RILEY CONSULTANTS BC120108

Engineers and Geologists

KAKARA RESERVOIR
DAM DESIGN REPORT

Report prepared for: Kakara Estate Ltd

Report prepared by: Titus Smith, Civil Engineer, CPEng

Report reviewed by: Don Tate, Director, CPEng

P.P.

Report Reference: 08822-E

Date: 25 November 2011

Copies to: Kakara Estate Ltd 1 copy

Riley Consultants Ltd 1 copy

Revision	Details	Date
1.0	Design Report	25 November 2011

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Land Development • Hydro & Water • Infrastructure • Forensic

BC120108

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KAKARA RESERVOIR
DAM DESIGN REPORT

1.0 Introduction

This report sets out design standards and criteria for the Kakara water storage reservoir at "Kintyre" Hillersden.

A version of this water storage reservoir has previously been granted Building Consent by the Marlborough District Council (refer to consent number BC091210). Due to a reduction in the area requiring irrigation, the volume of water stored has been reduced from 150,000 m^3 to 75,000 m^3. The dam design features presented in RILEY report 08822-C (22 July 2009) in the original Building Consent application have not changed other than minor reductions in dam breach and spill flows. All drawings have been updated to reflect these changes.

This report should be read in conjunction with:

Design Drawings – 08822-1 to 08822-9

Construction Specification

1.1 Overview

The proposed dam will comprise an earthfill embankment retaining a reservoir with 10 m water depth. The crest length of the dam will be approximately 520 m, set at an elevation of RL216.5 m. Full supply level (FSL) for the reservoir is set at RL 215.5 m, giving total water storage of around 75,000 m^3 for a dam earthfill volume of around 40,000 m^3.

An emergency spillway is provided with an outlet invert level set at RL215.5 m to control the maximum reservoir level under normal and flooding circumstances.

The reservoir floor and walls will be lined with an HDPE membrane liner that will extend to the crest level of the dam. A drainage system will be constructed beneath the HDPE liner to control groundwater pressures and to collect any seepage through the liner.

2.0 Design Standards and NZSOLD Potential Impact Category

The New Zealand Dam Safety Guidelines (NZSOLD 2000) outline typical design criteria based on the Potential Impact Classification (PIC) of a dam or water retaining structure (Ref 1). The classifications are related to the potential consequences of a dam breach, primarily related to potential for loss of life, and financial, social and environmental impacts.

The proposed Building (Dam Safety) Regulations 2008 were due to come into force on 1 July 2010. These have been replaced by the Building (Dam Safety) Amendment Regulations 2010. These regulations will now come into effect on 1 July 2012 with the process deferred until this date. These regulations define three dam classifications (High, Medium, Low) based on the consequences of dam failure. The main factors in the classification include:

1. Population at risk (PAR).
2. Potential damage to residential houses, critical infrastructure and time to restore to operation.
3. Effects on natural environment and community recovery time.

This methodology is slightly different to that presently used in the NZSOLD Guidelines, although an addendum is being developed at present aligning the NZSOLD Guidelines to the Dam Safety Regulations. Thus, the method in the Regulations is the appropriate method to use for this project.

Dam Break Assessment

Estimation of dam breach flows can be completed using empirical formulae developed from review of previous dam failures. One such method is that of Froehlich (Ref 2). This method gives a peak breach flow of up to 290 m^3/s, which approximately corresponds to the entire (full) reservoir emptying over 14 minutes.

The location of the reservoir in relation to roads, infrastructure and the nearby Wairau River is indicated on drawing 08822-01. In the unlikely event of a dam breach resulting in uncontrolled discharge of the reservoir, the breach flow will travel to the north/east before entering the Wairau River 0.5 to 1 km distant. The terrain between the reservoir location and the river is a gently sloping (approximately 1V:160H) historic natural flood berm of the Wairau River, which is being planted with grape vines.

The flow from a dam breach event would be anticipated to spread out over the gently sloping flood berm, and at a distance of 70 m from the reservoir, to be around 70 m wide. The peak flow depth and velocity at 70 m is from the embankment estimated at 1.5 m and 2.8 m/s respectively, while at the edge of the property (Wairau River) this would be expected to reduce to around 0.4 m depth and 1.5 m/s velocity

High voltage power lines running up the Wairau Valley pass within the dam breach inundation area, as near as 70 m downstream of the embankment. The lines are suspended by substantial double concrete power poles. It is considered unlikely that the poles would be knocked over or undermined by scour by the anticipated breach flow/duration, even in the event that a dam breach flows impacted directly on them. Damage is possible however, and in terms of the Building Act damage classification, the relevant damage levels is assessed to be “minimal” to “moderate”.

A building indicated on drawing 08822-01 northeast of the reservoir has been removed, and it is considered that the population at risk in terms of the Building Act is zero.

The proposed structure is considered to be a Low PIC structure in terms of the Building Act. Therefore, the design parameters selected for the dam are based on a low PIC dam. The design standards adopted are listed in Table 2.1.

Table 2.1: Design standards

Component	Design Standard	Method(s) of Analysis
Geological investigation	Determine foundation conditions.	Geological mapping, test pitting and hand augering, grading, Atterberg's limits and compaction tests.
Dam batter stability	FOS for steady state at FSL > 1.5.	Static assessment.
Seismicity	Withstand Operating Basis Earthquake (OBE) without yielding or significant damage (1:150yr event). and Withstand Maximum Design Earthquake (MDE) without breach of the dam (damage is acceptable since dam is LPI category, 1:475 yr event).	Pseudo-static analysis for OBE Fell damage indices for OBE and MDE.
Internal stability	Prevention of potential piping mechanisms via provision of an HDPE liner and a drainage system.	Critical filter and drainage design as per USDA-SCS (1994) method modified by Foster and Fell (1999).
Spillway capacity	To pass a 1 in 100 year ARI flood event with 300 mm freeboard.	Simplified hydrological catchment analysis

3.0 Hydrology and Spillways

The spillway has been assessed for the 1 in 100 year Annual Return Interval (ARI) event. Given the low PIC status of the reservoir this is within range of the NZSOLD guidelines.

The Kakara reservoir has a crest level above the level of the surrounding river terraces and does not have a contributing catchment. The contributing area to rainfall inflow is the 1.6 ha reservoir itself. The reservoir will be predominantly at risk to short intense summer storms. The Rational Method has been used with HIRDS rainfall data to estimate the 1 in 100 year ARI peak flow. This has been estimated at 330 l/s with a Time of Concentration of 10 minutes, with an additional inflow from the inlet to the reservoir of up to 100 l/s. A nominal 3 m wide emergency spillway is provided, which provides in excess of 2000 l/s spill capacity.

The spillway will be constructed through the cut-slope of the dam abutment. Flow from the spillway will be discharged to an unused river terrace to the west of the reservoir. The frequency of the spillway discharging is anticipated to be very low.

4.0 Dam Design

4.1 Geological Setting

Generally, the dam site is underlain by alluvial gravel and local sand and silt deposits. The gravels generally comprise predominantly rounded coarse to very coarse greywacke gravel.

Four exploratory trench excavation test pits were undertaken in the dam area on the former Wairau river terrace slopes and four small test pits at the bottom of the lower terrace slope. The general geology of the dam and reservoir area based on test pitting results is:

1. SILT with some gravel and clay (topsoil).

Table 4.1: Summary of laboratory test data

Sample	Material	Silt Content	Clay Content	In situ MC	OMC	Max DD	Air Voids% at OMC
TP1 @ 1.5m	Gravel	3	-	4.1	5.5	2.27	2.7
TP5 @ 1.5m	Gravel	3	-	3.9	7.0	2.23	1.5

The earth fill material is a silty gravel material as seen in the grading shown in Figure 4.2.

Standard compaction test results for the gravel indicate in situ moisture content is slightly below the optimum by up to 3.1%. The maximum dry density was achieved at between 1.5 – 2.7% air voids. Compaction quality control testing of the dam earthfill will be carried out on regular basis during the fill operation.

The lining of the embankment should ensure that the floor will remain dry with any leak through the liner being picked up in the perimeter drainage network in the reservoir.

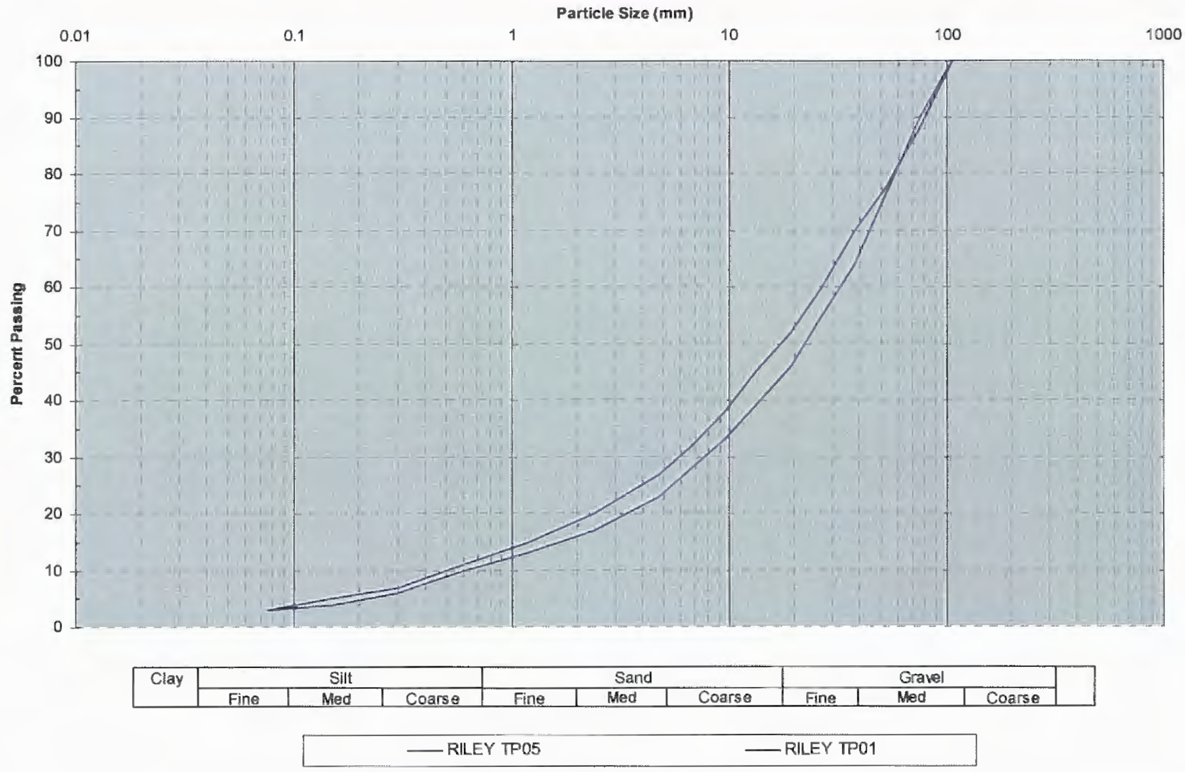

Figure 4.1: Dam earthfill gradings

Drainage Material 1 – Pipe Surround and Toe Drain

Filter compatibility had been checked for the interface between the drainage material for the cut-off and toe drains, the gravel earthfill, and the silt lenses found in the dam foundations. Filter/drainage material grading has been determined as per the USDA-SCS (1994) method modified by Fell el at (Ref 3). This method incorporates limitations to the design filter/drainage gradings to ensure adequate:

- filtration
- permeability
- internal stability of filter

- protection against segregation during placement.

The dam fill material is a silty gravel or type 3 to 4A material (i.e. up to 35% fines after re-grading). The silt lenses in the dam foundation are a Type 2A material (i.e. up to 85% fines) and require a relatively fine filter (D_{15} of less than 0.7 mm). A suitable drainage material compatible with both the gravel and the silt lenses is selected as shown below and in Figure 4.3.

Particle Size (mm)	Percent Passing (%)
20	100
9.5	78 – 100
4.75	68 – 100
2	53 – 90
1.18	38 – 75
0.6	20 – 55
0.3	0 – 37
0.15	0 – 17
0.075	0 – 2

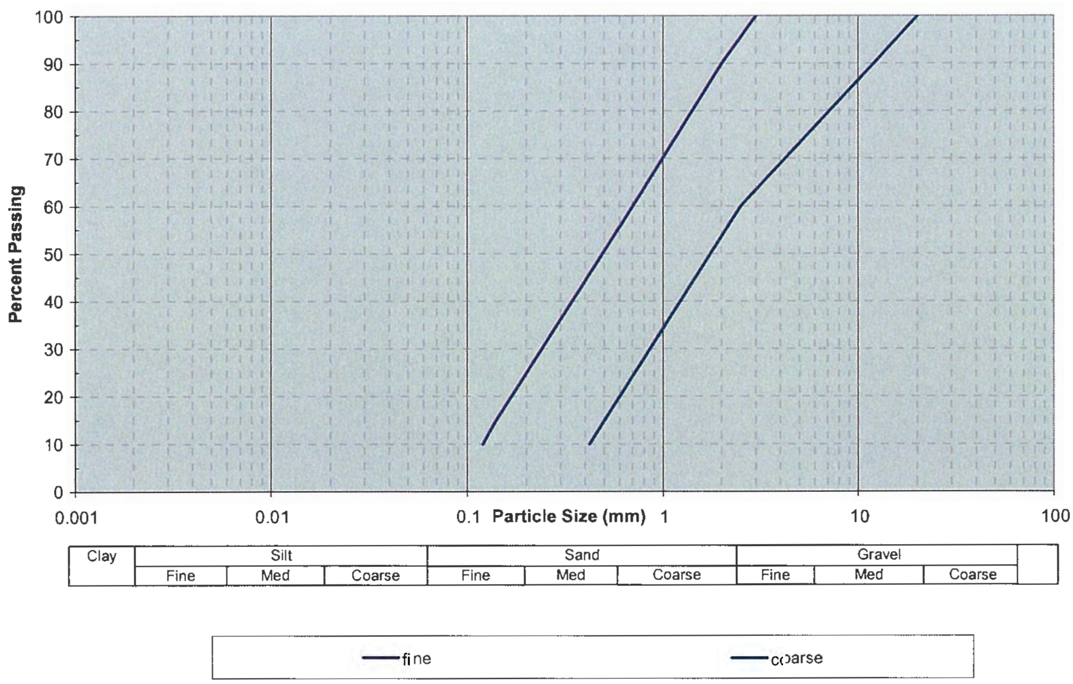

Figure 4.3: Plot of filter drainage envelopes

4.4.2 HDPE Liner

1.5 mm thick HDPE sheets will be used for the reservoir liner. Installation specification and testing shall be as per the liner product requirements.

4.4.3 Seepage

Groundwater was encountered at depth during the investigations in five pits and consisted of a moderate seep. Groundwater levels will fluctuate seasonally and are expected to be higher during wetter periods. A drainage system is proposed beneath the HDPE liner to intercept any groundwater flow, and prevent buoyancy pressures developing on the base of the liner.

Due allowance for dewatering of the reservoir excavation should be made during construction, as groundwater seepage from cut faces is likely to occur.

4.4.4 Outlet Works

An outlet pipe is required to allow discharge of 140 m^3/hr (39 l/s). A 250 mm PE pipe encased in bedding material has been provided (refer Dwg: 08822-4). The bedding material will meet the filter requirements as outlined above. A water stop and drainage detail at the reservoir outlet pipe will address the potential for leakage at this location (refer Dwg: 08822-8).

4.4.5 Seepage Control and Filter Design

The general layout of the embankment and drainage is shown in on Dwgs: 08822-1, 3 and 4. Filter diaphragms are specified surrounding the conduits in accordance with good practice. Compatibility of the filter and embankment materials have been assessed as stable.

4.5 Slope Stability and Seismic Resistance

4.5.1 General

The dam earthfill will be constructed at 1V:2H on the upstream side and 1V:2H on the downstream side. The stability of the dam slopes has been checked by a slope stability analysis.

Stability analyses for both static and seismic load cases have been carried out. As outlined in various references and observations of dam performance in severe seismic events, earthquake resistance should rely on defensive design measures in addition to analytical predications. Accordingly, we have assessed seismic resistance by both conventional analytical means and published predictors of earthquake damage based on observed performance (Pells and Fell 2003, refer Fell et al [Ref 3]) and also features of the dam design.

Liquefaction potential has been assessed for fill and foundation materials, and this is not considered to be an issue at this site.

4.5.2 Seismic Design Parameters

The seismic design parameters were estimated in accordance with the publication Probabilistic Seismic Hazard Assessment of New Zealand (Ref 4). These parameters are summarised in Table 4.3 below.

Table 4.3 Seismic Design Parameters

Design Level	Annual Probability of Exceedance	Peak Ground Acceleration
OBE	(1:150 year)	0.30g
MDE	(1:475 year)	0.45g

4.5.3 Stability Analyses

The parameters assumed for the stability analyses are shown in Table 4.4 below. These parameters are based on correlations with results of in situ and laboratory tests carried out during the geotechnical investigation at this site.

Table 4.4: Material effective strength parameters

Material	Model	Density γ (kN/m^3)	Cohesion C' (kPa)	Friction Angle ϕ' (deg)
Gravel earthfill	Mohr-Coulomb	20	1	35

Stability analyses were carried out by the SLIDE package. The FoS obtained for the design slopes (1:2 downstream, 1:2 upstream) are summarised in Table 4.5.

Table 4.5: Factors of safety for slope stability

Load Case	Minimum FoS Silty-gravel	Required Factor of Safety (NZSOLD)
Static (downstream)	1.69	1.5
Saturated embankment – complete liner failure	1.25	1.0
OBE (downstream)	1.0	1.2

The OBE was analysed using the US Army Corp of Engineers (1984) method as outlined in the ANCOLD Guidelines (Ref 5) as a useful screening tool for low hazard dams not susceptible to liquefaction. The results indicate that acceptable FoS exist for all load cases by the criteria except for the OBE seismic event, which is discussed further in the following section.

4.5.4 Seismic Resistance

Pseudo-static analysis of the embankment under the OBE PGA gives a factor of safety of 1.0, indicating that significant deformation to the embankment under this scenario is unlikely. While the NZSOLD Guidelines allows for the use of pseudo-static methods for seismic stability analysis of low hazard embankments, the approach does not accurately represent the stresses imposed on the embankment or the expected modes of failure. It should qualitatively be understood that momentary yield of the earth dam is likely under an OBE due to amplification of ground accelerations however rapid reversal of loading does not allow yielding to result in significant deformation. As the embankment will be constructed of well compacted, dilatant materials with good residual strength characteristics and suitable internal filtration detailing to mitigate cracking related problems, serviceability of the structure is not compromised.

A detailed seismic deformation analysis has not been undertaken for the structure under OBE or MDE loading due to its small scale. The toe drain provides some defense to prevent piping due to seismic or deflection induced cracking. The dam will constitute a compacted gravel silt mix that is expected to retain high strength following seismic induced yield.

A deformation analysis was carried out using the empirical method outlined in Fell et al (Ref 3) to estimate the damage likely in the OBE and MDE events. These analyses indicate minor lateral deformation on the highest dam section may occur at an extreme event seismic event (MDE). The results are summarised in Table 4.6.

Table 4.6: Seismic deformations

Design Case	Damage Description	Damage Class	Maximum Longitudinal Crack (mm)	Maximum Relative Crest Settlement (mm)
OBE	Minor	1	10	8
MDE	Moderate-Major	2-3	60	47

Based on the above this approach we consider that the seismic resistance of the dam meets accepted safety standards for a low potential impact dam. For the OBE event minor damage is likely. For the MDE event moderate damage is possible, however maximum crest settlement of 47 mm is much less than the available freeboard of 1 m at maximum water level.

A potential issue is the rupture of the liner during an MDE event. Slope stability is maintained for even a saturated embankment, allowing scope for a liner repair. The outlet penetration area and outlet/drainage pipes, which often represent a point of weakness for seepage resulting from seismic or settlement effects, is protected by a full-length filter drain surround and filter diaphragm.

5.0 Monitoring

RILEY considers that commissioning procedures for first filling should be implemented, including weekly visual inspections of the liner and embankment for signs of leaks through the liner. The seepage outlet draining the foundation can be separately monitored and flows should be recorded weekly for the first filling and then during subsequent routine inspections. A commissioning procedure will be produced for the filling phase.

6.0 Summary

The proposed water storage reservoir has been designed in accordance with the NZSOLD Guidelines. Below is a summary of the design considerations:

1. The dam falls into the low Potential Impact category with reference to the NZSOLD guidelines.
2. Dam batter slopes will be 1V:2H downstream and 1V:2H upstream for gravels. The dam earthfill will comprise compacted layers of locally selected gravel and silty gravels.
3. An HDPE membrane liner will be provided for lining the reservoir floor and walls and will extend to fully cover the upstream face of the dam.
4. The materials specified satisfy the filter compatibility criteria for their respective interfaces within the dam earthfill.

5. Estimated dam deformation due to an OBE and MDE seismic event are within a tolerable range, and indicate breach of the reservoir is unlikely to an accepted standard for a low potential impact dam.
6. The strength and uniformity of the dam foundation material requires verification prior to placement of fill. Weak soils will be undercut and backfilled with compacted fill. Quality of earthfill and the HDPE will be also be verified during construction.
7. Given the low potential impact status of the dam the design event for the spillway is the 1 in 100 year ARI event. An emergency spillway has been provided with a capacity significantly greater than the design flooding event.

7.0 Limitation

This report has been prepared solely for the benefit of Kakara Estate Ltd as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such parties' sole risk.

8.0 References

Ref. 1 NZSOLD, 2000. *New Zealand Dam Safety Guidelines*. New Zealand Society of Large Dams, Wellington.

Ref. 2 Froelich, D.C. (1995) *Peak Outflow from Breached Embankment Dam*. Journal of Water Resources Planning and Management, vol. 121, No 1, p. 90-97.

Ref. 3 Fell, R., P. MacGregor, D. Stapledon, and G. Bell, 2005. *Geotechnical Engineering of Dams*. Taylor and Francis Group, London.

Ref. 4 Stirling, M., *et al*, 2000. *Probabilistic Seismic Hazard Assessment of New Zealand: New Active Fault Seismicity Data Attenuation Relationships and Methods.* Institute of Geological & Nuclear Sciences Report 2000/53.

Ref. 5 ANCOLD, 1998. *Guidelines for Design of Dams for Earthquake.*

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APPENDIX A

Lab Test Results

Marlborough District Council
Date Received: 16/02/2012

BC120108

Nelson Laboratory
121 Bolt Road, Nelson
Private Bag 1, Nelson 7030
Telephone: +64 3 547 8568
0800 LABORATORY
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Fulton Hogan

Report No: MDD:NSN08S-0329
Issue No: 1

Maximum Dry Density Report

Client: Claudia Kaiser
Riley Consultants Limited
P O Box 100253
North Shore City

Auckland 0745
NZ

Project: QA Testing

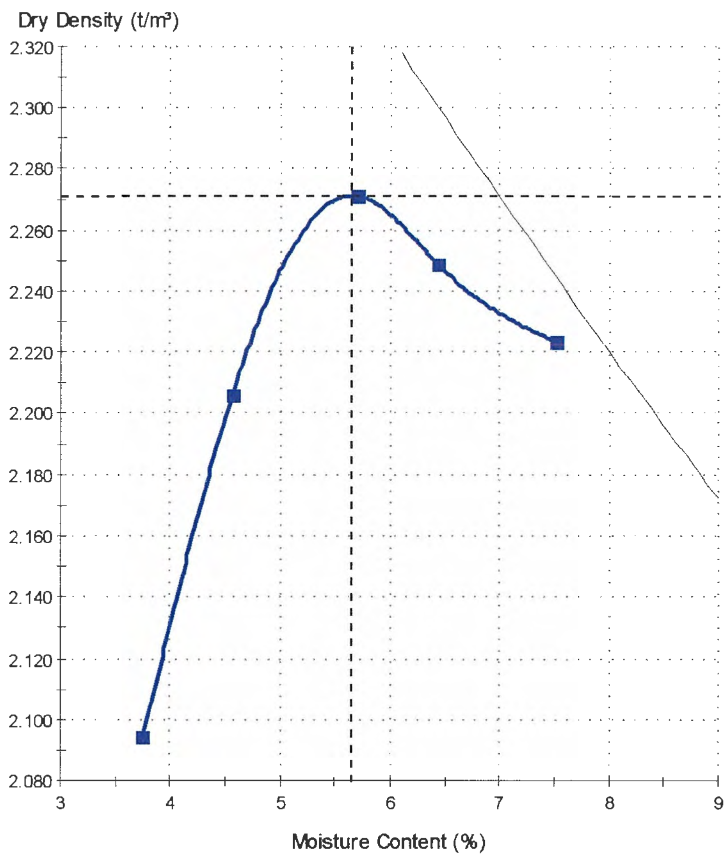
The test (s) reported herein (unless indicated) have been performed in accordance with the laboratory's scope of accreditation. Results only apply to samples as received. This report must be reproduced in full.

Approved Signatory: Alan Prescott
(Lab Manager)
Accreditation No:684
Date of Issue: 13/10/08

Sample Details

Sample ID:	NSN08S-0329	**Date Sampled:**	23/09/08
Sampling Method:	As Received - Not Accredited		
Source:	Wairau Valley (SH63)	**Material:**	Coarse In-Situ Material
Specification:	No Specification		
Location:	Kintyre Test Pit 01		
Tested By:	Justin Terrill	**Date Tested:**	01/10/08

Dry Density - Moisture Relationship



Test Results

NZS 4402:1986 Test 4.1.1

Maximum Dry Density (t/m³):	**2.27**
Optimum Moisture Content (%):	**5.5**
Assumed Solid Density (t/m³):	2.700
Oversize Sieve (mm):	37.5
Oversize Material (%):	54
Sample History:	Natural

Comments

N/A

Marlborough District Council
Date Received: 16/02/2012

BC120108

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121 Bolt Road, Nelson
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Fulton Hogan

Material Test Report

Report No: MAT:NSN08S-0329
Issue No: 2
This report replaces all previous issues of report no 'MAT:NSN08S-0329'.

Client: Claudia Kaiser
Riley Consultants Limited
P O Box 100253
North Shore City

Auckland 0745
NZ

Project: QA Testing

The test (s) reported herein (unless indicated) have been performed in accordance with the laboratory's scope of accreditation. Results only apply to samples as received. This report must be reproduced in full.

new zealand accredited laboratory

Alan Prescott
Approved Signatory: Alan Prescott
(Lab Manager)
Accreditation No:684
Date of Issue: 03/10/08

Sample Details

Sample ID:	NSN08S-0329
Client Sample ID:	Kintyre TP01
Material:	Coarse In-Situ Material
Sample Source:	Wairau Valley (SH63)
Site/Sampled From:	Kintyre Test Pit 01
Date Sampled:	23/09/2008
Specification:	No Specification
Sampled By:	Alan W.
Sampling Method:	As Received - Not Accredited
Date Tested:	01/10/2008
Technician:	Justin Terrill
Sampling Endorsed:	No

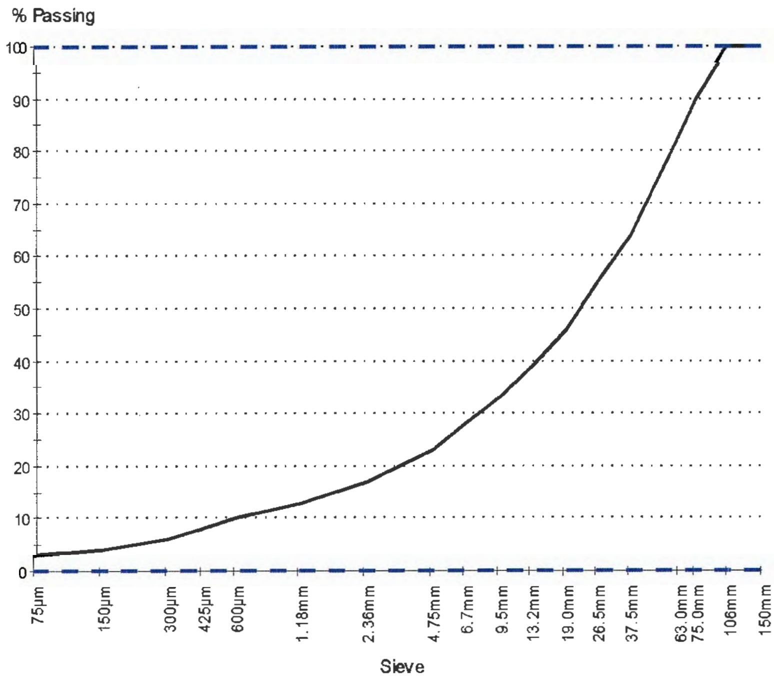
Other Test Results

Description	Method	Result	Limits
Corrected MDD (t/m³)	NZS 4402:1986 Test 4.1.1	2.27	N/A
Optimum Moisture Content (%)		5.7	N/A
Assumed Solid Density (t/m³)		2.700	N/A
Sample History		Natural	N/A
Oversize Sieve (mm)		37.5	N/A
Oversize Material (%)		54	N/A
Moisture Content (%)	NZS 4407:1991 Test 3.1	4.1	N/A

Particle Size Distribution

Method: NZS 4407:1991 Test 3.8.1
Drying by: Oven

Note: Percentage passing the finest sieve was obtained by difference.



Sieve Size	% Passing	Limits
150mm	100	0 – 100
106mm	100	0 – 100
75.0mm	90	0 – 100
63.0mm	83	0 – 100
37.5mm	64	0 – 100
26.5mm	55	0 – 100
19.0mm	46	0 – 100
13.2mm	39	0 – 100
9.5mm	33	0 – 100
6.7mm	28	0 – 100
4.75mm	23	0 – 100
2.36mm	17	0 – 100
1.18mm	13	0 – 100
600µm	10	0 – 100
425µm	8	0 – 100
300µm	6	0 – 100
150µm	4	0 – 100
75µm	3	0 – 100

Comments

N/A.

Marlborough District Council
Date Received: 16/02/2012

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Fulton Hogan

Maximum Dry Density Report

Report No: MDD:NSN08S-0331
Issue No: 1

Client: Claudia Kaiser
Riley Consultants Limited
P O Box 100253
North Shore City

Auckland 0745
NZ

Project: QA Testing

The test (s) reported herein (unless indicated) have been performed in accordance with the laboratory's scope of accreditation. Results only apply to samples as received. This report must be reproduced in full.

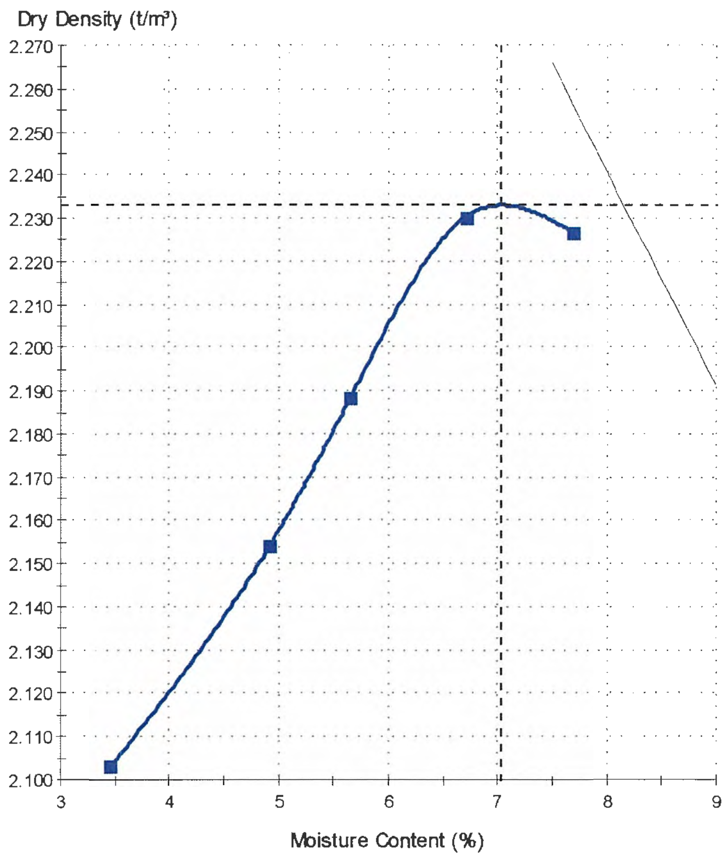
new zealand accredited laboratory

Approved Signatory: Alan Prescott
(Lab Manager)
Accreditation No:684
Date of Issue: 06/10/08

Sample Details

Sample ID:	NSN08S-0331	**Date Sampled:**	24/09/08
Sampling Method:	As Received - Not Accredited		
Source:	Wairau Valley (SH63)	**Material:**	Coarse In-Situ Material
Specification:	No Specification		
Location:	Kintyre Test Pit 05		
Tested By:	Alan Prescott	**Date Tested:**	06/10/08

Dry Density - Moisture Relationship



Test Results

NZS 4402:1986 Test 4.1.1

Maximum Dry Density (t/m³):	**2.23**
Optimum Moisture Content (%):	**7.0**
Assumed Solid Density (t/m³):	2.730
Oversize Sieve (mm):	37.5
Oversize Material (%):	30
Sample History:	Natural

Comments

N/A

Marlborough District Council
Date Received: 16/02/2012

BC120108

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Fulton Hogan

Material Test Report

Report No: MAT:NSN08S-0331
Issue No: 1

Client:	Claudia Kaiser Riley Consultants Limited P O Box 100253 North Shore City Auckland 0745 NZ
Project:	QA Testing

The test (s) reported herein (unless indicated) have been performed in accordance with the laboratory's scope of accreditation. Results only apply to samples as received. This report must be reproduced in full.

new zealand accredited laboratory

Alan Prescott
Approved Signatory: Alan Prescott
(Lab Manager)
Accreditation No:684
Date of Issue: 06/10/08

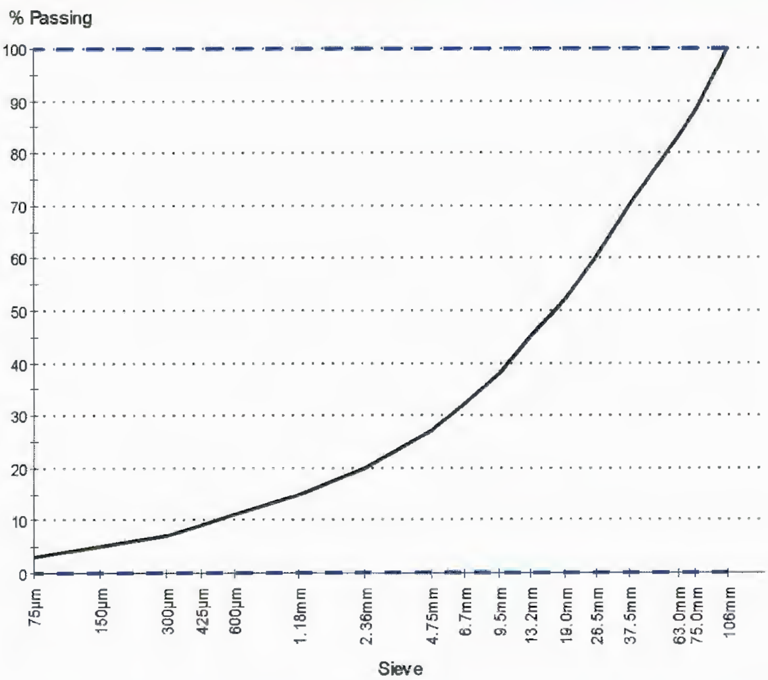
Sample Details

Sample ID:	NSN08S-0331
Client Sample ID:	Kintyre TP05
Material:	Coarse In-Situ Material
Sample Source:	Wairau Valley (SH63)
Site/Sampled From:	Kintyre Test Pit 05
Date Sampled:	24/09/2008
Specification:	No Specification
Sampled By:	Alan W.
Sampling Method:	As Received - Not Accredited
Date Tested:	06/10/2008
Technician:	Martin Black
Sampling Endorsed:	No

Other Test Results

Description	Method	Result	Limits
Moisture Content (%)	NZS 4407:1991 Test 3.1	3.9	N/A
Corrected MDD (t/m³)	NZS 4402:1986 Test 4.1.1	2.23	N/A
Optimum Moisture Content (%)		7.0	N/A
Assumed Solid Density (t/m³)		2.730	N/A
Sample History		Natural	N/A
Oversize Sieve (mm)		37.5	N/A
Oversize Material (%)		30	N/A

Particle Size Distribution



Method: NZS 4407:1991 Test 3.8.1
Drying by: Oven

Note: Percentage passing the finest sieve was obtained by difference.

Sieve Size	% Passing	Limits
106mm	100	0 – 100
75.0mm	88	0 – 100
63.0mm	83	0 – 100
37.5mm	70	0 – 100
26.5mm	60	0 – 100
19.0mm	52	0 – 100
13.2mm	45	0 – 100
9.5mm	38	0 – 100
6.7mm	32	0 – 100
4.75mm	27	0 – 100
2.36mm	20	0 – 100
1.18mm	15	0 – 100
600µm	11	0 – 100
425µm	9	0 – 100
300µm	7	0 – 100
150µm	5	0 – 100
75µm	3	0 – 100

Comments
N/A

Marlborough District Council
Date Received: 16/02/2012