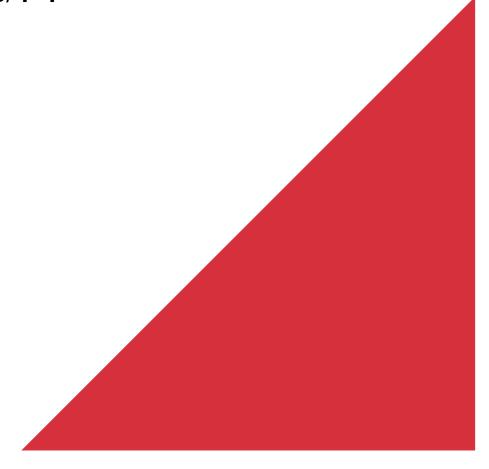


Watercare Services Limited

# **Woodlands Park Road Reservoirs**

**Geotechnical Factual Report** 

**GS13/424** 





### Watercare Services Limited

# Woodlands Park Road Reservoirs

# **Geotechnical Investigation Report**

GS13/424

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Date: Reference:

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Final

### **Contents**

| Site | e Location                | •••••• |
|------|---------------------------|--------|
| Inv  | estigations               | •••••  |
| 3.1  | Boreholes                 | •••••  |
| 3.2  | Dutch Cone Penetrometer's |        |
| 3.3  | Test Pits                 | •••••  |
| 3.4  | Hand Augers               |        |
| 3.5  | Laboratory Testing        | •••••  |
| 3.6  | Contamination Testing     |        |
| 3.7  | Groundwater Levels        |        |

# **Appendices**

- A Geotechnical Site Plan
- **B** Borehole Logs and Core Photographs
- C CPT Plots
- D Test Pit Logs and Photographs
- **E** Hand Auger Logs
- **F** Laboratory Testing Results
- **G** Contamination Testing Results

### 1 Introduction

Opus International Consultants Limited were commissioned by Watercare Services Limited to undertake a geotechnical investigation for the proposed Woodlands Park Road Reservoirs project.

The results of our geotechnical investigation are included in this factual report.

### 2 Site Location

The site is located west of Titirangi, Auckland as shown on the site plan included in Appendix A.

## 3 Investigations

### 3.1 Boreholes

Our geotechnical site investigation consisted of twelve fully cored HQ size machine boreholes at the locations briefed. Likewise as briefed, standard penetrometer tests (SPT's) were undertaken at 1.5 m intervals and push tube samples were taken for laboratory testing.

The drilling was undertaken by DrillForce Limited from the 16<sup>th</sup> of October to the 8<sup>th</sup> of November 2013.

The target depth of the boreholes as briefed was 15 m beneath ground level. Before the investigation commenced, it was agreed that BH13/08 be extended to 30 m+ depth to provide an indication of the site's deeper underlying geology. Piezometers were installed in BH13/02, 13/04, 13/07, 13/08 and 13/09.

All of the boreholes were logged in accordance with the NZGS *Guideline for the Field Classification* and *Description of Soil and Rock for Engineering Purposes*, December 2005.

The borehole locations are shown in the plan presented in Appendix A, borehole logs and corresponding core photographs are presented in Appendix B.

### 3.2 Dutch Cone Penetrometer's

Ten Dutch cone penetrometer's (CPT's) were undertaken at the locations briefed. The CPT's were undertaken by Ground Investigation Limited on the 5<sup>th</sup> and 6<sup>th</sup> of November 2013.

The CPT locations are shown in the plan presented in Appendix A, CPT plots are presented in Appendix C.

### 3.3 Test Pits

Six geotechnical test pits were carried out by DrillForce Limited on the 21<sup>st</sup> to the 23<sup>rd</sup> of November 2013 at the locations briefed.

The test pits were undertaken to simulate potential excavation conditions during construction of the proposed reservoir structures. Bulk samples were taken from each pit for laboratory testing if required. The test pit locations are shown in the plan presented in Appendix A, test pit logs and corresponding photographs are presented in Appendix D.

### 3.4 Hand Augers

Three hand augers were undertaken by the Opus Geotechnical Section on the 4<sup>th</sup> of November 2013. The hand auger locations were positioned in the centre of proposed reservoir footprints and were primarily undertaken to collect soil samples to be tested for contamination.

The hand auger locations are shown in the plan presented in Appendix A, hand auger logs are presented in Appendix E.

### 3.5 Laboratory Testing

Laboratory testing has been carried by Opus International Consultants Auckland Laboratory. Various core samples obtained from boreholes BH13/01, 13/03, 13/07 and 13/09 were tested.

| Borehole | Depth   | Test                            |
|----------|---------|---------------------------------|
| BH 13/01 | 3.0 m   | Plasticity Index                |
|          | 3.3 m   | One Dimensional Consolidation   |
|          | 3.35 m  | Consolidated Undrained Triaxial |
|          | 4.0 m   | Particle Size Distribution      |
|          | 6.7 m   | Unconfined Compressive Strength |
|          | 7.2 m   | Unconfined Compressive Strength |
|          | 9.4 m   | Unconfined Compressive Strength |
|          | 11.55 m | Unconfined Compressive Strength |
| BH 13/03 | 3.0 m   | Plasticity Index                |
|          | 3.25 m  | Consolidated Undrained Triaxial |
|          | 3.4 m   | One Dimensional Consolidation   |
|          | 4.2 m   | Plasticity Index                |
|          | 6.0 m   | Plasticity Index                |
|          | 6.35 m  | Consolidated Undrained Triaxial |
|          | 10.5 m  | Plasticity Index                |
|          |         |                                 |
| BH 13/07 | 3.0 m   | Plasticity Index                |
|          | 3.25 m  | One Dimensional Consolidation   |
|          | 3.35 m  | Consolidated Undrained Triaxial |
|          | 6.15 m  | UCS                             |

| Borehole | Depth  | Test                            |
|----------|--------|---------------------------------|
| BH 13/09 | 3.0 m  | Plasticity Index                |
|          | 3.3 m  | One Dimensional Consolidation   |
|          | 3.38 m | Consolidated Undrained Triaxial |
|          | 6.0 m  | Plasticity Index                |
|          | 6.3 m  | One Dimensional Consolidation   |
|          | 6.35 m | Consolidated Undrained Triaxial |
|          | 9.45 m | Plasticity Index                |

The results are presented in Appendix F.

### 3.6 Contamination Testing

Contamination testing was undertaken on six soil samples collected from the hand auger investigation. The testing was carried out by Hill Laboratories Limited on the 7<sup>th</sup> of November 2013. The soil samples were tested for hydrocarbons and heavy metals.

The results of the contamination testing are presented in Appendix G.

### 3.7 Groundwater Levels

The groundwater levels in boreholes BH13/02, 13/04, 13/07, 13/08 and 13/09 were measured by Opus on the  $19^{th}$  of November 2013.

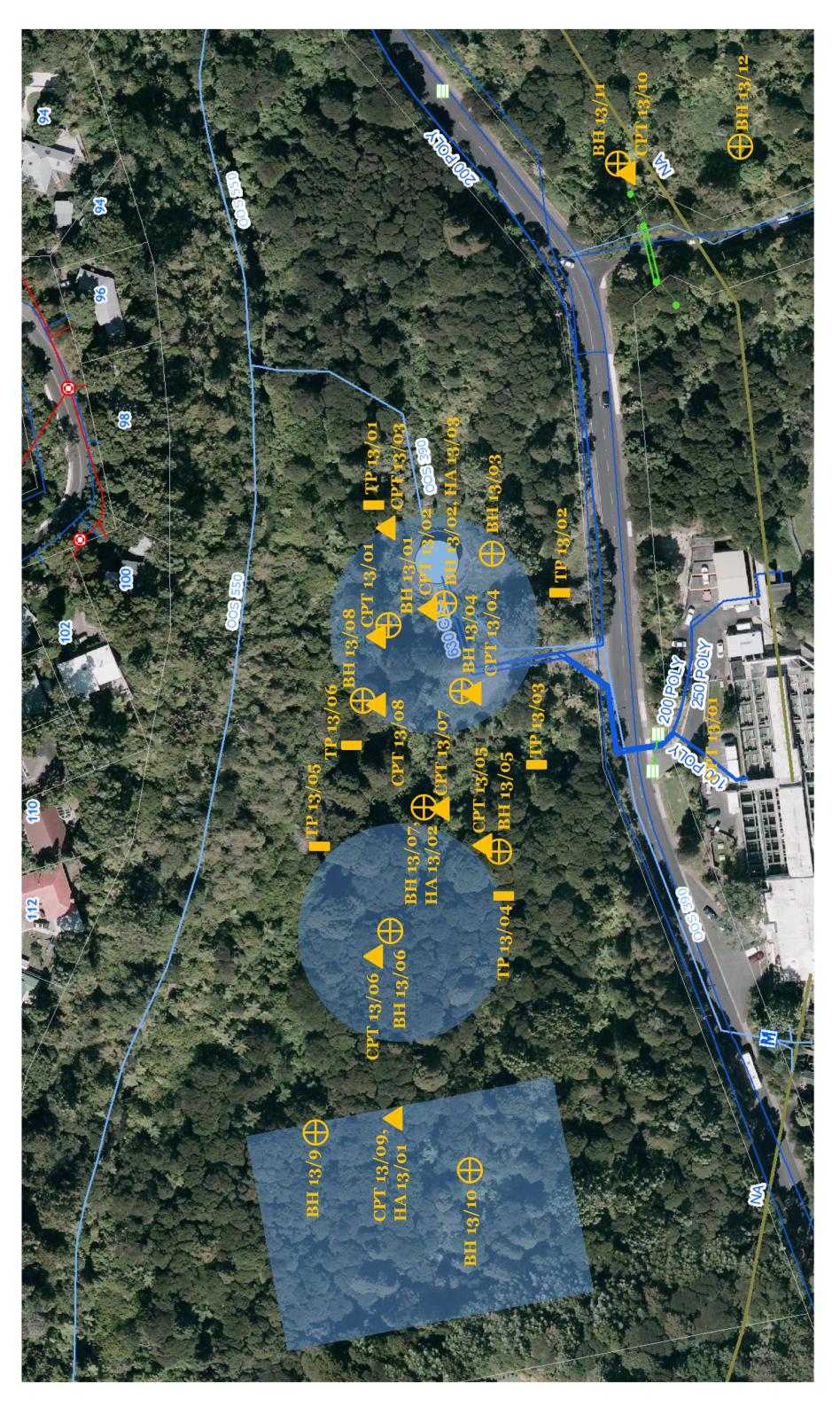
The groundwater levels are presented on each respective borehole logs in Appendix B.

### 4 Limitations

The results presented in this report are taken from tests undertaken at discreet locations. Ground conditions may change suddenly over short distances resulting in variations between positions or across the site.

This report has been prepared for the benefit of the Watercare Services Limited, for the purpose of providing geotechnical factual information for the proposed Woodlands Park Road Reservoirs. It is not to be relied upon or used out of context by any other person without further reference to the Auckland Geotechnical Section of Opus International Consultants.

# Appendix A Geotechnical Site Plan



# Manuka Road Reservoirs- Proposed Investigations

(Revision 2: CPT added at rectangular tank site, BH13/12 moved south)

BH = Borehole (nominally 15 m deep, except BH 13/08 at 30 m) CPT = Cone penetration test (to refusal)

TP = Trial pit (2 m to 4 m deep depending on requirements)

All investigation sites approximate only- to be located on site by measurement. Test sites that are inaccessible (e.g. due to terrain or water) will be relocated nearby.

Note

# Appendix B Borehole Logs & Core Photographs



|                        |                        |                | HOLE NO.       |
|------------------------|------------------------|----------------|----------------|
| BOREHOLE LO            | CO-ORD.   R.L.   SHEET |                |                |
| PROJECT                | CO-ORD.                | R.L.           | SHEET          |
| Manuka Road Reservoirs | 1746085 E 5910825 N    | 124.69 m       | 1 of 2         |
| LOCATION               | REF. GRID              | DATUM          |                |
| See Site Plan          | SM 6472 SO 61159       | MSL Akld. 1946 | LENGTH 15.19 m |

|                    |  |           |   |                  |               | See Site                             | Plan          |                    |                |               |                                      | SM 6472 SO  | 6115    | 59                         | N           | ISL A                   | kld. 1                 | 946    | LENGT                         | 15.        | .19      |
|--------------------|--|-----------|---|------------------|---------------|--------------------------------------|---------------|--------------------|----------------|---------------|--------------------------------------|---|---------|----------------------------|-------------|-------------------------|------------------------|--------|-------------------------------|------------|----------|
|                    |  |           |   |                  | 1             | ESTS                                 | Ŧ             |                    | 9<br>P         |               |                                      |   |         | CORE                       |             |                         | DRII                   | LING   |                               |            |          |
| GEOLOGY/UNIT       | MAIN DESCRIPTION   | R.L. (m)  | DET IN (III)                            | GRAPHIC LOG      | SPT 'N' VALUE | SPT BLOW<br>COUNTS OR<br>SHEAR VALUE | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIP<br>degree | s DETA                               | ILED DESCRIPTION  | RQD (%) | TOTAL CORE<br>RECOVERY (%) | SAMPLE TYPE | DRILLING                | DRILLING<br>FLUID LOSS | CASING | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER |          |
|                    | Clayey SILT; greyish brown streaked orange, firm, plastic.   |           | _×-                                     | <u>×</u> × ×     |               |                                      |               |                    |                |               |                                      |   |         |                            |             |                         |                        |        |                               |            | Ť        |
|                    | Trace manganese staining from 0.30m.   |           | -×-                                     | ~ <del>×</del> ; |               |                                      |               |                    |                |               |                                      |   |         |                            |             |                         |                        |        |                               |            |          |
|                    | Cl AV. with trace all light grounds along  | _124      | *                                       | * * *            |               |                                      |               |                    |                |               |                                      |   |         | 400                        |             | Auger                   |                        |        |                               |            |          |
|                    | CLAY; with trace silt, light grey streaked<br>orange, stiff, plastic.  |           | ŧ                                       |                  |               |                                      |               |                    |                |               |                                      |   |         | 100                        | HA          | Hand Auger              |                        |        |                               |            |          |
|                    | Some silt and trace manganese staining   | 1         | Œ                                       |                  |               |                                      |               |                    |                |               |                                      |   |         |                            |             |                         |                        |        |                               |            |          |
|                    | from 1.10m.  |           | 圭                                       |                  |               |                                      |               |                    |                |               |                                      |   |         |                            |             |                         |                        |        |                               |            |          |
| Colluviuii         | Occasional lenses of fine sandy silt and fine angular gravel from 1.60m.   | -         | E                                       |                  | 6             | 1//1/1/2/2                           |               |                    |                |               |                                      |   |         | 100                        | SPT         |                         |                        |        |                               |            |          |
|                    | angulai gravei nom 1.60m.  | 2         | ,£                                      |                  |               |                                      |               |                    |                |               |                                      |   |         |                            |             |                         |                        |        |                               |            |          |
|                    |  |           | `E                                      |                  |               |                                      |               |                    |                |               |                                      |   |         |                            |             |                         |                        |        |                               |            |          |
|                    |  |           | £                                       |                  |               |                                      |               |                    |                |               |                                      |   |         | 67                         | HQ          |                         |                        |        |                               |            |          |
|                    |  | _122      | ŧ                                       |                  |               |                                      |               |                    |                |               |                                      |   |         |                            |             |                         |                        |        |                               |            |          |
|                    | CLAY; with trace silt, brownish grey<br>streaked orange, stiff, plastic, some fine<br>angular silt fragments, some lenses of | ] 3       | 3==                                     |                  |               |                                      |               |                    |                |               |                                      |   |         |                            |             |                         |                        |        |                               |            |          |
|                    | sandy silt.  |           | Ē                                       |                  |               |                                      |               |                    |                |               |                                      |   |         | 100                        | PT          |                         |                        |        |                               |            |          |
|                    | Silty fine SAND; greyish brown streaked  |           |   |                  |               |                                      |               |                    |                |               |                                      |   |         |                            |             |                         |                        |        |                               |            |          |
|                    | orange, medium dense, brittle, occasional<br>1-3mmØ angular mudstone fragments.  | F         | ×                                       | ×                | 10            | 3//1/3/3/3                           |               |                    |                |               |                                      |   |         | 100                        | SPT         |                         |                        |        |                               |            |          |
|                    |  | 4         | ×                                       | ×                |               |                                      |               |                    |                |               |                                      |   |         |                            |             |                         |                        |        |                               |            |          |
|                    | Fine to medium sand and some sub-rounded gravels from 4.20m.   |           | - ×                                     | ×                |               |                                      |               |                    |                |               |                                      |   |         | 100                        | HQ          |                         |                        |        |                               |            |          |
|                    | Sub rounded gravels from 4.25m.  | 100       | ×                                       | ×                |               |                                      |               |                    |                |               |                                      |   |         |                            |             |                         |                        |        |                               |            |          |
|                    |  | _120      | _ ×                                     | ×                | 30            | 5//4/5/8/13                          |               |                    |                |               |                                      |   |         | 82                         | SPT         |                         |                        |        |                               |            |          |
|                    | Becomes weakly cemented to 5.80m with 0.5-1cmØ angular silt fragments from   | 5         | 5-]×                                    | ×                |               |                                      |               |                    |                |               |                                      |   |         |                            |             |                         |                        |        |                               |            |          |
|                    | 4.95m.   |           |   | ×                |               |                                      |               |                    |                |               |                                      |   |         |                            |             | line                    |                        |        |                               |            |          |
|                    |  |           | _ ×                                     | ×                |               |                                      |               |                    |                |               | Relict frac                          | ture, very steeply  |         | 69                         | HQ          | e Wir                   |                        |        |                               |            |          |
|                    |  |           | ]×                                      | ×                |               |                                      |               |                    |                |               | inclined di<br>clay coatii           | ture, very steeply<br>p; undulating, rough,<br>ig from 5.60m to 5.70m.          |         |                            |             | 4Q Triple Tube Wireline |                        |        |                               |            |          |
|                    |  | 6         | )<br> <br> <br>                         | ×                | 50+           | <br> 17//17/20/13<br>  for 30mm      |               |                    |                |               |                                      |   |         | 100                        | SPT         | Δ Trip                  |                        |        |                               |            |          |
| alloll             | Fine to coarse SANDSTONE; brownish grey, very weak, moderately weathered,  |           | +                                       | .× .             |               |                                      |               |                    |                |               | Fracture                             | steeply inclined dip;   |         |                            |             | -                       |                        |        |                               |            |          |
| Ninotupu Formation | some 1-3mmØ sub-rounded to angular gravel.   | _118      | 3                                       |                  |               |                                      |               |                    |                |               | planar, ro<br>from 6.40<br>Fracture. | ugh, manganese coating<br>in to 6.50m.<br>moderately inclined dip:              |         |                            |             |                         |                        |        |                               |            |          |
| ndn:               |  | 7         | - :::<br> -:::<br> -:::                 |                  |               |                                      | VW            | MW                 |                |               | undulating                           | , rough, clay coating at  | 84      | 100                        | HQ          |                         |                        |        |                               |            |          |
|                    |  | '         | -                                       |                  |               |                                      |               |                    |                |               | III Fracture 7                       | steeply inclined dip;<br>ough, manganese<br>6.90m.<br>one, multiple moderately  |         |                            |             |                         |                        |        |                               |            |          |
|                    |  |           | <u></u>                                 |                  | 50+           | 50 for 150mm                         |               |                    |                |               | Two fractu                           | ps; rough, manganese<br>om 7.00m to 7.25m.<br>ires, moderately inclined         |         |                            |             |                         |                        |        |                               |            |          |
|                    | Fine to coarse SANDSTONE; light grey, very weak, slightly weathered, some  | -         | -                                       |                  |               | 150mm<br> <br>                       |               |                    |                |               |                                      | ar, rough, manganese<br>7.30m and 7.50m.  |         | 100                        | SPT         |                         |                        |        |                               |            |          |
|                    | 1-3mmØ sub-rounded to angular gravel.  | 8         | 3-1::                                   |                  |               |                                      |               |                    |                |               | Fracture,<br>planar, ro<br>7.80m.    | steeply inclined dip;<br>ugh, limonite staining at                              |         |                            |             |                         |                        |        |                               |            |          |
|                    |  |           | ======================================= |                  |               |                                      | VW            | SW                 |                |               |                                      |   | 00      | 400                        |             |                         |                        |        |                               |            |          |
|                    |  |           | 4                                       |                  |               |                                      |               |                    |                |               | Fracture, planar, ro 7.80m.          | steeply inclined dip;<br>ugh, limonite staining at                              | 86      | 100                        | HQ          |                         |                        |        |                               |            |          |
|                    | Becomes fine to medium grained with occasional 1-3mmØ sub-rounded to angular   | _116      | ======================================= |                  |               |                                      |               |                    |                |               |                                      | / spaced fractures,   |         |                            |             |                         |                        |        |                               |            |          |
|                    | gravel.  Becomes moderately weathered and brownish grey from 8.70m.  | 9         | ,=                                      |                  | E0:           | 28//38/12                            | VW            | MW                 |                |               | rough, lim<br>8.70m to               | y spaced fractures,<br>y inclined dips; planar,<br>onite coating from<br>9.00m. |         |                            |             |                         |                        |        |                               |            |          |
|                    | Fine SANDSTONE; light bluish grey, very  | -         | ======================================= |                  | 50+           | for 15mm<br>N=50+                    |               |                    |                |               | Frontier                             | cently inclined dis-  |         | SC                         | SPT         |                         |                        |        |                               |            |          |
|                    | weak, slightly weathered.  |           | ======================================= |                  |               |                                      | VW            | SW                 |                |               | planar, ro                           | gently inclined dip;<br>ugh, limonite staining.                                 |         | 100                        |             |                         |                        |        |                               |            |          |
|                    | CLAY; greenish grey, hard, plastic.  | -         | 1                                       |                  |               |                                      |               |                    |                |               | Rodding                              | lane, gently inclined dip;  | 62      | 100                        | HQ          |                         |                        |        |                               |            |          |
|                    | (SEXT, greenish grey, hard, plastic.   |           | 1                                       |                  |               |                                      |               |                    |                |               | planar at s                          | 9.80m.  |         |                            |             | En.                     | IOLIES                 |        |                               |            | <u>_</u> |
|                    | FES hole was backfilled upon completion.   |           |   |                  |               |                                      |               |                    |                |               |                                      | 29/10/20  | 013     |                            |             |                         | ISHED                  |        | /10/20                        | 13         | _        |
|                    |  |           |   |                  |               |                                      |               |                    |                |               |                                      | DRILLER Glen INCLINATION/   |         |                            |             |                         | LLING C                | Dril   | lforce                        | Ltd        |          |
|                    |  |           |   |                  |               |                                      |               |                    |                |               |                                      | AZIMUTH -90°<br>LOGGED  |         |                            |             |                         | ECKED                  | 7      | Fracto                        | ·<br>      | _        |
| OGG                | ED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005)   | GUIDFI IN | FS                                      |                  |               | SFF ATTA                             | CHED K        | FY SHFF            | T FOR F        | KPI ANATI     | ION OF SYMBOLS                       | T Van De  |         |                            |             |                         | A (                    | Georg  |                               | BH1        | 3/       |
|                    | .33  | LIIV      |   |                  |               | JEENIN                               |               | . or ILL           | . 511 🗀        | 200111        |                                      | Watercare Servi   | ces l   | _imited                    | 1           |                         | 1-C                    | 0935.  | 25                            |            |          |

|          | NOTES   |  | STARTED      |                       | FINISHED      |          |
|----------|---|--|--------------|-----------------------|---------------|----------|
| 2        |   |  |              | 29/10/2013            | 29/10/2013    | 3        |
| 21       | Borehole was backfilled upon completion.                            |  | DRILLER      |                       | DRILLING CO.  |          |
|          |   |  |              | Glen                  | Drillforce Lt | d        |
| 3        |   |  | INCLINATION/ |                       | DRILLING RIG  |          |
| 31       |   |  | AZIMUTH      | -90°                  | Tractor       |          |
| 1        |   |  | LOGGED       |                       | CHECKED       |          |
| <u> </u> |   |  |              | T Van Deelen          | A George      | BH13/01  |
| į        | LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) GUIDELINES | SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS  | CLIENT       |                       | JOB NO.       | DI113/01 |
| 21       | EGGGED IN ACCOMDANCE WITH NZ GEOTECHNICAE GOGLETT (2003) GOIDEEINES | SEE ATTACHED RET SHEETT ON EXPENNATION OF STIMBOLS | Water        | care Services Limited | 1-C0935.25    |          |



| BOREHOLE               | LOG              |               | BH13/01        |
|------------------------|------------------|---------------|----------------|
| PROJECT                | CO-ORD.          | R.L.          | SHEET          |
| Manuka Road Reservoirs | 1746085 E 59108  | 25 N 124.69 m | 2 of 2         |
| LOCATION               | REF. GRID        | DATUM         | HOLE           |
| See Site Dian          | SM 6472 SO 61150 | MSI VNY 1046  | LENGTH 15 10 m |

|              |  |             |             |    |                                       |               |                    |                |               |   |  | 1       |                            |             | _                       |                     |                    |                               |                       | 5.19         |
|--------------|--|-------------|-------------|----|---------------------------------------|---------------|--------------------|----------------|---------------|---|--|---------|----------------------------|-------------|-------------------------|---------------------|--------------------|-------------------------------|-----------------------|--------------|
| GEOLOGY/UNIT | MAIN DESCRIPTION   | R.L. (m)    | GRAPHIC LOG |    | SPT BLOW COUNTS OR SHEAR VALUE        | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIP<br>degree | s <b>DETA</b> l   | LED DESCRIPTION  | RQD (%) | TOTAL CORE OO BACOVERY (%) | SAMPLE TYPE | DRILLING                | S                   | CASING             | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER<br>DETAILS |              |
|              | Fine SAND; greenish grey, dense, brittle, moderately cemented.   |             |             |    | <br>                                  |               |                    |                |               | Multiple rel<br>steeply inc<br>rough, trac<br>coating fro | ict fractures, gently to<br>ined dips; planar,<br>e clay and limonite<br>n 9.85m to 11.00m.  | 62      | 100                        | HQ          |                         |                     |                    |                               |                       |              |
|              |  | _114        |             | 50 | 1<br>18//14/15/12/<br>1 for 55mm<br>1 | 9             |                    |                |               |   |  |         | sc                         | SPT         |                         |                     |                    |                               |                       |              |
|              | Fine to medium SANDSTONE; greenish grey, very weak, unweathered to slightly weathered, occasional 1-2mmØ angular gravel. | 11<br>-     |             |    |                                       |               |                    |                |               | Fracture, g<br>planar, rou<br>limonite co                 | ently inclined dip;<br>gh, trace silt and<br>ating at 11.00m.  | 84      | 100                        | HQ          |                         |                     |                    |                               |                       |              |
| uo           |  | 12          | <u>-</u>    | 50 | 26//50 for 25mm                       |               |                    |                |               |   |  |         | SC                         | SPT         | ine                     |                     |                    |                               |                       | Alle Control |
| <u> </u>     | Progressively grades into some 1-4mmØ angular gravel by 13.00m.  Fine SANDSTONE; dark grey, very weak, unweathered.      | _112        |             |    |                                       | vw            | UW                 |                |               |   |  | 100     | 100                        | HQ          | HQ Triple Tube Wireline |                     |                    |                               |                       |              |
|              |  |             | <u></u>     | 50 | <br> <br>  50 for<br>  125mm          |               |                    |                |               |   |  |         | SC                         | SPT         |                         |                     |                    |                               |                       |              |
|              | Progressively grades into a fine to medium grained sandstone with some 1-2mmØ  | 14          | -           |    |                                       |               |                    |                |               |   |  | 98      | 100                        | HQ          |                         |                     |                    |                               |                       |              |
|              | angular gravel by 14.40m.  | _110        |             |    | <br> <br> <br> <br>                   |               |                    |                |               |   | es, moderately inclined<br>r, rough, dark greenish<br>gs at 14.40m.<br>ently inclined dip;<br>rough, dark greenish<br>g at 14.80m. |         |                            |             |                         |                     |                    |                               |                       |              |
| 4            |  | 15          | 5-          | 50 | 20//50 for<br>40mm                    |               |                    |                |               | grey coatin   | g at 14.80m.   |         | SC                         | SPT         |                         |                     |                    |                               |                       | :            |
|              | End of Borehole at 15.19m.   | 108         |             |    |                                       |               |                    |                |               |   |  |         |                            |             |                         |                     |                    |                               |                       |              |
| NOT          |  |             | •           |    | •                                     |               | •                  |                |               |   | STARTED 29/10/2  | 013     |                            |             |                         | ISHED               |                    | /10/20                        | 13_                   | _            |
| 3oreh        | ole was backfilled upon completion.  |             |             |    |                                       |               |                    |                |               |   | Oriller<br>Glei  |         |                            |             |                         | LLING C             | Co.<br><b>Dril</b> | lforce                        |                       |              |
|              |  |             |             |    |                                       |               |                    |                |               | _   | NCLINATION/<br>AZIMUTH -90°<br>-OGGED  |         |                            |             |                         | LLING F             | 1                  | Tracto                        |                       |              |
| OGGE         | D IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) 0  | SI IIDEI IN | FS          |    | SEE ATT                               | ACHED »       | EA SHEE            | TEOPE          | (ΡΙ ΔΝΙΛΤ     |   | T Van De Trient Watercare Serv   |         |                            |             | JOE                     | A (<br>B No.<br>1-C | Georg              | je                            | ВН1                   | 3/0          |

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| BH13/01  |
| DH 13/01 |
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Watercare Services Limited

Borehole 13/01





0.00m – 3.00m



3.00m – 6.10m Box 2 of 5

Watercare Services Limited

Borehole 13/01





6.10m – 8.90m Box 3 of 5



8.90m – 12.50m Box 4 of 5

| Manuka Reservoirs          |  |
|----------------------------|--|
|                            |  |
| Watercare Services Limited |  |
| Borehole 13/01             |  |



12.50m – 15.19m (E.O.H)

Box 5 of 5



|          |                        |                   |               | HOLE NO.                                     |   |
|----------|------------------------|-------------------|---------------|--|---|
|          | BOREHOLE LO            | OG                |               | BH13/02                                      | 2 |
| PROJECT  |                        | CO-ORD.           | R.L.          | SHEET  |   |
|          | Manuka Road Reservoirs | 1746091 E 5910813 | N 127.10 m    | 1 of 2                                       |   |
| LOCATION |                        | REF. GRID         | DATUM         | HOLE   |   |
|          | 0 0' . DI              | 014 0470 00 04450 | MOL ALL: 4040 | LENGTH 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 |   |

| _                                       |  |          |   | -                                       | _             | ESTS                                 | 픋             |                    | Ŋ.             |     |              |   | -                |         | CORE                       | -           |                         | DRI                    | LLING       |                               | -                     |   |
|---|--|----------|---|---|---------------|--------------------------------------|---------------|--------------------|----------------|-----|--------------|---|------------------|---------|----------------------------|-------------|-------------------------|------------------------|-------------|-------------------------------|-----------------------|---|
| GEOLOGY/UNIT                            | MAIN DESCRIPTION   | R.L. (m) | DEPTH (m)   |   | SPT 'N' VALUE | SPT BLOW<br>COUNTS OR<br>SHEAR VALUE | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIF |              | ILED DESCRIP  | TION             | RQD (%) | TOTAL CORE<br>RECOVERY (%) | SAMPLE TYPE | DRILLING                | DRILLING<br>FLUID LOSS | CASING      | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER<br>DETAILS |   |
| Fill                                    | Silty CLAY; brown streaked greyish brown and orange, firm, plastic, inclusions of 3cmØ angular, grey, gravel.  | _        | -   |   |               |                                      |               |                    |                |     |              |   |                  |         |                            |             |                         |                        |             |                               |                       |   |
| E S S S S S S S S S S S S S S S S S S S | CLAY; with trace silt, brownish grey<br>streaked dark orange, firm, plastic.<br>Clayey SILT; light brownish grey streaked<br>orange, firm, plastic.  | _126     | 1   |   |               |                                      |               |                    |                |     |              |   |                  |         | 100                        | НА          | Hand Auger              |                        |             |                               |                       |   |
|   | SILT; with trace fine sand, brownish grey, firm, brittle, trace fine angular silt fragments.   |          | -  ×<br>-  ×<br>-  ×<br>-  ×<br>-  ×<br>-  ×<br>2-  × | × , × , × , × , × , × ,                 | 2             | 1//0/1/0/1                           |               |                    |                |     |              |   |                  |         | 53                         | SPT         |                         | -                      |             |                               |                       |   |
|   | Trace limonite staining, trace clay, becomes slightly plastic from 2.40m.  Some lenses of grey and pink fine sandy   |          |   | × ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; |               |                                      |               |                    |                |     |              |   |                  |         | 76                         | HQ          |                         |                        |             |                               | 661 (2013)            |   |
|   | Some lenses of grey and pink fine sandy silt, and brownish orange silty fine to medium sand from 2.70m.  | _124     | 3   | × }<br>× }<br>× }                       | <br>          |                                      |               |                    |                |     |              |   |                  |         | 100                        | PT          |                         |                        |             |                               |                       |   |
|   | SILT: with some clay, brownish grey<br>streaked orange, very stiff, slightly plastic,<br>some pockets of orange brown fine to<br>medium sandy silt, trace limonite and<br>manganese streaks. | _        | 4   | × , , , , , , , , , , , , , , , , , , , | 8             | 3//2/1/2/3                           |               |                    |                |     |              |   |                  |         | 69                         | SPT         |                         |                        |             |                               |                       |   |
|   | Silty fine SAND; with trace fine angular<br>\gravels, dark brown, loose, brittle.<br>Fine sandy SILT; with trace clay, yellowish<br>brown, firm to stiff, slightly plastic,                  |          | -X X X X X X X X X X X X X X X X X X X                | × × × × × × × × × × × × × × × × × × ×   | 4             | 1//0/1/2/1                           |               |                    |                |     |              |   |                  |         | 58                         | HQ<br>SPT   |                         |                        |             |                               |                       |   |
| Colluvium                               |  | _122     | 5   | × × × × × × × ×                         |               |                                      |               |                    |                |     |              |   |                  |         | 58                         | HQ          | 4Q Triple Tube Wireline |                        |             |                               |                       |   |
|   |  | _        | 6 - × × × × × × × × × × × × × × × × × ×               | × × × × × × × × × × × × × × × × × × ×   | 8             | 1//1/2/3/2                           |               |                    |                |     |              |   |                  |         | 0                          | SPT         | HQ Triple               |                        |             |                               |                       |   |
|   | SILT; with trace fine sand and trace clay, greyish brown streaked orange, hard,  | _120     | 7-×-×<br>-×-×<br>7-×-×<br>-×-×-×<br>-×-×-×            | × ;                                     |               |                                      |               |                    |                |     |              |   |                  |         | 100                        | HQ          |                         |                        |             |                               |                       |   |
|   | slightly plastic, grading into a silty fine SAND; loose, brittle by 7.85m.  SILT; with some clay, light grey, hard, slightly plastic, with trace fine to medium                              |          |   | × }<br>× }<br>× }                       | 14            | 4//5/3/3/3                           |               |                    |                |     |              |   |                  |         | 100                        | SPT         |                         |                        |             |                               |                       |   |
|   | angular gravel and lenses of silty fine to medium sand.  |          | -× × -× × -× × -× × × -× × × × × × × ×                | ×                                       |               |                                      |               |                    |                |     | Relict fract | ture, very steep<br>o; undulating, s<br>from 8.70m to | oly              |         | 100                        | HQ          |                         |                        |             |                               |                       |   |
|   |  | _118     | × ×   | ×                                       | 21            | 6//4/5/5/7                           |               |                    |                |     | no coating   | from 8.70m to   | 9.00m.           |         | 100                        | SPT         |                         |                        |             |                               |                       |   |
|   | SILT; with trace fine sand, light grey, hard,<br>brittle, moderately cemented, some very<br>closely spaced incipient fractures.  |          |   | × }<br>× }<br>× }                       | <br>          |                                      |               |                    |                |     |              |   |                  |         | 100                        | HQ          |                         |                        |             |                               |                       |   |
| NOT<br>Singl                            | <b>TES</b> e piezometer installed upon completion.   |          |   |   |               |                                      |               |                    |                |     |              | STARTED<br>DRILLER                                    | 23/10/20<br>Glen | 13      |                            |             |                         | ISHED                  | Co.         | /10/20<br>Iforce              |                       | _ |
|   |  |          |   |   |               |                                      |               |                    |                |     |              | INCLINATION/<br>AZIMUTH<br>LOGGED                     | -90°             |         |                            |             |                         | LLING I                | R <i>IG</i> | Γracto                        |                       | _ |
|   | ED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005)   |          |   |   |               | SEE ATTA                             |               |                    |                |     |              | CLIENT  | T Van De         | elen    |                            |             | JOE                     | A NO.                  | Georg       | е                             | BH1                   | 3 |

|   | 23/10/2013                 | 24/10/2013    | 3        |
|---|----------------------------|---------------|----------|
|   | DRILLER                    | DRILLING CO.  |          |
|   | Glen                       | Drillforce Lt | id       |
|   | INCLINATION/               | DRILLING RIG  |          |
|   | AZIMUTH -90°               | Tractor       |          |
|   | LOGGED                     | CHECKED       |          |
|   | T Van Deelen               | A George      | BH13/02  |
| ٦ | CLIENT                     | JOB NO.       | DI113/02 |
| ٥ | Watercare Services Limited | 1-C0935.25    |          |



|                       |             |                  |        |           | HOLE NO. |         |
|-----------------------|-------------|------------------|--------|-----------|----------|---------|
| В                     | OREHOLE LOG |                  |        |           | BH1      | 3/02    |
| PROJECT               | CO-OR       | P.D.             | R.L.   |           | SHEET    |         |
| Manuka Road Reservoir | s 1         | 746091 E 59108   | 13 N 1 | 127.10 m  |          | 2 of 2  |
| LOCATION              | REF. G      | RID              | DATUN  | 1         | HOLE     |         |
| See Site Plan         |             | SM 6472 SO 61159 | MSI    | Akid 1946 | LENGTH   | 15 45 m |

|              |   |                           |   | _                 | See Site  | Plan          |                    |                |         |           | T                            | SM 6472 SC                       |         |  |     | /ISL A                  |            |             | LENGTH                        | 1 .        |
|--------------|---|---------------------------|---|-------------------|---|---------------|--------------------|----------------|---------|-----------|------------------------------|----------------------------------|---------|--|-----|-------------------------|------------|-------------|-------------------------------|------------|
| GEOLOGY/UNIT | MAIN DESCRIPTION  | R.L. (m)<br>DEPTH (m)     | GRAPHIC LOG   | $\vdash$          | SPT BLOW COUNTS OR SHEAR VALUE                        | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | C dec   | DIP grees | DETAIL                       | ED DESCRIPTION                   | RQD (%) | TOTAL CORE OS NO | _   | DRILLING                | S          | CASING      | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER |
|              | SILT; with trace fine sand, light grey, hard,<br>brittle, moderately cemented, some very<br>closely spaced incipient fractures. | -                         |   | ,                 |   |               | ->                 |                | 0 3     | 90        |                              | -                                | -       | 100  | HQ  | J-2                     |            |             | 28                            | <u> </u>   |
|              | Thin layer of fine to medium SAND; medium dense, brittle, weakly cemented.  |                           | - × × × × × × × × × × × × × × × × × × ×   | 30                | <br> <br> <br> <br>  16//7/8/7/8                      |               |                    |                |         |           | Bedding pla<br>dip; undulati | ne(?), steeply inclined ing.     |         |  | SPT |                         |            |             |                               |            |
|              | SILT; with trace fine sand, light grey, hard, brittle, 50% moderately cemented, some 1-2cmØ angular mudstone fragments.         | <sub>116</sub> 11-        | - × × × - × × - × × × - × × × - × × × - × × × - × × × - × × × × - × | )<br>)<br>)<br>)  |   |               |                    |                |         |           |                              |                                  |         | 62   |     |                         |            |             |                               |            |
|              | Fine sandy SILT; light grey, hard, brittle,   | -                         | × ×<br>× ×<br>× ×   | }                 |   |               |                    |                |         |           |                              |                                  |         | 100  | HQ  |                         |            |             |                               |            |
| ,            | 50% moderately cemented, some 1-2cmØ angular mudstone fragments.  | 12-                       | U U   | 350 <sup>-1</sup> | <br> 1//7/11/19/1<br>  for 55mm                       | 3             |                    |                |         |           |                              |                                  |         | 58   | SPT | e Wireline              |            |             |                               |            |
| Colluvium    | Fine SANDSTONE; with some silt, dark grey, extremely weak, slightly weathered, massive, occasional fine angular gravel.         | _ <sub>114</sub> 13-      |   |                   |   | EW            | sw                 |                |         |           |                              |                                  |         | 100  | HQ  | HQ Triple Tube Wireline |            |             |                               |            |
|              | SILT; with trace fine sand, light grey, hard,<br>brittle, occasional fine angular to<br>sub-rounded mudstone fragments.         |                           |   | *50 <sup>‡</sup>  | <br> <br> <br> //11/15/11/ <sup>-</sup><br>  for 70mm | 13            |                    |                |         |           |                              |                                  |         | 44   | SPT | _                       |            |             |                               |            |
|              |   | 14-                       | - × × × - × × - × × ×   | <b>&gt;</b>       |   |               |                    |                |         |           |                              |                                  |         |  |     |                         |            |             |                               |            |
|              |   |                           |   | )<br>}<br>}<br>}  |   |               |                    |                |         |           |                              |                                  |         | 81   | HQ  |                         |            |             |                               |            |
|              |   | _ <sub>112</sub> 15-      | - × × × × × × × × × × × × × × × × × × ×   | 27                | <br> <br>  7//5/6/7/9<br>                             |               |                    |                |         |           |                              |                                  |         | 100  | SPT |                         | -          |             |                               |            |
|              | End of Borehole at 15.45m.  | 16-                       | ×   |                   |   |               |                    |                |         |           |                              |                                  |         |  |     |                         |            |             |                               |            |
|              |   | _<br>_ <sub>110</sub> 17- | -<br>-<br>-<br>-<br>-<br>-  |                   |   |               |                    |                |         |           |                              |                                  |         |  |     |                         |            |             |                               |            |
|              |   | 110 '                     | -<br>-<br>-<br>-<br>-   |                   |   |               |                    |                |         |           |                              |                                  |         |  |     |                         |            |             |                               |            |
|              |   | _ 18-                     | -<br>-<br>-<br>-<br>-   |                   |   |               |                    |                |         |           |                              |                                  |         |  |     |                         |            |             |                               |            |
|              |   |                           |   |                   |   |               |                    |                |         |           |                              |                                  |         |  |     |                         |            |             |                               |            |
|              |   | -                         | -<br>-<br>-<br>-<br>-   |                   |   |               |                    |                |         |           |                              |                                  |         |  |     |                         |            |             |                               |            |
|              | TES   |                           | <u>'</u>  |                   |   | 1             | <u>'</u>           |                |         |           |                              | TARTED 23/10/2                   | 013     |  |     |                         | ISHED      |             | /10/20                        | 13         |
| Singl        | le piezometer installed upon completion.  |                           |   |                   |   |               |                    |                |         |           |                              | RILLER Gler                      | 1       |  |     |                         | LLING (    | Dril<br>Rig | Iforce I                      |            |
|              |   |                           |   |                   |   |               |                    |                |         |           | A.                           | ZIMUTH -90°<br>OGGED<br>T Van De | eelen   |  |     | Сн                      | ECKED<br>A |             | ractor<br>e                   | BH         |
| LOGG         | ED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005)  | GUIDELINE                 | S   |                   | SEE ATTA  | ACHED K       | EY SHEE            | T FOR          | R EXPLA | NATIO     | N OF SYMBOLS C               | Watercare Serv                   | ices    | Limite   | d   | JOE                     | 1-C        | 0935.       | 25                            |            |

Watercare Services Limited

Borehole 13/02





0.00m – 3.00m



3.00m – 6.45m

Watercare Services Limited

### Borehole 13/02





6.45m – 9.10m Box 3 of 5



9.10m – 12.00m Box 4 of 5

Watercare Services Limited

### Borehole 13/02





12.00m – 15.45m (E.O.H)

Box 5 of 5



|                        |                     |               | HOLE NO. |        |
|------------------------|---------------------|---------------|----------|--------|
| BOREH                  | OLE LOG             |               | BH1      | 3/03   |
| PROJECT                | CO-ORD.             | R.L.          | SHEET    |        |
| Manuka Road Reservoirs | 1746105 E 5910797 N | 127.65 m      |          | 1 of 2 |
| LOCATION               | REF. GRID           | DATUM         | HOLE     |        |
| 0 · . 0'( · D) · ·     | OM 0470 00 044F0    | MOL ALLE 4040 | LENGTH   | 45.45  |

|                         |   |          |                                   | _             | See Site                       | Plan          |                    |                |                   |       | SI                | 1 6472 SO |         |                                |             | ISL A                   | kld. 1  |             | LENGT                         | 15                    | 5                  |
|-------------------------|---|----------|-----------------------------------|---------------|--------------------------------|---------------|--------------------|----------------|-------------------|-------|-------------------|-----------|---------|--------------------------------|-------------|-------------------------|---------|-------------|-------------------------------|-----------------------|--------------------|
| GEOLOGY/UNIT            | MAIN DESCRIPTION  | R.L. (m) | GRAPHIC LOG                       | SPT 'N' VALUE | SPT BLOW COUNTS OR SHEAR VALUE | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIP  degrees 0 90 | DETAI | LED DESCRII       | PTION     | RQD (%) | TOTAL CORE OS BAS SECOVERY (%) | SAMPLE TYPE | DRILLING<br>METHOD      | s       | CASING      | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER<br>DETAILS |                    |
| Ē                       | SILT; with some clay, greyish brown blotched orange, firm, slightly plastic, some                                       |          | _                                 |               | <br> <br>                      |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | A STAN             |
|                         | rootlets, occasional 4cmØ angular concrete fragments.  CLAY; with some silt, brownish grey mottled                      |          |                                   |               | <br>                           |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | さくません              |
|                         | orange, firm, slightly plastic, some rootlets.  | _        |                                   |               | <br> <br> <br>                 |               |                    |                |                   |       |                   |           |         | 100                            | НА          | Hand Auger              |         |             |                               |                       | といろという             |
|                         | Silty CLAY; grey mottled orange, firm,  | 1        |                                   |               | <br> <br>                      |               |                    |                |                   |       |                   |           |         |                                |             | Han                     |         |             |                               |                       | きている               |
|                         | plastic, occasional fine angular silt fragments.  |          | -X_X                              |               | <br>                           |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | かんだん               |
|                         | Clayey SILT; brownish grey, firm, plastic,  | 126      | × ×                               |               | <br>                           |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | かんだる               |
|                         | some lenses of orangish brown silty fine to medium sand.  |          | -×-×                              | 4             | 1//1/1/1/1<br>                 |               |                    |                |                   |       |                   |           |         | 100                            | SPT         |                         |         |             |                               |                       | ASSES !            |
|                         | Silty fine to medium SAND; brown, very  | 2        | 2-×-×                             |               | <br>                           |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | STAP ST            |
|                         | loose, brittle, some fine angular mudstone fragments.   |          | × ×                               | 1             | <br> <br>                      |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | 1                  |
|                         | SILT; with some clay, light yellowish grey, firm, plastic, some horizons of pinkish grey                                |          |                                   | ,             |                                |               |                    |                |                   |       |                   |           |         | 100                            | HQ          |                         |         |             |                               |                       | ASSE               |
|                         | silty sand, occasional 1-2mmØ angular silt fragments.   |          |                                   | ,             | <br> <br>                      |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | State of           |
|                         |   | 3        | 3                                 | ,             |                                |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | きてき                |
|                         |   |          |                                   | ,             | <br>                           |               |                    |                |                   |       |                   |           |         | 100                            | PT          |                         |         |             |                               |                       | CLA CLIA           |
|                         | Trace clay and slightly plastic from 3.50m.   | _124     |                                   | 3             | <br> <br>  1//0/1/1/1          |               |                    |                |                   |       |                   |           |         | 100                            | SPT         |                         |         |             |                               |                       | そうとう               |
|                         | SILT; with trace clay, brownish grey streaked orange, firm, slightly plastic, trace                                     | 4        |                                   |               |                                |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | きてくれて              |
|                         | fine angular gravels.   |          |                                   | ,             | <br>                           |               |                    |                |                   |       |                   |           |         | 100                            | HQ          |                         |         |             |                               |                       | そうとうこと             |
|                         | Some manganese streaks from 4.30m.  |          | × × ×                             | ,             | <br> <br>                      |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | されるまれ              |
|                         |   |          | -\hat{\times} \times \hat{\times} | 4             | 1//1/1/1/1<br> <br>            |               |                    |                |                   |       |                   |           |         | 100                            | SPT         |                         |         |             |                               |                       | A CLIP             |
| Colluvium               | Some limonite streaks and larger 1-2cmØ   | 5        | 5= × × ×                          | ,             | <br> <br>                      |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | ASSA               |
|                         | silt fragments from 5.00m.  |          | -× × ×                            |               | <br>                           |               |                    |                |                   |       |                   |           |         |                                |             | line                    |         |             |                               |                       | 3                  |
|                         | Progressively grades into a fine sandy SILT;  | 122      |                                   | ,             | <br> <br>                      |               |                    |                |                   |       |                   |           |         | 100                            | HQ          | - Wire                  |         |             |                               |                       | をなる                |
|                         | firm, brittle, weakly cemented from 5.70m to 6.00m.   |          | * * *                             | ,             | <br>                           |               |                    |                |                   |       |                   |           |         |                                |             | e Tub                   |         |             |                               |                       | A CLIFF            |
|                         |   | 6        | 3                                 |               | <br> <br>                      |               |                    |                |                   |       |                   |           |         |                                |             | IQ Triple Tube Wireline |         |             |                               |                       | STEP S             |
|                         |   |          | -× · · · ×                        | }             | <br>                           |               |                    |                |                   |       |                   |           |         | 100                            | PT          | ¥                       |         |             |                               |                       | A STATE            |
|                         | Fine sandy SILT; greyish brown, very stiff to hard, brittle, occasional 1-3cmØ mudstone                                 | L        | × × ×                             |               | <br> <br>                      |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | A CONTRACTOR       |
|                         | fragments, occasional lenses of silty fine to coarse sand; some weakly cemented.  |          | × × ×                             | 9             | 3//1/2/3/3                     |               |                    |                |                   |       |                   |           |         | 100                            | SPT         |                         |         |             |                               |                       | STAR S             |
|                         | Some fine to medium angular gravel from 7.00m.  | 7        | * · × · × · × · ×                 | }             | <br> <br>                      |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | * CAPTY            |
|                         | 7.00111.  |          | × × ×                             | 1             | <br> -                         |               |                    |                |                   |       |                   |           |         | 100                            | HQ          |                         |         |             |                               |                       | 1                  |
|                         |   | _120     | - × × ×                           | 1             | <br>  <br>                     |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | AST SA             |
|                         | Heavy limonite staining from 7.80m to   |          | × × ×                             | 10            | 3//2/2/4/2                     |               |                    |                |                   |       |                   |           |         | 100                            | SPT         |                         |         |             |                               |                       | 3                  |
|                         | 7.90m. Poor recovery from 7.95m to 9.00m.   | 8        | 3- <del>-</del>                   |               | <br> <br>                      |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | きんない               |
|                         | Fragments of silty fine SAND; brownish grey, loose, brittle, weakly cemented. Suspected fine grained matrix washed away |          | ××                                |               | <br>                           |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | PANTAPA<br>PANTAPA |
|                         | during drilling.  |          |                                   |               | <br>                           |               |                    |                |                   |       |                   |           |         | 54                             | HQ          |                         |         |             |                               |                       | Ser.               |
|                         |   |          | ×                                 |               | <br> <br>                      |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | きてい                |
|                         | SILT; with trace fine sand and trace clay,<br>brownish grey streaked orange, hard,                                      | 9        | ) × ×                             | 1             | <br>                           |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | A STAN             |
|                         | slightly plastic, trace 1-5mmØ angular<br>mudstone fragments, some limonite and   |          | × × ×                             | 18            | 5//3/3/5/7<br>                 |               |                    |                |                   |       |                   |           |         | 82                             | SPT         |                         |         |             |                               |                       | Sight              |
|                         | manganese staining. Fine sandy SILT; greenish grey, hard,   | 118      | ×                                 | ,             |                                |               |                    |                |                   |       |                   |           |         |                                |             |                         |         |             |                               |                       | きているまで             |
|                         | brittle, weakly cemented, trace 1-2cmØ angular gravels, some limonite staining.   |          | * × ×                             | ,             | <br> <br>                      |               |                    |                |                   |       |                   |           |         | 100                            | HQ          |                         |         |             |                               |                       | ANTIBA             |
| N.C.                    |   |          | ļķ "×                             | 1             |                                |               | <u> </u>           |                |                   |       | STARTED           |           |         |                                | <u> </u>    | FINI                    | SHED    |             |                               |                       | ŝ                  |
| NO <sup>*</sup><br>Bore | <b>FES</b> hole was backfilled upon completion.   |          |                                   |               |                                |               |                    |                |                   |       | DRILLER           | 22/10/20  |         |                                |             | DRI                     | LLING ( | CO.         | /10/20                        |                       | _                  |
|                         |   |          |                                   |               |                                |               |                    |                |                   |       | INCLINATION       | Glen      |         |                                |             |                         | LLING F | Dril<br>Rig | lforce                        |                       | _                  |
|                         |   |          |                                   |               |                                |               |                    |                |                   | _     | AZIMUTH<br>LOGGED | -90°      | _       |                                |             |                         | CKED    |             | Fracto                        | r<br>                 | -                  |
|                         |   |          |                                   |               |                                |               |                    |                |                   |       |                   | T Van De  | elen    |                                |             |                         | Α (     | Georg       | е                             | ВН1                   | 4                  |



|          |                        |                     |               | HOLE NO.     |
|----------|------------------------|---------------------|---------------|--------------|
|          | BOREHOLE LO            | OG                  |               | BH13/03      |
| PROJECT  |                        | CO-ORD.             | R.L.          | SHEET        |
|          | Manuka Road Reservoirs | 1746105 E 5910797 N | 127.65 m      | 2 of 2       |
| -OCATION |                        | REF. GRID           | DATUM         | HOLE         |
|          | 0011.01                | OM 0470 00 04450    | MOL ALLE 4040 | LENGTH 45 45 |

|              |  |                       |  | _                | See Site                             | Plan          |                    |                | <u> </u> |                    |                        | SM 6472 SC           |         | 59<br>CORE                 |             | ISL A                   |         | 946<br>LLING | LENGT                         |                       |
|--------------|--|-----------------------|--|------------------|--------------------------------------|---------------|--------------------|----------------|----------|--------------------|------------------------|----------------------|---------|----------------------------|-------------|-------------------------|---------|--------------|-------------------------------|-----------------------|
| GEOLOGY/UNIT | MAIN DESCRIPTION   | R.L. (m)<br>DEPTH (m) | GRAPHIC LOG                                  | -                | SPT BLOW<br>COUNTS OR<br>SHEAR VALUE | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | deç      | DIP<br>grees<br>90 | DETAILE                | D DESCRIPTION        | RQD (%) | TOTAL CORE<br>RECOVERY (%) | SAMPLE TYPE | DRILLING                | S       | CASING       | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER<br>DETAILS |
|              | Fine sandy SILT; greenish grey, hard, brittle, weakly cemented, trace 1-2cmØ angular gravels, some limonite staining.  |                       | - × × × · × · · × · · · × · · · × · · · ×    | >                | <br> <br>                            |               |                    |                | 0        | 90                 |                        |                      |         | 100                        | HQ          |                         |         |              |                               |                       |
|              | Some 1-3mmØ angular gravels from 10.50m.   |                       | × × × × × × × × × × × × × × × × × × ×        | 12               | <br> -<br> -<br>  3//3/3/3/3         |               |                    |                |          |                    |                        |                      |         | 100                        | SPT         |                         |         |              |                               |                       |
|              | Poor recovery from 10.95m to 12.00m.<br>Suspected hard fragments of sand in a fine<br>grained matrix washed away during drilling.                                | 11-                   | -  | <b>&gt;</b>      | <br> <br> <br> <br>                  |               |                    |                |          |                    |                        |                      |         |                            |             |                         |         |              |                               |                       |
|              |  | _116                  | =  |                  | <br> <br> <br> <br>                  |               |                    |                |          |                    |                        |                      |         | 13                         | HQ          |                         |         |              |                               |                       |
|              | SILT; with trace clay, dark grey, hard, plastic, some streaks of fibrous organics, occasional 1cmØ mudstone fragments.   | 12-                   | × × × × × × × ×                              | 15               | <br> -<br>  5//3/4/3/5<br>           |               |                    |                |          |                    |                        |                      |         | 100                        | SPT         | Wireline                |         |              |                               |                       |
| Colluvium    | Fine sandy SILT; with trace clay, greenish grey, hard, brittle to slightly plastic, some weakly cemented material, occasional 1-4cmØ angular mudstone fragments. | 13-                   | - X X X X X X X X X X X X X X X X X X X      | >                | <br> <br> <br> <br> <br> <br>        |               |                    |                |          |                    | Weakly ceme<br>13.00m. | ented from 12.90m to |         | 67                         | HQ          | HQ Triple Tube Wireline |         |              |                               |                       |
|              |  | _114                  | - x · x · x · x · x · x · x · x · x · x      | 14               | <br> -<br> -<br> -<br>  4//4/4/3/3   |               |                    |                |          |                    |                        |                      |         | 67                         | SPT         |                         |         |              |                               |                       |
|              | Becomes greenish grey mottled yellowish brown from 14.00m.   | 14-                   | × × × × × × × × × × × × × × ×                | \<br>\<br>\<br>\ | <br> <br> <br> <br>                  |               |                    |                |          |                    | Weakly ceme<br>14.25m. | ented from 14.10m to |         |                            |             |                         |         |              |                               |                       |
|              | MUDSTONE; greenish grey, extremely weak, moderately weathered, multiple very closely spaced incipient fractures.   | -                     | _× ×   | ,                | <br> <br> <br> <br>                  | EW            | MW                 |                |          |                    |                        |                      | 0       | 100                        | HQ          |                         |         |              |                               |                       |
|              | Fine to medium SAND; dark greenish grey, medium dense, brittle, weakly cemented.   | 15-                   |  | 23               | <br> <br> <br>  16//9/5/5/4<br>      |               |                    |                |          |                    |                        |                      |         | 68                         | SPT         |                         |         |              |                               |                       |
|              | End of Borehole at 15.45m.   | 112                   | -<br>-<br>-<br>-<br>-                        |                  | <br>                                 |               |                    |                |          |                    |                        |                      |         |                            |             |                         |         |              |                               | 202020                |
|              |  |                       | -<br>-<br>-<br>-                             |                  | <br>                                 |               |                    |                |          |                    |                        |                      |         |                            |             |                         |         |              |                               |                       |
|              |  | 17-                   | -<br>-<br>-<br>-                             |                  | <br> <br> <br> <br> <br>             |               |                    |                |          |                    |                        |                      |         |                            |             |                         |         |              |                               |                       |
|              |  | _110                  | -<br>-<br>-<br>-                             |                  | <br> <br> <br> <br>                  |               |                    |                |          |                    |                        |                      |         |                            |             |                         |         |              |                               |                       |
|              |  | 18-                   | -<br>-<br>-<br>-                             |                  | <br> <br> <br> <br>                  |               |                    |                |          |                    |                        |                      |         |                            |             |                         |         |              |                               |                       |
|              |  | _                     | -<br>-<br>-<br>-                             |                  | <br> <br> <br> <br>                  |               |                    |                |          |                    |                        |                      |         |                            |             |                         |         |              |                               |                       |
|              |  | 19-                   | -<br>-<br>-<br>-                             |                  | <br> <br> <br> <br>                  |               |                    |                |          |                    |                        |                      |         |                            |             |                         |         |              |                               |                       |
|              |  | _108                  | -<br>-<br>-<br>-<br>-                        |                  | <br> <br> <br> <br> <br>             |               |                    |                |          |                    |                        |                      |         |                            |             |                         |         |              |                               |                       |
|              | TES shole was backfilled upon completion.  |                       | <u>†                                    </u> |                  |                                      |               |                    |                |          |                    |                        | ARTED 22/10/2        | 013     |                            |             |                         | SHED    |              | /10/20                        | 13                    |
| DOLE         | эного маз раскиней ирон сонтрівноп.  |                       |  |                  |                                      |               |                    |                |          |                    |                        | Gler                 | 1       |                            |             |                         | LLING C | Dril         | lforce                        | Ltd                   |
|              |  |                       |  |                  |                                      |               |                    |                |          |                    | AZ                     | IMUTH -90°<br>GGED   |         |                            |             |                         | CKED    | 7            | racto                         | r                     |
|              |  |                       |  |                  |                                      |               |                    |                |          |                    |                        | T Van De             | eelen   |                            |             | JOB                     | Α (     | Georg        | e                             | ВН                    |

Watercare Services Limited

Borehole 13/03





0.00m – 2.65m



2.65m – 5.10m Box 2 of 6

Watercare Services Limited

Borehole 13/03





5.10m – 7.60m Box 3 of 6



7.60m – 12.00m Box 4 of 6

Watercare Services Limited

### Borehole 13/03





12.00m – 14.50m Box 5 of 6





|                        |                     |          | HOLE NO.       |
|------------------------|---------------------|----------|----------------|
| BOREHOLE LO            | OG                  |          | BH13/04        |
| ROJECT                 | CO-ORD.             | R.L.     | SHEET          |
| Manuka Road Reservoirs | 1746065 E 5910805 N | 122.39 m | 1 of 2         |
| DCATION                | REF. GRID           | DATUM    | HOLE<br>LENGTH |

| <b>-</b>     |   |          |   | -                | TESTS                                | 표             |                    | S              |                   |        |                       | <u> </u> | COR                        | _           |                         | DRII                   | LLING       |                               |            |     |
|--------------|---|----------|---|------------------|--------------------------------------|---------------|--------------------|----------------|-------------------|--------|-----------------------|----------|----------------------------|-------------|-------------------------|------------------------|-------------|-------------------------------|------------|-----|
| GEOLOGY/UNIT | MAIN DESCRIPTION  | R.L. (m) | GRAPHIC LOG                             | SPT 'N' VALUE    | SPT BLOW<br>COUNTS OR<br>SHEAR VALUE | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIP  degrees 0 90 | DETAIL | LED DESCRIPTION       | RQD (%)  | TOTAL CORE<br>RECOVERY (%) | SAMPLE TYPE | DRILLING<br>METHOD      | DRILLING<br>FLUID LOSS | CASING      | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER | ı   |
|              | SILT; with some clay, brown mottled dark<br>brown, firm, plastic, some 1-2cmØ angular<br>gravel, some rootlets.   |          |   |                  |                                      |               |                    |                |                   |        |                       |          |                            |             |                         |                        |             |                               |            | Ž   |
| Ē            | Some 2-5cmØ angular concrete fragments from 0.50m.  Silty CLAY; grey mottled brownish grey and streaked orange, firm, plastic, occasional 0.5-1cmØ angular gravel.  Some lenses of clay with trace silt from 1.10m. | 122      |   |                  |                                      |               |                    |                |                   |        |                       |          | 100                        | HQ          | Hand Auger              |                        |             |                               |            |     |
|              | CLAY; with some silt, grey streaked orange, firm, plastic.  |          | -                                       | 4                | <br> -<br>  1//1/1/1/1               |               |                    |                |                   |        |                       |          | 100                        | SPT         |                         |                        |             |                               |            |     |
|              | No recovery from 1.95m to 3.00m.<br>Suspected gravel in the core barrel, fine<br>grained material washed away.  | _120     |   |                  | <br>                                 |               |                    |                |                   |        |                       |          | 0                          | HQ          |                         |                        |             |                               |            |     |
|              |   | 3        | 3                                       |                  | i<br>                                |               |                    |                |                   |        |                       |          | 100                        | PT          |                         |                        |             |                               |            |     |
|              | SILT; with some clay, trace fine sand and trace fine angular gravel, light brownish grey  |          |   | 3                | 1 1//1/0/1/1                         |               |                    |                |                   |        |                       |          | 100                        | SPT         |                         |                        |             |                               |            |     |
|              | streaked orange, firm, slightly plastic.  | 2        |   | ,                | <br>                                 |               |                    |                |                   |        |                       |          |                            |             |                         |                        |             |                               |            |     |
|              | Progressively grading into a silty fine SAND; loose, brittle, trace 1cmØ angular mudstone fragments, trace limonite staining by 4.50m.  | _118     |   | >                | <br> <br>                            |               |                    |                |                   |        |                       |          | 49                         | HQ          |                         |                        |             |                               |            |     |
|              | Fine sandy SILT; with trace fine angular gravel, brownish grey, firm, brittle.  |          | - × × ×                                 | 2                | <br>  1//1/1/0/0<br>                 |               |                    |                |                   |        |                       |          | 100                        | SPT         |                         |                        |             |                               |            |     |
|              | Fine sandy SILT; firm to hard, brittle, occasional weakly cemented 1-2mmØ lenses of sand.   | - (      | 5                                       | ,                | <br>                                 |               |                    |                |                   |        |                       |          |                            |             | eline                   |                        |             |                               |            |     |
| Colluvium    | Becomes weakly cemented with some limonite staining from 4.80m.   |          | - × × × × × × × × × × × × × × × × × × × | ,                | <br> -<br> -<br> -<br> -             |               |                    |                |                   |        |                       |          | 58                         | HQ          | IQ Triple Tube Wireline |                        |             |                               |            |     |
|              |   | _116     | × × ×                                   | ,                | <br> -<br> -                         |               |                    |                |                   |        |                       |          | 100                        | PT          | 쥪                       |                        |             |                               |            |     |
|              | Fine to medium sandy SILT; grey mottled orange, hard, brittle, weakly cemented from 6.80m to 6.95m.   |          |   | 10               | <br> <br>  2//1/2/3/4                |               |                    |                |                   |        |                       |          | 100                        | SPT         |                         |                        |             |                               |            |     |
|              | Clayey SILT; with trace fine to medium sand and occasional fine angular gravel, grey, very stiff, plastic.  | -        | 7_ <u>×</u> ×<br>-× ×<br>-× ×<br>-× ×   |                  | i<br> <br> -<br> -                   |               |                    |                |                   |        |                       |          | 100                        | HQ          |                         |                        |             |                               |            |     |
|              |   | -        | -x^x                                    | 8                | <br> <br> <br> <br>  2//2/1/2/3      |               |                    |                |                   |        |                       |          | 0                          | SPT         |                         |                        |             |                               |            |     |
|              | Fine sandy SILT; grey, hard, brittle, some 1-3cmØ angular mudstone fragments and  | - 8      | 3 × × × × × × × × × × × × × × × × × × × |                  | <br>                                 |               |                    |                |                   |        |                       |          |                            |             |                         |                        |             |                               |            |     |
|              | lenses of weakly cemented material.<br>Becomes a silty fine sand from 8.30m.  | _114     |   | ><br>><br>><br>> | <br> -<br> -<br> -<br> -<br> -       |               |                    |                |                   |        |                       |          | 100                        | HQ          |                         |                        |             |                               | 013<br>013 |     |
|              |   | (        | 9                                       | 17               | 9//4/3/4/6                           |               |                    |                |                   |        |                       |          | 100                        | SPT         |                         |                        |             |                               | 19/11/2013 |     |
|              | Fine sandy SILT; grey, hard, brittle, moderately to completely cemented, some 1-3cmØ angular mudstone and silt fragments.   |          | - x . x                                 | ><br>><br>><br>> | <br>                                 |               |                    |                |                   |        |                       |          | 69                         | HQ          |                         |                        |             |                               |            |     |
| NO Sing      | FES e piezometer installed upon completion.   |          |   |                  |                                      |               |                    |                |                   |        |                       | 10/2013  |                            |             |                         | ISHED                  |             | /10/20                        | 13         |     |
| Jii IY       | о раздотного птогалей протгоотприелон.  |          |   |                  |                                      |               |                    |                |                   |        | NCLINATION/           | Glen     |                            |             |                         | LLING C                | Dril<br>RiG | Iforce                        |            |     |
|              |   |          |   |                  |                                      |               |                    |                |                   | A      | AZIMUTH -90<br>LOGGED |          |                            |             |                         | ECKED                  |             | <u>Fractor</u>                |            |     |
|              |   |          |   |                  |                                      |               |                    |                |                   |        | <u>T Va</u><br>CLIENT | n Deelei | 1                          |             | JOE                     |                        | Georg       | е                             | ВН         | 113 |

| STARTED                    | I II VIOI ILD |   |
|----------------------------|---------------|---|
| 30/10/2013                 | 30/10/2013    | 3 |
| DRILLER                    | DRILLING CO.  |   |
| Glen                       | Drillforce Lt | a |
| INCLINATION                | DRILLING RIG  |   |
| AZIMUTH -90°               | Tractor       |   |
| LOGGED                     | CHECKED       |   |
| T Van Deelen               | A George      | В |
| CLIENT                     | JOB NO.       | 0 |
| Watercare Services Limited | 1-C0935.25    |   |
|                            |               |   |



|          | BOREHOLE L             | OG                  |               | BH1    | 3/04   |
|----------|------------------------|---------------------|---------------|--------|--------|
| PROJECT  |                        | CO-ORD.             | R.L.          | SHEET  |        |
|          | Manuka Road Reservoirs | 1746065 E 5910805 N | 122.39 m      |        | 2 of 2 |
| LOCATION |                        | REF. GRID           | DATUM         | HOLE   |        |
|          | One Otto Diese         | OM 6470 00 644F0    | MOL ALLE 4040 | LENGTH | 45 45  |

|                      |  |                       |  | 1                | TESTS                                   | ı             |                    | U              |              |                                 |  |         | COR                        |             |                         | DRIL                   | LING   | ì                             |                            |
|----------------------|--|-----------------------|--|------------------|---|---------------|--------------------|----------------|--------------|---------------------------------|--|---------|----------------------------|-------------|-------------------------|------------------------|--------|-------------------------------|----------------------------|
| GEOLOGY/UNIT         | MAIN DESCRIPTION   | R.L. (m)<br>DEPTH (m) | GRAPHIC LOG  | SPT 'N' VALUE    | SPT BLOW<br>COUNTS OR<br>SHEAR VALUE    | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIF<br>degre |                                 | AILED DESCRIPTION  | RQD (%) | TOTAL CORE<br>RECOVERY (%) | SAMPLE TYPE | DRILLING                | DRILLING<br>FLUID LOSS | CASING | BASE OF HOLE<br>& WATER LEVEL | -<br>PIEZOMETER<br>DETAILS |
|                      | Fine sandy SILT; grey, hard, brittle, moderately to completely cemented, some 1-3cmØ angular mudstone and silt fragments.    | _112                  | - × × × · × · · · · · · · · · · · · · ·                  | ,                |   |               |                    |                |              |                                 |  |         | 69                         | HQ          |                         |                        | _      |                               |                            |
|                      |  | 11-                   | × × × × × × × × × × × × × × × × × × ×                    | 18               | <br> <br>  5//3/4/6/5<br> <br> <br>     |               |                    |                |              |                                 |  |         | 100                        | SPT         | _                       |                        |        |                               |                            |
|                      |  | -                     | - × × × - × × · × · × · × · × · × · × ·                  | ><br>><br>><br>> | <br>                                    |               |                    |                |              | Dolliet from                    | atura etaanlu inglined   |         | 100                        | HQ          |                         |                        |        |                               |                            |
|                      |  | 12 <sup>-</sup>       | - X X X X X X X X X X X X X X X X X X X                  | 16               | <br> -<br> -<br>  5//4/3/4/5<br>        |               |                    |                |              | dip; plana<br>11.70m.           | cture, steeply inclined<br>ir, rough, no coating at                    |         | 100                        | SPT         | Wireline                |                        |        |                               |                            |
| Colluvium            |  | 13                    | × × × × × × × × × × × × × × × × × × ×                    | >                | <br>                                    |               |                    |                |              |                                 |  |         | 100                        | HQ          | HQ Triple Tube Wireline |                        |        |                               |                            |
| _                    | Clayey SILT; brownish grey, hard, slightly plastic, moderately to completely cemented, some 1-3cmØ angular mudstone and silt |                       | × × × × × × × × × × × × × × × × × × ×                    | 19               | <br> <br> <br>  6//3/5/5/6<br> <br>     |               |                    |                |              |                                 |  |         | 100                        | SPT         | _                       |                        |        |                               |                            |
|                      | fragments.   | 14-<br>_108           | -x ^ x<br>-x * x<br>-x * x<br>-x * x<br>-x * x<br>-x * x |                  | <br>                                    |               |                    |                |              | Two relicing inclined coating a | t fractures, steeply<br>ips; planar, smooth, no<br>114.10m and 14.40m. |         | 100                        | HQ          |                         |                        |        |                               |                            |
|                      | Some lenses of dark greenish grey fine to medium sand from 15.00m.   | 15                    | -×-×-<br>-×-×-<br>-×-×-<br>-×-×-<br>-×-×-<br>-×-×-       | 21               | <br> <br> <br> <br> <br> <br>  6//5/5/6 |               |                    |                |              |                                 |  |         | 100                        | SPT         |                         |                        |        |                               |                            |
|                      | End of Borehole at 15.45m.   | 16                    | -x x<br>-<br>-<br>-                                      | .]               | <br>                                    |               |                    |                |              |                                 |  |         |                            |             |                         |                        |        |                               |                            |
|                      |  | _106                  | -<br>-<br>-<br>-<br>-                                    |                  | <br>                                    |               |                    |                |              |                                 |  |         |                            |             |                         |                        |        |                               |                            |
|                      |  | 17 <sup>-</sup>       | -<br>-<br>-<br>-<br>-<br>-                               |                  | <br>                                    |               |                    |                |              |                                 |  |         |                            |             |                         |                        |        |                               |                            |
|                      |  | 18                    | -<br>-<br>-<br>-<br>-                                    |                  | <br>                                    |               |                    |                |              |                                 |  |         |                            |             |                         |                        |        |                               |                            |
|                      |  | _104                  | -<br>-<br>-<br>-<br>-                                    |                  | <br> <br> <br> <br> <br> <br>           |               |                    |                |              |                                 |  |         |                            |             |                         |                        |        |                               |                            |
|                      |  | 19                    |  |                  | <br>                                    |               |                    |                |              |                                 |  |         |                            |             |                         |                        |        |                               |                            |
|                      |  |                       | -<br>-<br>-<br>-<br>-<br>-                               |                  | <br>                                    |               |                    |                |              |                                 |  |         |                            |             |                         |                        |        |                               |                            |
| <b>NOT</b><br>Single | TES e piezometer installed upon completion.  |                       |  |                  |   |               |                    |                |              |                                 | STARTED 30/10/2 DRILLER CLASS  |         |                            |             |                         | SHED                   | 20.    | /10/20                        |                            |
|                      |  |                       |  |                  |   |               |                    |                |              |                                 | Gler INCLINATION/ AZIMUTH -90°   | 1       |                            |             | DRI                     | LLING F                | RIG    | Iforce  <br>Fractor           |                            |
|                      |  |                       |  |                  |   |               |                    |                |              |                                 |  |         |                            |             | Сн                      |                        |        |                               |                            |

Watercare Services Limited

Borehole 13/04





0.00m – 3.50m Box 1 of 6



3.50m – 6.50m

Watercare Services Limited

Borehole 13/04





6.50m – 9.45m Box 3 of 6



9.45m – 12.45m Box 4 of 6

| Manuka Reservoirs          |          |
|----------------------------|----------|
|                            | ODIIC    |
| Watercare Services Limited | WWW OPUS |
| Borehole 13/04             |          |



12.45m – 15.45m (E.O.H)

Box 5 of 5



|          |                |            |           |                | HOLE NO.       |             |
|----------|----------------|------------|-----------|----------------|----------------|-------------|
|          | BOREHOLE LO    | OG         |           |                | BH1            | 3/05        |
| PROJECT  |                | CO-ORD.    |           | R.L.           | SHEET          |             |
| Manuka R | oad Reservoirs | 1746014 E  | 5910793 N | 121.35 m       |                | 1 of 2      |
| LOCATION |                | REF. GRID  |           | DATUM          | HOLE<br>LENGTH |             |
| Caa      | Cita Diam      | CM 6470 CO | CAAEO     | MICL ALLA 4046 |                | 4 E 4 E 100 |

|              |   |                       | See Site Plan         |                |               |                                      |               |                    | SM 6472 SO 61159 MSL Aki |   |                     |         |               | kld. 1  | 946                        | LENGTI      | 15.4                 | 45 m                   |        |                               |                       |                          |
|--------------|---|-----------------------|-----------------------|----------------|---------------|--------------------------------------|---------------|--------------------|--------------------------|---|---------------------|---------|---------------|---------|----------------------------|-------------|----------------------|------------------------|--------|-------------------------------|-----------------------|--------------------------|
|              |   |                       |                       |                | Т             | ESTS                                 | _             |                    | (D                       |   |                     |         |               | CORE    |                            |             |                      | DRII                   | LLING  | ì                             |                       | Z                        |
| GEOLOGY/UNIT | MAIN DESCRIPTION  |                       | R.L. (m)<br>DEPTH (m) | GRAPHIC LOG    | SPT 'N' VALUE | SPT BLOW<br>COUNTS OR<br>SHEAR VALUE | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING           |   | DIP<br>egrees<br>90 | DETAILE | D DESCRIPTION | RQD (%) | TOTAL CORE<br>RECOVERY (%) | SAMPLE TYPE | DRILLING             | DRILLING<br>FLUID LOSS | CASING | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER<br>DETAILS | OTHER<br>INSTRUMENTATION |
| Topsoil      | SILT; with trace clay, brown, firm, plastic, abundant rootlets.   | slightly              | -                     | × ×            |               |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
| Top          | SILT; with some clay, brownish graslightly plastic.   | rey, firm,            |                       | × × ×          | 1             |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | Clayey SILT; brownish grey streak   | ked                   | -                     | × ×            |               |                                      |               |                    |                          |   |                     |         |               |         |                            |             | Jer                  |                        |        |                               |                       |                          |
|              | orange, firm, plastic.  |                       | -                     | ×-×            |               |                                      |               |                    |                          |   |                     |         |               |         | 100                        | НА          | Hand Auger           |                        |        |                               |                       |                          |
|              |   |                       | 1-                    | × <u>×</u> ×   | 1             |                                      |               |                    |                          |   |                     |         |               |         |                            |             | Han                  |                        |        |                               |                       |                          |
|              |   |                       | -                     | ***            | }             |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | SILT; with trace clay, brownish gre   |                       | 120 -                 | × × ×          |               |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | limonite streaks, firm, slightly plass occasional grey silt streaks.  | stic,                 | -                     | × × ×          | 4             | 0//1/1/1/1                           |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | 3 .,  |                       | -                     | ×××            | ] 4           | 0//1/1/1/1                           |               |                    |                          |   |                     |         |               |         | 100                        | SPT         |                      |                        |        |                               |                       |                          |
|              | Silty fine to medium SAND; with tr  | race fine             | 2-                    | ××             |               |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | angular gravel, brownish orange,<br>loose, brittle, some limonite stainin<br>Becomes weakly cemented from 2 | ng.                   |                       | ××             |               |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | SILT: with trace fine sand, brownis   | sh grev               | _                     | ×              | i             |                                      |               |                    |                          |   |                     |         |               |         | 100                        | HQ          |                      |                        |        |                               |                       |                          |
|              | streaked orange, firm to stiff, brittle<br>1-5cmØ weakly cemented angular                                   | le, some              | -                     | × × ×          | )<br> <br>    |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | with some manganese and limonit staining.   | ite                   | 3-                    | ×××            |               |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              |   |                       | -                     | × × ×          | }             |                                      |               |                    |                          |   |                     |         |               |         | 100                        | PT          |                      |                        |        |                               |                       |                          |
|              |   |                       | _118 -                | × ^ ×          | 1             |                                      |               |                    |                          |   |                     |         |               |         | 100                        |             |                      |                        |        |                               |                       |                          |
|              | Silty CLAY; greenish grey mottled stiff, slightly plastic, trace 1-2mm@                                     | l brown,<br>Ø angular | -                     | * * *          | 5 5           | 1//1/1/1/2                           |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | hard silt fragments.  |                       | -                     | ×_×            | 5             | 1//1/1/1/2                           |               |                    |                          |   |                     |         |               |         | 100                        | SPT         |                      |                        |        |                               |                       |                          |
|              | Fine to medium SAND; with trace   | fine                  | 4-                    | × ×            |               |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | angular gravels, dark grey, brittle,<br>moderately cemented.<br>Completely cemented from 4.20m              | n to 4 40m            | -                     |                |               |                                      |               |                    |                          |   |                     |         |               |         | 100                        | HQ          |                      |                        |        |                               |                       |                          |
|              | CLAY; with trace silt, firm, plastic, occasional fibrous wood organics.                                     |                       | -                     | × ×            | 1             |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | SILT; with trace clay, light grey, ve brittle.  |                       | -                     | × × ×          | 8             | 2//2/2/2/2                           |               |                    |                          |   |                     |         |               |         | 100                        | SPT         |                      |                        |        |                               |                       |                          |
| ig.          | Pockets of hard greyish pink silt fr 4.80m.   | rom                   | 5-                    | × ×            | }             |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
| Colluvium    | Some 1-10mmØ angular mudston  | ne                    | -                     | × ^ ×          | }             |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
| Ö            | fragments and occasional 5cm lor<br>segments of weakly cemented fine  | e to                  | _116 -                | × × ×          |               |                                      |               |                    |                          |   |                     |         |               |         | 400                        |             | eline                |                        |        |                               |                       |                          |
|              | medium sand.  Becomes weakly cemented from 5  | 5.60m.                | -                     | * × ×          |               |                                      |               |                    |                          |   |                     |         |               |         | 100                        | HQ          | e Wir                |                        |        |                               |                       |                          |
|              |   |                       | -                     | × × ×          | }             |                                      |               |                    |                          |   |                     |         |               |         |                            |             | Triple Tube Wireline |                        |        |                               |                       |                          |
|              |   |                       | 6-                    | × × ×          | <b>,</b>      |                                      |               |                    |                          |   |                     |         |               |         |                            |             | Trip                 |                        |        |                               |                       |                          |
|              |   |                       |                       | * * *          | 9             | 4//2/3/2/2                           |               |                    |                          |   |                     |         |               |         | 100                        | SPT         | 오                    |                        |        |                               |                       |                          |
|              |   |                       | _                     | × × ×          | }             |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | Abundant weakly cemented fine to<br>sand fragments from 6.60m to 6.8  | o medium<br>30m.      | -                     | × × ×          |               |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | -   |                       | 7-                    | × ×            | <u> </u>      |                                      |               |                    |                          |   |                     |         |               |         | 100                        | HQ          |                      |                        |        |                               |                       |                          |
|              | Clayey SILT; grey, hard, slightly pl  | Jactic                | · -                   | × × ×          | 1             |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | trace 1-3mmØ angular gravel.  | nasiic,               | 114 -                 | × <u>×</u> ×   | ;<br>;        |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | SILT; with trace fine sand, grey me   | ottled                | -                     | × × ×          | 1             | 8//6/9/8/11                          |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | orangish brown, hard, brittle, some staining.   | ie limonite           | -                     | × ^ ×          | 134           | Onorardi i i                         |               |                    |                          |   |                     |         |               |         | 100                        | SPT         |                      |                        |        |                               |                       |                          |
|              | Fine to medium SAND; grey mottle brown, medium dense, brittle, wea  | le orangish<br>akly   | 8-                    |                |               |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | cemented.  SILT; with trace fine sand, grey me  | ottled                | _ =                   | × ×            | 1             |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | orangish brown, hard, brittle, some staining.   |                       | -                     | × × ×          | ] i           |                                      |               |                    |                          |   |                     |         |               |         | 100                        | HQ          |                      |                        |        |                               |                       |                          |
|              | -   |                       | -                     | x × ×          |               |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | Lenses of greyish pink silt and dar fine to medium sand from 8.80m.   |                       | 9-                    | × ^ ×<br>× × × |               |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              |   |                       | -                     | × × ×          | 35            | 7//9/9/6/11                          |               |                    |                          |   |                     |         |               |         | 100                        | SPT         |                      |                        |        |                               |                       |                          |
|              | Fine to modition CANDOTONIS   |                       | _112 -                | × × ×          |               |                                      |               |                    |                          |   |                     |         |               |         |                            |             |                      |                        |        |                               |                       |                          |
|              | Fine to medium SANDSTONE; ex<br>weak, moderately weathered, limo  |                       | -                     |                |               |                                      | EVA           | NAVA (             |                          |   |                     |         |               | 000     |                            | LIC         |                      |                        |        |                               |                       |                          |
|              | staining.   |                       | -                     |                |               |                                      | EW            | MW                 |                          |   |                     |         |               | 26      | 58                         | HQ          |                      |                        |        |                               |                       |                          |
|              | L   |                       |                       | 1              |               |                                      |               |                    |                          | Ш | ШШ                  | 10-     | ARTED         |         |                            |             | I =                  | ISHED                  |        |                               | 14404K                | _                        |

| NOTES |
|-------|
|-------|

LOG\_A3 (8PHOTO PAGE) 1-00935.25 MANUKA ROAD RESERVOIRS GEOTECHNICAL TESTING.GPJ OPUS CHCH DEC12.GDT 13/12/13

Borehole was backfilled upon completion. T. = Topsoil.

31/10/2013 31/10/2013 DRILLING CO.
Drillforce Ltd DRILLER Glen INCLINATION/ AZIMUTH LOGGED Tractor -90° CHECKED A George JOB NO. 1-C0935.25 T Van Deelen Watercare Services Limited

FINISHED

BH13/05

STARTED

SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS

LOGGED I LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) GUIDELINES



| BOREHOLE LOG           |                     |          |                |        |  |  |  |  |  |
|------------------------|---------------------|----------|----------------|--------|--|--|--|--|--|
| PROJECT                | CO-ORD.             | R.L.     | SHEET          |        |  |  |  |  |  |
| Manuka Road Reservoirs | 1746014 E 5910793 N | 121.35 m |                | 2 of 2 |  |  |  |  |  |
| LOCATION               | REF. GRID           | DATUM    | HOLE<br>LENGTH |        |  |  |  |  |  |

|              |   |                       |             |               | See Site                             | Plan          |                    |                |               |          | SI                     | M 6472 SO | 6115    | 9                          | N           | ISL A                   | kld. 1                 | 946    | LENGTI                        | 15.        | 45 m  |
|--------------|---|-----------------------|-------------|---------------|--------------------------------------|---------------|--------------------|----------------|---------------|----------|------------------------|-----------|---------|----------------------------|-------------|-------------------------|------------------------|--------|-------------------------------|------------|-------|
|              |   |                       |             |               | TESTS .                              | I             |                    | ŋ              |               |          | CORE                   |           |         |                            |             | DRII                    |                        | N C    |                               |            |       |
| GEOLOGY/UNIT | MAIN DESCRIPTION  | R.L. (m)<br>DEPTH (m) | GRAPHIC LOG | SPT 'N' VALUE | SPT BLOW<br>COUNTS OR<br>SHEAR VALUE | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIP<br>degree | s DETAII | LED DESCRI             | PTION     | RQD (%) | TOTAL CORE<br>RECOVERY (%) | SAMPLE TYPE | DRILLING<br>METHOD      | DRILLING<br>FLUID LOSS | CASING | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER | OTHER |
|              | SILT; with trace clay, light grey, hard, slightly plastic, some 1-2mmØ lenses of  | -                     | × × ×       | 1             |                                      |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              | dark grey silt.   |                       | × × ×       | }             |                                      |               |                    |                |               |          |                        |           | 26      | 58                         | HQ          |                         |                        |        |                               |            |       |
|              |   | -                     | × × ×       | 17            | <br> <br>  3//1/2/6/6                |               |                    |                |               |          |                        |           |         | 100                        | SPT         |                         |                        |        |                               |            |       |
|              | Silty fine SAND; light grey, loose to medium  | -                     | ×<br>×      | 1             |                                      |               |                    |                |               |          |                        |           |         | 100                        | JF I        |                         |                        |        |                               |            |       |
|              | dense, brittle, weakly cemented. Streaked purple and brown from 10.90m. Occasional 5cm thick layers of clayey silt      | 11-                   | ×           |               | <br>                                 |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              | from 11.00m.  | _110 -                | × × .       |               | <br>                                 |               |                    |                |               |          |                        |           |         | 100                        | HQ          |                         |                        |        |                               |            |       |
|              | Fragments of moderately cemented fine to coarse SAND; with some silt, light grey streaked brown, medium dense, brittle, | -<br>-                |             |               | <br>                                 |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              | some limonite staining.   | 12-                   |             |               | <u> </u>                             |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | -                     |             | 25            | 7//6/6/6/7                           |               |                    |                |               |          |                        |           |         | 100                        | SPT         | eline                   |                        |        |                               |            |       |
| ٦            |   | -                     |             |               | <br>                                 |               |                    |                |               |          |                        |           |         |                            |             | HQ Triple Tube Wireline |                        |        |                               |            |       |
| Colluvium    |   | -                     |             |               |                                      |               |                    |                |               |          |                        |           |         |                            |             | ole Tut                 |                        |        |                               |            |       |
| ဝိ           |   | 13-                   |             |               | <br>                                 |               |                    |                |               |          |                        |           |         | 100                        | HQ          | JO Trip                 |                        |        |                               |            |       |
|              |   | 108 -                 |             |               |                                      |               |                    |                |               |          |                        |           |         |                            |             | _                       |                        |        |                               |            |       |
|              |   |                       |             |               | <br>                                 |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | -                     |             | 22            | 7//5/6/5/6                           |               |                    |                |               |          |                        |           |         | 49                         | SPT         |                         |                        |        |                               |            |       |
|              | Some 1-3cmØ angular fragments of sandstone from 13.95m.   | 14-                   |             |               |                                      |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              | Poor recovery from 14.20m to 15.00m.<br>Fine SANDSTONE; extremely weak, slightly  | -                     |             |               | <br>                                 |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              | weathered, suspected fine grained materials washed away during drilling.  | _                     |             |               |                                      |               |                    |                |               |          |                        |           |         | 43                         | HQ          |                         |                        |        |                               |            |       |
|              |   | -                     |             |               |                                      |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              | Fine to medium SAND; grey, dense, brittle, weakly cemented.   | 15-                   |             |               | <u> </u><br>                         |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | _106 -                |             | 50            | 6//9/16/19/6<br> <br>                |               |                    |                |               |          |                        |           |         | 100                        | SPT         |                         |                        |        |                               |            |       |
|              |   | -                     |             |               | <br>                                 |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              | End of Borehole from 15.45m.  | 16-                   |             |               | i<br>I                               |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | -                     |             |               |                                      |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   |                       |             |               | <br>                                 |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | -                     |             |               | <u> </u>                             |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | 17-                   |             |               | <br>                                 |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | 104 -                 |             |               | <br>                                 |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | _                     |             |               | <u> </u>                             |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | -                     |             |               | <br>                                 |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | 18-                   |             |               | <br>                                 |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | _ =                   |             |               | <u> </u>                             |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | -                     |             |               | <br>                                 |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | _                     |             |               | <br>                                 |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | 19-                   |             |               | <u> </u>                             |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | _102 -                |             |               | <br>                                 |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | -                     |             |               |                                      |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
|              |   | _                     |             |               | <br>                                 |               |                    |                |               |          |                        |           |         |                            |             |                         |                        |        |                               |            |       |
| 10           | TES   |                       |             |               |                                      |               |                    |                |               | 3        | STARTED                | 31/10/2   | 013     |                            |             | FIN                     | ISHED                  | 31     | /10/20                        | 13         |       |
|              | hole was backfilled upon completion.<br>Topsoil.  |                       |             |               |                                      |               |                    |                |               | I        | DRILLER                | Glen      |         |                            |             | DRI                     | ILLING (               | CO.    | Iforce                        |            |       |
|              |   |                       |             |               |                                      |               |                    |                |               | 1        | NCLINATION/<br>AZIMUTH | -90°      |         |                            |             |                         | ILLING F               |        | Fractor                       |            |       |
|              |   |                       |             |               |                                      |               |                    |                |               | L        | -OGGED                 | T Van Da  | alan    |                            |             | Сн                      | ECKED                  | 2000   | _                             |            |       |

| NO | т | ES |  |
|----|---|----|--|
| _  |   |    |  |

INCLINATION/ AZIMUTH LOGGED SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS

31/10/2013 31/10/2013 DRILLING CO.
Drillforce Ltd DRILLER Glen Tractor -90° CHECKED A George
JOB NO.
1-C0935.25 T Van Deelen BH13/05 CLIENT Watercare Services Limited

LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) GUIDELINES

LOGGED I

Watercare Services Limited

Borehole 13/05





0.00m - 3.00m



3.00m – 5.60m

Watercare Services Limited

Borehole 13/05





5.60m – 8.30m Box 3 of 6



8.30m – 11.30m Box 4 of 6

Watercare Services Limited

Borehole 13/05





12.50m – 14.30m Box 5 of 6





|          |                        |            |           |               | HOLE NO. |         |
|----------|------------------------|------------|-----------|---------------|----------|---------|
|          | BOREHOLE LO            | OG         |           |               | BH1      | 3/06    |
| PROJECT  |                        | CO-ORD.    |           | R.L.          | SHEET    |         |
|          | Manuka Road Reservoirs | 1745990 E  | 5910831 N | 120.96 m      |          | 1 of 2  |
| LOCATION |                        | REF. GRID  |           | DATUM         | HOLE     |         |
|          | Soo Sito Plan          | SM 6472 SO | 61150     | MCI VAIN 1016 | LENGTH   | 15 15 m |

|              |   |                       | T                                       | _                                       | See Site<br>ESTS                | - Iuii        | <u> </u>           |                |                  |      | - 011              | 1 6472 SO |         |                            | ORE             |                         | SL Akld. 1946<br>DRILLING |  |                               | 15                        | _   |  |  |  |
|--------------|---|-----------------------|---|---|---------------------------------|---------------|--------------------|----------------|------------------|------|--------------------|-----------|---------|----------------------------|-----------------|-------------------------|---------------------------|--|-------------------------------|---------------------------|---|--|--|--|
| GEOLOGY/UNIT | MAIN DESCRIPTION  | R.L. (m)<br>DEPTH (m) | GRAPHIC LOG                             | SPT 'N' VALUE                           |                                 | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIP  degrees 0 9 | DETA | ILED DESCRII       | PTION     | RQD (%) | TOTAL CORE<br>RECOVERY (%) | YPE             | DRILLING<br>METHOD      | S                         | CASING   | BASE OF HOLE<br>& WATER LEVEL | - PIEZOMETER<br>- DETAILS |   |  |  |  |
| Topsoil      | SILT; with trace clay, brown, firm, slightly plastic, abundant rootlets.  |                       | - 10 10<br>- 7 7 7 1                    | 3                                       |                                 |               |                    |                |                  |      |                    |           |         |                            |                 |                         |                           |  |                               |                           |   |  |  |  |
| _            | CLAY; with some silt, brownish grey streaked orange and grey, firm, plastic.  | 120                   |   |   |                                 |               |                    |                |                  |      |                    |           |         | 100                        | НА              | Hand Auger              |                           |  |                               |                           |   |  |  |  |
|              | CLAY; with trace silt, grey streaked orange, firm, plastic, occasional specks of white silt.  | 1                     |   |   |                                 |               |                    |                |                  |      |                    |           |         |                            |                 | _                       |                           |  |                               |                           |   |  |  |  |
|              | Some lenses of orangish brown silty fine sand with trace clay from 1.80m.  Some limonite streaks from 2.10m.  | - 2·                  |   | 4                                       | 1//1/1/1/1                      |               |                    |                |                  |      |                    |           |         | 100                        | SPT             |                         |                           |  |                               |                           |   |  |  |  |
|              | Clayey SILT; brownish grey, firm, slightly plastic, some lenses of non to weakly cemented silty fine to medium sand with manganese staining.  |                       | × × × × × × × × × × × × × × × × × × ×   |   |                                 |               |                    |                |                  |      |                    |           |         |                            | 100             | HQ                      |                           |  |                               |                           |   |  |  |  |
|              |   | <sup>-118</sup> 3     | × × × × × × × × × × × × × × × × × × ×   |   | <br>                            | <br>          | <br>               |                |                  |      |                    |           |         |                            |                 |                         | 100                       | PT   |                               |                           |   |  |  |  |
|              | SILT; with some clay and minor fine sand, light bluish grey, stiff, slightly plastic, some 1-5mmØ angular silt fragments.   |                       | - × ×<br>-× ×<br>-× × ×                 | 7                                       | 2//2/1/2/2                      |               |                    |                |                  |      |                    |           |         | 87                         | SPT             |                         |                           |  |                               |                           |   |  |  |  |
|              | SILT; with trace fine to medium sand, light grey, firm, brittle, some 1-5mmØ angular silt fragments.  | - 4                   | - × × × × × × × × × × × ×               | ,                                       |                                 |               |                    |                |                  |      |                    |           |         | 100                        | HQ              |                         |                           |  |                               |                           |   |  |  |  |
|              | Occasional pink and purple streaks of<br>clayey silt from 4.40m.  | _116                  | × ^ ×<br>-× ×<br>-× ×<br>-× ×           | 4                                       | <br> <br>  1//1/1/1/1<br>       |               |                    |                |                  |      |                    |           |         | 100                        | SPT             |                         |                           |  |                               |                           | Tribut the  |  |  |  |
| Colluvium    | SILT; with some clay, firm, light bluish grey, slightly plastic, occasional 1-5mmØ angular silt fragments.  | 5                     | - × × × - × × × - × × × × × × × × × × × | ><br>><br>><br>><br>>                   |                                 |               |                    |                |                  |      |                    |           |         | 93                         | HQ              | e Wireline              |                           |  |                               |                           | THEFT THE STATE AND A STATE OF  |  |  |  |
|              | Clayey SILT; light bluish grey, stiff, plastic.  SILT; with trace clay, stiff, slightly plastic, occasional 2-3cmØ hard silt fragments and purple streaks.                            | - 6                   | × × × × × × × × × × × × × × × × × × ×   | , 8                                     | <br> -<br> -<br>  3//1/2/3/2    |               |                    |                |                  |      |                    |           |         | 100                        | SPT             | HQ Triple Tube Wireline |                           |  |                               |                           |   |  |  |  |
|              |   | <sup>-114</sup> 7     | -114 7                                  |   |                                 |               |                    |                |                  |      |                    |           |         | 77                         | HQ              |                         |                           |  |                               |                           | and the same when the same and |  |  |  |
|              |   |                       |   | 8                                       | <br> <br> <br> <br>  2//2/2/2/2 |               |                    |                |                  |      |                    |           |         | 0                          | SPT             |                         |                           |  |                               |                           |   |  |  |  |
|              | Some 2-5mmØ angular silt fragments from 7.95m. SILT; with trace fine sand, light bluish grey, stiff, brittle. Some 1-2cmØ angular weakly cemented sand fragments from 8.40m to 8.50m. | 8                     |   | > |                                 |               |                    |                |                  |      |                    |           |         | 100                        | HQ              |                         |                           |  |                               |                           |   |  |  |  |
|              | Silty CLAY; light bluish grey, stiff, plastic.  | _ <sup>112</sup> 9    | × × × × × × × × × × × × × × × × × × ×   | 8                                       | 4//2/2/2/2                      |               |                    |                |                  |      |                    |           |         | 100                        | SPT             |                         |                           |  |                               |                           |   |  |  |  |
|              | SILT; with trace clay, bluish grey, stiff, slightly plastic, 1-3mmØ angular mudstone fragments.   |                       | - × × × - × ×                           | ,                                       |                                 |               |                    |                |                  |      |                    |           |         | 68                         | HQ              |                         |                           |  |                               |                           |   |  |  |  |
| NO1<br>Bore  | FES hole was backfilled upon completion.  |                       |   |   |                                 |               |                    |                |                  |      | STARTED<br>DRILLER | 5/11/20   | 13      |                            |                 |                         | SHED                      |  | 11/20                         | 13                        | _   |  |  |  |
|              |   |                       |   |   |                                 |               |                    |                |                  |      | INCLINATION        | Glen      |         |                            |                 |                         | LLING C                   | Dril   | lforce                        | Ltd                       |   |  |  |  |
|              |   |                       |   |   |                                 |               |                    |                |                  |      | AZIMUTH<br>LOGGED  | -90°      |         |                            | Tractor CHECKED |                         |                           | <u>r                                      </u> | _                             |                           |   |  |  |  |
|              |   |                       |   |   |                                 |               |                    |                |                  |      | CLIENT             | T Van De  | elen    |                            |                 | JOB                     | A (                       | Georg  | e                             | BH1                       | 3   |  |  |  |

| NOTES                   |
|-------------------------|
| Borehole was backfilled |
|                         |

| SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS | Watercare Services Limited | 1-C0935.25   |          |
|---|----------------------------|--------------|----------|
| 0   | CLIENT                     | JOB NO.      | DH 13/00 |
|   | T Van Deelen               | A George     | BH13/06  |
|   | LOGGED                     | CHECKED      |          |
|   | AZIMUTH -90°               | Tractor      |          |
|   | INCLINATION                | DRILLING RIG |          |
|   | Glen                       | d            |          |
|   | DRILLER                    |              |          |
|   | 5/11/2013                  | 5/11/2013    |          |
|   | STARTED                    | FINISHED     |          |



|                        |                     |              | HOLE NO.       |
|------------------------|---------------------|--------------|----------------|
| BOREHOLE LO            | OG                  |              | BH13/06        |
| PROJECT                | CO-ORD.             | R.L.         | SHEET          |
| Manuka Road Reservoirs | 1745990 E 5910831 N | 120.96 m     | 2 of 2         |
| LOCATION               | REF. GRID           | DATUM        | HOLE           |
| Soo Sito Plan          | SM 6472 SO 61159    | MSI ANN 1946 | LENGTH 15.45 m |

|              |  | See Site Plan                |   |             |                                |                                  |                    |                | SM 6472 SO 61159 CORE |    |            |                 | MSL Akid. 1946<br>DRILLING |                            |                         |                    | 15.     |              |                               |                    |  |
|--------------|--|------------------------------|---|-------------|--------------------------------|----------------------------------|--------------------|----------------|-----------------------|----|------------|-----------------|----------------------------|----------------------------|-------------------------|--------------------|---------|--------------|-------------------------------|--------------------|--|
| GEOLOGY/UNIT | MAIN DESCRIPTION   | R.L. (m)<br>DEPTH (m)        | GRAPHIC LOG   | $\vdash$    | SPT BLOW COUNTS OR SHEAR VALUE | ROCK STRENGTH                    | ROCK<br>WEATHERING | DEFECT SPACING | DIP<br>degree         |    | NILED DESC | CRIPTION        | RQD (%)                    | TOTAL CORE<br>RECOVERY (%) | SAMPLE TYPE             | DRILLING<br>METHOD | S       | CASING       | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER DETAILS |  |
|              | SILT; with trace clay, bluish grey, stiff,<br>slightly plastic, 1-3mmØ angular mudstone<br>fragments.  Some moderately cemented fine to                            |                              |   | <b>&gt;</b> |                                |                                  |                    |                |                       | 30 |            |                 |                            | 68                         | HQ                      |                    |         |              |                               |                    | and the same   |
|              | Some moderately cemented fine to mediums sand lenses from 10.30m to 10.50m. Occasional 1-4mmØ angular silt fragments. CLAY; with some silt, brown, stiff, plastic. |                              | × × × × × × × × × × × × × × × × × × ×   | 7           | <br> <br> <br>  3//1/2/2/2     |                                  |                    |                |                       |    |            |                 |                            | 100                        | SPT                     |                    |         |              |                               |                    | and the same of th |
|              | SILT; with trace clay, stiff, slightly plastic, occasional weakly cemented fine to medium sand lenses.   | 110<br>11-                   | <br>  ×   | <br>        |                                |                                  |                    |                |                       |    |            |                 |                            |                            |                         |                    |         |              |                               |                    | Characters are   |
|              |  |                              | × × × × × × × × × × × × × × × × × × ×   | <b>&gt;</b> |                                |                                  |                    |                |                       |    |            |                 |                            | 100                        | HQ                      |                    |         |              |                               |                    | en and and and   |
|              |  | <sup>-</sup> 12 <sup>.</sup> | - × × × - × × - × × - × × × - × × × - × | 9           | 3//3/2/2/2                     |                                  |                    |                |                       |    |            |                 |                            | 100                        | SPT                     | Wireline           |         |              |                               |                    | Newstrans control  |
| Colluvium    | Some 1-3cmØ angular mudstone fragments from 12.50m.  |                              |   |             |                                |                                  |                    |                |                       |    |            |                 |                            |                            | HQ Triple Tube Wireline |                    |         |              |                               | - nancaura         |  |
| O            |  |                              | × × × × × × × × × × × × × × × × × × ×   | )<br>)<br>) |                                |                                  |                    |                |                       |    |            |                 |                            | 57                         | HQ                      | 외                  |         |              |                               |                    |  |
|              |  |                              |   | 6           | 2//1/2/1/2<br> <br>            |                                  |                    |                |                       |    |            |                 |                            | 62                         | SPT                     |                    |         |              |                               |                    | differ retire trains to  |
|              | Some moderately cemented fine to medium sand fragments from 14.10m.  | 14                           | - × × × × × × × × × × × × × × × × × × ×                                       | ><br>><br>> |                                |                                  |                    |                |                       |    |            |                 |                            | 100                        | HQ                      |                    |         |              |                               |                    | vara vara vara   |
|              | SILT; with trace fine sand, hard, brittle,<br>some 1-2cmØ angular mudstone fragments.  | _ <sup>106</sup>             |   | <b>,</b>    |                                |                                  |                    |                |                       |    |            |                 |                            | 100                        | ΠQ                      |                    |         |              |                               |                    | A reference on   |
|              |  | 15                           | - × × × - × × - × × - × ×   | 16          | 3//1/3/3/9                     |                                  |                    |                |                       |    |            |                 |                            | 100                        | SPT                     |                    |         |              |                               |                    |  |
|              | End of Borehole at 15.45m.   | 16                           |   |             |                                |                                  |                    |                |                       |    |            |                 |                            |                            |                         |                    |         |              |                               |                    |  |
|              |  |                              | -<br>-<br>-<br>-  |             |                                |                                  |                    |                |                       |    |            |                 |                            |                            |                         |                    |         |              |                               |                    |  |
|              |  | - <sup>104</sup>             | -<br>-<br>-<br>-  |             |                                |                                  |                    |                |                       |    |            |                 |                            |                            |                         |                    |         |              |                               |                    |  |
|              |  |                              | -<br>-<br>-<br>-<br>-   |             |                                |                                  |                    |                |                       |    |            |                 |                            |                            |                         |                    |         |              |                               |                    |  |
|              |  | - 18·                        | -<br>-<br>-<br>-  |             |                                |                                  |                    |                |                       |    |            |                 |                            |                            |                         |                    |         |              |                               |                    |  |
|              |  |                              |   |             |                                |                                  |                    |                |                       |    |            |                 |                            |                            |                         |                    |         |              |                               |                    |  |
|              |  | <sup>102</sup>               | -   |             |                                |                                  |                    |                |                       |    |            |                 |                            |                            |                         |                    |         |              |                               |                    |  |
|              |  |                              | -   |             |                                |                                  |                    |                |                       |    |            |                 |                            |                            |                         |                    |         |              |                               |                    |  |
|              |  |                              | -   |             |                                |                                  |                    |                |                       |    | STARTED    |                 |                            |                            |                         | FINI               | ISHED   |              |                               |                    |  |
|              | FES hole was backfilled upon completion.   |                              |   |             |                                |                                  |                    |                |                       |    | DRILLER    | 5/11/20<br>Glen |                            |                            |                         | DRI                | LLING C | Co.<br>Drill | 11/201<br>Iforce              |                    |  |
|              |  |                              |   |             |                                | Inclination/ AZIMUTH -90° LOGGED |                    |                |                       |    | LLING F    | r               |                            |                            |                         |                    |         |              |                               |                    |  |
|              | ED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005)   | GLIIDELINE                   | :q  |             | SEE ATTA                       | NOUED V                          | CV OUE             |                |                       |    | CLIENT     | T Van De        | elen                       |                            |                         |                    | A (     | Georg        | <u>e</u>                      | BH1                | 3/   |

|      | NOTES   |   | STARTED             | FINISHED              |         |  |  |
|------|---|---|---------------------|-----------------------|---------|--|--|
|      | NOTES   | 5/11/2013   | 5/11/2013           |                       |         |  |  |
| 3    | Borehole was backfilled upon completion.                            | DRILLER<br>Glen                                   | Drillforce Ltd      |                       |         |  |  |
| ٥    |   |   | INCLINATION/        | DRILLING RIG Tractor  |         |  |  |
| 7,17 |   |   | Logged T Van Deelen | CHECKED A George      |         |  |  |
| íL   | LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) GUIDELINES | SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS | CLIENT              | JOB NO.<br>1-C0935.25 | BH13/06 |  |  |

Watercare Services Limited

Borehole 13/06





0.00m – 2.80m Box 1 of 5



2.80m – 5.20m Box 2 of 5

Watercare Services Limited

## Borehole 13/06





5.20m – 8.80m Box 3 of 5



8.80m – 11.95m Box 4 of 5

Watercare Services Limited

# Borehole 13/06





11.95m – 15.45m (E.O.H)

Box 5 of 5



| HoL      |                        |                     |               |         |  |  |  |  |  |  |  |
|----------|------------------------|---------------------|---------------|---------|--|--|--|--|--|--|--|
|          | BOREHOLE LO            | OG                  |               | BH13/07 |  |  |  |  |  |  |  |
| PROJECT  |                        | CO-ORD.             | R.L.          | SHEET   |  |  |  |  |  |  |  |
|          | Manuka Road Reservoirs | 1746025 E 5910818 N | 119.20 m      | 1 of 2  |  |  |  |  |  |  |  |
| -OCATION |                        | REF. GRID           | DATUM         | HOLE    |  |  |  |  |  |  |  |
|          | 0 0'1 - Pl             | 014 0470 00 04450   | MOL ALL: 4040 | LENGTH  |  |  |  |  |  |  |  |

|              |   |                       |  | Т             | ESTS                                 | Ŧ             |                    | 9              |                   |         |                               |          |         | CORE                       |             |                      | DRII                   | LLING              | ì                             |                      |     |
|--------------|---|-----------------------|--|---------------|--------------------------------------|---------------|--------------------|----------------|-------------------|---------|-------------------------------|----------|---------|----------------------------|-------------|----------------------|------------------------|--------------------|-------------------------------|----------------------|-----|
| GEOLOGY/UNIT | MAIN DESCRIPTION  | R.L. (m)<br>DEPTH (m) | GRAPHIC LOG                            | SPT 'N' VALUE | SPT BLOW<br>COUNTS OR<br>SHEAR VALUE | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIP  degrees 0 90 | DETAILE | ED DESCRIP                    | TION     | RQD (%) | TOTAL CORE<br>RECOVERY (%) | SAMPLE TYPE | DRILLING             | DRILLING<br>FLUID LOSS | CASING             | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER B DETAILS |     |
| Topsoil      | SILT; with trace clay, brown, firm, slightly plastic, some rootlets.  |                       | 11 11 11 11 11 11 11 11 11 11 11 11 11 | 4             |                                      |               |                    |                |                   |         |                               |          |         |                            |             |                      |                        |                    |                               |                      | < \ |
| Tc           | Fine sandy CLAY; with some silt and trace<br>angular fine gravel, greyish brown mottled<br>grey and streaked orange, firm, plastic, |                       |  |               |                                      |               |                    |                |                   |         |                               |          |         |                            |             | _                    |                        |                    |                               | Ш                    |     |
| ш            | trace limonite staining.  CLAY; with trace silt, grey mottled orange, firm, plastic, trace limonite streaks, trace                  |                       |  |               |                                      |               |                    |                |                   |         |                               |          |         | 100                        | НА          | Hand Auger           |                        |                    |                               | Ш                    |     |
| Colluvium    | grey silt specks.   | 1-                    |  |               |                                      |               |                    |                |                   |         |                               |          |         |                            |             | Har                  |                        |                    |                               | Ш                    |     |
| ŏ            | CLAY; with some silt, grey streaked orange, firm, plastic, trace limonite staining.   | _118                  |  |               |                                      |               |                    |                |                   |         |                               |          |         |                            |             |                      |                        |                    |                               | Ш                    |     |
|              |   |                       |  | 2             | 1//0/1/0/1                           |               |                    |                |                   |         |                               |          |         | 44                         | SPT         |                      |                        |                    |                               | Ш                    |     |
|              | CLAY; with trace silt, bluish grey, firm, plastic, trace fibrous organics.  | 2-                    |  |               |                                      |               |                    |                |                   |         |                               |          |         |                            |             |                      |                        |                    |                               | 81818                |     |
| Alluvium     | Fine sandy SILT; with trace clay, bluish grey, very stiff, slightly plastic, occasional   | -                     | × × ×                                  |               |                                      |               |                    |                |                   |         |                               |          |         | 100                        |             |                      |                        |                    |                               |                      |     |
| All          | 1-2cmØ angular gravel, occasional fibrous organics.   |                       | × × ×                                  | }             |                                      |               |                    |                |                   |         |                               |          |         | 100                        | HQ          |                      |                        |                    |                               |                      | ÷   |
|              | SILT; with trace fine sand, bluish grey   | 3-                    | × × ×                                  |               |                                      |               |                    |                |                   |         |                               |          |         |                            |             |                      |                        |                    |                               |                      |     |
|              | mottled yellowish brown, hard, brittle.   | _116                  | × × × × ×                              |               |                                      |               |                    |                |                   |         |                               |          |         | 100                        | PT          |                      |                        |                    |                               |                      |     |
|              |   | -                     | × × × × × ×                            | 9             | 3//1/2/3/3                           |               |                    |                |                   |         |                               |          |         | 100                        | SPT         |                      |                        |                    |                               |                      |     |
|              | Silty fine SAND; bluish grey, medium dense, brittle, 50% weakly cemented.   | 4-                    | × × ×                                  |               |                                      |               |                    |                |                   |         |                               |          |         |                            |             |                      |                        |                    |                               |                      |     |
|              |   | F :                   | ×                                      |               |                                      |               |                    |                |                   |         |                               |          |         | 100                        | HQ          |                      |                        |                    |                               | 19/11/2013           |     |
|              | SILT; with trace clay, bluish grey, hard,   |                       | × × ×                                  | 16            | 6//4/4/3/5                           |               |                    |                |                   |         |                               |          |         | 100                        | SPT         |                      |                        |                    |                               | <b>X</b>             |     |
|              | brittle, 1-2cmØ angular mudstone fragments.   | 5-                    | × × × ×                                | 1             |                                      |               |                    |                |                   |         |                               |          |         |                            |             |                      |                        |                    |                               |                      |     |
|              | Eino SANDSTONE: dayl are:   | _114                  | × ×<br>× ×<br>× ×                      | }             |                                      |               |                    |                |                   |         |                               |          |         |                            |             | eline                |                        |                    |                               |                      |     |
|              | Fine SANDSTONE; dark grey, very weak, slightly weathered, massive.  | :                     |  |               |                                      |               |                    |                |                   |         |                               |          | 57      | 100                        | HQ          | Triple Tube Wireline |                        |                    |                               |                      |     |
|              |   | 6-                    |  | E0:           | <br> <br>  50 for                    |               |                    |                |                   |         |                               |          |         | 100                        | SPT         | Triple T             |                        |                    |                               | 11                   |     |
| шn           |   | -                     |  | 50+           | 50 for<br>150mm                      |               |                    |                |                   |         |                               |          |         | 100                        | 5, 1        | 오                    |                        |                    |                               |                      |     |
| Colluvium    |   | -                     | _                                      |               |                                      | VW            | SW                 |                |                   |         |                               |          |         |                            |             |                      |                        |                    |                               |                      | i   |
| _            |   | 7-                    |  |               |                                      |               |                    |                |                   |         |                               |          | 100     | 100                        | HQ          |                      |                        |                    |                               |                      |     |
|              |   | _112                  |  |               |                                      |               |                    |                |                   |         |                               |          |         |                            |             |                      |                        |                    |                               |                      |     |
|              | Poor recovery from 7.50m to 9.45m.<br>Fragments of 1-4cmØ angular   | -                     | 0                                      | 23            | 7//6/6/5/6                           |               |                    |                |                   |         |                               |          |         | _                          |             |                      |                        |                    |                               |                      |     |
|              | SANDSTONE; dark grey, in a suspected fine grained matrix that has been washed away during drilling.                                 | 8-                    |  |               |                                      |               |                    |                |                   |         |                               |          |         | 0                          | SPT         |                      |                        |                    |                               |                      |     |
|              | · · · · · · · ·   | -                     |  |               |                                      |               |                    |                |                   |         |                               |          |         |                            |             |                      |                        |                    |                               |                      |     |
|              |   | -                     | 0 0 0                                  |               |                                      |               |                    |                |                   |         |                               |          |         | 10                         | HQ          |                      |                        |                    |                               |                      |     |
|              |   | ]                     | 0                                      |               |                                      |               |                    |                |                   |         |                               |          |         |                            |             |                      |                        |                    |                               |                      |     |
|              |   | 9-<br>_110            |  | 7             | 3//2/2/1/2                           |               |                    |                |                   |         |                               |          |         | 11                         | SPT         |                      |                        |                    |                               |                      |     |
|              | Fine sandy SILT; bluish grey, stiff, brittle,<br>1-3cmØ angular lenses of weakly cemented   | -                     | × ×                                    |               |                                      |               |                    |                |                   |         |                               |          |         |                            |             |                      |                        |                    |                               |                      |     |
|              | 1-3cm/p angular lenses of weakly cemented material.   |                       | × × × × × × × × × × × × × × × × × × ×  |               |                                      |               |                    |                |                   |         |                               |          |         | 100                        | HQ          |                      |                        |                    |                               |                      |     |
| NO           | TES .   |                       | ×                                      | 1             |                                      |               |                    |                |                   | Sī      | FARTED                        | 6/11/20  | 12      |                            |             | FIN                  | ISHED                  | 6/                 | 11/201                        | 3                    |     |
| Multi        | -level piezometer installed upon completion.<br>Topsoil   |                       |  |               |                                      |               |                    |                |                   |         | RILLER                        | Glen     |         |                            |             |                      | LLING                  | Co.<br><b>Dril</b> | Iforce I                      |                      |     |
|              |   |                       |  |               |                                      |               |                    |                |                   | Az      | CLINATION/<br>ZIMUTH<br>DGGED | -90°     |         |                            |             |                      | LLING F                |                    | Fractor                       |                      |     |
|              |   |                       |  |               |                                      |               |                    |                |                   | 120     | JUGED                         | T Van De | elen    |                            |             | OHE                  | _UNED<br>A (           | Georg              | е                             | BH1                  |     |

| NOTES |  |
|-------|--|
| NOTES |  |



|          | BOREHOLE LO            | OG         |           |                | BH1    | 3/07    |
|----------|------------------------|------------|-----------|----------------|--------|---------|
| PROJECT  |                        | CO-ORD.    |           | R.L.           | SHEET  |         |
|          | Manuka Road Reservoirs | 1746025 E  | 5910818 N | 119.20 m       |        | 2 of 2  |
| LOCATION |                        | REF. GRID  |           | DATUM          | HOLE   |         |
|          | Con Cita Dian          | CM 6472 CC | C44E0     | MCI AIRIN 4046 | LENGTH | 4 E 4 E |

|              |  |                       |                                     |                                       | See Site  | Plan          |                    |                |               |    | SI                 | M 6472 SO | 6115     | 59                         | N           | ISL A                   | Akld. 1                | 1946                | LENGTH                        | 15.                | 45 r  |
|--------------|--|-----------------------|-------------------------------------|---------------------------------------|---|---------------|--------------------|----------------|---------------|----|--------------------|-----------|----------|----------------------------|-------------|-------------------------|------------------------|---------------------|-------------------------------|--------------------|-------|
|              |  |                       |                                     |                                       | TESTS   | I             |                    | o              |               |    |                    |           |          | CORE                       |             |                         | DRII                   | LLING               |                               |                    |       |
| GEOLOGY/UNIT | MAIN DESCRIPTION   | R.L. (m)<br>DEPTH (m) | GRAPHIC LOG                         | SPT 'N' VALUE                         | SPT BLOW<br>COUNTS OR<br>SHEAR VALUE                | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIP<br>degree |    | .ED DESCRI         | IPTION    | RQD (%)  | TOTAL CORE<br>RECOVERY (%) | SAMPLE TYPE | DRILLING                | DRILLING<br>FLUID LOSS | CASING              | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER DETAILS | OTHER |
| _            | Silty fine SAND; bluish grey, medium dense,  | +                     | -× ×                                | -   "                                 | 0,00,   | _             |                    | <u> </u>       | 0             | 90 |                    |           | <u> </u> | _                          |             |                         | -                      |                     |                               | P1 P2              |       |
|              | Becomes weakly cemented from 10.40m to 10.50m.   |                       | × × × × × × ×                       | 16                                    | <br> <br> <br> <br>  8//5/5/3/3                     |               |                    |                |               |    |                    |           |          | 60                         | HQ          | -                       |                        |                     |                               |                    |       |
|              | Becomes moderately cemented from 10.95m to 11.20m.   | 11-                   | ] × ×                               |                                       |   |               |                    |                |               |    |                    |           |          |                            |             |                         |                        |                     |                               |                    |       |
|              | Clayey fine SAND; with trace silt, bluish grey, medium dense, slightly plastic, some 1-5cmØ angular sandstone fragments.                               | 108                   |                                     |                                       | <br> -<br> -<br> -<br> -                            |               |                    |                |               |    |                    |           |          | 77                         | HQ          |                         |                        |                     |                               |                    |       |
| _            | SILT; with some fine sand, some 1-6mmØ fine angular gravel and trace clay, bluish grey, hard, slightly plastic, occasional 1-3cmØ sandstone fragments. | 12-                   | × × × × × × × × × × × × × × × × × × | 14                                    | <br> <br> <br>  4//3/3/4/4<br>                      |               |                    |                |               |    |                    |           |          | 53                         | SPT         | e Wireline              |                        |                     |                               |                    |       |
| Collaviali   | Becomes moderately cemented from 12.70m to 12.80m.  SILT; with some clay and trace fine sand,  | 13 <sup>-</sup>       |                                     | ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; | <br> <br> <br> <br> <br>                            |               |                    |                |               |    |                    |           |          | 100                        | HQ          | HQ Triple Tube Wireline |                        |                     |                               |                    |       |
|              | bluish grey, stiff, slightly plastic, occasional<br>1-2cmØ moderately cemented sand<br>fragments.  |                       |                                     | 7                                     | <br> <br> <br> <br> <br>  4//1/1/3/2                |               |                    |                |               |    |                    |           |          | 0                          | SPT         | -                       |                        |                     |                               |                    |       |
|              |  | 14                    |                                     | ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; | -<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>- |               |                    |                |               |    |                    |           |          | 57                         | HQ          | _                       |                        |                     |                               |                    |       |
|              | Silty fine SAND; dark grey, medium dense, brittle, weakly cemented.  | 15·<br>_104           | - × × × - × × - ×                   |                                       | <br>  |               |                    |                |               |    |                    |           |          | 100                        | SPT         |                         | _                      |                     |                               |                    |       |
|              | End of Borehole at 15.45m.   | 16                    | -<br>-<br>-<br>-<br>-               |                                       |   |               |                    |                |               |    |                    |           |          |                            |             |                         |                        |                     |                               |                    |       |
|              |  |                       | -<br>-<br>-<br>-<br>-               |                                       | <br> <br> <br> <br>                                 |               |                    |                |               |    |                    |           |          |                            |             |                         |                        |                     |                               |                    |       |
|              |  | 17-<br>_102           |                                     |                                       | <br> <br> <br> <br>                                 |               |                    |                |               |    |                    |           |          |                            |             |                         |                        |                     |                               |                    |       |
|              |  | 18-                   | -<br>-<br>-<br>-<br>-               |                                       |   |               |                    |                |               |    |                    |           |          |                            |             |                         |                        |                     |                               |                    |       |
|              |  |                       | -<br>-<br>-<br>-<br>-               |                                       |   |               |                    |                |               |    |                    |           |          |                            |             |                         |                        |                     |                               |                    |       |
|              |  | 19 <sup>-</sup>       | -                                   |                                       |   |               |                    |                |               |    |                    |           |          |                            |             |                         |                        |                     |                               |                    |       |
|              |  |                       |                                     |                                       |   |               |                    |                |               |    |                    |           |          |                            |             |                         |                        |                     |                               |                    |       |
| lulti        | TES -level piezometer installed upon completion.   |                       |                                     |                                       |   |               | <u> </u>           | <u> </u>       |               |    | STARTED<br>DRILLER | 6/11/20   |          |                            | <u> </u>    |                         | ISHED                  | Co.                 | 11/201                        |                    | _     |
| -            | Topsoil  |                       |                                     |                                       |   |               |                    |                |               | 11 | NCLINATION/        | Glen      | 1        |                            |             |                         | ILLING F               | Dril<br>R <i>IG</i> | Ilforce I                     |                    | _     |
|              |  |                       |                                     |                                       |   |               |                    |                |               |    | AZIMUTH<br>.OGGED  | -90°      |          |                            |             | Сн                      | ECKED                  |                     | Tractor                       | ·                  |       |
|              |  |                       |                                     |                                       |   |               |                    |                |               | -  |                    | T Van Da  |          |                            |             | 1                       | Α.                     |                     |                               | 1                  |       |

INCLINATION/ AZIMUTH LOGGED SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS

6/11/2013 DRILLING CO.
Drillforce Ltd Tractor BH13/07

LOGGED I LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) GUIDELINES

-90° CHECKED A George JOB NO. 1-C0935.25 T Van Deelen CLIENT Watercare Services Limited

Watercare Services Limited

## Borehole 13/07





0.00m – 2.80m Box 1 of 5



2.80m – 6.00m Box 2 of 5

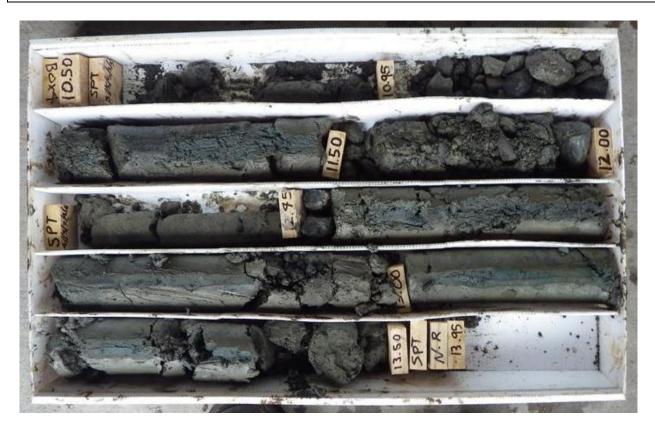
Watercare Services Limited

Borehole 13/07





6.00m – 10.50m Box 3 of 5



10.50m – 13.95m Box 4 of 5

| Manuka Reservoirs          |          |
|----------------------------|----------|
|                            |          |
| Watercare Services Limited | WWW OPUS |
| Borehole 13/07             |          |



13.95m – 15.45m (E.O.H) Box 5 of 5



|                        |                     |                | HOLE NO. |
|------------------------|---------------------|----------------|----------|
| BOREHOLE               | _OG                 |                | BH13/08  |
| PROJECT                | CO-ORD.             | R.L.           | SHEET    |
| Manuka Road Reservoirs | 1746063 E 5910827 I | 122.56 m       | 1 of 5   |
| LOCATION               | REF. GRID           | <i>DATUM</i>   | HOLE     |
| See Site Plan          | SM 6472 SO 61159    | MSL Akld. 1946 | 40.58 m  |

|                              |   |          |                       |                                       |               | See Site                             | Plan          |                    |                |                     |      | S          | M 6472 SO | 6115    | 9                          | IV          | ISL A                  | kld. 1                 | 946    |                               | 40.  | 58 m                     |
|------------------------------|---|----------|-----------------------|---------------------------------------|---------------|--------------------------------------|---------------|--------------------|----------------|---------------------|------|------------|-----------|---------|----------------------------|-------------|------------------------|------------------------|--------|-------------------------------|--|--------------------------|
|                              |   |          |                       |                                       | T             | ESTS                                 | I             |                    | o              |                     |      |            |           | (       | CORE                       |             |                        | DRII                   | LING   | _                             |  | N<br>O                   |
| GEOLOGY/UNIT                 |   | R.L. (m) | DEPTH (m)             | GRAPHIC LOG                           | SPT 'N' VALUE | SPT BLOW<br>COUNTS OR<br>SHEAR VALUE | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIP<br>egrees<br>90 | DET# | ILED DESCR | EIPTION   | RQD (%) | TOTAL CORE<br>RECOVERY (%) | SAMPLE TYPE | DRILLING<br>METHOD     | DRILLING<br>FLUID LOSS | CASING | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER DETAILS   | OTHER<br>INSTRUMENTATION |
| ToggoT                       | Sitty CLAY; brown mottled light brown, firm, plastic, abundant rootlets.  CLAY; with some silt, greyish brown streaked orange, firm, plastic, occasional 2mm lenses of brown, "hard" angular silt fragments.  | _122     | 2 -<br>2 -<br>1-<br>- |                                       |               |                                      |               |                    |                |                     |      |            |           |         | 100                        | НА          | Hand Auger             |                        |        |                               |  |                          |
|                              | CLAY; with trace silt, greyish brown, soft, plastic with very low remoulded strength. CLAY; with some silt, light greyish brown, stiff, plastic, trace 4cmØ lenses of dark reddish brown, brittle silty fine to medium sand.                          |          | 2-<br>2-<br>0 -       |                                       | 4             | 1//1/1/1/1                           |               |                    |                |                     |      |            |           |         | 69<br>77                   | SPT         |                        |                        |        |                               |  |                          |
|                              | Sitty fine to coarse SAND; greyish brown mottled orangish brown, medium dense, brittle.  Poor recovery from 3.45m to 4.95m. Fragments of 10-15cmØ, angular, weakly cemented fine to coarse SAND; in a suspected fine grained matrix that has been     |          | 3-                    | × × × × × × × × × × × × × × × × × × × | 20            | 5//3/4/5/8                           |               |                    |                |                     |      |            |           |         | 78                         | SPT         |                        |                        |        |                               |  |                          |
|                              | washed away during drilling.  | _11:     | -                     | × × × × × × × × × × × × × × × × × × × | 23            | 8//6/5/6/6                           |               |                    |                |                     |      |            |           |         | 56                         | HQ<br>SPT   |                        |                        |        |                               | 1941/2020   111/2020   1111/2020   1111/2020   1111/2020   1111/2020   1111/2020   1111/2020   1111/2020   1111/2020   1111/2020   1111/2020   1111/2020   111/2020   111/2020   111/2020   111/2020   111/2020   111/2020   111/2020   111/2020   111/2020   111/2020   111/2 |                          |
|                              | Clayey SILT; greyish brown, hard, plastic, some 2-5cmØ angular mudstone fragments and fine angular and rounded, grey and green gravels, some limonite and manganese streaks.  Becomes grey with trace fine sand and no manganese staining from 5.70m. | -        | 5                     |                                       |               |                                      |               |                    |                |                     |      |            |           |         | 100                        | HQ          | 2 Triple Tube Wireline |                        |        |                               |  |                          |
| 00 CHCH DECIZ.GD1 10/12/10   | SILT; with some fine sand and trace clay, grey, hard, slightly plastic, some fine to medium angular, red and green, gravels and occasional 2-5cmØ weakly cemented sand lenses.  | 110      | 6 —<br>7—             | × × × × × × × × × × × × × × × × × × × | 13            | 3//3/3/3/4                           |               |                    |                |                     |      |            |           |         | 90                         | SPT         | . OH                   |                        |        |                               |  |                          |
| GEOTECHINICAL TECTING GTG OT | Fine sandy SILT; dark grey, hard, brittle, with some fine to medium angular, grey, green and red, silt gravels.   |          | 8-<br>8-              | ×                                     | 14            | 4//4/5/4/5                           |               |                    |                |                     |      |            |           |         | 100                        | SPT         |                        |                        |        |                               |  |                          |
| 35.25 MAINONA ROAD AESENVOIN | Poor recovery from 9.45m to 10.5m. Fragments of moderately cemented fine to coarse SAND; dark grey, in a suspected  |          | 9                     | × × × × × × × × × × × × × × × × × × × | 19            | 4//4/5/4/6                           |               |                    |                |                     |      |            |           |         | 100                        | SPT         |                        |                        |        |                               |  |                          |
| NO NO                        | fine grained matrix that has been washed away during drilling.  DTES  |          | -                     | × ×<br>× ×                            |               |                                      |               |                    |                |                     |      | STARTED    | 16/10/20  | 112     | 20                         |             | FINI                   | SHED                   | 22     | 10/20                         |  |                          |

**NOTES** 

LOG\_A3 (&PHOTO PAGE) 1-C0935 25 MANUKA ROAD RESERVOIRS GEOTECHNICAL TESTING.GPJ OPUS CHCH DEC12.GDT 13/12/13

Single piezometer installed upon completion.

DRILLER INCLINATION/ AZIMUTH LOGGED 16/10/2013

Billy

-90°

22/10/2013 DRILLING CO.
Drillforce Ltd Tractor

LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) GUIDELINES

SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS

CHECKED A George JOB NO. 1-C0935.25 T Van Deelen BH13/08 CLIENT Watercare Services Limited



| Ho      |                        |            |           |              |        |         |  |  |  |  |  |
|---------|------------------------|------------|-----------|--------------|--------|---------|--|--|--|--|--|
|         | BOREHOLE LO            | )G         |           |              | BH1    | 3/08    |  |  |  |  |  |
| PROJECT |                        | CO-ORD.    |           | R.L.         | SHEET  |         |  |  |  |  |  |
|         | Manuka Road Reservoirs | 1746063 E  | 5910827 N | 122.56 m     |        | 2 of 5  |  |  |  |  |  |
| OCATION |                        | REF. GRID  |           | DATUM        | HOLE   |         |  |  |  |  |  |
|         | San Sita Plan          | SM 6472 SO | 61150     | MSI ANN 1946 | LENGTH | 40 58 m |  |  |  |  |  |

|              |  |   |                                       | T                                      | ESTS  | E             |                    | ō              |              |      |                     |          |         | CORE                       | _           |                         | DRIL                   | LING   |                               |                    | -                     |
|--------------|--|---|---------------------------------------|--|---|---------------|--------------------|----------------|--------------|------|---------------------|----------|---------|----------------------------|-------------|-------------------------|------------------------|--------|-------------------------------|--------------------|-----------------------|
| GEOLOGY/UNIT | MAIN DESCRIPTION   | R.L. (m)<br>DEPTH (m)                                   | GRAPHIC LOG                           | SPT 'N' VALUE                          | SPT BLOW<br>COUNTS OR<br>SHEAR VALUE            | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIP  degrees | DETA | AILED DESCR         | IPTION   | RQD (%) | TOTAL CORE<br>RECOVERY (%) | SAMPLE TYPE | DRILLING                | DRILLING<br>FLUID LOSS | CASING | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER DETAILS | _                     |
|              |  |   | × × × × × ×                           |  |   |               |                    |                |              |      |                     |          |         | 25                         | HQ          |                         |                        |        |                               |                    | TAY PA                |
|              | Fine to medium sandy SILT; dark grey, hard, brittle, some fine to medium angular, grey and green, gravels and occasional 3cmØ weakly cemented sand lenses.                                   | 112 -<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>- | × × × × × × × × × × × × × × × × × × × | 13                                     | 3//3/3/3/4                                      |               |                    |                |              |      |                     |          |         | 82                         | SPT         |                         |                        |        |                               |                    |                       |
|              | Becomes a silt with some fine to medium sand from 11.50m.  |   | × × × × × × × ×                       | )<br>;<br>;                            |   |               |                    |                |              |      |                     |          |         | 100                        | HQ          |                         |                        |        |                               |                    | 1                     |
|              |  | 12-   | × × × × × × × × × × × × × × × × × × × | 10                                     | 3//2/2/3/3                                      |               |                    |                |              |      |                     |          |         | 76                         | SPT         | Wireline                |                        |        |                               |                    | 2 . 2                 |
|              | Becomes mottled brown from 12.45m to 12.70m with fine to medium angular, dark grey, gravel from 12.45m.  | 110 -   | × × × × × × × × × × × × × × × × × × × | ><br>><br>><br>><br>><br>>             |   |               |                    |                |              |      |                     |          |         | 100                        | HQ          | HQ Triple Tube Wireline |                        |        |                               |                    |                       |
|              | Fine to medium SAND; dark grey, medium dense, brittle.   |   | × × ×                                 | 15                                     | <br> <br> <br>  4//4/3/4/4                      |               |                    |                |              |      |                     |          |         | 71                         | SPT         |                         |                        |        |                               |                    | 2                     |
|              | SILT; with some clay and trace fine sand, hard, slightly plastic, some 1-4cmØ angular mudstone fragments. SILT; with trace fine sand, hard, brittle, some 3-5cmØ angular mudstone fragments. | 14-   | × × × × × × × × × × × × × × × × × × × | )<br>)                                 | <del>                                    </del> |               |                    |                |              |      |                     |          |         |                            | 251         |                         |                        |        |                               |                    |                       |
|              | Some fine to medium angular to rounded, grey and green, gravel from 15.00m.  | _108 -  | × × × × × × × × × × × × × × × × × × × | )<br>)<br>)<br>)<br>18                 | 4//3/4/6/5                                      |               |                    |                |              |      |                     |          |         | 70                         | HQ<br>SPT   |                         | -                      |        |                               |                    | 2 . 2 . 2 . 2 . 2 . 2 |
|              | Becomes mottled brown from 16.20m.   | 16-   | × × × × × × × × × × × × × × × × × × × | ************************************** |   |               |                    |                |              |      |                     |          |         | 100                        | HQ          |                         |                        |        |                               |                    | 1 2 2 2 2             |
|              | Clayey SILT; dark grey, hard, plastic.   | 106 -   | × × × × × × × × × × × × × × × × × × × | 20                                     | <br> -<br>  6//3/5/6/6                          |               |                    |                |              |      |                     |          |         | 42                         | SPT         |                         |                        |        |                               |                    | 1                     |
|              | SILT; with trace clay, hard, slightly plastic, with some weakly cemented fine to coarse sand lenses and fine angular grey silt fragments.  | 17-   | × × × × × × × × × × × × × × ×         | ?                                      |   |               |                    |                |              |      |                     |          |         | 90                         | HQ          | -                       |                        |        |                               |                    | 1                     |
|              |  | 18-   | × × × × × × × × × × × × × × × × × × × | 32                                     | <br> <br> <br> <br> 10//8/8/7/9                 |               |                    |                |              |      |                     |          |         | 44                         | SPT         |                         |                        |        |                               |                    | 2                     |
|              | SILT; with some fine sand, hard, brittle, some 2-6cm long core segments of mudstone and sandstone, trace 1-3cmØ angular mudstone fragments.  | 19-   | × × × × × × × × × × × × × × × × × × × | ><br>><br>><br>><br>><br>>             |   |               |                    |                |              |      |                     |          |         | 71                         | HQ          |                         |                        |        |                               |                    | 1 . 2 . 2 . 2         |
|              |  |   | × × × × × × × × × × × × × × ×         | 20                                     | 10//4/5/6/5                                     |               |                    |                |              |      |                     |          |         | 38                         | SPT         | -                       |                        |        |                               |                    | 2                     |
|              | TES e piezometer installed upon completion.  |   |                                       |  |   |               |                    |                |              |      | STARTED             | 16/10/20 | 013     |                            |             |                         | ISHED                  |        | /10/20                        | 13                 |                       |
| -iriyl       | о розотного точаней прои сотпривион.   |   |                                       |  |   |               |                    |                |              |      | DRILLER INCLINATION | Billy    |         |                            |             |                         | ILLING C               | Dril   | lforce                        | Ltd                |                       |
|              |  |   |                                       |  |   |               |                    |                |              |      | AZIMUTH<br>LOGGED   | -90°     |         |                            |             |                         | ECKED                  |        | racto                         | <u>r</u>           |                       |
|              |  | GUIDELINES  |                                       |  | SEE ATT/  |               |                    |                |              |      | CLIENT              | T Van De | elen    |                            |             | 105                     | A (                    | Georg  | e                             | BH1                | 1                     |

| ۳. |   |   |              |                        |               |          |
|----|---|---|--------------|------------------------|---------------|----------|
| 3  | NOTES   |   | STARTED      |                        | FINISHED      |          |
| 5  | NOTES   |   |              | 16/10/2013             | 22/10/2013    | 3        |
| 2  | Single piezometer installed upon completion.                        |   | DRILLER      |                        | DRILLING Co.  |          |
| 3  |   |   |              | Billy                  | Drillforce Lt | d        |
| 3  |   |   | INCLINATION/ |                        | DRILLING RIG  |          |
| 31 |   |   | AZIMUTH      | -90°                   | Tractor       |          |
| d  |   |   | LOGGED       |                        | CHECKED _     |          |
| ᆀ. |   |   |              | T Van Deelen           | A George      | BH13/08  |
| اج | LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) GUIDELINES | SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS | CLIENT       |                        | JOB NO.       | D1113/00 |
| 2  | EUGGED IN ACCOMDANCE WITTING GEOTECHNICAE SOCIETY (2003) GOIDEEINES | OLE ATTACHED RET SHEETT ON EXPENNATION OF STMBOLS | Water        | rcare Services Limited | 1-C0935 25    |          |



|                        |            |           |                | HOLE NO. |         |
|------------------------|------------|-----------|----------------|----------|---------|
| BOREHOLE               | LOG        |           |                | BH1      | 3/08    |
| PROJECT                | CO-ORD.    |           | R.L.           | SHEET    |         |
| Manuka Road Reservoirs | 1746063 E  | 5910827 N | 122.56 m       |          | 3 of 5  |
| LOCATION               | REF. GRID  |           | DATUM          | HOLE     |         |
| See Site Plan          | SM 6472 SO | 61159     | MSL Akld. 1946 | LENGTH   | 40.58 m |

|               |   |                       |                | _             | See Site                       | Plan          |                    |                |              |            |         | SI                        | M 6472 SO   | 6115    | 59                | M   | ISL A    | kld. 1  | 946    | LENGII                        | 40                    | _              |
|---------------|---|-----------------------|----------------|---------------|--------------------------------|---------------|--------------------|----------------|--------------|------------|---------|---------------------------|-------------|---------|-------------------|-----|----------|---------|--------|-------------------------------|-----------------------|----------------|
| GEOLOG T/UNII | MAIN DESCRIPTION  | R.L. (m)<br>DEPTH (m) | GRAPHIC LOG    | SPT 'N' VALUE | SPT BLOW COUNTS OR SHEAR VALUE | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | <b>DI</b> II |            | DETAILE | ) DESCRI                  | IPTION      | RQD (%) | TOTAL CORE OO BAS | YPE | DRILLING | S       | CASING | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER<br>DETAILS |                |
| 4             | SILT; with some fine sand, hard, brittle, some 2-6cm long core segments of  | -                     | × × ×          | S             | , wow                          | or.           | шS                 |                | 0            | 90         |         |                           |             | ož.     | 57                | HQ  | ⊔≥       | 211     | 0      | ш «5                          |                       |                |
|               | mudstone and sandstone, trace 1-3cmØ angular mudstone fragments.  | -                     | × × ×          | <b>&gt;</b>   | <br>                           |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       |                |
|               |   | _102 -                | × × ×          | <b>&gt;</b>   | <u> </u>                       |               |                    |                |              |            |         |                           |             |         | 57                | HQ  |          |         |        |                               |                       |                |
|               |   | -                     | × × ×          | ,             |                                |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | 2              |
| İ             | Fine sandy SILT; hard, brittle, some 1-4cmØ angular mudstone fragments.   | 21-                   | × × ×          | 26            | <br> <br> 10//7/7/7/5          |               |                    |                |              |            |         |                           |             |         | 4.7               | ODT |          |         |        |                               |                       | 2000           |
|               |   | -                     | × × ×          | }             |                                |               |                    |                |              |            |         |                           |             |         | 47                | SPT |          |         |        |                               |                       |                |
|               |   |                       | ×××            | }             |                                |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | 10000          |
|               |   | -                     | × × × × × × ×  | *             | <br>                           |               |                    |                |              |            |         |                           |             |         | 100               | HQ  |          |         |        |                               |                       |                |
|               | Silty fine to medium SAND; medium dense,  | 22-                   | ×              |               | <br>                           |               |                    |                |              |            |         |                           |             |         | 100               | TIQ |          |         |        |                               |                       | 1              |
|               | brittle, some 1-5cm Øweakly cemented lenses, trace fine to medium angular, grey, green and red, gravel.                               | -                     | ××             |               |                                |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | 0.010.00       |
|               | g · · - · - · - · g · · · ·   | _100 -                | ××             | 18            | 6//4/4/5/5                     |               |                    |                |              |            |         |                           |             |         | 47                | SPT |          |         |        |                               |                       | To locate      |
|               |   | 23-                   | ×              |               | <br>                           |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | 910001         |
|               | Segment of fine to medium SANDSTONE;<br>slightly weathered, massive, with some fine<br>to medium angular gravel.                      | -                     | × × ×          | }             | <br>                           |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | - Control      |
|               | No recovery from 23.60m to 24.50m, "softer material" beneath segment of sandstone.  | -                     | * × ×          | *             | i<br>!                         |               |                    |                |              |            |         |                           |             |         | 60                | HQ  |          |         |        |                               |                       | 200            |
|               |   |                       | × × ×          | ,             | <br>                           |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       |                |
|               |   | 24-                   | × · ×<br>× · × | ,             | <br>                           |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | 2              |
|               |   | -                     | × × ×          | 3             | 0//1/0/2/0                     |               |                    |                |              |            |         |                           |             |         | 67                | SPT |          |         |        |                               |                       | and the second |
|               | Poor recovery from 24.50m to 26.00m.  | 98 -                  | × × ×          |               | <br>                           |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | 20100          |
|               | Poor recovery from 24.50m to 26.00m.<br>Fragments of moderately cemented fine to<br>coarse SAND; grey with fine to coarse             | -                     | × ^ ×<br>× × × |               | <br>                           |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | 100000         |
|               | angular gravels in a suspected fine grained matrix that has been washed away during drilling.   | 25-                   | × ^ ×          | }             |                                |               |                    |                |              |            |         |                           |             |         | 30                | HQ  |          |         |        |                               |                       | ar a service   |
|               | uning.  | -                     | × × ×          |               |                                |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       |                |
|               |   | -                     | × × ×          | }             | <br>                           |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | 20100          |
|               |   | -                     | × × ×          | 23            | 7//3/4/7/9                     |               |                    |                |              |            |         |                           |             |         | 60                | SPT |          |         |        |                               |                       |                |
|               | SILT; with trace clay and trace fine sand,  | 26                    | × × ×          | ,             |                                |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       |                |
|               | dark grey, hard, slightly plastic, some lenses<br>of weakly cemented fine to coarse sand,<br>trace fine angular, red, grey and green, | -                     | × × ×          | ,             | <u>.</u>                       |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | 1              |
|               | gravels, trace 0.5cm to 2cmØ angular mudstone fragments.  | _96 -                 | × × ×          | }             | <br>                           |               |                    |                |              |            |         |                           |             |         | 100               | HQ  |          |         |        |                               |                       | 20100          |
|               |   | -                     | × × ×          | }             | <br>                           |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       |                |
|               |   | 27-                   | × × ×          |               |                                |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | 2              |
|               |   | -                     | × × ×          | }             | ; ??<br>!                      |               |                    |                |              |            |         |                           |             |         | 36                | SPT |          |         |        |                               |                       | ar Caraci      |
|               |   |                       | × × ×          |               | į                              |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | -              |
|               |   | -                     | ×              | }             | <br>                           |               |                    |                |              |            |         |                           |             |         | 69                | HQ  |          |         |        |                               |                       | 0.00           |
| İ             | Fine sandy SILT; with trace clay, dark grey, hard, slightly plastic, some lenses of weakly  | 28-                   | ×××            | 1             | <br>                           |               |                    |                |              |            |         |                           |             |         | 09                | пQ  |          |         |        |                               |                       | 1              |
|               | cemented fine to coarse sand, trace fine angular, red, grey and green, gravels, trace 0.5cm to 2cmØ angular mudstone                  | 94 -                  | × × ×          |               |                                |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | 910001         |
|               | fragments. Some 5-10cm segments of weakly   | _94 -                 | × ^ ×<br>× × × | 50+           | 22//43/7<br>for 15mm           |               |                    |                |              |            |         |                           |             |         | 42                | SPT |          |         |        |                               |                       | -              |
|               | cemented fine sand and sandstone from 28.50m.   | 29-                   | ×              | }             | į                              |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | 0.0010.00      |
|               |   | -                     | × ^ ×<br>× × × |               | <br>                           |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | -              |
|               |   |                       | × × ×          | }             |                                |               |                    |                |              |            |         |                           |             |         | 100               | HQ  |          |         |        |                               |                       | -              |
|               |   |                       | × × ×          |               | i<br>                          |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | ar Causer Va   |
|               |   |                       | × ·× ·         | ]             |                                |               |                    |                |              |            |         |                           |             |         |                   |     |          |         |        |                               |                       | 6              |
|               | res   |                       |                |               |                                |               |                    |                |              |            |         | RTED                      | 16/10/20    | 013     |                   |     |          | SHED    |        | /10/20                        | 13                    |                |
| ngi           | e piezometer installed upon completion.   |                       |                |               |                                |               |                    |                |              |            |         | LLER                      | Billy       |         |                   |     |          | LLING ( | Dril   | Iforce                        | _td                   |                |
|               |   |                       |                |               |                                |               |                    |                |              |            | AZII    | LINATION/<br>MUTH<br>GGED | -90°        |         |                   |     |          | LLING F |        | Γractor                       |                       |                |
|               | ED IN ACCORDANCE MATERIALS OFFICE AND A COOLET COOLET   | CUIDEL                |                |               | OFF 4.T-                       | CLIED :       | 'EV 0' 'E-         | T 500 -        | VD: 411      | ATION OF S | CUI     | ENT                       | T Van De    |         |                   |     |          | A (     | Georg  |                               | BH1                   | 3              |
| rout          | ED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) 33   | JUIDELINES            | ,              |               | SEE ATTA                       | ICHED K       | LI SHEE            | ı ruk E        | AFLAN        | ATION OF S | INIDULO | Wate                      | rcare Servi | ices I  | imite             | d   |          | 1-C     | 0935.  | 25                            |                       |                |

| 3        | NOTES   |   | STARTED     |                        | FINISHED      |          |
|----------|---|---|-------------|------------------------|---------------|----------|
| 2        | NOTES   |   |             | 16/10/2013             | 22/10/2013    | 3        |
| 3        | Single piezometer installed upon completion.                        |   | DRILLER     |                        | DRILLING CO.  |          |
| 3        |   |   |             | Billy                  | Drillforce Lt | :d       |
| 3        |   |   | INCLINATION |                        | DRILLING RIG  |          |
| 31       |   |   | AZIMUTH     | -90°                   | Tractor       |          |
| 1        |   |   | LOGGED      |                        | CHECKED       |          |
| <u> </u> |   |   |             | T Van Deelen           | A George      | BH13/08  |
| į        | LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) GUIDELINES | SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS | CLIENT      | rooro Convisoo Limitad | JOB NO.       | DI 13/00 |



|                        |                     |                | HOLE NO. |
|------------------------|---------------------|----------------|----------|
| BOREHOLE LO            | JG                  |                | BH13/08  |
| PROJECT                | CO-ORD.             | R.L.           | SHEET    |
| Manuka Road Reservoirs | 1746063 E 5910827 N | 122.56 m       | 4 of 5   |
| LOCATION               | REF. GRID           | DATUM          | HOLE     |
| See Site Plan          | SM 6472 SO 61159    | MSL Akld. 1946 | 40.58 m  |

|              |  |          |   | T             | See Site                        | Fiaii         |                    | Ι              |                   |  | SM 6472 SC  | _       | COR                        |             | ISL A              | kld. 1  | LLING |                               | ′ <u>4</u>            |
|--------------|--|----------|---|---------------|---------------------------------|---------------|--------------------|----------------|-------------------|--|---|---------|----------------------------|-------------|--------------------|---------|-------|-------------------------------|-----------------------|
| GEOLUGY/UNII | MAIN DESCRIPTION   | R.L. (m) | DEPTH (m)<br>GRAPHIC LOG                | TI IAV IN FOR | SPT BLOW COUNTS OR SHEAR VALUE  | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIP  degrees 0 90 | DETA   | ILED DESCRIPTION  | RQD (%) | TOTAL CORE<br>RECOVERY (%) | SAMPLE TYPE | DRILLING<br>METHOD | ø       |       | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER<br>DETAILS |
|              |  |          | _ × ·× ·                                | 3             | <br> <br> 35  13//7/8/8/12      |               |                    |                | 0 90              | J  |   |         | 31                         | SPT         |                    |         |       |                               |                       |
| -            | MUDSTONE; extremely weak, slightly weathered, massive, bluish grey.  | 92       | * , , , , , , , , , , , , , , , , , , , | ` ;           |                                 |               |                    |                |                   | Fracture, splanar, sm<br>30.60m.<br>Fracture, s    | steeply inclined dip;<br>looth, clay coating at<br>noderately inclined dip; |         |                            |             |                    |         |       |                               |                       |
|              | SILT; with some fine sand, greenish grey, hard, brittle, some 1-2mmØ sub-rounded mudstone gravels.   | 3.       | -× × × × × × × × × × × × × × × × × × ×  |               |                                 |               |                    |                |                   | planar, sin<br>30.85m.                             | noderately inclined dip;<br>nooth, silt coating at                          | 38      | 100                        | HQ          |                    |         |       |                               |                       |
|              |  | 32       | -x x ;                                  | ` 1<br>` 1    | 5 7//4/4/4/3                    |               |                    |                |                   |  |   |         | 27                         | SPT         |                    |         |       |                               |                       |
| -            | Fine SAND; with trace silt, grey, loose, brittle. Becomes weakly cemented from 32.80m.   | 90       | - ×                                     |               |                                 |               |                    |                |                   |  |   |         | 100                        | HQ          |                    |         |       |                               |                       |
|              | Fine to medium sub-rounded gravelly fine to medium SAND; with trace silt, grey mottled greenish grey, medium dense, brittle, 50% weakly cemented.  | 3:       | 3                                       | 4             | <br> <br>                       | 2             |                    |                |                   |  |   |         | 28                         | SPT         |                    |         |       |                               |                       |
|              |  | 34       | 4-0                                     |               |                                 |               |                    |                |                   | Relict frac<br>undulating                          | ture(?), sub-vertical dip;<br>, rough.                                      |         | 100                        | HQ          |                    |         |       |                               |                       |
|              |  | _88      |   | 2             | <br> <br> 27  6//4/5/8/10<br>   |               |                    |                |                   |  |   |         | 47                         | SPT         |                    |         |       |                               |                       |
|              | Becomes moderately cemented from 35.50m.   | _        |   |               |                                 |               |                    |                |                   | Relict frac<br>undulating                          | ture(?), sub-vertical dip;<br>, rough.                                      |         | 58                         | HQ          |                    |         |       |                               |                       |
|              |  | 36       |   | 50            | 0+ 15//18/22/10<br>for 20mm     |               |                    |                |                   |  |   |         | 63                         | SPT         |                    |         |       |                               |                       |
| -            | Fine to medium SANDSTONE; with fine to medium sub-angular to angular gravel, grey, extremely weak, slightly weathered.   | _86      | 7                                       |               |                                 | W             | SW                 |                |                   | Three frac<br>moderatel<br>undulating<br>36.40m to | tures, gently to<br>y inclined dips;<br>, rough, no coating from<br>36.80m. | 31      | 100                        | HQ          |                    |         |       |                               |                       |
| -            | Silty fine SAND; dense, brittle, weakly cemented.  Fine to medium SANDSTONE; with fine to  |          | × ×                                     |               |                                 |               |                    |                |                   | Fracture,  | sub-vertical dip; wavy,<br>, rough, no coating from<br>37.50m.              |         |                            |             |                    |         |       |                               |                       |
|              | medium sub-angular to angular gravel, grey, extremely weak, slightly weathered.  | -        |   | 50            | 0+  25//28/22<br>  for 70mm<br> | w             | SW                 |                |                   | 37.35m to  | 37.50m.   |         | 100                        | SPT         |                    |         |       |                               |                       |
| -            | Fine to coarse SANDSTONE; with some fine to 3mmØ angular gravel, very weak, slightly weathered, progressively grading into a 1-3cmØ sub-rounded to angular CONGLOMERATE; with some fine to | _84      |   |               |                                 |               |                    |                |                   | Two fractudips; unducoating.                       | res, steeply inclined<br>lating, rough, no                                  | 68      | 100                        | HQ          |                    |         |       |                               |                       |
|              | coarse sand, very weak, slightly weathered.<br>Broken segment of core from 38.60 to<br>39.00m. Suspected very steeply inclined<br>fracture.  | 39       | 9-                                      | 50            | )<br> <br>  50 for<br>  140mm   | vw            | sw                 |                |                   |  |   |         | SC                         | SPT         |                    |         |       |                               |                       |
|              |  |          |   |               |                                 |               |                    |                |                   |  |   | 100     | 100                        | HQ          |                    |         |       |                               |                       |
|              | ES   |          |   |               |                                 |               |                    |                |                   |  | STARTED 16/10/2   | 2013    |                            |             |                    | SHED    |       | /10/20                        | 13                    |
| irigii       | e piezometer installed upon completion.  |          |   |               |                                 |               |                    |                |                   |  | DRILLER BIlly INCLINATION/  | /       |                            |             |                    | LLING C | Dril  | llforce                       | Ltd                   |
|              |  |          |   |               |                                 |               |                    |                |                   |  | AZIMUTH -90° LOGGED   |         |                            |             |                    | CKED    |       | Tracto                        | r                     |
|              |  |          |   |               |                                 |               |                    |                |                   |  | T Van D   | eelen   |                            |             | J                  |         | Georg | je                            | ВН                    |

| ۳. |   |   |              |                        |               |          |
|----|---|---|--------------|------------------------|---------------|----------|
| 3  | NOTES   |   | STARTED      |                        | FINISHED      |          |
| 5  | NOTES   |   |              | 16/10/2013             | 22/10/2013    | 3        |
| 2  | Single piezometer installed upon completion.                        |   | DRILLER      |                        | DRILLING Co.  |          |
| 3  |   |   |              | Billy                  | Drillforce Lt | d        |
| 3  |   |   | INCLINATION/ |                        | DRILLING RIG  |          |
| 31 |   |   | AZIMUTH      | -90°                   | Tractor       |          |
| d  |   |   | LOGGED       |                        | CHECKED _     |          |
| ᆀ. |   |   |              | T Van Deelen           | A George      | BH13/08  |
| اج | LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) GUIDELINES | SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS | CLIENT       |                        | JOB NO.       | D1113/00 |
| 2  | EUGGED IN ACCOMDANCE WITTING GEOTECHNICAE SOCIETY (2003) GOIDEEINES | OLE ATTACHED RET SHEETT ON EXPENNATION OF STMBOLS | Water        | rcare Services Limited | 1-C0935 25    |          |



| BOREHOLE LO            | )G                  |                | BH1    | 3/08    |
|------------------------|---------------------|----------------|--------|---------|
| PROJECT                | CO-ORD.             | R.L.           | SHEET  |         |
| Manuka Road Reservoirs | 1746063 E 5910827 N | 122.56 m       |        | 5 of 5  |
| LOCATION               | REF. GRID           | DATUM          | HOLE   |         |
| See Site Plan          | SM 6472 SO 61159    | MSL Akld. 1946 | LENGTH | 40.58 m |

| See Site Plan |  |          |                                 |               |                                      |               |                    |                |               |                |                     |                  |         | 40.                        | 58 n        |          |                        |                    |                               |                           |       |
|---------------|--|----------|---------------------------------|---------------|--------------------------------------|---------------|--------------------|----------------|---------------|----------------|---------------------|------------------|---------|----------------------------|-------------|----------|------------------------|--------------------|-------------------------------|---------------------------|-------|
|               | TESTS <sub>I</sub> O CORE DR                 |          |                                 |               |                                      | DRII          | LING               |                |               | 3              |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
| GEOLOGY/UNIT  | MAIN DESCRIPTION                             | R.L. (m) | GRAPHIC LOG                     | SPT 'N' VALUE | SPT BLOW<br>COUNTS OR<br>SHEAR VALUE | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIP<br>degree | es <b>DETA</b> | ILED DESCR          | IPTION           | RQD (%) | TOTAL CORE<br>RECOVERY (%) | SAMPLE TYPE | DRILLING | DRILLING<br>FLUID LOSS | CASING             | BASE OF HOLE<br>& WATER LEVEL | - PIEZOMETER<br>- DETAILS | OTHER |
|               |  |          |                                 |               |                                      | vw            | sw                 |                |               |                |                     |                  | 100     | 100                        | HQ          |          |                        |                    |                               |                           |       |
|               |  | _82      |                                 | 50+           | 50 for<br>80mm                       |               |                    |                |               |                |                     |                  |         | SC                         | SPT         |          |                        |                    |                               | 29,699                    |       |
|               | End of Borehole at 40.58m.                   | 41       | -<br>-<br>-<br>-<br>-<br>-<br>- |               | <br> <br> <br> <br> <br> <br> <br>   |               |                    |                |               |                |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
|               |  | 42       | -<br>-<br>-<br>-<br>-<br>-<br>- |               | <br>                                 |               |                    |                |               |                |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
|               |  | _80      | -<br>-<br>-<br>-                |               |                                      |               |                    |                |               |                |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
|               |  | 43       | -<br>-<br>-<br>-                |               | <br> <br> <br> <br>                  |               |                    |                |               |                |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
|               |  | _        | -<br>-<br>-<br>-                |               | <br> <br> <br>                       |               |                    |                |               |                |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
|               |  | 44       | -<br>-<br>-<br>-<br>-<br>-      |               | <br> <br> <br>                       |               |                    |                |               |                |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
|               |  | _78      | -<br>-<br>-<br>-<br>-           |               | <br> <br> <br>                       |               |                    |                |               |                |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
|               |  | 45       | -<br>-<br>-<br>-                |               | <br> <br> <br>                       |               |                    |                |               |                |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
|               |  | 100      |                                 |               | <br> <br> <br>                       |               |                    |                |               |                |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
|               |  |          | -                               |               | <br> <br> <br>                       |               |                    |                |               |                |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
|               |  | 47       | -                               |               | <br> <br> <br> <br>                  |               |                    |                |               |                |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
|               |  |          | -<br>-<br>-<br>-                |               |                                      |               |                    |                |               |                |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
|               |  | 48       | -<br>-<br>-<br>-                |               | ,<br> <br> <br> <br>                 |               |                    |                |               |                |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
|               |  | _74      | -<br>-<br>-<br>-                |               | <br>                                 |               |                    |                |               |                |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
|               |  | 49       |                                 |               | <br>                                 |               |                    |                |               |                |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
|               |  | _        |                                 |               | <br> <br> <br> <br>                  |               |                    |                |               |                |                     |                  |         |                            |             |          |                        |                    |                               |                           |       |
|               |  |          | -                               |               | <br> <br> <br>                       |               |                    |                |               |                | STARTED             |                  |         |                            |             | E/h/     | ISHED                  |                    |                               |                           |       |
|               | TES le piezometer installed upon completion. |          |                                 |               |                                      |               |                    |                |               |                | DRILLER INCLINATION | 16/10/2<br>Billy |         |                            |             | DRI      | LLING C                | Co.<br><b>Dril</b> | /10/20<br>Iforce              |                           | _     |
|               |  |          |                                 |               |                                      |               |                    |                |               |                | AZIMUTH<br>LOGGED   | -90°             |         |                            |             |          | ECKED                  | ٦ ٦                | Fractor                       | ·                         |       |
|               |  |          |                                 |               |                                      |               |                    |                |               |                |                     | T Van Da         |         |                            |             | 1 31 11  |                        | ~ ~ ~ ~ ~          | _                             |                           |       |

|   | INCLINATION/               |
|---|----------------------------|
|   | AZIMUTH -90°               |
|   | LOGGED                     |
|   | T Van Deelen               |
| SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS | CLIENT                     |
| SEE ATTACHED RET SHEET FOR EXPLANATION OF SYMBOLS | Watercare Services Limited |
|   |                            |

22/10/2013 DRILLING CO.
Drillforce Ltd Tractor CHECKED A George JOB NO. 1-C0935.25 BH13/08

LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) GUIDELINES

Watercare Services Limited

Borehole 13/08





0.00m – 3.45m Box 1 of 11



3.45m – 7.50m Box 2 of 11

Watercare Services Limited

Borehole 13/08





7.50m – 11.50m Box 3 of 11



11.5m – 14.65m Box 4 of 11

Watercare Services Limited

Borehole 13/08





14.65m – 18.00m Box 5 of 11



18.00m – 22.50m Box 6 of 11

Watercare Services Limited

Borehole 13/08





22.50m – 27.00m Box 7 of 11



27.00m – 31.00m Box 8 of 11

Watercare Services Limited

Borehole 13/08





31.00m – 34.50m Box 9 of 11



34.50m – 38.10m Box 10 of 11

| Manuka Reservoirs          |          |
|----------------------------|----------|
|                            | ODIIC    |
| Watercare Services Limited | WWW OPUS |
| Borehole 13/08             |          |



38.10m – 40.58m (E.O.H)

Box 11 of 11



|                        |                   |                | HOLE NO. |
|------------------------|-------------------|----------------|----------|
| BOREHO                 | LE LOG            |                | BH13/09  |
| PROJECT                | CO-ORD.           | R.L.           | SHEET    |
| Manuka Road Reservoirs | 1745933 E 5910849 | 123.61 m       | 1 of 2   |
| LOCATION               | REF. GRID         | <i>DATUM</i>   | HOLE     |
| See Site Plan          | SM 6472 SO 61159  | MSL Akld. 1946 | 15.45 m  |

|              |   |          |                    |                                       | ;             | See Site                             | Plan          |                    |                |   |               |               | SIVI   | 6472 SO        | 6115    | 9                          | IV          | ISL A                | kld. 1                 | 946    |                               | 15.4                   | 45 m                     |
|--------------|---|----------|--------------------|---------------------------------------|---------------|--------------------------------------|---------------|--------------------|----------------|---|---------------|---------------|--|----------------|---------|----------------------------|-------------|----------------------|------------------------|--------|-------------------------------|------------------------|--------------------------|
|              |   |          |                    |                                       | T             | ESTS                                 | Į             |                    | o              |   |               |               |  |                | (       | CORE                       |             |                      | DRII                   | LING   |                               |                        | N<br>O                   |
| GEOLOGY/UNIT | MAIN DESCRIPTION  | R.L. (m) | DEPTH (m)          | GRAPHIC LOG                           | SPT 'N' VALUE | SPT BLOW<br>COUNTS OR<br>SHEAR VALUE | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING |   | DIP<br>egrees | <b>DETA</b> I | LED DESCRIPT                                   | ΓΙΟΝ           | RQD (%) | TOTAL CORE<br>RECOVERY (%) | SAMPLE TYPE | DRILLING<br>METHOD   | DRILLING<br>FLUID LOSS | CASING | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER DETAILS     | OTHER<br>INSTRUMENTATION |
| Topsoil      | SILT; with trace clay, brown, firm, slightly plastic, some rootlets.                    | 1        | 丰                  |                                       | į             |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
| 유            | CLAY; with trace silt, light brownish grey streaked orange, firm, plastic.              |          | 丰                  |                                       | İ             |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              |   | F        | -                  |                                       |               |                                      |               |                    |                |   |               |               |  |                |         |                            |             | uger                 |                        |        |                               |                        |                          |
|              | Trace fine to coarse sand from 0.70m.   |          | E                  |                                       |               |                                      |               |                    |                |   |               |               |  |                |         | 100                        | HA          | Hand Auger           |                        |        |                               |                        |                          |
|              | Silty CLAY; with trace fine to coarse sand, grey mottled orangish brown, firm, plastic. |          | 1-1-1-1            |                                       |               |                                      |               |                    |                |   |               |               |  |                |         |                            |             | Ĭ                    |                        |        |                               |                        |                          |
|              |   |          | - <u>×</u>         |                                       | İ             |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              | CLAY; with trace silt, grey, firm, plastic,   | 122      | <u> </u>           |                                       |               |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              | limonite streaks.   |          | ŧ                  | $\equiv$                              | 4             | 1//1/1/1/1                           |               |                    |                |   |               |               |  |                |         | 100                        | SPT         |                      |                        |        |                               |                        |                          |
|              | No recovery from 1.95m to 3.00m. Inferred   | 1        | 2-                 |                                       | i             |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              | soft material washed away during drilling.  |          | -                  |                                       | l i           |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              |   |          | ]                  |                                       |               |                                      |               |                    |                |   |               |               |  |                |         | 0                          | HQ          |                      |                        |        |                               |                        |                          |
|              |   | F        | -                  |                                       |               |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              |   |          | _ =                |                                       | H             |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              | Fine to medium sandy SILT; with trace clay, stiff, slightly plastic, occasional 1-4mmØ  |          | 3 <del>-</del> ×   | × ×                                   | İ             |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              | angular silt fragments.   |          | -×                 | ×                                     |               |                                      |               |                    |                |   |               |               |  |                |         | 100                        | PT          |                      |                        |        |                               |                        |                          |
|              |   | _120     | ×                  | × ×                                   |               |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              |   |          | ×                  | × × ×                                 | 5             | 1//1/2/1/1                           |               |                    |                |   |               |               |  |                |         | 100                        | SPT         |                      |                        |        |                               |                        |                          |
|              |   |          | 4-×                | . × ×                                 |               |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              |   |          | ×                  | × ×                                   |               |                                      |               |                    |                |   |               |               |  |                |         | 100                        | HQ          |                      |                        |        |                               |                        |                          |
|              | Clayey SILT; with trace fine to medium sand, firm, plastic.                             |          | *<br>*             | <u> </u>                              |               |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
| _            |   |          | ×                  | × ×                                   | 4             | 1//0/1/2/1                           |               |                    |                |   |               |               |  |                |         | 100                        | SPT         |                      |                        |        |                               |                        |                          |
| Colluvium    | Silty fine to medium SAND; with some fine sub-rounded to angular gravel, dark grey,     | 1        | 5×                 |                                       |               |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
| 20           | loose, brittle.   |          |                    | ×                                     |               |                                      |               |                    |                |   |               |               |  |                |         |                            |             | an an                |                        |        |                               |                        |                          |
|              |   |          | = i×               | ×                                     |               |                                      |               |                    |                |   |               |               |  |                |         | 100                        | HQ          | ireline              |                        |        |                               |                        |                          |
|              | Fine to medium sandy SILT; with trace clay and occasional fine angular gravel, bluish   | _118     | ××                 | ××                                    | l             |                                      |               |                    |                |   |               |               |  |                |         |                            | -           | Triple Tube Wireline |                        |        |                               | 19/1/2013<br>19/1/2013 |                          |
|              | grey, firm, slightly plastic.   |          | -*<br>-*           | × ×                                   |               |                                      |               |                    |                |   |               |               |  |                |         |                            |             | ple Tu               |                        |        |                               |                        |                          |
|              |   |          | 6×                 | × × ×                                 |               |                                      |               |                    |                |   |               |               |  |                |         |                            |             | HQ Tri               |                        |        |                               | 11/2013                |                          |
|              |   |          | - \frac{1}{\times} | × · · · · ·                           | li            |                                      |               |                    |                |   |               |               |  |                |         | 100                        | PT          |                      |                        |        |                               | ¥¥                     |                          |
|              | Silty fine SAND; bluish grey, loose, brittle, trace 1-5mmØ silt fragments.              | -        | -×                 | ×                                     |               |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              | tude i diiniz dik naginana.   |          | ×                  | ×                                     | 6             | 1//1/1/2/2                           |               |                    |                |   |               |               |  |                |         | 100                        | SPT         |                      |                        |        |                               |                        |                          |
|              | SILT; with trace clay, bluish grey, stiff,  |          | 7-×                | × ×                                   | li            |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              | plastic.  |          | -×                 | × × ×                                 | İ             |                                      |               |                    |                |   |               |               |  |                |         | 100                        | HQ          |                      |                        |        |                               |                        |                          |
|              |   | _116     | ×                  | × ×                                   |               |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              | SILT; with some clay and trace fine to medium sand, dark bluish grey, stiff, slightly   |          | -×                 | × × ×                                 | 6             | 1//1/1/2/2                           |               |                    |                |   |               |               |  |                |         | 100                        | SPT         |                      |                        |        |                               |                        |                          |
|              | plastic, some 1-2mmØ angular gravels and mudstone fragments.                            |          | 8-×                | × × ×                                 | į             |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              |   |          | ]×                 | × × ×                                 |               |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              | SILT; with some fine to medium sand, bluish grey, hard, brittle, occasional 1-3cmØ      |          | ×                  | × × ×                                 |               |                                      |               |                    |                |   |               |               |  |                |         | 100                        | HQ          |                      |                        |        |                               |                        |                          |
|              | angular sandstone fragments.  | -        | ×                  | × × ×                                 |               |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              |   |          | 9-*                | × × ×                                 |               |                                      |               |                    |                |   |               |               |  |                |         |                            |             |                      |                        |        |                               |                        |                          |
|              | Fine sandy SILT; bluish grey, hard, brittle.  |          | \^                 | × · · ·                               | 11            | 3//2/2/3/4                           |               |                    |                |   |               |               |  |                |         | 100                        | SPT         |                      |                        |        |                               |                        |                          |
|              |   |          | - ×                | × ×                                   |               |                                      |               |                    |                |   |               |               |  |                |         | 100                        | 01 1        |                      |                        |        |                               |                        |                          |
|              |   | _114     | ×                  | ×××                                   |               |                                      |               |                    |                |   |               | Two relict f  | ractures, steepl<br>s; undulating, r<br>9.60m. | ly<br>rough at |         |                            |             |                      |                        |        |                               |                        |                          |
|              |   |          | ]×                 | × × × × × × × × × × × × × × × × × × × | İ             |                                      |               |                    |                |   |               | 9.50m and     | e.oum.   |                |         | 100                        | HQ          |                      |                        |        |                               |                        |                          |
| $\vdash$     | I   |          | l×                 | ×                                     | ш             |                                      |               |                    | I              | Ш | шШ            | 12            | STARTED  |                |         |                            |             | FINI                 | ISHED                  |        |                               | - 11-1-1-1-1-1         | $\dashv$                 |
| NO           | TES   |          |                    |                                       |               |                                      |               |                    |                |   |               | `             |  | 4/11/20        | 13      |                            |             |                      |                        | 4/     | 11/201                        | 3                      |                          |

SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS

LOG\_A3 (&PHOTO PAGE) 1-C0935 25 MANUKA ROAD RESERVOIRS GEOTECHNICAL TESTING.GPJ OPUS CHCH DEC12.GDT 13/12/13

Single piezometer installed upon completion. T. = Topsoil.

4/11/2013 4/11/2013 DRILLING CO.
Drillforce Ltd

DRILLING RIG DRILLER Glen INCLINATION/ AZIMUTH LOGGED Tractor -90° CHECKED A George JOB NO. 1-C0935.25 T Van Deelen CLIENT Watercare Services Limited

BH13/09

LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) GUIDELINES



| BOREHOLE LOG           |              |          |          |                |        |  |  |  |  |  |
|------------------------|--------------|----------|----------|----------------|--------|--|--|--|--|--|
| PROJECT                | CO-ORD.      |          | R.L.     | SHEET          |        |  |  |  |  |  |
| Manuka Road Reservoirs | 1745933 E 59 | 910849 N | 123.61 m |                | 2 of 2 |  |  |  |  |  |
| LOCATION               | REF. GRID    |          | DATUM    | HOLE<br>LENGTH |        |  |  |  |  |  |

|              |  |                       |                                       |               | See Site                                      | Plan          |                    |                |               |                               | SM 6472                                  | SO 611         | 59                         | N           | ISL A                   | Akld. 1                | 946         | LENGTH                        | 15.        | 45 r  |
|--------------|--|-----------------------|---------------------------------------|---------------|---|---------------|--------------------|----------------|---------------|-------------------------------|--|----------------|----------------------------|-------------|-------------------------|------------------------|-------------|-------------------------------|------------|-------|
|              |  |                       |                                       |               | TESTS   | Ţ             |                    | g              |               |                               |  |                | CORI                       |             |                         | DRII                   | LLING       | }                             |            |       |
| GEOLOGY/UNIT | MAIN DESCRIPTION   | R.L. (m)<br>DEPTH (m) | GRAPHIC LOG                           | SPT 'N' VALUE | SPT BLOW<br>COUNTS OR<br>SHEAR VALUE          | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIP<br>degree | s <b>DETAILE</b>              | ED DESCRIPTION                           | RQD (%)        | TOTAL CORE<br>RECOVERY (%) | SAMPLE TYPE | DRILLING                | DRILLING<br>FLUID LOSS | CASING      | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER | OTHER |
| 0            | Fine sandy SILT; bluish grey, hard, brittle.   |                       | × × ×                                 | 99            | 000   |               | E >                |                | 0 9           | 90                            |  | - 1            |                            | 0)          | 02                      |                        | _           | ш «                           |            |       |
|              | Some 3-5cmØ angular mudstone fragments at 10.50m.  | 11-                   | × × × × × × × × × × × × × × × × × × × | 11            | <br> <br> <br> <br>  3//2/3/3/3<br> <br> <br> |               |                    |                |               |                               |  |                | 31                         | HQ          |                         |                        |             |                               |            |       |
| -            | Fine to medium SAND; dark grey, medium dense, brittle.   | _112                  | × × × × × × × × × × × ×               | 3             | <br> -<br> -<br> -<br> -<br> -                |               |                    |                |               |                               |  |                | 100                        | HQ          |                         |                        |             |                               |            |       |
| -            | Fine sandy SILT; bluish grey, hard, trace fine to medium angular mudstone fragments.                                       | 12-                   | × × × × × × × × × × ×                 | 19            | <br> <br> <br>  6//3/5/5/6                    |               |                    |                |               |                               |  |                | 100                        | SPT         | Wireline                |                        |             |                               |            |       |
|              | SILT; with trace fine sand, dark greyish brown, hard, brittle, weakly cemented.  | -                     | × × ×                                 |               |   |               |                    |                |               |                               |  |                |                            |             | Tube \                  |                        |             |                               |            |       |
| Colluviuii   | Thin carbonaceous streak at 12.90m.  | 13-                   | × × × × × × × × × × × × × × × × × × × | }             | <br> -<br> -<br> -<br> -<br> -                |               |                    |                |               |                               |  |                | 100                        | HQ          | HQ Triple Tube Wireline |                        |             |                               |            |       |
|              | SILT; with trace clay, light bluish grey, hard, slightly plastic.  | 110                   | × × × × × × × × × × × × × × × × × × × | 17            | <br>  |               |                    |                |               |                               |  |                | 100                        | SPT         |                         |                        |             |                               |            |       |
| -            | MUDSTONE; yellowish brown, extremely weak, highly weathered. SILT; with trace fine sand, light bluish grey, hard, brittle. | 14-                   | × × × × × × × × × × × × × × × × × × × | ,             | <br>  | EW            | HW                 |                |               | Relict fractur<br>smooth from | e surfaces, planar,<br>13.95m to 14.10m. | 0              | 100                        | HQ          | _                       |                        |             |                               |            |       |
|              |  | 15-                   | × ^ ×<br>× ×<br>× ×<br>× ×            | 35            | <br> <br> <br> 9//7/8/11/9<br>                |               |                    |                |               |                               |  |                | 100                        | SPT         |                         | _                      |             |                               |            |       |
|              | End of Borehole at 15.45m.   |                       |                                       |               |   |               |                    |                |               |                               |  |                |                            |             |                         |                        |             |                               |            |       |
| ingl         | FES le piezometer installed upon completion. Topsoil.  | _104                  |                                       |               |   |               |                    |                |               | DF                            | RILLER                                   | 1/2013<br>Glen |                            |             | DR                      | IISHED<br>ILLING (     | Co.<br>Dril | /11/201                       |            |       |

4/11/2013 DRILLER Glen INCLINATION/ AZIMUTH LOGGED -90° T Van Deelen

LOGGED I LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) GUIDELINES

CLIENT Watercare Services Limited SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS

CHECKED A George JOB NO. 1-C0935.25 BH13/09

Watercare Services Limited

## Borehole 13/09





0.00m - 3.50m Box 1 of 5



3.50m – 6.00m Box 2 of 5

Watercare Services Limited

Borehole 13/09





6.00m – 9.00m



9.00m – 12.45m Box 4 of 5

Watercare Services Limited

## Borehole 13/09





12.45m – 15.45m (E.O.H)

Box 5 of 5



|                        |                     |          | HOLE NO.        |
|------------------------|---------------------|----------|-----------------|
| BORI                   | EHOLE LOG           |          | BH13/10         |
| PROJECT                | CO-ORD.             | R.L.     | SHEET           |
| Manuka Road Reservoirs | 1745918 E 5910806 N | 122.95 m | 1 of 2          |
| LOCATION               | REF. GRID           | DATUM    | HOLE<br>I ENGTH |

|              |   |                       |                                       | _             | See Site                       | Plan          |                    |                |                  |   | SM 6472 SO   | 611            |                            |     | ISL A                   | kld. 1       |        | LENGT                         | 15                    | 5                              |
|--------------|---|-----------------------|---------------------------------------|---------------|--------------------------------|---------------|--------------------|----------------|------------------|---|--|----------------|----------------------------|-----|-------------------------|--------------|--------|-------------------------------|-----------------------|--------------------------------|
| GEOLOGY/UNIT | MAIN DESCRIPTION  | R.L. (m)<br>DEPTH (m) | GRAPHIC LOG                           | SPT 'N' VALUE | SPT BLOW COUNTS OR SHEAR VALUE | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIP  degrees 0 9 | . DETAI                                   | LED DESCRIPTION  | RQD (%)        | TOTAL CORE OS NECOVERY (%) |     | DRILLING                | s            | CASING | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER<br>DETAILS |                                |
|              | CLAY; with trace silt, orangish brown, stiff, plastic, trace rootlets.  |                       |                                       |               | <br> <br>                      |               |                    |                |                  |   |  |                |                            |     |                         |              |        |                               |                       | Actions                        |
|              | CLAY; with some silt, orangish brown mottled light brownish grey, stiff, plastic, trace white silt specks.  Minor limonite staining from 1.00m.   | 122<br>1-             |                                       |               |                                |               |                    |                |                  |   |  |                | 100                        | НА  | Hand Auger              |              |        |                               |                       | のころもくころもくころもくころものころものころから こののこ |
|              | CLAY; with trace silt, light brownish grey<br>streaked orange, stiff, plastic, occasional<br>1-3cmØ angular mudstone fragments and  | -                     |                                       | 6             | <br> -<br> -<br>  1//1/2/1/2   |               |                    |                |                  |   |  |                | 100                        | SPT |                         | -            |        |                               |                       | からからから                         |
|              | lenses of silly sand.  Trace fine sand and becomes weakly cemented from 2.10m.  | _ 2-                  |                                       |               | <br>                           |               |                    |                |                  |   |  |                |                            |     | -                       |              |        |                               |                       | こうちょうかい しきいくりょう                |
|              |   | _120                  |                                       |               | <br>                           |               |                    |                |                  |   |  |                | 100                        | HQ  | -                       |              |        |                               |                       | かっていましていましているという               |
|              |   |                       |                                       |               | <br> <br> <br>                 |               |                    |                |                  |   |  |                | 100                        | PT  |                         |              |        |                               |                       | STATISTICS OF                  |
|              | Fine to medium sandy CLAY; with some silt,<br>yellowish brown mottled grey  |                       |                                       | 6             | <br> <br>  2//1/1/2/2<br>      |               |                    |                |                  |   |  |                | 100                        | SPT |                         |              |        |                               |                       | Shift Shift of                 |
|              |   | 4-                    |                                       |               | <br>                           |               |                    |                |                  |   |  |                | 100                        | HQ  |                         |              |        |                               |                       | State State State              |
| n            |   | -                     |                                       | 6             | <br> <br> <br>  3//2/1/2/1     |               |                    |                |                  |   |  |                | 60                         | SPT |                         |              |        |                               |                       | STANDSTANDS OF                 |
| Colluvium    |   | _ <sub>118</sub> 5-   |                                       |               | <br> <br>                      |               |                    |                |                  |   |  |                |                            |     |                         |              |        |                               |                       | States in                      |
| Co           | MUDSTONE; light orangish brown,<br>extremely weak, highly weathered.<br>No recovery from 5.50m to 6.00m.<br>Suspected fine grained material washed<br>away during drilling.   |                       |                                       |               |                                | EW            | HW                 |                |                  | Relict fract<br>undulating<br>coatings fr | ure surfaces; planar to<br>rough, limonite<br>om 5.20m to 5.50m. |                | 67                         | HQ  | 4Q Triple Tube Wireline |              |        |                               |                       | というというというとうこうとうこうないと           |
|              |   | 6-                    |                                       | 17            | <br> <br>  4//3/3/4/7<br>      |               |                    |                |                  |   |  |                | 100                        | PT  | H T                     |              |        |                               |                       | ALPAN PROPERTY                 |
|              | Silty fine SAND; greyish brown streaked orange, medium dense, brittle, trace limonite staining.   |                       | ×                                     |               | <br>                           |               |                    |                |                  |   |  |                | 100                        | SPT | -                       |              |        |                               |                       | Safe Safe Sie                  |
|              | CLAY; with trace silt, brown, hard, plastic, blocky/ lensmoidal, some manganese streaks.  Fine to medium SAND; with some silt and some fine angular gravel, light yellowish   | 116<br>7-             |                                       |               | <br> <br> <br> <br>            |               |                    |                |                  |   |  |                | 100                        | HQ  | -                       |              |        |                               |                       | SANTISPOLISMO IST              |
|              | brown mottled greyish brown, medium dense, brittle.  SILT; with some clay and trace fine sand, greyish brown streaked orange, hard, slightly plastic, some 1-3cmØ angular silt  | -                     | × ×<br>× ×<br>× ×                     | 12            | <br> <br> <br>  4//3/2/4/3<br> |               |                    |                |                  |   |  |                | 100                        | SPT |                         |              |        |                               |                       | SAPONAPONAPO                   |
|              | fragments. Fine sandy SILT; greyish brown, hard, brittle, weakly cemented. Silty CLAY; brown, hard, plastic, blocky/ lensmoidal. Silty fine to medium SAND; with some fine angular gravel, light brown mottled dark greyish brown, medium dense, brittle, trace | 8-                    | × × × × × × × × × × × × × × × × × × × |               | <br> <br> <br> <br> <br> <br>  |               |                    |                |                  | Relict fract<br>limonite sta<br>8.40m.    | ure surfaces, heavy<br>ining from 8.00m to                       |                | 43                         | HQ  |                         |              |        |                               |                       | となるとはなるないというというといること           |
|              | greyish brown, medium dense, brittle, trace<br>limonite staining.  Occasional streaks of white clay from<br>9.00m.  | _ <sup>114</sup> 9-   | × × × × × × × × × × × × × × × × × × × | 15            | <br> -<br> -<br>  2//3/3/3/6   |               |                    |                |                  |   |  |                | 100                        | SPT |                         |              |        |                               |                       | Shahasharan istra              |
|              | Becomes weakly cemented from 9.50m.   | -                     | × × × × × × × × × × × × × × ×         |               | <br>                           |               |                    |                |                  |   |  |                | 78                         | HQ  |                         |              |        |                               |                       | ARACIERACIERACIERA LA          |
| NO           | res   |                       | 1                                     |               | <u> </u>                       |               |                    |                | 1111111111       |   | STARTED  |                | 1                          |     | FIN                     | ISHED        |        | 44.5                          | 12                    | 6                              |
|              | hole was backfilled upon completion.  |                       |                                       |               |                                |               |                    |                |                  | ,   | 1/11/20<br>Driller<br>Gler                                       |                |                            |     | DRI                     | LLING C      | CO.    | 11/20<br>Iforce               |                       | -                              |
|              |   |                       |                                       |               |                                |               |                    |                |                  |   | INCLINATION/<br>AZIMUTH -90°                                     |                |                            |     | DRI                     | LLING F      | RIG    | Tracto                        |                       | -                              |
|              |   |                       |                                       |               |                                |               |                    |                |                  |   | Logged<br>T Van De   | e <u>e</u> len |                            |     | Сн                      | ECKED<br>A ( | Georg  |                               | BH1                   | 4.                             |
|              | ED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005)  | GUIDFI INF            |                                       | _             | SEE ATTA                       | <br>CHED K    | EY SHEE            | T FOR F        | ΥΡΙ ΔΝΔΤΙΟ       | ON OF SYMBOLS                             | CLIENT<br>Watercare Serv   |                |                            |     | JOE                     | No.          | 0935.  |                               | BUI                   | 1 1                            |

| NOTES   |  | STARTED      |                       | FINISHED      |          |
|---|--|--------------|-----------------------|---------------|----------|
|   |  |              | 1/11/2013             | 1/11/2013     |          |
| Borehole was backfilled upon completion.                                |  | DRILLER      |                       | DRILLING CO.  |          |
|   |  |              | Glen                  | Drillforce Lt | id       |
|   |  | INCLINATION/ |                       | DRILLING RIG  |          |
|   |  | AZIMUTH      | -90°                  | Tractor       |          |
|   |  | LOGGED       |                       | CHECKED _     |          |
|   |  |              | T Van Deelen          | A George      | BH13/10  |
| LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) GUIDELINES     | SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS  | CLIENT       |                       | JOB NO.       | D1113/10 |
| 200025 1171000125 1102 1171112 0201201111012 0001277 (2000) 00152211120 | OLE / I / I OT LE TOTAL | l Water      | care Services Limited | 1-C0935 25    |          |



|                        |                     |               | HOLE NO. |
|------------------------|---------------------|---------------|----------|
| BOREHOLE L             | OG                  |               | BH13/10  |
| PROJECT                | CO-ORD.             | R.L.          | SHEET    |
| Manuka Road Reservoirs | 1745918 E 5910806 N | 122.95 m      | 2 of 2   |
| LOCATION               | REF. GRID           | DATUM         | HOLE     |
| 0 01 01                | 014 0470 00 04470   | MOL ALL: 4040 | LENGTH   |

|              |  | T                      |   | _             | See Site   | Pian          |                    |                |               |                          |                         | SM 6472 SO                             | _       | CORE                       |     | ISL A                   | kld. 1  | LING   |                               | 15                    |
|--------------|--|------------------------|---|---------------|--|---------------|--------------------|----------------|---------------|--------------------------|-------------------------|--|---------|----------------------------|-----|-------------------------|---------|--------|-------------------------------|-----------------------|
| GEOLOGY/UNIT | MAIN DESCRIPTION   | R.L. (m)<br>DEPTH (m)  | GRAPHIC LOG   | SPT 'N' VALUE |  | ROCK STRENGTH | ROCK<br>WEATHERING | DEFECT SPACING | DIP<br>degree | s <b>DET</b> A           | AILED DESC              | CRIPTION                               | RQD (%) | TOTAL CORE<br>RECOVERY (%) | _   | DRILLING                | S       | CASING | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER<br>DETAILS |
|              | Silty fine to medium SAND; with some fine<br>angular gravel, light brown mottled dark<br>greyish brown, medium dense, brittle, trace<br>limonite staining.   |                        | * × .   |               |  |               |                    |                |               |                          |                         |  |         | 78                         | HQ  |                         |         |        |                               |                       |
|              | Becomes non-cemented from 10.50m.  |                        | * × .   | 12            | <br> <br> <br>  3//2/3/3/4                           |               |                    |                |               |                          |                         |  |         | 100                        | SPT | -                       |         |        |                               |                       |
|              | Silty fine to medium SAND; dark greyish brown, medium dense, brittle, some weakly cemented lenses of material with manganese coatings, occasional pockets of grey clay. Fine grained material washed away from 11.50m to 12.00m. | 112<br>11.             | × × × × × × × × × × × × × × × × × × ×   |               | <br>   |               |                    |                |               |                          |                         |  |         | 100                        | HQ  |                         |         |        |                               |                       |
|              | Fine sub-rounded to angular GRAVEL; with trace fine sand and trace silt, yellowish brown, medium dense, brittle.   | 12                     | - × × · × · · · · · · · · · · · · · · ·   | 2 25          | <br>   |               |                    |                |               |                          |                         |  |         | 100                        | SPT | reline                  |         |        |                               |                       |
| Colluvium    | Fine sub-rounded to angular gravelly fine to medium SAND; with trace silt, yellowish brown, medium dense, brittle.   | 110                    |   |               | <br> <br> <br> <br>                                  |               |                    |                |               | Vervalen                 | -1                      |  |         |                            |     | HQ Triple Tube Wireline |         |        |                               |                       |
| )            | Fine to medium SAND; with trace fine angular gravel, bluish grey mottled brown, medium dense, brittle, weakly cemented.  | 13                     |   |               | <br> <br> <br> <br> <br>                             |               |                    |                |               | fractures;<br>coating fr | undulating<br>om 12.90m | relict<br>, smooth, clay<br>to 13.00m. |         | 100                        | HQ  | 외                       |         |        |                               |                       |
|              |  | 14                     |   | 10            | <br>  1//1/2/3/4<br> <br> <br>                       |               |                    |                |               |                          |                         |  |         | 33                         | SPT |                         |         |        |                               |                       |
|              | Silty fine to medium SAND; with trace fine angular gravel, bluish grey, medium dense, brittle, moderately cemented.  Clayey SILT; bluish grey, hard, slightly  |                        | × × × × ×   |               | <br> <br> <br> <br>                                  |               |                    |                |               |                          |                         |  |         | 78                         | HQ  |                         |         |        |                               |                       |
|              | \plastic. Silty fine to medium SAND; with trace fine angular gravel, bluish grey, dense, brittle, moderately cemented.   | _ <sub>108</sub><br>15 | - × · · · · · · · · · · · · · · · · · ·   | 50+           | <br> <br> <br> <br> <br> 8//5/14/16/16<br>  for 45mm |               |                    |                |               |                          |                         |  |         | 100                        | SPT | -                       |         |        |                               |                       |
|              | End of Borehole at 15.42m.   | <sup>-</sup> 16        |   |               |  |               |                    |                |               |                          |                         |  |         |                            |     |                         |         |        |                               |                       |
|              |  | 106<br>17-             | -<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>- |               | <br> <br> <br> <br> <br> <br> <br>                   |               |                    |                |               |                          |                         |  |         |                            |     |                         |         |        |                               |                       |
|              |  | -<br>18                | -<br>-<br>-<br>-<br>-<br>-<br>-<br>-  |               | <br> <br> <br> <br> <br> <br> <br>                   |               |                    |                |               |                          |                         |  |         |                            |     |                         |         |        |                               |                       |
|              |  | 104                    | -<br>-<br>-<br>-<br>-<br>-<br>-<br>-  |               | <br>   |               |                    |                |               |                          |                         |  |         |                            |     |                         |         |        |                               |                       |
|              |  |                        | -<br>-<br>-<br>-<br>-   |               | <br>   |               |                    |                |               |                          |                         |  |         |                            |     |                         |         |        |                               |                       |
|              | TES chole was backfilled upon completion.  |                        |   |               |  |               |                    |                |               |                          | STARTED                 | 1/11/20                                | )13     |                            |     |                         | ISHED   |        | 11/20                         | 13                    |
| _010         | apon completion.   |                        |   |               |  |               |                    |                |               |                          | DRILLER                 | Glen                                   | 1       |                            |     |                         | LLING C | Dril   | lforce                        | Ltd                   |
|              |  |                        |   |               |  |               |                    |                |               |                          | AZIMUTH<br>LOGGED       | -90°                                   |         |                            |     |                         | CKED    |        | Fracto                        | -                     |
|              |  |                        |   |               |  |               |                    |                |               |                          |                         | T Van De                               | elen    |                            |     |                         | ΑC      | Georg  | е                             | BH1                   |

| NOTES    |   |
|----------|---|
| Borehole | ٧ |

Watercare Services Limited

## Borehole 13/10





0.00m – 3.00m



3.00m – 6.00m

Watercare Services Limited

Borehole 13/10





6.00m – 8.20m Box 3 of 6



8.20m – 11.65m

Watercare Services Limited

Borehole 13/10





11.65m – 15.00m Box 5 of 6



15.00m – 15.45m (E.O.H)

Box 6 of 6



|          |                       |                     |          | HOLE NO. |
|----------|-----------------------|---------------------|----------|----------|
|          | BOREHOLE L            | OG                  |          | BH13/11  |
| PROJECT  |                       | CO-ORD.             | R.L.     | SHEET    |
| M        | anuka Road Reservoirs | 1746226 E 5910756 N | 126.49 m | 1 of 2   |
| LOCATION |                       | REF. GRID           | DATUM    | HOLE     |

| _                  |   |                       |   | -                 | TESTS                                |                        |            | ORE         |                  | DRIL                      | LING   |                               | _          |
|--------------------|---|-----------------------|---|-------------------|--------------------------------------|------------------------|------------|-------------|------------------|---------------------------|--------|-------------------------------|------------|
| GEOLOGY/UNIT       | MAIN DESCRIPTION  | R.L. (m)<br>DEPTH (m) | GRAPHIC LOG   | SPT 'N' VALUE     | SPT BLOW<br>COUNTS OR<br>SHEAR VALUE | CPT qc<br>(MPa)        | TOTAL CORE | SAMPLE TYPE | RILLING          | DRILLING<br>FLUID LOSS    | CASING | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER |
|                    | CLAY; with some 1-10cmØ angular gravel, trace silt and trace fine sand, brownish orange,  |                       | _   | 0)                |                                      | 10 20                  | 30 - 1     | . 0         | <u> </u>         |                           |        | ш ж                           |            |
| Ē                  | firm, plastic.  Becomes mottled grey with trace silt and occasional 1-2cmØ angular gravel.  | _126                  |   |                   |                                      |                        |            |             | Auger            |                           |        |                               |            |
|                    | CLAY; with trace silt, brownish grey streaked orange, firm, plastic.  | 1                     |   | -                 |                                      |                        |            | HA          | Hand Auger       |                           |        |                               |            |
|                    | Clayey SILT; with trace fine sand, brownish grey mottled orange, firm, plastic.   |                       | × × × × × ×   | 3                 | 1 1//0/1/1/1                         |                        | 100        | SPT         |                  |                           |        |                               |            |
|                    | Becomes greyish brown with trace medium sand from 2.00m.  | 2                     | -x x<br>-x x<br>-x x  | 1                 |                                      |                        |            |             |                  |                           |        |                               |            |
|                    | Progressively grading into a silty fine SAND; loose, brittle by 3.00m.  | _124                  | - <u>x</u> <u>x</u> <u>x</u><br>- <u>x</u> <u>x</u> <u>x</u><br>- <u>x</u> <u>x</u> <u>x</u><br>- <u>x</u> <u>x</u> <u>x</u><br>- <u>x</u> <u>x</u> <u>x</u> <u>x</u> | - }<br>- }<br>- > |                                      |                        | 100        | HQ          |                  |                           |        |                               |            |
|                    | Fine SAND; with trace silt, greyish brown, medium dense, brittle, trace manganese staining.   | 3                     |   | _ <del>}</del>    |                                      |                        | 100        | PT          |                  |                           |        |                               |            |
|                    |   |                       |   | 10                | 3//2/2/3/3                           |                        | 100        | SPT         | _                |                           |        |                               |            |
|                    |   | 4                     |   | -                 |                                      |                        | 100        | HQ          |                  |                           |        |                               |            |
| _                  | Limonite staining from 4.50m to 4.70m.  | _122                  |   | 20                | 5//4/4/6/6                           |                        | 100        | SPT         | _                |                           |        |                               |            |
| Nihotupu Formation | Some manganese streaks from 4.95m.  | 5                     |   |                   |                                      |                        |            |             | _<br>_<br>_<br>_ |                           |        |                               |            |
| Nihotupu           | Becomes yellowish brown with trace limonite staining from 5.50m.  |                       |   |                   |                                      |                        | 100        | HQ          | Tube M           |                           |        |                               |            |
|                    | Fine to medium SAND; with trace silt, yellowish brown, medium dense, brittle. Relict fracture, gently inclined dip; planar, rough, limonite staining at 5.90m. Fine to coarse SAND; with some 1-5mmØ sub-rounded to angular gravel, yellowish brown, medium dense, brittle, some weakly cemented zones. | 6                     |   | 38                | 12//11/8/9/10                        |                        | 100        | SPT         | HQ Triple        |                           |        |                               |            |
|                    | Poor recovery from 6.45m to 7.50m. Fragments of 1-4cmØ angular weakly cemented SAND; in a suspected fine grained matrix that has been washed away during drilling.  | _120                  |   |                   | <br>                                 |                        |            |             |                  |                           |        |                               |            |
|                    |   | 7                     |   |                   |                                      |                        | 27         | HQ          |                  |                           |        |                               |            |
|                    | Intense zone of limonite staining from 7.70m.   | _                     |   | 37                | 23//13/8/8/8                         |                        | 100        | SPT         |                  |                           |        |                               |            |
|                    | Thin streaks of whitish brown clay from 8.00m to 8.50m.   | _118                  |   | -                 |                                      |                        | 100        | HQ          |                  |                           |        |                               |            |
|                    | Intense zone of limonite from 8.70m to 8.80m. Becomes brownish grey and weakly cemented from 8.80m. Relict fracture, moderately inclined dip; undulating, rough, limonite coating at 8.90m.   | 9                     |   | 3                 | 3//1/0/1/1                           |                        |            | SPT         |                  |                           |        |                               |            |
| NO.                | Poor recovery from 9.45m to 10.50m. Fragments of 1-4cmØ angular weakly cemented SAND; in a suspected fine grained matrix that has been washed away during drilling.   |                       |   |                   |                                      |                        | 29         | HQ          |                  |                           |        |                               |            |
|                    | TES chole was backfilled upon completion.   |                       |   | 1                 | STARTED DRILLER                      | 8/11/2013              | "          |             |                  | ISHED                     | O.     | 11/20                         |            |
| Bore Logg          |   |                       |   |                   | INCLINATION AZIMUTH LOGGED           | Glen -90°  T Van Deele | en         |             |                  | ILLING RI<br>ECKED<br>A G | 'G     | Iforce<br>Tracto<br>e         |            |



|          |                      |            |           |               | HOLE NO. |                      |
|----------|----------------------|------------|-----------|---------------|----------|----------------------|
|          | BOREHOLE L           | OG         |           |               | BH1      | 3/11                 |
| PROJECT  |                      | CO-ORD.    |           | R.L.          | SHEET    |                      |
| Man      | nuka Road Reservoirs | 1746226 E  | 5910756 N | 126.49 m      |          | <b>2</b> of <b>2</b> |
| LOCATION |                      | REF. GRID  |           | DATUM         | HOLE     |                      |
|          | Con Cita Diam        | CM C470 CC | 04450     | MCI AIdd 4040 | LENGTH   | 40                   |

|                            |   | See Site Plan                                    |                          | SM 6472 SO 61159      |             | MSL Aklo                       |                          | LENGT  | T                     | _     |
|----------------------------|---|--|--------------------------|-----------------------|-------------|--------------------------------|--------------------------|--|-----------------------|-------|
| ⊨                          |   | TES  |                          |                       | ORE         | D                              | RILLING                  |  | ~                     |       |
| GEOLOGY/UNIT               |   | R.L. (m) DEPTH (m) GRAPHIC LOG SPT N' VALUE      | COUNTS OR<br>SHEAR VALUE | CPT qc (MPa) 10 20 30 | SAMPLE TYPE | DRILLING<br>METHOD<br>DRILLING | FLUID LOSS CASING        | BASE OF HOLE<br>& WATER LEVEL                | PIEZOMETER<br>DETAILS | 7     |
| 35                         | MAIN DESCRIPTION  Fine to coarse SAND; with some 1-5mmØ sub-rounded to angula |  | ·                        | 10 20 30              | SA          | A M M                          | ぱ 3                      | 9 %  |                       |       |
|                            | medium dense, brittle, some weakly cemented zones.                            |  |                          | 29                    | HQ          |                                |                          |  |                       |       |
| (;                         | Fragments of hard angular CONCRETE.   | 116 - 50+ 5                                      | 0 for<br>5mm             | 100                   | SPT         |                                |                          |  |                       |       |
| educt                      |   |  |                          |                       |             |                                |                          |  |                       |       |
| (Aque                      |   | 11-  |                          |                       |             |                                |                          |  |                       | 1     |
| Fill / Concrete (Aqueduct) |   |  |                          | 20                    | HQ          |                                |                          |  |                       | 1     |
| Cond                       |   |  |                          |                       |             |                                |                          |  |                       | N. J. |
| / III /                    |   |  |                          |                       |             |                                |                          |  |                       |       |
|                            | End of Borehole at 12.00m. Underground service struck.                        | 12   |                          |                       |             | ine                            |                          |  | Public                | -     |
|                            | LING OF BOTOTOLO AC 12.00111. OTHER GROUND SETVICE STRUCK.                    |  |                          |                       |             | HQ Triple Tube Wireline        |                          |  |                       |       |
|                            |   |  |                          |                       |             | ole Tut                        |                          |  |                       |       |
|                            |   | 13-  |                          |                       |             | HQ Trij                        |                          |  |                       |       |
|                            |   |  |                          |                       |             |                                |                          |  |                       |       |
|                            |   |  |                          |                       |             |                                |                          |  |                       |       |
|                            |   |  |                          |                       |             |                                |                          |  |                       |       |
|                            |   | 14-  |                          |                       |             |                                |                          |  |                       |       |
|                            |   |  |                          |                       |             |                                |                          |  |                       |       |
|                            |   |  |                          |                       |             |                                |                          |  |                       |       |
|                            |   | 15   |                          |                       |             |                                |                          |  |                       |       |
|                            |   |  |                          |                       |             |                                |                          |  |                       |       |
|                            |   |  |                          |                       |             |                                |                          |  |                       |       |
|                            |   |  |                          |                       |             |                                |                          |  |                       |       |
|                            |   | 16-  |                          |                       |             |                                |                          |  |                       |       |
|                            |   |  |                          |                       |             |                                |                          |  |                       |       |
|                            |   |  |                          |                       |             |                                |                          |  |                       |       |
|                            |   | 17-  |                          |                       |             |                                |                          |  |                       |       |
|                            |   |  |                          |                       |             |                                |                          |  |                       |       |
|                            |   | -  |                          |                       |             |                                |                          |  |                       |       |
|                            |   |  |                          |                       |             |                                |                          |  |                       |       |
|                            |   | 18-  |                          |                       |             |                                |                          |  |                       |       |
|                            |   |  |                          |                       |             |                                |                          |  |                       |       |
|                            |   | IOO  |                          |                       |             |                                |                          |  |                       |       |
|                            |   | 19-  |                          |                       |             |                                |                          |  |                       |       |
|                            |   | 19   |                          |                       |             |                                |                          |  |                       |       |
|                            |   | ]  |                          |                       |             |                                |                          |  |                       |       |
|                            |   |  |                          |                       |             |                                |                          |  |                       |       |
|                            |   |  | STARTED                  |                       |             | FINISHE                        | - D                      |  |                       |       |
| NOT<br>Bore                | TES  chole was backfilled upon completion.                                    |  | DRILLER                  | 8/11/2013             |             | DRILLIN                        | 8 <i>i</i><br>IG CO.     | /11/20 <sup>-</sup>                          |                       |       |
|                            |   |  | INCLINATIO               | Glen                  |             | DRILLIN                        | Dri<br>IG RIG            | Ilforce<br>Tracto                            |                       |       |
|                            |   |  | AZIMUTH<br>LOGGED        | -90° T Van Deelen     |             | CHECK                          | <sub>ED</sub><br>A Georg | Tracto<br>ne                                 |                       |       |
|                            |   | SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOL | CLIENT                   | i van Deelen          |             | JOB NO                         | , , OCOI (               | <u>,                                    </u> | ⊢ B⊦                  | •     |

| NOTES   |                                | STARTED                 |              |           | FINISHED       |               |        |      |          |
|---|--------------------------------|-------------------------|--------------|-----------|----------------|---------------|--------|------|----------|
| NOTES   |                                |                         | 8/11/201     | 3         |                | 8/11          | /2013  |      |          |
| Borehole was backfilled upon completion.  |                                | DRILLER                 | Glen         |           | DRILLING (     | o.<br>Drillfo | rce Li | d    |          |
|   |                                | INCLINATION/<br>AZIMUTH | /<br>-90°    |           | DRILLING F     |               | actor  |      |          |
|   |                                | LOGGED                  | T Van Dee    | elen      | CHECKED<br>A ( | George        |        | BH13 | 2/4.4    |
| OGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) GUIDELINES SEE ATTACHED KEY SHE | EET FOR EXPLANATION OF SYMBOLS | CLIENT<br>Water         | rcare Servic | es Limite | ЈОВ NO.<br>1-C | 0935.25       | )      | БПІЗ | <i>y</i> |

Watercare Services Limited

Borehole 13/11





0.00m – 3.00m



3.00m – 5.80m Box 2 of 4

Watercare Services Limited

Borehole 13/11





5.80m – 9.45m Box 3 of 4





|                        |              |           |                | HOLE NO. |        |
|------------------------|--------------|-----------|----------------|----------|--------|
| BOREHOLE LO            | )G           |           |                | BH1      | 3/12   |
| PROJECT                | CO-ORD.      |           | R.L.           | SHEET    |        |
| Manuka Road Reservoirs | 1746229 E    | 5910719 N | 130.04 m       | 1        | 1 of 2 |
| LOCATION               | REF. GRID    |           | <b>DATUM</b>   | HOLE     |        |
| See Site Plan          | SM 6472 SO 6 | 1159      | MSL Akld. 1946 | LENGTH   | 15.4 m |

|                    | <br>  | 1         |   | _             | See Site                                 | riaii                      |                    |                |        |   | SM 6472 SO  |         |                            |             | ISL A                   | kld. 1  |            | LENGT                         |                       |  |
|--------------------|---|-----------|---|---------------|--|----------------------------|--------------------|----------------|--------|---|---|---------|----------------------------|-------------|-------------------------|---------|------------|-------------------------------|-----------------------|--|
| GEOLOGY/UNIT       |   | (r<br>(m) | GRAPHIC LOG                             | SPT 'N' VALUE | SPT BLOW COUNTS OR SHEAR VALUE           | ROCK STRENGTH              | ROCK<br>WEATHERING | DEFECT SPACING | DIP    |   |   |         | TOTAL CORE OO RECOVERY (%) | SAMPLE TYPE | ING                     | S       | _LING<br>ഇ | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER<br>DETAILS |  |
| GEOL               | MAIN DESCRIPTION  | R.L. (m)  | GRAP                                    | N. TAS        | SPT B<br>COUN'<br>SHEAF                  | ROCK                       | ROCK               | DEFEC          | degree | s DETAIL  | ED DESCRIPTION  | RQD (%) | TOTAL                      | SAMPI       | DRILLING<br>METHOD      | PRILL   | CASING     | BASE<br>& WAT                 | PIEZ                  |  |
|                    | CLAY; with some silt, brown streaked orange, firm, plastic, some rootlets.  | -         | ==                                      |               | <br> <br>                                |                            |                    |                |        | Ĭ   |   |         |                            |             |                         |         |            |                               |                       |  |
|                    | CLAY; with trace silt, brownish grey mottled orange, stiff, plastic, some 1-4mmØ angular hard silt fragments.                                   |           |   |               | <br>                                     |                            |                    |                |        |   |   |         | 100                        | НА          | Hand Auger              |         |            |                               |                       |  |
|                    | Becomes grey mottled orange from 1.20m.   | _ 1       |   |               | <br> <br> <br>                           |                            |                    |                |        |   |   |         |                            |             | _                       |         |            |                               |                       |  |
|                    | Trace manganese staining from 1.50m.  |           |   | 5             | <br> <br> <br>  2//1/1/1/2               |                            |                    |                |        |   |   |         | 100                        | CDT         |                         | -       |            |                               |                       |  |
|                    | Silty CLAY; with trace fine to coarse sand, brown mottled yellowish brown, firm, plastic, some 1-3mmØ angular silt fragments.                   | _128 2    |   |               | 2, 1, 1, 1, 1, 2                         |                            |                    |                |        |   |   |         | 100                        | SPT         |                         |         |            |                               |                       |  |
|                    | Silty fine to medium SAND; brown mottled yellowish brown, very loose, brittle, slightly dilatant in the core box, some 1-3mmØ angular gravel.   |           | × × × × × × × × × × × × × × × × × × ×   |               | <br>                                     |                            |                    |                |        |   |   |         | 87                         | HQ          |                         |         |            |                               |                       |  |
|                    |   | _ 3       | × × ×                                   |               | <br> <br> <br>                           |                            |                    |                |        |   |   |         | 100                        | PT          |                         |         |            |                               |                       |  |
|                    | Becomes yellowish brown with no dilatancy from 3.50m.   |           | × × ×                                   | 0             | <br> <br>  0//0/0/0/0<br>                |                            |                    |                |        |   |   |         | 100                        | SPT         |                         |         |            |                               |                       |  |
|                    | SILT; with some fine to medium sand and some clay, light brownish grey, soft, slightly plastic, trace 1-5mmØ angular silt fragments.            | 126 4     | × × × × ×                               |               | <br>                                     |                            |                    |                |        |   |   |         | 100                        | HQ          |                         |         |            |                               |                       |  |
| ıtion              |   |           | -× × × -× × ×                           | 0             | <br>                                     |                            |                    |                |        |   |   |         |                            |             |                         |         |            |                               |                       |  |
| Nihotupu Formation | Fine to medium SAND; with trace silt, greyish brown, very loose, brittle, slightly dilatant in the core box from 4.95m to 5.20m.                | _ 5       |   | U             | 0,70,70,70,70,70<br> <br> <br>           |                            |                    |                |        |   |   |         | 71                         | SPT         |                         |         |            |                               |                       |  |
| Nihotup            | Poor recovery from 4.95m to 6.00m.  |           |   |               | <br>                                     |                            |                    |                |        |   |   |         | 33                         | HQ          | 4Q Triple Tube Wireline |         |            |                               |                       |  |
|                    |   | _124 6    |   |               | <br> <br> <br> <br>                      |                            |                    |                |        |   |   |         | 100                        | PT          | HQ Trip                 |         |            |                               |                       |  |
|                    | SILT; with some fine to medium sand, stiff, brittle, trace limonite staining.   |           |   | 5             | 5  | <br> -<br>  2//1/1/1/2<br> |                    |                |        |   |   |         |                            | 100         | SPT                     |         |            |                               |                       |  |
|                    | Clayey fine SAND; with some silt, yellowish brown, loose, plastic.  Some limonite staining from 7.20m.  Silty fine SAND; dense, brittle, weakly | 7         |   | -             | <br>                                     |                            |                    |                |        |   |   |         | 100                        | HQ          |                         |         |            |                               |                       |  |
|                    | cemented.  Laminae streaks of manganese from 7.60m.   |           | × · · · · · · · · · · · · · · · · · · · | 50‡           | <br> <br> 8//12/12/18/<br>  for 25mm<br> | В                          |                    |                |        | Relict fractur<br>inclined dip;<br>limonite coar      | re, very steeply<br>undulating, rough,<br>ting at 7.40m.                      |         | 100                        | SPT         |                         |         |            |                               |                       |  |
|                    | Fine to coarse SANDSTONE; some 1-2cmØ sub-rounded to angular gravel, brownish grey, extremely weak, moderately cemented, limonite staining.     | _122 8    |   |               | <br>                                     | EW                         | MW                 |                |        | Fracture, mo<br>undulating, r<br>coating at 8.        | oderately inclined dip;<br>ough, trace limonite<br>30m.                       | 78      | 100                        | HQ          |                         |         |            |                               |                       |  |
|                    | Fine to medium SANDSTONE; with trace<br>0.5m-2cmØ angular gravel, brownish grey,<br>extremely weak, moderately weathered.                       | 9         |   |               | <br> -<br> -                             |                            |                    |                |        | Broken core<br>8.80m to 9.0                           | due to drilling from<br>0m.   |         |                            |             |                         |         |            |                               |                       |  |
|                    |   |           | ======================================= | 50+           | 28//35/15<br>  for 35mm<br>              | EW                         | MW                 |                |        | Three closel  | y spaced fractures,   |         | SC                         | SPT         | _                       |         |            |                               |                       |  |
|                    |   |           |   |               | <br> <br> <br> <br>                      | EVV                        | IVIVV              |                |        | very steeply<br>undulating, r<br>manganese<br>10.05m. | y spaced fractures,<br>inclined dips;<br>ough, trace<br>coating from 9.30m to | 54      | 100                        | HQ          |                         |         |            |                               |                       |  |
|                    | TES   |           |   |               |  |                            |                    |                |        |   | TARTED 7/11/20  | 13_     |                            |             |                         | ISHED   |            | 11/20                         | 13                    |  |
| Bore               | chole was backfilled upon completion.   |           |   |               |  |                            |                    |                |        |   | RILLER Glen   |         |                            |             |                         | LLING C | Dril       | lforce                        | Ltd                   |  |
|                    |   |           |   |               |  |                            |                    |                |        | A   | ICLINATION/<br>ZIMUTH -90°<br>DGGED   |         |                            |             |                         | LLING H |            | Fracto                        | r                     |  |
|                    |   |           |   |               | SEE ATTA                                 |                            |                    |                |        |   | T Van De  | elen    |                            |             |                         | A (     | Georg      | е                             | ВН                    |  |

| NOTES    |   |
|----------|---|
| Borehole | ١ |



|                        |                     |          | HOLE NO.       |  |  |  |  |  |  |  |  |  |  |
|------------------------|---------------------|----------|----------------|--|--|--|--|--|--|--|--|--|--|
| BOREHOLE LOG           |                     |          |                |  |  |  |  |  |  |  |  |  |  |
| PROJECT                | CO-ORD.             | R.L.     | SHEET          |  |  |  |  |  |  |  |  |  |  |
| Manuka Road Reservoirs | 1746229 E 5910719 N | 130.04 m | 2 of 2         |  |  |  |  |  |  |  |  |  |  |
| OCATION                | REF. GRID           | DATUM    | HOLE<br>LENGTH |  |  |  |  |  |  |  |  |  |  |

| _                  |   |                                |   |                         | See Site   | Plan              |                    |                |              |  | SM 6472   | 60 611     |                            |     | ISL A                   | kld. 1 |             | LENGT                         | 1                     | 15.4  |
|--------------------|---|--------------------------------|---|-------------------------|--|-------------------|--------------------|----------------|--------------|--|---|------------|----------------------------|-----|-------------------------|--------|-------------|-------------------------------|-----------------------|---|
| GEOLOGY/UNIT       | MAIN DESCRIPTION  | R.L. (m)                       | GRAPHIC LOG                             | SPT 'N' VALUE           | SPT BLOW COUNTS OR SHEAR VALUE                           | ROCK STRENGTH     | ROCK<br>WEATHERING | DEFECT SPACING | DIP  degrees | S DETA                                 | AILED DESCRIPTION   | RQD (%)    | TOTAL CORE OO RECOVERY (%) | 1   | DRILLING METHOD         | S      | CASING      | BASE OF HOLE<br>& WATER LEVEL | PIEZOMETER<br>DETAILS |   |
|                    | Silty fine SAND; light grey, loose, brittle, weakly cemented, abundant 1-3mmØ angular gravel down to 10.30m.  |                                | - × · · · · · · · · · · · · · · · · · · |                         | <br> <br> <br>   |                   |                    |                |              |  |   | 54         | 100                        | HQ  |                         |        |             |                               |                       | Andrew Arter and Andrew                                 |
|                    |   |                                | × × · · · · · · · · · · · · · · · · · · | 4                       | <br> <br>  2//1/1/1/1<br>                                |                   |                    |                |              |  |   |            | 0                          | SPT |                         |        |             |                               |                       | Sidners reserve   |
| Nihotupu Formation | Fine to 3mmØ GRAVEL; with some silt and some fine sand, grey, loose, brittle.  Progressively grading into a silty GRAVEL; brown mottled orange, loose, brittle by 11.40m.  SILT; with some 1-3mmØ angular gravel and trace clay, brownish orange, firm, slightly plastic.  No gravel and trace limonite and | _ 11                           | - 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | 2                       | <br>   |                   |                    |                |              |  |   |            | 100                        | HQ  |                         |        |             |                               |                       | adhdhamanadhamana una una una una una                   |
|                    | manganese staining from 11.40m.  Silty fine SAND; light grey, medium dense, brittle, weakly to moderately cemented.   | _118 2                         | × ×                                     | 31                      | <br> <br>  9//8/7/8/8<br>                                |                   |                    |                |              |  |   |            | sc                         | SPT | Wireline                |        |             |                               |                       | - was and company of the                                |
|                    | Occasional 2cm thick horizons of some fine angular gravel from 13.00m to 13.50m. Becomes completely cemented from 13.20m to 13.40m.   | _ 13                           | × × × × × × × × × × × × × × × × × × ×   |                         | <br>   |                   |                    |                |              |  | cture, very steeply<br>ip; undulating, rough,<br>unite coating from 12.60r<br>1.<br>cture, very steeply<br>ip; undulating, rough,<br>coating from 13.10m to |            | 100                        | HQ  | HQ Triple Tube Wireline |        |             |                               |                       | יטי יישראי אישראינאינאינאינאינאינאינאינאינאינאינאינאינא |
|                    |   |                                | × × .                                   | 50÷                     | <br>  6//17/13/14/<br>  for 35mm<br> <br>                | 6                 |                    |                |              | Relict frac<br>dip; undu<br>limonite c | cture, steeply inclined lating, rough, trace oating at 13.45m.  |            | sc                         | SPT |                         |        |             |                               |                       | Premare and a   |
|                    | Fine to coarse SAND; with some silt and some fine angular gravel, brownish grey, dense, brittle, weakly cemented.   | _116 4                         |   |                         | <br>   |                   |                    |                |              |  |   |            |                            |     |                         |        |             |                               |                       | the remaining the                                       |
|                    | Silty CLAY; brownish grey, hard, plastic. Fine SANDSTONE; brownish grey, very weak, slightly weathered, massive.  | _ 15                           | _ 15- 50                                | 50 <sup>4</sup> for 25m | <br> <br> <br> <br> <br> <br> 6//13/17/14/<br>  for 25mm | y <sub>6</sub> VW | v sw               | ,              |              |  |   | 55         | 85<br>SC                   | HQ  | _                       |        |             |                               |                       |   |
|                    | End of Borehole at 15.40m.  | _1146<br>_ 17<br>_1128<br>_ 19 |   |                         |  |                   |                    |                |              |  |   |            |                            |     |                         |        |             |                               |                       |   |
| NOT<br>Bore        | TES hole was backfilled upon completion.  |                                | -                                       |                         | <br>   |                   |                    |                |              |  | DRILLER   | 2013<br>en |                            |     | DRI                     | ISHED  | Co.<br>Dril | 11/201<br>Iforce              |                       | <u>_</u>  |
|                    |   |                                |   |                         |  |                   |                    |                |              |  | AZIMUTH -90° LOGGED   |            |                            |     |                         | ECKED  |             | Tracto                        | <u>r</u>              | _   |

Watercare Services Limited

Borehole 13/12





0.00m – 3.00m



3.00m – 6.30m

Manuka Reservoirs

Watercare Services Limited

Borehole 13/12





6.30m – 9.26m Box 3 of 5



9.26m – 13.00m Box 4 of 5

| Manuka |  |
|--------|--|
|        |  |

Watercare Services Limited

Borehole 13/12





13.00m – 15.40m (E.O.H)

Box 5 of 5

# Appendix C CPT Plots



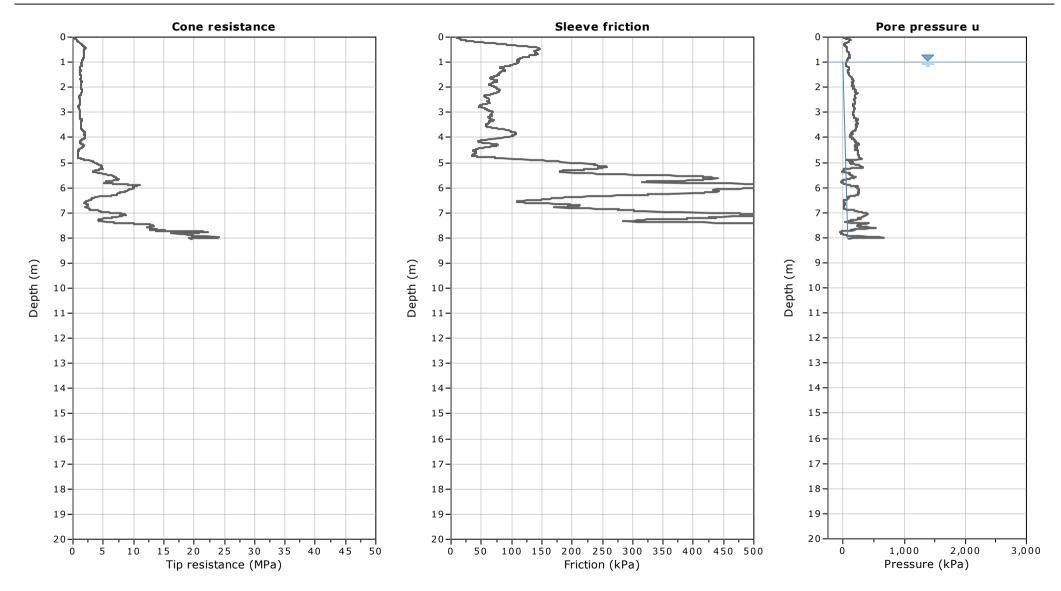
PO Box 21-956, Henderson, Auckland 0650 Ph: (09) 950 1919, (021) 191 6000 http://www.q-i.co.nz

CPT: CPT01

Total depth: 8.04 m, Date: 6/11/2013 Cone Type: 10 cm2, 50 MPa, Piezocone

Cone Operator: SP&TP

Project: 13-101 - Woodlands Park





PO Box 21-956, Henderson, Auckland 0650 Ph: (09) 950 1919, (021) 191 6000 http://www.q-i.co.nz

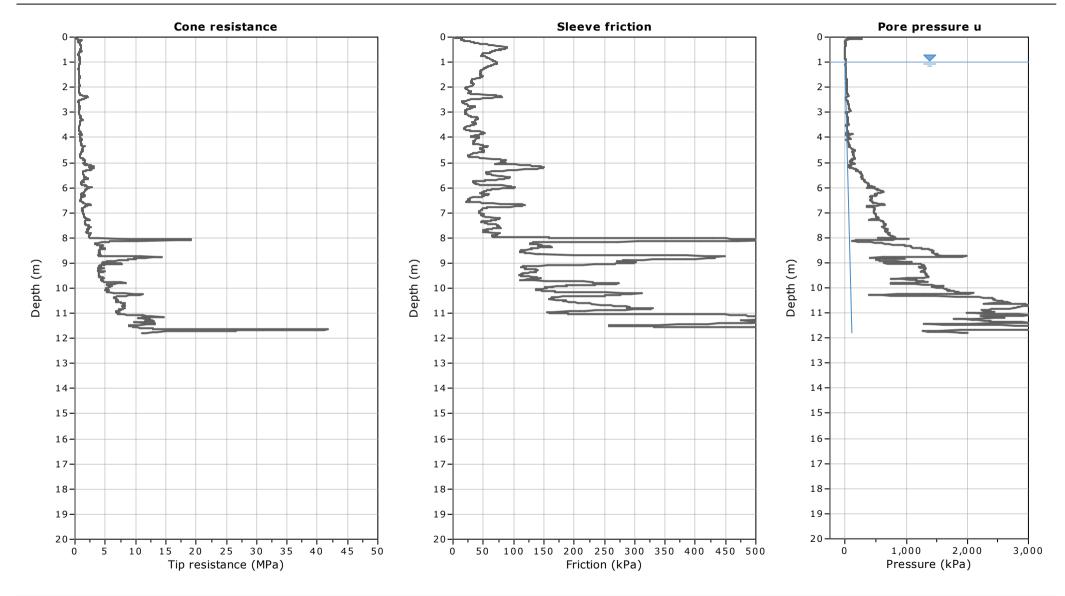
Total depth: 11.81 m, Date: 6/11/2013

Cone Type: 10 cm2, 50 MPa, Piezocone

Cone Operator: SP&TP

CPT: CPT02

Project: 13-101 - Woodlands Park





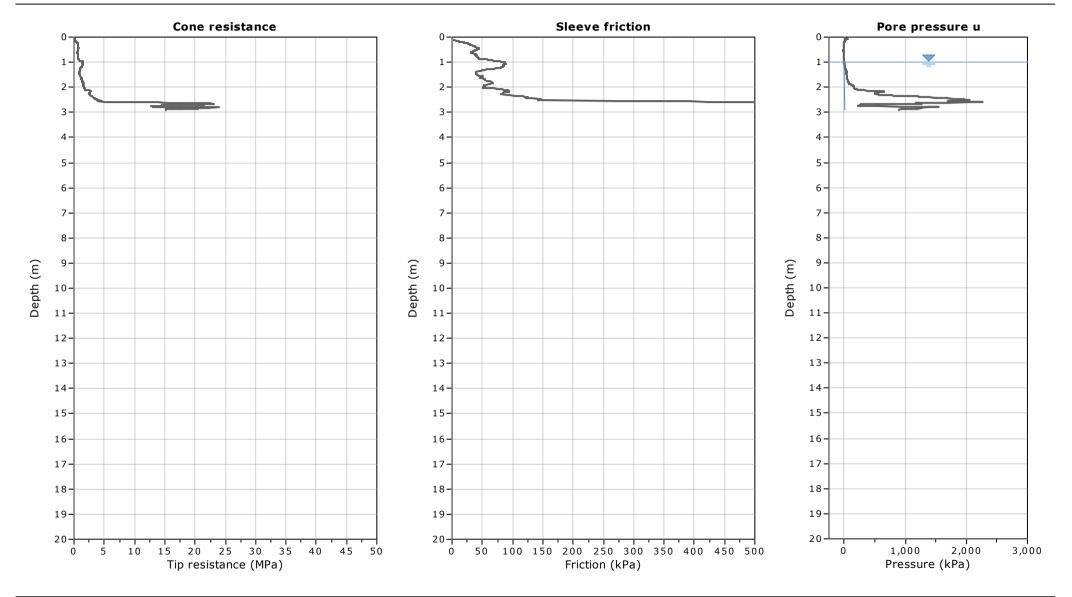
PO Box 21-956, Henderson, Auckland 0650 Ph: (09) 950 1919, (021) 191 6000 http://www.q-i.co.nz

CPT: CPT03

Total depth: 2.89 m, Date: 6/11/2013 Cone Type: 10 cm2, 50 MPa, Piezocone

Cone Operator: SP&TP

Project: 13-101 - Woodlands Park





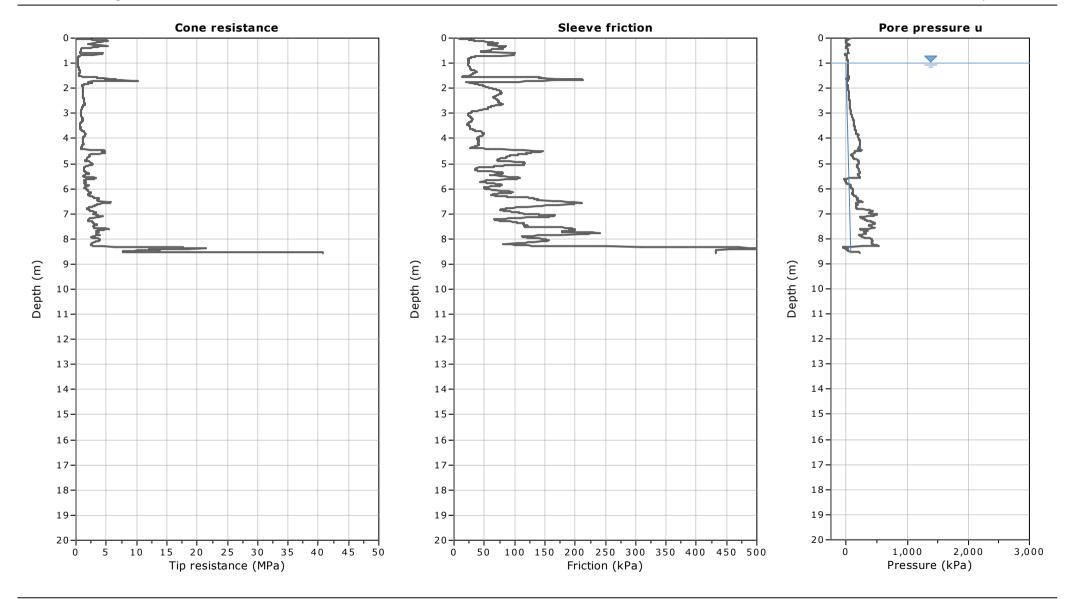
PO Box 21-956, Henderson, Auckland 0650 Ph: (09) 950 1919, (021) 191 6000 http://www.q-i.co.nz

CPT: CPT04

Total depth: 8.55 m, Date: 6/11/2013 Cone Type: 10 cm2, 50 MPa, Piezocone

Cone Operator: SP&TP

Project: 13-101 - Woodlands Park





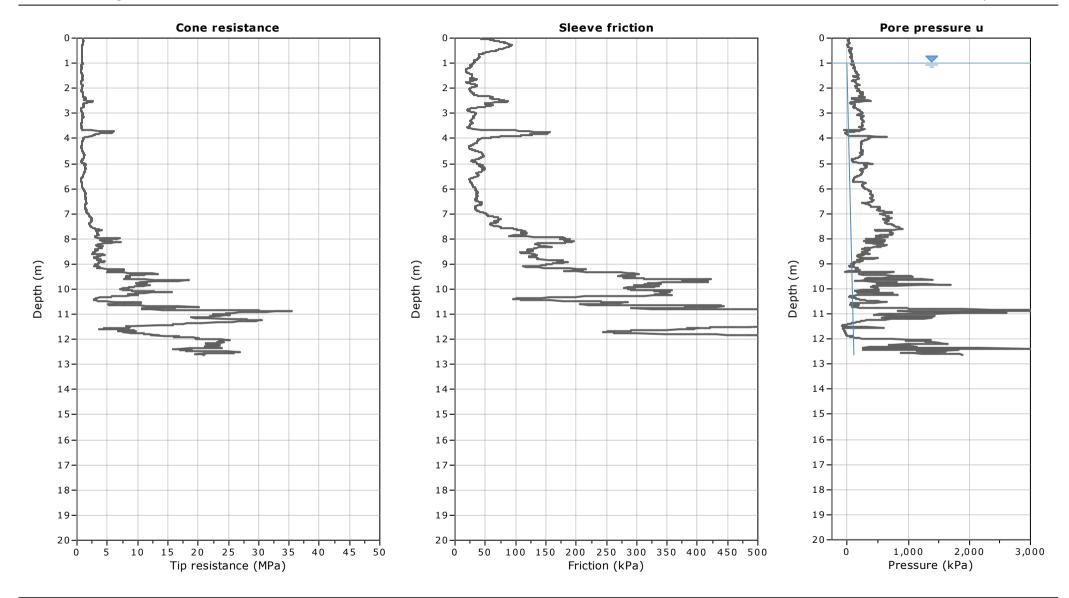
PO Box 21-956, Henderson, Auckland 0650 Ph: (09) 950 1919, (021) 191 6000 http://www.g-i.co.nz

Total depth: 12.62 m, Date: 5/11/2013 Cone Type: 10 cm2, 50 MPa, Piezocone

Cone Operator: SP&TP

CPT: CPT05

Project: 13-101 - Woodlands Park





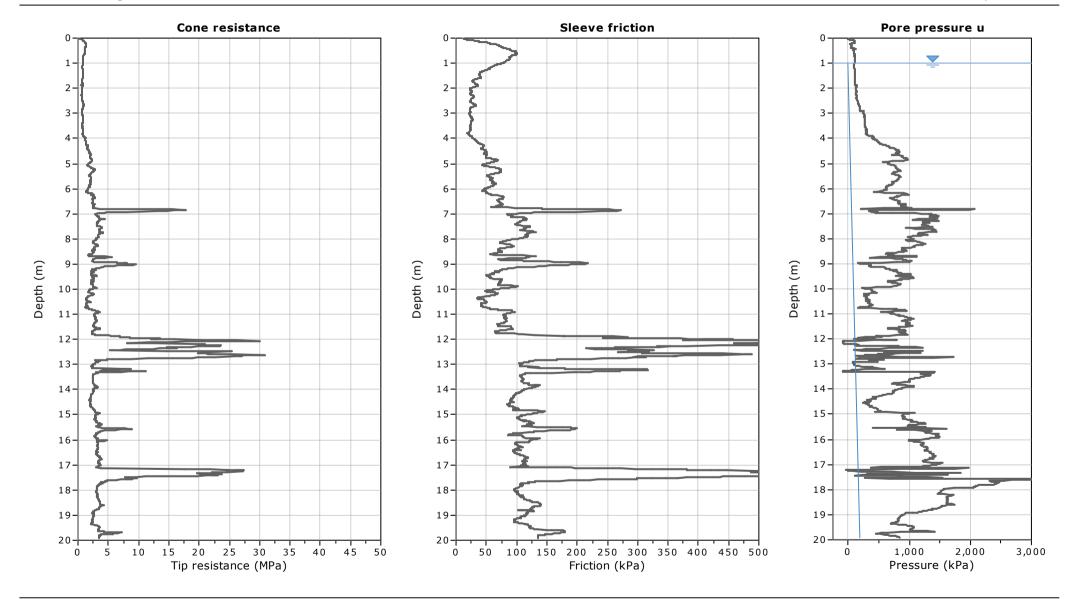
PO Box 21-956, Henderson, Auckland 0650 Ph: (09) 950 1919, (021) 191 6000 http://www.q-i.co.nz

CPT: CPT06

Total depth: 19.92 m, Date: 5/11/2013 Cone Type: 10 cm2, 50 MPa, Piezocone

Cone Operator: SP&TP

Project: 13-101 - Woodlands Park





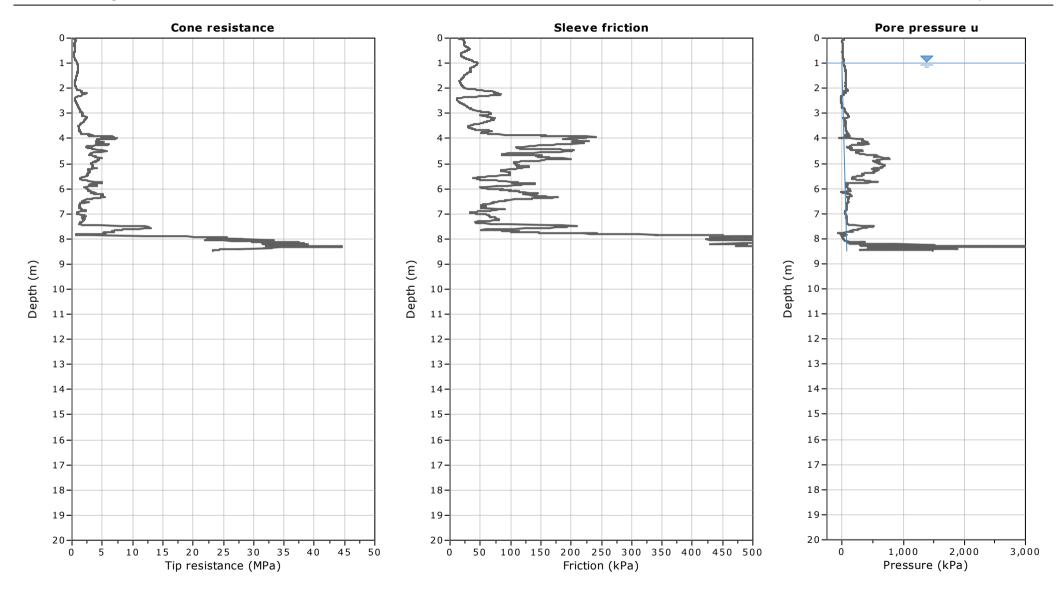
PO Box 21-956, Henderson, Auckland 0650 Ph: (09) 950 1919, (021) 191 6000 http://www.q-i.co.nz

CPT: CPT07

Total depth: 8.47 m, Date: 5/11/2013 Cone Type: 10 cm2, 50 MPa, Piezocone

Cone Operator: SP&TP

Project: 13-101 - Woodlands Park





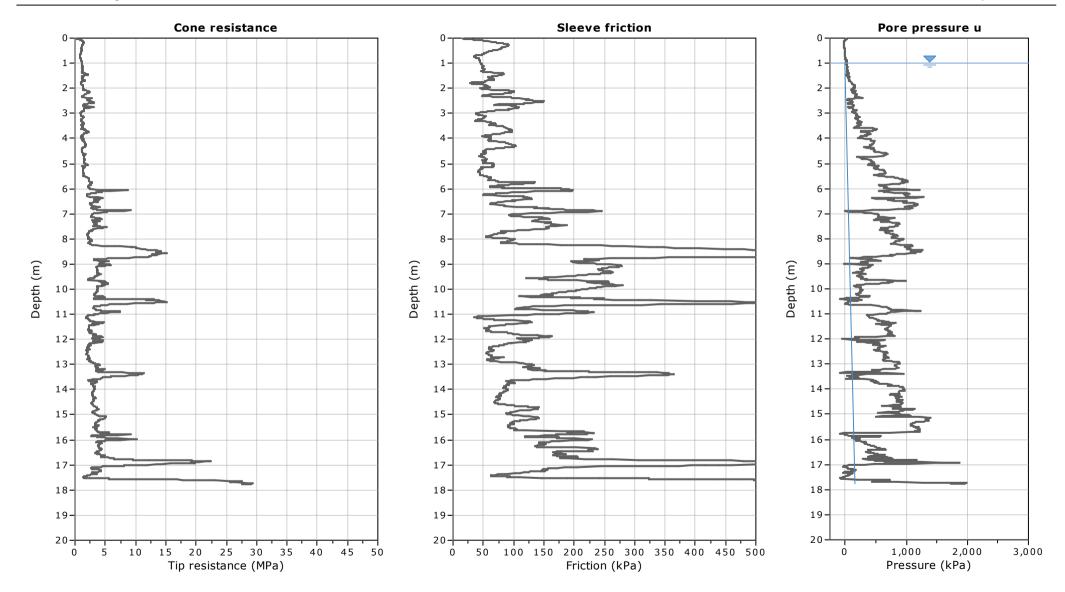
PO Box 21-956, Henderson, Auckland 0650 Ph: (09) 950 1919, (021) 191 6000 http://www.q-i.co.nz

CPT: CPT08

Total depth: 17.77 m, Date: 6/11/2013 Cone Type: 10 cm2, 50 MPa, Piezocone

Cone Operator: SP&TP

Project: 13-101 - Woodlands Park





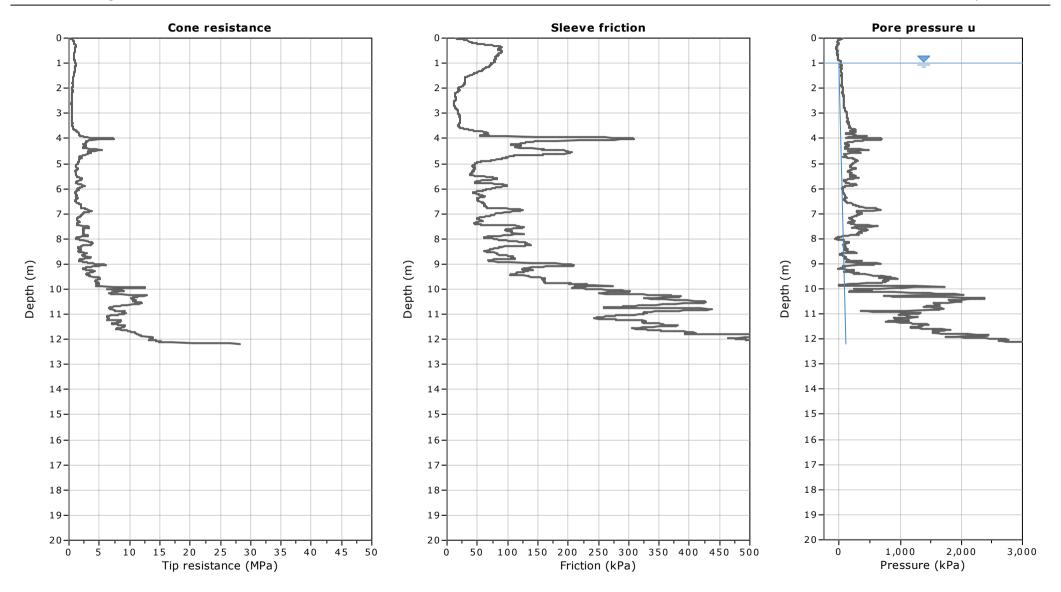
PO Box 21-956, Henderson, Auckland 0650 Ph: (09) 950 1919, (021) 191 6000 http://www.q-i.co.nz

СРТ: СРТ09

Total depth: 12.20 m, Date: 5/11/2013 Cone Type: 10 cm2, 50 MPa, Piezocone

Cone Operator: SP&TP

Project: 13-101 - Woodlands Park





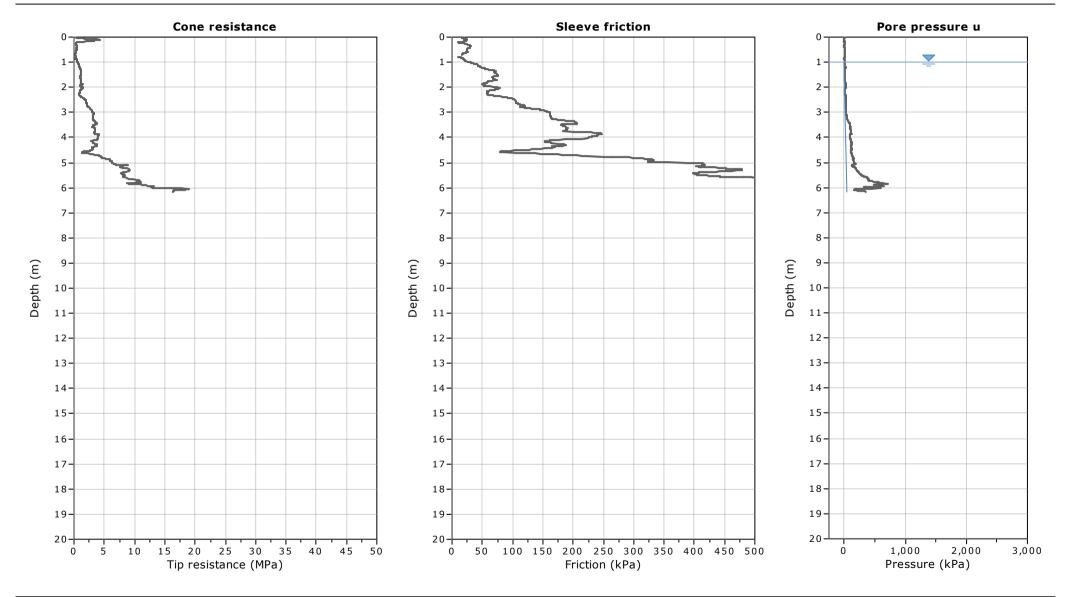
PO Box 21-956, Henderson, Auckland 0650 Ph: (09) 950 1919, (021) 191 6000 http://www.q-i.co.nz

CPT: CPT10

Total depth: 6.18 m, Date: 6/11/2013 Cone Type: 10 cm2, 50 MPa, Piezocone

Cone Operator: SP&TP

Project: 13-101 - Woodlands Park



# Appendix D Test Pit Logs & Photographs



#### 

|              | See Site Plan   |   |          |                       |                                       |          | 2 50     | 6115 | 9   MSL Akid. 1946 |                                 |       |                          |             | 2.4 m   |  |
|--------------|---|---|----------|-----------------------|---------------------------------------|----------|----------|------|--------------------|---------------------------------|-------|--------------------------|-------------|---------|--|
|              |   |   |          |                       |                                       |          |          |      |                    | SOI                             | L TES | TS                       |             |         |  |
| GEOLOGY/UNIT |   | DESCRIPTION   | R.L. (m) | DEPTH (m)             | GRAPHIC LOG                           | MOISTURE | <b>S</b> | Blow | s per              | <b>TROMETE</b> 100 mm  12 14 16 |       | SHEAR<br>STRENGTH<br>KPa | OTHER TESTS | SAMPLES |  |
| Η.           | •   | orown, stiff, moist, plastic, some rootlets.  |          | _                     | 71 1/2 - 71 1/2                       |          |          |      |                    |                                 |       |                          |             |         |  |
|              |   | ish grey, stiff, moist, slightly plastic, some rootlets.  mottled orange, stiff, moist, plastic, some limonite streaks.   |          | -<br>-<br>-<br>-<br>- | × × × × × × × × × × × × × × × × × × × |          |          |      |                    |                                 |       | 92/32                    |             |         |  |
| Colluvium    | Occasional lenses of brown                                | nish orange clayey silt with trace fine sand from 1.20m.  |          | 1-<br>-<br>-<br>-     |                                       |          |          |      |                    |                                 |       | 83/33                    |             |         |  |
|              | clay.   | ange, very stiff, moist, plastic, some lenses of yellowish brown sandy silt and purple clay, yellowish brown mottle purplish grey, hard, moist, slightly plastic. |          | -                     | <br>× ×<br>× × ×<br>× × ×             |          |          |      |                    |                                 |       | 158/56                   |             | Bulk    |  |
|              |   | some silt, brownish grey, loose, moist, slightly plastic, weakly cemented.  |          | 2-                    | × × ×                                 |          |          |      |                    |                                 |       | UTP                      |             | Sample  |  |
|              | End of Test Pit at 2.40m. M<br>One bulk soil sample taken |   |          | -                     |                                       |          |          |      |                    |                                 |       |                          |             |         |  |
|              |   |   |          | 3-                    |                                       |          |          |      |                    |                                 |       |                          |             |         |  |
|              |   |   | -12      | 24 _<br>-<br>-        |                                       |          |          |      |                    |                                 |       |                          |             |         |  |
|              |   |   |          | 4-<br>                |                                       |          |          |      |                    |                                 |       |                          |             |         |  |
|              |   |   | _        | -                     |                                       |          |          |      |                    |                                 |       |                          |             |         |  |

#### SKETCH OF EXPOSURE

TP13/01 - Excavation

TP13/01 - Stockpile





| NOTES Test pit was backfilled upon completion.   | LOGGED T Van Deelen               | DATE EXCAVATED 23/10/2013 |         |  |
|--|-----------------------------------|---------------------------|---------|--|
| NOTES  Fest pit was backfilled upon completion.  SV S23B, Correction Factor 1.337.  F. = Topsoil  Guideline for the field classification of soil and rock for engineering purposes: NZ Geotechnical Society (2005)  Determination of penetration resistance of a soil, NZS 4402 : 1988, Test 6.5.2 | OPERATOR Drillforce Ltd           | EXCAVATOR                 |         |  |
| Guideline for the field classification of soil and rock for engineering purposes: NZ Geotechnical Society (2005)  Determination of penetration resistance of a soil, NZS 4402 : 1988, Test 6.5.2  Shear strength using a hand held shear yane: NZ Geotechnical Society (8/2001)                    | CLIENT Watercare Services Limited | <i>Joв No.</i> 1-C0935.25 | TP13/01 |  |



#### 

|              |  | See Site Plan   |          | SM 647                            | 72 SO 61159   MSL Akld. 1946          |          |   |                          |             |                |
|--------------|--|---|----------|-----------------------------------|---------------------------------------|----------|---|--------------------------|-------------|----------------|
|              |  |   |          |                                   |                                       |          | SOIL TE   | STS                      |             |                |
| GEOLOGY/UNIT |  | DESCRIPTION   | R.L. (m) | DEPTH (m)                         | GRAPHIC LOG                           | MOISTURE | SCALA PENETROMETER  Blows per 100 mm  0 2 4 6 8 10 12 14 16 18 20 | SHEAR<br>STRENGTH<br>kPa | OTHER TESTS | SAMPLES        |
| H.           | Clayey SILT; brown, firm, m                                | noist, slightly plastic, abundant rootlets.   |          | _                                 | 711× 711×                             |          |   |                          |             |                |
| Ē            |  | n, stiff, dry, plastic, some 10-30cmØ angular grey boulders.  nottled orange, very stiff, dry, plastic, trace limonite. |          | -<br>-<br>-<br>-                  |                                       |          |   | 87/33                    |             |                |
|              |  |   |          | 1-<br>-<br>-<br>-                 |                                       |          |   | 112/60                   |             |                |
|              | Occasional lenses of brown                                 |   | -1:      | 24 _<br>-<br>-<br>-<br>-          |                                       |          |   | 120/64                   |             |                |
| Colluvium    | SIL1; with some clay, greyi                                | sh brown mottled orange, stiff, moist, slightly plastic, trace limonite staining.                                       |          | 2-                                | × × × × × × × × × × × × × × × × × × × |          |   | 74/33                    |             | Bulk<br>Sample |
|              |  |   |          | -<br>-<br>-<br>-                  | × × × × × × × × × × × × × × × × × × × |          |   | 74/28                    |             |                |
|              |  | y streaked orange, stiff, moist, slightly plastic.  y cemented fine sand and trace limonite staining from 3.20m.        |          | 3-                                | × × × × × × × × × × × × × × × × × × × |          |   | 69/27                    |             |                |
|              |  |   | -1:      | 22 -<br>-<br>-<br>-               | × × × × × × × × × × × × × × × × × × × |          |   | N/A                      |             |                |
|              | End of Test Pit at 4.0m. Tar<br>Two bulk soil samples take | rget depth reached.<br>n at 2.0m and 4.0m.  |          | -<br>4 -<br>-<br>-<br>-<br>-<br>- | × × ×                                 |          |   | 70/20                    |             | Bulk<br>Sample |
|              |  |   |          |                                   |                                       |          |   |                          |             |                |

#### SKETCH OF EXPOSURE

TP13/02 - Excavation

TP13/02 - Stockpile





| NOTES Test pit was backfilled upon completion.   | LOGGED T Van Deelen               | DATE EXCAVATED 23/10/2013 |         |  |  |
|--|-----------------------------------|---------------------------|---------|--|--|
| Set pit was backfilled upon completion. SV S23B, Correction Factor 1.337.  OP  Guideline for the field classification of soil and rock for engineering purposes: NZ Geotechnical Society (2005)  Cut of the field classification of soil and rock for engineering purposes: NZ Geotechnical Society (2005) | OPERATOR Drillforce Ltd           | EXCAVATOR                 |         |  |  |
| Guideline for the field classification of soil and rock for engineering purposes: NZ Geotechnical Society (2005)  Determination of penetration resistance of a soil, NZS 4402 : 1988, Test 6.5.2  Shear strength using a hand held shear vane: NZ Geotechnical Society (8/2001)                            | CLIENT Watercare Services Limited | <i>Jов No.</i> 1-C0935.25 | TP13/02 |  |  |



#### **LOG OF TRIAL PIT TP13/03** PROJECT R.L. Manuka Road Reservoirs 1746040 E 5910779 N 119.83 m 1 of 1 LOCATION REF. GRID DATUM See Site Plan SM 6472 SO 61159 MSL Akld. 1946 3 m

|              | See Site Plan   |          | ) VI 04/                           | 72 SO 61159   MSL AKI                 |                       | 3 m   |                          |             |                |
|--------------|---|----------|------------------------------------|---------------------------------------|-----------------------|---|--------------------------|-------------|----------------|
|              |   |          |                                    |                                       |                       | SOIL TE   | STS                      |             |                |
| GEOLOGY/UNIT | DESCRIPTION   | R.L. (m) | DEPTH (m)                          | GRAPHIC LOG                           | MOISTURE<br>CONDITION | SCALA PENETROMETER  Blows per 100 mm  0 2 4 6 8 10 12 14 16 18 20 | SHEAR<br>STRENGTH<br>kPa | OTHER TESTS | SAMPLES        |
| <u> </u>     | Clayey SILT; brown, stiff, moist, plastic, abundant rootlets.   |          |                                    | 74 1 <sup>N</sup> 77 1 <sup>N</sup>   |                       | 0 2 4 0 0 10 12 14 10 10 20                                       |                          |             |                |
| •            | CLAY; with some silt, grey mottled orange, stiff, moist, plastic, occasional limonite streaks.  |          | -                                  |                                       |                       |   | 86/38                    |             |                |
| E            | Some 1-3mmØ grey clay fragments from 1.00m.   |          | 1-<br>1-<br>-                      |                                       |                       |   | 96/43                    |             | Bulk<br>Sample |
| Colluvium    | Clayey SILT; with trace fine sand, light greyish brown streaked orange, stiff, moist, slightly plastic, occasional fine angular grey clayey silt fragments. |          | 8 -                                | × × × × × × × × × × × × × × × × × × × |                       |   | 104/37<br>158/48         |             | Bulk           |
|              | Clayey SILT; with trace fine sand, greyish brown streaked orange, very stiff, moist, plastic, some limonite streaks.  |          | -                                  | * * * * * * * * * * * * * * * * * * * |                       |   | 187+                     |             | Sample         |
|              | Fine SAND; with fine to medium gravel, brown, loose, moist, brittle, moderately cemented.   | _        | -                                  | <u> </u>                              |                       |   |                          |             |                |
|              | End of Test Pit at 3.00m. Material too hard to excavate. Two bulk soil samples taken at 1.0m and 2.0m.  |          | 3                                  |                                       |                       |   | UTP /                    |             |                |
|              |   | -11      | 6 -<br>4-<br>-<br>-<br>-<br>-<br>- |                                       |                       |   |                          |             |                |
|              |   |          |                                    |                                       |                       |   |                          |             |                |

#### SKETCH OF EXPOSURE

TP13/03 - Excavation

TP13/03 - Stockpile





| NOTES  Test pit was backfilled upon completion. SV S23B. Correction Factor 1.337.   | LOGGED                     | DATE EXCAVATED |         |  |
|---|----------------------------|----------------|---------|--|
|   | T Van Deelen               | 21/10/20       | )13     |  |
| T. = Topsoil.   | OPERATOR                   | EXCAVATOR      |         |  |
|   | Drillforce Ltd             |                |         |  |
| Guideline for the field classification of soil and rock for engineering purposes: NZ Geotechnical Society (2005)  | CLIENT                     | JOB NO.        |         |  |
| Determination of penetration resistance of a soil, NZS 4402 : 1988, Test 6.5.2  Shear strength using a hand held shear vane: NZ Geotechnical Society (8/2001) | Watercare Services Limited | 1-C0935.25     | TP13/03 |  |



#### **LOG OF TRIAL PIT** TP13/04 CO-ORD. PROJECT R.L. Manuka Road Reservoirs 1746002 E 5910790 N 123.12 m 1 of 1 LOCATION REF. GRID DATUM See Site Plan MSL Akld. 1946 SM 6472 SO 61159 4 m

|              |   | See Site Plan  |          |             |   | OIVI 041 | 2 SO 61159 MSL AK  | u. 1946                  | 4 m            |
|--------------|---|--|----------|-------------|---|----------|--|--------------------------|----------------|
|              |   |  |          |             |   |          | SOIL TE  | STS                      |                |
| GEOLOGY/UNIT |   | DESCRIPTION  | R.L. (m) | DEPTH (m)   | GRAPHIC LOG                             | MOISTURE | SCALA PENETROMETER  Blows per 100 mm  0 2 4 6 8 10 12 14 16 18 2 | SHEAR<br>STRENGTH<br>kPa | OTHER TESTS    |
| T.S          | SILT; with trace clay, brown                                | , stiff, moist, slightly plastic, some rootlets.   | F        |             | 1/ 1/ 1/ 1/ 1/                          |          |  |                          |                |
|              |   | stiff, moist, plastic, some limonite staining.   |          | -           |   |          |  | 147/28                   |                |
|              | Silty CLAY; with trace fine s<br>1-3mmØ grey clay fragmen   | and, light brownish grey mottled orange, very stiff, moist, slightly plastic, trace<br>ts. |          | 1-          | × × × × × × × × × × × × × × × × × × ×   |          |  | 123/48                   | Bulk<br>Sample |
|              | SILT; with some clay, orang                                 | ge mottled grey, very stiff, moist, slightly plastic.                                      |          | 22 -        | × × × × × × × × × × × × × × × × × × ×   |          |  | 117/40                   |                |
|              |   | ne to coarse sandy clay from 2.00m.  | _        | 2-          | ^                                       |          |  | 131/45                   | Bulk<br>Sample |
|              |   | ange, very stiff, moist, plastic. some 1-3mmØ angular mudstone fragments from 2.50m.       |          | -           | * × × × × × × × × × × × × × × × × × × × |          |  | 158/56                   |                |
|              |   |  | -12      | 3-<br>20 -  | × × × × × × × × × × × × × × × × × × ×   |          |  | 140/48                   |                |
|              | CLAY; with some silt, light of                              | grey mottled orange, stiff, moist, plastic.  |          |             | * * * * * * * * * * * * * * * * * * *   |          |  | 106/32                   |                |
|              | End of Test Pit at 4.0m. Tar<br>Two bulk soil samples taker | rget depth reached.<br>n at 1.0m and 2.0m.   |          |             |   |          |  | 91/43                    |                |
|              |   |  |          | -<br>-<br>- |   |          |  |                          |                |

#### SKETCH OF EXPOSURE

TP13/04 - Excavation

TP13/04 - Stockpile





| NOTES Test pit was backfilled upon completion.   | LOGGED T Van Deelen               | DATE EXCAVATED 21/10/2013 |         |  |  |
|--|-----------------------------------|---------------------------|---------|--|--|
| Fest pit was backfilled upon completion.  SV S23B, Correction Factor 1.337.  OPI  Guideline for the field classification of soil and rock for engineering purposes: NZ Geotechnical Society (2005)  October institute of constraint projectors of a soil NZS 4403 : 1099, Text 6.5.2 | OPERATOR Drillforce Ltd           | EXCAVATOR                 |         |  |  |
| Guideline for the field classification of soil and rock for engineering purposes: NZ Geotechnical Society (2005)  Determination of penetration resistance of a soil, NZS 4402 : 1988, Test 6.5.2  Shear strength using a hand held shear yane: NZ Geotechnical Society (8/2001)      | CLIENT Watercare Services Limited | <i>Jов No.</i> 1-C0935.25 | TP13/04 |  |  |



#### 

HOLE NO.

|              | See Site Plan   |   |             |                                       |                                       | M 647                 | 2 SO    | 6115 | 59    |                    | MSL Ak  | d. 1946                  | )EF111      | 4 m            |
|--------------|---|---|-------------|---------------------------------------|---------------------------------------|-----------------------|---------|------|-------|--------------------|---------|--------------------------|-------------|----------------|
|              |   |   |             |                                       |                                       |                       |         |      |       | ;                  | SOIL TE | STS                      |             |                |
| GEOLOGY/UNIT |   | DESCRIPTION   | R.L. (m)    | DEPTH (m)                             | GRAPHIC LOG                           | MOISTURE<br>CONDITION |         | Blov | ws po | NETROM<br>er 100 n |         | SHEAR<br>STRENGTH<br>KPa | OTHER TESTS | SAMPLES        |
| T.S          | Clayey SILT; brown, firm, m   | noist, slightly plastic, abundant rootlets.   |             | - : 24                                | 11/2 /11/2                            |                       |         |      |       |                    |         |                          |             |                |
|              | Silty CLAY; grey streaked o   | range with limonite, stiff to very stiff, moist, plastic, some rootlets.  |             |                                       | ×                                     |                       |         |      |       |                    |         | 142/56                   |             |                |
|              |   |   | -120        | 1                                     |                                       |                       |         |      |       |                    |         | 63/29                    |             |                |
|              | Silty CLAY; with trace fine s clay, silt and grey sandy cla                               | sand, greyish brown mottled orange, stiff, wet, plastic, some 4mmØ max lenses of y, trace limonite and manganese streaks.                       |             | *   X   X   X   X   X   X   X   X   X | × -                                   |                       |         |      |       |                    |         | 87/21                    |             |                |
| Colluvium    | Clayey SILT; with trace fine trace 5mmØ max. "hard" an                                    | sand, brownish grey, stiff, wet, plastic, some pockets of whitesh grey silty sand and and and silt fragments.                                   |             | 2 -××                                 | × × × ×                               |                       |         | \    |       |                    |         | 64/25                    |             | Bulk<br>Sample |
| Col          |   |   |             | - × - × - ×                           | × × × × × × × × × × × × × × × × × × × |                       | <u></u> | <br> |       |                    |         | N/A                      |             |                |
|              | Clayey SILT; with trace fine cemented pink and brown fi                                   | sand, greenish grey, very stiff, wet, slightly plastic, some 1-2cmØ lenses of weakly ine to coarse sand, trace limonite and manganese staining. |             | 3×                                    | × × × × × × × × × × × × × × × × × × × |                       |         |      |       |                    |         | 104/35                   |             |                |
|              | Some 4-5cmØ "hard" angul  | ar mudstone fragments from 3.50m.   |             | -\frac{1}{\times}                     | × × × × × × × × × × × × × × × × × × × |                       |         |      |       |                    |         | 91/33                    |             |                |
|              |   |   | +           | 4                                     | <u>×</u> × ,                          |                       |         |      |       |                    |         | 107/27                   | _           | Bulk<br>Sample |
|              | End of Test Pit at 4.0m. Tar<br>Scala-penetrometer test un<br>Two bulk soil samples taker | dertaken from 1.60m to 2.50m.   |             |                                       |                                       |                       |         |      |       |                    |         |                          |             |                |
|              |   |   | <u></u> 116 | )                                     |                                       |                       |         |      |       |                    |         |                          |             |                |

#### SKETCH OF EXPOSURE





| NOTES  Test pit was backfilled upon completion. SV S23B. Correction Factor 1.337.   | T Van Deelen  OPERATOR  Drillforce Ltd | DATE EXCAVATED  22/10/20  EXCAVATOR | 13      |  |
|---|--|-------------------------------------|---------|--|
| Guideline for the field classification of soil and rock for engineering purposes: NZ Geotechnical Society (2005)  Determination of penetration resistance of a soil, NZS 4402 : 1988, Test 6.5.2  Shear strength using a hand held shear vane: NZ Geotechnical Society (8/2001) | CLIENT Watercare Services Limited      | <i>Joв No.</i> 1-C0935.25           | TP13/05 |  |



#### **LOG OF TRIAL PIT TP13/06** PROJECT R.L. Manuka Road Reservoirs 1746051 E 5910832 N 122.03 m **1** of **1** LOCATION REF. GRID DATUM SM 6472 SO 61159 MSL Akld. 1946 See Site Plan 4 m

|                 |   | See Site Plail   |             |                                       | J. 10 -   | 1/2 30 61 139   WISL AKI  | 4. 1070                  |             | 4 111          |
|-----------------|---|--|-------------|---------------------------------------|---|---|--------------------------|-------------|----------------|
|                 |   |  |             |                                       |   | SOIL TES  | STS                      |             | ]              |
| GEOLOGY/UNIT    |   | DESCRIPTION  | R.L. (m)    | GRAPHIC LOG                           | MOISTURE  | SCALA PENETROMETER  Blows per 100 mm  0 2 4 6 8 10 12 14 16 18 20 | SHEAR<br>STRENGTH<br>kPa | OTHER TESTS | SAMPLES        |
| T.S             | Clayey SILT; brown, firm, m   | noist, slightly plastic, abundant rootlets.  | _           |                                       | √4.<br>   |   |                          |             |                |
|                 | SILT; with some clay, greyis<br>angular grey silt and "hard"                            | sh brown streaked orange, very stiff, moist, slightly plastic, some lenses of 1-4cmØ mudstone fragments.       |             | _ × × ×<br>-× × ×<br>-× × ×           | \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\                      |   | 123/33                   |             |                |
| ium             | Clayey SILT; with trace fine<br>angular "hard" grey mudsto                              | sand, greyish brown streaked orange, stiff, moist, slightly plastic, some 0.5-1cmØ ne fragments.               | _ 1         |                                       | ->  |   | 62/20                    |             |                |
| Colluvium       | Silty CLAY; with trace fine s manganese staining.                                       | sand, brownish grey streaked orange, very stiff, moist, plastic, trace limonite and                            |             | * * * * * * * * * * * * * * * * * * * | - 1<br>- 1<br>- 1<br>- 2<br>- 3<br>- 1<br>- 1<br>- 1<br>- 1 |   | 124/38                   |             |                |
|                 | fragments, some limonite a  | and brownish grey, very stiff, moist, plastic, occasional 1-2cmØ angular mudstone nd manganese staining.       | 2           | × ×                                   | -)<br>-<br>-<br>-<br>-                                      |   | 112/47                   |             | Bulk<br>Sample |
| ium             | Clayey SIL1; with trace to n some limonite staining, trac                               | nedium sand, greenish grey, very stiff, moist, plastic, some fibrous wood organics, se white pumiceous specks. |             |                                       | - }<br>- }<br>- }<br>- }                                    |   | 130/48                   |             |                |
| Recent Alluvium | Fine sandy CLAY; with som and silt, trace white pumice                                  | ne silt, greenish grey, stiff, wet, plastic, some lenses of pinkish brown silty fine sand ous specks.          | _ 3         | × × × × × × × × × × × × × × × × × × × | - ;<br>- ;<br>- ;<br>- ;<br>- ;<br>- ;<br>- ;               |   | 115/28                   |             |                |
|                 |   |  |             |                                       | -   |   | N/A                      |             | Bulk           |
|                 | End of Test Pit at 4.0m. Tar<br>Two bulk soil samples taker<br>Minimal seepage observed | n at 2.0m and 4.0m.  | <del></del> |                                       |   |   | 60/N/A                   |             | Sample         |
|                 |   |  |             |                                       |   |   |                          |             |                |

#### SKETCH OF EXPOSURE

TP13/06 - Excavation

TP13/06 - Stockpile





| NOTES Test pit was backfilled upon completion.  | T Van Deelen                      | DATE EXCAVATED 22/10/2013 |         |
|---|-----------------------------------|---------------------------|---------|
| SV S23B, Correction Factor 1.337. T.S = Topsoil.  | OPERATOR Drillforce Ltd           | EXCAVATOR                 |         |
| Guideline for the field classification of soil and rock for engineering purposes: NZ Geotechnical Society (2005)  Determination of penetration resistance of a soil, NZS 4402 : 1988, Test 6.5.2  Shear strength using a hand held shear vane: NZ Geotechnical Society (8/2001) | CLIENT Watercare Services Limited | <i>Jов No.</i> 1-C0935.25 | TP13/06 |

# Appendix E Hand Auger Logs



#### **LOG OF AUGER HOLE HA13/01** PROJECT R.L. SHEET Manuka Road Reservoirs 1745935 E 5910829 N 122.30 m **1** of **1** LOCATION REF. GRID DATUM MSL Akld. 1946 See Site Plan SM 6472 SO 61159 3 m

|              |   | See Site Plan   |                       | •                                       | 51VI 64/  | 72 SO 61159   IVIS   | L AKIG. 1946            |             | 3 m               |
|--------------|---|---|-----------------------|---|---|--|-------------------------|-------------|-------------------|
|              |   |   |                       |   |   | SO   | IL TESTS                |             |                   |
| GEOLOGY/UNIT |   | DESCRIPTION   | R.L. (m)<br>DEPTH (m) | GRAPHIC LOG                             | MOISTURE  | SCALA PENETROMETI  Blows per 100 mm  0 2 4 6 8 10 12 14 16 | SHEAR<br>STRENGTI<br>Pa | OTHER TESTS | SAMPLES           |
| <u>⊢</u>     | Clayey SILT; brown, stiff, m                          | oist, plastic.  |                       | - 21 1/2 (1.1/                          |   |  |                         |             |                   |
|              | CLAY; with some silt, brown                           | nish grey streaked orange, stiff, wet, plastic, trace limonite staining.                              |                       |   | -<br>-<br>-   |  |                         |             |                   |
|              |   | streaked orange, stiff, wet, plastic, trace limonite staining.  streaked orange, stiff, wet, plastic. | 1                     | × × - × - × - × - × - × - × - × - × - × | ><br>><br>-<br>-  |  | 90/44                   |             | Contam.<br>Sample |
| Colluvium    |   |   |                       |   | -   |  | 95/41                   |             |                   |
| රි           | Trace limonite specks from CLAY: with some silt and o | 1.75m.  ccasional fine sand, greyish brown, stiff, wet, plastic. Some limonite staining.              | 2                     |   |   |  | 89/44                   |             |                   |
|              |   | sand, greenish grey, stiff, wet, plastic, trace fine silt fragments.                                  | -120<br>              |   | -<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>- |  | 65/45                   |             |                   |
|              |   |   | 3                     | -×                                      | <b>&gt;</b>   |  | 77/35                   |             | Contam.<br>Sample |
|              | End of Hand Auger at 3.00<br>Two contamination sample | m.<br>s obtained from depths of 1.0m and 3.0m.  | _                     | -<br>-<br>-<br>-<br>-<br>-<br>-         |   |  |                         |             |                   |
|              |   |   | -118                  |   |   |  |                         |             |                   |
|              |   |   |                       | -                                       |   |  |                         |             |                   |

| SKETCH OF EXPOSURE |        |                |
|--------------------|--------|----------------|
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| OTES               | LOGGED | DATE EXCAVATED |

| NOTES  Hand auger was backfilled upon completion. SV Geo954, Correction Factor 1.478. T. = Topsoil.   | T Van Deelen  CHECKED BY:         | 4/11/201  EXCAVATOR       | 13      |
|---|-----------------------------------|---------------------------|---------|
|   | Opus International Consitants     | ;                         |         |
| Guideline for the field classification of soil and rock for engineering purposes: NZ Geotechnical Society (2005)  Determination of penetration resistance of a soil, NZS 4402 : 1988, Test 6.5.2  Shear strength using a hand held shear vane: NZ Geotechnical Society (8/2001) | CLIENT Watercare Services Limited | <i>Joв No.</i> 1-C0935.25 | HA13/01 |



SKETCH OF EXPOSURE

#### 

SM 6472 SO 61159

HOLE NO.

2 m

**MSL Akld. 1946** 

|              | dee die Fran   |       |                                       | •        | 2 00 01105 WOL ARIC                 |                          |             | <b>4</b> III      |
|--------------|--|-------|---------------------------------------|----------|-------------------------------------|--------------------------|-------------|-------------------|
|              |  |       |                                       |          | SOIL TES                            | STS                      |             |                   |
| GEOLOGY/UNIT | DESCLIDION  R.L. (m)  DESCRIPTION  | (iii) | GRAPHIC LOG                           | MOISTURE | SCALA PENETROMETER Blows per 100 mm | SHEAR<br>STRENGTH<br>kPa | OTHER TESTS | SAMPLES           |
|              | SILT; with some clay, brown, firm, moist, slightly plastic.  |       | ×. 'Z  1 <sup>X</sup> .               |          | 0 2 4 6 8 10 12 14 16 18 20         |                          |             |                   |
|              | Clayey SILT; brownish grey streaked orange, stiff, wet, slightly plastic.  CLAY; with some silt and trace fine to medium sand, grey mottled brown, very stiff, wet, plastic. | ×-    | × × × × × × × × × × × × × × × × × × × |          |                                     | N/A                      | 8           | Contam.<br>Sample |
| Colluvium    | Clayey SILT; brownish grey, stiff, wet, slightly plastic, trace limonite streaks.  |       |                                       |          |                                     | 124/46                   |             |                   |
|              | Silty CLAY; greenish grey, stiff, wet, plastic.  | × _   | × × ;<br>× × ;<br>× × ;               |          |                                     | 77/31                    |             |                   |
|              | End of Hand Auger at 2.00m. Two contamination samples obtained from depths of 0.5m and 2.0m.  3 -116   |       | ×                                     |          |                                     |                          |             | Contam.           |
|              |  |       |                                       |          |                                     |                          |             |                   |

See Site Plan

| NOTES  Hand auger was backfilled upon completion. SV Geo954, Correction Factor 1.478. T. = Topsoil. | T Van Deelen  | ### DATE EXCAVATED 4/11/2013              |                       |         |  |
|---|---|---|-----------------------|---------|--|
|   |   | CHECKED BY: Opus International Consitants | EXCAVATOR<br>S        |         |  |
|   | Guideline for the field classification of soil and rock for engineering purposes: NZ Geotechnical Society (2005)  Determination of penetration resistance of a soil, NZS 4402 : 1988, Test 6.5.2  Shear strength using a hand held shear vane: NZ Geotechnical Society (8/2001) | CLIENT  Watercare Services Limited        | ЈОВ NO.<br>1-C0935.25 | HA13/02 |  |



Hand auger was backfilled upon completion. SV Geo954, Correction Factor 1.478.

Guideline for the field classification of soil and rock for engineering purposes: NZ Geotechnical Society (2005) Determination of penetration resistance of a soil, NZS 4402 : 1988, Test 6.5.2 Shear strength using a hand held shear vane: NZ Geotechnical Society (8/2001)

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HOLE NO.

|              | See Site Plan  |  | S        | SM 647                              | '2 SO 61159                           | MSL Aklo              | d. 1946                   | DEPTH | 3 m                      |             |         |
|--------------|--|--|----------|-------------------------------------|---------------------------------------|-----------------------|---------------------------|-------|--------------------------|-------------|---------|
|              |  |  |          |                                     |                                       |                       | SOIL TES                  | STS   |                          |             |         |
| GEOLOGY/UNIT |  | DESCRIPTION  | R.L. (m) | DEPTH (m)                           | GRAPHIC LOG                           | MOISTURE<br>CONDITION | SCALA PENETR Blows per 10 | 00 mm | SHEAR<br>STRENGTH<br>kPa | OTHER TESTS | SAMPLES |
|              | Silty CLAY; brownish grey,  CLAY; with some silt, dark | stiff, moist, plastic. brownish grey streaked orange, firm to stiff, moist, plastic.   |          | -<br>-<br>-<br>-<br>-<br>-<br>1-    | × × × × × × × × × × × × × × × × × × × |                       |                           |       | 80/27<br>47/15           |             | Contam. |
| Colluvium    | ·  | ne silt, brownish grey streaked orange, stiff, wet, plastic. e clay and trace coarse sand, brown, stiff to very stiff, wet, slightly plastic, trace fine | -12      | -                                   |                                       |                       |                           |       | 95/34                    |             | Sample  |
|              | ŭ ŭ  |  | _        | 2                                   | × × × × × × × × × × × × × × × × × × × |                       |                           |       | 130/22<br>90/43          |             | Contam. |
|              | End of Hand Auger at 3.00<br>Two contamination samples | m.<br>s obtained from depths of 1.0m and 3.0m.   | -1:      | -3<br>-<br>-<br>-<br>-<br>-<br>24 - |                                       |                       |                           |       | 124/43                   | 3           | Sample/ |
|              |  |  | -        | 4-<br>                              |                                       |                       |                           |       |                          |             |         |

| SKETCH OF EXPOSURE             |              |                |
|--------------------------------|--------------|----------------|
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|                                |              |                |
|                                |              |                |
| OTES                           | LOGGED       | DATE EXCAVATED |
| 0120                           | T Van Deelen | 4/11/2013      |

T Van Deelen

Opus International Consitants
Ltd

Watercare Services Limited

CHECKED BY:

CLIENT

4/11/2013

HA13/03

EXCAVATOR

1-C0935.25

Јов No.

# Appendix F Laboratory Testing Results

#### PLASTICITY INDEX TEST REPORT



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor:

**Not Stated** 

Sampled by:

Tom Van Deelen

- -

Sampling method: Sample description: Pushtube

Sample condition:

Weathered Sandstone

Sample reference:

As received BH13/01

Sample depth:

3.0 - 3.5m

Project number:

Date sampled: 21/11/13

1-C0935.25

Lab ref number:

001/13

Client ref:

Tom Van Deelen

Folder number:

SEC13/AU/050

**Test Results** 

As rec'd water content:

48.7%

Liquid limit:

84

Plastic limit:

35

Plasticity Index:

49

| Test methods      |                          | Notes  |
|-------------------|--------------------------|--|
| Water Content:    | NZS 4402: 1986, Test 2.1 | Test performed on: Fraction passing 0.425mm test sieve     |
| Liquid Limit:     | NZS 4402: 1986, Test 2.2 | Sample descriptions are not covered by IANZ accreditation. |
| Plastic Limit:    | NZS 4402: 1986, Test 2.3 | i and in the second of the table decidentation.            |
| Plasticity Index: | NZS 4402: 1986, Test 2.4 |  |

Date tested:

04 - 05/12/13

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

Date reported: 10/12/2013

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**LANZ Approved Signatory** 

Thirushen Pillay

Designation:

Senior Civil Engineering Technician

Date:

10/12/2013

ACCREDITED LABORATORY

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LAF-103 (19/02/13)

Page 1 of 1

## ONE DIMENSIONAL CONSOLIDATION PROPERTIES TEST RESULT REPORT



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor:

**Not Stated** 

Subcontractor:

Not Stated

Sample reference:

BH13/01, 3.0 - 3.5m

Specimen depth: 3.30 - 3.35 metres

Sampled by:

**Tom Van Deelen** 

Date: 21/11/13

Date received : Sampling method :

21/11/13

Sample description :

Push Tube Weathered Sandstone

Sample condition:

As received

**OEDOMETER APPARATUS No: S17C** 

Project No: 1-C0935.25
Lab Ref No: 001b/13

Folder No: SEC13/AU/050

| SOIL PROPERTIES      |            |       |  |  |
|----------------------|------------|-------|--|--|
| Specimen Dimensions: |            |       |  |  |
| Diameter             | (mm):      | 50.53 |  |  |
| Initial height       | (mm):      | 16.08 |  |  |
| Final height         | (mm):      | 14.26 |  |  |
| Initial mass of s    | ample (g): | 51.88 |  |  |

CONSOLIDATION PROPERTIES

| Initial Wet Density          | pbi (t/m³) | 1.61 |
|------------------------------|------------|------|
|                              |            |      |
| Initial Dry Density          | pdi (t/m³) | 1.13 |
| Final Dry Density            | pdf (t/m³) | 1.27 |
| Initial Void Ratio           | eo         | 1.39 |
| Final Void Ratio             | ef         | 1.12 |
| Initial Degree of Saturation | Si (%)     | 82   |
| Final Degree of Saturation   | Sf (%)     | 100  |
| Solid Particle Density       | *Gs (t/m³) | 2.70 |
| INITIAL Water Content        | Wi (%)     | 42.5 |
| FINAL Water Content          | Wf (%)     | 42.7 |
|                              | 40 1 4     |      |

\*Gs is Assumed

| CONSOLIDATION PROPER | HES       |       |           |                 |                |              |   |
|----------------------|-----------|-------|-----------|-----------------|----------------|--------------|---|
| PRESSURE             | Pressure  | Void  | Intercept | Volume          | Coefficient of | Coeff. of    |   |
| RANGE                | Increment | Ratio | t90       | Compressibility | Consolidation  | Permeability |   |
| (kPa)                | (dp)      | _(e)  | (min)     | Mv=m²/MN        | Cv=m²/year     | k=m/year     |   |
| 0 - 12.5             | 12.5      | 1.367 | 0.4489    |                 | -              |              |   |
| 12.5 - 25            | 12.5      | 1.347 | 0.14      | 0.68            | 200.0          | 1.3          |   |
| 25 - 50              | 25        | 1.327 | 1.96      | 0.34            | 14.0           | 0.047        | - |
| 50 - 100             | 50        | 1.295 | 0.69      | 0.28            | 39.0           | 0.11         |   |
| 100 - 200            | 100       | 1.251 | 0.72      | 0.19            | 37.0           | 0.069        |   |
| 200 - 400            | 200       | 1.181 | 0.84      | 0.16            | 30.0           | 0.046        |   |
| 400 - 800            | 400       | 1.067 | 1.00      | 0.13            | 24.0           | 0.03         |   |
| 800 - 200            | -         | 1.082 | -         | -               | -              | -            |   |
| 200 - 50             | -         | 1.103 |           | -               | -              | -            |   |
| 50 - 12.5            | -         | 1.121 |           | -               | -              | •            |   |
| : <del>-</del>       | -         | -     | -         | -               | -              | -            |   |
|                      | -         | _     | _         | -               | -              | -            |   |

| Test Methods:                       |                        | Notes:                                      |
|-------------------------------------|------------------------|---|
| One Dimensional Consolidation Test. | NZS 4402:1986 Test 7.1 | Sample is saturated during test.            |
| Water Content                       | NZS 4402:1986 Test 2.1 | Load Increments applied at 1.35hr intervals |
|                                     |                        |   |

Date tested: 02- 03/12/13 Date reported: 11/12/13 Testing is covered by IANZ Accreditation
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**IANZ Approved Signatory** 

Thirushen Pillay

Designation: Senior Civil Engineering Technician

Date: 11/12/13

CSF 2120 (8/02)

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Auckland Laboratory

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#### ONE DIMENSIONAL CONSOLIDATION PROPERTIES **Applied Pressure vs Void Ratio TEST REPORT**



Project: Manuka Reservoirs Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor: **Not Stated** Subcontractor: **Not Stated** 

Sample reference: BH13/01, 3.0 - 3.5m Specimen depth: 3.30 - 3.35 metres

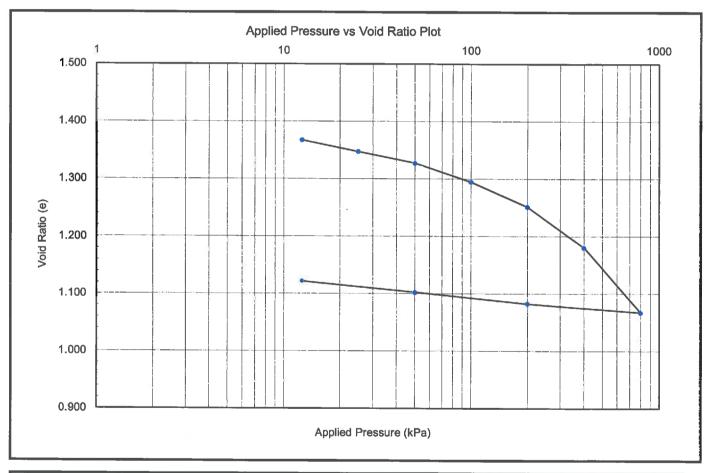
Sampled by: **Tom Van Deelen** Date: 21/11/13

Date received: 21/11/13

Sample description: Weathered Sandstone

Sampling method: Push Tube Sample condition: As received **OEDOMETER APPARATUS No: S17C**  Project No: 1-C0935.25 Lab Ref No: 001b/13

Folder No: SEC13/AU/050



| Test Method:                        |                        | Notes:                                      |  |
|-------------------------------------|------------------------|---|--|
| One Dimensional Consolidation Test: | NZS 4402:1986 Test 7.1 | Load Increments applied at 1.35hr intervals |  |
| Water Content:                      | NZS 4402:1986 Test 2.1 |   |  |
|                                     |                        |   |  |

Date tested: 02-03/12/13 Date reported : 11/12/13

**IANZ Approved Signatory** 

Thirushen Pillay

Senior Civil Engineering Technician

Date: 11/12/13

Designation :

CSF 2120 (8/02)

Unit A, 7 Ride Way, Nth Harbour Private Bag 10-1982, N.S.M.C.,

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accreditation Page 2 of 2

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of the laboratory



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#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Result Summary



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.35 - 3.5m

Sample Reference:

BH13/01

Sampled by:

Depth (m): 3.0 - 3.5

Tom Van Deelen

Date Sampled: 21/11/13

Sampling Method:

**Push Tube** 

Description:

Weathered Sandstone (Brown)

Comments:

Multistage Test.

Project No:

1-C0935.25

Lab Ref No:

001a/13

Client Ref No:

Tom Van Deelen

| ult at Maximum       | Stress Ratio            |                  |                 | Back Pressu                                      | re saturated a                 | t 450 kPa                             |                       |           |
|----------------------|-------------------------|------------------|-----------------|--|--------------------------------|---------------------------------------|-----------------------|-----------|
| Specimen             | TINAL PR                |                  | NAL PROPERT     | ROPERTIES  |                                |                                       |                       |           |
| Stage                | Confining               | Densit           | ies (t/m³)      | Water  | Particle                       | Densit                                | ies (t/m³)            | Water     |
| No                   | Pressure                | Wet              | Dry             | Content  | Density                        | Wet                                   | Dry                   | Conten    |
|                      | (kPa)                   | $(t/m^3)$        | $(t/m^3)$       | (%)  | $(t/m^3)$                      | (t/m³)                                | (t/m³)                | (%)       |
| 1                    | 75                      | 1.71             | 1.21            | 41.6   | 1                              | (0111)                                | (VIII)                | (70)      |
| 2                    | 150                     |                  | İ               |  | 2.70                           |                                       |                       |           |
| 3                    | 300                     |                  |                 |  | (assumed)                      | 1.83                                  | 1.29                  | 42.3      |
|                      |                         |                  |                 |  |                                |                                       |                       | 72.5      |
| Specimen             | Effective               |                  | Deg of Sa       | turation(Sr)                                     |                                |                                       |                       |           |
| Stage                | Confining               | Void             | Sr before       | Sr after   |                                | Values at Maxi                        | mum Stress Ratio      |           |
| No                   | Pressure                | Ratio            | Consolid.       | Consolid.  | S <sub>1</sub> -S <sub>3</sub> | m                                     |                       | rain      |
|                      | (kPa)                   | (e)              | (%)             | (%)  | (kPa)                          | (kPa)                                 |                       | %)        |
| 1                    | 75                      | 1.23             | 91              | 100  | 143.7                          | 32                                    |                       | .35       |
| 2                    | 150                     |                  |                 |  | 222.9                          | 70                                    | 1                     | .18       |
| 3                    | 300                     |                  |                 |  | 276.7                          | 157                                   | -                     | .97       |
|                      |                         |                  |                 |  |                                | 137                                   | 7                     |           |
| Specimen             | Effective               | Coefficient      | Volume          | Coefficient                                      | B at the                       |                                       |                       |           |
| Stage                | Confining               | of Consolidation | Compressibility | of Permeability                                  | start of                       | IANZ endorsement does not include the |                       | clude the |
| No                   | Pressure                | Cv               | Mv              | k  | test                           |                                       | and k values reported |           |
|                      | (kPa)                   | (m²/year)        | (m²/MN)         | (m/s)  |                                |                                       | lated for the followi |           |
| 1                    | 75                      | 6                | 0.30            | 4.6E-10  |                                | 4                                     | L+TOP+BOTTOM I        |           |
| 2                    | 150                     | 4.2              | 0.20            | 3.1E-10  | 96.00                          | Side Filter drain                     |                       | Diamage   |
| 3                    | 300                     | 2.7              | 0.170           | 1.4E-10  |                                | (L/D= Sample Length/Diameter.)        |                       |           |
|                      | TOTA                    | L STRESS R       | ESULT           |  | FFFF                           | TIVE STRESS                           | DECHIT                |           |
|                      | Intercept d             |                  | (kPa)           | <del>                                     </del> | Intercept d'                   | 29.58                                 |                       |           |
|                      | Beta b                  | 12.49            | (deg)           |  | Beta b'                        | 29.58                                 | (kPa)                 | l         |
|                      | Cohesion c              | 46               | (kPa)           |  | Cohesion c'                    |                                       | (deg)                 | Ì         |
|                      | Phi Æ                   | 13               | (deg)           |  | Phi Æ'                         | 32<br>23                              | (kPa)                 |           |
|                      | Correl coeff            | 0.9467           | _2              |  | Correl coeff                   |                                       | (deg)                 | 1         |
|                      | 001101 00011            | 0.7407           | <u> </u>        |  | Correi coerr                   | 0.9758                                | r                     |           |
|                      |                         |                  |                 | DY .   |                                |                                       |                       |           |
| Methods              |                         |                  |                 | Notes:   |                                |                                       |                       |           |
| Methods              | In House                |                  |                 | 0 134 1  |                                |                                       |                       |           |
| Methods<br>kial Test | In House<br>NZS 4402:19 | 96 Tost 6 2 1    |                 | Cv and Mv ha                                     | ive been round<br>Length/Diame | ed to 2 signification                 | ant figures.          |           |

Date Tested:

02-05/12/13

Date Reported:

10/12/13

Date: 10/12/13

IANZ Approved Signatory:

Designation: Thirushen Pillay- Senior Civil Engineering Technician

CSF 2130 (6/99)

Opus International Consultants Ltd Auckland Laboratory

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Page 1 of 8

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#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Mohr Coulomb Envelope Plot



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.35 - 3.5m

Sample Reference:

BH13/01

Sampled by:

Tom Van Deelen

Sampling Method:

**Push Tube** 

Description:

Weathered Sandstone (Brown)

Comments:

Multistage Test.

Depth (m): 3.0 - 3.5 Date Sampled: 21/11/13

Project No:

1-C0935.25

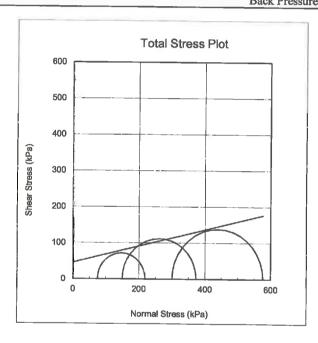
Lab Ref No:

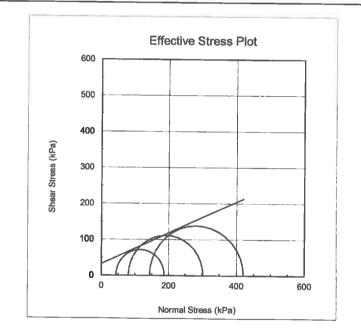
001a/13

Client Ref No:

Tom Van Deelen

#### Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT Mohr-Coulomb envelope plots Result at Maximum Stress Ratio Back Pressure Saturated at 450 kPa





| TOTAL STRESS RESULT |        |                |  |  |  |  |
|---------------------|--------|----------------|--|--|--|--|
| Intercept d         | 44.70  | (kPa)          |  |  |  |  |
| Beta b              | 12.49  | (deg)          |  |  |  |  |
| Cohesion c          | 46     | (kPa)          |  |  |  |  |
| Phi Æ               | 13     | (deg)          |  |  |  |  |
| Correl coeff        | 0.9467 | r <sup>2</sup> |  |  |  |  |

| EFFECTIVE STRESS RESULT |        |                |  |  |  |
|-------------------------|--------|----------------|--|--|--|
| Intercept d'            | 29.58  | (kPa)          |  |  |  |
| Beta b'                 | 21.62  | (deg)          |  |  |  |
| Cohesion c'             | 32     | (kPa)          |  |  |  |
| Phi Æ                   | 23     | (deg)          |  |  |  |
| Correl coeff            | 0.9758 | $\mathbf{r}^2$ |  |  |  |

| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

02-05/12/13

Date Reported:

IANZ Approved Signatory:

Opus International Consultants Ltd

10/12/13

10/12/13

Date: Designation: Thirushen Pillay- Senior Civil Engineering Technician

CSF 2130 (6/99)

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Shore City 0745, New Zealand

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### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - P vs Q Total Stress Plot



Project: Manuka Reservoirs
Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 3.35 - 3.5m Sample Reference: BH13/01

Sampled by: Tom Van Deelen

Sampling Method: Push Tube

Description: Weathered Sandstone (Brown)

Comments: Multistage Test.

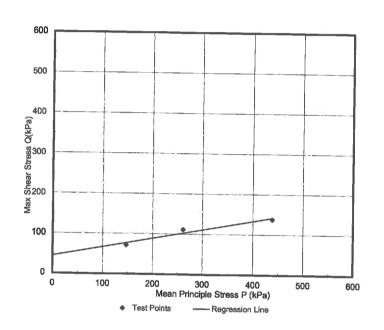
Depth (m): 3.0 - 3.5 Date Sampled: 21/11/13

 Project No:
 1-C0935.25

 Lab Ref No:
 001a/13

 Client Ref No:
 Tom Van Deelen

### Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT P vs Q Total Stress Plot- Back Pressure saturated at 450 kPa



| TOTAL STRE   | SS RESULT |                |
|--------------|-----------|----------------|
| Intercept d  | 44.70     | (kPa)          |
| Beta b       | 12.49     | (deg)          |
| Correl coeff | 0.9467    | r <sup>2</sup> |
| Cohesion c   | 46        | (kPa)          |
| Phi Æ        | 13        | (deg)          |

| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

02-05/12/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Data

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

All tests reported herain have been performed in accordance with the laboratory's ACCREDITED LABORATORY ROOF decreditation

Opus International Consultants Ltd Auckland Laboratory

Quality Management Systems Certified to ISO 9001

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#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - P' vs Q' Effective Stress Plot



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.35 - 3.5m

Sample Reference:

BH13/01

Sampled by:

Tom Van Deelen

Sampling Method:

Push Tube

Description:

Weathered Sandstone (Brown)

Comments: Multistage Test.

Project No:

1-C0935.25

Lab Ref No:

001a/13

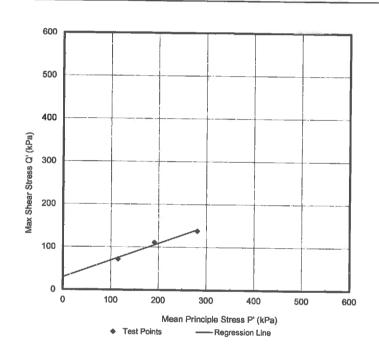
Client Ref No:

Depth (m): 3.0 - 3.5

Date Sampled: 21/11/13

Tom Van Deelen

#### Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT P' vs Q' Effective Stress Plot-Back Pressure saturated at 450 kPa



| EFFECTIVE STRESS RESULT |        |       |  |  |  |
|-------------------------|--------|-------|--|--|--|
| Intercept d'            | 29.58  | (kPa) |  |  |  |
| Beta b'                 | 21.62  | (deg) |  |  |  |
| Correl coeff            | 0.9758 | $r^2$ |  |  |  |
| Cohesion c'             | 32     | (kPa) |  |  |  |
| Phi Æ'                  | 23     | (deg) |  |  |  |

| Test Method   |                          | Notes |  |
|---------------|--------------------------|-------|--|
| Triaxial Test | In House                 |       |  |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |  |

Date Tested:

02-05/12/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Date:

10/12/13

Shore City 0745, New Zealand

Designation: Thirushen Pillay-Senior Civil Engineering Technician

Opus International Consultants Ltd

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#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - PvsQ Stress Path Plot



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.35 - 3.5m

Sample Reference: Sampled by:

BH13/01

Tom Van Deelen

Sampling Method: Description:

Push Tube

Weathered Sandstone (Brown)

Comments:

Multistage Test.

Depth (m): 3.0 - 3.5

Date Sampled: 21/11/13

Project No:

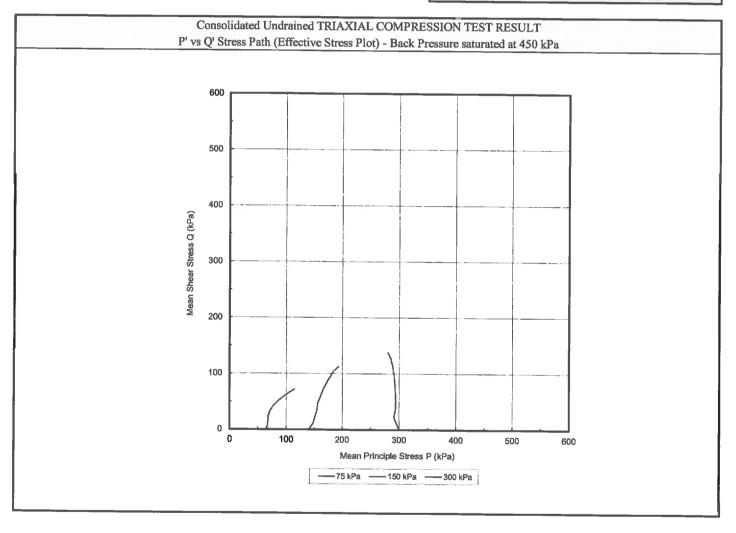
1-C0935.25

Lab Ref No:

001a/13

Client Ref No:

Tom Van Deelen



| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | 7 77                     |       |
| Triaxiai Test | In House                 |       |
| Based On:     | N7C 4400-1006 T ( 0.1    |       |
| Daseu OII.    | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

02-05/12/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

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Page 5 of 8

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Strain vs Deviator StressPlot



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.35 - 3.5m

Sample Reference:

BH13/01

Sampled by:

Tom Van Deelen

Sampling Method: Description:

**Push Tube** 

Comments:

Weathered Sandstone (Brown)

Multistage Test.

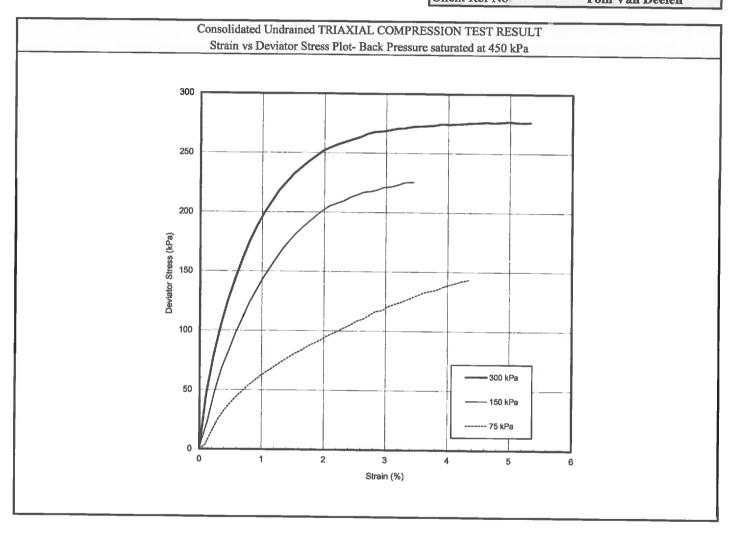
Depth (m): 3.0 - 3.5

Date Sampled: 21/11/13

Project No: Lab Ref No: 1-C0935.25

Client Ref No:

001a/13 Tom Van Deelen



| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

02-05/12/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Dete: 10/10/

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

CSF 2130 (6/99)

Opus International Consultants Ltd

Auckland Laboratory

Quality Management Systems Certified to ISO 9001

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#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Strain vs Pore Pressure Plot



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.35 - 3.5m

Sample Reference:

BH13/01

Sampled by: Sampling Method: Tom Van Deelen

Push Tube

Description:

Comments:

Weathered Sandstone (Brown)

Multistage Test.

Depth (m): 3.0 - 3.5

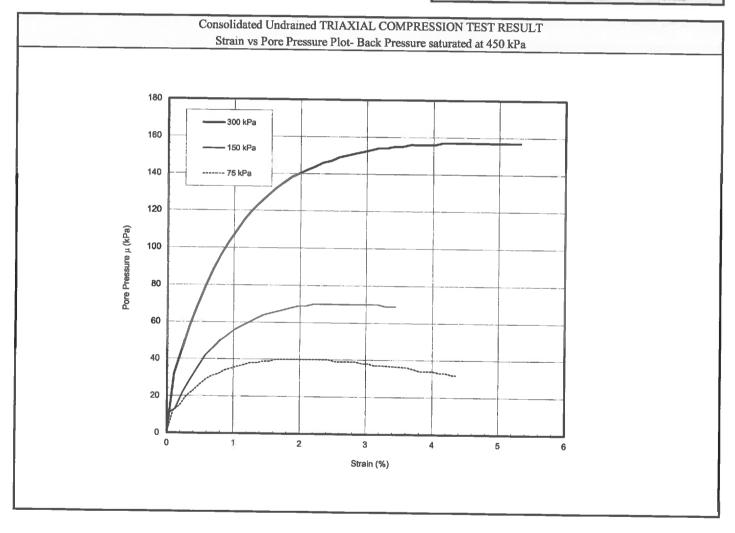
Date Sampled: 21/11/13

Project No: Lab Ref No: 1-C0935.25

001a/13

Client Ref No:

Tom Van Deelen



| Test Method   |                          | Notes | $\neg$   |
|---------------|--------------------------|-------|----------|
| Triaxial Test | In House                 |       | $\dashv$ |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |          |

Date Tested:

02-05/12/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

CSF 2130 (6/99)

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#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Displacement vs Öt Plot (Consolidation stage)



Project: Manuka Reservoirs Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 3.35 - 3.5m Sample Reference: BH13/01

Sampled by: Tom Van Deelen Sampling Method: **Push Tube** 

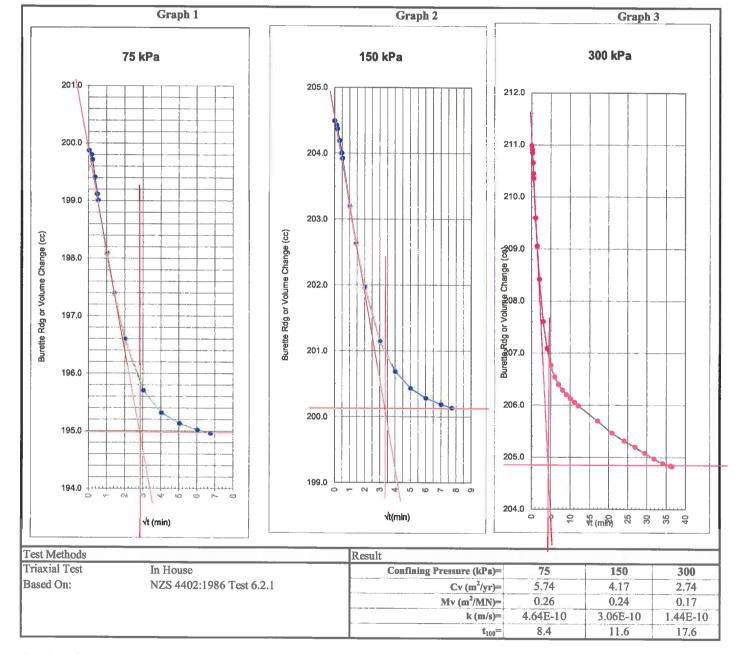
Description: Weathered Sandstone (Brown)

Comments: Multistage Test.

Depth (m): 3.0 - 3.5 Date Sampled: 21/11/13

Project No: 1-C0935.25 001a/13

Lab Ref No: Client Ref No: Tom Van Deelen



Date Tested:

02-05/12/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Designation: Thirushen Pillay- Senior Civil Engineering Technician





**Auckland Laboratory** Quality Management Systems Certified to ISO 9001 7A Ride Way, Albany

10/12/13

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### PARTICLE SIZE ANALYSIS (HYDROMETER METHOD)

#### TEST REPORT



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Sampled by:

Tom Van Deelen

Date sampled:

21/11/13

Sampling method:

**Not Stated** 

Sample condition:

As Received

Sample description:

Brown; slightly clayey sandy SILT; weathered

Solid Particle Density (t/m<sup>3</sup>)

2.75

Assumed

Water Content (as received)

45.4 %

Sample Reference:

BH13/01

Depth: 4.0 - 4.4 metres

Project number: 1-C0935.25

Lab ref number:

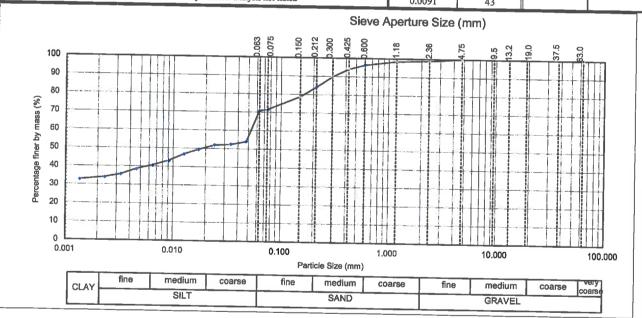
013/13

ref number: 013/1

Client ref: Folder number:

Tom Van Deelen SEC13/AU/050

|                    | Sieve Analysis   |                     |                  |                    |             |                    | Hydromete   | r Analysis         |             |
|--------------------|------------------|---------------------|------------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|
| Sieve Size<br>(mm) | Passing (%)      | Sieve Size<br>(mm)  | Passing (%)      | Sieve Size<br>(mm) | Passing (%) | Particle Size (mm) | Passing (%) | Particle Size (mm) | Passing (%) |
| 63.0               |                  | 4.75                | 100              | 0.300              | 90          | 0.0479             | 54          | 0.0065             | 41          |
| 37.5               |                  | 2.36                | 99               | 0.212              | 84          | 0.0340             | 52          | 0.0005             | 39          |
| 19.0               |                  | 1.18                | 98               | 0.150              | 79          | 0.0241             | 52          | 0.0048             |             |
| 13.2               | -                | 0.600               | 96               | 0.075              | 72          | 0.0172             | 49          |                    | 36          |
| 9.5                |                  | 0.425               | 94               | 0.063              | 71          | 0.0172             |             | 0.0023             | 34          |
| Note:              | "" denotes sieve | not used and/or hyd | rometer analysis |                    | - /1        | 0.0027             | 47          | 0.0014             | 33          |



Test Methods Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method) pH of suspension : 9.6 (Electrometric method was used)

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

Date Tested:

04 - 05/12/13

This report may only be reproduced in full

Date Reported:

10/12/13

IANZ Approved Signatory Thirushen Pillay

Designation:

Senior Civil Engineering Technician

Date:

10/12/13



All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

PF-LAB-100 (1/09/12)

Page 1 of 1



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Sampled by:

Opus - Tom Van Deelen

Date sampled:

21/11/13

Sampling method:

**Not Stated** 

Sample description:

Very weak Sandstone

Sample condition: Sample reference:

As received BH13/01

Sample depth (m):

6.7 - 6.85

Project number:

1-C0935.25

Lab ref number:

010/13

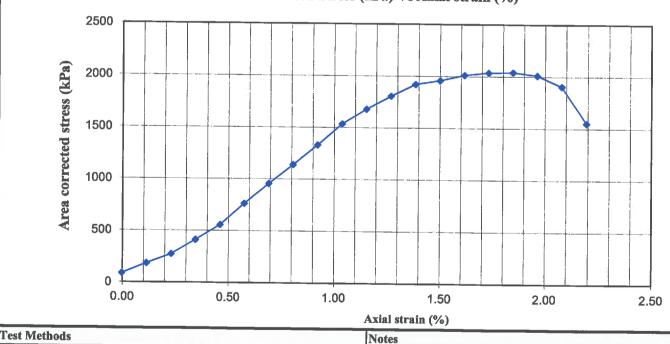
Client ref:

Tom Van Deelen

Folder number:

SEC13/AU/050

|                       |                    | Test results                   |              |
|-----------------------|--------------------|--------------------------------|--------------|
| Bulk density (t/m³)   | 2.00               | Initial sample diameter (mm)   | 60.7         |
| Water content (%)     | 20.8               | Initial sample length (mm)     | 86.6         |
| Dry density (t/m³)    | 1.65               | Initial sample area (mm²)      | 2890.5       |
| Maximum stress (kPa)  | 2000               | Initial Length:Diameter ratio  | 1.43:1       |
| Strain at failure (%) | 1.8                | Young's modulus (MPa)          | 169          |
| Mode of failure:      | Sheared            | For strain range               | 0.46 - 1.04% |
|                       | Area corrected Str | ress (kPa) Vs Axial strain (%) |              |
| 2500                  |                    |                                |              |
| 2000                  |                    |                                |              |
|                       |                    |                                |              |



UCS:

NZS 4402: 1986: Test 6.3.1

-Sample Descriptions are not covered by IANZ accreditation.

-The strain rate for this test was kept constant at 0.4mm/min.

Tested by:
Date tested:

ΑT

22/11/13

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

\_\_\_\_

**ACCREDITED LABORATORY** 

IANZ Approved Signatory

Thirushen Pillay

Senior Civil Engineering Technician

Date: 09/12/13

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

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Facsimile +64 9 415 4661 Website www.opus.co.nz



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Sampled by:

Opus - Tom Van Deelen

Date sampled:

21/11/13

Sampling method: Sample description:

**Not Stated** Very weak Sandstone

Sample condition:

As received BH13/01

Sample reference: Sample depth (m):

7.2 - 7.4

Project number:

1-C0935.25

Lab ref number:

011/13

Client ref:

Tom Van Deelen

Folder number:

SEC13/AU/050

|   |                |            |           | Test                       | results           |             |              |              |        |          |        |
|---|----------------|------------|-----------|----------------------------|-------------------|-------------|--------------|--------------|--------|----------|--------|
| Bulk density (t/m³)                             |                | 2          | 2.05      |                            | Initial           | sample di   | ameter (     | mm)          |        |          | 60.5   |
| Water content (%)                               |                | 2          | 21.3      | Initial sample length (mm) |                   |             |              |              | 115.5  |          |        |
| Dry density (t/m³)                              |                | 1          | .65       | _                          |                   | sample ar   |              |              |        |          | 2878.6 |
| Maximum stress (kPa)                            |                | 4          | 300       |                            |                   | Length:D    |              |              |        |          | 1.91:1 |
| Strain at failure (%)                           |                |            | s modulu  |                            |                   |             |              | 470          |        |          |        |
| Mode of failure: Sheared                        |                |            | ain range | ` /                        |                   |             |              | 0.17 - 0.69% |        |          |        |
| 4500 4500 4500 3500 3000 2500 1500 1000 500 0.0 | 00 0.20        | 0.40       | 0.60      | 0.80                       | 1.00<br>Axial str | 1.20        | 1.40         |              |        | .80      | 2.00   |
| Test Methods                                    |                |            |           |                            | Notes             |             |              |              |        |          |        |
| JCS: N  | ZS 4402: 1986: | Test 6.3.1 |           |                            | -Sample l         | Description | s are not co | overed by L  | ANZ ac | creditat | ion.   |
|   |                |            |           |                            |                   |             |              | s kept const |        |          |        |

Tested by: Date tested: AJ

22/11/13

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

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**IANZ Approved Signatory** 

Thirushen Pillay

Senior Civil Engineering Technician

Date: 09/12/13 **ACCREDITED LABORATORY** 

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Facsimile +64 9 415 4661 Website www.opus.co.nz



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Sampled by:

Opus - Tom Van Deelen

Date sampled:

10/12/13

Sampling method:

**Not Stated** 

Sample description:

Weak Sandstone

Sample condition:

As received

Sample reference:

BH13/01

Sample depth (m):

9.4 - 9.5

Project number:

1-C0935.25

Lab ref number:

015/13

Client ref:

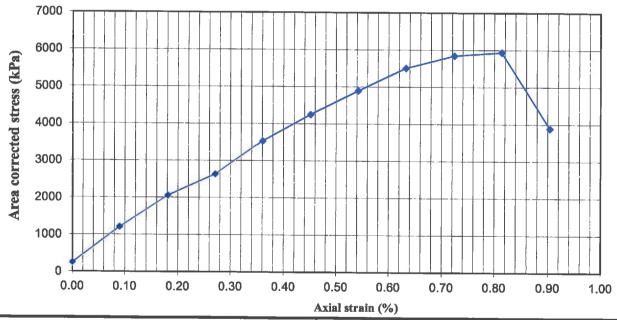
Tom Van Deelen

Folder number:

SEC13/AU/050

| Test results          |         |                               |              |  |
|-----------------------|---------|-------------------------------|--------------|--|
| Bulk density (t/m³)   | 2.05    | Initial sample diameter (mm)  | 61.0         |  |
| Water content (%)     | 20.6    | Initial sample length (mm)    | 110.6        |  |
| Dry density (t/m³)    | 1.70    | Initial sample area (mm²)     | 2922.0       |  |
| Maximum stress (kPa)  | 5900    | Initial Length:Diameter ratio | 1.81:1       |  |
| Strain at failure (%) | 0.81    | Young's modulus (MPa)         | 1000         |  |
| Mode of failure:      | Sheared | For strain range              | 0.00 - 0.18% |  |





Test Methods

Notes

UCS:

NZS 4402: 1986: Test 6.3.1

Thirushen Pillay

-Sample Descriptions are not covered by IANZ accreditation.

-The strain rate for this test was kept constant at 0.5mm/min.

**ACCREDITED LABORATORY** 

Tested by:

TPI/AOD

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested. This report may only be reproduced in full

Date tested:

11/12/13

Date: 12/12/13

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

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Website www.opus.co.nz

Senior Civil Engineering Technician

Shore City 0745, New Zealand



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Sampled by:

Opus - Tom Van Deelen

Date sampled:

10/12/13

Sampling method:

Sample description:

**Not Stated** 

Sample condition:

**Weak Sandstone** 

As received

Sample reference:

BH13/01

Sample depth (m):

11.55 - 11.7

Project number:

1-C0935.25

Lab ref number:

014/13

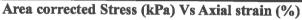
Client ref:

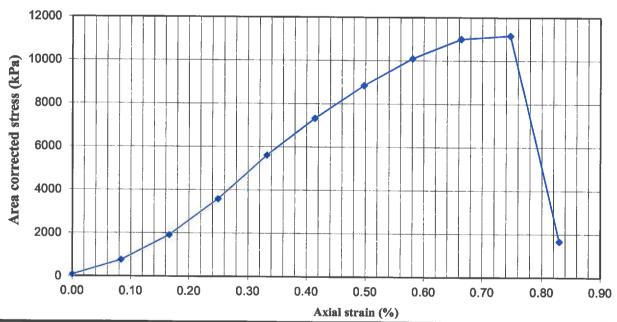
Tom Van Deelen

Folder number:

SEC13/AU/050

| Test results          |         |                               |              |  |
|-----------------------|---------|-------------------------------|--------------|--|
| Bulk density (t/m³)   | 2.10    | Initial sample diameter (mm)  | 61.1         |  |
| Water content (%)     | 18.0    | Initial sample length (mm)    | 120.5        |  |
| Dry density (t/m³)    | 1.80    | Initial sample area (mm²)     | 2932.5       |  |
| Maximum stress (kPa)  | 11000   | Initial Length:Diameter ratio | 1.97:1       |  |
| Strain at failure (%) | 0.75    | Young's modulus (MPa)         | 2180         |  |
| Mode of failure:      | Sheared | For strain range              | 0.17 - 0.42% |  |





Test Methods

Notes

Date: 12/12/13

UCS:

NZS 4402: 1986: Test 6,3.1

-Sample Descriptions are not covered by IANZ accreditation.

-The strain rate for this test was kept constant at 0.4mm/min.

Tested by:

TPI/AOD

Date tested: 11/12/13 Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

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**IANZ Approved Signatory** 

Thirushen Pillay

Senior Civil Engineering Technician



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### PLASTICITY INDEX TEST REPORT



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor:

**Not Stated** 

Sampled by:

Tom Van Deelen

Date sampled: 21/11/13

Sampling method:

**Pushtube** 

Sample description:

Brown; clayey SILT with clasts

Sample condition:

As received BH13/03

Sample reference: Sample depth:

3.0 - 3.5m

Project number:

1-C0935.25

Lab ref number:

002/13

Client ref:

Tom Van Deelen

Folder number:

SEC13/AU/050

| Tost | Dogula | he |
|------|--------|----|

As rec'd water content:

67.8%

Liquid limit:

83

Plastic limit:

34

Plasticity Index:

49

| Test methods      |                          | Notes  |
|-------------------|--------------------------|--|
| Water Content:    | NZS 4402: 1986, Test 2.1 | Test performed on: Fraction passing 0.425mm test sieve     |
| Liquid Limit:     | NZS 4402: 1986, Test 2.2 | Sample descriptions are not covered by IANZ accreditation. |
| Plastic Limit:    | NZS 4402: 1986, Test 2.3 |  |
| Plasticity Index: | NZS 4402: 1986, Test 2.4 |  |

Date tested:

06-09/12/13

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

Date reported:

10/12/2013

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IANZ Approved Signatory

Thirushen Pillay

Designation:

Senior Civil Engineering Technician

Date:

10/12/2013

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LAF-103 (19/02/13)

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### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION **Test Report - Result Summary**



Project:

Manuka Reservoirs

Location:

**Manuka Reservoirs** 

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.25 - 3.4m

Sample Reference: Sampled by:

BH13/03

Tom Van Deelen

Depth (m): 3.0 - 3.5

Sampling Method:

**Push Tube** 

Date Sampled: 21/11/13

Description:

Brown; clayey SILT; with clasts

Comments:

Multistage Test.

Project No:

1-C0935.25

Lab Ref No:

002a/13

Client Ref No:

Tom Van Deelen

| Specimen | tress Ratio           |                    |                 | Back Pressu     | re saturated a             | t 350 kPa  |                     |           |
|----------|-----------------------|--------------------|-----------------|-----------------|----------------------------|--|---------------------|-----------|
|          | Effective             | INIT               | TIAL PROPER     | TIES            | Solid                      | FINAL PROPERTIES   |                     |           |
| Stage    | Confining             | Densiti            | es (t/m³)       | Water           | Particle                   | Densitie   | es (t/m³)           | Water     |
| No       | Pressure              | Wet                | Dry             | Content         | Density                    | Wet  | Dry                 | Conten    |
|          | (kPa)                 | (t/m³)             | $(t/m^3)$       | (%)             | (t/m³)                     | $(t/m^3)$  | (t/m <sup>3</sup> ) | (%)       |
| 1        | 75                    | 1.62               | 0.97            | 67.4            |                            |  |                     |           |
| 2        | 150                   |                    |                 |                 | 2.70                       |  |                     |           |
| 3        | 300                   |                    |                 | <u></u>         | (assumed)                  | 1.75   | 1.11                | 57.2      |
| Specimen | Effective             |                    | Deg of Sat      | uration(Sr)     |                            |  |                     |           |
| Stage    | Confining             | Void               | Sr before       | Sr after        | -                          | Value of Maril   | G D                 |           |
| No       | Pressure              | Ratio              | Consolid.       | Consolid.       |                            | Values at Maxin  |                     | 190       |
| 140      | (kPa)                 | (e)                | (%)             | (%)             | \$1-\$3                    | m  |                     | rain      |
| 1        | 75                    | 1.79               | 100             |                 | (kPa)                      | (kPa)  |                     | 26)       |
| 2        | 150                   | 1.79               | 100             | 100             | 85.4                       | 40   | ł.                  | 33        |
| 3        | 300                   |                    |                 |                 | 124.3                      | 86   |                     | 17        |
|          | 300                   |                    |                 |                 | 264.3                      | 173  | 1.                  | 61        |
| Specimen | Effective             | Coefficient        | Volume          | Coefficient     | B at the                   |  |                     |           |
| Stage    | Confining             | of Consolidation   | Compressibility | of Permeability | start of                   | IANZ endorsement does not include the Cv, Mv and k values reported herein. |                     | clude the |
| No       | Pressure              | Cv                 | Mv              | k               | test                       |  |                     |           |
|          | (kPa)                 | (m²/year)          | (m²/MN)         | (m/s)           |                            | My & Cy calculated for the following conditions:                           |                     |           |
| 1        | 75                    | 2                  | 0.40            | 2.4E-10         |                            | L/D=2, RADIAL  | +TOP+BOTTOM I       | Drainage  |
| 2        | 150                   | 1.1                | 0.60            | 2.0E-10         | 95.00                      | Side Filter drains   |                     |           |
| 3        | 300                   | 0.2                | 0.400           | 3.0E-11         |                            | (L/D= Sample Length  | Diameter.)          |           |
|          | <u> </u>              |                    |                 |                 |                            |  |                     |           |
|          | TOTA                  | AL STRESS R        | ESULT           |                 | EFFEC                      | TIVE STRESS  | RESULT              |           |
|          | TOTA                  |                    | ESULT<br>(kPa)  |                 |                            | TIVE STRESS  |                     | <u> </u>  |
|          |                       | 5.23               |                 |                 | EFFEC Intercept d' Beta b' |  | (kPa)               |           |
|          | Intercept d           | 5.23<br>16.20      | (kPa)           |                 | Intercept d'               | 1.82   | (kPa)<br>(deg)      |           |
|          | Intercept d<br>Beta b | 5.23<br>16.20<br>5 | (kPa)<br>(deg)  |                 | Intercept d'<br>Beta b'    | 1.82<br>26.57  | (kPa)               |           |

Date Tested:

04-11/12/13

Date Reported:

12/12/13

Date: 12/12/13

IANZ Approved Signatory: Designation: Thirushen Pillay- Senior Civil Engineering Technician

CSF 2130 (6/99)

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Shore City 0745, New Zealand

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Opus International Consultants Ltd Auckland Laboratory

Quality Management Systems Certified to ISO 9001

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION **Test Report - Mohr Coulomb Envelope Plot**



Project: Manuka Reservoirs Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 3.25 - 3.4m

Sample Reference: BH13/03 Sampled by: Tom Van Deelen

Sampling Method: **Push Tube** 

Description: Brown; clayey SILT; with clasts

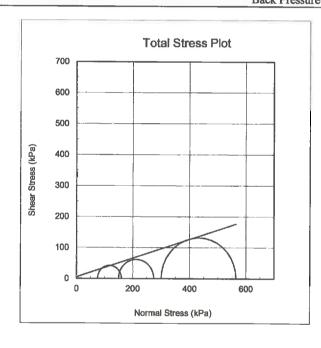
Comments: Multistage Test.

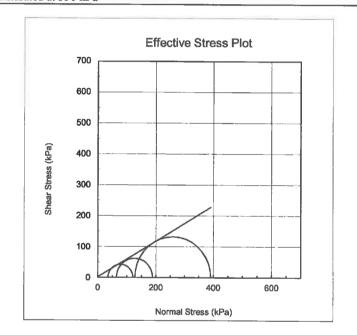
Depth (m): 3.0 - 3.5 Date Sampled: 21/11/13

> Project No: 1-C0935.25 Lab Ref No: 002a/13

Client Ref No: Tom Van Deelen

### Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT Mohr-Coulomb envelope plots Result at Maximum Stress Ratio Back Pressure Saturated at 350 kPa





| TOTAL STRESS RESULT |        |                |  |  |
|---------------------|--------|----------------|--|--|
| Intercept d         | 5.23   | (kPa)          |  |  |
| Beta b              | 16.20  | (deg)          |  |  |
| Cohesion c          | 5      | (kPa)          |  |  |
| Phi Æ               | 17     | (deg)          |  |  |
| Correl coeff        | 0.9921 | $\mathbf{r}^2$ |  |  |

| EFFECTIVE STRESS RESULT |        |                |  |  |  |
|-------------------------|--------|----------------|--|--|--|
| Intercept d'            | 1.82   | (kPa)          |  |  |  |
| Beta b'                 | 26.57  | (deg)          |  |  |  |
| Cohesion c'             | 2      | (kPa)          |  |  |  |
| Phi Æ'                  | 30     | (deg)          |  |  |  |
| Correl coeff            | 0.9972 | $\mathbf{r}^2$ |  |  |  |

| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

04-11/12/13

Date Reported:

12/12/13

IANZ Approved Signatory:

Date: 12/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

CSF 2130 (6/99)

Opus International Consultants Ltd

**Auckland Laboratory** 

Quality Management Systems Certified to ISO 9001

7A Ride Way, Albany Private Bag 101982, NS Mail Centre, North

Shore City 0745, New Zealand

Telephone +64 9 415 4660 Facsimile +64 9 415 4661 Website www.opus.co.nz

Page 2 of 8

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - P vs Q Total Stress Plot



Project:

Manuka Reservoirs

Location :

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.25 - 3.4m

Sample Reference: Sampled by:

BH13/03

Tom Van Deelen

Sampling Method:

Description:

**Push Tube** 

Brown; clayey SILT; with clasts

Comments:

Multistage Test.

Depth (m): 3.0 - 3.5

Date Sampled: 21/11/13

Project No:

1-C0935.25

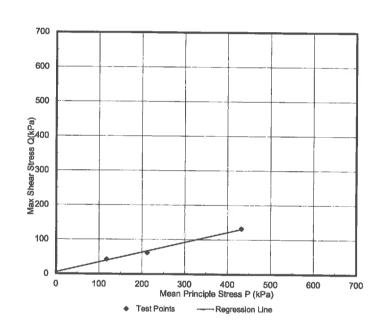
Lab Ref No:

002a/13

Client Ref No:

Tom Van Deelen

### Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT P vs Q Total Stress Plot-Back Pressure saturated at 350 kPa



| TOTAL STRE   |        |                |
|--------------|--------|----------------|
| Intercept d  | 5.23   | (kPa)          |
| Beta b       | 16.20  | (deg)          |
| Correl coeff | 0.9921 | r <sup>2</sup> |
| Cohesion c   | 5      | (kPa)          |
| Phi Æ        | 17     | (deg)          |

| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

04-11/12/13

Date Reported:

12/12/13

IANZ Approved Signatory:

Date: 12/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

Page 3 of 8

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### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - P' vs O' Effective Stress Plot



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

Sampling Method:

3.25 - 3.4m

Sample Reference:

BH13/03

Sampled by: Tom Van Deelen

Description:

**Push Tube** 

Brown; clayey SILT; with clasts

Comments: Multistage Test.

Project No:

1-C0935.25

Lab Ref No:

Depth (m): 3.0 - 3.5

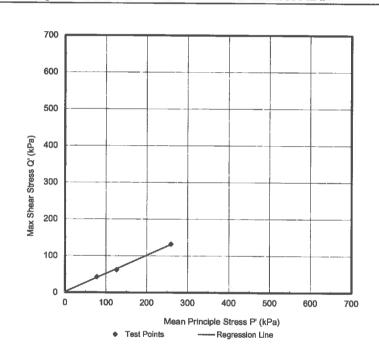
Date Sampled: 21/11/13

002a/13

Client Ref No:

Tom Van Deelen

### Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT P' vs Q' Effective Stress Plot-Back Pressure saturated at 350 kPa



| EFFECTIVE STRESS RESULT |        |                |  |  |
|-------------------------|--------|----------------|--|--|
| Intercept d'            | 1.82   | (kPa)          |  |  |
| Beta b'                 | 26.57  | (deg)          |  |  |
| Correl coeff            | 0.9972 | r <sup>2</sup> |  |  |
| Cohesion c'             | 2      | (kPa)          |  |  |
| Phi Æ'                  | 30     | (deg)          |  |  |

| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402;1986 Test 6.2.1 |       |

Date Tested:

04-11/12/13

Date Reported:

12/12/13

Date: 12/12/13

IANZ Approved Signatory: Designation: Thirushen Pillay-Senior Civil Engineering Technician

Page 4 of 8

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#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - PvsO Stress Path Plot



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.25 - 3.4m

Sample Reference: Sampled by:

BH13/03

Tom Van Deelen

Depth (m): 3.0 - 3.5 Date Sampled: 21/11/13

Sampling Method:

**Push Tube** 

Description:

Brown; clayey SILT; with clasts

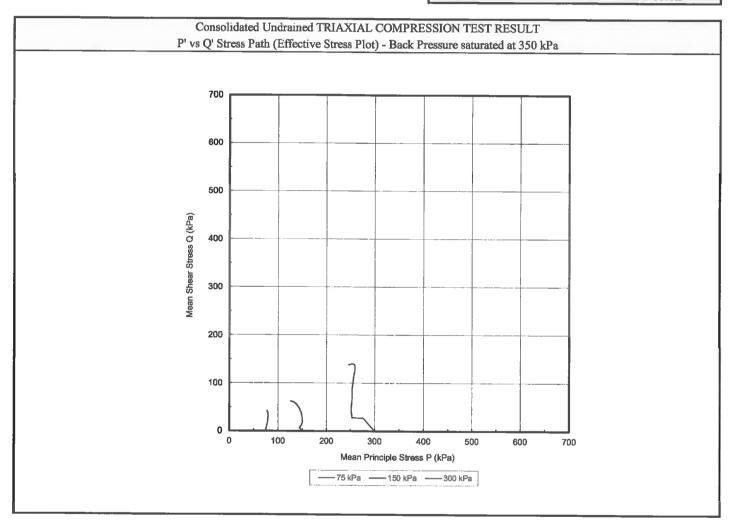
Comments:

Multistage Test.

Project No: 1-C0935.25 Lab Ref No: 002a/13

Client Ref No:

Tom Van Deelen



| Test Method   |                          | Notes |             |
|---------------|--------------------------|-------|-------------|
| Triaxial Test | In House                 |       | $\neg \neg$ |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |             |

Date Tested:

04-11/12/13

Date Reported:

12/12/13

IANZ Approved Signatory:

Date:

Designation: Thirushen Pillay- Senior Civil Engineering Technician

12/12/13

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### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Strain vs Deviator StressPlot



Project: Manuka Reservoirs Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 3.25 - 3.4m

Sample Reference: BH13/03 Sampled by: Tom Van Deelen

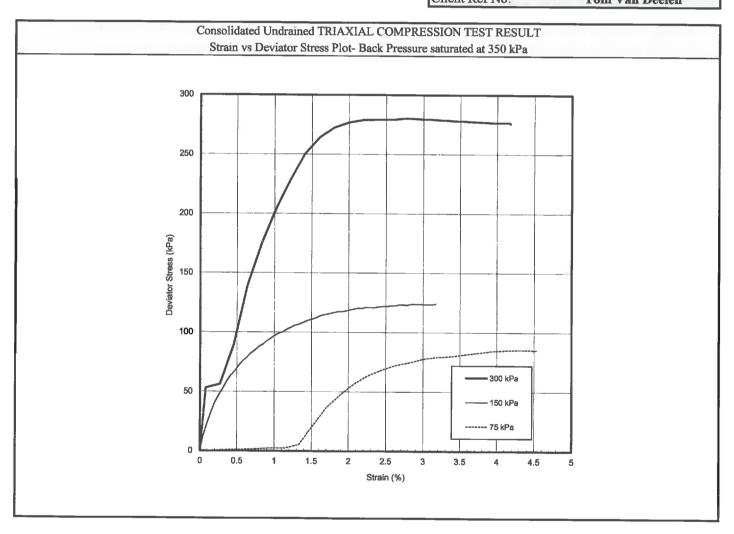
Sampling Method: **Push Tube** 

Description: Brown; clayey SILT; with clasts

Comments: Multistage Test.

Depth (m): 3.0 - 3.5 Date Sampled: 21/11/13

> Project No: 1-C0935.25 Lab Ref No: 002a/13 Client Ref No: Tom Van Deelen



| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

04-11/12/13

Date Reported:

12/12/13

IANZ Approved Signatory:

Date:

Designation: Thirushen Pillay- Senior Civil Engineering Technician

12/12/13

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Page 6 of 8

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Strain vs Pore Pressure Plot



Project: Manuka Reservoirs
Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 3.25 - 3.4m

Sample Reference: BH13/03 Depth (m): 3.0 - 3.5 Sampled by: Tom Van Deelen Date Sampled: 21/11/13

Sampling Method: Push Tube

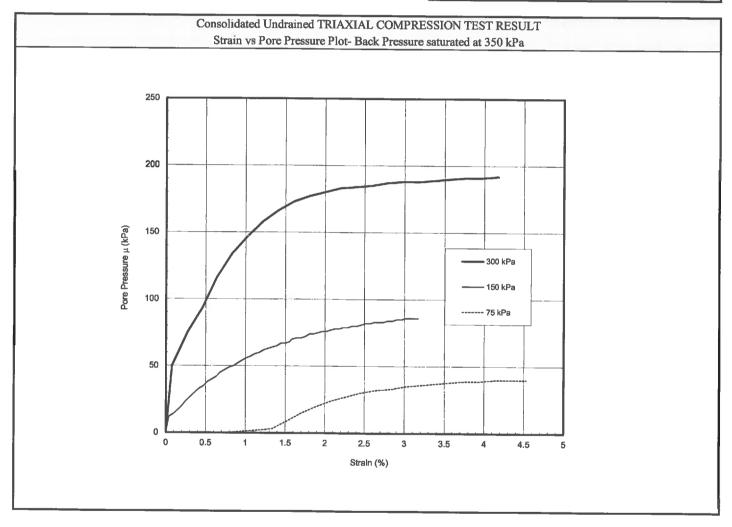
Description: Brown; clayey SILT; with clasts

Comments: Multistage Test.

Project No: 1-C0935.25

Lab Ref No: 002a/13

Client Ref No: Tom Van Deelen



| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

04-11/12/13

Date Reported:

12/12/13

IANZ Approved Signatory:

Date: 12/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

CSF 2130 (6/99)

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Page 7 of 8

#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Displacement vs Öt Plot (Consolidation stage)



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): Sample Reference:

3.25 - 3.4m

Sampled by:

BH13/03 Tom Van Deelen

Sampling Method:

**Push Tube** 

Description:

Brown; clayey SILT; with clasts

Comments:

Multistage Test.

Depth (m): 3.0 - 3.5 Date Sampled: 21/11/13

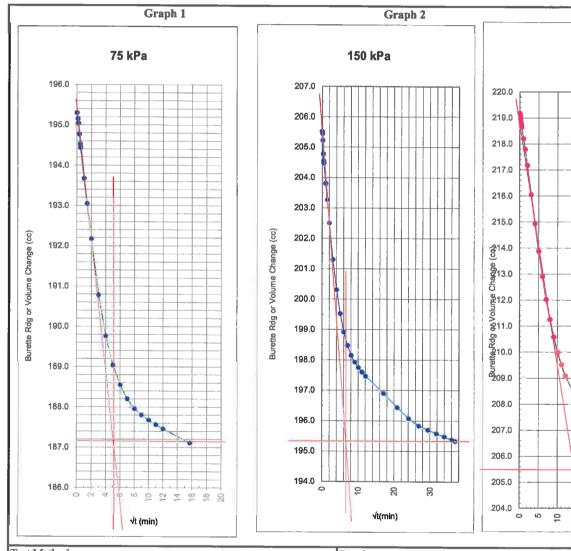
Project No: Lab Ref No:

1-C0935.25

Graph 3

002a/13

Client Ref No: Tom Van Deelen



300 kPa (mlm) % 30

Test Methods

Triaxial Test

In House

Based On:

NZS 4402:1986 Test 6.2.1

| Result                    |          | •        |          |
|---------------------------|----------|----------|----------|
| Confining Pressure (kPa)= | 75       | 150      | 300      |
| Cv (m²/yr)=               | 1.73     | 1.11     | 0.24     |
| $Mv (m^2/MN)=$            | 0.45     | 0.58     | 0.40     |
| k (m/s)=                  | 2.40E-10 | 1.98E-10 | 2.98E-11 |
| t <sub>100</sub> =        | 27.0     | 42.3     | 196.0    |

Date Tested:

04-11/12/13

Date Reported:

12/12/13

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IANZ Approved Signatory:

12/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

Page 8 of 8

### ONE DIMENSIONAL CONSOLIDATION PROPERTIES **TEST RESULT REPORT**



Project:

**Manuka Reservoirs** 

Location:

Manuka Reservoirs

Client:

Contractor:

Watercare Services Ltd c/o Opus International Consultants Ltd Not Stated

Subcontractor:

**Not Stated** 

Sample reference:

BH13/03, 3.0 - 3.5m

Specimen depth: 3.4 - 3.5 metres

Sampled by:

**Tom Van Deelen** 

Date: 21/11/13

Date received:

21/11/13

Sampling method:

Sample condition:

**Push Tube** 

Sample description:

Brown; clayey SILT with clasts

As received

Project No: Lab Ref No: 1-C0935.25

002b/13

Folder No:

SEC13/AU/050

| SOIL PROPERTIES      |            |       |  |  |  |
|----------------------|------------|-------|--|--|--|
| Specimen Dimensions: |            |       |  |  |  |
| Diameter             | (mm):      | 50.53 |  |  |  |
| Initial height       | (mm):      | 16.08 |  |  |  |
| Final height         | (mm):      | 13.20 |  |  |  |
| Initial mass of sa   | ample (g): | 50.62 |  |  |  |

**OEDOMETER APPARATUS No: S17C** 

| Initial Wet Density          | pbi (t/m³)   | 1.57 |
|------------------------------|--------------|------|
| Initial Dry Density          | pdi (t/m³)   | 0.93 |
| Final Dry Density            | pdf (t/m³)   | 1.13 |
| Initial Void Ratio           | eo           | 1.91 |
| Final Void Ratio             | ef           | 1.38 |
| Initial Degree of Saturation | Si (%)       | 98   |
| Final Degree of Saturation   | Sf (%)       | 100  |
| Solid Particle Density       | *Gs (t/m³)   | 2.70 |
| INITIAL Water Content        | Wi (%)       | 68.9 |
| FINAL Water Content          | Wf (%)       | 54.4 |
|                              | *Co is Assur | l    |

\*Gs is Assumed

| CONSOLIDATION PROPI | ERTIES    |       |           |                 |                |              |  |
|---------------------|-----------|-------|-----------|-----------------|----------------|--------------|--|
| PRESSURE            | Pressure  | Void  | Intercept | Volume          | Coefficient of | Coeff. of    |  |
| RANGE               | Increment | Ratio | t90       | Compressibility | Consolidation  | Permeability |  |
| (kPa)               | (dp)      | (e)   | (min)     | Mv=m²/MN        | Cv=m²/year     | k=m/year     |  |
| 0 - 12.5            | 12.5      | 1.889 | 0.724201  | -               | -              |              |  |
| 12.5 - 25           | 12.5      | 1.863 | 0.86      | 0.71            | 33.0           | 0.23         |  |
| 25 - 50             | 25        | 1.834 | 0.81      | 0.41            | 34.0           | 0.14         |  |
| 50 - 100            | 50        | 1.775 | 1.00      | 0.42            | 27.0           | 0.11         |  |
| 100 - 200           | 100       | 1.652 | 1.21      | 0.44            | 22.0           | 0.094        |  |
| 200 - 400           | 200       | 1.466 | 1.77      | 0.35            | 14.0           | 0.047        |  |
| 400 - 800           | 400       | 1.255 | 4.00      | 0.21            | 5.2            | 0.011        |  |
| 800 - 200           | -         | 1.300 | -         | -               | -              | -            |  |
| 200 - 50            | -         | 1.351 | -         | -               | -              |              |  |
| 50 - 12.5           |           | 1.385 | -         | -               | -              | _            |  |
| -                   | -         | -     | -         | -               | -              |              |  |
| _                   |           | -     | -         |                 | _              | -            |  |

**Test Methods:** One Dimensional Consolidation Test. NZS 4402:1986 Test 7.1 Sample is saturated during test. Water Content NZS 4402:1986 Test 2.1 Load Increments applied at 1.06hr intervals

Date tested: 04-05/12/13 Date reported: 11/12/13

Testing is covered by IANZ Accreditation This report may only be reproduced in full

**IANZ Approved Signatory** 

Thirushen Pillay

Designation: Senior Civil Engineering Technician Date:

11/12/13

CSF 2120 (8/02)

Tests Indicated as not accredited are outside the scope of the laboratory's **ACCREDITED LABORATORY** 

**Opus International Consultants Ltd** 

Auckland Laboratory

Quality Management Systems Certified to ISO 9001

Unit A, 7 Ride Way, Nth Harbour Private Bag 10-1982, N.S.M.C., Auckland, New Zealand

# ONE DIMENSIONAL CONSOLIDATION PROPERTIES Applied Pressure vs Void Ratio TEST REPORT



Project : Manuka Reservoirs
Location: Manuka Reservoirs

Client : Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor: Not Stated Subcontractor: Not Stated

Sample reference: BH13/03, 3.0 - 3.5m Specimen depth: 3.4 - 3.5 metres

Sampled by: Tom Van Deelen Date: 21/11/13

Date received : 21/11/13

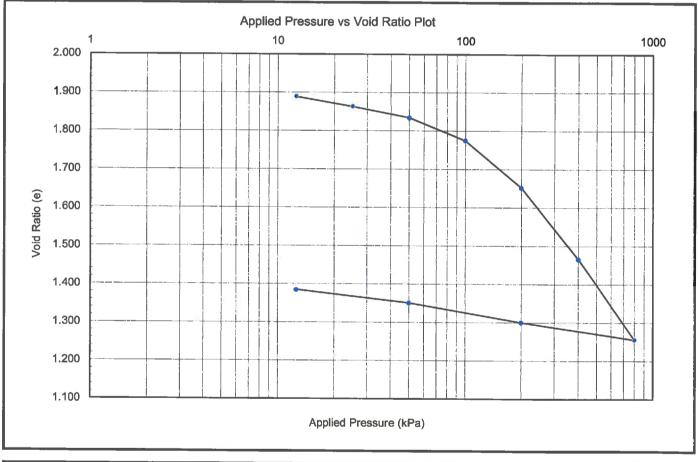
Sample description : Brown; clayey SILT with clasts

Sampling method: Push Tube
Sample condition: As received
OEDOMETER APPARATUS No: S17C

Project No: 1-C0935.25

Lab Ref No: 002b/13

Folder No: SEC13/AU/050



| Test Method:                        |                        | Notes:                                      |
|-------------------------------------|------------------------|---|
| One Dimensional Consolidation Test: | NZS 4402:1986 Test 7.1 | Load Increments applied at 1.06hr intervals |
| Water Content:                      | NZS 4402:1986 Test 2.1 |   |
|                                     |                        |   |

Date tested :
Date reported :

Designation :

04- 05/12/13 11/12/13

Testing is covered by IANZ Accreditation
This report may only be reproduced in full

**ACCREDITED LABORATORY** 

**IANZ Approved Signatory** 

Thirushen Pillay

Senior Civil Engineering Technician

Date: 11/12/13

CSF 2120 (8/02)

Unit A, 7 Ride Way, Nth Harbour Private Bag 10-1982, N.S.M.C., Auckland, New Zealand Page 2 of 2

Tests indicated as not accredited are

outside the scope

### PLASTICITY INDEX TEST REPORT



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor:

**Not Stated** 

Sampled by:

Tom Van Deelen

Sampling method:

Core Sample

Sample description:

Brown; clayey SILT

Sample condition: Sample reference: As received BH13/03

Sample depth:

4.2 - 4.4m

Project number:

Date sampled: 21/11/13

1-C0935.25

Lab ref number:

004/13

Client ref:

Tom Van Deelen

Folder number:

SEC13/AU/050

#### **Test Results**

As rec'd water content:

53.6%

Liquid limit:

67

Plastic limit:

32

Plasticity Index:

35

|                          | Notes  |
|--------------------------|--|
| NZS 4402: 1986, Test 2.1 | Test performed on: Fraction passing 0.425mm test sieve     |
| NZS 4402: 1986, Test 2.2 | Sample descriptions are not covered by IANZ accreditation. |
| NZS 4402: 1986, Test 2.3 | activation.  |
| NZS 4402: 1986, Test 2.4 |  |
|                          | NZS 4402 : 1986, Test 2.2<br>NZS 4402 : 1986, Test 2.3     |

Date tested:

Date reported:

02 - 03/12/13 10/12/2013 Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

This report may only be reproduced in full

**IANZ Approved Signatory** 

Thirushen Pillay

Designation:

Senior Civil Engineering Technician

Date:

10/12/2013

ACCREDITED LABORATORY

not accredited are outside the scope of the laboratory's accreditation

LAF-103 (19/02/13)

......

Page 1 of 1

### PLASTICITY INDEX TEST REPORT



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor:

Not Stated

Sampled by:

Tom Van Deelen

Sampling method:

Pushtube

Sample description:

Brown; clayey SILT; firm

Sample condition: Sample reference: As received BH13/03

Sample depth:

6.0 - 6.5m

Project number:

Date sampled: 21/11/13

1-C0935.25

Lab ref number:

003/13

Client ref:

Tom Van Deelen

Folder number:

SEC13/AU/050

**Test Results** 

As rec'd water content:

44.5%

Liquid limit:

57

Plastic limit:

25

Plasticity Index:

32

| Test methods      |                          | Notes  |
|-------------------|--------------------------|--|
| Water Content:    | NZS 4402: 1986, Test 2.1 | Test performed on: Fraction passing 0.425mm test sieve     |
| Liquid Limit:     | NZS 4402: 1986, Test 2.2 | Sample descriptions are not covered by IANZ accreditation. |
| Plastic Limit:    | NZS 4402: 1986, Test 2.3 | The second size not covered by 12/12 accreditation.        |
| Plasticity Index: | NZS 4402: 1986, Test 2.4 |  |

Date tested:
Date reported:

06/12/13 10/12/2013 Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

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**IANZ Approved Signatory** 

Thirushen Pillay

Designation:

Senior Civil Engineering Technician

Date:

10/12/2013

ACCREDITED LABORATORY

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LAF-103 (19/02/13)

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Page 1 of 1

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION **Test Report - Result Summary**



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

6.35 - 6.5m

Sample Reference:

BH13/03

Depth (m): 6.0 - 6.5

Sampled by:

Tom Van Deelen

Date Sampled: 21/11/13

Sampling Method:

Push Tube

Description:

Brown; clayey SILT; firm

Comments:

Multistage Test.

Project No:

1-C0935.25

Lab Ref No:

003a/13

Client Ref No:

Tom Van Deelen

|                               | ress Ratio            |                    |                         | Back Pressu     | re saturated a                 | t 350 kPa           |                       |                |
|-------------------------------|-----------------------|--------------------|-------------------------|-----------------|--------------------------------|---------------------|-----------------------|----------------|
| Specimen Effective            |                       | INITIAL PROPERTIES |                         | Solid           | FIN                            | FINAL PROPERTIES    |                       |                |
| Stage                         | Confining             | Densiti            | es (t/m³)               | Water           | Particle                       | Densiti             | es (t/m³)             | Water          |
| No                            | Pressure              | Wet                | Dry                     | Content         | Density                        | Wet                 | Dry                   | Conten         |
|                               | (kPa)                 | (t/m³)             | (t/m <sup>3</sup> )     | (%)             | (t/m <sup>3</sup> )            | (t/m³)              | (t/m <sup>3</sup> )   | (%)            |
| 1                             | 75                    | 1.79               | 1.27                    | 40.5            |                                |                     |                       |                |
| 2                             | 150                   |                    |                         |                 | 2.70                           |                     |                       |                |
| 3                             | 300                   |                    |                         |                 | (assumed)                      | 1.89                | 1.36                  | 39.1           |
| Specimen                      | Effective             |                    | Deg of Sat              | nration(Sr)     |                                |                     |                       |                |
| Stage                         | Confining             | Void               | Sr before               | Sr after        | -                              | Values at Mavis     | mum Stress Ratio      |                |
| No                            | Pressure              | Ratio              | Consolid.               | Consolid.       | S <sub>1</sub> -S <sub>3</sub> | m m                 |                       | rain           |
|                               | (kPa)                 | (e)                | (%)                     | (%)             | (kPa)                          | (kPa)               |                       | %)             |
| 1                             | 75                    | 1.12               | 98                      | 100             | 141.7                          | 29                  |                       | .32            |
| 2                             | 150                   | 1112               | , ,                     | 100             | 164.7                          | 70                  |                       | .31            |
| 3                             | 300                   |                    |                         |                 | 310.5                          | 169                 |                       | .59            |
|                               |                       |                    |                         |                 | 310.5                          | 109                 |                       |                |
| Specimen                      | Effective             | Coefficient        | Volume                  | Coefficient     | B at the                       |                     |                       |                |
| Stage                         | Confining             | of Consolidation   | Compressibility         | of Permeability | start of                       | IANZ end            | orsement does not in  | clude the      |
| No                            | Pressure              | Cv                 | Mv                      | k               | test                           | Cv, Mv a            | and k values reported | l herein.      |
|                               | (kPa)                 | (m²/year)          | (m²/MN)                 | (m/s)           |                                | Mv & Cv calcu       | lated for the followi | ng conditions: |
| 1                             | 75                    | 5                  | 0.30                    | 4.3E-10         |                                | L/D=2, RADIA)       | L+TOP+BOTTOM          | Drainage       |
| 2                             | 150                   | 1.3                | 0.20                    | 9.8E-11         | 98.00                          | Side Filter drain   | s Used                | _              |
| 3                             | 300                   | 1.5                | 0.150                   | 7.1E-11         |                                | (L/D= Sample Length | n/Diameter.)          |                |
|                               |                       | L STRESS R         |                         |                 |                                | TIVE STRESS         |                       |                |
|                               | Intercept d           |                    | (kPa)                   |                 | Intercept d'                   | 5.35                | (kPa)                 |                |
|                               | Beta b                | 15.83              | (deg)                   |                 | Beta b'                        | 27.34               | (deg)                 | 1              |
|                               | Cohesion c            | 25                 | (kPa)                   |                 | Cohesion c'                    | 6                   | (kPa)                 |                |
|                               | l                     |                    |                         |                 |                                | 31                  | (deg)                 | l .            |
|                               | Phi Æ                 | 16                 | (deg)                   |                 | Phi Æ'                         |                     |                       |                |
|                               | Phi Æ<br>Correl coeff | 16<br>0.9782       | (deg)<br>r <sup>2</sup> |                 | Correl coeff                   | 0.9815              | r <sup>2</sup>        |                |
|                               |                       |                    |                         |                 |                                |                     |                       |                |
| Methods                       | Correl coeff          |                    |                         | Notes:          | Correl coeff                   | 0.9815              | r <sup>2</sup>        |                |
| Methods<br>cial Test<br>d On: |                       | 0.9782             |                         | Cv and Mv ha    | Correl coeff                   | 0.9815              | r <sup>2</sup>        |                |

Date Tested:

04-10/12/13

Date Reported:

11/12/13

Date: 11/12/13

IANZ Approved Signatory:

CSF 2130 (6/99)

Designation: Thirushen Pillay- Senior Civil Engineering Technician

Opus International Consultants Ltd

**Auckland Laboratory** 

Quality Management Systems Certified to ISO 9001

7A Ride Way, Albany Private Bag 101982, NS Mail Centre, North

Shore City 0745, New Zealand

Page 1 of 8

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Mohr Coulomb Envelope Plot



Project: M

Manuka Reservoirs

Location:

**Manuka Reservoirs** 

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

6.35 - 6.5m

Sample Reference:

BH13/03

Sampled by:

Tom Van Deelen

Sampling Method:

Push Tube

Description:

Brown; clayey SILT; firm

Comments:

Multistage Test.

Depth (m): 6.0 - 6.5

Date Sampled: 21/11/13

Project No:

1-C0935.25

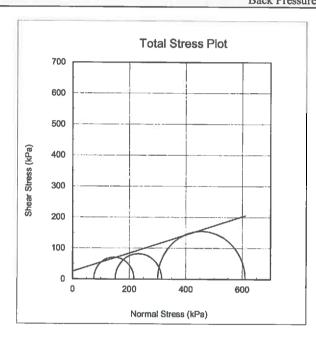
Lab Ref No:

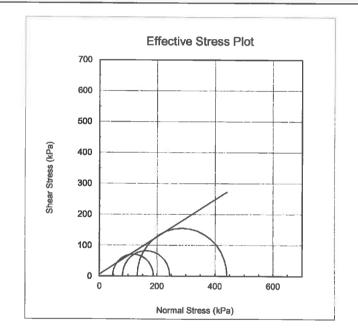
003a/13

Client Ref No:

Tom Van Deelen

# Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT Mohr-Coulomb envelope plots Result at Maximum Stress Ratio Back Pressure Saturated at 350 kPa





| TOTAL STRESS RESULT |        |                |  |  |
|---------------------|--------|----------------|--|--|
| Intercept d         | 24.05  | (kPa)          |  |  |
| Beta b              | 15.83  | (deg)          |  |  |
| Cohesion c          | 25     | (kPa)          |  |  |
| Phi Æ               | 16     | (deg)          |  |  |
| Correl coeff        | 0.9782 | $\mathbf{r}^2$ |  |  |

| EFFECTIVE STRESS RESULT |        |                |  |
|-------------------------|--------|----------------|--|
| Intercept d'            | 5.35   | (kPa)          |  |
| Beta b'                 | 27.34  | (deg)          |  |
| Cohesion c'             | 6      | (kPa)          |  |
| Phi Æ'                  | 31     | (deg)          |  |
| Correl coeff            | 0.9815 | $\mathbf{r}^2$ |  |

| Test Method   |                          | Notes |  |
|---------------|--------------------------|-------|--|
| Triaxial Test | In House                 |       |  |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |  |

Date Tested:

04-10/12/13

Date Reported:

11/12/13

IANZ Approved Signatory:

Opus International Consultants Ltd

Designation: Thirushen Pillay- Senior Civil Engineering Technician

CSF 2130 (6/99)

7A Ride Way, Albany

11/12/13

Private Bag 101982, NS Mail Centre, North Shore City 0745, New Zealand

Page 2 of 8
Telephone +64 9 415 4660

Facsimile +64 9 415 4661 Website www.opus.co.nz

Auckland Laboratory

Quality Management Systems Certified to ISO 9001

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - P vs Q Total Stress Plot



Project: Manuka Reservoirs
Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 6.35 - 6.5m Sample Reference: BH13/03

Sample Reference: BH13/03
Sampled by: Tom Van Deelen

Sampling Method: Push Tube

Description: Brown; clayey SILT; firm

Comments: Multistage Test.

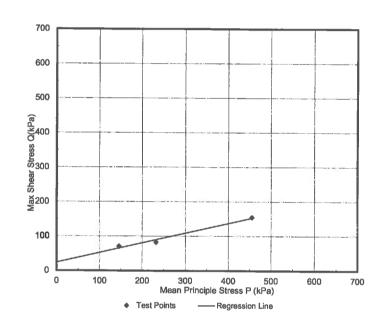
Depth (m): 6.0 - 6.5 Date Sampled: 21/11/13

 Project No:
 1-C0935.25

 Lab Ref No:
 003a/13

 Client Ref No:
 Tom Van Deelen

### Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT P vs Q Total Stress Plot- Back Pressure saturated at 350 kPa



| TOTAL STRE   |        |                |
|--------------|--------|----------------|
| Intercept d  | 24.05  | (kPa)          |
| Beta b       | 15.83  | (deg)          |
| Correl coeff | 0.9782 | r <sup>2</sup> |
| Cohesion c   | 25     | (kPa)          |
| Phi Æ        | 16     | (deg)          |

| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

04-10/12/13

Date Reported:

11/12/13

∬ Date:

11/12/13

IANZ Approved Signatory: Date Designation: Thirushen Pillay- Senior Civil Engineering Technician

Page 3 of 8

Opus International Consultants Ltd

Auckland Laboratory

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### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - P' vs Q' Effective Stress Plot



Project: Manuka Reservoirs
Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 6.35 - 6.5m

Sample Reference: BH13/03
Sampled by: Tom Van Deelen

Sampling Method: Push Tube

Description: Brown; clayey SILT; firm

Comments: Multistage Test.

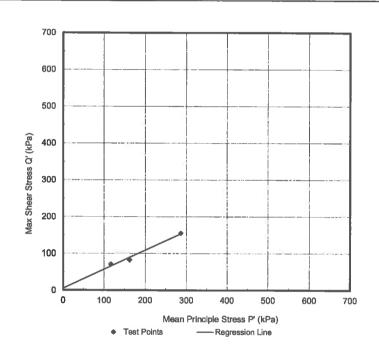
Depth (m): 6.0 - 6.5 Date Sampled: 21/11/13

 Project No:
 1-C0935.25

 Lab Ref No:
 003a/13

 Client Ref No:
 Tom Van Deelen

### Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT P' vs Q' Effective Stress Plot-Back Pressure saturated at 350 kPa



| EFFECTIVE S  | TRESS RES | ULT            |
|--------------|-----------|----------------|
| Intercept d' | 5.35      | (kPa)          |
| Beta b'      | 27.34     | (deg)          |
| Correl coeff | 0.9815    | r <sup>2</sup> |
| Cohesion c'  | 6         | (kPa)          |
| Phi Æ'       | 31        | (deg)          |

| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

04-10/12/13

Date Reported:

11/12/13

green of

Date: 11/12/13

Designation: Thirushen Pillay-Senior Civil Engineering Technician

All tests reported herein have been performed in accordance with the laboratory's ACCREDITED LABORATORY sope of accreditation

Opus International Consultants Ltd

Auckland Laboratory

IANZ Approved Signatory:

Quality Management Systems Certified to ISO 9001

7A Ride Way, Albany Private Bag 101982, NS Mail Centre, North Shore City 0745, New Zealand

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - PvsQ Stress Path Plot



Manuka Reservoirs Project: Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 6.35 - 6.5m

Sample Reference: BH13/03 Tom Van Deelen Sampled by:

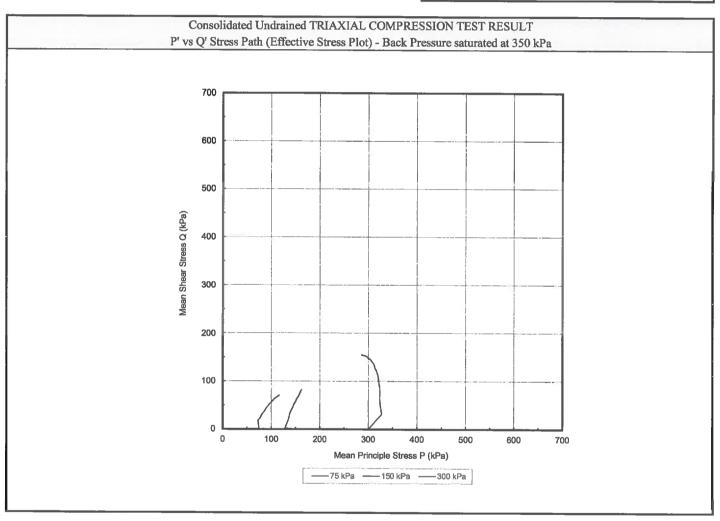
Sampling Method: Push Tube Description: Brown; clayey SILT; firm

Comments: Multistage Test.

Depth (m): 6.0 - 6.5 Date Sampled: 21/11/13

> Project No: 1-C0935.25 Lab Ref No: 003a/13

Client Ref No: Tom Van Deelen



| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

04-10/12/13

Date Reported:

11/12/13

IANZ Approved Signatory:

Designation: Thirushen Pillay- Senior Civil Engineering Technician

Date: 11/12/13



Page 5 of 8

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Strain vs Deviator StressPlot



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

6.35 - 6.5m

Sample Reference: Sampled by:

BH13/03

Tom Van Deelen

Sampling Method:

**Push Tube** 

Description:

Brown; clayey SILT; firm

Comments:

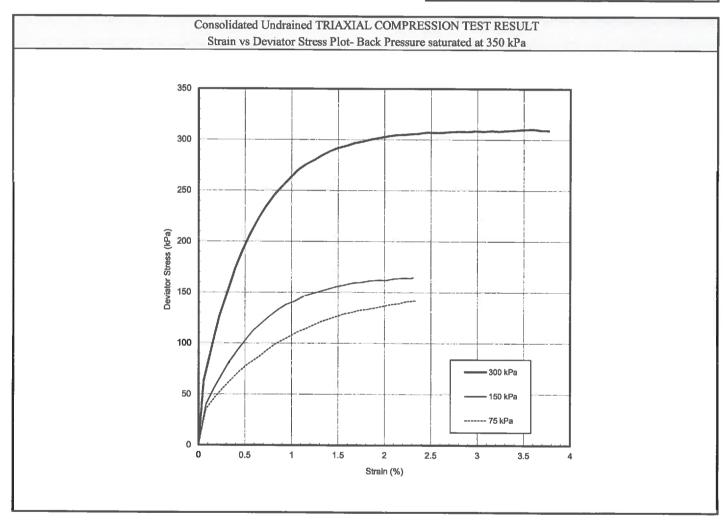
Multistage Test.

Depth (m): 6.0 - 6.5

Date Sampled: 21/11/13

Project No: 1-C0935.25 Lab Ref No: 003a/13

Client Ref No: Tom Van Deelen



| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

04-10/12/13

Date Reported:

11/12/13

IANZ Approved Signatory:

Designation: Thirushen Pillay-Senior Civil Engineering Technician

Date: 11/12/13

CSF 2130 (6/99)

Opus International Consultants Ltd

Auckland Laboratory

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Shore City 0745, New Zealand

Telephone +64 9 415 4660 Facsimile +64 9 415 4661 Website www.opus.co.nz

Page 6 of 8

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Strain vs Pore Pressure Plot



Project: Manuka Reservoirs
Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 6.35 - 6.5m

Sample Reference: BH13/03 Depth (m): 6.0 - 6.5
Sampled by: Tom Van Deelen Date Sampled: 21/11/13

Sampling Method: Push Tube

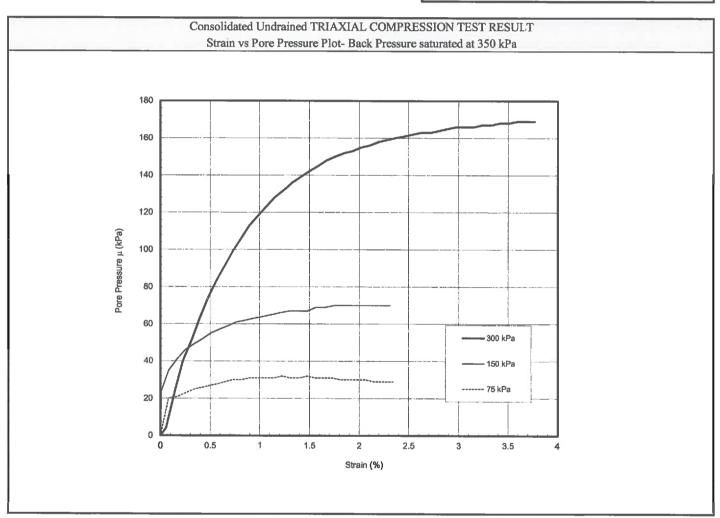
Description: Brown; clayey SILT; firm

Comments: Multistage Test.

Project No: 1-C0935.25

Lab Ref No: 003a/13

Client Ref No: Tom Van Deelen



| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6,2.1 |       |

Date Tested:

04-10/12/13

Date Reported:

11/12/13

IANZ Approved Signatory:

Date: 11/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

CSF 2130 (6/99)

Opus International Consultants Ltd

**Auckland Laboratory** 

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Page 7 of 8

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Displacement vs Öt Plot (Consolidation stage)



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): Sample Reference:

6.35 - 6.5m

Sampled by:

BH13/03 Tom Van Deelen

Sampling Method:

Push Tube

Description:

Brown; clayey SILT; firm

Comments:

Multistage Test.

Depth (m): 6.0 - 6.5 Date Sampled: 21/11/13

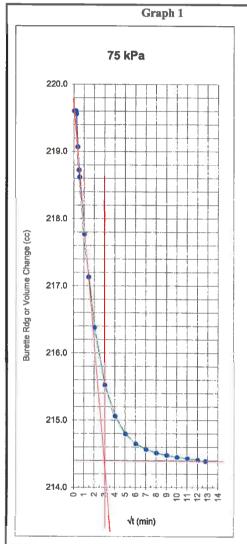
Project No: Lab Ref No:

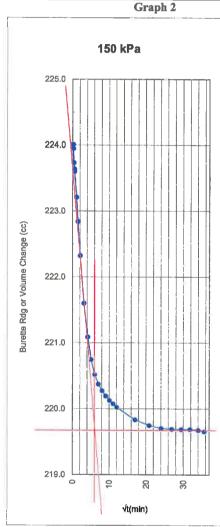
1-C0935.25

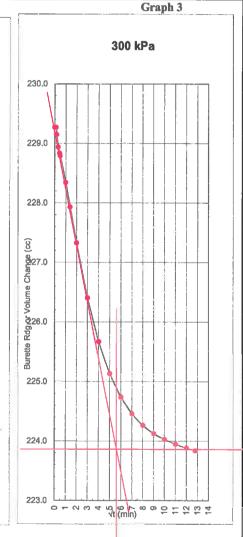
003a/13

Client Ref No: To

Tom Van Deelen







| Test  | Methods   |
|-------|-----------|
| Twice | viol Took |

Triaxial Test
Based On:

In House

NZS 4402:1986 Test 6.2.1

| _ | Result                    |          |          |          |
|---|---------------------------|----------|----------|----------|
|   | Confining Pressure (kPa)= | 75       | 150      | 300      |
|   | Cv (m²/yr)=               | 4.92     | 1.31     | 1.51     |
|   | $Mv (m^2/MN)=$            | 0.28     | 0.24     | 0.15     |
|   | k (m/s)=                  | 4.28E-10 | 9.76E-11 | 7.10E-11 |
|   | t <sub>100</sub> =        | 9.6      | 36.0     | 31.4     |

Date Tested:

04-10/12/13

Date Reported:

11/12/13

Quality Management Systems Certified to ISO 9001

IANZ Approved Signatory:

()

11/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

All tests reported herein have been performed in accordant with the laboratory's accreditation

### PLASTICITY INDEX **TEST REPORT**



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor:

**Not Stated** 

Sampled by:

Tom Van Deelen

Sampling method:

**Core Sample** 

Sample description:

Brownish grey; siltstone/sandstone

Sample condition: Sample reference:

As received BH13/03

Sample depth:

10.5 - 10.7m

Project number:

Date sampled: 21/11/13

1-C0935.25

Lab ref number:

005/13

Client ref:

Tom Van Deelen

Folder number:

SEC13/AU/050

#### **Test Results**

As rec'd water content:

42.9%

Liquid limit:

60

Plastic limit:

29

Plasticity Index:

31

| Test methods  |  | Notes   |
|---|--|---|
| Water Content: Liquid Limit: Plastic Limit: Plasticity Index: | NZS 4402: 1986, Test 2.1<br>NZS 4402: 1986, Test 2.2<br>NZS 4402: 1986, Test 2.3<br>NZS 4402: 1986, Test 2.4 | Test performed on: Fraction passing 0.425mm test sieve Sample descriptions are not covered by IANZ accreditation. |

Date tested: Date reported: 05/12/13 10/12/2013

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

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IANZ Approved Signatory

Thirushen Pillay

Designation:

Senior Civil Engineering Technician

Date:

10/12/2013

**ACCREDITED LABORATORY** 

Tests indicated as

LAF-103 (19/02/13)

**Opus International Consultants Ltd** 

**Auckland Laboratory** 

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Private Bag 101982, NS Mail Centre, North Shore City 0745, New Zealand

Telephone +64 9 415 4660 Facsimile +64 9 415 4661 Website www.opus.co.nz

Page 1 of 1

### PLASTICITY INDEX TEST REPORT



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor:

**Not Stated** 

Sampled by:

Tom Van Deelen

Sampling method:

Pushtube

Sample description: Sample condition: Grey; clayey SILT

Sample reference:

As received BH13/07

Sample depth:

3.0 - 3.5m

Project number:

Date sampled: 21/11/13

1-C0935.25

Lab ref number:

006/13

Client ref:

Tom Van Deelen

Folder number:

SEC13/AU/050

#### **Test Results**

As rec'd water content:

51.3%

Liquid limit:

76

Plastic limit:

33

Plasticity Index:

43

| Test methods      |                           | Notes  |
|-------------------|---------------------------|--|
| Water Content:    | NZS 4402: 1986, Test 2.1  | Test performed on: Fraction passing 0.425mm test sieve   |
| Liquid Limit:     | NZS 4402: 1986, Test 2.2  | Sample descriptions are not covered by IANZ accreditation.   |
| Plastic Limit:    | NZS 4402: 1986, Test 2.3  | , and the second |
| Plasticity Index: | NZS 4402 : 1986, Test 2.4 |  |

Date tested:

29/11/13 - 02/12/13

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

Date reported:

10/12/2013

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**IANZ Approved Signatory** 

Thirushen Pillay

Designation:

Senior Civil Engineering Technician

Date:

10/12/2013

ACCREDITED LABORATORY

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LAF-103 (19/02/13)

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Opus International Consultants Ltd

**Auckland Laboratory** 

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Shore City 0745, New Zealand

# ONE DIMENSIONAL CONSOLIDATION PROPERTIES TEST RESULT REPORT



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor:

**Not Stated** 

Subcontractor:

**Not Stated** 

Sample reference:

BH13/07, 3.0 - 3.5m

Specimen depth: 3.25 - 3.35 metres

Date: 21/11/13

Sampled by:

Tom Van Deelen

Date received:

21/11/13

Sampling method:

21/11/13 **Push Tube** 

Sample description:

Grey; clayey SILT

Sample condition:

As received

**OEDOMETER APPARATUS No: S17D** 

Project No: 1-C0935.25

Lab Ref No: 006b/13

Client Ref: Tom Van Deelen

| SOIL PROPERTIES      |            |       |  |  |  |  |
|----------------------|------------|-------|--|--|--|--|
| Specimen Dimensions: |            |       |  |  |  |  |
| Diameter             | 50.51      |       |  |  |  |  |
| Initial height (mm): |            | 19.76 |  |  |  |  |
| Final height         | 18.28      |       |  |  |  |  |
| Initial mass of s    | ample (g): | 64.76 |  |  |  |  |

| Initial Wet Density          | pbi (t/m³) | 1.64 |
|------------------------------|------------|------|
| Initial Dry Density          | pdi (t/m³) | 1.07 |
| Final Dry Density            | pdf (t/m³) | 1.16 |
| Initial Void Ratio           | eo         | 1.52 |
| Final Void Ratio             | ef         | 1.34 |
| Initial Degree of Saturation | Si (%)     | 94   |
| Final Degree of Saturation   | Sf (%)     | 100  |
| Solid Particle Density       | *Gs (t/m³) | 2.70 |
| INITIAL Water Content        | Wi (%)     | 52.9 |
| FINAL Water Content          | Wf (%)     | 49.7 |

| *Gs is Assumed | 1 |
|----------------|---|
|----------------|---|

| CONSOLIDATION PROP | ERTIES    |       |           |                |                |              |   |
|--------------------|-----------|-------|-----------|----------------|----------------|--------------|---|
| PRESSURE           | Pressure  | Void  | Intercept | Volume         | Coefficient of | Coeff. of    |   |
| RANGE              | Increment | Ratio | t90       | Compressibilty | Consolidation  | Permeability |   |
| (kPa)              | (dp)      | (e)   | (min)     | Mv=m²/MN       | Cv=m²/year     | k=m/year     | • |
| 0 - 12.5           | 12.5      | 1.519 | -         | -              | -              | -            |   |
| 12.5 - 25          | 12.5      | 1.518 | _         | -              | -              | _            |   |
| 25 - 50            | 25        | 1.513 | 1.89      | 0.083          | 23.0           | 0.019        |   |
| 50 - 100           | 50        | 1.496 | 1.77      | 0.13           | 24.0           | 0.032        |   |
| 100 - 200          | 100       | 1.461 | 1.77      | 0.14           | 24.0           | 0.033        |   |
| 200 - 400          | 200       | 1.387 | 3.49      | 0.15           | 12.0           | 0.017        |   |
| 400 - 800          | 400       | 1.268 | 9.61      | 0.12           | 4.0            | 0.0049       |   |
| 800 - 200          | -         | 1.291 | -         | -              | _              | -            |   |
| 200 - 50           | -         | 1.317 | -         | -              | -              | -            |   |
| 50 - 12.5          | _         | 1.335 | _         | -              | -              | -            |   |
| S=-                | -         | -     | _         | -              | -              | -            |   |
| -                  | -         | -     | _         | -              | -              | _            | l |

NZS 4402:1986 Test 7.1

|  | IVI | <u>letno</u> | as: |
|--|-----|--------------|-----|
|  |     | _            |     |

One Dimensional Consolidation Test.

Water Content

CONSOL IDATION DEODEDTIES

NZS 4402:1986 Test 2.1

Notes:

Sample is saturated during test.

Load Increments applied at 2.02hr intervals

Folder No: SEC13/AU/050

Date tested:

02-03/12/13

Date reported:

11/12/13

Testing is covered by IANZ Accreditation
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**IANZ Approved Signatory** 

Thirushen Pillay

Designation:

Senior Civil Engineering Technician

Date:

11/12/13

ACCREDITED LABORATORY

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CSF 2120 (8/02)
Opus International Consultants Ltd

Auckland Laboratory

Quality Management Systems Certified to ISO 9001

Unit A, 7 Ride Way, Nth Harbour Private Bag 10-1982, N.S.M.C., Auckland, New Zealand

# ONE DIMENSIONAL CONSOLIDATION PROPERTIES Applied Pressure vs Void Ratio TEST REPORT



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor:

Not Stated

Subcontractor:

**Not Stated** 

Sample reference: Sampled by:

BH13/07, 3.0 - 3.5m

Tom Van Deelen

Date received:

21/11/13

Sample description:

Grey; clayey SILT

Sampling method: Sample condition:

Push Tube As received

OEDOMETER APPARATUS No: S17D

Project No:

1-C0935.25

Lab Ref No:

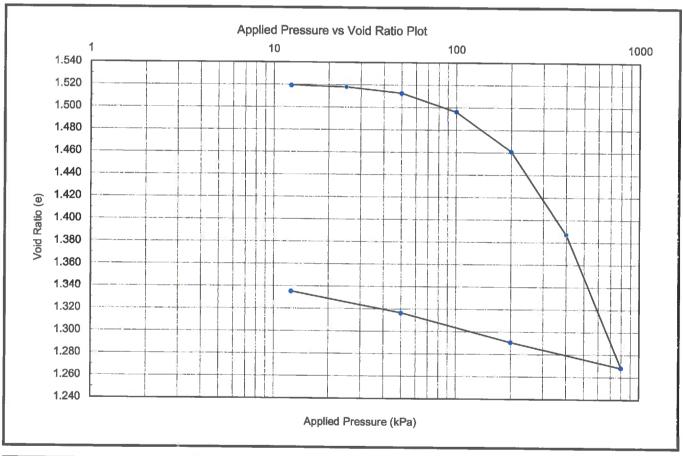
006b/13

Specimen depth: 3.25 - 3.35 metres

Date: 21/11/13

Client Ref:

Tom Van Deelen



| Test Method:                        |                        | Notes:                                      |  |  |
|-------------------------------------|------------------------|---|--|--|
| One Dimensional Consolidation Test: | NZS 4402:1986 Test 7.1 | Load Increments applied at 2.02hr intervals |  |  |
| Water Content:                      | NZS 4402:1986 Test 2.1 | Folder No: SEC13/AU/050                     |  |  |
|                                     |                        |   |  |  |

Date tested:
Date reported:

02-03/12/13 11/12/13 Testing is covered by IANZ Accreditation This report may only be reproduced in full

IANZ Approved Signatory

Thirushen Pillay

Designation:

Senior Civil Engineering Technician

Date:

11/12/13

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CSF 2120 (8/02)
Opus International Consultants Ltd

Quality Management Systems Certified to ISO 9001

**Auckland Laboratory** 

Unit A, 7 Ride Way, Nth Harbour Private Bag 10-1982, N.S.M.C., Auckland, New Zealand

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Result Summary



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.35 - 3.5m

Sample Reference: Sampled by:

BH13/07

Tom Van Deelen

Sampling Method:

Push Tube

Description: Comments:

Grey; clayey SILT Multistage Test.

Project No:

1-C0935.25

Lab Ref No:

006a/13

Client Ref No:

Depth (m): 3.0 - 3.5

Date Sampled: 21/11/13

Tom Van Deelen

| Stage     | Effective                  | I TN TY                       |                      |                 | re saturated :                 |   |   |               |
|-----------|----------------------------|-------------------------------|----------------------|-----------------|--------------------------------|---|---|---------------|
| -         | Specimen Effective INITIAL |                               |                      | RTIES           | Solid                          |   | AL PROPERT  | TEC           |
|           | Confining                  | Densities (t/m <sup>3</sup> ) |                      | Water           | Particle                       |   | ies (t/m³)  | Water         |
| No        | Pressure                   | Wet                           | Dry                  | Content         | Density                        | Wet                                       | Dry   | -             |
|           | (kPa)                      | $(t/m^3)$                     | $(t/m^3)$            | (%)             | (t/m <sup>3</sup> )            | (t/m <sup>3</sup> )                       |   | Conten        |
| 1         | 75                         | 1.70                          | 1.12                 | 51.3            | (VIII )                        | (Vm)                                      | (t/m³)  | (%)           |
| 2         | 150                        |                               |                      |                 | 2.70                           |   |   |               |
| 3         | 300                        |                               |                      |                 | (assumed)                      | 1.80                                      | 1.20  | 40.5          |
|           |                            |                               |                      |                 | (woodined)                     | 1.00                                      | 1.20  | 49.7          |
| Specimen  | Effective                  |                               | Deg of Sa            | turation(Sr)    |                                |   |   |               |
| Stage     | Confining                  | Void                          | Sr before            | Sr after        | 1                              | Values at Mayir                           | num Stress Ratio  |               |
| No        | Pressure                   | Ratio                         | Consolid,            | Consolid.       | S <sub>1</sub> -S <sub>3</sub> | m   |   |               |
|           | (kPa)                      | (e)                           | (%)                  | (%)             | (kPa)                          | (kPa)                                     |   | rain          |
| 1         | 75                         | 1.40                          | 99                   | 100             | 154.4                          | 36  |   | <del>%)</del> |
| 2         | 150                        |                               |                      |                 | 239.4                          | 67  | 1   |               |
| 3         | 300                        |                               |                      | 1               | 338.9                          | 134                                       |   | 82<br>50      |
|           |                            |                               |                      |                 | 350.7                          | 134                                       |   | 58            |
| Specimen  | Effective                  | Coefficient                   | Volume               | Coefficient     | B at the                       |   |   |               |
| Stage     | Confining                  | of Consolidation              | Compressibility      | of Permeability | start of                       | IANZ and                                  |   |               |
| No        | Pressure                   | Cv                            | Mv                   | k               | test                           |   | IANZ endorsement does not include<br>Cv, Mv and k values reported herei |               |
|           | (kPa)                      | (m²/year)                     | (m <sup>2</sup> /MN) | (m/s)           | iest                           |   |   |               |
| 1         | 75                         | 4                             | 0.20                 | 2.7E-10         |                                |   | ated for the followin   |               |
| 2         | 150                        | 0.6                           | 0.30                 | 6.0E-11         | 95.00                          | L/D=2, RADIAL                             | +TOP+BOTTOM D   | rainage       |
| 3         | 300                        | 0.5                           | 0.180                | 2.7E-11         | 95.00                          | Side Filter drains<br>(L/D= Sample Length |   |               |
|           |                            |                               |                      |                 |                                |   |   |               |
|           | TOTA                       | L STRESS RI                   | ESULT                |                 | EFFEC                          | TIVE STRESS                               | PESILT  |               |
|           | Intercept d                | 37.06                         | (kPa)                |                 | Intercept d'                   | 31.20                                     | (kPa)   |               |
|           | Beta b                     | 15.97                         | (deg)                |                 | Beta b'                        | 22.63                                     | (deg)   |               |
|           | Cohesion c                 | 39                            | (kPa)                |                 | Cohesion c'                    | 34  | (kPa)   |               |
|           | Phi Æ                      | 17                            | (deg)                |                 | Phi Æ                          | 25  | (deg)   |               |
|           | Correl coeff               | 0.9894                        | r <sup>2</sup>       | ļ               | Correl coeff                   | 0.9943                                    | (dcg)   |               |
|           |                            |                               |                      |                 |                                | 0.5210                                    |   |               |
| Methods   |                            |                               |                      | Notes:          |                                |   |   |               |
| xial Test | In House                   |                               |                      |                 | ve been rounds                 | ed to 2 significar                        | t figures   |               |
| ed On:    | NZS 4402:198               | 6 Test 6.2.1                  | 1                    | L/D= Sample I   | enoth/Diamet                   | ~ w ∠ aigiiiii¢ai<br>er                   | it figures.   |               |

Date Tested:

26/11/13 - 04/12/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician CSF 2130 (6/99)

Opus International Consultants Ltd

Auckland Laboratory

Quality Management Systems Certified to ISO 9001

7A Ride Way, Albany

Private Bag 101982, NS Mail Centre, North

Shore City 0745, New Zealand

Page 1 of 8

# CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Mohr Coulomb Envelope Plot



Project: Manuka Reservoirs
Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 3.35 - 3.5m Sample Reference: BH13/07

Sampled by: Tom Van Deelen

Sampling Method : Push Tube

Description: Grey; clayey SILT

Comments: Multistage Test.

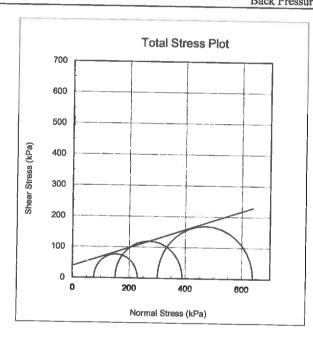
Depth (m): 3.0 - 3.5 Date Sampled: 21/11/13

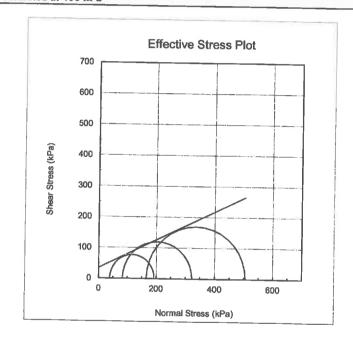
 Project No:
 1-C0935.25

 Lab Ref No:
 006a/13

 Client Ref No:
 Tom Van Deelen

Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT
Mohr-Coulomb envelope plots Result at Maximum Stress Ratio
Back Pressure Saturated at 400 kPa





| TOTAL STRESS RESULT |        |                |  |  |  |  |  |
|---------------------|--------|----------------|--|--|--|--|--|
| Intercept d         | 37.06  | (kPa)          |  |  |  |  |  |
| Beta b              | 15.97  | (deg)          |  |  |  |  |  |
| Cohesion c          | 39     | (kPa)          |  |  |  |  |  |
| Phi Æ               | 17     | (deg)          |  |  |  |  |  |
| Correl coeff        | 0.9894 | $\mathbf{r}^2$ |  |  |  |  |  |

| EFFECTIVE STRESS RESULT |        |                |
|-------------------------|--------|----------------|
| Intercept d'            | 31.20  | (kPa)          |
| Beta b'                 | 22.63  | (deg)          |
| Cohesion c'             | 34     | (kPa)          |
| Phi Æ'                  | 25     | (deg)          |
| Correl coeff            | 0.9943 | $\mathbf{r}^2$ |

| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 | 11000 |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

26/11/13 - 04/12/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

CSF 2130 (6/99)

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Facsimile +64 9 415 4661
Website www.opus.co.nz

ED LABORATORY scope of accreditation

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - P vs Q Total Stress Plot



Project:

Manuka Reservoirs

Location :

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.35 - 3.5m

Sample Reference: Sampled by:

BH13/07

Sampling Method:

Tom Van Deelen

Description:

**Push Tube** 

Comments:

Grey; clayey SILT Multistage Test.

Depth (m): 3.0 - 3.5

Date Sampled: 21/11/13

Project No: Lab Ref No:

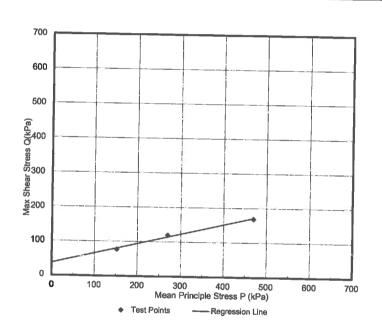
1-C0935.25

006a/13

Client Ref No:

Tom Van Deelen

### Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT P vs Q Total Stress Plot- Back Pressure saturated at 400 kPa



| TOTAL STRE   | SS RESULT |                |
|--------------|-----------|----------------|
| Intercept d  | 37.06     | (kPa)          |
| Beta b       | 15.97     | (deg)          |
| Correl coeff | 0.9894    | r <sup>2</sup> |
| Cohesion c   | 39        | (kPa)          |
| Phi AE       | 17        | (deg)          |

| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

26/11/13 - 04/12/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

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Page 3 of 8

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - P' vs Q' Effective Stress Plot



Project: Manuka Reservoirs
Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 3.35 - 3.5m Sample Reference: BH13/07

Sampled by: Tom Van Deelen
Sampling Method: Push Tube

Sampling Method:
Description:
Comments:
Push Tube
Grey; clayey SILT
Multistage Test.

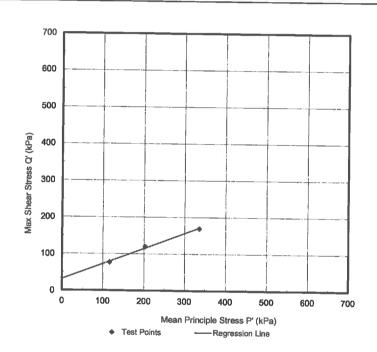
Depth (m): 3.0 - 3.5 Date Sampled: 21/11/13

Project No: 1-C0935.25

Lab Ref No: 006a/13

Client Ref No. Tom Van Deelen

# Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT P' vs Q' Effective Stress Plot-Back Pressure saturated at 400 kPa



| EFFECTIVE STRESS RESULT |        |                |
|-------------------------|--------|----------------|
| Intercept d'            | 31.20  | (kPa)          |
| Beta b'                 | 22.63  | (deg)          |
| Correl coeff            | 0.9943 | r <sup>2</sup> |
| Cohesion c'             | 34     | (kPa)          |
| Phi Æ'                  | 25     | (deg)          |

| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

26/11/13 - 04/12/13

Date Reported:

10/12/13

10/12/15

Date: 10/12/13

IANZ Approved Signatory: Date Designation: Thirushen Pillay- Senior Civil Engineering Technician

All tests reported harein have been performed in accordance with the laboratory's ACCREDITED LABORATORY SOPP of accordination

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Page 4 of 8

## CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - PvsQ Stress Path Plot



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.35 - 3.5<u>m</u>

Sample Reference:

BH13/07

Sampled by:

Tom Van Deelen

Sampling Method:

Push Tube

Description: Comments:

Grey; clayey SILT Multistage Test.

Depth (m): 3.0 - 3.5

Date Sampled: 21/11/13

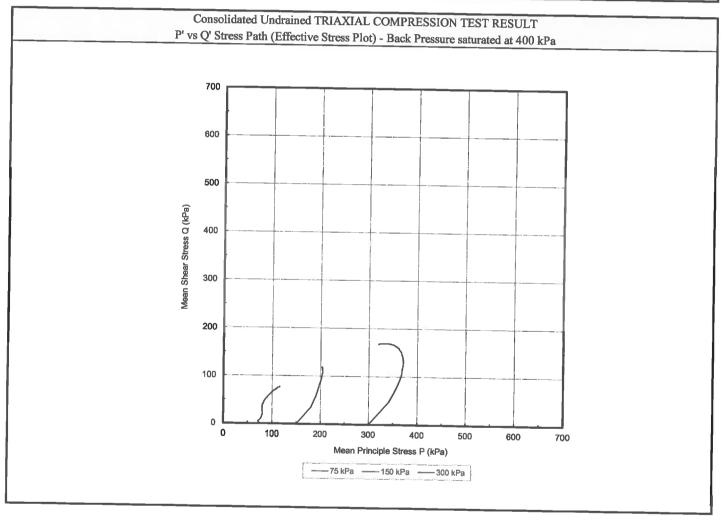
Project No: Lab Ref No:

1-C0935.25

006a/13

Client Ref No:

Tom Van Deelen



| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

26/11/13 - 04/12/13

Date Reported:

10/12/13

1 1/14

IANZ Approved Signatory:

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

CSF 2130 (6/99)

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### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Strain vs Deviator StressPlot



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.35 - 3.5m

Sample Reference:

BH13/07

Sampled by:

Tom Van Deelen

Sampling Method:

**Push Tube** 

Description: Comments:

Grey; clayey SILT Multistage Test.

Project No: 1-C0935.25 Lab Ref No: 006a/13

> 300 kPa 150 kPa

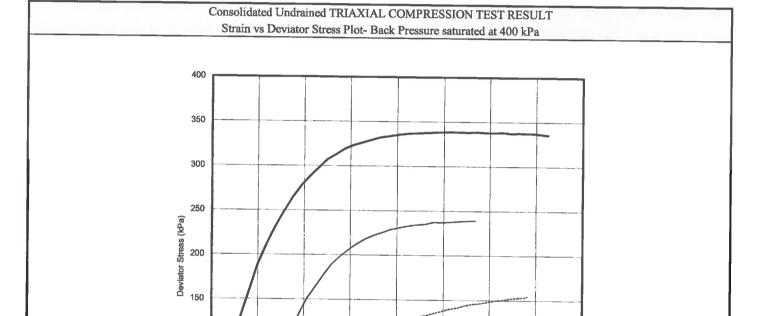
75 kPa

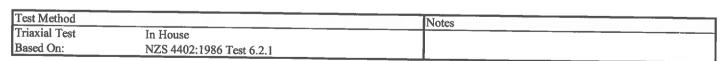
3.5

Depth (m): 3.0 - 3.5

Date Sampled: 21/11/13

Client Ref No: Tom Van Deelen





2

Strain (%)

2.5

1.5

Date Tested:

26/11/13 - 04/12/13

100

50

Date Reported:

10/12/13

IANZ Approved Signatory:

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

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Page 6 of 8

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Strain vs Pore Pressure Plot



Project: Manuka Reservoirs
Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 3.35 - 3.5m

Sample Reference: BH13/07
Sampled by: Tom Van Deelen

Sampling Method: Push Tube

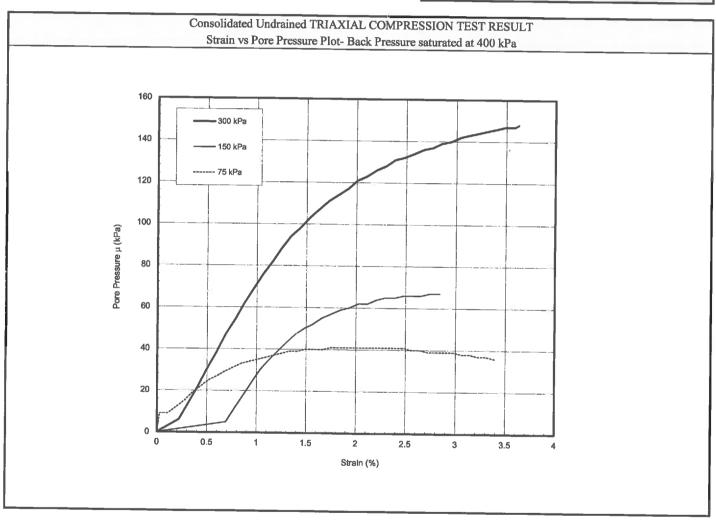
Description: Grey; clayey SILT Comments: Multistage Test.

Depth (m): 3.0 - 3.5 Date Sampled: 21/11/13

Project No: 1-C0935.25

Lab Ref No: 006a/13

Client Ref No: Tom Van Deelen



| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

26/11/13 - 04/12/13

Date Reported:

10/12/13

2/13 Milloy

Date: 10/12/13

IANZ Approved Signatory:

Designation: Thirushen Pillay- Senior Civil Engineering Technician

CSF 2130 (6/99)

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Page 7 of 8

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Displacement vs Öt Plot (Consolidation stage)



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Specimen Depth(m):

Watercare Services Ltd c/o Opus International Consultants Ltd 3.35 - 3.5m

Sample Reference:

BH13/07

Sampled by: Sampling Method: Tom Van Deelen

Description:

Push Tube

Comments:

Grey; clayey SILT Multistage Test. Depth (m): 3.0 - 3.5

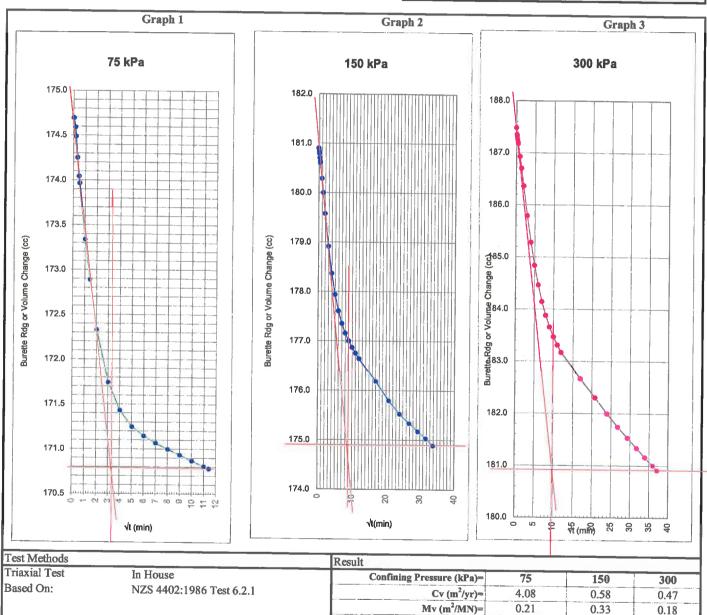
Date Sampled: 21/11/13

Project No: Lab Ref No: Client Ref No:

1-C0935.25

006a/13

Tom Van Deelen



Date Tested:

26/11/13 - 04/12/13

Date Reported:

IANZ Approved Signatory:

10/12/13

**July** 

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

10/12/13



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k (m/s)=

2.68E-10

11.6

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5.97E-11

81.0

Page 8 of 8

2.70E-11

100.0

#### UNCONFINED COMPRESSIVE STRENGTH WITH YOUNG'S MODULUS



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Sampled by:

Opus - Tom Van Deelen

Date sampled:

21/11/13

Sampling method: Sample description: Not Stated

Sample condition:

Weak Sandstone

Sample condition:

As received BH13/07

Sample depth (m):

6.15 - 6.30

Project number:

1-C0935.25

Lab ref number:

012/13

Client ref:

Tom Van Deelen

Folder number:

SEC13/AU/050

|                       |          |             |           |      | Test r | esult   | 3        |       |         |        |        |        |         |      |         |
|-----------------------|----------|-------------|-----------|------|--------|---|----------|-------|---------|--------|--------|--------|---------|------|---------|
| Bulk density (t/m³)   |          |             | 2.05      |      |        | Initia  | l sampl  | e dia | meter   | (mm    | )      |        |         |      | 60.3    |
| Water content (%)     |          |             | 17.6      | 5    |        |   | l sampl  |       |         |        |        |        |         |      | 120.6   |
| Dry density (t/m³)    |          | 1.75        |           |      |        |   |          |       |         |        |        | 2855.8 |         |      |         |
| Maximum stress (k     |          |             | 1700      | 0    |        | Initial sample area (mm²) Initial Length:Diameter ratio |          |       | _       |        | 2:1    |        |         |      |         |
| Strain at failure (%) |          |             | 0.58      | 1    |        |   | g's mo   |       |         |        |        |        |         |      | 7844    |
| Mode of failure:      |          |             | Shear     | ed   |        |   | rain ra  |       | (       | 7      |        |        | _       | 0.50 | - 0.58% |
| est Methods           |          | 0.10        | O.20      | 0.30 | 0.40   |   | 0.50     |       | 0.60    |        | 0.70   | 0.     | .80     | 0    | 90      |
| 'est Methods          |          |             |           |      |        |   | <u> </u> |       |         |        |        |        |         |      |         |
| JCS:                  | NZS 4402 | 2: 1986: To | est 6.3.1 |      |        |   | Descrip  | tions | are not | covere | d by L | AN7 90 | credite | tion |         |
|                       |          |             |           |      |        |   | ain rate |       |         |        |        |        |         |      |         |

Tested by:

ΑJ

Date tested:

22/11/13

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

IANZ Approved Signatory

Thirushen Pillay

Senior Civil Engineering Technician

Date: 09/12/13

ian

ACCREDITED LABORATORY

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LAF 017 (22/07/13)

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#### PLASTICITY INDEX TEST REPORT



1-C0935.25

007/13

Project: Manuka Reservoirs
Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor: Not Stated

Sampled by: Tom Van Deelen Date sampled: 21/11/13

Sampling method: Pushtube

Sample description: Brown; silty CLAY

Sample condition: As received
Sample reference: BH13/09

Sample depth: 3.0 - 3.5m Client ref: Tom Van Deelen Folder number: SEC13/AU/050

Test Results

As rec'd water content: 59.0%

Liquid limit: 73

Plastic limit: 40

Plasticity Index: 33

| Test methods      |                          | Notes  |
|-------------------|--------------------------|--|
| Water Content:    | NZS 4402: 1986, Test 2.1 | Test performed on: Fraction passing 0.425mm test sieve     |
| Liquid Limit:     | NZS 4402: 1986, Test 2.2 | Sample descriptions are not covered by IANZ accreditation. |
| Plastic Limit:    | NZS 4402: 1986, Test 2.3 |  |
| Plasticity Index: | NZS 4402: 1986, Test 2.4 |  |

Date tested: 29/11/13 - 02/12/13 Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

Date reported: 10/12/2013 This report may only be reproduced in full

IANZ Approved Signatory

Thirushen Pillay

Designation: Senior Civil Engineering Technician

Date: 10/12/2013

ACCREDITED LABORATORY

Project number:

Lab ref number:

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

LAF-103 (19/02/13)

Page 1 of 1

Opus International Consultants Ltd

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#### ONE DIMENSIONAL CONSOLIDATION PROPERTIES TEST RESULT REPORT



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor:

**Not Stated** 

Subcontractor:

**Not Stated** 

Sample reference:

BH13/09, 3.0 - 3.5m

Sampled by:

Tom Van Deelen

Specimen depth: 3.3 - 3.38 metres

Date: 21/11/13

Date received: Sampling method: 21/11/13

Sample description:

**Push Tube** 

Brown; silty CLAY

Sample condition:

As received

OEDOMETER APPARATUS No: \$17D

Project No: 1-C0935.25 Lab Ref No: 007b/13

Client Ref:

Tom Van Deelen

| SOIL PROPERTIES      |                             |       |  |  |  |
|----------------------|-----------------------------|-------|--|--|--|
| Specimen Dimensions: |                             |       |  |  |  |
| Diameter             | (mm):                       | 50.51 |  |  |  |
| Initial height       | (mm):                       | 19.76 |  |  |  |
| Final height         | (mm):                       | 17.07 |  |  |  |
| Initial mass of s    | Initial mass of sample (g): |       |  |  |  |

| W 1.1 4 999                  |            |      |
|------------------------------|------------|------|
| Initial Wet Density          | pbi (t/m³) | 1.51 |
| Initial Dry Density          | pdi (t/m³) | 0.97 |
| Final Dry Density            | pdf (t/m³) | 1.12 |
| Initial Void Ratio           | eo         | 1.78 |
| Final Void Ratio             | ef         | 1.40 |
| Initial Degree of Saturation | Si (%)     | 84   |
| Final Degree of Saturation   | Sf (%)     | 97   |
| Solid Particle Density       | *Gs (t/m³) | 2.70 |
| INITIAL Water Content        | Wi (%)     | 55.7 |
| FINAL Water Content          | Wf (%)     | 50.4 |

\*Gs is Assumed

| CONSOLIDATION PROP | ERTIES    |       |           |                |                |              |  |
|--------------------|-----------|-------|-----------|----------------|----------------|--------------|--|
| PRESSURE           | Pressure  | Void  | Intercept | Volume         | Coefficient of | Coeff. of    |  |
| RANGE              | Increment | Ratio | t90       | Compressibilty | Consolidation  | Permeability |  |
| (kPa)              | (dp)      | (e)   | (min)     | Mv=m²/MN       | Cv=m²/year     | k=m/year     |  |
| 0 - 12.5           | 12.5      | 1.771 | -         | -              | _              | -            |  |
| 12.5 - 25          | 12.5      | 1.749 | _         |                | -              | -            |  |
| 25 - 50            | 25        | 1.728 | 0.81      | 0.3            | 52.0           | 0.15         |  |
| 50 - 100           | 50        | 1.691 | 1.00      | 0.27           | 42.0           | 0.11         |  |
| 100 - 200          | 100       | 1.620 | 1.00      | 0.26           | 41.0           | 0.11         |  |
| 200 - 400          | 200       | 1.493 | 1.21      | 0.24           | 32.0           | 0.075        |  |
| 400 - 800          | 400       | 1.337 | 2.25      | 0.16           | 15.0           | 0.024        |  |
| 800 - 200          |           | 1.358 | -         | -              |                | _            |  |
| 200 - 50           | -         | 1.383 | -         | -              | -              | _            |  |
| 50 - 12.5          |           | 1.404 | -         | -              | _              |              |  |
| =                  | -         | -     | -         | <del>-</del>   | _              | -            |  |
| -                  | l .       | _     | _         | -              | _              | _            |  |

Test Methods:

Water Content

One Dimensional Consolidation Test.

NZS 4402:1986 Test 7.1 NZS 4402:1986 Test 2.1

Sample is saturated during test.

Load Increments applied at 1.667hr intervals

Folder No: SEC13/AU/050

Date tested: Date reported:

28-29/11/13 12/12/13

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**IANZ Approved Signatory** 

Thirushen Pillay

Designation:

Date: 12/12/13

Senior Civil Engineering Technician



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Auckland Laboratory Quality Management Systems Certified to ISO 9001

Unit A, 7 Ride Way, Nth Harbour Private Bag 10-1982, N.S.M.C., Auckland, New Zealand

#### ONE DIMENSIONAL CONSOLIDATION PROPERTIES **Applied Pressure vs Void Ratio TEST REPORT**



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client: Contractor: Watercare Services Ltd c/o Opus International Consultants Ltd **Not Stated** 

Subcontractor:

**Not Stated** 

Sample reference:

BH13/09, 3.0 - 3.5m

Sampled by:

Tom Van Deelen

Date received:

21/11/13

Sample description:

Brown; silty CLAY

Sampling method: Sample condition:

**Push Tube** As received

**OEDOMETER APPARATUS No: S17D** 

Project No:

1-C0935.25

Lab Ref No:

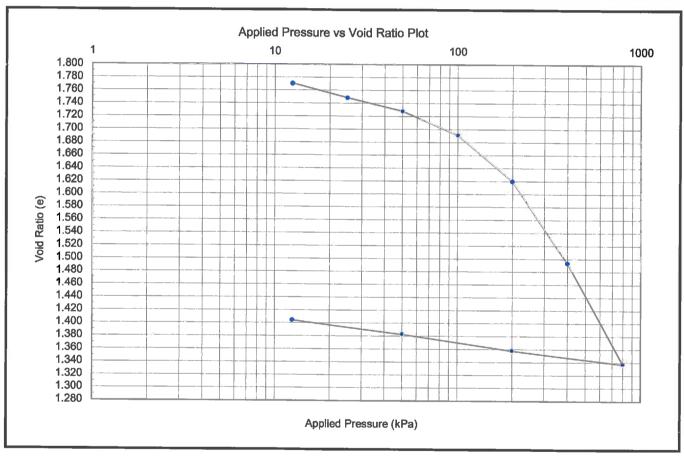
007b/13

Specimen depth: 3.3 - 3.38 metres

Date: 21/11/13

Client Ref:

Tom Van Deelen



| Test Method:                        |                        | Notes:                                       |
|-------------------------------------|------------------------|--|
| One Dimensional Consolidation Test: | NZS 4402:1986 Test 7.1 | Load Increments applied at 1.667hr intervals |
| Water Content:                      | NZS 4402:1986 Test 2.1 | Folder No: SEC13/AU/050                      |
|                                     |                        |  |

Date tested: Date reported: 28-29/11/13 12/12/13

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**IANZ Approved Signatory** 

Thirushen Pillay

Designation:

Senior Civil Engineering Technician

Date: CSF 2120 (8/02) 12/12/13

**Opus International Consultants Ltd** 

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Auckland, New Zealand

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not accredited are outside the scope

of the laboratory's

**Auckland Laboratory** Quality Management Systems Certified to ISO 9001

#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Result Summary



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.38 - 3.5m

Sample Reference:

BH13/09

Sampled by:

Tom Van Deelen

Sampling Method: Description:

Push Tube

Comments:

Brown; silty CLAY Multistage Test.

Depth (m): 3.0 - 3.5

Date Sampled: 21/11/13

Project No:

1-C0935.25

Lab Ref No:

007a/13

Client Ref No:

Tom Van Deelen

| esult at Maximum |              |                  |                     | Back Pressu     | re saturated a                 | it 400 kPa   |                         |           |  |
|------------------|--------------|------------------|---------------------|-----------------|--------------------------------|--|-------------------------|-----------|--|
| Specimen         | Effective    | INI              | TIAL PROPER         | RTIES           | Solid                          | FINAL PROPERTIES   |                         |           |  |
| Stage            | Confining    | Densit           | ies (t/m³)          | Water           | Particle                       |  | es (t/m <sup>3</sup> )  | Water     |  |
| No               | Pressure     | Wet              | Dry                 | Content         | Density                        | Wet  | Dry                     | Conten    |  |
|                  | (kPa)        | (t/m³)           | (t/m <sup>3</sup> ) | (%)             | (t/m <sup>3</sup> )            | (t/m³)   | $(t/m^3)$               | (%)       |  |
| 1                | 75           | 1.64             | 1.03                | 59.3            | (51117                         | (2111)   | (0111)                  | (70)      |  |
| 2                | 150          |                  | 1                   |                 | 2.70                           |  |                         |           |  |
| 3                | 300          |                  |                     |                 | (assumed)                      | 1.72   | 1.12                    | 53.0      |  |
|                  |              |                  |                     |                 | (                              | 1.72   | 1.12                    | 33.0      |  |
| Specimen         | Effective    |                  | Deg of Sa           | turation(Sr)    |                                |  |                         |           |  |
| Stage            | Confining    | Void             | Sr before           | Sr after        |                                | Values at Maxir  | num Stress Ratio        |           |  |
| No               | Pressure     | Ratio            | Consolid.           | Consolid.       | S <sub>1</sub> -S <sub>3</sub> | m  |                         | rain      |  |
|                  | (kPa)        | (e)              | (%)                 | (%)             | (kPa)                          | (kPa)  |                         | %)        |  |
| 1                | 75           | 1.62             | 99                  | 100             | 77.0                           | 31   |                         | 16        |  |
| 2                | 150          | ]                |                     |                 | 111.5                          | 76   | 1                       | 25        |  |
| 3                | 300          |                  |                     |                 | 190.9                          | 180  |                         | 60        |  |
|                  |              |                  |                     |                 |                                | 100  | 7.                      | -         |  |
| Specimen         | Effective    | Coefficient      | Volume              | Coefficient     | B at the                       |  |                         |           |  |
| Stage            | Confining    | of Consolidation | Compressibility     | of Permeability | start of                       | IANZ endorsement does not include the Cv, Mv and k values reported herein. |                         | clude the |  |
| No               | Pressure     | Cv               | Mv                  | k               | test                           |  |                         |           |  |
|                  | (kPa)        | (m²/year)        | (m²/MN)             | (m/s)           |                                |  | lated for the following |           |  |
| 1                | 75           | 1                | 0.20                | 8.6E-11         |                                |  | +TOP+BOTTOM I           |           |  |
| 2                | 150          | 0.6              | 0.30                | 6.2E-11         | 100.00                         | Side Filter drains   |                         | n annage  |  |
| 3                | 300          | 0.3              | 0.300               | 2.5E-11         |                                | (L/D= Sample Length  |                         |           |  |
|                  | TOTA         | L STRESS R       | FSIII T             |                 | E DE C                         |  |                         |           |  |
|                  | Intercept d  |                  | (kPa)               |                 |                                | TIVE STRESS  |                         |           |  |
|                  | Beta b       |                  | (deg)               |                 | Intercept d'                   | 1.56   | (kPa)                   |           |  |
|                  | Cohesion c   |                  | (kPa)               |                 | Beta b'                        | 23.39  | (deg)                   |           |  |
|                  | Phi Æ        |                  | . ,                 |                 | Cohesion c'                    | 2  | (kPa)                   |           |  |
|                  | Correl coeff | 0.9993           | (deg)               |                 | Phi Æ'                         | 26   | (deg)                   |           |  |
|                  | 00.101.0011  | 0.223            | r                   |                 | Correl coeff                   | 0.9966   | r²                      |           |  |
| t Methods        |              |                  |                     | Notes:          |                                |  |                         |           |  |
| axial Test       | In House     |                  |                     |                 | ve been round                  | ed to 2 significar   | nt figures              |           |  |
| sed On:          | NZS 4402:198 | 36 Test 6.2.1    |                     | L/D= Sample     | Length/Diame                   | ter  | in riguies.             |           |  |
|                  |              |                  |                     |                 |                                | PWA 4  |                         |           |  |

Date Tested:

26/11/13 - 04/12/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

CSF 2130 (6/99)

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Page 1 of 8

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## CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Mohr Coulomb Envelope Plot



Project: Manuka Reservoirs
Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 3.38 - 3.5m Sample Reference: BH13/09

Sampled by: Tom Van Deelen

Sampling Method: Push Tube

Description: Brown; silty CLAY
Comments: Multistage Test.

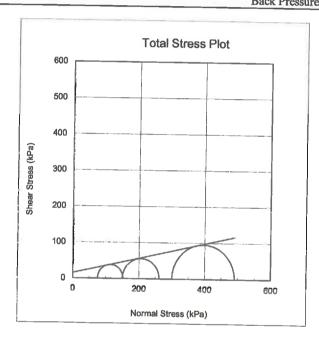
Depth (m): 3.0 - 3.5 Date Sampled: 21/11/13

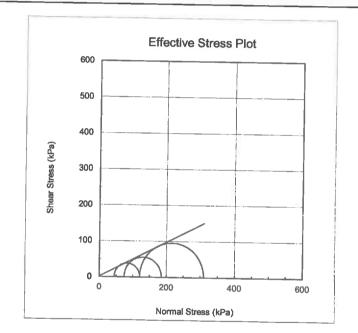
 Project No:
 1-C0935.25

 Lab Ref No:
 007a/13

 Client Ref No:
 Tom Van Deelen

# Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT Mohr-Coulomb envelope plots Result at Maximum Stress Ratio Back Pressure Saturated at 400 kPa





| TOTAL STRESS RESULT                |       |       |   |  |  |
|------------------------------------|-------|-------|---|--|--|
| Intercept d                        | 14.86 | (kPa) | _ |  |  |
| Beta b                             | 11.48 | (deg) |   |  |  |
| Cohesion c                         | 15    | (kPa) |   |  |  |
| Phi Æ                              | 12    | (deg) |   |  |  |
| Correl coeff 0.9993 r <sup>2</sup> |       |       |   |  |  |

| EFFECTIVE STRESS RESULT |        |       |  |  |  |  |
|-------------------------|--------|-------|--|--|--|--|
| Intercept d'            | 1.56   | (kPa) |  |  |  |  |
| Beta b'                 | 23.39  | (deg) |  |  |  |  |
| Cohesion c'             | 2      | (kPa) |  |  |  |  |
| Phi Æ'                  | 26     | (deg) |  |  |  |  |
| Correl coeff            | 0.9966 | $r^2$ |  |  |  |  |

| Test Method   |                          |       |
|---------------|--------------------------|-------|
|               |                          | Notes |
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

26/11/13 - 04/12/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

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Page 2 of 8

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - P vs Q Total Stress Plot



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.38 - 3.5m

Sample Reference:

BH13/09

Depth (m): 3.0 - 3.5

Sampled by:

Tom Van Deelen

Date Sampled: 21/11/13

Sampling Method:

Push Tube

Description:

Brown; silty CLAY

Comments:

Multistage Test.

Project No: Lab Ref No:

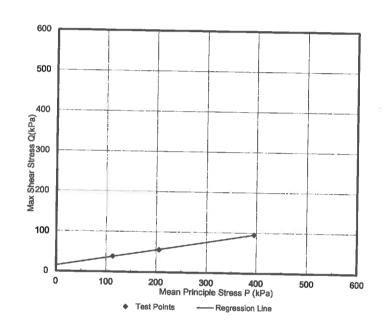
1-C0935.25

007a/13

Client Ref No:

Tom Van Deelen

## Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT P vs Q Total Stress Plot- Back Pressure saturated at 400 kPa



| TOTAL STRE   |        |                |
|--------------|--------|----------------|
| Intercept d  | 14.86  | (kPa)          |
| Beta b       | 11.48  | (deg)          |
| Correl coeff | 0.9993 | r <sup>2</sup> |
| Cohesion c   | 15     | (kPa)          |
| Phi Æ        | 12     | (deg)          |

| Test Method   |                          | Notes  |
|---------------|--------------------------|--------|
| Triaxial Test | In House                 | TYOLES |
| Based On:     | NZS 4402:1986 Test 6.2.1 |        |

Date Tested:

26/11/13 - 04/12/13

Date Reported:

10/12/13

Date: 10/12/13

IANZ Approved Signatory:

Designation: Thirushen Pillay- Senior Civil Engineering Technician

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#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - P' vs Q' Effective Stress Plot



Project:

Manuka Reservoirs

Location :

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.38 - 3.5m

Sample Reference:

BH13/09

Sampled by:

Tom Van Deelen

Sampling Method:

**Push Tube** 

Description: Comments:

Brown; silty CLAY Multistage Test.

Depth (m): 3.0 - 3.5

Date Sampled: 21/11/13

Project No: Lab Ref No:

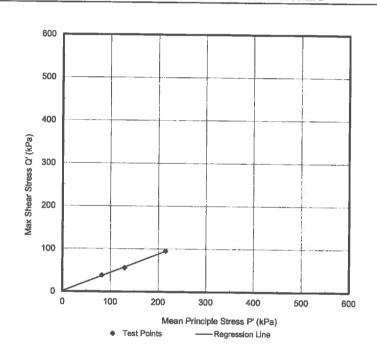
1-C0935.25

007a/13

Client Ref No:

Tom Van Deelen

#### Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT P' vs Q' Effective Stress Plot-Back Pressure saturated at 400 kPa



| <b>EFFECTIVE S</b> | TRESS RES | ULT            |
|--------------------|-----------|----------------|
| Intercept d'       | 1.56      | (kPa)          |
| Beta b'            | 23.39     | (deg)          |
| Correl coeff       | 0.9966    | r <sup>2</sup> |
| Cohesion c'        | 2         | (kPa)          |
| Phi Æ'             | 26        | (deg)          |

| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

26/11/13 - 04/12/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Date:

10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

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Shore City 0745, New Zealand

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Facsimile +64 9 415 4661 Website www.opus.co.nz

#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - PvsQ Stress Path Plot



Project:

Manuka Reservoirs

Location :

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

3.38 - 3.5m

Sample Reference:

BH13/09

Sampled by:

Tom Van Deelen

Sampling Method:

**Push Tube** 

Description: Comments:

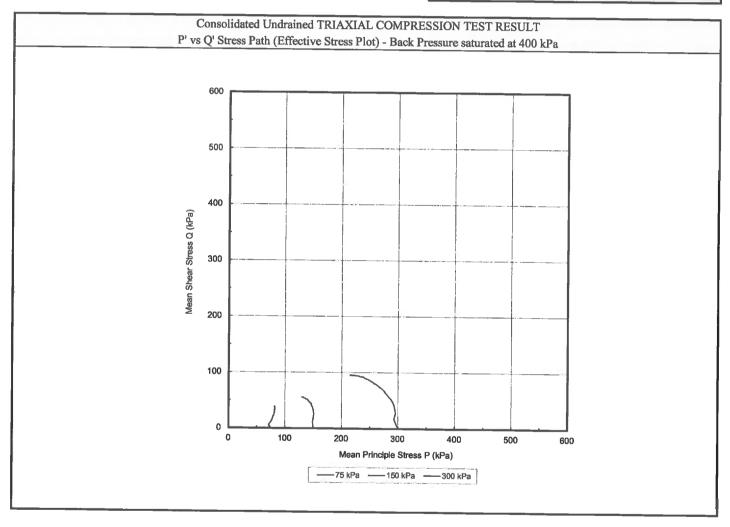
Brown; silty CLAY

Multistage Test.

Depth (m): 3.0 - 3.5 Date Sampled: 21/11/13

> Project No: 1-C0935.25 Lab Ref No: 007a/13

Client Ref No: Tom Van Deelen



| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

26/11/13 - 04/12/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

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### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Strain vs Deviator StressPlot



Project: Manuka Reservoirs
Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 3.38 - 3.5m Sample Reference: BH13/09

Sampled by: Tom Van Deelen

Sampling Method: Push Tube

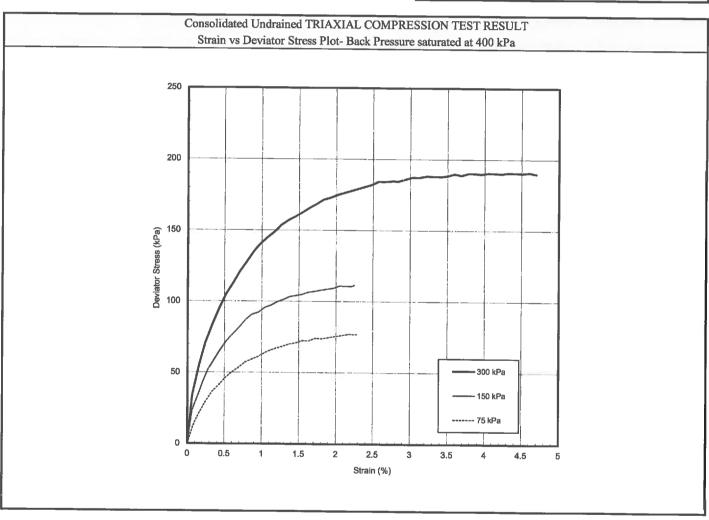
Description: Brown; silty CLAY
Comments: Multistage Test.

Depth (m): 3.0 - 3.5 Date Sampled: 21/11/13

Project No: 1-C0935.25

Lab Ref No: 007a/13

Client Ref No: Tom Van Deelen



| Test Method   |                          | Notes |   |
|---------------|--------------------------|-------|---|
| Triaxial Test | In House                 |       | - |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |   |

Date Tested:

26/11/13 - 04/12/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

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Auckland Laboratory

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### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Strain vs Pore Pressure Plot



Project: Manuka Reservoirs
Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 3.38 - 3.5m

Sample Reference: BH13/09 Depth (m): 3.0 - 3.5
Sampled by: Tom Van Deelen Date Sampled: 21/11/13

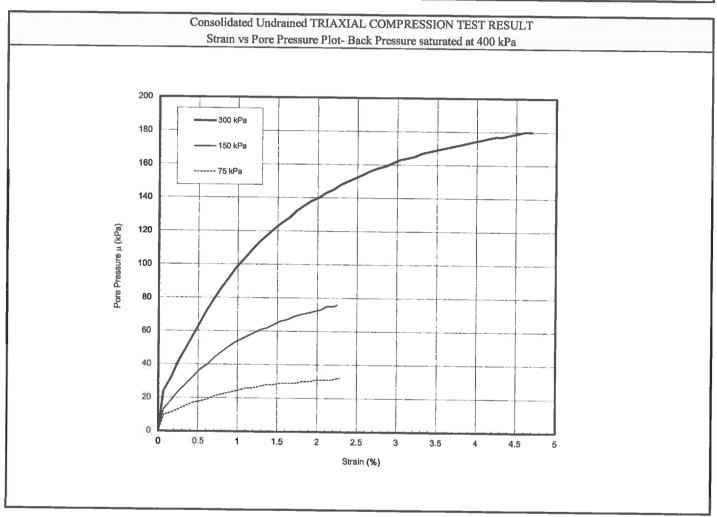
Sampling Method: Push Tube

Description: Brown; silty CLAY Comments: Multistage Test.

Project No: 1-C0935.25

Lab Ref No: 007a/13

Client Ref No: Tom Van Deelen



| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested: 26/11/13 - 04/12/13

Date Reported: 10/12/13

IANZ Approved Signatory: Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

All tests reported herein have been performed in accordance with the laboratory's acceptation of the second acceptation of the second of acceptation of the second of acceptation of the second of acceptation of the second

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Page 7 of 8

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Displacement vs Öt Plot (Consolidation stage)



Project: Manuka Reservoirs
Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 3.38 - 3.5m Sample Reference: BH13/09

Sampled by: Tom Van Deelen
Sampling Method: Push Tube

Description:
Comments:

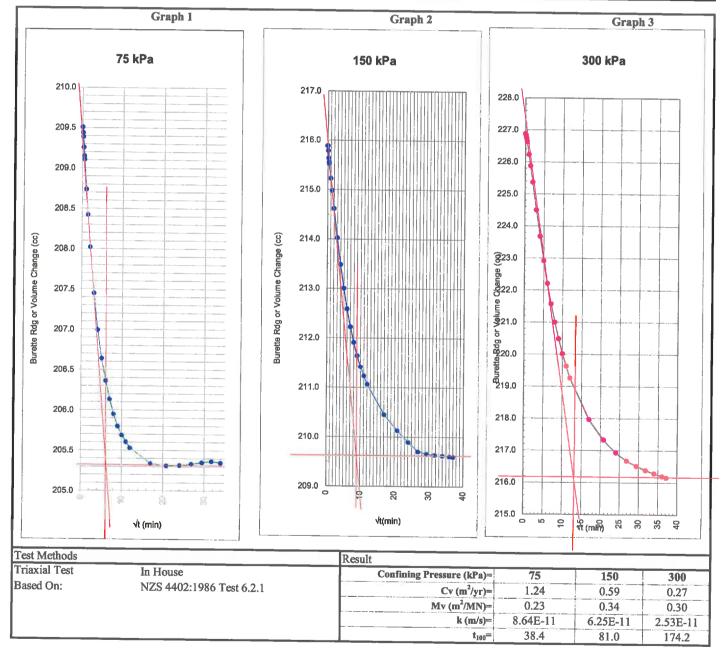
Brown; silty CLAY
Multistage Test,

Depth (m): 3.0 - 3.5 Date Sampled: 21/11/13

Project No: Lab Ref No:

1-C0935.25 007a/13

Client Ref No: Tom Van Deelen



Date Tested:

26/11/13 - 04/12/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

All tests reported harwin have been performed in secondary with the laboratory's accreditation and accreditation and accreditation and accreditation and accreditation and accreditation and accreditation and accreditation

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Auckland Laboratory
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#### PLASTICITY INDEX TEST REPORT



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor:

**Not Stated** 

Sampled by:

Tom Van Deelen

Sampling method:

Pushtube

Sample description:

Grey; siltstone

Sample condition: Sample reference: As received

Sample depth:

BH13/09 6.0 - 6.5m Project number:

Date sampled: 21/11/13

1-C0935.25

Lab ref number:

008/13

Client ref:

Tom Van Deelen

Folder number:

SEC13/AU/050

**Test Results** 

As rec'd water content:

41.6%

Liquid limit:

58

Plastic limit:

36

Plasticity Index:

22

| Test methods      |                           | Notes  |
|-------------------|---------------------------|--|
| Water Content:    | NZS 4402: 1986, Test 2.1  | Test performed on: Fraction passing 0.425mm test sieve     |
| Liquid Limit:     | NZS 4402: 1986, Test 2.2  | Sample descriptions are not covered by IANZ accreditation. |
| Plastic Limit:    | NZS 4402: 1986, Test 2.3  | 1 I I I I I I I I I I I I I I I I I I I                    |
| Plasticity Index: | NZS 4402 : 1986, Test 2.4 |  |

Date tested:
Date reported:

29/11/13 10/12/2013 Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

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**IANZ Approved Signatory** 

Thirushen Pillay

Designation:

Senior Civil Engineering Technician

Date:

10/12/2013

ACCREDITED LABORATORY

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

LAF-103 (19/02/13)

Page 1 of 1

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#### ONE DIMENSIONAL CONSOLIDATION PROPERTIES **TEST RESULT REPORT**



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor:

**Not Stated** 

Subcontractor:

**Not Stated** 

**Tom Van Deelen** 

Sample reference:

BH13/09, 6.0 - 6.5m

Specimen depth: 6.3 - 6.35 metres

Date: 21/11/13

Sampled by: Date received:

21/11/13

Sampling method:

**Push Tube** 

Sample description:

**Grey; Siltstone** 

Sample condition:

As received

**OEDOMETER APPARATUS No: S17C** 

1-C0935.25 Project No: Lab Ref No: 008b/13

Folder No: SEC13/AU/050

| SOIL PROPERTI        | ES_        |       |        |  |  |  |
|----------------------|------------|-------|--------|--|--|--|
| Specimen Dimensions: |            |       |        |  |  |  |
| Diameter             | (mm):      | 50.53 | $\neg$ |  |  |  |
| Initial height       | (mm):      | 16.08 |        |  |  |  |
| Final height         | (mm):      | 14.87 |        |  |  |  |
| Initial mass of s    | ample (g): | 54.15 |        |  |  |  |

CONCOLIDATION PROPERTIES

| Initial Wet Density          | pbi (t/m³) | 1.68 |
|------------------------------|------------|------|
| Initial Dry Density          | pdi (t/m³) | 1.20 |
| Final Dry Density            | pdf (t/m³) | 1.30 |
| Initial Void Ratio           | ео         | 1.25 |
| Final Void Ratio             | ef         | 1.08 |
| Initial Degree of Saturation | Si (%)     | 86   |
| Final Degree of Saturation   | Sf (%)     | 100  |
| Solid Particle Density       | *Gs (t/m³) | 2.70 |
| INITIAL Water Content        | Wi (%)     | 40.1 |
| FINAL Water Content          | Wf (%)     | 40.9 |
|                              | 40 1 4     | -    |

\*Gs is Assumed

| PRESSURE  | Pressure  | Void  | Intercept  | Volume          | Coefficient of | Coeff. of    |
|-----------|-----------|-------|------------|-----------------|----------------|--------------|
| RANGE     | Increment | Ratio | t90        | Compressibility |                | Permeability |
| (kPa)     | (dp)      | (e)   | (min)      | Mv=m²/MN        | Cv=m²/year     | k=m/year     |
| 0 - 12.5  | 12.5      | 1.242 | 1.21       |                 | -              | -            |
| 12.5 - 25 | 12.5      | 1.225 | 0.30       | 0.59            | 94.0           | 0.54         |
| 25 - 50   | 25        | 1.212 | 1.69       | 0.25            | 17.0           | 0.041        |
| 50 - 100  | 50        | 1.190 | 1.44       | 0.2             | 19.0           | 0.037        |
| 100 - 200 | 100       | 1.161 | 0.77       | 0.13            | 35.0           | 0.045        |
| 200 - 400 | 200       | 1.118 | 0.69       | 0.1             | 38.0           | 0.038        |
| 400 - 800 | 400       | 1.039 | 1.00       | 0.093           | 25.0           | 0.023        |
| 800 - 200 | -         | 1.055 | -          | -               | -              |              |
| 200 - 50  | -         | 1.072 |            |                 | -              | -            |
| 50 - 12.5 | -         | 1.084 | -          | -               | _              | -            |
|           | _         | -     | -          | -               | -              | -            |
| -         | _         | _     | l <u>-</u> |                 | _              | _            |

**Test Methods:** 

One Dimensional Consolidation Test.

NZS 4402:1986 Test 7.1

Water Content

NZS 4402:1986 Test 2.1

Sample is saturated during test.

Load Increments applied at 1.66hr intervals

Tests Indicated as not accredited are

outside the scope of the laboratory

Date tested: 28 - 29/11/13 Date reported: 11/12/13

Testing is covered by IANZ Accreditation This report may only be reproduced in full

ACCREDITED LABORATORY

#### IANZ Approved Signatory

Thirushen Pillay

Designation:

Senior Civil Engineering Technician

Date: CSF 2120 (8/02) 11/12/13

Unit A, 7 Ride Way, Nth Harbour Private Bag 10-1982, N.S.M.C., Auckland, New Zealand

Page 1 of 2

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**Auckland Laboratory** Quality Management Systems Certified to ISO 9001

#### ONE DIMENSIONAL CONSOLIDATION PROPERTIES **Applied Pressure vs Void Ratio TEST REPORT**



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor:

**Not Stated** 

Subcontractor:

**Not Stated** 

Sample reference:

BH13/09, 6.0 - 6.5m

Specimen depth: 6.3 - 6.35 metres Date: 21/11/13

Sampled by:

Tom Van Deelen

Date received:

21/11/13

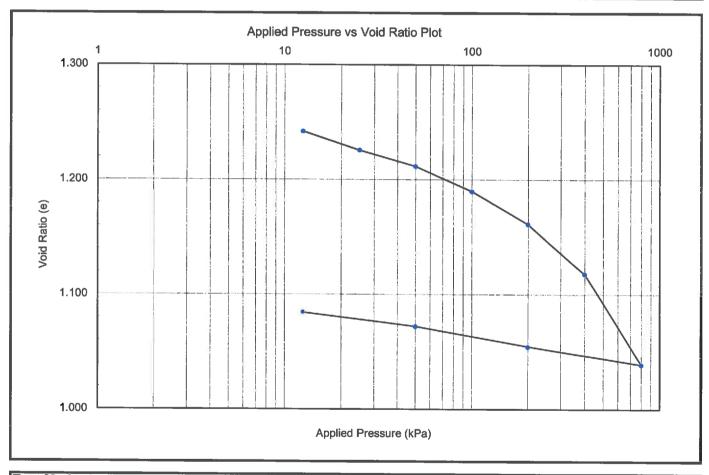
Sample description: Grey; Siltstone

Sampling method: Push Tube Sample condition: As received

**OEDOMETER APPARATUS No: S17C** 

Project No: 1-C0935.25 Lab Ref No: 008b/13

Folder No: SEC13/AU/050



| Test Method:                        |                        | Notes:                                      |
|-------------------------------------|------------------------|---|
| One Dimensional Consolidation Test: | NZS 4402:1986 Test 7.1 | Load Increments applied at 1.66hr intervals |
| Water Content:                      | NZS 4402:1986 Test 2.1 |   |
|                                     |                        |   |

Date tested:

28 - 29/11/13

Date reported:

11/12/13

Testing is covered by IANZ Accreditation This report may only be reproduced in full

**IANZ Approved Signatory** 

Thirushen Pillay

Designation 1

Senior Civil Engineering Technician

Date:

11/12/13

CSF 2120 (8/02)

**ACCREDITED LABORATORY** 

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

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Auckland Laboratory

Quality Management Systems Certified to ISO 9001

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Telephone +064 9 415 4660 Facsimile +064 9 415 4661 Website www.opus.co.nz

Page 2 of 2

#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Result Summary



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

6.35 - 6.5m

Sample Reference:

BH13/09

Sampled by:

Tom Van Deelen

Sampling Method:

**Push Tube** 

Description: Comments:

Grey; siltstone Multistage Test. Depth (m): 6.0 - 6.5

Date Sampled: 21/11/13

Project No:

1-C0935.25

Lab Ref No:

008a/13

Client Ref No:

Tom Van Deelen

| Result at Maximum |                |                     |                    | Back Pressure saturated at 350 kPa  |                                |  |                     |          |
|-------------------|----------------|---------------------|--------------------|---|--------------------------------|--|---------------------|----------|
| Specimen          | Effective      | INI                 | INITIAL PROPERTIES |   | Solid                          | FINAL PROPERTIES   |                     |          |
| Stage             | Confining      | Densit              | ies (t/m³)         | Water   | Particle                       |  | es (t/m³)           | Water    |
| No                | Pressure       | Wet                 | Dry                | Content   | Density                        | Wet  | Dry                 | -        |
|                   | (kPa)          | (t/m <sup>3</sup> ) | $(t/m^3)$          | (%)   | $(t/m^3)$                      | (t/m³)   | $(t/m^3)$           | Conten   |
| I                 | 75             | 1.80                | 1.31               | 37.8  | 10111                          | (7111)   | (Vm)                | (%)      |
| 2                 | 150            |                     | ]                  |   | 2.70                           |  |                     |          |
| 3                 | 300            |                     |                    |   | (assumed)                      | 1.89   | 1.36                | 39.0     |
| 0 :               |                |                     |                    |   |                                | 1.07   | 1.50                | 39.0     |
| Specimen          | Effective      |                     | Deg of Sa          | turation(Sr)  |                                |  |                     |          |
| Stage             | Confining      | Void                | Sr before          | Sr after  |                                | Values at Mayir  | num Stress Ratio    |          |
| No                | Pressure       | Ratio               | Consolid.          | Consolid  | S <sub>1</sub> -S <sub>3</sub> | m  |                     | rain     |
|                   | (kPa)          | (e)                 | (%)                | (%)   | (kPa)                          | (kPa)  |                     |          |
| 1                 | 75             | 1.06                | 96                 | 100   | 263.3                          | 7  |                     | %)<br>25 |
| 2                 | 150            |                     |                    | ]   | 370.9                          | 40   | 1                   |          |
| 3                 | 300            | <u>L</u>            |                    | j   | 439.1                          | 50   |                     | 18<br>21 |
|                   |                |                     |                    |   | 157.1                          | 30   | <u> </u>            | 21       |
| Specimen          | Effective      | Coefficient         | Volume             | Coefficient   | B at the                       |  |                     |          |
| Stage             | Confining      | of Consolidation    | Compressibility    | of Permeability   | start of                       | IANZ I   |                     |          |
| No                | Pressure       | Cv                  | Mv                 | k   | test                           |  | rsement does not in |          |
|                   | (kPa)          | (m²/year)           | (m²/MN)            | (m/s)   | iest                           | Cv, Mv and k values reported herein.  Mv & Cv calculated for the following condi |                     |          |
| 1                 | 75             | 5                   | 0.20               | 3.4E-10   | <del></del>                    |  |                     |          |
| 2                 | 150            | 4.7                 | 0.10               | 2.0E-10   | 96.00                          |  | +TOP+BOTTOM D       | rainage  |
| 3                 | 300            | 6.6                 | 0.080              | 1.7E-10   | il I                           | Side Filter drains   |                     |          |
|                   |                |                     | 0.000              | 1.72-10   |                                | (L/D= Sample Length/   | Diameter.)          |          |
|                   |                |                     |                    |   |                                |  |                     |          |
|                   | TOTA           | L STRESS RI         | ESIILT             |   | FIRE                           |  |                     |          |
|                   | Intercept d    |                     | (kPa)              |   | Interest II                    | TIVE STRESS  |                     |          |
|                   | Beta b         | - 1                 | (deg)              |   | Intercept d'                   | 79.23  | (kPa)               |          |
|                   | Cohesion c     |                     | (kPa)              |   | Beta b'                        | 17.22  | (deg)               |          |
|                   | Phi Æ          |                     | (kra)<br>(deg)     | ı   | Cohesion c'                    | 83   | (kPa)               |          |
|                   | Correl coeff   | 0.9477              | (deg)              |   | Phi Æ'                         | 18   | (deg)               |          |
|                   | 7 00101        | 0.5477              |                    |   | Correl coeff                   | 0.9155   | r <sup>2</sup>      |          |
| est Methods       |                | _                   |                    | NI-4  |                                |  |                     |          |
| riaxial Test      | In House       |                     |                    | Notes:  |                                |  |                     |          |
| ased On:          | 750 4400 400 4 |                     |                    | Cv and Mv have been rounded to 2 significant figures.  L/D= Sample Length/Diameter. |                                |  |                     |          |

Date Tested:

26/11/13 - 29/11/13

Date Reported:

10/12/13

Date: 10/12/13

IANZ Approved Signatory:

Designation: Thirushen Pillay- Senior Civil Engineering Technician

CSF 2130 (6/99)

Opus International Consultants Ltd

Auckland Laboratory

Quality Management Systems Certified to ISO 9001

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Shore City 0745, New Zealand

Page 1 of 8 Telephone +64 9 415 4660

Facsimile +64 9 415 4661 Website www.opus.co.nz

#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION **Test Report - Mohr Coulomb Envelope Plot**



Project:

Manuka Reservoirs

Location :

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): Sample Reference:

6.35 - 6.5m

BH13/09

Sampled by:

Tom Van Deelen

Sampling Method: Description: Comments:

Push Tube

Grey; siltstone Multistage Test. Depth (m): 6.0 - 6.5

Date Sampled: 21/11/13

Project No:

1-C0935.25

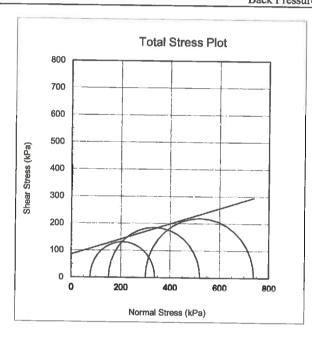
Lab Ref No:

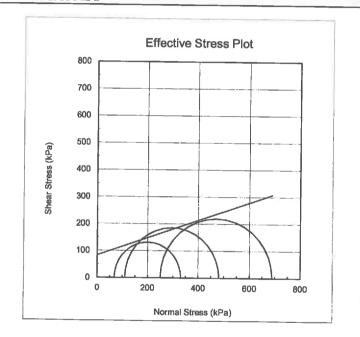
008a/13

Client Ref No:

Tom Van Deelen

#### Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT Mohr-Coulomb envelope plots Result at Maximum Stress Ratio Back Pressure Saturated at 350 kPa





| TOTAL STRESS RESULT |        |                |  |  |
|---------------------|--------|----------------|--|--|
| Intercept d         | 81.79  | (kPa)          |  |  |
| Beta b              | 15.34  | (deg)          |  |  |
| Cohesion c          | 85     | (kPa)          |  |  |
| Phi Æ               | 16     | (deg)          |  |  |
| Correl coeff        | 0.9477 | $\mathbf{r}^2$ |  |  |

| EFFECTIVE STRESS RESULT |        |                |  |  |  |
|-------------------------|--------|----------------|--|--|--|
| Intercept d'            | 79.23  | (kPa)          |  |  |  |
| Beta b'                 | 17.22  | (deg)          |  |  |  |
| Cohesion c'             | (kPa)  |                |  |  |  |
| Phi Æ'                  | 18     | (deg)          |  |  |  |
| Correl coeff            | 0.9155 | $\mathbf{r}^2$ |  |  |  |

| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

26/11/13 - 29/11/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Date: 10/12/13

CSF 2130 (6/99)

Designation: Thirushen Pillay- Senior Civil Engineering Technician

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Page 2 of 8

### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - P vs Q Total Stress Plot



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

6.35 - 6.5m

Sample Reference:

BH13/09

Sampled by:

Tom Van Deelen

Sampling Method:

Push Tube

Description: Comments:

Grey; siltstone Multistage Test. Depth (m): 6.0 - 6.5 Date Sampled: 21/11/13

Project No:

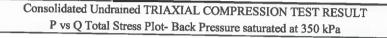
1-C0935.25

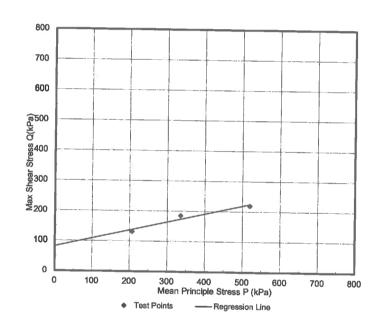
Lab Ref No:

008a/13

Client Ref No:

Tom Van Deelen





| TOTAL STRES  |        |                |
|--------------|--------|----------------|
| Intercept d  | (kPa)  |                |
| Beta b       | 15.34  | (deg)          |
| Correl coeff | 0.9477 | r <sup>2</sup> |
| Cohesion c   | 85     | (kPa)          |
| Phi Æ        | 16     | (deg)          |

| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

26/11/13 - 29/11/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Opus International Consultants Ltd

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

Page 3 of 8

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#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - P' vs Q' Effective Stress Plot



Project:

Manuka Reservoirs

Location

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

6.35 - 6.5m

Sample Reference:

BH13/09

Sampled by:

Tom Van Deelen

Sampling Method:

**Push Tube** 

Description: Comments:

Grey; siltstone Multistage Test. Depth (m): 6.0 - 6.5

Date Sampled: 21/11/13

Project No: Lab Ref No:

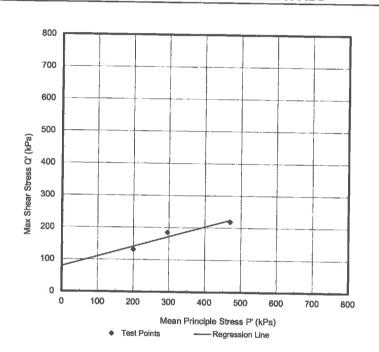
1-C0935.25

008a/13

Client Ref No:

Tom Van Deelen

#### Consolidated Undrained TRIAXIAL COMPRESSION TEST RESULT P' vs Q' Effective Stress Plot-Back Pressure saturated at 350 kPa



| EFFECTIVE STRESS RESULT |        |                |  |  |
|-------------------------|--------|----------------|--|--|
| Intercept d'            | 79.23  | (kPa)          |  |  |
| Beta b'                 | 17.22  | (deg)          |  |  |
| Correl coeff            | 0.9155 | r <sup>2</sup> |  |  |
| Cohesion c'             | 83     | (kPa)          |  |  |
| Phi Æ'                  | 18     | (deg)          |  |  |

| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

26/11/13 - 29/11/13

Date Reported:

10/12/13

Date: 10/12/13

IANZ Approved Signatory: Designation: Thirushen Pillay-Senior Civil Engineering Technician

Page 4 of 8

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Auckland Laboratory

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Shore City 0745, New Zealand

#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - PvsO Stress Path Plot



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m):

6.35 - 6.5m

Sample Reference:

BH13/09

Sampled by:

Tom Van Deelen

Sampling Method: Description:

Comments:

**Push Tube** 

Grey; siltstone Multistage Test. Depth (m): 6.0 - 6.5

Date Sampled: 21/11/13

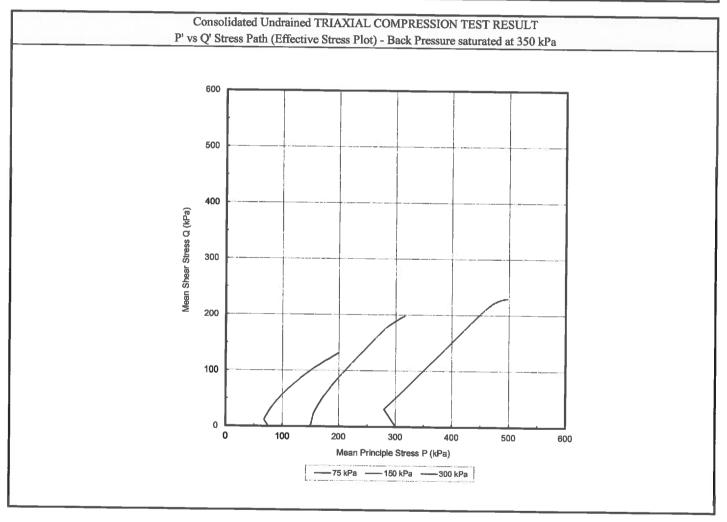
Project No: Lab Ref No:

1-C0935.25

008a/13

Client Ref No:

Tom Van Deelen



| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

26/11/13 - 29/11/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Date: 10/12/13

Designation: Thirushen Pillay-Senior Civil Engineering Technician

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Page 5 of 8

#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Strain vs Deviator StressPlot



Project:

Manuka Reservoirs

Location: Client:

Manuka Reservoirs

Specimen Depth(m):

Watercare Services Ltd c/o Opus International Consultants Ltd 6.35 - 6.5m

Sample Reference:

BH13/09

Sampled by:

Tom Van Deelen

Sampling Method: Description:

**Push Tube** 

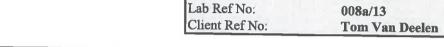
Comments:

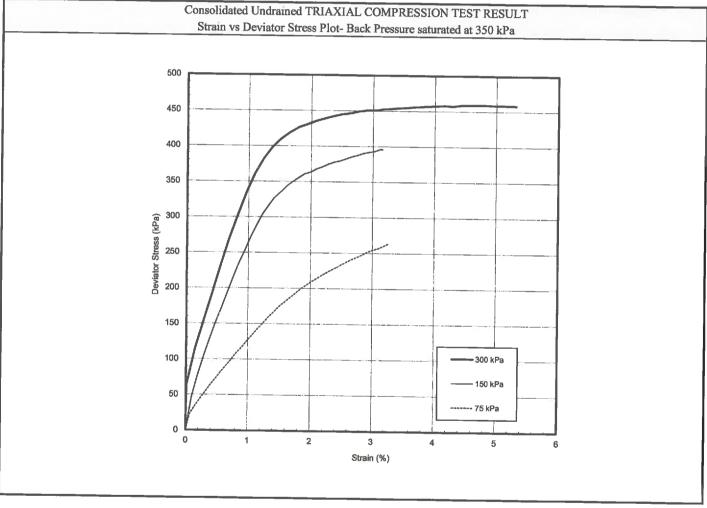
Grey; siltstone Multistage Test.

Depth (m): 6.0 - 6.5 Date Sampled: 21/11/13

Project No:

1-C0935.25





| Test Method   |                          | Notes |
|---------------|--------------------------|-------|
| Triaxial Test | In House                 |       |
| Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

26/11/13 - 29/11/13

Date Reported:

10/12/13

IANZ Approved Signatory: Designation: Thirushen Pillay- Senior Civil Engineering Technician

Date: 10/12/13

CSF 2130 (6/99)

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### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Test Report - Strain vs Pore Pressure Plot



Project: Manuka Reservoirs
Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 6.35 - 6.5m Sample Reference: BH13/09

Sampled by: Tom Van Deelen

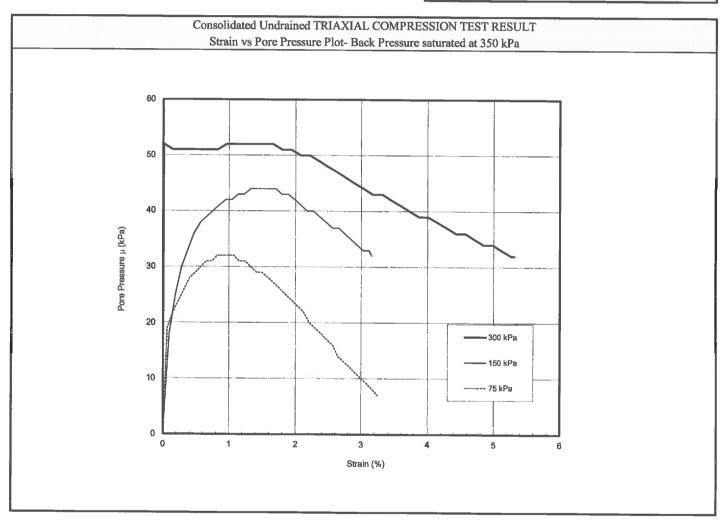
Sampling Method:
Description:
Comments:
Push Tube
Grey; siltstone
Multistage Test.

Depth (m): 6.0 - 6.5 Date Sampled: 21/11/13

Project No: 1-C0935.25

Lab Ref No: 008a/13

Client Ref No: Tom Van Deelen



|                                    | Test Method   |                          | Notes |
|------------------------------------|---------------|--------------------------|-------|
| Based On: NZS 4402:1986 Test 6.2.1 | Triaxial Test | In House                 |       |
|                                    | Based On:     | NZS 4402:1986 Test 6.2.1 |       |

Date Tested:

26/11/13 - 29/11/13

Date Reported:

10/12/13

IANZ Approved Signatory:

Date: 10/12/13

Designation: Thirushen Pillay- Senior Civil Engineering Technician

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Page 7 of 8

#### CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION Displacement vs Öt Plot (Consolidation stage)



Project: Manuka Reservoirs Location: Manuka Reservoirs

Client: Watercare Services Ltd c/o Opus International Consultants Ltd

Specimen Depth(m): 6.35 - 6.5m Sample Reference: BH13/09

Sampled by: Tom Van Deelen Sampling Method: **Push Tube** 

Description: Grey; siltstone Comments: Multistage Test.

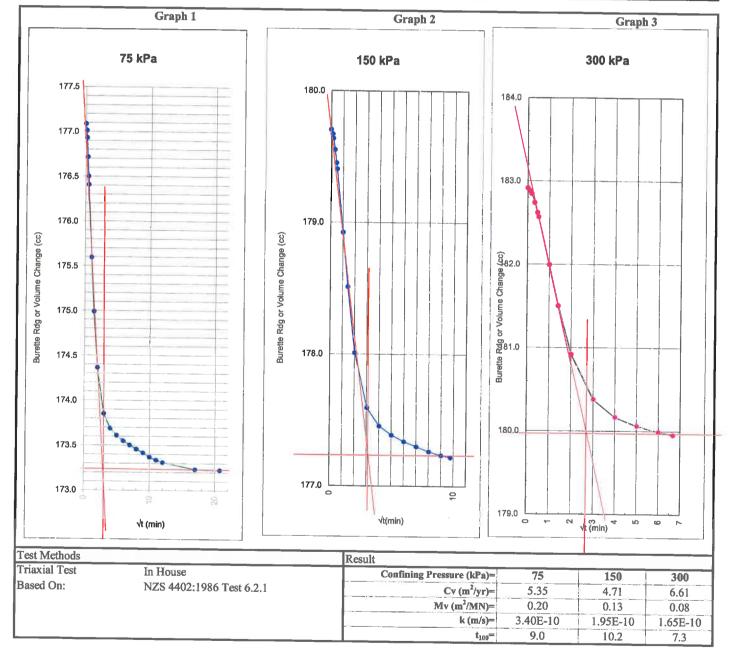
Depth (m): 6.0 - 6.5 Date Sampled: 21/11/13

Project No: Lab Ref No:

1-C0935.25 008a/13

Client Ref No:

Tom Van Deelen



Date Tested:

26/11/13 - 29/11/13

Date Reported:

IANZ Approved Signatory:

10/12/13

Designation: Thirushen Pillay-Senior Civil Engineering Technician

10/12/13



Telephone +64 9 415 4660 Facsimile +64 9 415 4661 Website www.opus.co.nz

Page 8 of 8

#### PLASTICITY INDEX TEST REPORT



Project:

Manuka Reservoirs

Location:

Manuka Reservoirs

Client:

Watercare Services Ltd c/o Opus International Consultants Ltd

Contractor:

**Not Stated** 

Sampled by:

Tom Van Deelen

Sampling method:

Core Sample

Sample description:

Grey; siltstone

Sample condition:

As received

Sample reference:

BH13/09

Sample depth:

9.45 - 9.65m

Project number:

Date sampled: 21/11/13

1-C0935.25

Lab ref number:

009/13

Client ref:

Tom Van Deelen

Folder number:

SEC13/AU/050

**Test Results** 

As rec'd water content:

44.3%

Liquid limit:

60

Plastic limit:

43

Plasticity Index:

17

| Test methods      |                          | Notes  |
|-------------------|--------------------------|--|
| Water Content:    | NZS 4402: 1986, Test 2.1 | Test performed on: Fraction passing 0.425mm test sieve     |
| Liquid Limit:     | NZS 4402: 1986, Test 2.2 | Sample descriptions are not covered by IANZ accreditation. |
| Plastic Limit:    | NZS 4402: 1986, Test 2.3 | Production of Mario according to the                       |
| Plasticity Index: | NZS 4402: 1986, Test 2.4 |  |

Date tested:
Date reported:

29/11/13 10/12/2013 Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

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**IANZ Approved Signatory** 

Thirushen Pillay

Designation:

Senior Civil Engineering Technician

Date:

10/12/2013

ACCREDITED LABORATORY

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

LAF-103 (19/02/13)

Page 1 of 1

Opus International Consultants Ltd

**Auckland Laboratory** 

Quality Management Systems Certified to ISO 9001

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Private Bag 101982, NS Mail Centre, North Shore City 0745, New Zealand

## Appendix G Contamination Testing Results



R J Hill Laboratories Limited 1 Clyde Street Private Bag 3205 Hamilton 3240, New Zealand Tel +64 7 858 2000 Fax +64 7 858 2001 Email mail@hill-labs.co.nz Web www.hill-labs.co.nz

### ANALYSIS REPORT

Page 1 of 2

SPv1

Client:

**OPUS International Consultants** 

Contact: Tom Van Deelen

C/- OPUS International Consultants

PO Box 5848 AUCKLAND 1141 

 Lab No:
 1200626

 Date Registered:
 07-Nov-2013

 Date Reported:
 18-Nov-2013

**Client Reference:** 

**Quote No:** 

Order No:

1-C095.25

Manuka Reservoirs 1-C0935

**Submitted By:** Tom Van Deelen

| Sample Type: Soil                            |                   |                             |                             |                             |                             |                             |
|--|-------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Sa   | mple Name:        | HA13/01-1.0m<br>04-Nov-2013 | HA13/01-3.0m<br>04-Nov-2013 | HA13/02-0.5m<br>04-Nov-2013 | HA13/02-2.0m<br>04-Nov-2013 | HA13/03-1.0m<br>04-Nov-2013 |
| ı  | _ab Number:       | 1200626.1                   | 1200626.2                   | 1200626.3                   | 1200626.4                   | 1200626.5                   |
| Individual Tests                             |                   |                             |                             |                             |                             |                             |
| Dry Matter                                   | g/100g as rcvd    | 64                          | 61                          | 75                          | 64                          | 64                          |
| Heavy metal screen level As,Cd               | ,Cr,Cu,Ni,Pb,Zn   |                             |                             |                             |                             |                             |
| Total Recoverable Arsenic                    | mg/kg dry wt      | < 2                         | < 2                         | < 2                         | < 2                         | < 2                         |
| Total Recoverable Cadmium                    | mg/kg dry wt      | < 0.10                      | 0.15                        | < 0.10                      | < 0.10                      | < 0.10                      |
| Total Recoverable Chromium                   | mg/kg dry wt      | 24                          | 24                          | 22                          | 24                          | 26                          |
| Total Recoverable Copper                     | mg/kg dry wt      | 12                          | 42                          | 7                           | 25                          | 34                          |
| Total Recoverable Lead                       | mg/kg dry wt      | 6.7                         | 8.9                         | 7.2                         | 6.1                         | 10.1                        |
| Total Recoverable Nickel                     | mg/kg dry wt      | 4                           | 27                          | 3                           | 8                           | 9                           |
| Total Recoverable Zinc                       | mg/kg dry wt      | 25                          | 97                          | 18                          | 39                          | 47                          |
| Polycyclic Aromatic Hydrocarbon              | ns Screening in S | oil                         |                             |                             |                             |                             |
| Acenaphthene                                 | mg/kg dry wt      | < 0.04                      | < 0.04                      | < 0.03                      | < 0.04                      | < 0.04                      |
| Acenaphthylene                               | mg/kg dry wt      | < 0.04                      | < 0.04                      | < 0.03                      | < 0.04                      | < 0.04                      |
| Anthracene                                   | mg/kg dry wt      | < 0.04                      | < 0.04                      | < 0.03                      | < 0.04                      | < 0.04                      |
| Benzo[a]anthracene                           | mg/kg dry wt      | < 0.04                      | < 0.04                      | < 0.03                      | < 0.04                      | < 0.04                      |
| Benzo[a]pyrene (BAP)                         | mg/kg dry wt      | < 0.04                      | < 0.04                      | < 0.03                      | < 0.04                      | < 0.04                      |
| Benzo[b]fluoranthene + Benzo[j] fluoranthene | mg/kg dry wt      | < 0.04                      | < 0.04                      | < 0.03                      | < 0.04                      | < 0.04                      |
| Benzo[g,h,i]perylene                         | mg/kg dry wt      | < 0.04                      | < 0.04                      | < 0.03                      | < 0.04                      | < 0.04                      |
| Benzo[k]fluoranthene                         | mg/kg dry wt      | < 0.04                      | < 0.04                      | < 0.03                      | < 0.04                      | < 0.04                      |
| Chrysene                                     | mg/kg dry wt      | < 0.04                      | < 0.04                      | < 0.03                      | < 0.04                      | < 0.04                      |
| Dibenzo[a,h]anthracene                       | mg/kg dry wt      | < 0.04                      | < 0.04                      | < 0.03                      | < 0.04                      | < 0.04                      |
| Fluoranthene                                 | mg/kg dry wt      | < 0.04                      | < 0.04                      | < 0.03                      | < 0.04                      | < 0.04                      |
| Fluorene                                     | mg/kg dry wt      | < 0.04                      | < 0.04                      | < 0.03                      | < 0.04                      | < 0.04                      |
| Indeno(1,2,3-c,d)pyrene                      | mg/kg dry wt      | < 0.04                      | < 0.04                      | < 0.03                      | < 0.04                      | < 0.04                      |
| Naphthalene                                  | mg/kg dry wt      | < 0.17                      | < 0.18                      | < 0.15                      | < 0.18                      | < 0.17                      |
| Phenanthrene                                 | mg/kg dry wt      | < 0.04                      | < 0.04                      | < 0.03                      | < 0.04                      | < 0.04                      |
| Pyrene                                       | mg/kg dry wt      | < 0.04                      | < 0.04                      | < 0.03                      | < 0.04                      | < 0.04                      |
| Sa   | ımple Name:       | HA13/03-3.0m<br>04-Nov-2013 |                             |                             |                             |                             |
|  | _ab Number:       | 1200626.6                   |                             |                             |                             |                             |
| Individual Tests                             |                   |                             |                             |                             |                             |                             |
| Dry Matter                                   | g/100g as rcvd    | 65                          | -                           | -                           | -                           | -                           |
| Heavy metal screen level As,Cd               | ,Cr,Cu,Ni,Pb,Zn   |                             |                             | 1                           |                             | 1                           |
| Total Recoverable Arsenic                    | mg/kg dry wt      | < 2                         | -                           | -                           | -                           | -                           |
| Total Recoverable Cadmium                    | mg/kg dry wt      | 0.11                        | -                           | -                           | -                           | -                           |
| Total Recoverable Chromium                   | mg/kg dry wt      | 30                          | -                           | -                           | -                           | -                           |
| Total Recoverable Copper                     | mg/kg dry wt      | 40                          | -                           | -                           | -                           | -                           |





This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.

The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked \*, which

| Sample Type: Soil                                  |              |                             |   |   |   |   |  |  |
|--|--------------|-----------------------------|---|---|---|---|--|--|
| Sa   | ample Name:  | HA13/03-3.0m<br>04-Nov-2013 |   |   |   |   |  |  |
|  | Lab Number:  | 1200626.6                   |   |   |   |   |  |  |
| Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn      |              |                             |   |   |   |   |  |  |
| Total Recoverable Lead                             | mg/kg dry wt | 6.7                         | - | - | - | - |  |  |
| Total Recoverable Nickel                           | mg/kg dry wt | 23                          | - | - | - | - |  |  |
| Total Recoverable Zinc                             | mg/kg dry wt | 81                          | - | - | - | - |  |  |
| Polycyclic Aromatic Hydrocarbons Screening in Soil |              |                             |   |   |   |   |  |  |
| Acenaphthene                                       | mg/kg dry wt | < 0.04                      | - | - | - | - |  |  |
| Acenaphthylene                                     | mg/kg dry wt | < 0.04                      | - | - | - | - |  |  |
| Anthracene   | mg/kg dry wt | < 0.04                      | - | - | - | - |  |  |
| Benzo[a]anthracene                                 | mg/kg dry wt | < 0.04                      | - | - | - | - |  |  |
| Benzo[a]pyrene (BAP)                               | mg/kg dry wt | < 0.04                      | - | - | - | - |  |  |
| Benzo[b]fluoranthene + Benzo[j] fluoranthene       | mg/kg dry wt | < 0.04                      | - | - | - | - |  |  |
| Benzo[g,h,i]perylene                               | mg/kg dry wt | < 0.04                      | - | - | - | - |  |  |
| Benzo[k]fluoranthene                               | mg/kg dry wt | < 0.04                      | - | - | - | - |  |  |
| Chrysene   | mg/kg dry wt | < 0.04                      | - | - | - | - |  |  |
| Dibenzo[a,h]anthracene                             | mg/kg dry wt | < 0.04                      | - | - | - | - |  |  |
| Fluoranthene                                       | mg/kg dry wt | < 0.04                      | - | - | - | - |  |  |
| Fluorene   | mg/kg dry wt | < 0.04                      | - | - | - | - |  |  |
| Indeno(1,2,3-c,d)pyrene                            | mg/kg dry wt | < 0.04                      | - | - | - | - |  |  |
| Naphthalene  | mg/kg dry wt | < 0.17                      | - | - | - | - |  |  |
| Phenanthrene                                       | mg/kg dry wt | < 0.04                      | - | - | - | - |  |  |
| Pyrene   | mg/kg dry wt | < 0.04                      | - | - | - | - |  |  |

#### SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

| Sample Type: Soil                                     |  |                         |           |  |  |  |
|---|--|-------------------------|-----------|--|--|--|
| Test  | Method Description   | Default Detection Limit | Sample No |  |  |  |
| Environmental Solids Sample<br>Preparation            | Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.                                   | -                       | 1-6       |  |  |  |
| Heavy metal screen level<br>As,Cd,Cr,Cu,Ni,Pb,Zn      | Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.   | -                       | 1-6       |  |  |  |
| Polycyclic Aromatic Hydrocarbons<br>Screening in Soil | Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis (modified US EPA 8270). Tested on as received sample. [KBIs:5786,2805,2695] | -                       | 1-6       |  |  |  |
| Dry Matter (Env)                                      | Dried at 103°C for 4-22hr (removes 3-5% more water than air dry), gravimetry. US EPA 3550. (Free water removed before analysis).                             | 0.10 g/100g as rcvd     | 1-6       |  |  |  |
| Total Recoverable digestion                           | Nitric / hydrochloric acid digestion. US EPA 200.2.  | -                       | 1-6       |  |  |  |

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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