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VOLUME 2



## **APPENDIX H**

Geotechnical Assessment, Tonkin and Taylor (2019)



**Geotechnical Assessment of  
Environmental Effects**

223 Kohimarama Road and 7 John  
Rymer Place, Auckland

Prepared for  
Ryman Healthcare Ltd

Prepared by  
Tonkin & Taylor Ltd

Date  
October 2019

Job Number  
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Ryman Healthcare Ltd

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## 1 Introduction

Tonkin & Taylor Ltd (T+T) have carried out this geotechnical effects assessment for the construction and operation of a comprehensive care retirement village ("Proposed Village") at 223 Kohimarama Road and 7 John Rymer Place, Kohimarama, Auckland ("Site").

To carry out this assessment, a geological/geotechnical ground model was developed based on site observations during walkovers, intrusive geotechnical site investigations and laboratory testing on selected samples.

Using the ground model, the geotechnical effects of the Proposed Village were assessed, and are presented in this report. The assessment has focused on the potential for slope instability and settlement due to groundwater drawdown and retention deformation, which were identified as the effects relevant to resource consent application.

Provided the recommendations provided in this report are followed, we conclude that in geotechnical terms the Site is suitable for the Proposed Village.

## 2 Proposed Village

The Proposed Village will comprise the following main buildings:

- A 6 level main building (B01) with communal amenities, serviced care suites, care beds and basement carparking;
- Three 5 level apartment buildings (B02, B04 and B06);
- Two 3 level apartment buildings (B03 and B05);
- A shared basement carpark/podium covering the footprint of buildings B02 to B06 with a bowling green.

A main accessway through from John Rymer Place to Kohimarama Road will be constructed between Building B01 and Buildings B02-B03.

The design and layout of the Proposed Village is presented in the architectural drawing set prepared by Beca and is described in detail in the Assessment of Environmental Effects. Further, the Civil Design Report by Beca details the earthworks and infrastructure services that will be required to construct and operate the Proposed Village. The Site will be earthworked and terraced to form building platforms, access roads and a gently graded site.

The approximate layout of the retaining walls and general basement footprints are shown in Figure 2-1. Detailed village drawings are presented in the Assessment of Environmental Effects (AEE).



Figure 2-1: Site general arrangement showing retaining walls and general basement footprint

### 3 Site description

The Site is shown in Figure 3-1, and described in more detail in the Assessment of Environmental Effects. In brief, the Site falls from Kohimarama Road towards the southeast, and has a series of undulations in the topography. At the western extent, the ground drops steeply (30 to 35°) into a valley that drains into the Orakei Basin. An old, flat playing field is located in the central area of the Site. The northern boundary is generally level with Selwyn College, except for an existing 60 m long, typically up to 1 m high, timber pole retaining wall. The southern and eastern boundaries are bounded by residential developments. A number of low retained height timber walls are constructed on neighbouring properties that are close to the Site boundaries.

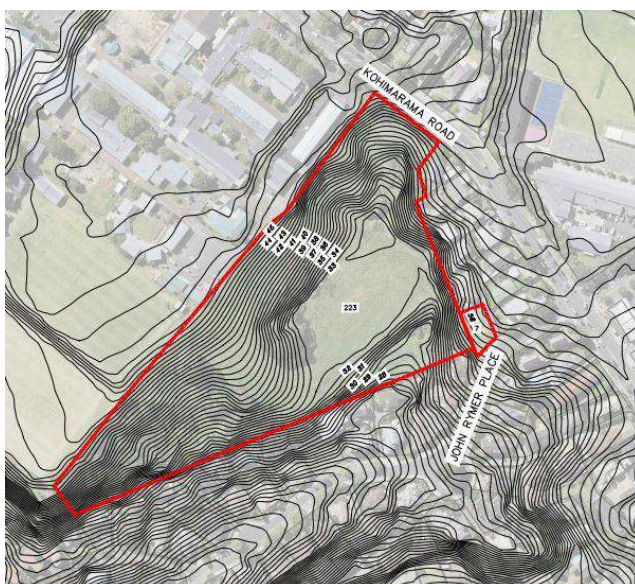


Figure 3-1 – Topographic contour of the Site (source: Auckland Council Geomaps Services)



A review of the historical development of the Site has been carried out, and included a review of aerial photographs<sup>1</sup> and historical geotechnical reports. The 1940 aerial stereopair shows a series of NW to SE trending drainage channels on the Site, likely to be influenced by the orientation and inclination of bedding in the underlying East Coast Bays Formation (“ECBF”) bedrock. Previously, these features have been assessed by others as being landslide headscarps features that would have significant implications for any proposed development at the Site. However, our current assessment includes site specific investigation and drilling and concludes that these features are likely to be drainage channels. The stability of these features are discussed in more detail in Section 5.

## **4 Existing environment – subsurface conditions**

### **4.1 General**

A geological and geotechnical ground model has been developed for the Site. This model is based on previous reports by other consultants, site observations during walkovers, intrusive geotechnical site investigations and laboratory testing on selected samples. The ground investigations completed by T+T as part of this report is outlined in Table 4.1. The investigation logs of the T+T investigations are presented in Appendix C, and additional detail relating to the development of the ground model is presented in Appendix D. Previous geotechnical assessments of the Site that have been carried out are presented in, with a more extensive discussion in Appendix E.

The subsurface conditions are predominantly ECBF rock and weathered rock (soil). Rockhead ranges from 10 m to 19 m below ground level, with the rock deepest beneath the existing playing field. Above the rockhead is weathered ECBF material, and the material transitions from rock to soil as it approaches ground level. Fill that is most likely to be surplus material from the field filling, is identified at the northern boundary of the Site. The flat area in the middle of the Site comprises an infilled gully that is formed of fill up to 9.4 m thick.

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<sup>1</sup> Refer to Appendix C for more details on year and source of aerial photographs

**Table 4.1: Summary of previous and current geotechnical assessments undertaken in the vicinity of the Site**

Report name	Consultant (Reference)	Investigation scope
Foundation completion report for St Johns College Trust Board, Gould Block	Harrison Grierson (1994) <sup>2</sup>	<ul style="list-style-type: none"> <li>Description of development works on properties 17/17A and 19/19A John Rymer Place adjacent to the Site</li> <li>18 boreholes (not available)</li> </ul>
Selwyn College – Proposed Subdivision	Babbage Consultants Limited (2001) <sup>3</sup>	<ul style="list-style-type: none"> <li>Aerial photograph assessment</li> <li>Slope stability assessment</li> <li>Five hand auger holes</li> <li>Measurement of groundwater levels</li> </ul>
223 Kohimarama Road – Geotechnical Assessment Report	AECOM NZ Limited (2016) <sup>4</sup>	<ul style="list-style-type: none"> <li>Geotechnical investigations comprising nine hand auger holes, seven machine excavator test pits, six machine cored drillholes, seventeen Cone Penetration Tests (CPTs) and five Dilatometer Tests</li> <li>Laboratory Testing</li> <li>Slope stability assessment</li> <li>Recommendations for earthworks and foundations for timber framed buildings</li> </ul>
Geotechnical effects report – 223 Kohimarama Road and 7 John Rymer Place, Kohimarama, Auckland	Tonkin + Taylor (This report)	<ul style="list-style-type: none"> <li>Six machine cored drillholes</li> <li>Sixteen Cone Penetration Tests</li> <li>Twenty hand auger holes</li> <li>Rising and falling head tests (permeability testing)</li> <li>Geotechnical effects assessment</li> </ul>

## 5 Slope stability assessment

There are geomorphological (topographical) features within the Site, which appear to have formed along bedding within the ECBF and indicate shallow bedding dipping towards the south-west and oblique to the slope which dips to the south east. These features indicate the possibility of historical slope instability, potentially deeper than a few metres, and have previously been assessed by others as potentially indicating deep-seated instability. If this were deep instability (more than 8-10 m depth), it would have significant implications for site development, and we have therefore considered these features in some detail.

Our assessment (refer Appendix D and E) concludes that these features are drainage channels as shown in Figure 5-1, rather than the result of deep slope instability. The features may indicate a mechanism (shown in Figure 5.2) by which material exposed at the toe of the channel was softened by weathering, which led to shallow (estimated at 5–9 m depth) slope instability (failure) along exposed bedding plane surfaces within the softened weathered material. The depth of the drainage channels is therefore interpreted to represent the minimum depth of the instability (i.e. where the bedding plane surfaces within the softened weather material is exposed). If instability does occur, the failures are assessed to manifest as localised, shallow failures.

<sup>2</sup> Harrison Grierson Consultants (1994), Foundation Completion Report

<sup>3</sup> Babbage Consultants Ltd (2001) Selwyn College – Proposed Subdivision, Babbage Consultants Limited

<sup>4</sup> AECOM (2016) Residential development and subdivision – 223 Kohimarama Road, Geotechnical Assessment Report

These shallow slope stability issues must be considered during detailed design of the Proposed Village, but with appropriate engineering are not expected to restrict the construction or operation of the Proposed Village. No slope stability adverse effects outside the Site boundaries are expected as a result of the Proposed Village.



Figure 5-1: 1940 aerial photograph showing the drainage channel features (left) and aerial photograph showing the position of these drainage channels in 2017 (right)

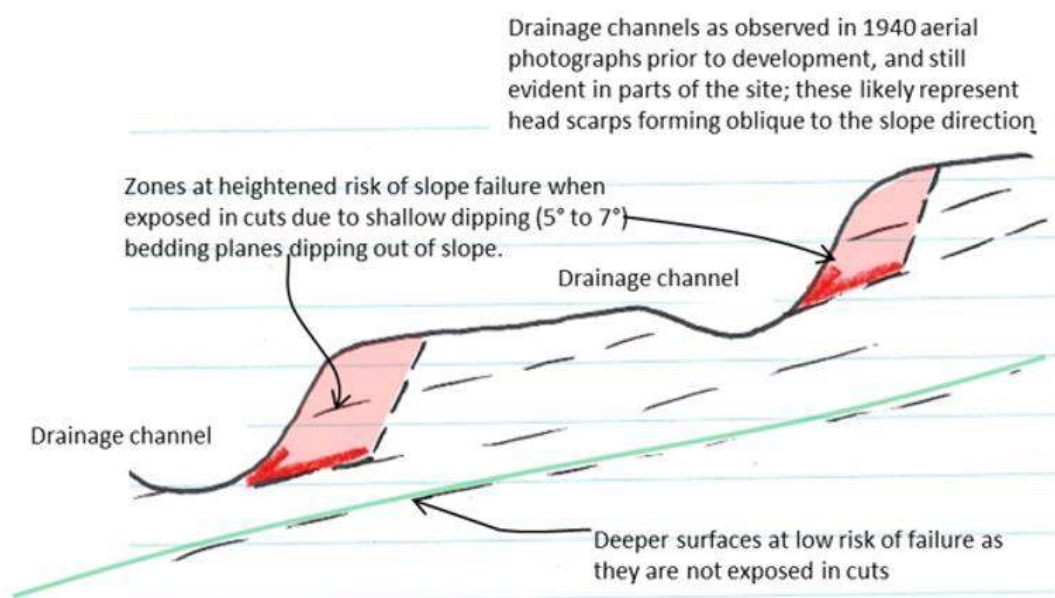


Figure 5-2: Sketch indicating potential slope movement mechanism and 1940 aerial photograph with drainage channels

## 5.1 Groundwater

A groundwater model has been developed for the Site based on geotechnical investigations and monitoring. The model development and factual supporting data are presented in Appendix D, Section D5. The groundwater level varies from summer to winter.

On the lower part of the Site, measured groundwater levels typically range from 1.5 to 10.0 Metres Below Ground Level (“**mbgl**”), and are generally within 4 m of the ground surface. On the slope along the northern boundary close to the ridgeline, piezometers indicate groundwater levels ranging from 4.0 to 9.9 mbgl. The groundwater regime appears to be generally hydrostatic at the Site (rather than a series of perched water tables).

## 6 Planning context

The planning context for the Site and the Proposed Village is addressed in the Assessment of Environmental Effects. In a geotechnical context, we understand that the relevant effects to be considered are:

- The potential for construction (excavation and retention) of the Proposed Village to affect adjacent land. A number of retaining walls are planned near Site boundaries and their effects to adjacent land and structures are assessed;
- Natural hazards that may affect the Proposed Village and adjacent land, specifically slippage, falling debris, subsidence, earthquake shaking and liquefaction/lateral spreading;
- The potential for construction works to affect the groundwater regime at the Site and consequently adjacent land.

In assessing these effects, we have considered the objectives and policies relevant to natural hazards (E36.2 and E36.3), and the objectives, policies and assessment criteria relevant to the diversion of groundwater (E2.3.(23) and E7.8.2(10)), which are set out in the Assessment of Environmental Effects. Our assessment methodology and results are presented in more detail below.

## 7 Assessment methodology

In order to assess the effects of the Proposed Village, the following methodology was adopted.

A geological and geotechnical ground model for the Site was progressively developed. An initial concept was prepared on a review of aerial photographs, geological maps, our internal geotechnical database, and previous investigations available for the Site. Based on this, and considering the proposed land use, a geotechnical investigation was then carried out. This included boreholes, cone penetration testing, geological mapping and assessment, and groundwater monitoring work. The ground model was then finalised and is summarised in Section 4 of this report.

Following the development of the subsurface model, the Proposed Village has been considered in the context of the subsurface conditions. In carrying out this work, we liaised with other experts (including Structural Engineers) and Ryman to understand the likely foundation and geotechnical requirements for the Proposed Village. The underlying ECBF bedrock generally provides a suitable founding layer for transferring structural loads from larger buildings.

The effects of the Proposed Village have then been assessed based on our experience with similar foundation systems and construction, in the context of the subsurface model and proposed geometry and structural form. The results of that assessment are set out below.

## **8 Assessment of geotechnical effects**

### **8.1 Seismic and liquefaction**

The seismic subsoil class has been assessed in terms of NZS 1170.5: 2004, Section 3.1.3<sup>6</sup>. On the basis of the Site investigation results, the Site is assessed as Site Class C (“shallow soil site”).

The clayey silt residual ECBF soils around Auckland are generally not considered to be at risk of liquefaction due to its high fines content. The fill beneath the playing field appears to be reworked ECBF soils and also has a high fines content. Geomorphological site observations also suggest that historical liquefaction has not occurred based on the Site topography.

Based on these observations and experience, liquefaction is not assessed as a consequential issue that requires specific design consideration at this Site.

### **8.2 Slope stability**

As outlined in Section 5, the risk of instability at the Site has been assessed based on a review of the existing historical geotechnical data, aerial photography, geological walkover inspections and a review of the borehole core from the completed machine-drilled boreholes. Based on the available observations and analyses, retaining walls will need to be designed to support lateral loads where potential shear surfaces are encountered in excavations.

The existing and proposed slopes have calculated factors of safety that meet normally accepted criteria. Therefore, there is no credible risk of slippage affecting adjacent sites provided normal engineering approaches to retention and construction sequencing are adopted during the construction of the Proposed Village. Refer to Appendix E for more details.

### **8.3 Settlement due to earthworks**

A high level assessment of ground settlement due to earthworks has been undertaken. We do not consider settlement to be a material concern to land outside the Site boundaries on the basis that no significant depths of soft and compressible materials have been identified within the Site, except towards the south and near the south-eastern boundary where deep fill is identified. Given the proposed filling and building layouts are well within the Site boundaries, the risk of the Proposed Village causing settlement outside the Site boundaries is assessed as negligible.

### **8.4 Groundwater drawdown settlement effects**

We have assessed the groundwater effects of the Proposed Village on the basis that a drained basement system is adopted. A drained basement system assumes any groundwater intercepted by the excavation will be lowered to around the excavation level by drainage installed behind the walls and floor slabs. The excavation of the proposed basements generally does not fall below the seasonal groundwater low points. However, at two locations within the Site (at the NE corner of B01 Level 2 and NE corner of B01 Level 0), the seasonal low groundwater level could be drawn down by around 2 m (during construction and operation). We have assessed the extent of influence of the drawdown, and conclude that it will not extend to the Site boundaries (and in any case the settlement effects are assessed to be less than 10 mm). Appendix F presents additional details of the assessment.

The proposed driveway excavation and retention is located above the lowest measured seasonal groundwater level and therefore is not assessed to result in groundwater drawdown induced settlement.

The risk of the Proposed Village causing groundwater induced settlement outside the Site boundaries is therefore assessed as negligible.

Walls and basements are likely to intercept groundwater when groundwater levels rise above the basement floor level. The groundwater inflow rate due to the excavation of the basement is estimated to be between 2 and 15 m<sup>3</sup>/day. The intercepted groundwater will be directed to the nearest manhole to be discharged offsite. The groundwater drawdown settlement effects assessments are presented in more detail in Appendix F.

The Proposed Village is expected to intercept groundwater during winter, but with negligible effects off the Site.

## 8.5 Retaining wall deflection settlement effects

We have carried out an assessment of the potential retaining wall effects outside the Site. The significant retaining walls are shown on Figure 8-1. For the purposes of this assessment, we have assessed the walls as being predominantly cantilevered reinforced concrete (RC) bored piles and as described in Table 8.1.

The effects assessed are based on the wall concepts presented, noting that engineering elements may be refined or modified during detailed design. If that occurs, the effects will be at least equivalent to the options discussed here. An example may be refining the spacing, depth or materials makeup of the retention (structural) system, while maintaining the facing system. This flexibility in engineering elements is required, as detailed design clarifies construction sequencing and any interaction between the buildings and the retaining walls (i.e. independent, or integral retention and basement walls).

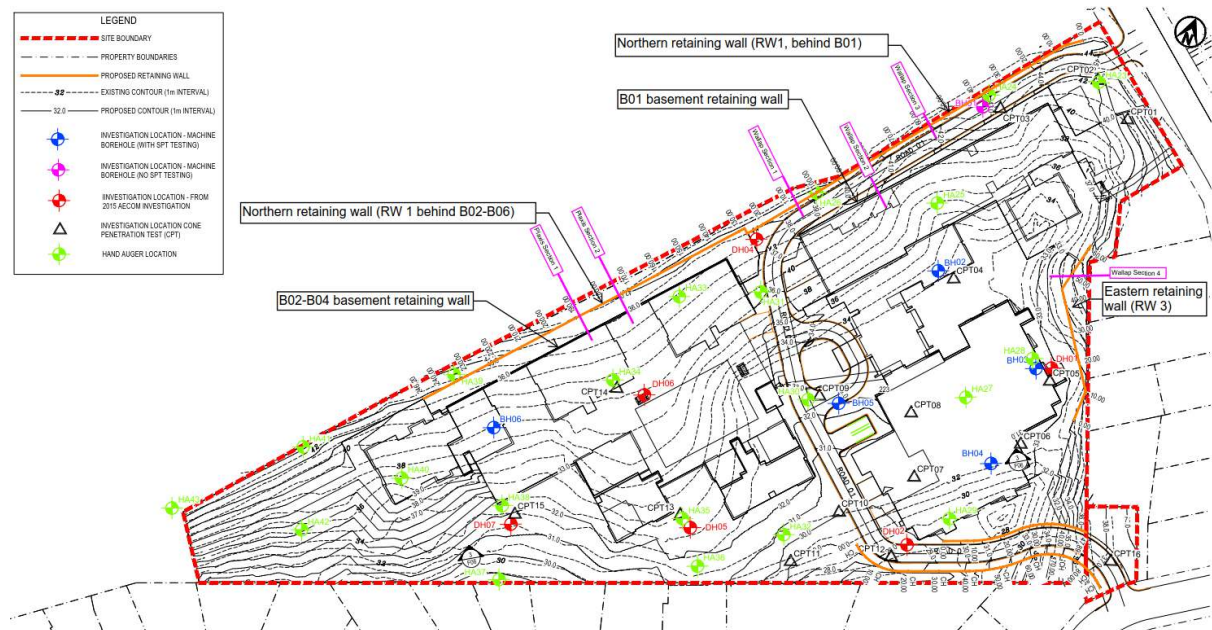
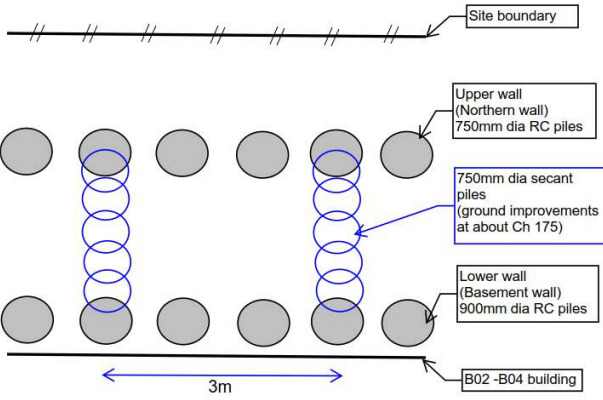


Figure 8-1 – Location of significant retaining walls

**Table 8.1: Description of proposed retaining walls at the Site**

Location	Description	Permanent retaining height of walls
Northern retaining wall near the Selwyn College boundary (Also known as RW1 in the Beca Civils drawings)	<p>The wall can be divided into two sections:</p> <p><u>1 -The northern wall behind B02, B04 &amp; B06</u></p> <p>Comprises 750 mm dia reinforced concrete piles (RC) at 1.5 m c.c to support the excavation upslope of the garden walkway behind B02, B04 &amp; B06</p> <p>At about Ch175, a row of 750 mm dia secant piles will be installed in between the upper and lower RC walls at 3 m centres to limit deflections and settlement in front of the light weight storage garage in Selwyn College land. (refer to figure below)</p>  <p><i>Figure 8-2 – Plan view showing ground improvement arrangements at Ch 175</i></p> <p><u>2 -The northern wall behind B02, B04 &amp; B06</u></p> <p>Wall is located upslope of the accessway behind B01 and comprises:</p> <ul style="list-style-type: none"> <li>• 900 mm cantilevered RC piles at 1 m c.c where retaining heights are between 4 and 6.2 m.</li> <li>• 450 mm dia cantilevered timber pole wall at 1 m c.c will retain soils that are less than 4 m high.</li> </ul>	Up to 4 m high but typically less than 3 m.
B02 and B04 basement wall, near the Selwyn College boundary	Comprises 900mm dia reinforced concrete piles at 1.5m c.c to support the two-level basement excavation. The basement wall will be at least 6 m away from the Northern retaining wall	Up to 6 m high.
B01 basement wall, near the Selwyn College boundary	Partial retention of the basement at the northern side of Building B01. The wall comprises 900 mm dia cantilevered RC piles at 1 m c.c. This wall is at least 10 m away from the northern retaining wall.	Between 3 to 5.5 m high
Eastern retaining wall located at the boundary to: - 3A John Rymer Place,	The wall comprises 450 mm dia cantilevered timber piles at 1.2 m c.c. This wall is between 0 and 2 m away from the boundary.	Up to 2.5 m high

- 249A Kohimarama Rd - 297A Kohimarama Rd (Also known as RW3 in the Beca Civils drawings)		
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A more detailed analysis of retaining walls that may induce mechanical deformation and settlement outside the Site has been assessed and is presented in Appendix G. The outcome is summarised as follows:

- The proposed northern retaining wall along the Selwyn College boundary will cause deformation effects outside the Site in localised places.
- The wall is typically 3 m in height, but has a localised area that is up to 6.1 m high (Chainage 108 to 126, and as shown on Figure 30314.0001-F8 in Appendix G).
- Deformations from the highest section of the cantilevered wall are likely to be in the order of 75 mm at the boundary, and reducing further back from the wall. At the critical location, there is an approximately 3 m grass verge on the neighbouring property, then an access road, then buildings at least 10 m from the boundary.
- This level of wall deformation is assessed as having a very low risk of adverse effects to Selwyn College buildings with less than 10 mm of settlement assessed.
- The access road may experience settlements of typically less than 30 mm, with differential settlement of up to 1 in 400. There is therefore a risk of some lateral and vertical deformation of the driveway surface. This could lead to new cracks or degradation from the existing condition. If they manifest, the cracks are likely to be observed running parallel to the boundary and could reduce the service life of the driveway. Any cracks that occur during construction of the retaining wall can be resealed. We are not aware of any services in the driveway that could be affected.
- Around Chainage 172 to 178, there is a light weight garage structure at around 4 m from the boundary. We have assessed the risk of deformation to the structure considering the setbacks and considering the likely proposed retention systems of the northern retaining wall (RW1 with ground improvements). We consider that any deformation that occurs is likely to be significantly less than deformation associated with seasonal shrink/swell effects (i.e. less than 5-10 mm of movement). Given the nature of the Selwyn College building (lightweight storage garage), we assess the risk of adverse effects to the building to be very low.
- We expect there to be less than 40 mm of estimated settlement at the boundary to the grass verges and fields at Selwyn College. The grass verge is located at the boundary while the fields are at 7 m away from the boundary. We assess no adverse settlement effects to the grass verge and fields that would restrict the use of the field (noting that deformation of the ground of up to 40 mm could occur, with associated settlement). There could be some movements at the boundary wire fence up to 40 mm that is likely to be restricted to tilting and undulation along the fence. The majority of the deflection and settlement will occur during construction of the northern wall. We expect the fence will be repairable once wall construction is complete.
- Retaining walls up to a single basement level for B01 (typically 3.5 m high) are more than 5 m away from the boundary. Accordingly, the risk of effects at the boundary is assessed as negligible.



## 9 Recommendations

The following recommendations address the potential adverse effects outlined in the report:

- The design of retention and earthworks at the Site shall consider the potential for shear surfaces to be present in the upper materials.
- The retaining walls shall be designed to limit deflection to the values set out in Table 9-1.
- Ryman should engage with Selwyn College in relation to monitoring and repairing any retaining wall deflection deformation and settlement effects. If a private agreement is not reached, a Construction Monitoring and Contingency Plan shall be prepared outlining the Alert and Alarm trigger levels during construction phase along the northern boundaries. The plan should include mitigation and contingency measures in the event that the Alert and Alarm levels are triggered during Construction. The recommended alert and alarm ground and building settlement of the land above the walls are outlined in Table 9-2. The location of the settlement and retaining wall pins are presented in Figure F10 in Appendix H.

**Table 9-1: Proposed Alert and Alarm levels for retaining wall pins**

Boundary	Retaining Wall Monitoring point (RTW)	Design limits	Construction	
		Deflection limits (mm)	Alert trigger level (mm)	Alarm trigger level (mm)
Northern Boundary	RTW 1-RWT4, RTW6, RW7	65	45	65
	RW5	20	15	20
	RTW8 to RTW10	75	55	75
	RTW11 to RTW13	45	30	45
	RTW15 To RTW17, RTW19-RTW 20	60	40	60
	RTW18	20	15	20
	RTW21 to RTW26	40	30	40

**Table 9-2: Proposed Alert and Alarm levels for ground and building settlement**

Mark ID	Comment	Settlement Alert Level (mm)	Settlement Alarm Level (mm)	Differential Settlement Alert Level	Differential Settlement Alarm Level
<b>Ground Settlement Pins</b>					
GS 1 to GS 13	Northern boundary	20	30	1:750	1:400
<b>Building Survey Pins</b>					
BS1, BH3, BH5	Selwyn College (>10m from boundary)	8	10	1:750	1:1000
BS2 and BS4, BS6 to BS11	Selwyn College (<5m from boundary)	8	10	1:750	1:1000

## 10 Conclusions

Provided the detailed design reflects the recommendations in this report, we assess:

- The Proposed Village excavations and retention are not expected to have any consequential effects on adjacent land, although some retaining walls proposed along the Selwyn College boundary are likely to induce some mechanical movement of soil;
- The Proposed Village is not assessed as likely to be at risk of being affected by slippage, falling debris, or subsidence. There is little to no risk of liquefaction or lateral spreading affecting the Village.
- The proposed excavations and retention are likely to encounter groundwater at times, but are set back sufficiently far from the boundary that no consequential adverse groundwater drawdown effects are expected outside the Site.
- Provided the recommendations provided in Section 8 are followed, we conclude that in geotechnical terms the Site is suitable for the Proposed Village.

## 11 Applicability

This report has been prepared for the exclusive use of our client Ryman Healthcare Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that this report will be submitted as part of an application for resource consent and that Auckland Council as the consenting authority will use the report for the purpose of assessing that application.

Tonkin & Taylor Ltd

Report prepared by:

.....  
Prisca Tang  
Geotechnical Engineer

Authorised for Tonkin & Taylor Ltd by:

.....  
Pierre Malan  
Project Director

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## **Appendix A: Concept Drawings**

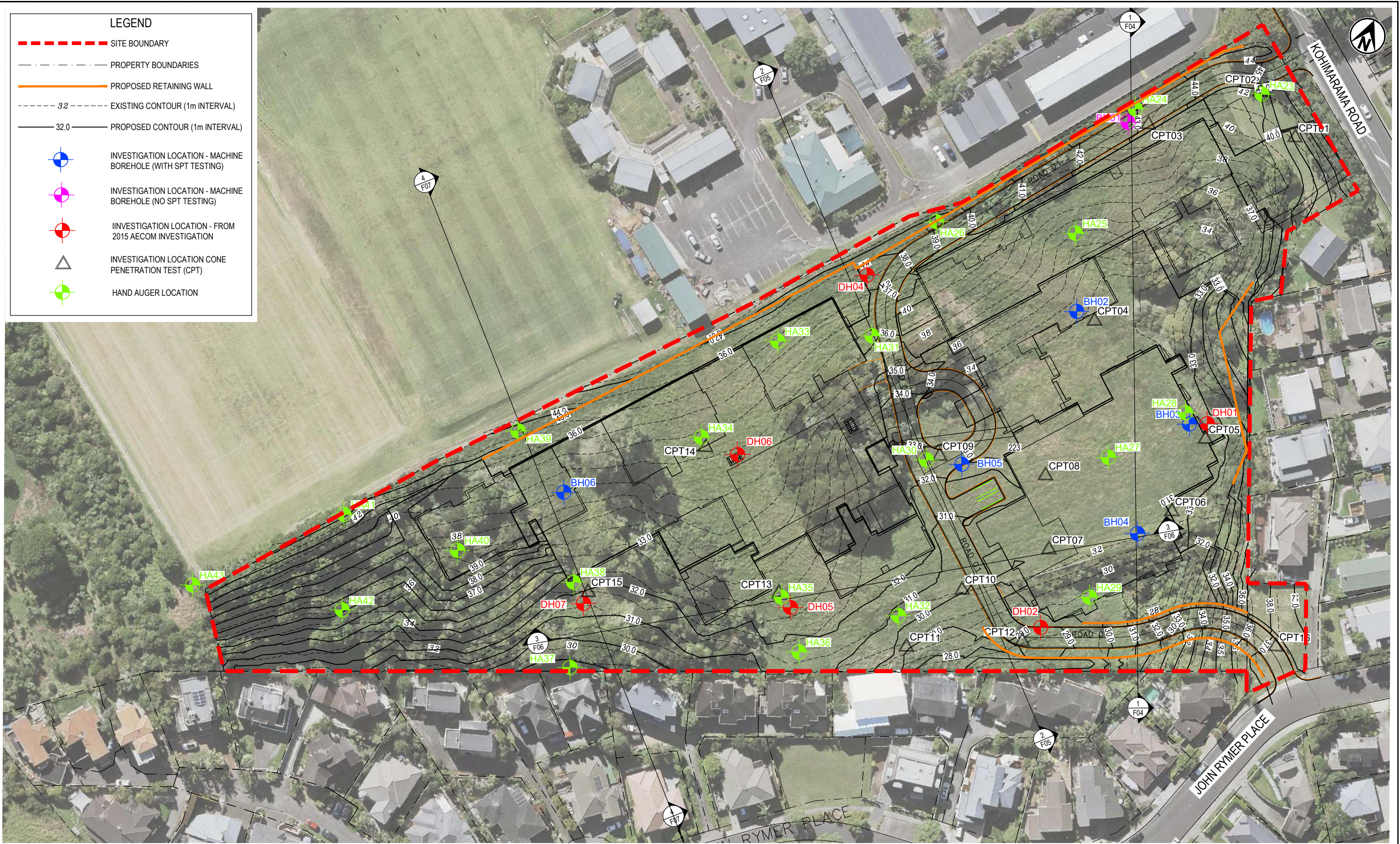
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- Refer to the Detailed Village Drawings in the Assessment of Environmental Effects (AEE)

## **Appendix B: T+T Investigation Location Plan and Geological Sections**

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- **Figure 3: Investigation location plan**
- **Figure 4 and 7: Geological sections**

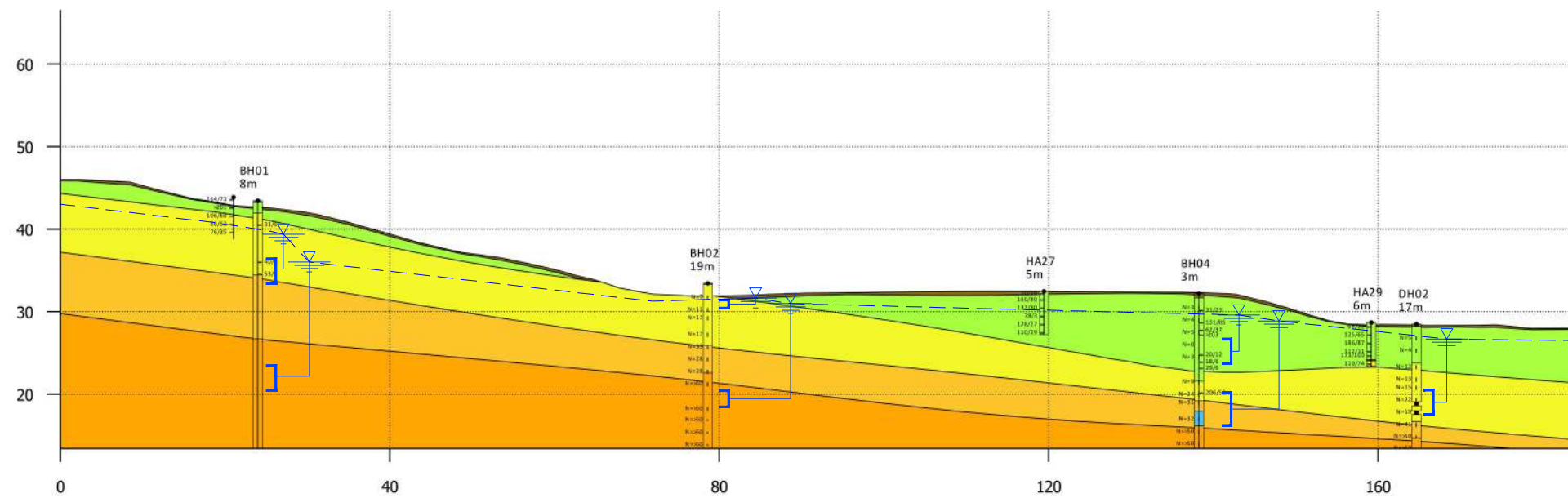


**SITE PLAN**  
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- NOTES:
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  2. BASEPLAN SUPPLIED BY BECA. REF " 3124460-221-Architect layout.dwg" DATED AUG 08 2019.
  3. EXISTING CONTOUR SUPPLIED BY BECA. REF " 3124460-221-EX Topo.dwg" DATED AUG 08 2019.
  4. PROPOSED CONTOUR SUPPLIED BY BECA. REF " 33124460-221-PR Contours.dwg" DATED AUG 08 2019.

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DRAWN	KMJA	Oct.18
CHECKED		
APPROVED		DATE

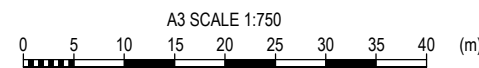
CLIENT	<b>RYMAN HEALTHCARE LIMITED</b>
PROJECT	<b>RYMAN SITE 3 - GEOTECHNICAL INVESTIGATION</b>
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FIG No.	30314.0001-F3
REV	2



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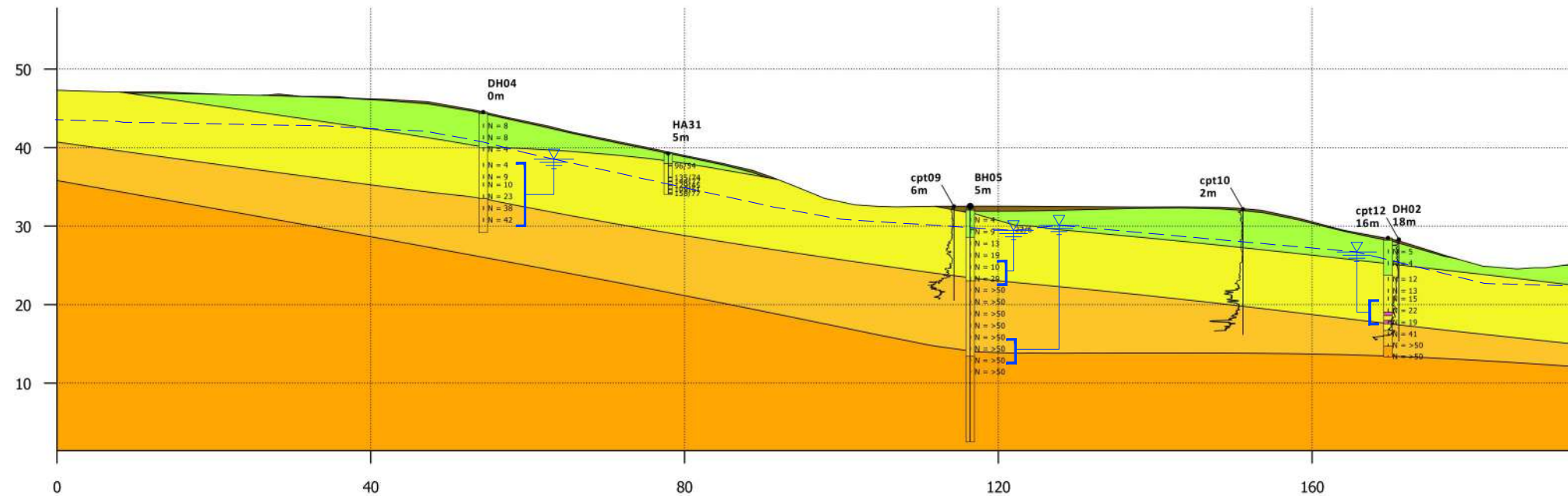
**LEGEND**

- TOPSOIL
- FILL
- ECBF RESIDUAL
- ECBF WEATHERED
- ECBF UNWEATHERED
- CORELESS
- SOFT ZONE
- INFERRED GROUND WATER LEVEL
- MEASURED GROUND WATER LEVEL
- PIEZOMETER RESPONSE ZONE



ORIGINAL IN COLOUR

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APPROVED	DATE	SCALE (A3) 1:750
		FIG No. FIGURE 4
		REV 1

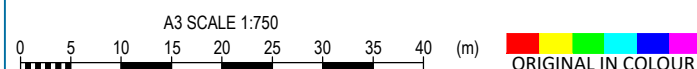


SECTION 2  
SCALE 1: 750  
F03

**LEGEND**

- TOPSOIL
- FILL
- ECBF RESIDUAL
- ECBF WEATHERED
- ECBF UNWEATHERED
- CORELESS
- SOFT ZONE
- INFERRED GROUND WATER LEVEL
- MEASURED GROUND WATER LEVEL
- PIEZOMETER RESPONSE ZONE

NOTES:  
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.



PROJECT No. 30314.1000

DESIGNED	KMJA	Nov.18
DRAWN		
CHECKED		

CLIENT **RYMAN HEALTHCARE LIMITED**  
PROJECT **RYMAN SITE 3 - GEOTECHNICAL INVESTIGATION**

TITLE 223 KOHIMARAMA ROAD AND 7 JOHN RYDER PLACE  
GEOLOGICAL CROSS SECTION 2

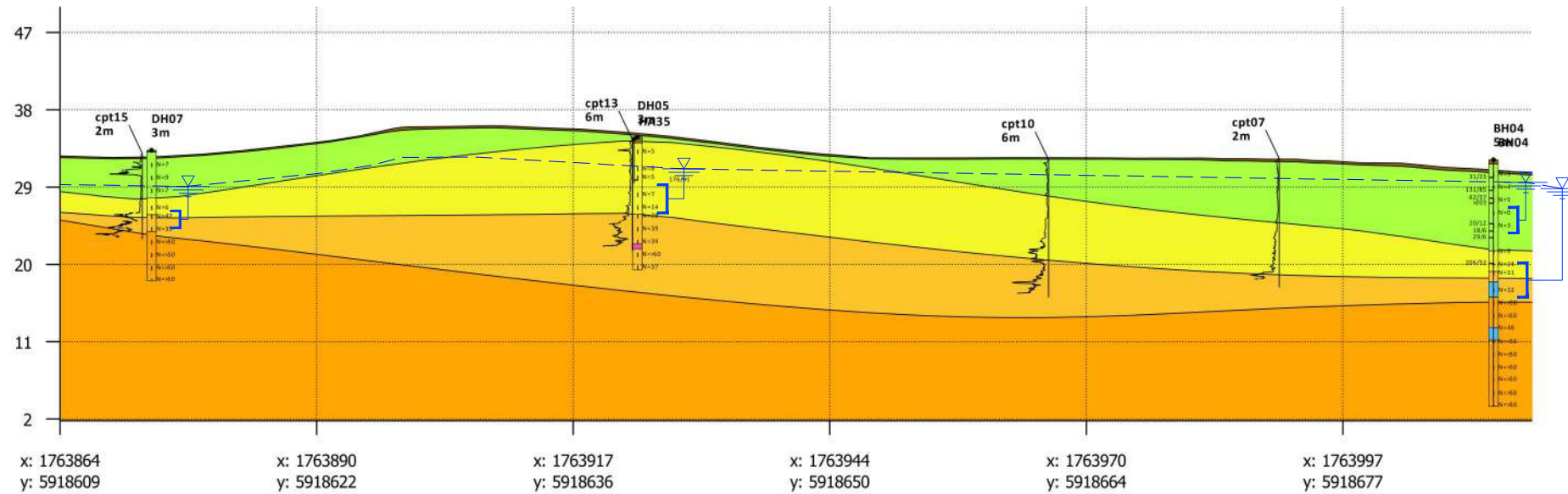
APPROVED DATE

SCALE (A3) 1:750

FIG No. FIGURE 5

REV 1





SECTION 3  
SCALE 1: 750

**LEGEND**

- TOPSOIL
- FILL
- ECBF RESIDUAL
- ECBF WEATHERED
- ECBF UNWEATHERED
- CORELESS
- SOFT ZONE
- INFERRED GROUND WATER LEVEL
- MEASURED GROUND WATER LEVEL
- PIEZOMETER RESPONSE ZONE

NOTES:  
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.



PROJECT No. 30314.1000

DESIGNED	KMJA	Nov.18
DRAWN		
CHECKED		

CLIENT RYMAN HEALTHCARE LIMITED

PROJECT RYMAN SITE 3 - GEOTECHNICAL INVESTIGATION

TITLE 223 KOHIMARAMA ROAD AND 7 JOHN RYDER PLACE  
GEOLOGICAL CROSS SECTION 3

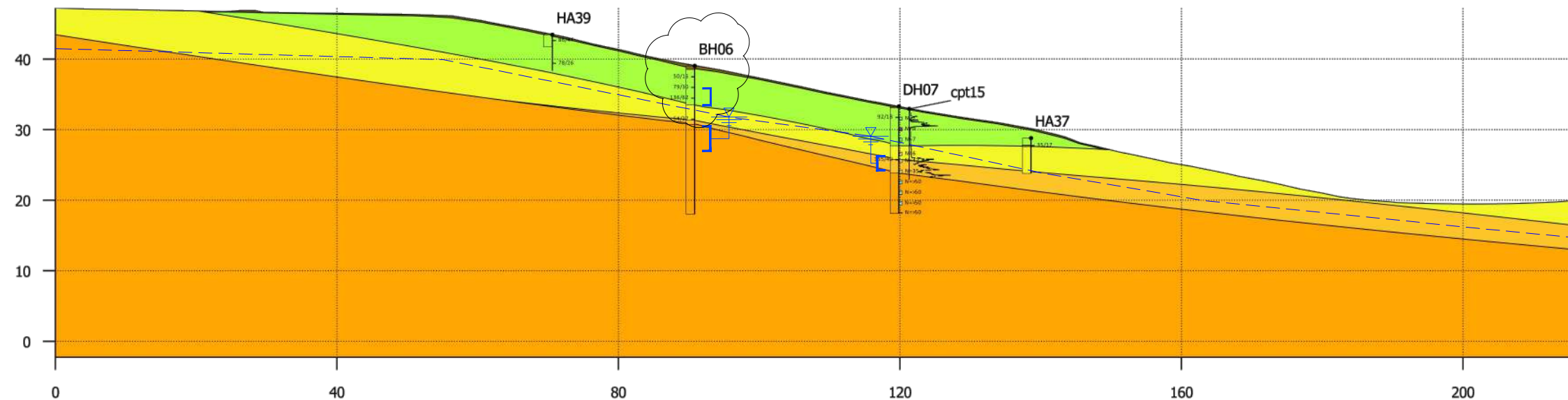
SCALE (A3) 1:750

FIG No. FIGURE 6

REV 1



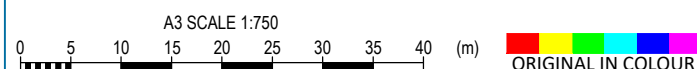




SECTION 4  
SCALE 1: 750 F03

LEGEND	
	TOPSOIL
	FILL
	ECBF RESIDUAL
	ECBF WEATHERED
	ECBF UNWEATHERED
	CORELESS
	SOFT ZONE
	INFERRED GROUND WATER LEVEL
	MEASURED GROUND WATER LEVEL
	PIEZOMETER RESPONSE ZONE

NOTES:  
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.



PROJECT No. 30314.1000

DESIGNED	KMJA	Nov.18
DRAWN		
CHECKED		

CLIENT RYMAN HEALTHCARE LIMITED  
PROJECT RYMAN SITE 3 - GEOTECHNICAL INVESTIGATION

TITLE 223 KOHIMARAMA ROAD AND 7 JOHN RYDER PLACE  
GEOLOGICAL CROSS SECTION 4

SCALE (A3) 1:750

FIG No. FIGURE 7

REV 1

## **Appendix C: Borehole logs, core photographs, hand augered borehole logs and CPTs**

---

- **BH01 log and core photographs**
- **BH02 log and core photographs**
- **BH03 log and core photographs**
- **BH04 log and core photographs**
- **BH05 log and core photographs**
- **Hand augered borehole logs**
- **CPT1 to CPT16**

## C1 Geotechnical Investigations

### C1.1 General

The T+T geotechnical site investigations comprised a total of 42 investigation locations. This included six fully cored machine (rotary cored) boreholes, 16 Cone Penetration Tests (CPTs) and 20 hand augers holes. Investigation locations are shown on the Site Investigation Plan (see Figure 3 in Appendix B).

### C1.2 Machine Drilled Boreholes

Five machine drilled boreholes (BH01 to BH05) were carried out across the Site between 8 October 31 and 24 October 2018 to depths of between 4.9 m and 30.0 m. An additional borehole (BH06) was undertaken between 6 and 11 November 2018 to 21.0 m depth. The boreholes were drilled by McMillan Drilling Ltd using a track mounted rotary core drill rig.

Boreholes were logged by an Engineering Geologist from T+T. Standard Penetration Tests (SPTs) were completed at approximately 1.5 m intervals (except in BH01 and BH06). Push tubes were collected from adjacent wash bored holes from within zones identified in the cored borehole. The Boreholes were drilled with PQ diameter (85 mm diameter core) in order to achieve better core recovery. Machine drilled boreholes were terminated in unweathered ECBF rock.

A borehole summary is presented in Appendix Table A. Borehole logs and core photographs are attached in Appendix C.

Standpipe piezometers were installed all boreholes (see Appendix Table A for details) to monitor groundwater levels across the Site. The standpipe piezometer installation records are shown on the borehole logs.

**Appendix Table A: Machine Drilled (rotary cored) borehole summary**

Borehole Reference	Estimated Ground Surface Elevation* (m)	Borehole Depth (m)	Diameter of Piezometer/s Installed (mm)	Screen depth Upper (Lower) (m)	Geological unit screened
BH 01	43.0	30.0	25 / 50	7.0 to 10.0 (20.0 to 23.0)	Upper: Fill Lower: ECBF Rock
BH 02	28.0	21.75	25 / 50	2.0 to 3.0 (13.0 to 15.0)	Upper: Residual Soils Lower: ECBF Rock
BH 03	32.0	30.09	25 / 50	3.0 to 4.0 7.0 to 10.5	Upper: Fill / Alluvium Lower: MW ECBF
BH 04	43.0	28.70	25 / 50	5.5 to 8.5 12.0 to 16.0	Upper: Fill Lower: MW ECBF
BH 05	32.0	21.13	25 / 50	7.0 to 10.0 17.0 to 20.0	Upper: Residual Soils Lower: MW ECBF
BH06	41.0	21.0	25 / 50	3.1 to 5.5 8.5 to 12.0	Upper: Residual Soils Lower: SW ECBF

\*Borehole elevations estimated based on Auckland Council GIS contour information

### C1.3 Cone Penetration Tests (CPTs)

Sixteen CPTs were completed on 5 February 2014. CPTs were completed by Perry Geotech Ltd. All CPT investigations were commenced at ground level (i.e. no pre-drill undertaken).

CPT outputs are presented in Appendix C. A summary of the CPT details is provided in Appendix Table B. CPT refusal was inferred to be approximately at the top of ECBF rock.

**Appendix Table B: CPT investigation summary**

CPT Reference	Estimated Ground Surface Elevation* (m)	CPT Depth below ground level (m)
CPT 01	41	18.24
CPT 02	43	17.55
CPT 03	43	4.78
CPT 04	34	11.46
CPT 05	32	13.72
CPT 06	32	15.60
CPT 07	32	14.03
CPT 08	32	11.79
CPT 09	32	11.81
CPT 10	32	15.50
CPT 11	31	13.53
CPT 12	28	12.78
CPT 13	36	12.44
CPT 14	41	14.16
CPT 15	33	9.74
CPT 16	38	18.37

\*CPT elevations estimated based on Auckland Council GIS contour information

#### **C1.4 Hand augered boreholes**

Twenty-one shallow (<1.0 m) hand augered boreholes have been undertaken in order to collect samples for laboratory testing. The results of the boreholes are presented in the separate T+T contamination report. An additional 20 No. hand auger holes have been undertaken in order to assess the soils within the top 5 m. These are attached in Appendix C.

#### **C1.5 Groundwater measurements**

Groundwater measurements were taken at the Site and are discussed in Appendix D.

# BOREHOLE LOG

BOREHOLE No.:

**BH01**

SHEET: 1 OF 3

DRILLED BY: Huri

LOGGED BY: OPRI

CHECKED: RHGR

START DATE: 08/10/2018

FINISH DATE: 09/10/2018

CONTRACTOR: McMillan Drilling

PROJECT: Ryman Site 3  
 JOB No.: 30314.0000  
 LOCATION: Kohimarama Road

CO-ORDINATES 5918797.00 mN  
 (NZTM2000) 1763966.20 mE

DIRECTION:  
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 43.50m  
 R.L. COLLAR: 43.50m  
 DATUM: ELLIPSOID  
 SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)						
Fill	Clayey SILT, some sand; brown with light brown. Dry to moist, low plasticity; sand, fine, sub-rounded to sub-angular, poorly sorted. 0.1m: grades to light brown.		UW	UW	HA	100		43	1	[Pattern]									
	Silty CLAY; light grey and light brown. Dry to moist, moderate plasticity. 0.8m: becoming light grey and light brown with orange-brown and red.																		
East Coast Bays Formation	Clayey SILT, with some sand lenses; light grey with orange-brown and red-brown mottling. Moist, moderate plasticity; sand, fine to medium.		UW	UW	PQTT	100	● 31/6 kPa	42	2	[Pattern]									
	Clayey SILT, with trace sand; light grey, mottled red and orange brown. Soft to firm, moist; sand, fine to medium. [Completely weathered ECBF, extremely weak.]																		
	3.00m: grades to light yellow brown.																		
	Silty, fine to medium SAND; light greyish brown. Wet, poorly sorted. [Completely weathered ECBF, extremely weak.]																		
	4.0-4.5m: CORE LOSS.																		
4.70m: grades to light grey, mottled brown.																			
Sandy SILT, with trace fibrous organics; brownish grey. Soft, moist, moderate plasticity. [Completely weathered ECBF, extremely weak.]		UW	UW	PQTT	86	● 40/6 kPa	36	7	[Pattern]			7.25m: J, 0° dip, PL, SM, 1mm clay layer, soft, light yellow brown						Box 3, 5.1-7.6m	
Clayey SILT, trace fibrous organics; brownish grey. Firm to stiff, moist, moderate plasticity; sand, fine to medium. [Completely weathered ECBF, extremely weak.] 7.20m: grades to grey.																			
Moderately weathered, grey SILTSTONE. Very weak, moist.		UW	UW	PQTT	100	● 54/3 kPa	34	9	[Pattern]			8.80m: DD, 5° dip, UD, SM, polished							Box 4, 7.6-10.0m

COMMENTS:

Hole Depth  
30m

Scale 1:50

# BOREHOLE LOG

BOREHOLE No.:

**BH01**

SHEET: 2 OF 3

DRILLED BY: Huri

LOGGED BY: OPRI

CHECKED: RHGR

START DATE: 08/10/2018

FINISH DATE: 09/10/2018

CONTRACTOR: McMillan Drilling

PROJECT: Ryman Site 3  
 JOB No.: 30314.0000  
 LOCATION: Kohimarama Road

CO-ORDINATES 5918797.00 mN  
 (NZTM2000) 1763966.20 mE

R.L. GROUND: 43.50m  
 R.L. COLLAR: 43.50m  
 DATUM: ELLIPSOID  
 SURVEY: Handheld GPS

DIRECTION:  
 ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE		ROCK DEFECTS																
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
East Coast Bays Formation	Moderately weathered, grey SILTSTONE. Very weak, moist.		UW	US	PQTT	100		33			2000								
	Moderately weathered, grey, fine to medium grained SANDSTONE. Very weak. Recovered as fine to medium SAND; grey. Moist, poorly sorted.		UW	US	PQTT	100		11			500								
	Moderately weathered, grey SILTSTONE. Very weak, moist, with black organic streaks.		UW	US	PQTT	100		32			600								
	Moderately weathered, fine to medium grained, massive SANDSTONE. Very weak, moist, poorly sorted.		UW	US	PQTT	100		12			800								
	Fine to coarse SAND layer. Loose to medium dense, moist, poorly sorted.		UW	US	PQTT	100		31			1000								
	Moderately weathered interbedded, grey, fine to medium grained SANDSTONE and SILTSTONE. Weak to very weak, moist. Moderately thick, shallow dipping bedding.		UW	US	PQTT	100		13			1200								
	Moderately weathered, grey, fine to medium grained SANDSTONE. Weak to very weak, moist.		UW	US	PQTT	100		30			1400								
Unweathered interbedded, grey, fine to medium grained SANDSTONE and SILTSTONE. Weak. Moderately thick, shallow dipping bedding.		UW	US	PQTT	100		14			1600									
		UW	US	PQTT	100		29			1800									
		UW	US	PQTT	100		15			2000									
		UW	US	PQTT	100		28			2200									
		UW	US	PQTT	100		16			2400									
		UW	US	PQTT	100		27			2600									
		UW	US	PQTT	100		26			2800									
		UW	US	PQTT	100		17			3000				16.90m: Multiple drilling induced breaks.					
		UW	US	PQTT	100		25			3200				17.50m: Organic brown/black streaks					
		UW	US	PQTT	96		18			3400									
		UW	US	PQTT	100		19			3600									
		UW	US	PQTT	100		24			3800									
		UW	US	PQTT	100		19.50m: moderately wide to closely spaced bedding.			4000									

COMMENTS:

Hole Depth  
30m

Scale 1:50



# BOREHOLE LOG

BOREHOLE No.:

**BH01**

SHEET: 3 OF 3

DRILLED BY: Huri

LOGGED BY: OPRI

CHECKED: RHGR

START DATE: 08/10/2018

FINISH DATE: 09/10/2018

CONTRACTOR: McMillan Drilling

PROJECT: Ryman Site 3  
 JOB No.: 30314.0000  
 LOCATION: Kohimarama Road

CO-ORDINATES 5918797.00 mN  
 (NZTM2000) 1763966.20 mE

DIRECTION:  
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 43.50m  
 R.L. COLLAR: 43.50m  
 DATUM: ELLIPSOID  
 SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE		ROCK DEFECTS																	
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
East Coast Bays Formation	Unweathered interbedded, grey, fine to medium grained SANDSTONE and SILTSTONE. Weak. Gently inclined, moderately thin to thick bedding.		UW	200	PQTT	100		23			2000	100	20.40m: J, 5° dip, PL, SM, N, CN							
	22.10m: moderately wide spaced bedding.		UW	200	PQTT	93		22			600	93	21.85m: J, 10° dip, UN, SM, N, CN							
	23.20 - 23.80m: sandstone grades to fine to coarse grained.		UW	200	PQTT	93		21			400	93								
	Unweathered, grey, interbedded fine to medium grained SANDSTONE with SILTSTONE. Weak. Gently inclined, moderately thick bedding.		UW	200	PQTT	96		20			200	93								
			UW	200	PQTT	96		23			200	93								
			UW	200	PQTT	96		24			200	93								
			UW	200	PQTT	96		19			200	93								
			UW	200	PQTT	96		25			200	93								
			UW	200	PQTT	96		18			200	96								
			UW	200	PQTT	96		26			200	96								
			UW	200	PQTT	100		17			200	100		26.50 - 29.00m: Organic brown streaks						
			UW	200	PQTT	100		27			200	100								
			UW	200	PQTT	100		16			200	100								
		UW	200	PQTT	100		28			200	100									
		UW	200	PQTT	100		15			200	100									
		UW	200	PQTT	100		29			200	100									
		UW	200	PQTT	100		14			200	100									
	30m: END OF BOREHOLE		UW	200	PQTT	100				200	100									

COMMENTS:

Hole Depth  
30m

Scale 1:50

PROJECT: Ryman Site 3		LOCATION: Kohimarama Road	JOB No.: 30314.0000
CO-ORDINATES: 5918797.00 mN (NZTM2000) 1763966.20 mE	DRILL TYPE:	HOLE STARTED: 08/10/2018	
R.L.: 43.50m	DRILL METHOD: RC	HOLE FINISHED: 09/10/2018	
DATUM: ELLIPSOID	DRILL FLUID:	LOGGED BY: OPRI	CHECKED: RHGR



0.00-2.30m



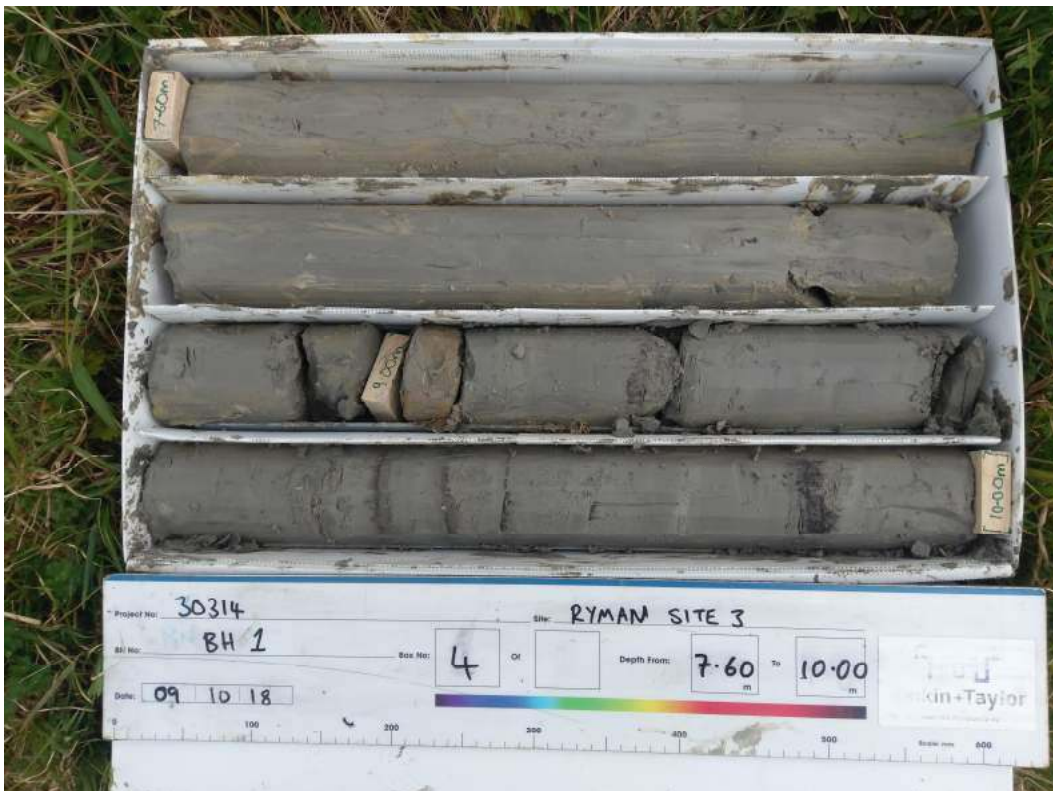
2.30-5.10m



PROJECT: Ryman Site 3		LOCATION: Kohimarama Road	JOB No.: 30314.0000
CO-ORDINATES: 5918797.00 mN (NZTM2000) 1763966.20 mE		DRILL TYPE:	HOLE STARTED: 08/10/2018
R.L.: 43.50m		DRILL METHOD: RC	HOLE FINISHED: 09/10/2018
DATUM: ELLIPSOID		DRILL FLUID:	DRILLED BY: McMillan Drilling
			LOGGED BY: OPRI CHECKED: RHGR



5.10-7.60m



7.60-10.00m

PROJECT: Ryman Site 3		LOCATION: Kohimarama Road	JOB No.: 30314.0000
CO-ORDINATES: 5918797.00 mN (NZTM2000) 1763966.20 mE	DRILL TYPE:	HOLE STARTED: 08/10/2018	
R.L.: 43.50m	DRILL METHOD: RC	HOLE FINISHED: 09/10/2018	
DATUM: ELLIPSOID	DRILL FLUID:	DRILLED BY: McMillan Drilling	LOGGED BY: OPRI CHECKED: RHGR



10.00-12.30m



12.30-14.60m

# CORE PHOTOS

BOREHOLE No.: **BH01**  
SHEET: 4 OF 5

PROJECT: Ryman Site 3		LOCATION: Kohimarama Road	JOB No.: 30314.0000
CO-ORDINATES: 5918797.00 mN (NZTM2000) 1763966.20 mE	DRILL TYPE:	HOLE STARTED: 08/10/2018	
R.L.: 43.50m	DRILL METHOD: RC	HOLE FINISHED: 09/10/2018	
DATUM: ELLIPSOID	DRILL FLUID:	LOGGED BY: OPR	CHECKED: RHGR



14.60-17.00m



17.00-19.50m

# CORE PHOTOS

BOREHOLE No.: **BH01**

SHEET: 5 OF 5

PROJECT: Ryman Site 3		LOCATION: Kohimarama Road	JOB No.: 30314.0000
CO-ORDINATES: (NZTM2000)	5918797.00 mN 1763966.20 mE	DRILL TYPE:	HOLE STARTED: 08/10/2018
R.L.:	43.50m	DRILL METHOD: RC	HOLE FINISHED: 09/10/2018
DATUM	ELLIPSOID	DRILL FLUID:	DRILLED BY: McMillan Drilling LOGGED BY: OPRI      CHECKED: RHGR



19.50-21.75m

# BOREHOLE LOG

BOREHOLE No.:

**BH02**

SHEET: 1 OF 3

DRILLED BY: Huri

LOGGED BY: OPRI

CHECKED: RHGR

START DATE: 11/10/2018

FINISH DATE: 11/10/2018

CONTRACTOR: McMillan Drilling

PROJECT: Ryman Site 3  
 JOB No.: 30314.0000  
 LOCATION: Kohimarama Road

CO-ORDINATES 5918741.20 mN  
 (NZTM2000) 1763970.40 mE

R.L. GROUND: 33.40m  
 R.L. COLLAR: 33.40m  
 DATUM: ELLIPSOID  
 SURVEY: Handheld GPS

DIRECTION:  
 ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE		ROCK DEFECTS																	
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
Top	SILT, with rootlets; Very soft, moist to wet, low plasticity.							33												
East Coast Bays Formation	Sandy, coarse GRAVEL; orange brown. Moist; gravel, angular; sand, fine to medium. [Residually weathered, ECBF, extremely weak]				PQTT	100		33												
	Fine to medium SAND, with minor silt; light brownish grey mottled orange. Loose, moist, poorly sorted. [Residually weathered, ECBF, extremely weak]							32						1.00m: Black organic streak.						
	Clayey SILT; brownish grey. Firm, moist, moderate plasticity. [Completely weathered, ECBF, extremely weak]					SPT	100	1/1 1/2 2/2 N=7	32											
	Fine to medium SAND, with trace silt; grey. Loose, moist, poorly sorted. [Completely weathered, ECBF, extremely weak]								31											
	SILT, with trace sand and clay; grey. Firm to stiff, moist, low plasticity. Sand, fine. [Completely weathered, ECBF, extremely weak]								30											
	SILT with minor to some clay, trace sand and organics; grey with yellow brown weathering. Stiff, moist, low to moderate plasticity. Sand, fine; Organics, amorphous. Interbedded with silty fine SAND with trace clay; grey. Firm to stiff, moist, low plasticity. Shallow dipping bedding planes. Interbedding moderately widely spaced. [Highly weathered, ECBF, extremely weak]					SPT	100	2/2 2/3 3/3 N=11	30											
	Silty fine SAND with trace clay; grey. Firm to stiff, moist, low plasticity. [Highly weathered, ECBF, extremely weak]								29											
	Fine SAND with trace to minor silt; grey. Medium dense, moist, moderately graded. [Highly weathered, ECBF, extremely weak]								28											
	5.60 - 5.90m: Broken by drilling, appears to be softened								27											
	Loose, moist								26											
East Coast Bays Formation	SILT with minor to some clay, trace sand and organics; grey with yellow brown weathering. Stiff, moist, low to moderate plasticity. Sand, fine; Organics, amorphous. Interbedded with fine SAND with trace to minor silt; grey. Medium dense, moist, moderately graded. Gently inclined, thin to moderately thin spaced beds. [Moderately to highly weathered, ECBF, extremely weak].							25												
					SPT	100	4/5 7/7 7/7 N=28	25												
								24												

COMMENTS:

Hole Depth  
21.75m

Scale 1:50

# BOREHOLE LOG

BOREHOLE No.:

**BH02**

SHEET: 2 OF 3

DRILLED BY: Huri

LOGGED BY: OPRI

CHECKED: RHGR

START DATE: 11/10/2018

FINISH DATE: 11/10/2018

CONTRACTOR: McMillan Drilling

PROJECT: Ryman Site 3  
 JOB No.: 30314.0000  
 LOCATION: Kohimarama Road

CO-ORDINATES 5918741.20 mN  
 (NZTM2000) 1763970.40 mE

R.L. GROUND: 33.40m  
 R.L. COLLAR: 33.40m  
 DATUM: ELLIPSOID  
 SURVEY: Handheld GPS

DIRECTION:  
 ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)						Description & Additional Observations
East Coast Bays Formation	[CONT] Interbedded SILT and SAND as above. [Moderately to highly weathered, ECBF, extremely weak].				PQTT	95	3/2 3/5 8/12 N=28	23	11			95						Box 4, 8.1-10.9m	
	Slightly weathered, grey SILTSTONE interbedded with fine to medium grained SANDSTONE. Very weak. Gently inclined, 10.85m: unweathered.				SPT	100			11										
					PQTT	80			22			80							
					SPT	100	7/13 13/15 18/4 for 15mm N>=50		12										
					PQTT	100			21			100							
	13.35m: moderately thickly bedded.				SPT	100			13										
					PQTT	100			20			100							
					SPT	100			14										
	Grey, fine to medium grained SANDSTONE. Very weak, weakly cemented, moist, poorly sorted.				PQTT	96			19			96							
	15.20m: moderately thinly bedded.				SPT	92	11/21 33/17 35 for 75mm N>=50		15										
				PQTT	100			18			100								
				SPT	100	14/36 for 75mm N>=50		17											
Unweathered, grey, fine to medium grained SANDSTONE. Very weak.				PQTT	100			17			100								
				SPT	100	18/32 for 55mm N>=50		16											
				PQTT	100			15			100								
Unweathered, grey, interbedded, fine to medium grained SANDSTONE and SILTSTONE. Very weak. Gently inclined thin to moderately thinly bedded.				SPT	100	22/28 for 75mm N>=50		14			95								
				PQTT	100			19											

COMMENTS:

Hole Depth  
21.75m

Scale 1:50



# BOREHOLE LOG

BOREHOLE No.:

**BH02**

SHEET: 3 OF 3

DRILLED BY: Huri

LOGGED BY: OPRI

CHECKED: RHGR

START DATE: 11/10/2018

FINISH DATE: 11/10/2018

CONTRACTOR: McMillan Drilling

PROJECT: Ryman Site 3  
 JOB No.: 30314.0000  
 LOCATION: Kohimarama Road

CO-ORDINATES 5918741.20 mN  
 (NZTM2000) 1763970.40 mE

R.L. GROUND: 33.40m  
 R.L. COLLAR: 33.40m  
 DATUM: ELLIPSOID  
 SURVEY: Handheld GPS

DIRECTION:  
 ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE  SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering <small>UW WW MW CW</small>	Rock Strength <small>US WS MS CS ES OS NS EW</small>	Sampling Method		Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%) <small>25 50 75</small>	Water Level	Casing	Installation	Core Box No
				SPT	PQTT						Defect Log <small>2000 600 200 100 50 20</small>	Fracture Spacing (mm)	RQD (%)					
East Coast Bays Formation	[CONT] Unweathered, grey, interbedded, fine to medium grained SANDSTONE and SILTSTONE. Very weak. Gently inclined thin to moderately thinly bedded.			PQTT	100	100		13				96						
	21.75m: END OF BOREHOLE			PQTT	100			12				100	21.15 - 21.25m: J, 50° dip, PL, SM,					Box 8, 21.2-21.6m; Box 8, 18.8-21.2m
								11										
								10										
								9										
								8										
								7										
								6										
								5										
								4										

COMMENTS:

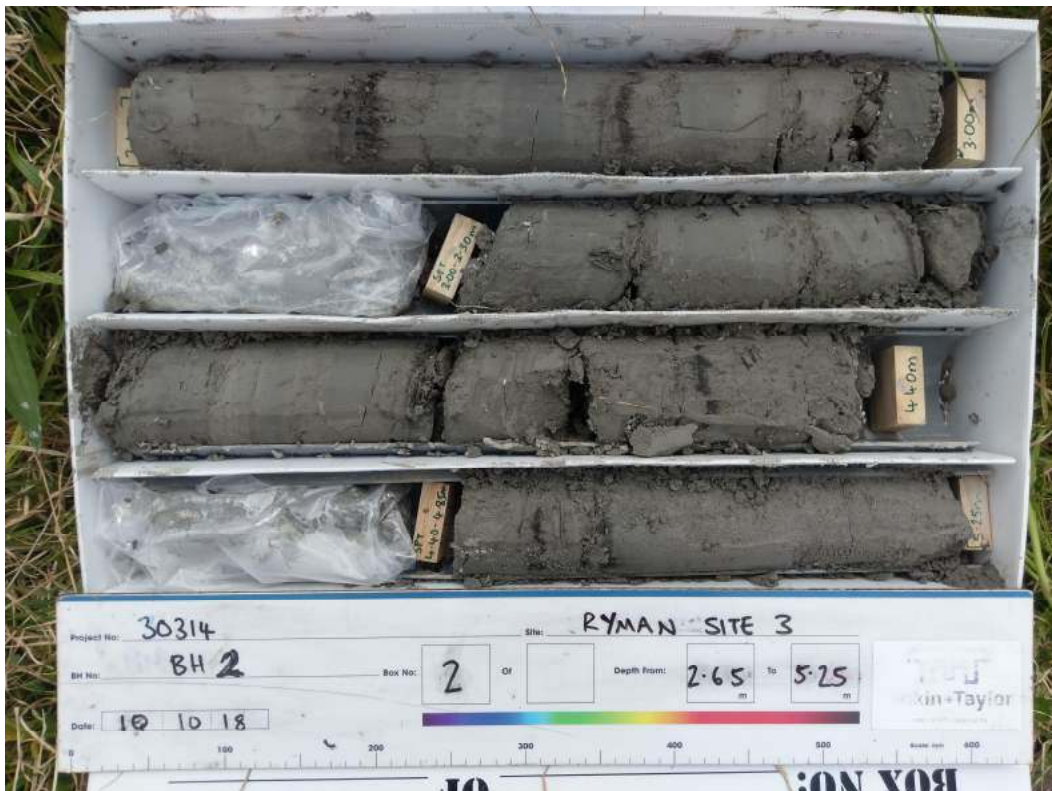
Hole Depth  
21.75m

Scale 1:50

PROJECT: Ryman Site 3		LOCATION: Kohimarama Road	JOB No.: 30314.0000
CO-ORDINATES: 5918741.20 mN (NZTM2000) 1763970.40 mE	DRILL TYPE:	HOLE STARTED: 11/10/2018	
R.L.: 33.40m	DRILL METHOD: RC	HOLE FINISHED: 11/10/2018	
DATUM: ELLIPSOID	DRILL FLUID:	DRILLED BY: McMillan Drilling	LOGGED BY: OPRI
		CHECKED: RHGR	



0.00-2.65m



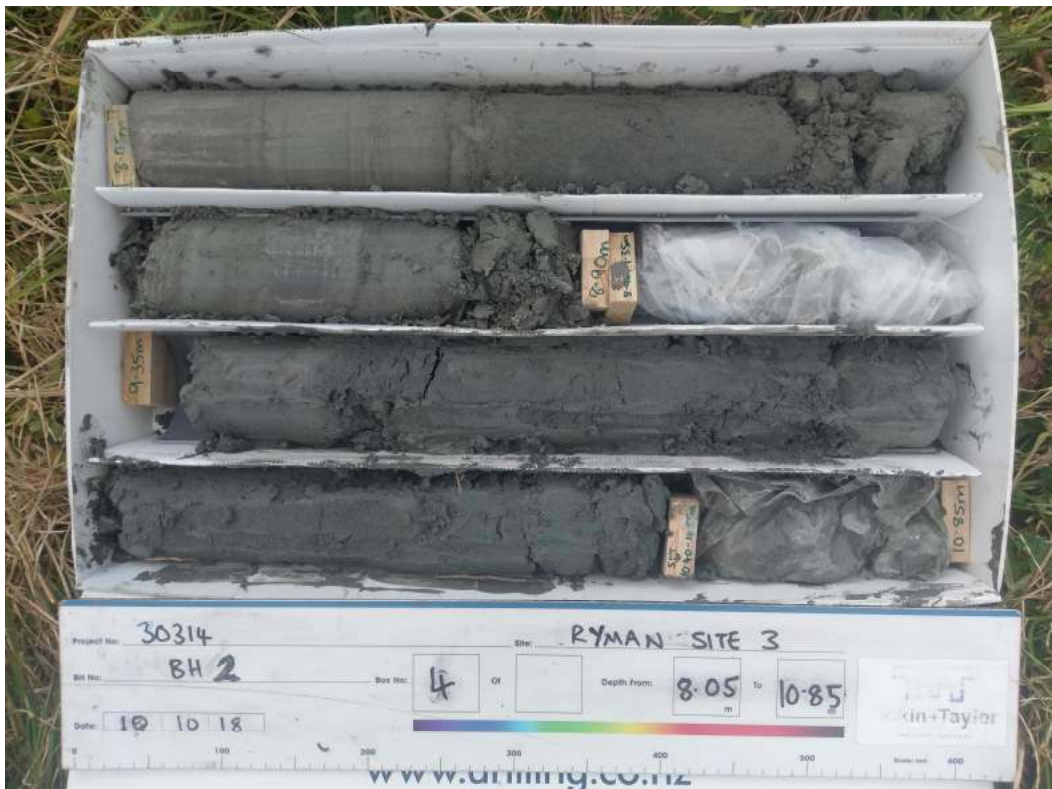
2.65-5.25m



PROJECT: Ryman Site 3		LOCATION: Kohimarama Road	JOB No.: 30314.0000
CO-ORDINATES: 5918741.20 mN (NZTM2000) 1763970.40 mE	DRILL TYPE:	HOLE STARTED: 11/10/2018	
R.L.: 33.40m	DRILL METHOD: RC	HOLE FINISHED: 11/10/2018	
DATUM: ELLIPSOID	DRILL FLUID:	DRILLED BY: McMillan Drilling	LOGGED BY: OPRI CHECKED: RHGR



5.25-8.05m



8.05-10.85m

PROJECT: Ryman Site 3		LOCATION: Kohimarama Road	JOB No.: 30314.0000
CO-ORDINATES: 5918741.20 mN (NZTM2000) 1763970.40 mE	DRILL TYPE:	HOLE STARTED: 11/10/2018	
R.L.: 33.40m	DRILL METHOD: RC	HOLE FINISHED: 11/10/2018	
DATUM: ELLIPSOID	DRILL FLUID:	LOGGED BY: OPRI	CHECKED: RHGR

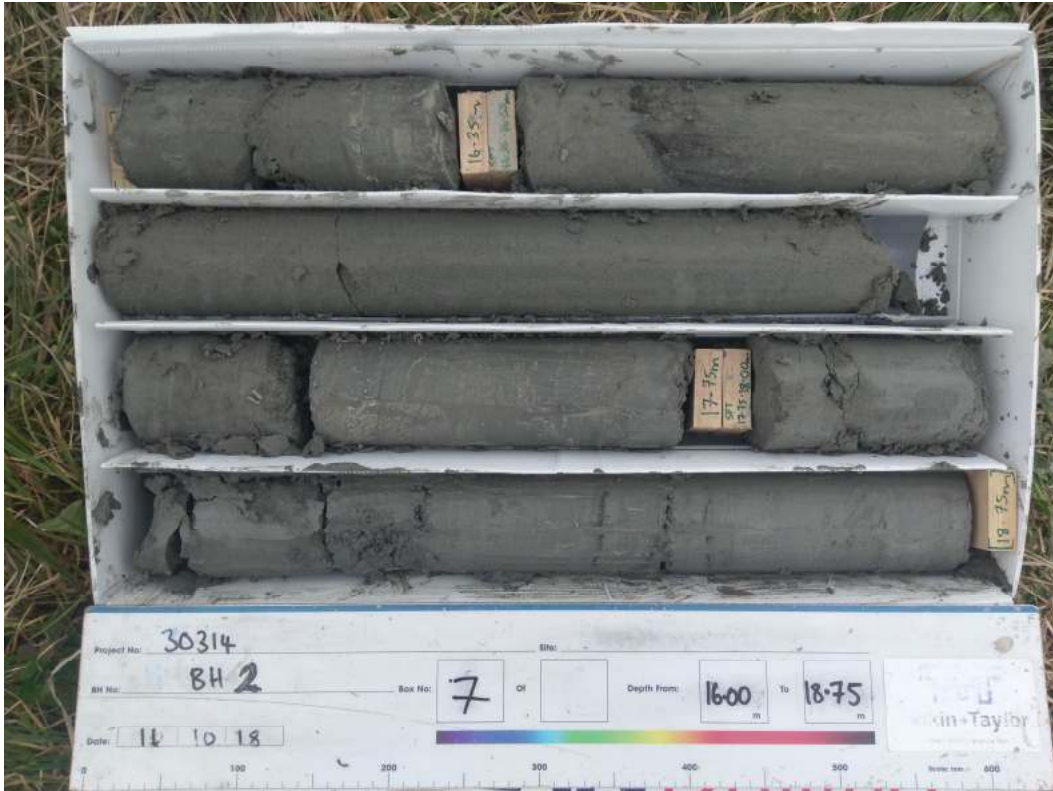


10.85-13.35m



13.35-16.00m

PROJECT: Ryman Site 3		LOCATION: Kohimarama Road	JOB No.: 30314.0000
CO-ORDINATES: 5918741.20 mN (NZTM2000) 1763970.40 mE	DRILL TYPE:	HOLE STARTED: 11/10/2018	
R.L.: 33.40m	DRILL METHOD: RC	HOLE FINISHED: 11/10/2018	
DATUM: ELLIPSOID	DRILL FLUID:	DRILLED BY: McMillan Drilling	LOGGED BY: OPRI CHECKED: RHGR



16.00-18.75m



18.75-21.15m

# CORE PHOTOS

BOREHOLE No.: **BH02**

SHEET: 5 OF 5

PROJECT: Ryman Site 3		LOCATION: Kohimarama Road	JOB No.: 30314.0000
CO-ORDINATES: (NZTM2000)	5918741.20 mN 1763970.40 mE	DRILL TYPE:	HOLE STARTED: 11/10/2018
R.L.:	33.40m	DRILL METHOD: RC	HOLE FINISHED: 11/10/2018
DATUM	ELLIPSOID	DRILL FLUID:	DRILLED BY: McMillan Drilling
			LOGGED BY: OPRI      CHECKED: RHGR



21.15-21.75m

# BOREHOLE LOG

BOREHOLE No.:

**BH03**

SHEET: 1 OF 4

DRILLED BY: Huri

LOGGED BY: PEMI

CHECKED: RHGR

START DATE: 12/10/2018

FINISH DATE: 12/10/2018

CONTRACTOR: McMillan Drilling

PROJECT: Ryman Site 3  
 JOB No.: 30314.0000  
 LOCATION: Kohimarama Road

CO-ORDINATES 5918724.50 mN  
 (NZTM2000) 1764013.90 mE

R.L. GROUND: 32.50m  
 R.L. COLLAR: 32.50m  
 DATUM: ELLIPSOID  
 SURVEY: Handheld GPS

DIRECTION:  
 ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)					
Fill	SILT, with rootlets, trace gravel; brown. Soft, moist, low plasticity; gravel, fine to medium, sub-SILT, with minor clay; light greyish brown, mottled orange. Soft, moist, moderate plasticity. [Highly weathered, ECBF, extremely weak] 0.70m: with trace sand, fine to medium.				PQTT	100	● 129/- kPa	32	1									
	CLAY, with some silt; orange brown. Very soft, moist, high plasticity.				SPT	100	0/1 1/1 1/2 ● N=5 83/- kPa	31	2									
	CLAY, with minor silt and trace gravel; brown mottled black and orange. Very soft to soft, moist, high plasticity; gravel, fine to medium, sub-angular to sub-rounded.				PQTT	90	0/0 0/0 1/1 ● N=2 20/- kPa	30	3									
Alluvial Deposits	SILT; dark brown. Very soft, moist, moderate plasticity. 3.75-4.4m: CORE LOSS.				PQTT	38	0/0 0/0 0/0 ● N=0	29	4									
	CLAY, with minor silt; greyish brown with dark brown mottling. Very soft, moist, high plasticity.				SPT	100	0/0 0/0 0/0 ● N=6	28	5									
East Coast Bays Formation	Sandy SILT; light grey mottled orange. Soft, moist, low plasticity; sand, fine to medium. [Completely weathered, ECBF, extremely weak]				PQTT	100	0/0 0/2 2/2 ● N=6	27	6									
	Sandy SILT; grey. Firm, mist, low plasticity; sand, fine. [Completely weathered, ECBF, extremely weak]				SPT	100	1/1 2/2 2/3 ● N=9	26	7									
	CLAY, with minor silt; grey. Stiff, moist, high plasticity. [Completely weathered, ECBF, extremely weak]				PQTT	100	2/3 4/5 5/5 ● N=19	25	8									
	Sandy SILT; grey. Stiff, moist, low plasticity; sand, fine. [Completely weathered, ECBF, extremely weak]				SPT	100		23	9									
	Silty, fine SAND; grey. Medium dense, moist, low plasticity to non-plastic; sand, sub-rounded to sub-angular. [Completely weathered, ECBF, extremely weak] 8.00m: loose, non-plastic, moist				PQTT	100		24										
	CLAY, with minor silt; grey. Stiff, moist, high plasticity. [Highly weathered, ECBF, extremely weak]				SPT	100		25										
					PQTT	100		26										
					SPT	100		27										
					PQTT	100		28										
					SPT	100		29										
					PQTT	100		30										
					SPT	100		31										
					PQTT	100		32										

3.85m: Too soft, unable to retrieve core.

9.65m: 30mm weakly cemented black organic streaks, undulating, sub-horizontal, 2mm thick

15/10/2018, dipped

Box 1, 0.0-2.5m

Box 2, 2.5-6.5m

Box 3, 6.0-9.0m

COMMENTS: Push tube samples and peak shear vane readings taken in an adjacent wash bored hole at: 1-1.3m, 2-2.4m, 2.5-2.9m, 3.5-4.0m and 5-5.5m.

Hole Depth 30.09m

Scale 1:50

# BOREHOLE LOG

BOREHOLE No.:

**BH03**

SHEET: 2 OF 4

DRILLED BY: Huri

LOGGED BY: PEMI

CHECKED: RHGR

START DATE: 12/10/2018

FINISH DATE: 12/10/2018

CONTRACTOR: McMillan Drilling

PROJECT: Ryman Site 3  
 JOB No.: 30314.0000  
 LOCATION: Kohimarama Road

CO-ORDINATES 5918724.50 mN  
 (NZTM2000) 1764013.90 mE

DIRECTION:  
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 32.50m  
 R.L. COLLAR: 32.50m  
 DATUM: ELLIPSOID  
 SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE				Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No			
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation												Description & Additional Observations											
East Coast Bays Formation	Silty, fine SAND; grey. Medium dense, moist, non-plastic; sand, sub-rounded to sub-angular. [Highly weathered, ECBF, extremely weak] CLAY, with minor silt; grey. Stiff, moist, high plasticity. [Highly weathered, ECBF, extremely weak] 10.90m: grades to very stiff.				UW	10	PQTT	100	0/1 2/3 3/5 N=13	22	11	[Yellow dotted pattern]	2000 1000 500 200 100 50 20											
	Unweathered, grey SILTSTONE. Very weak, horizontal bedding visible.				UW	10	PQTT	80		21	11	[Yellow dotted pattern]												
	11.8-12m: CORE LOSS.																							
	Unweathered, grey, fine grained SANDSTONE. Extremely weak. (Silty sand, weakly cemented in zones, 30% length 50-100mm thick zones.)				UW	10	PQTT	100	6/8 10/11 12/17 N>=50	20	12	[Yellow dotted pattern]												
	Unweathered, grey SILTSTONE. Very weak, horizontal bedding visible.				UW	10	PQTT	76	5/6 7/9 11/13 N=40	19	14	[Yellow dotted pattern]												
	14.75-15m: CORE LOSS.																							
	Slightly weathered, grey, coarse to medium grained SANDSTONE. Very weak (visible white sand grains).				UW	10	PQTT	84	3/6 9/17 24 for 75mm N>=50	17	15	[Yellow dotted pattern]												
	Slightly weathered, grey SILTSTONE. Very weak, horizontal bedding visible.				UW	10	PQTT	100	17/17 30/20 for 70mm N>=50	16	16	[Yellow dotted pattern]												
	16.4-16.5m: CORE LOSS.																							
	Silty, fine SAND; grey. Medium dense, moist, non-plastic; sand, sub-rounded. [Slightly weathered, ECBF, extremely weak]				UW	10	PQTT	100	4/5 4/4 3/5 N=16	14	18	[Yellow dotted pattern]												
	Slightly weathered, grey SILTSTONE. Extremely weak. [Sandy SILT]				UW	10	PQTT	100		19	19	[Yellow dotted pattern]												
	Silty, fine SAND; grey. Medium dense, moist, non-plastic; sand, sub-rounded. [Slightly weathered, ECBF, extremely weak]				UW	10	PQTT	100	6/11 14/18 18 for	13	13	[Yellow dotted pattern]												
	Slightly weathered, grey SILTSTONE. Very weak, horizontal bedding visible.				UW	10	PQTT	100																

COMMENTS: Push tube samples and peak shear vane readings taken in an adjacent wash bored hole at: 1-1.3m, 2-2.4m, 2.5-2.9m, 3.5-4.0m and 5-5.5m.

Hole Depth  
30.09m

Scale 1:50

# BOREHOLE LOG

**BOREHOLE No.:**

**BH03**

SHEET: 3 OF 4

DRILLED BY: Huri

LOGGED BY: PEMI

CHECKED: RHGR

START DATE: 12/10/2018

FINISH DATE: 12/10/2018

CONTRACTOR: McMillan Drilling

PROJECT: Ryman Site 3  
JOB No.: 30314.0000  
LOCATION: Kohimarama Road

CO-ORDINATES 5918724.50 mN  
(NZTM2000) 1764013.90 mE

DIRECTION:  
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 32.50m  
R.L. COLLAR: 32.50m  
DATUM: ELLIPSOID  
SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE		ROCK DEFECTS																			
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No			
East Coast Bays Formation	<p>19.8-24.6m: Unweathered, grey SILTSTONE. Very weak, horizontal bedding visible.</p> <p>Silty, fine SAND; grey. Dense, moist, non-plastic; sand, sub-rounded. [Moderately weathered, ECBF, extremely weak]</p> <p>24.65-24.85m: CORE LOSS (inferred silty sand).</p> <p>Slightly weathered, grey SILTSTONE. Very weak, horizontal bedding visible.</p> <p>Silty, fine SAND; grey. Dense, moist, non-plastic; sand, sub-rounded. [Moderately weathered, ECBF, extremely weak]</p> <p>Unweathered, grey SILTSTONE. Weak, horizontal bedding visible.</p> <p>26.60m: very weak.</p> <p>27.10m: weak.</p> <p>29.35m: very weak.</p> <p>29.60m: weak.</p>		UN		PQTT	100	30mm N>=50	12				100	20.35m: black organic streak, UN, sub-horizontal 20.68m: J, 0° dip, UN, N, CV 20.95 - 21.00m: DD, Cone NI 21.50m: DD 21.85m: J, 0° dip, UN, N, CN						Box 7, 18.0-20.7m			
			UN		SPT	100	9/9 9/12 15/14 for 25mm N>=50	11					100	23.20m: J, 0° dip, PL, R, coated silty sand 23.23 - 23.25m: XD, 0° dip, UN, VN, infill silty sand 23.30m: black organic streak, UN, sub-horizontal 23.70m: J, 0° dip, PL, VN, coated silty sand 23.70m: black organic streak, UN, sub-horizontal						Box 8, 20.7-23.5m		
			UN		PQTT	100	8/12 12/18 20 for 60mm N>=50	10					96	24.40m: DD								
			UN		SPT	0	19/31 for 50mm N>=50	8						68	25.35m: J, 0° dip, UN, VN, CV 25.40m: black organic streak, UN, 20°							
			UN		PQTT	79	18/32 for 50mm N>=50 Solid	7						100	25.92m: DD 26.15m: DD 26.23m: DD							
			UN		SPT	0	20/30 for 75mm N>=50 Solid	6						100	26.94m: DD 27.25m: black organic streak 27.30m: J, 15° dip, UN, T, CV 27.53m: J, 0° dip, UN, T, CV 27.55m: J, 0° dip, UN, T, CV 27.80m: black organic streak							
			UN		PQTT	100	14/27 35/15 for 35mm N>=50 Solid	5						100	28.25m: black organic streak 28.40m: black organic streak 28.93m: J, 5° dip, UN, T, CV 29.00m: black organic streak 29.25 - 29.35m: black organic streaks 29.84 - 29.87m: XD, 0° dip, UN, VN, infill silty sand, 30mm thick 29.93m: J, 0° dip, UN, VN, CV							
			UN		SPT	0		4														
			UN		PQTT	89		3						89								

COMMENTS: Push tube samples and peak shear vane readings taken in an adjacent wash bored hole at: 1-1.3m, 2-2.4m, 2.5-2.9m, 3.5-4.0m and 5-5.5m.

Hole Depth  
30.09m

Scale 1:50



# BOREHOLE LOG

BOREHOLE No.:

**BH03**

SHEET: 4 OF 4

DRILLED BY: Huri

LOGGED BY: PEMI

CHECKED: RHGR

START DATE: 12/10/2018

FINISH DATE: 12/10/2018

CONTRACTOR: McMillan Drilling

PROJECT: Ryman Site 3  
 JOB No.: 30314.0000  
 LOCATION: Kohimarama Road

CO-ORDINATES 5918724.50 mN  
 (NZTM2000) 1764013.90 mE

R.L. GROUND: 32.50m  
 R.L. COLLAR: 32.50m  
 DATUM: ELLIPSOID  
 SURVEY: Handheld GPS

DIRECTION:  
 ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE  SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering <small>UW MW SW CW</small>	Rock Strength <small>US MS SS ES EW</small>	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%) <small>25 50 75</small>	Water Level	Casing	Installation	Core Box No
										Defect Log <small>2000 600 400 200</small>	Fracture Spacing (mm) <small>20</small>	RQD (%)					
	30.09m: END OF BOREHOLE				0	17.33 for 15mm N=50 Solid											

COMMENTS: Push tube samples and peak shear vane readings taken in an adjacent wash bored hole at: 1-1.3m, 2-2.4m, 2.5-2.9m, 3.5-4.0m and 5-5.5m.

Hole Depth  
30.09m

Scale 1:50



PROJECT: Ryman Site 3		LOCATION: Kohimarama Road	JOB No.: 30314.0000
CO-ORDINATES: 5918724.50 mN (NZTM2000) 1764013.90 mE		DRILL TYPE:	HOLE STARTED: 12/10/2018
R.L.: 32.50m		DRILL METHOD: RC	HOLE FINISHED: 12/10/2018
DATUM: ELLIPSOID		DRILL FLUID:	DRILLED BY: McMillan Drilling
			LOGGED BY: PEMI CHECKED: RHGR



0.00-2.50m

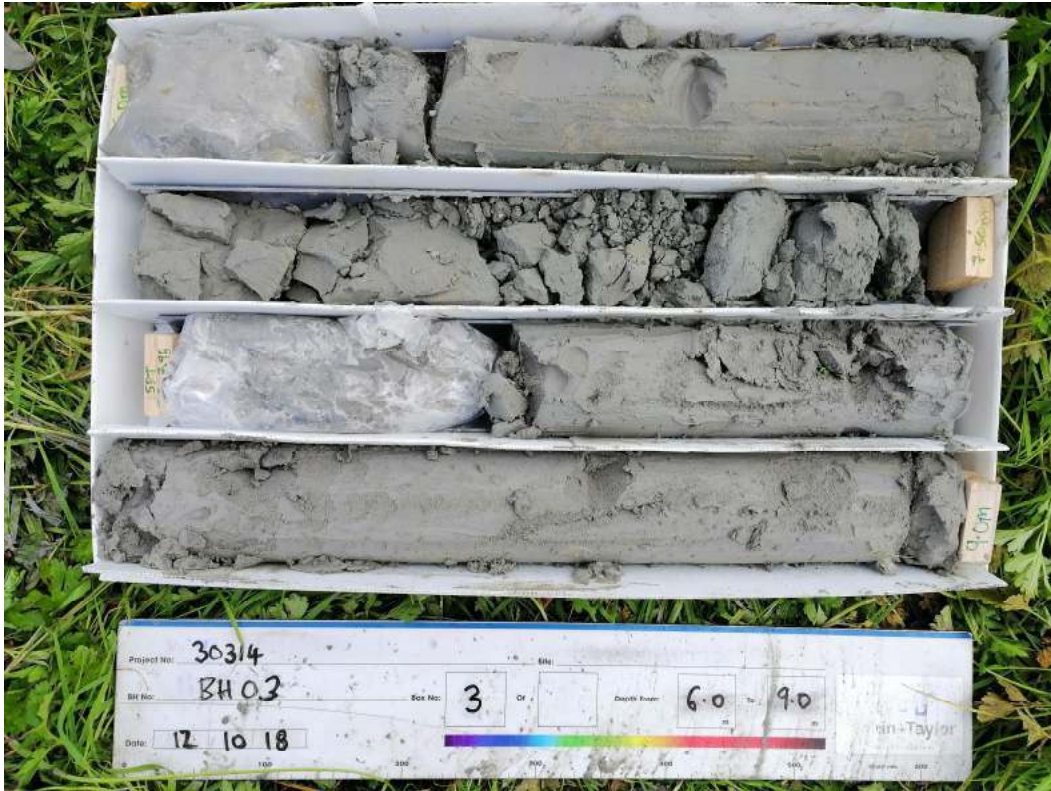


2.50-6.00m

# CORE PHOTOS

BOREHOLE No.: **BH03**  
SHEET: 2 OF 6

PROJECT: Ryman Site 3		LOCATION: Kohimarama Road	JOB No.: 30314.0000
CO-ORDINATES: (NZTM2000)	5918724.50 mN 1764013.90 mE	DRILL TYPE:	HOLE STARTED: 12/10/2018
R.L.:	32.50m	DRILL METHOD: RC	HOLE FINISHED: 12/10/2018
DATUM	ELLIPSOID	DRILL FLUID:	DRILLED BY: McMillan Drilling
			LOGGED BY: PEMI CHECKED: RHGR



6.00-9.00m



9.00-12.00m