# Appendices -7. Report of Topographical Survey and Soil Investigation

# REPORT

**Yachiyo Engineering Co Ltd.**

**The Project for Improvement of Equipment for Disaster Risk Management in the Republic of Fiji**

**Soils Investigation Report**

**Report prepared for:**

Yachiyo Engineering Co Ltd.

**Report prepared by:**

Tonkin & Taylor International Ltd

**Distribution:**

| | |
|---|---|
| Yachiyo Engineering Co Ltd. | 3 copies |
| Tonkin & Taylor International Ltd (FILE) | 1 copy |

**February 2013**

**T&TI Ref: 750942**

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# 1 Introduction

## 1.1 General

Yachiyo Engineering Co. Ltd (YEC) engaged Tonkin & Taylor International Ltd (T&TI) to carry out the soils investigations for the project for improvement of equipment for disaster risk management at three Fiji Meteorological service (Met service) sites in the Republic of Fiji. The investigations were carried out at the Fiji Metrological services office in Nadi, Viti Levu, the Metrological services office in Suva, Viti Levu and at the metrological service outpost at Vatudamu, Vanua Levu. A topographical survey of the site in Nadi is to be undertaken by local surveyors, Cadastral Solutions Limited.

The investigations have been carried out in accordance with the "Contract of Topographical Survey and Soil Explorations" provided to T&TI by YEC (ref: Appendix A). The soils investigation consisted of 2 hand auger boreholes and 2 Scala penetrometer tests at the Met Service office in Nadi, 3 hand auger boreholes and 3 Scala penetrometer tests at the Met Service office in Suva and 2 hand auger bore holes along with 2 Scala penetrometer tests at Vatudamu. Laboratory testing of recovered soil samples from the three sites was also undertaken. This work scope was agreed with YEC. This report summarises the results of the soils investigation carried out at these three sites.

## 1.2 Project Description

The Republic of Fiji consists of 332 islands occupying over 18,300 square kilometres in the southern Pacific Ocean. The capital is Suva located on the main island of Viti Levu.

The project involves construction of various works at three separate sites, two on Viti Levu and one on Vanua Levu; a new wind profiler system at the site in Nadi (Viti Levu) and a new automatic weather station at Suva (Viti Levu) and Vatudamu (Vanua Levu). The works are part of the project for improvement of equipment for disaster risk management in the republic of Fiji.

# 2 Site Description

The first site (Site A) is located in Nadi, on the western coast of Viti Levu. The site is approximately 1km from Nadi Airport within the CAAFI Compound at the Fiji Meteorological service office. The site is relatively flat, consisting of several flat building platforms divided by small embankments. The property is currently occupied by a large office building and meteorological instruments including radar and satellite dishes. Several underground cables supplying power to the external equipment dissect the site, however the exact alignment of these is unknown.

The second site (Site B) is located in Suva, on the south eastern coast of Viti Levu. The site is approximately 2km from the centre of town and is located on Fletcher Road at the Fiji Meteorological Service office. The site is situated above the road on a flat site which is currently occupied by a concrete 3 storey office building and various weather monitoring equipment including wind masts and rain and temperature gauges. At the time of the site visit, construction of a new office building was underway to the rear of the existing office building.

The third site (Site C) is located at Vatudamu approximately 10 km from Labasa, on the northern coast of Vanua Levu. The site is at the top of a ridge line approximately 120m above sea level and is located approximately 400m from the Vodafone telecommunication tower. The site is sloping down from east to west, and there are several flat building platforms created during the construction of the site office. The site is surrounded by steep slopes to the north, south and west. The site is currently occupied by a small service building, water tanks, satellites and a radar tower. Access to the site is by 4WD only via an unmaintained gravel road. Exposed andesite rock

was present at ground level at some locations within the site boundaries. An underground septic tank of an unknown size is located in the western corner of the site at the approximate location of the proposed new construction.

A site plan of each location and topographic survey of Site A is attached in Appendix B.

# 3 Summary of Site Survey

A topographical survey of the Nadi Met office site was undertaken by local surveyors, Cadastral Solutions in January 2013 under the supervision of T&TI. Each site investigation location at the Nadi Met office was surveyed and the co-ordinates and reduced levels (RL'S) are presented in Appendix B. The topographic survey plans are also presented in Appendix B.T&TI. Two cross sections, A and B were also taken across the site and these are presented in Appendix B.

# 4 Summary of Soils Investigation

## 4.1 General

The soils investigations were carried out in January 2013 and the scope of work was completed in accordance with the "Contract of Topographical Survey and Soil Explorations" attached in Appendix A. All tests were terminated in hard ground.

The following tasks were completed for the soils investigation:

- Site A – Fiji Meteorological Service, Nadi
  - 2 No. Hand auger boreholes (BH1A – BH2A) to 3m below existing ground level
  - 2 No. Scala penetrometer tests (SC1A – SC2A) to 3m below existing ground level
- Site B – Fiji Meteorological Service, Suva
  - 3 No. Hand auger boreholes (BH1B – BH3B) to between 1 and 3m below existing ground level
  - 3 No. Scala penetrometer tests (SC1B – SC3B) to between 2 and 5m below existing ground level
- Site C – Fiji Meteorological Service, Vatudamu
  - 2 No. Hand auger boreholes (BH1C – BH2C) to between 1 and 2m below existing ground level
  - 2 No. Scala penetrometer tests (SC1C – SC2C) to between 2 and 4m below existing ground level

The subsections below present a summary of the investigation work and laboratory testing results. Site investigation logs are presented in Appendix C and laboratory testing results are presented in Appendix C.

## 4.2 Handauger and Scala Penetrometer Investigations

The soil investigation testing, including hand augered boreholes and Scala penetrometer tests, was undertaken over three days (7-9 January 2013) at the Met service office Nadi, Met service office Suva and Vatudamu. In-situ shear strength testing was carried out in the hand auger boreholes in cohesive materials using a calibrated pilcon shear vane and samples were taken for geotechnical laboratory testing. The subsurface soils were described in accordance with NZ Geotechnical Society guidelines and shear strengths are recorded on the borehole logs presented

in Appendix C. The Scala penetrometer provides continuous soil strength data until hard ground/refusal is achieved (8 to 10 blows per 50mm penetration). The results of the Scala penetrometer tests are included in Appendix C.

Correlations between Scala penetrometer test results and SPT 'N' values have been developed over a long period of time. The developed correlations are particularly relevant in granular soils.

### 4.2.1 Site A - Fiji Meteorological Service, Nadi

Two hand auger boreholes and two Scala penetrometer tests were completed at this site on 7th January 2013. The hand auger boreholes extended to a depth of 3m below existing ground level where hard clays were encountered. No groundwater was encountered in either borehole at the site. The Scala penetrometer tests were terminated at depths of 5m below ground level.

### 4.2.2 Site B - Fiji Meteorological Service, Suva

Three hand auger boreholes and three Scala penetrometer tests were completed at this site on 8th January 2013. Hand auger boreholes BH1B was drilled to a depth of 1.3m where it hit an obstruction and was terminated. The corresponding Scala penetrometer test SC1B was also terminated at 1.3m after hitting the same obstruction. Two further hand augers (BH2B and BH3B) were drilled to a depth of up to 3.0m below existing ground level. Groundwater was encountered between 1.9 and 2.3m below ground level. The Scala penetrometer tests (SC2B and SC3B) were terminated at depths of 5m below ground level.

### 4.2.3 Site C - Fiji Meteorological Service, Vatudamu

Two hand auger boreholes and two Scala penetrometer tests were completed at this site on 9th January 2013. The hand auger boreholes were drilled to a depth of up to 1.9m below existing ground level where rock was encountered. No ground water was encountered in any of the boreholes. The Scala penetrometer tests were terminated at depths of up to 3.7m due to encountered rock.

## 4.3 Geotechnical Laboratory Schedule

The recovered samples were brought back to Auckland and geotechnical laboratory testing was carried out by Geotechnics Ltd. The laboratory tests have been completed in full accordance with the relevant New Zealand standards, identified in the subsections below, and the laboratory is fully accredited with International Accreditation New Zealand (IANZ) registration.

The soil testing consisted of the following:

- Site A - Fiji Meteorological Service, Nadi
  - Moisture content (2 No.)
  - Particle size distribution (2 No.)
  - Soil density (2 No.)
- Site B - Fiji Meteorological Service, Suva
  - Moisture content (2 No.)
  - Particle size distribution (2 No.)
  - Soil density (2 No.)
- Site C- Fiji Meteorological Service, Vatudamu

- Moisture content (2 No.)
- Particle size distribution (2 No.)
- Soil density (2 No.)

# 5 Subsurface Conditions

## 5.1 Geological Setting

On the island of Viti Levu the published geology, geological studies in southwest Viti Levu[1] indicates Site A (Nadi) is underlain by conglomerates, tuff, limestone and maris, while the published geology of Suva[2] indicates Site B (Suva) is underlain by conglomerates and clay.

The geology of east-central Vanua Levu[3] indicates Site C (Vatudamu) is underlain by Koroutari andesites consisting of andesite lavas, pyroclastic rocks and epiclastic breccias.

## 5.2 Ground and Groundwater Conditions

### 5.2.1 Site A - Fiji Meteorological Service, Nadi

The two hand auger boreholes across the building platform encountered very similar ground conditions and these are summarised in Table 1 below:

**Table 1 – Summary of ground conditions**

| Depth (Below ground level) | Geological unit | Soil description | Soil undrained shear strength (kPa) |
|---|---|---|---|
| 0.0m – 0.1m | Topsoil | SILT with some clay, light brown, dry, low plasticity | N/A |
| 0.1m – 2.5m | Volcanic Tuff | CLAY with some silt, orange/red brown, very stiff to hard, dry, low plasticity | 162 kPa to 210 kPa |
| 2.5m - >3.0m | Residual soil | Clay with trace silt, red brown mottled white, hard, dry, low plasticity | $210^{+}$kPa |

Groundwater was not encountered in either borehole during geotechnical investigations at this site.

[1] W.J Skiba 1964: Geological studies in southwest Viti Levu. Geological survey of Fiji
[2] P Ibbotson 1960: Geology of the Suva Area, Viti Levu. Geological survey Department, Suva Fiji
[3] P Ibbotson 1969: The Geology of East-central Vanua Levu. Geological Survey of Fiji

**Table 2 – Summary of Scala penetrometer results**

| Depth (Below ground level) | Average Scala Blows per 50mm | Soil Type | Inferred Strength | Equivalent SPT "N" values |
|---|---|---|---|---|
| 0.5m | 2 | Cohesive | Very stiff | 8 |
| 1.0m | 3.5 | Cohesive | Very stiff | 12 |
| 1.5m | 4 | Cohesive | Very stiff | 16 |
| 2.0m | 6 | Cohesive | Very stiff | 24 |
| 2.5m | 7.5 | Cohesive | Very stiff | 28 |
| 3.0m | 9.5 | Cohesive | Very stiff | 36 |
| 3.5m | 10 | Cohesive | Dense | $40^{+}$ |
| 4.0m | 11.5 | Cohesive | Dense | $40^{+}$ |
| 4.5m | 11 | Cohesive | Dense | $40^{+}$ |
| 5.0m | 12 | Cohesive | Dense | $40^{+}$ |

The two Scala penetrometer tests SC1A – SC2A were terminated at depths of 5m below ground level. From this in-situ testing, we can assess the soil strengths at specific depths below the site. The Scala results and inferred soil strength are summarised in Table 2 below:

From the table above, it can be noted that the soil strength increases with depth at the site.

### 5.2.2 Site B - Fiji Meteorological Service, Suva

The 3 No. hand auger boreholes across the site generally encountered similar ground conditions and these are summarised in Table 3 below:

**Table 3 – Summary of ground conditions**

| Depth (Below ground level) | Geological unit | Soil description | Soil undrained shear strength (kPa) |
|---|---|---|---|
| 0.0m – 0.2m | Topsoil | Clayey SILT, dark brown, damp, moderately plastic | N/A |
| 0.2m – 2.4m | Alluvial deposits | Clayey SILT with trace fine sand, orange brown, moist, moderately plastic. ( BH1B hit an obstruction at 1.3m and was terminated) | 45 kPa to 200 kPa |

| | | | |
|---|---|---|---|
| 1.9-2.5m | Gravel | Fine to medium Gravel, grey, angular | N/A |
| >2.5m | Residual soil | Silty CLAY, red brown mottled white, plastic, wet | 120-150kPa |

N/A – not applicable

Groundwater was encountered at a depth of between 1.9 and 2.3m below ground level.

The three scala penetrometer tests SC1B – SC3B were terminated at depths of up to 5m below ground level (SC1B was terminated at 1.7m below ground level). From this in-situ testing, we can assess the soil strengths at specific depths below the site. The Scala results and inferred soil strength are summarised in Table 4 below:

**Table 4 – Summary of Scala penetrometer results**

| Depth (Below ground level) | Average Scala Blows per 50mm | Soil Type | Inferred Strength | Equivalent SPT "N" values |
|---|---|---|---|---|
| 0.5m | 1.5 | Cohesive | Stiff | 4 |
| 1.0m | 1 | Cohesive | Stiff | 4 |
| 1.5m | 1.5 | Cohesive | Very Stiff | 4 |
| 2.0m | 2 | Cohesive | Very Stiff | 8 |
| 2.5m | 4 | Cohesive | Very Stiff | 16 |
| 3.0m | 2.5 | Cohesive | Very Stiff | 8 |
| 3.5m | 4 | Cohesive | Medium dense | 16 |
| 4.0m | 5.5 | Cohesive | Medium dense | 20 |
| 4.5m | 5.5 | Cohesive | Medium dense | 20 |
| 5.0m | 7 | Cohesive | Dense | 28 |

From the table above, it can be noted that the soil strength increases with depth at the site.

### 5.2.3 Site C- Fiji Meteorological Service, Vatudamu

The 2 No. hand auger boreholes across the site encountered similar ground conditions and these are summarised in Table 5 below. The investigations did not extend to full depth as they met refusal on what is believed to be weathered andesite rock surface. A visual inspection identified exposed rock outcrops and large andesite boulders at ground surface on the surrounding slopes.

**Table 5 – Summary of ground conditions**

| Depth (Below ground level) | Geological unit | Soil description | Soil undrained shear strength (kPa) |
|---|---|---|---|
| 0.0m – 0.05m | Topsoil | Clayey SILT with fine to medium gravel, light brown, dry, non plastic | N/A |
| 0.05m – 1.5m | Residual soil | CLAY trace silt, dark brown/red (maroon), medium plastic, dry | 45kPa - 210kPa |

N/A – not applicable

Groundwater was not encountered in either borehole during geotechnical investigations at this site.

The two Scala penetrometer tests SC1C – SC2C were terminated at depths of up to 3.7m below ground level. From this in-situ testing, we can assess the soil strengths at specific depths below the site. The Scala results and inferred soil strength are summarised in Table 6 below:

**Table 6 - Summary of Scala penetrometer results**

| Depth (Below ground level) | Average Scala Blows per 50mm | Soil Type | Inferred Strength | Equivalent SPT "N" values |
|---|---|---|---|---|
| 0.5m | 1.5 | Cohesive | Stiff | 4 |
| 1.0m | 1 | Cohesive | Stiff | 4 |
| 1.5m | 4 | Cohesive | Very stiff | 16 |
| 2.0m | 7 | Cohesive | Very stiff | 28 |
| 2.5m | 14 | Cohesive | Dense | $40^{+}$ |
| 3.0m | 15 | Cohesive | Dense | $40^{+}$ |
| 3.5m | 16 | Cohesive | Dense | $40^{+}$ |
| 3.7m | 20 | Cohesive | Hard | $40^{+}$ |

In addition, the borehole logs of the geotechnical investigations carried out for the design and construction of the Met service office and radar tower at Vatudamu have been provided to T&TI by Fiji Meteorological Service. The investigations for the office and radar tower were located to the east of the T&TI boreholes. However due to uncertainties in elevations and the extent of earthworks required for the construction of the radar tower and office the results of the geotechnical investigations from this project cannot be relied upon.

# 6 Geotechnical Laboratory Testing Results

A summary of the geotechnical laboratory testing results is presented in Table 7 below. A full set of the geotechnical testing data sheets is presented in Appendix C.

**Table 7 – Summary of geotechnical testing**

| Sample Identification | Specific Gravity | Grain Size Analysis | Moisture Content |
|---|---|---|---|
| Nadi – HA1A (1.0m-1.2m) | 2.84 t/m$^3$ | silty CLAY with trace gravel | 33.6% |
| Nadi – HA2A (2.1m-2.8m) | 2.83 t/m$^3$ | silty CLAY with some sand and trace gravel | 35.6% |
| Suva – HA2B (1.9m-2.7m) | 2.73 t/m$^3$ | sandy SILT with some clay and trace of gravel | 43.0% |
| Suva – HA3B (0.5m-0.7m) | 2.74 t/m$^3$ | clayey sandy SILT | 32.6% |
| Vatudamu HA1C (0.4m-0.5m) | 2.82 t/m$^3$ | SAND and SILT with some clay and trace of gravel | 51.9% |
| Vatudamu – HA2C (1.0m-1.2m) | 2.82 t/m$^3$ | silty SAND with minor clay and trace of gravel | 55.5% |

# 7 Discussion and Engineering Properties

Recommendations and opinions contained in this report are based upon data from:

- 2 No. hand auger boreholes and 2 No. Scala penetrometer tests at Fiji Meteorological Service, Nadi
- 3 No. hand auger boreholes and 3 No. Scala penetrometers tests at Fiji Meteorological Service, Suva
- 2 No. hand auger boreholes and 2 No. Scala penetrometer tests at Fiji Meteorological Service, Vatudamu

The nature and continuity of the subsoil away from the test locations is inferred, but it must be appreciated that actual conditions could vary from the assumed model.

From the results of the soils investigation, geotechnical laboratory testing and also using published empirical relationships, we have assessed the engineering properties for the underlying soils at the three sites for the designer's consideration in the following subsections.

Actual ground conditions should be confirmed by a person competent to judge whether the soils exposed in the foundation excavations are compatible with those described within this report.

## 7.1 Solid Density Range

### 7.1.1 Site A – Nadi Met office

The Volcanic Tuff deposits (1.0m-1.2m) can be assumed to have the following solid density:

Solid Density = 2.84 t/m$^3$

The residual soils (2.1m-2.8m) can be assumed to have the following solid densitiy:

Solid Density range = 2.83 t/m$^3$

### 7.1.2 Site B – Suva Met office

The Alluvial deposits (0.2m to 2.4m) can be assumed to have the following solid densities:

Solid Density range = 2.73 to 2.74 t/m$^3$

### 7.1.3 Site C – Vatudamu Met office

The residual soils (0.05m to 1.5m) can be assumed to have the following solid density:

Solid Density range = 2.82 t/m$^3$

## 7.2 Effective Cohesion (c')

### 7.2.1 Site A – Nadi Met office

The near surface materials (upper 2m) are cohesive and the assessed effective cohesion for design purposes, can be taken as:

c' (Effective Cohesion) = 5 kPa

### 7.2.2 Site B – Suva Met office

The near surface material provides some effective cohesion due to the cohesive nature of the soil but there is some sand present in the soil. A value of 2 kPa may be used for design.

c' (Effective Cohesion) = 2 kPa

### 7.2.3 Site C – Vatudamu Met office

The near surface material does not contain much fine silt and clay and therefore may behave like a granular soil. A value of 0 kPa may be used for design.

c' (Effective Cohesion) = 0 kPa

## 7.3 Effective Internal Friction Angle (φ)

### 7.3.1 Site A – Nadi Met office

The effective internal friction angle for the near surface material (clay) has been estimated using a correlation from the Scala penetrometer results. A value of 30° may be used as the effective internal friction angle for design.

Φ (Effective internal friction angle) = 30°

### 7.3.2 Site B – Suva Met office

The effective internal friction angle for the near surface alluvium (clayey silt) has been estimated using a correlation from the Scala penetrometer and shear strength results. A value of 28° may be used as the effective internal friction angle for design.

Φ (Effective internal friction angle) = 28°

### 7.3.3 Site C – Vatudamu Met office

The effective internal friction angle for the near residual soils has been estimated using a correlation from the Scala penetrometer and shear strength results. A value of 30° may be used as the effective internal friction angle for design.

Φ (Effective internal friction angle) = 30°

## 7.4 Young's Modulus Range (E)

The soil stiffness or Youngs Modulus, E has been calculated from a correlation with SPT N values (Bowles et al) derived from the available shear strength and Scala penetrometer readings. The table below gives the range of Youngs Modulus values for varying depths.

### 7.4.1 Site A – Nadi Met office

**Table 8 – Summary of Youngs Modulus (E) with depth (cohesive soils only)**

| Depth (Below Ground level) | Shear strength (kPa) | Estimated Young's Modulus, E (MPa) |
|---|---|---|
| 0.5 m | 160 | 25 |
| 1.0 m | 200+ | 32 |
| 1.5 m | 200+ | 32 |
| 2.0 m | 200+ | 32 |
| 2.5 m | 200+ | 32 |
| 3.0 m | 200+ | 32 |

### 7.4.2 Site B – Suva Met office

**Table 9 – Summary of Youngs Modulus (E) with depth (cohesive soils only)**

| Depth (Below Ground level) | Shear strength (kPa) | Estimated Young's Modulus, E (MPa) |
|---|---|---|
| 0.5 m | 80 | 12 |
| 1.0 m | 100 | 15 |
| 1.5 m | 190 | 30 |
| 2.0 m | 160 | 25 |
| 2.5 m | 90 | 13 |
| 3.0 m | 120 | 20 |

### 7.4.3 Site C – Vatudamu Met office

**Table 10 – Summary of Youngs Modulus (E) with depth (cohesive soils only)**

| Depth (Below Ground level) | Shear strength (kPa) | Estimated Young's Modulus, E (MPa) |
|---|---|---|
| 0.5 m | 70 | 9 |
| 1.0 m | 150 | 23 |
| 1.5 m | 190 | 30 |
| 2.0 m | 160 | 25 |
| 2.5 m | 90 | 14 |
| 3.0 m | 120 | 20 |

## 7.5 Foundation Design

### 7.5.1 General

Following discussions with YEC, it is understood that either strip or pad foundations will be constructed for the three proposed equipment installations at Nadi, Suva or Vatudamu, providing the ground conditions are suitable.

The site investigation data has indicated that shallow foundations may be utilised at the three sites depending on actual loadings. We have provided bearing pressures at different depths in the upper 3m of subsoil.

We recommend using a strength reduction factor of 0.5 ($\phi_G = 0.5$) to give an ultimate limit state (ULS) bearing capacity, in accordance with New Zealand Design Standards (ref: NZS 1170). For serviceability limit state design we recommend a strength reduction factor of 0.33 ($\phi_G = 0.3$) to give an allowable bearing capacity.

### 7.5.2 Site A – Nadi Met office

We recommend that all foundations should be embedded at least 0.5m below finished ground level.

Strip or pad foundations would be constructed in the near surface volcanic tuff material. Bearing capacities for this material based on the in situ testing undertaken are shown in Table 11 below.

**Table 11 – Bearing pressures within the Volcanic Tuff deposits**

| Depth | Bearing Pressures | | | | | |
|---|---|---|---|---|---|---|
| | Shallow strip footings up to 1 m wide | | | Shallow isolated pad footings up to 2.5 m wide | | |
| | *Allowable* | *ULS*[(1)] | *Ultimate* | *Allowable* | *ULS*[(1)] | *Ultimate* |
| 0.5m | 100kPa | 150kPa | 300kPa | 120kPa | 180kPa | 360kPa |

[(1)] ULS = Ultimate Limit State (ref. NZS1170)

We recommend that all foundation excavations are inspected and tested by a competent person to ensure the ground conditions and bearing capacities are similar to those encountered during this investigation.

### 7.5.3 Site B – Suva Met office

We recommend that all foundations should be embedded at least 0.5m below finished ground level.

The strip or pad foundations would be constructed in the near surface alluvial deposits. Bearing capacities for this material based on the in situ testing undertaken are shown in Table 12 below.

**Table 12 – Bearing pressures within the alluvial deposits**

| Depth | Bearing Pressures | | | | | |
|---|---|---|---|---|---|---|
| | Shallow strip footings up to 1 m wide | | | Shallow isolated pad footings up to 2.5 m wide | | |
| | *Allowable* | *ULS* | *Ultimate* | *Allowable* | *ULS* | *Ultimate* |
| 0.6m | 100kPa | 150kPa | 300kPa | 120kPa | 180kPa | 360kPa |

We recommend that all foundation excavations are inspected and tested by a competent person to ensure the ground conditions and bearing capacities are similar to those encountered during this investigation.

### 7.5.4 Site C – Vatudamu Met office

We recommend that all foundations should be embedded at least 0.5m below finished ground level.

The strip or pad foundations would be constructed in the near surface Residual soils materials. Bearing capacities for this material based on the in situ testing undertaken are shown in Table 13 below.

**Table 13 – Bearing pressures within the Residual soils**

| Depth | Bearing Pressures | | | | | |
|---|---|---|---|---|---|---|
| | Shallow strip footings up to 1 m wide | | | Shallow isolated pad footings up to 2.5 m wide | | |
| | *Allowable* | *ULS* | *Ultimate* | *Allowable* | *ULS* | *Ultimate* |
| 0.6m | 100kPa | 150kPa | 300kPa | 120kPa | 180kPa | 360kPa |

We recommend that all foundation excavations are inspected and tested by a competent person to ensure the ground conditions and bearing capacities are similar to those encountered during this investigation.

## 7.6 Settlement

T&TI have not been provided with any vertical loads for the proposed structures. It is recommended that settlement analysis is carried out following completion of the detailed design of the new equipment.

# 8 Applicability

This report has been prepared for the benefit of YEC with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Tonkin & Taylor International Ltd

Environmental and Engineering Consultants

| Report prepared by: | Authorised for Tonkin & Taylor International Ltd by: |
|---|---|
| ..... | ..... |
| Chris Thurlow | Chris Freer |
| Geotechnical engineer | Project Director |

## Appendix B: Topographical Survey and Geotechnical Investigation Location Plans

Tonkin & Taylor

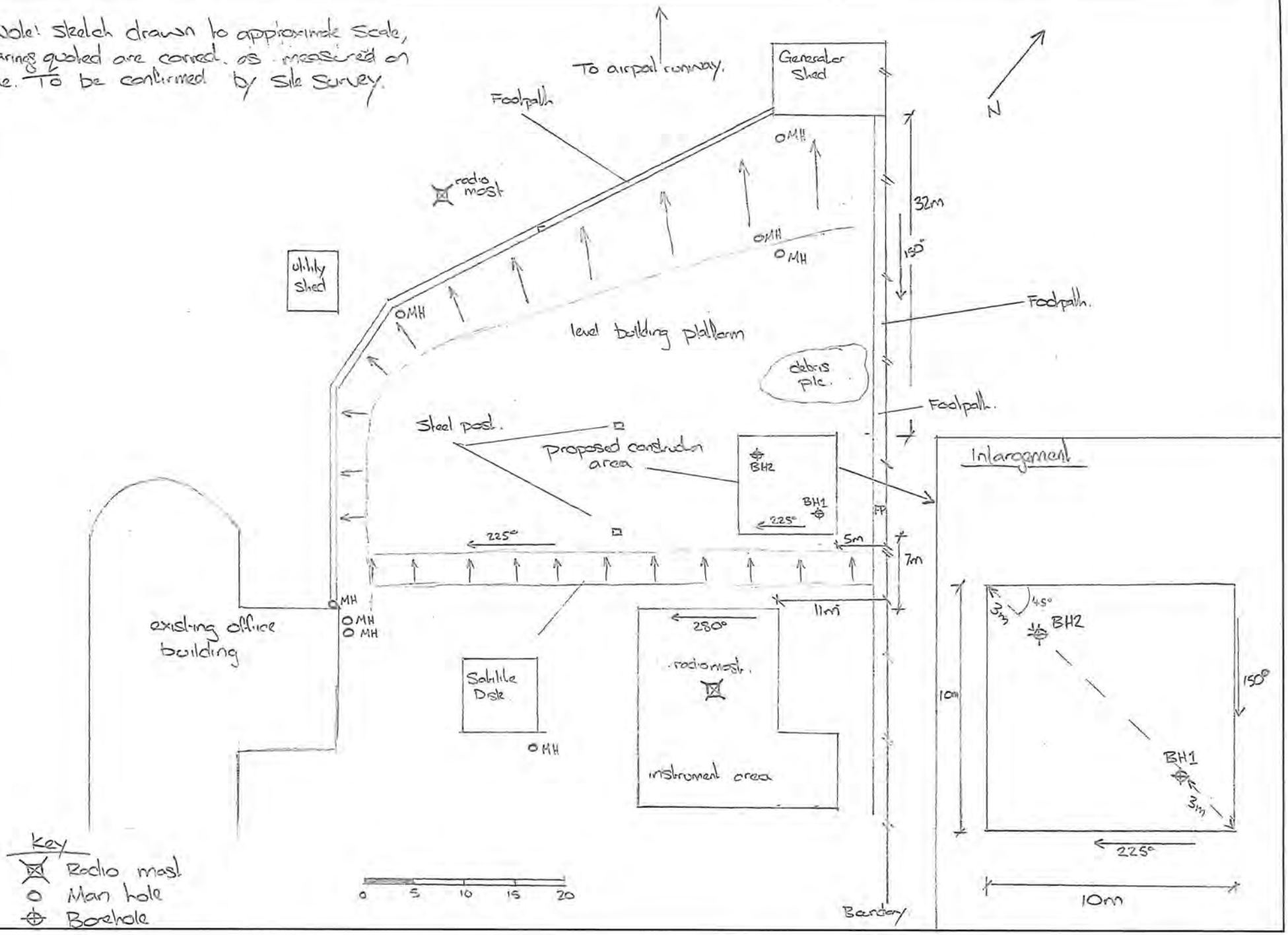
Project: Fiji Radio

Description: Site Sketch

Computed: 7/1/13 CJT 20
Checked: 20
Revised: 20
Checked: 20

Office:
Job No: 750942
File:
Sheet No.

Note: Sketch drawn to approximate Scale, bearings quoted are correct as measured on site. To be confirmed by Site Survey.

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Tonkin & Taylor

Project: Fiji Radio

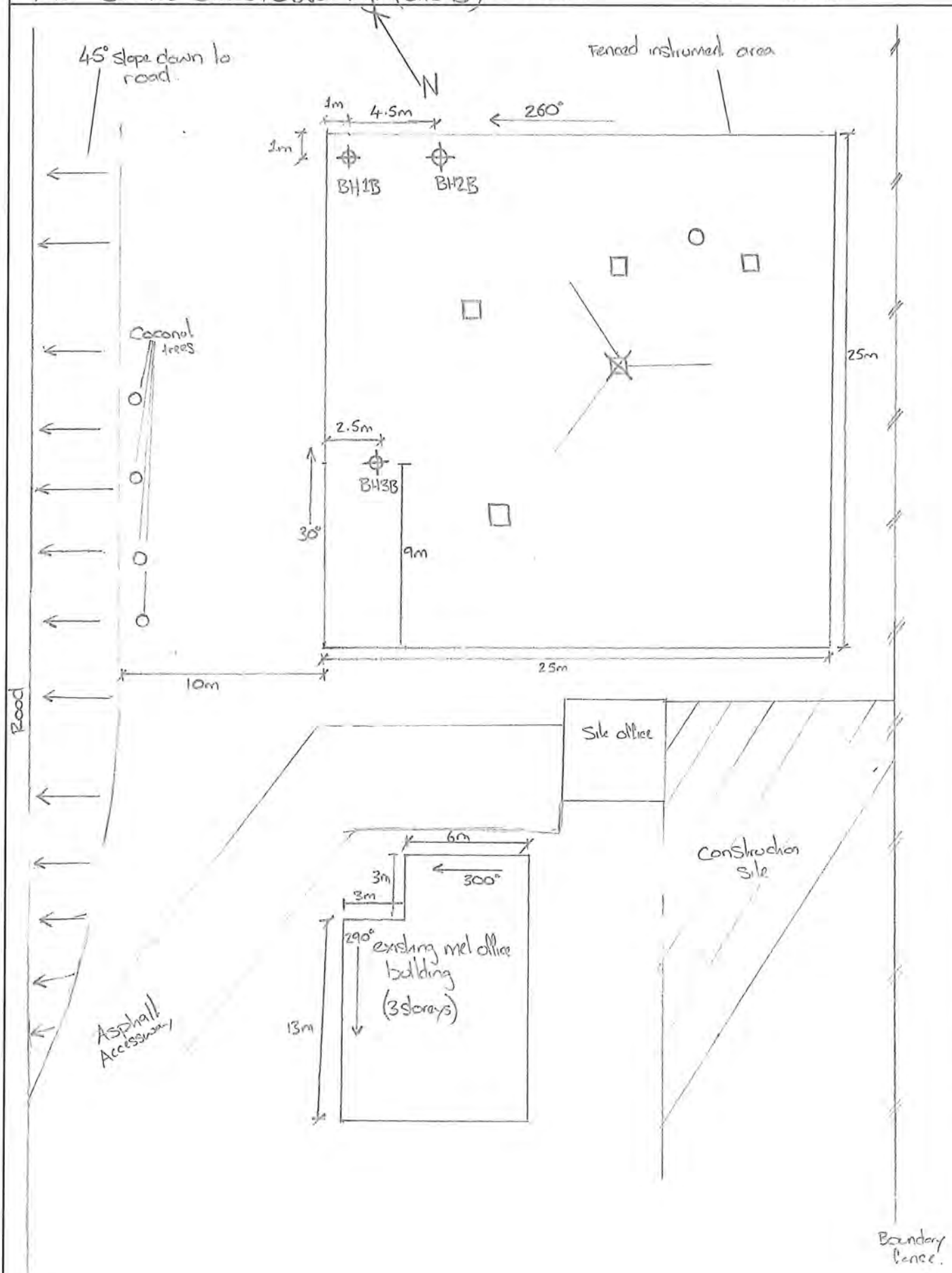
Computed: CJT 8/1/2013 Office: Auckland

Checked: 20 Job No: 750942

Revised: 20 File:

Checked: 20 Sheet No.

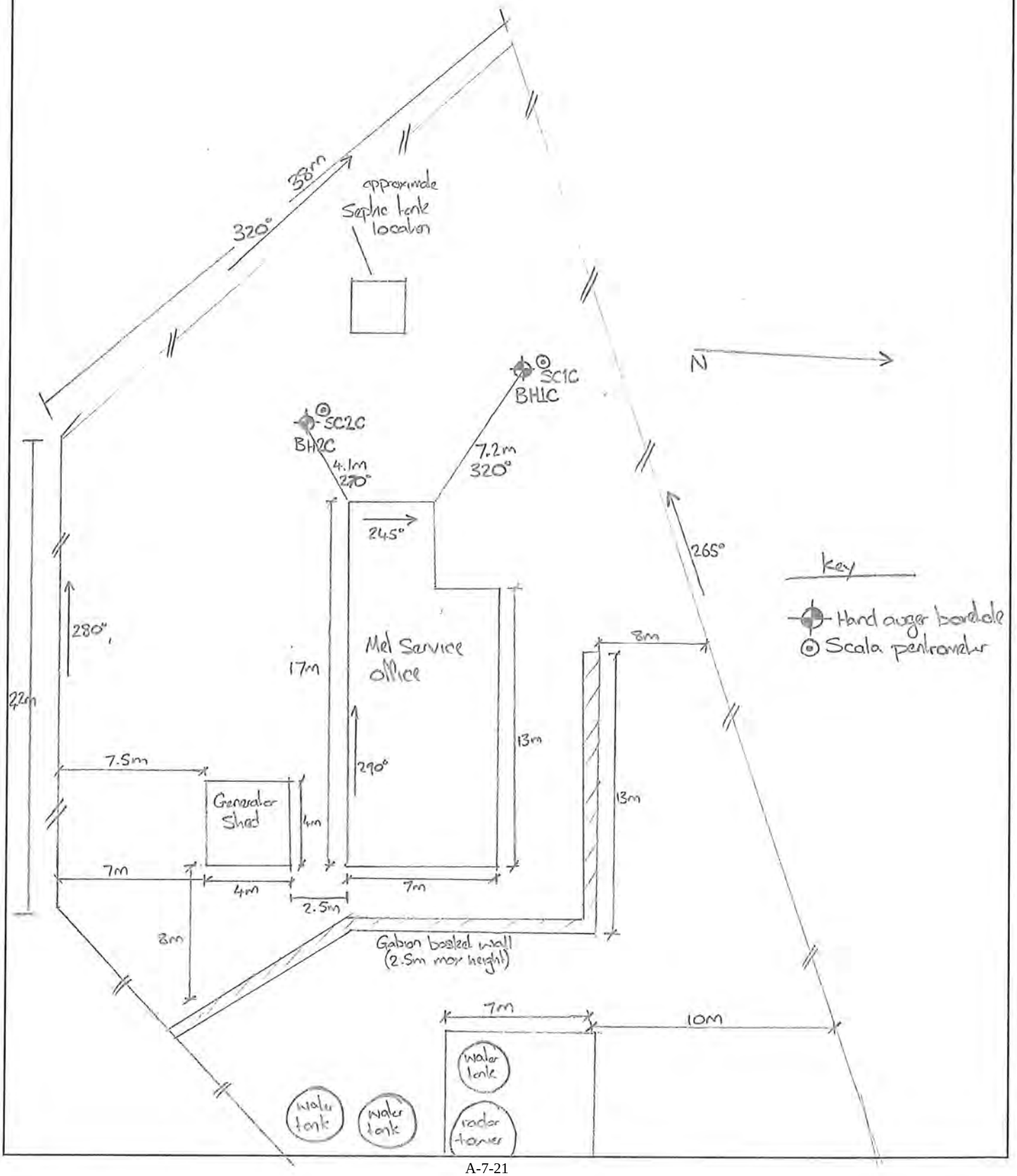
Description: Site Sketch
Met Service office, Suva Fiji (site B)

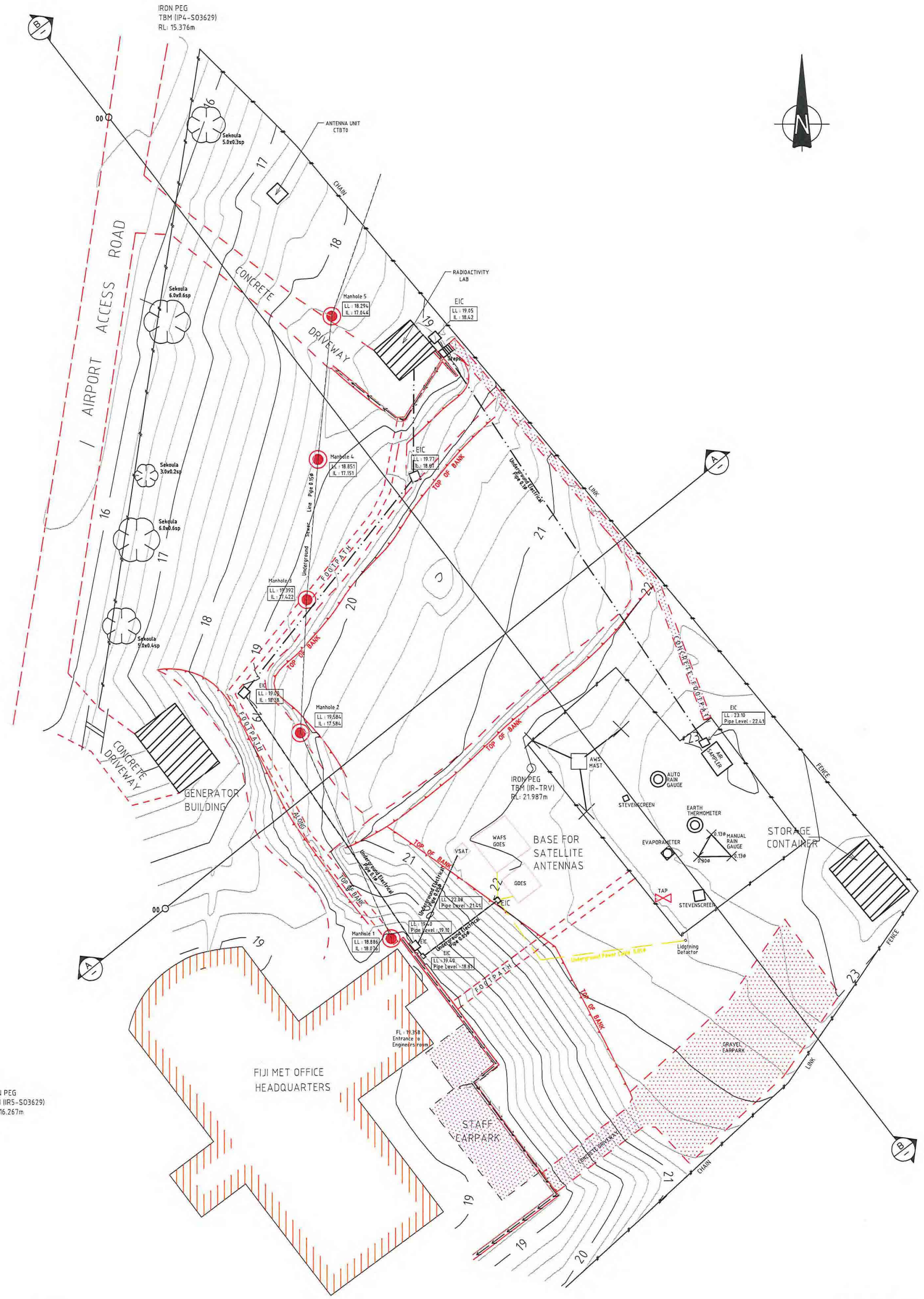


Tonkin & Taylor

Project: Fiji Radio | Computed: CJT | 9/1/2013 | Office: Auckland
Checked: 20 | Job No: 750942
Revised: 20 | File:
Checked: 20 | Sheet No.

Description: Site sketch - Geotechnical investigations
Site C - Fiji Met Service Valudamu






NOTES:
1. Survey supplied by Cadastrals Surveyors, Planners and Development Consultants.
2. Datum of survey: Fiji Map Grid Datum 1986
3. Origin of survey: Approved survey plan S03629 (FMG).
4. Level Datum: Mean sea level (Lands Dept) Datum.
5. Origin of levels: Standard Survey Mark 3506 of S04242 RL: 27.064m (MSL) on Lands Department Triangulation Network.
6. Survey Methodology: Grid and String Method.
7. Contour Intervals: 0.25m (as required).
8. Schedule of TBM description:

| TBM Name | Easting Coord | Northing Coord | RL (MSL) Value |
|---|---|---|---|
| IP4 S03629 | 186 15 18.880 | 39 15532.920 | 15.379m |
| IR - TRAV | 186 1567.680 | 39 15436.831 | 21.987m |
| IR5 S03629 | 186 1496.188 | 39 15393.511 | 16.267m |

9. MH denotes Manholes.
10. EIC denotes U/G Electrical Inspection Chambers.

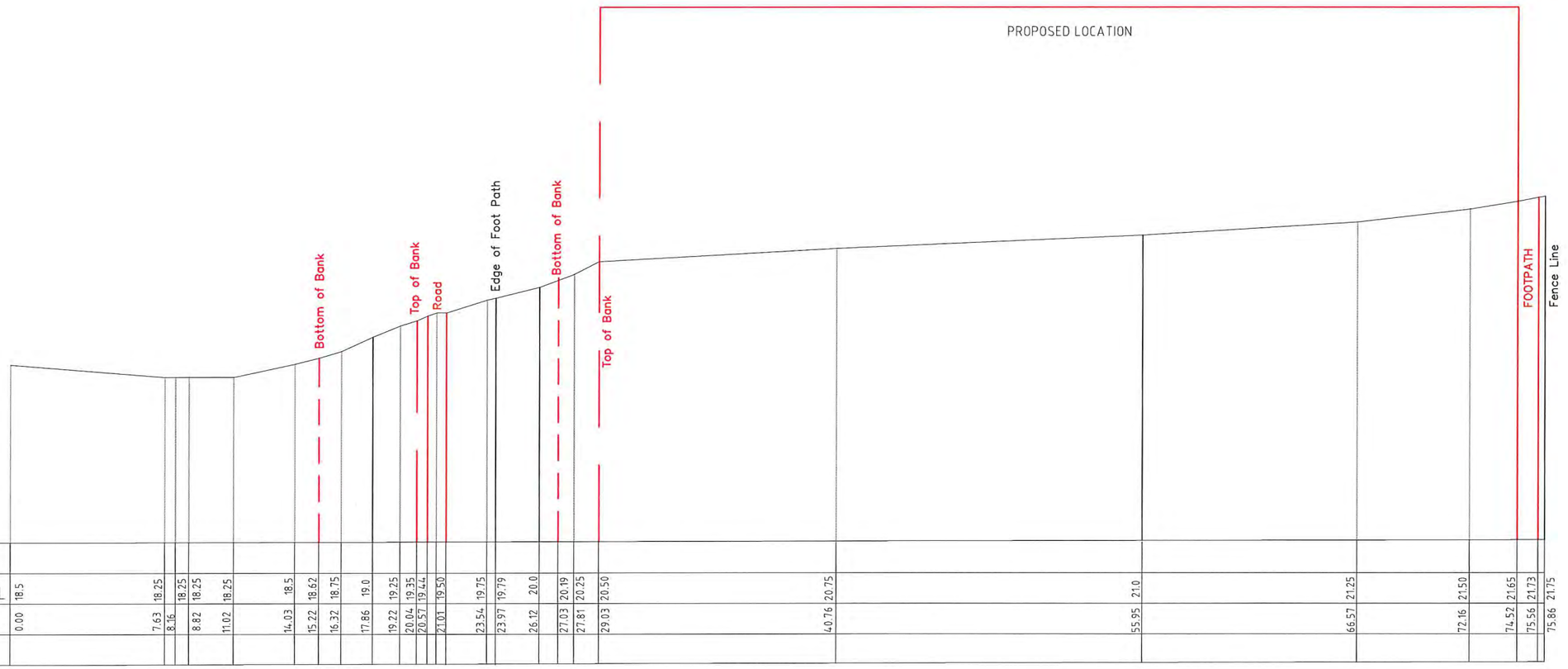
Tonkin & Taylor
Environmental and Engineering Consultants
105 Carlton Gore Road, Newmarket, Auckland
www.tonkin.co.nz

| | | |
|---|---|---|
| DRAWN | KAH | Feb. 13 |
| DRAFTING CHECKED | | |
| APPROVED | | |
| CADFILE : \\750942-01.dwg | | |
| SCALES (AT A3 SIZE) 1:500 | | |
| PROJECT No. 750942 | | |

# YACHIYO ENGINEERING CO LTD
## EQUIPMENT IMPROVEMENT FOR DISASTER RISK MANAGEMENT
## NADI MET SERVICE OFFICE, NADI, FIJI
Topograhpical Survey

FIG. No. Figure 1.
REV. 0

L:\750942\WorkingMaterial\CAD\DWGS\750942-01.dwg F1 28/02/2013 1:50:00 p.m.




| DATUM: 15m | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESIGN LEVEL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| GROUND LEVEL | 18.5 | 18.25 | 18.25 | 18.25 | 18.25 | 18.5 | 18.62 | 18.75 | 19.0 | 19.25 | 19.35 | 19.44 | 19.50 | 19.75 | 19.79 | 20.0 | 20.19 | 20.25 | 20.50 | 20.75 | 21.0 | 21.25 | 21.50 | 21.65 | 21.73 | 21.75 | | | | |
| CHAINAGE | 0.00 | 7.63 | 8.16 | 8.82 | 11.02 | 14.03 | 15.22 | 16.32 | 17.86 | 19.22 | 20.04 | 20.57 | 21.01 | 23.54 | 23.97 | 26.12 | 27.03 | 27.81 | 29.03 | 40.76 | 55.95 | 66.57 | 72.16 | 74.52 | 75.56 | 75.86 | | | | |
| GRADIENT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

CROSS SECTION A–A
SCALE 1:250 (H) 1:100 (v)

A3 SCALE 1:100 (V)
0 1 2 3 4 5 (m)

A3 SCALE 1:250 (H)
0 5 10 15 (m)

NOTES:
1. Cross Section supplied by Cadastrals Surveyors, Planners and Development Consultants. Ref: CSL 1829 – C.S

Tonkin & Taylor International
Environmental and Engineering Consultants
105 Carlton Gore Road, Auckland, NEW ZEALAND
www.tonkin.co.nz

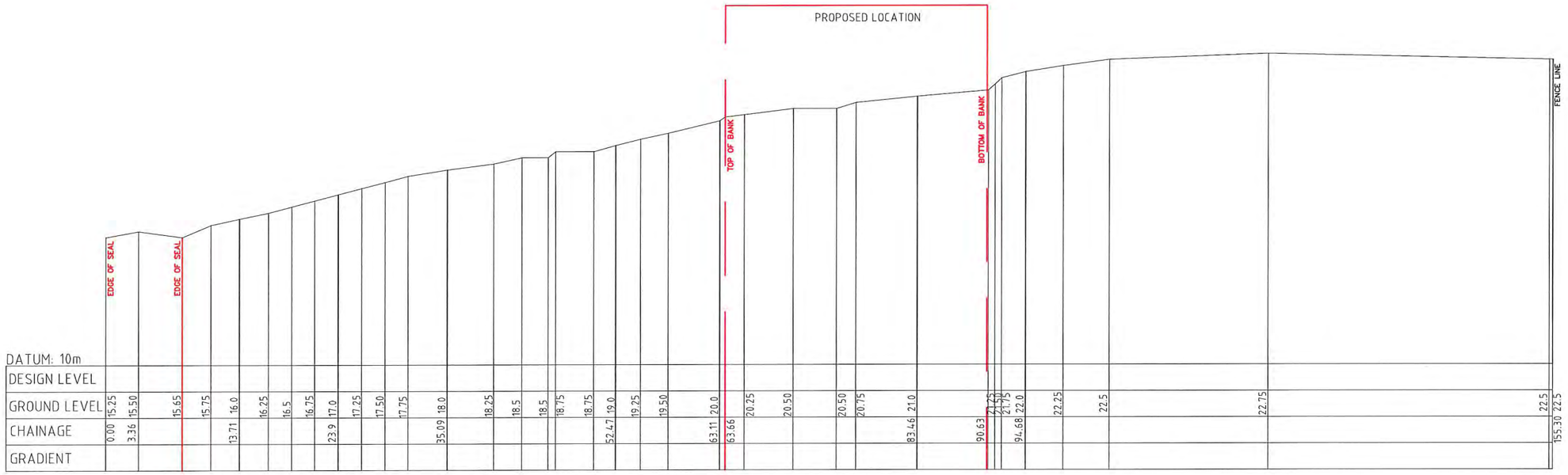
| | | |
|---|---|---|
| DRAWN | KAH | Feb. 13 |
| DRAFTING CHECKED | | |
| APPROVED | | |
| CADFILE : \\750942–02.dwg | | |
| SCALES (AT A3 SIZE) 1:250 | | |
| PROJECT No. 750942 | | |

YACHIYO ENGINEERING CO LTD
EQUIPMENT IMPROVEMENT FOR DISASTER RISK MANAGEMENT
NADI MET SERVICE OFFICE, NADI, FIJI
Cross Section A–A

FIG. No. Figure 2 | REV. 0

A-7-23

L:\750942\WorkingMaterial\CAD\DWGS\750942-02.dwg, F2, 28/02/2013 3:19:38 p.m., KAH, 1:1




CROSS SECTION B–B
SCALE: 1:500 (H) 1:200 (V)

A3 SCALE 1:200 (V)
0 2 4 6 8 10 (m)

A3 SCALE 1:500 (H)
0 5 10 15 20 25 (m)

NOTES:
1. Cross Section supplied by Cadastrals Surveyors, Planners and Development Consultants. Ref: CSL 1829 – C.S

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105 Carlton Gore Road, Auckland, NEW ZEALAND
www.tonkin.co.nz

| | | |
|---|---|---|
| DRAWN | KAH | Feb. 13 |
| DRAFTING CHECKED | | |
| APPROVED | | |
| CADFILE : \\750942–02.dwg | | |
| SCALES (AT A3 SIZE) 1:500 | | |
| PROJECT No. 750942 | | |

YACHIYO ENGINEERING CO LTD
EQUIPMENT IMPROVEMENT FOR DISASTER RISK MANAGEMENT
NADI MET SERVICE OFFICE, NADI, FIJI
Cross Section B–B

FIG. No. Figure 3 REV. 0

A-7-24

L:\750942\WorkingMaterial\CAD\DWGS\750942-02.dwg, F3, 28/02/2013 3:19:13 p.m., KAH, 1:1

## Appendix C: Investigation Logs and Geotechnical Laboratory Testing

- **Hand auger borehole logs**
- **Scala Penetrometer results**
- **Geotechnical Laboratory Testing**

# TONKIN & TAYLOR LTD

# BOREHOLE LOG

BOREHOLE No:BH1A
Hole Location: Refer site plan.

SHEET 1 OF 1

PROJECT: Improvement of Equipment for Disaster Risk Management LOCATION: Met. Office, Valudamu JOB No: 750942

CO-ORDINATES:
R.L.:
DATUM:

DRILL TYPE: Hand Auger
DRILL METHOD: HA
DRILL FLUID:

HOLE STARTED: 7/1/13
HOLE FINISHED: 7/1/13
DRILLED BY: CJT
LOGGED BY: CJT CHECKED:

| GEOLOGICAL | | | | | | | | ENGINEERING DESCRIPTION | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION. | FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) / DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 200 1000 2000 |
| TOPSOIL<br>VOLCANIC TUFF | | | | | | | | 0.5<br>1.0<br>1.5<br>2.0<br>2.5<br>3.0<br>3.5<br>4 | | | | | | | |
| RESIDUAL SOIL | | | | | | | | | | | | | | | |

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.
ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

TOPSOIL, organic; light brown. Dry

CLAY; red brown. Stiff, dry, non-plastic, low cohesion, crumbly

0.5

Some sand/fine gravel present

Fine gravelly material present (volcanic tuff)
1-1.2m: Sample collected for laboratory testing

1.0

CLAY, trace silt and sand; red brown with trace yellow. Dry, non-plastic, non-cohesive

1.5

2.0

2.1-2.4m: Sample collected for laboratory testing - poor recovery.

2.5

CLAY; red brown mottled white. Dry, non-plastic, increased cohesion

3.0

**END OF BOREHOLE AT 3m.**

Unable to auger further due to soil stiffness.

3.5

T+T DATATEMPLATE.GDT amm

Log Scale 1:20

BORELOG 750942.GPJ 26-Feb-2013

# TONKIN & TAYLOR LTD

# BOREHOLE LOG

BOREHOLE No:BH1B
Hole Location: Refer site plan.

SHEET 1 OF 1

PROJECT: Improvement of Equipment for Disaster Risk Management LOCATION: Met. Office, Valudamu JOB No: 750942

CO-ORDINATES:
R.L.:
DATUM:

DRILL TYPE: Hand Auger
DRILL METHOD: HA
DRILL FLUID:

HOLE STARTED: 8/1/13
HOLE FINISHED: 8/1/13
DRILLED BY: CJT
LOGGED BY: CJT CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

| GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION. | FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 10 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000 | SOIL DESCRIPTION / ROCK DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOPSOIL | | | | HAND AUGER | | • 30/15kPa<br>• 55/18kPa<br>• 70/22kPa<br>• 112/20kPa | | | 0.5<br>1.0<br>1.5<br>2.0<br>2.5<br>3.0<br>3.5<br>4 | | | | | | | | TOPSOIL, organic; dark brown. Damp<br>Silty CLAY; brown/light orange. Damp, moderate plasticity, cohesive<br>Becoming clayey SILT; brown/light orange. Damp, moderate plasticity, medium cohesion<br>SILT, some clay and sand; orange brown. Loosely packed, moist, moderate plasticity, crumbly<br>**END OF BOREHOLE AT 1.3m.**<br>Unable to penetrate - hit obstruction: Fine SAND/SILT, trace clay; orange brown. Damp, non-plastic, low cohesion |

Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

T+T DATATEMPLATE.GDT amm

Log Scale 1:20

BORELOG 750942.GPJ 26-Feb-2013

# TONKIN & TAYLOR LTD

# BOREHOLE LOG

BOREHOLE No:BH1C
Hole Location: Refer site plan.

SHEET 1 OF 1

PROJECT: Improvement of Equipment for Disaster Risk Management LOCATION: Met. Office, Valudamu JOB No: 750942

CO-ORDINATES:
R.L.:
DATUM:

DRILL TYPE: Hand Auger
DRILL METHOD: HA
DRILL FLUID:

HOLE STARTED: 9/1/13
HOLE FINISHED: 9/1/13
DRILLED BY: CJT
LOGGED BY: CJT CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 10 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.
ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

TOPSOIL
RESIDUAL SOIL

HAND AUGER

108/10kPa
92/10kPa
UTP

TOPSOIL, organic, with gravel inclusions; dark brown. Moist

Sand Silt with trace gravel and some clay, trace silt, dark red brown, dry, moderate plasticity, medium cohesion, fine.
Colour change to dark brown grey mottled red
Dark red brown CLAY, trace silt, moderate plasticity
Becoming moist

0.5

Sandy silt, trace gravel and minor clay, light purple grey, loose, crumbly.

1.0

1.5

WEATHERED ANDESITE ROCK

**END OF BOREHOLE AT 1.5m.**

2.0
2.5
3.0
3.5
4

T+T DATATEMPLATE.GDT amm

Log Scale 1:20

BORELOG 750942.GPJ 26-Feb-2013

# TONKIN & TAYLOR LTD

# BOREHOLE LOG

BOREHOLE No:BH2A
Hole Location: Refer site plan.

SHEET 1 OF 1

PROJECT: Improvement of Equipment for Disaster Risk Management LOCATION: Met. Office, Valudamu JOB No: 750942

CO-ORDINATES:
R.L.:
DATUM:

DRILL TYPE: Hand Auger
DRILL METHOD: HA
DRILL FLUID:

HOLE STARTED: 7/1/13
HOLE FINISHED: 7/1/13
DRILLED BY: CJT
LOGGED BY: CJT CHECKED:

| GEOLOGICAL | | | | | | | | | ENGINEERING DESCRIPTION | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION. | FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) / DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000 | SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling. |
| TOPSOIL | | | | | | | | | | | | | | | | TOPSOIL, organic; light brown. Dry |
| VOLCANIC TUFF | | | | HAND AUGER | | 108/16kPa | | 0.5 | | | | | | | | CLAY, with trace silt, trace gravel fragments; reddish brown. Dry, non-plastic, non-cohesive (possible volcanic material); gravel, coarse |
| | | | | | | >140kPa | | | | | | | | | | Becoming less silty |
| | | | | | | >140kPa | | 1.0 | | | | | | | | Sample taken for testing |
| | | | | | | >140kPa | | | | | | | | | | |
| | | | | | | >140kPa | | 1.5 | | | | | | | | |
| | | | | | | >140kPa | | | | | | | | | | |
| | | | | | | >140kPa | | 2.0 | | | | | | | | |
| | | | | | | >140kPa | | | | | | | | | | |
| RESIDUAL SOIL | | | | | | 140/38kPa | | 2.5 | | | | | | | | Silty CLAY; reddish brown mottled white. Stiff, non-plastic |
| | | | | | | >140kPa | | 3.0 | | | | | | | | CLAY, with trace gravel; white mottled red. Cohesion increasing; gravel, fine |
| | | | | | | | | | | | | | | | | **END OF BOREHOLE AT 3m.** |
| | | | | | | | | 3.5 | | | | | | | | |
| | | | | | | | | 4 | | | | | | | | |

T+T DATATEMPLATE.GDT amm

Log Scale 1:20

BORELOG 750942.GPJ 26-Feb-2013

# TONKIN & TAYLOR LTD

# BOREHOLE LOG

BOREHOLE No:BH2B
Hole Location: Refer site plan.

SHEET 1 OF 1

PROJECT: Improvement of Equipment for Disaster Risk ManagementLOCATION: Met. Office, Valudamu JOB No: 750942

CO-ORDINATES:
R.L.:
DATUM:

DRILL TYPE: Hand Auger
DRILL METHOD: HA
DRILL FLUID:

HOLE STARTED: 8/1/13
HOLE FINISHED: 8/1/13
DRILLED BY: CJT
LOGGED BY: CJT CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

| GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION. | FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000 | SOIL DESCRIPTION / ROCK DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOPSOIL | | On completion | | HAND AUGER | | 40/15kPa<br>60/16kPa<br>70/20kPa<br>130/45kPa<br>>140kPa<br>118/26kPa<br>110/25kPa<br>60/24kPa<br>60/35kPa<br>80/35kPa | | | 0.5<br>1.0<br>1.5<br>2.0<br>2.5<br>3.0<br>3.5<br>4 | | | | | | | | TOPSOIL<br>Silty CLAY; brown/light orange. Damp, moderate plasticity, cohesive<br>0.5<br>Clayey SILT, some sand; orange/brown. Moderate plasticity, medium cohesion; sand, fine<br>1.0<br>1.5<br>Very silt, fine SAND; red brick colour. Loose packed, less plasticity, loess cohesion, crumbly<br>Fine SAND, with silt, trace clay; light brown mottled red. Non-plastic, non-cohesive<br>2.0<br>Silty CLAY, trace sand; yellow brown. Damp, moderate plasticity, cohesive<br>Silty, fine SAND, some gravel; brick red. Damp, non-cohesive; gravel, fine to medium (10-25mm)<br>Silty, fine SAND; red. Wet, non-cohesive<br>2.5<br>Silty CLAY; light orange brown mottled white (cream). Low plasticity, medium cohesion<br>3.0<br>**END OF BOREHOLE AT 3m.**<br>3.5 |

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.
ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

T+T DATATEMPLATE.GDT amm

Log Scale 1:20



BORELOG 750942.GPJ 26-Feb-2013

# TONKIN & TAYLOR LTD

# BOREHOLE LOG

BOREHOLE No:BH2C
Hole Location: Refer site plan.

SHEET 1 OF 1

PROJECT: Improvement of Equipment for Disaster Risk Management LOCATION: Met. Office, Valudamu JOB No: 750942

CO-ORDINATES:
R.L.:
DATUM:

DRILL TYPE: Hand Auger
DRILL METHOD: HA
DRILL FLUID:

HOLE STARTED: 9/1/13
HOLE FINISHED: 9/1/13
DRILLED BY: CJT
LOGGED BY: CJT CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.
ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

TOPSOIL
RESIDUAL SOIL

HAND AUGER

60/12kPa
30/10kPa
>140kPa
>140kPa
>140kPa
UTP

TOPSOIL, organic, coarse gravel; dark brown

Sand Silt with trace gravel and some clay.

0.5

Sandy Silt, trace gravel, minor clay.

1.0

1.5

Sandy Silt, trace gravel, minor clay, orange /maroon colour. Loose, dry, moderate plasticity, crumbly

WEATHERED ANDESITE ROCK

**END OF BOREHOLE AT 1.9m.**

Top of rock.

2.0
2.5
3.0
3.5
4

T+T DATATEMPLATE.GDT amm

Log Scale 1:20



BORELOG 750942.GPJ 26-Feb-2013

# TONKIN & TAYLOR LTD

# BOREHOLE LOG

BOREHOLE No:BH3B
Hole Location: Refer site plan.

SHEET 1 OF 1

PROJECT: Improvement of Equipment for Disaster Risk Management LOCATION: Met. Office, Valudamu JOB No: 750942

CO-ORDINATES:
R.L.:
DATUM:

DRILL TYPE: Hand Auger
DRILL METHOD: HA
DRILL FLUID:

HOLE STARTED: 8/1/13
HOLE FINISHED: 8/1/13
DRILLED BY: CJT
LOGGED BY: CJT CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 200 | DEFECT SPACING (mm) 50 200 1000 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.
ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

WATER: On completion

METHOD: HAND AUGER

TESTS: 45/20kPa; 102/35kPa; 130/32kPa; UTP; UTP; UTP; 130/15kPa; 100/45kPa; 80/16kPa; 85/20kPa

TOPSOIL, organic; dark brown. Moist

Silty CLAY, trace sand; brown orange. Moist, moderate plasticity

0.5

Clayey SILT, with trace sand; orange brown. Damp, low plasticity, low cohesion; sand, fine

1.0

1.5

Fine to medium GRAVEL (5-20mm dia.); grey, angular

SILT, with some sand, some clay; white mottled red. Wet, non-plastic, cohesive; sand, fine

2.0

2.5

3.0

**END OF BOREHOLE AT 3m.**

3.5

4

T+T DATATEMPLATE.GDT amm

Log Scale 1:20

BORELOG 750942.GPJ 26-Feb-2013

TONKIN & TAYLOR

# SCALA PENETROMETER LOG

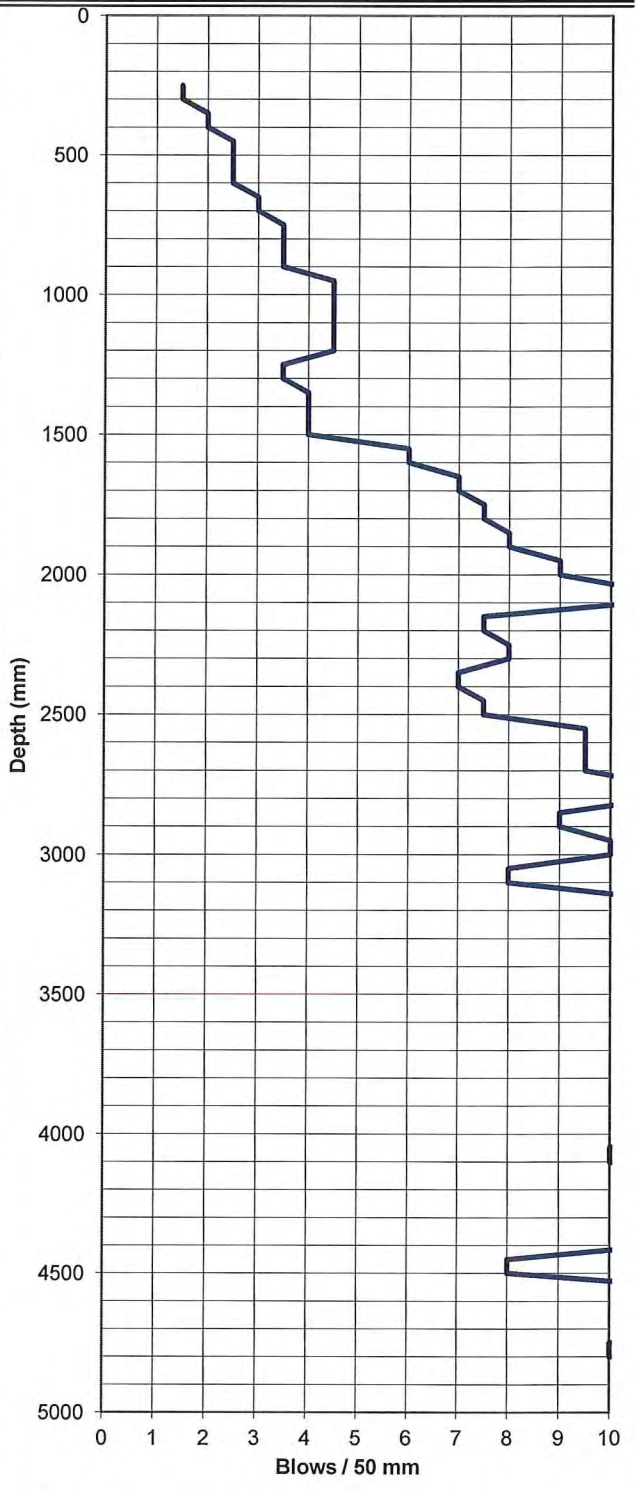
Job No: *750942*
Project: *Improvement of Equipment for Disaster Risk Management*
Location: *Met Office Nadi*

Date: *7/01/2013*
Operated by: *CJT*
Logged by: *CJT*
Checked by: *ADP*

**Test No.** ***SC1A***
**Sheet** ***1*** **of** ***1***

| mm Driven | No. of Blows |
|---|---|
| 50 | |
| 100 | |
| 150 | |
| 200 | |
| 250 | 1.5 |
| 300 | 1.5 |
| 350 | 2 |
| 400 | 2 |
| 450 | 2.5 |
| 500 | 2.5 |
| 550 | 2.5 |
| 600 | 2.5 |
| 650 | 3 |
| 700 | 3 |
| 750 | 3.5 |
| 800 | 3.5 |
| 850 | 3.5 |
| 900 | 3.5 |
| 950 | 4.5 |
| 1000 | 4.5 |
| 1050 | 4.5 |
| 1100 | 4.5 |
| 1150 | 4.5 |
| 1200 | 4.5 |
| 1250 | 3.5 |
| 1300 | 3.5 |
| 1350 | 4 |
| 1400 | 4 |
| 1450 | 4 |
| 1500 | 4 |
| 1550 | 6 |
| 1600 | 6 |
| 1650 | 7 |
| 1700 | 7 |
| 1750 | 7.5 |
| 1800 | 7.5 |
| 1850 | 8 |
| 1900 | 8 |
| 1950 | 9 |
| 2000 | 9 |
| 2050 | 10.5 |
| 2100 | 10.5 |
| 2150 | 7.5 |
| 2200 | 7.5 |
| 2250 | 8 |
| 2300 | 8 |
| 2350 | 7 |
| 2400 | 7 |
| 2450 | 7.5 |
| 2500 | 7.5 |

| mm Driven | No. of Blows |
|---|---|
| 2550 | 9.5 |
| 2600 | 9.5 |
| 2650 | 9.5 |
| 2700 | 9.5 |
| 2750 | 11 |
| 2800 | 11 |
| 2850 | 9 |
| 2900 | 9 |
| 2950 | 10 |
| 3000 | 10 |
| 3050 | 8 |
| 3100 | 8 |
| 3150 | 10.5 |
| 3200 | 10.5 |
| 3250 | 11 |
| 3300 | 11 |
| 3350 | 12 |
| 3400 | 12 |
| 3450 | 11.5 |
| 3500 | 11.5 |
| 3550 | 12.5 |
| 3600 | 12.5 |
| 3650 | 12.5 |
| 3700 | 12.5 |
| 3750 | 12.5 |
| 3800 | 12.5 |
| 3850 | 11 |
| 3900 | 11 |
| 3950 | 11 |
| 4000 | 11 |
| 4050 | 10 |
| 4100 | 10 |
| 4150 | 11 |
| 4200 | 11 |
| 4250 | 12 |
| 4300 | 12 |
| 4350 | 11 |
| 4400 | 11 |
| 4450 | 8 |
| 4500 | 8 |
| 4550 | 11.5 |
| 4600 | 11.5 |
| 4650 | 13 |
| 4700 | 13 |
| 4750 | 10 |
| 4800 | 10 |
| 4850 | 14.5 |
| 4900 | 14.5 |
| 4950 | 14.5 |
| 5000 | 14.5 |




Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer

SC FijiSC2A.xlsx

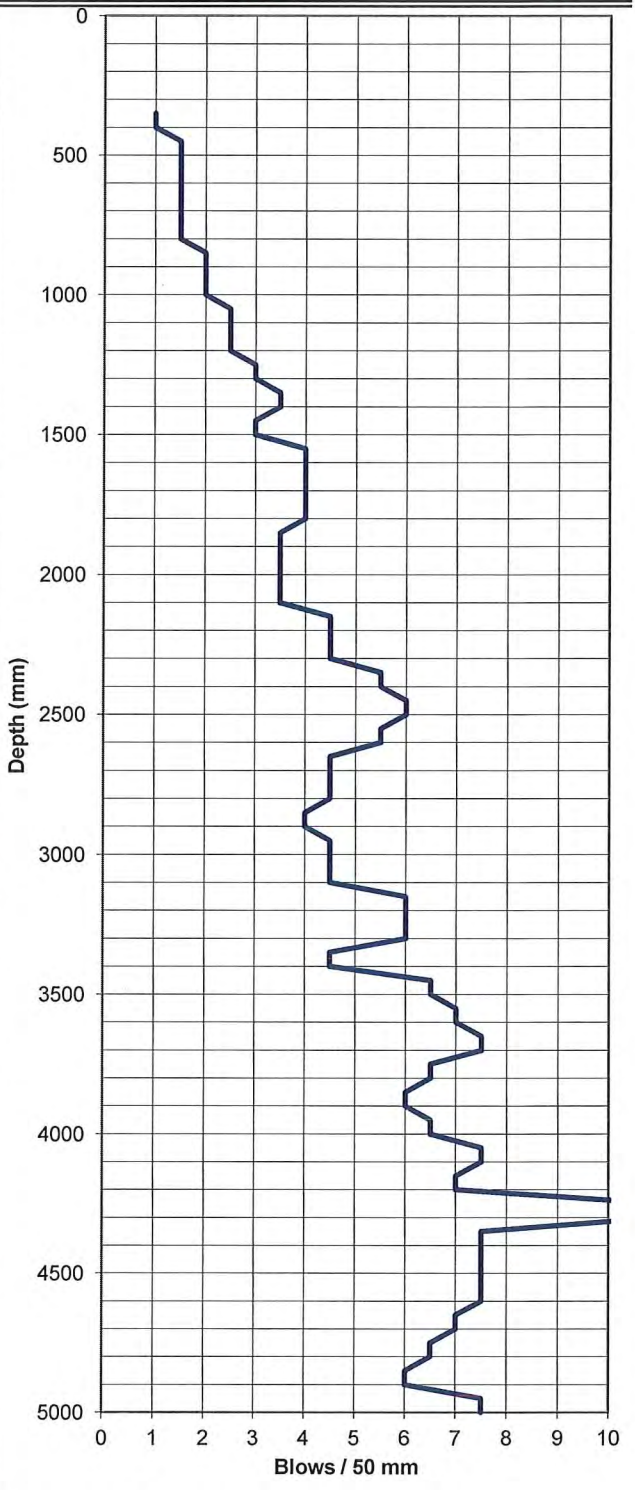
**TONKIN & TAYLOR**

# SCALA PENETROMETER LOG

| | | | | | |
|---|---|---|---|---|---|
| Job No: | *750942* | Date: | *7/01/2013* | **Test No.** | ***SC2A*** |
| Project: | *Improvement of Equipment for Disaster Risk Management* | Operated by: | *CJT* | | |
| | | Logged by: | *CJT* | **Sheet** | ***1*** |
| Location: | *Met Office Nadi* | Checked by: | *ADP* | **of** | ***1*** |

| mm Driven | No. of Blows |
|---|---|
| 50 | |
| 100 | |
| 150 | |
| 200 | |
| 250 | |
| 300 | |
| 350 | 1 |
| 400 | 1 |
| 450 | 1.5 |
| 500 | 1.5 |
| 550 | 1.5 |
| 600 | 1.5 |
| 650 | 1.5 |
| 700 | 1.5 |
| 750 | 1.5 |
| 800 | 1.5 |
| 850 | 2 |
| 900 | 2 |
| 950 | 2 |
| 1000 | 2 |
| 1050 | 2.5 |
| 1100 | 2.5 |
| 1150 | 2.5 |
| 1200 | 2.5 |
| 1250 | 3 |
| 1300 | 3 |
| 1350 | 3.5 |
| 1400 | 3.5 |
| 1450 | 3 |
| 1500 | 3 |
| 1550 | 4 |
| 1600 | 4 |
| 1650 | 4 |
| 1700 | 4 |
| 1750 | 4 |
| 1800 | 4 |
| 1850 | 3.5 |
| 1900 | 3.5 |
| 1950 | 3.5 |
| 2000 | 3.5 |
| 2050 | 3.5 |
| 2100 | 3.5 |
| 2150 | 4.5 |
| 2200 | 4.5 |
| 2250 | 4.5 |
| 2300 | 4.5 |
| 2350 | 5.5 |
| 2400 | 5.5 |
| 2450 | 6 |
| 2500 | 6 |

| mm Driven | No. of Blows |
|---|---|
| 2550 | 5.5 |
| 2600 | 5.5 |
| 2650 | 4.5 |
| 2700 | 4.5 |
| 2750 | 4.5 |
| 2800 | 4.5 |
| 2850 | 4 |
| 2900 | 4 |
| 2950 | 4.5 |
| 3000 | 4.5 |
| 3050 | 4.5 |
| 3100 | 4.5 |
| 3150 | 6 |
| 3200 | 6 |
| 3250 | 6 |
| 3300 | 6 |
| 3350 | 4.5 |
| 3400 | 4.5 |
| 3450 | 6.5 |
| 3500 | 6.5 |
| 3550 | 7 |
| 3600 | 7 |
| 3650 | 7.5 |
| 3700 | 7.5 |
| 3750 | 6.5 |
| 3800 | 6.5 |
| 3850 | 6 |
| 3900 | 6 |
| 3950 | 6.5 |
| 4000 | 6.5 |
| 4050 | 7.5 |
| 4100 | 7.5 |
| 4150 | 7 |
| 4200 | 7 |
| 4250 | 11 |
| 4300 | 11 |
| 4350 | 7.5 |
| 4400 | 7.5 |
| 4450 | 7.5 |
| 4500 | 7.5 |
| 4550 | 7.5 |
| 4600 | 7.5 |
| 4650 | 7 |
| 4700 | 7 |
| 4750 | 6.5 |
| 4800 | 6.5 |
| 4850 | 6 |
| 4900 | 6 |
| 4950 | 7.5 |
| 5000 | 7.5 |




Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer

SC FijiSC1B.xlsx

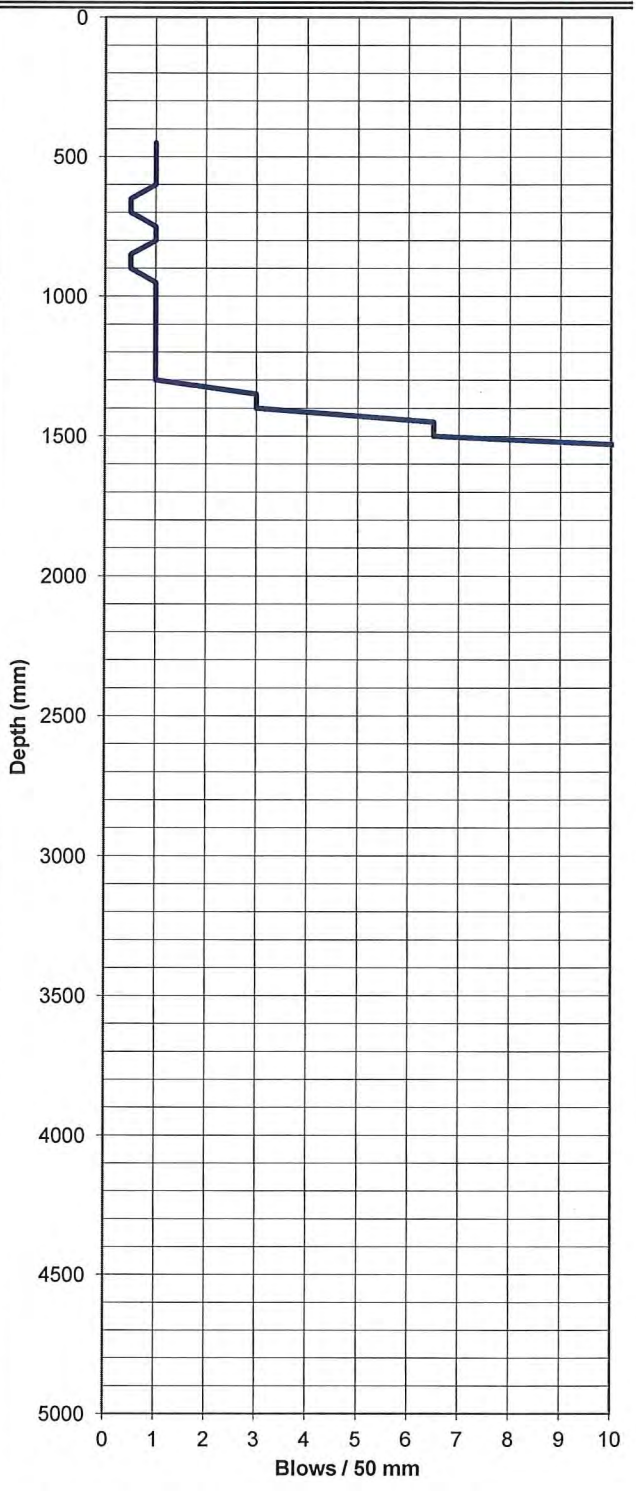
**TONKIN & TAYLOR**

# SCALA PENETROMETER LOG

| | | | | | |
|---|---|---|---|---|---|
| Job No: | *750942* | Date: | *8/01/2013* | **Test No.** | ***SC1B*** |
| Project: | *Improvement of Equipment for Disaster Risk Management* | Operated by: | *CJT* | | |
| | | Logged by: | *CJT* | **Sheet** | ***1*** |
| Location: | *Met Office Suva* | Checked by: | *ADP* | **of** | ***1*** |

| mm Driven | No. of Blows |
|---|---|
| 50 | |
| 100 | |
| 150 | |
| 200 | |
| 250 | |
| 300 | |
| 350 | |
| 400 | |
| 450 | *1* |
| 500 | *1* |
| 550 | *1* |
| 600 | *1* |
| 650 | *0.5* |
| 700 | *0.5* |
| 750 | *1* |
| 800 | *1* |
| 850 | *0.5* |
| 900 | *0.5* |
| 950 | *1* |
| 1000 | *1* |
| 1050 | *1* |
| 1100 | *1* |
| 1150 | *1* |
| 1200 | *1* |
| 1250 | *1* |
| 1300 | *1* |
| 1350 | *3* |
| 1400 | *3* |
| 1450 | *6.5* |
| 1500 | *6.5* |
| 1550 | *12.5* |
| 1600 | *12.5* |
| 1650 | *22* |
| 1700 | *22* |
| 1750 | |
| 1800 | |
| 1850 | |
| 1900 | |
| 1950 | |
| 2000 | |
| 2050 | |
| 2100 | |
| 2150 | |
| 2200 | |
| 2250 | |
| 2300 | |
| 2350 | |
| 2400 | |
| 2450 | |
| 2500 | |

| mm Driven | No. of Blows |
|---|---|
| 2550 | |
| 2600 | |
| 2650 | |
| 2700 | |
| 2750 | |
| 2800 | |
| 2850 | |
| 2900 | |
| 2950 | |
| 3000 | |
| 3050 | |
| 3100 | |
| 3150 | |
| 3200 | |
| 3250 | |
| 3300 | |
| 3350 | |
| 3400 | |
| 3450 | |
| 3500 | |
| 3550 | |
| 3600 | |
| 3650 | |
| 3700 | |
| 3750 | |
| 3800 | |
| 3850 | |
| 3900 | |
| 3950 | |
| 4000 | |
| 4050 | |
| 4100 | |
| 4150 | |
| 4200 | |
| 4250 | |
| 4300 | |
| 4350 | |
| 4400 | |
| 4450 | |
| 4500 | |
| 4550 | |
| 4600 | |
| 4650 | |
| 4700 | |
| 4750 | |
| 4800 | |
| 4850 | |
| 4900 | |
| 4950 | |
| 5000 | |




Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer

SC FijiSC2B.xlsx

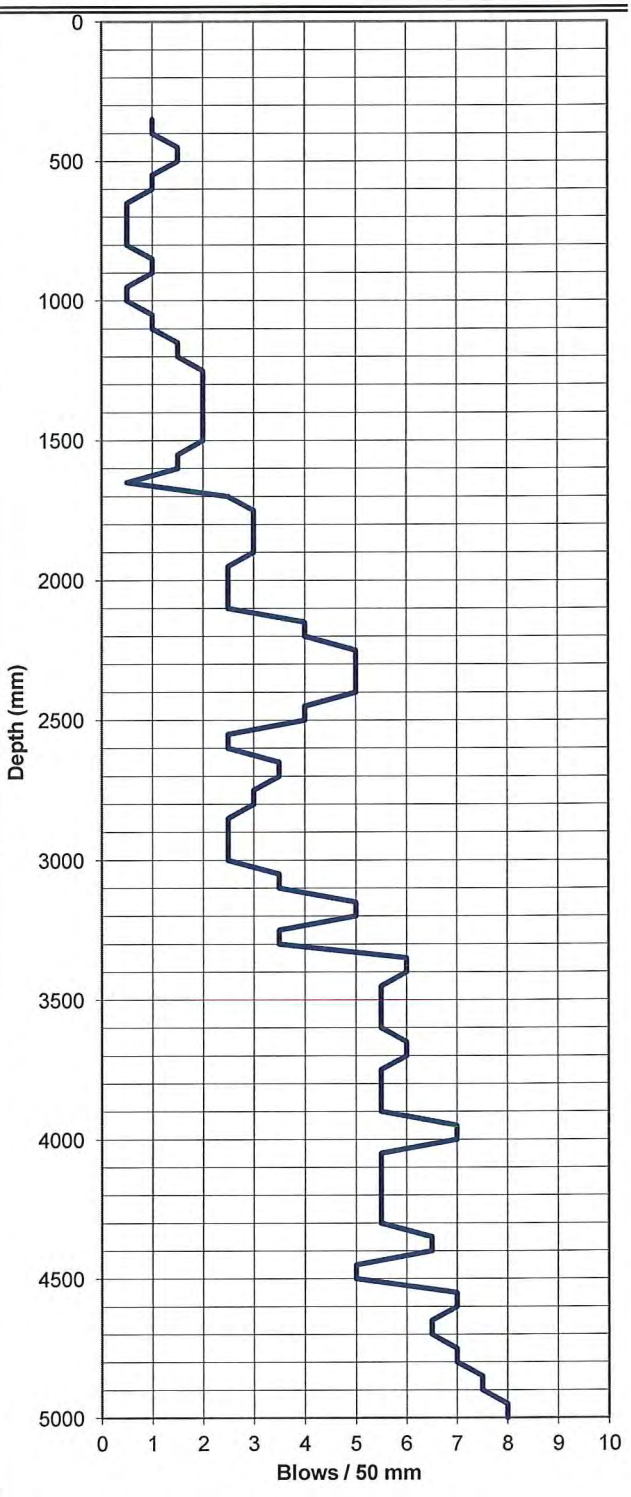
**TONKIN & TAYLOR**

# SCALA PENETROMETER LOG

| | | | | | |
|---|---|---|---|---|---|
| Job No: | *750942* | Date: | *8/01/2013* | **Test No.** | ***SC2B*** |
| Project: | *Improvement of Equipment for Disaster Risk Management* | Operated by: | *CJT* | | |
| | | Logged by: | *CJT* | **Sheet** | ***1*** |
| Location: | *Met Office Nadi* | Checked by: | *ADP* | **of** | ***1*** |

| mm Driven | No. of Blows |
|---|---|
| 50 | |
| 100 | |
| 150 | |
| 200 | |
| 250 | |
| 300 | |
| 350 | 1 |
| 400 | 1 |
| 450 | 1.5 |
| 500 | 1.5 |
| 550 | 1 |
| 600 | 1 |
| 650 | 0.5 |
| 700 | 0.5 |
| 750 | 0.5 |
| 800 | 0.5 |
| 850 | 1 |
| 900 | 1 |
| 950 | 0.5 |
| 1000 | 0.5 |
| 1050 | 1 |
| 1100 | 1 |
| 1150 | 1.5 |
| 1200 | 1.5 |
| 1250 | 2 |
| 1300 | 2 |
| 1350 | 2 |
| 1400 | 2 |
| 1450 | 2 |
| 1500 | 2 |
| 1550 | 1.5 |
| 1600 | 1.5 |
| 1650 | 0.5 |
| 1700 | 2.5 |
| 1750 | 3 |
| 1800 | 3 |
| 1850 | 3 |
| 1900 | 3 |
| 1950 | 2.5 |
| 2000 | 2.5 |
| 2050 | 2.5 |
| 2100 | 2.5 |
| 2150 | 4 |
| 2200 | 4 |
| 2250 | 5 |
| 2300 | 5 |
| 2350 | 5 |
| 2400 | 5 |
| 2450 | 4 |
| 2500 | 4 |

| mm Driven | No. of Blows |
|---|---|
| 2550 | 2.5 |
| 2600 | 2.5 |
| 2650 | 3.5 |
| 2700 | 3.5 |
| 2750 | 3 |
| 2800 | 3 |
| 2850 | 2.5 |
| 2900 | 2.5 |
| 2950 | 2.5 |
| 3000 | 2.5 |
| 3050 | 3.5 |
| 3100 | 3.5 |
| 3150 | 5 |
| 3200 | 5 |
| 3250 | 3.5 |
| 3300 | 3.5 |
| 3350 | 6 |
| 3400 | 6 |
| 3450 | 5.5 |
| 3500 | 5.5 |
| 3550 | 5.5 |
| 3600 | 5.5 |
| 3650 | 6 |
| 3700 | 6 |
| 3750 | 5.5 |
| 3800 | 5.5 |
| 3850 | 5.5 |
| 3900 | 5.5 |
| 3950 | 7 |
| 4000 | 7 |
| 4050 | 5.5 |
| 4100 | 5.5 |
| 4150 | 5.5 |
| 4200 | 5.5 |
| 4250 | 5.5 |
| 4300 | 5.5 |
| 4350 | 6.5 |
| 4400 | 6.5 |
| 4450 | 5 |
| 4500 | 5 |
| 4550 | 7 |
| 4600 | 7 |
| 4650 | 6.5 |
| 4700 | 6.5 |
| 4750 | 7 |
| 4800 | 7 |
| 4850 | 7.5 |
| 4900 | 7.5 |
| 4950 | 8 |
| 5000 | 8 |




Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer

TONKIN & TAYLOR

# SCALA PENETROMETER LOG

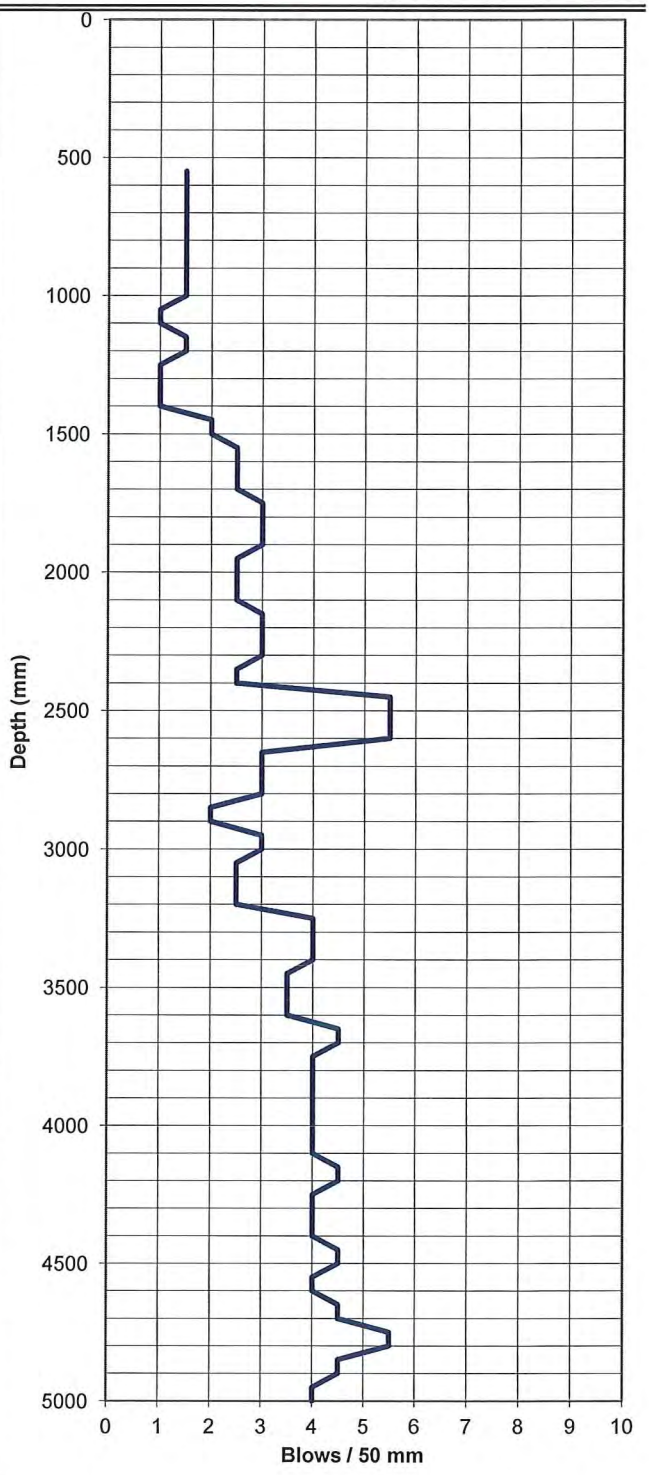
Job No: *750942*
Project: *Improvement of Equipment for Disaster Risk Management*
Location: *Met Office Suva*

Date: *8/01/2013*
Operated by: *CJT*
Logged by: *CJT*
Checked by: *ADP*

**Test No.** ***SC3B***
**Sheet** ***1***
**of** ***1***

| mm Driven | No. of Blows |
|---|---|
| 50 | |
| 100 | |
| 150 | |
| 200 | |
| 250 | |
| 300 | |
| 350 | |
| 400 | |
| 450 | |
| 500 | |
| 550 | 1.5 |
| 600 | 1.5 |
| 650 | 1.5 |
| 700 | 1.5 |
| 750 | 1.5 |
| 800 | 1.5 |
| 850 | 1.5 |
| 900 | 1.5 |
| 950 | 1.5 |
| 1000 | 1.5 |
| 1050 | 1 |
| 1100 | 1 |
| 1150 | 1.5 |
| 1200 | 1.5 |
| 1250 | 1 |
| 1300 | 1 |
| 1350 | 1 |
| 1400 | 1 |
| 1450 | 2 |
| 1500 | 2 |
| 1550 | 2.5 |
| 1600 | 2.5 |
| 1650 | 2.5 |
| 1700 | 2.5 |
| 1750 | 3 |
| 1800 | 3 |
| 1850 | 3 |
| 1900 | 3 |
| 1950 | 2.5 |
| 2000 | 2.5 |
| 2050 | 2.5 |
| 2100 | 2.5 |
| 2150 | 3 |
| 2200 | 3 |
| 2250 | 3 |
| 2300 | 3 |
| 2350 | 2.5 |
| 2400 | 2.5 |
| 2450 | 5.5 |
| 2500 | 5.5 |

| mm Driven | No. of Blows |
|---|---|
| 2550 | 5.5 |
| 2600 | 5.5 |
| 2650 | 3 |
| 2700 | 3 |
| 2750 | 3 |
| 2800 | 3 |
| 2850 | 2 |
| 2900 | 2 |
| 2950 | 3 |
| 3000 | 3 |
| 3050 | 2.5 |
| 3100 | 2.5 |
| 3150 | 2.5 |
| 3200 | 2.5 |
| 3250 | 4 |
| 3300 | 4 |
| 3350 | 4 |
| 3400 | 4 |
| 3450 | 3.5 |
| 3500 | 3.5 |
| 3550 | 3.5 |
| 3600 | 3.5 |
| 3650 | 4.5 |
| 3700 | 4.5 |
| 3750 | 4 |
| 3800 | 4 |
| 3850 | 4 |
| 3900 | 4 |
| 3950 | 4 |
| 4000 | 4 |
| 4050 | 4 |
| 4100 | 4 |
| 4150 | 4.5 |
| 4200 | 4.5 |
| 4250 | 4 |
| 4300 | 4 |
| 4350 | 4 |
| 4400 | 4 |
| 4450 | 4.5 |
| 4500 | 4.5 |
| 4550 | 4 |
| 4600 | 4 |
| 4650 | 4.5 |
| 4700 | 4.5 |
| 4750 | 5.5 |
| 4800 | 5.5 |
| 4850 | 4.5 |
| 4900 | 4.5 |
| 4950 | 4 |
| 5000 | 4 |




Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer

SC FijiSC1C.xlsx

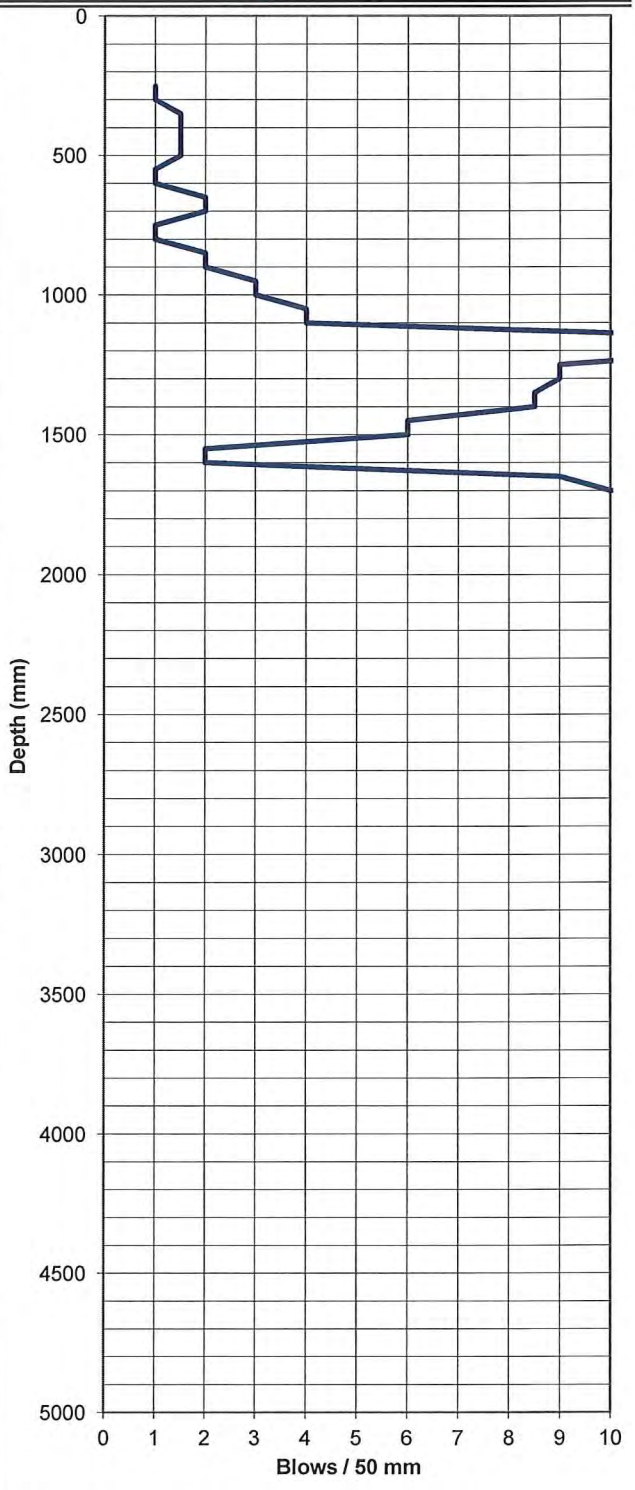
**TONKIN & TAYLOR**

# SCALA PENETROMETER LOG

| | | | | | |
|---|---|---|---|---|---|
| Job No: | *750942* | Date: | *9/01/2013* | **Test No.** | ***SC1C*** |
| Project: | *Improvement of Equipment for Disaster Risk Management* | Operated by: | *CJT* | | |
| | | Logged by: | *CJT* | **Sheet** | ***1*** |
| Location: | *Met Office Vatudamu* | Checked by: | *ADP* | **of** | ***1*** |

| mm Driven | No. of Blows |
|---|---|
| 50 | |
| 100 | |
| 150 | |
| 200 | |
| 250 | *1* |
| 300 | *1* |
| 350 | *1.5* |
| 400 | *1.5* |
| 450 | *1.5* |
| 500 | *1.5* |
| 550 | *1* |
| 600 | *1* |
| 650 | *2* |
| 700 | *2* |
| 750 | *1* |
| 800 | *1* |
| 850 | *2* |
| 900 | *2* |
| 950 | *3* |
| 1000 | *3* |
| 1050 | *4* |
| 1100 | *4* |
| 1150 | *12* |
| 1200 | *13* |
| 1250 | *9* |
| 1300 | *9* |
| 1350 | *8.5* |
| 1400 | *8.5* |
| 1450 | *6* |
| 1500 | *6* |
| 1550 | *2* |
| 1600 | *2* |
| 1650 | *9* |
| 1700 | *10* |
| 1750 | *43* |
| 1800 | *25* |
| 1850 | |
| 1900 | |
| 1950 | |
| 2000 | |
| 2050 | |
| 2100 | |
| 2150 | |
| 2200 | |
| 2250 | |
| 2300 | |
| 2350 | |
| 2400 | |
| 2450 | |
| 2500 | |

| mm Driven | No. of Blows |
|---|---|
| 2550 | |
| 2600 | |
| 2650 | |
| 2700 | |
| 2750 | |
| 2800 | |
| 2850 | |
| 2900 | |
| 2950 | |
| 3000 | |
| 3050 | |
| 3100 | |
| 3150 | |
| 3200 | |
| 3250 | |
| 3300 | |
| 3350 | |
| 3400 | |
| 3450 | |
| 3500 | |
| 3550 | |
| 3600 | |
| 3650 | |
| 3700 | |
| 3750 | |
| 3800 | |
| 3850 | |
| 3900 | |
| 3950 | |
| 4000 | |
| 4050 | |
| 4100 | |
| 4150 | |
| 4200 | |
| 4250 | |
| 4300 | |
| 4350 | |
| 4400 | |
| 4450 | |
| 4500 | |
| 4550 | |
| 4600 | |
| 4650 | |
| 4700 | |
| 4750 | |
| 4800 | |
| 4850 | |
| 4900 | |
| 4950 | |
| 5000 | |




Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer

SC FijiSC2C.xlsx

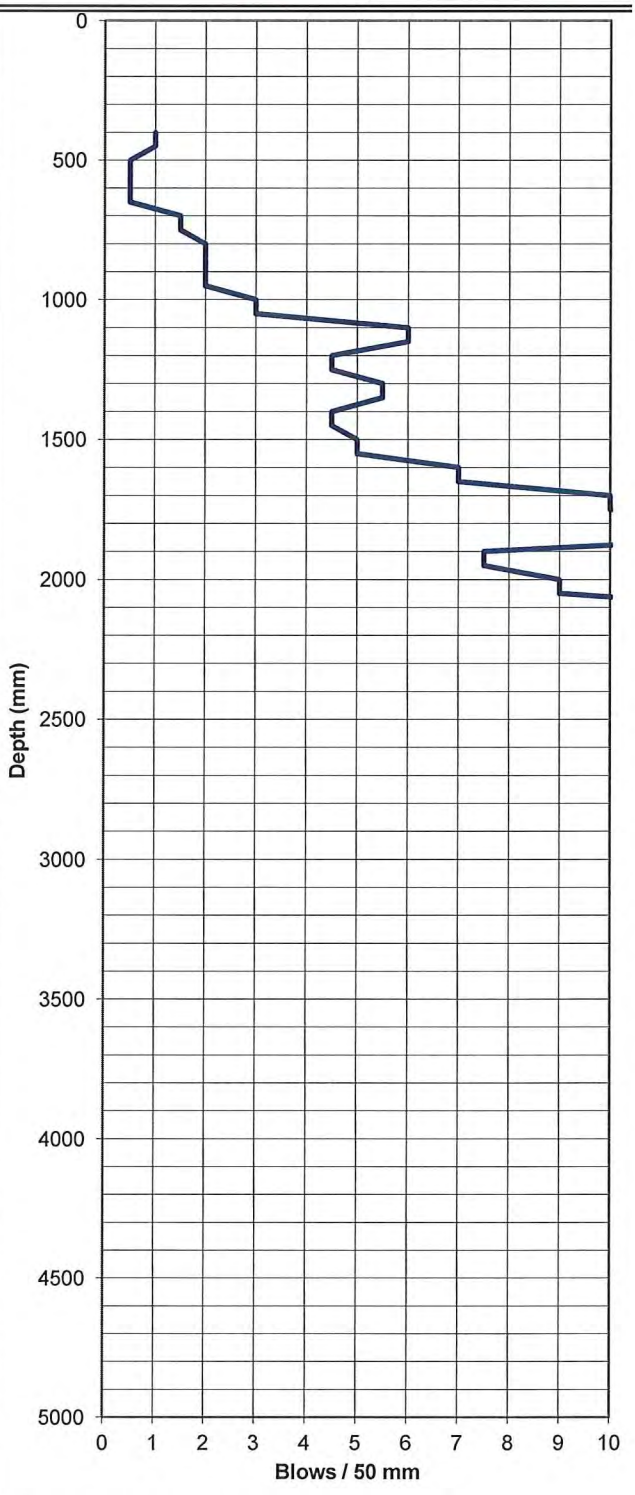
**TONKIN & TAYLOR**

# SCALA PENETROMETER LOG

| | | | | | |
|---|---|---|---|---|---|
| Job No: | *750942* | Date: | *9/01/2013* | **Test No.** | ***SC2C*** |
| Project: | *Improvement of Equipment for Disaster Risk Management* | Operated by: | *CJT* | | |
| | | Logged by: | *CJT* | **Sheet** | ***1*** |
| Location: | *Met Office Nadi* | Checked by: | *ADP* | **of** | ***1*** |

| mm Driven | No. of Blows |
|---|---|
| 50 | |
| 100 | |
| 150 | |
| 200 | |
| 250 | |
| 300 | |
| 350 | |
| 400 | 1 |
| 450 | 1 |
| 500 | 0.5 |
| 550 | 0.5 |
| 600 | 0.5 |
| 650 | 0.5 |
| 700 | 1.5 |
| 750 | 1.5 |
| 800 | 2 |
| 850 | 2 |
| 900 | 2 |
| 950 | 2 |
| 1000 | 3 |
| 1050 | 3 |
| 1100 | 6 |
| 1150 | 6 |
| 1200 | 4.5 |
| 1250 | 4.5 |
| 1300 | 5.5 |
| 1350 | 5.5 |
| 1400 | 4.5 |
| 1450 | 4.5 |
| 1500 | 5 |
| 1550 | 5 |
| 1600 | 7 |
| 1650 | 7 |
| 1700 | 10 |
| 1750 | 10 |
| 1800 | 13 |
| 1850 | 13 |
| 1900 | 7.5 |
| 1950 | 7.5 |
| 2000 | 9 |
| 2050 | 9 |
| 2100 | 13 |
| 2150 | 13 |
| 2200 | 19 |
| 2250 | 19 |
| 2300 | 19 |
| 2350 | 19 |
| 2400 | 17.5 |
| 2450 | 17.5 |
| 2500 | 14.5 |

| mm Driven | No. of Blows |
|---|---|
| 2550 | 14.5 |
| 2600 | 14.5 |
| 2650 | 14.5 |
| 2700 | 117 |
| 2750 | 17 |
| 2800 | 16 |
| 2850 | 16 |
| 2900 | 15.5 |
| 2950 | 15.5 |
| 3000 | 14 |
| 3050 | 14 |
| 3100 | 15 |
| 3150 | 15 |
| 3200 | 14 |
| 3250 | 14 |
| 3300 | 17.5 |
| 3350 | 17.5 |
| 3400 | 15 |
| 3450 | 15 |
| 3500 | 16.5 |
| 3550 | 16.5 |
| 3600 | 16.5 |
| 3650 | 16.5 |
| 3700 | 41 |
| 3750 | |
| 3800 | |
| 3850 | |
| 3900 | |
| 3950 | |
| 4000 | |
| 4050 | |
| 4100 | |
| 4150 | |
| 4200 | |
| 4250 | |
| 4300 | |
| 4350 | |
| 4400 | |
| 4450 | |
| 4500 | |
| 4550 | |
| 4600 | |
| 4650 | |
| 4700 | |
| 4750 | |
| 4800 | |
| 4850 | |
| 4900 | |
| 4950 | |
| 5000 | |




Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer

GEOTECHNICS
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Form No.: S4
Form Date: January 2004

**Plate No.:** Page of **Your Job No.:** 750942.000

**Site : Site A-Nadi Met Office, Site B-Suva Met Office and Site C-Vatudamu Met Office, Fiji** **Our Job No.:** 615990.000

**Test Method Used: NZS 4402:1986 Test 2.1 Determination of Water Content**

## WATER CONTENT TEST RESULTS

**Table 1: Water Content**

| Site: | | Site A-Nadi Met Office, Fiji | | Site B-Suva Met Office, Fiji | | Site C-Vatudamu Met Office, Fiji | |
|---|---|---|---|---|---|---|---|
| BH No.: | | 1A | 2A | 2B | 3B | 1C | 2C |
| Depth | (m) | 1.0-1.2 | 2.1-2.8 | 1.9-2.7 | 0.5-0.7 | 0.4-0.5 | 1.0-1.2 |
| Water Content | % | 33.6 | 35.6 | 43.0 | 32.6 | 51.9 | 55.5 |

**Remarks :** The water content reported to the nearest 0.1 %.

Tested by: ST Date: 27/2/13 Checked by: AJFG Date: 27/2/13

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Form No.: 84
Form Date: January 2004

Plate No.: Page of Your Job No.: 750942.000

Site : Site A-Nadi Met Office, Site B-Suva Met Office and Site C-Vatudamu Met Office, Fiji Our Job No.: 615990.000

Test Method Used: NZS 4402:1986 Test 2.7.2 Determination of Solid Density of Soil Particles by Vacuum

## SOLID DENSITY TEST RESULTS

**Table 1: Solid Density**

| Site: | Site A-Nadi Met Office, Fiji | | Site B-Suva Met Office, Fiji | | Site C-Vatudamu Met Office, Fiji | |
|---|---|---|---|---|---|---|
| BH No.: | 1A | 2A | 2B | 3B | 1C | 2C |
| Depth (m) | 1.0-1.2 | 2.1-2.8 | 1.9-2.7 | 0.5-0.7 | 0.4-0.5 | 1.0-1.2 |
| Av.Solid Density ($t/m^3$) | 2.84 | 2.83 | 2.73 | 2.74 | 2.82 | 2.82 |

**Remarks :** Solid density was performed on whole material.

The average solid density reported to the nearest 0.01 $t/m^3$.

Tested by: ST Date: 27/2/13 Checked by: AJFG Date: 27/2/13

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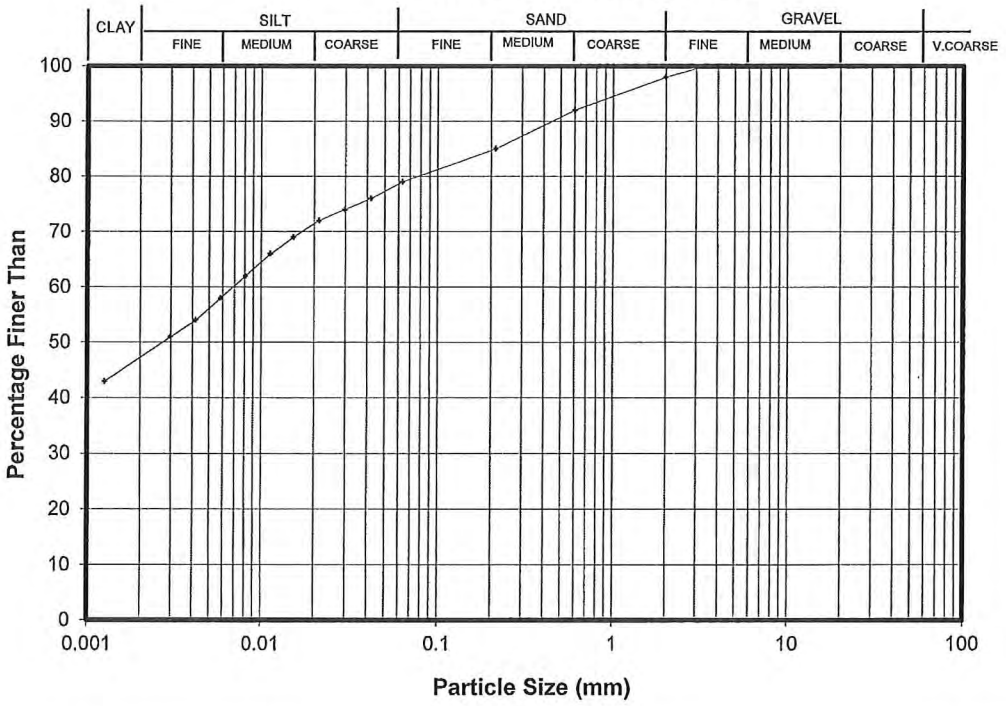
Form No.: P6
Form Date: January 2004
File: P:\615990.000\Working material\BH1A_1.0-1.2m_Hydro.xlsx

Plate No.: Page of Your Job No.: **750942.000**
Site: **Site A-Nadi Met Office, Fiji** Our Job No.: **615990.000**
BH No.: **1A** Sample ID.: --- Depth: **1.0-1.2 (m)**
Test Method Used : NZS 4402:1986 Test 2.8.4 Hydrometer

## PARTICLE SIZE ANALYSIS




| Sieve (mm) | Total % Passing | Sieve (mm) | Total % Passing |
|---|---|---|---|
| 4.75 | 100 | | |
| 3.35 | 100 | | |
| 2.00 | 98 | | |
| 0.600 | 92 | | |
| 0.212 | 85 | | |
| 0.063 | 79 | | |

| Equivalent Particle Diameter D (mm) | % of Particles Finer than D |
|---|---|
| 0.0418 | 76 |
| 0.0298 | 74 |
| 0.0212 | 72 |
| 0.0153 | 69 |
| 0.0113 | 66 |
| 0.0081 | 62 |
| 0.0058 | 58 |
| 0.0042 | 54 |
| 0.0030 | 51 |
| 0.0013 | 43 |

Sample history : As received.
Description: silty CLAY with some sand and trace of gravel, firm, red mixed with light grey/yellow, high plasticity.

Solid Density (Measured) : 2.84 t/m$^3$

Remarks : A sub sample was split from the original sample for hydrometer analysis. This sample was soaked with a dispersing agent (~2 hrs), then the mechanical shaker was used, until the material was brought into suspension, before proceeding with the test.
Suspension pH 8.0
The classification of gravel-sand-silt-clay components were described on the basis of particle size analysis.
Sample description is not IANZ endorsed.

Entered by : ST Date : 11/2/13 Checked by : MS Date : 11/2/13

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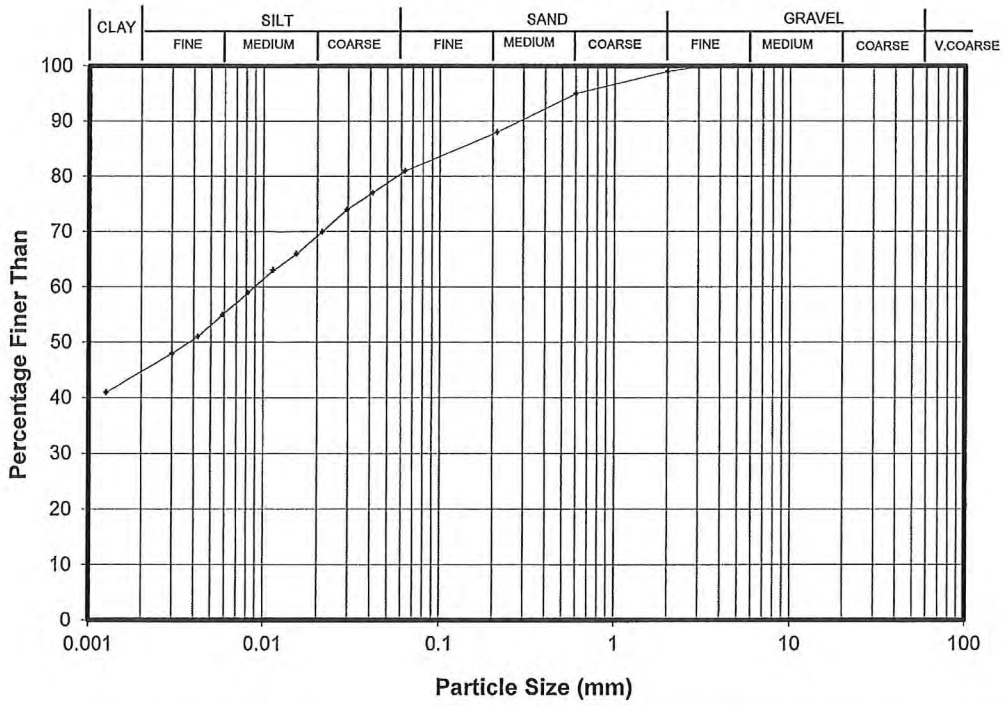
Form No.: P6
Form Date: January 2004
File: P:\615990.000\Working material\BH2A_2.1-2.8m_Hydro.xlsx

Plate No.: Page of Your Job No.: **750942.000**
Site: **Site A-Nadi Met Office, Fiji** Our Job No.: **615990.000**
BH No.: **2A** Sample ID.: --- Depth: **2.1-2.8 (m)**
Test Method Used : NZS 4402:1986 Test 2.8.4 Hydrometer

## PARTICLE SIZE ANALYSIS




| Sieve (mm) | Total % Passing | Sieve (mm) | Total % Passing |
|---|---|---|---|
| 4.75 | 100 | | |
| 3.35 | 100 | | |
| 2.00 | 99 | | |
| 0.600 | 95 | | |
| 0.212 | 88 | | |
| 0.063 | 81 | | |

| Equivalent Particle Diameter D (mm) | % of Particles Finer than D |
|---|---|
| 0.0412 | 77 |
| 0.0296 | 74 |
| 0.0213 | 70 |
| 0.0153 | 66 |
| 0.0114 | 63 |
| 0.0082 | 59 |
| 0.0059 | 55 |
| 0.0042 | 51 |
| 0.0030 | 48 |
| 0.0013 | 41 |

Sample history : As received.
Description: silty CLAY with some sand and trace of gravel, firm, red mixed with light grey, high plasticity.

Solid Density (Measured) : 2.83 t/m$^3$

Remarks : A sub sample was split from the original sample for hydrometer analysis. This sample was soaked with a dispersing agent (~2 hrs), then the mechanical shaker was used, until the material was brought into suspension, before proceeding with the test.
Suspension pH 8.0
The classification of gravel-sand-silt-clay components were described on the basis of particle size analysis.
Sample description is not IANZ endorsed.

Entered by : ST Date : 11/2/13 Checked by : MS Date : 11/2/13

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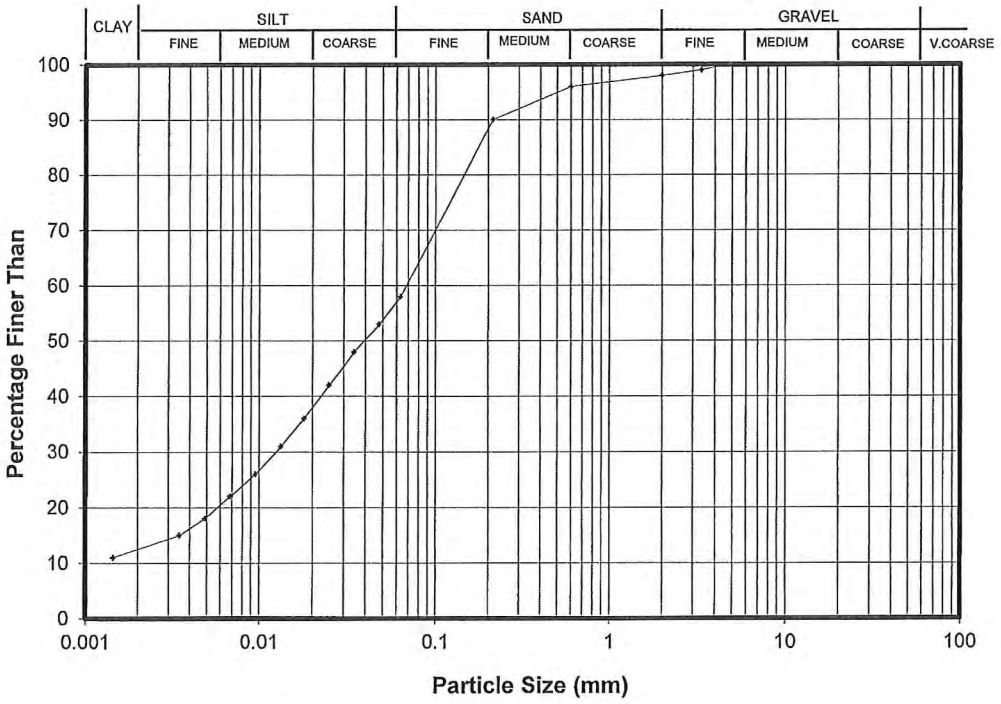
Form No.: P6
Form Date: January 2004
File: P:\615990.000\Working material\Site B_BH2B_1.9-2.7m_Hydro.xlsx

Plate No.: Page of Your Job No.: **750942.000**
Site: **Site B - Suva Met Office, Fiji** Our Job No.: **615990.000**
BH No.: **2B** Sample ID.: --- Depth: **1.9-2.7 (m)**
Test Method Used : NZS 4402:1986 Test 2.8.4 Hydrometer

## PARTICLE SIZE ANALYSIS




| Sieve (mm) | Total % Passing | Sieve (mm) | Total % Passing |
|---|---|---|---|
| 4.75 | 100 | | |
| 3.35 | 99 | | |
| 2.00 | 98 | | |
| 0.600 | 96 | | |
| 0.212 | 90 | | |
| 0.063 | 58 | | |

| Equivalent Particle Diameter D (mm) | % of Particles Finer than D |
|---|---|
| 0.0477 | 53 |
| 0.0344 | 48 |
| 0.0248 | 42 |
| 0.0179 | 36 |
| 0.0133 | 31 |
| 0.0095 | 26 |
| 0.0068 | 22 |
| 0.0049 | 18 |
| 0.0035 | 15 |
| 0.0014 | 11 |

Sample history : As received.
Description: sandy SILT with some clay and trace of gravel, firm, light yellowish brown mixed with light grey, mottled orange-dark red, medium-high plasticity, dilatant.
Solid Density (Measured) : 2.73 t/m$^3$

Remarks : A sub sample was split from the original sample for hydrometer analysis. This sample was soaked with a dispersing agent (~2 hrs), then the mechanical shaker was used, until the material was brought into suspension, before proceeding with the test.
Suspension pH 8.0
The classification of gravel-sand-silt-clay components were described on the basis of particle size analysis.
Sample description is not IANZ endorsed.

Entered by : ST Date : 27/2/13 Checked by : AJFC Date : 27/2/13

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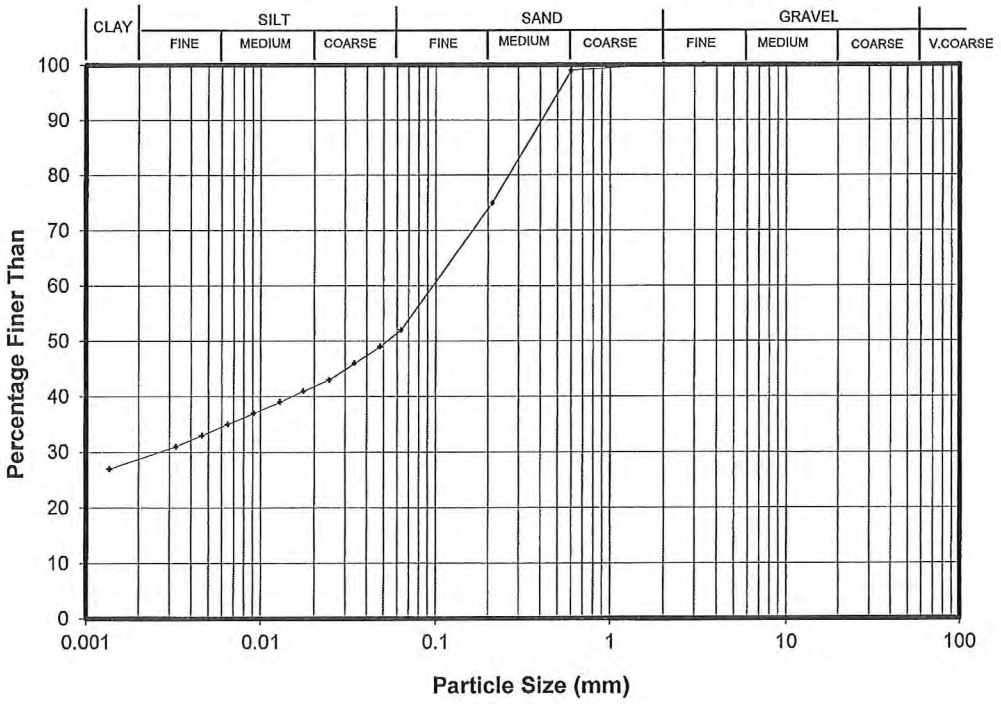
Form No.: P6
Form Date: January 2004
File: P:\615990.000\Working material\Site B_BH3B_0.5-0.7m_Hydro.xlsx

Plate No.: Page of Your Job No.: **750942.000**
Site: **Site B - Suva Met Office, Fiji** Our Job No.: **615990.000**
BH No.: **3B** Sample ID.: --- Depth: **0.5-0.7 (m)**
Test Method Used : NZS 4402:1986 Test 2.8.4 Hydrometer

## PARTICLE SIZE ANALYSIS




| Sieve (mm) | Total % Passing | Sieve (mm) | Total % Passing |
|---|---|---|---|
| 4.75 | --- | | |
| 3.35 | 100 | | |
| 2.00 | 100 | | |
| 0.600 | 99 | | |
| 0.212 | 75 | | |
| 0.063 | 52 | | |

| Equivalent Particle Diameter D (mm) | % of Particles Finer than D |
|---|---|
| 0.0478 | 49 |
| 0.0341 | 46 |
| 0.0244 | 43 |
| 0.0174 | 41 |
| 0.0128 | 39 |
| 0.0091 | 37 |
| 0.0065 | 35 |
| 0.0046 | 33 |
| 0.0033 | 31 |
| 0.0014 | 27 |

Sample history : As received.
Description: clayey silty SAND, firm, light yellowish brown, mottled orange-red, medium-high plasticity, dilatant.

Solid Density (Measured) : 2.74 t/m$^3$

Remarks : A sub sample was split from the original sample for hydrometer analysis. This sample was soaked with a dispersing agent (~2 hrs), then the mechanical shaker was used, until the material was brought into suspension, before proceeding with the test.
Suspension pH 8.0
The classification of sand-silt-clay components were described on the basis of particle size analysis. Sample description is not IANZ endorsed.

Entered by : ST Date : 27/2/13 Checked by : AJFG Date : 27/2/13

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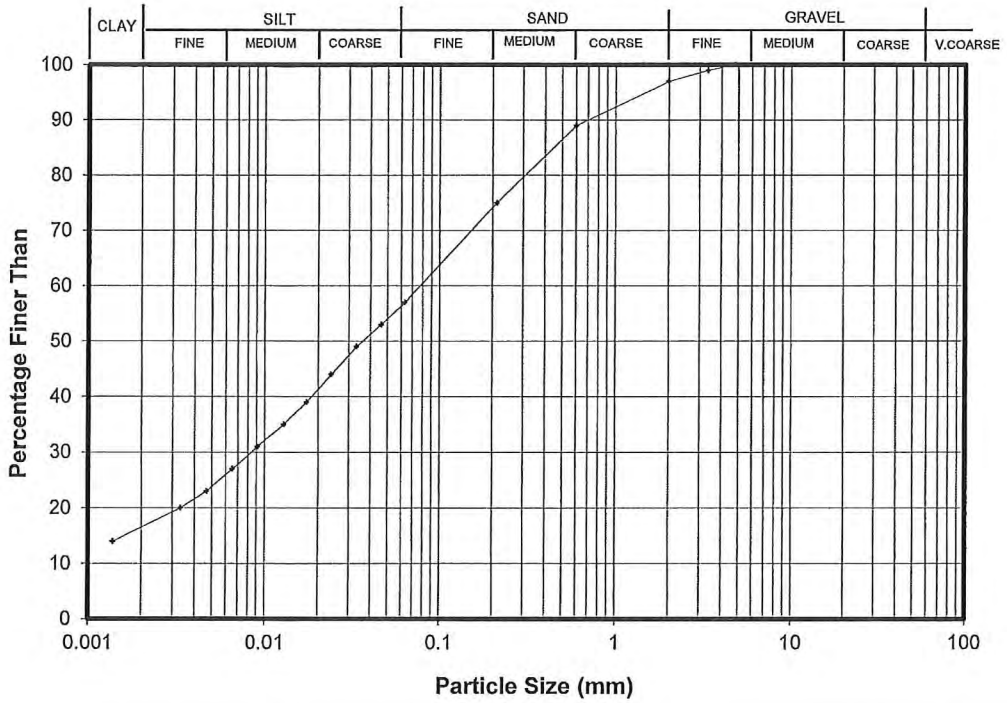
Form No.: P6
Form Date: January 2004
File: P:\615990.000\Working material\Site C_BH1C_0.4-0.5m_Hydro.xlsx

Plate No.: Page of Your Job No.: **750942.000**
Site: **Site C - Vatudamu Met Office, Fiji** Our Job No.: **615990.000**
BH No.: **1C** Sample ID.: --- Depth: **0.4-0.5 (m)**
Test Method Used : NZS 4402:1986 Test 2.8.4 Hydrometer

## PARTICLE SIZE ANALYSIS




| Sieve (mm) | Total % Passing | Sieve (mm) | Total % Passing |
|---|---|---|---|
| 4.75 | 100 | | |
| 3.35 | 99 | | |
| 2.00 | 97 | | |
| 0.600 | 89 | | |
| 0.212 | 75 | | |
| 0.063 | 57 | | |

| Equivalent Particle Diameter D (mm) | % of Particles Finer than D |
|---|---|
| 0.0461 | 53 |
| 0.0331 | 49 |
| 0.0238 | 44 |
| 0.0171 | 39 |
| 0.0127 | 35 |
| 0.0091 | 31 |
| 0.0065 | 27 |
| 0.0047 | 23 |
| 0.0033 | 20 |
| 0.0014 | 14 |

Sample history : As received.
Description: SAND-SILT with trace of gravel and some clay, firm, dark red, low to medium plasticity, dilatant.

Solid Density (Measured) : 2.82 t/m$^3$

Remarks : A sub sample was split from the original sample for hydrometer analysis. This sample was soaked with a dispersing agent (~2 hrs), then the mechanical shaker was used, until the material was brought into suspension, before proceeding with the test.
Suspension pH 8.0
The classification of gravel-sand-silt-clay components were described on the basis of particle size analysis.
Sample description is not IANZ endorsed.

Entered by : ST Date : 11/2/13 Checked by : MS Date : 11/2/13

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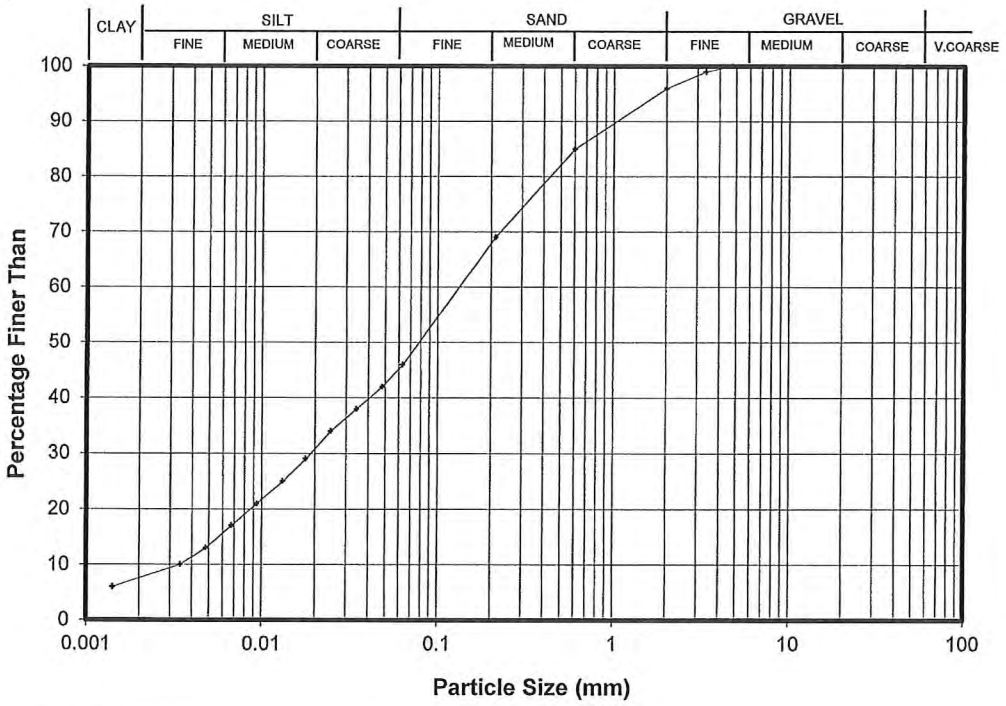
Form No.: P6
Form Date: January 2004
File: P:\615990.000\Working material\Site C_BH2C_1.0-1.2m_Hydro.xlsx

Plate No.: Page of Your Job No.: **750942.000**
Site: **Site C - Vatudamu Met Office, Fiji** Our Job No.: **615990.000**
BH No.: **2C** Sample ID.: --- Depth: **1.0-1.2 (m)**
Test Method Used : NZS 4402:1986 Test 2.8.4 Hydrometer

## PARTICLE SIZE ANALYSIS




| Sieve (mm) | Total % Passing | Sieve (mm) | Total % Passing |
|---|---|---|---|
| 4.75 | 100 | | |
| 3.35 | 99 | | |
| 2.00 | 96 | | |
| 0.600 | 85 | | |
| 0.212 | 69 | | |
| 0.063 | 46 | | |

| Equivalent Particle Diameter D (mm) | % of Particles Finer than D |
|---|---|
| 0.0480 | 42 |
| 0.0344 | 38 |
| 0.0246 | 34 |
| 0.0177 | 29 |
| 0.0131 | 25 |
| 0.0094 | 21 |
| 0.0067 | 17 |
| 0.0048 | 13 |
| 0.0034 | 10 |
| 0.0014 | 6 |

Sample history : As received.
Description: silty SAND with trace of gravel and minor clay, firm, red, low to medium plasticity, dilatant.

Solid Density (Measured) : 2.82 t/m$^3$

Remarks : A sub sample was split from the original sample for hydrometer analysis. This sample was soaked with a dispersing agent (~2 hrs), then the mechanical shaker was used, until the material was brought into suspension, before proceeding with the test.
Suspension pH 8.0
The classification of gravel-sand-silt-clay components were described on the basis of particle size analysis.
Sample description is not IANZ endorsed.

Entered by : ST Date : 11/2/13 Checked by : MS Date : 11/2/13