

3 March 2016

KAREPIRO DEVELOPMENT STAGES 2Bi & 4i

GEOTECHNICAL COMPLETION REPORT

KAREPIRO HOLDINGS LIMITED

Ref: 2014-1007BD Rev: 0

Table of Contents

| | |
|---|---|
| 1. INTRODUCTION | 1 |
| 2. PROJECT BACKGROUND | 1 |
| 3. DESCRIPTION OF EARTHWORKS | 2 |
| 4. GEOTECHNICAL QUALITY CONTROL | 3 |
| 4.1. Site Observations | 3 |
| 4.2. Compaction Control | 3 |
| 5. EVALUATION OF COMPLETED EARTHWORKS | 4 |
| 5.1. Natural Hazards | 4 |
| 5.2. Land Stability and Erosion Control | 4 |
| 5.3. Retaining Walls | 5 |
| 5.4. Reinforced Earth Slopes | 5 |
| 5.5. Bush Covenant Zones | 5 |
| 5.6. Fill Induced Settlement | 5 |
| 5.7. Service Line Trenches | 6 |
| 5.8. Subsoil Drains | 6 |
| 5.9. Subsoil Drain Outlets | 6 |
| 5.10. Road Subgrades | 6 |
| 5.11. Local Purpose Reserve | 7 |
| 5.12. Design of Shallow Foundations | 7 |
| 5.12.1. Bearing Capacity | 7 |
| 5.12.2. Foundation Settlements | 7 |
| 5.12.3. Soil Expansiveness Classification | 7 |
| 5.13. Topsoil Depths | 8 |
| 6. CLOSURE | 8 |

Appendices

- Appendix A – Statement of Professional Opinion as to the Suitability of Land For Building Development
- Appendix B – Drawings
- Appendix C – Laboratory Test Data
- Appendix D – Field Test Data
- Appendix E – Producer Statements

1. INTRODUCTION

In accordance with our instructions, this Geotechnical Completion Report has been prepared for Karepiro Holdings Limited as part of the documentation to be submitted to Auckland Council following earthworks to form stages 2Bi and 4i of the Karepiro development. Construction of this residential subdivision has been undertaken in accordance with the Auckland Council Resource Consent number R55169A and Engineering Approval letters dated; 4 October 2014, 17 November 2014 and 20 October 2015. Specific structures constructed during the civil works to create the subdivision include a number of timber pole retaining walls and segmental block retaining walls.

This report contains our Suitability Statement, specific comments related to items raised in the Resource Consent, relevant test data and the Woods Limited as-built plan set as provided in Appendix B.

This report covers the construction period September 2014 to February 2016 and is intended to be used for certification purposes for new lots (listed below) created from Lot 800 DP 480643 as follows:

43 new residential lots numbered 31 to 36, 62 to 82, 84 to 90, and 102 to 110 inclusive;

2 new roads named Woodridge Drive and Eastview Drive

1 new privateway named Tirohanga Crescent.

1 Local purpose reserve on Lot 303

These stages of the Karepiro Development are located off Woodridge Drive. As can be seen from the as-built plans, all of the lots have been affected by filling as part of the earthworks operations to a maximum depth of approximately 13 metres.

Stage 2Bi encompasses Lots 31 to 33, 66 to 78, 84 to 90 and 102 to 110 inclusive. Stage 4i encompasses Lots 34 to 36, 62 to 65 and 79 to 82 inclusive.

2. PROJECT BACKGROUND

The initial geotechnical investigations and design, were undertaken by Coffey Geotechnics (NZ) Limited. CMW have undertaken the construction observation and any subsequent design.

A large body of geotechnical investigation and design work and a number of Geotechnical Reports on the subject land were prepared by Coffey Geotechnics prior to earthworks commencement. The conclusions and recommendations of these reports, as referenced below, have been reviewed during the preparation of this document.

- Coffey Geotechnics, Geotechnical Report referenced GENZSILV12728, dated 30 March 2010
- Coffey Geotechnics, Geotechnical Report referenced GENZSILV12728, dated 13 June 2010
- Coffey Geotechnics, Geotechnical Report referenced GENZSILV12728, dated 27 August 2010
- CMW Geosciences, Lot 104 Design Memo referenced 2014_1007AC Rev. 0 dated 27 July 2014
- CMW Geosciences, Reinforced Slope Designs referenced 2014_1007AH Rev. 0 dated 23 September 2014
- CMW Geosciences, Keystone Wall Designs referenced 2014_1007AJ Rev. 0 dated 22 October 2014
- CMW Geosciences, Lot 58 - 61 Earthworks Revisions, Geotechnical Works referenced 2014_1007AX Rev. 0 dated 30 July 2015

3. DESCRIPTION OF EARTHWORKS

West City Construction Limited mobilised to site in September 2013. Initially the earthworks and civil construction were undertaken to form Stages 1 and 2A of the subdivision. During this period erosion and sediment controls were installed for the entire site, including sediment retention ponds on lots 50 to 52 and 83 to 117.

As part of the earthworks operations during Stage 2 construction, a shear key was constructed in mid-February 2014. This shear key extends into stage 4i below the northern intersection of roads 2 and 3. Subsoil drainage was installed up the rear face of this shear key excavation.

In September 2014 works began to strip the gully feature running below lots 86 to 74. All organics, mullock and soft alluvium were stripped and deep subsoil drainage was installed along the gully alignment.

Excavation of a shear key which runs along the northern extent of stages 2Bi and 4i followed the gully works and continued through to March 2015. The key was excavated down the rock and had a base width of 12 metres. The key was fully backfilled with engineered fill and subsoil drainage installed along the back face of the excavation. A large batter slope was formed above this excavation with geogrid reinforcement installed in the slope face.

During construction of the shear key, the gully feature was filled and the lots formed along the alignment of Road 3. Portions of the area along road 3 and surrounding sites had been used as a borrow area during previous earthworks stages resulting in all lots requiring the placement of engineered fill to form the final levels.

During January deep counterfort drains below Lot 104 were installed. This was followed by filling the lot and batter slope to final levels in March.

Construction of both the cantilever timber pole retaining walls and the segmental block walls began in March 2015 and continued throughout the remaining construction period.

An undercut below the tiered retaining wall on lot 62 was completed in May 2015 and a counterfort drain installed on the eastern boundaries of lots 62 to 67.

At the end of May the subgrades for Roads 2, 3 and 6 were prepared and lime stabilised. In the following months the civil works were constructed including road formations, retaining walls, and drainage. By August 2015, the lots between road 2 and road 3 were finished and being topsoiled.

A design change in August resulted in an extension to Shear Key C on the western extent and the shear key was constructed to the northern intersection of Roads 2 and 3.

In September all service trenches were excavated and the combined services installed. Fill was also being placed at this time to form lots 34 to 36. These were subsequently trimmed to grade and the retaining walls constructed on the boundaries.

Civil works for the stage continued through to February 2016.

The main items of plant used by the contractor, West City Construction Limited, included:

- 3 x 826 Compactors
- 4 x D7's and Scoops
- 1 x D8 and Scoop
- 1 x D7 Bulldozer
- 1 x D6 Bulldozer
- 1 x 210 Hitachi Excavator
- 2 x 200 Hitachi Excavators
- 1 x 12T Excavator
- 1 x 5t Hitachi Excavator
- 1 x 46T Excavator
- 1 x 35T Excavator

1 x Tractor and Disks
 2 x Dump Trucks
 1 x Hitachi Loader
 1 x Lime spreader
 2 x Hoes

4. GEOTECHNICAL QUALITY CONTROL

4.1. Site Observations

During the earthworks site visits were typically undertaken several times each week to assess compliance with NZS 4431 and specific design recommendations and specifications.

Site visits were carried out to observe and confirm compliance relating to:

- Adequate topsoil stripping;
- Fill areas prior to the placement of fill materials to ascertain that all mullock and soft inorganic subsoils had been removed;
- Shear key excavations to confirm soil and rock mass conditions and appropriateness of the ground model and design;
- Installation of subsoil drains including counterfort drains, underfill drains and shear key drainage but excluding road under-channel drains;
- Backfilling of subsoil drains;
- Excavation and backfilling of sewer and stormwater trenches;
- Subsoil drain connections to outlets and flushing at the completion of the works;
- Retaining wall pile excavations;
- Keystone wall construction;
- Placement of geogrid reinforcement;
- Reinforced batter slope facing;
- Construction of cantilever pile retaining walls including ground conditions, pile size, spacing and depth; and
- Placement and compaction of engineered fills.

4.2. Compaction Control

The compaction control criteria adopted for all engineered fills on this site were as follows:

Minimum Shear Strength (Measured by hand held shear vane calibrated using NZGS 2001 method) and Maximum Air Voids Method (As defined in NZS 4402)

| | |
|---|---------|
| Air voids percentage average value* less than | 10 % |
| Air voids percentage maximum single value | 12 % |
| Undrained shear strength average value* not less than | 140 kPa |
| Undrained shear strength minimum single value | 110 kPa |

*The average value is determined over any ten consecutive tests

Vane shear strength, water content and in situ density tests were carried out on all areas of the engineered filling to at least the frequency recommended by NZS 4431.

These tests showed on a number of occasions that the required compaction standards were not being achieved and to the best of our knowledge the failing areas of fill were re-worked as necessary. Subsequent testing confirmed compliance with the specification.

5. EVALUATION OF COMPLETED EARTHWORKS

5.1. Natural Hazards

The appended as-built drawings depict the extents of a series of zones that contain limitations intended to ensure that future building and/ or earthworks on the lots is undertaken in a manner that does not lead to buildings being subject to any of the natural hazards described in section 106 of the Resource Management Act, i.e. erosion, falling debris, subsidence, slippage, and inundation. Consideration of the inundation hazard was outside the scope of CMW's brief. The applied zones include:

- **Specific Design Zones (retaining)** - intended to protect the retaining walls from overloading at the crest or undermining at the toe that could lead to instability;
- **Specific Design Zones (slope)** – intended to protect building development from long term creep effects on or adjacent to steep slopes and to protect the slopes from inappropriate loading or undermining. In some locations, this provides a buffer between land that is suitable for NZS3604-type (Light Timber Framed Building) foundations and No Build Zones.;
- **Piled Foundation Zones** - intended to protect building development from long term creep effects in locations not requiring the engagement of an engineer to assess these effects; and
- **No Build Zone** – intended to ensure that stability conditions are not able to be compromised by development in areas outside the building platforms on the affected lots.
- **Bush Covenant Zones** – These zones were imposed by the resource consent conditions and intended to protect bush areas.

Full descriptions of the restrictions associated with each of these zones are presented in the Suitability Statement (Appendix A). Additional information is also provided in some of the following sections.

5.2. Land Stability and Erosion Control

The subdivision scheme layout includes a series of batter slopes to form level terraces for building platforms. The batters include portions of the residential lots with maximum gradients of 1(v) in 1.8(h) as depicted on the as-built drawings.

Design of the works to provide appropriate stability conditions that meet regulatory requirements for the land within these stages, including the batters, has led to the construction of shear keys, deep subsoil drainage, reinforced earth slopes, segmental block retaining walls and cantilever pole retaining walls.

Stability conditions for finished ground profiles have been assessed under a range of groundwater conditions which satisfy ultimate limit state design criteria. The soil parameters for the analyses were selected from extensive investigation undertaken at the site and from experience in this terrain. We consider that the stability results are satisfactory for all building platform areas and we are therefore satisfied that these areas are not subject to the natural stability hazards described in Section 106 of the Resource management Act and Section 71(3) of the Building Act.

On all steep land, including on engineered batter slopes, surface stability can be compromised by indiscriminate disposal of stormwater onto the ground surface and/ or by removal of vegetation.

Building and landscape designers must ensure that all runoff from solid surfaces is directed into the stormwater system. It is also important that care is paid to the disposal of stormwater during

construction so that concentrated discharges (e.g. from unconnected spouting) are not directed towards steep ground.

Depths of mulch and topsoil applied to sloping areas should be limited to less than 150mm to minimise the risks of saturation leading to localised slumping on batter face. Wherever practical on such land, and particularly on steep batters, existing vegetation and grass cover should be well maintained. Any vegetation cleared beyond the immediate area of building platforms for temporary construction purposes should be replanted or replaced as soon as possible. The roots of an established vegetation cover can serve to bind the surface soils while the foliage can reduce rain infiltration and soil saturation, resulting in better resistance to erosion and shallow slumping.

5.3. Retaining Walls

Retaining walls have been constructed in the locations shown on the appended Retaining Walls As-built Plans. These walls reach a maximum height of approximately 3 metres. The cantilever timber pole retaining walls were designed by Hutchinson Consulting Engineers Limited while the segmental block retaining walls were designed by this consultancy.

The construction of all the retaining walls was observed by this consultancy and copies of the Producer Statement - Construction Review are provided in Appendix E.

Descriptions of the building and earthworks restrictions within the vicinity of these walls (Specific Design Zones – retaining) are contained in the Suitability Statement in Appendix A. All lots contain these zones.

5.4. Reinforced Earth Slopes

On the steeper filled slopes within the development, geogrid reinforcement has been installed during construction to achieve the required global stability conditions and control surface creep. Lots containing or immediately adjacent to these slopes include Lot 84 and 85.

House designers should be made aware of the presence of the slope reinforcement to avoid a clash with foundations. A typical detail of the reinforced earth slope is appended for reference in Appendix B.

Descriptions of the building and earthworks restrictions within the vicinity of these slopes (Specific Design Zones – slopes) are contained in the Suitability Statement in Appendix A.

5.5. Bush Covenant Zones

Existing native bush within some lots is protected by Resource Consent conditions for the development and building development within these areas is prohibited. Areas within the bush contain steep gradients in places and have not been engineered to improve natural stability conditions.

Lots 102, 103 and 104 contain zones of Bush Covenant within the lot. Land within the Bush Covenant Zones may be subject to hazards as described in section 71(3) of the Building Act however the presence of the existing vegetation in these areas will provide a degree of enhancement to stability conditions.

5.6. Fill Induced Settlement

The majority of the filling on this stage of the development was placed early in the construction programme. The deepest fills were completed by March 2014. A series of settlement markers was installed in areas of deep fill at its completion and have been periodically monitored for both horizontal and vertical movements. Both horizontal and vertical changes have been noted to be within the survey accuracy limits.

On the basis of the results, we are satisfied that t_{90} primary consolidation settlement has been achieved here and that fill induced settlement does not pose a hazard to NZS 3604 type building development.

5.7. Service Line Trenches

As part of the civil works, sanitary sewer and stormwater services were trenched throughout the development as shown on the appended Woods Stormwater and Sanitary Sewer As-built Plans.

Stormwater and sanitary sewer trenches in key locations contain a punched draincoil to facilitate draining of any groundwater seepages within the trench bedding. These draincoils are connected to the downstream stormwater manhole to outlet and water. This drainage has been installed as a precautionary measure that is not considered to be necessary for private connections.

As is normal on all subdivisions, building developments involving foundations within a 45 degree zone of influence from 500mm below pipe inverts will require engineering input. The Auckland Council drawing referenced SW22 provided in Appendix B extracted from Chapter 4 of the Auckland Council Code of Practice for Land development and Subdivision depicts their requirements for stormwater pipes. Details for water and wastewater pipes are available in the Watercare COP1 - General Requirements and Procedures. The majority of lots are known to have service trenches within the proximity of the lots. The resulting restrictions are presented in the Suitability Statement below and indicated on the appended Drainage Restriction Plans.

5.8. Subsoil Drains

The appended Subsoil Drainage as-built plan shows the positions of counterfort drains which were constructed in the natural ground during the earthworks operations. The drains were installed to help control groundwater levels and are either linked to the reticulated storm water system or extend to formed outlets within bush areas. The ongoing operation of these drains is important to the overall stability conditions of the site.

Typical trench excavations were between 3 and 5 metres deep in the natural ground beneath the filling. Accordingly they are predominantly beyond the depths of anticipated foundations. Locations and depths of this drainage is shown on the appended Subsoil Drainage Plan.

Descriptions of the restrictions are contained in the appended Suitability Statement.

5.9. Subsoil Drain Outlets

On lots where subsoil or retaining wall drainage discharges to bush it is important that the function of these outlets is maintained. Details of the outlet structures and locations are shown on the Subsoil Drainage Plan as built plan and Retaining Wall T-bar Outlets detail drawing. Lots containing subsoil drain outlets include lots 102 and 103.

5.10. Road Subgrades

Penetration resistance testing was carried out on the road subgrades during construction and the results of this testing were forwarded to Woods Limited for pavement remedial design. Where soft ground with low equivalent CBR values was identified it was generally undercut and geogrid and geotextile cloth was installed. All road subgrade areas were subsequently lime/ cement stabilised to achieve appropriate CBR values.

Benkelman Beam testing of the base course was carried out by Road Test Limited on each road and those results were also forwarded to Woods.

5.11. Local Purpose Reserve

Lot 303 has been created as a local purpose reserve and is suitable for its intended use.

5.12. Design of Shallow Foundations

5.12.1. Bearing Capacity

Once bulk earthworks and top-soiling of the building platforms had been completed, our staff drilled hand auger boreholes on platforms in natural ground to determine representative finished ground conditions and hence evaluate likely foundation options for future building development. Our assessments of bearing capacity for the design of shallow foundations on each building platform are contained in the appended Suitability Statement.

At current subgrade levels all lots have been assessed as having a geotechnical ultimate bearing capacity of 300 kPa within the influence of conventional shallow residential building foundation loads.

If higher geotechnical ultimate bearing capacities are required, further specific site investigation and design of foundations should be carried out prior to Building Consent application.

5.12.2. Foundation Settlements

At the bearing pressures specified above and subject to the design requirements for soil expansiveness provided below, differential settlement of shallow foundations for buildings designed in accordance with NZS 3604 (including the 600mm subfloor fill depth limit) should be within code limits.

5.12.3. Soil Expansiveness Classification

Five sets of soil tests were carried out on samples taken from likely foundation level on lots within these stages of the development.

Testing was carried out in accordance with NZS 4402, "Methods of Testing Soils for Civil Engineering Purposes" test 2.2 and 2.6 and were used in conjunction with visual-tactile assessment of the site soils to determine expansive site Classes as defined in AS 2870, "Residential Slabs and Footings – Construction". All test results are appended.

On this basis we have assessed the AS 2870 Site Class for all lots these stages of the development to be M (moderate). Details of foundation options for this Class are contained in the appended Suitability Statement.

In recent years in Auckland, there have been examples of concrete floors and/ or foundations that have been poured on dry, desiccated subgrades in summer months on expansive soils and have undergone heaving and cracking once the soil moisture contents have returned to higher levels. Foundation contractors need to be made aware of this issue and the need to maintain appropriate moisture contents in the footings and building platform subgrade between the time of excavation and the pouring of concrete.

Remedial actions that may be appropriate include platform protection with a hard fill layer, pouring of a blinding layer of concrete in footing bases and soaking of the building platform with sprinklers for an extended period.

Home owners need to be aware that the planting of high water demand plants where their roots may extend close to footings can also cause settlement damage.

5.13. Topsoil Depths

Topsoil depths have been checked by the drilling of a borehole in the approximate centre of the building platform on each lot. The results are considered indicative for each lot, but may be subject to variations. Topsoil depths are between 100 and 300mm on these stages of the development.

Site specific findings are contained in the appended Suitability Statement Summary (Appendix A). However, it is possible that further levelling works have been undertaken since our investigations and accordingly, we strongly recommend that lot purchasers complete their own checks of topsoil depths.

6. CLOSURE

The appended Statement of Professional Opinion is provided to the Auckland Council and Karepiro Holdings Limited for their purposes alone on the express condition that it will not be relied upon by any other person. It is important that prospective purchasers satisfy themselves as to any specific conditions pertaining to their particular land interest.

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 appended Suitability Statement 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 CMW by other members of the project team are accurate and correct in all respects.

**For and on behalf of
CMW Geosciences (NZ) Limited**

Prepared by:



Sam Gibb

Senior Geotechnical Engineer, CPEng

Reviewed and Approved by:



Richard Knowles

Principal Geotechnical Engineer, CPEng

Appendix A

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

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

I, S.E.Gibb, of CMW Geosciences (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 Developer as the Geotechnical Engineer on Stages 2Bi and 4i of the Karepiro Development.
2. The extent of investigations carried out to date are described in the Coffey Geotechnical Investigation Design Report referenced GENZSILV12728, dated 30 March 2010, 13 June 2010 and 27 August 2010 and the subsequent design reports reference in Section 2 of this report. The conclusions and recommendations of those documents have been re-evaluated in the preparation of this report. The results of all tests carried out are also appended.
3. In my professional opinion, not to be construed as a guarantee, I consider that:
 - (a) The earth fills shown on the appended Total Fill Depth As-built Plan have been placed in compliance with NZS 4431, the Legacy Rodney District Council Plans and related documents.
 - (b) The completed earthworks give due regard to land slope and foundation stability considerations on the building platform areas, but as shown on the appended building restriction zones plans, areas on all lots have gradients steeper than 1(v) in 4 (h) (and generally up to 1(v) in 1.8(h)) or are adjacent to land having such gradients. Accordingly, restrictions incorporating Specific Design Zones (Slope) and Piled Foundation Zones have been applied as depicted on the as-built plans as follows:
 - **Specific Design Zone (Slope) areas** have been applied on Lots 33, 34, 36, 63 to 82, 84 to 90, 102 to 110 inclusive. No building construction and no earthworks (i.e. cut or fills of any depth) should take place within the designated **Specific Design Zone (Slope) areas** unless endorsed by a Chartered Professional Engineer experienced in geomechanics and familiar with the contents of this report. The endorsement will need to consider the implications of the proposals on both global stability conditions and soil creep on the building platform, the interaction with service pipes and associated trench backfills, control of surface water, construction sequencing, timing and temporary support requirements construction of all earthworks, foundations and retaining walls and if necessary, comment on what aspects require engineering inspections and certification.

This limitation also applies to long term landscaping works, including any proposed minor cuts either on or near batter toes to be retained by new landscaping walls that might not normally require engineering, and to landscaping fills on or immediately above the batter slopes.

Lots 84 and 85 are located adjacent to the large batter slope containing geogrid reinforcing. It is anticipated that portions of these dwellings will be piled however depths and extents of piling are dependent on development proposals. A typical detail of the reinforced earth batter in this location has been included in the asbuilt drawings for reference.

- **Piled Foundation Zones** have been applied to Lots 33, 34, 36, 63 to 71, 86 to 90, 102, 103 and 104 inclusive above the Specific Design Zone (Slope) areas. Building foundations within the **Piled Foundation Zones** may be piled without the need for

specific engineering design based on the following table and with reference to the building restriction zone plans appended:

TABLE 1: FOUNDATION REQUIREMENTS WITHIN PILED FOUNDATION ZONES

| Design Case | Applies to Lot Numbers | Downslope Leading Edge Pile Minimum Depth (m) | Depth of Lateral Load to be Applied to Downslope Leading Edge Piles Only (m) | Pile Depth for all Load Bearing Foundations Within Remainder of Piled Foundation Zone (m) |
|-------------|--|---|--|---|
| A | 33, 34, 36, 63, 64, 65, 66, 67, 68, 69, 70, 71, 86, 87, 88, 89, 90 | 3 | 1.0 | 2 |
| B | 102, 103, 104 | 4 | 1.5 | 2 |

The following design parameters may be assumed for the design of these piles:

$\emptyset' = 30$ degrees

$S_u = 100$ kPa

Geotechnical ultimate end bearing capacity at and beyond 2.0m depth = 450 kPa

Ultimate side adhesion beyond 1.5m depth = 25 kPa. Ignore side adhesion in the top 1.5m.

These Piled Foundation Zone requirements may be amended as part of a specific design by a Chartered Professional Engineer, experienced in geomechanics and familiar with the contents of this report.

The structural engineer should attend to the pile details, including ensuring that the design allows for any differential movement that may occur between piled and un-piled portions of the building.

- (c) **No Build / Bush Covenant Zone** areas defined on Lots 84, 85, 102, 103 and 104 are designated no-build zones on the basis of potential for instability and/ or because of the presence of covenanted bush.
No building construction and no earthworks may take place in these areas.
- (d) **Specific Design Zone (Retaining)** areas have been applied on **all lots** for the protection of the function of the retaining walls. No building construction and no earthworks (i.e. cut or fills of any depth) should take place within the designated **Specific Design Zone (Retaining)** areas unless endorsed by a Chartered Professional Engineer experienced in geomechanics and familiar with the contents of this report. The endorsement will need to consider the stability implications of the earthworks and building proposals on the retaining walls.
- (e) The function of the subsoil drains installed beneath Lots 62 to 67, 70, 74, 84 to 90, 104 and 110 inclusive must not be impaired by any building development or landscaping works. Any

bored or driven piles must be positioned to avoid damaging the draincoils. Where any subsoil drain is intercepted by building works, it must be reinstated under the direction of a Chartered Professional Engineer to ensure the integrity of the subsoil drainage system.

- (f) The formed drainage outlets on Lots 102 and 103 inclusive must be kept free of debris and otherwise maintained as necessary to ensure there ongoing function.
- (g) A geotechnical ultimate bearing capacity of 300 kPa may be assumed for shallow foundation design on the building platforms of all lots.

If for any reason higher geotechnical bearing capacities are required, further specific site investigation and design of foundations should be carried out prior to Building Consent application.

- (h) The expansive site Class for all lots has been assessed as AS2870 Class M (Moderate). We recommend that building designers note on the Building Consent drawings the need to maintain appropriate moisture levels across building subgrades and in footing excavations (as described in Section 5.12.3 of the Geotechnical Completion Report) for reference by foundation contractors.
- (i) The backfilling and compaction of the storm water and sanitary sewer trenches on this subdivision has been carried out to appropriate standards having regard for the prevailing ground conditions and associated compaction induced pipe loadings.

However, no building development should take place within the 45 degree zone of influence of drain inverts unless endorsed by specific design 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 trench backfill. A copy of drawing SW22 extracted from Chapter 4 of the Auckland Council Code of Practice for Land development and Subdivision this document is provided in Appendix B for clarification. Details for water and wastewater pipes are available in the Watercare COP1 - General Requirements and Procedures.

Lots containing drainage line restrictions include 31 to 36, 62, 66 to 68, 72 to 82, 84 to 89, 102 to 104, 106 and 107.

- (j) Subject to the geotechnical limitations, restrictions and recommendations contained in clauses 3(b), 3(c), 3(d), 3(e), 3(f), 3(g), 3(h) and 3(i) above:
 - (i) The filled and natural ground is generally suitable for residential buildings constructed in accordance with NZS 3604 and the requirements of AS2870 for the appropriate expansive soil class.
 - (ii) Where shallow foundations are appropriate, design may be carried out in accordance with AS 2870 (Class M) or alternately, a specific foundation and structural design may be undertaken by a Chartered Professional Engineer.
4. Road subgrades have been formed with appropriate regard for slope stability and settlement risks.
 5. As required by the Resource Consent, the fencing installed on top of all retaining walls greater than 1.2 metres in height on Lots 62 and 79 to 82 inclusive shall be maintained in place for perpetuity. Should any fence require to be replaced it shall be replaced with like for like fencing.

No fence or wall shall be erected within any rear yard of the above mentioned lots in addition to the fencing installed on top of the retaining walls. Owners of such lots may however plant within the rear yard to provide privacy should it be required providing such planting does not compromise the structural integrity of the retaining wall.

6. This statement of Professional opinion shall be read in conjunction with the Geotechnical Completion Report and shall not be copied or reproduced except in conjunction with the full geotechnical completion report.

The following table summarises the conditions on each of each residential lots.

**For and on behalf of
CMW Geosciences (NZ) Limited**



Sam Gibb

Senior Geotechnical Engineer, CPEng

GCR Summary Table

| Condition | Specific Design Zone (slope) | Piled Foundation Zone / Design Case | Bush Covenant / No Build Zone | Specific Design Zone (retaining) | Subsoil Drains Present | On-site Drainage Outlet Present | Geotechnical Ultimate Bearing Capacity (kPa) | AS2870 Expansive Class | Service Lines Restrictions | Indicative Topsoil Depth (mm) |
|--------------------------------|---|--|--|---|-------------------------------|--|---|-----------------------------------|---------------------------------------|--|
| GCR SOPO Clause | 3(b) | 3(b) | 3(c) | 3(d) | 3(e) | 3(f) | 3(g) | 3(h) | 3(i) | |
| Lot number | | | | | | | | | | |
| 31 | | | | ● | | | 300 | M | ● | 250 |
| 32 | | | | ● | | | 300 | M | ● | 200 |
| 33 | ● | A● | | ● | | | 300 | M | ● | 200 |
| 34 | ● | A● | | ● | | | 300 | M | ● | 150 |
| 35 | | | | ● | | | 300 | M | ● | 300 |
| 36 | ● | A● | | ● | | | 300 | M | ● | 200 |
| 62 | | | | ● | ● | | 300 | M | ● | 100 |
| 63 | ● | A● | | ● | ● | | 300 | M | | 200 |
| 64 | ● | A● | | ● | ● | | 300 | M | | 100 |
| 65 | ● | A● | | ● | ● | | 300 | M | | 100 |
| 66 | ● | A● | | ● | ● | | 300 | M | ● | 100 |
| 67 | ● | A● | | ● | ● | | 300 | M | ● | 300 |
| 68 | ● | A● | | ● | | | 300 | M | ● | 200 |
| 69 | ● | A● | | ● | | | 300 | M | | 250 |
| 70 | ● | A● | | ● | ● | | 300 | M | | 250 |
| 71 | ● | A● | | ● | | | 300 | M | | 100 |
| 72 | ● | | | ● | | | 300 | M | ● | 150 |
| 73 | ● | | | ● | | | 300 | M | ● | 150 |
| 74 | ● | | | ● | ● | | 300 | M | ● | 200 |
| 75 | ● | | | ● | | | 300 | M | ● | 180 |
| 76 | ● | | | ● | | | 300 | M | ● | 200 |

| Condition | Specific Design Zone (slope) | Piled Foundation Zone / Design Case | Bush Covenant / No Build Zone | Specific Design Zone (retaining) | Subsoil Drains Present | On-site Drainage Outlet Present | Geotechnical Ultimate Bearing Capacity (kPa) | AS2870 Expansive Class | Service Lines Restrictions | Indicative Topsoil Depth (mm) |
|-----------------------|---------------------------------|--|----------------------------------|-------------------------------------|------------------------|------------------------------------|---|---------------------------|-------------------------------|----------------------------------|
| GCR SOPO Clause | 3(b) | 3(b) | 3(c) | 3(d) | 3(e) | 3(f) | 3(g) | 3(h) | 3(i) | |
| Lot number | | | | | | | | | | |
| 77 | ● | | | ● | | | 300 | M | ● | 150 |
| 78 | ● | | | ● | | | 300 | M | ● | 150 |
| 79 | ● | | | ● | | | 300 | M | ● | 150 |
| 80 | ● | | | ● | | | 300 | M | ● | 200 |
| 81 | ● | | | ● | | | 300 | M | ● | 200 |
| 82 | ● | | | ● | | | 300 | M | ● | 100 |
| 84 | ● | | ● | ● | ● | | 300 | M | ● | 200 |
| 85 | ● | | ● | ● | ● | | 300 | M | ● | 200 |
| 86 | ● | A● | | ● | ● | | 300 | M | ● | 150 |
| 87 | ● | A● | | ● | ● | | 300 | M | ● | 150 |
| 88 | ● | A● | | ● | ● | | 300 | M | ● | 180 |
| 89 | ● | A● | | ● | ● | | 300 | M | ● | 150 |
| 90 | ● | A● | | ● | ● | | 300 | M | | 200 |
| 102 | ● | B● | ● | ● | | ● | 300 | M | ● | 150 |
| 103 | ● | B● | ● | ● | | ● | 300 | M | ● | 200 |
| 104 | ● | B● | ● | ● | ● | | 300 | M | ● | 150 |
| 105 | ● | | | ● | | | 300 | M | | 150 |
| 106 | ● | | | ● | | | 300 | M | ● | 200 |
| 107 | ● | | | ● | | | 300 | M | ● | 200 |
| 108 | ● | | | ● | | | 300 | M | | 150 |
| 109 | ● | | | ● | | | 300 | M | | 200 |
| 110 | ● | | | ● | ● | | 300 | M | | 220 |