING LABORATORY №434

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

Specialist Quality Assurance Service in Aggregate, Concrete and Soils Testing

The expected in-service life of the HDPE is in the order of 300 years, and that of the GCL is expected to be well in excess of 100 years. It is acknowledged that the life of the HDPE is extended, and the risk of damage to the HDPE is reduced, by the presence of a GCL under the HDPE geomembrane.

In addition to the liner system on the base of the landfill, and the sidewalls of the toe bund, the rock sidewalls will be sprayed with a polyurea waterproofing membrane over shotcrete.

The shotcrete will be applied to the excavated rock surface to create a more even surface for the polyurea membrane. The shotcrete will be applied by a specialist shotcrete contractor.

The polyurea waterproofing system, which is applied using specialist spraying equipment by a specialist contractor, is used internationally for waterproofing rock walls of embankments, tunnels and building as well as landfills and water retaining structures.

As shown on Drawing C2 the waterproofing membrane is protected from the waste by the installation of a graded drainage material, which also has the dual purpose of draining the face of the rockwall.

There are well established techniques for constructing the interface between the HDPE / GCL liner system of the base of the landfill and the polyurea on the rockwalls. An example of this is shown in the photograph below (Figure 4.2).

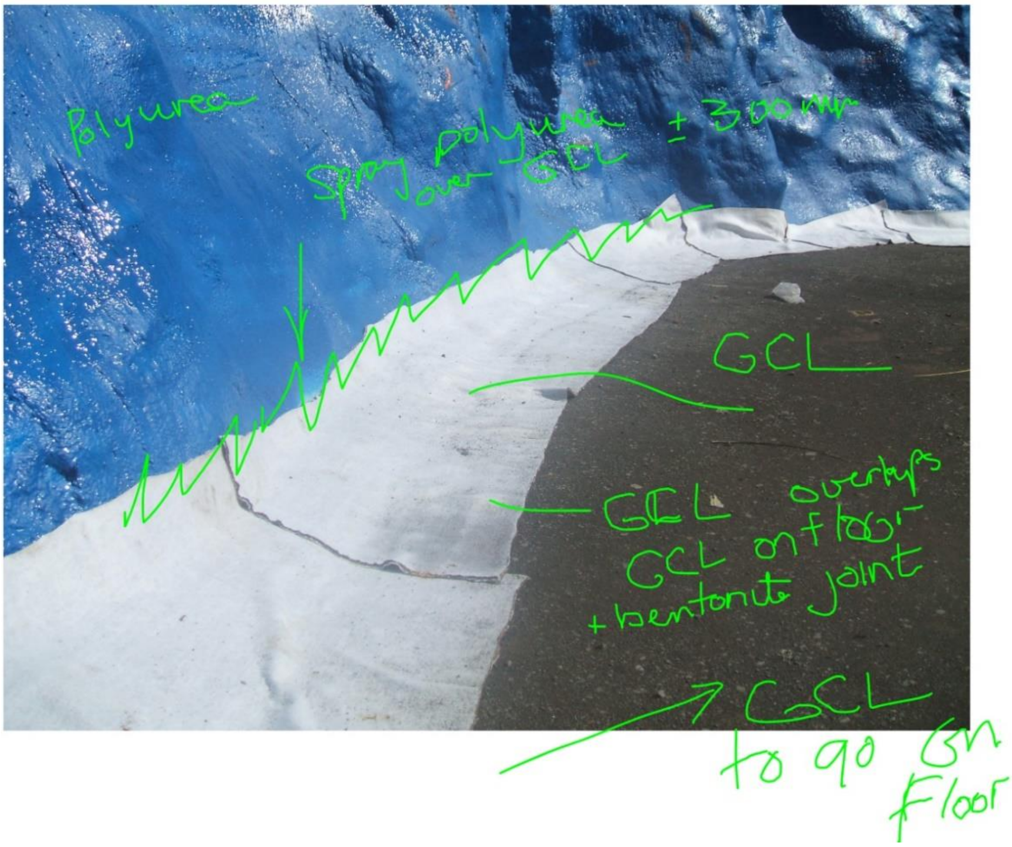


Figure 4.2: Interface between HDPE/GCL liner and polyurea membrane.

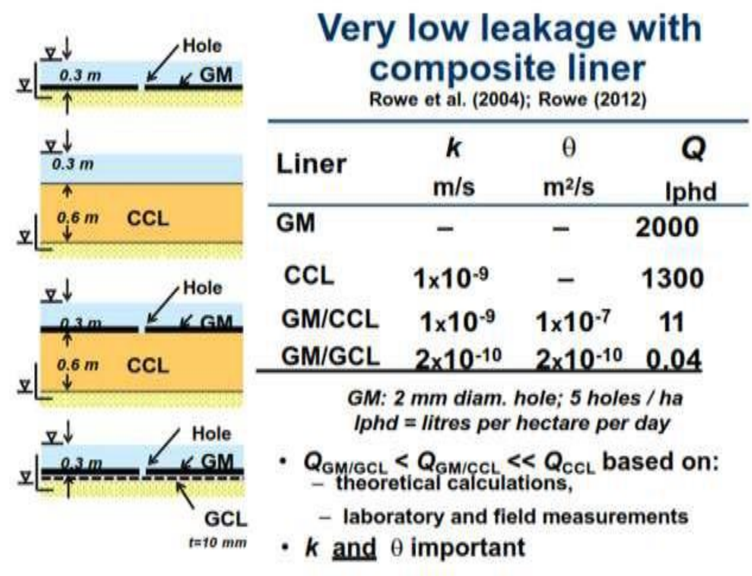
4.4.2 Lining system potential leakage (this Addendum replace all of Section 4.4.2)

While every attempt is made to avoid leakage of leachate from a landfill, some leakage may occur through defects that may be present in the lining system, from either the manufacturing process or installation.

However, to assess potential effects, it is standard international practice to assume that some defects will be present.

The potential for defects is minimised by having good QA programmes in place, both for geosynthetic liner manufacture and for lining system construction. This assumes good field placement with a well-prepared smooth surface and geomembrane wrinkle control to provide good contact between the geomembrane and the underlying surface. In the case of the Woodstock Landfill, it is assumed that a high level of construction QA will be provided, resulting in no more than the assumed defects in the geomembrane. As most of the liner system is horizontal, apart from the toe bund, it will be easier to achieve a high level of construction quality assurance.

Methods have been developed for calculating leakage through defects in a composite lining system make due allowance for the contact between the HDPE geomembrane and the underlying clay or GCL. Field and laboratory measurements of actual leakage through different lining system have been undertaken by Rowe at al, and the results are shown in Figure 4.3 below. The figure clearly shows the incremental benefit between a geomembrane (GM). or clay (CCL), liner alone compared to a composite HDPE / GCL lining system as shown in the bottom example, the same system that is proposed for the Woodstock Landfill. The research suggests that leakage rates in the order of 0.04 litres per hectare per day could be expected. It is recommended that for a conservative assessment of the impact of the potential leakage of leachate through the liner system a leakage rate of 0.1 litres per hectare per day should be adopted.



Liner	k m/s	θ m²/s	Q lphd
GM	–	–	2000
CCL	1×10^{-9}	–	1300
GM/CCL	1×10^{-9}	1×10^{-7}	11
GM/GCL	2×10^{-10}	2×10^{-10}	0.04

Figure 4.3: Laboratory and field measurements of liner seepage through known defects (Rowe et al).

As shown on the Drawing C4 in Appendix 2 Drawings Issue 2 (Attachment 7) and described in Section 4.8 of Appendix 5 Engineering Report, the Woodstock Landfill will also have an underdrainage system below the liner. While the primary purpose of this underdrainage system is to collect and convey any inflow of groundwater to prevent uplift of the liner, any leachate which may have travelled through the liner system would be collected by the underdrainage system.

With the proposed cell development programme each cell will have its own underdrainage system. Each section of the underdrainage system terminates at a manholes at the outside of the toe bund, before discharging into the perimeter surface drain at the most downstream manhole.

Each manhole will also be equipped with a valve on the inlet that can be closed when there is no more flow from the underdrainage system. The manholes will be linked together, and the downstream outlet manhole will also be fitted with a valve to prevent discharge into the surface water system, if required.

The outlet from the downstream manhole will be equipped with continuous pH and conductivity metering so any change in the chemistry of the discharge from the underdrainage system can be detected. In the event of a change in the chemistry of the discharge a more intensive testing programme of the discharge can be undertaken to ascertain whether this is caused by leachate leakage. Further details on the methodology for assessing whether there is leachate in the surface water system is detailed in Appendix 4A Hydrogeology Report 2 (Attachment 1). In addition, appropriate conditions are detailed in Appendix 10 Proposed Condition of Consent Issue 2 (Attachment 7).

4.5 Leachate Collection (this Addendum replace all of Section 4.5)

Leachate is the liquid produced when rainwater percolates through the waste to the landfill lining system, collecting dissolved and/or suspended matter from the waste as it passes through. A landfill is managed to minimise the volume of leachate that is produced. This is achieved by:

- Minimising the size of the active tip area where waste is exposed to rainfall;
- Covering areas with intermediate or final cover as soon as is practicable so that as much water as possible is shed into the stormwater collection system and minimising percolation of water through these layers into the underlying waste;
- Providing professionally managed stormwater systems to separate all stormwater flow from areas where waste is placed and ensuring all site stormwater is diverted away from rubbish.

All stormwater that meets waste will be treated as leachate and will not be discharged to the stormwater system.

Leachate generated within the landfill will flow to the leachate collection system at the base of the landfill from where it will be removed for treatment and disposal (refer Section 6.4 of Appendix 5 Engineering Report).

The general layout of the proposed leachate collection system is shown on Drawing C1 in Appendix 2.

The system will be designed so that the leachate head on the liner does not exceed a selected target value, typically in the order of 300 mm. The leachate pipes will be HDPE PE100 for durability and strength. A non-woven cushion geotextile will be placed beneath the aggregate layers to protect the geomembrane from puncturing as a result of the loads, i.e., weight of waste, on the aggregate.

The leachate collection system will comprise:

1. All landfill/lining system surfaces having a grade of no less than 2.0 % falling to leachate collection drains;
2. A high permeability aggregate layer on the floor areas of the landfill to collect leachate and direct it to the main collector drains. This will be a poorly graded (uniform size) aggregate nominally 20 mm particle size (or larger), in a layer with a minimum thickness of 300 mm;
3. A primary leachate collection drain at the centre of the floor with a grade of at least 2%. This would comprise an HDPE perforated leachate collection pipe sized for the expected maximum leachate flows, with some redundancy. It would be surrounded by a coarse aggregate layer, typically with a 40 mm minimum particle size. This is shown on Detail B on Drawing C1 of Appendix 2 Drawings Issue 2 (Attachment 7).
4. Leachate collection drains at the toe of all slopes, on the benches and on the floor, detailed similarly to the primary leachate drain;
5. Secondary leachate pipes on floor areas (if required) so that the drainage path through the drainage layer does not result in excessive hydraulic head over the liner system.
6. An overflow leachate pipe will be installed parallel to the toe bund as shown on Detail A on Drawing C1 of Appendix 2 Drawings Issue 2 (Attachment 7). This pipe will allow for the lateral movement of leachate between each of the cells should there be a build up of leachate in a particular cell. This pipe is capped when first installed and then connected up when the adjacent cell is constructed.

7 The leachate pipes will convey leachate to a common point next to the toe bund, as shown on Detail A on Drawing C1 of Appendix 2 Drawings Issue 2 (Attachment 7). An additional layer of HDPE geomembrane will be installed beneath any leachate sumps within the landfill for additional security against potential leakage. At this point a large diameter HDPE riser pipe is laid on the side slope of the toe bund, and a specialist submersible pump is installed inside the riser. Pressure transducers on the pump control the pumping process and enable the landfill operator to monitor the depth of leachate in the landfill.

Leachate will be pumped from this point out of the landfill to a leachate storage facility. Pumping is preferred rather than a gravity discharge because:

- It avoids a pipe penetration through the lining system on the toe bund;
- It allows greater options for storage of leachate, allowing for pond/tank water levels to be above the base of the landfill.

Initially, the leachate collection / storage facility will be located within the landfill footprint as shown on Detail A of Drawing C1 of Appendix 2 Drawings Issue 2 (Attachment 7). As the landfill construction progresses from east to west the storage facility will be progressively moved. The leachate storage facility has capacity for at least 5 days of leachate generation.

In the final stages of the landfill construction the leachate will terminate in a large sump and a permanent leachate storage facility constructed. A resource consent for this facility will be required.

Provision will be made for access to the ends of leachate pipelines for cleaning the pipes. Access to the downstream ends, when the leachate pump is removed, provide for cleaning using flushing hoses, which would have a practical reach limit of up to 200 m going up the pipe. Access to the upstream ends (where practicable) will provide for flushing the leachate lines and launching inspection / monitoring equipment.

There is a high level of redundancy in the leachate collection system as summarised below:

- The drainage blanket is continuous over the whole floor, sides, and side slopes of the toe bund
- The slopes of the floor are high
- The capacity of the leachate collection pipes have a high factor of safety
- Each cell has its own leachate collection system, but leachate will be able to migrate from cell to cell in a westerly direction
- An overflow pipe connects each cell

A leachate drainage layer/liner protection layer on the side slopes to convey leachate to leachate collection pipes on the floor and bench areas. The methodology for installing this drainage layer is shown in Figure 4.4 below.

As noted in Section 6.1.4 it is expected that most of the leachate will be recirculated back into the landfill to assist with compaction of the waste and dust control.

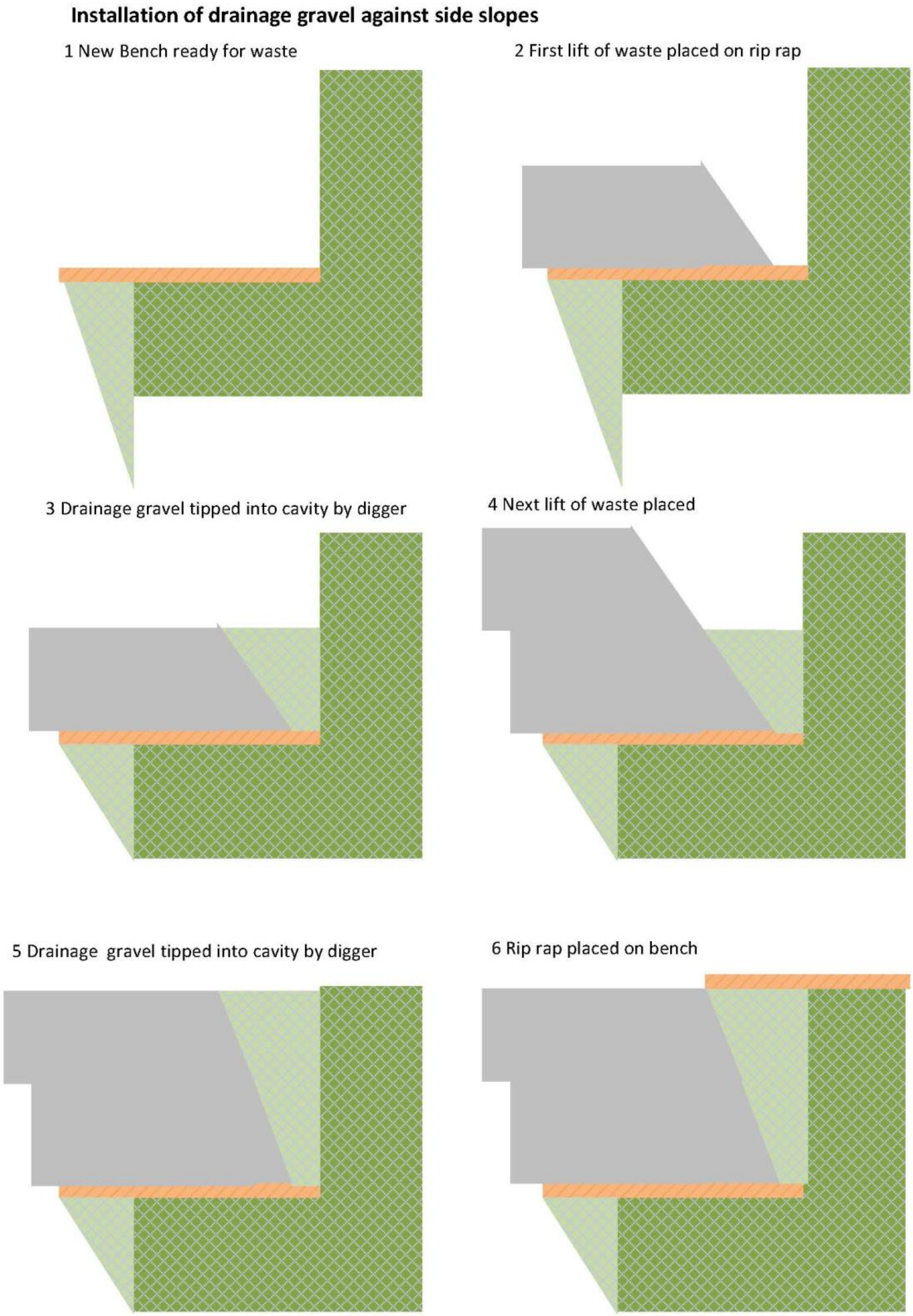


Figure 4.4 Installation of drainage gravel against side slopes

4.7.2 Landfill stormwater systems

The stormwater collection and conveyance system at the landfill is based on:

- Open channel stormwater drains will be provided above the landfill to prevent stormwater from entering the active quarry and landfill activities. These will direct water to the existing flow paths on the west and east sides of the landfill.
- Open channel stormwater drains will be provided to the west of the landfill to prevent stormwater from entering the active quarry and landfill activities. These will direct water to the existing flow paths on the west side of the landfill.
- Within the operational quarry and landfill area benches will divert stormwater from active waste filling areas. These bench drains will divert stormwater to the sedimentation ponds.
- A system of temporary stormwater drains within the operational quarry area, as required to suit the stage of operation, diverting all stormwater to the landfill perimeter drain. Where required to maintain water quality temporary sedimentation ponds would be constructed. These would the drain to the perimeter drainage system.
- In the upper areas of the landfill bench drains on the final cap will discharge runoff to the perimeter road and it will flow into the existing flow paths to the west and east of the landfill site.
- In the lower areas of the landfill site permanent stormwater drains on the outside of each side of the landfill will collect runoff and direct it to the perimeter stormwater system, with all this stormwater passing through the sedimentation ponds for removal of sediment prior to discharging from the site.
- The stormwater is proposed to be discharged onto the existing slopes above the true left bank of the Woodstock Stream through a stormwater dissipater.

The preliminary assessment indicates that approximately 8 hectares of catchment would be directed into the permanent stormwater system.

Preliminary sizing of the primary sedimentation pond is that will need a capacity of approximately 2400 cubic metres. The pond will be constructed with a primary decant system that would discharge to the dissipator, as does the overflow. The ponds and decant system will provide considerable attenuation of the stormwater flows into the Woodstock Stream.

An overflow weir is proposed to be constructed on the south side of the sedimentation pond. In the event of a significant storm that resulted in an overflow of the main stormwater system an overland flow path will direct stormwater into the gully directly to the south of the sedimentation ponds. At the base of this gully a secondary sedimentation / attenuation pond would be constructed.

Sediment control ponds will be constructed downstream of the stockpile areas that are outside the primary stormwater catchment.

The general layout of proposed stormwater systems is shown on Drawing B2 in Appendix 2. Details of the perimeter drain, and sedimentation ponds are shown on Drawing C4 in Appendix 2.

As noted in the proposed conditions of consent the quality of the water in the Woodstock Stream will be monitored at the location SW01 as shown on Drawing E2 in Appendix 2.

Stormwater systems will be designed for the following events:

- Temporary systems: 20 % Annual Exceedance Probability (AEP)
- Sedimentation pond: 10% AEP
- Sedimentation pond overflow: 1% AEP
- Permanent systems: 1% AEP

The ponds, and other sediment control structures, will be designed and maintained in accordance with Environment Canterbury Erosion & Sediment Control Toolbox For Canterbury.

Where the Environment Canterbury Erosion & Sediment Control Toolbox For Canterbury does not cover a particular situation GD05 Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region will be utilised.

During the post closure the site will still be subject to meeting conditions of any remaining resource consents and will still be required to have a Management Plan that will include details of maintenance and monitoring of the stormwater systems.

6.1.2 Leachate Composition

In section 9 of Appendix 5 Engineering Report several contingent events are described, some of which may result in the discharge of leachate into the environment. An additional Hydrogeology Report, Appendix 4A of the Application, has been prepared and includes an assessment of the impact of any such discharges.

In order that Appendix 4A can assess the impact on the receiving environment it was necessary to provide an assessment of the characteristics of the leachate that are most likely to be generated at the Woodstock Landfill.

There are numerous publications of leachate characteristics from various sites, but there is also considerable variability in the reported characteristics. The composition of leachate varies significantly from landfill to landfill and varies over time due to many factors including:

- The source of the waste, particularly whether it is municipal waste or not
- The climate at the landfill site, particularly rainfall
- The waste acceptance criteria in operation, particularly in relation to heavy metals.

In order to provide a realistic, and most probable, data set for the Woodstock Landfill the leachate data sets from sites that may be relevant have been collated. The attached Table 6.1A Woodstock Landfill Leachate Composition Sources provides details of the background to the data set, a summary of the waste profile for the site, and commentary on the characteristics of the leachate at each of the sites.

The data sets have been summarised onto the attached Table 6.1B Expected Woodstock Landfill Leachate Composition. Table 6.1B includes projected Mean and 95 percentile values for the key contaminants that may impact on the environment.

Table 6.1A Woodstock Landfill Leachate Composition Data Sources

Name	Source and Background	Waste Profile	Commentary
Burwood BH7	An historical data set was provided for the application to extend the landfill in 2012. It is not clear what period the data set covered.	The Burwood Landfill has been the primary landfill for the greater Christchurch area since 1984 until its closure as the municipal landfill in 2005. In addition to being the primary municipal landfill (for residential and commercial waste) it also received large amounts of treated wood waste, contaminated soils, and sewage treatment biosolids. From 2005 until 2012 it also received large amounts of contaminated soils and biosolids for capping purposes.	BH7 is a borehole immediately downstream of the historic Burwood Landfill. BH7 is the closest monitoring bore to the historic landfill but as the landfill was not lined it is possible that the leachate at BH7 is partly diluted and there has been some attenuation of contaminant levels as it passes through the underlying strata prior to reaching the borehole.
Redvale	Three data sets of leachate collected from the Redvale (Auckland) Landfill were provided as part of the 2019 Application for the proposed Auckland Regional Landfill at Riverhead. The data set is reported as starting in the late 1990's until 2018.	Redvale has been the largest landfill in the Auckland Region since 1992. In addition to receiving most of Auckland's municipal waste it has received very large quantities of contaminated soils (up to 40% of total waste received) and other industrial wastes.	The leachate at Redvale is collected at three points around the perimeter of the landfill. While this landfill is not lined the underlying mudstone strata is of extremely low permeability. There is a comprehensive leachate collection and removal system with the leachate being disposed of in a leachate evaporator. The quality of this data set is likely to be good. The characteristics of the leachate at Redvale will be significantly affected by the large quantities of green waste and food waste, and the high rainfall of approximately 1500mm per year. This will result with very fast degradation of the waste in an acidic environment resulting in very high Ammoniacal N concentrations.
WasteMINZ Class 2	This data set is included in the 2018 WasteMINZ Guideline and reported as being from 2 Waikato sites from 2007 to 2012, and from C&D Landfill (USA)	The WasteMINZ Guideline reports that the Waikato waste is at consented and lined sites that accepted C&D waste proposed for Class 2 landfills. There is no detail of the waste characteristics from the C&D (USA) study by Melendez.	The quality of the data from this source is suspect and it may be that some has been reported in mg/l and some reported in ug/l. It is noted that the data set attributed to Melendez (1996) noted below reports some data as being in mg/l whereas the original report quotes concentration in ug/l.
Fairfield	This data set is an historical record of leachate composition reported from twice yearly sampling of leachate reported to the Otago Regional Council in the site's Annual Report. The record runs from the year 2000 to 2015. This landfill is now closed.	The waste disposed at this site was a mixture of municipal waste from private collectors (with the majority of the municipal waste going to the Dunedin CC Green Island Landfill), commercial wastes, demolition waste, and some contaminated soils.	The leachate collection system encloses the whole site and while the site is not lined the basegrade is of very low permeability marine sediments. The quality of the data is very high. The rainfall at this site is approximately 800mm per year. The characteristics of the leachate from this site are likely to be the closest to that which could be expected at Woodstock Landfill.
C&D USA	This data set is summarised from a 1996 paper by Melendez, that analysed leachate data from 20 C&D sites in the USA. Not all sites measured all parameters but on average most parameters were measured at 10 to 12 sites.	The report notes that while the C&D sites primarily receive C&D waste there were often large quantities of grass and other vegetation. The report notes that many of the sites receive quantities of contaminated soils, and that the waste acceptance processes varied considerably from state to state.	The quality of this data set is generally good as it comes from many sites. However, the variability in waste acceptance could result in some landfills being more like municipal landfills.

Note: Leachate composition for the Kate Valley Landfill at Waipara is not publicly available as it is not required to be reported to Environment Canterbury as a condition of consent.

Table 6.1B **Expected Woodstock Landfill Leachate Characteristics**

Data source	Burwood BH7		Redvale		WasteMINZ Class 2		Fairfield		C&D USA (Melendez)		Adopted for Assessment	
Determinand	**Lower**	**Upper**	**Mean**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Mean**	**95 percentile**
pH					5.9	8.3	7.3	7.5	6.45	7.6		
COD												
BOD_5				150	1.4	38			5.7	920		
Ammoniacal-N	127	195	700	1300	0.86	99	290	340	140	480	150	350
Chloride					0.3	28			2.65	2.65		
Suspended solids												
BOD_{20}												
TOC					55	191			15	2100		
Fatty acids (as C)												
Alkalinity (as $CaCO_3$)					70	1930			38.2	6250		
Conductivity (µS/cm)					120	554						
Nitrate-N												
Nitrite-N												
Sulphate (as SO_4)					360	1900			11.7	1700	500	1900
Phosphate (as P)												
Sodium							1150	1900	773	1290		
Magnesium							180	350				
Potassium												
Calcium												
Aluminium											2	5
Chromium	0.0016	0.0153	0.452	1.4	0.027	0.64			0.0014	0.046	0.02	0.05
Manganese									0.076	0.258	20	20
Iron					0.0023	0.3	22	235	0.275	5.2		
Nickel	0.0023	0.0069							0.12	0.17	0.1	0.17
Copper					0.001	0.102			0.04	0.21	0.05	0.2
Zinc	0.0042	0.019			0.0025	5.5	0.13	0.27	0.049	1.5	0.1	1.5
Cadmium			0.0024	0.01					0.005	0.025	0.01	0.025
Lead			0.0248	0.28	0.001	103	0.03	0.1	0.04	0.8	0.05	0.3
Arsenic	0.029	0.18	0.1653	0.34	18	200			0.015	0.04	0.15	0.35
Mercury			0.0005	0.01					0.005	0.009	0.005	0.01
PCP												

Key Parameters for assessment

7 Ancillary Works

7.1 Bin Exchange Area and Weighbridge

7.1.4 Design(this Addendum is additional to the existing Section 7.1.4)

A preliminary concept plan for the proposed Container Transfer, which includes the bin exchange area, and the weighbridge is shown on Drawing F1 of Appendix 2 Drawings Issue 2 (Attachment 7).

7.2 Site Roading

7.2.1 Access roading

7.2.1.1 Description (this Addendum replaces the existing Section 7.1.4)

The access to the site and the location of the various access routes around the site are shown on Drawing F2 of Appendix 2 Drawings Issue 2 (Attachment 7). The labels on the drawing correspond to the headings used below.

Trig Road Intersection.

The existing entry where vehicles enter the site off Trig Road was installed under previous consents and has operated safely. The entrance has excellent visibility of over 400 metres to the west and approximately 50 metres to the east where Trig Road effectively ends with 90-degree bends to the left and to right into farm tracks. The gate at this access point is kept locked when there are no staff at the quarry or landfill.

The Applicant has offered a Condition of Consent to upgrade the Trig Road intersection to comply with WDC Standard Drawing 218.

Access Road (Right of Way)

The main access to the site is via the existing right of way off Trig Road. The section of accessway from Trig Road to the Container Transfer / Site Facilities Area, is approximately 1.6km long and can only be used by customers of the site, service workers and staff. Signage will clearly advise that the road is not open to the public. This section of road will be used by the following vehicles:

- Truck and trailers hauling quarry products from the site
- Truck and tailers hauling waste to the site
- Contractors service vehicles
- Staff vehicles
- Fuel delivery trucks

The right of way terminates at the physical entry point of the main Woodstock Quarries site. As noted in the AEE for this Application it is expected that the peak traffic generation would just over 200 vehicles per day. It is proposed that this right of way be upgraded to have a minimum carriageway width of 6.0 metres.

Site Roads.

The roads beyond the Container Transfer / Site Facilities Area will only be used by WQL staff, approved quarry customers, contractors that service on site vehicles and plant, the occasional fuel delivery truck, and specialist landfill construction contractors. All users of these roads will be fully inducted.

This section of road will be used by the following vehicles:

- Specialist off road trucks hauling quarry products to the Container Transfer Area.
- Specialist off road trucks hauling waste from the Container Transfer Area to the active landfill face.

- Approved quarry customers truck and trailer accessing the lower pit stockpile area
- Contractors service vehicles
- Company 4WD vehicles
- Fuel delivery trucks

All the Site Roads will be designed, and maintained, in accordance with Section 5 Planning for Roads and Vehicle Operating Areas of the Worksafe Good Practice Guideline Health and Safety at Opencast Mines, Alluvial Mines and Quarries.

In addition, WQL will be required to modify, and maintain, a Traffic Management Plan (TMP) that complies with the Health and Safety at Work Act 2015. This TMP is required to protect workers and visitors to the site and will be continually modified as the site is developed. The Applicant has offered a Condition of Consent requiring Site Roads to be constructed and maintained to this standard.

The gravel road will operate on a one-way system as shown on Drawing B2 in Appendix 2 Drawings Issue 2 (Attachment 7). This provides for safety and efficiency of access for all vehicles on this primary access route onto the landfill site. The design objective is for the grade not to exceed 8 % to be suitable for hauling full waste vehicles up- hill.

7.4.2 Dust Suppression and road washing (this Addendum replaces the existing Section 7.4.2)

The recirculated leachate will be the primary method of dust control in the active landfill area. The leachate is sprayed over the surface using a large droplet irrigation system. The irrigation of the active landfill area is crucial to ensure that the waste is well compacted. Moisture sensors are connected to the irrigation controller to ensure there is not excessive irrigation.

Water for additional dust suppression on the roads and wheel wash will be sourced primarily from the sedimentation ponds on site. The water for dust suppression will be pumped into a large water cart. This is expected to use approximately 10 cubic metres of water per day.

The only area where road washing is envisaged is at the Container Transfer Area. This may require washing a few times a year, mainly in the summer.

7.4.3 Firefighting water supply (this Addendum replaces the existing Section 7.4.3)

The primary firefighting resource will be the large on-site water cart equipped with a spray pump system. This will be able to access most areas of the site, and be able to quickly respond to a fire, whether it be in the landfill or on adjacent land. The water cart will be always kept full of water.

It is proposed to install approximately five 25 cubic metre water tanks on the hill above the landfill that will be kept full for firefighting. A 100mm gravity water main, with fire hydrants at key locations, will be installed on the eastern perimeter road. A small water pump and rising main will fill these tanks when the sedimentation pond has live storage in it.

Any additional water required for firefighting will be drawn from the sedimentation ponds. They would also be available for filling monsoon buckets carried by helicopters.

The dead water capacity of the proposed sedimentation pond is approximately 700 cubic metres.

Additional sources may be available from the Woodstock Stream. These sources could be used in emergencies to fill water tankers for fire-fighting purposes.

7.5 Wastewater (this Addendum is additional to the existing Section 7.5)

At the Container Transfer Area, a three-stage oil separator will be installed at the outlet of the stormwater collection system.

At the facilities workshop a three-stage oil separator will be installed at the outlet of the stormwater collection system.

7.7 Fuel, Oil and Other Hazardous Substances (New Section)

The current quarry operation has the following hazardous substances on the site, all of which are stored in approved facilities. Explosives are not kept on site.

- 10,000 litre double skinned self-contained fuel tank
- 5,000 litre double skinned self-contained fuel tank
- 1,500 litre mobile diesel tank
- Dangerous goods container for storing lubricants

For the combined quarry / landfill operation proposed under the Application the additional hazardous substances are likely to be added.

- 5,000 litre double skinned self-contained fuel tank at the Facilities area
- Dangerous goods container for storing lubricants at the Facilities area
- Certified explosive magazine at the upper quarry area

The location of these existing and potential hazardous substances is shown on Drawing A5 in Appendix 2 Drawings Issue 2 (Attachment 7).

9.3 Earthquake (this Addendum is additional to the existing Section 9.3)

The USA EPA Seismic Design Guide provides a particularly good summary of the potential failure modes that could occur at a landfill under seismic forces and are depicted in Figure 9.1 below.

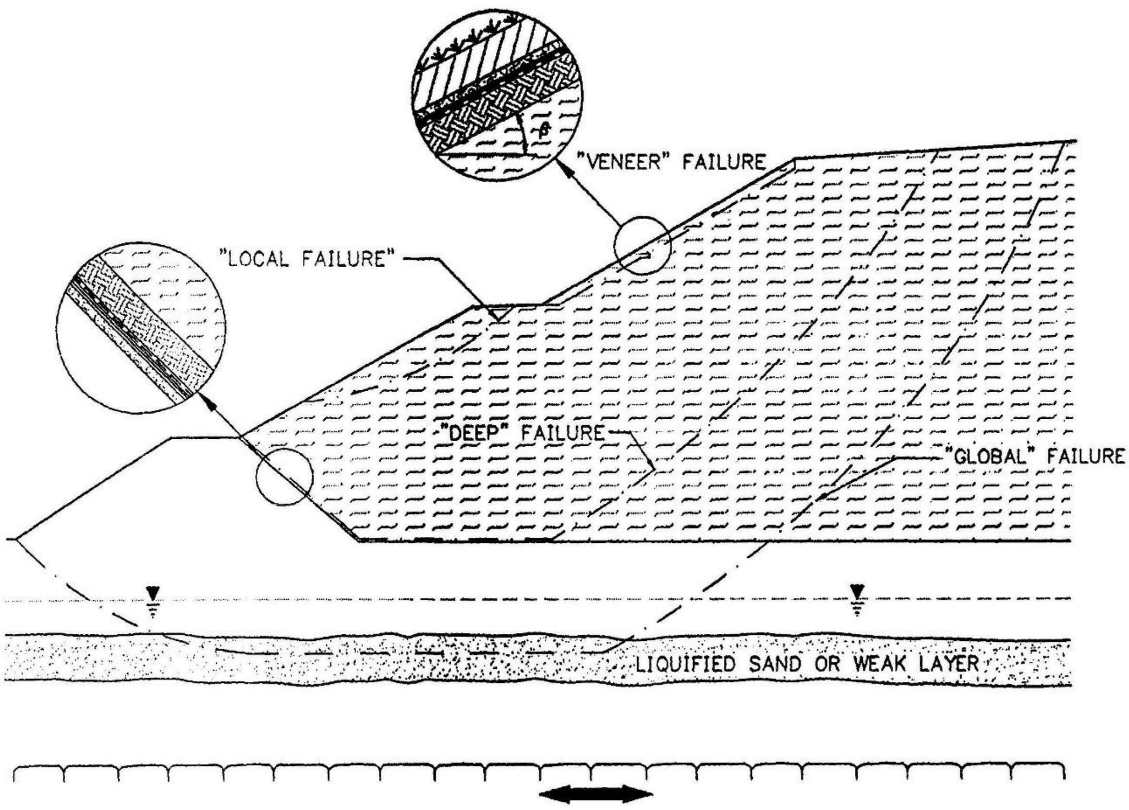


Figure 9.1: Potential Failure Modes of Landfills Subject to Seismic Forces

A description of these various failure modes could affect the Woodstock Landfill, the vulnerability to each mode, the potential consequences of failure, and the likelihood of the failure mode occurring are summarised in Table 9.1 below.

Table 9.1 Potential Failure Modes for Woodstock Landfill

Failure Mode	Vulnerability	Potential Consequences	Likelihood
Global	This type of failure is always due to an undetected weak layer, or layers that are susceptible to liquefaction. At Woodstock Landfill there is a dense, high strength layer of rock	Minor lateral movement of the full site	Very Low
Deep	A Deep failure, or lateral movement, could occur to the toe bund, and or waste pile. However, C&D waste is inherently strong due to the "reinforcing" effect of timber in the waste stream, and many of the soils are good granular fill.	Failure, or lateral movement, of a section of the toe bund. Failure of part of the waste pile, especially the working face.	Low
Local	A local failure is one that can occur with fresh waste that has not been compacted properly or is very wet.	Minor slips of the front face of the waste pile.	Low

Failure Mode	Vulnerability	Potential Consequences	Likelihood
Veneer	Veneer failure can occur when the capping layers are fresh, or there is a build-up of water under the capping. At Woodstock much of the landfill capping material has good drainage properties and there is a significant surplus of soils to ensure that the cap is thick.	Minor slips of the front face of the waste pile.	Medium

Following the 1994 North Ridge earthquake in California several researchers investigated failures of landfill liner systems. In almost all cases the failure of the HDPE liner occurred in the following locations:

- At the top of a slope adjacent to an anchor trench
- Along a longitudinal join of the HDPE liner, especially on side slopes
- Close to a defect in the liner, such as a scratch.

Of these failure modes the deep failure is of the most relevant to the Woodstock Landfill and could result in a failure of part of the toe bund. This failure is most likely to be over a short length of, say, 3 to 5 metres, and could result in a localised failure of the liner on the toe bund, probably along a longitudinal join. This type of failure would be obvious and the work force on site would be able to respond and repair the failure quite promptly. There could be a short-term localised release of leachate that flows into the perimeter drain, and down into the sedimentation ponds.

A deep failure could also manifest itself with a series of smaller displacements of the toe bund, which could lead to a series of small failures of the liner over a longer length. These too are most likely to be short failures along a longitudinal join at 6 to 8m spacings, depending on the width of the HDPE rolls used for the construction. There could be a slower release of leachate, albeit over a longer length, through the toe bund, which flows into the perimeter drain, and down into the sedimentation ponds. Such a failure would appear as a seep due to low head of leachate behind the toe bund. This failure may not be immediately obvious, and could occur over a few days before being identified, or triggering an alarm of the environmental monitoring system.