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# District Plan Change Application

# Servicing Report – Holmes Block

# Selwyn Plantation Board Limited

26 February 2010
Reference: 36951-001
Revision 5

Connell Wagner

## Document Control

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# Contents

# 1. Introduction

## 1.1 General

Selwyn Plantation Board Limited (SPBL) has engaged Connell Wagner to undertake a servicing feasibility study to support their application for a change to the Selwyn District Plan. The proposal will see the re-zoning of the Holmes block. Refer to the locality plan in ***Appendix A***.

This report investigates the following servicing issues:

- Wastewater Disposal
- Stormwater Management
- Water Supply
- Power supply
- Telecommunications supply

Information has been drawn from the Selwyn District Council (SDC), Network Utility operators, site investigations and experience gained from recent developments on surrounding land.

## 1.2 Background

Preliminary site investigation work was undertaken by Connell Wagner during August 2008. The investigation included a site walkover, a topographic survey, subsurface geotechnical investigation and discussions with the services providers.

### 1.2.1 Holmes Block

#### *Land Information*

C's T: CB206/66, CB383/123, CB256/155 and CB36d/1239 (part only)
Approx area: 92.3 ha

#### *General Layout*

The site is generally rectangular.

The site is bounded to the north by SH 1, to the east by Dunns Crossing Road, to the south by Burnham School Road, and to the west by existing farm land.

Access to site is via Dunns Crossing Road and Burnham Scholl Road.

#### *Existing Use*

The site is covered with grass and is currently used for grazing.

#### *Topography*

The site is relatively flat with a slight fall towards the south east. The general grade of the site is approximately 0.5% (1:200).

#### *Geotechnical Investigation*

A geotechnical investigation was carried out on the site in August 2008. The investigation included a walk over and test pitting in key locations to provide information on the underlying soil conditions. The geotechnical report has been included as ***Appendix B***. A summary of the results is as follows:

The following geological model has been inferred for the Holmes block:

- 200mm Topsoil overlying,
- Sandy GRAVEL to depth

### *Groundwater*

Well logs from the Environment Canterbury (ECan) database indicate that the depth to groundwater in the area is approximately 12m. This depth is expected to vary seasonally and annually.

The proposed rezoning area does not fall within the Christchurch Groundwater Recharge Zone.

### *Distance to Existing Wells*

The nearest community supply wells (1577 and 1617) are approximately 500m up gradient (peizometric contour) as described by the ECan database. No other wells are within 1000m of the site. The site does not currently fall within a theoretical Community Drinking Water Supply Protection Zone when plotted in accordance with the Proposed Natural Resources Regional Plan (PNRRP).

There is one existing private well that is less than 50m from the site (Well m36/7538, approx 1000m west along Burnham School Road). A separation distance of 50m between existing private wells and discharges to ground is generally used by ECan to trigger additional resource consent requirements. The design of any discharge should take into account the location of this well.

# 2. Sewerage Reticulation

## 2.1 Outline Development Plan Servicing

The sewage from Rolleston township is processed at the sewage treatment plant located between Springston-Rolleston and Lincoln-Rolleston Roads, and then sent to the disposal area at Burnham School Road. We are advised by Council that a decision has not been made regarding the staging of the rural-residential land in the district, and will be linking this assessment with the Structure Plan process. They go on to say that until the staging had been decided, they will not be in a position to respond fully to our request for information on the capacity and connection to the Council's reticulation

The SDC is in the process of developing and adopting a Wastewater Strategy for townships within its District.

## 2.2 Design Flows

The proposed plan change includes re-zoning the site to cater for approximately 126 residential properties.

The Christchurch City Council Infrastructure Design Standard (Draft 2007) sets the following minimum design criteria for the design of sewerage reticulation.

**Table 1 - Sewage Design Flows for Holmes Block**

| | |
|---|---|
| Residential Sewer flows | 220 l/day |
| Assuming population per lot | 2.7 Persons/Lot |
| Total Lots | 126 Lots |
| Peak to average ratio | 2.5 |
| Dilution from infiltration and inflow ratio | 2.0 |

*Average Sewer Flow* *=126 Lots x 2.7 Persons/Lot x 220 l/day/Person*
*=74,844 l/day*
*=0.87 l/s*

*Maximum Sewer Flow* *=0.87 l/s x 2.5 x 2.0*
*=4.3 l/s*

There are existing connection points along Dunns Crossing Road to the existing SDC reticulated sewer system.

## 2.3 Physical Constraints

At the Holmes Block, it is feasible to service part of the site from the existing gravity reticulation in Dunn Crossing Road. That part of the site at the south-western end is not able to be serviced by extending the existing reticulation by gravity means. Options included servicing part of the site from the existing reticulation where practical, and then having a separate gravity system that conveys wastewater from the rest of the site into a sewer pump station, and then pumped into the Council reticulation. As an alternative, all of the site could drain to a pump station, and then be pumped into Council infrastructure

## 2.4 Additional Infrastructure Requirements

It maybe that some upgrading to existing infrastructure will be required. An alternative is to extend any new reticulation through to a point on the Council system that has the capacity to accept the additional flow.

## 2.5 Conclusions

From preliminary calculations, the block can be serviced under gravity internally. It will require a pumping station to ultimately discharge into the existing Council network.

# 3. Stormwater

## 3.1 Existing Stormwater Management

Rolleston has no stormwater reticulation network. All stormwater is discharged directly to ground via soakage pits and basins

A resource consent for the discharge of stormwater will be required from ECan

Recent subdivisions to the north and south of the proposed rezoning site have utilised soakage to ground for stormwater management.

## 3.2 Options for Stormwater Disposal

### 3.2.1 General

As there is no reticulated stormwater network then the only practical option is the disposal of stormwater by way of pre-treatment of stormwater and discharge to ground. Discharge of private roof water directly to ground can be made without pre-treatment.

The Geotechnical Investigation Report has been prepared (included as ***Appendix B***). The report indicates that sandy gravels are present at a depth of approximately 0.2m – 0.4m on the sites. These soil conditions would allow for the effective discharge of stormwater to ground given that sandy gravels are expected to be capable of an infiltration rate of at least 1000mm/hr.

A resource consent from ECan will be required in order to discharge water containing contaminants to either surface water or ground. Stormwater from the development will need to be treated to remove contaminants, to reduce the effects on the environment to be less than minor.

It is expected that the most feasible method of pre-treatment is the use of grass swales located within the road reserve throughout the development. Additional treatment such as the use of a stormwater pond or infiltration basin may be required prior to discharging to surface or groundwater.

Stormwater from roof areas is expected to be discharged to ground via individual on-site soakage areas. During large duration events stormwater from roof areas will be directed to the road.

### 3.2.2 Discharge of Stormwater to Ground

Discharge of stormwater to ground has been utilised in recent subdivisions in Rolleston. Based on similar investigations in the locality, the site should have good drainage characteristics which would make discharge to ground feasible. Similar subdivisions in Rolleston have provided swales along the roads, which then discharge into soakpits. Should kerb and channel be preferred over roadside swales, a piped network would be required, which would discharge into an alternative treatment system such as an infiltration base.

In general, the first flush stormwater (stormwater from the first 15 - 25mm of any storm) is more polluted than stormwater runoff from later in a storm event. As a result, the first flush stormwater is generally treated using treatment systems which provide higher levels of contaminant removal than the treatment systems required for subsequent stormwater runoff. This first flush can be treated through a swale system or infiltration basin. Stormwater runoff from large rainfall events, which exceed the first 15-25mm runoff threshold, can be discharged directly to ground using rapid infiltration trenches or soakpits.

Flows in excess of the capacity of the primary system can be directed to the road as a secondary flow path.

### 3.2.3 Conclusion

Given the expected underlying ground characteristics and the topography of the site, disposal to ground can be achieved feasibly.

It is therefore recommended that the development incorporates disposal of stormwater to ground as the main means of disposal of stormwater from the development.

## 3.3 Estimated Contaminant Loadings

Contaminant loadings for the roading stormwater runoff have been estimated using the Auckland Regional Council's TP10 document.

Following treatment using grassed swales with a nine minute retention time, the stormwater is expected to have the following contaminant loadings:

| Contaminant | Expected Loading Following Swale Treatment |
|---|---|
| Sediment | 16.3g/m3 |
| Zinc | 0.124g/m3 |
| Copper | 0.033g/m3 |
| Total Petroleum Hydrocarbons | 0.624g/m3 |

## 3.4 Conclusions

The area proposed for re-zoning is well suited to ground soakage as the primary method of stormwater removal and this method has been successfully implemented in Rolleston

As with all ground soakage systems, the efficiency can decrease over time. However, by adopting a conservative approach to the design of the systems, ensuring that there are adequate options for future upgrading and making allowance for secondary flows, ground soakage systems can provide a cost-effective long-term solution to stormwater disposal. There are alternatives that include the use of proprietary treatment devices, but there are more costly to install, and there is a reluctance from Council to accept them because they are more difficult to maintain than grassed areas.

Adequate measures would need to be implemented to ensure the effects of the discharge on the underlying groundwater are reduced to an acceptable level using suitable treatment and attenuation devices as required. The discharge will require a resource consent from ECan to discharge to ground.

# 4. Water Supply

## 4.1 Outline Development Plan Servicing

At the Holmes Block, there is an existing 150 mm water main in Dunns Crossing road and a 100mm main in Burnham Scholl Road.

The existing reticulation could be extended into the site, but some upgrading of the existing services may be required. Council may also consider the need for a new well, and may ask for a small area of land to be set aside for this purpose.

## 4.2 Required Demand

The proposed plan change includes re-zoning the site to cater for approximately 126 residential properties.

The Christchurch City Council Infrastructure Design Standard (CCCIDS) (Draft 2007) sets the following minimum design criteria for the design of sewerage reticulation.

**Table 2 - Water Design Requirements**

| | |
|---|---|
| Total Additional Lots | 126 Lots |
| Peak Living Zone Design Flow Rates | 0.175 litres/second/connection |

The peak expected domestic demand is therefore:

*Peak Demand (Holmes Hub)* *=126 Lots x 0.175 l/s/connection*
*=22.05 l/s*

The water supply reticulation should comply with the New Zealand Fire Service Fire Fighting Water Supplies Code of Practice (SNZ PAS 4509:2003) for fire fighting flows, residual fire pressure and the spacing of hydrants. Residential housing without sprinkler systems is classified as W3 under the code of practice. Water demand for fire fighting is 25l/s as can be seen in Table 3.

**Table 3 - New Zealand Fire Service Water Requirements**

| Water supply classification | Water flow required within a radial distance of 135m (l/s) | Additional water flow required within a radial distance of 270m (l/s) | Water Storage | | Maximum number of fire hydrants to provide flow |
|---|---|---|---|---|---|
| | | | Time (min) | Volume (m3) | |
| W3 | 12.5 | 12.5 | 30 | 45 | 2 |

The total peak demand can be estimated using the following formula:

Peak $Demand_{Total}$ $= Demand_{Fire\ Flow} + 0.5 \times Peak\ Demand_{Domestic}$
$=25l/s + 0.5 \times 22.05l/s$
$=36.0l/s$.

In order to comply with the Fire Service Code of Practice the principal mains within the developments must have a minimum size of 100mm diameter.

## 4.3 Conclusions

The adjacent existing water reticulation system at the Holmes block allows the site to be serviced easily with good connection points for the proposed residential development area.

A small utility allotment may also be required if the Council requires a well to be located on the site.

# 5. Power supply

At the Holmes block, there is overhead and underground power reticulation along Dunns Crossing Road, and overhead power along Burnham School Road. The reticulation is predominately 11kV – 33kV (high Voltage).

The block is located near the Rolleston District substation, and work is currently being carried out by Orion to relieve the existing load and provide spare capacity. They have also advised that they have no intention of undergrounding the existing overhead high voltage reticulation, and intend to upgrade the existing 33kV line to a 66kV line in the near future.

# 6. Telephone supply

We have received as-built plans from Telecom showing that there are existing telephone services along Dunns Road. This reticulation is generally a 50 pair cable, and upgrading work to this is likely to be required. The requirement for upgrading is unlikely to prohibit the development

# 7. Summary

The site can be serviced for sewer by means of gravity sewer reticulation and a pumping station.

The site is suited to ground soakage as a method for disposal of stormwater. Suitable long term solutions can be provided to dispose of stormwater on-site.

The site can be reticulated by potable water from the Council's water supply.

Connection to the Council's sewage and water reticulation will most likely require some upgrading to existing services.

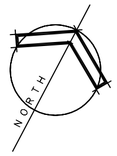
Planned upgrades to the power reticulation in Rolleston will mean sufficient power is available for the block.

The telephone services will need to be upgraded to provide an adequate level of service.

# Appendix A

**Development Site**

A2




STATE HIGHWAY No.1
(MAIN SOUTH ROAD)

MAIN SOUTH LINE

LEGEND

- SPOTHEIGHT
- TELECOM PILLAR
- LP LIGHT POLE
- POWER POLE
- WATER METER
- WATER VALVE
- FH FIRE HYDRANT
- MANHOLE
- SUMP
- SS SEWER PIPES
- Z OVERHEAD POWERLINES
- SW STORMWATER PIPES
- FENCE
- WA WATER SUPPLY FENCE

**DATA QUALITY STATEMENTS**

**PROPERTY DATA**
The property data has been sourced from Land Information New Zealand (LINZ) and is current as at August 2008.

**SURVEYED DATA**
Surveyed data has been captured using survey equipment, to a relative accuracy within approximately 30mm (horizontal and vertical).

**SERVICES DATA**
Where services have features visible on the surface, their positions have been verified by field survey. The accuracy of unverified services is unknown. Also, there may be services for which no records were provided and which are not shown on this plan. In all cases, if the location of a service is considered important, the relevant service provider should be consulted.

**SURVEY ORIGIN DATA**
Vertical elevations are in terms of Christchurch Drainage Datum .
The origin of levels is …….. RL ……m.
The origin of survey is


Pt Lot 1
DP 61557

PROPOSED BOUNDARY

Pt
RS 1759

Pt Section 1
Res 309

Lot 1
DP 361539

Lot 8
DP 361539

NEWMAN
ROAD

Lot 9
DP 361539

Lot 14
DP 361539

Lot 8
DP 71316

CENTRE LINE OF
EXISTING TRACK

Pt
RS 33357

RS 32956

DUNNS CROSSING ROAD

Lot 9
DP 71316

Lot 10
DP 71316

BURNHAM SCHOOL ROAD

BURNHAM
SCHOOL ROAD

Lot 2
DP 326361

Lot 1
DP 387190

Lot 2
DP 387190

Lot 3
DP 387190

Section 1
SO 317609

Lot 1
DP 326361

RS 41594

SCALE 1:3,000

| Rev | Date | Revision Details | By | Ver | App |
|---|---|---|---|---|---|
| A | 08.08 | FOR CLIENT | RS | BDT | BDT |

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Project
SELWYN PLANTATION BOARD LIMITED
PROPOSED PLAN CHANGE
ROLLESTON

Drawing Title
SITE SURVEY
HOLMES HUB

| | Signed | Date |
|---|---|---|
| Surveyed | SE | 07.08 |
| Designed | | |
| Drawn | RS | 08.08 |
| Verified | BDT | 08.08 |
| Approved | ANG | 08.08 |

CW Project No. 36951
Scale 1:3,000@A2
Drawing No. SU-02.1 Rev. A

# Appendix B

**Geotechnical Report**

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# Geotechnical Investigation Report Proposed Plan Change at Rolleston Selwyn Plantation Board Ltd

25 September 2008
Reference 36951/001
Revision 0

Connell Wagner

## Document Control

Connell Wagner

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|---|---|---|---|---|---|---|
| 0 | 25 September 2008 | Issue | CG | CG | AK | MDF |
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## Appendix D

Test Pit Logs and Explanatory Notes – Skellerup Block

## Appendix E

Results of Soak Tests – Skellerup Block

# 1. Introduction

## 1.1 General

Connell Wagner has been engaged by the Selwyn Plantation Board Ltd (SPBL) to provide surveying, planning and engineering services in respect of the potential plan change request of two sites off Dunns Crossing Road on the southern side of Rolleston. The two sites are herein referred to as the Holmes Hub Site, and the Skellerup Block.

As part of the engineering services, it has been necessary to undertake a preliminary ground investigation comprising test pits and soakage tests to support the proposed plan change.

This is the geotechnical factual report following the ground investigation undertaken by Connell Wagner on 12 September 2008. The report summarises the geological, geotechnical and hydrological conditions at the two sites.

# 2. Summary and Conclusions

- Connell Wagner has been engaged by the Selwyn Plantation Board Ltd (SPBL) to provide surveying, planning and engineering services in respect of the potential plan change request of two sites off Dunns Crossing Road on the southern side of Rolleston.
- As part of the engineering services, it was necessary to undertake a preliminary ground investigation comprising test pits and soak tests to support the proposed plan change.
- The object of the geotechnical investigation was to determine the geological, geotechnical and hydrological properties of the ground.
- The two sites are located approximately 2km southwest of the township of Rolleston.
- The geology of the site is shown on the Institute of Geological and Nuclear Sciences (GNS) geological map sheet 21: Christchurch, scale 1:250,000. The map indicates the site is underlain by the Burnham Formation for the Otiran Stage of the Hawera Series.
- Test pit excavations were carried out on 12 September 2008 by Connell Wagner.
- Groundwater was not encountered in any of the test pits and it is therefore inferred to be deeper than 1.5m below ground level (mbgl).
- The underlying geology comprises 1-3m thick stratal sets of gravel, intercalated with sand and loess-silt layers. The seepage rates through the gravelly silt were observed to be slightly lower than those measured in the gravels.
- Typical design soakage rates were in the order of $3x10^{-4}$ $m^3$/sec to $5x10^{-5}$ $m^3$/sec

# 3. Scope of Work

## 3.1 Objectives

The object of the geotechnical investigation was to determine the geological, geotechnical and hydrological properties of the ground under the two sites.

## 3.2 Scope

The scope of the work for this investigation comprised of a geotechnical walk-over and assessment of the two sites, the intrusive ground investigation including test pitting and the subsequent preparation of this report.

## 3.3 Field Investigations

The ground investigations were undertaken on 12 September 2008 and comprised of a site walk over by an engineering geologist and the excavation of three test pits on each site, with associated soak tests. The results of these investigations are discussed in this report.

## 3.4 Report

This report has been divided into two sections, assessing each site separately. Section 4 presents the data obtained for the Holmes Hub Site, whilst section 5 present the data obtained for the Skellerup Block.

# 4. Site Conditions – Holmes Hub Site

## 4.1 Site Description

The site is located approximately 2km southwest of Rolleston as shown in Figure 1, in Appendix A. The site is bounded to the north by State Highway 1, to the east by Dunns Crossing Road and to the south the site is bounded by Burnham School Road, to the west is agricultural pasture land.

The site is approximately 92ha and generally flat lying with a gradual slope towards the south and south east. In the recent past the site was a wooded plantation, however the trees have been removed and the roots were also raked out; no evidence of tree roots was observed during our investigations. The site is currently divided into paddocks and used for agricultural dairy pasture purposes.

## 4.2 Regional Geology

The geology of the site is shown on the Institute of Geological and Nuclear Sciences (GNS) geological map sheet 21: Christchurch, scale 1:250,000. The map indicates the site is underlain by the Burnham Formation for the Otiran Stage of the Hawera Series. The unit comprises a sandy matrix-supported massive gravel, often with long-axis pebble alignment and stratal sets 1 to 3m thick, intercalated with minor lenticular sand and loess-silt layers (Browne, 2002). Our site investigations essentially confirmed the published geology.

## 4.3 Regional Earthquake Hazard

During our site investigation we observed no signs of active faulting and published information indicates that no active faults cross the site. GNS indicates peak ground acceleration, expected at 10% probability in the next 50 years for this site to be 0.2 to 0.3 g.

## 4.4 Subsurface Investigations

### *4.4.1 Test Pits*

Three test pits were excavated at the site on 12 September 2008 by Connell Wagner. The test pit logs are included in Appendix B. The test pits showed a thin layer of silty and sandy topsoil overlaying sandy gravel. The gravel was logged as '*Sandy GRAVEL with cobbles and minor boulders. Mid brown, medium to coarse grained, rounded, gap graded, near horizontal long-axis pebble alignment. Moist*'.

The test pits were terminated at between 1.4 - 1.5m and soak tests were carried out.

## 4.5 In-situ Testing

### *4.5.1 Soak Tests*

The Department of Building and Housing describes a field soak test procedure in clause E1: surface water of the building code. The method requires a borehole 100-150mm diameter to be drilled in which the soakage test is then carried out. The test requires the hole to be filled with water and the level maintained for a minimum of four hours after which the rate of the drop in water level is recorded.

The soak tests carried out on the Holmes site were not done according to this standard method; due to underlying gravel strata, it would not have been possible to drill a borehole 100-150mm diameter due to the cobbles and boulders present, many of which were greater than 100mm, also the borehole would not have remained open without support from a casing. The flow rate of water out from the gravels meant that it would not have likely been possible to keep the water level constant for the 4 hours required.

The soak tests were instead carried out in the test pit excavations. The dimensions of the pit were recorded prior to 0.5 to 1.0m of water being pumped into the pit. The rate of water seepage out from the pit was then recorded.

The time was recorded for each 100mm drop in the level of water in the pit. The detailed results are presented in Appendix C, and summarised in Figure 4 and Table 1 below:

**Table 1: Flow Rates observed in the soak tests**

| Test | Depth of water (m) | Observed Flow Rate ($m^3$/sec) | Design soakage rate ($m^3$/sec) |
|---|---|---|---|
| H-1 | 1.0 | $5.10 \times 10^{-4}$ (L)<br>$4.49 \times 10^{-3}$ (U) | $1 \times 10^{-5}$ |
| H-2 | 0.5 | $2.00 \times 10^{-3}$ (L)<br>$3.08 \times 10^{-3}$ (U) | |
| H-3 | 0.5 | $1.65 \times 10^{-3}$ (L)<br>$3.50 \times 10^{-3}$ (U) | |

(L) Lower limit (U) Upper Limit

### 4.6 Groundwater

Groundwater was not encountered in any of the test pits and it is therefore inferred to be deeper than 1.5m below ground level (mbgl). Our previous investigations in the overall Rolleston area indicated that groundwater is generally located at depth.

# 5. Site Conditions – Skellerup Block

## 5.1 Site Description

The site is located approximately 2km southwest of Rolleston as shown in Figure 1, in Appendix A. The site is bounded to the east by Dunns Crossing Road; to the west, north and south there is agricultural pasture land.

The site is approximately 73ha and generally flat lying with a gradual slope towards the south and south east. In the recent past the site was a wooded plantation, however the trees have been removed and evidence of tree roots was observed during our investigations. The site is currently divided into paddocks and used for agricultural dairy pasture purposes.

## 5.2 Regional Geology

The geology of the site is shown on the Institute of Geological and Nuclear Sciences (GNS) geological map sheet 21: Christchurch, scale 1:250,000. The map indicates the site is underlain by the Burnham Formation for the Otiran Stage of the Hawera Series. The unit comprises a sandy matrix-supported massive gravel, often with long-axis pebble alignment and stratal sets 1-3m thick, intercalated with minor lenticular sand and loess-silt layers (Browne, 2002). Our site investigations essentially confirmed the published geology.

## 5.3 Regional Earthquake Hazard

During our site investigation we observed no signs of active faulting and published information indicates that no active faults cross the site. GNS indicates peak ground acceleration, expected at 10% probability in the next 50 years for this site to be 0.2 to 0.3 g.

## 5.4 Subsurface Investigations

### *5.4.1 Test Pits*

The test pit logs are included in Appendix D. The test pits showed a thin layer of silty and sandy topsoil overlaying sandy gravel. The main soil stratum was logged as '*Gravelly silt and silty sandy gravel with cobbles and minor clay and boulders. Light brown, cohesive. Gravel is medium to coarse grained, rounded, gap graded, near horizontal long-axis pebble alignment. Sand is angular. Moist'. Large tree roots in the upper part.'*

The test pits were terminated at between 1.4 - 1.5m and soak tests were carried out.

## 5.5 In-situ Testing

### *5.5.1 Soak Tests*

The Department of Building and Housing describes a field soak test procedure in Clause E1: surface water of the building code. The method requires a borehole 100-150mm diameter to be drilled in which the soakage test is then carried out. The test requires the hole to be filled with water and the level maintained for four hours after which the rate of the drop in water level is recorded.

The soak tests carried out on the Holmes site were not done according to this standard method; due to mainly gravel strata. It would not have been possible to drill a borehole 100-150mm diameter due to the cobbles and boulders being present, many of which were greater than 100mm, also the borehole would not have remained open without support from a casing. The flow rate of water out from the gravels meant that it would not have likely been possible to keep the water level constant for the 4 hours required.

The soak tests were instead carried out in the test pit excavations. The dimensions of the pit were recorded prior to 0.5m of water being pumped into the pit. The rate of water seepage out from the pit was then recorded.

0.5m of water depth was pumped into the pits and the time was recorded for each 100mm drop in the level of water in the pit. The results are presented in Appendix E, in Figure 4 in Appendix A and summarised in Table 1 below:

**Table 2: Flow Rates observed in the soak tests**

| Test | Depth of water (m) | Observed Flow Rate ($m^3$/sec) | Design soakage rate ($m^3$/sec) |
|---|---|---|---|
| S-1 | 0.5 | $4.80 \times 10^{-4}$ (L)<br>$6.50 \times 10^{-4}$ (U) | $5.0 \times 10^{-5}$ |
| S-2 | 0.5 | $1.40 \times 10^{-4}$ (L)<br>$1.40 \times 10^{-4}$ (U) | $1.0 \times 10^{-5}$ |
| S-3 | 0.2 | $5.26 \times 10^{-3}$ (L)<br>$8.33 \times 10^{-3}$ (U) | $5.0 \times 10^{-4}$ |

(L) Lower limit (U) Upper Limit

### 5.6 Groundwater

Groundwater was not encountered in any of the test pits and it is therefore inferred to be deeper than 1.5m below ground level (mbgl). Our previous investigations in the overall Rolleston area indicated that groundwater is generally located at depth.

# 6. Summary

## 6.1 Holmes Hub Site

The geology encountered in the test pits was generally sandy gravel and the soak tests were therefore undertaken in these materials. As described in Section 4.2, the Burnham Formation comprises 1-3m thick stratal sets of gravel, intercalated with sand and loess-silt layers. The inferred seepage rates through the sandy gravels were fairly consistent across the site. It is inferred however, that there may be lenses of loess silt within the areas in which storm water management is proposed, if this is the case the soakage rates are likely to be lower than those observed on site. For this reason, a factor of safety has been added to the calculated rates to provide a preliminary design soakage rate of $1x10^{-5}$ $m^3$/sec.

## 6.2 Skellerup Block

The geology encountered in the test pits was generally gravelly silt with some silty sandy gravel. The geology was found to vary across the site and this is reflected in the range of inferred seepage rates. The observed rates through the gravels were faster than those through the silts. A lower bound design soakage rate of $1x10^{-5}$ $m^3$/sec has therefore been adopted to account for the variability of the ground across the site.

# 7. Limitations

We have prepared this report in accordance with the brief as provided. The contents of the report are for the sole use of the Client and no responsibility or liability will be accepted to any third party. Data or opinions contained within the report may not be used in other contexts or for any other purposes without our prior review and agreement.

The recommendations in this report are based on data collected at specific locations and by using shallow test pits with limited site coverage. Only a finite amount of information has been collected to meet the specific financial and technical requirements of the Client's brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgment and it must be appreciated that actual conditions could vary from the assumed model.

Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.

Subsurface conditions, such as groundwater levels, can change over time. This should be borne in mind, particularly if the report is used after a protracted delay.

# 8. References

1 Institute of Geological and Nuclear Sciences (1992) Geological Map 1, scale 1:25,000: Geology of the Christchurch Urban Area.

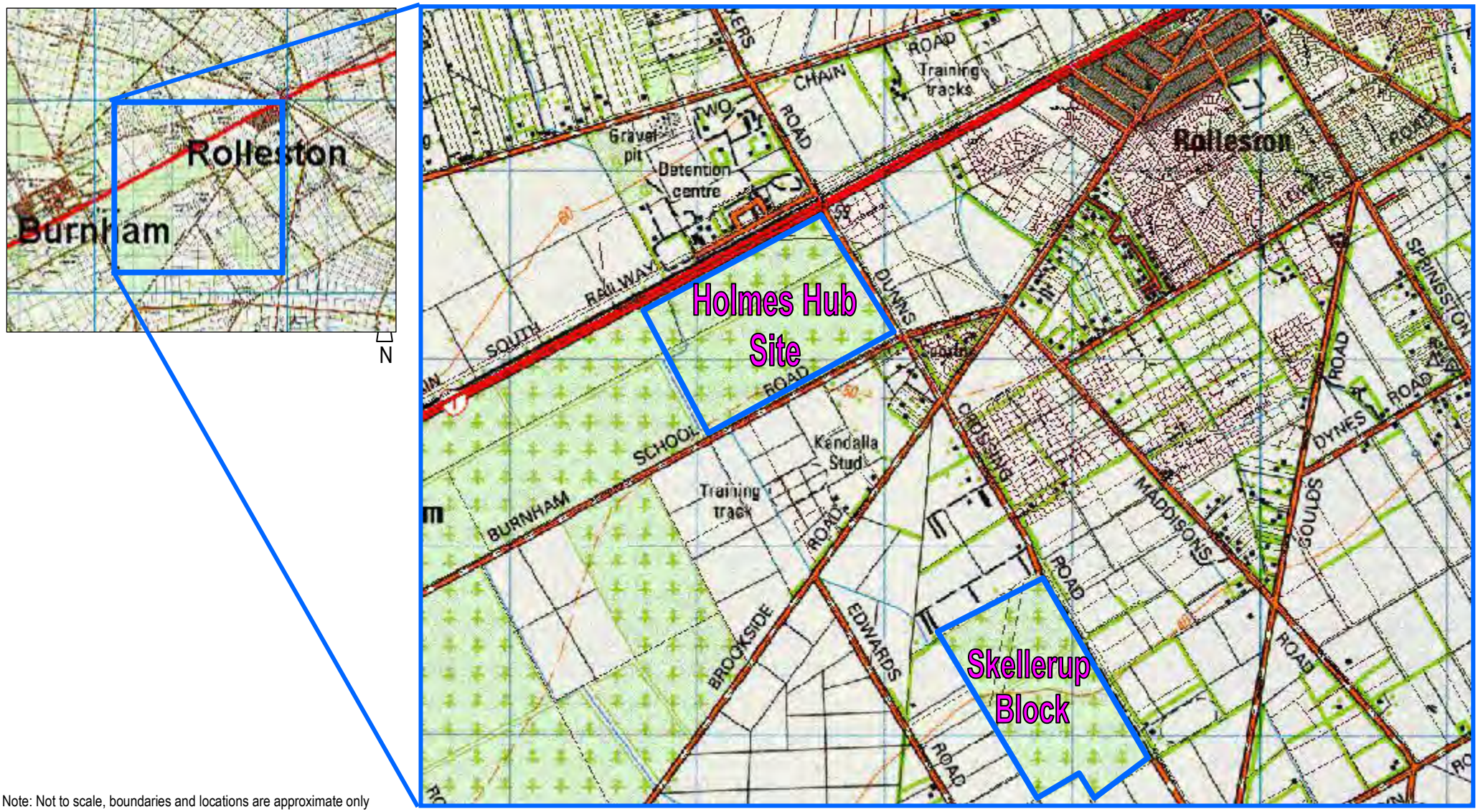
2 http://www.gns.cri.nz (accessed on 02/09/2008)

3 Browne, G H (2002), A large-scale flood event in 1994 from the mid-Canterbury Plains, New Zealand, and implications for ancient fluvial deposits. Spec. Publs Int. Ass. Sediment. 32, 99-109.

4 Dept of Building and Housing (2006) Compliance Document for New Zealand Building Code Clause E1, Surface Water.

# *Appendix A*

**FIGURES**




Note: Not to scale, boundaries and locations are approximate only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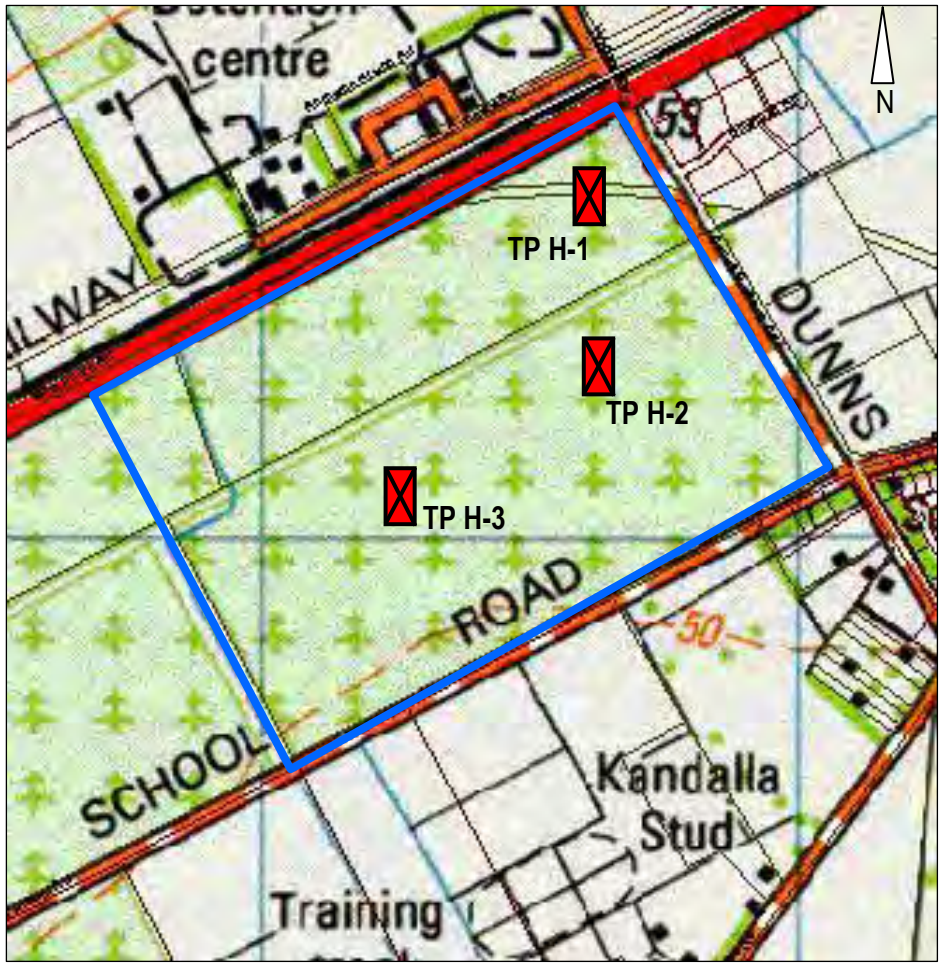
| | |
|---|---|
| Client | Selwyn Plantation Board Ltd |
| Project | Proposed Plan Change at Rolleston |
| By | CG |
| Date | September 2008 |
| Job Number | 36951-001 |

Figure 1
Site location

| | |
|---|---|
| Paper Size | A4 |
| Revision | A |

## HOLMES HUB SITE




## SKELLERUP BLOCK


Approximate location of test pits with soak tests

| Approximate coordinates: | TPH-1 1547696 , 5172033 | TPS-1 1548839, 5169926 |
|---|---|---|
| *(measured with hand-held GPS)* | TPH-2 1547734 , 5171797 | TPS-2 1549448, 5169261 |
| | TPH-3 1547283 , 5171554 | TPS-3 1548668, 5169475 |

Note: Not to scale, boundaries and locations are approximate only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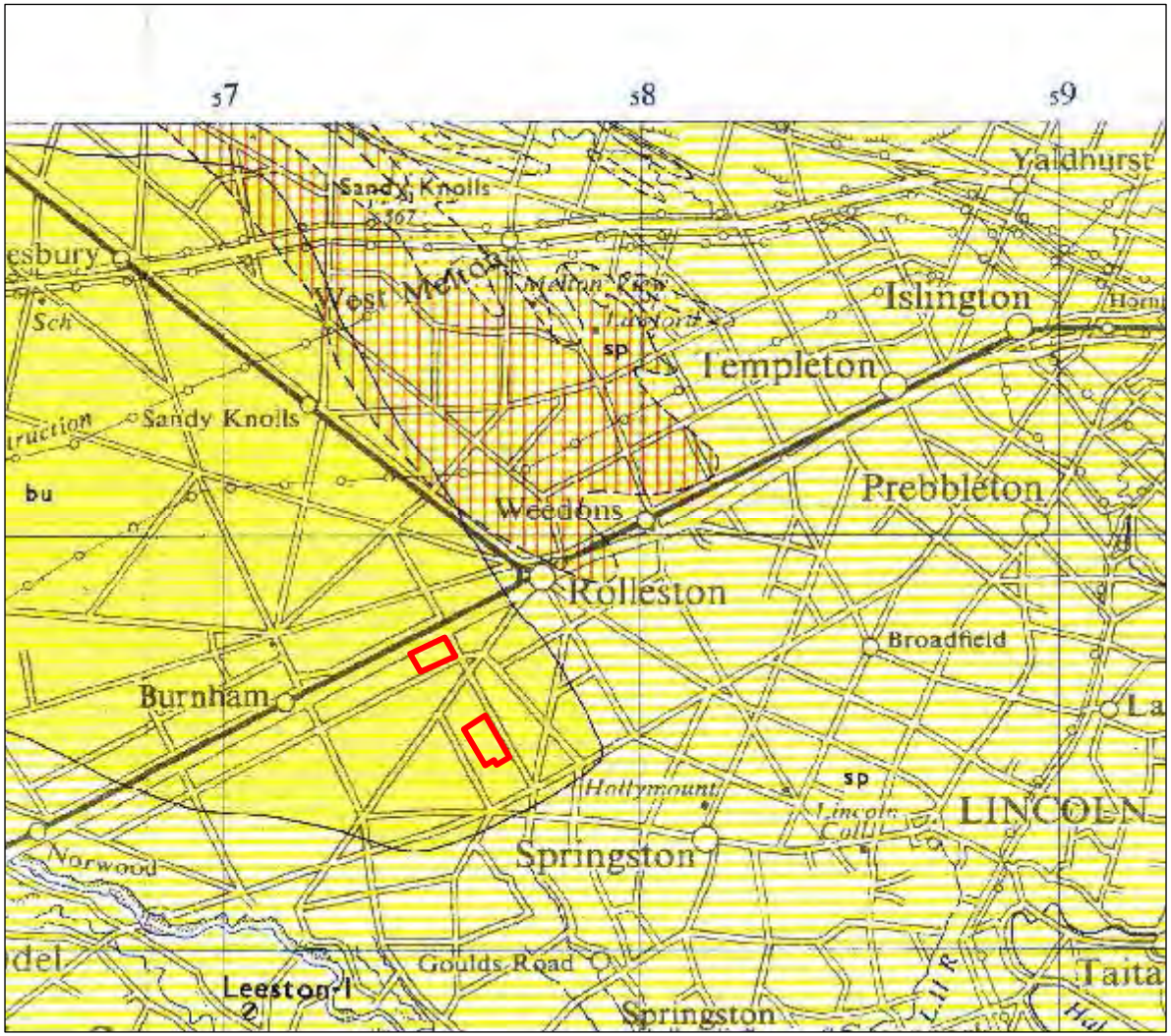
| | | | |
|---|---|---|---|
| Client | Selwyn Plantation Board Ltd | Figure 2<br>Test Pit Location plan | Paper Size A4 |
| Project | Proposed Plan Change at Rolleston | | Revision A |
| By | CG | Date September 2008 | Job Number 36951-001 |




## GEOLOGICAL LEGEND

| | | |
|---|---|---|
| ch | Marine, estuarine and lagoonal deposits. Dune sand | CHRISTCHURCH FORMATION |
| sp | Overlain by dune sand River gravel and alluvium Overlain by loess | SPRINGSTON FORMATION |
| h | Loess | BANKS PENINSULA LOESS |
| bu | Glacial outwash gravel Overlain by loess | BURNHAM FORMATION |
| ws | Till Glacial outwash gravel Overlain by loess | WINDWHISTLE FORMATION |
| wo | Till Glacial outwash gravel | WOODLANDS FORMATION |
| ho | Glacial outwash gravel, overlain by loess | HORORATA FORMATION |

Approximate site boundaries: Holmes Hub site  Skellerup Block

Note: Not to scale, boundaries and locations are approximate only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| | |
|---|---|
| Client | Selwyn Plantation Board Ltd |
| Project | Proposed Plan Change at Rolleston |
| By | CG |

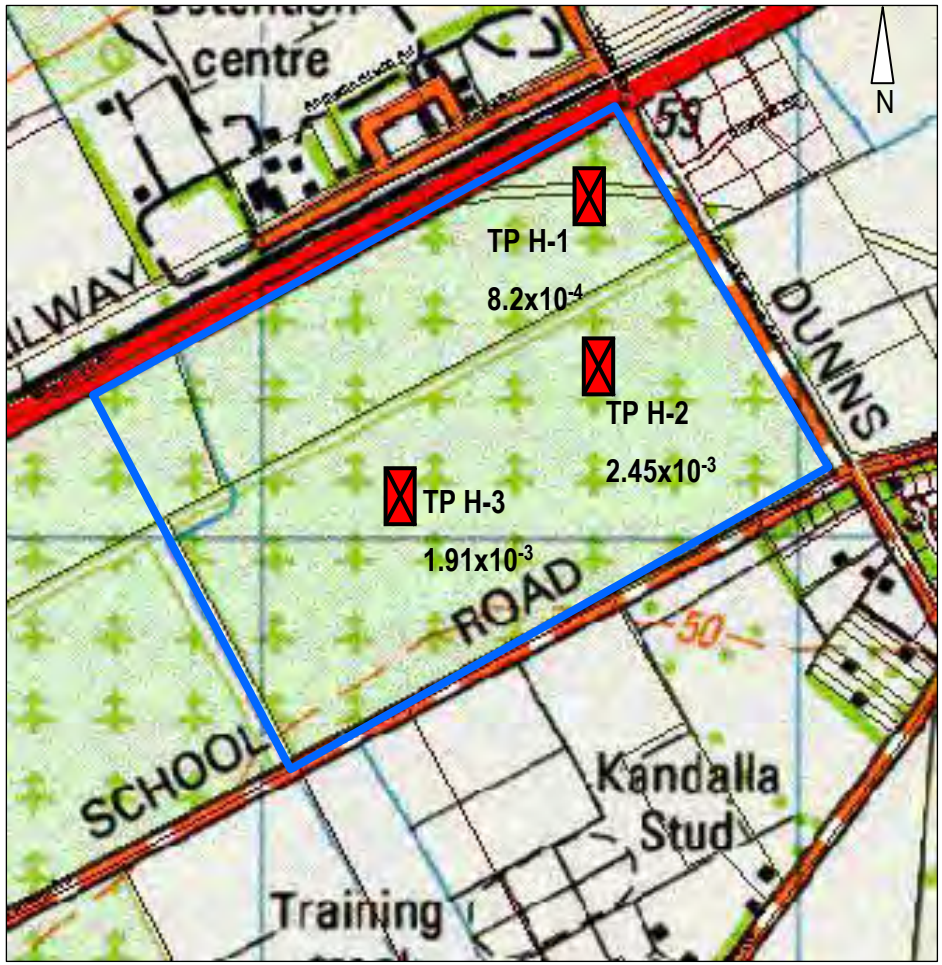
Figure 3

Extract from the 1:250,000 GNS Map sheet 21: Christchurch

| | | | |
|---|---|---|---|
| Date | September 2008 | Job Number | 36951-001 |

| | |
|---|---|
| Paper Size | A4 |
| Revision | A |

## HOLMES HUB SITE




## SKELLERUP BLOCK


Approximate location of test pits with soak tests

| | | |
|---|---|---|
| Approximate coordinates: | TPH-1 1547696 , 5172033 | TPS-1 1548839, 5169926 |
| *(measured with hand-held GPS)* | TPH-2 1547734 , 5171797 | TPS-2 1549448, 5169261 |
| | TPH-3 1547283 , 5171554 | TPS-3 1548668, 5169475 |

Note: Not to scale, boundaries and locations are approximate only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| | | | |
|---|---|---|---|
| Client | Selwyn Plantation Board Ltd | Paper Size | A4 |
| Project | Proposed Plan Change at Rolleston | Revision | A |
| By | CG | Date | September 2008 |
| Job Number | 36951-001 | | |

Figure 4
Observed Average Soakage Rates

# *Appendix B*

**TEST PIT LOGS AND EXPLANATORY NOTES – HOLMES HUB SITE**

# Open Excavation Log

Test Pit No. **TP H-1**

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| | | | |
|---|---|---|---|
| Client: Selwyn Plantation Board Ltd | Location (measured using hand held GPS): 1547696 , 5172033 | | Date: 12/09/2008 |
| Project: SPBL Rolleston Plan Change | Logged By: CG | Weather Conditions: cloudy & dry | Job Number: 36951-001 |

| Water | Depth (m) | Soil Symbol | FACE 1 — SOIL DESCRIPTION: Colour, structure, weathering, subordinate/ main / minor COMPONENTS. |
|---|---|---|---|
| | 0 | | Grass over sandy TOPSOIL, brown, moist. |
| | 0 – 1.5 | | Sandy GRAVEL with cobbles and minor boulders. Mid brown, medium to coarse grained, rounded, gap graded, near horizontal long-axis pebble alignment. Moist. |
| | 1.5 | | End of Test Pit at 1.5m (Target Depth) |

| Water | Depth (m) | Soil Symbol | FACE 2 — SOIL DESCRIPTION: Colour, structure, weathering, subordinate/ main / minor COMPONENTS. |
|---|---|---|---|
| | 0.5 | | |
| | 1 | | |
| | 1.5 | | |
| | 2 | | |
| | 2.5 | | |

Undrained Shear Strength (kPa) ●
Measured Using a Hand Held Shear Vane[1]
25 50 75 100 125 150

Scala Penetrometer Test[2] ×
(Blows/ 150mm)
2 4 6 8 10 12

Test Description
1 - Hand held shear vane test in accordance with BS1377:1990
2 - Scala Penetrometer Test in accordance with NZS4402:1986 for the first three meters

Notes
Groundwater not encountered
Soak test undertaken and reported separately

Pit dimensions
1.0m
2.2m

Connell Wagner

# Open Excavation Log

Test Pit No. **TP H-2**

**Connell Wagner Limited**
195 Hereford St. (PO Box 1061
Christchurch New Zealand

Telephone: +64 3 366 0821
Facsimile: +64 3 379 6955

| | | | |
|---|---|---|---|
| Client: Selwyn Plantation Board Ltd | Location (measured using hand held GPS): 1547734, 5171797 | | Date: 12/09/2008 |
| Project: SPBL Rolleston Plan Change | Logged By: CG | Weather Conditions: cloudy & dry | Job Number: 36951-001 |

| Water | Depth (m) | Soil Symbol | FACE 1 — SOIL DESCRIPTION: Colour, structure, weathering, subordinate/ main / minor COMPONENTS. |
|---|---|---|---|
| | 0 | | Grass over silty TOPSOIL, brown, moist. |
| | 0.5 | | Sandy GRAVEL with cobbles and minor boulders. Mid brown, medium to coarse grained, rounded, gap graded, near horizontal long-axis pebble alignment. Moist. |
| | 1 | | |
| | 1.5 | | End of Test pit at 1.4m (Target depth) |
| | 2 | | |
| | 2.5 | | |

| Water | Depth (m) | Soil Symbol | FACE 2 — SOIL DESCRIPTION: Colour, structure, weathering, subordinate/ main / minor COMPONENTS. |
|---|---|---|---|
| | 0 | | |
| | 0.5 | | |
| | 1 | | |
| | 1.5 | | |
| | 2 | | |
| | 2.5 | | |

Undrained Shear Strength (kPa) ●
Measured Using a Hand Held Shear Vane[1]
25 50 75 100 125 150

Scala Penetrometer Test[2] ×
(Blows/ 150mm)
2 4 6 8 10 12

Test Description
1 - Hand held shear vane test in accordance with BS1377:1990
2 - Scala Penetrometer Test in accordance with NZS4402:1986 for the first three meters

Notes
Groundwater not encountered
Soak test undertaken and reported separately

Pit dimensions
1.0m
2.0m

# Open Excavation Log

Test Pit No. **TP H-3**

**Connell Wagner Limited**
195 Hereford St. (PO Box 1061
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Telephone: +64 3 366 0821
Facsimile: +64 3 379 6955

| | | | |
|---|---|---|---|
| Client: Selwyn Plantation Board Ltd | Location (measured using hand held GPS): 1547283, 5171554 | | Date: 12/09/2008 |
| Project: SPBL Rolleston Plan Change | Logged By: CG | Weather Conditions: cloudy & dry | Job Number: 36951-001 |

| Water | Depth (m) | Soil Symbol | FACE 1 — SOIL DESCRIPTION: Colour, structure, weathering, subordinate/ main / minor COMPONENTS. |
|---|---|---|---|
| | 0 | | Grass over silty TOPSOIL, brown, moist. |
| | 0.5 | | Sandy GRAVEL with cobbles and minor boulders. Mid brown, medium to coarse grained, rounded, gap graded, near horizontal long-axis pebble alignment. Moist. |
| | 1 | | |
| | 1.5 | | End of Test pit at 1.4m (Target depth) |
| | 2 | | |
| | 2.5 | | |

| Water | Depth (m) | Soil Symbol | FACE 2 — SOIL DESCRIPTION: Colour, structure, weathering, subordinate/ main / minor COMPONENTS. |
|---|---|---|---|
| | 0 | | |
| | 0.5 | | |
| | 1 | | |
| | 1.5 | | |
| | 2 | | |
| | 2.5 | | |

Undrained Shear Strength (kPa) ●
Measured Using a Hand Held Shear Vane[1]
25 50 75 100 125 150

Scala Penetrometer Test[2] ×
(Blows/ 150mm)
2 4 6 8 10 12

Test Description
1 - Hand held shear vane test in accordance with BS1377:1990
2 - Scala Penetrometer Test in accordance with NZS4402:1986 for the first three meters

Notes
Groundwater not encountered
Soak test undertaken and reported separately

Pit dimensions
1.0m
2.1m

# GENERAL NOTES

This site investigation was carried out in accordance with described in the New Zealand Geotechnical Society's "*Guidelines for the Field Description of Soils and Rocks in Engineering Use*" for the specific purpose and client as defined in the introductory section(s) of this document. The report should not be used by other parties or for other purposes without prior consultation with Connell Wagner, as it may not contain adequate or appropriate information.

## LOGGING

The information on the Logs (Boreholes, Test Pits, Natural Exposures etc.) has been based on a visual and tactile assessment except at the discrete locations where test information has been reported (eg field and/or laboratory results).

Reference should be made to our standard sheets for the definition of our logging procedures (Soil and/or Rock Descriptions, as appropriate).

## GROUNDWATER

Unless otherwise indicated, the water levels given on the logs are the levels of free water or seepage in the test hole recorded at the given time of measuring. The measured ground water level may be affected by the method of investigation (for example, if rotary drilling is utilised, drilling fluids will be pumped into the ground).

The actual groundwater level may differ from the recorded level depending on material permeabilities. Further variations of this level could occur with time due to such effects as seasonal and tidal fluctuations or construction activities.

Final confirmation of levels can only be made by appropriate instrumentation techniques and programmes.

## SAMPLING

Samples extracted during the fieldwork phase of a site investigation may be 'disturbed' or 'undisturbed' (as indicated on the logs) depending on the intended mature and purpose of the sample as well as the practicable method of extraction, transportation, extrusion and testing. This aspect should be taken into account when assessing test results which must of necessity reflect the effects of such disturbance.

Generally, 'disturbed' samples would be suitable for visual identification, moisture content determination, Atterberg Limits testing, compaction and California bearing ratio (CBR) testing, amongst others.

The amount sampled is also a limiting factor in the suitability for testing purposes, for example, a minimum of 10 kg is necessary for compaction and CBR testing.

'Undisturbed' samples are normally necessary for laboratory testing such as shrink-swell tests. These samples are obtained by pushing a thin-walled, mild steel tube with a machined cutting edge into the soil, and extracting the assembly. The soil (normally of nominal 50 mm diameter) is extruded at the laboratory prior to testing.

## LABORATORY TESTING

Laboratory testing is normally carried out in accordance with relevant British, Australian or New Zealand Standards (eg AS1289) or to State Roads Authoities or TransitNZ Standards where specified. All testing is carried out in ISO9001 laboratories unless prior agreements are made between Connell Wagner and the client.

Where tests are used which are not covered by Standard procedures, the method details are provided in the report.

All soil properties (as measured by laboratory testing) exhibit inherent variability and thus a certain statistical number of tests is required in order to predict an average property with any degree of confidence. The site

variability of soil strata, future changes in moisture and other conditions and the discrete sampling positions must also be considered when assessing the representative nature of the laboratory programme.

Certain laboratory tests provide interpreted soil properties as derived by conventional mathematical procedures. The applicability of such properties to engineering design must be assessed with due regard to the site, sample condition, procedure and the proposed development.

INTERPRETATION OF RESULTS

The discussion and any recommendations contained within this report are normally based on a site evaluation from discrete test hole data. Generalised or idealised subsurface conditions (including any cross-sections contained in the report) have been assumed or prepared by interpolation and /or extrapolation of these data. As such, these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in the generalised ground conditions used for this report can occur, particularly between discrete test hole locations. Furthermore, certain design or construction procedures may have been assumed in assessing the soil-structure interaction behaviour of the site.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed in this report should be referred to Connell Wagner for appropriate assessment and comment.

FOUNDATION DEPTH

Where referred to in the report, the recommended depth of any foundation (piles, caissons, footings, etc.) is an engineering estimate of the depth to which they should be constructed. The estimate is influenced and perhaps limited by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The depth remains, however, an estimate and therefore liable to variation. Foundation drawings, designs and specifications based upon this report should provide for variations in the final depth depending upon the ground conditions at each point of support.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in this report for the inclusion in the contract documents or engineering specification of the subject development, such reproduction should include all of the report, including appendices (if any).

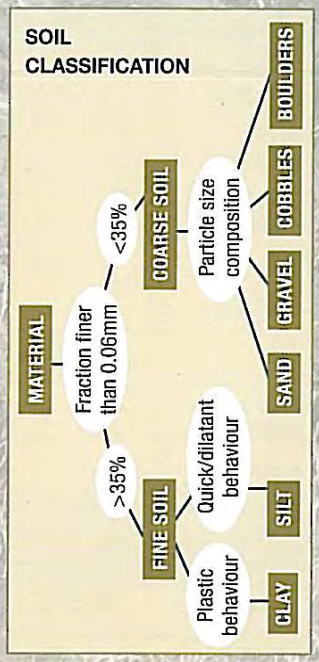
# SOIL > field guide sheet

FIELD DESCRIPTION OF SOIL

**SEQUENCE OF TERMS** – fraction – colour – structure – strength – moisture – bedding – plasticity – sensitivity – additional

## GRAIN SIZE CRITERIA

| TYPE | COARSE | | | | | | | FINE | | ORGANIC |
|---|---|---|---|---|---|---|---|---|---|---|
| | Boulders | Cobbles | Gravel | | | Sand | | | Silt | Clay | Organic Soil |
| | | | coarse | medium | fine | coarse | medium | fine | | | |
| Size Range (mm) | 200 | 60 | 20 | 6 | 2 | 0.6 | 0.2 | 0.06 | 0.002 | | |
| Graphic Symbol | | | | | | | | | | | |




## PROPORTIONAL TERMS DEFINITION (COARSE SOILS)

| Fraction | Term | % of Soil Mass | Example |
|---|---|---|---|
| Major | (....)<br>[UPPER CASE] | ≥ 50<br>[major constituent] | GRAVEL |
| Subordinate | (....) y<br>[lower case] | 20 – 50 | Sandy |
| Minor | with some ...<br>with minor ... | 12 – 20<br>5 – 12 | with some sand<br>with minor sand |
| | with trace of (or slightly)... | < 5 | with trace of sand<br>(slightly sandy) |

## DENSITY INDEX (RELATIVE DENSITY) TERMS

| Descriptive Term | Density Index ($R_D$) | SPT "N" value (blows / 300 mm) | Dynamic Cone (blows / 100 mm) |
|---|---|---|---|
| Very dense | > 85 | > 50 | > 17 |
| Dense | 65 – 85 | 30 – 50 | 7 – 17 |
| Medium dense | 35 – 65 | 10 – 30 | 3 – 7 |
| Loose | 15 – 35 | 4 – 10 | 1 – 3 |
| Very loose | < 15 | < 4 | 0 – 2 |

Note: • No correlation is implied between Standard Penetration Test (SPT) and Dynamic Cone Test values.
• SPT "N" values are uncorrected. • Dynamic Cone Penetrometer (Scala)

## CONSISTENCY TERMS FOR COHESIVE SOILS

| Descriptive Term | Undrained Shear Strength (kPa) | Diagnostic Features |
|---|---|---|
| Very soft | < 12 | Easily exudes between fingers when squeezed |
| Soft | 12 – 25 | Easily indented by fingers |
| Firm | 25 – 50 | Indented by strong finger pressure and can be indented by thumb pressure |
| Stiff | 50 – 100 | Cannot be indented by thumb pressure |
| Very stiff | 100 – 200 | Can be indented by thumb nail |
| Hard | 200 – 500 | Difficult to indent by thumb nail |

## ORGANIC SOILS/ DESCRIPTORS

| Term | Description |
|---|---|
| Topsoil | Surficial organic soil layer that may contain living matter. However topsoil may occur at greater depth, having been buried by geological processes or man-made fill, and should then be termed a buried topsoil. |
| Organic clay, silt or sand | Contains finely divided organic matter; may have distinctive smell; may stain; may oxidise rapidly. Describe as for inorganic soils. |
| Peat | Consists predominantly of plant remains.<br>***Firm***: Fibres already compressed together ***Spongy***: Very compressible and open stucture ***Plastic***: Can be moulded in hand and smears in fingers<br>***Fibrous***: Plant remains recognisable and retain some strength ***Amorphous***: No recognisable plant remains |
| Roolets | Fine, partly decomposed roots, normally found in the upper part of a soil profile or in a redeposited soil (e.g. colluvium or fill) |
| Carbonaceous | Discrete particles of hardened (carbonised) plant material. |

## MOISTURE CONDITION

| Condition | Description | Granular Soils | Cohesive Soils |
|---|---|---|---|
| Dry | Looks and feels dry | Run freely through hands | Hard, powdery or friable |
| Moist | Feels cool, darkened in colour | Tend to cohere | Weakened by moisture, but no free water on hands when remoulding |
| Wet | | | Weakened by moisture, free water forms on hands when handling |
| Saturated | Feels cool, darkened in colour and free water is present on the sample | | |

## PLASTICITY (CLAYS & SILTS)

| Term | Description |
|---|---|
| High plasticity | Can be moulded or deformed over a wide range of moisture contents without cracking or showing any tendency to volume change |
| Low plasticity | When moulded can be crumbled in the fingers; may show quick or dilatant behaviour |

## GRADING (GRAVELS & SANDS)

| Term | Description | |
|---|---|---|
| Well graded | Good representation of all particle sizes from largest to smallest | |
| Poorly graded | Limited representation of grain sizes - further divided into: | |
| | Uniformly graded | Most particles about the same size |
| | Gap graded | Absence of one or more intermediate sizes |


**NZ GEOTECHNICAL SOCIETY INC**

This field sheet has been taken from and should be used and read with reference to the document FIELD DESCRIPTION OF SOIL AND ROCK. Guideline For the Field Classification and Description of Soil and Rock for Engineering Purposes. NZ Geotechnical Society Inc, December 2005. **www.nzgeotechsoc.org.nz**

compiled by KATE WILLIAMS design KARRYN MUSCHAMP

# ROCK > field guide sheet

FIELD DESCRIPTION OF ROCK

**SEQUENCE OF TERMS** – weathering – colour – fabric – rock name – strength – discontinuities – additional

## SCALE OF ROCK MASS WEATHERING

| Term | Grade | Abbreviation | Description |
|---|---|---|---|
| Unweathered (fresh rock) | I | UW | Rock mass shows no loss of strength, discolouration or other effects due to weathering. There may be slight discolouration on major rock mass defect surfaces or on clasts. |
| Slightly Weathered | II | SW | The rock mass is not significantly weaker than when fresh. Rock may be discoloured along defects, some of which may have been opened slightly. |
| Moderately Weathered | III | MW | The rock mass is significantly weaker than the fresh rock and part of the rock mass may have been changed to a soil. Rock material may be discoloured and defect and clast surfaces will have a greater discolouration, which also penetrates slightly into the rock material. Increase in density of defects due to physical disintegration. |
| Highly Weathered | IV | HW | Most of the original rock mass strength is lost. Material is discoloured and more than half the mass is changed to a soil by chemical decomposition or disintegration (increase in density of defects/fractures). Decomposition adjacent to defects and at the surface of clasts penetrates deeply into the rock material. Lithorelicts or corestones of unweathered or slightly weathered rock may be present. |
| Completely Weathered | V | CW | Original rock strength is lost and the rock mass changed to a soil either by decomposition (with some rock fabric preserved) or by physical disintegration. |
| Residual Soil | VI | RS | Rock is completely changed to a soil with the original fabric destroyed (pedological soil). |

## ROCK STRENGTH TERMS

| Term | Field Identification of Specimen | Unconfined uniaxial compressive strength $q_u$ (MPa) | Point load strength $I_{s(50)}$ (MPa) |
|---|---|---|---|
| Extremely strong | Can only be chipped with geological hammer | > 250 | >10 |
| Very strong | Requires many blows of geological hammer to break it | 100 – 250 | 5 – 10 |
| Strong | Requires more than one blow of geological hammer to fracture it | 50 – 100 | 2 – 5 |
| Moderately strong | Cannot be scraped or peeled with a pocket knife. Can be fractured with single firm blow of geological hammer | 20 – 50 | 1 – 2 |
| Weak | Can be peeled by a pocket knife with difficulty. Shallow indentations made by firm blow with point of geological hammer | 5 – 20 | <1 |
| Very weak | Crumbles under firm blows with point of geological hammer. Can be peeled by a pocket knife | 1 – 5 | |
| Extremely weak (soil description required) | Indented by thumb nail or other lesser strength terms used for soils | <1 | |

Note: • No correlation is implied between $q_u$ and $I_{s(50)}$

## SPACING OF DEFECTS/ DISCONTINUITIES

| Term | Spacing |
|---|---|
| Very widely spaced | >2 m |
| Widely spaced | 600 mm – 2 m |
| Moderately widely spaced | 200 mm – 600 mm |
| Closely spaced | 60 mm – 200 mm |
| Very closely spaced | 20 mm – 60 mm |
| Extremely closely spaced | <20 mm |

## APERTURE OF DISCONTINUITY SURFACES

| Term | Aperture (mm) | Description |
|---|---|---|
| Tight | Nil | Closed |
| Very Narrow | > 0 – 2 | |
| Narrow | 2 – 6 | |
| Moderately Narrow | 6 – 20 | Gapped |
| Moderately Wide | 20 – 60 | Open |
| Wide | 60 – 200 | |
| Very Wide | > 200 | |

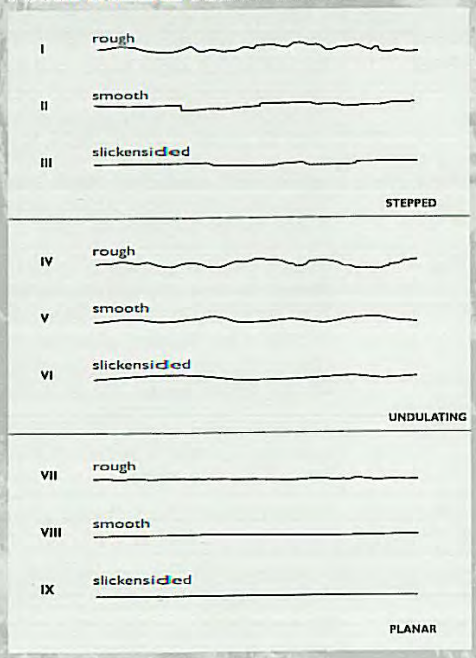
## BEDDING THICKNESS TERMS

| Term | Bed Thickness |
|---|---|
| Thinly laminated | < 2 mm |
| Laminated | 2 mm - 6 mm |
| Very thin | 6 mm - 20 mm |
| Thin | 20 mm - 60 mm |
| Moderately thin | 60 mm - 200 mm |
| Moderately thick | 0.2 m - 0.6 m |
| Thick | 0.6 m - 2 m |
| Very thick | > 2 m |

## BEDDING INCLINATION TERMS

| Term | Inclination (from horizontal) |
|---|---|
| Sub-horizontal | 0° – 5° |
| Gently inclined | 6° – 15° |
| Moderately inclined | 16° – 30° |
| Steeply inclined | 31° – 60° |
| Very steeply inclined | 61° – 80° |
| Sub-vertical | 81° – 90° |

## ROUGHNESS AND APERTURE

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This field sheet has been taken from and should be used and read with reference to the document FIELD DESCRIPTION OF SOIL AND ROCK. Guideline For the Field Classification and Description of Soil and Rock for Engineering Purposes. NZ Geotechnical Society Inc, December 2005. www.nzgeotechsoc.org.nz

# *Appendix C*

**RESULTS OF SOAK TESTS – HOLMES HUB SITE**

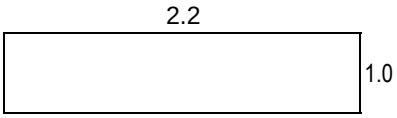
Connell Wagner Limited
195 Hereford St. (PO Box 1061
Christchurch New Zealand
Telephone: +64 3 366 0821
Facsimile: +64 3 379 6955

# Soak Test in Open Excavation

Test No. **TP H-1**

| Client | Location (measured using hand held GPS) | | Date |
|---|---|---|---|
| Selwyn Plantation Board Ltd | 1547696 , 5172033 | | 12/09/2008 |
| **Project** | **Engineer** | **Weather Conditions** | **Job Number** |
| SPBL Rolleston Plan Change | CG | cloudy/dry | 36951-001 |

Test Pit Dimensions (m)

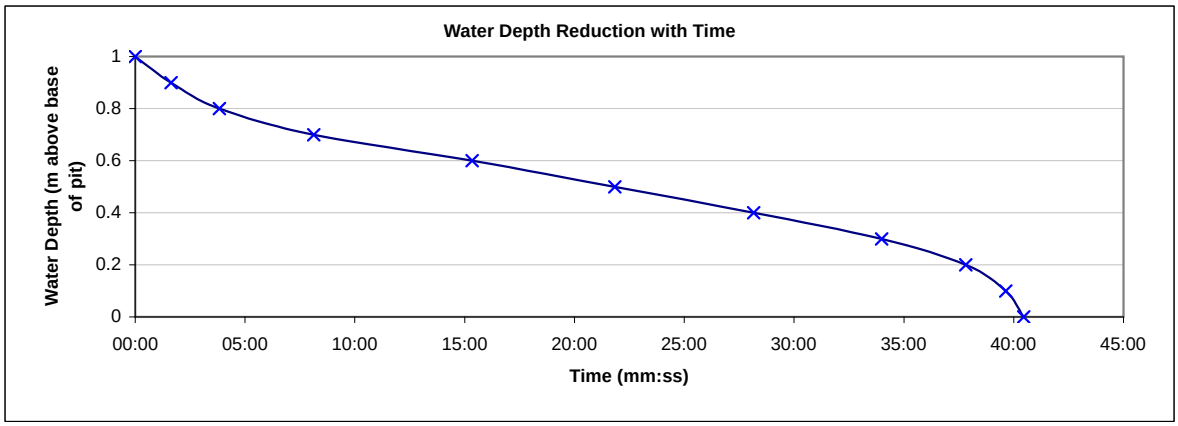



Depth of water added: 1.0 m above base of pit
Volume of water added: 2.2 m$^3$

Time taken for water to soak away:

| Water depth (m) | Time | Flow Rate m$^3$/sec |
|---|---|---|
| 1 | 00:00 | - |
| 0.9 | 01:38 | 0.00224 |
| 0.8 | 03:50 | 0.00167 |
| 0.7 | 08:08 | 0.00085 |
| 0.6 | 15:20 | 0.00051 |
| 0.5 | 21:50 | 0.00056 |
| 0.4 | 28:10 | 0.00058 |
| 0.3 | 33:59 | 0.00063 |
| 0.2 | 37:49 | 0.00096 |
| 0.1 | 39:38 | 0.00202 |
| 0 | 40:27 | 0.00449 |

Flow rate of water into the ground




Calculated Flow Rate

| | |
|---|---|
| maximum | 0.00449 m$^3$/sec |
| minimun | 0.00051 m$^3$/sec |
| average | 0.00082 m$^3$/sec |

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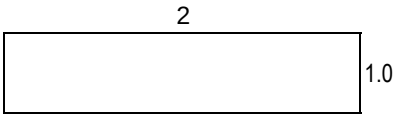
# Soak Test in Open Excavation

Test No. **TP H-2**

| Client | Location (measured using hand held GPS) | | Date |
|---|---|---|---|
| Selwyn Plantation Board Ltd | 1547734, 5171797 | | 12/09/2008 |
| **Project** | **Engineer** | **Weather Conditions** | **Job Number** |
| SPBL Rolleston Plan Change | CG | cloudy/dry | 36951-001 |

Test Pit Dimensions (m)



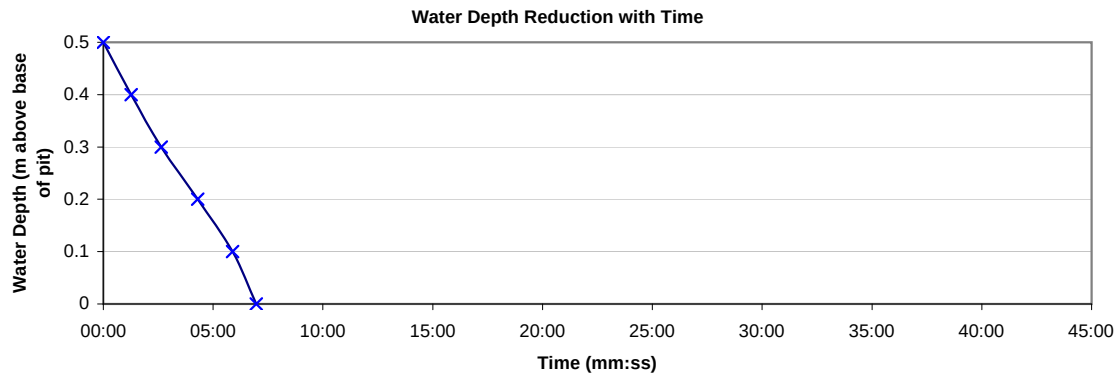

Depth of water added: 0.5 m above base of pit

Volume of water added: 1.0 $m^3$

Time taken for water to soak away:

| Water depth (m) | Time | Flow Rate $m^3$/sec |
|---|---|---|
| 0.5 | 00:00 | - |
| 0.4 | 01:16 | 0.00263 |
| 0.3 | 02:38 | 0.00244 |
| 0.2 | 04:18 | 0.00200 |
| 0.1 | 05:53 | 0.00211 |
| 0 | 06:58 | 0.00308 |

Flow rate of water into the ground




Calculated Flow Rate

| | |
|---|---|
| maximum | 0.00308 $m^3$/sec |
| minimun | 0.00200 $m^3$/sec |
| average | 0.00245 $m^3$/sec |

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# Soak Test in Open Excavation

Test No. **TP H-3**

| Client | Location (measured using hand held GPS) | | Date |
|---|---|---|---|
| Selwyn Plantation Board Ltd | 1547283, 5171554 | | 12/09/2008 |
| **Project** | **Engineer** | **Weather Conditions** | **Job Number** |
| SPBL Rolleston Plan Change | CG | cloudy/dry | 36951-001 |

Test Pit Dimensions (m)

2.1

1.0

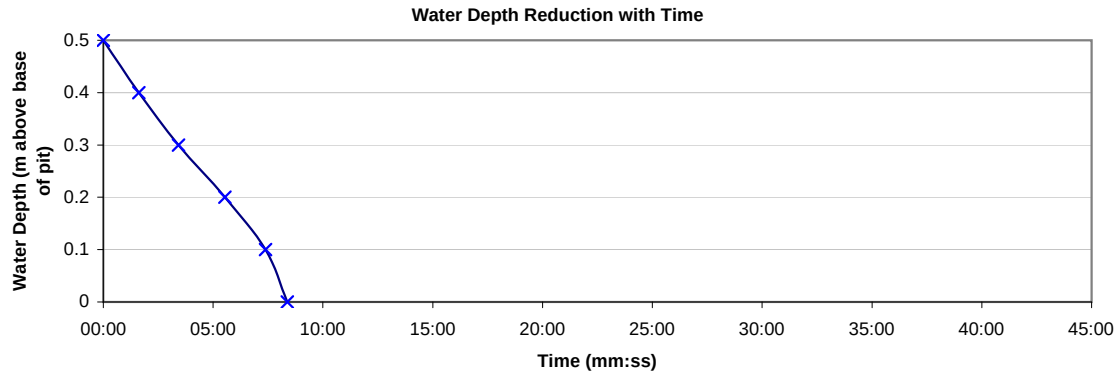
Depth of water added: 0.5 m above base of pit

Volume of water added: 1.05 $m^3$

Time taken for water to soak away:

| Water depth (m) | Time | Flow Rate $m^3$/sec |
|---|---|---|
| 0.5 | 00:00 | - |
| 0.4 | 01:37 | 0.00216 |
| 0.3 | 03:25 | 0.00194 |
| 0.2 | 05:32 | 0.00165 |
| 0.1 | 07:23 | 0.00189 |
| 0 | 08:23 | 0.00350 |

Flow rate of water into the ground




Calculated Flow Rate

| | |
|---|---|
| maximum | 0.00350 $m^3$/sec |
| minimun | 0.00165 $m^3$/sec |
| average | 0.00191 $m^3$/sec |

# *Appendix D*

**TEST PIT LOGS AND EXPLANATORY NOTES – SKELLERUP BLOCK**

Connell Wagner

# Open Excavation Log

Test Pit No. **TP S-1**

**Connell Wagner Limited**
195 Hereford St. (PO Box 1061
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Facsimile: +64 3 379 6955

| | | | |
|---|---|---|---|
| Client: Selwyn Plantation Board Ltd | Location (measured using hand held GPS): 1548839, 5169926 | | Date: 12/09/2008 |
| Project: SPBL Rolleston Plan Change | Logged By: CG | Weather Conditions: cloudy & dry | Job Number: 36951-001 |

| Water | Depth (m) | Soil Symbol | FACE 1 — SOIL DESCRIPTION: Colour, structure, weathering, subordinate/ main / minor COMPONENTS. |
|---|---|---|---|
| | 0 | | Grass over silty TOPSOIL, brown, moist with large tree roots. |
| | 0.5 | | Gravelly SILT with cobbles and minor clay and boulders. Light brown, cohesive. Gravel is medium to coarse grained, rounded, gap graded, near horizontal long-axis pebble alignment. Moist. Large tree roots in the upper part. |
| | 1 | | |
| | 1.5 | | End of Test pit at 1.4m (Target depth) |
| | 2 | | |
| | 2.5 | | |

| Water | Depth (m) | Soil Symbol | FACE 2 — SOIL DESCRIPTION: Colour, structure, weathering, subordinate/ main / minor COMPONENTS. |
|---|---|---|---|
| | 0 | | |
| | 0.5 | | |
| | 1 | | |
| | 1.5 | | |
| | 2 | | |
| | 2.5 | | |

Undrained Shear Strength (kPa) ●
Measured Using a Hand Held Shear Vane[1]
25 50 75 100 125 150

Scala Penetrometer Test[2] ×
(Blows/ 150mm)
2 4 6 8 10 12

Test Description
1 - Hand held shear vane test in accordance with BS1377:1990
2 - Scala Penetrometer Test in accordance with NZS4402:1986 for the first three meters

Notes
Groundwater not encountered
Soak test undertaken and reported separately

Pit dimensions
1.0m
2.0m

# Open Excavation Log

Test Pit No. **TP S-2**

**Connell Wagner Limited**
195 Hereford St. (PO Box 1061
Christchurch New Zealand
Telephone: +64 3 366 0821
Facsimile: +64 3 379 6955

| | | | |
|---|---|---|---|
| Client: Selwyn Plantation Board Ltd | Location (measured using hand held GPS): 1549448, 5169261 | | Date: 12/09/2008 |
| Project: SPBL Rolleston Plan Change | Logged By: CG | Weather Conditions: cloudy & dry | Job Number: 36951-001 |

Undrained Shear Strength (kPa) ●
Measured Using a Hand Held Shear Vane[1]
25 50 75 100 125 150
Scala Penetrometer Test[2] ×
(Blows/ 150mm)
2 4 6 8 10 12

| Water | Depth (m) | Soil Symbol | FACE 1 — SOIL DESCRIPTION: Colour, structure, weathering, subordinate/ main / minor COMPONENTS. |
|---|---|---|---|
| | 0 | | Grass over silty TOPSOIL, with large tree roots up to 60mm diameter, brown, moist. |
| | 0.5 | | Gravelly SILT with boulders and minor clay. Light brown, cohesive. Gravel is medium to coarse grained, rounded, gap graded, near horizontal long-axis pebble alignment. Moist. Large tree roots in the upper part. |
| | 1 | | |
| | 1.5 | | End of Test pit at 1.5m (Target depth) |
| | 2 | | |
| | 2.5 | | |

| Water | Depth (m) | Soil Symbol | FACE 2 — SOIL DESCRIPTION: Colour, structure, weathering, subordinate/ main / minor COMPONENTS. |
|---|---|---|---|
| | 0 | | |
| | 0.5 | | |
| | 1 | | |
| | 1.5 | | |
| | 2 | | |
| | 2.5 | | |

Test Description
1 - Hand held shear vane test in accordance with BS1377:1990
2 - Scala Penetrometer Test in accordance with NZS4402:1986 for the first three meters

Notes
Groundwater not encountered
Soak test undertaken and reported separately

Pit dimensions
1.0m
1.9m

Connell Wagner

**Connell Wagner Limited**
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# Open Excavation Log

Test Pit No. **TP S-3**

| | | | |
|---|---|---|---|
| Client: Selwyn Plantation Board Ltd | Location (measured using hand held GPS): 1548668, 5169475 | | Date: 12/09/2008 |
| Project: SPBL Rolleston Plan Change | Logged By: CG | Weather Conditions: cloudy & dry | Job Number: 36951-001 |

| Water | Depth (m) | Soil Symbol | FACE 1 — SOIL DESCRIPTION: Colour, structure, weathering, subordinate/ main / minor COMPONENTS. |
|---|---|---|---|
| | 0 | | Grass over silty TOPSOIL, with large tree roots up to 60mm diameter, brown, moist. |
| | 0.5 | | Silty Sandy GRAVEL with minor cobbles yellowish brown, rounded, gap graded, near horizontal long-axis pebble alignment. Sand is angular. Moist. Large tree roots in the upper part. |
| | 1 | | |
| | 1.5 | | End of Test pit at 1.4m (Target depth) |
| | 2 | | |
| | 2.5 | | |

| Water | Depth (m) | Soil Symbol | FACE 2 — SOIL DESCRIPTION: Colour, structure, weathering, subordinate/ main / minor COMPONENTS. |
|---|---|---|---|
| | 0 | | |
| | 0.5 | | |
| | 1 | | |
| | 1.5 | | |
| | 2 | | |
| | 2.5 | | |

Undrained Shear Strength (kPa) ●
Measured Using a Hand Held Shear Vane[1]
25 50 75 100 125 150

Scala Penetrometer Test[2] ×
(Blows/ 150mm)
2 4 6 8 10 12

Test Description
1 - Hand held shear vane test in accordance with BS1377:1990
2 - Scala Penetrometer Test in accordance with NZS4402:1986 for the first three meters

Notes
Groundwater not encountered
Soak test undertaken and reported separately

Pit dimensions
1.0m
2.0m

# GENERAL NOTES

This site investigation was carried out in accordance with described in the New Zealand Geotechnical Society's "*Guidelines for the Field Description of Soils and Rocks in Engineering Use*" for the specific purpose and client as defined in the introductory section(s) of this document. The report should not be used by other parties or for other purposes without prior consultation with Connell Wagner, as it may not contain adequate or appropriate information.

## LOGGING

The information on the Logs (Boreholes, Test Pits, Natural Exposures etc.) has been based on a visual and tactile assessment except at the discrete locations where test information has been reported (eg field and/or laboratory results).

Reference should be made to our standard sheets for the definition of our logging procedures (Soil and/or Rock Descriptions, as appropriate).

## GROUNDWATER

Unless otherwise indicated, the water levels given on the logs are the levels of free water or seepage in the test hole recorded at the given time of measuring. The measured ground water level may be affected by the method of investigation (for example, if rotary drilling is utilised, drilling fluids will be pumped into the ground).

The actual groundwater level may differ from the recorded level depending on material permeabilities. Further variations of this level could occur with time due to such effects as seasonal and tidal fluctuations or construction activities.

Final confirmation of levels can only be made by appropriate instrumentation techniques and programmes.

## SAMPLING

Samples extracted during the fieldwork phase of a site investigation may be 'disturbed' or 'undisturbed' (as indicated on the logs) depending on the intended mature and purpose of the sample as well as the practicable method of extraction, transportation, extrusion and testing. This aspect should be taken into account when assessing test results which must of necessity reflect the effects of such disturbance.

Generally, 'disturbed' samples would be suitable for visual identification, moisture content determination, Atterberg Limits testing, compaction and California bearing ratio (CBR) testing, amongst others.

The amount sampled is also a limiting factor in the suitability for testing purposes, for example, a minimum of 10 kg is necessary for compaction and CBR testing.

'Undisturbed' samples are normally necessary for laboratory testing such as shrink-swell tests. These samples are obtained by pushing a thin-walled, mild steel tube with a machined cutting edge into the soil, and extracting the assembly. The soil (normally of nominal 50 mm diameter) is extruded at the laboratory prior to testing.

## LABORATORY TESTING

Laboratory testing is normally carried out in accordance with relevant British, Australian or New Zealand Standards (eg AS1289) or to State Roads Authoities or TransitNZ Standards where specified. All testing is carried out in ISO9001 laboratories unless prior agreements are made between Connell Wagner and the client.

Where tests are used which are not covered by Standard procedures, the method details are provided in the report.

All soil properties (as measured by laboratory testing) exhibit inherent variability and thus a certain statistical number of tests is required in order to predict an average property with any degree of confidence. The site

variability of soil strata, future changes in moisture and other conditions and the discrete sampling positions must also be considered when assessing the representative nature of the laboratory programme.

Certain laboratory tests provide interpreted soil properties as derived by conventional mathematical procedures. The applicability of such properties to engineering design must be assessed with due regard to the site, sample condition, procedure and the proposed development.

INTERPRETATION OF RESULTS

The discussion and any recommendations contained within this report are normally based on a site evaluation from discrete test hole data. Generalised or idealised subsurface conditions (including any cross-sections contained in the report) have been assumed or prepared by interpolation and /or extrapolation of these data. As such, these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in the generalised ground conditions used for this report can occur, particularly between discrete test hole locations. Furthermore, certain design or construction procedures may have been assumed in assessing the soil-structure interaction behaviour of the site.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed in this report should be referred to Connell Wagner for appropriate assessment and comment.

FOUNDATION DEPTH

Where referred to in the report, the recommended depth of any foundation (piles, caissons, footings, etc.) is an engineering estimate of the depth to which they should be constructed. The estimate is influenced and perhaps limited by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The depth remains, however, an estimate and therefore liable to variation. Foundation drawings, designs and specifications based upon this report should provide for variations in the final depth depending upon the ground conditions at each point of support.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in this report for the inclusion in the contract documents or engineering specification of the subject development, such reproduction should include all of the report, including appendices (if any).

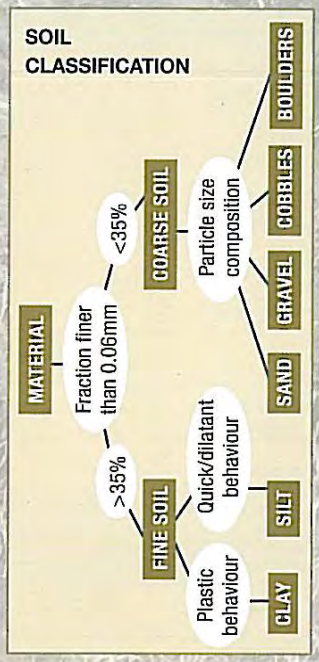
# SOIL > field guide sheet

FIELD DESCRIPTION OF SOIL

**SEQUENCE OF TERMS** – fraction – colour – structure – strength – moisture – bedding – plasticity – sensitivity – additional

## GRAIN SIZE CRITERIA

| TYPE | COARSE | | | | | | | FINE | | ORGANIC |
|---|---|---|---|---|---|---|---|---|---|---|
| | Boulders | Cobbles | Gravel | | | Sand | | | Silt | Clay | Organic Soil |
| | | | coarse | medium | fine | coarse | medium | fine | | | |
| Size Range (mm) | 200 | 60 | 20 | 6 | 2 | 0.6 | 0.2 | 0.06 | 0.002 | | |
| Graphic Symbol | | | | | | | | | | | |




## PROPORTIONAL TERMS DEFINITION (COARSE SOILS)

| Fraction | Term | % of Soil Mass | Example |
|---|---|---|---|
| Major | (....)<br>[UPPER CASE] | ≥ 50<br>[major constituent] | GRAVEL |
| Subordinate | (....) y<br>[lower case] | 20 – 50 | Sandy |
| Minor | with some ...<br>with minor ... | 12 – 20<br>5 – 12 | with some sand<br>with minor sand |
| | with trace of (or slightly)... | < 5 | with trace of sand<br>(slightly sandy) |

## DENSITY INDEX (RELATIVE DENSITY) TERMS

| Descriptive Term | Density Index ($R_D$) | SPT "N" value (blows / 300 mm) | Dynamic Cone (blows / 100 mm) |
|---|---|---|---|
| Very dense | > 85 | > 50 | > 17 |
| Dense | 65 – 85 | 30 – 50 | 7 – 17 |
| Medium dense | 35 – 65 | 10 – 30 | 3 – 7 |
| Loose | 15 – 35 | 4 – 10 | 1 – 3 |
| Very loose | < 15 | < 4 | 0 – 2 |

Note: • No correlation is implied between Standard Penetration Test (SPT) and Dynamic Cone Test values.
• SPT "N" values are uncorrected. • Dynamic Cone Penetrometer (Scala)

## CONSISTENCY TERMS FOR COHESIVE SOILS

| Descriptive Term | Undrained Shear Strength (kPa) | Diagnostic Features |
|---|---|---|
| Very soft | < 12 | Easily exudes between fingers when squeezed |
| Soft | 12 – 25 | Easily indented by fingers |
| Firm | 25 – 50 | Indented by strong finger pressure and can be indented by thumb pressure |
| Stiff | 50 – 100 | Cannot be indented by thumb pressure |
| Very stiff | 100 – 200 | Can be indented by thumb nail |
| Hard | 200 – 500 | Difficult to indent by thumb nail |

## ORGANIC SOILS/ DESCRIPTORS

| Term | Description |
|---|---|
| Topsoil | Surficial organic soil layer that may contain living matter. However topsoil may occur at greater depth, having been buried by geological processes or man-made fill, and should then be termed a buried topsoil. |
| Organic clay, silt or sand | Contains finely divided organic matter; may have distinctive smell; may stain; may oxidise rapidly. Describe as for inorganic soils. |
| Peat | Consists predominantly of plant remains.<br>***Firm***: Fibres already compressed together ***Spongy***: Very compressible and open stucture ***Plastic***: Can be moulded in hand and smears in fingers<br>***Fibrous***: Plant remains recognisable and retain some strength ***Amorphous***: No recognisable plant remains |
| Roolets | Fine, partly decomposed roots, normally found in the upper part of a soil profile or in a redeposited soil (e.g. colluvium or fill) |
| Carbonaceous | Discrete particles of hardened (carbonised) plant material. |

## MOISTURE CONDITION

| Condition | Description | Granular Soils | Cohesive Soils |
|---|---|---|---|
| Dry | Looks and feels dry | Run freely through hands | Hard, powdery or friable |
| Moist | Feels cool, darkened in colour | Tend to cohere | Weakened by moisture, but no free water on hands when remoulding |
| Wet | | | Weakened by moisture, free water forms on hands when handling |
| Saturated | Feels cool, darkened in colour and free water is present on the sample | | |

## PLASTICITY (CLAYS & SILTS)

| Term | Description |
|---|---|
| High plasticity | Can be moulded or deformed over a wide range of moisture contents without cracking or showing any tendency to volume change |
| Low plasticity | When moulded can be crumbled in the fingers; may show quick or dilatant behaviour |

## GRADING (GRAVELS & SANDS)

| Term | Description | |
|---|---|---|
| Well graded | Good representation of all particle sizes from largest to smallest | |
| Poorly graded | Limited representation of grain sizes - further divided into: | |
| | Uniformly graded | Most particles about the same size |
| | Gap graded | Absence of one or more intermediate sizes |


**NZ GEOTECHNICAL SOCIETY INC**

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compiled by KATE WILLIAMS design KARRYN MUSCHAMP

# ROCK > field guide sheet

FIELD DESCRIPTION OF ROCK

**SEQUENCE OF TERMS** – weathering – colour – fabric – rock name – strength – discontinuities – additional

## SCALE OF ROCK MASS WEATHERING

| Term | Grade | Abbreviation | Description |
|---|---|---|---|
| Unweathered (fresh rock) | I | UW | Rock mass shows no loss of strength, discolouration or other effects due to weathering. There may be slight discolouration on major rock mass defect surfaces or on clasts. |
| Slightly Weathered | II | SW | The rock mass is not significantly weaker than when fresh. Rock may be discoloured along defects, some of which may have been opened slightly. |
| Moderately Weathered | III | MW | The rock mass is significantly weaker than the fresh rock and part of the rock mass may have been changed to a soil. Rock material may be discoloured and defect and clast surfaces will have a greater discolouration, which also penetrates slightly into the rock material. Increase in density of defects due to physical disintegration. |
| Highly Weathered | IV | HW | Most of the original rock mass strength is lost. Material is discoloured and more than half the mass is changed to a soil by chemical decomposition or disintegration (increase in density of defects/fractures). Decomposition adjacent to defects and at the surface of clasts penetrates deeply into the rock material. Lithorelicts or corestones of unweathered or slightly weathered rock may be present. |
| Completely Weathered | V | CW | Original rock strength is lost and the rock mass changed to a soil either by decomposition (with some rock fabric preserved) or by physical disintegration. |
| Residual Soil | VI | RS | Rock is completely changed to a soil with the original fabric destroyed (pedological soil). |

## ROCK STRENGTH TERMS

| Term | Field Identification of Specimen | Unconfined uniaxial compressive strength $q_u$ (MPa) | Point load strength $I_{s(50)}$ (MPa) |
|---|---|---|---|
| Extremely strong | Can only be chipped with geological hammer | > 250 | >10 |
| Very strong | Requires many blows of geological hammer to break it | 100 – 250 | 5 – 10 |
| Strong | Requires more than one blow of geological hammer to fracture it | 50 – 100 | 2 – 5 |
| Moderately strong | Cannot be scraped or peeled with a pocket knife. Can be fractured with single firm blow of geological hammer | 20 – 50 | 1 – 2 |
| Weak | Can be peeled by a pocket knife with difficulty. Shallow indentations made by firm blow with point of geological hammer | 5 – 20 | <1 |
| Very weak | Crumbles under firm blows with point of geological hammer. Can be peeled by a pocket knife | 1 – 5 | |
| Extremely weak (soil description required) | Indented by thumb nail or other lesser strength terms used for soils | <1 | |

Note: • No correlation is implied between $q_u$ and $I_{s(50)}$

## SPACING OF DEFECTS/ DISCONTINUITIES

| Term | Spacing |
|---|---|
| Very widely spaced | >2 m |
| Widely spaced | 600 mm – 2 m |
| Moderately widely spaced | 200 mm – 600 mm |
| Closely spaced | 60 mm – 200 mm |
| Very closely spaced | 20 mm – 60 mm |
| Extremely closely spaced | <20 mm |

## APERTURE OF DISCONTINUITY SURFACES

| Term | Aperture (mm) | Description |
|---|---|---|
| Tight | Nil | Closed |
| Very Narrow | > 0 – 2 | |
| Narrow | 2 – 6 | |
| Moderately Narrow | 6 – 20 | Gapped |
| Moderately Wide | 20 – 60 | Open |
| Wide | 60 – 200 | |
| Very Wide | > 200 | |

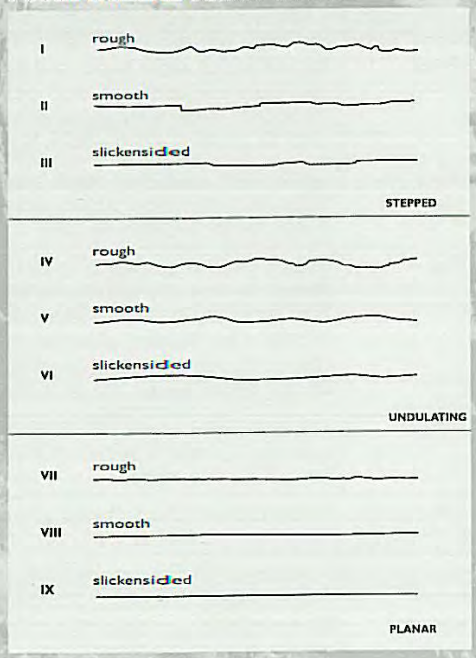
## BEDDING THICKNESS TERMS

| Term | Bed Thickness |
|---|---|
| Thinly laminated | < 2 mm |
| Laminated | 2 mm - 6 mm |
| Very thin | 6 mm - 20 mm |
| Thin | 20 mm - 60 mm |
| Moderately thin | 60 mm - 200 mm |
| Moderately thick | 0.2 m - 0.6 m |
| Thick | 0.6 m - 2 m |
| Very thick | > 2 m |

## BEDDING INCLINATION TERMS

| Term | Inclination (from horizontal) |
|---|---|
| Sub-horizontal | 0° – 5° |
| Gently inclined | 6° – 15° |
| Moderately inclined | 16° – 30° |
| Steeply inclined | 31° – 60° |
| Very steeply inclined | 61° – 80° |
| Sub-vertical | 81° – 90° |

## ROUGHNESS AND APERTURE

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# *Appendix E*

**RESULTS OF SOAK TESTS – SKELLERUP BLOCK**

Connell Wagner

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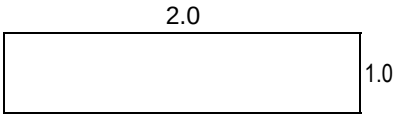
# Soak Test in Open Excavation

Test No. **TP S-1**

| Client | Location (measured using hand held GPS) | | Date |
|---|---|---|---|
| Selwyn Plantation Board Ltd | 1548839, 5169926 | | 12/09/2008 |
| **Project** | **Engineer** | **Weather Conditions** | **Job Number** |
| SPBL Rolleston Plan Change | CG | cloudy/dry | 36951-001 |

Test Pit Dimensions (m)



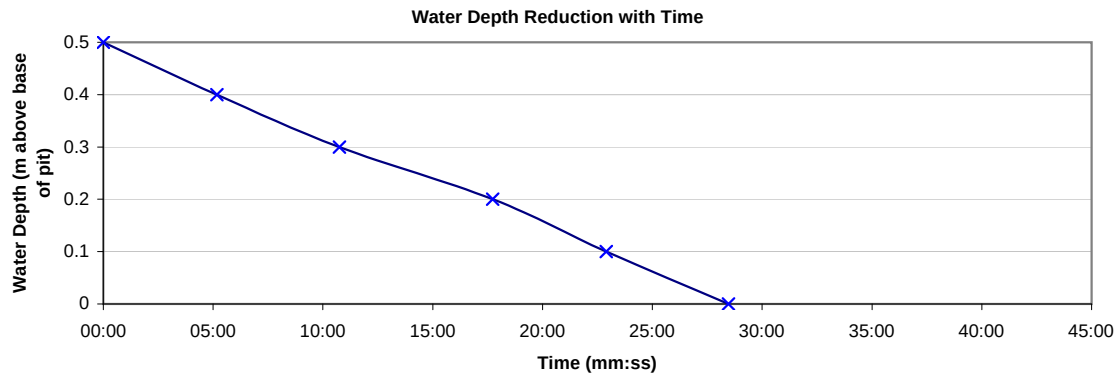

Depth of water added: 0.5 m above base of pit

Volume of water added: 1.0 $m^3$

Time taken for water to soak away:

| Water depth (m) | Time | Flow Rate $m^3$/sec |
|---|---|---|
| 0.5 | 00:00 | - |
| 0.4 | 05:10 | 0.00065 |
| 0.3 | 10:45 | 0.00060 |
| 0.2 | 17:44 | 0.00048 |
| 0.1 | 22:54 | 0.00065 |
| 0 | 28:28 | 0.00060 |

Flow rate of water into the ground




Calculated Flow Rate

| | |
|---|---|
| maximum | 0.00065 $m^3$/sec |
| minimun | 0.00048 $m^3$/sec |
| average | 0.00059 $m^3$/sec |

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# Soak Test in Open Excavation

Test No. **TP S-2**

| Client | Location (measured using hand held GPS) | | Date |
|---|---|---|---|
| Selwyn Plantation Board Ltd | 1549448, 5169261 | | 12/09/2008 |
| **Project** | **Engineer** | **Weather Conditions** | **Job Number** |
| SPBL Rolleston Plan Change | CG | cloudy/dry | 36951-001 |

Test Pit Dimensions (m)

1.9 × 1.0

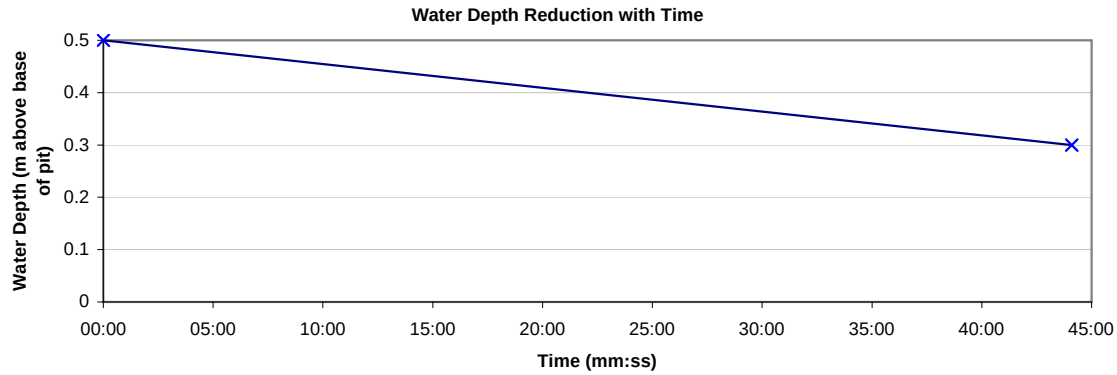
Depth of water added: 0.5 m above base of pit

Volume of water added: 0.95 $m^3$

Time taken for water to soak away:

| Water depth (m) | Time | Flow Rate $m^3$/sec |
|---|---|---|
| 0.5 | 00:00 | - |
| 0.4 | | |
| 0.3 | 44:06 | 0.00014 |
| 0.2 | Test terminated | |
| 0.1 | | |
| 0 | | |

Flow rate of water into the ground




Calculated Flow Rate

| | |
|---|---|
| maximum | 0.00014 $m^3$/sec |
| minimun | 0.00014 $m^3$/sec |
| average | 0.00014 $m^3$/sec |

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# Soak Test in Open Excavation

Test No. **TP S-3**

| Client | Location (measured using hand held GPS) | | Date |
|---|---|---|---|
| Selwyn Plantation Board Ltd | 1548668, 5169475 | | 12/09/2008 |
| **Project** | **Engineer** | **Weather Conditions** | **Job Number** |
| SPBL Rolleston Plan Change | CG | cloudy/dry | 36951-001 |

Test Pit Dimensions (m)

2.0

1.0

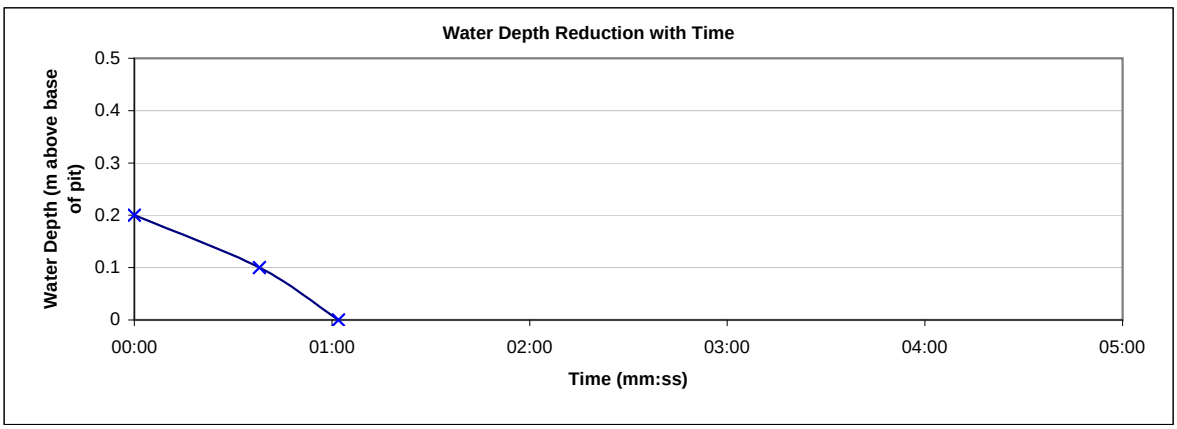
Depth of water added: 0.2 m above base of pit

Volume of water added: 0.4 $m^3$

Time taken for water to soak away:

| Water depth (m) | Time | Flow Rate $m^3$/sec |
|---|---|---|
| 0.5 | Unable to fill pit to 0.5m due to infiltration rate | |
| 0.4 | | |
| 0.3 | | |
| 0.2 | 00:00 | - |
| 0.1 | 00:38 | 0.00526 |
| 0 | 01:02 | 0.00833 |

Flow rate of water into the ground




Calculated Flow Rate

| | |
|---|---|
| maximum | 0.00833 $m^3$/sec |
| minimun | 0.00526 $m^3$/sec |
| average | 0.00680 $m^3$/sec |