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GEOTECHNICAL COMPLETION REPORT

FOR

STAGE 2

SOLWAY SUBDIVISION

LOTS 1 through 26 (inclusive)

AT

285 ARA-KOTINGA ROAD

WHITFORD

FOR

SPINNAKER BAY LIMITED

DOCUMENT RECORD

CLIENT Spinnaker Bay Limited

PROJECT Stage 2 - Solway Subdivision, 285 Ara Kotinga Road

PROJECT NO. 5046.2

DOCUMENT Geotechnical Completion Report for Residential
Lots 1 through 26 (inclusive)

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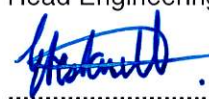
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Geotek Services Limited

15 June 2016

THOROUGH ANALYSIS • DEPENDABLE ADVICE

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Construction Monitoring

-Roadtest Fill Reports & Location plans (35 sheets)

Slope Stability Analyses – Accessway 3

(2 sheets)

Foundation Soils Data

-Hand Auger Borehole Records HA1-26

(26 sheets)

-Summary of Laboratory Testing for Soil Reactivity

(8 sheets)

-CSIRO Foundation Maintenance & Footing Performance

(4 sheets)

-Additional Requirements for Classes M, H1, H2 and E sites

(2 sheets)

Geotechnical Investigation Reports

-Proposed 34 Lot Rural-Residential Subdivision at 285 Ara-Kotinga Road, Whitford

Geotechnical Investigation Report (GIR) dated 3 October 2013 (ref 5046)

(376 sheets)

1. Introduction

This Geotechnical Completion Report (GCR) covers the earthworks construction for Stage 2 of the rural residential subdivision at 285 Ara-Kotinga Road, Whitford, which includes 26 lots, numbered 1 through 26 (inclusive) as shown on the Surveywrx "As Built" plans, as listed in the preceding Table of Contents, along with copies appended at the end of this report.

Please note, this report does not detail any of the construction and earthworks associated with the formation of Ara-Kotinga Road itself, which is detailed in a separate report entitled "Geotechnical Completion Report for Ara-Kotinga Road Extension within Stage 2 of the Solway Subdivision" (reference 5046.1 dated 15 June 2016). The report herein does however describe the construction of Accessway 2 and Accessway 3, as well as the Private Road at the end of Ara-Kotinga Road, all of which are private lanes accessing the lots themselves. As per Section 2.B.5 of Auckland Council's Code of Practice for Land Development & Subdivision, this report does not detail any of the accessway construction above subgrade level.

2. Geotechnical Investigation Report

Our consultancy prepared the following Geotechnical Investigation Report (GIR) for this subdivision, which is reproduced in the appendices, for ease of reference:

*"Proposed 34 Lot Rural-Residential Subdivision at 285 Ara-Kotinga Road, Whitford
Geotechnical Investigation Report (GIR)" dated 3 October 2013 (reference 5046)*

Please note that we have removed appendices from this GIR which do not relate to Stage 2 i.e. plans, borehole records, slope stability analyses which relate to lots within Stage 1 for which we prepared GCR dated 29 September 2015 (reference 5046.1) prepared by ourselves for Lots 27, 28, 29, 30, 31, 33 & 34.

During earthworks construction as well as in preparing this Completion Report, we have revisited the Conclusions and Recommendations made in the GIR, and duly reconsidered these in light of the recent earthworks operations.

3. Earthworks Construction Summary

On review of the original earthworks proposals by Crang Civil Consulting Ltd, (project number 1074, revision 2 dated 18/11/14), which included earthworks proposals within some of the lots, we generally consider that, for the most part, the majority of the earthworks were in keeping with the expectations of our GIR. Where we

have deviated from the proposals, we will provide a narrative explaining the reasons and discuss the Geotechnical consequences, along with any additional geotechnical assessment that was required.

Our original GIR split the lots into 6 blocks based on clustering of lots, which we referred to as Blocks A through Block F. Each cluster was positioned on areas of pasture grass, typically comprising gently sloping land. The following is therefore a summary of the earthworks activities undertaken on each of the lots within Stage 2, summarised under each Block as per the original GIR layout.

3.1 Block A - Lot 1

This lot is positioned along the eastern side of the recently completed Ara-Kotinga Road extension within Stage 1 and is accessed directly from the road. Lot 1 was not included in Stage 1 as it was still being earthworked at the time of our preparing our Stage 1 GCR. In our GIR we identified the DBP as being at risk of slope instability, with a pre-existing sloping gully and man-made pond below it comprising weak and disturbed underlying ground conditions. We recommended that these unsuitable materials be undercut and replaced initially with underfill drainage, and then filled with earthfill, compacted to an engineered standard to provide a slope buttress to the DBP.

In mid-December 2014, the existing pond was drained and all pre-existing fill along with unsuitable natural material such as gully mullock and soft soils were stripped. As the gully was stripped back upslope towards the DBP, we encountered significant deposits of disturbed ground, indicative of landslide debris, with evidence of planar shear surfaces. The site was left untouched for around a month over Christmas before re-commencing with stripping in early January 2015. As the slip debris had been left steeply battered, it had subsequently slumped down and into the gully head. All disturbed landslide debris was excavated, resulting in a significant stockpile of wet and disturbed material, which required significant drying and re-work as it was progressively blended back into the bulk fill

A key of hardfill was constructed at the eastern boundary of the lot and within the gully invert, with subsoil drainage day-lighting under this key and discharging into the established wetland to the east. Subsoil drainage comprising a 160mm perforated coil wrapped in filtersock and surrounded with blue-chip drainage metal, was extended back up the gully invert, after the invert had been stripped down to competent natural soils free of organic or compressible soils. The subsoil drainage was extended further up the slope, and in doing so we encountered several springs. The drainage was installed around the head of the gully to tap these active seepages.

Once the subsoil drainage was installed in the lower half of the gully, filling with clay fill commenced. The fill comprised excess spoil, which was cut down from the elevated ridgelines, as the road was being formed beyond CH900 for the main area of Stage 2. The material was wet, very silty and sensitive in nature and

compaction to the engineered specification was not achievable. We therefore revised the fill specification to allow for a lesser required undrained shear strength of no less than 70 kPa, with average strengths being around 100 kPa, which we refer to as "Non-Structural Fill". The embankment design was also revised to accommodate this large volume of lesser strength fill anticipated, but at the same time still requiring high strength good quality fill, referred to as "Structural Fill", to underlie and support the DBP. We therefore developed an embankment design that catered for both requirements, which is shown in figure 1 below. In addition, a 3 metre wide toe key was constructed, where the structural fill rises up from the gully invert, comprising a combination of drainage metal and rotten rock.

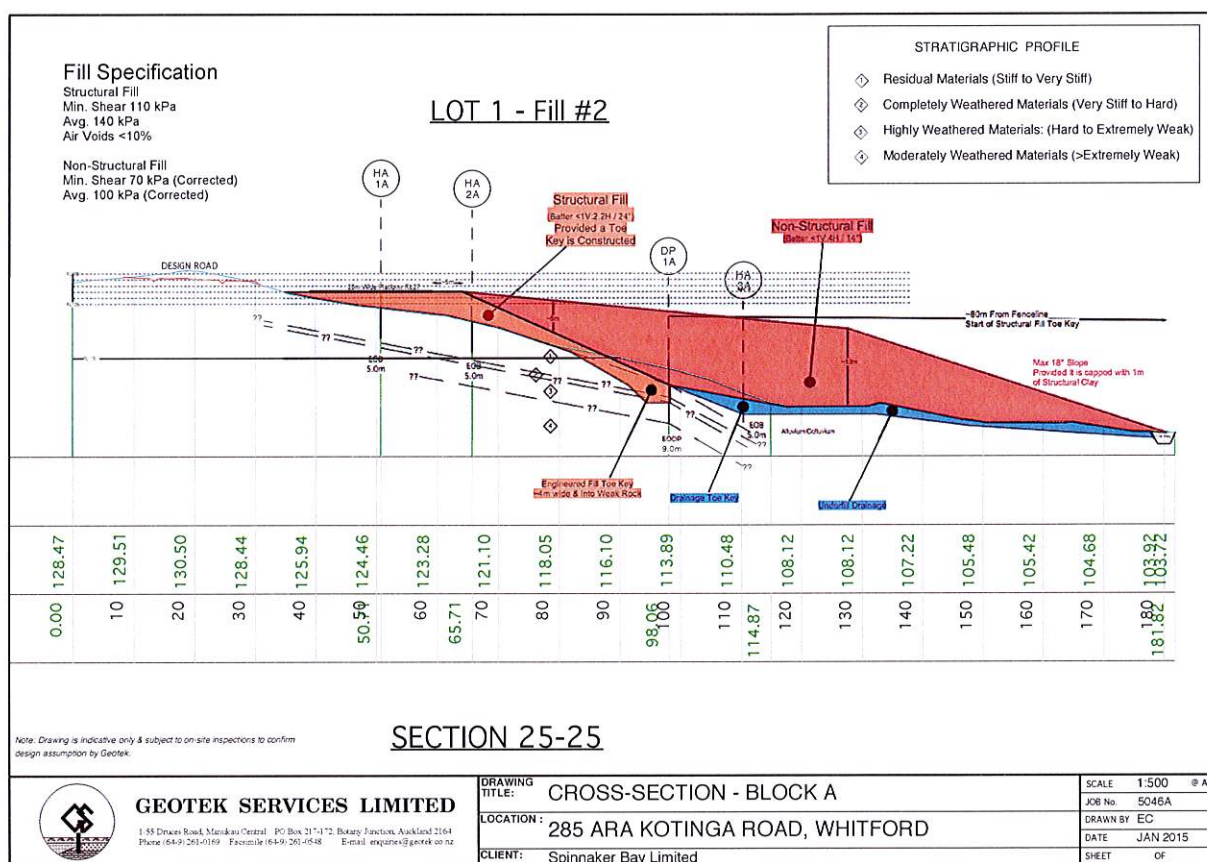


Figure 1 - Lot 1 Embankment Gully Fill Design & Earthworks Specification

Filling within Lot 1 continued until May 2015, when the onset of winter rains made filling too difficult. We also noted some soil saturation, and instructed a mid-fill subsoil drain be installed, to help with drainage in the non-structural fill over winter.

As well as our own measurement of undrained shear strengths on a frequent basis through January, February, March, April, May & June 2015, frequent fill testing was undertaken by Roadtest as follows:

- January 2015: a total of 11 (no.) fill tests were undertaken by Roadtest Ltd on Lot 1 (Area labelled Fill 2) with the majority of the tests passing, apart from numbers 40, 41, & 60. All these tests failed on low shear strengths due to the fill being too wet. The areas were reworked and passed on subsequent retesting.
- February 2015: a total 15 (no.) fill tests undertaken by Roadtest Ltd on Lot 1, with all but number 222 test passing. This test failed on high air voids but with high strengths indicating dry fill. The area was reworked and retested with satisfactory results.
- March 2015: a total of 5 (no.) fill tests undertaken by Roadtest Ltd on Lot 1, with all tests passing.
- April 2015: 2 (no.) fill tests undertaken by Roadtest Ltd on Lot 1 and both passed.
- May 2015: 1 (no.) fill test undertaken by Roadtest Ltd on Lot 1, and passed.

After the winter hiatus, filling on Lot 1 re-commenced after a significant time was spent discing, undercutting and drying out the saturated fill surface. Fill imported from Pine Harbour Marina was blended with the non-structural fill. In November 2015, 4 (no.) fill tests were undertaken by Roadtest Ltd directly underlying the DBP on Lot 1, with all tests passing.

Once the final fill surface was reached, topsoil was spread over the whole area.

The finished level of the DBP is around RL125 whereas the revised design showed it at RL127. The reason for this lesser height was a short-fall in available engineered fill material. For this reason, during the formation of the Ara-Kotinga Road, a relatively low-height fill embankment was formed along the western boundary of Lot 1, which was meant to have tied into the DBP platform level. Because of the lowering of the DBP platform level, an approximately 2 metre high, very steep fill bank has been left adjacent to the DBP. The fill batter extended slightly over the DBP but has since been trimmed back, so that the DBP is underlain predominantly with engineered fill. This very steep batter will likely require support by a retaining wall at the time of house construction.

The final positioning of the DBP on Lot 1 has been moved relative to its original position, to provide sufficient set back from the steep cut batter to the west. The filled slope comprising structural fill to the east of the DBP was finished at around 15° with a vertical height of around 3 metres before levelling out on the Non-Structural Fill Platform which falls very gently over a width of around 40 metres before sloping down to the wetland at an average gradient of 18°.

Please refer to the appended "as-built" cross section profile for Lot 1.

3.2 Block B – Lots 2 & 7:

Situated on an east to west trending spur, itself feeding off a larger ridgeline, we did not anticipate any earthworks would be required on these two lots. However deforestation works resulted in access tracks and decant pits being formed, which required subsequent remediation by the earthworks contractors under our supervision.

The positioning of the DBP's on both lots have remained unchanged and, to the best of our knowledge the DBP's have been stripped to confirm the presence of competent natural subgrade, with the exception of the engineered backfill pits on Lot 2. The subgrade was then covered with approximately 0.2 metres depth of topsoil.

3.2.1 Lot 2

Pine trees were felled to the west of Lot 2 and, to the best of our knowledge, were replanted with seedlings.

Deforestation works formed an access track cut and working platform which extended into the south-eastern corner of the site, leaving a steep bank no more than 2.0 metres high, and around 10 metres to the south-east of the DBP. Another smaller track ran along the northern side of the DBP, which has been trimmed and smoothed to similar pre-existing natural contours. Two forestry pits were found to have been excavated within the footprint of the DBP on the platform itself, with another two to the west and beyond the DBP. The pits within the DBP were no deeper than 1 metre and the two pits beyond the DBP were up to 2 metres depth. All four were stripped out and backfilled with compacted engineered fill under our supervision.

Three buttress drains were installed on the steep slopes to the north of the DBP as per our original recommendations.

Future driveway access will require careful formation (and possible retaining wall) as it runs between the Lot 7 boundary and the crest of a steep gully slope to the south.

3.2.2 Lot 7

The DBP ground profile was, to the best of our knowledge left relatively unaltered. A small forestry pit was positioned to the north-west of the DBP, with a cut-off drain feeding the pit running along the western side of the platform. The pit was cleaned out and backfilled with clean clay.

Three buttress drains were installed on the steep slopes to the north-west of the DBP as per our original recommendations.

3.3 Block B – Lots 3, 4, 5 & 6 as well as Accessway 2:

All four lots are situated along the crown of a long south to north trending ridgeline. Lot 6 is accessed directly from Ara Kotinga Road, whilst Lots 3, 4 & 5 are all accessed via a private right-of-way called Accessway 2.

Only Lot 4 was originally recommended for earthworks, by cutting down the ridgeline by up to 4 metres so that the steep eastern slope would be unloaded, and a level building platform created, with sufficient setback from the very steep eastern slope.

Pine trees were felled along the upper portions of the very steep eastern slopes below Lots 3, 4 & 5 which, to the best of our knowledge, have been replanted with seedlings.

These lots were initially used as a staged clayfill stockpiling area, without the original topsoil having been stripped, starting in October 2014. The material was spoil created from the progressive cutting down of the ridgelines. Once the fill area within Lot 1 had been formalized, the significantly large stockpile was gradually moved by dumptruck until the original surface was restored around February 2015.

Earthworks operations then commenced with the cutting down of the ridgeline on Lot 4, and formation of Accessway 2 by cut excavation only. A decision was made to cut down Accessway 2 by a further 2 metres, so that filling of the very steep western side of the accessway was no longer required. The resulting cutting down of the accessway has improved stability, but has resulted in a short but steep batter below the DBP on Lot 4.

A decision was then made in March 2015 to excavate the ridgeline under Lots 5 & 6, as a shortfall in fill for the main Ara-Kotinga embankment was becoming apparent. During the excavation, it was found that once the relatively thin crust of cohesive clay had been removed, the underlying material was very silty and sensitive once disturbed, and was becoming problematic in reconstitution as engineered fill. We used the excavation of this ridgeline as an opportunity to map any structural features and defects within the underlying weathered soil, which transitioned to a weathered rock mass. An exploration trench was excavated under our instruction, to assess the continuance of what we initially thought was a fault trace trending from the south to the north. Whilst the surface initially appeared to be indicative of a fault, we found the continuity of such a feature was not consistent, and it essentially disappeared once we extended it into Lot 4 from Lot 5. We re-assessed the feature as a sharp stratigraphic contact between two differing types of material, with similar contacts observed in the main cut embankment, with the reddish sensitive silts to the eastern belonging to the Cape Rodney Formation, whilst the orange brown stained clays and silts to the west were Waipapa Group materials. We concluded that there was no obvious continuous planar surfaces, faults or significant defects and warranted no further exploration by trenching.

The area was subsequently re-instated with compacted fill to an engineered standard under our supervision.

We summarise the significant excavation on a Lot by Lot basis, as follows:

3.3.1 Lot 3

The DBP was, to the best of our knowledge, left relatively unaltered. We understand that a small decant pond at the end of Accessway 2 was filled, once works were completed.

The DBP is in the same location as was assessed in our GIR and, to the best of our knowledge, the DBP is underlain by competent natural subgrade and is covered with approximately 0.3 metres depth of natural topsoil, all of which was determined by drilling no less than 5 hand augers, as well as excavation of shallow digger pits.

Three buttress drains were installed on the steep slopes to the east of the DBP, with two drains installed to the north-west, as per our original recommendations.

3.3.2 Lot 4

The resulting excavation was more-or-less in keeping with our expectations, in that up to 4.5 metres of cut was removed, which has resulted in a near level DBP around RL187. There is however an approximately 18° batter slope along the southern side of the DBP, which slopes down from the boundary with Lot 5, over a height not exceeding 2.5 metres. The cut platform has been day-lighted to the north and east, whilst the western side of the DBP encroaches to within 1 metre of a short but steep cut batter above the accessway.

The DBP has been altered from its original square shape assessed in our GIR by moving it back from the man-made cutting to the north-west, as well as from the steep natural slope to the north-east so that a minimum 10 metres setback is achieved as per the recommendations in our original GIR. The DBP now comprises a bottle-shape, which narrows to the north, to avoid the steep slopes below. To the best of our knowledge, the DBP is underlain by competent natural subgrade and is covered with approximately 0.2 metres depth of topsoil.

Given the steepness of the slope to the east, it was decided to install four column drains, instead of the 2 buttress drains and 2 column drains as recommended in our GIR.

Four buttress drains were also installed below the Accessway 2, as part of the recommended slope stability drainage measures.

3.3.3 Lot 5

Although only minimal excavation was originally anticipated, the majority of the lot was cut down by just over 2 metres depth, which has resulted in a near-level DBP around RL191. As discussed in section 3.3 above, there was however an additional over-cut of around 2 metres depth, which was subsequently backfilled with engineered fill under our supervision, the extent of which is indicated on the appended cut/fill as-built plans.

The DBP is in the same location as was assessed in our GIR and, to the best of our knowledge, the DBP is underlain by either competent natural subgrade or engineered fill and is covered with approximately 0.1 metre depth of topsoil.

Three buttress drains were installed on the steep slopes to the west of the DBP, as per our original recommendations.

3.3.4 Lot 6

Only minimal excavation was originally anticipated, but actual earthworks resulted in up to 2 metres of the crown being cut down and levelled around RL193. The earthworks has resulted in a 1 metre high batter along the northern side of the DBP and a 2.5 metre high batter, at 18 degrees along the southern edge of the DBP, which falls down to Ara Kotinga Road. The DBP encroaches slightly on both the northern batter, and the south-western batter.

The DBP is in the same location as was assessed in our GIR and, to the best of our knowledge, the DBP is underlain by either competent natural subgrade or engineered fill, and is covered with approximately 0.2 metres depth of topsoil.

Three buttress drains were installed on the steep slopes to the east of the DBP, as per our original recommendations.

3.4 Block C – Lots 8 through 12:

These lots are situated on a very broad and gently sloping ridgeline trending from north to south, on the southern side of the main accessway. Lots 8, 11 & 12 are accessed directly from Ara Kotinga Road, whilst Lots 9 & 10 are accessed via a private right-of-way called Accessway 3.

Pine tree clearing of some of the steep slopes surrounding the block took place prior to the start of subdivision construction. To the best of our knowledge, apart from being used as temporary stockpile locations for topsoil (predominantly Lot 8) as well for controlled burn-offs of woody vegetation remnants, these lots were generally unaltered by earthworks. There was however cut excavation earthworks undertaken for the formation of Accessway 3, which runs below the western boundaries of Lots 8 and 9, and

the north-western corner of Lot 10. The original design of Accessway 3 was revised as Ara Kotinga Road itself was lowered, and re-aligned at the intersection, which in turn, resulted in the lowering of Accessway 3. The knock-on effect has been the formation of a slightly higher and steeper cut batter slope between the Accessway and the lots themselves.

During the excavation for Accessway 3, situated below the common boundary between Lots 8 and 9, a strong seepage or spring was noted and on further exploration we found evidence of a relict failure surface day-lighting out of the slope but at relatively shallow depths, and localised to a cross slope length of less than 20 metres,. On review of our historical aerial photographs and our original geomorphology interpretation, we had identified a headscarp feature in 1940, which had become obscured by the growth of a large stand of pine trees, presumably planted to help keep the spring dewatered as well as arrest erosion. The stand of trees was removed as part of the pine deforestation but had been covered with pine tree debris and mulch. When this was cleared and bulk excavation commenced in April 2015, the presence of a spring became more obvious. We instructed the contractor to expose a large surface area of the failure surface in May 2015, which was found to comprise a slick, greasy surface, with strong seepages noted at the interface, dipping out of the slope at around 10° with overlying disturbed residual to completely weathered Waitemata Group soils, and underlying very stiff completely, becoming highly weathered Waitemata Group Materials. The surface was found to be around 3 metres below the finished accessway level, and day-lighting out of the batter slope above the pre-existing gully. The area was left exposed and unsupported for several weeks, as earthworking resources were in short supply. The area slumped quite significantly, with failure along the greasy planar surface and ongoing seepages.

In June 2015, all the recent slumped soils as well as much of the pre-existing disturbed soils were undercut, and the failure surface further exposed, to the north and south, and revealed a broad concave shaped failure feature, with the failure surface rising up to the south until it day-lighted. To the north, the planar surface appeared to be "flattening" out as well as dissipating, under the accessway, with the greasy clay no longer evident, and nil seepages. We undertook slope stability analyses of the feature, assuming appropriately low effective soil strengths determined via back-analysed conditions which found limiting equilibrium assuming nil cohesion and angle of internal friction of 15° for a planer surface dipping out of the slope at 10°. Please refer to the appended slope stability results. From these analyses we determined that the feature could be satisfactorily stabilised using a combination of hardfill buttress at the toe of the excavation as well as extensive subsoil drainage, which was installed around the back of the cut where the seepages appeared to emanate from, before being piped down to an existing gully underfill drain to the west. The area was then backfilled with significant volumes of imported rotten rock to the finished level of the accessway.

As the accessway was being formed further to the north of the remediated area, an additional area of superficially disturbed soil, around 1 to 1.5 metres deep was identified and undercut. In addition a series of

four buttress drains were installed below the accessway, prior to the filling and formation of the batters supporting the accessway. A further four buttress drains were installed below the accessway to the south.

In addition, a 15 metre long buttress drain was constructed along the joint boundaries of Lots 8 and 9 and connected into the previously installed ring drainage. The drain was around 4 metres deep at its upslope end and excavated down and into the highly weathered Waitemata Group Materials. Although there was evidence of disturbed materials overlying the highly weathered materials, we did not observe any distinct surface between the two units, and no obvious failure surfaces were apparent. Seepages at the time of excavation in December 2015 were no longer evident.

We summarise any significant earthworks on a Lot by Lot basis, as follows:

3.4.1 Lot 8

The main accessway was cut down by around 3 metres along the northern boundary, forming a steep batter, with gradients as steep as 30 degrees, the crest of which is situated around 5 metres to the north-west of the DBP. Accessway 3 was formed along the western boundary by cutting down similarly by around 3 metres, forming a similar steep, 30 degree batter that runs along the boundary.

The DBP has been rotated slightly from the positioned recommended in our GIR, to pull the north-western corner back from the steep accessway batters.

To the best of our knowledge, the DBP was unaltered by earthworks and the DBP has been stripped to confirm the presence of competent natural subgrade, and subsequently covered with approximately 0.2 metres depth of topsoil.

As discussed above, a buttress drain has been constructed along the common boundary between Lot 8 and Lot 9.

3.4.2 Lot 9

Accessway 3 was formed along the western boundary by cutting down by around 3 metres, forming a steep 30 degree batter that runs along that boundary.

To the best of our knowledge, the DBP was unaltered by earthworks.

The DBP is in the same location as was assessed in our GIR and, to the best of our knowledge, the DBP is underlain by competent natural subgrade and is covered with approximately 0.2 metres

depth of natural topsoil, all of which was determined by drilling no less than 5 hand augers as well as shallow digger pits.

As discussed above, a buttress drain has been constructed along the common boundary between Lot 8 and Lot 9.

3.4.3 Lot 10

The accessway nips into the north-western corner of the lot, with a steep 30 degree batter formed below, whilst the remainder of the lot was, to the best of knowledge, unaltered by subdivision earthworks.

To the best of our knowledge, the DBP was unaltered by earthworks.

The DBP is in the same location as was assessed in our GIR and, to the best of our knowledge, the DBP is underlain by competent natural subgrade and is covered with approximately 0.2 metres depth of natural topsoil, all of which was determined by drilling no less than 5 hand augers as well as shallow digger pits.

Three column drains were installed to the south of the platform, as per our original recommendations.

3.4.4 Lot 11

An old above-ground water tank within the DBP was removed, and to the best of our knowledge, the DBP was unaltered by earthworks.

The DBP is in the same location as was assessed in our GIR and, to the best of our knowledge, the DBP is underlain by competent natural subgrade and is covered with approximately 0.2 metres depth of natural topsoil, all of which was determined by drilling no less than 5 hand augers as well as shallow digger pits.

3.4.5 Lot 12

The main accessway was cut down along the north-western boundary by as much as 4 metres, forming a batter slope at 30 degrees.

The DBP has been altered from its original position assessed in our GIR by moving it back from the man-made cutting to the north as well as from the steep natural slope to the north-west. The DBP now measures 24m by 17m and to the best of our knowledge, is underlain by competent natural subgrade and is covered with approximately 0.1 metres depth of natural topsoil, all of which was determined by drilling no less than 5 hand augers as well as shallow digger pits.

Two buttress drains were installed down the slope to the north-east of the DBP, with three column drains installed to the south-east, as per our original recommendations.

3.5 Block D – Lots 13 through 16:

These lots are situated along the western side of a south-west to north-east trending ridgeline, and exposed to steep west to north-west facing slopes, with the exception of Lot 16, with a steep easterly facing slope. Ara-Kotinga Road provides direct access along the eastern side of Lots 13 to 15, and along the western side of Lot 16.

Pine tree clearing of the steep slopes below the DBP was undertaken prior to the start of subdivision earthworks, and to the best of our knowledge, have been replanted with seedlings.

To satisfy the slope stability recommendations in our GIR, the pre-existing ridgeline under the DBP on Lots 13, 14 & 15 was cut down by up to 3.5 metres depth, with the DBP on Lot 16 being cut down by up to 4 metres.

We summarise any significant earthworks on a Lot by Lot basis, as follows:

3.5.1 Lot 13

The DBP was cut down by as much as 3.75 metres depth, resulting in a uniform batter slope of around 1V:7H ramping down from the more elevated ridgeline to the south. When the site was excavated, non-cohesive and silty materials were exposed, and the subgrade was damaged by the wheel rutting of heavy machinery at the onset of winter in 2015. The site was mulched and left until summer 2016, when it was stripped back and the disturbed ground was undercut and replaced with engineered clay fill no thicker than 0.4 metres which, to the best of our knowledge covers the entire DBP and covered with around 0.2 m of topsoil.

The DBP is in the same location as was assessed in our GIR.

We originally recommended three column drains be installed to the west of the DBP, however once the platform was marked out, we noted that the very steep slope was further to the south-west, and we considered that adequate subsoil drainage would be achieved with two drains.

3.5.2 Lot 14

Similarly to Lot 13 to the south, the DBP on Lot 14 was cut down by as much as 3.75 metres.

The DBP is in the same location as was assessed in our GIR and, to the best of our knowledge, the DBP is underlain by competent natural subgrade and is covered with approximately 0.3 metres depth of natural topsoil.

As per our original recommendations, two buttress drains were installed to the west of the DBP however, the contractor over-excavated a large platform along the downslope edge of the DBP so he could bench the digger back into the slope for the southern most drain. The platform was under the western edge of the DBP, and was filled back up with engineered clay fill under our supervision.

3.5.3 Lot 15

Similarly to Lot 13 & 14 to the south, the DBP on Lot 15 was cut down by as much as 3.75 metres. An aggregate stockpile on the DBP was continually replenished throughout the construction of the subdivision, but was fully removed before the DBP was covered with topsoil.

The DBP is in the same location as was assessed in our GIR and, to the best of our knowledge, the DBP is underlain by competent natural subgrade and is covered with approximately 0.2 metres depth of natural topsoil.

As per our original recommendations, three column drains were installed to the north-west of the platform. The first attempt at drilling the horizontal drains encountered obstructions, and so the drain outlets were moved a few metres upslope, where they were successfully installed.

3.5.4 Lot 16

The DBP was cut down by as much as 4 metres with uniform batter slopes at around 14° being formed back up to the ridge to the north and the south. The resulting cut formation has formed a large "U" shaped platform with a level DBP that has not allowed for fast enough discharge of overland flows and surface water collected over winter 2015, causing softening of the exposed non-cohesive and silty subgrade. A shallow swale has since been formed through the centre of the DBP to help shed the overland flows, with discharge to the rest of the slope to the east, which is lined with rip-rap rocks just before the crest of the slope.

The DBP is in the same location as was assessed in our GIR and, to the best of our knowledge, the DBP is underlain by competent natural subgrade and is covered with approximately 0.1 metres depth of natural topsoil.

As per our original recommendations, three buttress drains were installed down the steep slope to the east.

3.6 Block E – Lots 17, 18 & 19:

These lots are positioned on the northern side of the continuation of the ridge-line from Block D, which twists from trending north-east, to trending west to east. These three lots are all accessed directly from the northern side of Ara-Kotinga Road.

Pine tree clearing of the steep slopes below the DBP's was undertaken prior to the start of subdivision earthworks, and to the best of our knowledge, have been replanted with seedlings.

Although there were no bulk earthworks requirements needed to satisfy moderate to deep-seated slope stability recommendations in our GIR, we understand that some localised earthworks were undertaken, which were associated with the road formation as well as tidying up of recent earthworks disturbance from access tracks.

We summarise the significant excavation on a Lot-by-Lot basis, as follows:

3.6.1 Lot 17

A haul road was constructed through the centre of the platform, by placing fill along the northern side of the track. Once the subdivision works were completed, the DBP was, to the best of our knowledge, stripped back to expose competent natural subgrade and covered with around 0.2 m of topsoil. The south-western corner of the DBP is adjacent to a structural fill batter supporting the accessway however, given that the DBP is situated on a 1V:3H slope, all future development will require specific design to mitigate the risk of soil creep.

As per our original recommendations, three buttress drains were installed to the north of the DBP.

3.6.2 Lot 18

The ridge to the south of the DBP was cut down to accommodate the formation of the accessway, with the near level cut extending around halfway into the DBP, and the maximum depth of cut being 2 metres. A low-height steep cut face remains at the north-west corner of the DBP, which was the old haul track, which had been cut into the slope. This will need specific design on account of slopes in excess of 14°.

The DBP was, to the best of our knowledge, stripped back to expose competent natural subgrade and covered with around 0.2 m of topsoil.

3.6.3 Lot 19

An existing rotunda was removed, and pre-existing non-engineered fill under the structure was excavated from under the DBP, which resulted in a batter formed along the south-eastern site of the platform, which has been battered back at a gradient as steep as 25° but typically 20° and no higher than 2.5 metres. This batter will need to be supported by a retaining wall at the time of building development, unless it can be reduced by additional excavation or else buttressed with fill and/or retaining.

The DBP was, to the best of our knowledge, stripped back to expose competent natural subgrade and covered with around 0.1 m of topsoil.

3.7 Block F – Lots 20 through 26:

These lots are positioned on the continuation of the ridge-line from Block D, which twists from trending towards the west to trending initially towards the south, then the south-east. These lots are accessed directly via a private road that starts at the cul-de-sac head of Ara-Kotinga Road.

In January 2015, the end of the Private Road was stripped to subgrade level with filling commencing in February 2015. In March 2015, the gully slope at the start of the Private Road was stripped, with tree stumps removed, and a toe key excavated to support an engineered fill batter, prior to the start of bulk filling. The toe key was excavated down to a depth of around 1 metre below the stripped ground surface at which depth we encountered hard highly weathered Waitemata siltstone with frequent dark grey materials exposed. The key was approximately 2 to 3 metres wide and the embankment was progressively filled and then re-shaped to form a gradient of no steeper than 30°. Along with our own inspections and shear vane testing, the following is a summary of the formal fill testing undertaken:

- In February, 13 (no.) fill tests on the Private Road, with all but 1 (no.) fill test passing due to high air voids due to inadequate compaction. The area was reworked and passed on subsequent testing.
- In March a total of 23 (no.) fill tests on the Private Road, with the majority of the tests passing, apart from 7 (no.). These tests failed on low shear strengths due to the fill being too wet, and high air voids due to inadequate compaction. The areas were reworked and passed on subsequent retesting.

The embankment was dressed with topsoil and seeded in May 2015 but before grass could establish itself, heavy rains caused a superficial slump failure of the topsoil, which extended no deeper than 0.5 metres into the underlying clay surface. We later discovered from the contractor that this was the result of uncontrolled overland flows being inadvertently diverted over the face of the slope. Overland flows were then diverted

and the face was mulched and protected with shade cloth anchored down with wire fixed to warratahs and, to the best of our knowledge, has not suffered any additional slope movement.

Pine tree clearing of the steep slopes below the DBP's was undertaken prior to the start of subdivision earthworks, and to the best of our knowledge, the bare slopes have been replanted with seedlings.

Although there were no bulk earthworks requirements needed to satisfy the moderate to deep-seated slope stability recommendations in our GIR, we understand that some localised earthworks were undertaken which were associated with the road formation, as well as tidying up of both forestry and recent earthworks disturbance from decant pits and access tracks, in particular in and around Lot 23 and 24 DBP's.

To the best of our knowledge, the DBP's on Lots 20, 21, 22, 25, & 26 were left relatively unaltered.

We summarise any significant earthworks as well as any subsoil drains installed on a Lot-by-Lot basis, as follows:

3.7.1 Lot 20

To the best of our knowledge, the DBP was unaltered by earthworks.

The DBP is in the same location as was assessed in our GIR and, to the best of our knowledge, the DBP is underlain by competent natural subgrade and is covered with approximately 0.2 metres depth of natural topsoil, all of which was determined by drilling no less than 5 hand augers.

3.7.2 Lot 21

To the best of our knowledge, the DBP was unaltered by earthworks.

The DBP is in the same location as was assessed in our GIR and, to the best of our knowledge, the DBP is underlain by competent natural subgrade and is covered with approximately 0.2 metres depth of natural topsoil, all of which was determined by drilling no less than 5 hand augers.

3.7.3 Lot 22

To the best of our knowledge, the DBP was unaltered by earthworks.

The DBP is in the same location as was assessed in our GIR and, to the best of our knowledge, the DBP is underlain by competent natural subgrade and is covered with approximately 0.2 metres depth of natural topsoil, all of which was determined by drilling no less than 5 hand augers as well as shallow digger pits.

3.7.4 Lot 23

Two large forestry pits had been excavated near the centre of the DBP, with another pit to the west of the DBP. The central pits were undercut to remove wet, forming a large trench joining the two pits, weak material before being backfilled with engineered clay fill, monitored by ourselves by frequent measurement of undrained shear strengths, as the fill was compacted in layered lifts.

The pit outside the platform was shaped to allow water to drain out of it.

The DBP is in the same location as was assessed in our GIR, and, to the best of our knowledge, the DBP has been stripped to confirm the presence of either competent natural subgrade and/or engineered fill and subsequently covered with approximately 0.1 metre depth of topsoil.

As per our original recommendations, three buttress drains were installed to the north-west of the platform.

3.7.5 Lot 24

A small and relatively shallow forestry pit was excavated in the north-eastern corner of the DBP, which was shaped to allow water to drain out of it.

The DBP is in the same location as was assessed in our GIR, and, to the best of our knowledge, the DBP has been stripped to confirm the presence of competent natural subgrade and subsequently covered with approximately 0.2 metres depth of topsoil.

As per our original recommendations, three buttress drains were installed to the west of the platform.

3.7.6 Lot 25

To the best of our knowledge, the DBP was unaltered by earthworks.

The DBP is in the same location as was assessed in our GIR and, to the best of our knowledge, the DBP is underlain by competent natural subgrade and is covered with approximately 0.2 metres depth of natural topsoil all of which was determined by drilling no less than 5 hand augers.

3.7.7 Lot 26

A localised high-point on the ridge line to the north of the DBP was cut down by around 2.0 metres, with the cut extending out into the north-west corner of the DBP.

The DBP is in the same location as was assessed in our GIR and, to the best of our knowledge, the DBP is underlain by competent natural subgrade and is covered with approximately 0.2 metres depth of natural topsoil, all of which was determined by drilling no less than 5 hand augers.

As per our original recommendations, three buttress drains were installed on the steep slope to the south of the DBP.

4. Earthworks Operations

Earthworks construction was carried out generally in accordance with part 2 of NZS4404:2010, "Land Development and Subdivision Engineering" and its companion document, NZS4431:1989, "Code of Practice for Earth Fill for Residential Development."

Site inspections were performed generally at the request of the earthworks contractors together with occasional random spot checks made by both ourselves, and Roadtest Limited. The main earthworks contractor was Dempsey Wood Limited with work on Lot 1 as well as Lots 4, 5 & 6 undertaken by C & R Developments. The primary purpose of the inspections was to confirm the suitability of stripping, prior to filling, with the removal of all topsoil and tree stumps, as well as any pre-existing fill, and to confirm the presence of competent natural ground. To the best of our knowledge, we were afforded an opportunity to undertake topsoil stripping inspections prior to fill placement, with locally won engineered fill. Topsoil, as well as materials deemed as unsuitable for re-use as engineered fill, were stockpiled separately from the stockpiles of more competent silts and clays.

It is our understanding that the bulk earthwork activities within Stage 2 ran from October 2014 until May 2016, however the main focus of construction was with the formation of Ara-Kotinga Road and the work on the lots was undertaken in a piecemeal fashion when resources were available.

5. Earthworks Specification and Control

In combination with our own spot checks of undrained shear strength in recently compacted fill, Roadtest Limited were retained on this project to undertake IANZ endorsed fill control tests. General earthworks procedures and compaction testing were carried out in accordance with NZS4404:2010 part 2 and NZS4431:1989 where appropriate.

In order to provide the most flexibility for variations in soil types, the earthworks compaction criteria used for control were the maximum allowable air voids/minimum allowable shear strength figures, as follows:-

Air Voids and Shear Vane (for cohesive soils only)

	Air Voids Percentage (as defined IN NZS4402:1986)	Undrained Shear Strength (Measured insitu by IANZ calibrated vane)	Minimum Average Value kPa	Minimum Single Value kPa
	Maximum Average Value %	Maximum Single Value %		
General Fill (Structural)	10	12	140	110
Lot 1 Fill (Non Structural)	8	10	100	70

Note: The average value was to be determined over any ten consecutive tests.

During the filling operations, contract lab staff carried out Nuclear Densometer Testing of Field Dry Density to NZS 4407:1991; Test 4.2.1, and Field Water Content in accordance with NZS 4402:1986; Test 2.1, together with Vane Shear Strength Tests using a method based on NZ Geotechnical Society 2001 which involve correction to BS1377 standard.

Ongoing provisional results were supplied to us, and any failed tests resulted in the areas were reworked and retested. The final test results, (which numbered a total of 45), are summarised in the appendices, together with test location sketches.

6. Butress and Column Drains

We can confirm that the buttress drains, on Lots 2, 3, 5, 6, 7, 8, 9, 12, 14, 16, 17, 23, 24 and 26 have been constructed to our satisfaction and more-or-less in the locations we anticipated, and therefore in keeping with the recommendations in our investigation reports, with the exception of Lot 4, where two of the recommended buttress drains were replaced with two additional column drains, and Lots 8 and 9 which had a buttress drain installed along their common boundary.

Furthermore, we can confirm that column drains, on Lots 4, 10, 12, 13 and 15 have been constructed to our satisfaction and more-or-less in the locations we anticipated, and therefore in keeping with the recommendations in our investigation reports with the exception of Lot 13, where one of the column drains was not required as the DBP was positioned further away from the at-risk slope

These drain locations, extents and depths have been included in the As-built plans by Surveyworx, a copy of which are appended to this report.

The drain outlets have been marked with two steel warratahs, with wire fixed to the coil outlet and spray painted white, to avoid the outlets becoming lost or buried. The drains should perform as intended without any maintenance, however we still recommend annual inspection to confirm the outlets have not been lost or buried.

Please refer to the appended 'Stormwater Maintenance Checklist – Annual'.

7. Topsoil Depths & Soil Moisture Hand Auger Boreholes

Upon completion of the earthworks, we drilled a 1.0 metre deep hand augered borehole in the centre of each DBP to measure topsoil depths, as well as collect soil samples for moisture content testing and to aid with expansive soils classification. The hand augers encountered no more than 0.3 metres depth of topsoil at the time of drilling. With the exception of Lot 1, the underlying soils were found to comprise stiff natural clayey SILTS and silty CLAYS with moisture contents ranging from 23.3% (Lot 2) to as much as 60% (Lot 15) averaging 40%. The Lot 1 DBP comprised very stiff engineered fill with a moisture content of around 28%.

The topsoil depth and moisture contents on a lot-by-lot basis are summarised as follows:

HA/LOT	Topsoil depth (mm)	Sample Depth (m)	Fill/Natural	Moisture Content
HA1/Lot 1	100	0.5	Fill	28.16%
HA2/Lot 2	200	0.5	Natural	23.38%
HA3/Lot 3	300	0.5	Natural	40.77%
HA4/Lot 4	200	0.5	Natural	38.88%
HA5/Lot 5	100	0.5	Natural	31.22%
HA6/Lot 6	200	0.5	Natural	29.27%
HA7/Lot 7	200	0.5	Natural	34.41%
HA8/Lot 8	200	0.5	Natural	46.08%
HA9/Lot 9	200	0.5	Natural	40.90%
HA10/Lot 10	200	0.5	Natural	59.54%
HA11/Lot 11	200	0.5	Natural	41.58%
HA12/Lot 12	100	0.5	Natural	37.21%
HA13/Lot 13	200	0.5	Natural	35.26%
HA14/Lot 14	300	0.5	Natural	49.34%
HA15/Lot 15	200	0.5	Natural	59.95%
HA16/Lot 16	100	0.5	Natural	34.44%
HA17/Lot 17	200	0.5	Natural	35.49%
HA18/Lot 18	200	0.5	Natural	35.02%
HA19/Lot 19	100	0.5	Natural	40.62%
HA20/Lot 20	200	0.5	Natural	40.30%
HA21/Lot 21	200	0.5	Natural	37.64%
HA22/Lot 22	200	0.5	Natural	45.71%
HA23/Lot 23	100	0.5	Natural	56.38%
HA24/Lot 24	200	0.5	Natural	33.40%
HA25/Lot 25	200	0.5	Natural	31.77%
HA26/Lot 26	200	0.5	Natural	38.65%

From these moisture contents, we were able to select 5 locations for further testing which we considered to be representative of the surrounding DBP. Testing undertaken was for site classification of soil expansivity,

acknowledging that the greater the soil moisture, the greater the potential for shrinkage, all of which is discussed in the following section.

8. Expansive Soils Classification

In the past, we have adopted the AS2870 method using laboratory measured shrink/swell indices to determine the class of “expansivity” within which the tested soil samples fall. However, in our experience, there are shortcomings in this method, which relies on the in-situ moisture content to measure the “maximum” volumetric shrinkage strain (i.e. a theoretically prolonged dry summer). The results generally always indicate a lower volumetric shrinkage as the natural moisture content decreases, whilst samples with higher moisture contents result in a greater volumetric shrinkage. Whilst the procedure for “swelling” the sample attempts to account for a potentially higher “future” moisture content, (which could occur during a prolonged wet winter), we believe this swelling component underestimates the upper limit which shrinkage can occur from.

To better account for the range of extremes in soil moisture and the effect on volumetric shrinkage on drying, we consider that determination of the Plastic Limit and Liquid Limit of the soil is an important measure of the potential reactivity of the soil. Furthermore, measurement of the Linear Shrinkage of soil sample from its Liquid Limit provides a useful, albeit extreme, indicator of the volumetric shrinkage the soil could undergo. All of this information is then used in a holistic approach, tempered with engineering judgement, to determine an appropriate soil classification.

From the borehole sample results above, we determined where soils with higher moisture contents were located on each of the five blocks (ignoring Lot 1, due to its isolation as well as being underlain with engineered fill) and then collected further soil samples from different locations in each of the blocks. The samples were tested to determine the natural moisture content, plastic limit, liquid limit and percentage of linear shrinkage for each of the samples, which we summarise as follows:

Sample	Depth sampling started	Natural Water Content	Plastic Limit	Liquid Limit	Plasticity Index	Linear Shrinkage
# 1, Lot 3 Natural silty CLAY	0.5m	43%	43%	100%	56%	20%
#2 Lot 10 Natural silty CLAY	0.5m	61%	44%	102%	58%	20%
#3 Lot 15 Natural silty CLAY	0.5m	53%	48%	97%	49%	23%
#4 Lot 19 Natural silty CLAY	0.5m	44%	35%	62%	27%	16%
#5 Lot 23 Natural silty CLAY	0.5m	47%	43%	91%	48%	16%

The samples all plotted slightly below the A-Line on the plasticity chart, which shows there is a slight distinction with the soil behaving predominantly as a SILT, which is in keeping with our expectations. The plasticity ranged from high to very high, which should not be confused with the classification system of AS2870.

The values of linear shrinkage indicate that all samples shrunk in excess of 15% as well as their liquid limits being in excess of 50% which is the broad-brush limit of a "good ground" indicator or Class S (Slightly) expansive soil as per NZS3604:2011.

Furthermore, we also considered it appropriate to recover push tube samples for core shrinkage testing (as per AS2870) from seven locations (including Lot 1), with the results as follows:

Sample	Moisture Content	Volumetric Shrinkage Strain	Iss (strain per pF)	y _s
# 1, Lot 3 Natural silty CLAY	45%	7.94%	4.4%	45mm
#2 Lot 10 Natural silty CLAY	60.6%	10.9%	6.0%	60mm
#3 Lot 15 Natural silty CLAY	66.9%	7.53%	4.2%	45mm
#4 Lot 19 Natural silty CLAY	36.0%	7.48%	4.2%	45mm
#5 Lot 23 Natural silty CLAY	43.3%	3.99%	2.2%	25mm
# 6, Lot 1 Fill clayey SILT	27.4%	2.53%	1.4%	15mm
#7 Lot 22 Natural silty CLAY	49.7%	9.47%	5.3%	50mm

We can see from the above results that the majority of the DBP's are underlain with soils which exhibit characteristic surface movement ranging between 45 to 60mm which is in the range of Class H1 or Highly expansive soils. We consider that the result on Lot 23 of Moderately expansive soil is an outlier, given that the adjacent Lot 22 returned a Highly expansive classification.

Lot 1 exhibited a low magnitude of shrinkage which we consider to be a direct result of the engineered fill underlying the site, comprising materials which were artificially dried and conditioned to meet the required engineered fill compaction specification. We would however consider that with time, the fill material will gradually increase with moisture and fall within the Moderate Classification.

Therefore, based on these tests and figures, and acknowledging that it is the differential effects of soil moisture and volume changes across a building footprint that cause damage to buildings, we have set the primary classification for the lots as follows:

- Class H1 (Highly) expansive soils, with a value of y_s set at 60mm.
Lots 2 through 26 (inclusive).
- Class M (moderately) expansive soils, with a value of y_s set at 40mm.
Lot 1

9. Designated Building Platforms (DBP)

As discussed herein, to the best of our knowledge, there is engineered filling underlying the majority of Lot 1 DBP as well as relatively localised and superficial effects of recent earthworks operations including the placement of engineered fill beneath some areas of the DBP specifically on Lots 2, 5, 6, 13, 14 & 23.

The remaining lots have either been altered by cut excavation only or no known alteration at all.

Therefore apart from the relatively minor adjustment of the DBP's on Lot 1, Lot 8 and Lot 12, the DBP's on the remaining lots are more-or-less in the original locations as identified in our GIR, with any recent land modification having no perceived adverse effect on the assessed stability of the DBP's.

As a result of the above subsoil drainage works, we now consider that the risk of moderate to deep seated slope instability affecting future residential dwellings contained within each nominated DBP has been appropriately mitigated, with the exception of shallow surface creep, as discussed in the Conclusions and Recommendations section 10 below.

We therefore consider that, the conclusions and recommendations made in our 2013 GIR, remain largely appropriate for any future development within the Designated Building Platforms (DBP's).

10. Conclusions and Recommendations

On the basis of our geotechnical investigation, our inspections, observations, laboratory and insitu testing as described herein, it is our Professional Opinion, that Lots 1 through 26 within the proposed residential subdivision at 285 Ara-Kotinga Road as covered under this report, each comprise a Designated Building Platform with an area of no less than 400m² (typically 20 metres by 20 metres with the exception of Lots 4 & 12) that are generally suitable in terms of section 2 "Earthworks & Geotechnical Requirements" of NZS4404:2010 "Land Development and Subdivision Infrastructure" as well as section 2 "Earthworks and Geotechnical Requirements" of the Auckland Council Code of Practice for Land Development & Subdivision (Version 1.6 dated 24 September 2013), for the development of conventional residential dwellings to be

constructed, so as to apply foundation loads that do not exceed those of NZS3604:2011, subject to the following recommendations:

10.1 Slope Stability & Soil Creep

We generally consider the risk of moderate to deep-seated slope instability impacting on future residential-type buildings contained within the DBP to be satisfactorily low, provided that future development is undertaken in accordance with the recommendations and limitations described herein.

We do however consider that future foundations and/or structures within some areas of the DBP on the majority of the Lots (with the exception of Lot 1, 5, 9, 11, 15 & 21) could be at risk of soil creep or loss of lateral support ranging from 1.0 to 1.5 metres depth and we recommend that at the time of formulating individual lot development proposals, these sites should be subject to a review by a Geo-Professional, to more accurately determine the “at-risk” foundations and/or structures.

As a guide, we have indicated an area on each of the affected DBPs along with dimensions, which we refer to as a Soil Creep Specific Design Zone (SCSDZ) – please refer to the appended site plans. We recommend that foundations (including structures such as retaining walls) within the identified creep zone be designed to resist the loss of lateral support, of between 1.0 to 1.5 metres, with this depth measured from underside of topsoil on the existing ground surface level.

Earth pressure must be calculated as “at-rest” ($K_0 = 1 - \sin \phi'$) conditions, calculated assuming $\phi' = 28^\circ$ plus any upslope surcharges from sloping ground or applied loads, and assume a soil density $\gamma = 18 \text{ kN/m}^3$. We recommend assuming a minimum overall pile embedment of 2.0 metres for 1.0 metre of soil creep, and 3.0 metres for 1.5 metres of soil creep, unless the calculated embedment from Broms Theory results in a greater embedment depth. For calculating embedment using Broms theory, we recommended assuming an appropriately conservative value of 80 kPa for undrained soil shear strength (S_u) unless future specific investigation reveals otherwise. The lateral creep forces loading pile foundations should be calculated over an equivalent width of 3 pile diameters (3D).

We generally recommend using a row of soldier piles at a maximum of 3D centres to isolate the loss of support to the underside of any on grade floors.

We stress that the extent and details of such specifically designed foundations will need to be addressed for each individual development at Building Consent stage.

10.2 Slope Stability Beyond the DBP

We stress that, given the presence of steep slopes situated beyond the DBP on the majority of the lots, there is a heightened risk of slope failures occurring and that even with the recent replanting of such slopes, there are no guarantees that slope instability by way of shallow to moderately-deep seated failures won't occur.

Lots which don't appear to comprise slopes steeper than 25° include Lot 1, 8, 9, 20 & 21.

It is essential that any and all overland flows identified are directed away from at-risk slopes, and **under no circumstances** should concentrated overflows from any source discharge into or onto the ground in an uncontrolled fashion with specific emphasis on discharges from downpipes being collected, detained and then discharged as per the recommendations herein.

We strongly recommend that future homeowners are pro-active with additional planting of such high risk areas which we broadly identify as being steeper than around 25° as well as undertaking regular inspections of such slopes, especially after periods of heavy rainfall, so that any significant movement is identified with advice then sought from a Geo-Professional.

10.3 Foundations for Residential Buildings – Vertical Bearing Capacity

Subject to careful inspections by a Geo-Professional of the exposed subgrade, to confirm the underlying ground conditions comprise competent natural soils and/or engineered fill subgrade, ultimate bearing pressures for shallow strip and pad foundations should be generally limited to no greater than 300 kPa.

The purpose of these subgrade inspections is to check that all topsoil and any other deleterious material has been removed, including (but not limited) to the unlikely presence of pre-existing non-engineered fill as well as the removal of any previously undetected tree stumps along with their root balls and any disturbed and/or desiccated soil, which should then be replaced with engineered fill at the time of construction.

Although we are not aware of any currently existing service trenches and buried drains in close proximity to the DBPs, we caution that during construction, new services lines and trenches could result in foundations being within 45° envelopes rising from the invert of (particularly paralleling) service trenches. It should therefore be checked that appropriate mitigation measures such as using hardfill backfill within the trenches is undertaken, unless such foundation details are found by specific design, to be satisfactory, which may include piling foundations.

To the above figure(s) should be applied an appropriate factor of safety, such as 2.0 for Factored Load Design to calculate the Dependable Load Capacity, or 3.0 for Working Strength Design to calculate the Allowable Load Capacity.

10.4 Specific Foundation Design for Mitigation of Expansive Soils

Upon review of the expansiveness classifications, as discussed earlier, we consider that the following classification is applicable:

- Class H1 (Highly) expansive soils, with a value of y_s set at 60mm.
Lots 2 through 26 (inclusive).
- Class M (moderately) expansive soils, with a value of y_s set at 40mm.
Lot 1

Therefore, instead of the design of shallow foundations as normally covered by NZS3604, care should be taken to mitigate against the potential seasonal shrinkage and swelling effects of expansive foundation soils on **both** superstructures and floors. Specific engineering design should be undertaken by a qualified engineer, experienced in the design of footing systems for houses, who may then utilise the provisions of section 4 of AS2870.

One common means of compliance for this is the use of a suitably designed proprietary stiffened raft system such as a "Rib-Raft", or any other similar systems supported by either BRANZ certification, or a suitable "Producer Statement – Design", or "Design Review", issued by a Chartered Professional Engineer, who is familiar with the contents of this report.

Alternatively, specific design may be undertaken, for which the designer could utilise the concepts contained in section 4 of AS2870, using a software package such as SLOG. Although Appendix A of AS2870 indicates that the designer may be a builder experienced in footing construction, or other person experienced in residential building construction, who may then make use of the standard designs of section 3 of AS2870 for Class H1 soils, it is our understanding that a DBH Determination in New Zealand found that because AS2870 is only an "Informative" Section of NZS3604, its non-specific designs as detailed in its Section 3, do not automatically constitute an 'Acceptable Solution' in the context of the NZ Building Code without validating verification by engineering design.

If non-AS2870 design methodologies are to be used, then all foundations for superstructures should be fully founded within competent natural and/or engineered fill and extend to a minimum depth of:

- o 600mm below the final cleared ground level or
- o 750mm below finished ground level, whichever results in the greater embedment.

Where brick veneer construction is proposed, consideration should be given to minimising potentially unsightly cracking of the veneer due to possible differential movements by, for example, installing control joints at spacings of no more than 1.5 times the panel height, up to a maximum of 3.6 metres, but positioned where possible or reasonable, to coincide with re-entrant corners of openings in the veneer, and/or by strengthening of the foundations in accordance with generally accepted practice.

Particular attention should be given to clause 7.5.8.6.4 of NZS3604 and its associated comment, such that saw cuts or free control joints should not pass through exposed areas of thin (e.g. vinyl) and/or brittle (e.g. ceramic tiles) floor coverings, unless specific measures are utilised to address this issue.

We also draw the foundation/slab designer's attention to clauses 5.6 and 6.6 of AS2870:2011 with respect to the additional detailing and construction requirements for Class M & H1, as appended.

10.5 Subgrade Preparation/Protection

Because of the importance of the issue of expansive soils, once the exposed subgrade has been inspected by a Geo-Professional and confirmed as being competent natural soil and/or engineered fill, it should be covered with 100mm of granular fill such as GAP40 basecourse, as soon as possible. The granular layer will not only provide protection from the drying effects of wind and sun, but the voids within it will also serve as a reservoir of additional moisture to recharge the subgrade, being careful to form a cross-fall on the subgrade to minimise undue ponding.

Likewise, footing inverts should be poured as soon as possible once inspected by a Geo-Professional, or covered with a protective layer of site concrete.

If subgrade degradation occurs by:

- excessive drying out resulting in dessication shrinkage cracking or
- subgrade softening after a period of wet weather,

it is likely to be more practical and will be more immediate and have greater surety, to undercut the depth of the degraded zone and replace that material immediately with granular fill.

While it is accepted that "all concrete slabs crack" (most often due to shrinkage as they cure), failure to take sufficient care of the underlying subgrade before pouring the concrete slab, could result in:

- swelling of extensively cracked and/or dessicated subgrade beneath the slab, in turn causing a "hogging" of the slab or
- shrinkage of significantly wet and/or weakened subgrade, in turn causing a settlement of the ground supporting the slab.

Although minor movement within the slab may be of little structural significance, it can still have adverse aesthetic effects in garage floors, or areas of "brittle" floor tiling. Excessive "hogging" of the slab has been known to also lift footings, leading to structural distortions in walls.

10.6 Foundation Care & Maintenance

The recommendations given above to mitigate the risk of expansive soils do not necessarily remove the risk of external influences affecting the moisture in the subgrade supporting the foundations and floors.

All owners should also be aware of the detrimental effects that significant trees can have on building foundation soils, viz

- i. their presence can induce differential consolidation settlements beneath foundations through localised soil water deprivation, or conversely
- ii. foundation construction too soon after their removal can result in soil swelling and raising foundations and/or slabs as the soils rehydrate.

To this end, care should be taken to avoid

- (a) having significant trees positioned where their roots could migrate beneath the house foundations, and
- (b) constructing foundations on soils that have been differentially excessively desiccated by nearby trees, whether still existing, or recently removed.

We recommend that homeowners make themselves familiar with the appended Homeowners' Guide published by CSIRO, with particular emphasis on maintenance of drains, water pipes, gutters and downpipes.

10.7 Cut/Fill Limitations within the DBP

Given the sensitivity of our stability analyses to additional load placed on the majority of the slopes as well as the limitations imposed by NZS3604, we stress that fills greater than 0.6 metres, should not be undertaken on these sites, without further review by a Geo-Professional who is familiar with the contents of this report.

Furthermore, given that the sites are predominantly gently sloping, we anticipate that cuts may be required to accommodate level building footprints within the DBP, and therefore also recommend limiting such cuts to a maximum height of 2.5 metres, with all cuts requiring support by engineer designed retaining walls, unless they can be battered back at less than 1V:4H or a site specific geotechnical assessment is undertaken. We have provided retaining wall design parameters for support of cut ground only in the following section.

10.8 Retaining Walls Supporting Cut Only within the DBP

For the design of cantilever and/or flexible diaphragm retaining walls that can deform sufficiently to mobilize active pressures, we recommend calculating coefficients of active lateral earth pressure (K_a) (i.e. timber pole retaining walls not supporting critical structures and/or long-term traffic loads). However for stiff, inflexible retaining walls, which are unable to deflect sufficiently to generate active earth pressures, we recommend calculating coefficients of at-rest lateral earth pressure (K_o) (i.e. concrete and/or masonry retaining walls supporting building loads and/or driveways/car-parking areas).

We recommend assuming the following soils parameters for retaining wall design:

Material Type	Angle of Internal Friction ϕ'	Bulk Density γ	Undrained Shear Strength (C_u) for Pole Embedment*	Geotechnical Ultimate Bearing Capacity for Shallow Foundations	Ultimate Undrained Shear Strength for calculating sliding resistance of shallow foundations (S_u)
Natural Soils/Existing Engineered Earth Fill	28°	18 kN/m ³	80 kPa	300 kPa	30 kPa

*For the calculation of pole embedment depths, the Broms method may be used provided that depths are not less than 4 pile diameters, for which the above stated undrained shear strength value may be assumed, subject to confirmation by Engineering inspection during construction.

To the above figures please apply an appropriate strength reduction factor for satisfying Ultimate Limit State conditions.

Furthermore, the above figures make no allowances for any surcharges, be they ground slopes and/or applied loads, and hence, all retaining wall designs should also accommodate all anticipated upslope surcharges. Furthermore, reduced toe support by existing or proposed excavations and/or slopes must be taken into consideration, along with the potential for soil creep as discussed in section 11.1 above.

In accordance with good Engineering design principles, all retaining walls should be constructed with rear base drainage down to underside of footing level and backfilled with lightly tamped, free draining granular material. Care should be taken to avoid excessive compaction adjacent to retaining walls.

10.9 Ancillary Structures (e.g. Water Tanks)

We highlight the importance of not overlooking the careful positioning of ancillary structures within the DBP, and away from slopes steeper than 1V:4H, unless reviewed by a Geo-Professional to ensure they are not at stability and/or soil creep risk. For instance, water tanks when full, can impart a significant load on slopes, and can be at risk of slope failure, unless mitigation measures such as partial burying of the tank or soldier piles are incorporated in the design.

10.10 Stormwater Collection & Disposal

All stormwater runoff from roofs and paved areas, should be collected and temporarily detained in a specifically sized detention tank (or additional space allowed for in the main tanks). The purpose of the temporary detention is to limit the flows onto slopes as well as into gullies during peak storms. Sizing should be undertaken using the design procedures provided in the legacy Auckland Council "On-Site Stormwater Management Manual" whereby the outflow from the detention tank should not exceed the pre-development flows of the areas affected by the proposed development, by using an appropriately sized orifice plate not less than 10mm diameter to prevent blockages.

Discharges from the detention tank on Lots 8, 9, 10, 20, 21 & 22 are to be piped to the provided reticulated stormwater connection.

Discharges from the detention tank on Lots 4, 5 & 6 are to be piped to a new connection made in the adjacent reticulated stormwater line at the time of building works.

Discharges from the detention tank on Lots 1, 2, 3, 7, 11, 12, 13, 14, 15, 16, 17, 18, 19, 23, 24, 25 & 26 must be piped via a sealed flexible 110mm diameter coil downslope of the DBP, before being disposed via one of the following formalised outlet devices which are situated well away from the DBP, as indicated on the appended plan entitled "Designated Building Platforms, Stormwater Discharge & Effluent Disposal Field Locations Over Finished Contours":

- discharge into a watercourse with adequate erosion and scour protection or
- returned to overland flow by feeding into a bubble-up level-spreader comprising a 0.4 metre x 0.4 metre x 6.0 metre long trench containing a 110mm diameter punched coil, and backfilled with graded drainage metal and aligned parallel to the contours so that its discharges are spread evenly along its crest.

The approximate locations of these private stormwater outlets is indicated on the appended site plan but should be confirmed by a Geo-Professional prior to construction and before a drainlayer installs the system, as well as providing an as-built record as part of Code Compliance to allow for future inspection and maintenance.

An important part of the construction of such systems is the laying of the sealed flexible pipe which must comprise a heavy duty corrugated "nova-flo" or "nova-coil" which is to be snaked down slopes steeper than 18° and fixed to the slope at regular intervals with No. 8 wire tied to waratahs driven to at least 1.5 metres depth on each side of the pipe. The pipe should be covered with hessian cloth or coconut matting pinned to

the slope and then covered with mulch to provide UV protection to the pipe by encouraging vegetative growth.

We have appended a simple Stormwater Maintenance Checklist to be completed on an annual basis with copies sent to Council and retained on the property file as a record. The original records should be retained by the homeowner on-site and passed onto future homeowners.

The greatest risk is failure of the system/s, which could lead to uncontrolled discharges of stormwater in and around the building/s, which in turn could lead to land instability.

Finally, any overland flows identified should be directed away from the building footprint and under no circumstances should concentrated overflows from any source discharge into or onto the ground in an uncontrolled fashion with specific emphasis on discharges from downpipes being collected, detained and then discharged as per the recommendations herein.

10.11 Effluent Disposal

Based on the information from our boreholes drilled across the site, we consider that the site soils can be classified into Category 5/6 of TP58 "On-site Wastewater Systems: Design and Management Manual", Third Edition, and we are satisfied that effluent disposal fields designed in accordance with TP58, can be designed assuming a disposal rate of 3mm/m²/day using dripper lines.

Furthermore, the disposal system for each lot should be the subject of further specific design once building proposals are known, and subject to the level of pre-treatment proposed.

We have generally positioned such fields on land which we do not consider to be at significant risk of slope instability, and further consider that such slopes will not be adversely affected by the disposal of treated effluent provided that daily volumes/area do not exceed 3 litres/m²/day. We have also maintained the minimum required separation from water-courses as per TP58.

To illustrate that each lot has sufficient land application area, we have shown on the appended plan entitled "Designated Building Platforms, Stormwater Discharge & Effluent Disposal Field Locations Over Finished Contours" a minimum 900m² area for such disposal. This area comprises a 600m² area for primary disposal and 300m² reserve area. This is based on the conservative assumption of a 5 bedroom (8 person) dwelling with each person producing 220 litres per day, resulting in a peak wastewater production of 1760 litres per day.

Please note that in some localised areas, the slopes within the nominated areas could be as steep as 30°, and we recommend that at the time of dripper line installation, adjacent slopes with lesser gradients are considered for dripper line placement.

However, for Lots 4, 5, 6 & 7, we did not consider there to be any suitable effluent disposal areas contained within the lots themselves on account of steep to very steep slope gradients as well as identified slope instability. Therefore a large area to the north-west of Lot 3 has been identified as being suitable for disposal of treated effluent which is to be piped from these lots to Lot 503 which comprises 4 separate sub-titles each comprising 900m².

Furthermore, for Lots 8, 9 & 10, we did not consider there to be sufficient land area available for effluent disposal areas contained within the lots themselves. Therefore a large area to the south of Lot 10 has been identified as being suitable for disposal of treated effluent which is to be piped from these lots to Lot 504 which comprises 3 separate sub-titles each comprising 900m².

We therefore consider that either each lot contains sufficient area, or has been provided a sufficient area elsewhere, for some form of disposal system that would meet the requirements of TP58.

Whilst some of these areas have been subject to recent native planting, we encourage future owners to provide additional planting to help with the evapotranspiration of the disposed treated effluent.

10.12 Development Outside of the Designated Building Platforms

As discussed in the GIR, the approach adopted on this project has been to identify and designate a building platform (DBP) on each proposed lot, primarily positioned in an area evaluated to be within manageable risk levels of slope instability. Furthermore, the evaluation is broadly in terms of the requirements of NZS3604:2011 for the construction of light-weight residential buildings, as well as the recommendations and limitations described herein. This is not to preclude development outside of that designated platform or the limitations of NZS3604 or the recommendations and limitations described herein, but rather, to require additional geotechnical evaluation, which will likely require further investigation. Such an assessment must be undertaken by a suitably experienced Geo-Professional, who is familiar with the content of this report, as well as the previous Geotechnical Investigation Report, which is appended for ease of reference.

We stress that the term “development” extends to earthworks, retaining walls as well as landscaping as in certain circumstances, such works could adversely impact on the stability of the DBP as it currently exists.

11. Statement of Professional Opinion as to Suitability of Land for Building Development

Owner/Developer: Spinnaker Bay Limited

Location: Stage 2, Solway Subdivision, 285 Ara-Kotinga Road, Whitford
Lots 1 through 26 (inclusive)

Development: Rural Residential Subdivision

I, Eugene Crestanello of Geotek Services Limited, hereby confirm that:

1. I am a Geo-professional as defined in clause 1.2.2 of NZS4404:2010 and was retained by the Owner/Developer as the Geo-professional on the above development.
2. The extent of our preliminary investigations are described in our Geotechnical Investigation Report (GIR) dated 3 October 2013 (reference 5046), with a copy of this report appended for ease of reference. The conclusions and recommendations of this GIR has been re-evaluated in the preparation of this Statement, as well as the extent of our inspections during construction, along with the results of all tests and/or re-evaluations carried out are as described in the covering Geotechnical Completion Report (GCR) (reference 5046.2) and the associated appendices.
3. In my Professional Opinion, not to be construed as a guarantee, I consider that:
 - (a) To the best of our knowledge, the appended Surveywrx drawing set entitled 'Earthworks Cut-Fill Plan' (Drawing reference number 55-932-605-18, dated 16/6/16 and comprising 10 sheets) shows the approximate extent of bulk earthworks undertaken on Stage 2.
 - (b) On the basis of our observations and testing which included lot by lot hand augering, we consider that, to the best of our knowledge, the filled ground beneath the DBP on Lots 1, 2, 5, 6, 13, 14 & 23 comprises engineered fill which has generally been placed in accordance with NZS4431:1989 and should be competent to support light-weight residential-type building loads as per the expectations of NZS3604:2011.
 - (c) On the basis of our observations and testing which included lot by lot hand augering, we consider that, to the best of our knowledge, the ground beneath the DBP on Lots 3, 4, 7, 8, 9, 10, 11, 12, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25 & 26 comprises natural soil which should be competent to support light-weight residential-type building loads as per the expectations of NZS3604:2010.

- (d) The "Non-Structural Fill" on Lot 1 should NOT be considered as suitable for support of buildings but is considered as suitably engineered in terms of providing buttressing stability to the Engineered Fill supporting the DBP however it is anticipated to undergo some degree of consolidation over the next 5 to 10 years, which could result in ground settlement at the surface but will not reduce support to, nor adversely affect the DBP.
- (e) The completed works in and around the DBP on each lot give due regard to land slope and foundation stability considerations, with the exception of shallow soil creep, which will require specific foundation design.
- (f) Both the original ground, and the engineered filled ground underlying the DBP's, is suitable for the erection thereon of structures designed and built in accordance with the Building Act 2004 and NZS3604:2011 as well as other related documents, provided that:
 - (i) Careful inspections by a Geo-Professional of the exposed subgrade should be undertaken, to confirm the underlying ground conditions comprise competent natural soils and/or engineered fill subgrade and to check that all topsoil and any other deleterious material has been removed.
 - (ii) All structures including those undertaken in accordance with NZS3604:2011, have their floors and foundations designed and built to mitigate the effects of Class H1 expansive soils as defined in AS2870, or for a characteristic surface ground movement value y_s of 60 mm, with the exception of Lot 1 which should be designed and built to mitigate the effects of Class M expansive soils as defined in AS2870, or for a characteristic surface ground movement value y_s of 40 mm.
 - (iii) All foundations and/or structures (including retaining wall structures) situated within the Soil Creep Specific Design Zones (SCSDZ) on the majority of the lots (with the exception of Lots 1, 5, 9, 11, 15 & 21) are designed to mitigate the effects of soil creep (or loss of lateral support) ranging from 1.0 to 1.5 metres depth as listed in the appended "Designated Building Platform Requirements Summary Table on a Lot-by-Lot Basis" as well as indicated on the appended site plans. The soil creep depth should be measured from the underside of topsoil on the existing ground surface level. Please refer to the covering GCR for further design guidance however we strongly recommend that at the time of formulating individual lot development proposals, these sites should be subject to a review by a Geo-Professional familiar with this report to more accurately determine the "at-risk" foundations and/or structures.

- (iv) Although we are not aware of any currently existing service trenches and buried drains in close proximity to the DBPs, we caution that during construction, new services lines and trenches could result in foundations being within 45° envelopes rising from the invert of (particularly paralleling) service trenches. It should therefore be checked that appropriate mitigation measures such as using hardfill backfill within the trenches is undertaken unless such foundation details are found by specific design, to be satisfactory.
- (v) Fills greater than 0.6 metres should not be undertaken within the DBP, without further review by a Geo-Professional who is familiar with the contents of this report.
- (vi) Furthermore, we anticipate that some significant cuts could be required to accommodate building footprints within the DBP and we also recommend limiting such cuts to a maximum height of 2.5 metres, with all cuts requiring support by engineer designed retaining walls unless they can be battered back at less than 1V:4H. Please refer to the covering GCR for further retaining wall design guidance.
- (vii) Careful positioning of ancillary structures such as water tanks within the DBP. Please note that, unless water tanks are buried to depths commensurate with the specified soil creep depth, these structures will also be at risk of loss of lateral soil support. If proposed outside of the DBP then their positioning will need to be reviewed by a Geo-Professional to ensure they are not at stability and/or soil creep risk.
- (viii) All stormwater runoff from roofs and paved areas, should be collected and temporarily detained in a specifically sized detention tank (or additional space allowed for in the main tanks). The purpose of the temporary detention is to limit the flows onto slopes into the gullies during peak storms. Sizing should undertaken using the design procedures provided in the legacy Auckland Council "On-Site Stormwater Management Manual" whereby the outflow from the detention tank should not exceed the pre-development flows of the areas effected by the proposed development, using an appropriately sized orifice plate not less than 10mm diameter to prevent blockages.

Discharges from the detention tank on Lots 8, 9, 10, 20, 21 & 22 are to be piped to the provided reticulated stormwater connection. Discharges from the detention tank on Lots 4, 5 & 6 are to be piped to a new connection made in the adjacent reticulated stormwater line at the time of building works.

Discharges from the detention tank on Lots 1, 2, 3, 7, 11, 12, 13, 14, 15, 16, 17, 18, 19, 23, 24, 25 & 26 must be piped via a sealed flexible 110mm diameter coil downslope of the DBP,

before being disposed via one of the following formalised outlet devices which are situated well away from the DBP, as indicated on the appended plan entitled "Designated Building Platforms, Stormwater Discharge & Effluent Disposal Field Locations Over Finished Contours":

- discharge into a watercourse with adequate erosion and scour protection or
- returned to overland flow by feeding into a bubble-up level-spreader comprising a 0.4 metre x 0.4 metre x 6.0 metre long trench containing a 110mm diameter punched coil, and backfilled with graded drainage metal and aligned parallel to the contours so that its discharges are spread evenly along its crest.

The locations of these private stormwater outlets should be confirmed by a Geo-Professional prior to construction and before a drainlayer installs the system, as well as providing an as-built record as part of Code Compliance to allow for future inspection and maintenance.

An important part of the construction of such systems is the laying of the sealed flexible pipe which must comprise a heavy duty corrugated "nova-flo" or "nova-coil" which is to be snaked down slopes steeper than 18° and fixed to the slope at regular intervals with No. 8 wire tied to waratahs driven to at least 1.5 metres depth on each side of the pipe. The pipe should be covered with hessian cloth or coconut matting pinned to the slope and then covered with mulch to provide UV protection to the pipe by encouraging vegetative growth.

We have appended a simple Stormwater Maintenance Checklist to be completed on an annual basis with copies sent to Council and retained on the property file as a record. The original records should be retained by the homeowner on-site and passed onto future homeowners.

The greatest risk is failure of the system/s, which could lead to uncontrolled discharges of stormwater in and around the building/s, which in turn could lead to land instability.

Finally, any overland flows identified should be directed away from the building footprint and under no circumstances should concentrated overflows from any source discharge into or onto the ground in an uncontrolled fashion with specific emphasis on discharges from downpipes being collected, detained and then discharged as per the recommendations herein.

4. ANY development which is proposed outside of the DBP and/or the limitations of NZS3604 and/or the recommendations and limitations described herein, should be subject to additional geotechnical evaluation, undertaken by a suitably experienced Geo-Professional, who is familiar with the content of this report, as well as the previous Geotechnical Investigation Report.

We stress that the term “development” extends to earthworks, as in certain circumstances, such works could adversely impact on the stability of the DBP as it currently exists.

5. We stress that, given the presence of steep slopes situated beyond the DBP on many of the lots, there is a heightened risk of slope failures occurring and that even with the recent replanting of such slopes, there are no guarantees that slope instability by way of shallow to moderately-deep seated failures won't occur.

It is essential that any and all overland flows identified are directed away from at-risk slopes and under no circumstances should concentrated overflows from any source discharge into or onto the ground in an uncontrolled fashion with specific emphasis on discharges from downpipes being collected, detained and then discharged as per the recommendations herein.

We strongly recommend that future homeowners are pro-active with additional planting of such high risk areas which we broadly identify as being steeper than around 25° as well as undertaking regular inspections of such slopes, especially after periods of heavy rainfall, so that any significant movement is identified with advice then sought from a Geo-Professional.

6. This Professional Opinion is furnished to the local Territorial Authority and the current owner/developer, for their purposes alone, on the express condition that it will not be relied upon by any other person, and does not remove the necessity for the normal inspection of foundation conditions at the time of erection of any structure.
7. This statement shall be read in conjunction with my Geotechnical Completion Report and shall not be copied or reproduced except in conjunction with a full copy of this report as well its associated enclosures.

12. Limitations

Except to the extent that Council may rely on it in order to issue an associated Consent, this report Statement of Professional Opinion has been commissioned solely for the benefit of our client, Spinnaker Bay Limited, specifically in relation to the project as described herein, and to the limits of our engagement. Any

variations from the development proposals as described herein as forming the basis of our appraisal should be referred back to us for further evaluation. Copyright of Intellectual Property remains with Geotek Services Limited, and this report may NOT be used by any other entity, or for any other proposals, without our written consent. Therefore, no liability is accepted by this firm or any of its directors, servants or agents, in respect of any other geotechnical aspects of this site, nor for its use by any other person or entity, and any other person or entity who relies upon any information contained herein does so entirely at their own risk, with the exception that the local Territorial Authority may rely on it to the extent of its appropriateness, conditions and limitations, when issuing the subject consent. Where other parties may wish to rely on it, whether for the same or different proposals, this permission may be extended, subject to our satisfactory review of their interpretation of the report.

Although this report and Statement of Professional Opinion may be submitted to a local authority in connection with an application for a consent, permission, approval, or pursuant to any other requirement of law, this disclaimer shall still apply and require all other parties to use due diligence where necessary, and does not remove the necessity for the normal inspection of site conditions and the design of foundations as would be made under all normal circumstances.

Although regular site visits have been undertaken for observation, for providing guidance and instruction and for testing purposes, the geotechnical services scope did not include full time site presence. To this end, our report and Statement of Professional Opinion also relies on the Contractors' work practices and assumes that when we have not been present to observe the work, it has been completed to high standards and in accordance with the drawings, instructions and consent conditions provided to them. Similarly it assumes that all as-built information and other details provided to the Client and/or Geotek Services Limited by other members of the project team are accurate and correct in all respects.

GEOTEK SERVICES LIMITED



E. Crestanello (Bsc. Geol.)

Senior Associate/Engineering Geologist