FOUNDATION ENGINEERING

SUPPLEMENTARY GEOTECHNICAL COMPLETION REPORT

ON THE GRANGE SUBDIVISION STAGE 7 (PART)

AT MANHATTAN RISE, OREWA

FOR CABRA HOLDINGS LIMITED

PROJECT NO 10439 **21 SEPTEMBER 2005**

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APPENDICES

Introduction and Description of Subdivision

This Supplementary Geotechnical Completion Report has been prepared for Cabra Holdings Limited as part of the documentation required to be submitted to the Rodney District Council following residential subdivisional development.

It contains our Suitability Statement, relevant test data and the Hutchinson Consultants Limited as-built plan set relating to specific parts of Stage 7 of The Grange Residential Subdivision as follows:

Hutchinson Consultants As Built Plans		
Title	**Reference No.**	**Date**
Cover	10151/AB1	August 2005
Original Contour Plan	10151/AB2	August 2005
As Built Contour Plan	10151/AB3	August 2005
Undercut Depth Contour Plan	10151/AB4	August 2005
Abandoned & Removed Stormwater Plan	10151/AB5	August 2005
As Built Stormwater Plan	10151/AB6	August 2005
Stormwater Connection Plan	10151/AB7	August 2005
As Built Subsoil Drainage	10151/AB8	August 2005
Abandoned & Removed Sanitary Sewer	10151/AB9	August 2005
As Built Sanitary Sewer Plan	10151/AB10	August 2005
Sanitary Sewer Connections	10151/AB11	August 2005
As Built Retaining Wall Plan	10151/AB12	August 2005
As Built Water Main Plan	10151/AB13	August 2005
Consent Notice Plan	10151/AB14	August 2005
Stormwater to Ambassador Bush	10151/AB15	August 2005
As-built Bored Drainage Plan	10151/AB16	August 2005

This report covers the construction period July 2004 to April 2005 and is intended to be used for certification purposes for residential lots numbered 616 to 620 and 646 to 648 DP 322833 and lots 621 to 632 DP 322956.

Stage 7 of The Grange subdivision is located at Manhattan Rise, Orewa and as can be seen on the as-built undercut depth contour plan, a total of 16 of the lots have been partly or totally affected by filling, to a maximum depth of approximately 11 metres.

Background and Related Reports

A Geotechnical Investigation Report on the subject land was prepared by this Consultancy, reference 7237, dated 3 September 1996. Earthworks were subsequently undertaken in conjunction with the construction of Grand Drive and earlier stages of The Grange subdivision in 1998 to 2001 and a Geotechnical Completion Report (GCR) was prepared by this consultancy reference 7237/8299 dated 26 March 2001 covering the filling placed during this time. Subsequently, additional earthworks were carried out for the formation of stage 7 in 2002/ 2003 and a Geotechnical Completion Report was prepared reference 10439, dated 10 July 2003. To address geotechnical issues that arose during winter 2004 a Proposed Remedial Works report was prepared (ref: 10439, dated 11 October 2004). The conclusions and recommendations of these reports have been reviewed during the preparation of this document.

Earthworks Operations

- Plant

  The main items of plant used by the principal contractor Hiway Stabilizers and the earthworks sub-contractor Gideon Contractors during the 2004/2005 earthworks season were:

  1 x Hitachi EX200 Excavator
  1 x Hitachi Zaxis 230 Excavator
  1 x Hitachi EX135 Excavator
  1 x Sumitomo SH200 Excavator
  1 x Sumitomo SH120 Excavator
  1 x Komatsu PC300 Excavator
  1 x Komatsu PC120 Excavator
  1 x Cat D6H Bulldozer
  1 x Cat 910E Front-end Loader
  1 x Sakai SV512 TFB Vibrating Compactor
  1 x Lime Spreader
  1 x Lime Hoe
  1 x Track Mounted Lime Hammer Mill

- Construction Programme

  Following the identification of tension cracking, bulging and deflection of timber pole retaining walls early in the 2004 winter period, groundwater monitoring in standpipe

piezometers identified a highly elevated water table over much of the site. Remedial site works were considered to be required and these commenced late July 2004 with installation of a series of counterfort drains and sub-horizontal bored drains in the area surrounding Manhattan Rise to lower the water table and reduce pore water pressures. The bored drains were installed at 5 metre centres and extended a distance of up to approximately 70 metres through transition zone materials and into Waitemata Group bedrock. The counterfort drains were installed through lots 619 to 624, 627, 628 and 646 and were constructed to depths of up to 5 metres. These drains were either connected directly into the stormwater reticulation where available or temporarily day-lighted on the lower lots with flows directed into stormwater cesspits. High flow rates were observed in some of these drains.

Earthworks operations for construction of a buttress fill and associated undercutting began early February 2005. Topsoil was stripped and stockpiled on the upper portions of the site and the existing timber pole retaining walls above lots 616, 620 to 621 and 623 were removed to facilitate construction. A buttress fill was excavated in a series of 12 stages each typically 10 to 15 metres in length and a minimum of 14 metres wide founded into competent Waitemata Group bedrock. The earthworks began at the eastern end of the buttress fill with a series of benches being cut below the upper retaining wall to facilitate construction.

Sets of relief wells were installed prior to and during the initial stages of the earthworks excavations to relieve possible groundwater pressures within the underlying bedrock. These wells were drilled approximately 3 metres into bedrock and backfilled with 50/14 scoria drainage aggregate and were later connected into the buttress fill drainage blanket.

Two further deep trial pits were excavated on 22 February 2005 to depths of up to approximately 8 metres during the remedial works to obtain further subsoil information and to locate the existing sub-soil gully drainage. Many shallower pits were also excavated across the site to provide further subsoil information.

During the first stage of construction the alignment of the buttress fill to the east of Manhattan Rise was shifted towards the north by approximately 10 metres from the design alignment. This was necessary as the upper surface of the bedrock was found to be dipping back into the slope and towards the east, which meant that the excavation in the original proposed alignment would have been too deep to safely and practically undertake.

The earthworks contractors often had difficulty excavating the buttress fill foundation due to the strength of the rock and a rock-breaker had to be used on one occasion. The up-slope edge of this foundation was typically 2 metres below the transition from soil to rock. A base drain was constructed at the upslope edge of the foundation comprising a 160mm diameter Hiway grade perforated Novacoil drain with SAP50 scoria backfilling. A SAP50 scoria drainage blanket was placed to a minimum thickness of 300mm over the buttress fill foundation and on the benches and upslope face of the excavation to a level of approximately 2 to 3 metres below finished ground level. The drainage blanket was then covered with a non-woven geotextile filter cloth to inhibit ingress of silts and clays into the drainage material prior to the placement and compaction of filling.

All buttress drains and most bored drains installed during the first stage of remedial works were connected into the buttress fill drainage network. However, some of the bored drains were destroyed during the buttress fill excavation. As these drains were installed as a part of the initial remedial works to provide short term groundwater level control they were not considered to be critical to the long term performance of the later buttress fill and associated drainage network.

The buttress fill excavation was backfilled with lime stabilised cohesive soil that had been excavated and mixed on site with 20 Kg per square metre lime (equivalent to an application rate of approximately 2 percent).

During stage 3 of the buttress fill construction the base drain had to be excavated approximately 2 metres below the foundation level in order to maintain fall to the point where the thrust outlet drain was located.

A buried pile wall was constructed along the western and upper south-western site boundary as a precautionary measure prior to construction of the buttress fill west of Manhattan Rise. The reinforced concrete piles were typically extended 1 metre into bedrock materials at depths of up to 13 metres.

Extensive undercutting of the overburden soils above the buttress fill alignment was undertaken within lots 625 to 627, and 647 to 649 to remove fissured and softened material. The undercuts were extended down to competent residual or transitional soils typically around 5 to 7 metres in depth with a nominal 5 degree back slope. A base drain was installed at the upslope edge of the excavations comprising a 160mm diameter Hiway grade perforated Novacoil drain with SAP50 scoria backfilling and geotextile filter cloth cover. This was connected into the drainage network. The first stage of undercut within lot 625 exposed a highly limonitic zone within higher

permeability than surrounding strata. This area was noted as having high groundwater flows in earlier stages of the works. An additional scoria blanket was placed over the limonitic zone to pick up groundwater flows in this area. The undercuts were typically backfilled with lime stabilised cohesive soil.

Four machine wash bore holes were drilled on 19 April 2005 to depths of up to 24 metres and standpipe piezometers installed for groundwater monitoring. Five additional hand auger boreholes were drilled on 26 April 2005 in the upper portion of the site to assess subsoil conditions and groundwater levels.

Upon completion of bulk earthworks, cuts were undertaken to facilitate reconstruction of the timber pole retaining walls where they had been removed. Pole Specialists Limited began wall construction in early April 2005 and an additional retaining wall was constructed above 625 to 627 to facilitate formation of level building platforms on these lots.

Topsoil was respread over the site followed by mulching and hydro-seeding.

Sets of bored drains were drilled to tap deep groundwater seepages during early April 2005 in two fan shaped arrays extending from stormwater manholes within lots 625 and 626. These drains extended up to approximately 70 metres and were drilled through residual and transitional materials into Waitemata Group bedrock.

Compaction Quality Control

- Control Criteria

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

- Field Control

  Prior to the placement of fill materials all areas were inspected to ascertain that soft/unsuitable subsoils had been removed to our satisfaction and where appropriate, underfill drains and scoria blankets were installed to tap groundwater seepages as described above. Engineering inspections were undertaken on a daily basis during the remainder of the earthworks to confirm compliance with NZS 4431 or as otherwise required.

Due to the variable nature of the excavated soils and to ensure required shear strengths would be achieved, all filling was stabilised with 2% lime prior to placement and compaction.

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.

Control tests carried out on the filling showed that on a few occasions the required compaction standards were not being achieved. Results of the test failures were relayed to the site foreman and/or his staff, and to the best of our knowledge the affected areas of fill were re-worked as necessary. In each case, further testing was carried out until compliance with the standards was achieved.

Expansive Soil Testing

Expansive soil tests were carried out on samples selected from around the site and within the zone of likely influence of shallow building foundations during preparation of the Geotechnical Completion Report for the Grange Subdivision Stage 7 reference 10439, dated 10 July 2003. The results of these tests were utilised for this report.

These tests were 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.

Project Evaluation

- Foundations for Buildings

  At current subgrade levels all filled and undisturbed natural ground has a geotechnical ultimate bearing capacity of 300 kPa within the influence of conventional shallow residential building foundation loads.

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

Where a geotechnical ultimate bearing capacity greater than 300 kPa is required, further specific site investigation and design of foundations should be carried out prior to building consent application.

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

- Expansive Soils

  The AS 2870 Site Class for this subdivision is S (slight). Specific design alternatives for this Site Class, are presented in the Suitability Statement.

- Stormwater Controls

  It is important on all lots that due care is paid to the design and construction of appropriate stormwater disposal systems. These systems should serve to collect all runoff from roofs, decks and paved areas, together with discharges from retaining wall drains and other subsoil drains and should connect directly into the public stormwater drainage network.

  Uncontrolled stormwater discharges onto the ground surface or into soakage pits can cause erosion, scour and/or instability on sloping land.

- 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. Further details including lots in this subdivision considered most likely to be affected by this requirement are contained in the Suitability Statement and affected areas are shown on the appended consent notice plan.

- Abandoned Sewer Lines

  As shown on appended abandoned and removed sanitary sewer plan a number of sanitary sewer pipes have been made redundant. These pipes were completely removed from the ground and replacement pipes have been installed where shown on the as-built sanitary sewer plan.

- Land Drainage

The appended as-built subsoil drainage plan shows the positions of:

(a) Existing Subsoil Drains (placed prior to 2004):
Perforated underfill drains with associated drainage aggregates were placed in mucked out gully inverts prior to filling to tap groundwater seepages and also in cut benches formed prior to filling, particularly when land gradients were greater than 1 in 4, as required by NZS 4431. These drains were installed as a part of the original subdivisional development works and were later connected into the 2004/2005 subsoil drainage network.

(b) As-built Subsoil Drains and Drainage Blanket (placed during 2004/2005):
Perforated underfill drains with associated drainage aggregates were placed along the edges of the buttress fill undercuts prior to filling to tap groundwater seepages. The outfall for the subsoil drainage network is via the stormwater pipe discharging to the Ambassador Glade bush.

These drains were intended to intercept localised groundwater seepages and springs during earthworks and to help provide general control over groundwater levels and were installed as a precautionary measure, and they need no specific maintenance.

In association with the subsoil drains, scoria drainage blankets were installed along the base and upslope face of the main buttress fill and within an area of seepage located within lot 625 and the Manhattan Rise road alignment where shown on the appended plan.

As the existing and as-built subsoil drains and drainage blanket are all very deep, we consider that the likelihood of damage to the drains from any future site excavation or building piling operations is extremely unlikely. Accordingly, no future building restrictions will be required on their account.

(c) Bored Drains:
During earthworks construction a series of up to 70 metre long 40 mm diameter horizontally bored drains were constructed in the region of lots 625 to 632.

These drains were provided to help control groundwater levels in the area and are linked into the stormwater disposal system.

As these drains are very deep, we consider that the likelihood of damage from any future site excavation or piling operations is extremely unlikely. Accordingly, no future building restrictions will be required on their account.

(d) Counterfort Drains:

During initial site works commencing in 2004 a series of 600 mm wide counterfort drains were constructed over the site. Those remaining after the 2004/2005 earthworks are shown on the appended as-built subsoil drainage plan. Trench excavation depths for the counterfort drains were typically 4 to 5 metres.

As the counterfort drains located along the southern portions of lots 622 and 624 typically have 2 to 3 metres of fill cover, we consider that the likelihood of damage to the drains from any future site excavation or piling operations is extremely unlikely. Accordingly, no future building restrictions will be required on their account.

However, we recommend that due to its shallow depth, the presence of the counterfort drain along the western boundary of lots 622, 623, 627 and 628 should be recorded on Council's Hazard Register. In addition, if the drain is interrupted during excavation work on these lots it should be reinstated or connected into the drainage system required by such work.

These counterfort drains were provided to help control groundwater levels in the area and are linked into the subsoil drainage network or stormwater disposal system, as shown on the appended plan. Details of resulting building restrictions are presented in the Suitability Statement.

- Road Subgrades

The Manhattan Rise road subgrade was lime stabilised to achieve appropriate standards and to allow for a reduction in sub-base metal depths.

- Retaining Walls

Much of the site has been formed to final gradients with the construction of boundary retaining walls in the locations shown on the as-built retaining wall plan. These walls reach a maximum height of approximately 2.2 metres and were designed and inspected by Hutchinson Consultants Limited. A copy of their Producer Statement - Construction Review is appended.

Details of resulting building and earthworks restrictions within the vicinity of these walls are presented in the Suitability Statement.

- Topsoil

  Topsoil depths in likely building platform areas were checked by the drilling of a borehole in the approximate centre of each of the lots. Our findings, which are indicative only and subject to variation at other locations, show that likely topsoil depths are between 50 mm and 350 mm.

Statement Of Professional Opinion As To The Suitability Of Land For Building Development

I, R.W. Melville-Smith, of Foundation Engineering Consultants Limited Auckland hereby confirm that:

1. I am a Chartered Professional Engineer experienced in the field of geotechnical engineering and was retained by the Owner/Developer as the Geotechnical Engineer on stage 7 of the Grange residential subdivision. This Suitability Statement relates only to lots 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 646, 647 and 648. For these lots it supersedes the recommendations our previous Suitability Statement contained in our original GCR dated 10 July 2003. For the remainder of stage 7 lots, our earlier Suitability Statement still applies.

2. All previous reports relating to this land (as described above) have been reviewed in the preparation of this document. The results of all tests carried out are appended.

3. In my professional opinion, not to be construed as a guarantee, I consider that:

   (a) The earth fills shown on the appended undercut depth contour plan have been placed in compliance with NZS 4431, Rodney District Council's Standards for Engineering Design and Construction (and the provisions of the RDC District Plan) and related documents.

   (a) The completed earthworks give due regard to land slope and foundation stability considerations within residential lots 616 to 632 and 646 to 648.

   (c) The function of the counterfort drain installed along the western boundary of lots 622, 623, 627 and 628 should not be impaired by any building development or landscaping works. A consent notice is recommended for these lots to record this requirement. However the compaction of the surficial soils and drainage aggregates may not be to certifiable standards and therefore any building foundations within 2 metres of the drain centre line will require Engineering design.

   The function of the counterfort and bored drains installed on lots 622, 623, 625 to 632 inclusive and all underfill drains should not be impaired by any building development or landscaping works. In particular, any bored or driven piles must be positioned to avoid damaging these drains. They have been installed in accordance with good engineering practice and should require no specific maintenance.

(d) A geotechnical ultimate bearing capacity of 300 kPa may be assumed for foundation design on lots 616 to 632 and 646 to 648.

(e) The backfilling and compaction of the stormwater and sanitary sewer 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.

(f) No building construction, including the construction of additional retaining walls and no earthworks should take place either above or below any retaining wall within a distance equal to 1.5 times the wall height unless endorsed by specific designs and by construction inspections undertaken by a Chartered Professional Engineer experienced in geomechanics to ensure that no additional loads are applied to the walls.

(g) The assessed AS 2870 expansive site Class for all lots is S (slight).

(h) Subject to the geotechnical limitations, restrictions, recommendations and expansive soil assessments associated with 3(b), 3(c), 3(d), 3(e), 3(f), and 3(g) above:

(i) The 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 S) 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 450mm.

4. Road subgrades and access lot subgrades have been formed to standards appropriate for their intended use.

The professional opinion contained within this report is furnished to the Rodney District Council and Cabra Holdings 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.

FOUNDATION ENGINEERING CONSULTANTS LIMITED

K. A. W. Lentfer
ENGINEERING GEOLOGIST

Report Reviewed By:

R.W. Melville-Smith
PRINCIPAL GEOTECHNICAL ENGINEER