



**MILLWATER - PRECINCT 2
STAGE 4A**

Geotechnical Completion Report

Prepared for
WFH Properties Ltd

Prepared by
Tonkin & Taylor Ltd

Date
May 2017

Job Number
21854.001/S4A.v1



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Executive summary

Tonkin + Taylor Ltd (T+T) was engaged by WFH Properties Ltd (WFH) to monitor and provide earthworks certification for the 9 No. Residential Lots contained within Stage 4A of Precinct 2 in the Millwater Subdivision in Silverdale. Stage 4A comprises high density residential Lots 1011 to 1019 inclusive as shown on the Woods Final Contour As-Built Plans (Woods Ref 33218-04A-100-AB to -102) in Appendix A1. This Geotechnical Completion Report contains information required for subdivisional earthworks completion reporting, as well as outlining geotechnical design issues that need to be considered for subsequent building design and construction on each residential Lot.

Previous geotechnical investigation work across the subdivision was undertaken by T+T and reported in:

- a 2000 and 2001 Preliminary feasibility reporting (Ref. [1] and [2]).
- b 2003 Major reconnaissance report covering land in the Silverdale North and Orewa West areas (Ref. [3]).
- c 2004 Geotechnical Investigation Report for the Wainui Road Subdivision (Ref. [4]), updated in October 2005 following scheme modifications (Ref. [5]).
- d 2006 Investigation report following purchase of Westlake property (Ref. [6]).
- e May 2014 Geotechnical Investigation Report for Precinct 2 (Ref. [7]).

Woods Ltd (Woods) undertook the engineering design for this stage and the overall subdivision.

Bulk earthworks commenced on site in late 2014 and were completed by October 2016. Earthworks comprised the following:

- a Stripping of vegetation, organic materials and topsoil to stockpile.
- b Installation of gully and subsoil drains.
- c Cut to fill earthworks across the entire site, as shown on Woods Cut/Fill Contour As-Built, Original Surface to Earthworks Surface (Woods Ref. 33218-04A-110-AB) in Appendix A1.

Civil earthworks commenced on site in November 2016 and were completed by May 2017, and comprised the following:

- a Minor cut to fill earthworks across parts of the site as part of final Lot development, as shown on the Woods Cut/Fill Contour As-Built Plan Earthworks Surface – Final Surface (Woods Ref 33218-04A-111-AB) in Appendix A1.
- b Construction of 3 No. timber pole retaining walls (i.e. Walls 306, 307 and 308) in the location shown on the Woods Retaining Walls As-Built Plans (Woods Ref 33218-04A-130-AB to -134) in Appendix A1.
- c Installation of roading and services.

Overall subdivisional soil types are moderately expansive (Class M), based on laboratory testing undertaken in accordance with AS 2870:2011 (Ref. [9]). Due to this classification, soils lie outside the definition of good ground within NZS 3604:2011 (Ref. [10]). Building foundations will require either specific foundation design for expansive soils or foundation design in accordance with AS 2870:2011 (Ref. [9]). Subject to design issues outlined in Section 3, and CSIRO recommendations outlined in the appendices relating to expansive soils foundation design and home owner maintenance, each residential Lot is considered to have a building platform area generally suitable for domestic residential development subject to specific geotechnical assessment and foundation design due to the presence of expansive soils.

Foundation design for residential development should proceed in accordance with Sections 6.5 to 6.10 of this report.

1 Introduction

1.1 General

Tonkin + Taylor Ltd (T+T) was engaged by WFH Properties Ltd (WFH) to monitor and provide earthworks certification for the 9 No. Residential Lots contained within Stage 4A of Precinct 2 in the Millwater Subdivision in Silverdale. Stage 4A comprises high density residential Lots 1011 to 1019 inclusive as shown on the Woods Final Contour As-Built Plans (Woods Ref 33218-04A-100-AB to -102) in Appendix A1.

Previous geotechnical investigation work across the subdivision was undertaken by T+T and reported in:

- a 2000 and 2001 Preliminary feasibility reporting (Ref. [1], [2]).
- b 2003 Major reconnaissance report covering land in the Silverdale North and Orewa West areas (Ref. [3]).
- c 2004 Geotechnical Investigation Report for the Wainui Road Subdivision (Ref. [4]), updated in October 2005 following scheme modifications (Ref. [5]).
- d 2006 Investigation report following purchase of Westlake property (Ref. [6]).
- e May 2014 Geotechnical Investigation Report for Precinct 2 (Ref. [7]).

The preliminary (Ref. [1], [2]) and investigation (Ref. [3], [4], [5], [6], [7]) reports noted the presence of existing instability comprising landsliding, soil creep and shallow slope movement across much of Precinct 2. These features were proposed to be stabilised, and/or undercut and replaced with engineered fill, during development works. While these stabilisation works are required across much of Precinct 2, such works were not required to achieve satisfactory factors of safety against instability for the finished development of Stage 4A.

Earthworks compaction control, in terms of minimum shear strengths and maximum air voids, was recommended, and, along with other recommendations, has been incorporated into our control of the works and, where applicable, included in completion reporting.

The scope of work covered by this completion report includes:

- a Review of geotechnical investigation reporting for the site;
- b Monitoring and certification of earthworks operations in compliance with NZS 4431:1989 (Ref. [8]);
- c Monitoring and certification of construction of 3 No. timber pole retaining walls (i.e. Walls 306, 307 and 308);
- d Assessment of soils for expansive conditions in accordance with AS 2870:2011 (Ref. [9]);
- e Certification of completed Lots for residential development in accordance with NZS 3604:2011 (Ref. [10]).

Woods Ltd (Woods) undertook subdivision engineering design and civil works construction observations. As-built plans showing final contours and cut and fill depths have been prepared by Woods and are attached in Appendix A1.

1.2 Description of Subdivision

The Millwater subdivision is situated to the north of the Silverdale Township, and west of the Metro Park East reserve area, and comprises approximately 260 hectares. The subdivision is bound to the south and west by Wainui Road, to the north by the Orewa Estuary and to the east by the Orewa Estuary and Millwater Parkway. The original site comprised a mix of farm properties and associated dwellings and existing residential developments.

The Precinct 2, Stage 4A area of the Millwater subdivision is located within what is known as Precinct 2 in the Silverdale North Structure Plan.

The Precinct 2 area is bound by Manuel Road to the northwest, Old Mill Road to the east, Wainui Road to the south and west, and Precinct 3 to the northeast. The overall Precinct 2 and Stage 4A areas are shown on T+T Drawing 21854.001-P2S4A-100 in Appendix A2.

Pre-development gradients within the Stage 4A area were gentle to moderately steep (1 in 15 to 1 in 4 (V:H)) with an overall fall to the south east.

Post-development gradients within the Stage 4A area are gentle (1 in 15 to 1 in 10 (V:H)) and generally fall to the south east as before. In order to form more level building platforms, 3 No. timber pole retaining walls have been constructed along some Lot boundaries as shown on T+T Drawing 21854.001-P2S4A-101, and Woods Drawing 33218-04A-130-AB to -134. In addition, a geogrid reinforced segmental block (Screen Block) wall has been constructed in the southern part of Stage 4A.

Stage 4A is presently accessed from the existing Bonair Crescent.

1.3 Geological Setting

Published geological mapping and information indicates the Precinct 2 area is underlain by Northland Allochthon materials. In addition to the Northland Allochthon, our investigations identified the presence of alluvial materials on site.

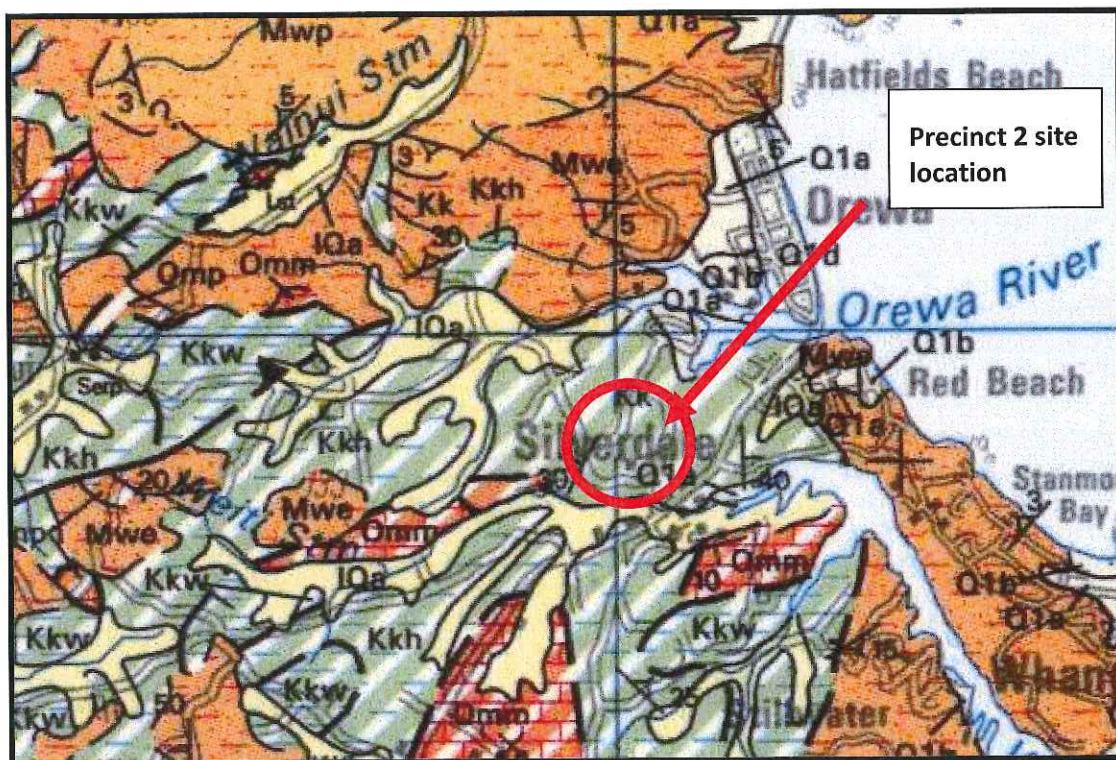


Figure 1 - Local Geology (from Edbrooke)

Land south of the Orewa River is located on an area of extensively deformed and sheared mudstones and muddy to sandy limestones described as Onerahi Chaos – Northland Allochthon material. Recent stream alluvium and slope colluvium derived from residual Northland Allochthon material is mapped towards the base of the gullies at the bottom of the slopes. Recent stream alluvium and discontinuous areas of older Pleistocene Age alluvium are also likely to be present overlying the Northland Allochthon.

Summary descriptions of geological units in Wainui/Manuel Roads area (after Kermode 1991) are as follows:

a **Northland Allochthon**

Deformed sediments, commonly known as Onerahi Chaos - Northland Allochthon: forms hummocky rolling hills covering more than 100 km² west of Whangaparaoa Peninsula. Mixture of undifferentiated deposits of various and widely sized (cm-km), randomly oriented blocks comprising conglomerate limestone, mudstone, alternating sandstone and mudstone, and serpentinite in a matrix of closely fractured and crushed, moderately soft, grey, brown, and greenish grey mudstone and some sandstone (calcareous or siliceous). Some of the large blocks, especially of limestone, have been mapped individually.

b **Pleistocene Age Alluvium**

Up to 20 m thick and from 3 to 10 m above present base level: forms higher coastal and valley terraces throughout the map area; in places locally discontinuous or absent. These alluvial deposits are typically very thinly to very thickly bedded, yellow-grey to orange-brown, angular to well rounded, mixed sizes (usually graded, coarse becoming fine upwards) of mud, sand and gravel, comprising rock fragments and weathered rock residue from the hinterland. They include some beds of black, humus-rich clay and white, pumice silt.

Geological cross-sections through the Precinct 2, Stage 4A area are enclosed as Drawing Numbers 21854.001-P2S4A-103 to -107 in Appendix A2. Borehole logs from the post-earthworks investigations are enclosed in Appendix E.

Fill material placed across the site to form the final design profile typically comprised site-won Northland Allochthon.

2 Earthworks Operations

2.1 Plant

Bulk earthworks were undertaken by Hick Bros Civil Construction Ltd (Hicks). Various areas of soft and/or wet materials were encountered during the works and were undercut and replaced with engineered fill. Much of this undercut material was considered suitable for re-use as engineered fill when conditioned appropriately. Accordingly, mixing of the cohesive fill materials with lime/cement to facilitate fill placement and compaction was undertaken by Hiway Stabilizers Ltd (Hiway) under Hicks' control.

Civil works, including timber pole retaining walls, construction has been completed by JG Civil Ltd (JGCL).

Various earthworks equipment was used to undertake the works, comprising D6 and D8 bulldozers and scoops, motor scrapers, tractors and discs, sheepsfoot compactors, padfoot rollers, and a number of 12 to 35 tonne excavators. This plant generally carried out all construction earthworks.

Specialist contractors and plant were brought on site for pavement construction. Certification of the pavement construction is beyond the scope of this report.

2.2 Construction Programme

Subdivisional earthworks commenced from late 2014 through to October 2016 under Hicks' control. Civil earthworks and construction for the residential Lots were under JGCL's control and were undertaken progressively from November 2016 through to completion in May 2017.

Key Stage 4A earthworks components included:

- a Stripping of vegetation, organic materials and topsoil to stockpile.
- b Installation of gully and subsoil drains.
- c Cut to fill earthworks across the entire site, as shown on Woods Cut/Fill Contour As-Built, Original Surface to Earthworks Surface (Woods Ref. 33218-04A-110-AB) in Appendix A1.

Key Stage 4A civil works components included:

- a Minor cut to fill earthworks across parts of the site as part of final Lot development, as shown on the Woods Cut/Fill Contour As-Built Plan Earthworks Surface – Final Surface (Woods Ref 33218-04A-111-AB) in Appendix A1.
- b Construction of 3 No. timber pole retaining walls (i.e. Walls 306, 307 and 308) in the location shown on the Woods Retaining Walls As-Built Plans (Woods Ref 33218-04A-130-AB to -134) in Appendix A1.
- c Installation of roading and services.

The earthworks, retaining walls, undercuts and subsoil drainage as-built plans are included in Appendix A1 (Woods Drawings 33218-04A-100-AB to -102, -110 to -112, -120 to -122 and -130 to -134), and show the earthworks undertaken across the site.

2.3 Compaction Control

Compaction control criteria, consisting of maximum allowable air voids and minimum allowable shear strengths, were used for cohesive fill control. The Technical Specification included in our Geotechnical Investigation Report (Ref. [4],[5],[6],[7]) included the following requirement for the subdivisional earthworks:

Minimum Shear Strength and Maximum Air Voids Method

Minimum Undrained Shear Strength (Measured by insitu vane – IANZ calibrated)

General fills:

Average value not less than	140 kPa
Minimum single value	110 kPa

Maximum Air Voids Percentage (as defined in NZS 4402:1986)

General fills:

Average value not more than	10%
Maximum single value	12%

The average corrected shear strength value was determined over any ten consecutive tests.

Regular in situ density, strength and water content tests were carried out on the filling at, or in excess of, the frequency recommended by NZS 4431:1989 (Ref. [8]). Test results are contained in Appendix E.

Quality Control (QC) testing showed that the results for the filling were consistently meeting the required undrained shear strength and air voids criteria, demonstrating that the water content of placed fill was consistently at, or close to, optimum. To the best of our knowledge, any problems encountered were rectified, where required, by close monitoring of the selection of borrow materials, discing and remixing of the available soil types, and minor reworking.

3 Geotechnical Development Works

3.1 Subsoil Drainage

A network of subsoil drains has been installed within the original gully alignments across Precinct 2 during the original bulk earthworks, in addition to those drains installed as part of the timber pole retaining walls construction.

The subsoil drains installed within the gullies were excavated into the underlying rock to intercept groundwater and springs. The subsoil drains comprised 600mm to 1m wide trenches, installed in the base of the mucked out gully alignments, prior to placement of up to 9m of fill, and backfilled with:

- a 160mm diameter, Hiway grade, perforated Nexus pipes along the base of the trench.
- b SAP50 scoria over the top of the Nexus pipe to within 1m of the ground surface (at time of construction).
- c Bidim A19 geotextile filter-cloth over the top of the scoria.
- d Compacted, engineered fill within the top metre of the trench.

The gully drains discharge into the main downslope gully that runs centrally through Precinct 2.

In addition to the above, subsoil drains were installed as part of the retaining wall structures.

Timber pole wall drainage comprised a 110mm diameter Nexus pipe covered in SAP50 scoria installed along the rear of the timber poles and brought through under the base of the wall to discharge into the reticulated stormwater system. A cap of engineered fill was placed over the top of the drainage trench to limit surface seepage.

The subsoil drainage system and connections are shown on the Woods Shear Key, Undercuts & Subsoil Drains As-Built Plans (Woods Ref 33218-04A-120-AB to -122) in Appendix A1, and on T+T Drawing 21854.001-P2S4A-102 in Appendix A2.

3.2 Timber Pole Walls

Three timber pole retaining walls were constructed across this stage of the subdivision, comprising Walls 306, 307 and 308 at the location shown on T+T Drawing 21854.001-P2S4A-101. These walls were designed by T+T and allow for the various design conditions encountered across the stage, including toe slopes, slope surcharges and vehicle surcharges, as appropriate. Construction drawings for Walls 306, 307 and 308 were issued in August 2016 and a copy of these are included in Appendix A2. These walls were constructed during the Civils construction stage by JGCL.

The walls comprise high density timber poles installed to various depths dependent on design conditions. Inspections for these walls were undertaken by T+T staff to confirm pile hole diameter, depth and spacing, pile sizes, and installation of drainage materials and lagging, in accordance with the design drawings.

The drainage pipes from behind the walls are connected into the stormwater system, as shown on the Woods subsoil drainage as-built plans in Appendix A1.

These walls have been designed to accommodate a maximum 5kPa surcharge, although development immediately behind/above the walls is likely to be precluded by Council planning rules.

Certification of Walls 306, 307 and 308 in accordance with the relevant Engineering Approval is to be supplied under a separate cover.

4 Stability Analyses

As noted in Section 1, slope stability analyses undertaken during the investigation stage of the project identified that shear keys were not required to achieve satisfactory factors of safety against slope instability for the finished development of Stage 4A.

Observations and monitoring were undertaken during bulk earthworks construction to confirm that the ground conditions exposed were consistent with the assumptions made in the stability analyses.

We are satisfied that the design stability analyses remain valid for the completed works on the following basis:

- a the exposed ground conditions generally conform to those assumed for design;
- b the as-built profiles match design levels;
- c the earthworks monitoring shows compliance with specified criteria, upon which fill properties have been based.

5 Project Evaluation / Building Design Considerations

5.1 General

Ground conditions within Precinct 2, Stage 4A straddle a range of “design conditions” including cut ground, filled ground and expansive soils. The following sections set out relevant geotechnical design issues.

5.2 Bearing capacity for building foundations

All filled and natural ground within the influence of conventional residential shallow strip and pad foundation loads is assessed as generally having a geotechnical ultimate bearing capacity of 300kPa, as required by NZS 3604:2011 (Ref. [10]). This corresponds to a factored (Ultimate Limit State) bearing capacity of 150kPa and working (Serviceability Limit State) bearing capacity of 100kPa.

Due to the presence of expansive soils, foundation conditions fall outside the definition of “good ground” contained in NZS 3604:2011 (Ref. [10]). In terms of AS 2870:2011 (Ref. [9]), the soils present are considered to lie within Site Class M (moderately expansive) with characteristic surface movements anticipated to be in the range of 20mm to 40mm. Due allowance should be made for expansive soils, as discussed in Section 5.11.

Where a geotechnical ultimate bearing capacity greater than 300kPa is required to support any dwelling constructed outside the scope of NZS 3604:2011 (Ref. [10]), further specific site investigation and design of foundations will be required.

5.3 Settlement

From our inspections during earthworks operations, and the results of compaction quality control testing, we consider that differential settlement induced by self-weight of engineered fill should now be largely complete. Further settlements should be within normally accepted design tolerances of 25mm, as outlined in NZS 3604:2011 (Ref. [10]), with respect to conventional building development.

Settlement plates were installed in the areas of greatest fill thickness, prior to fill placement, to monitor the settlement of the subgrade through Precinct 2. This monitoring shows that settlements of up to 145mm occurred during development. This settlement occurred between February 2016 and December 2016, with negligible movement since that time. We consider that settlement of the underlying soils is also essentially complete under the current surcharge.

In order to minimise the risk of ground settlements exceeding 25 mm, NZS 3604:2011 (Ref. [10]) allows a maximum fill surcharge of 600 mm over the building platform during future development. Filling in excess of this thickness should be subject to specific foundation design and assessment.

5.4 Retaining walls

Due to the shallow grades across most of the Stage 4A Lots, it is not anticipated that significant retaining walls will be required as part of any Lot development. However, if walls are required, then the retaining wall design will be dependent on the site specific requirements.

For preliminary design we recommend the use of the following geotechnical design parameters:

$$\gamma = 18 \text{ kN/m}^3,$$

$$c' = 0 \text{ kPa},$$

$$\phi' = 30^\circ,$$

$$K_a = 0.30,$$

$$K_p = 3.33,$$

"Su" of 50kPa for the embedment soil (subject to confirmation during construction).

These values are based on level ground above and below the wall and will require appropriate amendment to allow for slope, traffic and other surcharges or toe slopes and the specific lot geometry and development requirements, as applicable.

All retaining walls should include a layer of free draining granular fill (with geotextile over the top) immediately behind the wall covered with a 0.3m thick (minimum) compacted clay fill cap, with intercepted groundwater seepage piped into the reticulated stormwater system.

Any walls greater than 1.5m retained height will require a geotechnical assessment, as a minimum, to check and confirm that the stability of the subject (or adjacent) Lot is not detrimentally affected.

The existing timber pole retaining walls constructed within the Precinct 2 Stage 4A area are shown on the Woods Retaining Walls As-Built Plans (Woods Ref 33218-04A-130-AB to -134). These walls have been designed to accommodate a maximum 5kPa surcharge, although development immediately behind/above the walls is likely to be precluded by Council planning rules. The presence of these walls should be taken into account for any proposed works downslope of the walls, specifically to ensure that any proposed cuts do not undermine the base of the walls. In general, earthworks should be limited to no closer than 1.5m from the toe of the walls.

For clarity, the Lots within Stage 4A that will need to consider the presence of the existing retaining walls during site development are:

- a Timber wall 306 – Lots 1011 to 1013 inclusive
- b Timber wall 307 – Lots 1014 to 1016 inclusive
- c Timber wall 308 – Lots 1017 to 1019 inclusive

5.5 Subsoil Drainage

Following gully muckouts during initial bulk earthworks, groundwater drainage was installed using Nexus drains covered in geotextile cloth to permanently handle ground water flows.

The extent of the subsoil drainage systems are shown on the Woods Shear Key, Undercuts & Subsoil Drains As-Built Plans (Woods Ref 33218-04A-120-AB to -122) in Appendix A1, and on T+T Drawing 21854.001-P2S4A-102 in Appendix A2.

This drainage system is relatively deep and located so that it is unlikely to be encountered during future residential site development and is expected to be maintenance free. Any deep excavations should take account of the presence of these drains nonetheless. If a drain is encountered, damaged, or identified as defective, repairs should be observed by a Chartered Professional (Geotechnical) Engineer familiar with this report, and notified to Auckland Council.

The Woods Shear Key, Undercuts & Subsoil Drains As-Built Plans (Woods Ref 33218-04A-120-AB to -122) shows the location and invert of the subsoil drainage through this Stage.

5.6 Post Earthworks Investigations

Following the completion of earthworks operations, T+T have undertaken supplementary fieldwork to confirm the consistency of the natural subsoils and engineered fill. From the investigations, we confirm that the subsoils are considered to have a geotechnical ultimate bearing capacity of 300kPa, as required by NZS 3604:2011 (Ref. [10]). This corresponds to a factored (Ultimate Limit State) bearing capacity of 150kPa and working (Serviceability Limit State) bearing capacity of 100kPa. Associated borehole logs and site plan (T+T Drawing 21854.001–P2S4A–110) are attached in Appendix E.

5.7 Stormwater

Public stormwater services have been installed within the Precinct 2, Stage 4A. Stormwater and runoff from roofs, decks and paved areas, together with discharges from retaining wall drains and other subsoil drains must be connected directly into the public stormwater drainage network.

5.8 Service lines

Trench backfill has been compacted to minimise potential for future settlements. However, where building envelopes lie adjacent to or across service lines, all foundations should extend and be founded below the 45 degree zone of influence line from pipe inverts. This requirement is to avoid excessive pipe surcharges, and to allow for future maintenance of the system without detrimentally affecting adjacent structures. Subject to approval from Auckland Council, foundations may extend and bridge over service lines provided specific foundation design is undertaken.

A copy of the stormwater as-built plans (Woods Stormwater As-Built Plans, Woods Ref 33218–4A–300–AB to –304) are included in Appendix A1.

5.9 Road subgrades

Based on the fill monitoring and site observations during development, filled and natural ground within the road and vehicle access Lots is considered generally suitable for the proposed residential pavements. Subgrade strength testing was carried out following excavation to formation levels along the road alignments. These subgrade test results were passed on to Woods for use in their pavement design. All road subgrades have been lime and cement stabilised to assist in pavement strengths, and to minimise the impact of expansive soils on road pavements.

For future road construction in other parts of the Precinct 2 Stage 4A development, within natural ground, a design CBR of 2% is considered appropriate while, within engineered fill areas, a design CBR of 7% is appropriate.

5.10 Topsoil

Following completion of topsoil spreading and grassing, topsoil depths were measured in each of the Lots and these are shown on T+T Drawing 21854.001–P2S4A–111 attached in Appendix E. Due to variations in placement depths and earth worked surface levels, topsoil depths may vary from those recorded.

5.11 Expansive soils

Expansive soils (or “reactive soils” using Australian terminology) are clay soils that undergo appreciable volume change upon changes in moisture content. The reactivity and the typical range of movement that could be expected from soils underlying any given building site depend on the amount of clay present, clay mineral type, and proportion, depth and distribution of clay throughout the soil profile. Moisture changes tend to occur slowly in clays and produce swelling upon wetting and shrinkage upon drying.

Apart from seasonal moisture changes (wet winters / dry summers) other factors that can influence soil moisture content include:

- a Influence of garden watering and site drainage;
- b The presence of large trees (especially fast growing Australian species such as eucalyptus) close to building envelopes, and;
- c Initial soil moisture conditions at construction time.

Visually, the surfaces of expansive soils are noted for developing extensive cracking during dry periods (especially late summer through autumn in Auckland) and can be locally identified by this feature when sites are excavated and left for a week or two to dry out. Further information on expansive soils is given in Appendices C and D of this report.

In order to assess for the presence of expansive soils within this stage of the development, representative soil samples were retrieved from near surface strata and tested by Geotechnics Ltd to determine soil shrinkage characteristics in accordance with AS 1289.7.1.1.

Based on the laboratory results (attached in Appendix E), the foundation soils on this stage of the subdivision lie outside the definition of 'good ground' as outlined in NZS 3604:2011 (Ref. [10]).

In terms of AS 2870:2011 (Ref. [9]), the soils present are considered to lie within Site Class M (moderately expansive) with characteristic surface movements anticipated to be in the range of 20mm to 40mm.

Accordingly, building foundations on this stage of the subdivision will need to be subject to specific foundation design by a Chartered Professional Engineer familiar with the contents of this report and responsible for design of structural elements (including foundations) of the building. Reference should be made to AS 2870:2011 (Ref. [9]) for assistance.

6 Statement of Professional Opinion as to the Suitability of Land for Building Development

I, Mr C.J. Freer of Tonkin & Taylor Ltd, P O Box 5271, Wellesley St, Auckland, hereby confirm that:

- 6.1 I am a Chartered Professional Engineer experienced in the field of geotechnical engineering and an authorised representative of Tonkin + Taylor who was retained by WFH Properties Ltd as the Geotechnical Engineer on Precinct 2 Stage 4A (comprising high density residential Lots 1011 to 1019 inclusive) of the Millwater Residential Subdivision Development off the Millwater Parkway in Silverdale. Inspection and observation of the works have been carried out during construction by either myself or staff acting under my direction.
- 6.2 The extents of preliminary investigations are described in Tonkin & Taylor Ltd Precinct 2 Geotechnical Investigation Report Ref No. 21854.001 dated May 2014. The conclusions and recommendations of those documents have been re-evaluated in the preparation of this report. Details of all earthworks control tests performed are enclosed (Appendix E).
- 6.3 The Contractors have confirmed that the work undertaken has been completed in accordance with the drawings, specifications and any variations issued and is consistent with the inspections and observations carried out by Tonkin & Taylor Ltd. Complete Construction Certificates have been provided by the Contractors and are presented in Appendix B. Tonkin & Taylor Ltd accepts no liability for any errors or omissions represented by those documents.
- 6.4 On the basis of our observations and inspections together with the information supplied by others, including the Contractor's Construction Certificates, it is my professional opinion, not to be construed as a guarantee that:
 - 6.4.1 The earth fills shown on the attached Woods drawings, Project No 33216, Millwater, Precinct 2, Stage 4A, Drawing Numbers 33218-04A-100-AB to -102 and -110 to -112, have been generally placed in compliance with NZS 4431:1989 (Ref. ([8])).
 - 6.4.2 The completed earthworks give due regard to land slope and foundation stability considerations.
- 6.5 **For High Density Residential Lots 1011 to 1019 inclusive:**
 - 6.5.1 **Foundation design**
The filled and natural ground within residential Lot boundaries is considered generally suitable for the erection thereon of light timber framed, flexibly clad residential buildings subject to clauses 6.5.2 to 6.5.5.
 - 6.5.2 **Bearing capacity**
Foundation design for these Lots should limit geotechnical ultimate bearing capacity to 300 kPa (factored (ULS) 150 kPa, working (SLS) 100 kPa). This is as specified in NZS 3604:2011 (Ref. [10]).
 - 6.5.3 **Expansive soils**
Due to the presence of expansive clay soils, foundation soils lie outside the definition of 'good ground' in NZS 3604:2011 (Ref. [10]). Soils are considered to lie in Site Class M (moderately expansive) as defined in AS 2870:2011 (Ref. [9]) with anticipated characteristic surface ground movements of 20mm to 40mm. Clause 6.5.3.1 of this Geotechnical Completion Report may be used for expansive soil foundation design on this subdivision:

6.5.3.1 Specific foundation design for expansive soils

Specific foundation design should be undertaken by a Chartered Professional Engineer familiar with the contents of this report and responsible for design of structural elements (including foundations) of the building.

The minimum specific design requirements set for expansive soils within this clause are:

- i) Minimum foundation embedment of 600 mm following topsoil removal and benching of building platform areas to finished ground levels
- ii) Four bar steel reinforcing cages should be used
- iii) For buildings having brittle exterior cladding, for example brick veneer, stucco plaster, solid plaster, block work, styrofoam type cladding or sprayed plaster over harditex systems etc, the potential effects of seasonal ground movements need to be considered by the building designer.

The above minimum requirements within this clause may be superceded if individual engineers are able to demonstrate their specific design solutions are applicable to site soil conditions to the satisfaction of Auckland Council. Specific design may be undertaken by first principles or by reference to AS 2870:2011 (Ref. [9]), Section 4 and related documents.

6.5.4 Floor Slab Construction

Slab on grade construction is expected to be relatively straightforward across the subdivision, but problems can occur with slab construction on shrink/swell sensitive soils. In soils which become desiccated in summer, subsequent capillary moisture rise may cause dry soils to wet up and swell, causing slab uplift and building distress. Alternatively, construction during winter may result in subgrade soils with high moisture contents drying out through summer, with subsequent soil shrinkage and possible building deformation.

The structural engineer should take likely construction timeframes into account and confirm that their design and construction methodologies will accommodate the soil shrinkage or swelling that may occur.

The Contractor should ensure that the ground beneath the floor slab areas is suitably conditioned to ensure that the subgrade is neither too dry nor too wet prior to hardfill placement and concrete pouring to avoid undue shrink or swell movements.

6.5.5 Building maintenance - Owners responsibility

The owner is responsible for maintenance of the building and site and should be familiar with the performance and maintenance requirements set out in CSIRO sheet BTF18 Foundation Maintenance and Footing Performance: A Home Owners Guide. A copy of this sheet is included in Appendix D.

6.5.6 Retaining walls / Earthworks

No retaining wall construction in excess of 1.5 metres height and no earthworks involving fills in excess of 600mm depth should take place on these Lots unless endorsed by a suitable design undertaken by a Chartered Professional (Geotechnical)

Engineer familiar with the contents of this report and responsible for design of structural elements of the building.

6.6 Underfill (Subsoil) drainage

Underfill (Subsoil) drains have been installed during subdivisional development in the locations shown on the Woods Shear Key, Undercuts & Subsoil Drains As-Built Plans (Woods Ref 33218-04A-120-AB to -122) in Appendix A1, and on T+T Drawing 21854.001-P2S4A-102 in Appendix A2. These drains are considered to be maintenance free. This drainage system is relatively deep and located so that it is unlikely to be encountered during future residential site development. Although future works are unlikely to encounter the drains, their location should be considered prior to designing deep foundations and, if damaged, repairs should be observed by a Chartered Professional (Geotechnical) Engineer familiar with this report, and notified to Auckland Council.

The Woods Shear Key, Undercuts & Subsoil Drains As-Built Plans (Woods Ref 33218-04A-120-AB to -122) shows the location of the subsoil drains through these Lots.

6.8 Stormwater and Sanitary Sewer Lines

Where building envelopes lie adjacent to or across service lines, all foundations should extend and be founded below the 45 degree zone of influence line extending from pipe inverts. This requirement is to avoid excessive pipe surcharges, and to allow for future maintenance of the system without detrimentally affecting adjacent structures. Subject to approval from Auckland Council, foundations may extend and bridge over service lines provided specific foundation design is undertaken. A copy of the stormwater as-built plans are included in Appendix A1.

6.9 Road and Access Lots

Based on the fill monitoring and site observations undertaken during site development, the filled and natural ground within Precinct 2, Stage 4A is considered generally suitable for residential road and accessway construction. Scala penetrometer testing should be undertaken when road subgrades have been prepared to confirm subgrade strengths. Subject to such subgrade testing, for future road construction in other parts of the Precinct 2 Stage 4A development, within natural ground, a design CBR of 2% is considered appropriate, while within engineered fill areas, a design CBR of 7% is appropriate.

6.10 Unexpected ground conditions

Our assessment is based on interpolation between borehole positions, site observations and periodic earthworks control visits. Local variations in ground conditions may occur. Although unlikely, unfavourable ground conditions may be encountered during site benching and footing excavations. It is important that we be contacted in this eventuality, or in the event that any variation in subsoil conditions from those described in the report are found. Design assistance is available as required to accommodate any unforeseen ground conditions present.

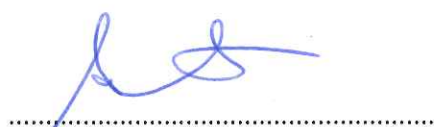
7 Applicability

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

It does not remove the necessity for the normal inspection of foundation conditions at the time of erection of any dwelling, especially in cases where concrete blockwork and/or brick veneer or stucco plaster buildings are sited partly on fill or partly on natural ground, or where they are entirely sited on filling whose depth changes significantly across the building platform.

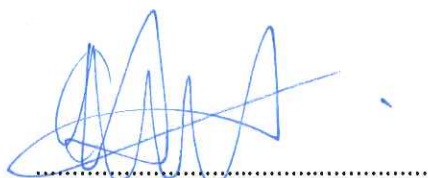
Tonkin & Taylor Ltd

Report prepared by:



Andrew Linton
Senior Geotechnical Engineer

Technical review by:



Andrew Stiles
Senior Geotechnical Engineer

Authorised for Tonkin & Taylor Ltd by:



Chris Freer
Project Director BE (Civil), MIPENZ, C.P. Eng.

JXXL

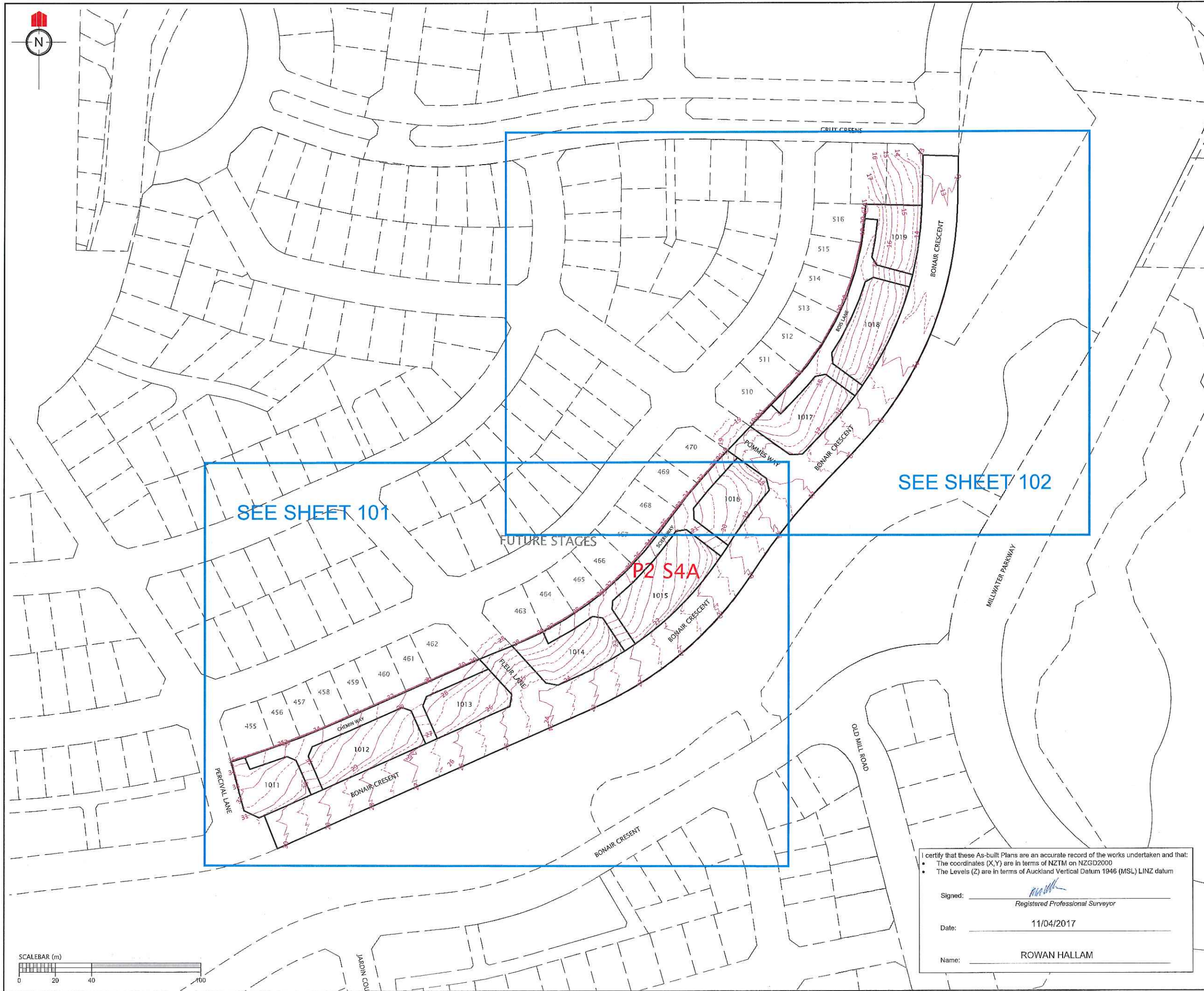
p:\21854\21854.001 - precinct 2\gcr\stage 4a\jxxl 170511 p2s4a-gcr - final.docx

8 References

- [1] Tonkin & Taylor Ltd., October 2001. *Stoney Block*, T+T Ref. 18214.
- [2] Tonkin & Taylor Ltd., May 2001. *Silverdale Blocks, Silverdale, Geotechnical Issues – Future Medium Density Development*, T+T Ref. 18213.
- [3] Tonkin & Taylor Ltd., November 2003. *Silverdale North and Orewa West Blocks, Silverdale, Geotechnical Issues – Future Medium Density Development*, T+T Ref. 20914.
- [4] Tonkin & Taylor Ltd., November 2004. *Wainui Road Subdivision, Silverdale, Geotechnical Investigation Report*, T+T Ref. 21854.
- [5] Tonkin & Taylor Ltd., October 2005. *Wainui Road Subdivision, Silverdale, Geotechnical Investigation Report – Scheme Plan 7*, T+T Ref. 21854.
- [6] Tonkin & Taylor Ltd., March 2006. *Silverdale North – Westlake Block, Geotechnical Investigation Report*, T+T Ref. 21854.
- [7] Tonkin & Taylor Ltd., June 2014. *Millwater – Precinct 2, Geotechnical Investigation Report*. T+T Ref. 21854.001
- [8] New Zealand Standards, 1989. *NZS 4431:1989 Code of Practice for Earth Fill for Residential Development*.
- [9] Standards Australia, 2011. *AS 2870:2011 Residential slabs and footings*.
- [10] New Zealand Standards, 2011. *NZS 3604:2011 Timber Framed Buildings*.

Appendix A1: Woods Drawings

- 33218-04A-100-AB to -102 Final Contour As-Built Plans
- 33218-04A-110-AB Cut/Fill Contour As-Built Plan
Original Surface – Earthworks Surface
- 33218-04A-111-AB Cut/Fill Contour As-Built Plan
Earthworks Surface – Final Surface
- 33218-04A-112-AB Cut/Fill Contour As-Built Plan
Original Surface – Final Surface
- 33218-04A-120-AB to -122 Shear Key, Undercut & Subsoil Drains As-Built
Plans
- 33218-04A-130-AB to -134 Retaining Wall As-Built Plans
- 33218-4A-300-AB to -304 Stormwater As-Built Plans




REVISION DETAILS	NAME	DATE

NOTES

1. CONTOURS ARE AT 0.5 METRE INTERVALS
2. BOUNDARIES ARE SUBJECT TO FINAL SURVEY.

LEGEND	
	CONTOURS MAJOR
	CONTOURS MINOR
	STAGE BOUNDARIES
	LOT BOUNDARIES

CLIENT:



WOODS
Engineers. Surveyors. Planners.


**MILLWATER
PRECINCT 2
STAGE 4A**

**FINAL CONTOUR
AS-BUILT PLAN
PAGE 1 OF 3**

AUCKLAND COUNCIL

I certify that these As-built Plans are an accurate record of the works undertaken and that:

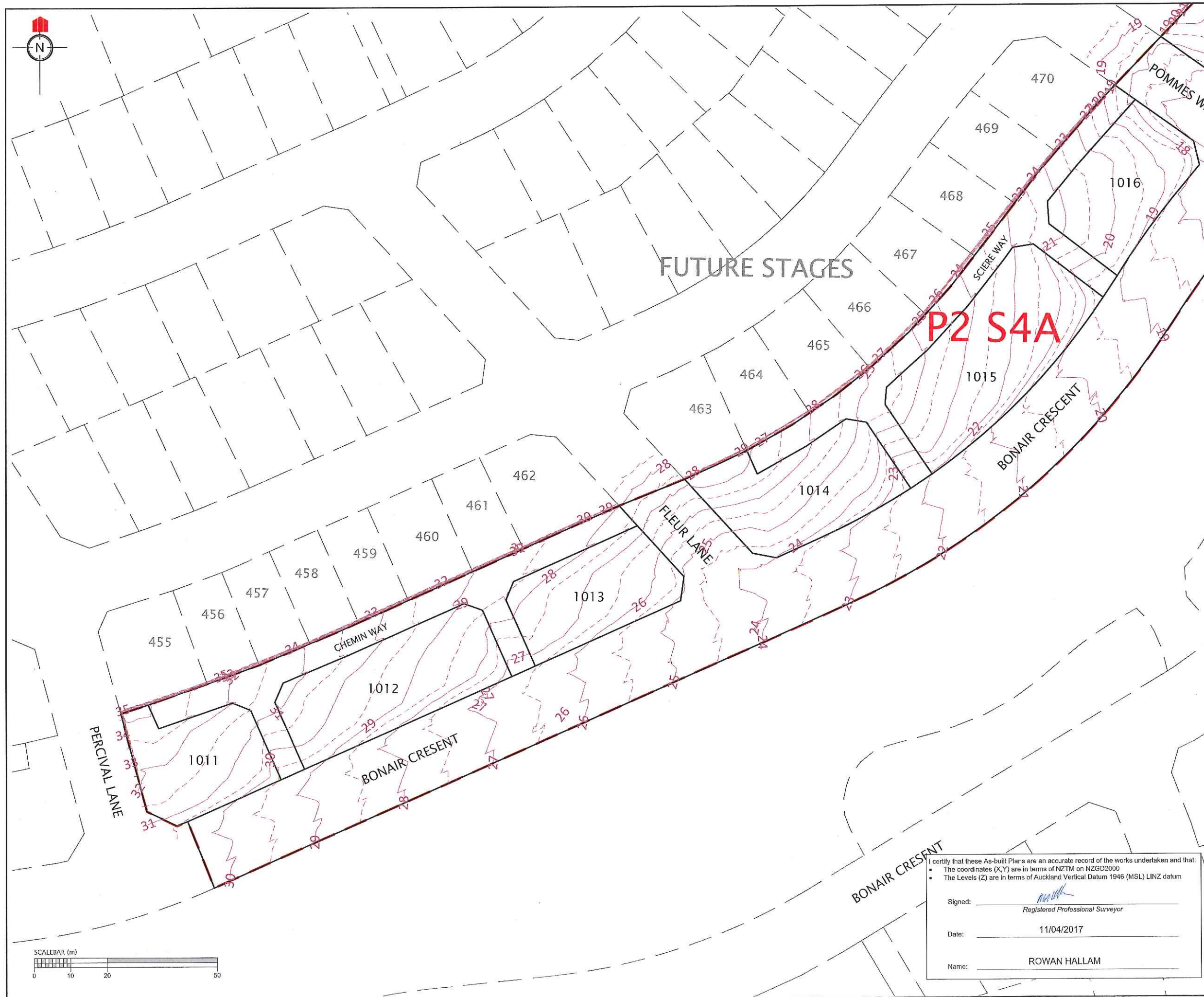
- The coordinates (X,Y) are in terms of NZTM on NZGD2000
- The Levels (Z) are in terms of Auckland Vertical Datum 1946 (MSL) LINZ datum

Signed: 
Registered Professional Surveyor

Date: 11/04/2017

Name: ROWAN HALLAM

DESIGNED: AC	ASBUILT
CHECKED: KR	DRAWN: SP
APPROVED: MRH	SURVEYED: WOODS
JOB NUMBER: 33218	SCALE: 1:2000 @ A3
ISSUED: APRIL 2017	REV.
DWG. NO. 33218-04A-100-AB	



REVISION DETAILS		NAME	DATE

NOTES
1. CONTOURS ARE AT 0.5 METRE INTERVALS
2. BOUNDARIES ARE SUBJECT TO FINAL SURVEY.

LEGEND
— CONTOURS MAJOR
- - CONTOURS MINOR
- - STAGE BOUNDARIES
— LOT BOUNDARIES

CLIENT:

**MILLWATER
PRECINCT 2
STAGE 4A**

**FINAL CONTOUR
AS-BUILT PLAN
PAGE 2 OF 3**

AUCKLAND COUNCIL

DESIGNED: AC	ASBUILT
CHECKED: KR	DRAWN: SP
APPROVED: MRH	SURVEYED: WOODS
JOB NUMBER: 33218	SCALE: 1:1000 @ A3
ISSUED: MARCH 2017	
DWG. NO. 33218-04A-101-AB	REV.

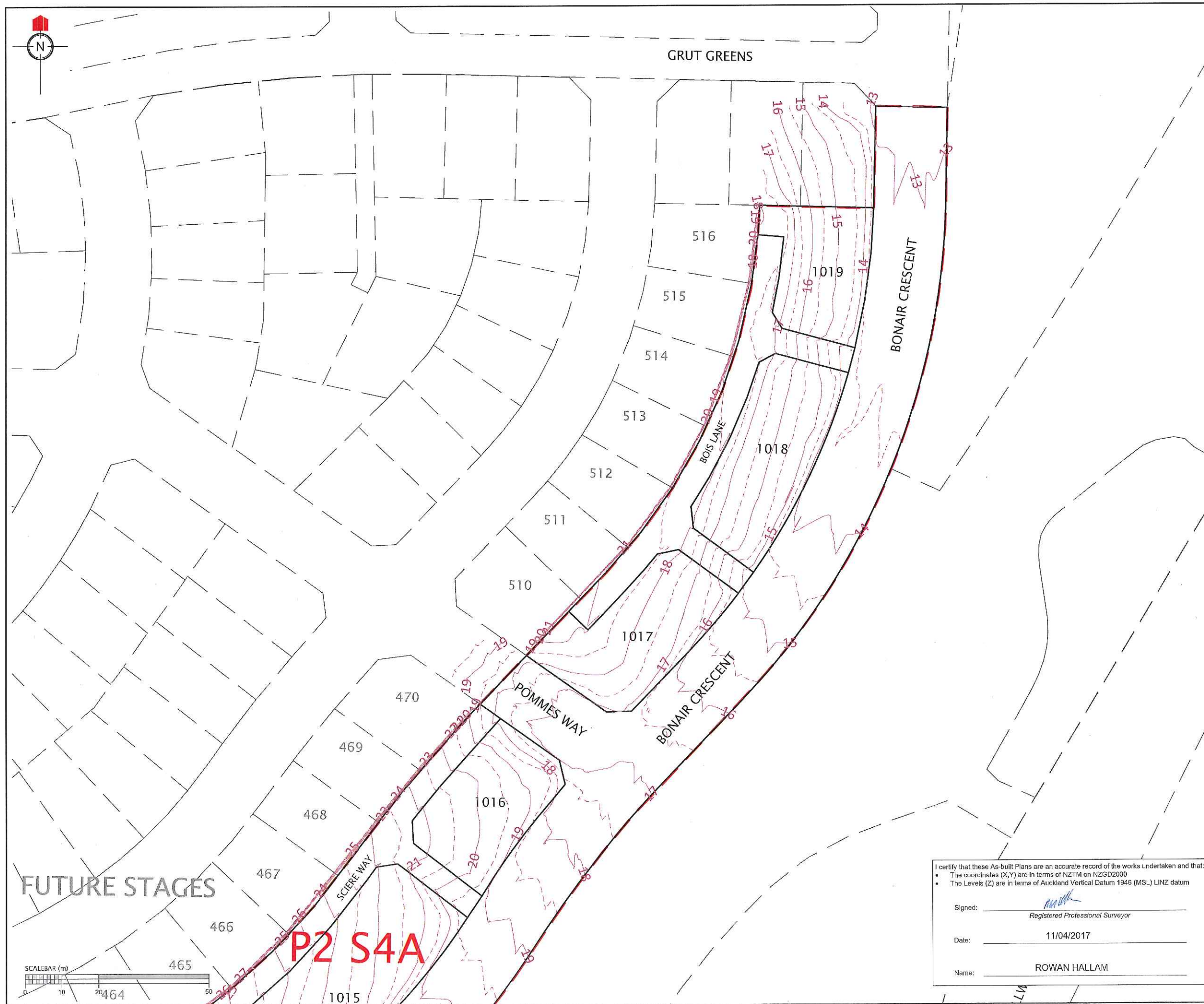
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- The Levels (Z) are in terms of Auckland Vertical Datum 1946 (MSL) LINZ datum

Signed: Registered Professional Surveyor

Date: 11/04/2017

Name: ROWAN HALLAM



REVISION DETAILS	NAME	DATE

NOTES

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2. BOUNDARIES ARE SUBJECT TO FINAL SURVEY.

LEGEND

- CONTOURS MAJOR
- - - CONTOURS MINOR
- - - STAGE BOUNDARIES
- LOT BOUNDARIES

CLIENT:



MILLWATER PRECINCT 2 STAGE 4A

FINAL CONTOUR
AS-BUILT PLAN
PAGE 3 OF 3

AUCKLAND COUNCIL

I certify that these As-built Plans are an accurate record of the works undertaken and that:

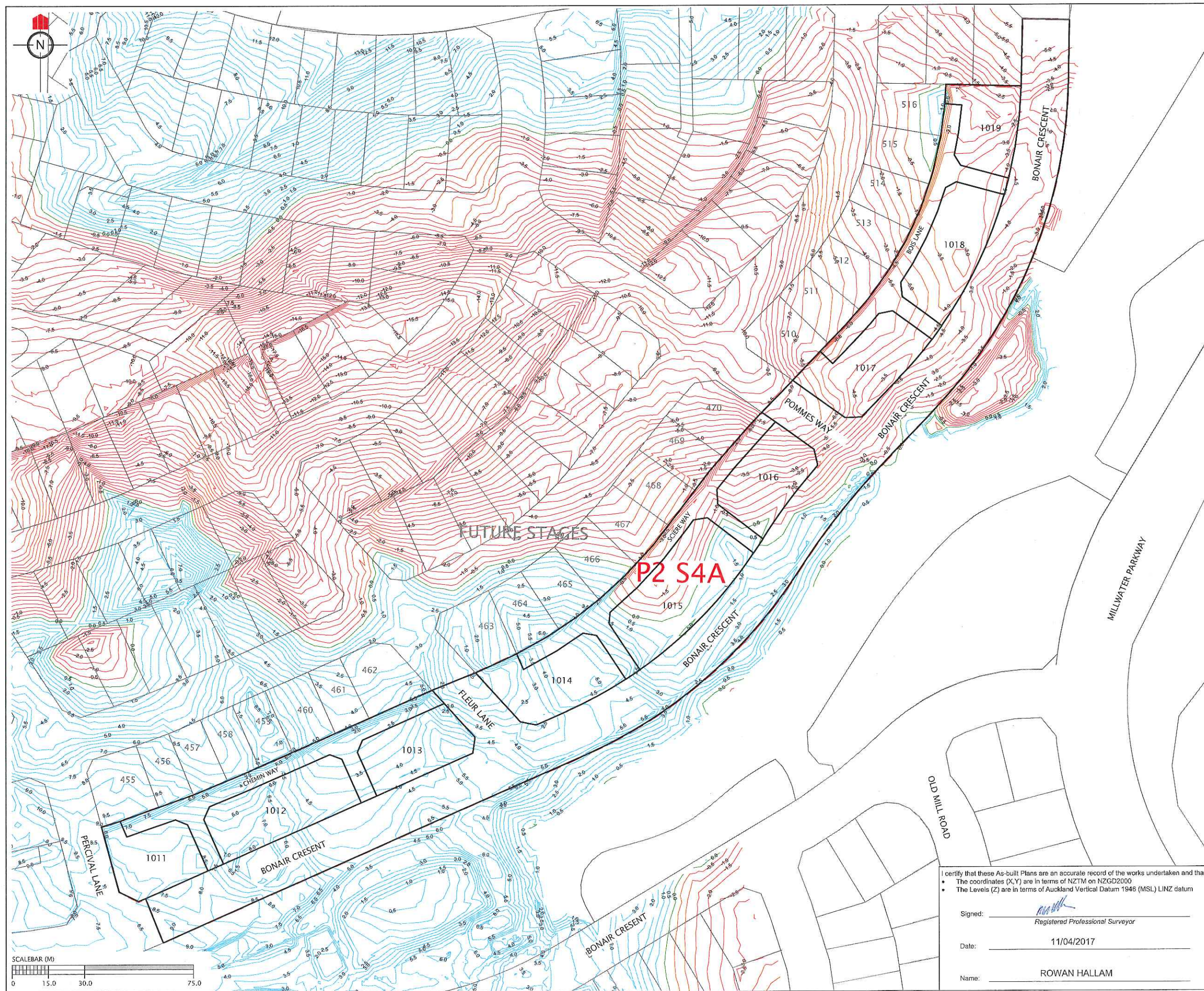
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- The Levels (Z) are in terms of Auckland Vertical Datum 1948 (MSL) LINZ datum

Signed: 
Registered Professional Surveyor

Date: 11/04/2017

Name: ROWAN HALLAM

DESIGNED: AC	ASBUILT
CHECKED: KR	DRAWN: SP
APPROVED: MRH	SURVEYED: WOODS
JOB NUMBER: 33218	SCALE: 1:1000 @ A3
ISSUED: MARCH 2017	
DWG. NO. 33218-04A-102-AB	REV.



REVISION DETAILS		NAME	DATE

NOTES
1. CONTOURS ARE AT 0.5 METRE INTERVALS

LEGEND

- ZERO CONTOUR
- CUT CONTOUR
- FILL CONTOUR
- STAGE BOUNDARIES
- LOT BOUNDARIES

CLIENT:

WOODS
Engineers, Surveyors, Planners.

**MILLWATER
PRECINCT 2
STAGE 4A**

**CUT/FILL CONTOUR AS-BUILT
ORIGINAL SURFACE -
EARTHWORKS SURFACE**

AUCKLAND COUNCIL

I certify that these As-built Plans are an accurate record of the works undertaken and that:

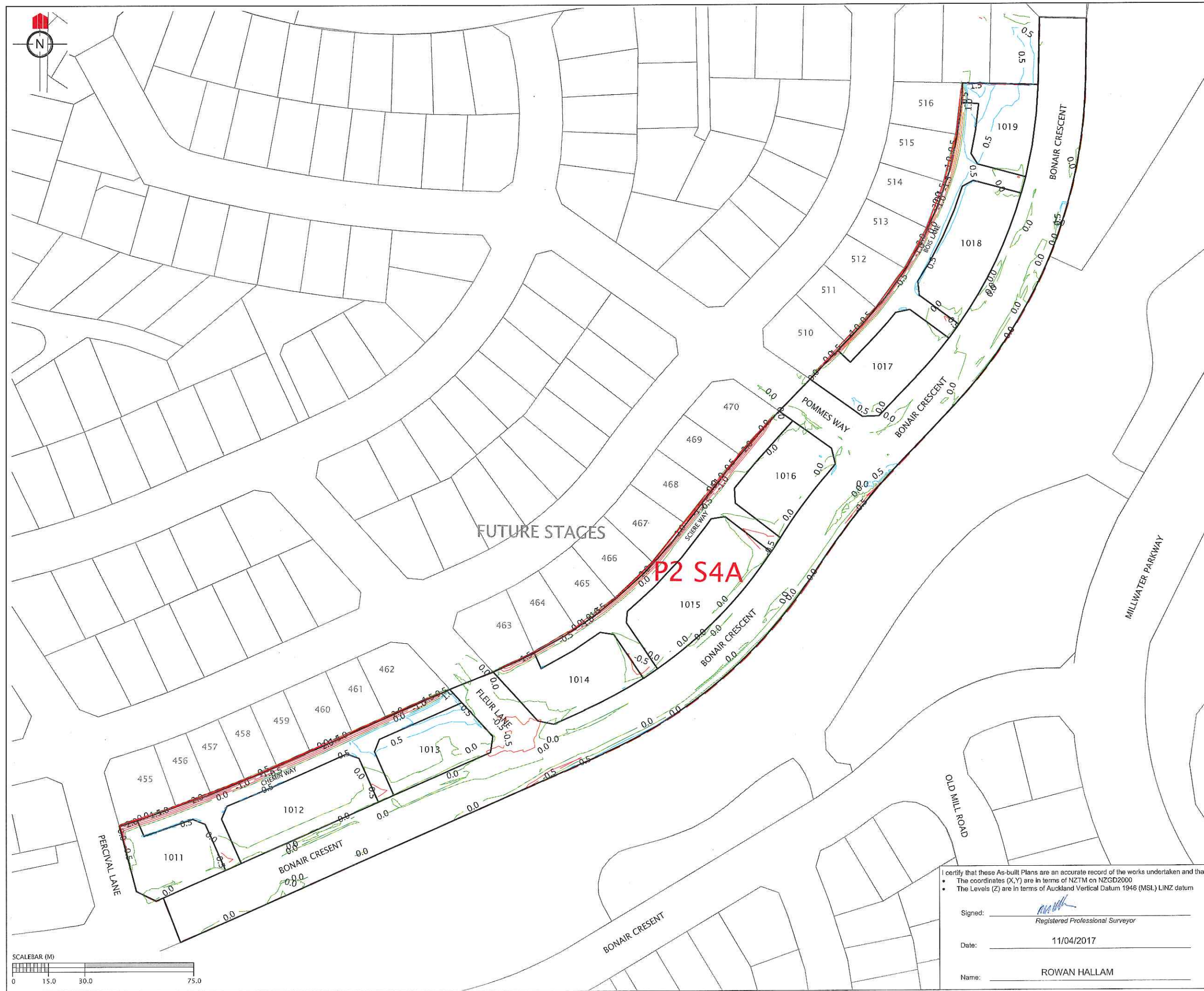
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- The Levels (Z) are in terms of Auckland Vertical Datum 1946 (MSL) LINZ datum

Signed: 
Registered Professional Surveyor

Date: 11/04/2017

Name: ROWAN HALLAM

DESIGNED: AC	ASBUILT
CHECKED: KR	DRAWN: KR
APPROVED: MRH	SURVEYED: WOODS
JOB NUMBER: 33218	SCALE: 1:1500 @ A3
ISSUED: APRIL 2017	
DWG. NO. 33218-04A-110-AB	REV.



REVISION DETAILS	NAME	DATE

NOTES
1. CONTOURS ARE AT 0.5 METRE INTERVALS

LEGEND	
	ZERO CONTOUR
	CUT CONTOUR
	FILL CONTOUR
	STAGE BOUNDARIES
	LOT BOUNDARIES

CLIENT:




MILLWATER PRECINCT 2 STAGE 4A

CUT/FILL CONTOUR AS-BUILT
EARTHWORKS SURFACE - FINAL
SURFACE

AUCKLAND COUNCIL

I certify that these As-built Plans are an accurate record of the works undertaken and that:

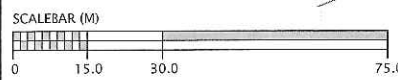
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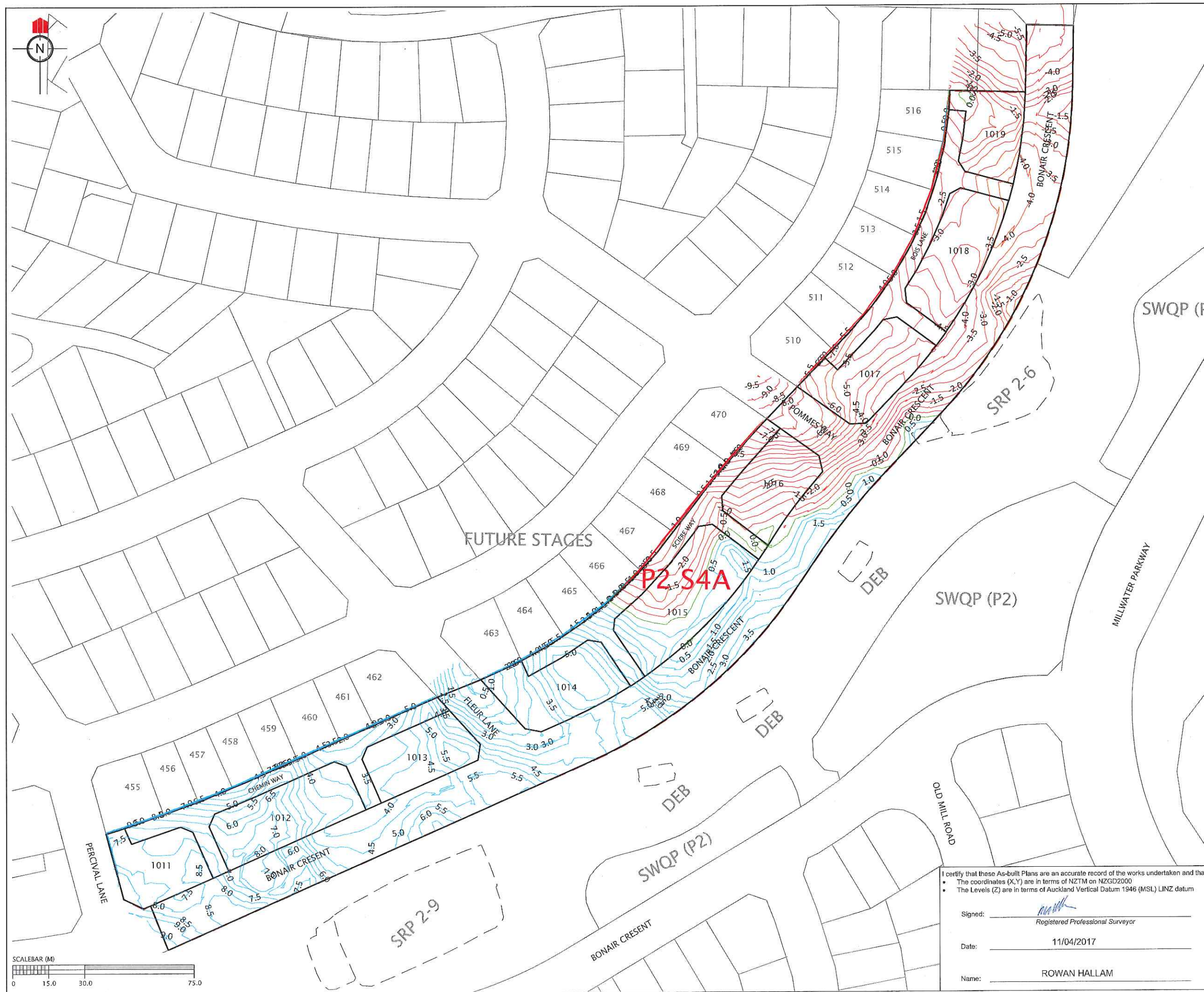
Signed: 
Registered Professional Surveyor

Date: 11/04/2017

Name: ROWAN HALLAM

DESIGNED: AC	ASBUILT
CHECKED: KR	DRAWN: KR
APPROVED: MRH	SURVEYED: WOODS
JOB NUMBER: 33218	SCALE: 1:1500 @ A3
ISSUED: APRIL 2017	
DWG. NO. 33218-04A-111-AB	REV.





REVISION DETAILS		NAME	DATE

NOTES
1. CONTOURS ARE AT 0.5 METRE INTERVALS

LEGEND
— ZERO CONTOUR
— CUT CONTOUR
— FILL CONTOUR
- - - STAGE BOUNDARIES
— LOT BOUNDARIES

CLIENT:

WFH PROPERTIES

WOODS
Engineers. Surveyors. Planners.

**MILLWATER
PRECINCT 2
STAGE 4A**

**CUT/FILL CONTOUR AS-BUILT
ORIGINAL SURFACE - FINAL
SURFACE**

AUCKLAND COUNCIL

DESIGNED: AC	ASBUILT
CHECKED: KR	DRAWN: KR
APPROVED: MRH	SURVEYED: WOODS
JOB NUMBER: 33218	SCALE: 1:1500 @ A3
ISSUED: APRIL 2017	
DWG. NO. 33218-04A-112-AB	REV.

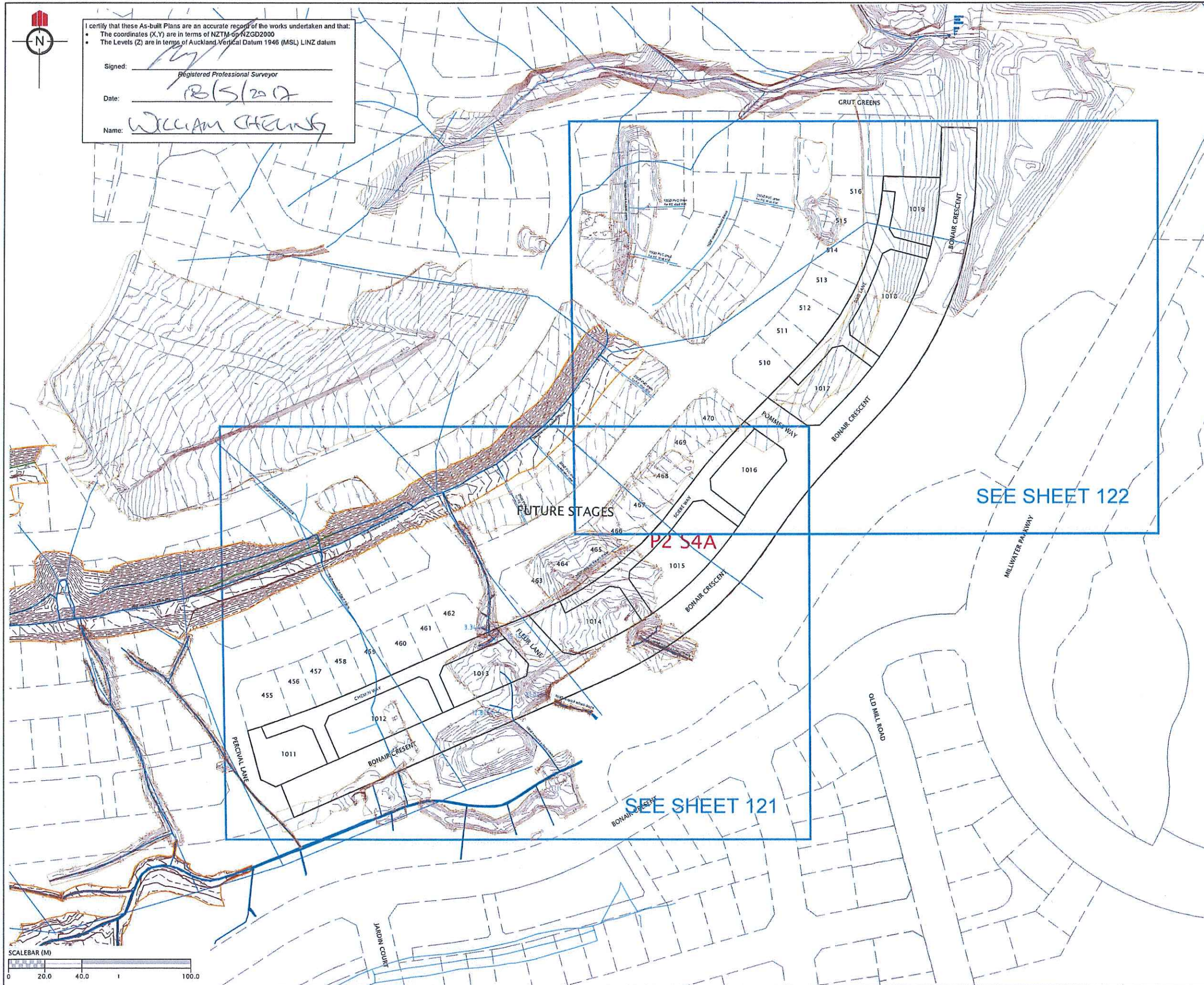
I certify that these As-built Plans are an accurate record of the works undertaken and that:

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- The Levels (Z) are in terms of Auckland Vertical Datum 1946 (MSL) LINZ datum

Signed: Registered Professional Surveyor

Date: 11/04/2017

Name: ROWAN HALLAM



I certify that these As-built Plans are an accurate record of the works undertaken and that:
• The coordinates (X,Y) are in terms of NZTM-02 NZGD2000
• The Levels (Z) are in terms of Auckland Vertical Datum 1946 (MSL) LINZ datum

Signed: _____
Registered Professional Surveyor
Date: 18/5/2017
Name: William Cheung

REVISION DETAILS	NAME	DATE
R1 Additional Precinct 3 Undercuts Added	KR	18/05/2017

NOTES

1. CONTOURS ARE AT 0.5 METRE INTERVALS

LEGEND

	NOVACOIL SUBSOIL DRAINS
	REINFORCED EARTH & RETAINING WALL SUBSOIL DRAINS
	EXISTING STORMWATER DRAINAGE
	NEW STORMWATER DRAINAGE
	STAGE BOUNDARIES
	LOT BOUNDARIES
	CONTOURS
	SHEAR KEY & UNDERCUT AREAS

CLIENT:

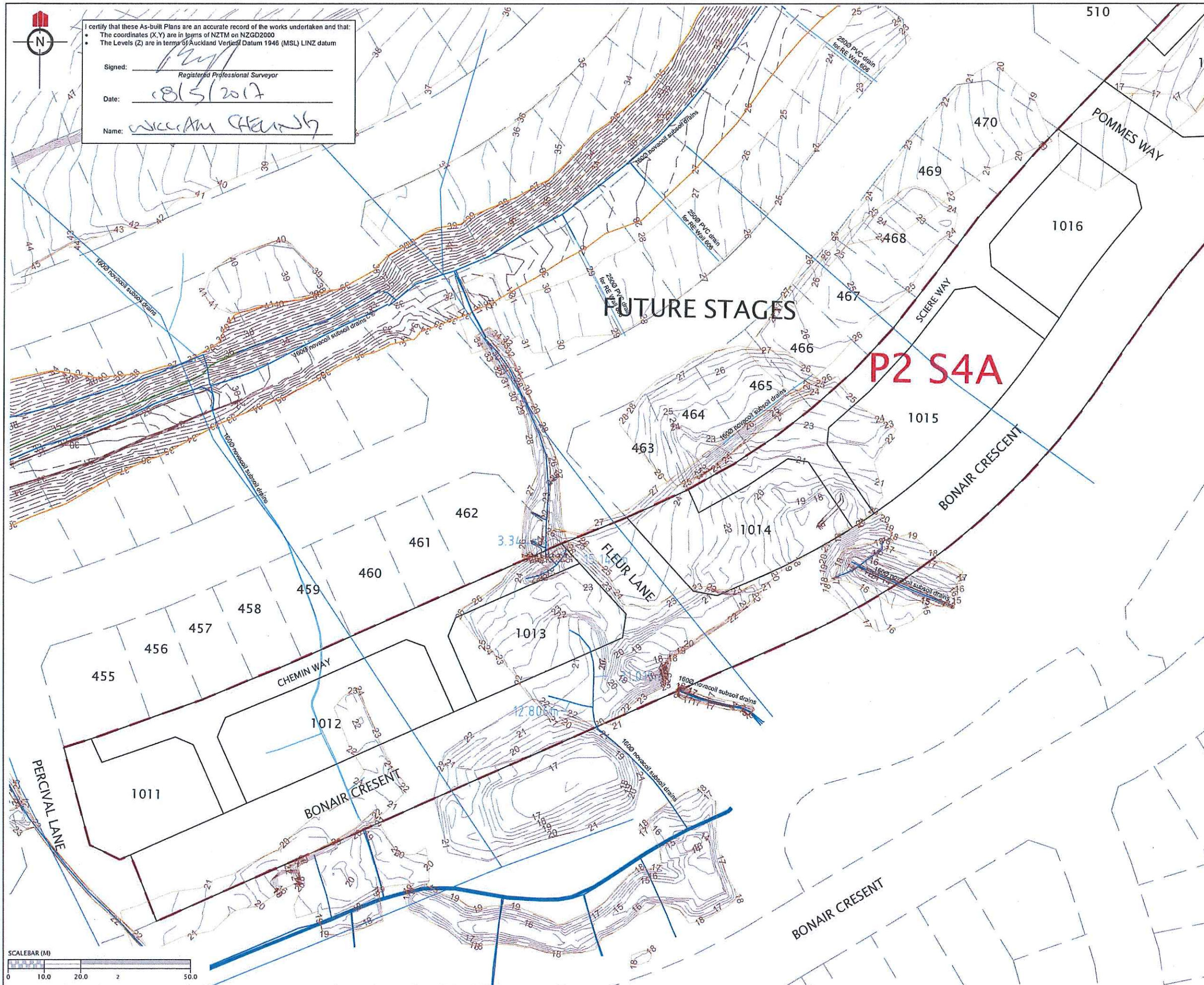


MILLWATER PRECINCT 2 STAGE 4A

SHEAR KEY, UNDERCUTS &
SUBSOIL DRAINS
AS-BUILT PLAN
PAGE 1 OF 3

AUCKLAND COUNCIL

DESIGNED: AC	ASBUILT
CHECKED: KR	DRAWN: KR
APPROVED: MRH	SURVEYED: HICKS
JOB NUMBER: 33218	SCALE: 1:2000 @ A3
ISSUED: MAY 2017	
DWG. NO. 33218-04A-120-AB	REV. 1



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• The coordinates (X,Y) are in terms of NZTM on NZGD2000
• The Levels (Z) are in terms of Auckland Vertical Datum 1946 (MSL) LINZ datum

Signed: [Signature]
Registered Professional Surveyor
Date: 18/5/2017
Name: William Henry

REVISION DETAILS	NAME	DATE
R1 Additional Precinct 3 Undercuts Added	KR	18/05/2017

NOTES

1. CONTOURS ARE AT 0.5 METRE INTERVALS

LEGEND

- NOVACOIL SUBSOIL DRAINS
- REINFORCED EARTH & RETAINING WALL SUBSOIL DRAINS
- EXISTING STORMWATER DRAINAGE
- NEW STORMWATER DRAINAGE
- STAGE BOUNDARIES
- LOT BOUNDARIES
- CONTOURS
- SHEAR KEY & UNDERCUT AREAS

CLIENT:

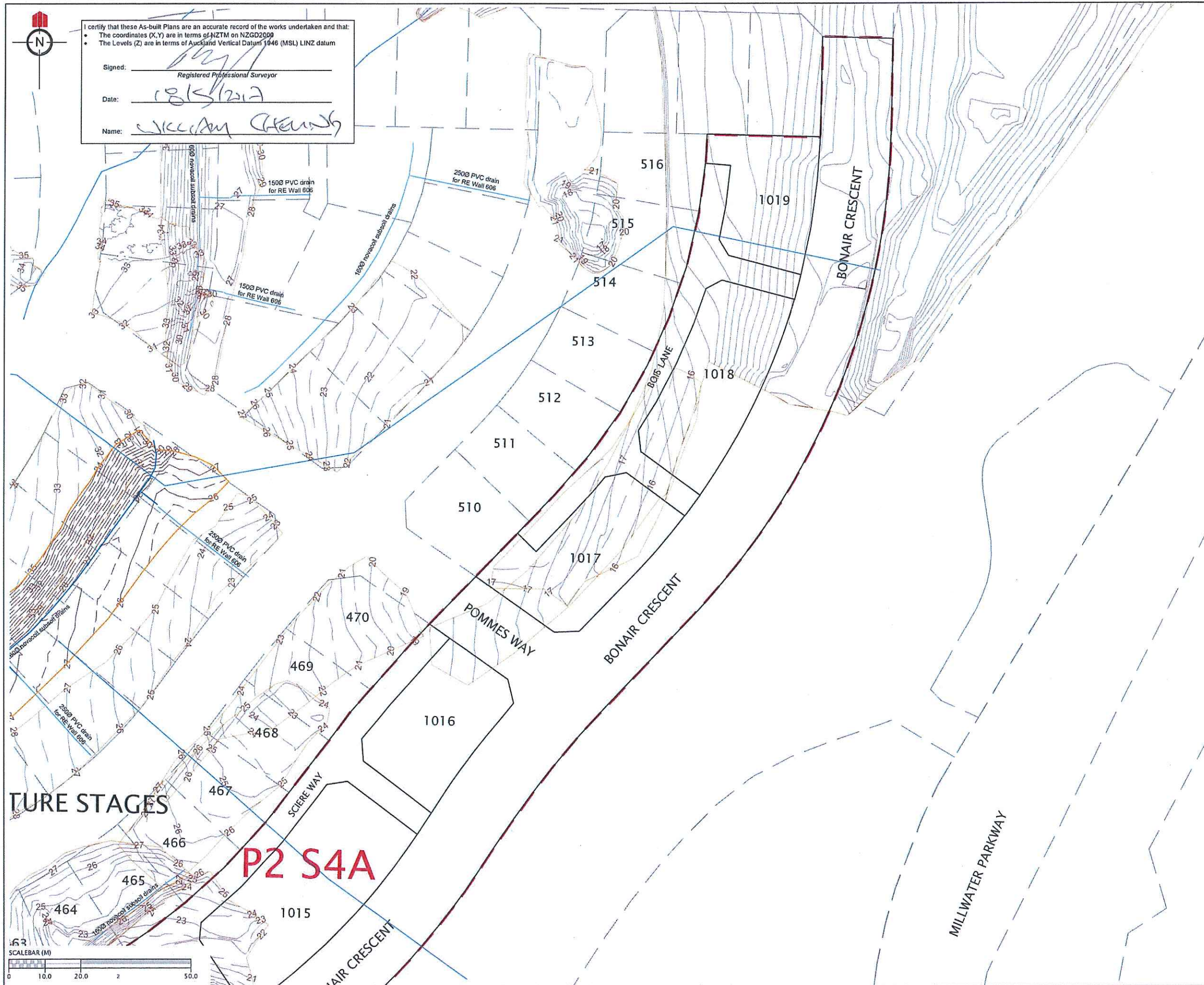


MILLWATER PRECINCT 2 STAGE 4A

SHEAR KEY, UNDERCUTS &
SUBSOIL DRAINS
AS-BUILT PLAN
PAGE 2 OF 3

AUCKLAND COUNCIL

DESIGNED: AC	ASBUILT
CHECKED: KR	DRAWN: KR
APPROVED: MRH	SURVEYED: HICKS
JOB NUMBER: 33218	SCALE: 1:1000 @ A3
ISSUED: MAY 2017	
DWG. NO. 33218-04A-121-AB	REV. 1



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• The coordinates (X,Y) are in terms of NZTM on NZGD2009
• The Levels (Z) are in terms of Auckland Vertical Datum 1946 (MSL) LINZ datum

Signed: _____
Registered Professional Surveyor

Date: 18/5/2017


Name: William Greaney

REVISION DETAILS	NAME	DATE
R1 Additional Precinct 3 Undercuts Added	KR	18/05/2017

NOTES
1. CONTOURS ARE AT 0.5 METRE INTERVALS

LEGEND	
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	REINFORCED EARTH & RETAINING WALL SUBSOIL DRAINS
	EXISTING STORMWATER DRAINAGE
	NEW STORMWATER DRAINAGE
	STAGE BOUNDARIES
	LOT BOUNDARIES
	CONTOURS
	SHEAR KEY & UNDERCUT AREAS

CLIENT:



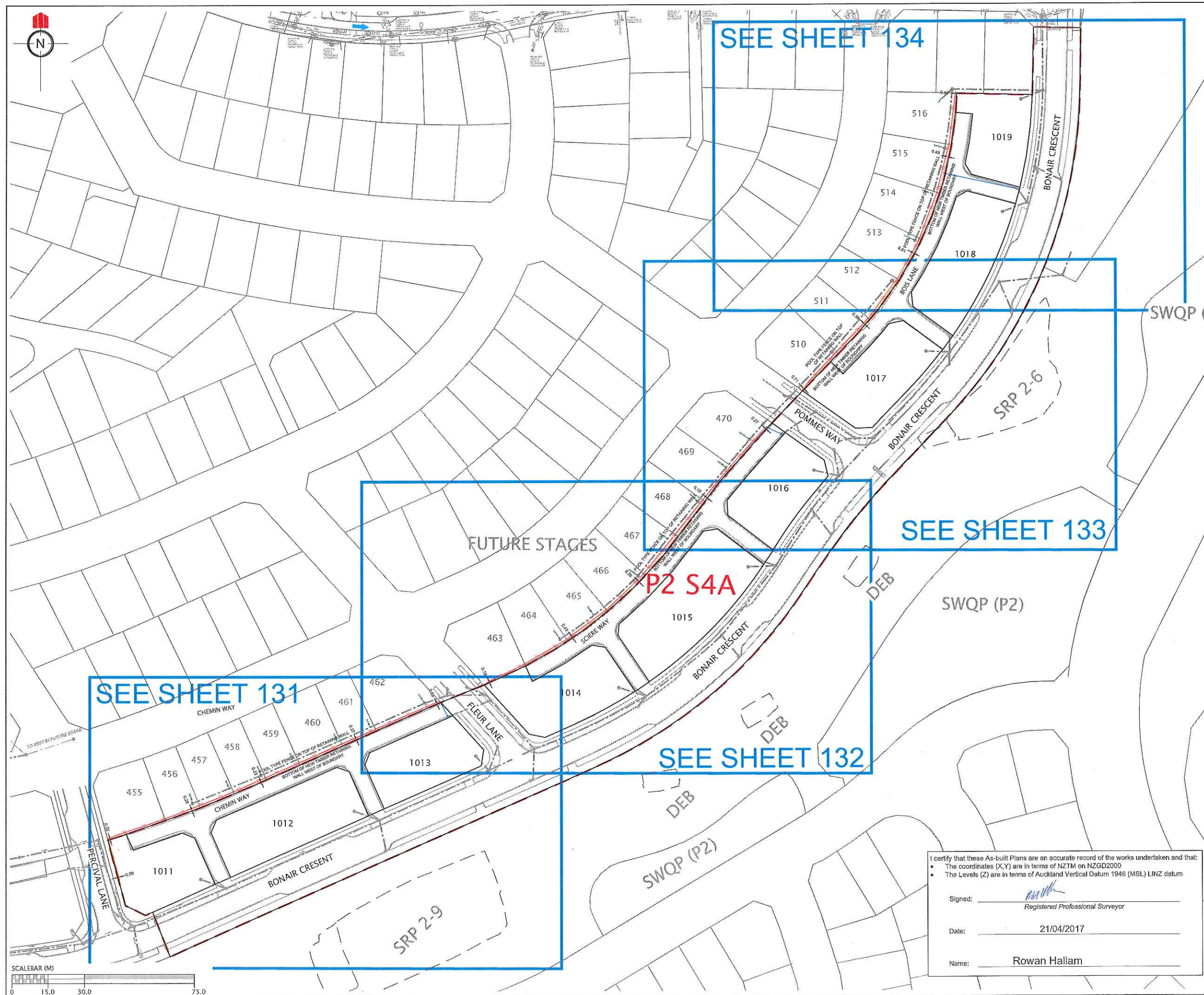
WOODS
Engineers. Surveyors. Planners.

**MILLWATER
PRECINCT 2
STAGE 4A**

**SHEAR KEY, UNDERCUTS &
SUBSOIL DRAINS
AS-BUILT PLAN
PAGE 3 OF 3**

AUCKLAND COUNCIL

DESIGNED: AC	ASBUILT
CHECKED: KR	DRAWN: KR
APPROVED: MRH	SURVEYED: HICKS
JOB NUMBER: 33218	SCALE: 1:1000 @ A3
ISSUED: MAY 2017	
DWG. NO. 33218-04A-122-AB	REV. 1



REVISION DETAILS		NAME	DATE

NOTE:
BOTTOM FACE OF WALL AS SHOWN IS
FRONT FACE OF WOODEN POSTS

BOTTOM FACE OF WALL
AS SHOWN ON PLAN

POSTS ○○○○
WOODEN RETAINING WALL

LEGEND:

- BOTTOM FACE OF WALL
- TOP FACE OF WALL
- EXISTING WALL
- ▤ CATCH PIT/BERM SUMP
- ⊙ STORMWATER MANHOLE
- FENCES
- STORMWATER LINE
- BOUNDARY
- WALL DRAINAGE

CLIENT:

WFH
PROPERTIES

WOODS
Engineers, Surveyors, Planners.

**MILLWATER
PRECINCT 2
STAGE 4A**

**RETAINING WALL AS-BUILT
PAGE 1 OF 5**

AUCKLAND COUNCIL

DESIGNED: AC	ASBUILT
CHECKED: KR	DRAWN: KR
APPROVED: MRH	SURVEYED: WOODS
JOB NUMBER: 33218	SCALE: 1:1500 @ A3
ISSUED: MARCH 2017	
DWG. NO. 33218-04A-130-AB	REV. 2

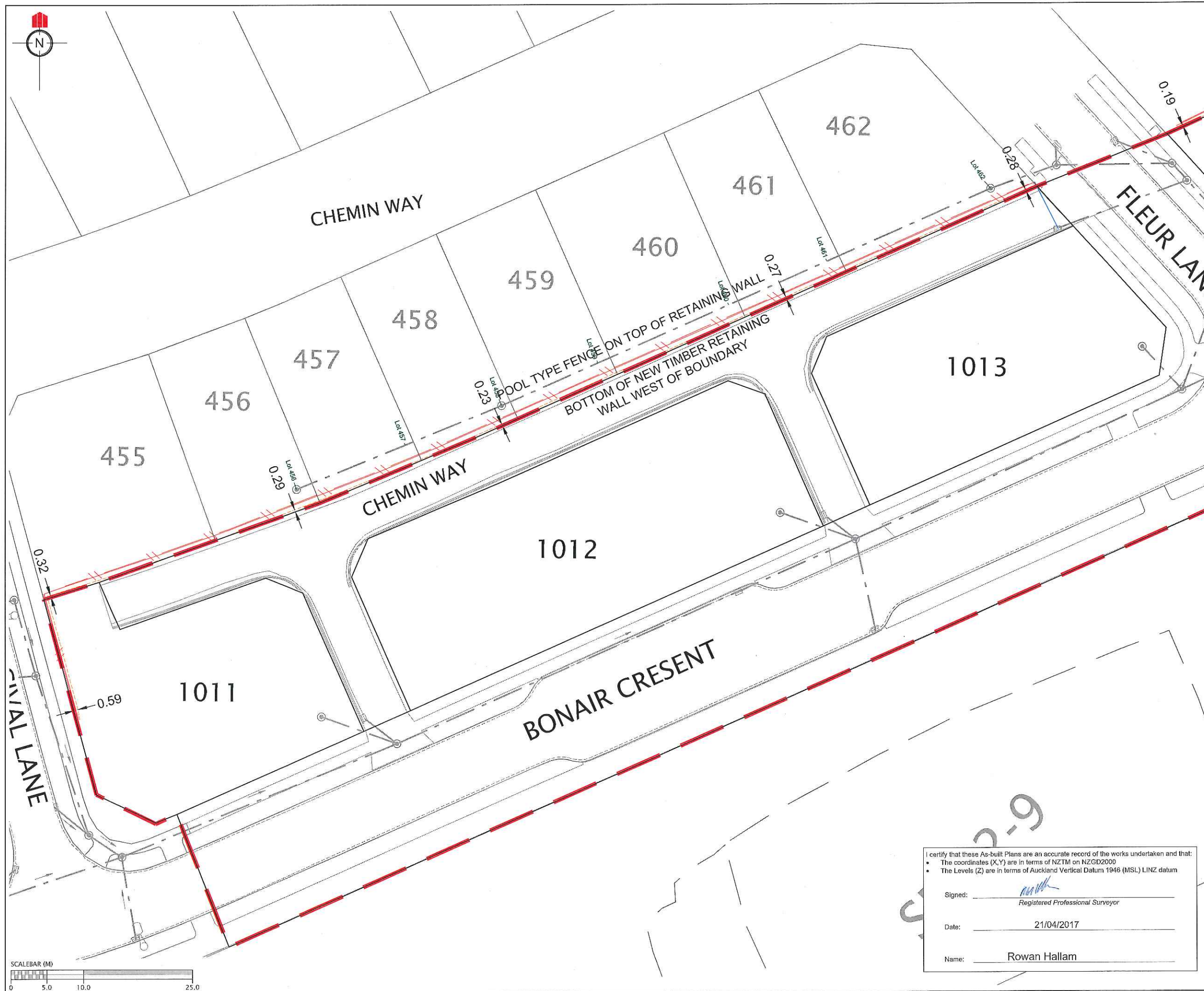
I certify that these As-built Plans are an accurate record of the works undertaken and that:

- The coordinates (X,Y) are in terms of NZTM on NZGD2000
- The Levels (Z) are in terms of Auckland Vertical Datum 1946 (MSL) LINZ datum

Signed: _____
Registered Professional Surveyor

Date: 21/04/2017

Name: Rowan Hallam



REVISION DETAILS		NAME	DATE

NOTE:
BOTTOM FACE OF WALL AS SHOWN IS
FRONT FACE OF WOODEN POSTS

BOTTOM FACE OF WALL
AS SHOWN ON PLAN

POSTS ○○○○
WOODEN RETAINING WALL

LEGEND:

- BOTTOM FACE OF WALL
- TOP FACE OF WALL
- EXISTING WALL
- CATCH PIT/BERM SUMP
- STORMWATER MANHOLE
- FENCES
- STORMWATER LINE
- BOUNDARY
- WALL DRAINAGE

CLIENT:

WFH
PROPERTIES

WOODS
Engineers, Surveyors, Planners.

**MILLWATER
PRECINCT 2
STAGE 4A**

**RETAINING WALL AS-BUILT
PAGE 2 OF 5**

AUCKLAND COUNCIL

DESIGNED: AC	ASBUILT
CHECKED: KR	DRAWN: KR
APPROVED: MRH	SURVEYED: WOODS
JOB NUMBER: 33218	SCALE: 1:500 @ A3
ISSUED: MARCH 2017	
DWG. NO. 33218-04A-131-AB	REV.

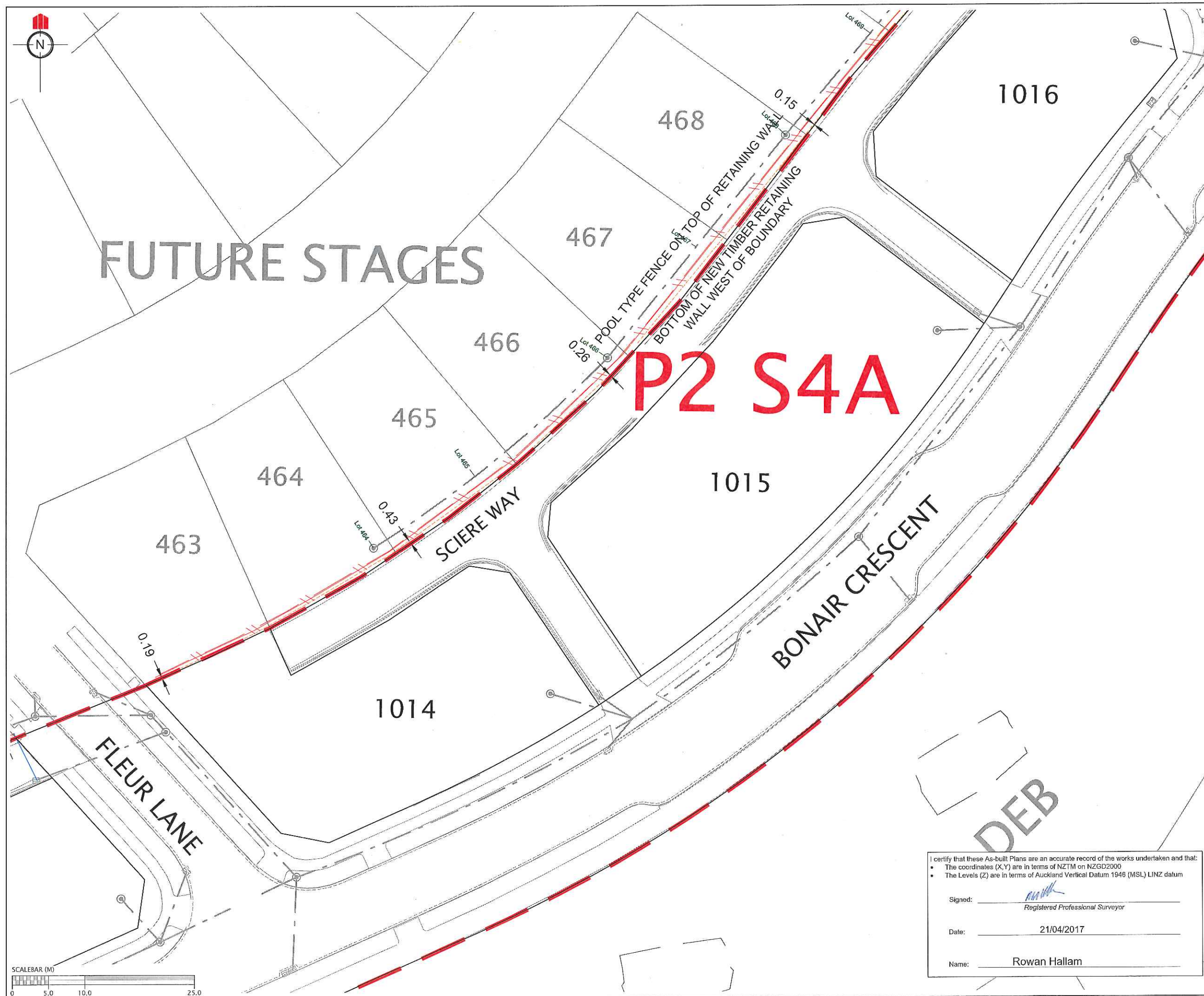
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Registered Professional Surveyor

Date: 21/04/2017

Name: Rowan Hallam



REVISION DETAILS		NAME	DATE

NOTE:
BOTTOM FACE OF WALL AS SHOWN IS
FRONT FACE OF WOODEN POSTS

BOTTOM FACE OF WALL
AS SHOWN ON PLAN

POSTS
WOODEN RETAINING WALL

LEGEND:

- BOTTOM FACE OF WALL
- TOP FACE OF WALL
- EXISTING WALL
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- STORMWATER MANHOLE
- FENCES
- STORMWATER LINE
- BOUNDARY
- WALL DRAINAGE

CLIENT:

WFH PROPERTIES

WOODS
Engineers, Surveyors, Planners.

**MILLWATER
PRECINCT 2
STAGE 4A**

**RETAINING WALL AS-BUILT
PAGE 3 OF 5**

AUCKLAND COUNCIL

DESIGNED: AC	ASBUILT
CHECKED: KR	DRAWN: KR
APPROVED: MRH	SURVEYED: WOODS
JOB NUMBER: 33218	SCALE: 1:500 @ A3
ISSUED: MARCH 2017	
DWG. NO. 33218-04A-132-AB	REV.

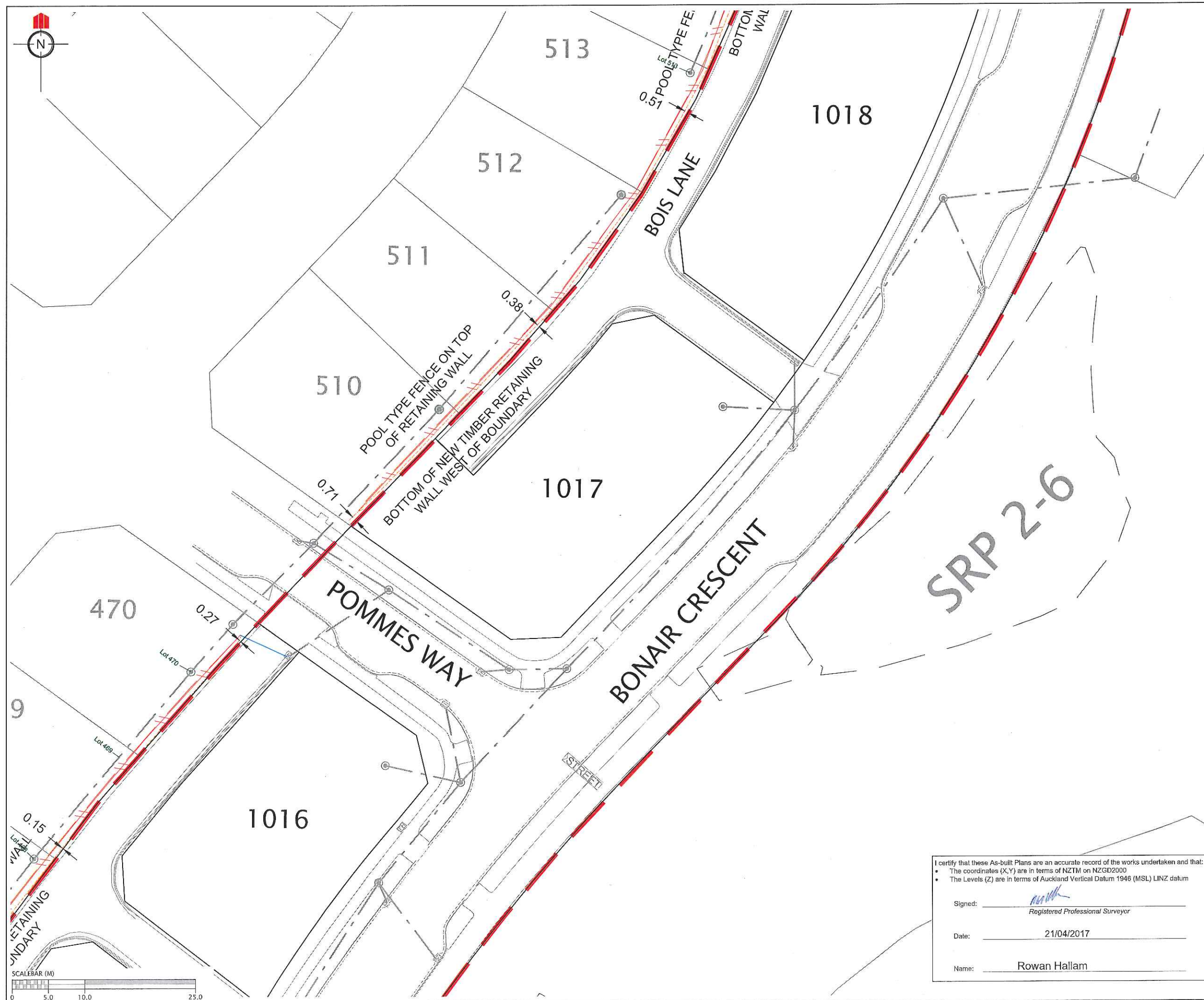
I certify that these As-built Plans are an accurate record of the works undertaken and that:

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- The Levels (Z) are in terms of Auckland Vertical Datum 1948 (MSL) LINZ datum

Signed:
Registered Professional Surveyor

Date: 21/04/2017

Name: Rowan Hallam



REVISION DETAILS	NAME	DATE

NOTE:
BOTTOM FACE OF WALL AS SHOWN IS
FRONT FACE OF WOODEN POSTS

BOTTOM FACE OF WALL
AS SHOWN ON PLAN

POSTS ○ ○ ○

WOODEN RETAINING WALL

LEGEND:

- BOTTOM FACE OF WALL
- TOP FACE OF WALL
- EXISTING WALL
- CATCH PIT/BERM SUMP
- STORMWATER MANHOLE
- FENCES
- STORMWATER LINE
- BOUNDARY
- WALL DRAINAGE

CLIENT:



MILLWATER PRECINCT 2 STAGE 4A

RETAINING WALL AS-BUILT
PAGE 4 OF 5

AUCKLAND COUNCIL

DESIGNED: AC	ASBUILT
CHECKED: KR	DRAWN: KR
APPROVED: MRH	SURVEYED: WOODS
JOB NUMBER: 33218	SCALE: 1:500 @ A3
ISSUED: MARCH 2017	
DWG. NO. 33218-04A-133-AB	REV.

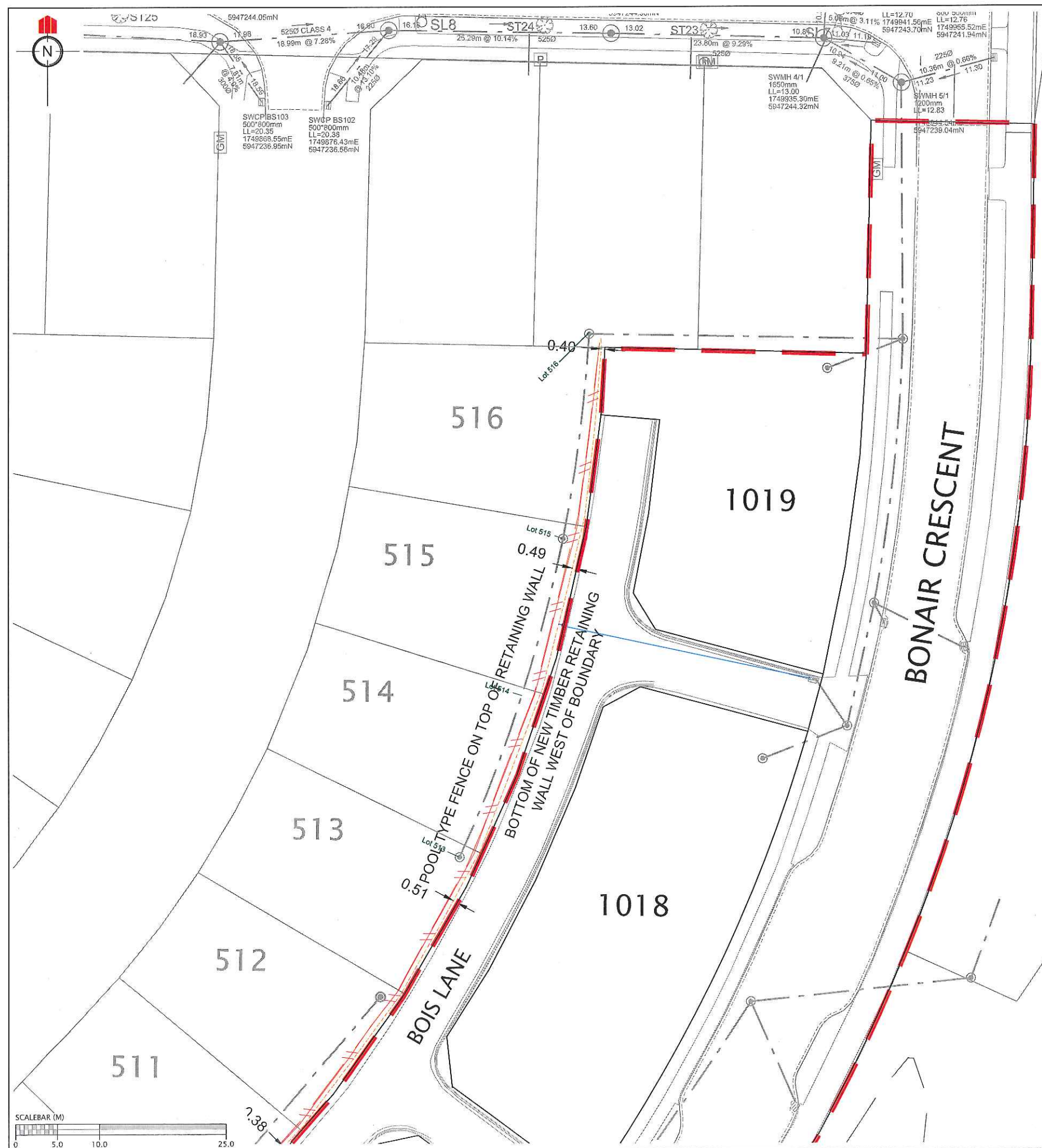
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- The coordinates (X,Y) are in terms of NZTM on NZGD2000
- The Levels (Z) are in terms of Auckland Vertical Datum 1946 (MSL) LINZ datum

Signed: Rowan Hallam
Registered Professional Surveyor

Date: 21/04/2017

Name: Rowan Hallam



I certify that these As-built Plans are an accurate record of the works undertaken and that:

- The coordinates (X,Y) are in terms of NZTM on NZGD2000
- The Levels (Z) are in terms of Auckland Vertical Datum 1946 (MSL) LINZ datum

Signed: Rowan Hallam
Registered Professional Surveyor

Date: 21/04/2017

Name: Rowan Hallam

REVISION DETAILS		NAME	DATE

NOTE:
BOTTOM FACE OF WALL AS SHOWN IS
FRONT FACE OF WOODEN POSTS

BOTTOM FACE OF WALL
AS SHOWN ON PLAN

POSTS ○○○○
WOODEN RETAINING WALL

LEGEND:

- BOTTOM FACE OF WALL
- TOP FACE OF WALL
- EXISTING WALL
- ☐ CATCH PIT/BERM SUMP
- STORMWATER MANHOLE
- FENCES
- STORMWATER LINE
- BOUNDARY
- WALL DRAINAGE

CLIENT:

WFH
PROPERTIES

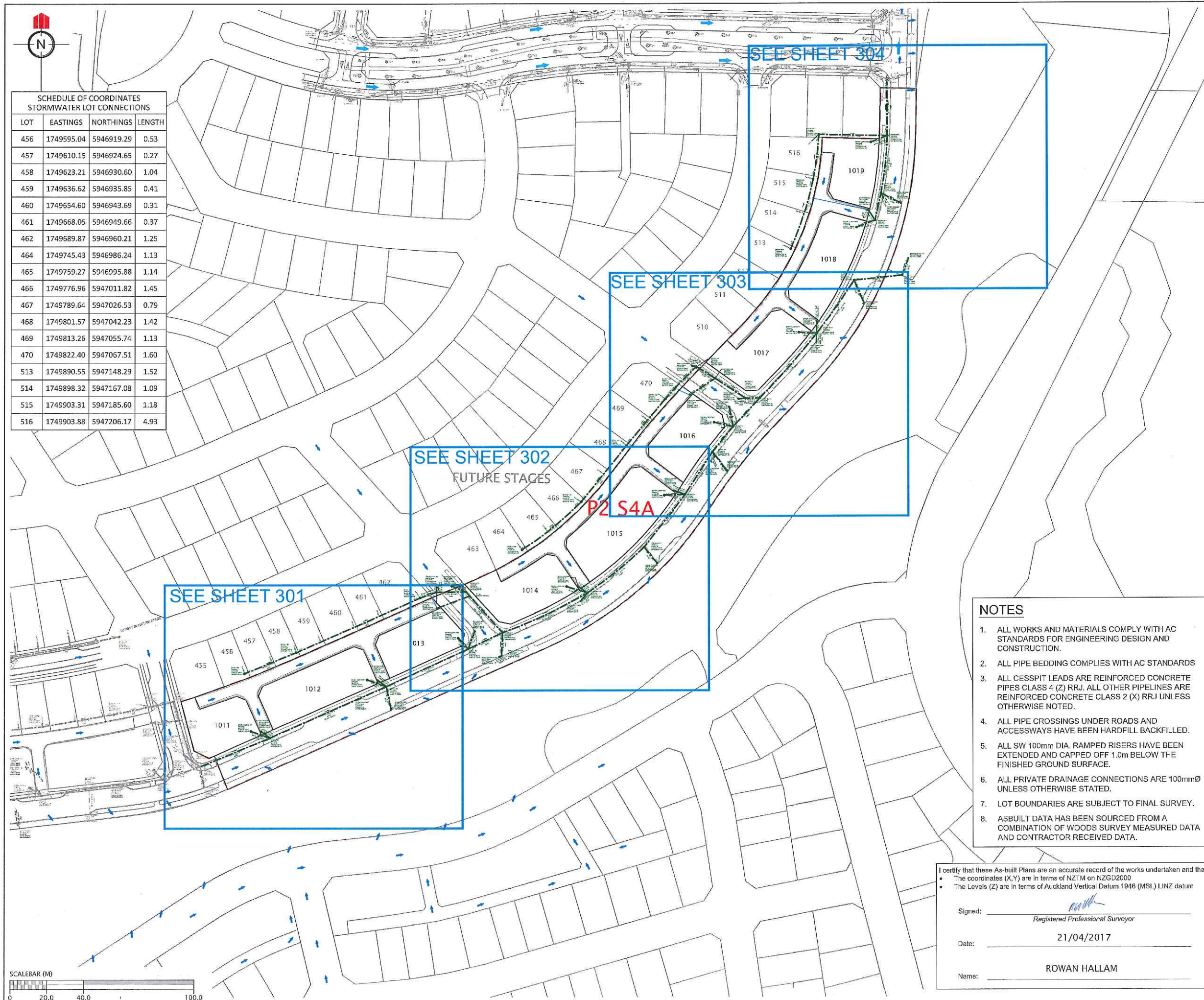
WOODS
Engineers, Surveyors, Planners.

**MILLWATER
PRECINCT 2
STAGE 4A**

**RETAINING WALL AS-BUILT
PAGE 5 OF 5**

AUCKLAND COUNCIL

DESIGNED: AC	ASBUILT
CHECKED: KR	DRAWN: KR
APPROVED: MRH	SURVEYED: WOODS
JOB NUMBER: 33218	SCALE: 1:500 @ A3
ISSUED: MARCH 2017	
DWG. NO. 33218-04A-134-AB	REV.



SCHEDULE OF COORDINATES STORMWATER LOT CONNECTIONS			
LOT	EASTINGS	NORTHINGS	LENGTH
456	1749595.04	5946919.29	0.53
457	1749610.15	5946924.65	0.27
458	1749623.21	5946930.60	1.04
459	1749636.62	5946935.85	0.41
460	1749654.60	5946943.69	0.31
461	1749668.05	5946949.66	0.37
462	1749689.87	5946960.21	1.25
464	1749745.43	5946986.24	1.13
465	1749759.27	5946995.88	1.14
466	1749776.96	5947011.82	1.45
467	1749789.64	5947026.53	0.79
468	1749801.57	5947042.23	1.42
469	1749813.26	5947055.74	1.13
470	1749822.40	5947067.51	1.60
513	1749890.55	5947148.29	1.52
514	1749898.32	5947167.08	1.09
515	1749903.31	5947185.60	1.18
516	1749903.88	5947206.17	4.93

REVISION DETAILS		NAME	DATE

LEGEND
STORMWATER MANHOLE
STORMWATER CESSPIT
STORMWATER DOUBLE CESSPIT
OVERLAND FLOW
NEW STORMWATER
EXISTING STORMWATER
RETAINING WALL DRAINAGE
STAGE BOUNDARY

CLIENT:

**MILLWATER
PRECINCT 2
STAGE 4A**

STORMWATER AS-BUILT
OVERALL LAYOUT
Sheet 1 of 5

AUCKLAND COUNCIL

DESIGNED: AC	ASBUILT
CHECKED: KR	DRAWN: SP
APPROVED: MRH	SURVEYED: WOODS
JOB NUMBER: 33218	SCALE: 1:2000 @ A3
ISSUED: MARCH 2017	
DWG. NO. 33218-4A-300-AB	REV.

- NOTES**
1. ALL WORKS AND MATERIALS COMPLY WITH AC STANDARDS FOR ENGINEERING DESIGN AND CONSTRUCTION.
 2. ALL PIPE BEDDING COMPLIES WITH AC STANDARDS
 3. ALL CESSPIT LEADS ARE REINFORCED CONCRETE PIPES CLASS 4 (Z) RRJ. ALL OTHER PIPELINES ARE REINFORCED CONCRETE CLASS 2 (X) RRJ UNLESS OTHERWISE NOTED.
 4. ALL PIPE CROSSINGS UNDER ROADS AND ACCESSWAYS HAVE BEEN HARDFILL BACKFILLED.
 5. ALL SW 100mm DIA. RAMPED RISERS HAVE BEEN EXTENDED AND CAPPED OFF 1.0m BELOW THE FINISHED GROUND SURFACE.
 6. ALL PRIVATE DRAINAGE CONNECTIONS ARE 100mmØ UNLESS OTHERWISE STATED.
 7. LOT BOUNDARIES ARE SUBJECT TO FINAL SURVEY.
 8. ASBUILT DATA HAS BEEN SOURCED FROM A COMBINATION OF WOODS SURVEY MEASURED DATA AND CONTRACTOR RECEIVED DATA.

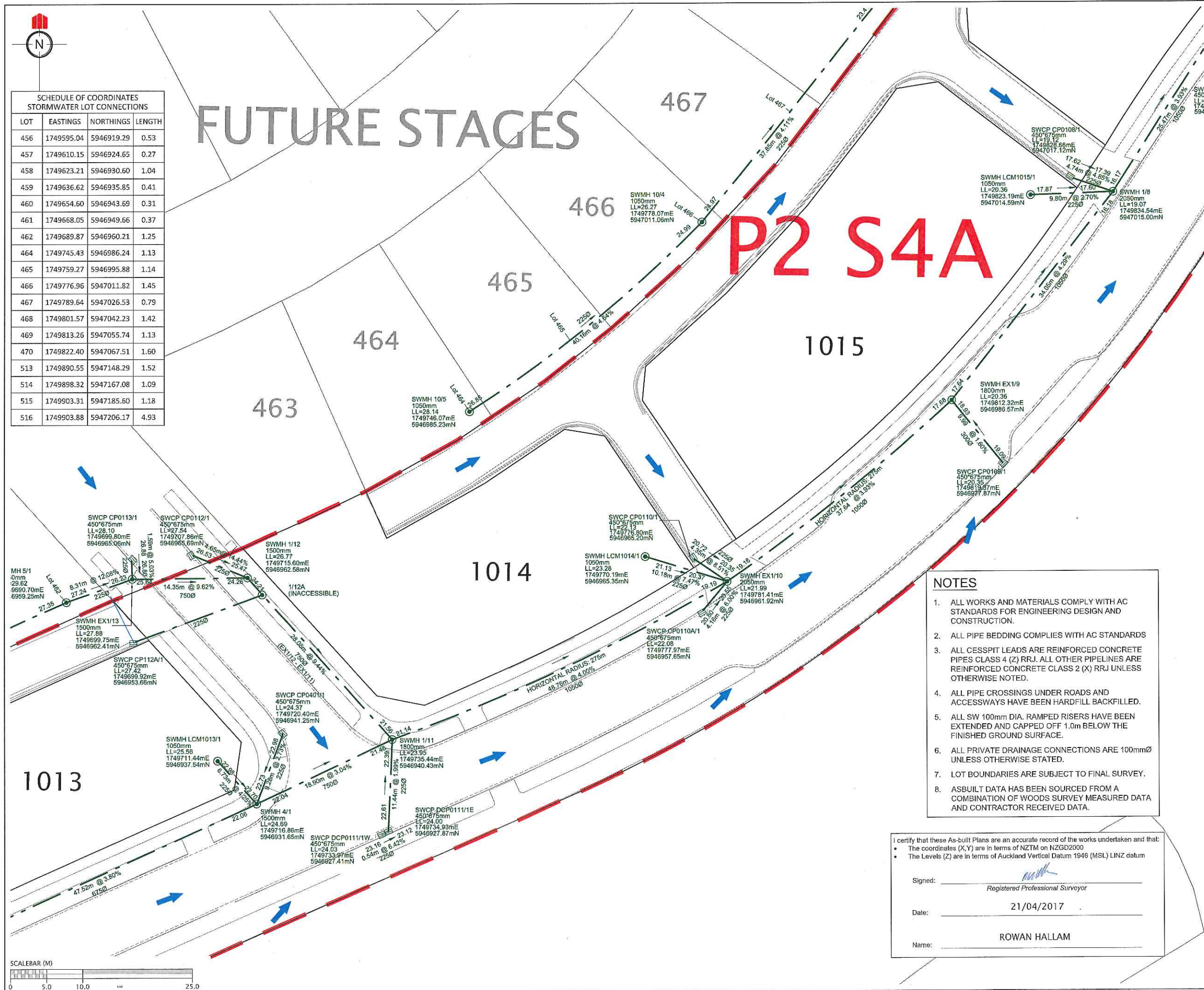
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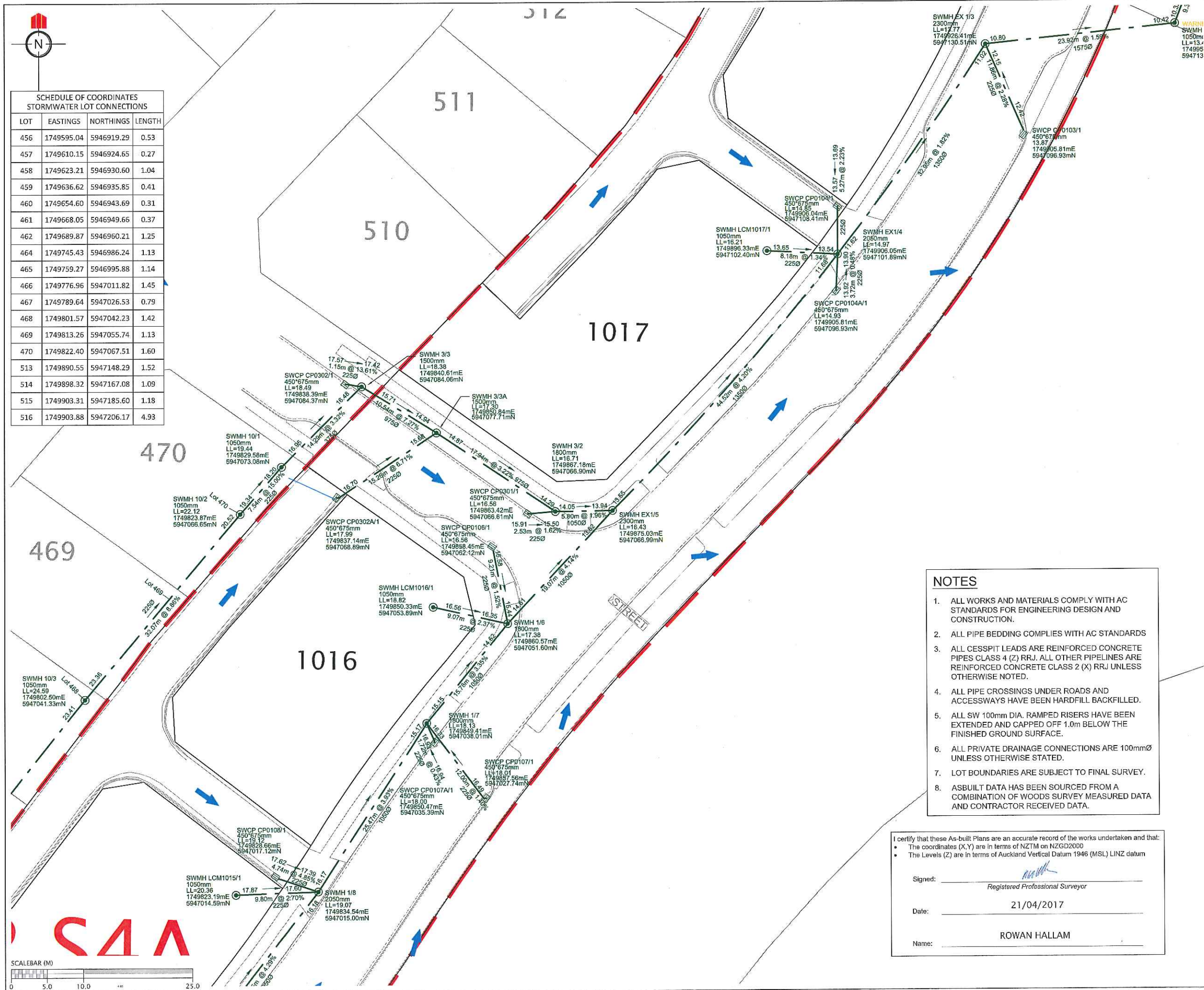
- The coordinates (X,Y) are in terms of NZTM on NZGD2000
- The Levels (Z) are in terms of Auckland Vertical Datum 1946 (MSL) LINZ datum

Signed: Registered Professional Surveyor

Date: 21/04/2017

Name: ROWAN HALLAM





REVISION DETAILS		NAME	DATE

LEGEND	
STORMWATER MANHOLE	
STORMWATER CESSPIT	
STORMWATER DOUBLE CESSPIT	
OVERLAND FLOW	
NEW STORMWATER	
EXISTING STORMWATER	
RETAINING WALL DRAINAGE	
STAGE BOUNDARY	

CLIENT:

WFH
PROPERTIES

WOODS
Engineers, Surveyors, Planners.

**MILLWATER
PRECINCT 2
STAGE 4A**

STORMWATER AS-BUILT
Sheet 4 of 5

AUCKLAND COUNCIL

DESIGNED:	AC	ASBUILT
CHECKED:	KR	DRAWN: SP
APPROVED:	MRH	SURVEYED: WOODS
JOB NUMBER:	33218	SCALE: 1:500 @ A3
ISSUED:	MARCH 2017	
DWG. NO.	33218-4A-303-AB	REV.

- NOTES**
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 2. ALL PIPE BEDDING COMPLIES WITH AC STANDARDS
 3. ALL CESSPIT LEADS ARE REINFORCED CONCRETE PIPES CLASS 4 (Z) RRJ. ALL OTHER PIPELINES ARE REINFORCED CONCRETE CLASS 2 (X) RRJ UNLESS OTHERWISE NOTED.
 4. ALL PIPE CROSSINGS UNDER ROADS AND ACCESSWAYS HAVE BEEN HARDFILL BACKFILLED.
 5. ALL SW 100mm DIA. RAMPED RISERS HAVE BEEN EXTENDED AND CAPPED OFF 1.0m BELOW THE FINISHED GROUND SURFACE.
 6. ALL PRIVATE DRAINAGE CONNECTIONS ARE 100mmØ UNLESS OTHERWISE STATED.
 7. LOT BOUNDARIES ARE SUBJECT TO FINAL SURVEY.
 8. ASBUILT DATA HAS BEEN SOURCED FROM A COMBINATION OF WOODS SURVEY MEASURED DATA AND CONTRACTOR RECEIVED DATA.

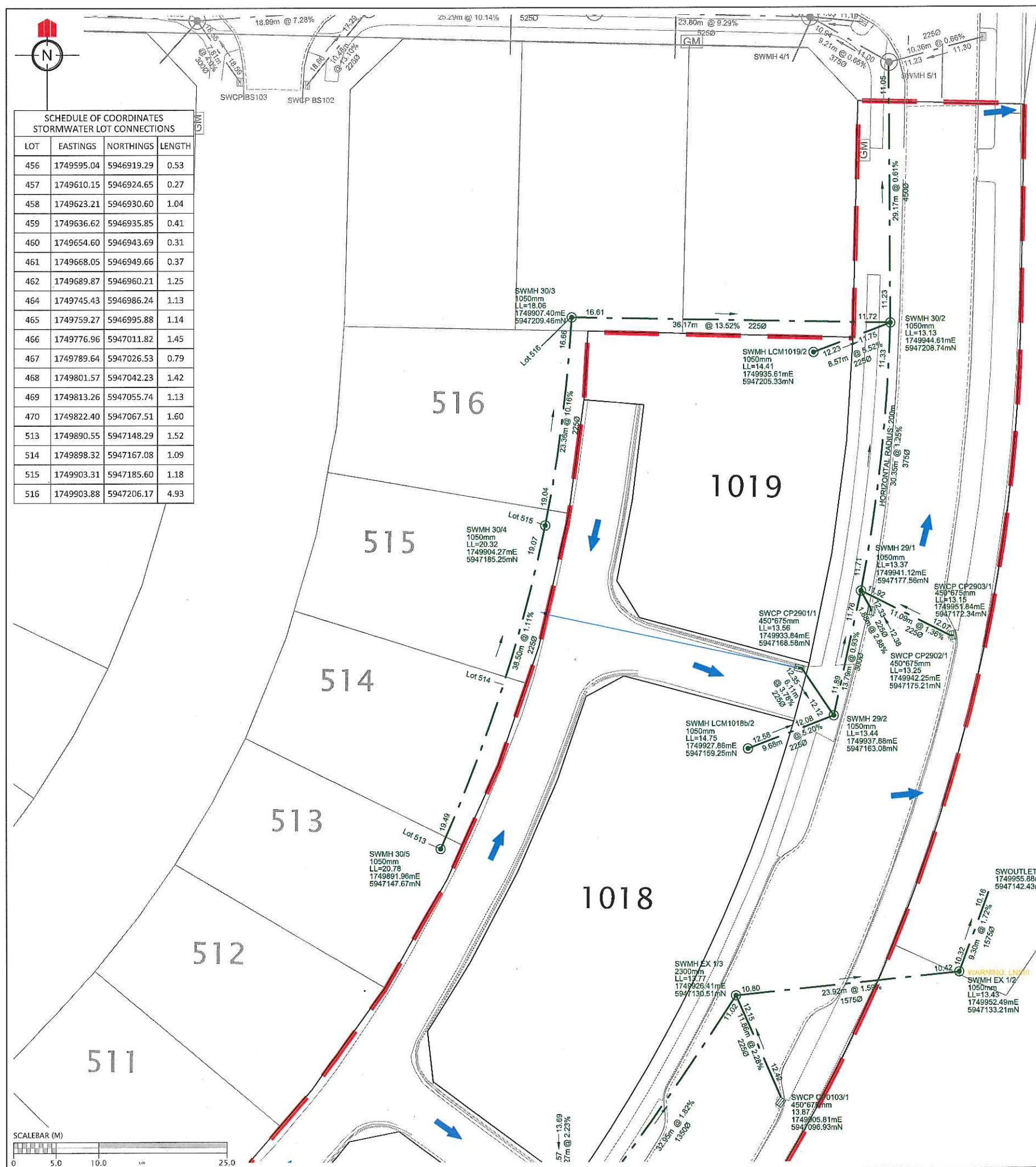
I certify that these As-built Plans are an accurate record of the works undertaken and that:

- The coordinates (X,Y) are in terms of NZTM on NZGD2000
- The Levels (Z) are in terms of Auckland Vertical Datum 1946 (MSL) LINZ datum

Signed: _____
Registered Professional Surveyor

Date: 21/04/2017

Name: ROWAN HALLAM



NOTES

1. ALL WORKS AND MATERIALS COMPLY WITH AC STANDARDS FOR ENGINEERING DESIGN AND CONSTRUCTION.
2. ALL PIPE BEDDING COMPLIES WITH AC STANDARDS
3. ALL CESSPIT LEADS ARE REINFORCED CONCRETE PIPES CLASS 4 (Z) RRJ. ALL OTHER PIPELINES ARE REINFORCED CONCRETE CLASS 2 (X) RRJ UNLESS OTHERWISE NOTED.
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6. ALL PRIVATE DRAINAGE CONNECTIONS ARE 100mmØ UNLESS OTHERWISE STATED.
7. LOT BOUNDARIES ARE SUBJECT TO FINAL SURVEY.
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I certify that these As-built Plans are an accurate record of the works undertaken and that:

- The coordinates (X,Y) are in terms of NZTM on NZGD2000
- The Levels (Z) are in terms of Auckland Vertical Datum 1946 (MSL) LINZ datum

Signed: _____
Registered Professional Surveyor

Date: 21/04/2017

Name: ROWAN HALLAM

REVISION DETAILS		NAME	DATE
LEGEND			
STORMWATER MANHOLE			
STORMWATER CESSPIT			
STORMWATER DOUBLE CESSPIT			
OVERLAND FLOW			
NEW STORMWATER			
EXISTING STORMWATER			
RETAINING WALL DRAINAGE			
STAGE BOUNDARY			
CLIENT:			
MILLWATER PRECINCT 2 STAGE 4A			
STORMWATER AS-BUILT Sheet 5 of 5			
AUCKLAND COUNCIL			
DESIGNED: AC	ASBUILT		
CHECKED: KR	DRAWN: SP		
APPROVED: MRH	SURVEYED: WOODS		
JOB NUMBER: 33218	SCALE: 1:500 @ A3		
ISSUED: MARCH 2017			
DWG. NO. 33218-4A-304-AB	REV.		

Appendix A2: T+T Drawings

- **21854.001-P2S4A-100** **Drawing List and Site Location Plan**
- **21854.001-P2S4A-101** **Geotechnical Works Plan**
- **21854.001-P2S4A-102** **Geotechnical Works Subsoil Drain Plan**
- **21854.001-P2S4A-103** **Geological Cross Section 6**
- **21854.001-P2S4A-104** **Geological Cross Section 7**
- **21854.001-P2S4A-105** **Geological Cross Section 8**
- **21854.001-P2S4A-106** **Geological Cross Section 17**
- **21854.001-P2S4A-107** **Geological Cross Section 18**

Timber Pole Walls 306 – 308 Drawings

- **21854.001-P2S3-120** **Typical Timber Pole Retaining Wall Details**
- **21854.001-P2S3-121** **Pipe Crossing Timber Pole Retaining Wall Detail**
- **21854.001-P2S3-122** **Standard Fence Panel Detail**
- **21854.001-P2S3-123** **Pipe Crossing Typical Elevation**
- **21854.001-P2S3-124** **Stormwater Pipe Crossing Typical Elevation**

WFH PROPERTIES LTD
RESIDENTIAL SUBDIVISION
MILLWATER-PRECINCT 2 (STAGE 4A)
Completion Report Issue

DRAWING Rev Title

GENERAL

- 21854.001-P2S4A-100 1 Drawing List and Site Location Plan
- 21854.001-P2S4A-101 1 Geotechnical Works Plan
- 21854.001-P2S4A-102 1 Geotechnical Works Subsoil Drain Plan
- 21854.001-P2S4A-103 1 Geogical Cross Section 6
- 21854.001-P2S4A-104 1 Geogical Cross Section 7
- 21854.001-P2S4A-105 1 Geogical Cross Section 8
- 21854.001-P2S4A-106 1 Geogical Cross Section 17
- 21854.001-P2S4A-107 1 Geogical Cross Section 18

APPENDIX A2 (FOR INFORMATION ONLY)

- 21854.001-P2S3-120 A Typical Timber Pole Retaining Wall Detail
- 21854.001-P2S3-121 B Pipe Crossing Timber Pole Retaining Wall Detail
- 21854.001-P2S3-122 A Standard Fence Panel Detail
- 21854.001-P2S3-123 A Pipe Crossing Typical Elevation
- 21854.001-P2S3-124 A Stormwater Pipe Crossing Typical Elevation

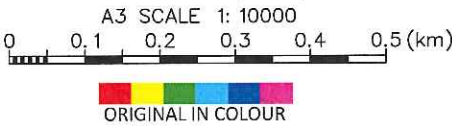
APPENDIX E

- 21854.001-P2S4A-111 1 Post Earthworks Investigation Plan
- 21854.001-P2S4A-112 1 Topsoil Depths Plan
- 21854.001-P2S4A-113 1 Earthworks Testing Location Plan

- Denotes drawing this issue: 10/05/2017



Street map sourced from Land Information New Zealand data (Crown Copyright Reserved).



LOCATION PLAN
SCALE 1: 10000

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				DRAWN :	JC	May.17
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				DRAFTING CHECKED :		
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				NOT FOR CONSTRUCTION		
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1. All dimensions are in millimetres unless noted otherwise.
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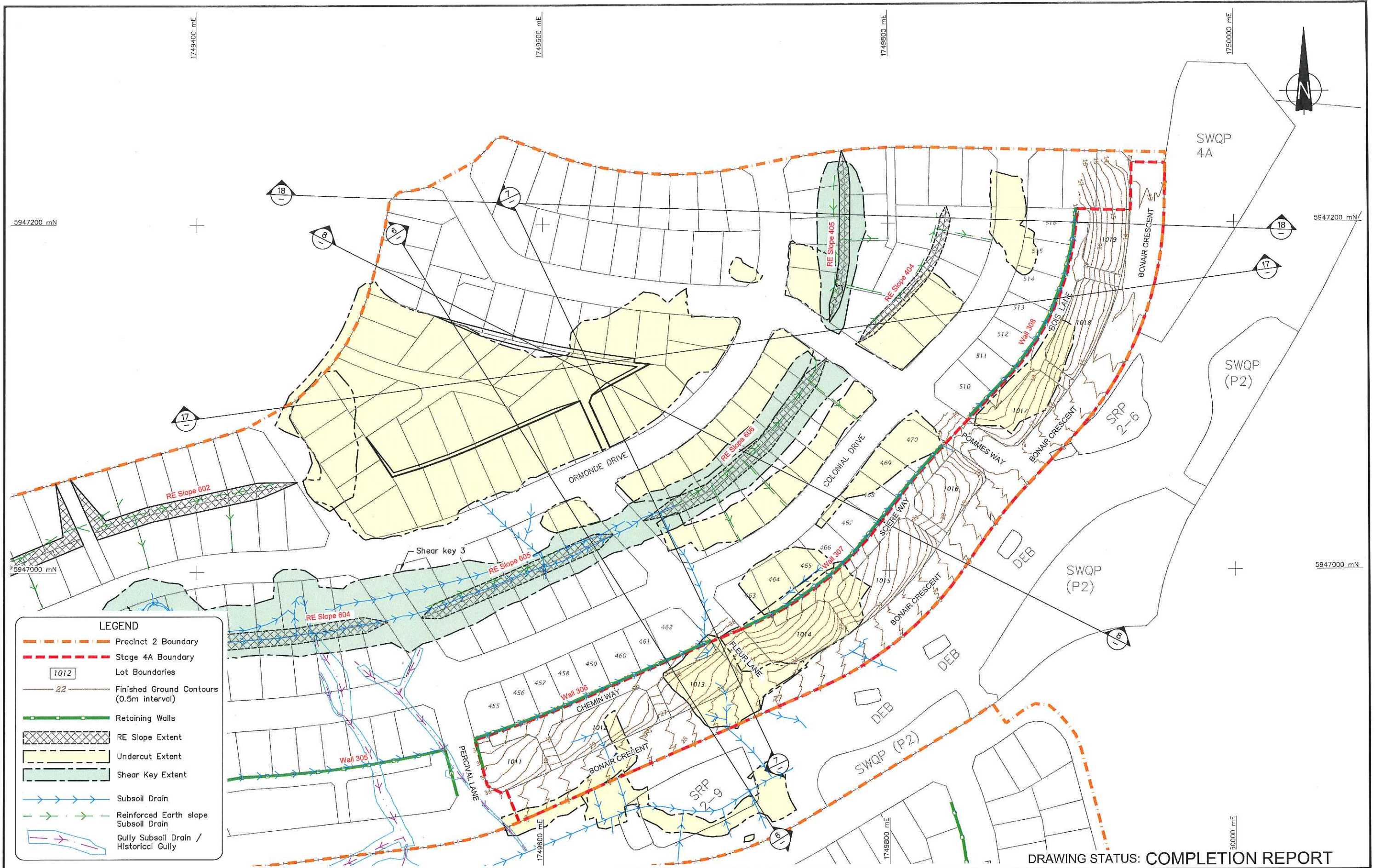
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DRAWING STATUS: COMPLETION REPORT

CLIENT, PROJECT		WFH PROPERTIES LTD RESIDENTIAL SUBDIVISION	
TITLE		MILLWATER – PRECINCT 2 (STAGE 4A) Drawing List and Site Location Plan	
SCALES (AT A3 SIZE)	DWG. No.	REV.	
AS SHOWN	21854.001-P2S4A-100	1	

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NOTES :

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- As-built plan supplied by WOODS reference "33218-04A-100-AB FINAL CONTOURS.dwg" & "33218-04A-110-AB CUT FILL CONTOURS.dwg", dated April 2017.
- Undercuts, shearkey & subsoil drains supplied by WOODS, reference "33218-04A-120-AB SK UC & SUBSOIL.dwg", dated April 2017.
- Coordinate Datum: NZGD2000, New Zealand Transverse Mercator (NZTM2000). Level Datum: LINZ (MSL) Auckland Vertical Datum 1946

REFERENCE :

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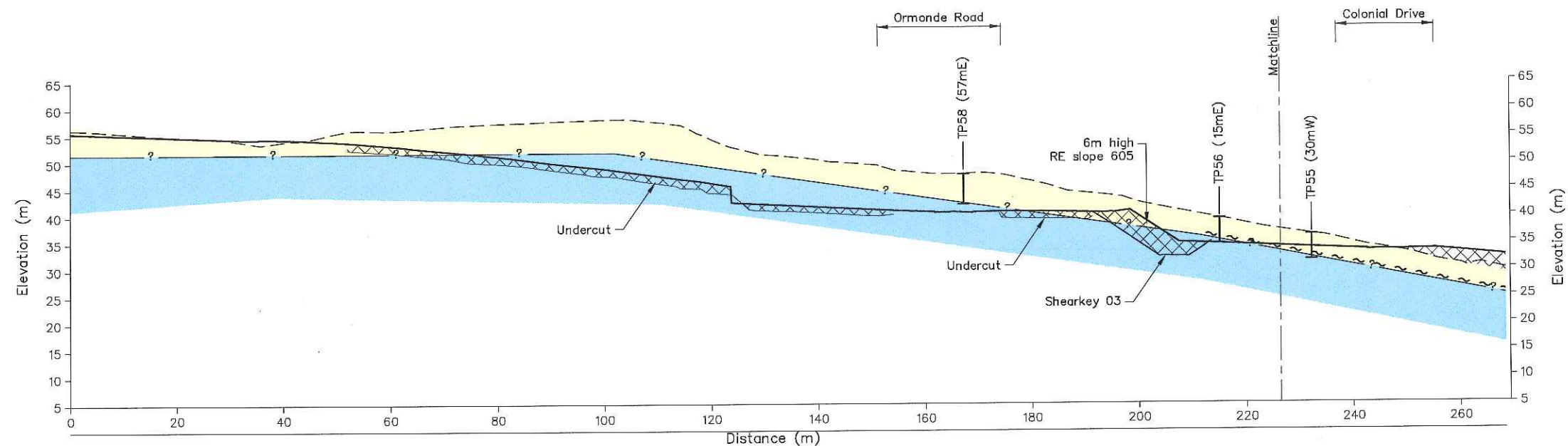
CLIENT, PROJECT
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TITLE
MILLWATER - PRECINCT 2 (STAGE 4A)
Geotechnical Works Subsoil Drain Plan

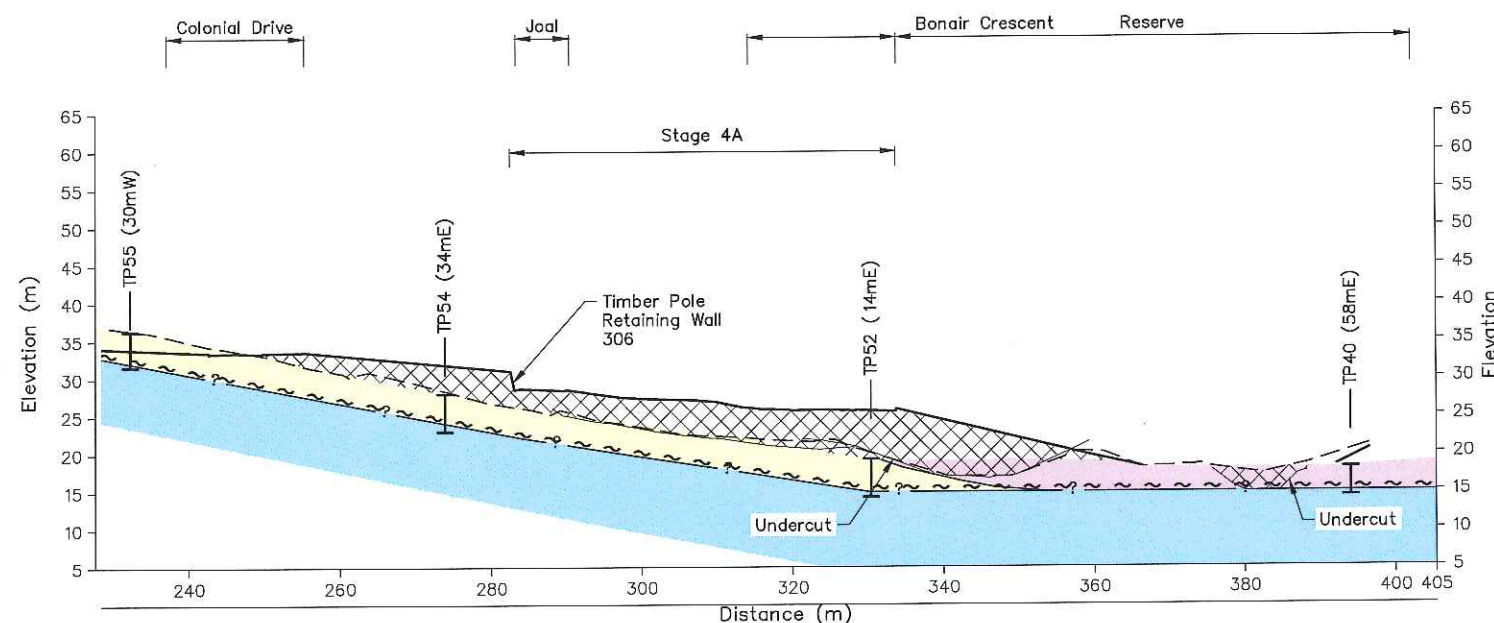
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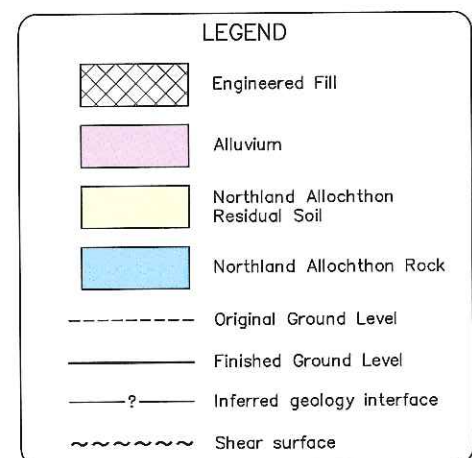
REV.
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SECTION 6
SCALE 1:1000
101



SECTION 6
SCALE 1:1000
101 CONT'D



A3 SCALE 1:1000
0 5 10 15 20 30 40 50 (m)

A3 SCALE 1:1000
0 5 10 15 20 30 40 50 (m)
ORIGINAL IN COLOUR

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				DRAFTING CHECKED :		
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REVISION DESCRIPTION				BY	DATE	

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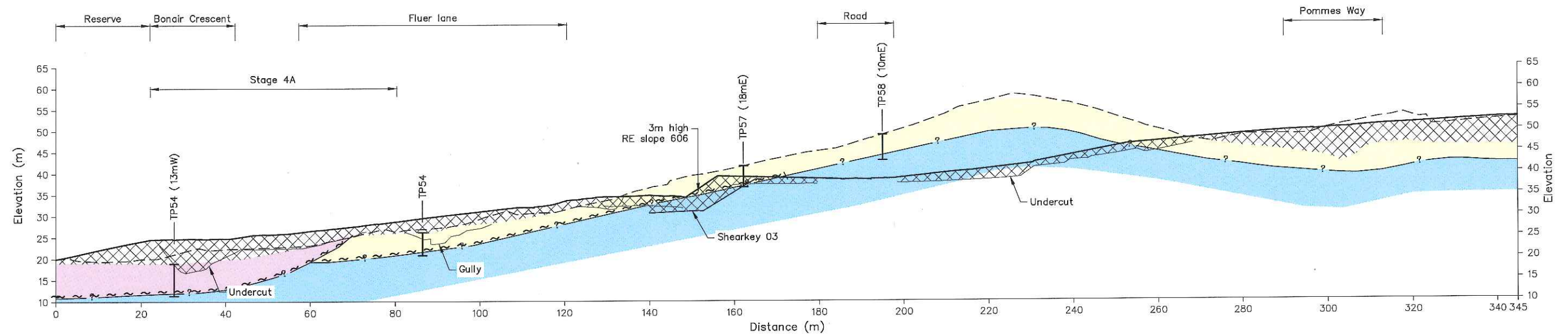
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CLIENT, PROJECT	WFH PROPERTIES LTD RESIDENTIAL SUBDIVISION
TITLE	MILLWATER - PRECINCT 2 (STAGE 4A) Geological Cross Section 6
SCALES (AT A3 SIZE)	1:1000
DWG. No.	21854.001-P2S4A-103
REV.	1

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SECTION 7
SCALE 1:1000

LEGEND	
	Engineered Fill
	Alluvium
	Northland Allochthon Residual Soil
	Northland Allochthon Rock
	Original Ground Level
	Finished Ground Level
	Inferred geology interface
	Shear surface

A3 SCALE 1:1000
0 5 10 15 20 30 40 50 (m)

DRAWING STATUS: COMPLETION REPORT

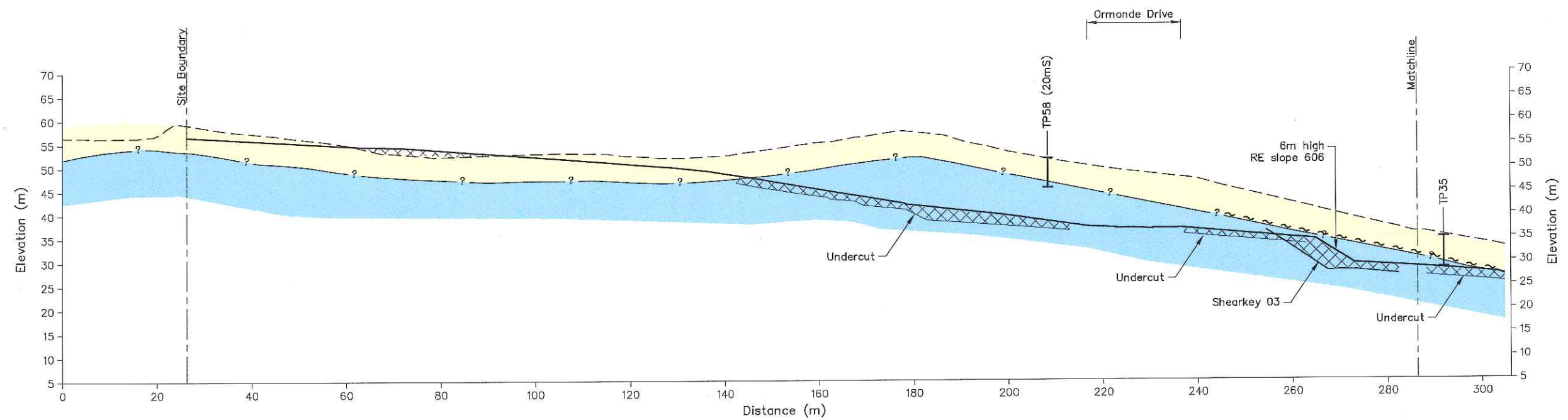
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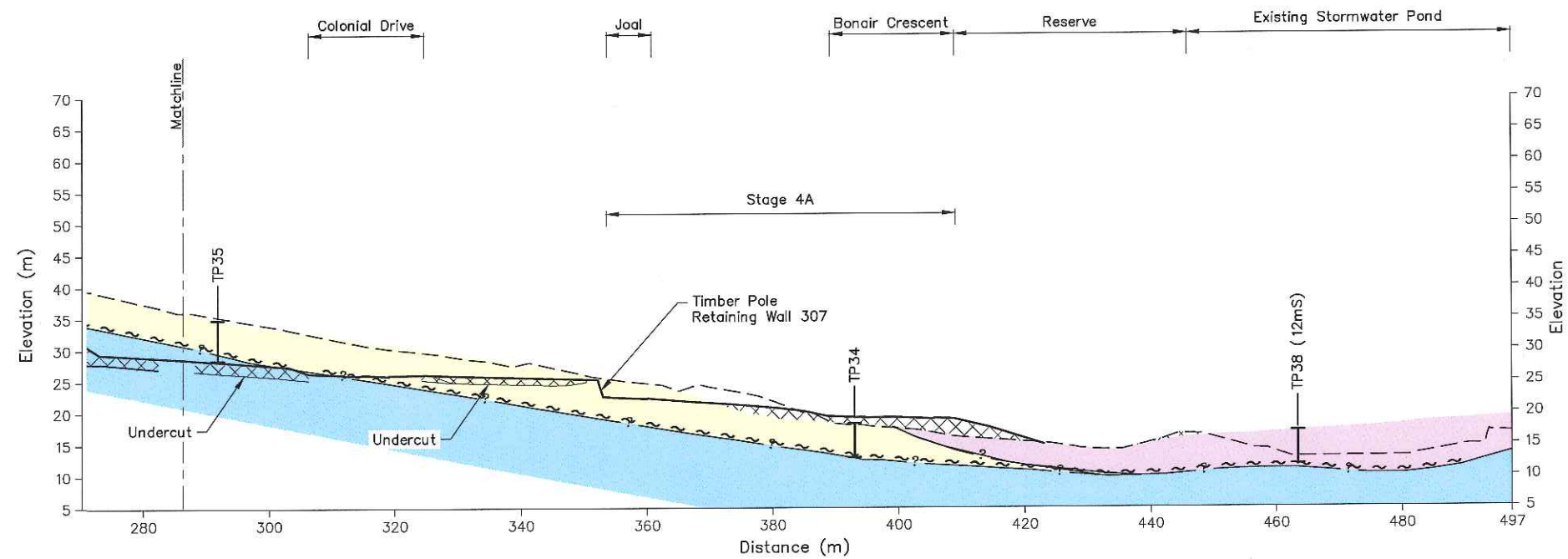
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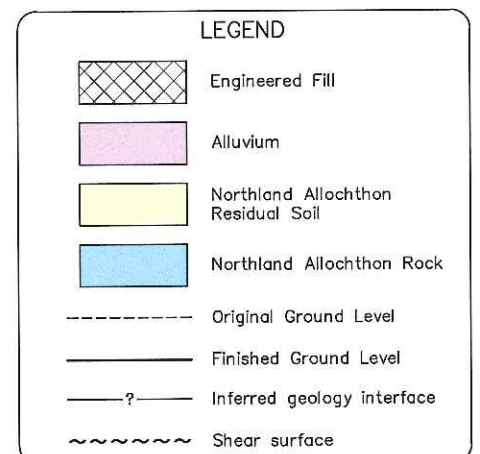
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TITLE	MILLWATER - PRECINCT 2 (STAGE 4A) Geological Cross Section 7		
SCALES (AT A3 SIZE)	1:1000	DWG. No.	21854.001-P2S4A-104
		REV.	1



SECTION 8
SCALE 1:1000



SECTION 8 CONT'D
SCALE 1:1000



A3 SCALE 1:1000
0 5 10 15 20 30 40 50 (m)

DRAWING STATUS: COMPLETION REPORT

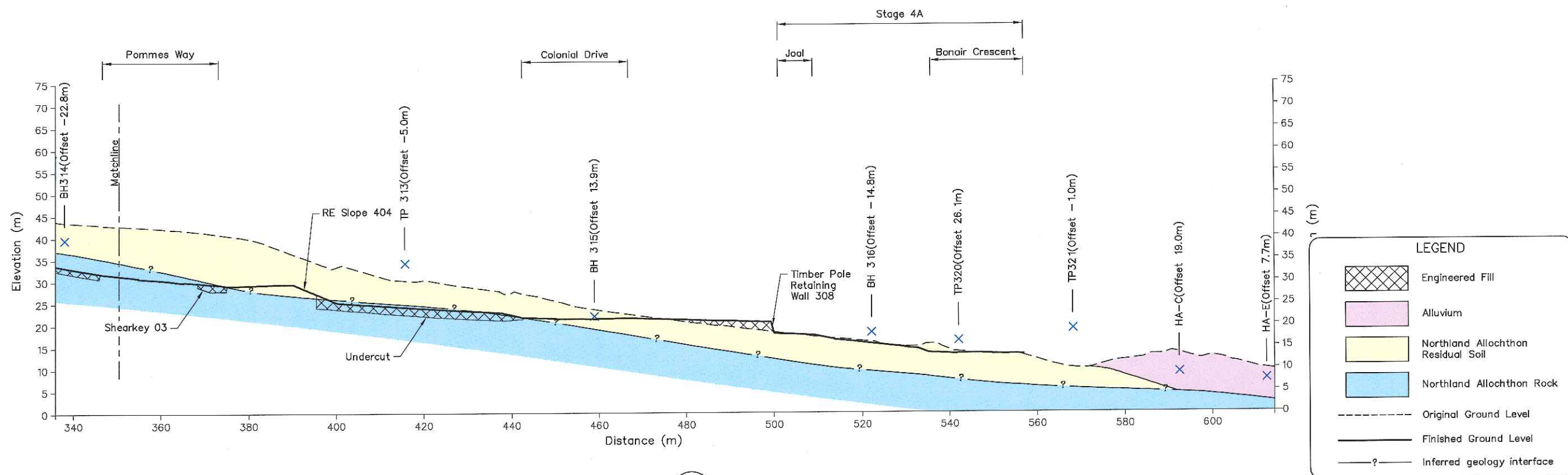
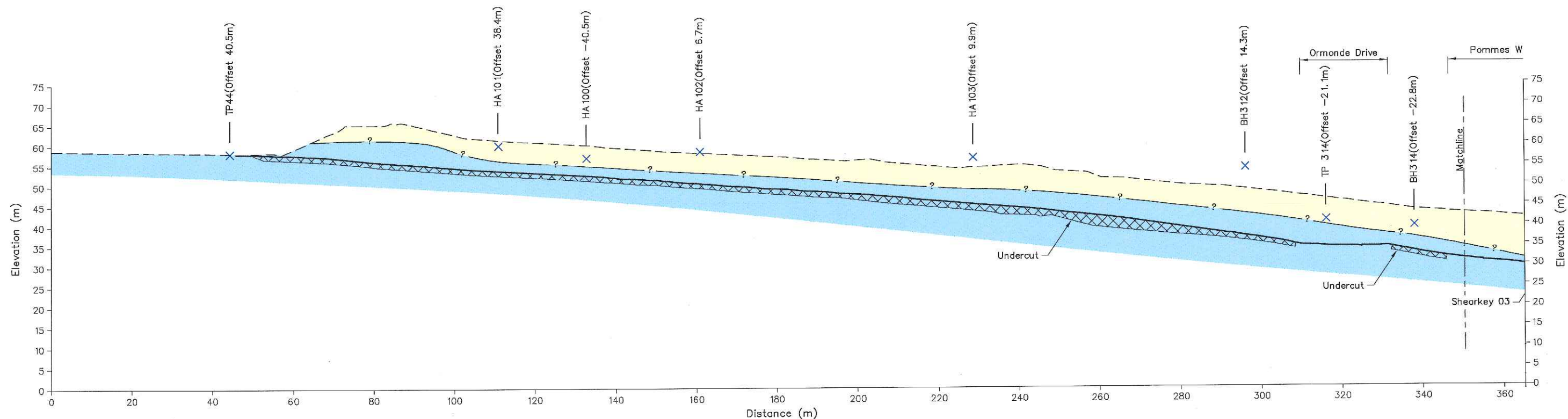
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TITLE	MILLWATER — PRECINCT 2 (STAGE 4A) Geological Cross Section 8		
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REVISION		REV.	1

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SECTION 17
SCALE 1:1000

A3 SCALE 1:1000
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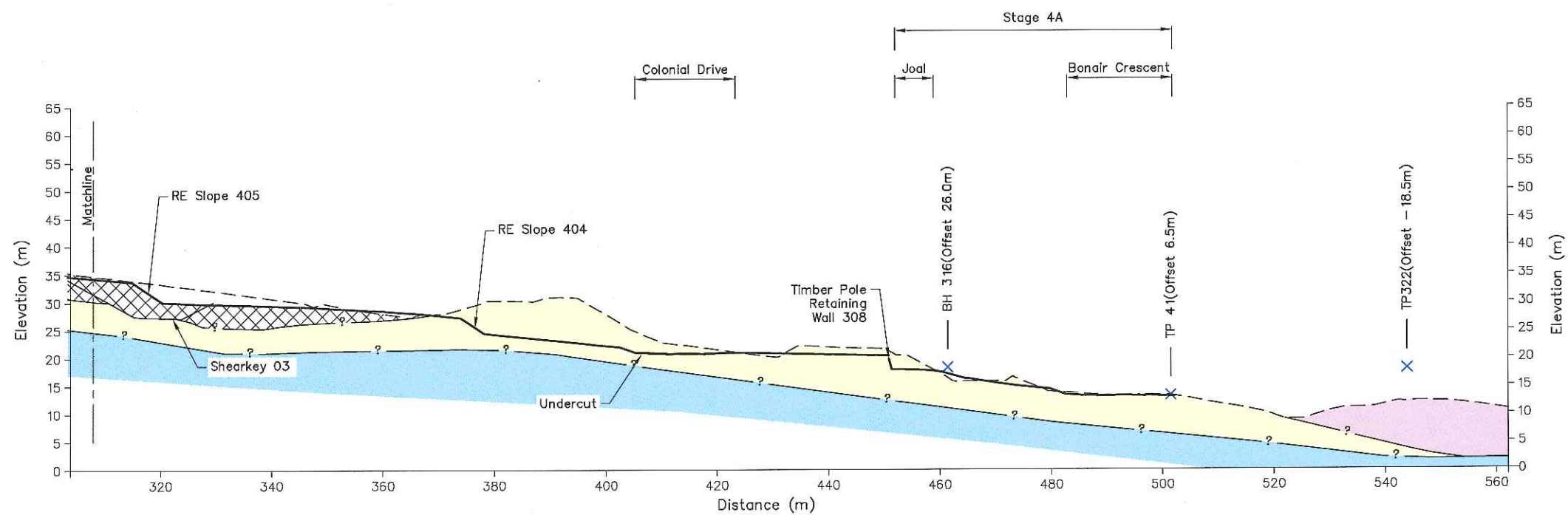
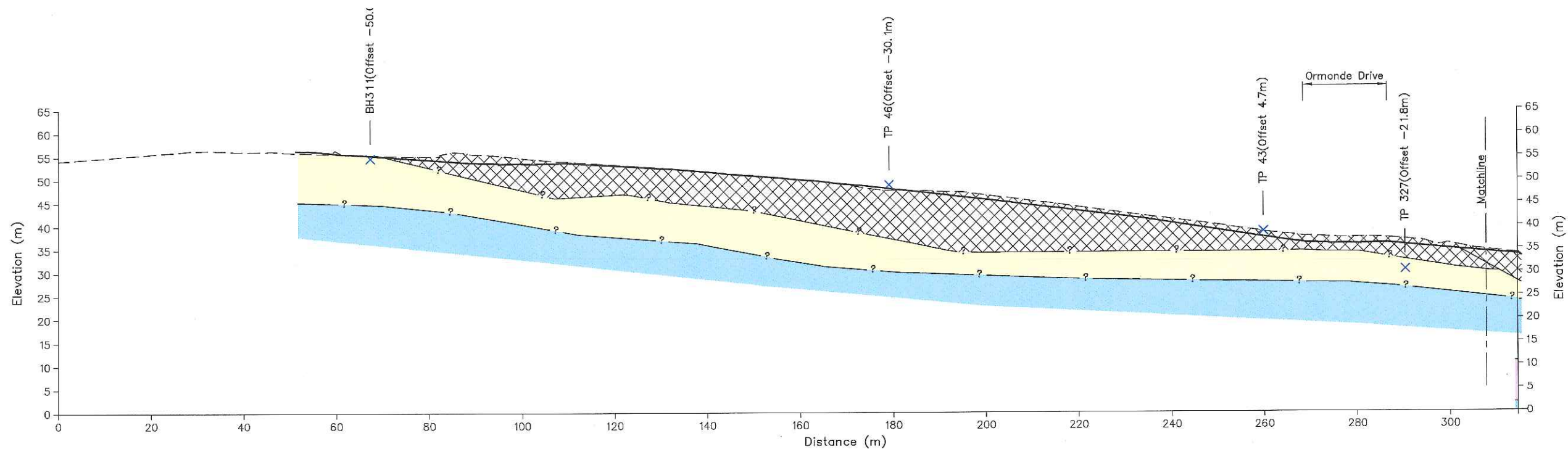
TITLE
MILLWATER - PRECINCT 2 (STAGE 4A)
Geological Cross Section 17

SCALE (AT A3 SIZE)
1:1000

DWG. No.
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REV.
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SECTION 18
SCALE 1:1000

LEGEND	
	Engineered Fill
	Alluvium
	Northland Allochthon Residual Soil
	Northland Allochthon Rock
	Original Ground Level
	Finished Ground Level
	Inferred geology interface

A3 SCALE 1:1000
0 5 10 15 20 30 40 50 (m)

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NOTES :
1. All dimensions are in metres unless noted otherwise.

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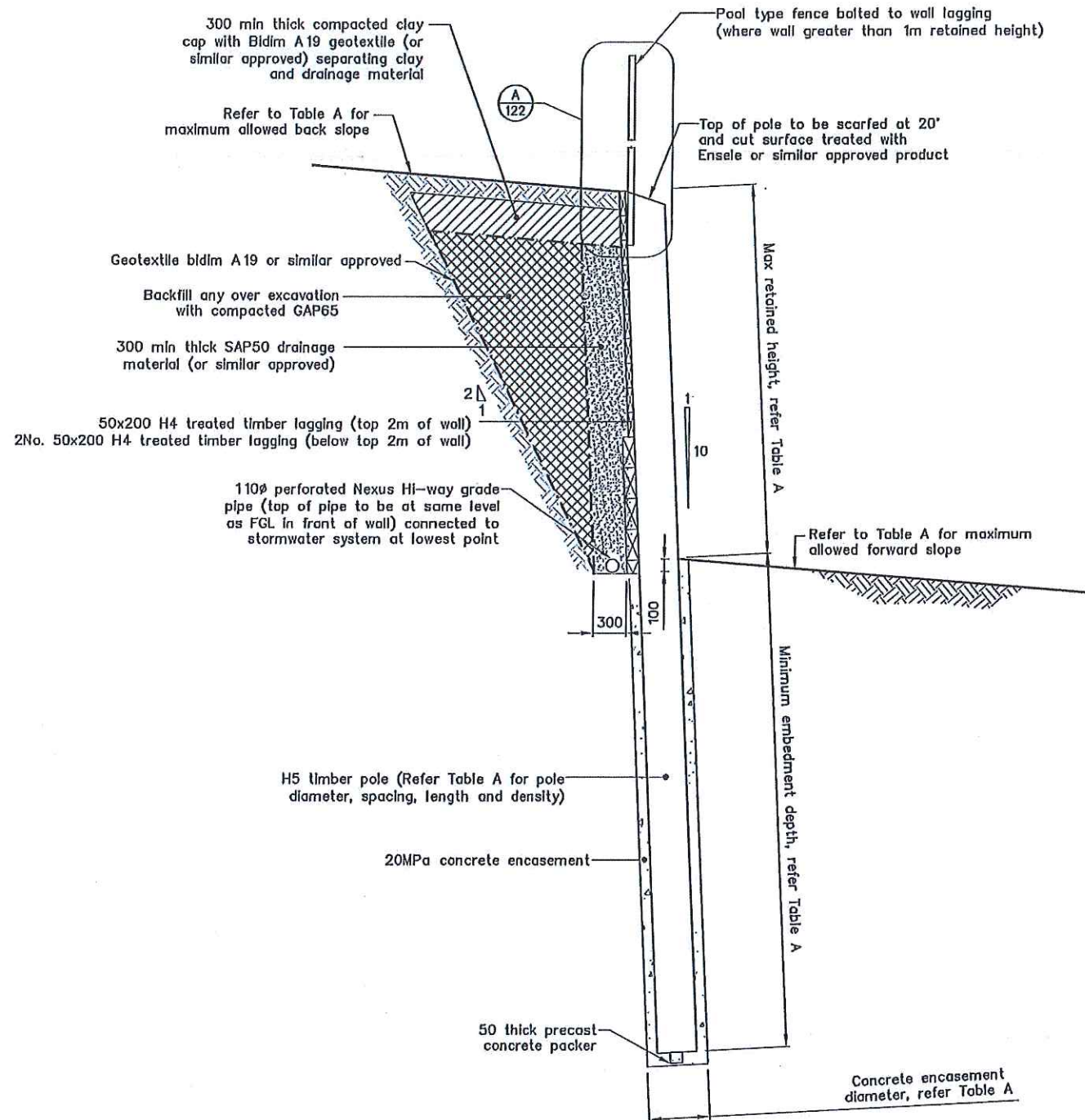
Tonkin+Taylor

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DRAWING STATUS: COMPLETION REPORT

CLIENT, PROJECT	WFH PROPERTIES LTD RESIDENTIAL SUBDIVISION
TITLE	MILLWATER - PRECINCT 2 (STAGE 4A) Geological Cross Section 18
SCALES (AT A3 SIZE)	1:1000
DWG. No.	21854.001-P2S4A-107
REV.	1

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TYPICAL DETAIL - TIMBER POLE RETAINING WALL (TP)
SCALE 1:50

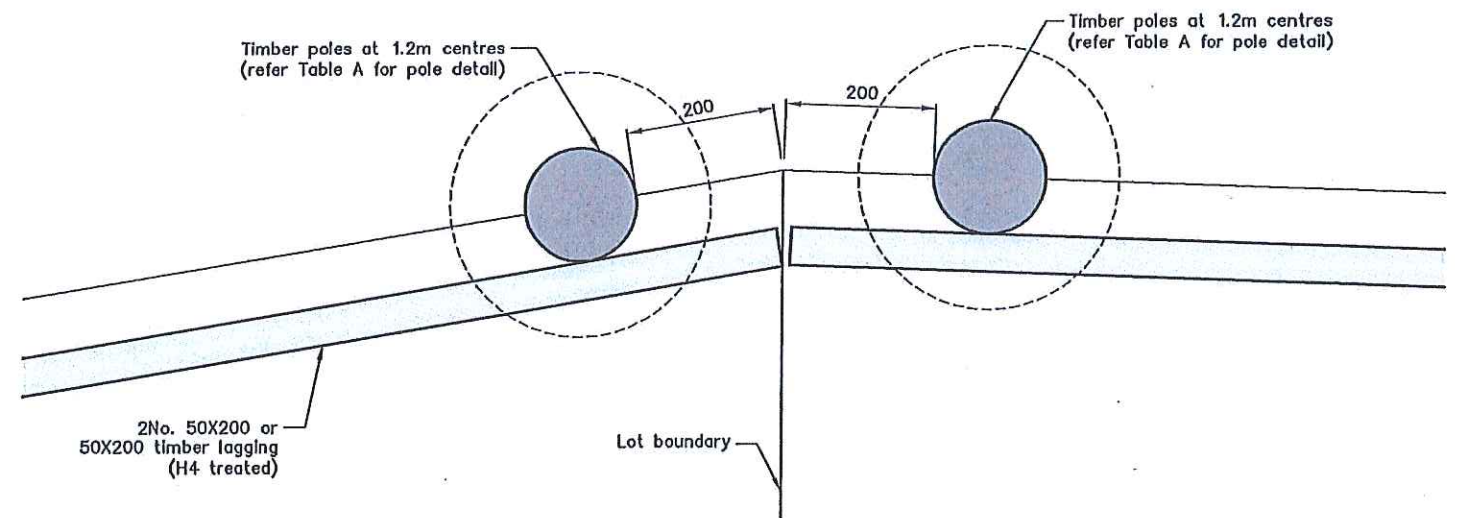
Refer to Table A

TABLE A: TIMBER POLE DETAIL TABLE

Wall No.	Wall Type	Pole Type	Retained Height (m)	Pole Length (m)	Minimum Embedment (m)	Pole/Pile Size (mm)	Pole Density	Pole Spacing (m)	Min Hole Size (mm)	Maximum Backslope	Maximum Frontslope
306, 308	C	Timber Pole	≤3.0	9	6	375	High	1.2	525	1v:12h	1v:12h
	E3	Timber Pole	≤2.5	7.5	5	300	High	1.2	450	1v:12h	1v:12h
	F1	Timber Pole	≤2.0	6	4	225	High	1.2	375	1v:12h	1v:12h
	G	Timber Pole	≤1.5	4.2	2.7	200	High	1.2	350	1v:12h	1v:12h
	H	Timber Pole	≤1.0	2.4	1.4	150	High	1.2	300	1v:12h	1v:12h
304, 305	D	Timber Pole	≤3.0	8	5	350	High	1.2	500	1v:12h	1v:12h
	E3	Timber Pole	≤2.5	7.5	5	300	High	1.2	450	1v:12h	1v:12h
	F1	Timber Pole	≤2.0	6	4	225	High	1.2	375	1v:12h	1v:12h
	G	Timber Pole	≤1.5	4.2	2.7	200	High	1.2	350	1v:12h	1v:12h
	H	Timber Pole	≤1.0	2.4	1.4	150	High	1.2	300	1v:12h	1v:12h
307	E	Timber Pole	≤2.5	7	4.5	275	High	1.2	425	1v:12h	1v:12h
	F1	Timber Pole	≤2.0	6	4	225	High	1.2	375	1v:12h	1v:12h
	G	Timber Pole	≤1.5	4.2	2.7	200	High	1.2	350	1v:12h	1v:12h
	H	Timber Pole	≤1.0	2.4	1.4	150	High	1.2	300	1v:12h	1v:12h

NOTE

1. All poles shall be sourced from the same region and documentation shall be provided.
2. For each pole size, 10% of all poles shall be tested in accordance with the specification.
3. Retaining walls have been designed with 10kPa surcharge on upslope side for residential use purposes.
4. Design makes no provision for over excavation in front of wall (e.g. for service trenches). All such temporary excavations, if required, should be reviewed and confirmed as acceptable by a suitably qualified Geotechnical Engineer.



TYPICAL DETAIL AT LOT BOUNDARY
SCALE 1:10

A3 SCALE 1:50
0 0.5 1.0 1.5 2.0 2.5 (m)

A3 SCALE 1:10
0 0.1 0.2 0.3 0.4 0.5 (m)

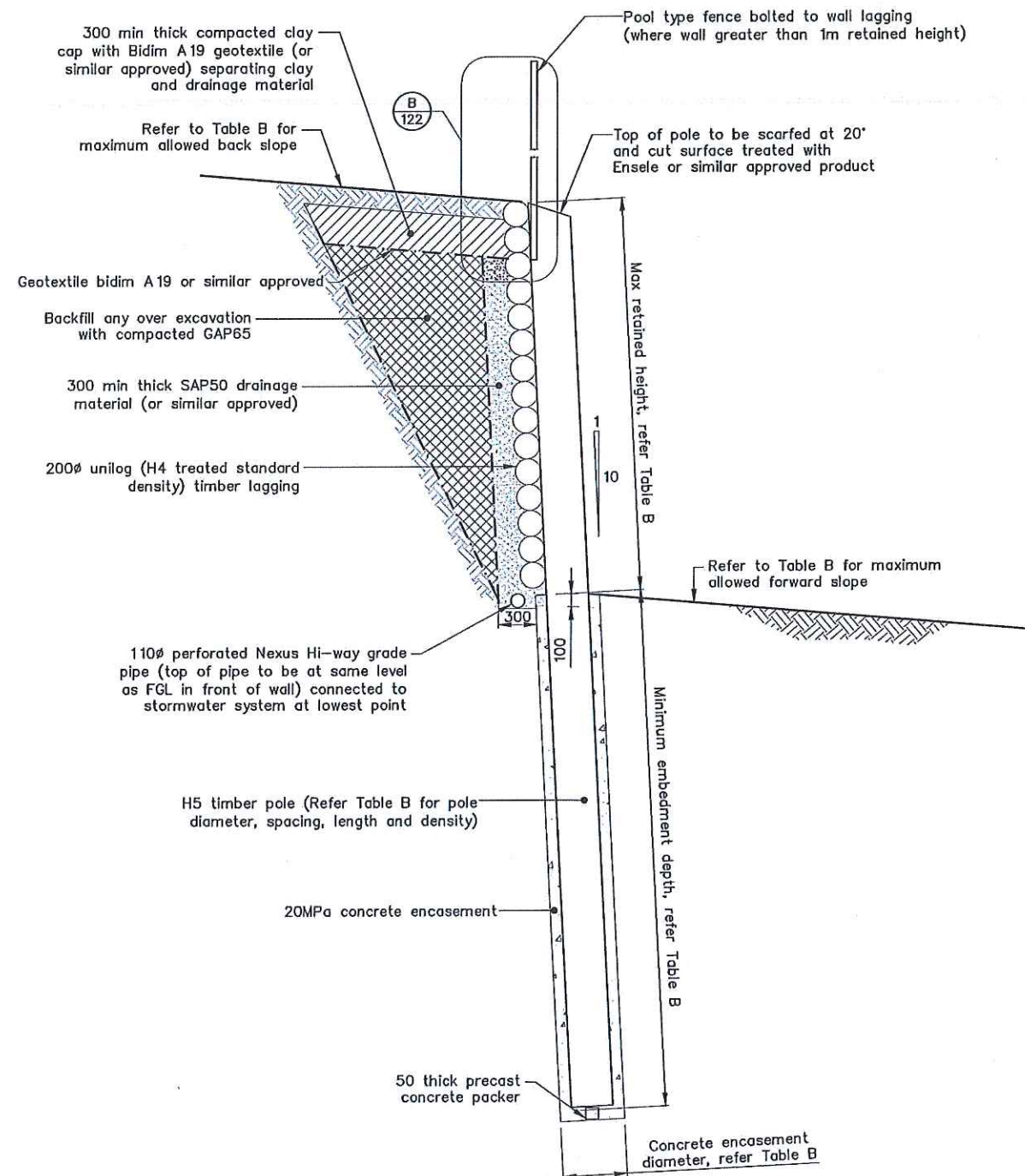
				DESIGNED :	JXXL	Feb. 16
				DRAWN :	JC	Feb. 16
				DESIGN CHECKED :	for 216	
				DRAFTING CHECKED :	for 216	
				CADFILE :	\\21854.001-P2S3-120_122.dwg	
				APPROVED :	15/2/16	
A	Construction Issue			This drawing is not to be used for construction purposes unless signed as approved		
REVISION DESCRIPTION	BY	DATE	COPYRIGHT ON THIS DRAWING IS RESERVED			

NOTES :		
1. All dimensions are in millimetres unless noted otherwise.		
2. Wall setout to be provided by WOODS		
3. Small end diameter to be placed at top of wall.		
4. All cut surfaces to be treated with Ensele or similar approved timber sealant.		
5. All pile holes to be inspected by T&T prior to pouring concrete.		
REFERENCE :		

Tonkin+Taylor
105 Carlton Gore Road, Newmarket, Auckland
Tel. (09) 355 6000 Fax. (09) 307 0265
www.tonkintaylor.co.nz

DRAWING STATUS: CONSTRUCTION ISSUE

CLIENT, PROJECT		
WFH PROPERTIES LTD		
MILLWATER PRECINCT 2		
TITLE		
STAGE 3 RETAINING WALLS		
Typical Timber Pole Retaining Wall Detail		
SCALES (AT A3 SIZE)	DWG. No.	REV.
AS SHOWN	21854.001-P2S3-120	A



TYPICAL DETAIL — PIPE CROSSING TIMBER POLE RETAINING WALL (PCTP)
SCALE 1:50

Refer to table B

TABLE B: WALL PIPE CROSSING DETAIL TABLE

Wall No.	Wall Type	Pile Type	Retained Height (m)	Pile Length (m)	Minimum Embedment (m)	Pile spacing (m)	Min Hole Size (mm)	Maximum Backslope	Maximum Frontslope
304, 305, 306, 307	PC TP1	450 SED	≤3.0	9.0	6.0	2.80	600	1v: 12h	1v: 12h
308	PC TP2	375 SED	≤2.2	7.0	4.8	2.80	550	1v: 12h	1v: 12h

NOTE

1. All poles shall be sourced from the same region and documentation shall be provided.
2. For each pole size, 10% of all poles shall be tested in accordance with the specification.
3. Retaining walls have been designed with 10kPa surcharge on upslope side for residential use purposes.
4. Design makes no provision for over excavation in front of wall (e.g. for service trenches). All such temporary excavations, if required, should be reviewed and confirmed as acceptable by a suitably qualified Geotechnical Engineer.

A3 SCALE 1:50
0 0.5 1.0 1.5 2.0 2.5 (m)

DESIGNED :	JXXL	Aug. 16
DRAWN :	JC	Aug. 16
DESIGN CHECKED :	RJ	8/16
DRAFTING CHECKED :	RJ	8/16
CADFILE :	\\21854.001-P2S3-120_122.dwg	
APPROVED :	RJL 29/8/16	
REVISION DESCRIPTION	BY	DATE
A Construction Issue	AJL	Feb. 16

This drawing is not to be used for construction purposes unless signed as approved
COPYRIGHT ON THIS DRAWING IS RESERVED

REFERENCE :

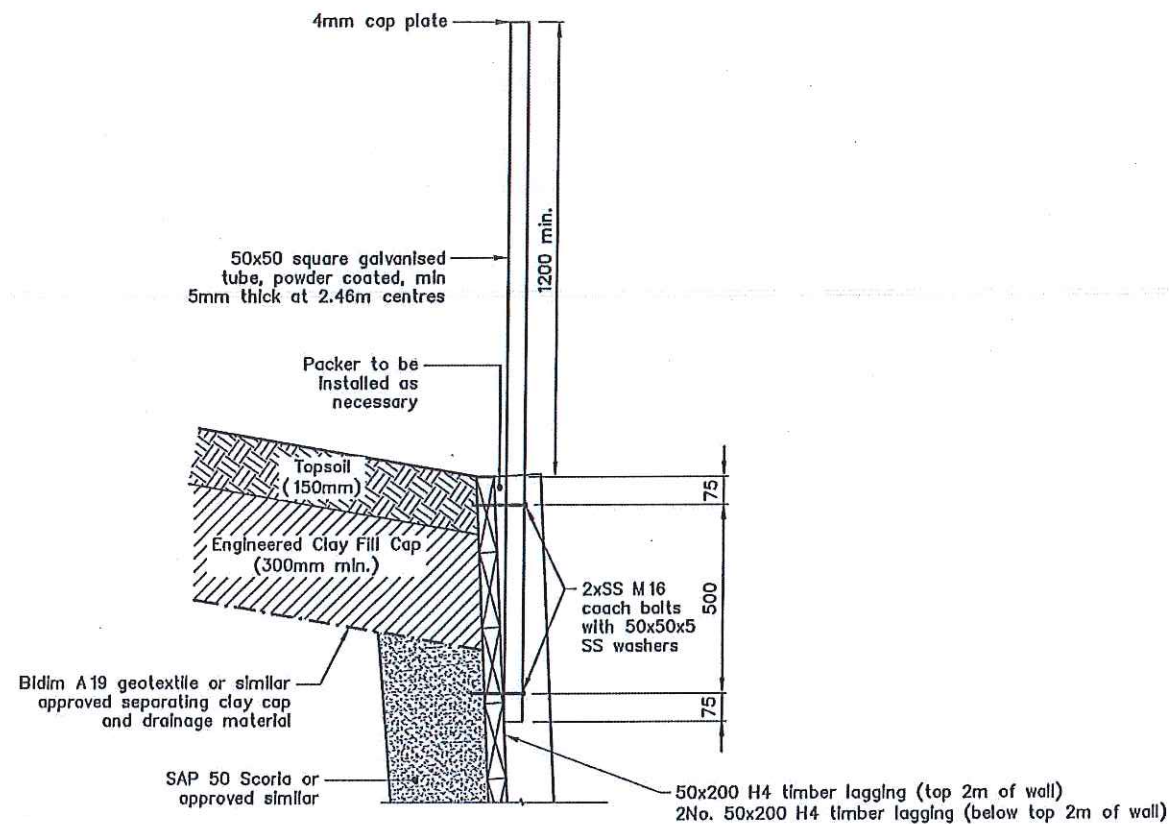
Tonkin+Taylor

105 Carlton Gore Road, Newmarket, Auckland
Tel. (09) 355 6000 Fax. (09) 307 0265
www.tonkintaylor.co.nz

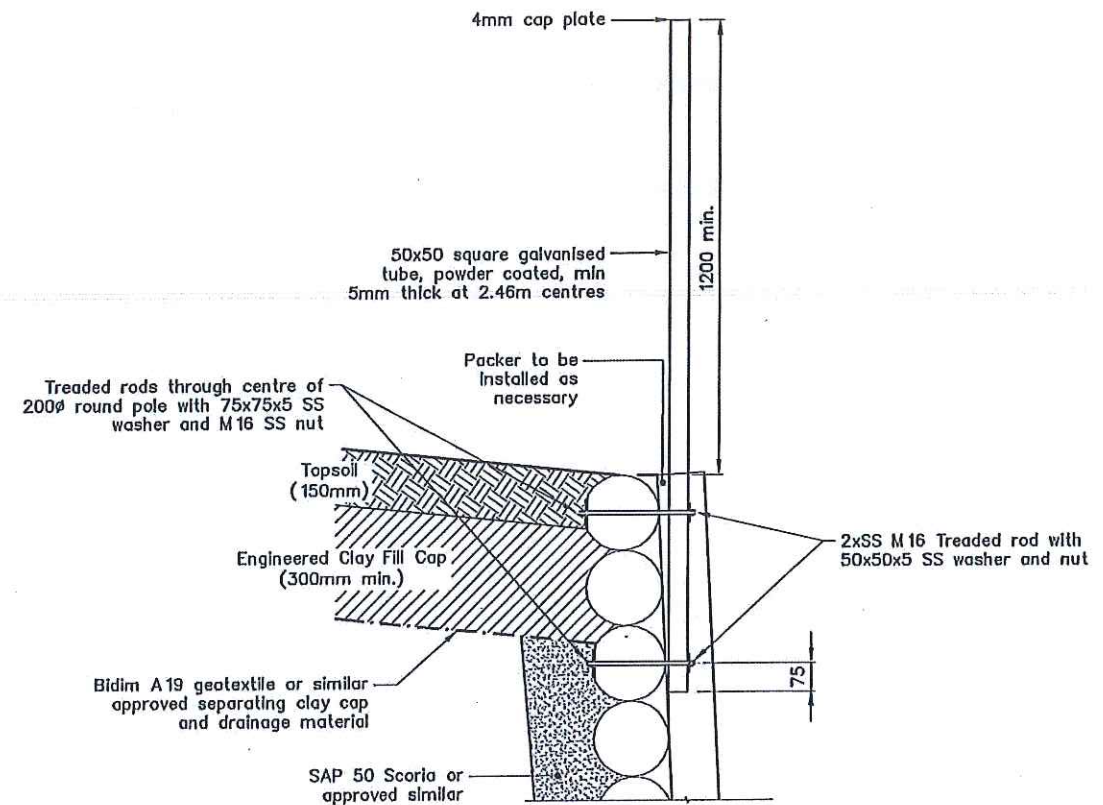
DRAWING STATUS: CONSTRUCTION ISSUE

CLIENT, PROJECT
WFH PROPERTIES LTD
MILLWATER PRECINCT 2

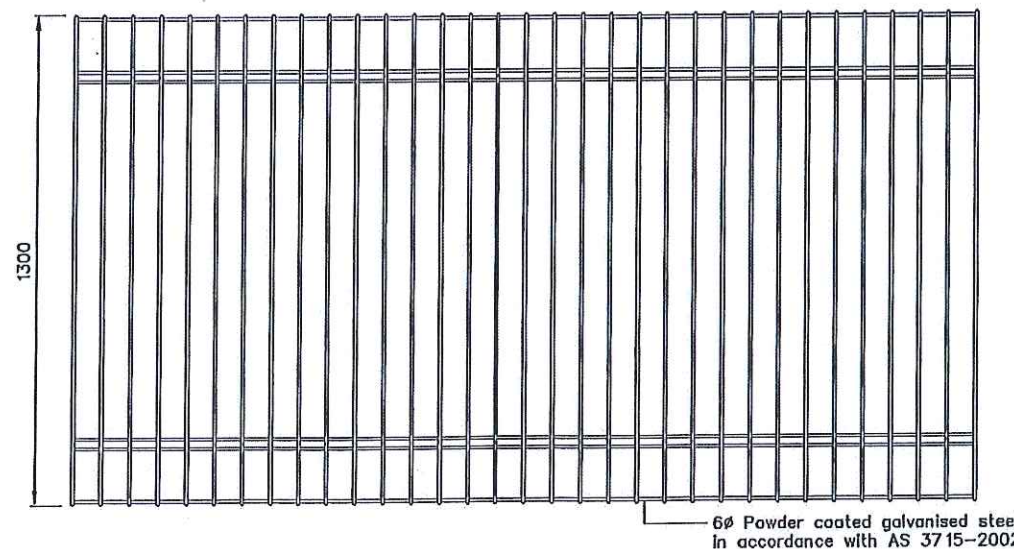
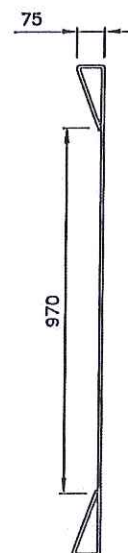
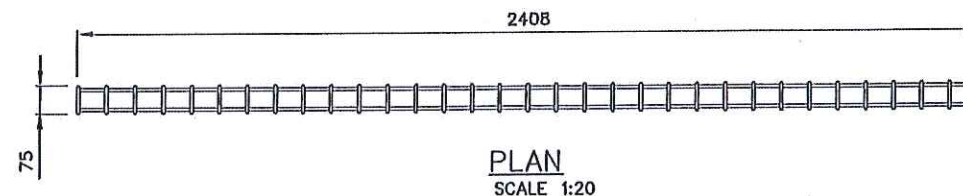
TITLE
STAGE 3 RETAINING WALLS
Pipe Crossing Timber Pole Retaining Wall Detail
SCALES (AT A3 SIZE)
AS SHOWN
DWG. No.
21854.001-P2S3-121
REV.
B



DETAIL A POST DETAIL
SCALE 1:20



DETAIL B POST DETAIL
SCALE 1:20



A3 SCALE 1:20
0 0.2 0.4 0.6 0.8 1.0 (m)

				DESIGNED :	JXXL	Feb. 16	NOTES : 1. All dimensions are in millimetres unless noted otherwise. 2. Fence panels to be hot dip galvanised and black powder coated. 3. Fence panels must not have more than 100mm gap from ground level to base of installed panel. 4. Posts to be 50mm hot dip galvanised pipe and black powder coated. 5. Posts to be installed vertically and packed out appropriately. 6. Fence panels & posts to be installed in accordance with manufacturers specifications.
				DRAWN :	JC	Feb. 16	
				DESIGN CHECKED :	M	2/16	
				DRAFTING CHECKED :	M	2/16	
				CADFILE :	\\21854.001-P253-120_122.dwg		
				APPROVED :	15/2/16		
A	Construction Issue			This drawing is not to be used for construction purposes unless signed as approved			REFERENCE :
REVISION DESCRIPTION	BY	DATE	COPYRIGHT ON THIS DRAWING IS RESERVED				

- NOTES :
1. All dimensions are in millimetres unless noted otherwise.
 2. Fence panels to be hot dip galvanised and black powder coated.
 3. Fence panels must not have more than 100mm gap from ground level to base of installed panel.
 4. Posts to be 50mm hot dip galvanised pipe and black powder coated.
 5. Posts to be installed vertically and packed out appropriately.
 6. Fence panels & posts to be installed in accordance with manufacturers specifications.

REFERENCE :

Tonkin+Taylor
105 Carlton Gore Road, Newmarket, Auckland
Tel. (09) 355 6000 Fax. (09) 307 0265
www.tonkintaylor.co.nz

DRAWING STATUS: CONSTRUCTION ISSUE

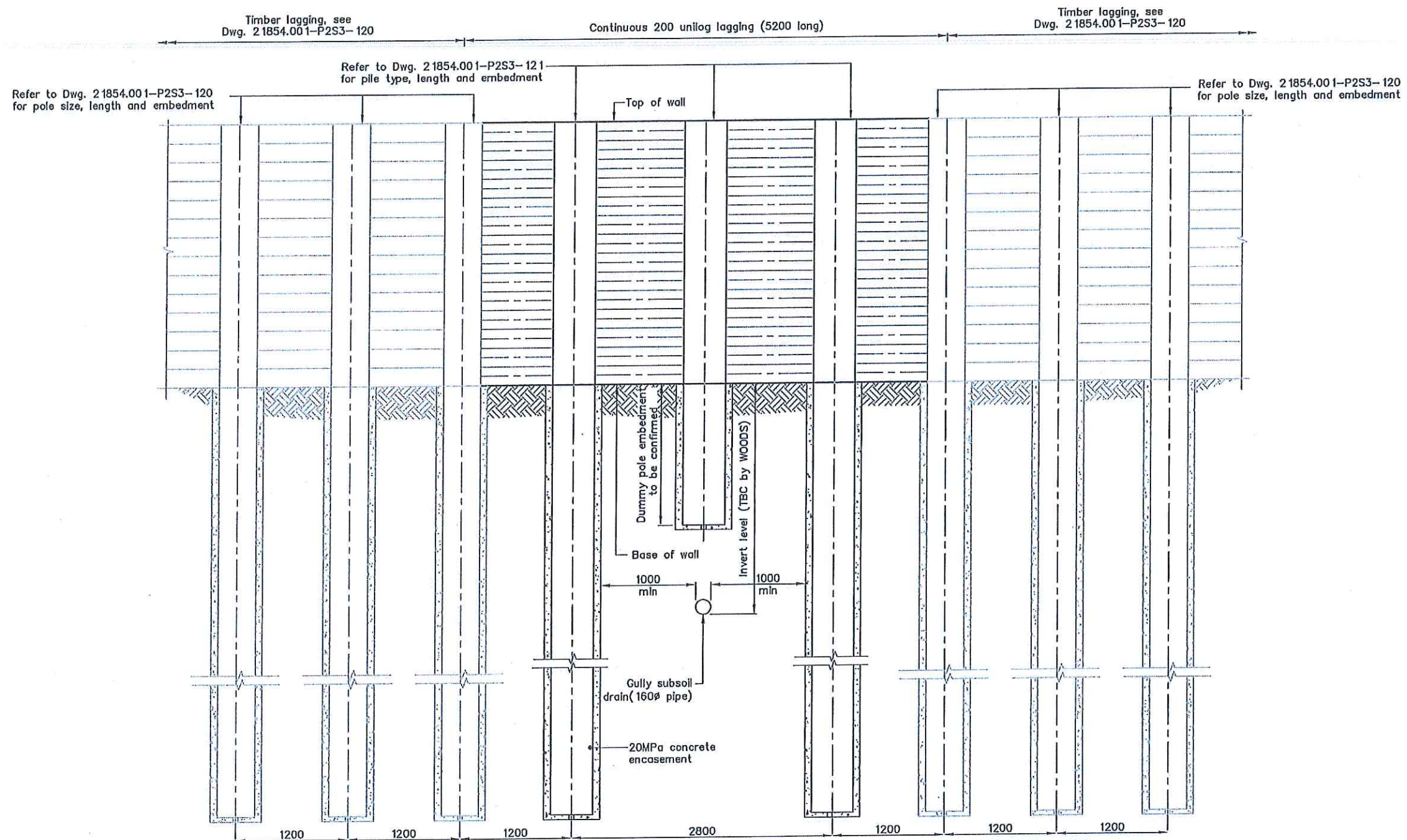
CLIENT, PROJECT
WFH PROPERTIES LTD
MILLWATER PRECINCT 2

TITLE
STAGE 3 RETAINING WALL
Standard Fence Panel Detail

SCALES (AT A3 SIZE)
1:20

DWG. No.
21854.001-P253-122
REV.
A

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PIPE CROSSING TYPICAL ELEVATION
SCALE 1:50

SCALE 1:50
0 0.5 1.0 1.5 2.0 2.5 (m)

				DESIGNED :	JXXL	Feb. 16
				DRAWN :	JC	Feb. 16
				DESIGN CHECKED :	AL	2/16
				DRAFTING CHECKED :	AL	2/16
				CADFILE :	\\21854.001-P2S3-123.dwg	
				APPROVED :	[Signature] 15.2.16	
A	Construction Issue			This drawing is not to be used for construction purposes unless signed as approved		
REVISION DESCRIPTION	BY	DATE	COPYRIGHT ON THIS DRAWING IS RESERVED			

NOTES :
1. All dimensions are in millimetres unless noted otherwise.
2. Wall setout to be provided by WOODS.
3. All cut ends of timber to be painted with a suitable timber preservative.
4. All cut ends of steel to be painted with a suitable anti-rust paint.
5. Refer to specifications for other details.
6. All pile holes to be inspected by T&T prior to pouring concrete.
7. Gully subsoil drainage set out to be provided by WOODS.
REFERENCE :

Tonkin+Taylor
105 Carlton Gore Road, Newmarket, Auckland
Tel. (09) 355 6000 Fax. (09) 307 0265
www.tonkintaylor.co.nz

DRAWING STATUS: CONSTRUCTION ISSUE

CLIENT, PROJECT	WFH PROPERTIES LTD MILLWATER PRECINCT 2
TITLE	STAGE 3 RETAINING WALL Pipe Crossing Typical Elevation
SCALES (AT A3 SIZE)	AS SHOWN
DWG. No.	21854.001-P2S3-123
REV.	A

Appendix B: Contractors Certificates

- **Hick Bros Ltd – Sixth Schedule (Bulk Earthworks – Stage 2)**
- **Hick Bros Ltd – Sixth Schedule (Bulk Earthworks – Stage 3)**
- **JG Civil Ltd – Sixth Schedule (Civil Earthworks)**
- **JG Civil Ltd – Producer Statement 3 (Timber Pole Retaining Walls 306, 307 and 308 Construction)**
- **PermaPine Ltd – Timber Pole Grading and Treatment Certification**
- **Pinepac Group Ltd – Timber Pole Grading and Treatment Certification**
- **ICB Retaining and Construction Ltd – Producer Statement 3 (Screen Block Retaining North Harbour Fencing Ltd – Producer Statement 3 (Pool Fence Installation for Walls 306, 307 and 308)**

Schedule 6 – Form of Producer Statement – Construction

ISSUED BY	HICK BROS CIVIL CONSTRUCTION LTD	(Contractor)
TO	WFH PROPERTIES LTD	(Principal)
IN RESPECT OF	PRECINCT 2 STAGE 2 EW CONTRACT 33203-01	(Description of Contract Works)
AT	PRECINCT 2 – MILLWATER – SILVERDALE NORTH	(Address)

HICK BROS CIVIL CONSTRUCTION LTD (Contractor) has contracted to WFH PROPERTIES LTD (Principal) to carry out and complete certain building works in accordance with a Contract titled PRECINCT 2 STAGE 2 ('the Contract')

I ROB FENWICK (Duly Authorised Agent) a duly authorised representative of HBCLL (Contractor) believe on reasonable grounds that HBCLL (Contractor) has carried out and completed:

☒ All

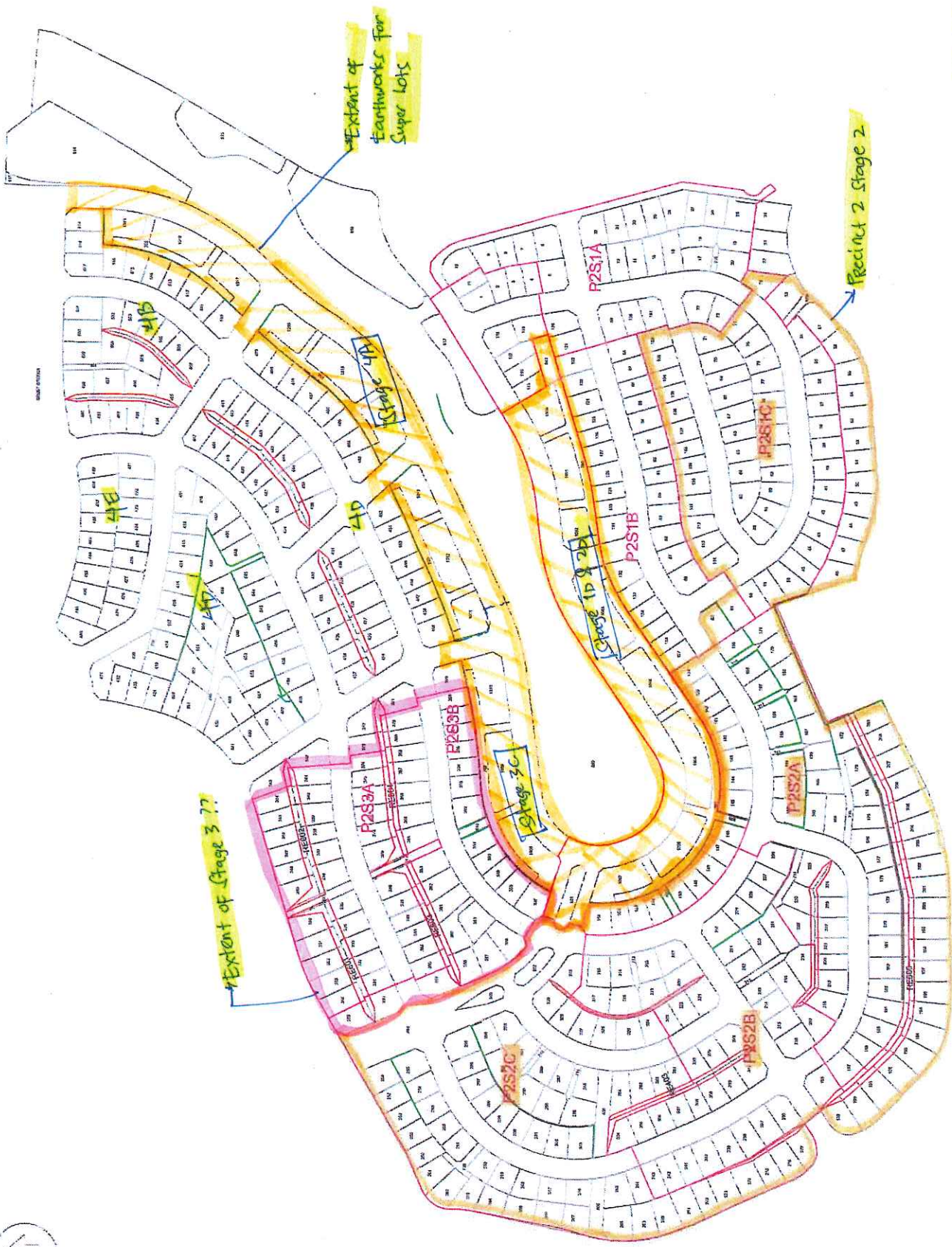
☐ Part only as specified in the attached particulars of the contract works in accordance with the Contract


(Signature of Authorised Agent on behalf of)

Date 16-12-2015

HICK BROS CIVIL CONSTRUCTION LTD
(Contractor)

42 FORGE ROAD, SILVERDALE.
(Address)



Extent of Earthworks for Super lots

Precinct 2 Stage 2

Extent of Stage 3 ??

Stage 1B

Stage 1C

Stage 2

Stage 3

P2S1A

P2S1B

P2S1C

P2S2A

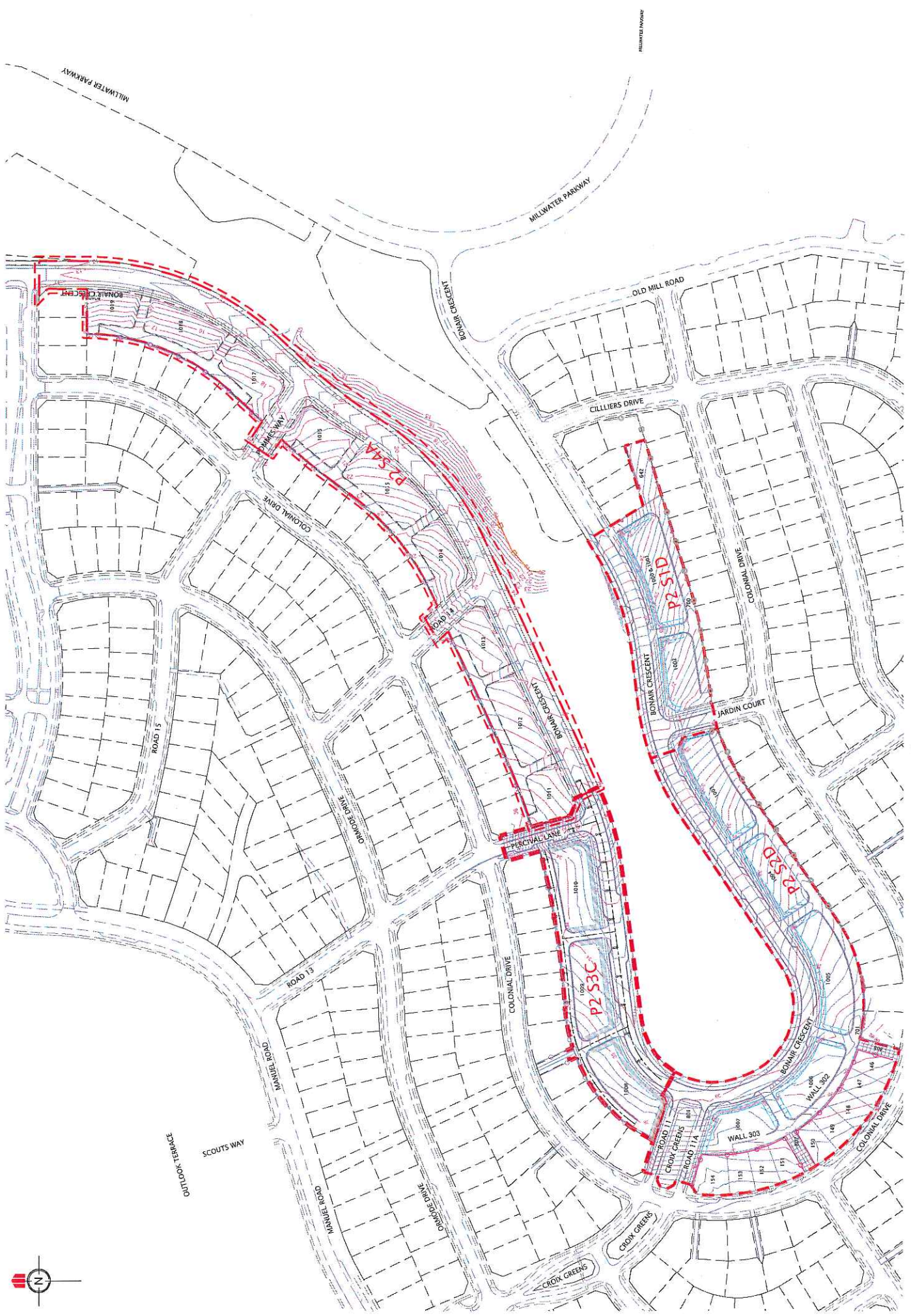
P2S2B

P2S2C

P2S3A

P2S3B

P2S3C



PS3 - FORM OF PRODUCER STATEMENT- CONSTRUCTION

ISSUED BY: HICK BROS CIVIL CONSTRUCTION LIMITED

TO: WFH PROPERTIES

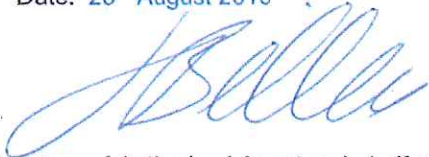
IN RESPECT OF: MILLWATER PRECINCT 2 STAGE 3 GEOTECHNICAL REMEDIATION AND BULK EARTHWORKS

AT: PRECINCT 2 STAGE 3 CONTRACT 33213 - 01

HICK BROS CIVIL CONSTRUCTION LTD has contracted to WFH PROPERTIES to carry out and complete certain building works in accordance with a contract, titled MILLWATER PRECINCT 2 STAGE 3 GEOTECHNICAL REMEDIATION AND BULK EARTHWORKS ("the contract")

I JAMES BILKEY a duly authorized representative of HICK BROS CIVIL CONSTRUCTION LIMITED believe on reasonable grounds that HICK BROS CIVIL CONSTRUCTION LIMITED has carried out and completed part only as specified in the attached particulars of the contract works in accordance with the contract.

Date: 23rd August 2016



(Signature of Authorized Agent on behalf of)

HICK BROS CIVIL CONSTRUCTION LIMITED
(Contractor)

42 FORGE ROAD, SILVERDALE
(Address)

Attachments:

- 1) List detailing works carried out

ATTACHMENT 1

MILLWATER PRECINT 2 STAGE 3 GEOTECHNICAL REMEDIATION AND BULK EARTHWORKS

LIST OF WORK CARRIED OUT:

- 1) All the earthworks within Stage 3
- 2) Construction of Reinforced Earth Wall 601 including drainage
- 3) Construction of Reinforced Earth Wall 602 including drainage
- 4) Construction of Reinforced Earth Wall 603 including drainage
- 5) Construction of Reinforced Earth Wall 604 including drainage
- 6) Construction of Reinforced Earth Wall 605 including drainage
- 7) Construction of Reinforced Earth Wall 606 including drainage
- 8) Construction of Reinforced Earth Wall 404 including drainage
- 9) Construction of Reinforced Earth Wall 405 including drainage
- 10) Subsoil drainage as instructed and asbuilt

JB


Schedule 6 – Form of Producer Statement – Construction

ISSUED BY JGCIVIL LTD. (Contractor)
TO WFH PROPERTIES LTD. (Principal)
IN RESPECT OF CONTRACT 33218-01 (Description of Contract Works)
AT PRECINCT 2 STAGE 4A, MILLWATER DEVELOPMENT (Address)

JG Civil Ltd (Contractor) has contracted to *WFH PROPERTIES Ltd* (Principal) to carry out and complete certain building works in accordance with a Contract titled *PRECINCT 2 STAGE 4A* ("the Contract")

I JOEL GIDDY (Duly Authorised Agent) a duly authorised representative of *JG Civil Ltd* (Contractor) believe on reasonable grounds that *JG Civil Ltd* (Contractor) has carried out and completed:

- ☒ All
☐ Part only as specified in the attached particulars of the contract works in accordance with the Contract
[Click to enter details of attached particulars](#)

+ 
(Signature of Authorised Agent on behalf of)
JG CIVIL LTD
(Contractor)
180 FOUNDRY ROAD
(Address)

Date 30/03/2017

Schedule 6 – Form of Producer Statement – Construction

ISSUED BY JGCIVIL LTD. (Contractor)
TO WFH PROPERTIES LTD. (Principal)
IN RESPECT OF CONTRACT 33218-01 (Description of Contract Works)
AT PRECINCT 2 STAGE 4A, MILLWATER DEVELOPMENT (Address)

JG Civil Ltd (Contractor) has contracted to *WFH PROPERTIES Ltd* (Principal) to carry out and complete certain building works in accordance with a Contract titled *PRECINCT 2 STAGE 4A* ('the Contract')

I JOEL GIDDY (Duly Authorised Agent) a duly authorised representative of *JG Civil Ltd* (Contractor) believe on reasonable grounds that *JG Civil Ltd* (Contractor) has carried out and completed:

☐ All

☒ Part only as specified in the attached particulars of the contract works in accordance with the Contract

[Click to enter details of attached particulars](#)

RETAINING WALLS

+ 

Date

30/03/2017

(Signature of Authorised Agent on behalf of)

JG CIVIL LTD

(Contractor)

180 FOUNDRY ROAD

(Address)



PermaPine

33 White Rd, RD1, Reporoa, New Zealand

Permapine

Ministry for Primary Industries (MPI)

Registration: 01 OA 2009 1400

Fax: 07 3338766

Date: 18/10/16

CCA TREATMENT CERTIFICATE

This is to certify that the product described below has been CCA treated to the following specifications.

Details of treatment

Type of treatment	Tanalith CCA Oxide	
Plant registration number	159	
Preservative Components (relative proportions of CCA components)	Copper %: 23 – 25 Cromium %: 38 - 45 Arsenic %: 30 – 37	
Standard	NZS 3640 HAZARD CLASS: H5	
Retention	Copper Retention % m/m	Total Active Elements (TAE) %m/m
H3	0.08	0.37
H4	0.16	0.72
H5	0.22	0.95
H6	0.40	1.80

Customer	Albany ITM	
Delivery DKT Numbers:	284766, 284763, 285174, 285201, 284719, 284686 & 384337	
Order numbers	397/119831SP, 119883SP, 119883SP, 11982 & 120793SP	
Packet numbers	Multiple numbers – delivery dkts attached	
Earliest Treatment Dates:	Between: 09/06/2016 – 12/02/2016	

Contact details

Ian Piebenga

General Manager, PermaPine Ltd

Signed

**PINEPAC ROUNDWOOD**

246 Main Road, Kumeu
Auckland, New Zealand
Telephone: (09) 412 7011
Facsimile: (09) 412 6293

PRODUCERS STATEMENT

All construction poles supplied to Albany ITM, on order number 397/117822SP, meet or exceed the minimum standards of NZS3605:2001.

Species: Radiata Pine
Timber Pile and Poles: NZS3605:2001
Characteristic stress tables as per: NZS3603
Timber Treatment: NZS3640 [hazard class: H5]
Treatment plant brand: 687 01 H5

The construction poles supplied meet or exceed the "High Density" Threshold of 450kg/m³.

Treatment:

This is to certify that all poles supplied are free of any visible signs of fungal attack, bark and have been treated with Sarmix Oxcel C 680 – CCA wood preservative to charge retention of not less than 8.4 kg/m³.

Sarmix Oxcel C 680 is a copper chrome arsenic wood preservative to meet the optimum formulation ratio recommended by the Forest Research Institute. It is widely used in New Zealand and corresponds to the CCA formulations used in Australia.

Sarmix Oxcel C 680 conforms to NZS3640:2003 having relative proportions.

Chromium 38 – 45%
Copper 23 – 25%
Arsenic 30 – 37%

The Preservative is approved by the Timber Preservation Council for use at the following retentions:

Hazard Class	Brand Identification
H5 0.95% TAE (8.4 kg / m ³)	687 01 H5

The timber treatment process has been carried out by Pinepac, 246 Main Road Kumeu, Auckland, New Zealand. Pinepac Group is "Woodmark" registered and a member of the Timber Preservation Council (TPC)

Should you require any further information in this regard, please do not hesitate to contact me.

John van Zijl
Site Manager – Pinepac Roundwood
PINEPAC GROUP

Mobile: 0272289283 | Office: 09 412 7011 | Fax: 09 412 6293 | DDI: 09 412 6702
246 Main Road, Kumeu, Auckland 0618
Email: john.vanzijl@pinepac.co.nz
Web: www.pinepac.co.nz

SIXTH SCHEDULE

(NZS 3910:2003)

FORM OF PRODUCER STATEMENT CONSTRUCTION

ISSUED BY

ICB Retaining & Construction Limited

(Contractor)

TO

J G Civil

(Principal)

IN RESPECT OF

Mass Block Retaining Wall

(Description of Contract Works)

AT

Millwater, Precinct 2, Bonair Crs

(Address)

ICB Retaining & Construction Ltd

(Contractor)

has contracted to

J G Civil

(Principal)

to carry out and complete certain building works in accordance with a contract, titled

Mass Block Retaining Wall

(The Project)

(The Contract)

I,

Chris Burke

(Duly Authorised Agent)

a duly authorised

representative of

ICB Retaining & Construction Limited

(Contractor)

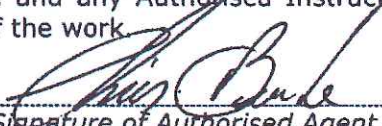
Believe on reasonable grounds that

ICB Retaining & Construction Limited

(Contractor)

has carried out and completed:

☒ All ☐ Part only as specified in the attached particulars of the building works in accordance with the Building Consent No. and any Authorised Instruction / Variations that have been issued during the course of the work.


(Signature of Authorised Agent on Behalf of)

4th March 2017

(Date)

ICB Retaining & Construction Limited

(Contractor)

PO Box 303 340, North Harbour, Auckland

(Address)

Schedule 6 – Form of Producer Statement – Construction

ISSUED BY North Harbour Fencing Ltd (Contractor)
TO J. G. CIVIL LTD (Principal)

IN RESPECT OF POOL FENCING ON RETAINING WALL (Description of Contract Works)
AT MILLWATER STAGE 4A (Address)

NH FENCING (Contractor) has contracted to J. G. CIVIL (Principal) to carry out and complete certain building works in accordance with a Contract titled: ('the Contract')

Ray Herbert (Duly Authorised Agent) a duly authorised representative of NH FENCING (Contractor) believe on reasonable grounds that NH FENCING (Contractor) has carried out and completed:

☐ All

☒ Part only as specified in the attached particulars of the contract works in accordance with the Contract

POOL FENCING

Ray Herbert
(Signature of Authorised Agent on behalf of)

Date 28/3/17

NORTH HARBOUR FENCING LTD
(Contractor)

51A FOUNDRY RD, SILVERDALE
(Address)

Appendix C: NZS 3604:2011 Expansive Soils (Extract)

NZS 3604:2011 Expansive Soils (Extract)

Expansive soils tend to be moderately to highly plastic clays that undergo appreciable volume change upon changes in moisture content. Technically, they are defined in NZS 3604:2011 as those soils having a liquid limit of more than 50% and a linear shrinkage of more than 15%. Where soils are quite silty or sandy, shrink and swell is less of a problem, due to the lower clay contents.

Building damage resulting from expansive soil movement can range from relatively minor brick veneer cracking and internal cracking on wall corners and wall ceiling corners with attendant door and windows jamming, through to extensive cracking of foundation block framework, extensive internal visual cracking and significant warping of building frames. Damage is dependent on building construction and materials and is rarely of structural concern.

NZS 3604:2011 "Timber Framed Buildings" defines good ground as follows:

"Any soil or rock capable of permanently withstanding an ultimate bearing capacity of 300 kPa (i.e. an allowable bearing pressure of 100 kPa using a factor of safety of 3.0), but excludes:

- a) Potentially compressible ground such as topsoil, soft soils such as clay which can be moulded easily in the fingers, and uncompacted loose gravel which contains obvious voids;*
- b) Expansive soils being those that have a liquid limit of more than 50% when tested in accordance with NZS 4402 Test 2.2, and a linear shrinkage of more than 15% when tested in accordance with NZS 4402 Test 2.6, and*
- c) Any ground which could foreseeably experience movement of 25 mm or greater for any reason including one or a combination of: land instability, ground creep, subsidence, seasonal swelling and shrinking, frost heave, changing ground water level, erosion, dissolution of soil in water, and effects of tree roots."*

Foundations on expansive soils are outside the scope of NZS 3604:2011 as an acceptable solution to the New Zealand Building Code (NZBC). Specific engineering design of foundation elements is involved where expansive soils are present with a recommendation that AS 2870:2011 is used for building design. While not mandatory, AS 2870 designs will allow for a non-specific design foundation to be used without resorting to further ongoing investigation or design.

This geotechnical completion report has classified the soils present on this subdivision to be in Site Class M as per the requirements of AS 2870:2011. Descriptions of the various site classes, together with characteristic surface ground movements are outlined below.

Allowing for some correlation with NZS 3604, the various site classes applicable to NZ conditions are considered to be:

Characteristic Surface Movements	Site Class	Description
a) 20 mm (Note NZS 3604:2011 assumes movement of 25 mm as part of underlying design.)	Class A (sand) and/or Class S (Silts) Equivalent to NZS 3604:2011 "Good Ground" sites	Poor to slightly expansive
b) 20 mm – 40 mm	Class M	Moderately expansive
c) 40 mm – 60 mm	Class H1	Highly expansive
d) 60 mm – 75mm	Class H2	Highly expansive
e) > 75 mm	Class E	Extremely expansive

AS 2870 uses a range of factors to assess characteristic soil movement including:

- i. Building distress due to ground movement visible on adjacent structures,
- ii. Known soil properties and site specific testing to determine the shrink / swell index of a soil (Test 7.1.1 in AS 1289 – Methods of Testing Soils for Engineering Purposes).

AS 2870 is based on defining soil types into various hazard classes based on expected surface movement and depth of desiccation that could occur. It then applies various foundation designs and embedment depths based on the form of building construction (slab on ground, strip footing, stiffened raft, stiffened slab with deep edge beams, etc). AS2870 uses more reinforcing steel than NZ designs generally would to create stiffer foundations that are better able to tolerate ground movement.

The Australian approach also regards expansive soil to a considerable extent being a home owner maintenance issue and significant emphasis is put into ensuring that people understand the influence that trees and dry summers etc may have on foundation performance. See Appendix D.

**Appendix D: CSIRO – BTF18 – Foundation
Maintenance and Footing
Performance: A Homeowners Guide**

Foundation Maintenance and Footing Performance: A Homeowner's Guide



BTF 18
replaces
Information
Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

Tree root growth

Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation

Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpend).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

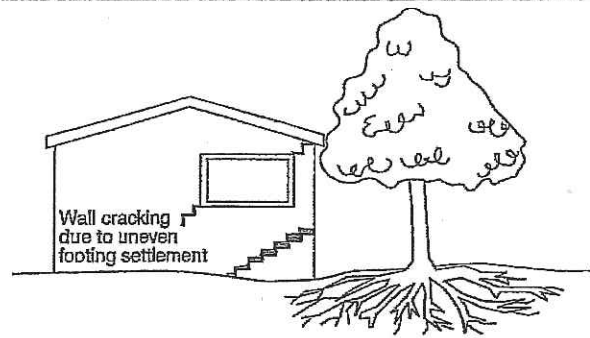
Seasonal swelling/shrinkage in clay

Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish-effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

Trees can cause shrinkage and damage



As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots

In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself

Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures

Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures

Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures

Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.

Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.

- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table CI of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing

Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage

In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

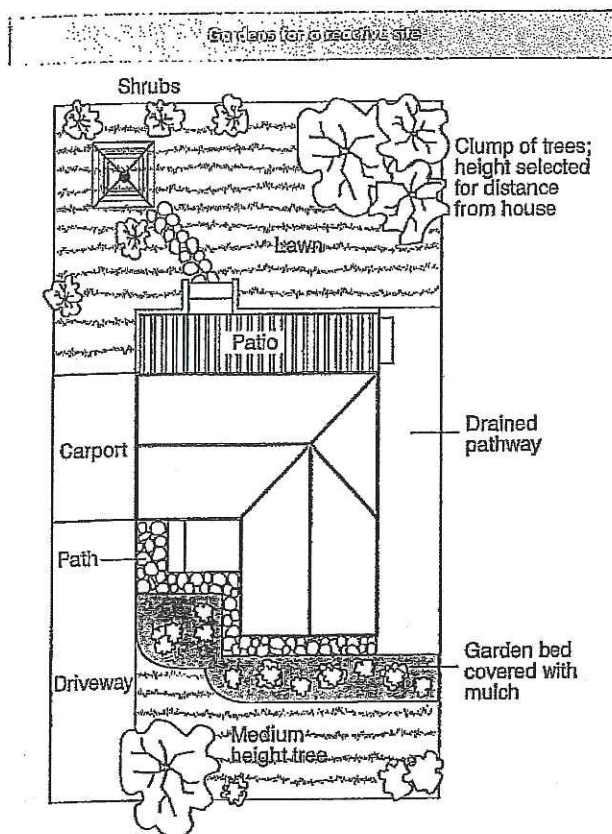
Protection of the building perimeter

It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired	5-15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15-25 mm but also depend on number of cracks	4



should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

The information in this and other issues in the series was derived from various sources and was believed to be correct when published.

The information is advisory. It is provided in good faith and not claimed to be an exhaustive treatment of the relevant subject.

Further professional advice needs to be obtained before taking any action based on the information provided.

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Appendix E: Test Results

- **21854.001–P2S4A–110** **Post Earthworks Investigation Plan**
- **21854.001–P2S4A–111** **Topsoil Depth Plan**
- **21854.001–P2S4A–112** **Earthworks Testing Location Plan**
- **Soil Expansion Test Results**
- **Post Earthworks Investigation Borehole Logs (BH A1 to BH A12)**
- **Earthworks Test Results**

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LEGEND

- Precinct 2 Boundary
- Stage 4A Boundary
- Lot Boundaries
- Finished Ground Contours (0.5m interval)
- Retaining Walls
- RE Slope Extent
- Fill Contours
- Zero Contours
- Cut Contours
- Expansive soil test samples @ 0.5m and 1.0m depth
- Hand Auger to 3m depth (fully logged)

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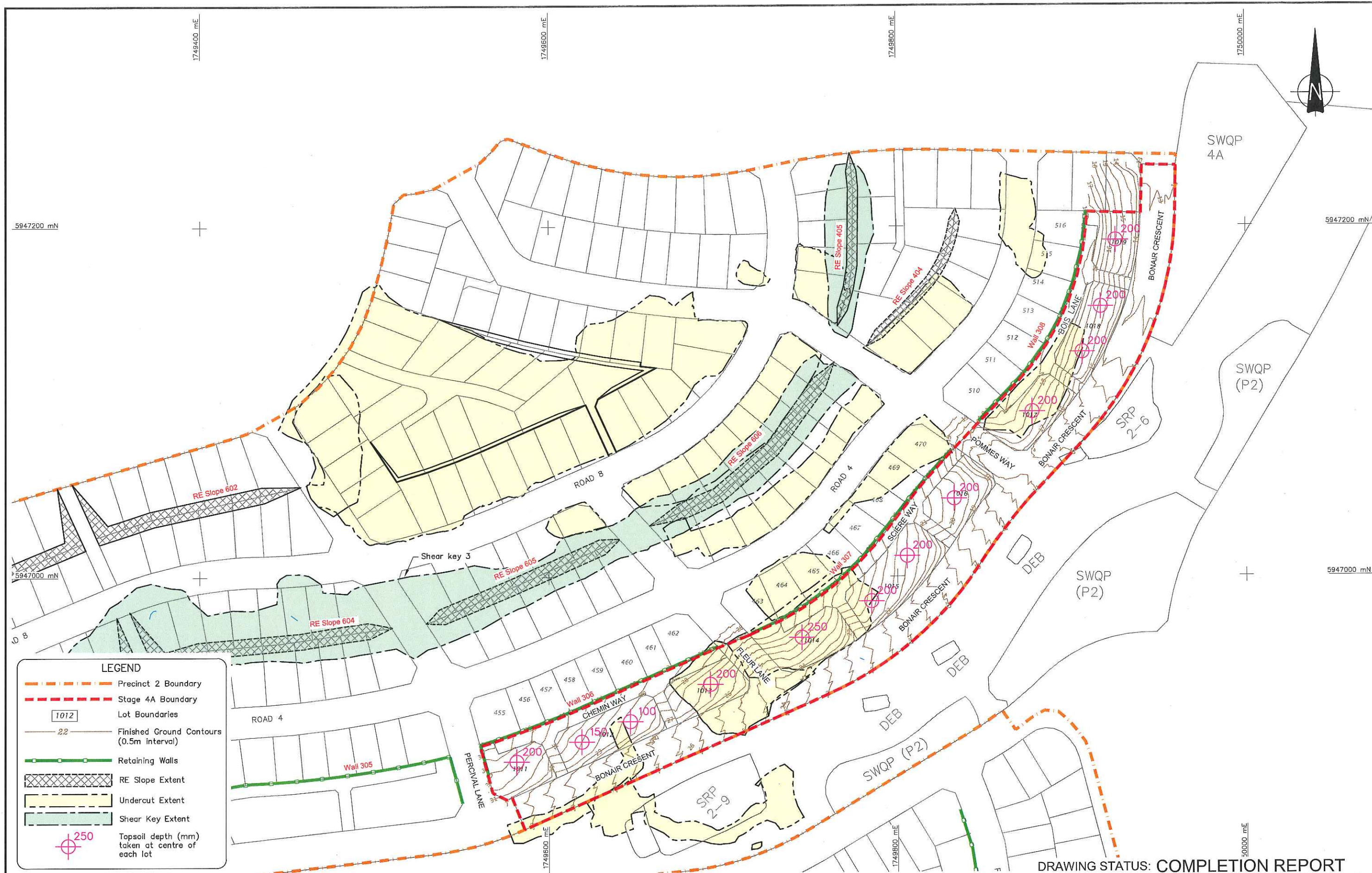
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Post Earthworks Investigation Plan

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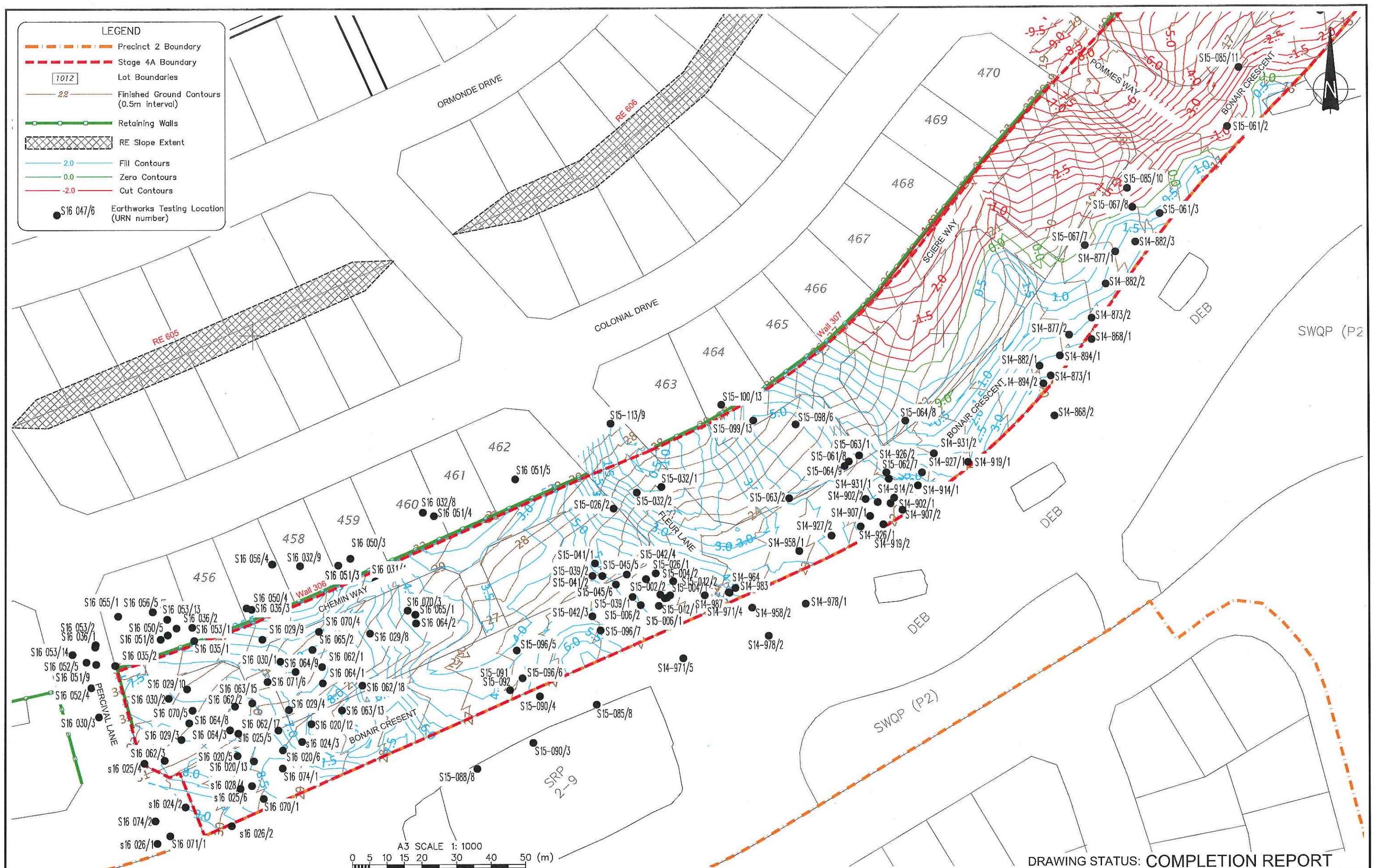
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Topsoil Depths Plan		
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MILLWATER - PRECINCT 2 (STAGE 4A)	
Earthworks Testing Location Plan	
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	REV. 1



Our Ref: 1002124.0000.0.0/Rep1
Customer Ref: 21854.0037
12 April 2017

Tonkin & Taylor
PO Box 5271, Wellesley Street, Auckland 1141

Attention: Andrew Linton

Dear Andrew

Precinct 2, Stage 4A, Millwater
Laboratory Test Report

Samples from the above mentioned site have been tested as received and according to your instructions. Test results are included in this report.

Samples destroyed during testing.

Please reproduce this report in full when transmitting to others or including in internal reports.

If we can be of any further assistance, feel free to get in touch. Contact details are provided at the bottom of this page.

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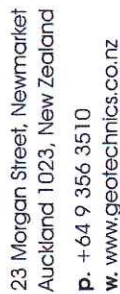
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Site: Precinct 2, Stage 4A, Millwater

Your Job No: 21854.0037

Our Job No: 1002124.0000.0.0

Test Method Used: AS 1289.7.1.1 - 2003 Determination of the Shrink - Swell Index

SUMMARY OF SHRINK - SWELL TEST RESULTS

Sample No.:		A4 E1	A1 E1	A2 E2	A3 E3	A4 E4	
DEPTH		(m)	0.5	1.0	1.0	1.0	
Applied Pressure		(kPa)	55	55	55	55	
SWELL TEST	Initial Water Content	(%)	22.9	25.7	20.6	15.4	
	Bulk Density	(t/m³)	2.00	1.95	2.11	2.16	
	Dry Density	(t/m³)	1.63	1.55	1.75	1.87	
	Final Water Content	(%)	24.5	27.6	22.8	18.1	
	Swelling Strain	(%)	0.29	0.53	0.00	0.26	
SHRINKAGE TEST	Initial Water Content	(%)	22.9	18.1	13.4	20.1	
	Estimated Shrinkage Limit	(%)	13.4	11.1	7.1	14.3	
	Shrinkage Strain	(%)	4.0	3.2	1.6	4.1	
	Inert Material Estimate in the Soil Specimen	(%)	0	0	0	0	
	Soil Crumbling During Shrinkage		Nil	Nil	Nil	Nil	
Cracking of the Shrinkage Specimen			Moderate	Moderate	Moderate	Minor	
SHRINK - SWELL INDEX		(%)	2.3	1.9	0.9	2.4	1.7

Remarks: The test results are IANZ accredited.

Entered by: ST

Date: 12/4/2017

Checked by: JK

Date: 12/4/2017



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GEOTECHNICS

Site: Precinct 2, Stage 4A, Millwater

Your Job No: 21854.0037

Our Job No: 1002124.0000.0.0

Test Method Used: AS 1289.7.1.1 - 2003 Determination of the Shrink - Swell Index

SUMMARY OF SHRINK - SWELL TEST RESULTS

Sample No.:	A5 E5	A5 E5	A6 E6	A6 E6	A7 E7	A7 E7	A8 E8	A8 E8
DEPTH	(m)	0.5	1.0	0.5	1.0	0.5	1.0	0.5
Applied Pressure	(kPa)	55	55	55	55	55	55	55
SWELL TEST	Initial Water Content (%)	37.2	21.9	27.2	20.1	25.2	17.9	24.4
	Bulk Density (t/m ³)	1.80	2.06	1.87	2.01	1.96	2.08	1.87
	Dry Density (t/m ³)	1.31	1.69	1.47	1.67	1.57	1.76	1.50
	Final Water Content (%)	38.4	22.2	29.2	21.8	26.6	19.0	25.4
	Swelling Strain (%)	0.07	0.02	0.11	0.15	0.05	0.10	0.02
SHRINKAGE TEST	Initial Water Content (%)	39.8	25.3	21.4	19.3	30.9	19.4	31.0
	Estimated Shrinkage Limit (%)	16.3	7.8	7.9	8.5	16.3	7.4	13.7
	Shrinkage Strain (%)	4.9	4.8	2.4	2.2	4.7	2.1	2.1
	Inert Material Estimate in the Soil Specimen	0	0	0	0	0	0	0
	Soil Crumbling During Shrinkage	Nil	Nil	Nil	Nil	Nil	Nil	Nil
SHRINK - SWELL INDEX	Cracking of the Shrinkage Specimen	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
	(%)	2.8	2.7	1.4	1.2	2.6	1.2	1.2

Remarks: The test results are IANZ accredited.

Entered by: ST

Date: 12/4/2017

Checked by: JK

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GEOTECHNICS

Site: Precinct 2, Stage 4A, Millwater

Your Job No: 21854.0037

Our Job No: 1002124.0000.0.0

Test Method Used: AS 1289.7.1.1 - 2003 Determination of the Shrink - Swell Index

SUMMARY OF SHRINK - SWELL TEST RESULTS

Sample No.:	A9E9	A9E9	A10E10	A10E10	A11E11	A12E12	A12E12
DEPTH	(m)	0.5	1.0	0.5	1.0	0.5	1.0
Applied Pressure	(kPa)	55	55	55	55	55	55
SWELL TEST	Initial Water Content (%)	18.8	20.1	17.5	13.9	19.4	32.2
	Bulk Density (t/m ³)	2.09	2.04	2.07	2.02	2.09	1.87
	Dry Density (t/m ³)	1.76	1.70	1.76	1.77	1.75	1.41
	Final Water Content (%)	20.6	22.2	19.4	17.4	20.1	33.0
	Swelling Strain (%)	0.44	0.47	0.23	0.02	0.1	0.04
SHRINKAGE TEST	Initial Water Content (%)	19.6	22.2	20.7	16.4	20.4	28.5
	Estimated Shrinkage Limit (%)	7.3	11.0	5.1	4.4	7.5	10.9
	Shrinkage Strain (%)	2.6	0.9	3.6	3.0	4.3	4.4
	Inert Material Estimate in the Soil Specimen (%)	0	0	0	0	0	0
	Soil Crumbling During Shrinkage	Nil	Nil	Nil	Nil	Nil	Nil
SHRINK - SWELL INDEX	Cracking of the Shrinkage Specimen	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
	(%)	1.6	0.6	2.0	1.7	2.4	2.4

Remarks: The test results are IANZ accredited.

Entered by: ST

Date: 12/4/2017

Checked by: JK









Date: 12/4/2017

BOREHOLE LOG

BOREHOLE No.: **1011 (A1)**

Hole Location: Refer to site plan

SHEET: 1 OF 1

PROJECT: P2S4 2017				LOCATION: Millwater Precinct 2				JOB No.: 21854.001 P2S4										
CO-ORDINATES: (NZTM 2000)				DRILL TYPE: 50mm hand auger				HOLE STARTED: 14/02/2017										
R.L.:				DRILL METHOD: HA				HOLE FINISHED: 14/02/2017										
DATUM:				DRILL FLUID:				LOGGED BY: rbe		CHECKED:								
GEOLOGICAL		ENGINEERING DESCRIPTION																
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.		FLUID LOSS (%)	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION	WEATHERING	STRENGTH/STIFFNESS CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSION STRENGTH (MPa)	DEFECT SPACING (mm)	Description and Additional Observations
Fill							● 181/60 kPa					D	VSt					SILT, non plastic, dry, brown
							● 208/56 kPa					M	VSt-H					SILT, some clay, low to no plasticity, moist, grey mottled reddish and yellowish brown, with inclusions of clayey SILT, medium plasticity, moist, yellowish brown
							● >211 kPa			1								
							● >211 kPa											
							● UTP											SILT, non plastic, dry to moist, grey with trace of yellowish brown inclusions
							● UTP			2								1.9m: dry, very hard to auger, grey and greenish grey with gravelly fragments (limestone?)
							● UTP											
Hukerenui Mudstone							● UTP					D						SILT, friable, dry, light grey. Extremely hard to auger
																		2.5m: Refusal

COMMENTS:

Hole Depth
2.5m

BOREHOLE LOG

BOREHOLE No.: **1013 (A4)**

Hole Location: Refer to site plan

SHEET: 1 OF 1

PROJECT: P2S4 2017				LOCATION: Millwater Precinct 2				JOB No.: 21854.001 P2S4			
CO-ORDINATES: (NZTM 2000)				DRILL TYPE: 50mm hand auger				HOLE STARTED: 14/02/2017			
R.L.:				DRILL METHOD: HA				HOLE FINISHED: 14/02/2017			
DATUM:				DRILL FLUID:				DRILLED BY: Geotechnics Ltd			
								LOGGED BY: rbe			
								CHECKED:			
GEOLOGICAL				ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.				FLUID LOSS (%) WATER CORE RECOVERY (%) METHOD CASING		TESTS SAMPLES RL (m) DEPTH (m)		GRAPHIC LOG MOISTURE CONDITION WEATHERING STRENGTH/PLASTICITY CLASSIFICATION		SHEAR STRENGTH (kPa) 1 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 940 945 950 955 960 965 970 975 980 985 990 995 1000 1005 1010 1015 1020 1025 1030 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9035 9040 9045 9050 9055 9060 9065 9070 9075 9080 9085 9090 9095 9100 9105 9110 9115 9120 9125 9130 9135 9140 9145 9150 9155 9160 9165 9170 9175 9180 9185 9190 9195 9200 9205 9210 9215 9220 9225 9230 9235 9240 9245 9250 9255 9260 9265 9270 9275 9280 9285 9290 9295 9300 9305 9310 9315 9320 9325 9330 9335 9340 9345 9350 9355 9360 9365 9370 9375 9380 9385 9390 9395 9400 9405 9410 9415 9420 9425 9430 9435 9440 9445 9450 9455 9460 9465 9470 9475 9480 9485 9490 9495 9500 9505 9510 9515 9520 9525 9530 9535 9540 9545 9550 9555 9560 9565 9570 9575 9580 9585 9590 9595 9600 9605 9610 9615 9620 9625 9630 9635 9640 9645 9650 9655 9660 9665 9670 9675 9680 9685 9690 9695 9700 9705 9710 9715 9720 9725 9730 9735 9740 9745 9750 9755 9760 9765 9770 9775 9780 9785 9790 9795 9800 9805 9810 9815 9820 9825 9830 9835 9840 9845 9850 9855 9860 9865 9870 9875 9880 9885 9890 9895 9900 9905 9910 9915 9920 9925 9930 9935 9940 9945 9950 9955 9960 9965 9970 9975 9980 9985 9990 9995 10000 10005 10010 10015 10020 10025 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BOREHOLE LOG

BOREHOLE No.: **1014 (A5)**

Hole Location: Refer to site plan

SHEET: 1 OF 1

PROJECT: P2S4 2017				LOCATION: Millwater Precinct 2				JOB No.: 21854.001 P2S4							
CO-ORDINATES: (NZTM 2000)				DRILL TYPE: 50mm hand auger				HOLE STARTED: 02/03/2017							
R.L.:				DRILL METHOD: HA				HOLE FINISHED: 02/03/2017							
DATUM:				DRILL FLUID:				DRILLED BY: Geotechnics Ltd							
								LOGGED BY: rbe							
								CHECKED:							
GEOLOGICAL				ENGINEERING DESCRIPTION											
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION				Description and Additional Observations											
FLUID LOSS (%)				SHEAR STRENGTH (kPa)											
WATER				COMPRESSIVE STRENGTH (MPa)											
CORE RECOVERY (%)				DEFECT SPACING (mm)											
METHOD															
CASING															
TESTS															
SAMPLES															
RL (m)															
DEPTH (m)															
GRAPHIC LOG															
MOISTURE CONDITION															
WEATHERING															
STRENGTH-DENSITY CLASSIFICATION															



BOREHOLE LOG

BOREHOLE No.: 1015a (A6)

Hole Location: Refer to site plan

SHEET: 1 OF 1

PROJECT: P2S4 2017				LOCATION: Millwater Precinct 2				JOB No.: 21854.001 P2S4																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
CO-ORDINATES: (NZTM 2000)				DRILL TYPE: 50mm hand auger				HOLE STARTED: 02/03/2017																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
R.L.:				DRILL METHOD: HA				HOLE FINISHED: 02/03/2017																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
DATUM:				DRILL FLUID:				DRILLED BY: Geotechnics Ltd																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION	FLUID LOSS (%)	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION	WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)		COMPRESSION STRENGTH (MPa)		DEFECT SPACING (cm)	Description and Additional Observations																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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Fill						● >211 kPa			1		D-M	H							SILT, non plastic, dry to moist, brown																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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BOREHOLE LOG

BOREHOLE No.: 1015b (A7)

Hole Location: Refer to site plan

SHEET: 1 OF 1

PROJECT: P2S4 2017		LOCATION: Millwater Precinct 2		JOB No.: 21854.001 P2S4	
CO-ORDINATES: (NZTM 2000)		DRILL TYPE: 50mm hand auger		HOLE STARTED: 02/03/2017	
R.L.:		DRILL METHOD: HA		HOLE FINISHED: 02/03/2017	
DATUM:		DRILL FLUID:		DRILLED BY: Geotechnics Ltd	
				LOGGED BY: rbe	
				CHECKED:	

GEOLOGICAL		ENGINEERING DESCRIPTION															
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION	FLUID LOSS (%)	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION	WEATHERING	STRENGTH/PLASTICITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (kPa)	DEFECT SPACING (mm)	Description and Additional Observations
Fill						● UTP				TS	M		H				SILT, non plastic, moist, brown mottled yellowish brown
						● >211 kPa											sandy SILT, non plastic, moist, light yellowish brown, minor grey inclusions
						● UTP											SILT, non plastic, moist, grey with small yellowish brown inclusions
						● >211 kPa											SILT, non plastic, dry to moist, grey, minor gravel
						● 173/92 kPa											1.1m: minor yellowish brown inclusions
						● >211 kPa											clayey SILT, and SILT, low to no plasticity, yellowish brown and grey, minor fine gravel
						● 163/51 kPa											SILT, low plasticity, moist, light brownish white mottled yellowish brown, minor grey inclusions and fine gravel
						● 122/21 kPa											clayey SILT, low plasticity, moist, light greyish white, yellowish brown and brown, with grey inclusions
					● 169/24 kPa											SILT, non plastic, moist, light grey, gritty (crushed siltstone)	
Hukerenui Mudstone																	2.8m: Dry white silt, solid refusal. (rock)
																	2.8m: Refusal
																	2.8m: Refusal

COMMENTS:

Hole Depth 2.8m

Scale 1:20

BOREHOLE LOG

BOREHOLE No.: **1016 (A8)**

Hole Location: Refer to site plan

SHEET: 1 OF 1

PROJECT: P2S4 2017				LOCATION: Millwater Precinct 2				JOB No.: 21854.001 P2S4			
CO-ORDINATES: (NZTM 2000)				DRILL TYPE: 50mm hand auger				HOLE STARTED: 02/03/2017			
R.L.:				DRILL METHOD: HA				HOLE FINISHED: 02/03/2017			
DATUM:				DRILL FLUID:				DRILLED BY: Geotechnics Ltd			
								LOGGED BY: rbe			
								CHECKED:			
GEOLOGICAL				ENGINEERING DESCRIPTION							
TESTS	GRAPHIC LOG	MOISTURE CONDITION	WEATHERING	STRENGTH-DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (kPa)	DEFECT SPACING (mm)	Description and Additional Observations			
GEOLOGICAL UNIT: GENERIC NAME: ORIGIN: MATERIAL COMPOSITION:	TS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 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512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1049 1050 1051 1052 1053 1054 1055 1056 1057 1058 1059 1060 1061 1062 1063 1064 1065 1066 1067 1068 1069 1070 1071 1072 1073 1074 1075 1076 1077 1078 1079 1080 1081 1082 1083 1084 1085 1086 1087 1088 1089 1090 1091 1092 1093 1094 1095 1096 1097 1098 1099 1100 1101 1102 1103 1104 1105 1106 1107 1108 1109 1110 1111 1112 1113 1114 1115 1116 1117 1118 1119 1120 1121 1122 1123 1124 1125 1126 1127 1128 1129 1130 1131 1132 1133 1134 1135 1136 1137 1138 1139 1140 1141 1142 1143 1144 1145 1146 1147 1148 1149 1150 1151 1152 1153 1154 1155 1156 1157 1158 1159 1160 1161 1162 1163 1164 1165 1166 1167 1168 1169 1170 1171 1172 1173 1174 1175 1176 1177 1178 1179 1180 1181 1182 1183 1184 1185 1186 1187 1188 1189 1190 1191 1192 1193 1194 1195 1196 1197 1198 1199 1200 1201 1202 1203 1204 1205 1206 1207 1208 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1409 14										



BOREHOLE No.: 1017 (A9)

Hole Location: Refer to site plan

SHEET: 1 OF 1

CoreLog - 12/05/2017 3:32:35 p.m. - Produced with Core-GS by GeRoc



BOREHOLE LOG

BOREHOLE No.: 1018a (A10)

Hole Location: Refer to site plan

SHEET: 1 OF 1

PROJECT: P2S4 2017		LOCATION: Millwater Precinct 2		JOB No.: 21854.001 P2S4	
CO-ORDINATES: (NZTM 2000)		DRILL TYPE: 50mm hand auger		HOLE STARTED: 02/03/2017	
R.L.:		DRILL METHOD: HA		HOLE FINISHED: 02/03/2017	
DATUM:		DRILL FLUID:		DRILLED BY: Geotechnics Ltd	
				LOGGED BY: rbe	
				CHECKED:	
GEOLOGICAL		ENGINEERING DESCRIPTION			
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION	FLUID LOSS (%) WATER CORE RECOVERY (%) METHOD CASING TESTS SAMPLES RL (m) DEPTH (m) GRAPHIC LOG MOISTURE CONDITION WEATHERING STRENGTH/QUALITY CLASSIFICATION SHEAR STRENGTH (kPa) COMPRESSIVE STRENGTH (kPa) DEFECT SPACING (mm)	Description and Additional Observations			
Fill	DRY 02/03/2017	SILT, non plastic, moist, dark brown SILT, minor clay, non plastic, moist, grey, minor yellowish brown inclusions, minor fine gravel 0.95m: dry light grey silt, unable to auger			
Hukerenui Mudstone		1m: Refusal 1m: Refusal			
COMMENTS:					
Hole Depth 1m					
Scale 1:20					

BOREHOLE LOG

BOREHOLE No.: 1018a (A11)

Hole Location: Refer to site plan

SHEET: 1 OF 1

PROJECT: P2S4 2017		LOCATION: Millwater Precinct 2		JOB No.: 21854.001 P2S4		
CO-ORDINATES: (NZTM 2000)		DRILL TYPE: 50mm hand auger		HOLE STARTED: 02/03/2017		
R.L.:		DRILL METHOD: HA		HOLE FINISHED: 02/03/2017		
DATUM:		DRILL FLUID:		DRILLED BY: Geotechnics Ltd		
				LOGGED BY: rbe		
				CHECKED:		
GEOLOGICAL		ENGINEERING DESCRIPTION				
<small>GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION</small>	<small>FLUID LOSS (%)</small> <small>WATER</small> <small>CORE RECOVERY (%)</small> <small>METHOD</small> <small>CASING</small>	<small>TESTS</small>	<small>SAMPLES</small> <small>RL (m)</small> <small>DEPTH (m)</small>	<small>GRAPHIC LOG</small> <small>MOISTURE / WEATHERING</small> <small>STRENGTH/STIFFNESS CLASSIFICATION</small>	<small>SHEAR STRENGTH (kPa)</small> <small>COMPRESSIVE STRENGTH (kPa)</small> <small>DEFECT SPACING (cm)</small>	<small>Description and Additional Observations</small>
Fill		● UTP		M	H	SILT, non plastic, moist, brown
		● 134/50 kPa			VSL	SILT, non plastic, moist, grey with yellowish brown inclusions
		● UTP		D	H	clayey SILT, low plasticity, moist, grey
		● >211 kPa	1	M		SILT, friable, dry, grey and yellowish brown
Hukerenui Mudstone		● UTP				SILT, non plastic, moist, grey with reddish brown and brown mottles
		● UTP				
		● UTP				
		● UTP	2			
		● UTP				2.4m: very hard to auger
						2.4m: Refusal
			3			

COMMENTS:

Hole Depth
2.4m

Scale 1:20

BOREHOLE LOG

BOREHOLE No.: 1019 (A12)

Hole Location: Refer to site plan

SHEET: 1 OF 1

PROJECT: P2S4 2017			LOCATION: Millwater Precinct 2			JOB No.: 21854.001 P2S4																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CO-ORDINATES: (NZTM 2000)			DRILL TYPE: 50mm hand auger			HOLE STARTED: 02/03/2017																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.			FLUID LOSS (%)			WATER			CORE RECOVERY (%)			METHOD			CASING			TESTS			SAMPLES			RL (m)			DEPTH (m)			GRAPHIC LOG			MOISTURE CONDITION			WEATHERING			STRENGTH/DENSITY CLASSIFICATION			SHEAR STRENGTH (kPa)			COMPRESSION STRENGTH (kPa)			DEFECT SPACING (cm)			Description and Additional Observations																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Fill			DRY 02/03/2017																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													

COMMENTS:

Hole Depth

2.8m

Scale 1:20

NZGS August 2001 Guidelines for hand held shear vane test.

URN	Easting	Northing	RL	Location	Tech.	Date	Nuclear Wet Density (t/m ³)	Oven Dry Density (t/m ³)	Moisture content (%)	Solid Density (t/m ³) assumed	Oven Calculated Air Voids (%)	Shear Strength (kPa) (UTP = Unable to penetrate)				Average Shear Strength (kPa)	Re - Test (Y)	pass / fail Specification > 140 kPa and < 10 % Air Voids)
												Test 1	Test 2	Test 3	Test 4			
S14-868/1	2860332.697	6508714.237	16.117	BulkFill	YA	12/06/2015	1.84	1.43	28.9	2.7	5.8	205	205	205	205	205		P
S14-868/2	2860321.839	6508692.299	16.164	BulkFill	YA	12/06/2015	1.85	1.43	29.3	2.7	5.2	205	205	205	205	205		P
S14-873/1	2860320.831	6508703.843	17.5	BulkFill	YA	13/06/2015	1.87	1.45	28.6	2.7	4.5	205	205	205	205	205		P
S14-873/2	2860332.778	6508720.417	17.528	BulkFill	YA	13/06/2015	1.86	1.44	28.8	2.7	5.1	205	205	205	205	205		P
S14-877/1	2860339.807	6508739.507	17.554	BulkFill	YA	15/06/2015	1.86	1.44	29.3	2.7	4.8	205	205	205	205	205		P
S14-877/2	2860326.205	6508715.589	17.618	BulkFill	YA	15/06/2015	1.87	1.43	30.9	2.7	2.9	205	205	205	205	205		P
S14-882/1	2860317.588	6508706.714	17.87	BulkFill	YA	16/06/2015	1.86	1.45	27.6	2.7	6.0	UTP	UTP	UTP	UTP	UTP		P
S14-882/2	2860336.928	6508730.258	17.735	BulkFill	YA	16/06/2015	1.84	1.44	27.5	2.7	6.9	205	205	205	205	205		P
S14-882/3	2860345.542	6508742.339	17.689	BulkFill	YA	16/06/2015	1.87	1.46	27.8	2.7	5.3	205	205	205	205	205		P
S14-894/1	2860323.52	6508709.809	18.789	BulkFill	YA	19/06/2015	1.97	1.60	22.7	2.7	4.1	205	205	205	205	205		P
S14-894/2	2860318.67	6508701.588	19.255	BulkFill	YA	19/06/2015	1.97	1.58	24.4	2.7	2.7	205	205	205	205	205		P
S14-902/1	2860274.176	6508667.363	16.947	BulkFill	YA	24/06/2015	1.96	1.57	24.4	2.7	3.4	205	205	205	205	205		P
S14-902/2	2860287.053	6508668.844	17.097	BulkFill	YA	24/06/2015	1.94	1.59	22.2	2.7	5.8	205	205	205	205	205		P
S14-907/1	2860288.298	6508663.71	18.042	BulkFill	YA	25/06/2015	1.95	1.60	22.2	2.7	5.5	205	205	205	205	205		P
S14-907/2	2860277.673	6508665.445	18.219	BulkFill	YA	25/06/2015	1.90	1.52	24.9	2.7	5.6	137	154	171	195	164		P
S14-914/1	2860282.164	6508672.439	19.411	BulkFill	YA	26/06/2015	1.91	1.53	24.9	2.7	5.4	205	205	205	205	205		P
S14-914/2	2860275.255	6508668.936	19.095	BulkFill	YA	26/06/2015	1.91	1.53	24.3	2.7	6.0	171	154	147	188	165		P
S14-919/1	2860296.57	6508679.122	19.059	BulkFill	YA	29/06/2015	1.91	1.54	24.3	2.7	5.6	205	205	205	205	205		P
S14-919/2	2860272.113	6508661.296	20.412	BulkFill	YA	29/06/2015	1.94	1.61	20.7	2.7	7.1	205	205	205	205	205		P
S14-926/1	2860285.599	6508660.714	20.682	BulkFill	YA	30/06/2015	1.95	1.64	19.2	2.7	8.0	205	205	205	205	205		P
S14-926/2	2860273.034	6508676.22	21.087	BulkFill	YA	30/06/2015	1.96	1.64	19.2	2.7	7.6	205	205	205	205	205		P
S14-927/1	2860283.36	6508676.169	20.795	BulkFill	YA	1/07/2015	1.80	1.40	28.1	2.7	8.5	137	154	171	192	164		P

Job: Silverdale PRECINCT 2, Stage 4A

Client: Tonkin & Taylor

Job # 614089.000/1

T&T Job #: 21854.0010

Entered By: YARHN/JED

NZS 4407:1991 Field water content and field dry density using a nuclear densometer

Checked By:

Test 4.2.1 Direct Transmission Mode

NZGS August 2007 Guidelines for hand held shear vane test.

URN	Eastings	Northing	RL	Location	Tech.	Date	Nuclear Wet Density (t/m ³)	Oven Dry Density (t/m ³)	Oven Moisture content (%)	Solid Density (t/m ³) assumed	Oven Calculated Air Voids (%)	Shear Strength (kPa)				Average Shear Strength (kPa)	Re - Test (Y)	pass / fail Specification > 140 kPa and < 10 % Air Voids
												Test 1	Test 2	Test 3	Test 4			
S14-927/2	2660257.088	6508658.16	20.903	BulkFill	YA	1/07/2015	1.88 1.90	1.49 1.49	27.3 27.3	2.7 2.7	4.4 3.9	120	137	154	171	146		P
S14-931/1	2660270.493	6508667.712	21.44	BulkFill	YA	2/07/2015	1.84 1.88	1.42 1.44	28.0 28.0	2.7 2.7	6.0 4.7	120	137	154	202	153		P
S14-931/2	2660286.79	6508681.63	20.978	BulkFill	YA	2/07/2015	1.85 1.83	1.42 1.41	31.0 31.0	2.7 2.7	3.7 4.1	120	137	154	202	153		P
S14-958/1	2660247.763	6508653.76	21.276	BulkFill	RHN	13/07/2015	1.83 1.88	1.34 1.37	36.9 37.4	2.7 2.7	1.2 0.9	122	132	135	135	131		P
S14-958/2	2660234.058	6508637.524	20.086	BulkFill	RHN	13/07/2015	1.88 1.88	1.37 1.37	37.4 37.4	2.7 2.7	0.0 0.0	117	117	144	141	130		P
S14-964	2660227.285	6508641.982	20.667	BulkFill	RHN	14/07/2015	1.88 1.91	1.49 1.49	25.9 25.9	2.7 2.7	5.9 6.3	180	180	180	180	180		P
S14-971/4	2660227.532	6508641.886	22.21	BulkFill	RHN	17/07/2015	1.90 -	1.49 -	27.9 -	2.7 -	2.9 3.5	180	180	150	165	169		P
S14-971/5	2660214.054	6508623.058	17.482	BulkFill	RHN	17/07/2015	- 1.84	- 1.38	- 32.7	- 2.7	- 3.5	90	150	150	105	124		F
S14-978/1	2660249.511	6508638.573	20.165	BulkFill	RHN	22/07/2015	1.82 1.87	1.37 1.41	32.7 32.2	2.7 2.7	4.4 2.2	165	126	135	111	134		P
S14-978/2	2660238.793	6508629.392	18.097	BulkFill	RHN	22/07/2015	1.95 1.84	1.40 1.40	32.2 31.8	2.7 2.7	3.2 3.9	150	165	150	165	158	Y	P
S14-983	2660229.235	6508643.237	22.347	BulkFill	RHN	23/07/2015	1.79 1.79	1.33 1.33	34.5 34.5	2.7 2.7	4.7 4.8	135	123	150	126	134		P
S14-987	2660220.276	6508641.185	22.547	BulkFill	RHN	24/07/2015	- -	- -	- -	2.7 2.7	- -	150	195	195	180	180		P
S15-002/2	2660207.517	6508641.455	19.344	Bonair Cres - Undercut Backfill	JED	15/09/2015	- 1.87	- 1.43	- 30.8	2.7 2.7	- 3.0	195	195	195	195	195		P
S15-004/1	2660208.795	6508640.402	20.422	Bonair Cres - Undercut Backfill	JED	15/09/2015	1.87 -	1.43 -	30.8 -	2.7 2.7	2.9 -	195	195	195	195	195		P
S15-004/2	2660211.209	6508645.3	20.762	Bonair Cres - Undercut Backfill	JED	15/09/2015	- -	- -	- -	2.7 2.7	- -	195	195	195	195	195		P
S15-006/1	2660207.073	6508638.238	21.308	Bonair Cres - Undercut Backfill	JED	16/09/2015	- -	- -	- -	2.7 2.7	- -	195	180	195	165	184		P
S15-006/2	2660201.843	6508638.472	20.91	Bonair Cres - Undercut Backfill	JED	16/09/2015	- -	- -	- -	2.7 2.7	- -	150	135	165	180	158		P
S15-012/1	2660209.456	6508640.543	22.251	Bonair Cres - Undercut Backfill	JED	16/09/2015	1.81 1.82	1.41 1.41	28.8 28.8	2.7 2.7	7.4 7.2	UTP	UTP	UTP	UTP	UTP		P
S15-012/2	2660210.351	6508641.233	22.321	Bonair Cres - Undercut Backfill	JED	16/09/2015	- -	- -	- -	2.7 2.7	- -	UTP	UTP	UTP	UTP	UTP		P
S15-026/1	2660206.215	6508647.594	23.077	Bonair Cres - Undercut Backfill	JED	22/09/2015	- -	- -	- -	2.7 2.7	- -	195	195	195	195	195		P

Job: Silverdale PRECINCT 2, Stage 4A

Client: Tonkin & Taylor
T&T Job #: 21854.0010

Job # 614089.000/1
Entered By: YAJRHNJED
Checked By:

NZS 4407:1991 Field water content and field dry density using a nuclear densometer
Test 4.2.1 Direct Transmission Mode

NZGS August 2001 Guidelines for hand held shear vane test.

URN	Eastings	Northing	RL	Location	Tech.	Date	Nuclear Wet Density (t/m ³)	Oven Dry Density (t/m ³)	Oven Moisture content (%)	Solid Density (t/m ³) assumed	Oven Calculated Air Voids (%)	Shear Strength (kPa)				Average Shear Strength (kPa)	Re-Test (Y)	pass / fail Specification > 140 kPa and < 10 % Air Voids)
												Test 1	Test 2	Test 3	Test 4			
S15-028/2	2660194.05	6508666.345	24.438	Bonair Cres - Undercut Backfill	JED	22/09/2015	-	-	-	2.7	-	195	195	195	195	195		P
S15-032/1	2660207.936	6508672.475	25.709	Bonair Cres - Undercut Backfill	JED	23/09/2015	1.97	1.58	24.9	2.7	2.4	UTP	UTP	UTP	UTP	UTP		P
S15-032/2	2660200.808	6508670.883	25.376	Bonair Cres - Undercut Backfill	JED	23/09/2015	1.96	1.57	24.9	2.7	2.6	UTP	UTP	UTP	UTP	UTP		P
S15-039/1	2660189.505	6508640.821	21.763	Bonair Cres - Undercut Backfill	JED	25/09/2015	2.10	1.81	16.3	2.7	3.6	UTP	UTP	UTP	UTP	UTP		P
S15-039/2	2660187.895	6508646.949	21.603	Bonair Cres - Undercut Backfill	JED	25/09/2015	2.10	1.80	16.3	2.7	3.9	UTP	UTP	UTP	UTP	UTP		P
S15-041/1	2660188.841	6508650.547	22.063	Bonair Cres - Undercut Backfill	JED	25/09/2015	-	-	-	2.7	-	UTP	UTP	UTP	UTP	UTP		P
S15-041/2	2660190.74	6508646.885	20.892	Bonair Cres - Undercut Backfill	JED	25/09/2015	1.93	1.57	22.7	2.7	6.3	UTP	UTP	UTP	UTP	UTP		P
S15-042/3	2660187.835	6508635.293	21.831	Bonair Cres - Undercut Backfill	JED	26/09/2015	1.91	1.56	22.7	2.7	6.9	UTP	UTP	UTP	UTP	UTP		P
S15-042/4	2660203.408	6508645.954	22.863	Bonair Cres - Undercut Backfill	JED	26/09/2015	1.91	1.50	27.4	2.7	3.4	UTP	UTP	UTP	UTP	UTP		P
S15-045/5	2660197.801	6508647.31	23.318	Bonair Cres - Undercut Backfill	JED	29/09/2015	1.91	1.50	27.4	2.7	3.5	UTP	UTP	UTP	UTP	UTP		P
S15-045/6	2660194.827	6508644.446	23.169	Bonair Cres - Undercut Backfill	JED	29/09/2015	1.91	1.50	27.4	2.7	3.5	UTP	UTP	UTP	UTP	UTP		P
S15-061/1	2660359.467	6508608.669	15.104	Bonair Rd14	TAJ	9/10/2015	1.93	1.54	25.0	2.7	4.2	196	196	196	196	196		P
S15-061/2	2660372.329	6508775.45	16.753	Bonair Rd14	TAJ	9/10/2015	1.92	1.54	25.0	2.7	4.8	196	196	196	196	196		P
S15-061/3	2660352.673	6508750.487	17.654	Bonair Rd14	TAJ	9/10/2015	1.94	1.58	23.0	2.7	5.2	196	196	196	196	196		P
S15-061/8	2660282.238	6508679.47	19.511	Bonair Pit	TAJ	9/10/2015	1.95	1.58	23.0	2.7	5.0	196	196	196	196	196		P
S15-062/7	2660273.744	6508674.421	21.608	Bonair Pit	TAJ	12/10/2015	2.01	1.64	22.2	2.7	2.6	196	196	196	196	196		P
S15-063/1	2660285.253	6508681.219	22.064	Bonair pit	TAJ	13/10/2015	2.00	1.64	22.2	2.7	2.9	196	196	196	196	196		P
S15-063/2	2660244.891	6508668.958	22.733	Bonair Pit	TAJ	13/10/2015	1.92	1.50	28.2	2.7	2.3	196	196	196	196	196		P
S15-064/8	2660278.605	6508691.139	21.424	Bonair pit	TAJ	14/10/2015	1.93	1.50	28.2	2.7	2.0	196	196	196	196	196		P
S15-064/9	2660261.004	6508678.18	21.986	Bonair Pit	TAJ	14/10/2015	1.84	1.46	25.6	2.7	8.5	196	196	196	196	196		P
S15-067/7	2660330.966	6508741.402	18.257	Bonair	TAJ	15/10/2015	1.84	1.47	25.6	2.7	8.1	196	196	196	196	196		P

Job: Silverdale PRECINCT 2, Stage 4A

Client: Tonkin & Taylor

Job # 614089.000/1

T&T Job #: 21854.0010

Entered By: YARIN/JED

Test 4.2.1 Direct Transmission Mode

Checked By:

NZGS August 2001 Guidelines for hand held shear vane test.

URN	Easting	Northing	RL	Location	Tech.	Date	Nuclear Wet Density (t/m ³)	Oven Dry Density (t/m ³)	Oven Moisture content (%)	Solid Density (t/m ³) assumed	Oven Calculated Air Voids (%)	Shear Strength (kPa)				Average Shear Strength (kPa)	Re - Test (Y)	pass / fail Specification > 140 kPa and < 10 % Air Voids)
												Test 1	Test 2	Test 3	Test 4			
S15-087/8	2660344.774	6508752.31	17.755	Bonair	TAJ	15/10/2015	1.96	1.70	15.4	2.7	10.8	196	196	196	196	196		F
S15-085/8	2660189.002	6508609.809	17.989	Bonair Pond	TAJ	6/11/2015	1.97	1.71	15.4	2.7	10.3	196	196	196	196	196		P
S15-085/10	2660343.317	6508757.844	18.572	Bonair Drainline	TAJ	6/11/2015	2.02	1.67	20.7	2.7	3.4	196	196	196	196	196		P
S15-085/11	2660375.794	6508792.443	15.674	Bonair Drainline	TAJ	6/11/2015	2.03	1.68	20.7	2.7	2.9	196	196	196	196	196		P
S15-088/8	2660154.424	6508591.441	21.775	Bonair Pond	TAJ	9/11/2015	1.90	1.53	23.8	2.7	6.7	196	196	196	196	196		P
S15-090/3	2660170.682	6508598.891	21.692	Bonair Pond	TAJ	10/11/2015	1.91	1.54	23.8	2.7	6.3	196	196	196	196	196		P
S15-090/4	2660172.827	6508612.305	21.312	Bonair Pond	TAJ	10/11/2015	1.83	1.36	34.9	2.7	2.3	196	196	196	196	196		P
S15-091	2660164.008	6508614.166	22.682	Bonair Pond	TAJ	11/11/2015	1.85	1.37	34.9	2.7	1.6	196	196	196	196	196		P
S15-092	2660164.008	6508614.166	22.682	Bonair Pond	TAJ	11/11/2015	2.04	1.68	21.3	2.7	2.0	196	196	196	196	196		P
S15-096/5	2660165.96	6508625.563	24.325	Bonair pond	TAJ	22/11/2015	2.03	1.67	21.3	2.7	2.6	196	196	196	196	196		P
S15-096/8	2660167.638	6508617.585	24.079	Bonair pond	TAJ	22/11/2015	1.93	1.62	19.6	2.7	8.4	196	196	196	196	196		P
S15-096/7	2660190.196	6508631.254	24.338	Bonair pond	TAJ	22/11/2015	1.93	1.61	19.6	2.7	8.7	196	196	196	196	196		P
S15-098/6	2660246.842	6508690.27	21.859	Bonair	TAJ	24/11/2015	1.92	1.59	21.1	2.7	7.8	196	196	196	196	196		P
S15-099/13	2660234.82	6508691.449	23.667	Bonair	TAJ	25/11/2015	1.93	1.60	21.1	2.7	7.2	196	196	196	196	196		P
S15-100/13	2660225.356	6508696.059	25.264	Bonair	TAJ	26/11/2015	1.94	1.62	19.8	2.7	7.8	196	196	196	196	196		P
S15-113/9	2660193.262	6508690.797	28.478	Re Wall	TAJ	14/12/2015	1.88	1.51	24.4	2.7	7.3	196	196	196	196	196		P
S16 020/5	26600085.169	6508595.449	20.732	Silt pond	NTW	28/01/2016	2.06	1.75	18.1	2.7	3.6	196	196	196	196	196		P
S16 020/6	26600098.241	6508597.007	20.058	Silt pond	NTW	28/01/2016	1.95	1.60	22.2	2.7	5.3	154	196	134	144	157		P
S16 020/12	2660106.561	6508604.582	18.442	Beside reserve	TAJ	28/01/2016	1.96	1.61	22.2	2.7	4.9	196	196	196	196	196		P
S16 020/13	26600089.956	6508593.841	20.471	Beside reserve	TAJ	28/01/2016	1.92	1.61	19.6	2.7	8.9	196	196	196	196	196		P
s16 024/2	2660070.070	6508590.636	22.476	Silt pond	TAJ	20/02/2016	1.93	1.57	23.1	2.7	5.8	151	196	196	196	182		P
s16 024/3	2660103.854	6508599.447	20.883	Silt pond	TAJ	20/02/2016	1.95	1.58	23.1	2.7	4.9	196	196	196	196	196		P

Job: Silverdale PRECINCT 2, Stage 4A

Client: Tonkin & Taylor
T&T Job #: 21854.0010

Job # 614089.000/1
Entered By: YARHNJED
Checked By:

NZS 4407:1991 Field water content and field dry density using a nuclear densometer
Test 4.2.1 Direct Transmission Mode

NZGS August 2007 Guidelines for hand held shear vane test.

URN	Easting	Northing	RL	Location	Tech.	Date	Nuclear Wet Density (t/m ³)	Oven Dry Density (t/m ³)	Oven Moisture content (%)	Solid Density (t/m ³) assumed	Oven Calculated Air Voids (%)	Shear Strength (kPa)				Average Shear Strength (kPa)	Re - Test (V)	pass / fail Specification > 140 kPa and < 10 % Air Voids
												Test 1	Test 2	Test 3	Test 4			
s16 025/4	2660058.186	6508593.293	23.588	Silt pond	TAJ	3/02/2016	2.10 2.12	1.84 1.86	13.8	2.7	6.2 5.5	205	205	205	205	205		P
s16 025/5	2660085.408	6508601.916	22.351	Silt pond	TAJ	3/02/2016	2.00 2.01	1.88 1.89	19.4	2.7	5.3 4.9	205	205	205	205	205		P
s16 025/6	2660086.027	6508585.972	21.757	Silt pond	TAJ	3/02/2016	1.98 1.98	1.54 1.54	28.5	2.7	0.0 0.0	205	205	205	205	205		P
s16 026/1	2660061.916	6508570.168	23.591	Silt pond	TAJ	4/02/2016	2.00 2.01	1.63 1.63	23.1	2.7	2.2 1.8	205	205	205	205	205		P
s16 026/2	2660083.467	6508575.185	22.833	Silt pond	TAJ	4/02/2016	1.86 1.87	1.46 1.47	27.5	2.7	6.0 5.4	205	205	205	205	205		P
s16 028/4	2660089.383	6508586.768	23.763	Silt pond	TAJ	9/02/2016	2.11 2.10	1.87 1.86	12.9	2.7	6.8 7.2	205	205	205	205	205		P
s16 029/3	2660068.862	6508600.150	24.795	silt pond	TAJ	10/02/2016	1.87 1.87	1.50 1.50	24.5	2.7	7.6 7.5	192	205	205	171	193		P
s16 029/10	2660070.529	6508614.760	25.928	Silt pond	TAJ	11/02/2016	1.99 1.99	1.39 1.39	43.5	2.7	-11.8 -11.6	205	205	205	205	205		P
s16 030/2	2660065.177	6508612.079	26.692	Silt pond	TAJ	12/02/2016	2.03 2.04	1.74 1.74	17.0	2.7	6.2 5.9	205	205	205	205	205		P
s16 030/3	2660045.100	6508606.733	27.383	Silt pond	TAJ	12/02/2016	1.99 1.99	1.80 1.60	23.8	2.7	2.4 2.4	205	205	205	205	205		P
s16 032/9	2660103.322	6508650.132	27.807	Siltpond	TAJ	15/02/2016	2.01 1.99	1.71 1.89	17.8	2.7	6.5 7.2	205	205	205	205	205		P
s16 029/4	2660100.060	6508608.686	23.835	Silt pond	TAJ	10/02/2016	1.91 1.91	1.54 1.54	24.3	2.7	5.6 5.6	205	205	205	205	205		P
s16 029/9	2660092.461	6508629.002	25.821	Silt pond	TAJ	11/02/2016	1.91 1.91	1.49 1.49	28.3	2.7	2.6 2.8	164	154	157	161	159		P
s16 030/1	2660097.532	6508622.619	25.814	Silt pond	TAJ	12/02/2016	1.86 1.86	1.38 1.38	34.5	2.7	1.2 1.2	205	205	205	205	205		P
s16 031/1	2660125.257	6508645.663	26.622	Siltpond	TAJ	13/02/2016	1.93 1.90	1.68 1.56	21.9	2.7	6.6 8.0	205	205	205	205	205		P
s16 032/8	2660103.322	6508650.132	27.807	Siltpond	TAJ	15/02/2016	2.01 1.99	1.71 1.69	17.8	2.7	6.5 7.2	205	205	205	205	205		P
s16 035/1	2660072.606	6508628.704	30.181	Silt pond	TAJ	22/02/2016	2.16 2.16	1.69 1.69	27.8	2.7	0.0 0.0	205	205	205	205	205		P
s16 035/2	2660049.801	6508621.535	30.676	Silt pond	TAJ	22/02/2016	2.04 2.05	1.81 1.81	13.1	2.7	9.4 9.3	205	205	205	205	205		P
s16 036/1	2660044.115	6508627.552	31.532	Silt pond	TAJ	23/02/2016	2.12 2.10	1.82 1.80	16.3	2.7	2.9 3.9	205	205	205	205	205		P
s16 036/2	2660067.464	6508632.302	30.769	Silt pond	TAJ	23/02/2016	2.06 2.06	1.76 1.76	16.9	2.7	5.0 5.1	205	205	205	205	205		P
s16 036/3	2660089.342	6508637.642	30.095	Silt pond	TAJ	23/02/2016	1.94 1.94	1.56 1.56	24.4	2.7	4.3 4.4	205	205	205	205	205		P
s16 050/3	2660117.952	6508652.222	29.605	Silt pond	TAJ	15/03/2016	2.18 2.17	1.93 1.92	12.8	2.7	3.8 4.2	196	196	196	196	196		P

Job: Silverdale PRECINCT 2, Stage 4A

Client: Tonkin & Taylor
T&T Job #: 21854.0010

Job # 614089.000/1
Entered By: YAJRN/JED
Checked By:

NZS 4407:1991 Field water content and field dry density using a nuclear densometer
Test 4.2.1 Direct Transmission Mode
NZGS August 2001 Guidelines for hand held shear vane test.

URN	Eastings	Northing	RL	Location	Tech.	Date	Nuclear Wet Density (t/m ³)	Oven Dry Density (t/m ³)	Oven Moisture content (%)	Solid Density (t/m ³) assumed	Oven Calculated Air Voids (%)	Shear Strength (kPa)				Average Shear Strength (kPa)	Re - Test (Y)	pass / fail Specification > 140 kPa and < 10 % Air Voids
												Test 1	Test 2	Test 3	Test 4			
S16 050/4	2660087.838	6508638.041	30.436	Re Wall	TAJ	15/03/2016	1.83	1.39	31.9	2.7	4.2	196	196	196	196	196		P
S16 050/5	2660064.93	6508630.304	31.007	Re Wall	TAJ	15/03/2016	2.08	1.76	18.3	2.7	2.7	196	196	196	196	196		P
S16 051/3	2660114.461	6508650.28	30.754	Silt pond	TAJ	18/03/2016	2.05	1.73	18.5	2.7	4.1	196	196	196	196	196		P
S16 051/4	2660142.049	6508664.407	29.794	Silt pond	TAJ	18/03/2016	2.03	1.62	25.7	2.7	0.0	196	196	196	196	196		P
S16 051/5	2660165.654	6508674.895	28.788	Silt pond	TAJ	18/03/2016	2.05	1.60	28.4	2.7	0.0	196	196	196	196	196		P
S16 051/8	2660062.891	6508629.118	31.854	Silt pond	TAJ	18/03/2016	1.85	1.37	34.6	2.7	1.8	196	196	196	196	196		P
S16 051/9	2660044.303	6508621.876	32.191	Silt pond	TAJ	18/03/2016	1.94	1.49	30.0	2.7	0.1	196	196	196	196	196		P
S16 052/4	2660042.89	6508615.15	33.338	Silt pond	TAJ	17/03/2016	1.99	1.77	12.4	2.7	12.3	196	196	196	196	196	Y	F
S16 052/5	2660041.438	6508622.542	33.164	Silt pond	TAJ	17/03/2016	1.88	1.42	32.2	2.7	1.5	196	196	196	196	196		P
S16 053/1	2660072.038	6508632.503	32.986	Silt pond	TAJ	18/03/2016	2.05	1.53	33.7	2.7	0.0	140	154	182	146	156		P
S16 053/2	2660043.989	6508626.909	33.824	Silt pond	TAJ	18/03/2016	1.99	1.71	16.3	2.7	8.8	196	196	196	196	196		P
S16 053/3	2660064.744	6508634.833	33.468	Shear key	TAJ	18/03/2016	2.02	1.39	45.3	2.7	0.0	196	196	196	196	196		P
S16 053/4	2660037.494	6508624.759	34.398	Shear key	TAJ	18/03/2016	2.17	1.88	15.3	2.7	1.7	196	196	196	196	196		P
S16 055/1	2660050.635	6508635.787	34.606	silt pond	TAJ	21/03/2016	2.14	1.84	16.4	2.7	1.8	196	196	196	196	196		P
S16 056/4	2660095.277	6508650.669	33.691	Silt pond	TAJ	22/03/2016	2.06	1.67	23.5	2.7	0.0	196	196	196	196	196		P
S16 056/5	2660060.6	6508637.037	34.712	Silt pond	TAJ	22/03/2016	2.07	1.68	23.5	2.7	0.0	196	196	196	196	196		P
S16 062/1	2660109.679	6508621.051	26.935	Main Fill	TA	5/04/2016	2.08	1.80	15.6	2.7	5.4	196	196	196	196	196		P
S16 062/2	2660084.425	6508609.747	27.246	Main Fill	TA	5/04/2016	2.09	1.81	15.6	2.7	4.9	196	196	196	196	196		P
S16 062/3	2660063.986	6508594.13	27.66	Main Fill	TA	5/04/2016	2.13	1.88	13.2	2.7	5.4	196	196	196	196	196		P
S16 062/7	2660096.959	6508602.77	26.678	Main Fill	TA	5/04/2016	2.11	1.82	15.5	2.7	4.2	196	196	196	196	196		P
S16 062/18	2660121.316	6508615.63	26.811	Main Fill (up a level)	TA	5/04/2016	2.18	1.92	13.6	2.7	3.0	196	196	196	196	196		P
S16 063/3	2660115.462	6508608.516	27.255	Main Fill	TA	6/04/2016	2.14	1.89	13.1	2.7	5.4	196	196	196	196	196		P
							2.13	1.88	13.1	2.7	5.6	196	196	196	196	196		P
							2.06	1.85	11.5	2.7	10.2	196	196	196	196	196		F

Job: Silverdale PRECINCT 2, Stage 4A

Client: Tonkin & Taylor

Job # 614089.000/1

T&T Job #: 21854.0010

Entered By: YARHNJED

NZS 4407:1991 Field water content and field dry density using a nuclear densometer

Checked By:

Test 4.2.1 Direct Transmission Mode

NZGS August 2001 Guidelines for hand held shear vane test.

URN	Eastings	Northings	RL	Location	Tech.	Date	Nuclear Wet Density (t/m ³)	Oven Dry Density (t/m ³)	Oven Moisture content (%)	Solid Density (t/m ³) assumed	Oven Calculated Air Voids (%)	Shear Strength (kPa)				Average Shear Strength (kPa)	Re - Test (Y)	pass / fail Specification > 140 kPa and < 10 % Air Voids
												Test 1	Test 2	Test 3	Test 4			
S16 063/15	2660089.497	6508510.671	27.785	Main Fill	TA	6/04/2016	2.16 2.17	1.94 1.95	11.2 11.2	2.7 2.7	6.5 5.8	196	196	196	196	196		P
S16 064/1	2660109.906	6508516.343	27.949	Main Fill	TA	7/04/2016	2.19 2.19	1.94 1.94	12.9 12.9	2.7 2.7	3.4 3.2	196	196	196	196	196	Y	P
S16 064/2	2660136.881	6508533.497	26.92	Main Fill	TA	7/04/2016	2.15 2.13	1.93 1.92	11.0 11.0	2.7 2.7	7.1 7.7	196	196	196	196	196	Y	P
S16 064/3	2660083.005	6508502.885	28.195	Main Fill	TA	7/04/2016	2.14 2.14	1.91 1.92	11.6 11.6	2.7 2.7	7.0 6.7	196	196	196	196	196	Y	P
S16 064/8	2660071.15	6508504.942	28.704	Main Fill	TA	7/04/2016	2.13 2.13	1.77 1.77	20.1 20.1	2.7 2.7	0.0 0.0	196	196	196	196	196		P
S16 064/9	2660101.994	6508519.674	28.058	Main Fill	TA	7/04/2016	2.13 2.13	1.91 1.90	12.0 12.0	2.7 2.7	6.6 6.9	196	196	196	196	196		P
S16 065/1	2660136.663	6508536.013	27.111	Main Fill	TA	8/04/2016	2.14 2.14	1.87 1.87	14.8 14.8	2.7 2.7	3.2 3.2	168	196	136	150	163		P
S16 065/2	2660106.895	6508525.992	28.353	Main Fill	TA	8/04/2016	2.20 2.22	1.90 1.92	15.8 15.8	2.7 2.7	0.0 0.0	196	196	196	196	196		P
S16 070/1	2660092.805	6508583.021	26.121	Beside reserve	TA	14/04/2016	2.08 2.08	1.69 1.69	23.2 23.2	2.7 2.7	0.0 0.0	192	192	192	192	192		P
S16 070/2	2660050.887	6508568.071	27.622	Beside reserve	TA	14/04/2016	2.05 2.05	1.80 1.80	13.4 13.4	2.7 2.7	9.0 9.0	192	192	192	192	192		P
S16 070/3	2660134.447	6508637.209	28.322	Beside reserve	TA	14/04/2016	2.03 2.05	1.58 1.59	28.8 28.8	2.7 2.7	0.0 0.0	192	192	192	192	192		P
S16 070/4	2660108.806	6508531.198	29.551	Beside reserve	TA	14/04/2016	2.08 2.09	1.74 1.74	19.7 19.7	2.7 2.7	1.5 1.2	192	192	192	192	192		P
S16 070/5	2660072.122	6508508.599	31.155	Beside reserve	TA	14/04/2016	1.99 1.95	1.68 1.64	18.4 18.4	2.7 2.7	6.8 8.9	192	192	192	192	192		P
S16 071/1	2660065.618	6508572.301	27.485	Beside reserve	TA	15/04/2016	2.02 2.03	1.67 1.68	20.8 20.8	2.7 2.7	3.2 3.0	192	192	192	192	192		P
S16 071/6	2660093.935	6508516.785	30.675	Beside reserve	TA	15/04/2016	2.09 2.10	1.81 1.82	15.4 15.4	2.7 2.7	4.9 4.8	192	192	192	192	192		P
S16 074/1	2660098.223	6508591.766	27.752	Beside reserve	TA	20/04/2016	2.17 2.18	1.91 1.91	13.8 13.8	2.7 2.7	3.1 2.7	192	192	192	192	192		P
S16 074/2	2660061.356	6508576.658	29.193	Beside reserve	TA	20/04/2016	2.08 2.09	1.73 1.74	20.2 20.2	2.7 2.7	1.0 0.4	192	192	192	192	192		P

