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12 January 2015

Cabra Developments Limited
C/- Cato Bolam Consultants Limited
PO Box 157
Orewa
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Attention: Mr T Lemon

Dear Tom

RE: Geotechnical Completion Report for Residential Subdivision Stage J1A (Lots 2, 3, 11, 13, 14, 15) at 1161 Coatesville-Riverhead Highway, Riverhead

This Geotechnical Completion Report presents all supporting geotechnical data and our Suitability Statement in relation to land development works recently completed at the above location.

It has been prepared in accordance with instructions received from Cato Bolam Consultants Limited and forms part of the documentation required by Auckland Council to achieve certification under Section 224(c) of the Resource Management Act 1991.

If you have any queries or you require any further clarification on any aspects of this report, please do not hesitate to contact the undersigned.

For and on behalf of Coffey

A handwritten signature in black ink, appearing to read "P. Bosselmann", written over a horizontal line.

P.B.C. Bosselmann

Senior Principal

Distribution:	Cabra Developments Limited	3 Copies
	Cato Bolam Consultants Limited	1 Copy
	Auckland Council	3 Copies
	Original held by Coffey Geotechnics (NZ) Limited	

Coffey Geotechnics (NZ) Limited
GENZAUCK15847AA
12 January 2015

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1 INTRODUCTION AND DESCRIPTION OF SUBDIVISION

This Geotechnical Completion Report (GCR) has been prepared for Cabra Developments Limited as part of the documentation required to be submitted to Auckland Council following residential subdivisional development.

It contains our Suitability Statement, relevant test data and the Cato Bolam Consultants Limited as-built plan set relating to Stage J1A of the residential subdivision at 1161 Coatesville-Riverhead Highway, Riverhead, as follows:

Table 1: Cato Bolam Consultants Limited As-Built Plans

Title	Job No.	Sheet No.	Rev No.	Date
Water Reticulation As Built	32558	E600	-	11 December 2014
PWC Sewer As Built	32558	E601	-	11 December 2014
Final Contour Level As Built Plan	32558	E602	R3	12 January 2015
Cut and Fill Contour As Built Plan	32558	E604	R2	12 January 2015
Stormwater As Built Plan	32558	E605	R1	12 December 2014
Road As Built Plan	32558	E606	-	11 December 2014
Stormwater Pipeline Zone of Influence Plan	32558	E607	-	12 December 2014

This report covers the construction period May to December 2014. It is intended to be used for certification purposes as follows:

- six residential lots numbered 2 ,3, 11, 13, 14 and 15; and
- The extension of 2 existing roads named Riverhead Point Drive and Pohutukawa Parade.

Stage J1A is located off the southern side of Kaipara Portage Road, Riverhead and as can be seen on the Cut and Fill Contour as-built plan, all six lots have been partly affected by filling, to a maximum depth of approximately 3.5 metres.

2 RELATED REPORTS

A Geotechnical Investigation Report (GIR) on the subject land was prepared by this Consultancy, reference GENZAUCK15395, dated 22 May 2012. In addition to this, two Geotechnical Completion Reports (GCR's) have also been prepared by this consultancy relating to stages J4 and J5B (dated 30 October 2013) and stages J2, J5C and J7 (dated 4 March 2014), both referenced GENZAUCK15847AA.

The conclusions and recommendations of these reports have been reviewed during the preparation of this document.

3 EARTHWORKS OPERATIONS

3.1 Plant

The main items of plant used by the Contractor, Hick Bros Civil Construction Limited (Hick Bros) were:

- 2 x 25 tonne excavator;
- 1 x 18 tonne excavator;
- 1 x 4.5 tonne excavator;
- 1 x D6 bulldozer;
- 1 x D4 bulldozer;
- 1 x 825 sheep foot compactor;
- 1 x 12 tonne single drum pad foot compactor;
- 1 x moxy articulated dump truck;
- 1 x tractor.

3.2 Construction Programme

This report relates to the earthworks construction period from May 2014 to December 2014 during which earthworks construction was undertaken by Hicks Bros. Earthworks operations undertaken at the subject site prior to this were captured within the aforementioned GCR's in section 2 above, and will not be reiterated herein.

Earthworks for Stage J1A resumed in late May 2014 with cut and fill operations on Lots 13, 14 and 15. Given the material being used and the time of year, fill placed required lime drying (ie. to reduce soil water content) to achieve optimum compaction.

In early June 2014 Hicks Bros began to strip topsoil and unsuitable surficial soils from Lot 3 prior to backfilling with lime stabilised clay fill materials. Two existing underfill drains (detailed in our GCR for stages J4 and J5B) were extended into Lot 3 to tap identified localised pockets of wet natural ground.

By mid June 2014, lime stabilised clay had been placed over Lots 2 and 3 bringing them up to finished level. A cantilever timber pole retaining wall (designed by Coffey) was constructed along the southern boundary of Lots 2 and 3, and consisted of 150mm to 200mm SED timber piles with 50mm thick by 150mm wide timber rails. Construction of this retaining wall was completed under Coffey observation near the end of June 2014. Following this, Lots 2 and 3 were topsoiled and mulched.

In mid-July 2014, some localised pockets of wet natural ground were encountered near the Pohutukawa Parade/ Riverhead Point Drive intersection. The existing subsoil drain which runs along the western boundary of Lot 2 was extended under the road and into Lot 1 (outside this stage of the subdivision) to tap the identified wet areas. The drain consisted of a 150mm diameter Hiway grade perforated nova coil in the base of the trench, covered with approximately 600mm depth of SAP50 drainage scoria and geotextile cloth. The section of the drain beneath the road was completely backfilled with compacted GAP65.

By late August 2014, the majority of earthworks had been completed. Roads and footpaths were formed and paved through to October 2014.

In mid November 2014 it was noted that one of the retaining wall piles on Lot 2 (near the south-west corner of the site) had rotated (due to heavy machine trafficking above the wall by the contractor). The contractor corrected the alignment of this pile using an excavator to push pile back to the correct orientation and pouring a strip of concrete (approximately 600mm deep by 300mm wide by 600m long) in-front of the pile to support the toe of the pile. We are satisfied with this approach, given the retained height of the pile here is only approximately 0.8 metres.

In early December a subsoil drain within Lot 3 was extended towards the retaining wall on the southern boundary, where a spring had developed as a result of the foundation excavation for the retaining wall. The drain consisted of a 150mm diameter Hiway grade perforated nova coil with approximately 600mm of SAP drainage scoria. Over the scoria the drain was backfilled with Engineer certified hardfill, completing Coffey's involvement with geotechnical construction observation on this stage of the subdivision.

4 QUALITY ASSURANCE AND CONTROLS

4.1 Inspections

During the earthworks engineering inspections were undertaken on a regular basis to assess compliance with NZS 4431 and our project specific recommendations and specifications. Project specific inspections were required on this stage of the development for:

- topsoil stripping prior to fill placement;
- installation of underfill/subsoil drains; and
- construction of a cantilever timber pole retaining wall on Lots 2 and 3.

4.2 Quality Control Criteria

4.2.1 Compaction

Due to the varying soil types being used as filling, the compaction control criteria of minimum allowable shear strength and maximum allowable air voids was used for quality assurance purposes.

Specification details were as follows:

Minimum Shear Strength and Maximum Air Voids Method

(a) Air Voids Percentage

(As defined in NZS 4402)

General Fill

Average value less than 10%

Maximum single value 12%

(b) Undrained Shear Strength

(Measured by Pilcon shear vane - calibrated using NZGS 2001 method)

Average value not less than 140 kPa

Minimum single value 110 kPa

4.3 Quality Assurance Testing

4.3.1 Compaction

- (i) Insitu density monitoring was carried out on the general fill areas and a series of hand auger boreholes were also drilled at selected locations as an added check on quality control.
- (ii) Regular insitu density, strength and water content tests were carried out on all areas of the filling at or in excess of the frequency recommended by NZS 4431.
- (iii) Control tests carried out on the filling showed that on all occasions the required compaction standards were being achieved.

5 PROJECT EVALUATION

5.1 Bearing Capacity and Settlement of Building Foundations

Following the completion of earthworks operations, we returned to the site on 2 December 2014 and drilled a hand auger borehole in the approximate centre of each lot in order to assess representative finished ground conditions and hence evaluate likely foundation options for future building development. Our resulting bearing capacity recommendations are presented in the appended Suitability Statement.

At current subgrade levels all cut, filled and undisturbed inorganic natural ground has a geotechnical ultimate bearing capacity of 300 kPa (as required by NZS 3604) within the zone influence of conventional shallow residential building foundation loads.

At these bearing pressures differential settlements due to building loads should be within Building Code limits.

Where any building platforms have been rutted by heavy machinery, or softened due to ponded rainwater, they should be trimmed back to competent ground and reinstated with compacted hardfill to design subgrade level prior to the commencement of building construction.

It should be noted that NZS 3604 only allows a maximum backfill depth of 600mm over the platform of a dwelling unless an Engineering design solution is proposed, on account of the risk of induced consolidation of the underlying subsoils caused by the weight of the backfill.

5.2 Expansive Soils

One set of expansive soil tests was carried out on a sample recovered from Lot 14 within the zone of likely influence of shallow building foundations and produced a liquid limit of 81 and a linear shrinkage of 17%.

These limit tests were carried out in accordance with NZS 4402, "Methods of Testing Soils for Civil Engineering Purposes" test section 2 and were primarily intended to assess the Expansive Classes of the site materials as defined in AS 2870, "Residential Slabs and Footings – Construction".

All test results are IANZ (International Accreditation New Zealand) endorsed and full details are appended.

The assessed AS 2870 Site Class for this subdivision is M (moderate). Specific design alternatives for this Site Class are presented in the Suitability Statement.

5.3 Fill Induced Settlement

As a result of our pre-fill inspections, quality control testing and the elapsed time since the placement of the majority of the filling, we are of the opinion that induced differential settlements beneath or within the certified filling due to its imposed weight should be insignificant with respect to conventional NZS 3604 residential building development.

5.4 Service Trenches

As is normal on all subdivisions, building developments involving foundations within a 45 degree zone of influence from pipe inverts will require Engineering input. The attached Cato Bolam Plan (Sheet no. E607) depicts the areas affected by the stormwater lines within the lots.

5.5 Underfill/ Subsoil Drains

The appended Cut and Fill Contour as-built plan (Sheet no. E604) shows the positions of perforated underfill/subsoil drains that were placed in mucked out gully areas prior to filling and in areas where wet natural ground was noted to tap groundwater seepages. These drains are shown to extend through Lots 2 and 3, and the subdivision roads.

As these drains were installed to intercept groundwater seepages, it is important that their long term function is not adversely affected. For the most part these drains are buried sufficiently deep and fall beyond the influence of foreseeable shallow foundation systems, however, if any drains are exposed by foundation excavations and/or future earthworks to create level building platforms, then they will need to be reinstated under the guidance and observation of Coffey.

5.6 Road Subgrades

Penetration resistance tests were undertaken at regular intervals on the road subgrades and the results were subsequently forwarded to Cato Bolam Consultants Limited for pavement design purposes. We understand that areas demonstrating low equivalent CBR values were subsequently stabilised with lime/cement and/or undercut by 0.4 metres and replaced with Woodhill sand wrapped in geotextile cloth to achieve appropriate standards. Coffey were only involved with providing factual results from penetration resistance testing on the road subgrades.

5.7 Retaining Walls

The southern boundaries of Lots 2 and 3 are supported by a cantilever timber pole retaining wall. This wall reaches a maximum height of approximately 1.6 metres and was designed and inspected by this Consultancy. A copy of the Contractor's Producer Statement – Construction (PS3) and our Producer Statement - Construction Review (PS4) are attached in Appendices 5 and 4 respectively.

Building setbacks from this wall are specified in the Suitability Statement.

5.8 Topsoil

Topsoil depths in likely building platform areas were checked by the drilling of a borehole in the approximate centre of each lot. Our findings, which are indicative only and subject to variation at other locations, show that likely topsoil depths are between 100mm and 200mm.

Site specific findings are presented in the Suitability Statement Summary.

5.9 Contractor's Work

We have relied on the Contractor's work practices and assume that the works have been carried out in accordance with:

- (i) The approved Contract drawings and design details,
- (ii) The approved Contract specifications,
- (iii) Authorised Variations during the execution of the works,
- (iv) The conditions of Resource, Earthworks and Building Consents where applicable,
- (v) The relevant Coffey Geotechnics reports, recommendations and site instructions,

and that all as-built information and other details provided to the Client and/or Coffey Geotechnics are accurate and correct in all respects.

6 STATEMENT OF PROFESSIONAL OPINION AS TO THE SUITABILITY OF LAND FOR BUILDING DEVELOPMENT

I, P.G. Marchant, of Coffey Geotechnics (NZ) Limited, Auckland, hereby confirm that:

1. I am a Chartered Professional Engineer experienced in the field of geotechnical engineering as defined in section 1.2.3 of NZS 4404 and was retained by the Owner/Developer as the Geotechnical Engineer on Stage J1A of the 1161 Coatesville-Riverhead Highway, Riverhead residential subdivision.
2. The extent of preliminary investigations carried out to date are described in Geotechnical Investigation Report number GENZAUCK15395, dated 22 May 2012, and the conclusions and recommendations of that document have been re-evaluated in the preparation of this report.
3. In my professional opinion, not to be construed as a guarantee, I consider that:
 - (a) The earth fills shown on the appended Cut and Fill Contour as-built plan have been placed in compliance with NZS 4431, Auckland Council's Code of Practice for Land Development and Subdivision (Section 2 – Earthworks and Geotechnical Requirements) and related documents.

- (b) The completed earthworks give due regard to land slope and foundation stability considerations within the residential lots.
- (c) A geotechnical ultimate bearing capacity of 300 kPa may be assumed for foundation design on all lots.
- (d) The backfilling and compaction of the stormwater and common services trenches on this subdivision has where possible been carried out to appropriate standards having regard for the prevailing ground conditions and associated compaction induced pipe loadings.

Nevertheless, no building development should take place within the 45 degree zone of influence of drain inverts unless endorsed by specific site investigations, foundation designs and by construction inspections undertaken by a Chartered Professional Engineer experienced in geomechanics to ensure that lateral stability and differential settlement issues are addressed and that building loads are transferred beyond the influence of the pipe and beyond the extent of the trench backfill.

- (e) The cantilever timber pole retaining wall situated along the southern boundary of Lots 2 and 3 has a retained height ranging between approximately 0.6 metres and 1.6 metres. No building development or earthworks are permitted within 1 metre of the base of the wall within Lot 2 and within 1.6 metres of the base of the wall within Lot 3 without specific site investigation and specific engineering design to ensure that the stability of the wall is not compromised.
 - (f) Subject to the geotechnical limitations, restrictions, recommendations and expansive soil assessments associated with 3(b), 3(c), 3(d) and 3(e) above:
 - (i) The cut, filled and undisturbed original ground within residential lot boundaries is generally suitable for residential buildings constructed in accordance with NZS 3604 and related documents.
 - (ii) On all lots foundation design may be carried out in accordance with AS 2870 (Class M) or in accordance with NZS 3604 provided that in this latter case the minimum foundation depth below cleared ground level following topsoil removal and benching of building platform areas is 600mm.
4. Road subgrades have been formed having due regard for slope stability and settlement, although CBR values do vary between natural and filled ground, site conditions and on construction trafficking as is to be expected. It is likely that subgrade CBR's will be significantly lower than 7 within any areas of non-stabilised natural ground.

The professional opinion contained within this report is furnished to Auckland Council and Cabra Developments Limited for their purposes alone on the express condition that it will not be relied upon by any other person. Prospective purchasers should still satisfy themselves as to any specific conditions pertaining to their particular land interest.

Geotechnical Completion Report
(this report must be read and/or reproduced in its entirety)

The appended table summarises the status of each residential lot covered by this Suitability Statement.

For and on behalf of Coffey

Prepared By:



J.R. Fisher

Engineering Geologist

Reviewed By:



P.G. Marchant

Principal Geotechnical Engineer
MIPENZ, CPEng.

Authorised By:



P.B.C. Bosselmann

Senior Principal

Table 2: Suitability Statement Summary

Lot No.	Comments	Topsoil Depth (mm)	Ultimate Bearing (kPa)	AS2870 :2011 Class
2	No construction or earthworks permitted within 1 metre of the base of the retaining wall without specific site investigation and engineering design. Function of underfill drains to be preserved. Elsewhere, AS 2870 foundation design or NZS 3604 with minimum footing depth 600mm.	200	300	M
3	No construction or earthworks permitted within 1.6 metres of the base of the retaining wall without specific site investigation and engineering design. Function of underfill drains to be preserved. Elsewhere, AS 2870 foundation design or NZS 3604 with minimum footing depth 600mm.	200	300	M
11	AS 2870 foundation design or NZS 3604 with minimum footing depth 600mm.	200	300	M
13	AS 2870 foundation design or NZS 3604 with minimum footing depth 600mm.	200	300	M
14	AS 2870 foundation design or NZS 3604 with minimum footing depth 600mm.	100	300	M
15	AS 2870 foundation design or NZS 3604 with minimum footing depth 600mm.	200	300	M