RILEY CONSULTANTS

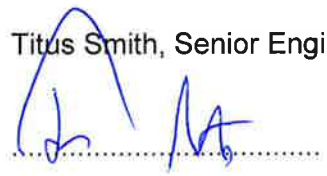
GREYMOUTH FLOOD WALL UPGRADE DESIGN GEOTECHNICAL REPORT

Engineers and Geologists

GREYMOUTH FLOOD WALL UPGRADE DESIGN
GEOTECHNICAL REPORT

Report prepared for: Good Earth Matters

Report prepared by: Titus Smith, Senior Engineer, CPEng



Report reviewed by: Don Tate, Director, CPEng

Report Reference: 09828-A

Date: 9 November 2009

Copies to: Good Earth Matters 2 copies

Riley Consultants Ltd 1 copy

Revision:	Details:	Date:
0	Report	9 November 2009

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GREYMOUTH FLOOD WALL UPGRADE DESIGN GEOTECHNICAL REPORT

1.0 Introduction

Riley Consultants Ltd (RILEY) has been engaged by Good Earth Matters to provide geotechnical input for the design of upgrading works of the flood protection system along both sides of the Grey River downstream of the rail bridge. The details of the floodwall upgrade are provided in the construction documents completed by others, the main elements of the project from a geotechnical standpoint being:

- Concrete floodwalls founded on existing stopbanks over a length of around 1500 m
- A new section of stopbank around 1 m above existing ground level and 140 m long
- A new section of stopbank around 4 m above existing ground level and 110m long
- Raising of existing stopbanks by 0.2 m to 0.7 m over a length of around 1300 m
- Minor raising/re-contouring of existing stopbanks over a length of around 2800 m.

The design standard for the upgrade is for 600 mm freeboard in a 1:50 flood, and a higher standard of 600 mm freeboard in a 1:150 flood where new floodwalls are proposed.

1.1 Scope

The overall aim of the investigation is principally to provide information to assist the overall design of the upgrade project. The desired end result is to confirm that relevant geotechnical issues have been taken into account and that the risk of failure of the various structures in terms of geotechnical failure modes is acceptably low for the adopted design standard. The geotechnical work is not a condition assessment of the existing stopbanks as such; rather confirmation is required that the proposed works do not exacerbate existing geotechnical risks for the proposed design standard. The purpose of this geotechnical report is to document the results of the investigation, and to summarise conclusions and recommendations on geotechnical aspects of the project.

2.0 Geological Setting

Published information (Ref 1) for the site indicates the existing stopbanks adjacent to the Grey River upstream of the estuary (i.e. upstream of the Goods Shed on the true left and Cobden Island on the true right) are generally underlain by river gravel, sand and silt of young river flats. Estuarine deposits are indicated around the periphery of the estuary south of the Fisherman's Wharf area, and marine gravel and sand are indicated along the river banks downstream of the estuary. Significant reclamation efforts have occurred along the banks of the river including training levees and revetments at the river mouth.

At the upstream limit of the true left stopbank, the Cobden Limestone of Peter Range is encountered. This limestone is regionally westward dipping at an angle of around 27°.

3.0 History of Flood Wall Development

From 1979 development of a flood protection scheme in Greymouth had been underway. In 1986, North Tip Road was raised, along with installation of the gated culvert at Range Creek.

Following severe flooding in 1988, a new system of stopbanks and floodwall was proposed. Construction of the new infrastructure was completed in 1991, and no significant upgrading of the scheme has been undertaken since. The nature and extent of reclamation work and stopbank construction previous to the events of 1979 have not been reviewed in detail, however it is understood that significant historical activity has occurred in the area, and variable quality fill is likely to exist beneath the current floodwall arrangement.

A series of performance and risk reviews have been undertaken since completion of the flood wall in 1991, and key relevant findings from these reports (Ref 2, 3) are summarised below.

Cobden

- A specific area of low quality historic fill within a reclaimed river channel in the area of Taylor St has been identified, and there has been an associated settlement issue
- The earth stopbank is subject to significant seepage resulting in landward-side flooding, and the majority of this flow is inferred to be via the aforementioned area of historic fill

Mawhera Quay

- Flood wall seepage area has been identified around the intersection with Boundary St, and west toward Johnston St pump station. Water pressure has been observed beneath the adjacent road pavement in this area.

4.0 Basis for Investigation

As a condition assessment of the existing stopbank is outside the scope of this report, investigation has been targeted around areas where significant stopbank raising will occur. This is to ensure that the additional floodwall height is appropriately designed and detailed so as not to negatively affect the existing stopbank stability. The key areas selected for targeted investigation generally incorporate a raise for the 1:50 AEP flood standard of more than 200 mm. Investigation has therefore been targeted at:

- Two Bridges
- Mawhera Quay
- Goods Shed
- Fisherman's Wharf
- Cobden around Range Creek Culvert

Note that the section of stopbank at Cobden around Taylor St previously identified as having deficient foundations will not be modified under the proposed works, and has not been targeted for investigation.

The scope of the investigation was derived after a walkover inspection and assessment of the key areas in terms of geotechnical risk. A draft programme of investigation was derived and agreed with WCRC.

5.0 Fieldwork and Laboratory Testing

A programme of sub-surface investigation has been undertaken, including excavation and logging of 24 test pits. Test pit locations are indicated on the drawings in appendix A, and test pit logs are included in appendix B. 4 Machine drillholes were undertaken by CW Drilling. The fieldwork was overseen by technicians or geologists from RILEY and logs are presented in terms of the New Zealand Geotechnical Society Guidelines. Initially hand augers were attempted in some locations but were abandoned at an early stage due to difficulties with gravels.

Laboratory tests have included particle size distribution on selected samples, and a standard Proctor compaction test on a sample of existing stopbank material. Results are included in appendix C.

6.0 Geotechnical Considerations and Recommendations

Observations from the investigations along with comments and recommendations for specific locations are detailed in the follow sections. In each case geotechnical failure modes are considered, these may include:

- Seepage effects and internal erosion
- Slope stability
- Settlement
- Loss of support or undermining
- Foundation instability or overstressing

All of the above failure modes may not be applicable in all locations.

6.1 Two Bridges

This area is located at the base of a large limestone bluff, adjacent to the railway line. The railway appears to have been founded on bedrock, and water flow is exiting the base of the outcrop via open defects and a large solution cavity to the river via covered drains.

To achieve the design stopbank crest level in this area, an earth fill up to 4 m above existing fill height is required. The culvert beneath the fill draining seepage flows from the bluff area is cracked and deformed and will require replacement. In addition a small bridge will be replaced by a culvert. The vertical height from the existing culvert inverts to final stopbank crest level is around 7 m.

6.1.1 Investigations and Geotechnical Model

Four test pits and two boreholes were completed in the two bridges area. Ground conditions generally comprise limestone bedrock overlain by dense river gravels 1 m to 2 m deep, overlain by soft river sediments around 1 m thick, overlain by a minimum of around 1.5 m of granular fill. SPT values in the soft river sediments are very low (as low as 0) increasing to typically in excess of 30 in the denser gravels. The fill is variable in composition and in places contained wood fragments, steel and brick inclusions. Groundwater seeps were noted near the base of the test pits, but flows were only modest. Groundwater level within the pits and boreholes was similar to the level of the adjacent river. However, during drilling of DH3 a higher water table was observed within the underlying rock. The water pressure was not artesian (i.e. stabilised below ground level) however was some meters higher than the piezometric level in the overlying alluvium. It is inferred that interconnected defects within the limestone bluff adjacent to the site provide conduits for water from the bluff, which exit at various locations including the two open drains observed on site, as well as sub-surface seepage points, and possibly higher elevation drainage points at times of heavy rainfall and high water pressures within the bluff.

A stability assessment of the proposed fill embankment slope has been completed using a two-dimensional limit equilibrium model. The assessment indicates that the presence of the soft alluvial sediment underlying the existing fill results in acceptable factors of safety under the additional loading of the proposed stopbank fill. However in the event of elevated groundwater levels within the stopbank such as may occur in the event of heavy rainfall locally resulting in seepage pressures from beneath/behind the stopbank from the limestone bluff, factors of safety approach 1 (i.e. a state of failure). Removal of the existing fill and underlying soft sediment, and founding on denser alluvial sediments was then modelled. The resulting factors of safety are around 1.7 for the normal (observed) groundwater profile, and 1.5 for a postulated adverse groundwater profile associated with high seepage rates from the underlying bluff or a rapid drawdown scenario from recession of river flood level. The results are summarised in table 1, and printouts of the stability analysis are included in appendix 4. Note that high water levels in the Grey River do not represent a critical load case for this section of stopbank on the landward side, which is well buttressed by the railway on the landward side.

Scenario	Factor of Safety
New stopbank constructed on existing sediments – normal groundwater levels	1.5
New stopbank constructed on existing sediments – high groundwater levels	1.0
New stopbank foundation excavated to dense alluvial sediment – normal groundwater levels	1.7
New stopbank foundation excavated to dense alluvial sediment – high groundwater levels	1.5

Table 1: Factors of Safety

In addition liquefaction and excessive settlement are significant risks. Liquefaction of this very loose soil is likely in even a moderate earthquake with subsequent major slumping and settlement of the fill embankment. It is therefore recommended that the existing fill and soft underlying sediments be undercut, and the stopbank fill founded on the dense underlying sediments.

6.1.2 Key Considerations

Geotechnical considerations for the area include:

1. The strength of the sand/silt in situ river sediments is low, and it is recommended that the area be undercut to allow founding of the stopbank and proposed culverts on dense materials. Some of the existing fill may be able to be re-used. The plan and depth extent of undercutting will require conformation on site.
2. Seepage flows from the bluff must be adequately drained to ensure that seepage pressures do not build up within the stopbank fill. The old culverts are scheduled for replacement, and the new culverts should be carried through to interface with the rock bluff. Detailed logging of the rock bluff should be undertaken at the time of construction, and drainage works installed for any open defects in the rock face, so that all seepage flows are collected and passed through the culverts beneath the stopbank fill. Free draining fill materials should be used up to the level of the existing railway, as the lower portion of the stopbank will not be required to retain water due to the site geometry.
3. Erosion protection of the new stopbank is required, as it forms the outside of a river bend and will be impacted by the main channel of the river during flood flows. Heavy rock protection should be allowed for the full extent of the stopbank batter.
4. The necessary sub-excavations are below the river level and groundwater inflows should be expected. Careful management of these inflows and the natural springflows are required by contractors to ensure that fill standards are not compromised. In particular contingency measures should be in place such as pumps and construction methodology to minimise the time of exposure within the lowest excavation levels.
5. The existing fill embankment where it supports the railway is relatively steep, and design concepts should aim to avoid any significant destabilising effects. It is recommended the existing fill is not undercut except for minor trimming of the face and that temporary slopes do not exceed the existing slope.

6.2 Mawhera Quay

This refers to the section of stopbank incorporating existing prefabricated concrete retaining walls that run adjacent Mawhera Qy and Richmond Qy roads. It is proposed to install a freestanding concrete wall around 0.9m high along the crest of the existing stopbank.

The design stopbank cross section is known from a drawing supplied by the WCRC (reproduced in figure 1). This incorporates a sloping, low permeability upstream core zone extending around 2.5m vertically. The core then runs horizontally into the centre of the stopbank, and ties into a “clay core” cutoff indicated to be 6m deep within founding soils. The landside batter is supported by 2 low precast concrete retaining walls. The main potential issues associated with the floodwalls are seepage along or near the interface with the underlying soils, and foundation resistance to various potential failure modes. Due to the low height of these walls settlement or bearing capacity are not likely to be issues.

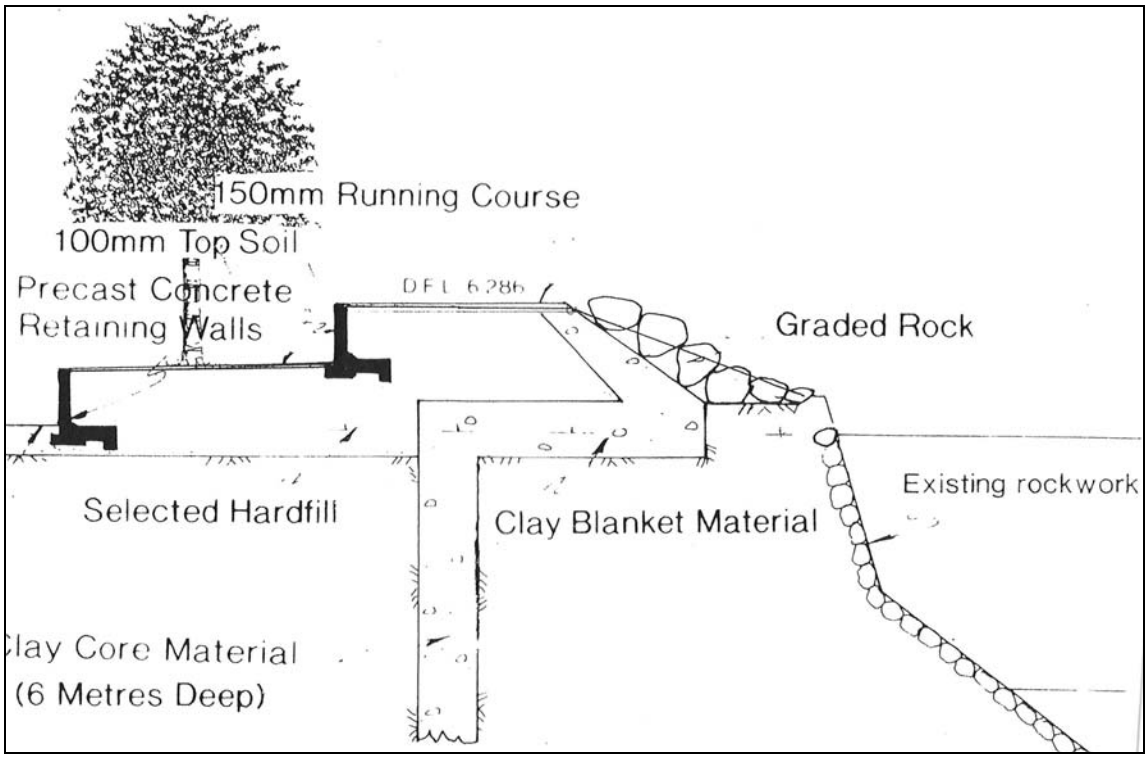


Figure 1: Original Design Section for Mawhera Quay Flood Wall

6.2.1 Investigations

Six shallow test pits and one drill hole were completed along this section of stopbank

(a) Floodwall Section

Generally the supplied design stopbank profile was confirmed by the investigation, although pits only extended to around 0.5m deep to ensure damage to the existing stopbank was minimised. Laboratory testing including 2 particle size distribution tests on each of the sloping silty gravel core and general fill zone were completed in addition to a standard compaction test on core material. Grading curves for the samples are indicated in figure 2. Laboratory testing indicates the low permeability upstream core is a silt with sand and gravel that is expected to effectively limit seepage flows. The grading of the adjacent gravel fill has been checked for filter compatibility with the core, and is found to generally comply with the "no erosion" criteria. The materials exhibit a degree of gap-grading, however given the short duration of any seepage flow through the upper part of the stopbank, it is considered unlikely that piping features or internal erosion would develop.

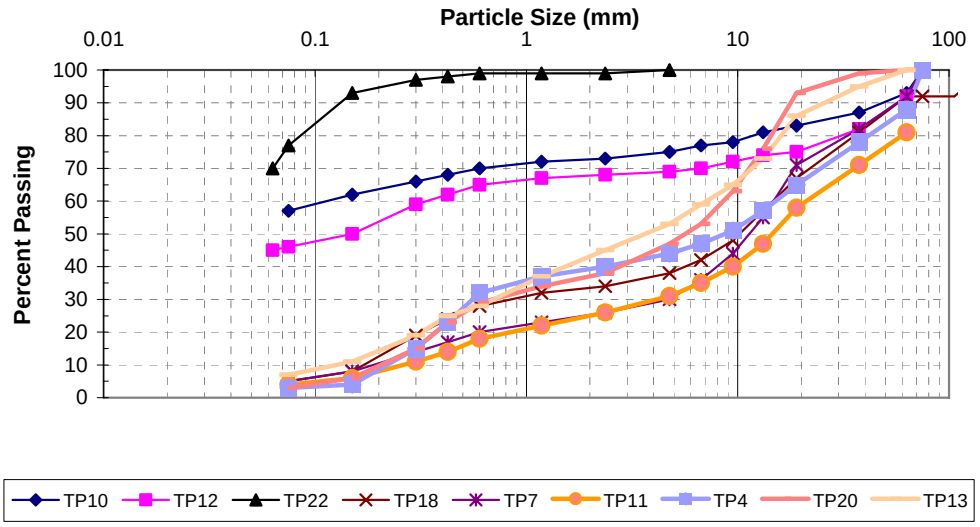


Figure 2: Plot of Laboratory Grading Curves

(b) Area of Observed Seepage Pressure

The drill hole was located to the west of the section near the intersection of Mawhera Qy and Richmond Qy roads, where seepage has been experienced in recent flood events. The borehole was located on the landward side of the 6m deep clay cutoff indicated in the supplied design drawing. The materials encountered by the drill hole generally comprised fill to around 3.4m, gravel and sandy gravel to around 7m, with sand and gravelly sand below this to the hole target depth of 10m. None of the sediments encountered in the hole would provide significant resistance to seepage flow from the adjacent river, and as the stopbank central clay cutoff extends only 6m, it is interpreted that seepage flows are able to pass beneath the cutoff zone and discharge in the stopbank toe area. It is also quite likely that the clay cutoff is not very effective in reducing flow or pressure in the upper founding soils. and minimal head loss due to seepage is occurring in even the near surface soils.

The permeability of the founding soils at this location are likely at the upper limit of the hardfills tested, as the nature of the founding gravel soils is similar. Based on various correlations from grading curves the permeability is assessed as in the range 4 to 8 $x10^{-4}$ m/s. This is significantly higher than the in situ permeability test, but this test appears to give an unrealistically low permeability.

Based on previous transient groundwater modelling we have undertaken for stopbanks a head loss due to seepage can be derived, based on permeability. A head loss of only 1m is predicted at the toe of the stopbank (i.e. the carriageway), and thus for only moderate flood events artesian pressure is predicted beneath the carriageway. This is consistent with the observed heaving of the carriageway seal in previous flood events i.e. artesian uplift pressure exceeds the weight of the overlying materials.

6.2.2 Key Considerations

(a) Floodwall Section

For design of the floodwall RILEY recommends the following:

1. The wall be located near the river-side of the stopbank, with the footing cast insitu directly on the low permeability core zone after removal of topsoil etc, and extending onto the free draining bulk fill zone.
2. A key be incorporated in the footing to increase resistance to sliding. The key should be located within the free-draining gravel rather than the low permeability core, to ensure minimal disturbance to the core zone.
3. During construction, the core zone should be exposed and tested to ensure it has appropriate density and moisture content to act as a footing foundation and water retaining material for concrete structure interface. It may be appropriate to re-condition the core zone by addition of water/scarifying/re-compaction.
4. The footing should found on the low-permeability zone a minimum width of 200mm and preferably more. It is possible the low permeability material may not be encountered or at marginal thickness at tentative founding level (for example if hardfill thickness is greater than about 300mm). For this scenario placement of low permeability soil will be required to create a continuous seepage barrier, as it may not be desirable to lower the founding wall level.
5. A worst-case overturning and uplift stability check be undertaken including full water pressure on the wall face, and full water pressure along the foundation slab (i.e. seepage pressure assuming a crack forms at the interface). A factor of safety greater than 1.0 would be appropriate for such an extreme flood case if the flood level is taken to the top of the wall.
6. To ensure erosion/deterioration at the river-side foundation interface of the wall does not occur, it is recommended that a filter fabric detail down the face of the wall and between the core and riprap be incorporated. Riprap should be placed on the fabric against the base of the wall and marry in with the existing rip rap.
7. Wall stability should be checked for failure modes of uplift, sliding and overturning. A typical required factor of safety is 1.5 for these modes, for a conservative assumption of a flood level at the top of the wall. This water level is higher than the 1% AEP flood level. We recommend that the base width be a minimum of 1m, in order to provide a minimum seepage length. Each of these failure modes should be checked for a triangular uplift distribution i.e. headwater at the upstream end to zero at the downstream toe. We have considered placement of a drain at the landward toe, but due to the free draining hardfill we consider this is not required. Also it is most likely no seepage will reach the downstream toe, and even if it did would be expected to be only modest flows.
8. Consideration should be given to the detail at the end of the walls ie how seepage is minimised around the end of the wall.

(b) Area Of Observed Seepage Pressure

At this position there is a risk of initiation of erosion by a ground heave mechanism possibly leading to a breach of the stopbank by piping. Although the risk of initiation is high (particularly in floods greater than encountered to date) there must be other factors present for a breach to potentially occur. The gravel soils are unlikely to hold a roof or be highly erodible in seepage flow and thus gross enlargement of a piping hole is unlikely. Some loss of the finer fractions within the matrix may occur, leading to higher permeability and flow rates. In a worst case scenario if sufficient erosion occurred the crest may slump and/or the walls be undermined and then the crest may overtop if the flood is high enough at the time.

The short duration of peak flood loading would reduce this risk. Overall the risk of a breach in say a 1:100 flood event is assessed as moderate to low.

The options to improve stopbank security could involve;

- Seepage reduction measures
- Drainage / buttressing
- Combination of the above

It appears the existing clay cutoff at this location is not fully effective. Seepage reduction measures could involve a deep cut off using plastic concrete or conventional concrete. These however are very expensive solutions and more suited to large dams. Drainage or buttressing are considered more cost effective options. These are described below.

(a) Raising of the ground to add weight. This would involve removal of existing seal and placing fill.
(b) A deep toe drain or similar. This would be a trench backfilled with highly permeable gravel excavated to the maximum practical depth.

Option (b) above is considered most cost effective solution. Further design analyses are recommended to develop the concept, in particular the required geometry, grading and required design standard. Option (a) would be very disruptive as a significant fill depth may be required. With any option there are various practical constraints to be considered.

6.3 Goods Shed

A new section of stopbank up around 1 m high is required adjacent to the existing Goods Shed.

6.3.1 Investigations

Three test pits up to 4 m depth were completed in the Goods Shed area. Fill comprising variable silt, sand, gravel and boulders and was encountered to at least 2 m depth. The soils encountered are generally considered to be an appropriate foundation for the proposed stopbank in terms of strength and potential settlement. Some permeable materials were encountered along with boulders.

6.3.2 Key Considerations

The new stopbank requires a competent foundation, and an appropriate detail for keying the low permeability upstream core zone into the foundation to limit foundation seepage.

All loose, permeable or soft materials require removal from the stopbank footprint, an undercut over the whole footprint of 0.5 to 1 m is envisaged. In places a deeper sub-excavation may be required either over the whole footprint or as a cut off for seepage control. The typical cross section for the new stopbank should incorporate an upstream silt core and downstream free draining shoulder similar to the existing stopbanks in the area. The upstream core zone should be keyed into in situ ground. The recommended new stopbank cross section is indicated in drawing 09828-5.

6.4 Fisherman's Wharf

A freestanding wall around 0.9 m high is proposed for the Fisherman's Wharf section of stopbank.

6.4.1 Investigations

Four test pits were completed in the area. These pits revealed an upstream core zone and free draining bulk fill typical cross section, incorporating a similar cross section and materials to those at Mawhera Quay. It is unlikely however, that the stopbank incorporates the 6 m cut-off zone of Mawhera Quay, as the stopbank is significantly lower at this location.

6.4.2 Key Considerations

It is considered appropriate to use a similar wall detail to that suggested for Mawhera Quay, with the wall being located at the river-side of the existing stopbank crest, and keying into the existing low-permeability upstream core zone. Design loadings and considerations for the wall are anticipated to be similar to those at Mawhera Quay, although additional consideration of wave impact loading and overtopping effects due to the proximity of the site to the river mouth.

6.5 Cobden

The existing stopbank in the area within around 300 m upstream of the existing Range Creek culvert is very steep, and has a narrow cross section and crest width due to the constraint of the adjacent road. Seepage has been noted around and/or beneath the culvert, and remediation of this structure has been raised as item for consideration in our brief. During the site visit, seepage was observed exiting adjacent to the culvert toward the Grey River. It is therefore likely that the seepage direction will reverse during flooding of the river, and the seepage flows will exit toward Cobden.

It is proposed to raise the entire road embankment to achieve the design stopbank height, rather than attempting to raise the already steep and narrow existing banks adjacent to the road. In the Range Creek culvert location, new culvert sections will be added on either side of the existing structure, and earth fill placed to tie in to the existing stopbank batter.

6.5.1 Investigations

Three test pits and one drill hole were completed in the area. The test pits determined that the river side low permeability facing is present on the stopbank.

The drill hole identified sandy gravel beneath the culvert level (base of stopbank fill). The in situ foundation material is likely to be highly permeable, and it is also considered likely that seepage along the interface of the culverts with natural ground and backfill is occurring. Design details of the wing wall extensions have been sighted, but nothing of the original wing wall and culvert installation which apparently predates the stopbank upgrade of the late 1980's. No internal inspection of the culverts was undertaken however it is considered likely that settlement of the culverts has occurred to some extent, as the stopbank height has been raised at least once following original construction.

6.5.2 Key Considerations

RILEY supports the idea of raising the road embankment across its full width in this area. The existing road surface should be removed and the upstream core be extended appropriately, as indicated in drawing 09828-5 attached.

At the culvert location, the recommended detail for limiting seepage is a new earth liner layer within the fill surrounding the culvert extension. There is the potential for seepage pressure from either direction (i.e. the Grey River side during flood, and the Cobden side during normal operation/local rainfall events). Therefore the recommended detail incorporates an

internal low permeability core zone on the Grey River side of the culvert, with a supporting shoulder of general stopbank fill material. This arrangement is indicated in drawing 09828-6. It is important that the low permeability core zone is well keyed into the existing low permeability facing layer on the river-side stopbank batter. The previously noted possibility of culvert settlement raises the potential for seepage originating from pipe joints, and it is recommended that an internal inspection of the culverts be completed as part of the structure upgrade.

In the culvert location, the founding level for compacted fill is beneath river level, and occupies the normal drainage path for the Cobden estuary area. Construction will therefore require careful planning and execution, with consideration given to drainage so that fill quality is not adversely affected by water within the excavation. Very high compaction standards are required below and around the pipes in particular.

7.0 Summary of Main Points

1. Investigations have been completed with the purpose of assisting the overall design of the upgrade project. There have been no major issues identified which could detrimentally affect the project, although in some areas challenging ground conditions have been identified requiring specific measures to minimise risk to an acceptably low level.
2. As expected the two Bridges section had the most challenging ground conditions, i.e. soft founding soils requiring undercutting and high groundwater levels.
3. Recommendations are included in this report for each of the areas investigated.
4. Confirmation of assumptions will be required during construction to ensure that the design objectives are fulfilled, and appropriate action taken if conditions differ from those encountered to date. Recommended construction methods and inspection procedures are included in appendix 5: Construction Specification Clauses.

8.0 Limitation

This report has been prepared solely for the benefit of Good Earth Matters 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.

Recommendations and opinions in this report are based on data from limited test positions. The nature and continuity of subsoil conditions away from the test positions are inferred, and it must be appreciated that actual conditions could vary considerably from the assumed model.

During excavation and construction the site should be examined by an engineer or engineering geologist competent to judge whether the exposed subsoils are compatible with the inferred conditions on which the report has been based. It is possible that the nature of the exposed subsoils may require further investigation and the modification of the design based upon this report.

Riley Consultants Ltd would be pleased to provide this service to Good Earth Matters and believes the project would benefit from such continuity. In any event, it is essential Riley

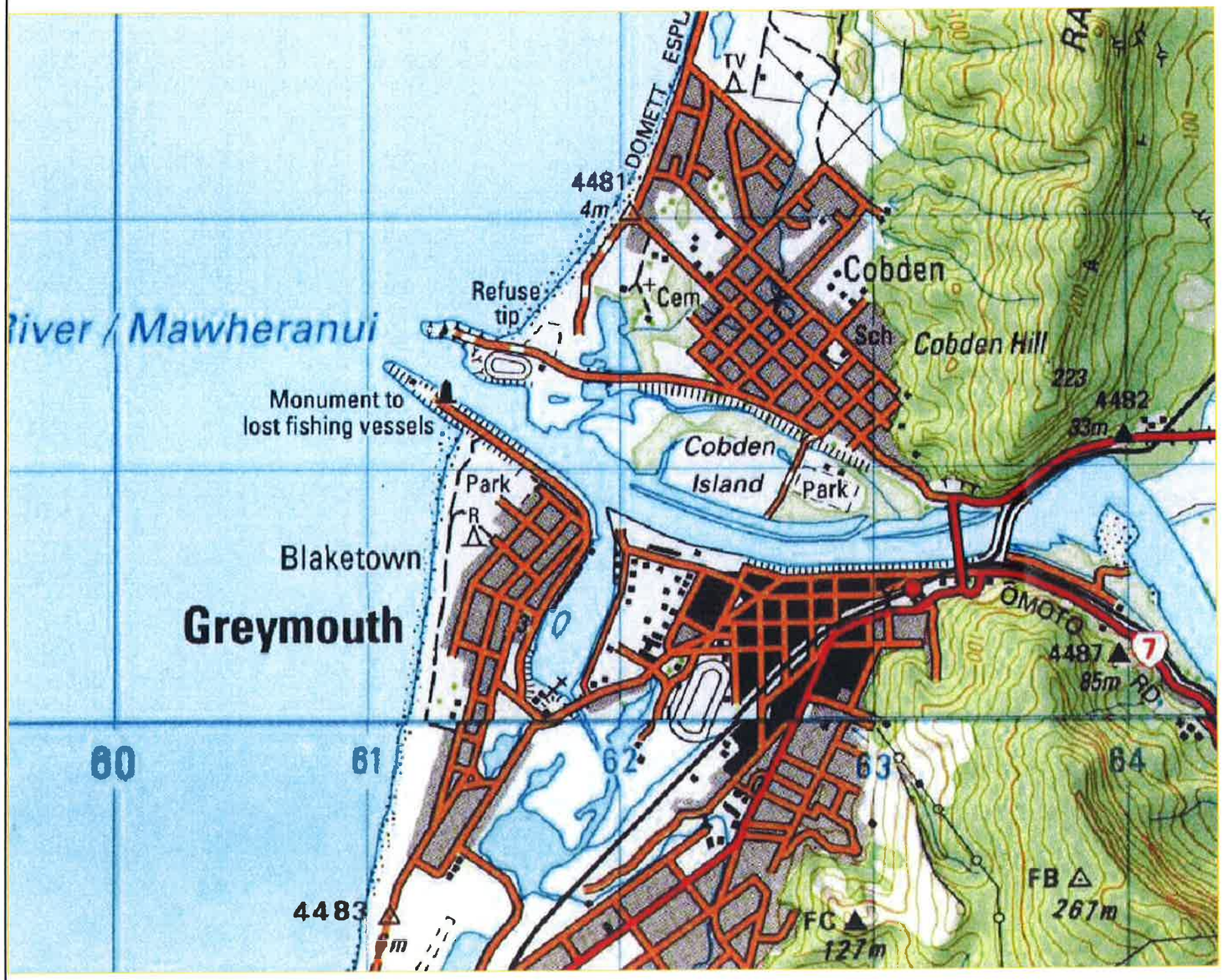
Consultants Ltd is contacted if there is any variation in subsoil conditions from those described in the report as it may affect the design parameters recommended in the report.

9.0 References

1 Nathan, S (1978) *1:63,360 Scale Geological Map, Sheet S44 Greymouth*. New Zealand Geological Survey.
2 Young A.J.A. (1998) *Review of Condition of Greymouth Floodwall*. RiskCorp Australia Pty Ltd
3 Hall R.J. (1999) *Report: Greymouth Flood Protection: System Integrity.* Civil & Environmental Consulting Ltd.

APPENDIX 1

Drawings



LOCATION PLAN
SCALE 1:20000

GOOD EARTH MATTERS

GREYMOUTH FLOOD WALL, GREYMOUTH

DRAWING INDEX - TENDER ISSUE
NOVEMBER 2008

DRAWING NUMBER	DRAWING NAME	DRAWING REVISION
09828-0	LOCATION PLAN & DRAWING LIST	0
09828-1	GEOTECHNICAL INVESTGATION – SITE PLAN – SHEET 1 OF 3	0
09828-2	GEOTECHNICAL INVESTGATION – SITE PLAN – SHEET 2 OF 3	0
09828-3	GEOTECHNICAL INVESTGATION – SITE PLAN – SHEET 3 OF 3	0
09828-4	GEOTECHNICAL INVESTGATION – CROSS SECTIONS AT 2 BRIDGES SITE	0
09828-5	CONCEPTUAL STOPBANK RAISING DETAILS	0
09828-6	RANGE CREEK CULVERT UPGRADE – CONCEPT DRAWING	0
09828-7	GEOTECHNICAL INVESTGATION – CLINOMETER CROSS SECTIONS	0
09828-8	GEOTECHNICAL INVESTGATION – CLINOMETER CROSS SECTIONS	0
09828-9	GEOTECHNICAL INVESTGATION – CLINOMETER CROSS SECTION	0

CONCEPTUAL - NOT FOR CONSTRUCTION

REV	DESCRIPTION	BY	DATE
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DESIGN TS | CHECKED
DRAWN HN | CHECKED
DATE DRAWN 09/2008

APPROVED FOR ISSUE: DRAFT
DATE: / /

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TITLE
GOOD EARTH MATTERS
GREYMOUTH FLOOD WALL, GREYMOUTH
LOCATION PLAN AND DRAWING LIST

CADFILE 09828-0
SCALES (A3) AS SHOWN
ACENZ
DRAWING No. 09828-0
REV. 0

0	FIRST ISSUE		
REV	DESCRIPTION	BY	DATE

DESIGN: DRT | CHECKED:
DRAWN: MP | CHECKED:
DATE DRAWN: SEPT. 2009

APPROVED FOR ISSUE: DRAFT
DATE: / /

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TITLE

GOOD EARTH MATTERS

GREYMOUTH FLOOD WALL, GREYMOUTH

GEOTECHNICAL INVESTIGATION - SITE PLAN - SHEET 1 OF 3

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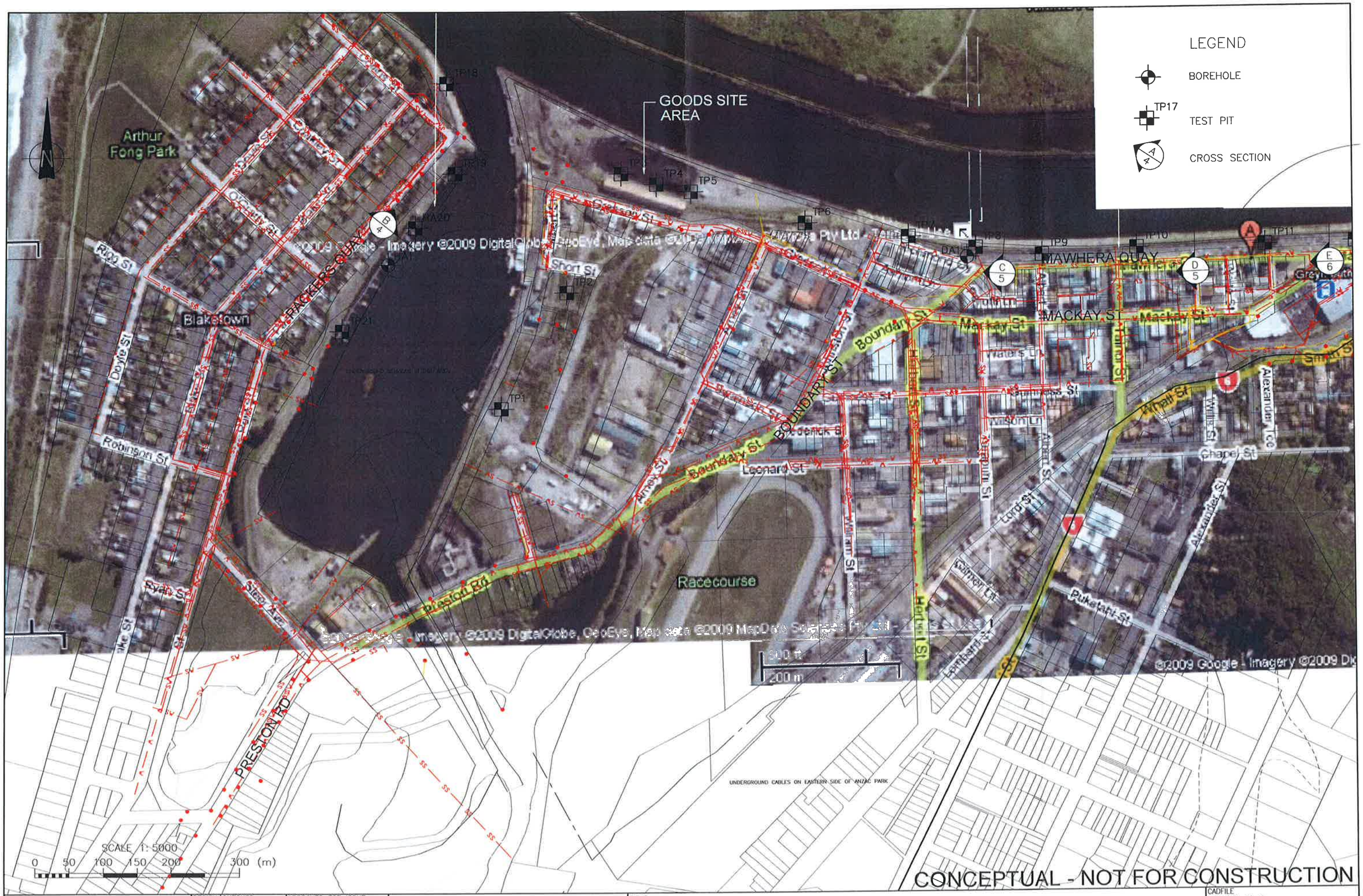

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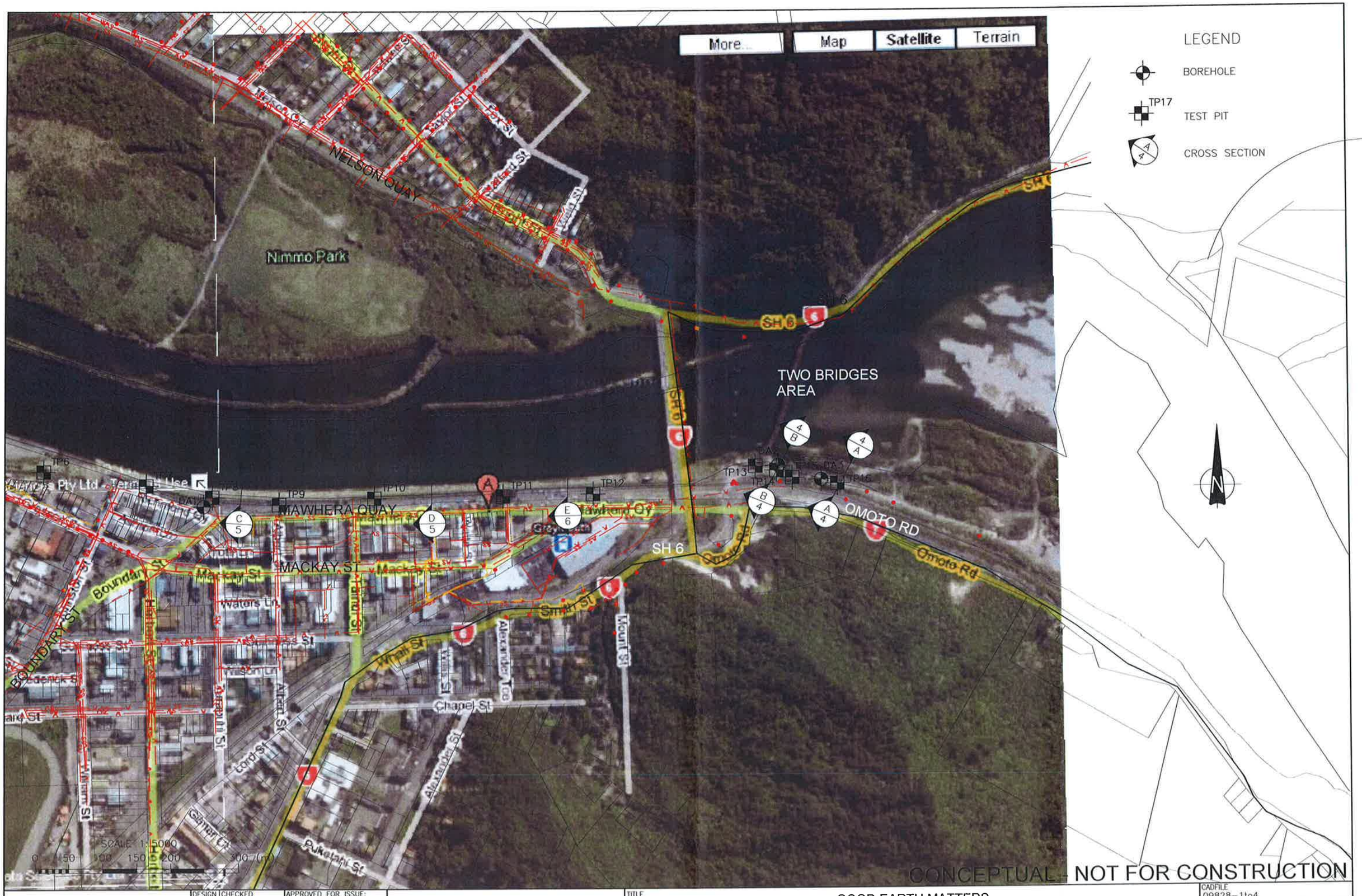
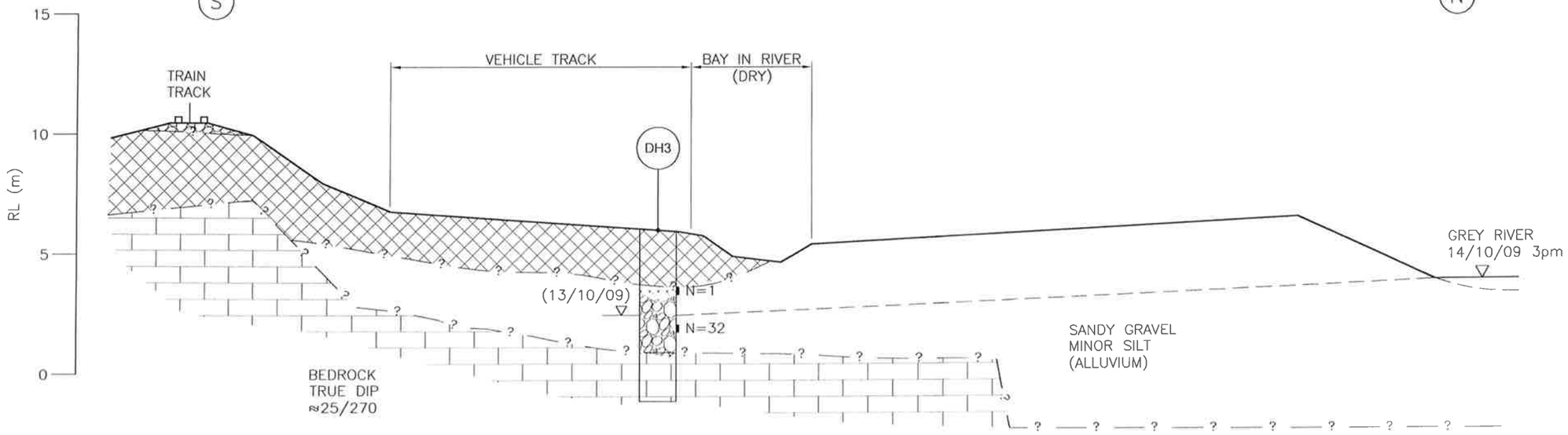
		DRAWN MP	CHECKED			GOOD EARTH MATTERS GREYMOUTH FLOOD WALL, GREYMOUTH GEOTECHNICAL INVESTIGATION - SITE PLAN - SHEET 2 OF 3	SCALES (A3) 1:5000
0	FIRST ISSUE			DATE: / /			ACENZ DRAWING No. 09828-2 REV. 0
REV	DESCRIPTION	BY	DATE	DATE DRAWN SEPT. 2009			



		DESIGN DRT	CHECKED	APPROVED FOR ISSUE: DRAFT	RILEY CONSULTANTS P.O.BOX 100 253 N.S.M.C. AUCKLAND TEL. 09-4897872 FAX. 09-4897873	TITLE	CADFILE 09828-1to4
		DRAWN MP	CHECKED	DATE: / /		GOOD EARTH MATTERS GREYMOUTH FLOOD WALL, GREYMOUTH GEOTECHNICAL INVESTIGATION - SITE PLAN - SHEET 3 OF 3	SCALES (A3) 1:5000
0	FIRST ISSUE						DRAWING No. 09828-3
REV	DESCRIPTION	BY	DATE	DATE DRAWN SEPT. 2009			REV. 0

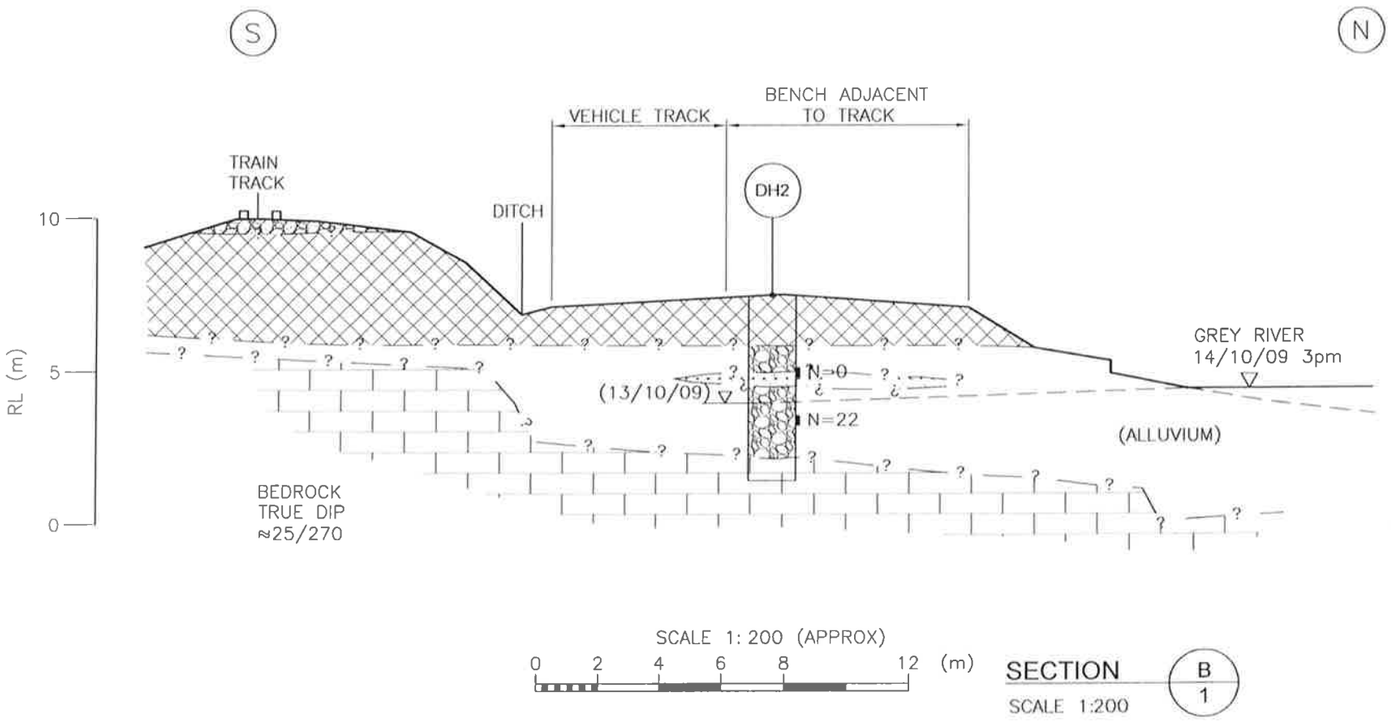


SCALE 1: 200 (APPROX)

0 2 4 6 8 12 (m)

SECTION A/1

SCALE 1:200



SCALE 1: 200 (APPROX)

0 2 4 6 8 12 (m)

SECTION B/1

SCALE 1:200

NOTES:-

1. GROUND PROFILE PRODUCED FROM TAPE CLINOMETER SURVEY
2. ELEVATIONS APPROXIMATED FROM GPS
3. SOIL DESCRIPTIONS ARE SIMPLIFIED, REFER TO REPORT AND BORE LOSS FOR DETAILS

LEGEND

MATERIALS

- SANDY GRAVEL (FILL)
- SILT, LOCAL ORGANICS
- SANDY GRAVEL
- (ALLUVIUM)
- BEDROCK (COBDEN LIMESTONE)

CONTACTS

- KNOWN
- APPROXIMATE
- INFERRED

- DH3 — DRILL HOLE LOCATION (150mm DIA CONCENTRIC WIDTH NOT TO SCALE)
- N=22 — SPT TEST (NZ STANDARDS)
- GROUND WATER (DATE MEASURED)

CONCEPTUAL - NOT FOR CONSTRUCTION

REV	DESCRIPTION	BY	DATE
0	FIRST ISSUE		

DESIGN: AvD | CHECKED:
DRAWN: HN | CHECKED:
DATE DRAWN: NOV 09

APPROVED FOR ISSUE: DRAFT
DATE: / /

RILEY CONSULTANTS
P.O.BOX 100 253
N.S.M.C.
AUCKLAND
TEL. 09-4897872
FAX. 09-4897873

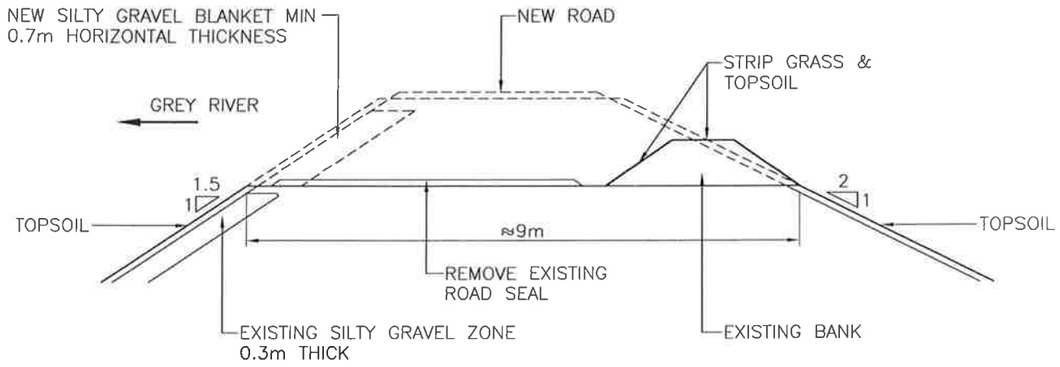
TITLE

GOOD EARTH MATTERS

GREYMOUTH FLOOD WALL, GREYMOUTH

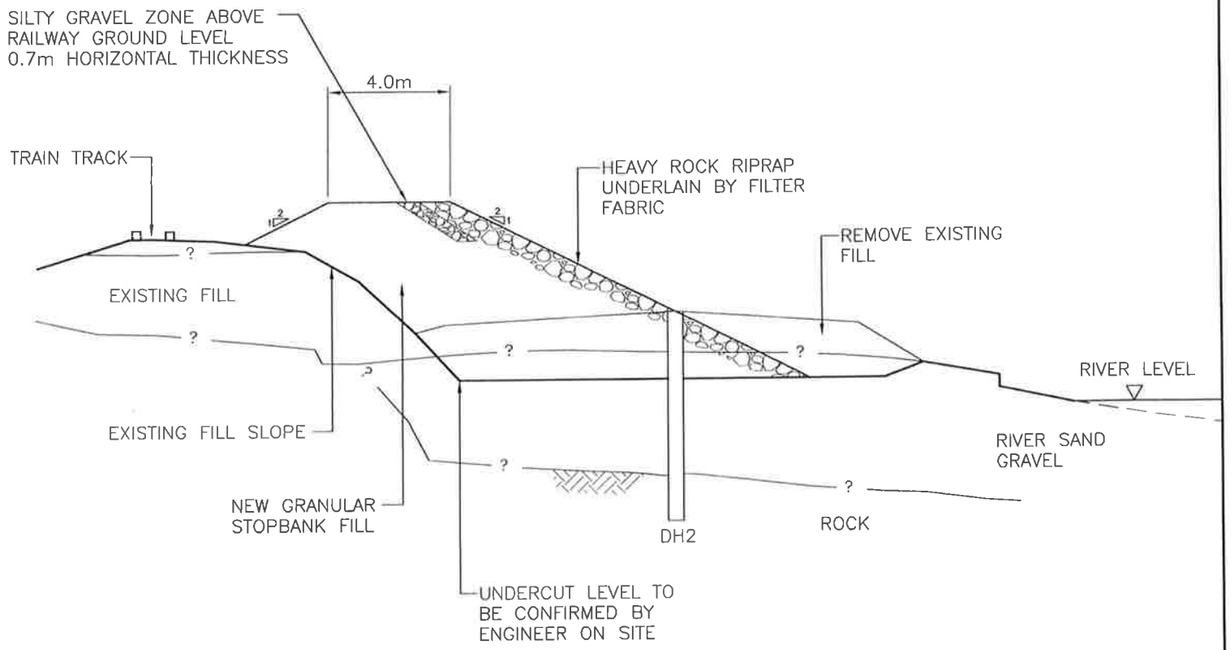
GEOTECHNICAL INVESTIGATION - CROSS SECTIONS AT 2 BRIDGES SITE

CADFILE: 09828-1to4
SCALES (A3): AS SHOWN
DRAWING No.: 09828-4
REV.: 0
ACENZ



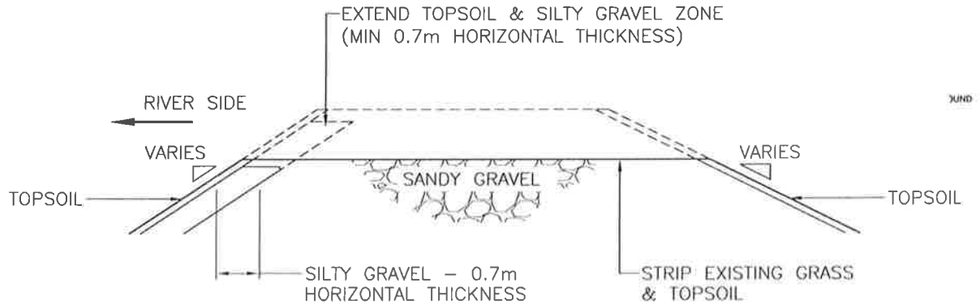
COBDEN NEAR RANGE CREEK CULVERT

SCALE 1:100 (APPROX)



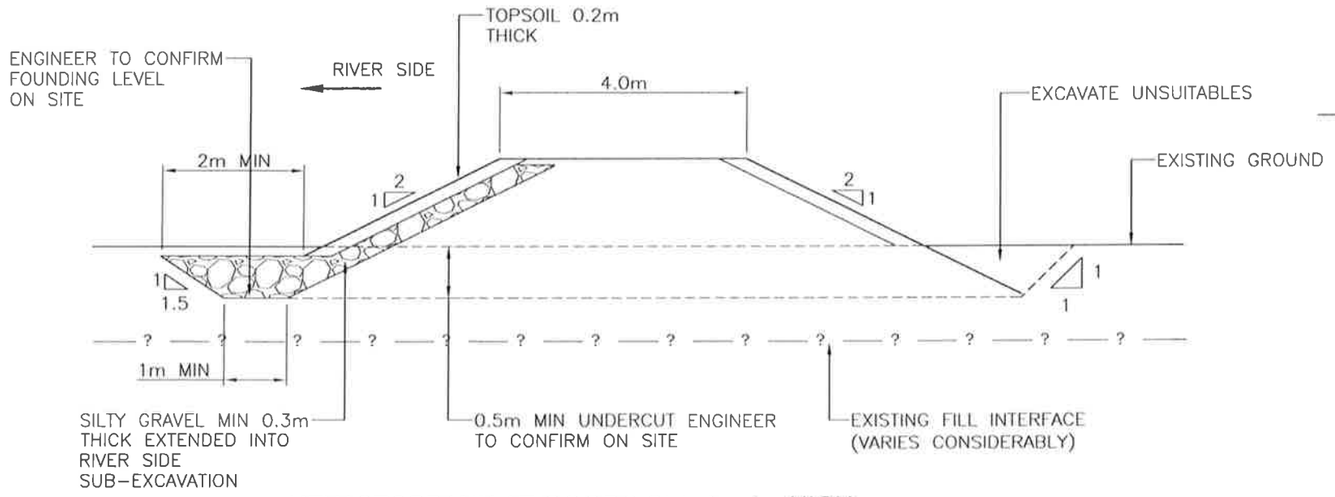
2 BRIDGES AREA

SCALE 1:200



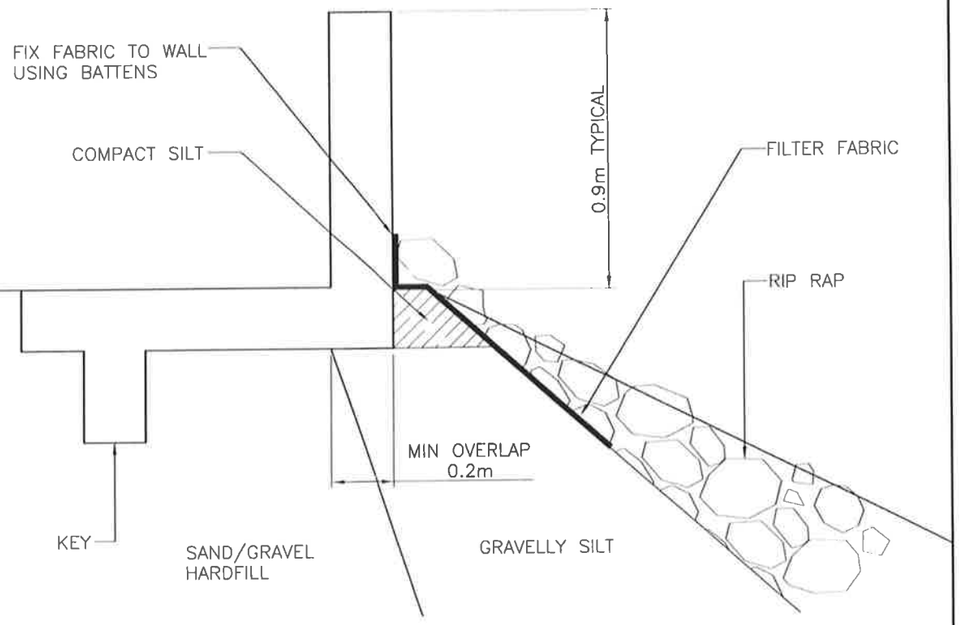
GENERAL STOPBANK RAISE 0.2m TO 0.6m

SCALE 1:100 (APPROX)



NEW STOPBANK AT GOODS SHED ≈ 1m HIGH

SCALE 1:100 (APPROX)



CONCRETE FLOOD WALL - MAWHERA QUAY & FISHERMAN'S WARF

SCALE 1:20 (APPROX)

CONCEPTUAL - NOT FOR CONSTRUCTION

REV	DESCRIPTION	BY	DATE
0	FIRST ISSUE		

DESIGN: TS | CHECKED:
DRAWN: HN | CHECKED:
DATE DRAWN: NOV 09

APPROVED FOR ISSUE: DRAFT
DATE: / /

RILEY CONSULTANTS
P.O.BOX 4355 CHRISTCHURCH
TEL. 03–3794402
FAX. 03–3794403

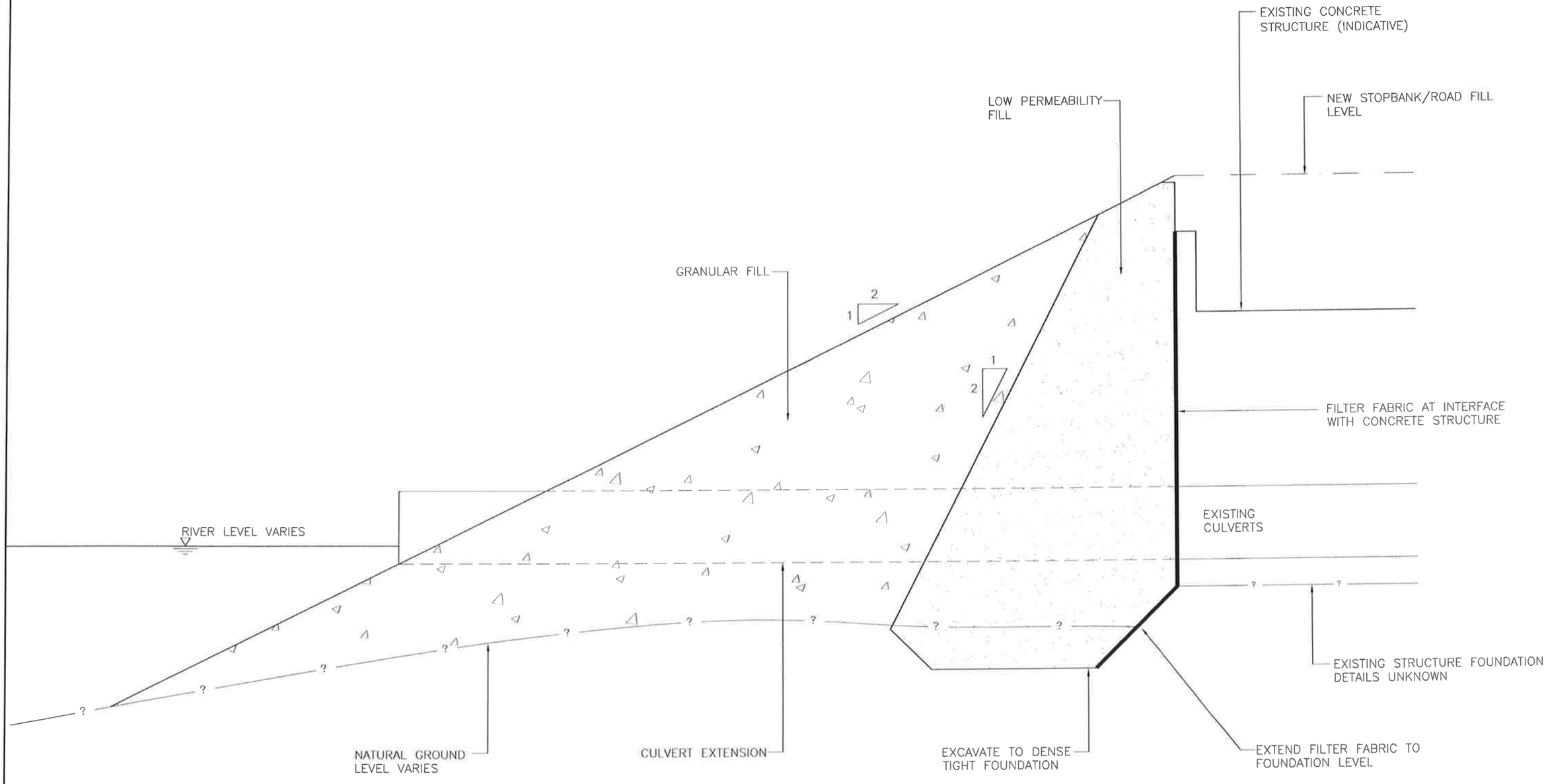
TITLE

GOOD EARTH MATTERS

GREYMOUTH FLOOD WALL, GREYMOUTH

CONCEPTUAL STOPBANK RAISING DETAILS

CADFILE: 09828–5&6
SCALES (A3): AS SHOWN
DRAWING No.: 09828-5
REV.: 0



CONCEPTUAL RANGE CREEK CULVERT UPGRADE

SCALE 1:50 (APPROX)

CONCEPTUAL - NOT FOR CONSTRUCTION

REV	DESCRIPTION	BY	DATE
0	FIRST ISSUE		

DESIGN: TS | CHECKED:
DRAWN: HN | CHECKED:
DATE DRAWN: NOV 09

APPROVED FOR ISSUE: DRAFT
DATE: / /

RILEY CONSULTANTS
P.O.BOX 4355 CHRISTCHURCH
TEL. 03-3794402
FAX. 03-3794403

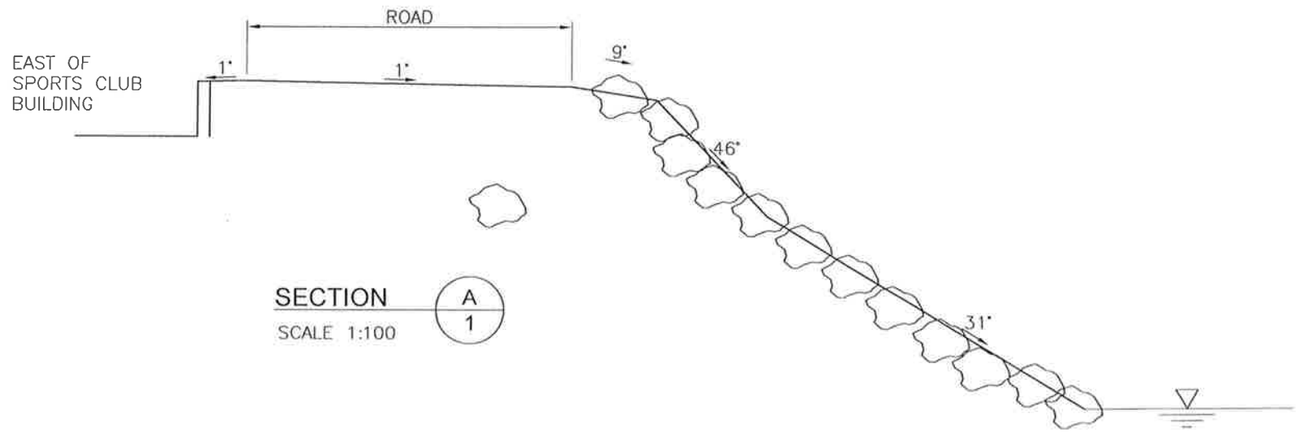
TITLE

GOOD EARTH MATTERS

GREYMOUTH FLOOD WALL, GREYMOUTH

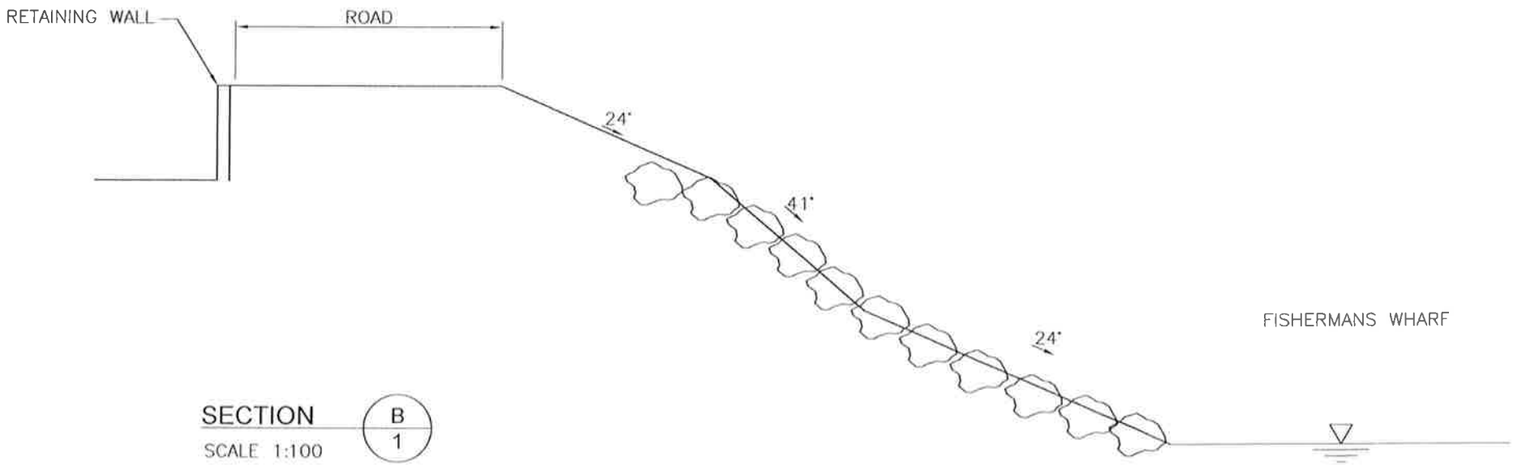
RANGE CREEK CULVERT UPGRADE - CONCEPT DRAWING

CADFILE: 09828-5&6
SCALES (A3): AS SHOWN
ACENZ
DRAWING No.: 09828-6
REV.: 0



SECTION A/1

SCALE 1:100



SECTION B/1

SCALE 1:100

SCALE 1: 100

0 1 2 3 4 6 (m)

CONCEPTUAL - NOT FOR CONSTRUCTION

			DESIGN MJB	CHECKED	APPROVED FOR ISSUE: DRAFT	RILEY CONSULTANTS P.O.BOX 100 253 N.S.M.C. AUCKLAND TEL. 09-4897872 FAX. 09-4897873	TITLE: GOOD EARTH MATTERS GREYMOUTH FLOOD WALL, GREYMOUTH GEOTECHNICAL INVESTIGATION - CLINOMETER CROSS SECTIONS	CADFILE 08828-7to9
			DRAWN JM	CHECKED				SCALES (A3) 1:100
0	FIRST ISSUE		DATE DRAWN SEPT 2009		DATE: / /			ACENZ DRAWING No. 08828-7 REV. 0
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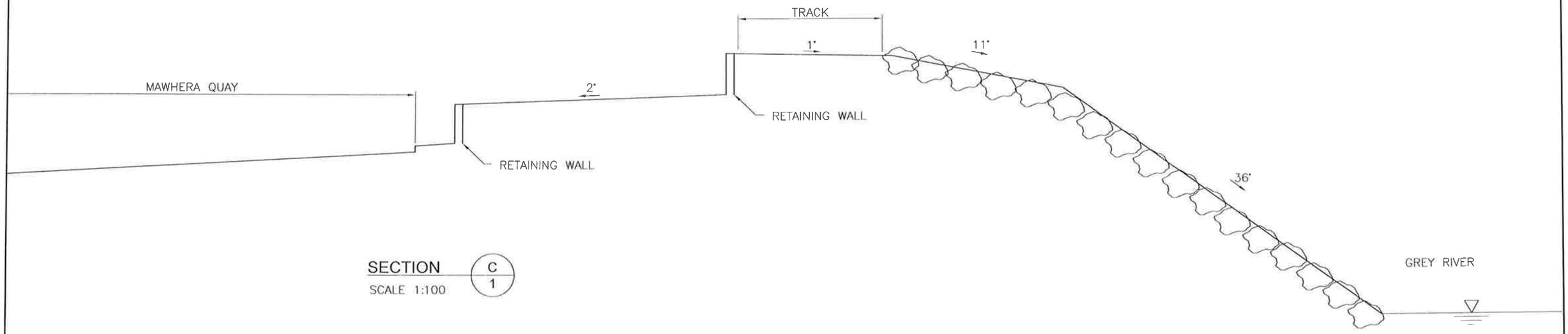
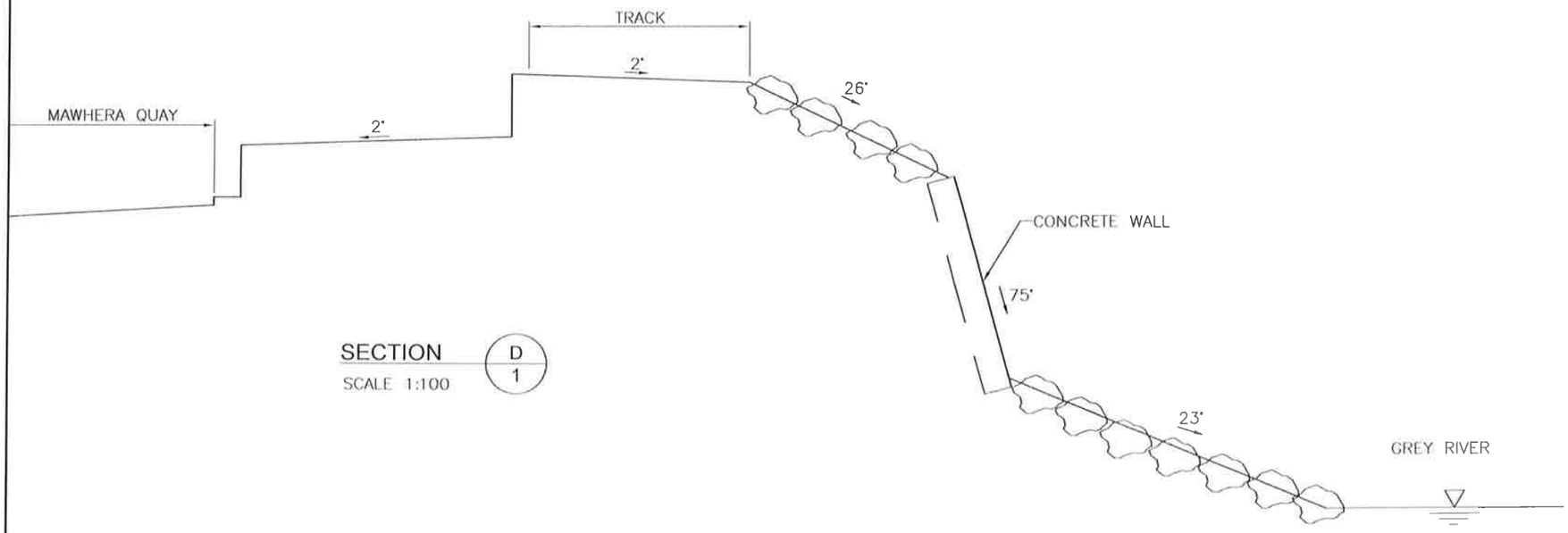


SECTION C/1
SCALE 1:100



SECTION D/1
SCALE 1:100

SCALE 1:100
0 1 2 3 4 6 (m)

CONCEPTUAL - NOT FOR CONSTRUCTION

REV	DESCRIPTION	BY	DATE
0	FIRST ISSUE		

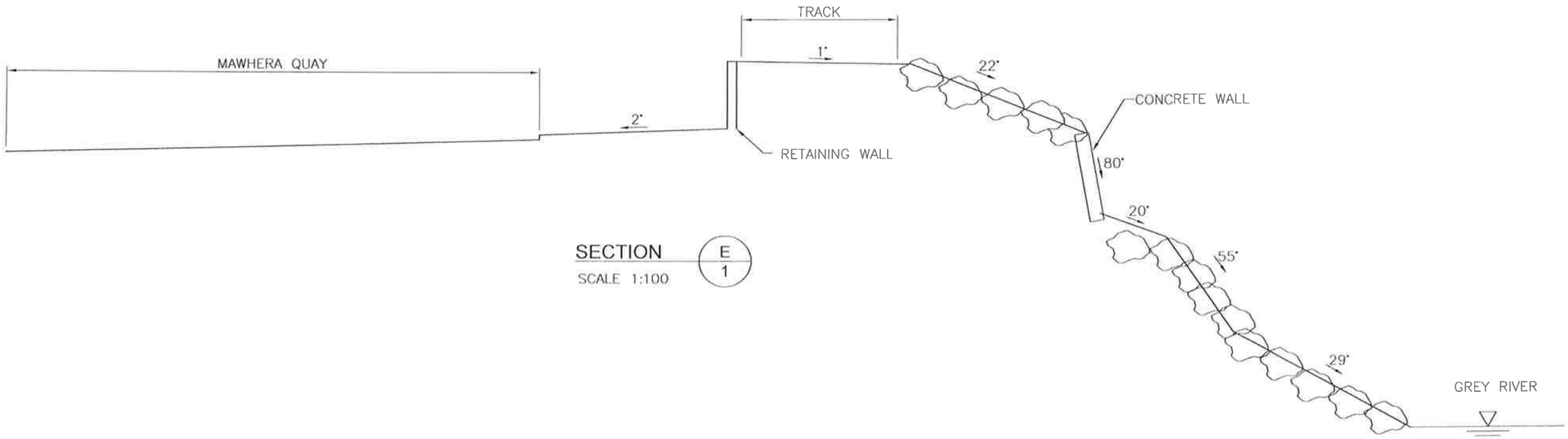
DESIGN MJB | CHECKED
DRAWN JM | CHECKED
DATE DRAWN SEPT 2009

APPROVED FOR ISSUE: DRAFT
DATE: / /

RILEY CONSULTANTS
P.O.BOX 100 253
N.S.M.C.
AUCKLAND
TEL. 09-4897872
FAX. 09-4897873

TITLE
GOOD EARTH MATTERS
GREYMOUTH FLOOD WALL, GREYMOUTH
GEOTECHNICAL INVESTIGATION - CLINOMETER CROSS SECTIONS

CADFILE 08828-7to9
SCALES (A3) 1:100
ACENZ
DRAWING No. 08828-8
REV. 0



SECTION E/1

SCALE 1:100

SCALE 1: 100

0 1 2 3 4 6 (m)

CONCEPTUAL - NOT FOR CONSTRUCTION

			DESIGN MJB	CHECKED	APPROVED FOR ISSUE: DRAFT	RILEY CONSULTANTS P.O.BOX 100 253 N.S.M.C. AUCKLAND TEL. 09-4897872 FAX. 09-4897873	TITLE: GOOD EARTH MATTERS GREYMOUTH FLOOD WALL, GREYMOUTH GEOTECHNICAL INVESTIGATION - CLINOMETER CROSS SECTION
			DRAWN JM	CHECKED			
0	FIRST ISSUE		DATE DRAWN SEPT 2009		DATE: / /		CADFILE 08828-7to9 SCALES (A3) 1:100 DRAWING No. 08828-9 REV. 0
REV	DESCRIPTION	BY DATE					ACENZ

APPENDIX 2

Geotechnical Logs

RILEY CONSULTANTS
Engineers and Geologists

Riley Consultants Ltd
4 Fred Thomas Drive
Takapuna, AKL
Tel: 09 4897872
Fax: 09 4897873

TEST PIT LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood	Greymouth	Crest of stopbank	TP1

Job No.:	Start Date: / Finish Date:	Ground Level (m):	Co-Ordinates ():
09828			

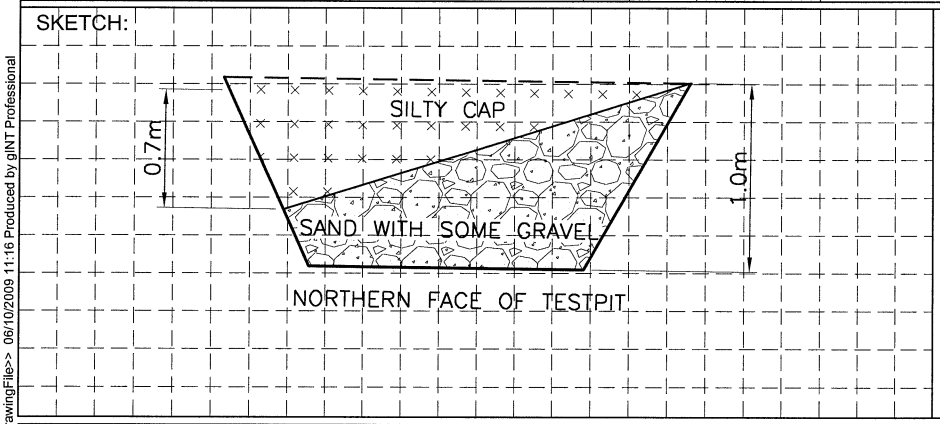
Client:	Hole Depth:	Sheet:
Good Earth Matters	1.00 m	1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering	Field Strength (Soil / Rock)	Defect Description	Samples	Tests
	0.70	SILT; trace clay, very large angular limestone boulder inclusions up to 300mmø						No. 1 1, 2, 1, 2, 2, 1, 3, 2, 3, 4, 20
	1.00	medium to coarse gravelly SAND; minor cobbles, grey, well graded, non plastic, gravels and cobbles are rounded greywacke						No. 2 2, 1, 2, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 1, 2, 2, 2, 2, 2
		EOH @ 1.00 m						

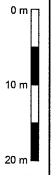
Soil Description: subordinate, particle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT).
Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).

Weathering: RS CW HW MW SW UW
Field Strength: VS/VL SL/L F/MD S/MD VS/VD H/EW W W/S VS ES

SKETCH:

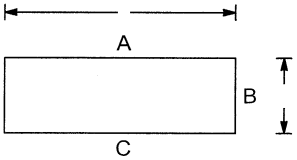


MAP



1:1000

Shoring/Support:
Stability:



- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER ☐ None
☐ Slow Seep (depth)
☐ Rapid Inflow (depth)

PIT TERMINATED DUE TO:
☒ Target depth ☐ Flooding
☐ Refusal ☐ Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

RILEY CONSULTANTS Engineers and Geologists
Riley Consultants Ltd
4 Fred Thomas Drive
Takapuna, AKL
Tel: 09 4897872
Fax: 09 4897873

TEST PIT LOG

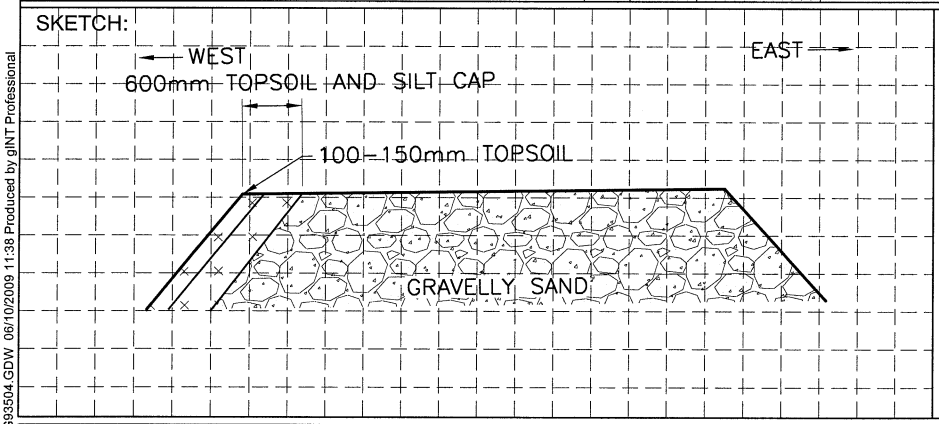
Project:	Location:	Hole position:	No.:
Greymouth Flood	Greymouth	stopbank	TP2

Job No.:	Start Date: 17-09-09 Finish Date:	Ground Level (m):	Co-Ordinates ():
09828			

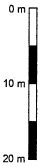
Client:	Hole Depth:	Sheet:
Good Earth Matters	1.00 m	1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering	Field Strength	Defect Description	Samples	Tests
		Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT). Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).		RS CW HW MW SW UW	Soil: VS/VL S/St F/D St/VD VSt/H Rock: VW W MS S VS ES	(type, orientation, spacing, roughness, persistence aperture, infilling etc)		
	0.60	SILT; trace to minor clay, minor large angular gravels up to 100-300mm across						No. 1 0, 1, 1, 1, 0, 1, 2, 2, 5, 2, 0, 0, 1, 5, 2, 3, 3, 6, 3
	1.00	gravelly SAND; rounded greywacke gravels generally up to 150mmø, occasionally up to 300mmø						No. 2 1, 1, 1, 2, 3, 3, 2, 2, 3, 4, 7, 8, 6, 5, 6, 6, 5, 5, 5
	1	EOH @ 1.00 m						
	2							
	3							
	4							
	5							

SKETCH:

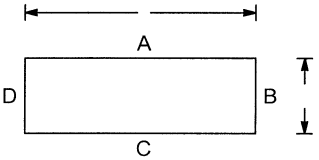


MAP



1:1000

Shoring/Support:
Stability:



- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER ☐ None
☐ Slow Seep (depth)
☐ Rapid Inflow (depth)

PIT TERMINATED DUE TO:
☒ Target depth ☐ Flooding
☐ Refusal ☐ Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

RILEYAKL.GLB Log RILEY TP 09828.GPJ DWG93504.GDW 06/10/2009 11:38 Produced by gINT Professional

RILEY CONSULTANTS
Engineers and Geologists

Riley Consultants Ltd
4 Fred Thomas Drive
Takapuna, AKL
Tel: 09 4897872
Fax: 09 4897873

TEST PIT LOG

Project: Greymouth Flood	Location: Greymouth	Hole position: Western end good shed	No.: TP3
Job No.: 09828	Start Date: 17-09-09 Finish Date:	Ground Level (m):	Co-Ordinates ():
Client: Good Earth Matters	Hole Depth: 3.70 m		Sheet: 1 of 1

Elevation (m)	Depth (m)	Geological Description (Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT). Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).)	Legend	Weathering (RS CW HW MW SW UW)	Field Strength Soil / Rock (VS/VL S/L F/MD St/D VSt/VD H/EW VW W MS S VS ES)	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Samples	Tests
	0.30	[FILL] sandy GRAVELS; mixed with coal gravels up to 100mm (rounded), black						
	0.90	no coal, gravels up to 300mmø, light grey						
	1.20	gap 40mm road chip, angular, dark brown						No. 1 0, 1, 2, 2, 2, 3, 5, 5, 4, 5, 4, 4, 5, 2, 2, 5, 20
	1.70	coarse SAND; trace to minor rounded greywacke gravels, 80mmø to <20mmø, light brown						
	2.50	SILT; some clay, trace sand, yellow/orange/brown, moderately plastic, minor - some gravels & boulders up to 500mm across (greatest dimension) gravels very light grey/brown white						
	3.70	clayey SILT; greenish grey, angular limestone boulders <300mm greatest dimension						
		EOH @ 3.70 m						

SKETCH:

MAP

0 m 10 m 20 m
1:1000

Shoring/Support:
Stability:

A B C D

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER
- [ ] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

PIT TERMINATED DUE TO:
- [X] Target depth
- [ ] Flooding
- [ ] Refusal
- [ ] Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

RILEY CONSULTANTS Engineers and Geologists
Riley Consultants Ltd
4 Fred Thomas Drive
Takapuna, AKL
Tel: 09 4897872
Fax: 09 4897873

TEST PIT LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood	Greymouth	Mid of good shed	TP4

Job No.:	Start Date: 17-09-09 Finish Date:	Ground Level (m):	Co-Ordinates ():
09828			

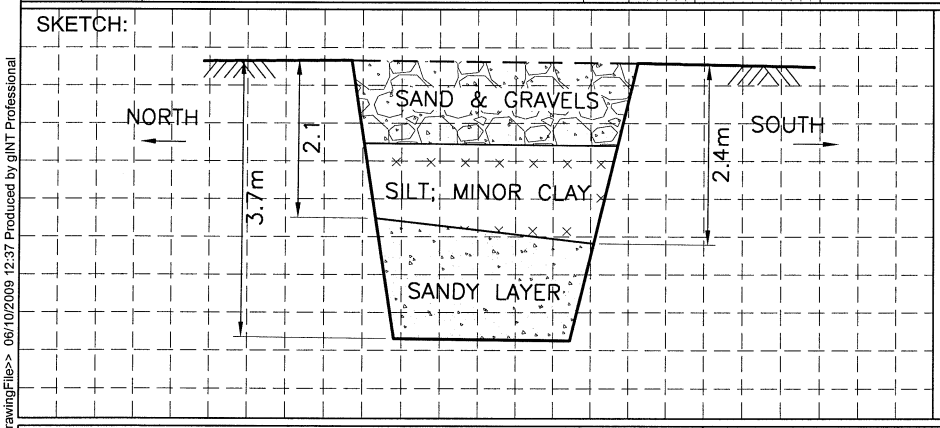
Client:	Hole Depth:	Sheet:
Good Earth Matters	3.70 m	1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering	Field Strength	Defect Description	Samples	Tests
	0.30	[FILL] SAND; some coal and rounded greywacke gravels and cobbles						No. 1 1, 2, 20 PSD test
	1.10	generally no coal, medium to coarse gravelly SAND; minro cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						
	2.10	SILT; minor clay, trace sand, minor limestone boulder, boulders up to 300mm across, occasionally up to 500mm, yellowish brown, orange and light grey/brown staining						No. 2 1, 1, 1, 6, 3, 3, 2, 6, 7, 3, 5, 3, 8, 4, 9, 4, 3, 7, 4
	3.70	course SAND; minor to some rounded greywacke gravels and cobbles						
		EOH @ 3.70 m						

Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT).
Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).

Weathering: RS CW HW MW SW UW
Field Strength: Soil VSoft Soft FirM Stiff VStiff Hard | Rock VW Ws S VS ES

SKETCH:



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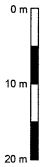
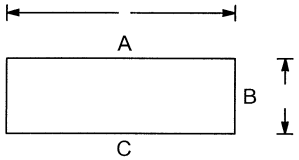


1:1000

Shoring/Support:
Stability:



- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER
- [ ] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

PIT TERMINATED DUE TO:
- [X] Target depth
- [ ] Flooding
- [ ] Refusal
- [ ] Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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RILEY CONSULTANTS Engineers and Geologists
Riley Consultants Ltd
4 Fred Thomas Drive
Takapuna, AKL
Tel: 09 4897872
Fax: 09 4897873

TEST PIT LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood	Greymouth	East end good shed	TP5

Job No.:	Start Date: 17-09-09 Finish Date:	Ground Level (m):	Co-Ordinates ():
09828			

Client:	Hole Depth:	Sheet:
Good Earth Matters	3.90 m	1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering	Field Strength (Soil | Rock)	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Samples	Tests
	0.40	[FILL] medium to coarse gravelly SAND; coal, minor cobbles, grey, non plstic, gravels and cobbles are rounded greywacke						
	0.65	silty gravelly SAND; gravels are fine to coarse grained, well graded, rounded greywacke						
	0.95							
	1.10	minor angular limestone gravels <40mmø, coal inclusions, generally dark brown-black						
		predominantly medium brown, no coal						
	2.20	sandy gravelly SILT; minor clay, angular to subangular limestone boulders up to 700mm across						
	2.90	SAND; medium grained gravels and boulders, minor rounded greywacke gravels, grey, non plastic, pocekts of limestone gravels with silty weathered material void infill						
	3.90	gravelly SAND; light medium grey, gravels are fine to coarse grained, rounded greywacke, occasional rounded greywacke cobbles, trace angular limestone cobbles - boulders						
		EOH @ 3.90 m						

SKETCH:

MAP

0 m
10 m
20 m
1:1000

Shoring/Support:
Stability:

A
D B
C

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER
- [ ] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

PIT TERMINATED DUE TO:
- [X] Target depth
- [ ] Flooding
- [ ] Refusal
- [ ] Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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RILEY CONSULTANTS
Engineers and Geologists
Riley Consultants Ltd
4 Fred Thomas Drive
Takapuna, AKL
Tel: 09 4897872
Fax: 09 4897873

TEST PIT LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood	Greymouth	Crest of stopbank	TP6

Job No.:	Start Date: 17-09-09 Finish Date:	Ground Level (m):	Co-Ordinates ():
09828			

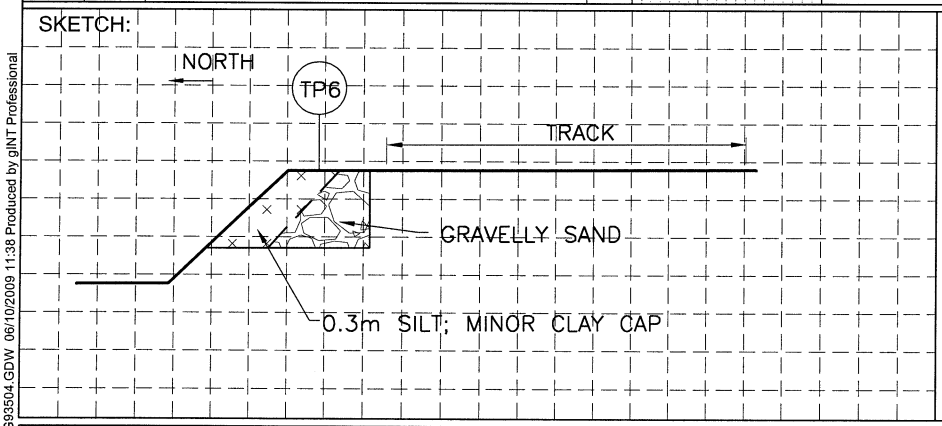
Client:	Hole Depth:	Sheet:
Good Earth Matters	0.75 m	1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering	Field Strength	Defect Description	Samples	Tests
	0.30	SILT; minor clay, trace to minor sand, minor rounded greywacke gravels						
	0.75	medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						PSD test
	1	EOH @ 0.75 m						No. 1 0, 1, 0, 1, 0, 1, 0, 1, 1, 20 No. 2 1, 1, 1, 1, 20
	2							
	3							
	4							
	5							

Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT).
Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).

Weathering: RS, CW, HW, MW, SW, UW
Field Strength — Soil: VS/VL, S/M, F/MD, St/D, VSt/VD, H/Vst; Rock: VW, W, MS, S, VS, ES
Defect Description: (type, orientation, spacing, roughness, persistence aperture, infilling etc)

SKETCH:



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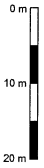

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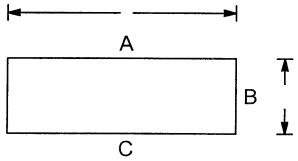
Shoring/Support:
Stability:



- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER
- [ ] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

PIT TERMINATED DUE TO:
- [X] Target depth
- [ ] Flooding
- [ ] Refusal
- [ ] Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

RILEYAKL.GLB Log RILEY TP 09828.GPJ DWG93504.GDW 06/10/2009 11:38 Produced by gINT Professional

RILEY CONSULTANTS Engineers and Geologists
Riley Consultants Ltd
4 Fred Thomas Drive
Takapuna, AKL
Tel: 09 4897872
Fax: 09 4897873

TEST PIT LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood	Greymouth	Middle of stopbank track	TP7

Job No.:	Start Date: 17-09-09 Finish Date:	Ground Level (m):	Co-Ordinates ():
09828			

Client:	Hole Depth:	Sheet:
Good Earth Matters	0.85 m	1 of 1

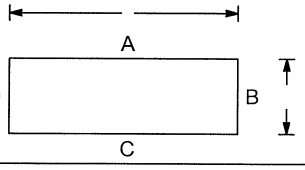
Elevation (m)	Depth (m)	Geological Description	Legend	Weathering	Field Strength	Defect Description	Samples	Tests
		Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT). Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).		RS CW HW MW SW UW	Soil: VSVL SFL FIRM STIFD VSTIFD HD VW W MS S VS ES — Rock	(type, orientation, spacing, roughness, persistence aperture, infilling etc)		
	0.40	medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						
	0.65	dark brown topsoil stained layer with trace organic material, i.e wood						PSD test
	0.85							No. 1 1, 1, 2, 2, 3, 3, 4, 5, 20
	1	medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						
		EOH @ 0.85 m						
	2							
	3							
	4							
	5							

SKETCH:

MAP

0 m
10 m
20 m
1:1000

Shoring/Support:
Stability:



- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER
- [ ] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

PIT TERMINATED DUE TO:
- [X] Target depth
- [ ] Flooding
- [ ] Refusal
- [ ] Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

RILEY CONSULTANTS
Engineers and Geologists
Riley Consultants Ltd
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Takapuna, AKL
Tel: 09 4897872
Fax: 09 4897873

TEST PIT LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood	Greymouth	Mid stopbank track	TP8

Job No.:	Start Date: / Finish Date:	Ground Level (m):	Co-Ordinates ():
09828	17-09-09		

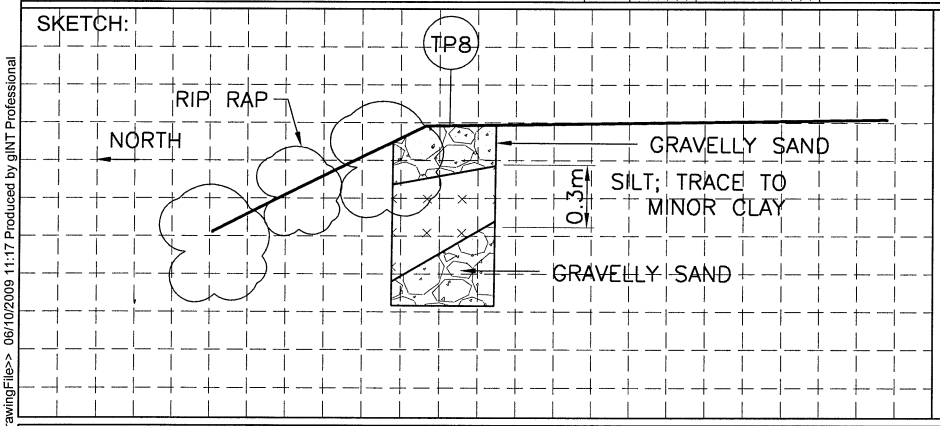
Client:	Hole Depth:	Sheet:
Good Earth Matters	0.75 m	1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering	Field Strength	Defect Description	Samples	Tests
	0.30	medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						No. 1 1, 3, 3, 10, 20
	0.60							No. 2 1, 2, 1, 3, 5, 12, 20
	0.75	SILT; trace to minor clay, brownish orange, orange and brownish grey staining						
	1	medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						
		EOH @ 0.75 m						
	2							
	3							
	4							
	5							

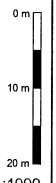
Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT).
Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).

Weathering: RS CW HW MW SW UW
Field Strength: Soil | Rock — VSvL SiL MD SvD VSvD VF F W WS S VS ES

SKETCH:



MAP



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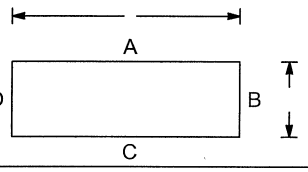
Shoring/Support:
Stability:



- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER ☐ None
☐ Slow Seep (depth)
☐ Rapid Inflow (depth)

PIT TERMINATED DUE TO:
☒ Target depth ☐ Flooding
☐ Refusal ☐ Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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Fax: 09 4897873

TEST PIT LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood	Greymouth	Middle of stopbank track	TP9

Job No.:	Start Date: 17-09-09 Finish Date:	Ground Level (m):	Co-Ordinates ():
09828			

Client:	Hole Depth:	Sheet:
Good Earth Matters	0.90 m	1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering (RS CW HW MW SW UW)	Field Strength (Soil: VS/VL SL MD St/D VSt/VD HSt/VH; Rock: VW W Ms S VS ES)	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Samples	Tests
	0.30	medium to coarse gravelly SAND; grey, non plastic, gravels are rounded greywacke						
	0.50							
	0.75	medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						
	0.90							
	1	silty TOPSOIL staining, dark brown						No. 1 1, 4, 3, 2, 3, 3, 7, 5, 20
		pockets of topsoil/silty material, predominantly gravelly sand						
		EOH @ 0.90 m						
	2							
	3							
	4							
	5							

SKETCH:

MAP

0 m
10 m
20 m
1:1000

Shoring/Support:
Stability:

A
D B
C

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER ☐ None
☐ Slow Seep (depth)
☐ Rapid Inflow (depth)

PIT TERMINATED DUE TO:
☒ Target depth ☐ Flooding
☐ Refusal ☐ Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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RILEY CONSULTANTS Engineers and Geologists
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TEST PIT LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood	Greymouth	Above concrete stopbank wall	TP10

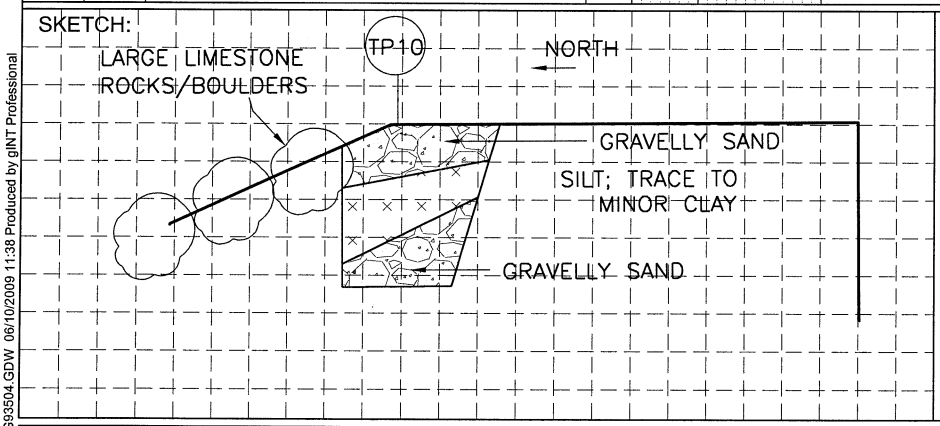
Job No.:	Start Date: 17-09-09 Finish Date:	Ground Level (m):	Co-Ordinates ():
09828			

Client:	Hole Depth:	Sheet:
Good Earth Matters	0.90 m	1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering (RS CW MW SW UW)	Field Strength Soil (VS VL S F MD St VSt H VH) Rock (EW VW W MS S VS ES)	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Samples	Tests
	0.35	medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						
	0.90	SILT; minor clay, minor sand, dark brown topsoil staining						PSD test Proctor test
	1	EOH @ 0.90 m						
	2							
	3							
	4							
	5							

Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT).
Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).

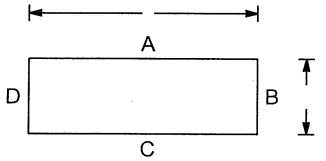
SKETCH:



MAP

1:1000

Shoring/Support:
Stability:



- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER ☐ None
☐ Slow Seep (depth)
☐ Rapid Inflow (depth)

PIT TERMINATED DUE TO:
☒ Target depth ☐ Flooding
☐ Refusal ☐ Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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Riley Consultants Ltd
4 Fred Thomas Drive
Takapuna, AKL
Tel: 09 4897872
Fax: 09 4897873

TEST PIT LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood	Greymouth	Middle of stopbank track	TP11

Job No.:	Start Date: / Finish Date:	Ground Level (m):	Co-Ordinates ():
09828	18-09-09		

Client:	Hole Depth:	Sheet:
Good Earth Matters	0.55 m	1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering	Field Strength (Soil / Rock)	Defect Description	Samples	Tests
	0.20	medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						
	0.55	dark brown staining, trace silt						No. 1 1, 1, 2, 4, 3, 4, 10, 5, 10, 10, 10
	1	EOH @ 0.55 m						
	2							
	3							
	4							
	5							

Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT).
Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).

Weathering: RS CW HW MW SW UW
Field Strength: VS/VL SL/LO FI/MO SV/D VS/VD VW/W W MS S VS ES

SKETCH:

MAP

0 m
10 m
20 m
1:1000

Shoring/Support:
Stability:

A
B
C
D

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER
- [ ] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

PIT TERMINATED DUE TO:
- [X] Target depth
- [ ] Flooding
- [ ] Refusal
- [ ] Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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4 Fred Thomas Drive
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TEST PIT LOG

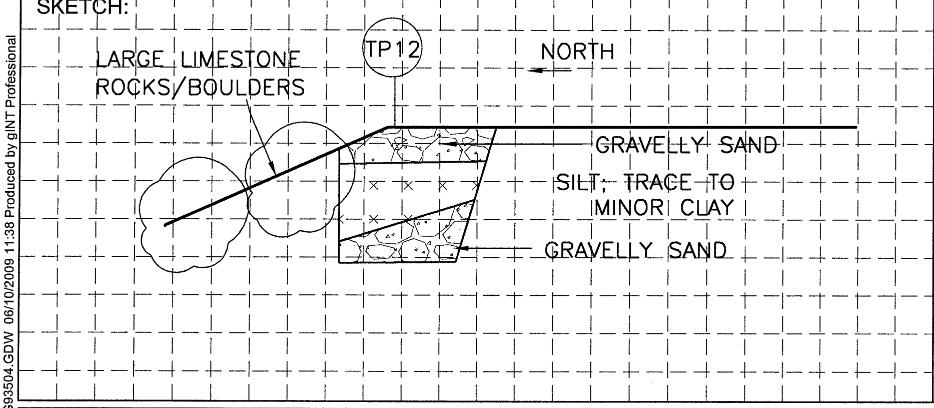
Project: Greymouth Flood	Location: Greymouth	Hole position:	No.: TP12
Job No.: 09828	Start Date: 18-09-09 Finish Date:	Ground Level (m):	Co-Ordinates ():
Client: Good Earth Matters	Hole Depth: 0.65 m		Sheet: 1 of 1

Geological Description: Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT). Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).

Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)

Depth (m)	Geological Description	Tests
0.10	medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke	No. 1: 1, 2, 2, 2, 2, 2, 7, 20; PSD test
0.50	SILT; trace to minor clay, trace to minor rounded greywacke gravels and angular limestone gravels-boulders, grey, non plastic	No. 2: 1, 1, 2, 3, 3, 4, 10, 6, 11, 8, 8, 8, 6, 5, 4, 9, 5, 3, 3, 4
0.65	medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke	
	EOH @ 0.65 m	

SKETCH:



MAP

1:1000

Shoring/Support:
Stability:

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER: ☐ None; ☐ Slow Seep (depth); ☐ Rapid Inflow (depth)

PIT TERMINATED DUE TO: ☒ Target depth; ☐ Flooding; ☐ Refusal; ☐ Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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TEST PIT LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood	Greymouth	Between two bridges	TP13

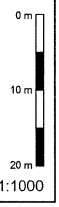
Job No.:	Start Date: / Finish Date:	Ground Level (m):	Co-Ordinates ():
09828	18-09-09		

Client:	Hole Depth:	Sheet:
Good Earth Matters	3.70 m	1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering (RS, CW, MW, HW, SW, UW)	Field Strength (Soil: VS/VL, S/L, MD, St/D, VSt/VD, H/VH; Rock: EW, W, Ws, S, VS, ES)	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Samples	Tests
	0.80	[FILL] medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke, root and organic debris inclusions.						No. 1 1, 1, 1, 1, 1, 1, 1, 1, 6, 3, 2, 2, 3, 3, 1, 2, 2, 2, 2
	1 1.50	medium to coarse silty gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke, black carbonaceous organic inclusions						PSD test
	2 2.50	organic content, reducing with depth, occasional brick and steel inclusions						
	3 3.30	very large wood fragments inclusions(up to 600mm across), steel and brick inclusions						
	3.70	large angular limestone BOULDERS						
	4 5	to hard to dig due to large limestone boulders/bedrock EOH @ 3.70 m						

SKETCH:

MAP



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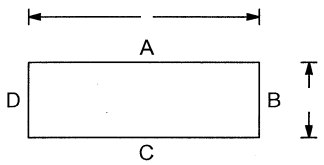
Shoring/Support:
Stability:



- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER
- [ ] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

PIT TERMINATED DUE TO:
- [X] Target depth
- [ ] Flooding
- [ ] Refusal
- [ ] Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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RILEY CONSULTANTS Engineers and Geologists
Riley Consultants Ltd
4 Fred Thomas Drive
Takapuna, AKL
Tel: 09 4897872
Fax: 09 4897873

TEST PIT LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood	Greymouth	Between two bridges	TP14

Job No.:	Start Date: / Finish Date:	Ground Level (m):	Co-Ordinates ():
09828			

Client:	Hole Depth:	Sheet:
Good Earth Matters	3.00 m	1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering (RS CW HW MW SW UW)	Field Strength (Soil: VS/VL S/L S/MD S/D S/VD V S/W V/W; Rock: W Ws S VS ES)	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Samples	Tests
	0	[FILL] medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						
	1.30							
	1.50	silty gravelly SAND; dark brown, organic pockets, trace wood and inorganic debris						
	2.00	angular limestone boulders inclusions						
		medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke, angular limestone boulders						
	3.00	EOH @ 3.00 m						

SKETCH:

MAP

0 m
10 m
20 m
1:1000

Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT).
Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).

Shoring/Support:
Stability:

A
B
C
D

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER
- [ ] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

PIT TERMINATED DUE TO:
- [X] Target depth
- [ ] Flooding
- [ ] Refusal
- [ ] Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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Riley Consultants Ltd
4 Fred Thomas Drive
Takapuna, AKL
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TEST PIT LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood	Greymouth	Between two bridges	TP15

Job No.:	Start Date: / Finish Date:	Ground Level (m):	Co-Ordinates ():
09828	18-09-09		

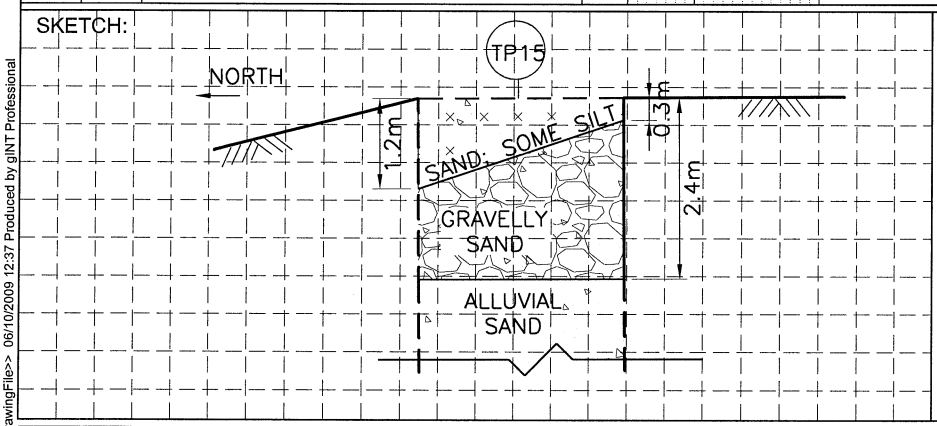
Client:	Hole Depth:	Sheet:
Good Earth Matters	5.00 m	1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering	Field Strength	Defect Description	Samples	Tests
	0 – 1.20	[FILL] SAND; some silt and rounded greywacke gravels, brown, non plastic rootlets						
	1.20 – 2.40	gravelly SAND; trace silt, minor cobbles, gravels and cobbles are well graded, rounded greywacke, aungular limestone boulder inclusions, occasional silty band/pocket						
	2.40 – 3.50	medium grained SAND; grey, occasional tree/wood inclusions						
	3.70	seepage						
	5	EOH @ 5.00 m						

Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT).
Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).

Weathering: RS CW MW SW UW
Field Strength: Soil VS/VL S/MD St/D VSt/VD — Rock VW W MS S VS ES
Defect Description: (type, orientation, spacing, roughness, persistence aperture, infilling etc)

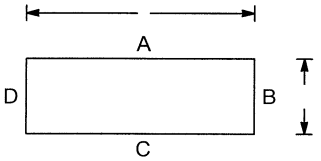
SKETCH:



MAP

1:1000

Shoring/Support:
Stability:



- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER ☐ None
☐ Slow Seep (depth)
☐ Rapid Inflow (depth)

PIT TERMINATED DUE TO:
☒ Target depth ☐ Flooding
☐ Refusal ☐ Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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RILEY CONSULTANTS
Engineers and Geologists

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4 Fred Thomas Drive
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TEST PIT LOG

Project: Greymouth Flood	Location: Greymouth	Hole position: Between two bridges	No.: **TP16**
Job No.: 09828	Start Date: 21-09-09 Finish Date:	Ground Level (m):	Co-Ordinates ():
Client: Good Earth Matters	Hole Depth: 3.80 m		Sheet: 1 of 1

Elevation (m)	Depth (m)	Geological Description Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT). Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).	Legend	Weathering RS CW HW MW SW UW	Field Strength Soil | Rock VS/VL S/L F/MD St/D VSt/VD H/EW VW W MS S VS ES	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Samples	Tests
	0.50	[FILL] medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						
	2.50	trace large subangular limestone boulders inclusions, up to 1m in diameter, occasional wood inclusions						
	3.60	sandy SILT; fine gravels, minor rounded gravels, brown, non plastic						
	3.80	medium grained SAND; grey, non plastic						
		3.60 m seepage						
		EOH @ 3.80 m						

SKETCH:

MAP

0 m
10 m
20 m
1:1000

Shoring/Support:
Stability:

A
B
C
D

- ● Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- ▼ Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER
- [ ] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

PIT TERMINATED DUE TO:
- [X] Target depth
- [ ] Flooding
- [ ] Refusal
- [ ] Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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Tel: 09 4897872
Fax: 09 4897873

TEST PIT LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood	Greymouth	Adjacent sportsclub	TP17

Job No.:	Start Date: / Finish Date:	Ground Level (m):	Co-Ordinates ():
09828	21-09-09		

Client:	Hole Depth:	Sheet:
Good Earth Matters	0.60 m	1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering	Field Strength (Soil | Rock)	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Samples	Tests
	0.20	medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						
	0.45							
	0.60	SILT; some limestone gravels, light orange/brown, non plastic						
	1	medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						
		EOH @ 0.60 m						
	2							
	3							
	4							
	5							

Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT).
Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).

Weathering: RS, CW, HW, MW, SW, UW
Field Strength: VS/VL, S/L, S/MD, S/VD, VS/VD, VW, W, Ws, S, VS, ES

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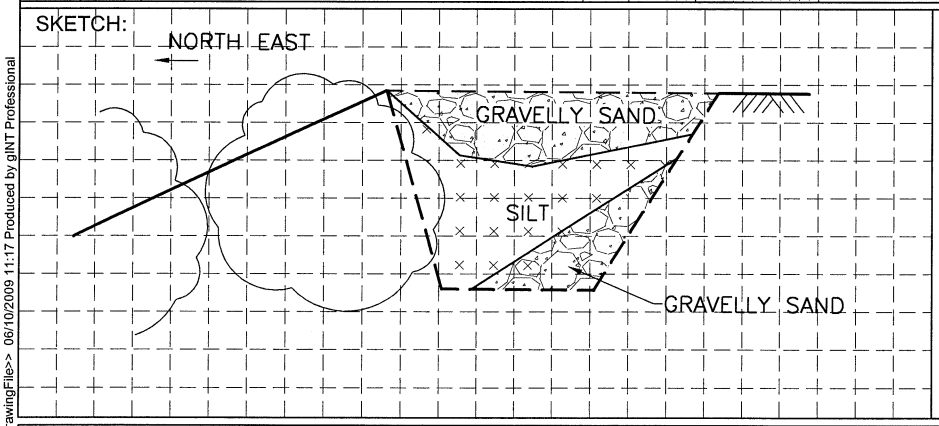

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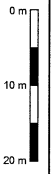

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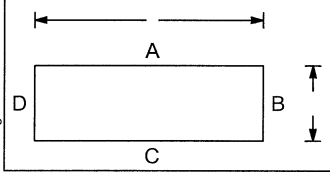
Shoring/Support:
Stability:



- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER ☐ None
☐ Slow Seep (depth)
☐ Rapid Inflow (depth)

PIT TERMINATED DUE TO:
☒ Target depth ☐ Flooding
☐ Refusal ☐ Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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TEST PIT LOG

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Project: Greymouth Flood	Location: Greymouth	Hole position: East of sports club	No.: **TP18**
Job No.: 09828	Start Date: 21-09-09 Finish Date:	Ground Level (m):	Co-Ordinates ():
Client: Good Earth Matters	Hole Depth: 0.65 m		Sheet: 1 of 1

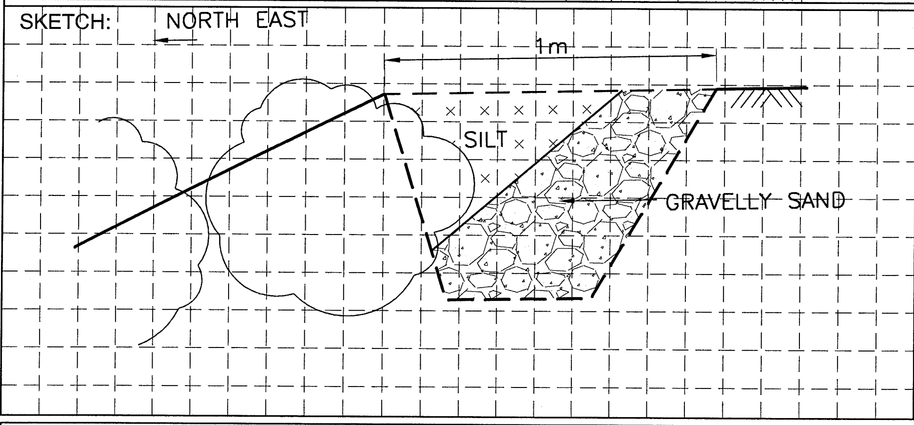
Elevation (m)	Depth (m)	Geological Description	Legend	Weathering	Field Strength (Soil / Rock)	Defect Description	Samples	Tests
	0.50	limestone boulders generally <400mm in diameter with SILT; trace fine gravels, trace sand, minor clay, predominantly orange/brown void infill						
	0.65	medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						
		EOH @ 0.65 m						

Geological Description: Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT). Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).

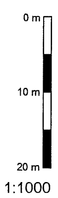
Weathering: RS CW HW MW SW UW. Field Strength: VS/VL S/L F/MD St/D VSt/VD H/EW VW W MS S VS ES

Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)

SKETCH: NORTH EAST



MAP



Shoring/Support:
Stability:

A, B, C, D

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER ☐ None
☐ Slow Seep (depth)
☐ Rapid Inflow (depth)

PIT TERMINATED DUE TO:
☒ Target depth ☐ Flooding
☐ Refusal ☐ Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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Riley Consultants Ltd
4 Fred Thomas Drive
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Tel: 09 4897872
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TEST PIT LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood	Greymouth	North fishermans wharf	TP19

Job No.:	Start Date: / Finish Date:	Ground Level (m):	Co-Ordinates ():
09828	21-09-09		

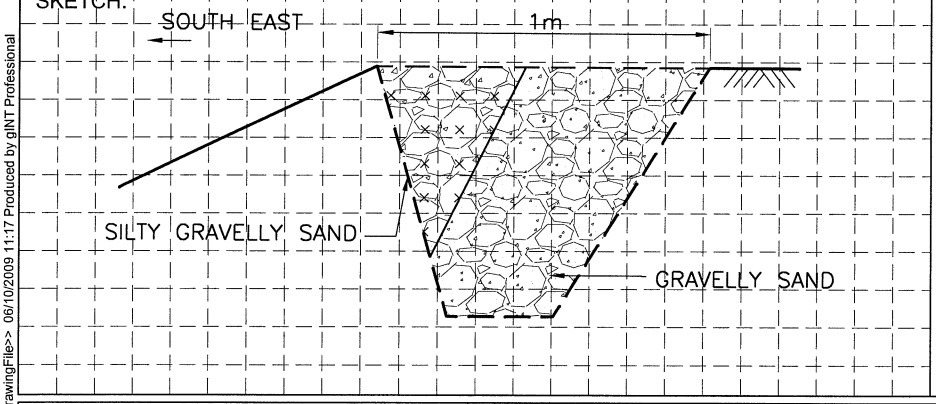
Client:	Hole Depth:	Sheet:
Good Earth Matters	0.55 m	1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering	Field Strength	Defect Description	Samples	Tests
	0.40	medium to coarse silty gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						
	0.55	medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						
	1	EOH @ 0.55 m						
	2							
	3							
	4							
	5							

Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT).
Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).

Weathering: RS CW HW MW SW UW
Field Strength: Soil — VSL SL F St VSt H; Rock — EW W MS S VS ES
Defect Description: (type, orientation, spacing, roughness, persistence aperture, infilling etc)

SKETCH:



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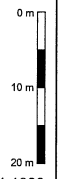

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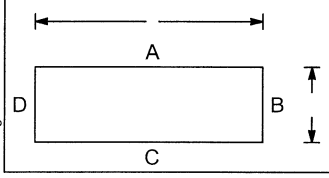
Shoring/Support:
Stability:



- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER
- [ ] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

PIT TERMINATED DUE TO:
- [X] Target depth
- [ ] Flooding
- [ ] Refusal
- [ ] Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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RILEY CONSULTANTS
Engineers and Geologists

Riley Consultants Ltd
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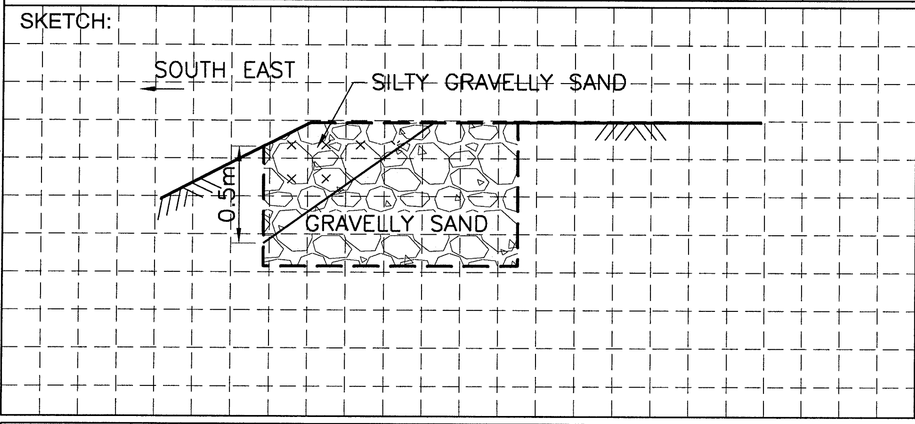
TEST PIT LOG

Project: Greymouth Flood	Location: Greymouth	Hole position: Above Fishermans wharf	No.: TP20
Job No.: 09828	Start Date: Finish Date:	Ground Level (m):	Co-Ordinates ():
Client: Good Earth Matters	Hole Depth: 0.70 m		Sheet: 1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering	Field Strength	Defect Description	Samples	Tests
		Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT). Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).		RS CW HW MW SW UW	Soil: VS/VL S/L F/MD St/D VSt/VD H/EW Rock: VW W MS S VS ES	(type, orientation, spacing, roughness, persistence aperture, infilling etc)		
	0.50	(Topsoil) gravelly silty SAND; rounded greywacke gravels generally minor rounded graywacke cobble, dark brown, non plastic						
	0.70	gravelly SAND; rounded greywacke gravels generally, minor rounded greywacke cobbles, medium grey, non plastic						PSD test
		EOH @ 0.70 m						

Depth scale: 1, 2, 3, 4, 5

SKETCH:



MAP

0 m
10 m
20 m
1:1000

Shoring/Support:
Stability:

A
B
C
D

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER
- [ ] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

PIT TERMINATED DUE TO:
- [x] Target depth
- [ ] Flooding
- [ ] Refusal
- [ ] Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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Tel: 09 4897872
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RILEY CONSULTANTS Engineers and Geologists

TEST PIT LOG

Project: Greymouth Flood	Location: Greymouth	Hole position: Crest of stopbank	No.: **TP21**
Job No.: 09828	Start Date: 21-09-09 Finish Date:	Ground Level (m):	Co-Ordinates ():
Client: Good Earth Matters	Hole Depth: 0.80 m		Sheet: 1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering	Field Strength	Defect Description	Samples	Tests
	0.30	(Topsoil) gravelly silty SAND; rounded greywacke gravels generally minor rounded graywacke cobble, dark brown, non plastic, rootlets.						
	0.80	medium to coarse gravelly SAND; minor cobbles, grey, non plastic, gravels and cobbles are rounded greywacke						
		EOH @ 0.80 m						

Geological Description header notes: Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT). Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).

Weathering: RS CW HW MW SW UW

Field Strength: Soil | Rock — VS/VL S/L F/MD St/D VSt/VD H/EW VW W MS S VS ES

Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)

SKETCH:

MAP

0 m 10 m 20 m 1:1000

Shoring/Support:
Stability:

A B C D

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER
☐ None
☐ Slow Seep (depth)
☐ Rapid Inflow (depth)

PIT TERMINATED DUE TO:
☒ Target depth ☐ Flooding
☐ Refusal ☐ Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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TEST PIT LOG

Project: Greymouth Flood	Location: Greymouth	Hole position: Adjacent culvert	No.: TP22
Job No.: 09828	Start Date: 22-09-09 Finish Date:	Ground Level (m):	Co-Ordinates ():
Client: Good Earth Matters	Hole Depth: 1.80 m		Sheet: 1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering (RS CW HW MW SW UW)	Field Strength Soil / Rock (VS/VL S/L F/MD St/D VSt/VD H/EW VW W MS S VS ES)	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Samples	Tests
	0.25	gravelly SAND; minor silt(topsoil), rounded greywacke gravels generally <30mm in diameter, dark brown, non plastic, rootlets						
	1.10	SILT; minor clay, minor rounded greywacke gravels, trace to minor sand, light grey and orange, non plastic, trace to minor roots, occasional inorganic debris						PSD test
	1.80	large limestone BOULDERS, occasional large concrete block, approximately 1.0m						
		EOH @ 1.80 m						

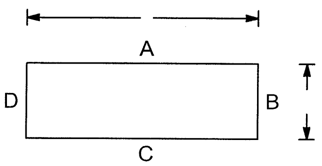
Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT).
Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).

SKETCH:

MAP

0 m
10 m
20 m
1:1000

Shoring/Support:
Stability:



- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER
- [ ] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

PIT TERMINATED DUE TO:
- [X] Target depth
- [ ] Flooding
- [ ] Refusal
- [ ] Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

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Engineers and Geologists
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TEST PIT LOG

Project: Greymouth Flood	Location: Greymouth	Hole position: Crest of stopbank	No.: TP23a
Job No.: 09828	Start Date: 22-09-09 Finish Date:	Ground Level (m):	Co-Ordinates ():
Client: Good Earth Matters	Hole Depth: 0.60 m		Sheet: 1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering (RS CW HW MW SW UW)	Field Strength Soil / Rock (VS/VL S/L F/MD St/D VSt/VD H/EW VW W MS S VS ES)	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Samples	Tests
	0.60	SILT; trace clay, trace sand, minor to some rounded greywacke gravels, light brown/grey and orange, rootlets						
		EOH @ 0.60 m						

Geological Description: Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT). Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).

Depth scale: 1, 2, 3, 4, 5

SKETCH:

MAP

0 m
10 m
20 m
1:1000

Shoring/Support:
Stability:

A
B
C
D

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER
- [ ] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

PIT TERMINATED DUE TO:
- [x] Target depth
- [ ] Flooding
- [ ] Refusal
- [ ] Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

Riley Consultants Ltd
4 Fred Thomas Drive
Takapuna, AKL
Tel: 09 4897872
Fax: 09 4897873

TEST PIT LOG

Project: Greymouth Flood	Location: Greymouth	Hole position: Below Road	No.: **TP23b**
Job No.: 09828	Start Date: 22-09-09 Finish Date:	Ground Level (m):	Co-Ordinates ():
Client: Good Earth Matters	Hole Depth: 0.60 m		Sheet: 1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering	Field Strength	Defect Description	Samples	Tests
	0.20	gravelly silty SAND (topsoil); rounded greywacke gravels <150mm in diameter, dark brown						
	0.60	coarse grained gravelly SAND; rounded greywacke gravels trace-minor rounded greywacke cobbles.						
		EOH @ 0.60 m						

Geological Description: Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT). Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).

Weathering: RS CW HW MW SW UW

Field Strength: Soil | Rock — VS/VL S/L F/MD St/D VSt/VD H/EW VW W MS S VS ES

Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)

SKETCH:

MAP

1:1000

Shoring/Support:
Stability:

A B C D

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER
- [ ] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

PIT TERMINATED DUE TO:
- [X] Target depth
- [ ] Flooding
- [ ] Refusal
- [ ] Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

RILEY CONSULTANTS Engineers and Geologists
Riley Consultants Ltd
4 Fred Thomas Drive
Takapuna, AKL
Tel: 09 4897872
Fax: 09 4897873

TEST PIT LOG

Project: Greymouth Flood	Location: Greymouth	Hole position: Crest of stopbank	No.: **TP24a**
Job No.: 09828	Start Date: Finish Date:	Ground Level (m):	Co-Ordinates ():
Client: Good Earth Matters	Hole Depth: 1.00 m		Sheet: 1 of 1

Elevation (m)	Depth (m)	Geological Description	Legend	Weathering	Field Strength	Defect Description	Samples	Tests
		Soil Description: subordinate, praticle size, MAJOR, minor; colour, structure; strength; moisture condition; grading; bedding; plasticity; sensitivity; major qualifications; weathering of clasts; subordinate qualifications; minor qualifications; additional structure; (GEOLOGIC UNIT). Rock Description: weathering; colour; texture; fabric and orientation; NAME; strength; additional description, (GEOLOGIC UNIT).		RS CW HW MW SW UW	Soil: VS/VL S/L F/MD St/D VSt/VD H/EW; Rock: VW W MS S VS ES	(type, orientation, spacing, roughness, persistence aperture, infilling etc)		
	0.20	TOPSOIL; sand, minor silt, round greywacke gravels						
	1.00	gravelly SAND; rounded greywacke gravels generally <50mm in diameter, trace rounded greywackey cobbles, medium grey, non plastic						
		EOH @ 1.00 m						

SKETCH:

MAP

0 m
10 m
20 m
1:1000

Shoring/Support:
Stability:

A
B
C
D

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) P=Peak, R=Residual, UTP=Unable to penetrate
- Scala Penetrometer - blows/50mm

GROUNDWATER
- [ ] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

PIT TERMINATED DUE TO:
- [x] Target depth
- [ ] Flooding
- [ ] Refusal
- [ ] Machine limit

Remarks

All dimensions in metres Scale 1:50		Shear Vane No.	Logged by: MJB	Checked by:

RILEY CONSULTANTS
Engineers and Geologists
Riley Consultants
395 Madras Street
CHRISTCHURCH 8011
Tel: 03.379.4402
Fax: 03.379.4403

BORE HOLE LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood Wall Geotech	Greymouth, West Coast		DH1

Job No.:	Start Date: 13-10-09 Finish Date: 13-10-09	Ground Level (m LINZ):	Co-Ordinates (NZMG):
09828		6.90	E 2,362,642.0 N 5,860,582.0

Client:	Hole Depth:	Sheet:
West Coast Regional Council	10.00 m	1 of 1

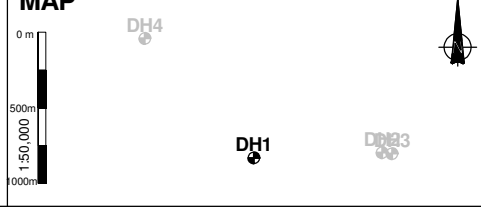
Type	Run	Fluid & Water	Legend	Geological Description	Elevation (m LINZ)	Depth (m)	Samples	Tests	Backfill / Piezometer
TRC		1 15		Grey sandy fine GRAVEL. Moist (FILL)		1	1-2m		
				2.50 m - 2.95 m Medium to coarse GRAVEL.		2	2-3m SPT2.5m	SPT 2.50 m 2, 2, 2, 3, 3, 5; N = 13	
					+3.40	3	3-4m		
				Sandy GRAVEL. Moist to wet (ALLUVIUM)		4	SPT4.0m	SPT 4.00 m 3, 14, 12, 7, 7, 5; N = 31	
				4.00 m - 4.45 m Medium to coarse GRAVEL with some sand and trace of silt			4-5m		
		1		5.50 m - 5.95 m Medium to coarse GRAVEL with some sand and minor silt 5.50 m Driller comment - increased resistence 5.50 m - 5.95 m Medium to coarse GRAVEL with some sand and minor silt 5.50 m Driller comment - increased resistence		5	5-6m SPT5.5m	SPT 5.50 m 4, 8, 6, 9, 6, 6; N = 27	
						6	6-7m		
				7.00 m - 7.15 m Coarse SAND with minor silt 7.15 m - 7.23 m GRAVEL with minor sand 7.23 m - 7.45 m No recovery 7.50 m - 10.00 m Becomes gravelly SAND with trace of silt.		7	SPT7m	SPT 7.00 m 7, 10, 11, 8, 8, 9; N = 36	
							7-8m		
		2			-3.10	8	8-9m		
						9	9-10m		
				EOH @ 10.00 m		10			
						11			

RILEY AGS 3_1 NZ LIB 11.GLB Log RILEY BH 09828 - GREYMOUTH FLOOD WALL.GPJ DWG76988.GDW 21/10/2009 16:02 Produced by gINT Professional

Explanations:

- 1 Water Strike (1st, 2nd ...)
- 1 Water Rise (1st, 2nd ...) and Rise Time (minutes)
- Small Disturbed Sample
- Large Disturbed Sample

MAP



Remarks

Material description is of drilled tailings except for SPT split spoon core samples.

Located on intermediate bench behind dolphin statue, 1.7m from wall supporting top bench.

All dimensions in metres Scale 1:73	Contractor: CW Drilling & Investigation Ltd	Rig/Plant Used: Hitachi Ex60 Multidrill	Driller: Barclay Moir	Logged by: AvD	Checked by:

RILEY CONSULTANTS
Engineers and Geologists

Riley Consultants
395 Madras Street
CHRISTCHURCH 8011
Tel: 03.379.4402
Fax: 03.379.4403

BORE HOLE LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood Wall Geotech	Greymouth, West Coast		DH2

Job No.:	Start Date: 13-10-09 Finish Date: 13-10-09	Ground Level (m LINZ):	Co-Ordinates (NZMG):
09828		6.40	E 2,363,490.0 N 5,860,617.0

Client:	Hole Depth:	Sheet:
West Coast Regional Council	6.10 m	1 of 1

Type	Run	Fluid & Water	Legend	Geological Description	Elevation (m LINZ)	Depth (m)	Samples	Tests	Backfill / Piezometer
TRC		15		Grey fine to medium GRAVEL with some sand and minor silt. Moist (FILL)		1	1-2m		
					+4.60				
				Sandy GRAVEL with minor silt. Moist to wet (ALLUVIUM)		2	2-3m SPT2.5m	SPT 2.50 m Self Pen. 225mm; 1, 1, 0, 0, 0, 0; N = 0	
				2.50 m - 2.80 m (SPT core) Dark grey moderately densely packed silty SAND. Moist					
				2.80 m - 2.90 m (SPT core) sandy SILT with trace of clay. Moist to wet; low plasticity		3			
				3.20 m - 4.80 m Becomes silty sandy GRAVEL			3-4m		
				4.00 m - 4.20 m (SPT core) Boulder		4	SPT4.0m	SPT 4.00 m 19, 7, 9, 6, 4, 3; N = 22	
				4.20 m - 4.30 m (SPT core) Sandy medium GRAVEL. Moist to wet 4.30 m - 4.45 m (SPT core) Sandy fine GRAVEL.			4-5m		
				4.80 m - 5.40 m Becomes gravelly SAND with some silt		5			
					+1.00		5-6m		
				Angular chips of light brown mudstone (COBDEN LIMESTONE)		6			
					+0.30				
				EOH @ 6.10 m		7			

RILEY AGS 3_1 NZ LIB 11.GLB Log RILEY BH 09828 - GREYMOUTH FLOOD WALL.GPJ DWG76988.GDW 21/10/2009 16:02 Produced by gINT Professional

Explanations:

- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and Rise Time (minutes)
- Small Disturbed Sample
- Large Disturbed Sample

MAP

Remarks

Material description is of drilled tailings except for SPT split spoon core samples.

Located on bench 13m downstream of culvert, 3.5m off north edge of vehicle track.

All dimensions in metres Scale 1:48	Contractor: CW Drilling & Investigation Ltd	Rig/Plant Used: Hitachi Ex60 Multidrill	Driller: Barclay Moir	Logged by: AvD	Checked by:

RILEY CONSULTANTS
Engineers and Geologists
Riley Consultants
395 Madras Street
CHRISTCHURCH 8011
Tel: 03.379.4402
Fax: 03.379.4403

BORE HOLE LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood Wall Geotech	Greymouth, West Coast		DH3

Job No.:	Start Date: 13-10-09 Finish Date: 14-10-09	Ground Level (m LINZ):	Co-Ordinates (NZMG):
09828		8.30	E 2,363,556.0 N 5,860,610.0

Client:	Hole Depth:	Sheet:
West Coast Regional Council	7.20 m	1 of 1

Type	Run	Fluid & Water	Legend	Geological Description	Elevation (m LINZ)	Depth (m)	Samples	Tests	Backfill / Piezometer
TRC		15 2 15 1 2		Grey fine to medium GRAVEL with some sand and minor silt. Moist (FILL)		1	1-2m		
					+5.80	2	2-3m SPT2.5m	SPT 2.50 m 1, 0, 0, 1, 0, 0; N = 1	
				Sandy GRAVEL with minor silt. Moist to wet (ALLUVIUM) 2.60 m - 2.70 m lens of organic black/yellow organic (fibrous) silt, low plasticity. 2.80 m Becomes moist to wet		3	3-4m		
				4.00 m - 4.45 m (SPT core) Grey gravelly coarse SAND. Wet to saturated		4	SPT4.0m 4-5m	SPT 4.00 m 4, 11, 6, 11, 10, 7; N = 34	
					+3.20	5	5-6m		
				Angular chips of light brown mudstone (COBDEN LIMESTONE)		6	6-7m		
					+1.10	7			
				EOH @ 7.20 m					

RILEY AGS 3_1 NZ LIB 11.GLB Log RILEY BH 09828 - GREYMOUTH FLOOD WALL.GPJ DWG76988.GDW 21/10/2009 16:02 Produced by gINT Professional

Explanations:

- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and Rise Time (minutes)
- Small Disturbed Sample
- Large Disturbed Sample

MAP

Remarks

Material description is of drilled tailings except for SPT split spoon core samples

Located on north edge of road, 35m east (along road) from wooden bridge centreline; 2.5m from wing wall.

All dimensions in metres Scale 1:48	Contractor: CW Drilling & Investigation Ltd	Rig/Plant Used: Hitachi Ex60 Multidrill	Driller: Barclay Moir	Logged by: AvD	Checked by:

RILEY CONSULTANTS
Engineers and Geologists
Riley Consultants
395 Madras Street
CHRISTCHURCH 8011
Tel: 03.379.4402
Fax: 03.379.4403

BORE HOLE LOG

Project:	Location:	Hole position:	No.:
Greymouth Flood Wall Geotech	Greymouth, West Coast		DH4

Job No.:	Start Date: 14-10-09 Finish Date: 14-10-09	Ground Level (m LINZ):	Co-Ordinates (NZMG):	Sheet:
09828		6.60	E 2,361,921.0 N 5,861,372.0	1 of 1

Client: West Coast Regional Council

Hole Depth: 10.45 m

Type	Run	Fluid & Water	Legend	Geological Description	Elevation (m LINZ)	Depth (m)	Samples	Tests	Backfill / Piezometer
TRC		1 15		Grey fine to medium GRAVEL with some sand and minor silt and local cobbles. Moist (FILL)		1			
				1.20 m - 1.70 m Boulder (weak light brown mudstone)			1-2m		
					+4.10	2	2-3m SPT2.5m	SPT 2.50 m 4, 3, 3, 1, 4, 3; N = 11	
				Sandy GRAVEL with minor silt. Moist to wet (ALLUVIUM)		3	3-4m		
		1				4	SPT4m	SPT 4.00 m 2, 3, 3, 2, 3, 3; N = 11	
							4-5m		
						5			
							5-6m		
						6			
							6-7m		
				7.00 m - 7.13 m (SPT core) sandy GRAVEL 7.13 m - 7.27 m (SPT core) Coarse SANd with minor SILT 7.25 m - 7.45 m (SPT core) No recovery 7.50 m Becomes more siltly		7	SPT7m	SPT 7.00 m 4, 9, 16, 10, 9, 11; N = 46	
							7-8m		
						8			
				8.50 m - 8.62 m (SPT core) Cobble/boulder 8.62 m - 8.71 m (SPT core) Dark grey silty SAND. Wet 8.71 m - 8.95 m (SPT core) No recovery			8-9m SPT8.5m	SPT 8.50 m 6, 6, 11, 8, 10, 6; N = 35	
						9			
							9-10m		
SPT		2		10.00 m - 10.45 m (SPT core) Coarse to medium GRAVEL	-3.85	10	SPT10m	SPT 10.00 m 2, 3, 5, 4, 5, 4; N = 18	
				EOH @ 10.45 m		11			

Explanations:

- 1 — Water Strike (1st, 2nd ...)
- 1 — Water Rise (1st, 2nd ...) and Rise Time (minutes)
- Small Disturbed Sample
- Large Disturbed Sample

MAP

Remarks

Material description is of drilled tailings except for SPT split spoon core samples.

Located immediately southwest of culvert on Hill Quay, Cobden (south side of road).

All dimensions in metres Scale 1:73	Contractor: CW Drilling & Investigation Ltd	Rig/Plant Used: Hitachi Ex60 Multidrill	Driller: Barclay Moir	Logged by: AvD	Checked by:

RILEY AGS 3_1 NZ LIB 11.GLB Log RILEY BH 09828 - GREYMOUTH FLOOD WALL.GPJ DWG76988.GDW 21/10/2009 16:02 Produced by gINT Professional

APPENDIX 3

Laboratory Test Results

Canterbury Laboratory

325 Pound Rd, Yaldhurst
PO Box 16-064, Christchurch 8441
Telephone: +64 3 349 9142
Facsimile: +64 3 349 9143
www.fultonhogan.com
0800 LABORATORY

Material Test Report

Report No: MAT:CAN09S-6040
Issue No: 1

Client:
Riley Consultants Ltd
PO Box 4355
Christchurch Mail Centre

Christchurch 8140
NZ

Project: QA Testing - Aggregates

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: Max Burford
(Supervisor)
IANZ Accreditation No:200
Date of Issue: 30/09/09

Sample Details

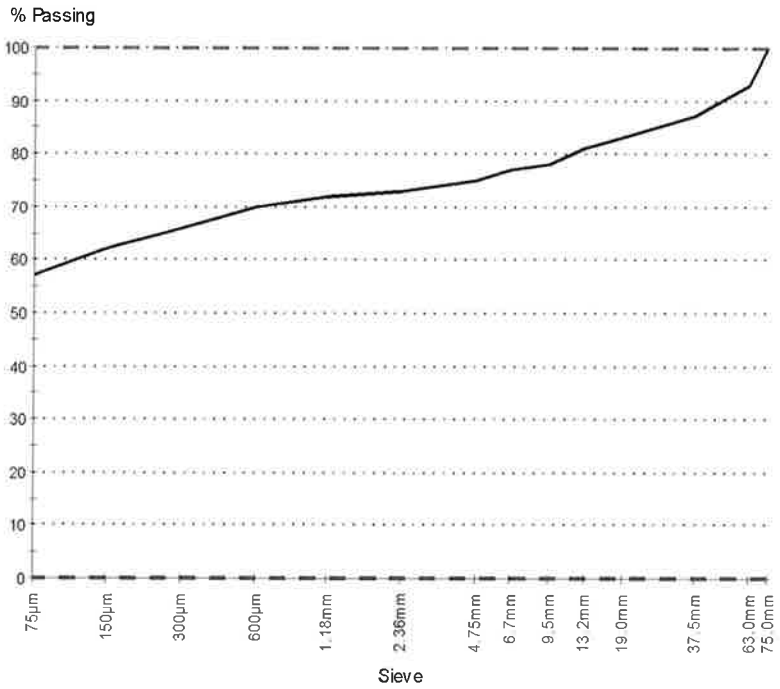
Sample ID:	CAN09S-6040
Client Sample ID:	TP10 O/N 09828
Material:	Clay
Sample Source:	Miscellaneous Source
Site/Sampled From:	Greymouth Flood Walls TP10
Date Sampled:	18/09/2009
Specification:	No Specification
Sampled By:	Advised - See Comments
Sampling Method:	As Received - Not Accredited
Date Tested:	30/09/2009
Technician:	Max Burford
Sampling Endorsed:	No

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

Method: NZS 4407:1991 Test 3.8.2
Drying by: Oven



Sieve Size	% Passing	Limits
75.0mm	100	0 – 100
63.0mm	93	0 – 100
37.5mm	87	0 – 100
19.0mm	83	0 – 100
13.2mm	81	0 – 100
9.5mm	78	0 – 100
6.7mm	77	0 – 100
4.75mm	75	0 – 100
2.36mm	73	0 – 100
1.18mm	72	0 – 100
600µm	70	0 – 100
300µm	66	0 – 100
150µm	62	0 – 100
75µm	57	0 – 100

Comments
N/A

Canterbury Laboratory

325 Pound Rd, Yaldhurst
PO Box 16-064, Christchurch 8441
Telephone: +64 3 349 9142
Facsimile: +64 3 349 9143
www.fultonhogan.com
0800 LABORATORY

Material Test Report

Report No: MAT:CAN09S-6043
Issue No: 1

Client:
Riley Consultants Ltd
PO Box 4355
Christchurch Mail Centre

Christchurch 8140
NZ

Project: QA Testing - Aggregates

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: Max Burford
(Supervisor)
IANZ Accreditation No:200
Date of Issue: 30/09/09

Sample Details

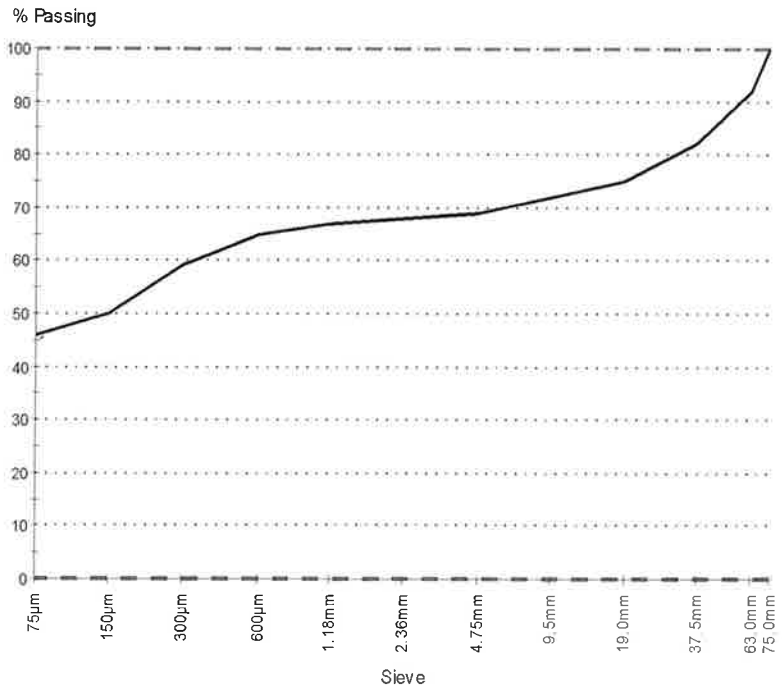
Sample ID:	CAN09S-6043
Client Sample ID:	TP12 O/N 09828
Material:	Gravelly Sandy SILT
Sample Source:	Miscellaneous Source
Site/Sampled From:	Greymouth Flood Walls TP 12
Date Sampled:	18/09/2009
Specification:	No Specification
Sampled By:	Advised - See Comments
Sampling Method:	As Received - Not Accredited
Date Tested:	30/09/2009
Technician:	Max Burford
Sampling Endorsed:	No

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

Method: NZS 4407:1991 Test 3.8.2
Drying by: Oven



Sieve Size	% Passing	Limits
75.0mm	100	0 – 100
63.0mm	92	0 – 100
37.5mm	82	0 – 100
19.0mm	75	0 – 100
9.5mm	72	0 – 100
4.75mm	69	0 – 100
2.36mm	68	0 – 100
1.18mm	67	0 – 100
600µm	65	0 – 100
300µm	59	0 – 100
150µm	50	0 – 100
75µm	46	0 – 100
63µm	45	0 – 100

Comments

Sampled by Alan Williams
Field Moisture Content = 20.7%

Canterbury Laboratory

325 Pound Rd, Yaldhurst
PO Box 16-064, Christchurch 8441
Telephone: +64 3 349 9142
Facsimile: +64 3 349 9143
www.fultonhogan.com
0800 LABORATORY

Material Test Report

Report No: MAT:CAN09S-6047
Issue No: 1

Client:
Riley Consultants Ltd
PO Box 4355
Christchurch Mail Centre

Christchurch 8140
NZ

Project: QA Testing - Aggregates

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: Max Burford (Supervisor)
IANZ Accreditation No:200
Date of Issue: 30/09/09

Sample Details

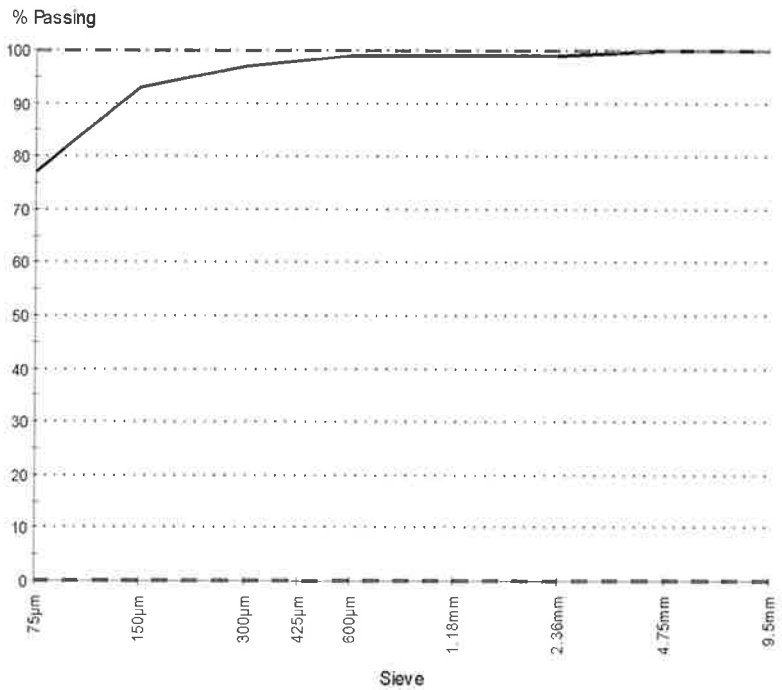
Sample ID:	CAN09S-6047
Client Sample ID:	TP 22 O/N 90828
Material:	Sandy SILT
Sample Source:	Miscellaneous Source
Site/Sampled From:	Greymouth Flood Walls TP 22
Date Sampled:	21/09/2009
Specification:	No Specification
Sampled By:	Advised - See Comments
Sampling Method:	As Received - Not Accredited
Date Tested:	30/09/2009
Technician:	Max Burford
Sampling Endorsed:	No

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

Method: NZS 4407:1991 Test 3.8.2
Drying by: Oven



Sieve Size	% Passing	Limits
9.5mm	100	0 – 100
4.75mm	100	0 – 100
2.36mm	99	0 – 100
1.18mm	99	0 – 100
600µm	99	0 – 100
425µm	98	0 – 100
300µm	97	0 – 100
150µm	93	0 – 100
75µm	77	0 – 100
63µm	70	0 – 100

Comments

Sampled by Alan Williams
Field Moisture Content = 37.6%

Canterbury Laboratory

325 Pound Rd, Yaldhurst
PO Box 16-064, Christchurch 8441
Telephone: +64 3 349 9142
Facsimile: +64 3 349 9143
www.fultonhogan.com
0800 LABORATORY

Maximum Dry Density Report

Report No: MDD:CAN09S-6040
Issue No: 1

Client:
Riley Consultants Ltd
PO Box 4355
Christchurch Mail Centre

Christchurch 8140
NZ

Project: QA Testing - Aggregates

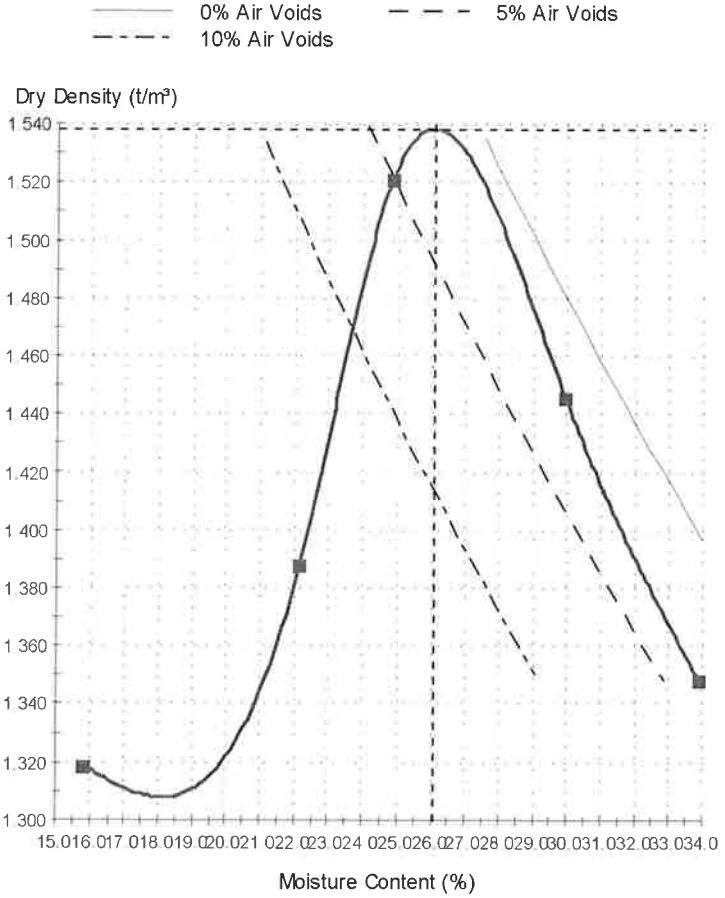
The test (s) reported herein (unless indicated) have been performed in accordance with the laboratory's scope of accreditation. Results only apply to samples as received. This report must be reproduced in full.

Approved Signatory: Max Burford
(Supervisor)
IANZ Accreditation No:200
Date of Issue: 30/09/09

Sample Details

Sample ID:	CAN09S-6040	**Material:**	Clay
Client Sample ID:	TP10 O/N 09828	**Material Source:**	Miscellaneous Source
Date Sampled:	18/09/09	**Sampled By:**	Advised - See Comments
Sampling Method:	As Received - Not Accredited	**Sampled From:**	Greymouth Flood Walls TP10
Date Tested:	30/09/09	**Specification:**	No Specification
Technician:	Max Burford	**Endorsed Sample?:**	No

Dry Density - Moisture Relationship



Test Results

NZS 4402:1986 Test 4.1.1

Maximum Dry Density (t/m³):	**1.54**
Optimum Moisture Content (%):	**26**
Assumed Solid Density (t/m³):	2.660
Oversize Sieve (mm):	19.0
Oversize Material (%):	17
Sample History:	Natural

Comments

As received moisture content = 33.8%
Sorry about X axis - this computer system is a work in progress

Canterbury Laboratory

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www.fultonhogan.com
0800 LABORATORY

Material Test Report

Report No: MAT:CAN09S-6045
Issue No: 1

Client:
Riley Consultants Ltd
PO Box 4355
Christchurch Mail Centre

Christchurch 8140
NZ

Project: QA Testing - Aggregates

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: Max Burford
(Supervisor)
IANZ Accreditation No:200
Date of Issue: 30/09/09

Sample Details

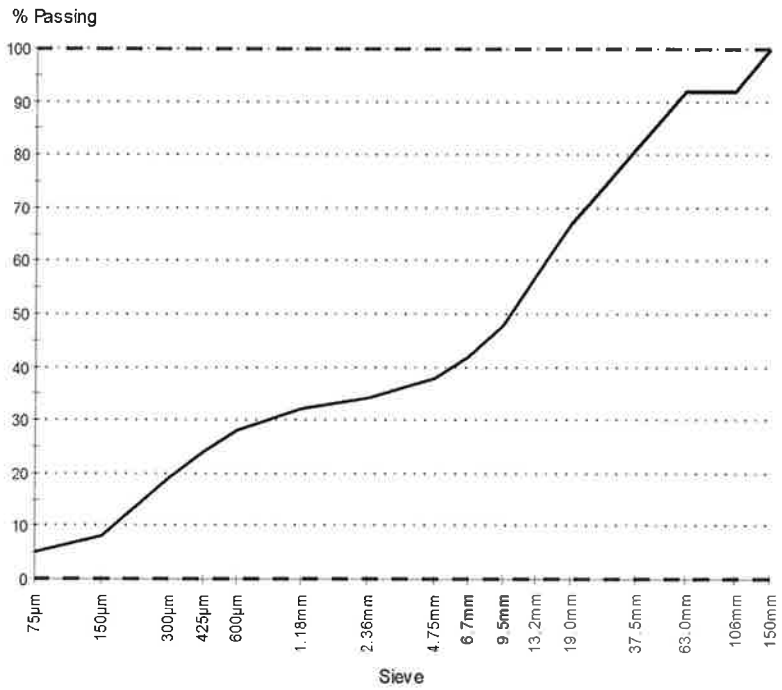
Sample ID:	CAN09S-6045
Client Sample ID:	TP18 O/N 09828
Material:	Sandy Gravel
Sample Source:	Miscellaneous Source
Site/Sampled From:	Greymouth Flood Walls TP18
Date Sampled:	21/09/2009
Specification:	No Specification
Sampled By:	Advised - See Comments
Sampling Method:	As Received - Not Accredited
Date Tested:	30/09/2009
Technician:	Max Burford
Sampling Endorsed:	No

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

Method: NZS 4407:1991 Test 3.8.2
Drying by: Oven



Sieve Size	% Passing	Limits
150mm	100	0 – 100
106mm	92	0 – 100
63.0mm	92	0 – 100
37.5mm	81	0 – 100
19.0mm	67	0 – 100
13.2mm	57	0 – 100
9.5mm	48	0 – 100
6.7mm	42	0 – 100
4.75mm	38	0 – 100
2.36mm	34	0 – 100
1.18mm	32	0 – 100
600µm	28	0 – 100
425µm	24	0 – 100
300µm	19	0 – 100
150µm	8	0 – 100
75µm	5	0 – 100

Comments

Sampled by Alan Williams
Field Moisture Content = 5.1%

Canterbury Laboratory

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Material Test Report

Report No: MAT:CAN09S-6041
Issue No: 1

Client:
Riley Consultants Ltd
PO Box 4355
Christchurch Mail Centre

Christchurch 8140
NZ

Project: QA Testing - Aggregates

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: Max Burford
(Supervisor)
IANZ Accreditation No:200
Date of Issue: 30/09/09

Sample Details

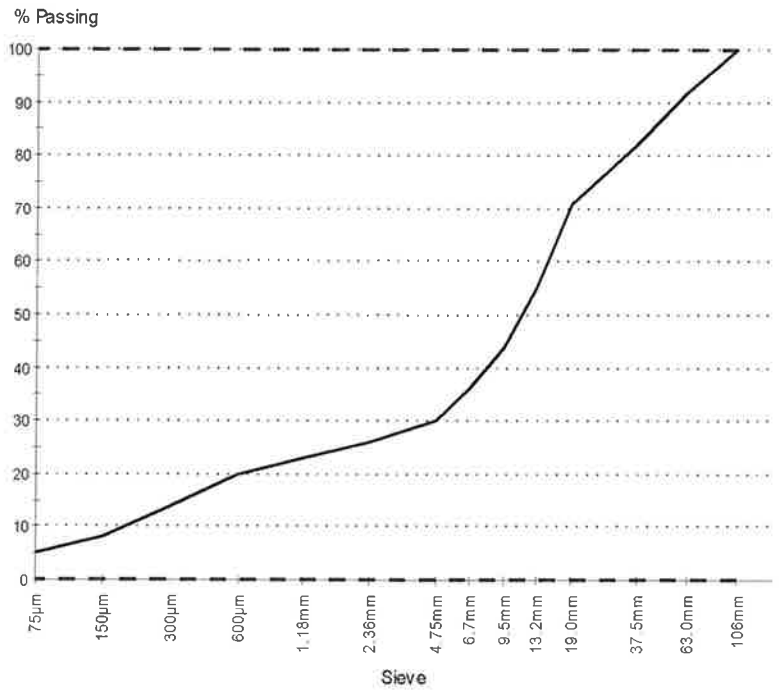
Sample ID:	CAN09S-6041
Client Sample ID:	TP7 O/N 09828
Material:	Sandy Gravel
Sample Source:	Miscellaneous Source
Site/Sampled From:	Greymouth Flood Walls TP7
Date Sampled:	17/09/2009
Specification:	No Specification
Sampled By:	Advised - See Comments
Sampling Method:	As Received - Not Accredited
Date Tested:	30/09/2009
Technician:	Max Burford
Sampling Endorsed:	No

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

Method: NZS 4407:1991 Test 3.8.2
Drying by: Oven



Sieve Size	% Passing	Limits
106mm	100	0 – 100
63.0mm	92	0 – 100
37.5mm	82	0 – 100
19.0mm	71	0 – 100
13.2mm	55	0 – 100
9.5mm	44	0 – 100
6.7mm	36	0 – 100
4.75mm	30	0 – 100
2.36mm	26	0 – 100
1.18mm	23	0 – 100
600µm	20	0 – 100
300µm	14	0 – 100
150µm	8	0 – 100
75µm	5	0 – 100

Comments

Sampled by Alan Williams
Field moisture Content = 15.5%

Canterbury Laboratory

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Material Test Report

Report No: MAT:CAN09S-6042
Issue No: 1

Client:
Riley Consultants Ltd
PO Box 4355
Christchurch Mail Centre

Christchurch 8140
NZ

Project: QA Testing - Aggregates

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: Max Burford
(Supervisor)
IANZ Accreditation No:200
Date of Issue: 30/09/09

Sample Details

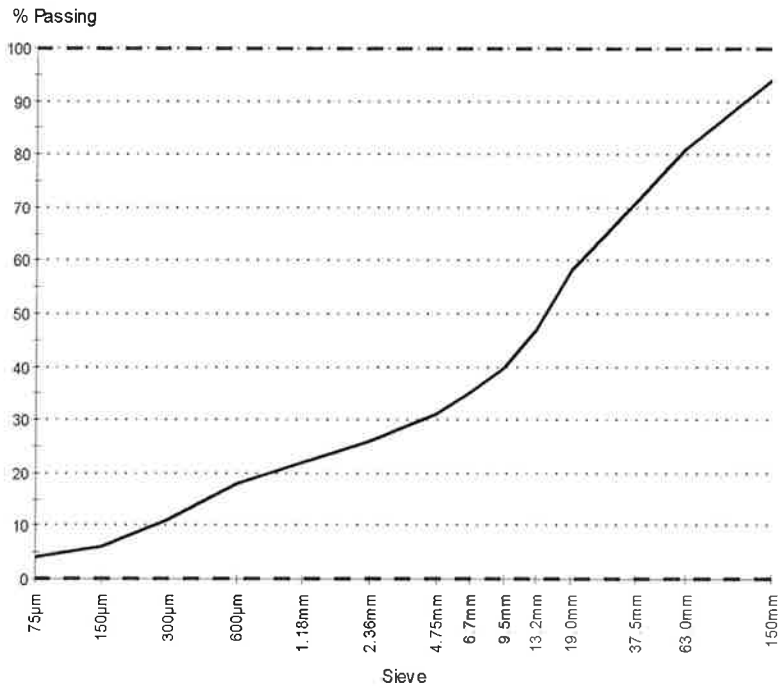
Sample ID:	CAN09S-6042
Client Sample ID:	TP11 O/N 90828
Material:	Sandy Gravel
Sample Source:	Miscellaneous Source
Site/Sampled From:	Greymouth Flood Walls TP11
Date Sampled:	18/09/2009
Specification:	No Specification
Sampled By:	Advised - See Comments
Sampling Method:	As Received - Not Accredited
Date Tested:	30/09/2009
Technician:	Max Burford
Sampling Endorsed:	No

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

Method: NZS 4407:1991 Test 3.8.2
Drying by: Oven



Sieve Size	% Passing	Limits
150mm	94	0 – 100
63.0mm	81	0 – 100
37.5mm	71	0 – 100
19.0mm	58	0 – 100
13.2mm	47	0 – 100
9.5mm	40	0 – 100
6.7mm	35	0 – 100
4.75mm	31	0 – 100
2.36mm	26	0 – 100
1.18mm	22	0 – 100
600µm	18	0 – 100
300µm	11	0 – 100
150µm	6	0 – 100
75µm	4	0 – 100

Comments

Sampled by Alan Williams
Field Moisture Content = 4.5%

Canterbury Laboratory

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Material Test Report

Report No: MAT:CAN09S-6044
Issue No: 1

Client:
Riley Consultants Ltd
PO Box 4355
Christchurch Mail Centre

Christchurch 8140
NZ

Project: QA Testing - Aggregates

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: Max Burford
(Supervisor)
IANZ Accreditation No:200
Date of Issue: 30/09/09

Sample Details

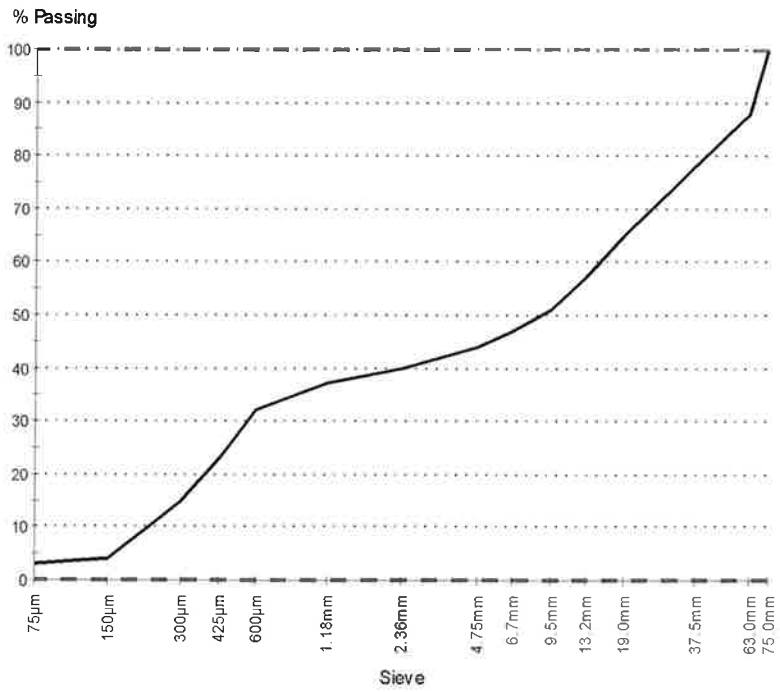
Sample ID:	CAN09S-6044
Client Sample ID:	TP4 O/N 09828
Material:	Sand
Sample Source:	Miscellaneous Source
Site/Sampled From:	Greymouth Flood Walls TP4
Date Sampled:	17/09/2009
Specification:	No Specification
Sampled By:	Advised - See Comments
Sampling Method:	As Received - Not Accredited
Date Tested:	30/09/2009
Technician:	Max Burford
Sampling Endorsed:	No

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

Method: NZS 4407:1991 Test 3.8.2
Drying by: Oven



Sieve Size	% Passing	Limits
75.0mm	100	0 – 100
63.0mm	88	0 – 100
37.5mm	78	0 – 100
19.0mm	65	0 – 100
13.2mm	57	0 – 100
9.5mm	51	0 – 100
6.7mm	47	0 – 100
4.75mm	44	0 – 100
2.36mm	40	0 – 100
1.18mm	37	0 – 100
600µm	32	0 – 100
425µm	23	0 – 100
300µm	15	0 – 100
150µm	4	0 – 100
75µm	3	0 – 100

Comments

Field moisture content = 4.3%

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Material Test Report

Report No: MAT:CAN09S-6046
Issue No: 1

Client:
Riley Consultants Ltd
PO Box 4355
Christchurch Mail Centre

Christchurch 8140
NZ

Project: QA Testing - Aggregates

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: Max Burford (Supervisor)
IANZ Accreditation No:200
Date of Issue: 30/09/09

Sample Details

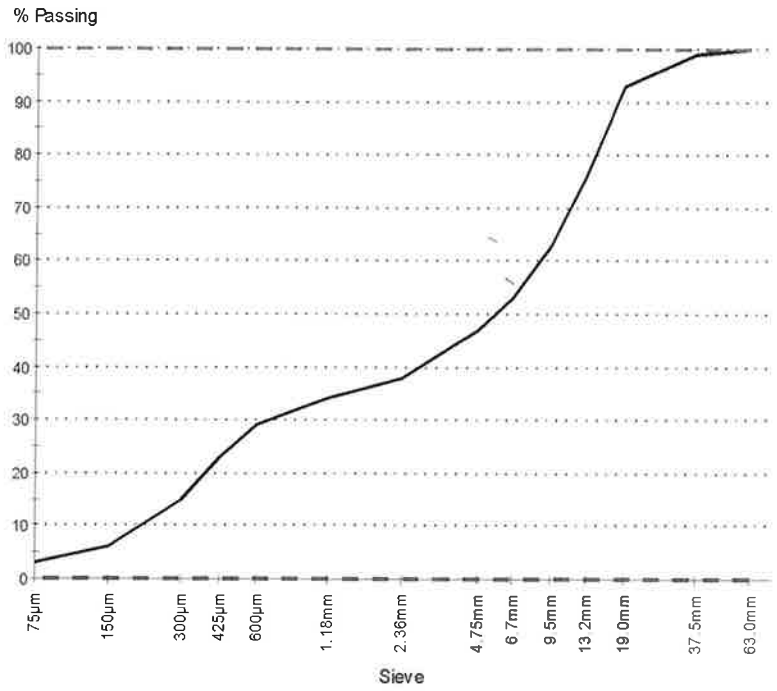
Sample ID:	CAN09S-6046
Client Sample ID:	TP20 O/N 09828
Material:	Sandy Gravel
Sample Source:	Miscellaneous Source
Site/Sampled From:	Greymouth Flood Walls TP20
Date Sampled:	21/09/2009
Specification:	No Specification
Sampled By:	Advised - See Comments
Sampling Method:	As Received - Not Accredited
Date Tested:	30/09/2009
Technician:	Max Burford
Sampling Endorsed:	No

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

Method: NZS 4407:1991 Test 3.8.2
Drying by: Oven



Sieve Size	% Passing	Limits
63.0mm	100	0 – 100
37.5mm	99	0 – 100
19.0mm	93	0 – 100
13.2mm	76	0 – 100
9.5mm	63	0 – 100
6.7mm	53	0 – 100
4.75mm	47	0 – 100
2.36mm	38	0 – 100
1.18mm	34	0 – 100
600µm	29	0 – 100
425µm	23	0 – 100
300µm	15	0 – 100
150µm	6	0 – 100
75µm	3	0 – 100

Comments

Sampled by Alan Williams
Field Moisture Content = 15.9%

Canterbury Laboratory

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0800 LABORATORY

Material Test Report

Report No: MAT:CAN09S-6048
Issue No: 1

Client:
Riley Consultants Ltd
PO Box 4355
Christchurch Mail Centre

Christchurch 8140
NZ

Project: QA Testing - Aggregates

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: Max Burford
(Supervisor)
IANZ Accreditation No:200
Date of Issue: 30/09/09

Sample Details

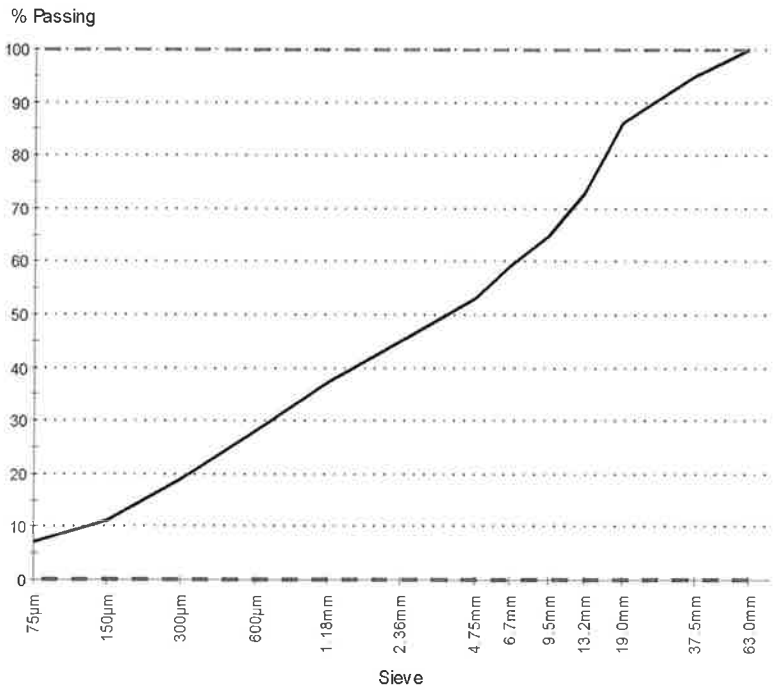
Sample ID:	CAN09S-6048
Client Sample ID:	TP 13 O/N 90828
Material:	Sandy Gravel
Sample Source:	Miscellaneous Source
Site/Sampled From:	Greymouth Flood Walls TP 13
Date Sampled:	18/09/2009
Specification:	No Specification
Sampled By:	Advised - See Comments
Sampling Method:	As Received - Not Accredited
Date Tested:	30/09/2009
Technician:	Max Burford
Sampling Endorsed:	No

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

Method: NZS 4407:1991 Test 3.8.2
Drying by: Oven



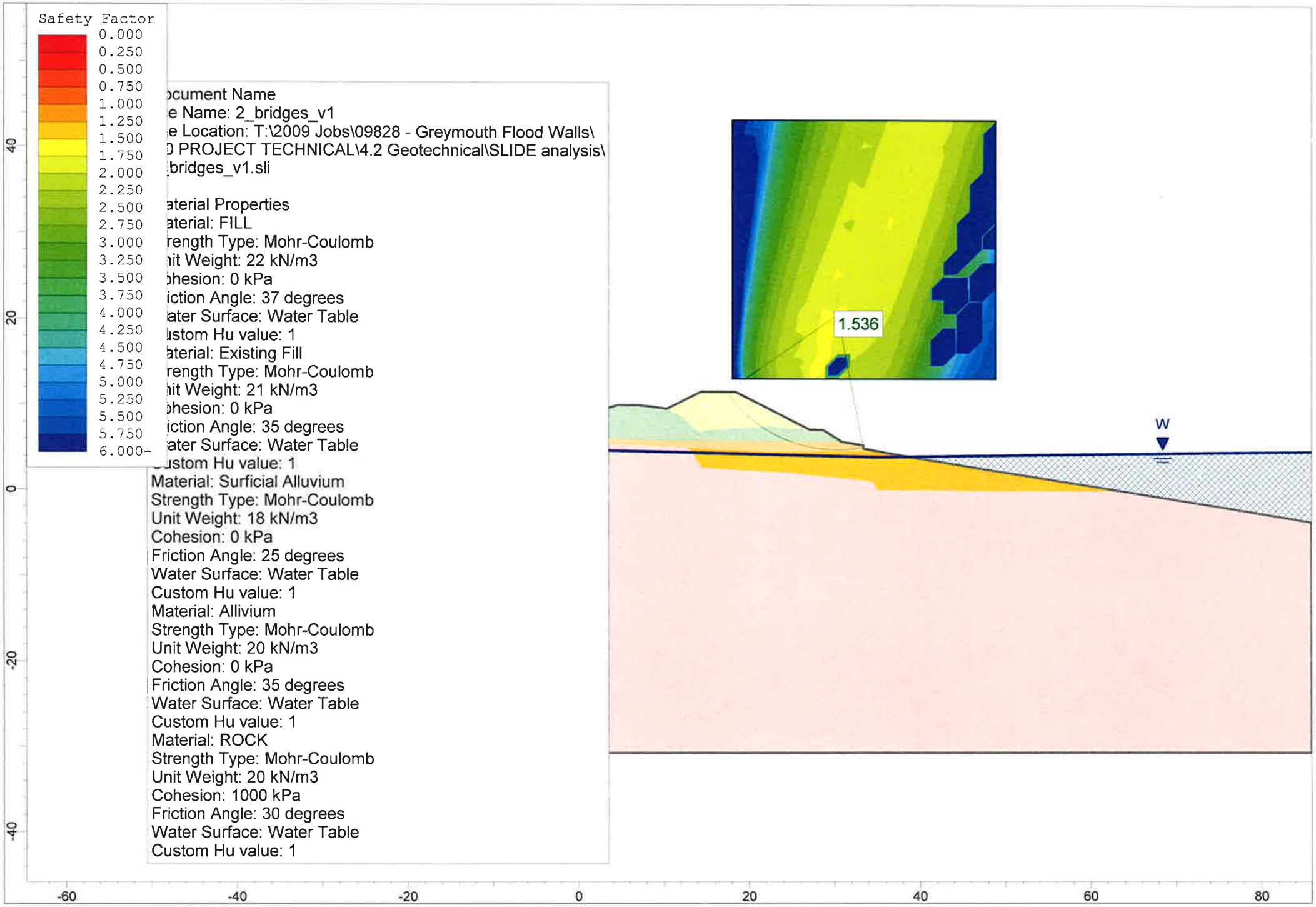
Sieve Size	% Passing	Limits
63.0mm	100	0 – 100
37.5mm	95	0 – 100
19.0mm	86	0 – 100
13.2mm	73	0 – 100
9.5mm	65	0 – 100
6.7mm	59	0 – 100
4.75mm	53	0 – 100
2.36mm	45	0 – 100
1.18mm	37	0 – 100
600µm	28	0 – 100
300µm	19	0 – 100
150µm	11	0 – 100
75µm	7	0 – 100

Comments

Sampled by Alan Williams - Field Moisture Content = 18.9%
Estimated Total Coal Content of Sample = 46% (Calculated from 19.0mm - 4.75mm by mass)
(minus 4.75mm fraction by bulk density)

APPENDIX 4

Stability Assessment Printouts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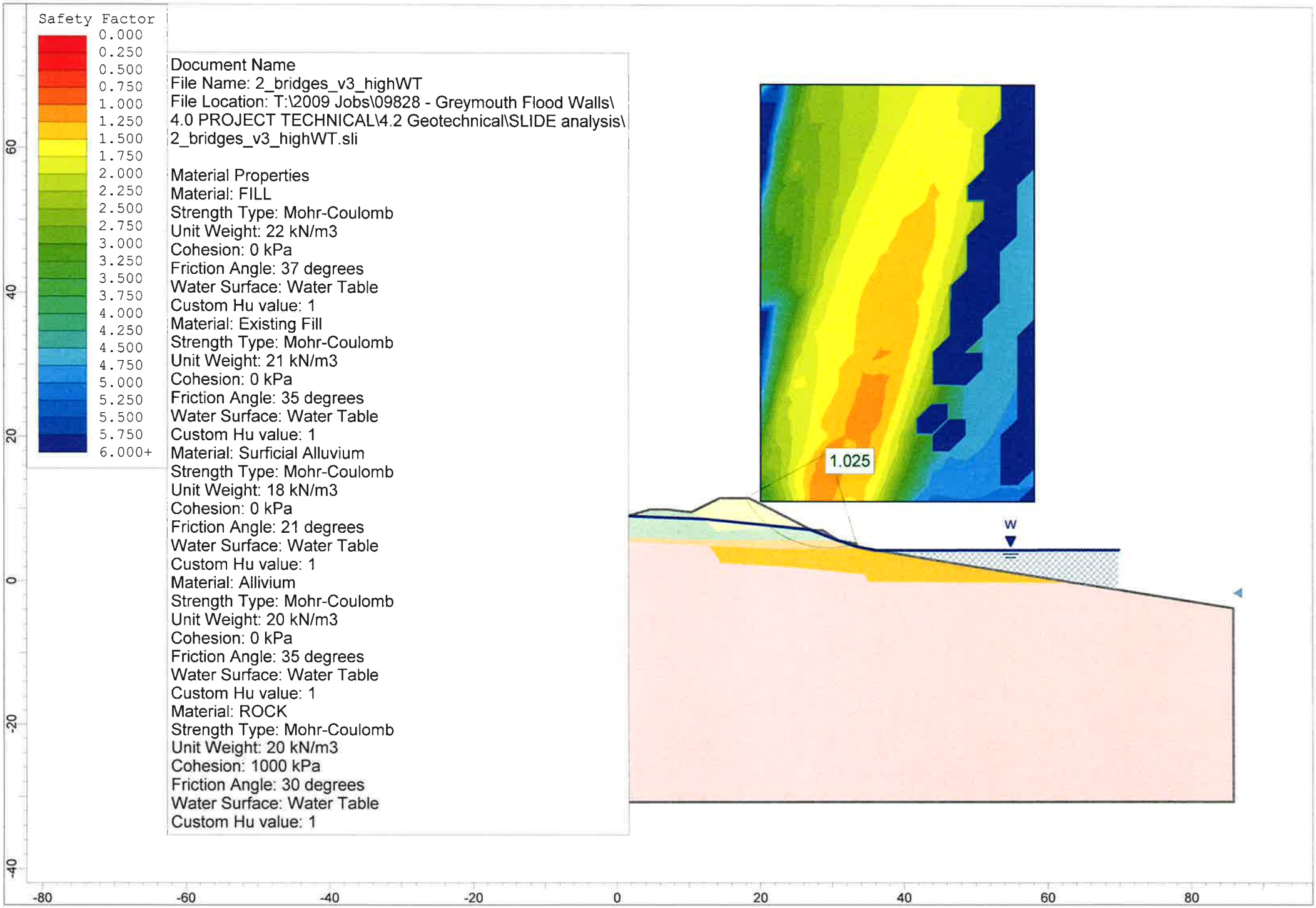
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
2.750
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
ocument Name
e Name: 2_bridges_v1
e Location: T:\2009 Jobs\09828 - Greymouth Flood Walls\
0 PROJECT TECHNICAL\4.2 Geotechnical\SLIDE analysis\
bridges_v1.sli
aterial Properties
aterial: FILL
rength Type: Mohr-Coulomb
it Weight: 22 kN/m3
hesion: 0 kPa
iction Angle: 37 degrees
ater Surface: Water Table
ustom Hu value: 1
aterial: Existing Fill
rength Type: Mohr-Coulomb
it Weight: 21 kN/m3
hesion: 0 kPa
iction Angle: 35 degrees
ater Surface: Water Table
ustom Hu value: 1
Material: Surficial Alluvium
Strength Type: Mohr-Coulomb
Unit Weight: 18 kN/m3
Cohesion: 0 kPa
Friction Angle: 25 degrees
Water Surface: Water Table
Custom Hu value: 1
Material: Allivium
Strength Type: Mohr-Coulomb
Unit Weight: 20 kN/m3
Cohesion: 0 kPa
Friction Angle: 35 degrees
Water Surface: Water Table
Custom Hu value: 1
Material: ROCK
Strength Type: Mohr-Coulomb
Unit Weight: 20 kN/m3
Cohesion: 1000 kPa
Friction Angle: 30 degrees
Water Surface: Water Table
Custom Hu value: 1
1.536
W
40
20
0
-20
-40
-60
-40
-20
0
20
40
60
80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0.500
0.750
1.000
1.250
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1.750
2.000
2.250
2.500
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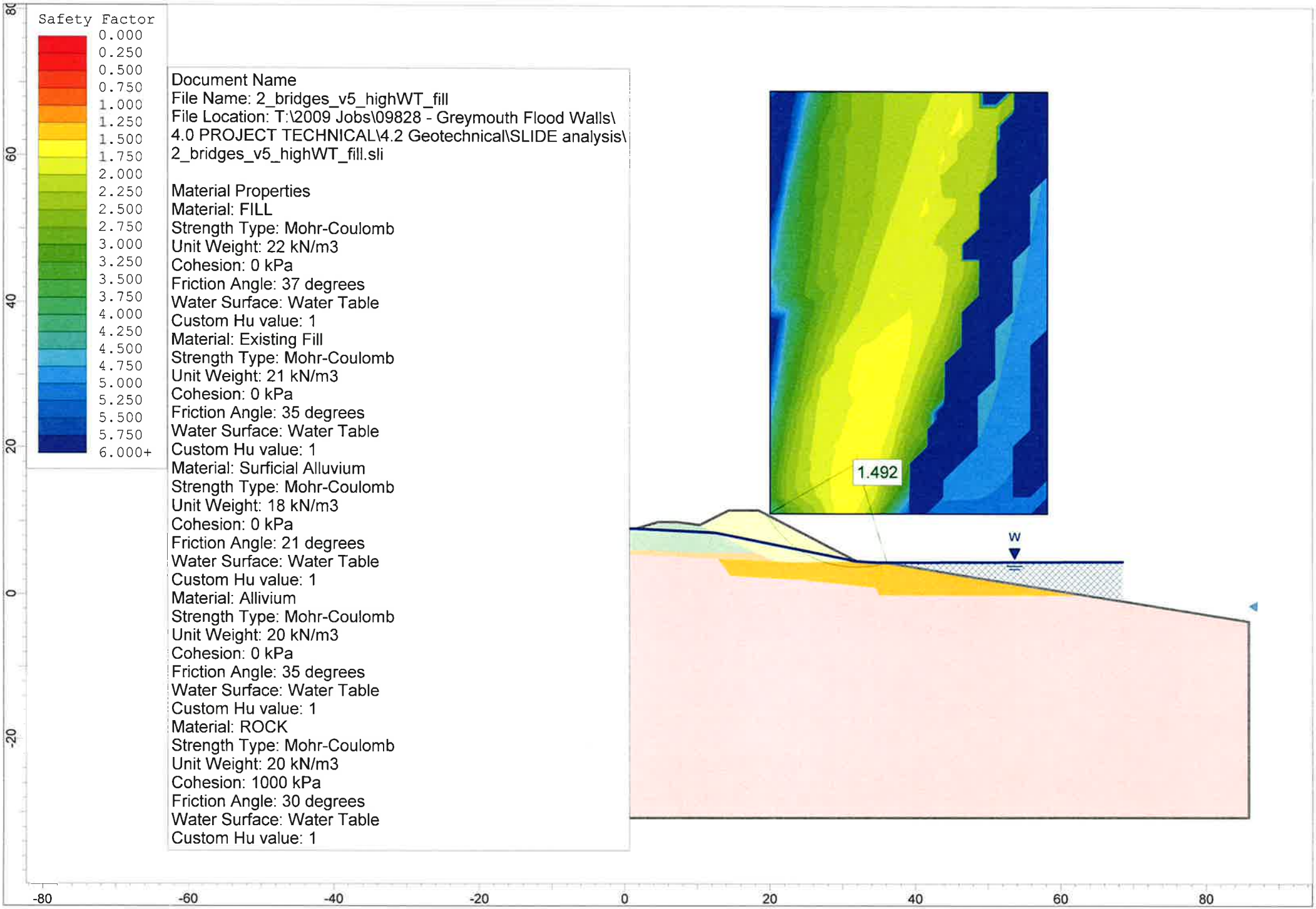
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
Document Name
File Name: 2_bridges_v3_highWT
File Location: T:\2009 Jobs\09828 - Greymouth Flood Walls\
4.0 PROJECT TECHNICAL\4.2 Geotechnical\SLIDE analysis\
2_bridges_v3_highWT.sli
Material Properties
Material: FILL
Strength Type: Mohr-Coulomb
Unit Weight: 22 kN/m3
Cohesion: 0 kPa
Friction Angle: 37 degrees
Water Surface: Water Table
Custom Hu value: 1
Material: Existing Fill
Strength Type: Mohr-Coulomb
Unit Weight: 21 kN/m3
Cohesion: 0 kPa
Friction Angle: 35 degrees
Water Surface: Water Table
Custom Hu value: 1
Material: Surficial Alluvium
Strength Type: Mohr-Coulomb
Unit Weight: 18 kN/m3
Cohesion: 0 kPa
Friction Angle: 21 degrees
Water Surface: Water Table
Custom Hu value: 1
Material: Allivium
Strength Type: Mohr-Coulomb
Unit Weight: 20 kN/m3
Cohesion: 0 kPa
Friction Angle: 35 degrees
Water Surface: Water Table
Custom Hu value: 1
Material: ROCK
Strength Type: Mohr-Coulomb
Unit Weight: 20 kN/m3
Cohesion: 1000 kPa
Friction Angle: 30 degrees
Water Surface: Water Table
Custom Hu value: 1
1.025
W
60
40
20
0
-20
-40
-80
-60
-40
-20
0
20
40
60
80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0.250
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
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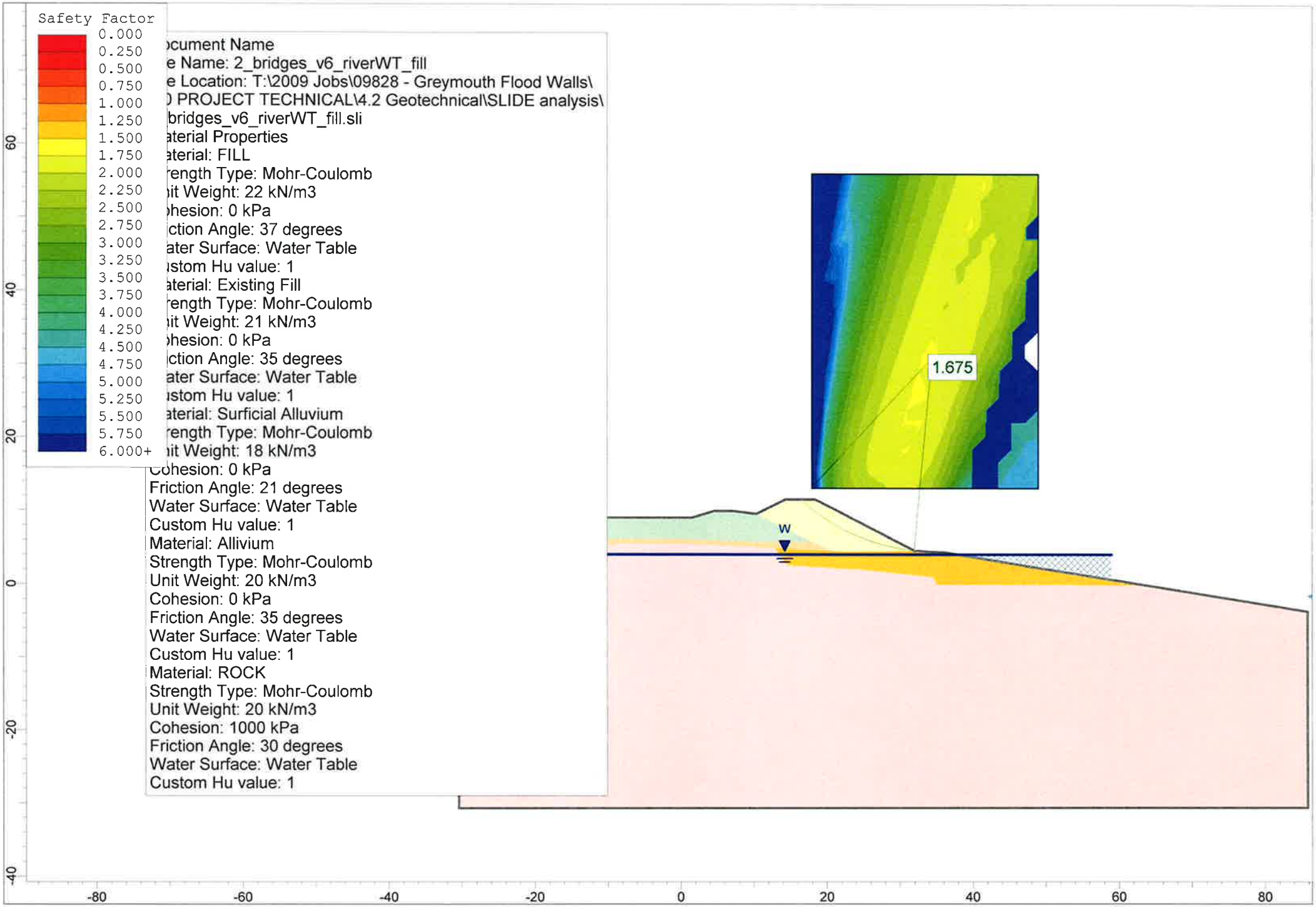
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
Document Name
File Name: 2_bridges_v5_highWT_fill
File Location: T:\2009 Jobs\09828 - Greymouth Flood Walls\
4.0 PROJECT TECHNICAL\4.2 Geotechnical\SLIDE analysis\
2_bridges_v5_highWT_fill.sli
Material Properties
Material: FILL
Strength Type: Mohr-Coulomb
Unit Weight: 22 kN/m3
Cohesion: 0 kPa
Friction Angle: 37 degrees
Water Surface: Water Table
Custom Hu value: 1
Material: Existing Fill
Strength Type: Mohr-Coulomb
Unit Weight: 21 kN/m3
Cohesion: 0 kPa
Friction Angle: 35 degrees
Water Surface: Water Table
Custom Hu value: 1
Material: Surficial Alluvium
Strength Type: Mohr-Coulomb
Unit Weight: 18 kN/m3
Cohesion: 0 kPa
Friction Angle: 21 degrees
Water Surface: Water Table
Custom Hu value: 1
Material: Allivium
Strength Type: Mohr-Coulomb
Unit Weight: 20 kN/m3
Cohesion: 0 kPa
Friction Angle: 35 degrees
Water Surface: Water Table
Custom Hu value: 1
Material: ROCK
Strength Type: Mohr-Coulomb
Unit Weight: 20 kN/m3
Cohesion: 1000 kPa
Friction Angle: 30 degrees
Water Surface: Water Table
Custom Hu value: 1
1.492
W
80
60
40
20
0
-20
-80
-60
-40
-20
0
20
40
60
80


Safety Factor
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0.250
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
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3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
ocument Name
e Name: 2_bridges_v6_riverWT_fill
e Location: T:\2009 Jobs\09828 - Greymouth Flood Walls\
) PROJECT TECHNICAL\4.2 Geotechnical\SLIDE analysis\
bridges_v6_riverWT_fill.sli
aterial Properties
aterial: FILL
rength Type: Mohr-Coulomb
it Weight: 22 kN/m3
hesion: 0 kPa
ction Angle: 37 degrees
ater Surface: Water Table
stom Hu value: 1
aterial: Existing Fill
rength Type: Mohr-Coulomb
it Weight: 21 kN/m3
hesion: 0 kPa
ction Angle: 35 degrees
ater Surface: Water Table
stom Hu value: 1
aterial: Surficial Alluvium
rength Type: Mohr-Coulomb
it Weight: 18 kN/m3
Cohesion: 0 kPa
Friction Angle: 21 degrees
Water Surface: Water Table
Custom Hu value: 1
Material: Allivium
Strength Type: Mohr-Coulomb
Unit Weight: 20 kN/m3
Cohesion: 0 kPa
Friction Angle: 35 degrees
Water Surface: Water Table
Custom Hu value: 1
Material: ROCK
Strength Type: Mohr-Coulomb
Unit Weight: 20 kN/m3
Cohesion: 1000 kPa
Friction Angle: 30 degrees
Water Surface: Water Table
Custom Hu value: 1
1.675
W
60
40
20
0
-20
-40
-80
-60
-40
-20
0
20
40
60
80

APPENDIX 5

Construction Specification Clauses

SECTION C: PROJECT SPECIFICATION

C.3 STOPBANK CONSTRUCTION – EARTHWORKS

C.3.1 SCOPE

This section of the specification covers:

- All earthworks for the stopbank raising inclusive of fill materials brought from off site.
- Preparation of ground surfaces for filling and concrete structures.
- Temporary drainage.

C.3.2 GROUND CONDITIONS

RILEY has completed a geotechnical investigation in new stopbank foundation areas and existing stopbanks where raising is to take place. The results of the ground investigation are presented in RILEY report 09828-A (attached). The contractor shall familiarise themselves with the contents of this report, which provides background information on soil types, groundwater and constructability aspects of the project.

C.3.3 EXCAVATIONS AND PREPARATION FOR FILL

This work consists of excavation below the stripped surfaces until suitable foundations for placement of fill materials is uncovered and includes:

- removal of materials within the stopbank footprint for areas of new stopbank,
- preparation of existing stopbanks for placement of additional fill,
- preparation of existing stopbanks for construction of concrete flood walls.

C.3.3.1 Clearing

All areas to be occupied by the permanent construction shall be cleared of all vegetation, such as grass, scrub, exposed roots, and any other organic material prior to stripping. Cleared materials shall be disposed of in dump areas to be designated by the Engineer.

C.3.3.2 Stripping

Stripping refers to the removal from all areas subject to excavation or filling, of all organic material remaining after clearing, i.e. topsoil, peat and humus. These materials shall be removed to expose soil or rock containing insignificant amounts of organic material.

All significant volumes of topsoil shall be stockpiled for later re-use. Materials containing insufficient amounts of topsoil for practical separation shall be disposed of in dump areas to be designated by the Engineer.

C.3.3.3 Drainage

All areas to be filled shall have effective surface drainage at all times. Temporary diversions or other suitable methods shall be utilised to keep surface and subsurface water away from the works area. All earthworks shall be carried out in the dry.

Any remedial work or extra excavation that could have been avoided by good drainage and sound earthwork practices shall be completed at no cost to the Principal.

C.3.3.4 New Stopbank Foundations

C.3.3.4 (a) General

New stopbanks will be constructed in the Goods Shed, 2-Bridges and Cobden areas. Geotechnical investigations indicate undercut to varying extents will be required to provide a suitable foundation of stopbank fill. Final undercut profiles will be determined by the Engineer on site. Prior to any filling, the stopbank footprint will be exposed and inspected by the Engineer. The Contractor shall be responsible for maintenance of the approved surface until filling commences.

(b) Goods Shed

The new stopbank section is located within a previously reclaimed goods loading area. Recently the area appears to have been used to stockpile coal. It is anticipated that at least 0.5 m of undercut will be required to remove the disturbed upper layer of fill, which contains coal fragments and other deleterious material.

(c) 2-Bridges

The new stopbank abuts the existing railway fill, and is located in an area of previously reclaimed riverbed. Geotechnical investigations indicate that 1 m to 3 m of fill overlies 1 m to 2 m of soft river sediment, which overlies 0 m to 2 m of dense granular river sediment, over bedrock. Where the new stopbank crest is to be more than 3 m above existing ground level, it is envisaged that the existing fill be removed along with the soft river sediment, and the stopbank founded on the underlying dense gravel. The deeper sub-excavations will be below the groundwater level (as well as the typical Grey River level), and Contractors shall also note extensive seepage occurs from the base of the rock bluff.

(d) Cobden

The new stopbank will be founded on top of the existing stopbank/road embankment. It is anticipated that no undercut will be required to obtain a suitable fill foundation; however the existing road pavement should be removed, along with all grass, topsoil and soft fill materials associated with the existing small stopbank adjacent to the road.

C.3.3.5 Preparation of Existing Stopbanks for Raising

Existing stopbanks to be raised by less than 200 mm shall be cleared of grass and/or vegetation along the crest, exposing topsoil free of grass, scrub, exposed roots, and any other organic material.

Existing stopbanks to be raised by more than 200 mm shall be cleared and stripped along the crest, exposing the underlying granular bank fill and low permeability river-side silty gravel capping layer.

C.3.3.6 Preparation for Concrete Flood Walls

This applies to the proposed concrete flood walls in the Mawhera Quay and Fisherman's Wharf areas. The walls are generally located on the river-side of the stopbank, with their foundation keying into the existing silty gravel zone identified in the geotechnical investigation.

The specified wall foundation cut shall be made to the river-side portion of the stopbank, exposing the silty gravel zone. If the silty gravel zone is not exposed, additional excavation will be directed. Testing shall be completed by the Contractor on the exposed silty gravel zone to confirm material type, consistency, density and moisture content. Scarifying, moisture conditioning, and compaction of the in situ soil may be directed by the Engineer depending on the results of testing.
If the additional excavation is more than 200 mm below the design wall foundation level for a significant length, compacted type 2 earth fill may be used to bring the foundation to design level.

C.3.4 FILL MATERIALS

C.3.4.1 General

The stopbank fill materials shall be obtained from borrow areas off site.

C.3.4.3 General Stopbank Fill (Type 1)

General stopbank fill shall be sourced off site. The material shall consist of a well graded sand/gravel mix conforming to the grading limits indicated in Table 1. The envelope is based on the envelope of tests on the existing stopbank material. In addition the d15 value shall be less than 0.7 mm to maintain filter compatibility with Type 1 material.

Table 1: Grading envelope for general stopbank fill (type 1 fill)

Particle Size (mm)	Percent Passing (%)
200	100
9.5	40 - 80
1.18	20 - 50
0.075	0 – 15

C.3.4.4 Low Permeability Fill (Type 2)

River-side low permeability fill (where specified) shall be sourced off site from an appropriate quarry or borrow area. The material shall consist of well graded silt, sand and gravel mix of low permeability(or a silt/ sand mixture ?). The envelope is based on the envelope of tests on the existing stopbank material. The particle size distribution after handling and placement shall conform to Table 2. If the material is produced by mixing two materials the contractor shall demonstrate to the Engineers satisfaction that effective mixing is obtained at all times. In locations where concrete structures will be in direct contact with type 2 fill (i.e. concrete flood walls) the maximum particle size shall be 20mm.

Table.2: Grading envelope for low permeability fill (type 2 fill)

Particle Size (mm)	Percent Passing (%) - General type 2 fill	Percent Passing (%) - Type 2 fill in contact with concrete structures
75	100	100
20	80 - 100	100
1.18	60 -100	60-100
0.075	35 - 85	35 - 85

C.3.4.6 Filter Cloth and Riprap

Riprap is specified in a separate section of this specification. However, the following points should be observed where riprap is specified over type 2 fill on new sections of stopbank, and adjacent to new sections of concrete floodwall.

Filter cloth shall be placed between riprap and the underlying soil to protect the stopbank fill and ensure it does not disperse into the riprap. Cloth joints shall be lapped 500 mm minimum. No material shall be permitted between the lapped sections of cloth. The cloth shall be placed without folds or wrinkles.

Where riprap abuts concrete structures, filter fabric shall be affixed to the concrete by battens or similar prior to placement of riprap. The fabric shall be in continuous contact with the underlying soil, requiring the overlying riprap to be sufficiently well graded to effectively hold it in place.

Riprap shall be placed in such a way that the underlying fabric is not damaged.

C.3.5 PLACEMENT AND COMPACTION OF FILL

C.3.5.1 General

Fill shall be placed to the lines and levels indicated on the drawings or otherwise instructed by the Engineer. The requirements for fill quality are specified in Section C.3.6.

Any material not complying with the specified requirements shall be removed at no cost to the Principal.

All bulk earthworks shall be carried out in fully drained conditions with no free water on the working surfaces. Cut and fill areas shall be sloped and graded adequately so that they do not pond stormwater, and drains shall be installed as necessary on a regular basis to deflect run off from the areas of operation or to drain ponded water as soon as ponds are seen to develop.

No fill shall be placed during periods of wet weather. In the event of fill operations ceasing in any area on account of wet weather or for more than two days for any reason, the Contractor shall obtain the Engineer's approval of the conditions of the fill surface before recommencing fill operations. The engineer may direct removal, conditioning or scarifying of all or part of the exposed sections of fill prior to earthworks resuming.

No new fill shall be placed over previously placed fill that has not achieved the required standard of compaction, has become contaminated, or has deteriorated from the required fill standards. Previously placed fill which does not comply shall be reinstated or removed at no cost to the Principal. Positive and effective drainage shall be maintained during filling operations to minimise deterioration of material exposed in the upper fill layers. Special care shall be taken to avoid hollows which could pond runoff.

The combined operations of spreading and compacting shall be undertaken using very systematic and properly managed procedures to the satisfaction of the Engineer, to ensure that the entire surface of each loose layer receives the specified minimum number of passes of the roller before further loose material is spread.

The specified minimum number of passes shall apply even if tests indicate the compaction requirements are met with fewer passes. Compaction of all material shall be carried out using specialised compacting equipment, separate from that used for transportation.

C.3.5.1 Placement and Compaction of Type 1 Fill

The fill shall be spread out in a uniform thickness layer. Loose layer thickness shall not exceed 200 mm.

Compaction of fill shall be carried out using a 10-tonne (static weight), smooth steel drum vibrating roller. Each fill layer shall be given at least four passes, even if compaction tests are met with fewer passes.

Where stopbank fill abuts sloping ground steeper than 18º (1V:3H), the natural ground or fill being filled against shall be keyed in. The horizontal width of the key shall be equal to the thickness of the compacted layer.

Prior to placement of the next lift, compaction tests in accordance with section 3.7 shall be carried out, and any areas found to be deficient repaired. All areas in which remediation of deficient fill has been necessary shall be re-tested in accordance with section 3.7 prior to additional fill being placed.

C.3.5.5 Acceptance Standards for Fill

General Fill (Type 1)

Deflection of the fill during a proof roll shall be less than 3 mm, and no weaving shall be permitted.

At the 2 Bridges location, type 1 fill shall also be subject to:

> Minimum of 95% of optimum dry density as obtained from a Standard Compaction Test, and
>
> maximum of 5% air voids averaged over 10 consecutive tests, and 7% on any one test.

Low Permeability Fill (Type 2)

> Minimum of 95% of optimum dry density as obtained from a Standard Compaction Test, and
>
> maximum of 5% air voids averaged over 10 consecutive tests, and 7% on any one test.

C.3.5.6 Unsuitable Material

Unsuitable material shall be placed removed from the site, and disposed of by the contractor.

C.3.5.7 Topsoil and Grassing

Topsoil shall be placed on all stopbank batters and crests that will not be otherwise surfaced (i.e. roads). Topsoil shall be free of stones and vegetation or roots. It shall be placed with a minimum thickness of 200 mm, and be compacted via track rolling. Grassing is covered in a separate section of this specification.

C.3.5.8 Tolerances and Profiles

The construction tolerances for the project are defined elsewhere, however in relation to the type 2 fill zone located on the river-side of the stopbank, the dimensions indicated on the drawings are minimum dimensions. The type 2 fill material is permitted to extend up to half the total stopbank width, with the final thickness to be nominated by the contractor on the basis of material costs and anticipated construction methodologies.

C.3.6 QUALITY CONTROL

The Contractor shall appoint an experienced full time earthworks supervisor, whose duties shall include the control of filling operations in accordance with this specification.

The Contractor shall undertake sufficient tests on site to become thoroughly familiar with fill types and behaviour under compaction, and satisfy himself that the compacted fill meets the specified requirements.

All material control tests shall be carried out and paid for by the Contractor.

The testing shall be carried out by an IANZ registered laboratory or their representative for the tests indicated. This shall include both laboratory and field testing. The results shall be supplied to the Engineer demonstrating compliance with this specification, at no less than every two weeks. Any non compliance shall be reported at the weekly meeting and actions taken. Formal results shall be provided to the Engineer for each monthly progress payment. Up to 10% payment over and above retentions will be withheld if this information is not provided, or is incomplete, accompanying the progress payment application, at the Engineer's discretion. The scope and frequency of testing can only be altered at the instruction of the Engineer.

If requested by the Engineer, testing shall be carried out in the full time presence of the Engineer or his representative.

At any location the Engineer may carry out his own tests at his discretion. If there is any discrepancy the Engineer's results shall prevail.

C.3.7 TESTING REQUIREMENTS

C.3.6.1 Compaction Testing

Control tests shall be carried out by the Contractor.

The fill compaction requirements and related tests are defined in Table 3 and the list of qualifying notes.

Table.3: Test methods

Test	Test Method and/or Test Description
Optimum moisture/density	Standard compaction test as per NZS 4402:1986
Air voids	As defined in NZS 4402:1986 and involving intermediate tests in situ density, water content and solid density below
In-situ density	NDM Method
Water content	NDM Method, with confirmatory laboratory tests as per NZS 4402:1986, Test 2.1
Solid density	NDM Method
Sieve analysis	NZS 4402:1986, Test 2.8.1

Note 1: In situ Density - The air voids content of the compacted soil at any test location shall be taken as the mean of the air voids results from a set of density tests. A set of density tests shall comprise two or more individual tests made within an area of 0.5 m².

The frequency of testing will depend on the consistency of the fill operations and materials. The testing rate will be generally as follows at the commencement of filling.

Table 4: Fill testing regime

Test	Material	Frequency
In situ moisture/ density (NDM method with laboratory moisture content)	Type 1 fill (at new 2 Bridges and Cobden stopbanks only) In situ silty gravel river-side face on existing stopbanks (at new concrete flood wall locations only) Type 2 fill	1 set per 1000 m^3 fill placed 1 set per 50 m length 1 set per lift over 50 m length
Standard Compaction test (Proctor Test)	Type 1 fill (specifically the material to be used at the 2 Bridges fill) Type 2 fill	2 sets prior to start of construction 2 sets prior to start of construction, 1 set per 500 m^3 thereafter
Sieve Analysis	Type 1 fill Type 2 fill	3 sets prior to start of construction, 1 set per 2,000 m^3 thereafter. 3 sets prior to start of construction, 1 set per 500 m^3 thereafter.

The Engineer may reduce or increase the frequency of testing as he judges appropriate, depending on the consistency of the results.

C.3.6.2Inspections and Approvals

The following critical points during construction must be inspected by the Engineer prior to further work being carried out in the area. No filling, concrete work, or quarry excavation for fill purposes shall commence without the Engineer's approval. All surfaces are to be surveyed for quantity measurement purposes. The Engineer must be informed at least 48 hours prior to the following hold points being reached, to ensure construction is not delayed.

Hold Points

- Inspection of each section of stripped, excavated and trimmed concrete floodwall foundation, prior to placement of concrete.
- For all sections of stopbank to be raised by more than 200 mm, inspection of each section of stripped, excavated and trimmed stopbank prior to placement of fill.
- Inspection of the prepared subgrade prior to placement of any fill at each of the Goods Shed, 2-Bridges and Cobden areas.
- At the 2-Bridges site, inspection of the installed culverts and their interfaces with the in situ rock and associated drainage works prior to backfilling.