5 March 2024

**RURAL SUBDIVISION**

**PALLISER DOWNS STAGE 1A**

# GEOTECHNICAL COMPLETION REPORT

Cabra Rural Developments Limited / Rahopara Farms Limited

AKL2019-0017AF Rev 1

| AKL2019-0017AF | | |
|---|---|---|
| **Date** | **Revision** | **Comments** |
| 2 November 2023 | A | Initial draft for internal review |
| 14 February 2024 | 0 | Draft issue to client |
| 4 March 2024 | B | Amended with inclusion of Lot 33 additional works |
| 5 March 2024 | 1 | Final issue |

| | Name | Signature | Position |
|---|---|---|---|
| **Prepared by** | Navneel Karan | | Engineering Geologist |
| **Reviewed by** | Richard Knowles |  | Principal Geotechnical Engineer<br>CMEngNZ, CPEng |
| **Authorised by** | Chris Ritchie |  | Principal Engineering Geologist<br>CMEngNZ, PEngGeol |

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# APPENDICES

# 1 INTRODUCTION

In accordance with our instructions, this Geotechnical Completion Report has been prepared for Cabra Rural Developments Limited / Rahopara Farms Limited as part of the documentation to be submitted to Auckland Council following earthworks to form Stage 1A of the Palliser Downs development.

This report covers the construction period March 2022 to February 2024 and is intended to be used for certification purposes for new lots (listed below) created from existing lots 1 and 2 DP 55674 on newly Deposited Plan 596653 as follows:

- 5 new rural residential lots numbered lots 33 to 37;
- 1 new road numbered lots 5 and depicted as Road 2;
- one accessway servicing lots 33, 34 and 37 via way of easements rather than a separate lot.

This stage of the Palliser Downs Development is located on the western side of Palliser Downs Drive, Wainui. As can be seen from the as-built plans, all of the lots have been formed by cuts up to 5m deep and minor fills up to 1m deep while the road alignment has been more extensively filled.

Construction of this subdivision has been undertaken in general accordance with;

- Auckland Council's Resource Consent number BUN60069542 and Engineering Approval letter dated 13 May 2019.
- NZS4431:1989
- Auckland Council's Code of Practice for Land Development and Subdivision, Chapter 2 - Earthworks and Geotechnical, Version 1.6 dated September 2013.

This development was granted Resource Consent without existing geotechnical investigations. Accordingly, analyses completed to support the recommendations of the report are presented in Appendix F. In granting the Resource Consent, conservatively large on-site wastewater disposal areas were assigned. To date no additional soakage categorisation reporting has been completed.

For the construction of this stage of the development, the following roles were fulfilled as defined in NZS 4431:2022 and the Ministry for the Environment Contaminated Land Management Guidelines:

- Geotechnical Designer: CMW Geotechnical NZ Limited
- Certifier: CMW Geotechnical NZ Limited
- Recognised Laboratory: CMW Geotechnical NZ Limited
- Contractor: Opie Contractors Limited
- Sub-contractor (earthworks): Bob Hick Earthmoving

As CMW has fulfilled the roles of both earth fills Certifier and Geotechnical Designer, this report has been prepared as a combined report covering both of these aspects of the project work.

# 2 DESCRIPTION OF WORKS

The main earthworks contractor, Bob Hick Earthmoving Limited (BHE), working under Opie Contractors, commenced topsoil stripping of the first section of Road 2 on 29 March 2022. This was associated with gully muckouts, undercuts, drainage construction with outlets into the creek and backfill with engineered fill.

On 4 May 2022, BHE had stripped most of the east-west trending alignment of Road 2, rather than continue stripping north, BHE focus on fill road to grade by using cut material from proposed platforms.

On 9 May 2022, BHE mucked out a silt pond where soft material was found at the base of the silt pond. The silt pond base was undercut by a further 300mm before backfilling with engineered fill. On 18 May 2022, the gully muckout for the culvert began, this was be backfilled with engineered fill.

There was a break between August 2022 and October 2022, due to winter conditions being unsuitable for earthworks, filling for the proposed road batter began on 26 October 2022 followed by topsoil stripping on the proposed lots on 28 October 2022.

During Christmas 2022 and New Years 2023, BHE completed filling for the cul-de-sac.

Road 2 was stabilised and tested on 16 March 2023 and metal was placed on road on 18 to 19 April 2023.

By the end of April 2023 most of the lots had been formed to subgrade level and were re-topsoiled, however, earthworks additional works to improve stability conditions in the low batter to the south of the Lot 33 platform were completed in February 2024.

The main items of plant used by the earthworks sub-contractors included:

- 1 x CAT 320C Excavator
- 1 x 20T Excavator
- 1 x Cat 815 Padfoot Compactor
- 1 x Moxy Dump Truck
- 1 x Bulldozer

# 3 GEOTECHNICAL QUALITY CONTROL

## 3.1 Site Observations

During the works site visits were typically undertaken several times each week to assess compliance with NZS 4431 and project 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 topsoil, existing uncertified fills and soft inorganic subsoils had been removed;
- Installation of subsoil drains, excluding road under-channel drains;
- Backfilling of subsoil drains;
- Placement and compaction of engineered fills.

## 3.2 Compaction Control

Compaction of engineered earth fills was controlled by undrained shear strength measured by handheld shear vane calibrated using the NZGS 2001 method and by air voids as defined by NZS4402.

The criteria for undrained shear strength were a minimum single value of 100 kPa and minimum average of any 10 consecutive tests of 140 kPa.

The criteria for air voids were a maximum single value of 12% and maximum average of any 10 consecutive tests of 10%.

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 required by the project specification (1/500m$^3$).

While these tests showed on a few occasions that the contractor was struggling to achieve the required compaction standards with the prevailing site and soil conditions, to the best of our knowledge, all areas of fill were re-worked as necessary. Subsequent testing confirmed compliance with the specification.

# 4 EVALUATION OF COMPLETED EARTHWORKS

## 4.1 Natural Hazards

Natural hazards have been assessed for the completed landform across the lots and on each lot a **Stable Building Area** considered suitable for NZS 3604 type building development has been defined as depicted on the appended as-built plans. These areas are considered to be free of the natural hazards described in Section 71(3) of the Building Act, i.e. erosion, falling debris, subsidence, slippage, and inundation , although the eastern extents of the Lot 36 Stable Building Area have been earthworked by others previously. Further comment is provided in Section 4.4.5 and in the Suitability Statement in Appendix A.

Consideration of the inundation hazard was outside the scope of CMW's brief and has been assessed by others.

For reference purposes only, the Nominated Building Platforms from the Resource Consent approval have been included on the as-built drawings. Development recommendations and restrictions at these locations are those of the **Stable Building Areas** and any other **Specific Design** or **Bush Covenant Zones** they lie within following minor amendments to the original layout as outlined below.

### 4.1.1 Land Stability

The subdivision scheme layout includes a series of batter slopes to form level terraces for building platforms. The batters include portions of the lots with moderately steep gradients as depicted on the as-built drawings. Design of the works to provide appropriate stability conditions that meet regulatory requirements for the land, including grassed, planted and rock-faced batters, has led to earthworks undercuts being completed in some areas to replace low strength soils with engineered fills, and to the installation of subsoil drainage.

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 investigations undertaken at the site and from experience in this terrain. Details of our investigations and analyses are provided in ***Appendix F***.

Stability conditions outside the Stable Building Areas may not achieve the same stability conditions as the **Stable Building Areas** and in most cases contain sloping land or are adjacent to sloping land. Accordingly, the following zones of restricted activity have been applied outside the **Stable Building Areas**:

- **Specific Design Zones** – All areas that are not either **Stable Building Areas** or **Bush Covenant Zones**. Development is not prohibited in these areas but it will be subject to specific investigation and design intended to protect any building development from natural hazards, including long term creep effects on or adjacent to steep slopes, and to protect the slopes from inappropriate loading or undermining. These zones include batter areas recently mulched planted as part of the development of the subdivision.
- **Bush Covenant Zones** – intended to protect areas of established vegetation and to ensure that stability conditions are not able to be compromised.

  Plantings within some areas of the lots is protected by Resource Consent conditions and accordingly vegetation removal, earthworks and building development are prohibited in these areas. These areas are present on all the lots on this stage of the development but are outside the Stable Building Areas. Their extents are depicted on the appended C&R Surveyors Limited as-built plans.

  The Bush Covenant Zones contain land that has not been evaluated or engineered to improve the natural stability conditions. Land in these areas may be subject to natural 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 as described in Section 4.1.2 below.

Full descriptions of the restrictions associated with these zones are presented in our Opinion on Suitability in ***Appendix A***. Additional information is also provided in some of the following sections.

### 4.1.2 Erosion

On all sloping land in this geological setting, including on engineered batter slopes, localised surface stability can be compromised, and erosion can be instigated by indiscriminate disposal of concentrated stormwater onto the ground surface and/ or by removal of vegetation. Further comments on stormwater disposal are provided in Section 4.7 below.

On batters, depths of mulch and topsoil should be limited to less than 150mm to minimise the risks of saturation leading to localised slumping on batter face, which is typified by the mulch layer sliding off the clay subgrade beneath. Wherever practical on such land, and particularly on steep batters, any plantings and grass cover should be well maintained as 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.

### 4.1.3 Liquefaction

The liquefaction risk for the lots on this development has been assessed by review of Auckland Council GIS maps that confirm the damage category to be: Very Low Vulnerability.

### 4.1.4 Fill Induced Settlement

On the basis of the relatively minor magnitude of fill depths beneath Stable Building Areas, together with the elapsed time since it was placed, we consider that remaining post-construction settlements will be within code limits.

## 4.2 Subsoil Drains and Groundwater

The as-built plans show the positions of subsoil drains and their outlets that were installed during the earthworks as described in the following sub-sections.

Descriptions of restrictions associated with these drains and outlets are contained in our appended Opinion on Suitability in ***Appendix A***.

### 4.2.1 Underfill Drains

These drains were installed at the bases of fills to assist with the earthworks operations by capturing seepages at the cleared ground level. They require no specific maintenance and while their ongoing function is not critical to stability conditions, but they provide ongoing control of groundwater levels and pore water pressure relief so their ongoing function should not be compromised by future works.

Typically these drains comprise punched draincoils surrounded by drainage gravel. Specific design details are provided in the project reports and specifications. If drain depths are unclear at specific locations, they can be estimated from the depths of fills depicted on the as-built plans.

### 4.2.2 Subsoil Drain Outlets

On lots where subsoil drainage discharges to bush it is important that the function of these outlets is maintained. Details of the locations are shown on the as built plans.

### 4.2.3 Groundwater

Groundwater levels beneath the engineered fills can be expected to be controlled by the underfill drains and should therefore typically be deeper than 2m, subject to seasonal variations.

In some areas of natural ground, counterfort drains have been installed to maintain supressed groundwater levels. Based on our work to date we anticipate groundwater levels remaining well below the depth of influence of anticipated earthworks and foundation works for NZS 3604 type dwellings.

## 4.3 Road Subgrades

Penetration resistance testing was carried out on the road subgrades during construction and the results of this testing were forwarded to Hutchinson Consulting Engineers Limited for pavement remedial design. Where soft ground with low equivalent CBR values was identified it was generally undercut and hardfill was placed. All road subgrade areas were subsequently lime 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 Hutchinson Consulting Engineers.

## 4.4 Design of Shallow Foundations in Stable Building Areas

The as-built plans depict the extents of areas described as **Stable Building Areas**. They also depict the original Nominated Building Platforms from the Resource Consent and these typically fall within the final Stable Building Areas.

### 4.4.1 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 our Opinion on Suitability in ***Appendix A.***

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

### 4.4.2 Foundation Settlements

At the bearing pressures specified in ***Appendix A*** 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.

### 4.4.3 Soil Expansiveness Classification

Seasonal soil moisture variations within most clay-rich soils typically result in the soil swelling during winter months and then shrinking during summer months. These seasonal movements can cause issues such as cracking of concrete floors, brittle cladding and masonry walls or distortion of building frames causing doors and windows to jam from differential settlement. The effects are further compounded by local influences that worsen differential movements. These may include growth of high demand trees and shrubs that cause localised soil drying or either leaking pipes or tree root removal, leading to localised wetting.

The potential effects need to be managed in a combination of appropriate:

- classification of the level of risk
- design of foundations
- management of soil moisture conditions by contractors during construction

- management of landscaping and plantings by homeowners throughout a building's lifetime

Testing on 5 samples, one on each building platform within this stage of the development, was completed in accordance with the requirements of NZS 3604. All testing was completed by RoadTest Limited, a testing laboratory accredited by IANZ for the tests undertaken. Results are provided in ***Appendix D*** together with important additional information for landowners.

Results of our assessment for each lot are contained in our Statement of Opinion on Suitability of Land in ***Appendix A.***

### 4.4.4 Site (Seismic) Class

Our assessments of NZS 1170.5 site Class(es) is provided in our Opinion of Suitability and the Summary Table, both in ***Appendix A***.

### 4.4.5 Existing Fills (Lot 36 Stable Platform Area)

The eastern portions of the Lot 36 Stable Building Area were earthworked by others prior to the works described herein. The extent of the affected area is between PT03 to PT07 on this lot depicted on appended CMW Drawings 01 to 03. Retrospective investigations indicate shallow fills here that generally appear to have been placed to an engineering standard such as our fill specification. Nevertheless, we consider it prudent for any building subgrade and foundations in this area to be subject to further engineering inspection as described in the appended Opinion of Suitability in ***Appendix A.***

## 4.5 Construction of Foundations in Stable Building Areas

### 4.5.1 Topsoil Depths on Stable Building Areas

Topsoil depths on Stable Building Areas 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 50 and 300mm on this stage of the development.

Site specific findings are contained in our Opinion on Suitability Summary in ***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.

### 4.5.2 Brown Inorganic Soils

Beneath the clay soil mantle across the site, naturally occurring dark greyish brown deposits of inorganic Hukerenui soils from the Northland Allochthon Group are present. These deposits may be exposed beneath topsoil in areas that have been cut during the bulk earthworks, or may be included in engineered fills that have been placed. These are NOT topsoil and are suitable for foundations but may be difficult to distinguish from topsoil other than from their high clay content and absence of organic odour. If uncertainty exists, professional advice should be sought from an experienced geo-professional familiar with the contents of this report to avoid unnecessary construction delay and expense.

### 4.5.3 Soil Expansivity

***Appendix D*** contains important additional recommendations for contractors for the appropriate preparation of subgrade areas prior to floor construction to minimise risks of shrinkage and swelling due to high soil expansivity.

## 4.6 On Site Effluent Disposal

The appended CMW Site Plan (drawing 01) shows areas outside Stable Building Areas that have been assessed by CMW Geosciences as being geotechnically suitable (stable) for surface mounted dripper lines for effluent disposal fields.

The total size of disposal area assigned on each lot complies with the requirements of the Resource Consent and was conservatively sized for low permeability soils. Site specific testing may provide beneficial results.

## 4.7 Stormwater Disposal

As mentioned in Section 4.1.2 above, surface stability can be severely compromised by indiscriminate disposal of concentrated 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 appropriately designed and located outlets to minimise these risks. 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.

Appropriate locations for stormwater outlets are typically either:

- formed outlet structures with scour control located in gully inverts (the geotechnically preferred option), or
- engineered spreader bars located on low-gradient land, with appropriate downslope scour control

On this site, most of the lots contain gullies within Bush Covenant area that are suitable for private discharge of stormwater using the first option above. Stormwater disposal into the roadside swales is not permitted.

We have also nominated the most suitable location(s) on each lot for the design and installation of spreader bars for discharge of the private stormwater if desired. This design should be undertaken by an experienced civil engineer at the time of Building Consent, taking into account the anticipated disposal volumes from all solid surfaces, including water tank overflows and any overflows anticipated from swimming pools.

Nevertheless we recommend as part of the architectural and landscape design on these lots, that designers and owners consider methods to limit the extents of solid surface areas that lead to the need to collect and concentrate stormwater to an outfall, but rather consider use of permeable surfaces and surface water infiltration across broad areas as would occur in natural, undeveloped landforms.

# 5 CLOSURE

Additional important information regarding the use of your CMW report is provided in the '*Using your CMW Report*' document attached to this report.

This report has been prepared for use by Cabra Rural Developments Limited / Rahopara Farms Limited in relation to the Rural subdivision Palliser downs STAGE 1a project in accordance with the scope, proposed uses and limitations described in the report. Should you have further questions relating to the use of your report please do not hesitate to contact us.

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 Opinion on Suitability in ***Appendix A*** and our Suitability Statement in ***Appendix B*** also rely 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, they assume 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.

Where a party other than Cabra Rural Developments Limited / Rahopara Farms Limited seeks to rely upon or otherwise use this report, the consent of CMW should be sought prior to any such use. CMW can then advise whether the report and its contents are suitable for the intended use by the other party.

## USING YOUR CMW GEOTECHNICAL REPORT

Geotechnical reporting relies on interpretation of facts and collected information using experience, professional judgement, and opinion. As such it generally has a level of uncertainty attached to it, which is often far less exact than other engineering design disciplines. The notes below provide general advice on what can be reasonably expected from your report and the inherent limitations of a geotechnical report.

**Preparation of your report**

Your geotechnical report has been written for your use on your project. The contents of your report may not meet the needs of others who may have different objectives or requirements. The report has been prepared using generally accepted Geotechnical Engineering and Engineering Geology practices and procedures. The opinions and conclusions reached in your report are made in accordance with these accepted principles. Specific items of geotechnical or geological importance are highlighted in the report.

In producing your report, we have relied on the information which is referenced or summarised in the report. If further information becomes available or the nature of your project changes, then the findings in this report may no longer be appropriate. In such cases the report must be reviewed, and any necessary changes must be made by us.

**Your geotechnical report is based on your project's requirements**

Your geotechnical report has been developed based on your specific project requirements and only applies to the site in this report. Project requirements could include the type of works being undertaken; project locality, size and configuration; the location of any structures on or around the site; the presence of underground utilities; proposed design methodology; the duration or design life of the works; and construction method and/or sequencing.

The information or advice in your geotechnical report should not be applied to any other project given the intrinsic differences between different projects and site locations. Similarly geotechnical information, data and conclusions from other sites and projects may not be relevant or appropriate for your project.

**Interpretation of geotechnical data**

Site investigations identify subsurface conditions at discrete locations. Additional geotechnical information (e.g. literature and external data source review, laboratory testing etc) are interpreted by Geologists or Engineers to provide an opinion about a site specific ground models, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist due to the variability of geological environments. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. Interpretation of factual data can be influenced by design and/or construction methods. Where these methods change review of the interpretation in the report may be required.

**Subsurface conditions can change**

Subsurface conditions are created by natural processes and then can be altered anthropically or over time. For example, groundwater levels can vary with time or activities adjacent to your site, fill may be placed on a site, or the consistency of near surface conditions might be susceptible to seasonal changes. The report is based on conditions which existed at the time of investigation. It is important to confirm whether conditions may have changed, particularly when large periods of time have elapsed since the investigations were performed.

**Interpretation and use by other design professionals**

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical report. To help avoid misinterpretations, it is important to retain the assistance of CMW to work with other project design professionals who are affected by the contents of your report. CMW staff can explain the report implications to design professionals and then review design plans and specifications to see that they have correctly incorporated the findings of this report.

**Your report's recommendations require confirmation during construction**

Your report is based on site conditions as revealed through selective point sampling. Engineering judgement is then applied to assess how indicative of actual conditions throughout an area the point sampling might be. Any assumptions made cannot be substantiated until construction is complete. For this reason, you should retain geotechnical services throughout the construction stage, to identify variances from previous assumption, conduct additional tests if required and recommend solutions to problems encountered on site.

A Geotechnical Engineer, who is fully familiar with the site and the background information, can assess whether the report's recommendations remain valid and whether changes should be considered as the project develops. An unfamiliar party using this report increases the risk that the report will be misinterpreted.

**Environmental Matters Are Not Covered**

Unless specifically discussed in your report environmental matters are not covered by a CMW Geotechnical Report. Environmental matters might include the level of contaminants present of the site covered by this report, potential uses or treatment of contaminated materials or the disposal of contaminated materials. These matters can be complex and are often governed by specific legislation.

The personnel, equipment, and techniques used to perform an environmental study can differ significantly from those used in this report. For that reason, our report does not provide environmental recommendations. Unanticipated subsurface environmental problems can have large consequences for your site. If you have not obtained your own environmental information about the project site, ask your CMW contact about how to find environmental risk-management guidance.

# APPENDIX A: STATEMENT OF PROFESSIONAL OPINION ON SUITABILITY OF LAND FOR BUILDING CONSTRUCTION

# STATEMENT OF PROFESSIONAL OPINION ON SUITABILITY OF LAND FOR BUILDING CONSTRUCTION

**Development:** Stage 1A of the Palliser Downs Development
**Developer:** Cabra Rural Developments Limited / Rahopara Farms Limited
**Location:** Palliser Downs Drive, Wainui

I, Richard Knowles, of CMW Geotechnical NZ Limited, Auckland, hereby confirm that:

1. As a Chartered Professional Engineer experienced in the field of geotechnical engineering, I am a Geo-professional as defined in clause 1.2.2 of NZS 4404:2010 and was retained by the Developer as the geo-professional on the above development.
2. The extent of analyses carried out to date are presented in ***Appendix F***. The extent of my inspections during construction, and the results of all tests and/ or evaluations carried out are as described in my Geotechnical Completion Report dated February 2024.
3. My certification of the earth fills placed on this site is contained in ***Appendix B***.
4. In my professional opinion, not to be construed as a guarantee, I consider that:
    a. The completed earthworks take into account land slope and foundation stability considerations on the Stable Building Areas. Outside the Stable Building Areas the land contains **No Build Bush Covenant Zones** as depicted on the as-built plans**.** All other areas are **Specific Design Zones** and contain areas specified as suitable for effluent disposal fields. A stable accessway has been provided to each Stable Building Area.
    b. No building construction and no earthworks (i.e. cut or fills of any depth) should take place within the designated **Specific Design Zone** 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 buildings, control of surface water 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.
    c. **No Build Bush Covenant Zone** areas defined on Lots 33 to 37 inclusive on the as-built plans are designated no-build zones on the basis of potential for instability and/ or because of the presence of protected bush.

        No building construction and no earthworks may take place in these areas other than as required for construction of stormwater outlets.
    d. The function of the subsoil drains installed beneath Lots 33 and 35 inclusive as shown on the as-built plans 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.
    e. The formed drainage outlets depicted on the as-built plans on Lot 33 must be kept free of debris and otherwise maintained as necessary to ensure their ongoing function.
    f. On all Stable Building Platforms (i.e. lots 33 to 37 inclusive) a geotechnical ultimate bearing capacity of 300 kPa may be assumed for shallow foundation design on the building platforms.

g. The site (seismic) subsoil class has been assessed in accordance with NZS1170.5:2004 Clause 3.1.3 from borelogs that included measurements of geotechnical properties. Our assessment is that the Stable Building Areas on lots 33 to 37 are all Class C- shallow soil.

h. The eastern portions of the Lot 36 Stable Building Area were earthworked by others. The extent of the affected area is between PT03 to PT07 on this lot depicted on appended CMW Drawings 01 to 03. While retrospective investigations indicate shallow fills here that generally appear to have been placed to an engineering standard, we consider it prudent for any building subgrade and foundations in this area to be subject to inspection by a Chartered Professional Engineer to confirm its condition.

i.

| Assessment of Characteristic Surface Movements and Design Classes for NZS 3604 Compliant Buildings on Stable Building Platforms | | |
|---|---|---|
| **Lots** | **Assessed AS2870 Site Class / 300 Year Design Characteristic Surface Movement (Ys)** | **Anticipated Equivalent NZBC B1/AS1 Expansivity Class for Design / 500 Year Design Characteristic Surface Movement( Ys)** |
| **33 to 35** | M (moderately reactive) / 40mm | M / 44mm |
| **36 and 37** | H1 (highly reactive) / 60mm | H / 78mm |

B1/AS1 provides an Acceptable Solution through NZS 3604 for foundation design applying to a limited range of compliant building sizes, shapes and materials and only for concrete floor design with strip footings. In all other cases, NZS 3604 directs the use of AS2870 or a specific design.

If AS2870 is used for the design solution, it must be noted that the characteristic surface movements in that code apply to a (less conservative) 300 year return period drought while B1/AS1 provides for a 500 year return period drought.

Prior to the introduction of the B1/AS1 design information in November 2019, minimum foundation depths recommended as appropriate by geotechnical consultants in Auckland for shallow footing design under AS2870 were typically of the order of 600mm for Class M and 750mm for Class H1.

j. On the basis of the earth fill certification and subject to the geotechnical limitations, restrictions and recommendations contained in clauses 4(a), 4(b), 4(c), 4(d), 4(e), 4(f), 4(g), 4(h) and 4(i) above, the filled and natural ground within **Stable Building Areas** is generally suitable for buildings constructed in accordance with NZS 3604 and the requirements of NZBC Clause B1/AS1 where appropriate. Alternatively, a specific foundation and structural design may be undertaken by a Chartered Professional Engineer.

k. As described in Section 4.7 of the Geotechnical Completion Report, stormwater disposal should be to formed outlets in gully areas that are typically located in the Bush Covenant Areas, or to engineer designed spreader bars in the locations nominated on the CMW Site Plan, ***Drawing 01***. The design must consider anticipated future flows and appropriate scour/ erosion controls.

5. Road subgrades have been formed with appropriate regard for slope stability and settlement risks.

The following table summarises the conditions on each of the Stable Building Areas.

**For and on behalf of CMW Geosciences**

Richard Knowles

Principal Geotechnical Engineer CMEngNZ, CPEng

| SOPO Summary Table | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Condition | Specific Design Zone (slope) | Bush Covenant / No Build Zone | Subsoil Drains Present | On-site Drainage Outlet Present | Geotechnical Ultimate Bearing Capacity (kPa) | NZS 1170.5 Site (seismic) Class | Subgrade Inspection due to existing fills | AS2870 Expansive Class | Indicative Topsoil Depth (mm) |
| Lot Number (Stable Building Area) | GCR SOPO Clause | | | | | | | | |
| | 4(b) | 4(c) | 4(d) | 4(e) | 4(f) | 4(g) | 4(h) | 4(i) | |
| **33** | ✓ | ✓ | ✓ | ✓ | 300 | C | | M | 200 |
| **34** | ✓ | ✓ | | | 300 | C | | M | 300 |
| **35** | ✓ | ✓ | ✓ | | 300 | C | | M | 200 |
| **36** | ✓ | ✓ | | | 300 | C | ✓ part only | H1 | 200 |
| **37** | ✓ | ✓ | | | 300 | C | | H1 | 300 |

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# APPENDIX B: STATEMENT OF SUITABILITY OF ENGINEERED FILL FOR LIGHTWEIGHT STRUCTURES

# STATEMENT OF SUITABILITY OF ENGINEERED FILLS FOR LIGHTWEIGHT STRUCTURES

| | |
|---|---|
| **To:** | Auckland Council |
| **Development:** | Stage 1A of the Palliser Downs Development |
| **Land Title(s):** | Lot 1 DP 556774, Lot 2 DP 556774 |
| **Location:** | Palliser Downs Drive, Wainui |
| **Resource Consent Nos:** | BUN60069542 |
| **Developer:** | Cabra Rural Developments Limited / Rahopara Farms Limited |
| **Geotechnical Designer:** | Richard Knowles of CMW Geotechnical NZ Limited |
| **Certifier:** | Richard Knowles of CMW Geotechnical NZ Limited |

This Statement of Suitability is provided as an appendix to the CMW Geosciences Geotechnical Completion Report referenced in the page footer below, that also contains all as-built plans, test results and test inspection records relevant to the work completed.

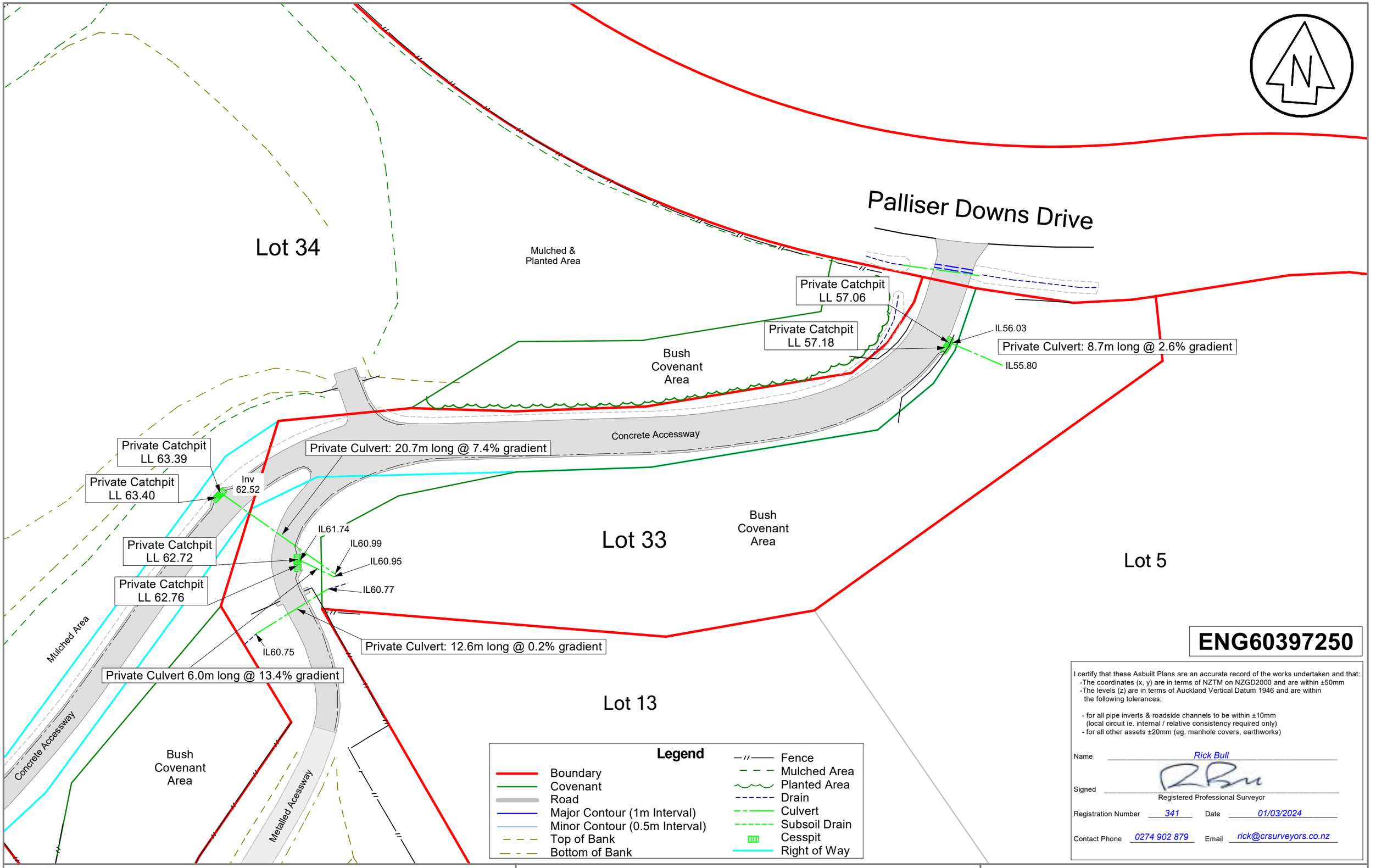
1. I, Richard Knowles, confirm that I am qualified as a certifier as defined in NZS4431:2022.
2. During this work, I was retained as certifier and I or my certifier's representative undertook inspections and testing as documented in the Geotechnical Completion Report.
3. I am satisfied that the engineered fill shown in the attached as-built survey was placed, compacted and tested in accordance with the attached specification and that all variations and non-compliances have been documented in the Geotechnical Completion report.
4. Based on the information available, I certify that, to the best of my knowledge, the intent of the geotechnical designer has been achieved.
5. This certification does not remove the necessity for normal inspection and design of foundations as would be made in natural ground.

**For and on behalf of CMW Geosciences**

Richard Knowles

Principal Geotechnical Engineer CMEngNZ, CPEng

# APPENDIX C: AS-BUILT DRAWINGS




**ENG60397250**

I certify that these Asbuilt Plans are an accurate record of the works undertaken and that:
- The coordinates (x, y) are in terms of NZTM on NZGD2000 and are within ±50mm
- The levels (z) are in terms of Auckland Vertical Datum 1946 and are within the following tolerances:
  - for all pipe inverts & roadside channels to be within ±10mm (local circuit ie. internal / relative consistency required only)
  - for all other assets ±20mm (eg. manhole covers, earthworks)

Name: *Rick Bull*

Signed

Registered Professional Surveyor

Registration Number: *341* Date: *01/03/2024*

Contact Phone: *0274 902 879* Email: *rick@crsurveyors.co.nz*


*Registered Professional Land Surveyors*

PO Box 564
Orewa 0946

Phone (09) 426 4051
www.crsurveyors.co.nz


Client:

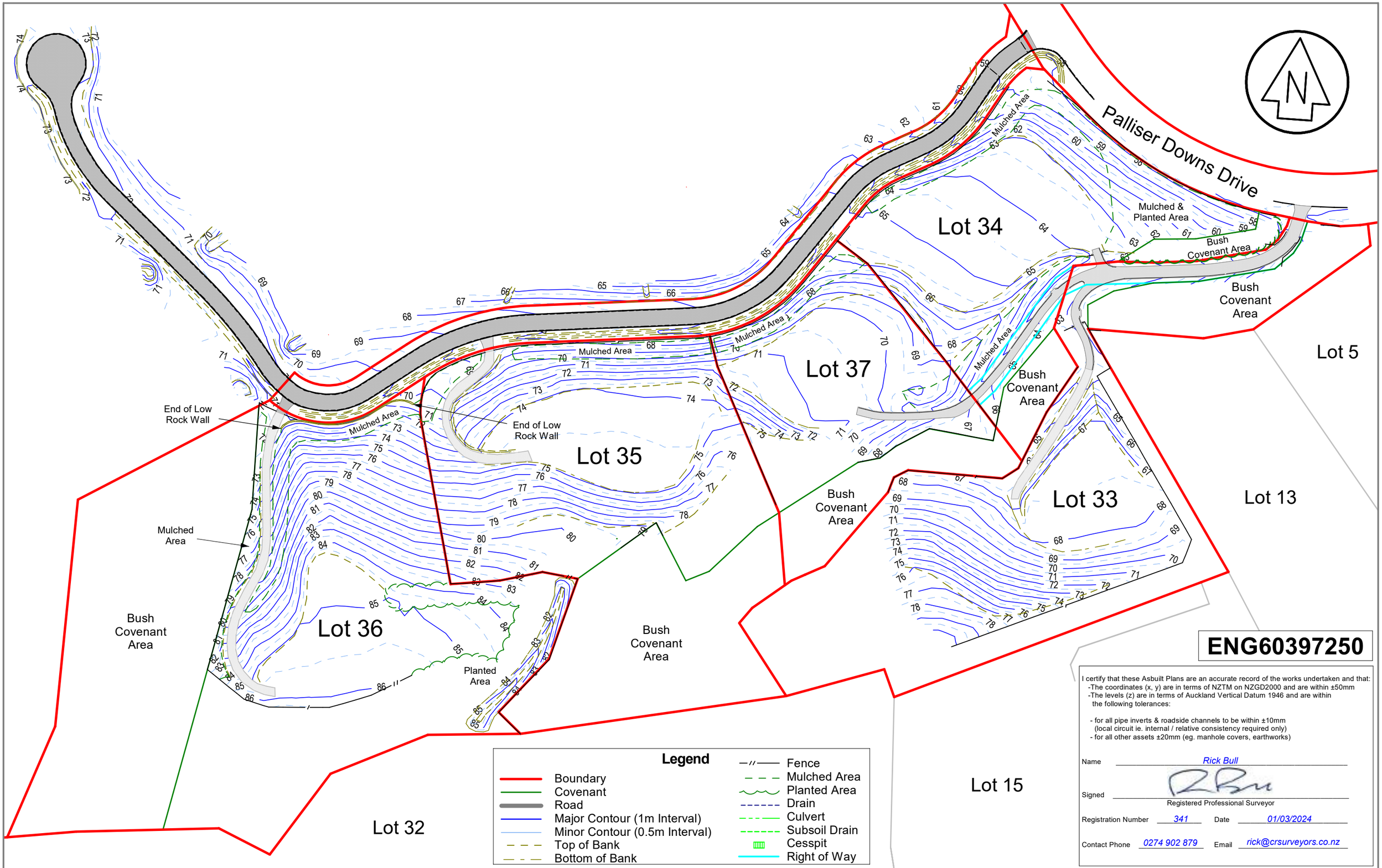
Cabra Rural Developments &
Rahopara Farms Ltd
Palliser Downs Drive - Wainui

Drawing Title:

**Asbuilt - Drainage & Accessway Stormwater**

| Original Size: | Original Scale: | Date: | Job Number: |
|---|---|---|---|
| A3 | 1:500 | 01/03/2024 | 7723 - Rev 4 |

JH




**Legend**

- Boundary
- Covenant
- Road
- Major Contour (1m Interval)
- Minor Contour (0.5m Interval)
- Top of Bank
- Bottom of Bank
- Fence
- Mulched Area
- Planted Area
- Drain
- Culvert
- Subsoil Drain
- Cesspit
- Right of Way

**ENG60397250**

I certify that these Asbuilt Plans are an accurate record of the works undertaken and that:
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- -The levels (z) are in terms of Auckland Vertical Datum 1946 and are within the following tolerances:
  - for all pipe inverts & roadside channels to be within ±10mm (local circuit ie. internal / relative consistency required only)
  - for all other assets ±20mm (eg. manhole covers, earthworks)

Name: Rick Bull

Signed: _____

Registered Professional Surveyor

Registration Number: 341 Date: 01/03/2024

Contact Phone: 0274 902 879 Email: rick@crsurveyors.co.nz


*Registered Professional Land Surveyors*

PO Box 564
Orewa 0946

Phone (09) 426 4051
www.crsurveyors.co.nz


Client: Cabra Rural Developments & Rahopara Farms Ltd

Palliser Downs Drive - Wainui

Drawing Title: **Asbuilt - Contour Plan**

| Original Size: | Original Scale: | Date: | Job Number: |
|---|---|---|---|
| A3 | 1:1500 | 01/03/2024 | 7723 - Rev 4 |

JH

Earthworks Notes

Area of Earthworks:
Total Area: 69977m²
Cut Area: 33795m²
Fill Area: 34222m²

Volume of Earthworks:
Cut: 29375m³
Fill: 27030m³

Cut and fill volumes and levels are based from existing surface (after earthworks) to original surface

Cut Area

Fill Area

N

Palliser Downs Drive

Lot 34

Lot 37

Lot 35

Lot 36

Lot 5

Lot 13

Lot 33

Lot 15

Lot 32

Mulched Area

Mulched & Planted Area

Bush Covenant Area

End of Low Rock Wall

Planted Area

Area of Undercutting (Typically 1.5m Depth)

**Legend**

- Boundary
- Covenant
- Road
- Major Contour (1m Interval)
- Minor Contour (0.5m Interval)
- Top of Bank
- Bottom of Bank
- Fence
- Mulched Area
- Planted Area
- Drain
- Culvert
- Subsoil Drain
- Cesspit
- Right of Way

**ENG60397250**

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-The coordinates (x, y) are in terms of NZTM on NZGD2000 and are within ±50mm
-The levels (z) are in terms of Auckland Vertical Datum 1946 and are within the following tolerances:

- for all pipe inverts & roadside channels to be within ±10mm (local circuit ie. internal / relative consistency required only)
- for all other assets ±20mm (eg. manhole covers, earthworks)

Name: Rick Bull

Signed:

Registered Professional Surveyor

Registration Number: 341 Date: 01/03/2024

Contact Phone: 0274 902 879 Email: rick@crsurveyors.co.nz


**Registered Professional Land Surveyors**

PO Box 564
Orewa 0946

Phone (09) 426 4051
www.crsurveyors.co.nz


Client:

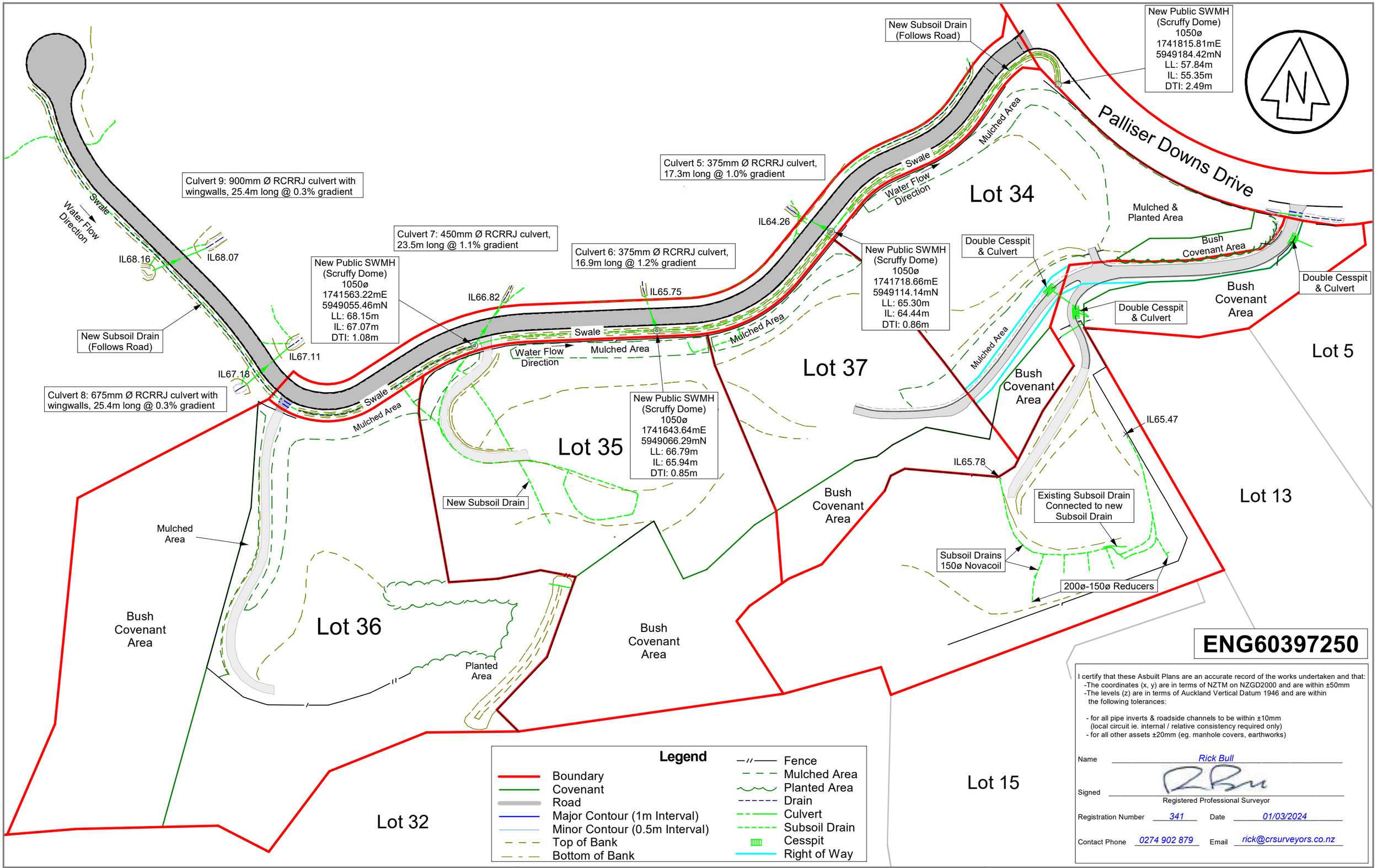
Cabra Rural Developments &
Rahopara Farms Ltd
Palliser Downs Drive - Wainui

Drawing Title:

# Cut to Fill Contour Plan

| Original Size: | Original Scale: | Date: | Job Number: |
|---|---|---|---|
| A3 | 1:1500 | 01/03/2024 | 7723 - Rev 4 |

JH




**Legend**

- Boundary
- Covenant
- Road
- Major Contour (1m Interval)
- Minor Contour (0.5m Interval)
- Top of Bank
- Bottom of Bank
- Fence
- Mulched Area
- Planted Area
- Drain
- Culvert
- Subsoil Drain
- Cesspit
- Right of Way

**ENG60397250**

I certify that these Asbuilt Plans are an accurate record of the works undertaken and that:
-The coordinates (x, y) are in terms of NZTM on NZGD2000 and are within ±50mm
-The levels (z) are in terms of Auckland Vertical Datum 1946 and are within the following tolerances:

- for all pipe inverts & roadside channels to be within ±10mm (local circuit ie. internal / relative consistency required only)
- for all other assets ±20mm (eg. manhole covers, earthworks)

Name: Rick Bull

Signed

Registered Professional Surveyor

Registration Number: 341 Date: 01/03/2024

Contact Phone: 0274 902 879 Email: rick@crsurveyors.co.nz


Registered Professional Land Surveyors
PO Box 564
Orewa 0946
Phone (09) 426 4051
www.crsurveyors.co.nz


Client:

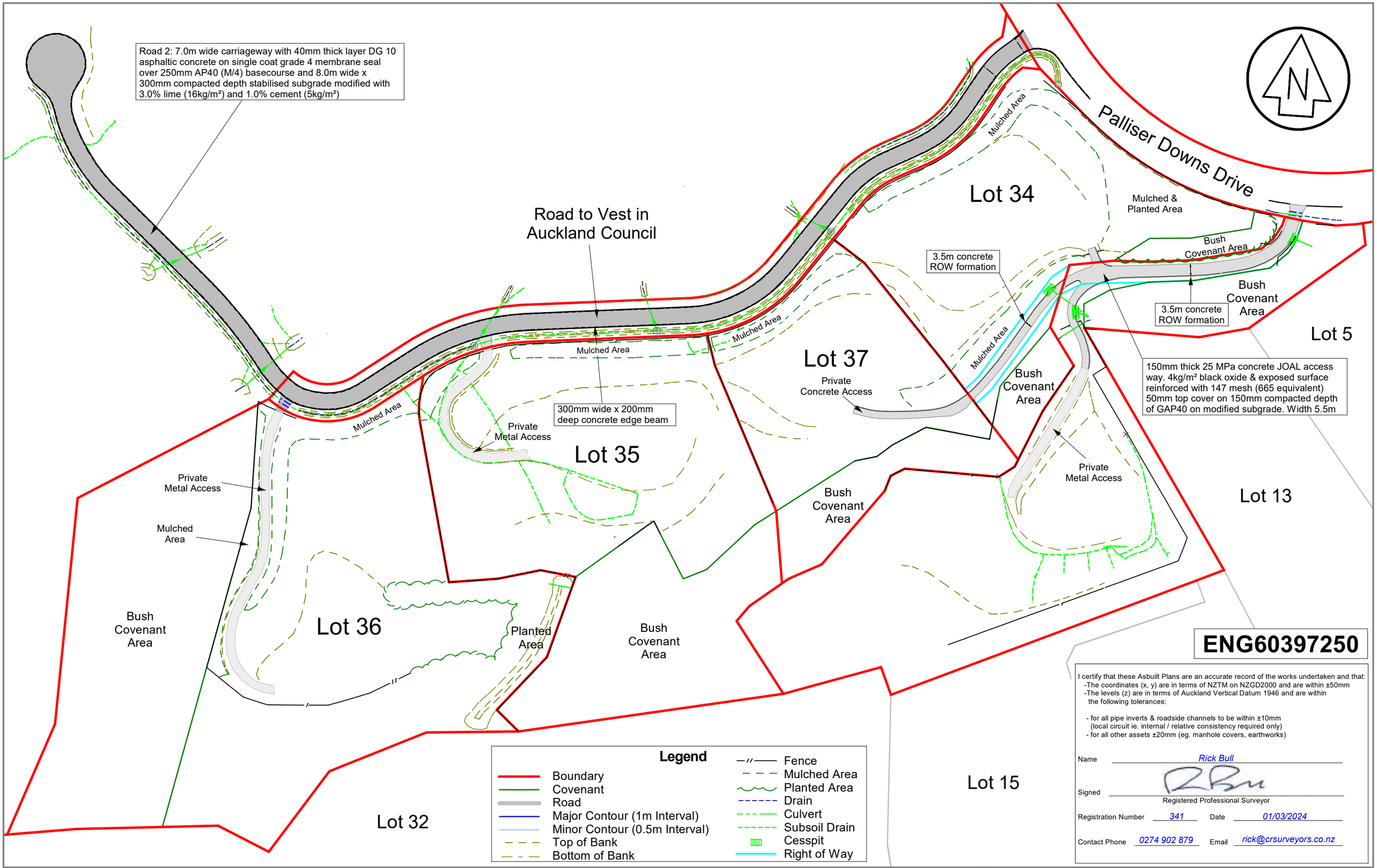
# Cabra Rural Developments & Rahopara Farms Ltd
# Palliser Downs Drive - Wainui

Drawing Title:

## Asbuilt - Drainage Road 2 Stormwater

| Original Size: | Original Scale: | Date: | Job Number: |
|---|---|---|---|
| A3 | 1:1500 | 01/03/2024 | 7723 - Rev 4 |

JH




**ENG60397250**

I certify that these Asbuilt Plans are an accurate record of the works undertaken and that:
- The coordinates (x, y) are in terms of NZTM on NZGD2000 and are within ±50mm
- The levels (z) are in terms of Auckland Vertical Datum 1946 and are within the following tolerances:
  - for all pipe inverts & roadside channels to be within ±10mm (local circuit ie. internal / relative consistency required only)
  - for all other assets ±20mm (eg. manhole covers, earthworks)

Name: Rick Bull

Signed: _____

Registered Professional Surveyor

Registration Number: 341 Date: 01/03/2024

Contact Phone: 0274 902 879 Email: rick@crsurveyors.co.nz


*Registered Professional Land Surveyors*

PO Box 564
Orewa 0946

Phone (09) 426 4051
www.crsurveyors.co.nz


Client:

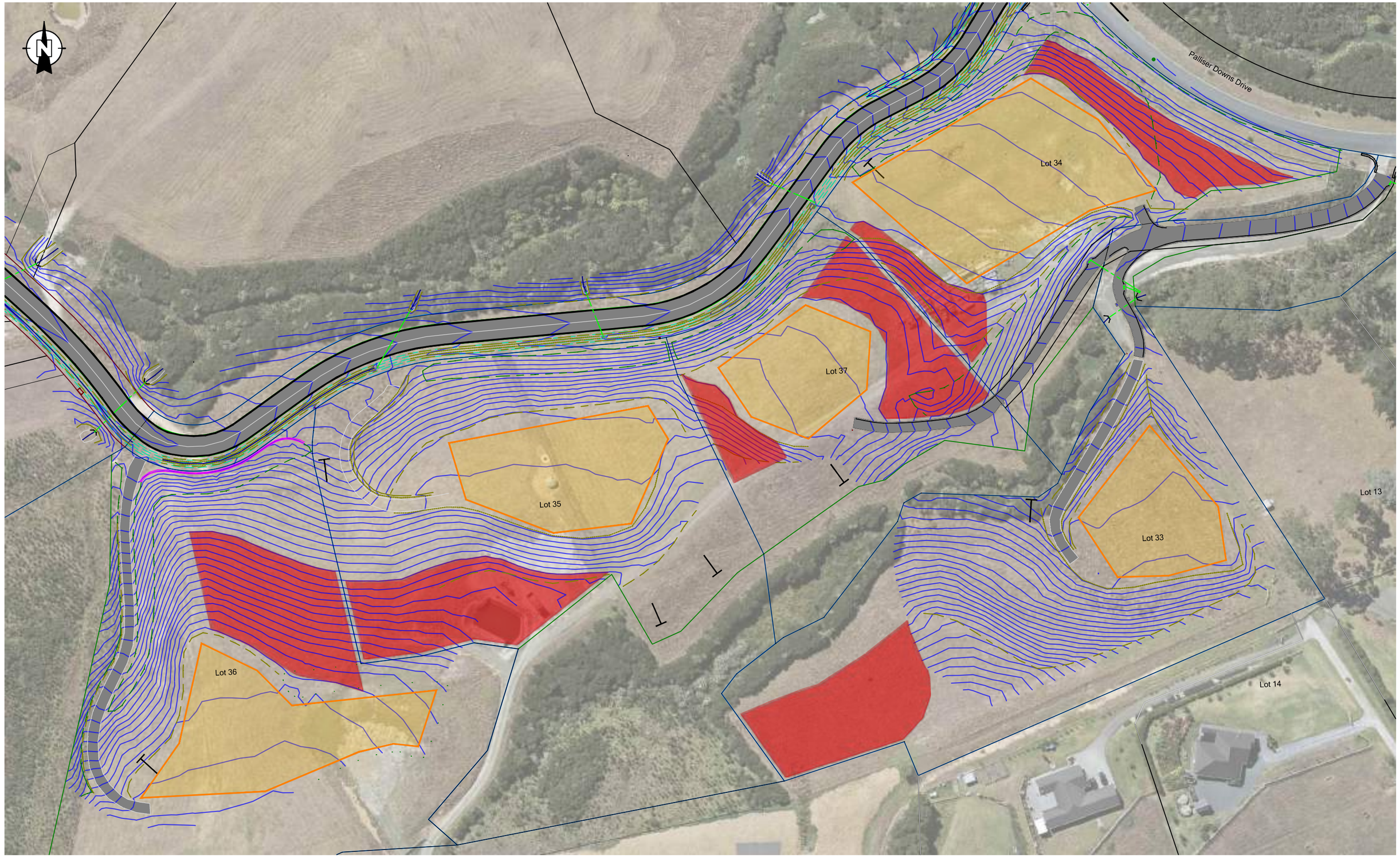
# Cabra Rural Developments & Rahopara Farms Ltd
# Palliser Downs Drive - Wainui

Drawing Title:

## Asbuilt - Roading Plan

| Original Size: | Original Scale: | Date: | Job Number: |
|---|---|---|---|
| A3 | 1:1500 | 01/03/2024 | 7723 - Rev 4 |

JH




LEGEND:

- OPTIONAL SPREADER BAR
- PROPOSED STABLE BUILDING AREA
- PROPOSED EFFLUENT DISPOSAL AREA

NOTES:

1. BASE PLAN ADAPTED FROM AUCKLAND CITY COUNCIL GEOMAPS

CMW Geosciences
Great People | Practical Solutions

| | | | |
|---|---|---|---|
| CLIENT: CABRA RURAL DEVELOPMENTS LTD | | DRAWN: GB | PROJECT: AKL2019-0017 |
| PROJECT: PALLISER DOWNS, STAGE 3 | | CHECKED: RK | DRAWING: 01 |
| | | REVISION: 0 | SCALE: 1:2000 |
| TITLE: SITE PLAN | | DATE: 13/02/2024 | SHEET: A3 L |

\\CMWGEOSCIENCES.SHAREPOINT.COM@SSL\DAVWWWROOT\SITES\AUCKLANDTEAM\SHARED DOCUMENTS\AUCKLAND PROJECT DOCUMENTS\2019\AKL2019-0017 PALLISER DOWNS, STAGE 3\05 DRAWINGS\CAD\AKL2019-0017 24066 EDA AREAS.DWG

Palliser Downs Drive

Lot 34
PT01
PT02
PT03
PT04
PT05
PT06

Lot 37
PT01
PT02
PT03
PT04
PT05
PT06

Lot 35
PT01
PT02
PT03
PT04
PT05
PT06

Lot 36
PT01
PT02
PT03
PT04
PT05
PT06
PT07
PT08
PT09
PT10

Lot 33
PT01
PT02
PT03
PT04
PT05
PT06

Lot 13

Lot 14

LEGEND:

- OPTIONAL SPREADER BAR
- PT1 — PROPOSED STABLE BUILDING AREA SETOUT POINTS
- PROPOSED EFFLUENT DISPOSAL AREA

NOTES:

1. SEE SHEET 03 FOR SETOUT COORDINATE TABLE

CMW Geosciences
Great People | Practical Solutions

| | | | |
|---|---|---|---|
| CLIENT: CABRA RURAL DEVELOPMENTS LTD | | DRAWN: GB | PROJECT: AKL2019-0017 |
| PROJECT: PALLISER DOWNS, STAGE 3 | | CHECKED: RK | DRAWING: 02 |
| | | REVISION: 0 | SCALE: 1:2000 |
| TITLE: PLAN - STABLE BUILDING AREAS | | DATE: 13/02/2024 | SHEET: A3 L |

\\CMWGEOSCIENCES.SHAREPOINT.COM@SSL\DAVWWWROOT\SITES\AUCKLANDTEAM\SHARED DOCUMENTS\AUCKLAND PROJECT DOCUMENTS\2019\AKL2019-0017 PALLISER DOWNS, STAGE 3\05 DRAWINGS\CAD\AKL2019-0017 24066 EDA AREAS.DWG

| STABLE BUILDING AREA COORDINATE TABLE (NZTM) | | | |
|---|---|---|---|
| LOT REF | POINT REF | EASTING | NORTHING |
| LOT 33 | PT01 | 1741837.954 | 5949034.814 |
| -II- | PT02 | 1741862.364 | 5949005.975 |
| -II- | PT03 | 1741865.127 | 5948986.916 |
| -II- | PT04 | 1741844.628 | 5948981.417 |
| -II- | PT05 | 1741826.545 | 5948980.896 |
| -II- | PT06 | 1741812.665 | 5949002.190 |
| LOT 34 | PT01 | 1741795.772 | 5949158.265 |
| -II- | PT02 | 1741819.755 | 5949143.528 |
| -II- | PT03 | 1741840.107 | 5949118.428 |
| -II- | PT04 | 1741816.915 | 5949111.420 |
| -II- | PT05 | 1741767.325 | 5949088.007 |
| -II- | PT06 | 1741732.286 | 5949121.337 |
| LOT 35 | PT01 | 1741588.696 | 5949028.642 |
| -II- | PT02 | 1741659.502 | 5949041.804 |
| -II- | PT03 | 1741666.653 | 5949029.977 |
| -II- | PT04 | 1741653.514 | 5948999.926 |
| -II- | PT05 | 1741625.812 | 5948996.627 |
| -II- | PT06 | 1741594.724 | 5949008.530 |
| LOT 36 | PT01 | 1741500.686 | 5948957.350 |
| -II- | PT02 | 1741520.482 | 5948947.624 |
| -II- | PT03 | 1741532.750 | 5948935.264 |
| -II- | PT04 | 1741584.197 | 5948940.648 |
| -II- | PT05 | 1741577.716 | 5948920.648 |
| -II- | PT06 | 1741569.061 | 5948921.620 |
| LOT 36 | PT07 | 1741556.810 | 5948918.788 |
| -II- | PT08 | 1741523.204 | 5948904.671 |
| -II- | PT09 | 1741479.139 | 5948902.381 |
| -II- | PT10 | 1741492.674 | 5948921.742 |
| LOT 37 | PT01 | 1741715.612 | 5949077.664 |
| -II- | PT02 | 1741738.685 | 5949068.166 |
| -II- | PT03 | 1741737.298 | 5949047.577 |
| -II- | PT04 | 1741716.492 | 5949030.139 |
| -II- | PT05 | 1741696.189 | 5949037.923 |
| -II- | PT06 | 1741684.511 | 5949055.422 |

NOTES:

1. SEE SHEET 02 FOR SETOUT COORDINATE REFERENCES

CMW Geosciences
Great People | Practical Solutions

| | | | |
|---|---|---|---|
| CLIENT: **CABRA RURAL DEVELOPMENTS LTD** | | DRAWN: GB | PROJECT: AKL2019-0017 |
| PROJECT: **PALLISER DOWNS, STAGE 3** | | CHECKED: RK | DRAWING: 03 |
| | | REVISION: 0 | SCALE: NTS |
| TITLE: **STABLE BUILDING AREA COORDS TABLE** | | DATE: 13/02/2024 | SHEET: A3 L |

# APPENDIX D: SOIL EXPANSIVITY

| SOIL EXPANSIVITY | | | |
|---|---|---|---|
| **Project:** | Palliser Downs Stage 1A Rural Subdivision | **Job Number:** | AKL2019-0017AF Appendix D |
| **Site Address:** | Palliser Downs Drive, Wainui | **Client:** | Cabra Rural Developments Ltd & Rahopara Farms Ltd |
| **Prepared by:** | Richard Knowles | **Reviewed by:** | Chris Ritchie |

# 1 INTRODUCTION

Seasonal soil moisture variations within most clay-rich soils typically result in the soil swelling during winter months and then shrinking during summer months. These seasonal movements can cause issues such as cracking of concrete floors, brittle cladding and masonry walls or distortion of building frames causing doors and windows to jam from differential settlement. The effects are further compounded by local influences that worsen differential movements. These may include growth of high demand trees and shrubs that cause localised soil drying or either leaking pipes or tree root removal, leading to localised wetting.

The potential effects need to be managed in a combination of appropriate:

- classification of the level of risk (refer to Sections 2 to 4)
- design of foundations (refer to Section 4)
- management of soil moisture conditions by contractors during construction (refer to Section 5)
- management of landscaping and plantings by homeowners throughout a building's lifetime (refer to Section 6)

# 2 CLASSIFICATION METHODS AND REFERENCES

| References | | |
|---|---|---|
| **Reference** | **Test Methods Specified** | **Potential Assessment Outcomes** |
| **NZS3604-2011**<br>*Timber Framed Buildings* | *(Refer to "Definitions – Good Ground")*<br>Liquid Limit (LL) and Linear Shrinkage (LS)<br>(NZS4402-1986 Test 2.2 and 2.6) | "Good Ground" OR<br>Not "Good Ground" = LL>50 and LS>15 |
| **AS2870-2011**<br>*Residential Slabs and Footings* | *(Refer to Clause2.3.2)*<br>Shrink-Swell Indices<br>(AS1289 Tests 7.1.1 to 7.1.3),<br>OR<br>Correlation with other clay index tests,<br>OR<br>Visual-tactile ID by a qualified person | *(Refer to Table 2.3 and Section 3)*<br>Classes S, M, H1, H2, E with associated characteristic ground movements and design solutions for 300 year return period drought. |
| **BRANZ Report SR120A (2008)**<br>*Soil Expansivity in the Auckland Region* | Shrink-Swell Indices<br>(AS1289 Tests 7.1.1 to 7.1.3)<br>Recommended soil suction profile given | Use of AS2870 Classes |
| **NZBC Acceptable Solution B1/AS1**<br>(from Nov 2019)<br>**Applied amendments to the wording of NZS3604** to cover a method for a simple building form. | *(Clause7.5.13)*<br>Specific requirements for the Acceptable Solution for Simple Buildings:<br>Enquiry at local TA,<br>and/ or<br>a Cert. of Suitability per NZS4431,<br>and/ or<br>Soil tests by a qualified Engineer<br>*(Clause7.5.13.1.2)*<br>Soil tests are:<br>Shrink-Swell Indices<br>(AS1289 Tests 7.1.1 to 7.1.3) | Provides an Acceptable Solution for only a limited range of NZS3604 building sizes, shapes and materials on expansive soils.<br>The provided acceptable design solution is only for a concrete slab with perimeter foundation.<br>Classes S, M, H and E. and Characteristic ground movement limits based on a 500 year return period |

| | | |
|---|---|---|
| **Auckland Council Code of Practice for Land development and Subdivision** (Chapter 2, version 2, May 2023) (ACCoPs) | *(Clause2.5.2)* Moisture Content (MC), Liquid Limit (LL), Plastic Limit (PL) (NZS4402-1986 Tests 2.1 to 2.4) plotted on plasticity chart (Plasticity Index, PI=LL-PL vs LL) | Use of NZBC B1/AS1 for foundation design. Any other specific design method to require Auckland Council or external review |
| Notes:<br>Liquid Limit test can be replicated by Cone Penetration Limit (CPL) Test, NZS4402-1986 Test 2.5.<br>Assessments using shrink-swell indices have been found to be unreliable in the Auckland context and are therefore not favoured in ACCoPs<br>B1/AS1 converted characteristic surface movements from 300 years in AS2870 to 500 years by multiplying values by 1.11.<br>B1/AS1 did not alter the NSZ 3604 “Good Ground” definition and did not repeal NZS3604 Informative Section 17 on expansive soils. | | |

# 3 TESTING REGIME

Testing on 6 samples (1 from each Stage 1A lot plus one from future lot 44) was completed in accordance with the requirements of NZS 3604. All testing was completed by RoadTest Limited, a testing laboratory accredited by IANZ for the tests undertaken. Results are provided below.

ROADTEST LTD

Revision 1

**DETERMINATION OF THE WATER CONTENT, CONE PENETRATION LIMIT & LINEAR SHRINKAGE**
**TEST METHOD NZS 4402 : 1986 TEST 2.1, 2.5 & 2.6**

Project Name : **Palliser Downs**

Client : CMW Geosciences
Address : PO Box 300206
Albany, Auckland 0754

Attention : Conor L

Project No : 23 0001 39
Page : 1 of 1
Date of Order : 30.06.23

Sample Method : Hand auger
Sample Date : 27.06.23
Sampled By : CMW Geosciences

**Test Details :**

Test performed on : Whole Sample
History : Natural

| Sample No. | Location | Depth (m) | Cone Penetration (CPL) | Linear Shrinkage (LS) | Natural Water Content (%) |
|---|---|---|---|---|---|
| 983Q | HA02 | 0.4 - 0.8 | 86 | 22 | 44.6 |
| 984Q | HA04 | 0.4 - 0.8 | 73 | 18 | 44.3 |
| 985Q | HA06 | 0.4 - 0.8 | 83 | 19 | 43.2 |
| 986Q | HA08 | 0.4 - 0.8 | 87 | 17 | 45.6 |
| 987Q | HA10 | 0.4 - 0.8 | 66 | 16 | 31.4 |
| 988Q | HA11 | 0.4 - 0.8 | 53 | 13 | 32.8 |

Comments :

| | | | |
|---|---|---|---|
| Tested By: | HC / DT | Date : | 03.07.23 |
| Calculated By : | HC | Date : | 11.07.23 |
| Checked By : | HC | Date : | 12.07.23 |

**Figure 1: Laboratory Test Results.**

# 4 ASSESSMENT OF TEST RESULTS

The testing confirms that:

- All of the soils tested on Stage 1A were expansive in terms of the NZS 3604 definition and were therefore outside the definition of “good ground”.

| Assessment of Characteristic Surface Movements and Design Classes for NZS 3604 Compliant Buildings on Stable Building Platforms | | |
|---|---|---|
| **Lots** | **Assessed AS2870 Site Class / 300 Year Design Characteristic Surface Movement (Ys)** | **Anticipated Equivalent NZBC B1/AS1 Expansivity Class for Design / 500 Year Design Characteristic Surface Movement( Ys)** |
| **33 to 35** | M (moderately reactive) / 40mm | M / 44mm |
| **36 and 37** | H1 (highly reactive) / 60mm | H / 78mm |

B1/AS1 provides an Acceptable Solution through NZS 3604 for foundation design applying to a limited range of compliant building sizes, shapes and materials and only for concrete floor design with strip footings. In all other cases, NZS 3604 directs the use of AS2870 or a specific design.

If AS2870 is used for the design solution, it must be noted that the characteristic surface movements in that code apply to a (less conservative) 300 year return period drought while B1/AS1 provides for a 500 year return period drought.

Prior to the introduction of the B1/AS1 design information in November 2019, minimum foundation depths recommended as appropriate by geotechnical consultants in Auckland for shallow footing design under AS2870 were typically of the order of 600mm for Class M and 750mm for Class H1.

# 5 SITE PREPARATION DURING CONSTRUCTION

Foundation contractors need to be aware of the extreme damage potentially caused by expansive soils and the imperativeness of maintaining optimum moisture contents in all footing excavations and across building platform subgrades between the time of excavation and the pouring of concrete. Pouring foundations on dry, desiccated ground in summer months can lead to heaving and cracking, requiring extensive repairs or even complete house re-builds. Similarly, where perimeter foundations have been treated but floor slabs have been poured on dry ground, infiltration of moisture via pipe bedding can lead to localised heave, uplift and significant slab damage.

Remedial actions that may be appropriate include combinations of 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.

# 6 SITE MAINTENANCE AND LANDSCAPING

Landowners must be mindful of the potential impacts of planting or removal of high water demand plants. Where their roots may extend close to footings (i.e. within a lateral distance of 1.5 times the mature tree height), these actions can lead to significant settlement or heave damage.

For a comprehensive understanding of the potential effects of expansive soils, maintenance recommendations and vegetation management information, we strongly recommend that land owners obtain a copy of CSIRO publication BTF 18 (Foundation Maintenance and Footing Performance – A Homeowners Guide) that is available online.

# APPENDIX E: FIELD TEST DATA

# LF11 Rev.15 Soil Field Density NDM Direct Transmission with VSS Report (Cohesive Soils)

Auckland Laboratory
CMW Geosciences (NZ) Ltd Partnership
11/63, Arrenway Drive, Rosedale, NZ 0632
PO Box 300206, Albany, Auckland, NZ 0752
Phone: +64 (09) 4144 632

| | |
|---|---|
| **Project:** | Palliser Downs |
| **Project No:** | AKL2019-0017 |
| **Location:** | Wainui |
| **Report No:** | AKL2019-0017LAA Rev.1 |
| **Report Date:** | 6/03/2024 |
| **Client:** | Cabra Rural Developments Limited |
| **Client Address:** | 3 Alice Ave, Orewa 0931 |

**Test Methods:** NZS 4407 2015 Test 3.1 ◊; NZS 4407 2015 Test 4.2; NZGS:August 2001

**Notes:** Solid Density: Assumed; Solid Density Data Source: N/A; Testing Locations Selected By: CMW Field Staff; ◊ Only samples <2.0mm will be considered for endorsed testing; ① Blade size of 19mm used.

Measurements marked * are not accredited and are outside the scope of the laboratories accreditation

| Date Sampled | Sample No. | Test Location* | | Soil Description* | Solid Density (t/m³) * | Vane ID | | In-situ Vane Shear Strengths | | | | | Field and Laboratory Testing Data | | | | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Test Site | RL/Details | | | Head # | Blade # ① | Test 1 (kPa) | Test 2 (kPa) | Test 3 (kPa) | Test 4 (kPa) | Ave. | Gauge Wet Density (t/m³) ** | Gauge Dry Density (t/m³) | Gauge Water Content (%) | Gauge Air Voids (%) | Gauge Probe Depth (mm) | Oven Water Content (%) | Oven Dry Density (t/m³) | Oven Calculated Air Voids (%) * | |
| 4/04/2022 | N1 | Undercut filling | - | CLAY | 2.70 | 1824 | 1824 | 84 | 135 | 113 | 138 | 118 | 1.72 | 1.19 | 44.5 | 3 | 300 | | | | |
| | N2 | Undercut filling | - | CLAY | 2.70 | 1824 | 1824 | 154 | 206 | 235 | 154 | 187 | 1.84 | 1.38 | 33.7 | 2 | 300 | 27.7 | 1.44 | 7 | |
| 8/04/2022 | N3 | Road 2 | - | CLAY | 2.70 | 1824 | 1824 | 151 | 145 | 154 | 171 | 155 | 1.75 | 1.22 | 43.9 | 2 | 300 | 40.1 | 1.25 | 4 | |
| | N4 | Road 2 | - | CLAY | 2.70 | 1824 | 1824 | 154 | 148 | 138 | 196 | 159 | 1.86 | 1.40 | 33.4 | 2 | 300 | 30.9 | 1.42 | 3 | |
| 11/04/2022 | N5 | Road 2 | - | CLAY | 2.70 | 1824 | 1824 | 235 | 235 | 235 | 235 | 235 | 1.75 | 1.26 | 39.0 | 5 | 300 | 40.8 | 1.24 | 4 | |
| 29/04/2022 | N6 | Road 2 | - | CLAY | 2.70 | 1824 | 1824 | 235 | 132 | 193 | 203 | 191 | 1.78 | 1.20 | 47.7 | -2 | 300 | 45.4 | 1.22 | -1 | |
| | N7 | Road 2 | - | CLAY | 2.70 | 1824 | 1824 | 209 | 235 | 193 | 203 | 210 | 1.76 | 1.25 | 41.5 | 2 | 300 | 40.5 | 1.26 | 3 | |
| 3/05/2022 | N8 | Road 2 | - | CLAY | 2.70 | 1824 | 1824 | 235 | 235 | 219 | 203 | 223 | 1.77 | 1.27 | 39.5 | 3 | 300 | 37.0 | 1.29 | 4 | |
| 2/05/2022 | N9 | Road 2 | - | CLAY | 2.70 | 1824 | 1824 | 158 | 171 | 171 | 200 | 175 | 1.87 | 1.39 | 34.2 | 1 | 300 | 34.1 | 1.39 | 1 | |
| 4/05/2022 | N10 | Road 2 | - | CLAY | 2.70 | 1824 | 1824 | 235 | 235 | 235 | 219 | 231 | 1.82 | 1.35 | 34.5 | 3 | 300 | 31.7 | 1.38 | 5 | |
| 12/05/2022 | N11 | Pond | -200mm | CLAY | 2.70 | 1824 | 1824 | 106 | 122 | 100 | 100 | 107 | 1.79 | 1.31 | 36.9 | 3 | 300 | 37.2 | 1.31 | 3 | |
| | N12 | Pond | -1000mm | CLAY | 2.70 | 1824 | 1824 | 126 | 161 | 154 | 138 | 145 | 1.82 | 1.34 | 35.8 | 3 | 300 | 43.7 | 1.26 | -2 | |
| | N13 | Pond | -1000mm | CLAY | 2.70 | 1824 | 1824 | 135 | 138 | 235 | 235 | 186 | 1.83 | 1.41 | 29.3 | 6 | 300 | - | - | - | No sample taken |
| 25/05/2022 | N14 | Culvert fill | - | CLAY | 2.70 | 1824 | 1824 | 106 | 109 | 97 | 100 | 103 | - | - | - | - | - | - | - | - | No sample taken |
| | N15 | Culvert fill | - | CLAY | 2.70 | 1824 | 1824 | 122 | 132 | 138 | 154 | 137 | 1.75 | 1.26 | 39.4 | 4 | 300 | 40.2 | 1.25 | 4 | |
| | N16 | Culvert fill | - | CLAY | 2.70 | 1824 | 1824 | 203 | 206 | 154 | 206 | 192 | 1.75 | 1.19 | 46.8 | 0 | 300 | 39.7 | 1.25 | 4 | |
| 26/05/2022 | N17 | Culvert 1 | - | CLAY | 2.70 | 1824 | 1824 | 206 | 119 | 64 | 119 | 127 | 1.77 | 1.24 | 42.9 | 1 | 300 | | | | No sample taken |
| | N18 | Culvert 1 | - | CLAY | 2.70 | 1824 | 1824 | 138 | 206 | 235 | 235 | 204 | 1.80 | 1.38 | 29.8 | 7 | 300 | 28.9 | 1.39 | 8 | |
| 27/10/2022 | N20 | Lot 34 Undercut 1st half | +1000mm | CLAY | 2.70 | 2080 | 2080 | 140 | 142 | 145 | 151 | 145 | 1.84 | 1.40 | 31.7 | 4 | 300 | 28.5 | 1.43 | 6 | |
| 29/10/2022 | N21 | Lot 34 Batter edge/HP edge | +500mm | CLAY | 2.70 | 2080 | 2080 | 140 | 155 | 145 | 140 | 145 | 1.86 | 1.38 | 35.1 | 1 | 300 | 30.0 | 1.43 | 4 | |
| 7/11/2022 | N22 | Lot 34 Undercut area 2 | +800mm | CLAY | 2.70 | 2992 | 2992 | 155 | 155 | 141 | 124 | 144 | 1.82 | 1.38 | 31.4 | 5 | 300 | 30.4 | 1.39 | 6 | |
| 16/11/2022 | N23 | Lot 34 | - | CLAY | 2.70 | 1824 | 1824 | 123 | 112 | 95 | 137 | 117 | 1.90 | 1.44 | 31.5 | 1 | 300 | - | - | - | No sample taken |
| 29/11/2022 | N27 | Lot 34 | - | CLAY Fill | 2.70 | 1195 | 1195 | 160 | 156 | 139 | 189 | 161 | 1.79 | 1.36 | 30.9 | 7 | 300 | 30.1 | 1.37 | 8 | |
| | N28 | Lot 34 | - | CLAY Fill | 2.70 | 1195 | 1195 | 160 | 174 | 186 | 203 | 181 | 1.83 | 1.36 | 34.3 | 3 | 300 | 32.9 | 1.38 | 4 | |
| 23/02/2023 | N48 | Lot 33 | -700mm | CLAY Fill | 2.70 | 2992 | 2992 | 197 | 183 | 141 | 155 | 169 | 1.88 | 1.38 | 36.2 | -1 | 300 | 27.8 | 1.47 | 5 | |
| 5/03/2023 | N53 | Road 2 | +600mm | ENG CLAY Fill | 2.70 | 2080 | 2080 | 151 | 161 | 158 | 165 | 159 | 1.77 | 1.25 | 41.1 | 2 | 300 | 40.1 | 1.26 | 3 | |
| 13/03/2023 | N54 | Lot 33 BP edge | +1000mm | ENG CLAY Fill | 2.70 | 2080 | 2080 | 140 | 140 | 140 | 140 | 140 | 1.80 | 1.31 | 36.8 | 3 | 300 | 35.2 | 1.33 | 4 | |

** Gauge Wet Densities outside of the calibrated range of 1.754 to 2.611 t/m³ are not accredited and are outside the laboratories scope of accreditation.

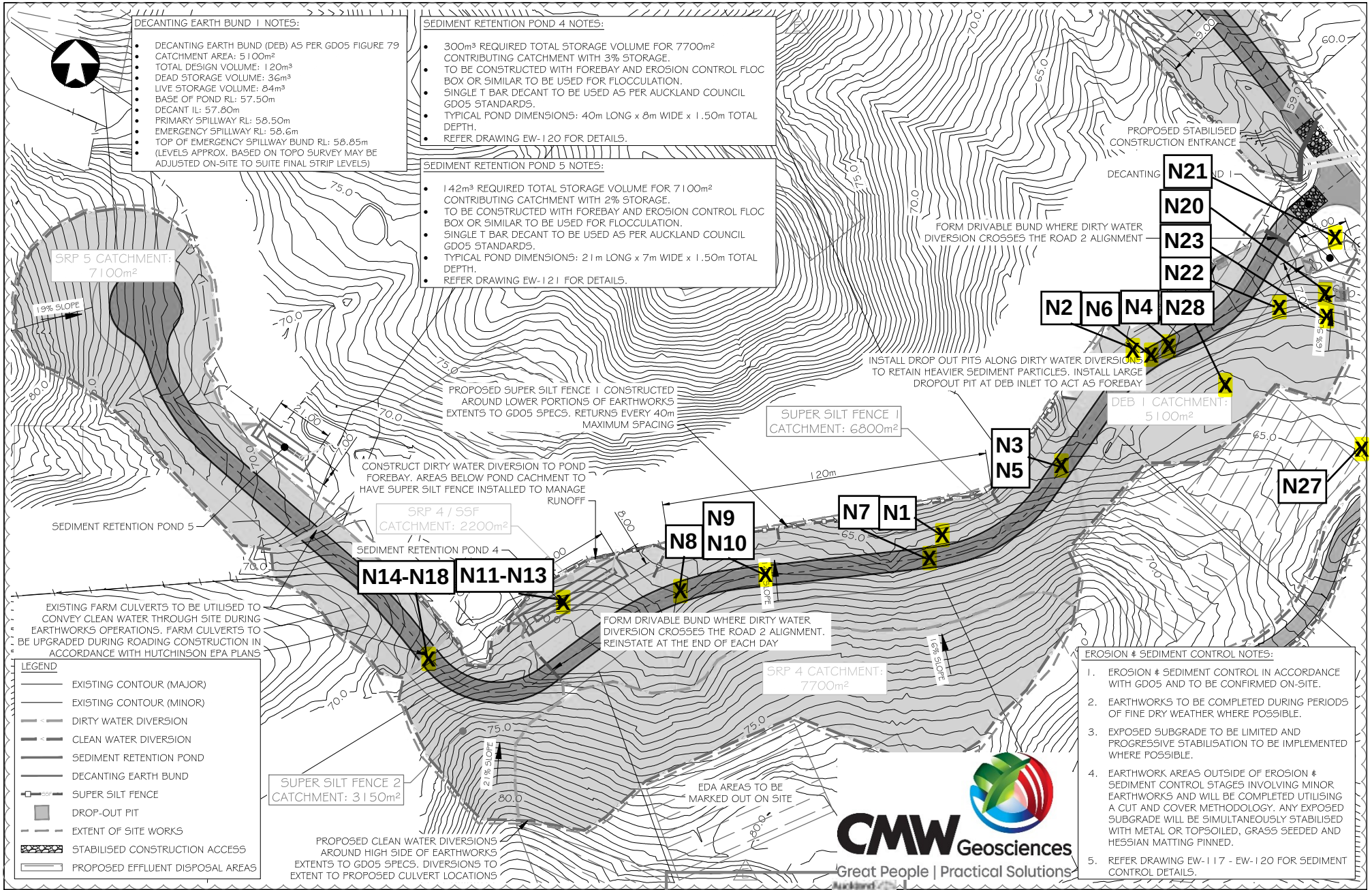
This report should only be reproduced in full.

This report replaces reports numbered AKL2019-0017LAA Rev.0 - **Master Site Plan updated, no change to point locations.**

Created By: JLM Date: 11/04/2022

Checked By: JP Date: 6/03/2024

Authorised Signatory (KTP): JLM Date: 6/03/2024




| No. | Revision | Drawn | Chk. | Appd. | Date |
|---|---|---|---|---|---|
| E | EDA AREAS ADDED | MS | PF | IH | MAR 2022 |
| D | SRP 4 & SILT FENCE CATCHMENTS CLOSED UP | MS | PF | IH | MAR 2022 |
| C | DEB 1 DROP OUT PIT & DRIVEABLE BUNDS ADDED. EXISTING CULVERTS TO BE UTILISED FOR CLEAN WATER | MS | PF | IH | MAR 2022 |
| B | DEB 4 UPDATED TO SEDIMENT POND 5 | MS | PF | IH | MAR 2022 |
| A | SEDIMENT CONTROL DETAILS REVISED | MS | PF | IH | FEB 2022 |

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| | | |
|---|---|---|
| Design | M. SYMONS | FEB 2022 |
| Drawn | M. SYMONS | FEB 2022 |
| Checked | P. FARLEY | FEB 2022 |
| Approved | I. HUTCHINSON | FEB 2022 |
| Scale | 1:1250 @ A3 | |
| Scale vert. exag. | | |

ENG60397250 / VIJAY.K
Approved Engineering Plan
09/09/2022

Project: GABRA RURAL DEVELOPMENTS & RAHOPARA FARMS LTD
PALLISER DOWNS STAGE 2 (2021)
PALLISER DOWNS DRIVE
WAINUI
ENGINEERING PLAN APPROVAL

Title: ROAD 2 EROSION & SEDIMENT CONTROL PLAN

Sheet No.: EW-115

Job No.: A3-24066 EPA

Rev.: E

# LF14 Rev.13 Dynamic Cone Penetration (DCP) Test Report

NZS 4402: 1988 Test 6.5.2

| | |
|---|---|
| **Project:** | Palliser Downs |
| **Project No:** | AKL2019-0017 |
| **Location:** | Wainui |
| **Report No:** | AKL2019-0017LAB Rev.1 |
| **Test Date:** | 26/05/2022 |
| **Tested By:** | LSW/PH |
| **Client:** | Cabra Rural Development Limited |
| **Client Address:** | 9B/30 Foundry Road, Silverdale, Auckland |
| **CBR Test Calculation:** | Austroad (2010) |

Auckland Laboratory
CMW Geotechnical NZ Limited
11/63, Arrenway Drive, Rosedale, NZ 0632
PO Box 300206, Albany, Auckland, NZ 0752
Phone: +64 (09) 4144 632

Testing Locations Selected By: CMW Field Staff

*** Equivalent CBR Values are not accredited and are outside the scope of the laboratory's accreditation**

| Test No | 21 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Location | Road 2 | | | | | | | | | |
| Chainage & Offset | CH 320 L | | | | | | | | | |
| Material & Layer | Fill SG | | | | | | | | | |
| Depth (mm) | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* |
| 0 - 100 | 1 | 2 | | | | | | | | |
| 100 - 200 | 2 | 4 | | | | | | | | |
| 200 - 300 | 2 | 4 | | | | | | | | |
| 300 - 400 | 2 | 4 | | | | | | | | |
| 400 - 500 | 3 | 6 | | | | | | | | |
| 500 - 600 | 6 | 13 | | | | | | | | |
| 600 - 700 | 5 | 10 | | | | | | | | |
| 700 - 800 | 7 | 15 | | | | | | | | |
| 800 - 900 | 7 | 15 | | | | | | | | |
| 900 - 1000 | | | | | | | | | | |

| Test No | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Location | | | | | | | | | | |
| Chainage & Offset | | | | | | | | | | |
| Material & Layer | | | | | | | | | | |
| Depth | | | | | | | | | | |
| 0 - 100 | | | | | | | | | | |
| 100 - 200 | | | | | | | | | | |
| 200 - 300 | | | | | | | | | | |
| 300 - 400 | | | | | | | | | | |
| 400 - 500 | | | | | | | | | | |
| 500 - 600 | | | | | | | | | | |
| 600 - 700 | | | | | | | | | | |
| 700 - 800 | | | | | | | | | | |
| 800 - 900 | | | | | | | | | | |
| 900 - 1000 | | | | | | | | | | |

This report replaces reports numbered AKL2019-0017LAB Rev.0 - **Master Site Plan updated, no change to point location**

| | | | |
|---|---|---|---|
| Created by: | RS | Date: | 25/05/2022 |
| Checked by: | JP | Date: | 6/03/2024 |
| Authorised Signatory: | JLM | Date: | 6/03/2024 |



*Equivalent CBR values calculated using AUSTROADS (2010) Guide to Pavement Technology Part 2, Figure 5.3, For Fine Grained Cohesive Soils, and are relevant to fine grained cohesive soils only.

# LF14 Rev.13 Dynamic Cone Penetration (DCP) Test Report

NZS 4402: 1988 Test 6.5.2

| | |
|---|---|
| **Project:** | Palliser Downs |
| **Project No:** | AKL2019-0017 |
| **Location:** | Wainui |
| **Report No:** | AKL2019-0017LAB Rev.1 |
| **Test Date:** | 26/05/2022 |
| **Tested By:** | LSW/PH |
| **Client:** | Cabra Rural Development Limited |
| **Client Address:** | 9B/30 Foundry Road, Silverdale, Auckland |
| **CBR Test Calculation:** | Austroad (2010) |

Auckland Laboratory
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11/63, Arrenway Drive, Rosedale, NZ 0632
PO Box 300206, Albany, Auckland, NZ 0752
Phone: +64 (09) 4144 632

Testing Locations Selected By: CMW Field Staff

*** Equivalent CBR Values are not accredited and are outside the scope of the laboratory's accreditation**

| Test No | 11 | | 12 | | 13 | | 14 | | 15 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Location | Road 2 | | Road 2 | | Road 2 | | Road 2 | | Road 2 | |
| Chainage & Offset | CH 120 L | | CH 140 R | | CH 160 L | | CH 180 R | | CH 200 L | |
| Material & Layer | CH SG Natural | | Fill SG | | Fill SG | | Fill SG | | Fill SG | |
| Depth (mm) | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* |
| 0 - 100 | 1 | 2 | 2 | 4 | 1 | 2 | 2 | 4 | 3 | 6 |
| 100 - 200 | 3 | 6 | 2 | 4 | 2 | 4 | 2 | 4 | 4 | 8 |
| 200 - 300 | 2 | 4 | 3 | 6 | 2 | 4 | 3 | 6 | 3 | 6 |
| 300 - 400 | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 4 | 5 | 10 |
| 400 - 500 | 3 | 6 | 2 | 4 | 2 | 4 | 3 | 6 | 5 | 10 |
| 500 - 600 | 4 | 8 | 2 | 4 | 2 | 4 | 3 | 6 | 4 | 8 |
| 600 - 700 | 3 | 6 | 2 | 4 | 2 | 4 | 4 | 8 | 3 | 6 |
| 700 - 800 | 3 | 6 | 3 | 6 | 2 | 4 | 8 | 18 | 3 | 6 |
| 800 - 900 | 4 | 8 | 4 | 8 | 2 | 4 | 6 | 13 | 3 | 6 |
| 900 - 1000 | | | | | | | | | | |

| Test No | 16 | | 17 | | 18 | | 19 | | 20 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Location | Road 2 | | Road 2 | | Road 2 | | Road 2 | | Road 2 | |
| Chainage & Offset | CH 220 R | | CH 240 L | | CH 260 R | | CH 280 L | | CH 300 R | |
| Material & Layer | Fill SG | | Fill SG | | Fill SG | | Fill SG | | Fill SG | |
| Depth | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* |
| 0 - 100 | 2 | 4 | 2 | 4 | 2 | 4 | 1 | 2 | 1 | 2 |
| 100 - 200 | 3 | 6 | 4 | 8 | 3 | 6 | 4 | 8 | 2 | 4 |
| 200 - 300 | 3 | 6 | 2 | 4 | 3 | 6 | 2 | 4 | 3 | 6 |
| 300 - 400 | 2 | 4 | 3 | 6 | 3 | 6 | 2 | 4 | 2 | 4 |
| 400 - 500 | 2 | 4 | 5 | 10 | 4 | 8 | 2 | 4 | 2 | 4 |
| 500 - 600 | 2 | 4 | 5 | 10 | 3 | 6 | 2 | 4 | 2 | 4 |
| 600 - 700 | 3 | 6 | 5 | 10 | 4 | 8 | 2 | 4 | 4 | 8 |
| 700 - 800 | 4 | 8 | 9 | 20 | 5 | 10 | 2 | 4 | 3 | 6 |
| 800 - 900 | 4 | 8 | 14 | 20+ | 8 | 18 | 2 | 4 | 5 | 10 |
| 900 - 1000 | | | | | | | | | | |

This report replaces reports numbered AKL2019-0017LAB Rev.0 - **Master Site Plan updated, no change to point location**

| | | | |
|---|---|---|---|
| Created by: | RS | Date: | 25/05/2022 |
| Checked by: | JP | Date: | 6/03/2024 |
| Authorised Signatory: | JLM | Date: | 6/03/2024 |



*Equivalent CBR values calculated using AUSTROADS (2010) Guide to Pavement Technology Part 2, Figure 5.3, For Fine Grained Cohesive Soils, and are relevant to fine grained cohesive soils only.

# LF14 Rev.13 Dynamic Cone Penetration (DCP) Test Report

NZS 4402: 1988 Test 6.5.2

| | |
|---|---|
| **Project:** | Palliser Downs |
| **Project No:** | AKL2019-0017 |
| **Location:** | Wainui |
| **Report No:** | AKL2019-0017LAB Rev.1 |
| **Test Date:** | 26/05/2022 |
| **Tested By:** | LSW/PH |
| **Client:** | Cabra Rural Development Limited |
| **Client Address:** | 9B/30 Foundry Road, Silverdale, Auckland |
| **CBR Test Calculation:** | Austroad (2010) |

Auckland Laboratory
CMW Geotechnical NZ Limited
11/63, Arrenway Drive, Rosedale, NZ 0632
PO Box 300206, Albany, Auckland, NZ 0752
Phone: +64 (09) 4144 632

Testing Locations Selected By: CMW Field Staff

*** Equivalent CBR Values are not accredited and are outside the scope of the laboratory's accreditation**

| Test No | 1 | | 2 | | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Location | Road 2 | | Road 2 | | Road 2 | | Road 2 | | Road 2 | |
| Chainage & Offset | CH 20 L | | CH 30 R | | CH 40 L | | CH 50 R | | CH 60 L | |
| Material & Layer | CH SG Natural | | CH SG Natural | | CH SG Natural | | CH SG Natural | | CH SG Natural | |
| Depth (mm) | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* |
| 0 - 100 | 3 | 6 | 2 | 4 | 3 | 6 | 3 | 6 | 2 | 4 |
| 100 - 200 | 5 | 10 | 3 | 6 | 5 | 10 | 12 | 20+ | 2 | 4 |
| 200 - 300 | 2 | 4 | 4 | 8 | 5 | 10 | 7 | 15 | 2 | 4 |
| 300 - 400 | 1 | 2 | 4 | 8 | 3 | 6 | 4 | 8 | 4 | 8 |
| 400 - 500 | 2 | 4 | 1 | 2 | 0 | 0 | 2 | 4 | 2 | 4 |
| 500 - 600 | 1 | 2 | 2 | 4 | 1 | 2 | 3 | 6 | 2 | 4 |
| 600 - 700 | 1 | 2 | 1 | 2 | 2 | 4 | 2 | 4 | 3 | 6 |
| 700 - 800 | 1 | 2 | 2 | 4 | 2 | 4 | 3 | 6 | 1 | 2 |
| 800 - 900 | 2 | 4 | 2 | 4 | 2 | 4 | 4 | 8 | 2 | 4 |
| 900 - 1000 | | | | | | | | | | |

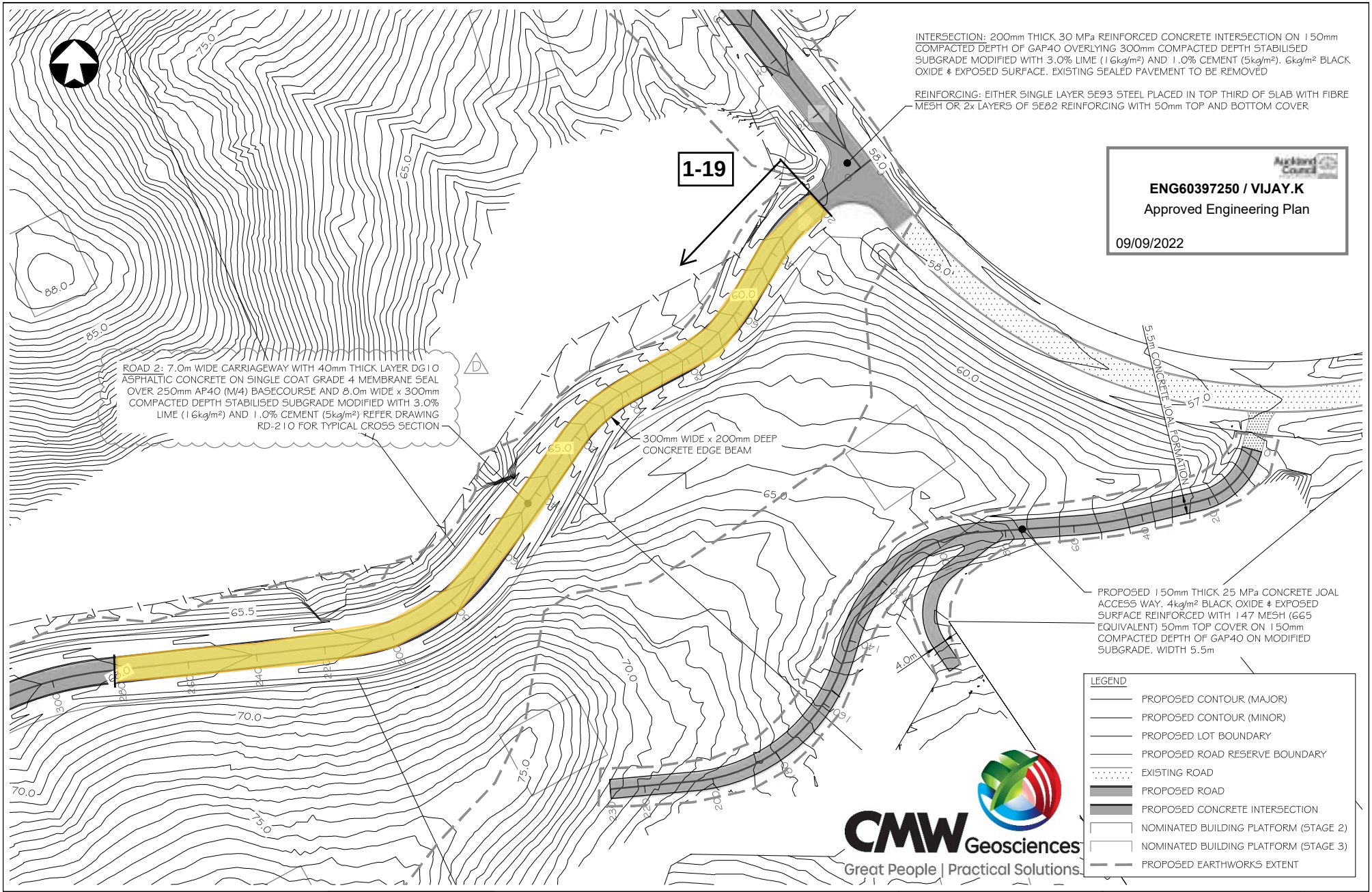
| Test No | 6 | | 7 | | 8 | | 9 | | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Location | Road 2 | | Road 2 | | Road 2 | | Road 2 | | Road 2 | |
| Chainage & Offset | CH 70 R | | CH 80 L | | CH 90 R | | CH 100 L | | CH 110 R | |
| Material & Layer | CH SG Natural | | CH SG Natural | | CH SG Natural | | CH SG Natural | | CH SG Natural | |
| Depth | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* |
| 0 - 100 | 1 | 2 | 3 | 6 | 3 | 6 | 3 | 6 | 2 | 4 |
| 100 - 200 | 8 | 18 | 3 | 6 | 4 | 8 | 4 | 8 | 2 | 4 |
| 200 - 300 | 4 | 8 | 4 | 8 | 3 | 6 | 4 | 8 | 4 | 8 |
| 300 - 400 | 3 | 6 | 2 | 4 | 2 | 4 | 3 | 6 | 3 | 6 |
| 400 - 500 | 3 | 6 | 3 | 6 | 2 | 4 | 3 | 6 | 3 | 6 |
| 500 - 600 | 3 | 6 | 2 | 4 | 2 | 4 | 4 | 8 | 3 | 6 |
| 600 - 700 | 4 | 8 | 2 | 4 | 2 | 4 | 4 | 8 | 3 | 6 |
| 700 - 800 | 5 | 10 | 2 | 4 | 2 | 4 | 4 | 8 | 2 | 4 |
| 800 - 900 | 4 | 8 | 2 | 4 | 2 | 4 | 4 | 8 | 2 | 4 |
| 900 - 1000 | | | | | | | | | | |

This report replaces reports numbered AKL2019-0017LAB Rev.0 - **Master Site Plan updated, no change to point location**

| | | | |
|---|---|---|---|
| Created by: | RS | Date: | 25/05/2022 |
| Checked by: | JP | Date: | 6/03/2024 |
| Authorised Signatory: | JLM | Date: | 6/03/2024 |



*Equivalent CBR values calculated using AUSTROADS (2010) Guide to Pavement Technology Part 2, Figure 5.3, For Fine Grained Cohesive Soils, and are relevant to fine grained cohesive soils only.




| No. | Revision | Drawn | Chk. | Appd. | Date |
|---|---|---|---|---|---|
| D | BASECOURSE DEPTH INCREASED TO 250mm | MS | PF | IH | AUG 2022 |
| C | CONCRETE INTERSECTION CHANGED TO 30 MPa | MS | PF | IH | JUN 2022 |
| B | AC MIX CHANGED FROM DG10 TO DG10 | MS | PF | IH | MAY 2022 |
| A | ROAD 2 REVISED LEVELS | MS | PF | IH | APR 2022 |
| - | ISSUE FOR EPA APPROVAL | - | - | - | FEB 2022 |

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| | | |
|---|---|---|
| Design | M. SYMONS | FEB 2022 |
| Drawn | M. SYMONS | FEB 2022 |
| Checked | P. FARLEY | FEB 2022 |
| Approved | L HUTCHINSON | FEB 2022 |
| Scale | 1:1000 @ A3 | |
| Scale vert. exag. | | |

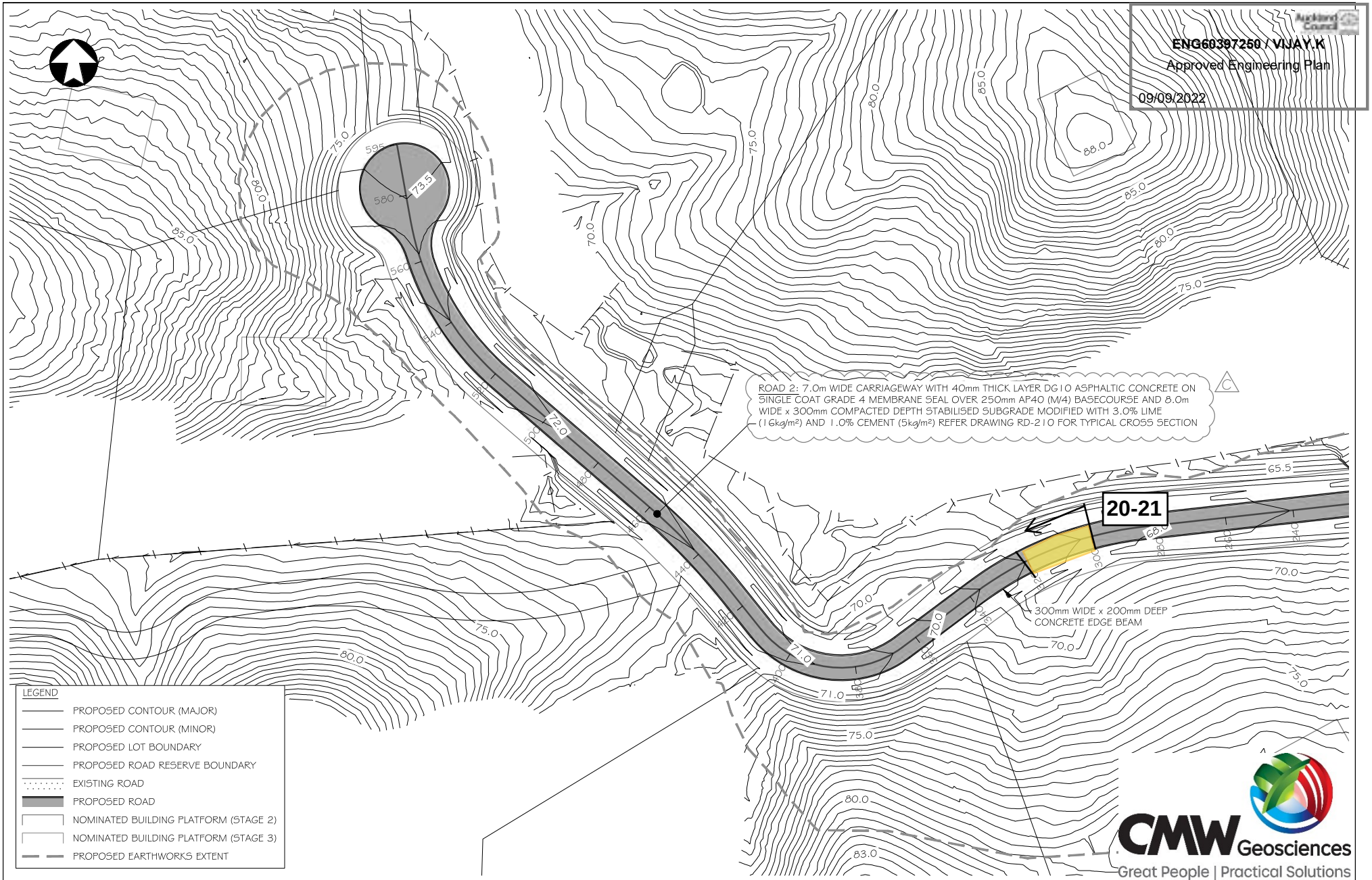
Project
CABRA RURAL DEVELOPMENTS & RAHOPARA FARMS LTD
PALLISER DOWNS STAGE 2 (2021)
PALLISER DOWNS DRIVE
WAINUI
ENGINEERING PLAN APPROVAL

Title
PROPOSED ROAD 2 LAYOUT PLAN - SHEET 1 OF 2

Sheet No.
RD-203

Job No.
A3-24066 EPA

Rev.
D




| No. | Revision | Drawn | Chk. | Appd. | Date |
|---|---|---|---|---|---|
| C | BASECOURSE DEPTH INCREASED TO 250mm | MS | PF | IH | AUG 2022 |
| B | AC MIX CHANGED FROM DG10 TO DG10 | MS | PF | IH | MAY 2022 |
| A | ROAD 2 REVISED LEVELS | MS | PF | IH | APR 2022 |
| - | ISSUE FOR EPA APPROVAL | - | - | - | FEB 2022 |

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| | | |
|---|---|---|
| Design | M. SYMONS | FEB 2022 |
| Drawn | M. SYMONS | FEB 2022 |
| Checked | P. FARLEY | FEB 2022 |
| Approved | L HUTCHINSON | FEB 2022 |
| Scale | 1:1000 @ A3 | |
| Scale vert. exag. | | |

Project
CABRA RURAL DEVELOPMENTS & RAHOPARA FARMS LTD
PALLISER DOWNS STAGE 2 (2021)
PALLISER DOWNS DRIVE
WAINUI
ENGINEERING PLAN APPROVAL

Title
PROPOSED ROAD 2 LAYOUT PLAN - SHEET 2 OF 2

Sheet No.
RD-204

Job No.
A3-24066 EPA

Rev.
C

# LF11 Rev.17 Soil Field Density NDM Direct Transmission with VSS Report (Cohesive Soils)

Auckland Laboratory
CMW Geotechnical NZ Limited
11/63, Arrenway Drive, Rosedale, NZ 0632
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Phone: +64 (09) 4144 632

| | |
|---|---|
| **Project:** | Palliser Downs |
| **Project No:** | AKL2019-0017 |
| **Location:** | Wainui |
| **Report No:** | AKL2019-0017LAD Rev.1 |
| **Report Date:** | 6/03/2024 |
| **Client:** | Cabra Rural Developments Limited |
| **Client Address:** | 3 Alice Ave, Orewa 0931 |

**Test Methods:**
NZS 4407 2015 Test 3.1 ◊
NZS 4407 2015 Test 4.2
NZGS:August 2001

**Notes:**
Solid Density: Assumed
Solid Density Data Source: N/A
Testing Locations Selected By: CMW Field Staff
◊ Only samples <2.0mm will be considered for endorsed testing
① Blade size of 19mm used.

Measurements marked * are not accredited and are outside the scope of the laboratories accreditation

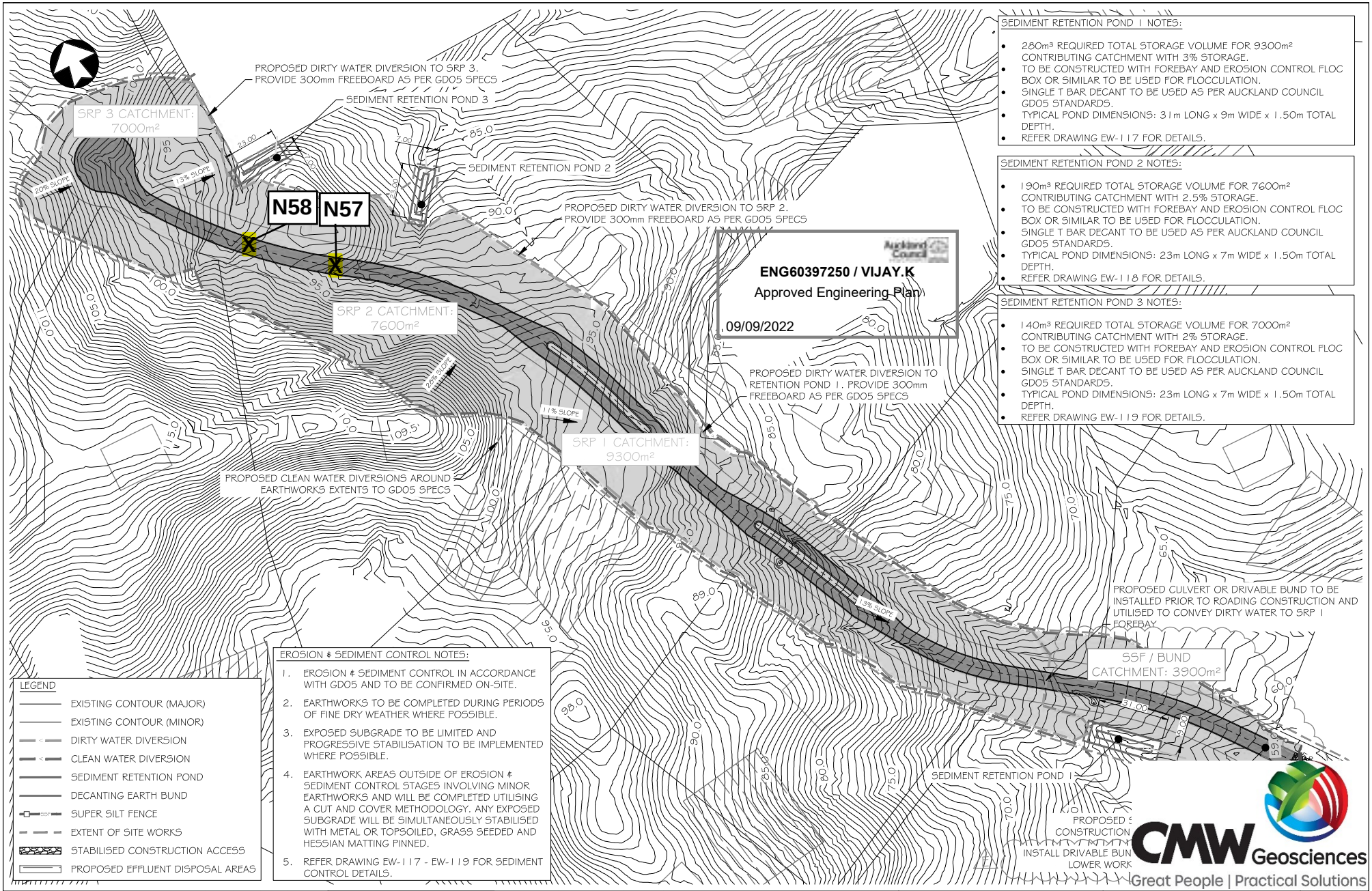
| Date Sampled | Sample No. | Test Location* | | Soil Description* | Solid Density (t/m³) * | Vane ID | | In-situ Vane Shear Strengths | | | | | Field and Laboratory Testing Data | | | | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Test Site | RL/Details | | | Head # | Blade # ① | Test 1 (kPa) | Test 2 (kPa) | Test 3 (kPa) | Test 4 (kPa) | Ave. | Gauge Wet Density (t/m³) ** | Gauge Dry Density (t/m³) | Gauge Water Content (%) | Gauge Air Voids (%) | Gauge Probe Depth (mm) | Oven Water Content (%) | Oven Dry Density (t/m³) | Oven Calculated Air Voids (%) * | |
| 16/01/2023 | N44 | Lot 101 | - | CLAY Fill | 2.70 | 1702 | 1702 | 162 | 182 | 169 | 169 | 171 | 1.93 | 1.49 | 29.5 | 1 | 300 | 34.5 | 1.43 | -3 | |
| | N45 | Lot 101 | - | CLAY Fill | 2.70 | 1702 | 1702 | UTP | UTP | UTP | UTP | UTP | 1.94 | 1.51 | 28.6 | 1 | 300 | 25.9 | 1.54 | 3 | |
| 23/02/2023 | N46 | Lot 101 | - | CLAY Fill | 2.70 | 2992 | 2992 | 169 | 155 | 155 | 141 | 155 | 1.79 | 1.36 | 31.5 | 7 | 300 | 30.4 | 1.38 | 7 | |
| | N47 | Lot 101 | - | CLAY Fill | 2.70 | 2992 | 2992 | 197 | 197 | 141 | 191 | 182 | 1.81 | 1.36 | 33.3 | 5 | 300 | 32.5 | 1.36 | 5 | |
| 2/03/2023 | N49 | Lot 101 Rock undercut | +1000mm | CLAY Fill | 2.70 | 1702 | 1702 | UTP | UTP | UTP | UTP | UTP | 2.01 | 1.71 | 18.1 | 6 | 300 | - | - | - | No sample taken |
| | N50 | Lot 101 Rock undercut | +500mm | CLAY Fill | 2.70 | 1702 | 1702 | UTP | UTP | UTP | UTP | UTP | 1.96 | 1.64 | 19.6 | 7 | 300 | 20.9 | 1.62 | 6 | |
| 6/03/2023 | N51 | Lot 55 | +1500mm | CLAY Fill | 2.70 | 1702 | 1702 | UTP | UTP | 141 | 177 | 159+ | 1.79 | 1.34 | 33.7 | 5 | 300 | 35.5 | 1.32 | 4 | |
| | N52 | Lot 55 | +1000mm | CLAY Fill | 2.70 | 1702 | 1702 | UTP | UTP | UTP | UTP | UTP | 1.84 | 1.39 | 32.3 | 4 | 300 | 31.9 | 1.39 | 4 | |
| 15/03/2023 | N55 | Lot 55 shear key 1st lift | - | CLAY Fill | 2.70 | 1702 | 1702 | 182 | 145 | 139 | 142 | 152 | 1.74 | 1.27 | 37.1 | 6 | 300 | 43.1 | 1.22 | 2 | |
| 29/03/2023 | N56 | Lot 55 shear key | - | CLAY Fill | 2.70 | 1702 | 1702 | 142 | 139 | 142 | 149 | 143 | 1.77 | 1.26 | 40.9 | 2 | 300 | 39.4 | 1.27 | 3 | |
| 5/04/2023 | N57 | Road 1 | - | CLAY Fill | 2.70 | 1702 | 1702 | UTP | UTP | UTP | UTP | UTP | 1.77 | 1.37 | 29.4 | 9 | 300 | 26.9 | 1.40 | 11 | |
| | N58 | Road 1 | - | CLAY Fill | 2.70 | 1702 | 1702 | UTP | UTP | UTP | UTP | UTP | 1.71 | 1.22 | 39.9 | 6 | 300 | 46.0 | 1.17 | 3 | |
| 20/04/2023 | N59 | Lot 55 Shear key | Final lift | CLAY Fill | 2.70 | 1702 | 1702 | UTP | UTP | UTP | UTP | UTP | 1.76 | 1.33 | 32.4 | 7 | 300 | - | - | - | No sample taken |

** Gauge Wet Densities outside of the calibrated range of 1.754 to 2.611 t/m³ are not accredited and are outside the laboratories scope of accreditation.



This report replaces reports numbered AKL2019-0017LAD Rev.0 - **Master Site Plan updated, no change to point locations**

Created By: RS Date: 28/02/2023
Checked By: JP Date: 6/03/2024
Authorised Signatory (KTP): JLM Date: 6/03/2024




SEDIMENT RETENTION POND 1 NOTES:

- 280m³ REQUIRED TOTAL STORAGE VOLUME FOR 9300m² CONTRIBUTING CATCHMENT WITH 3% STORAGE.
- TO BE CONSTRUCTED WITH FOREBAY AND EROSION CONTROL FLOC BOX OR SIMILAR TO BE USED FOR FLOCCULATION.
- SINGLE T BAR DECANT TO BE USED AS PER AUCKLAND COUNCIL GD05 STANDARDS.
- TYPICAL POND DIMENSIONS: 31m LONG x 9m WIDE x 1.50m TOTAL DEPTH.
- REFER DRAWING EW-117 FOR DETAILS.

SEDIMENT RETENTION POND 2 NOTES:

- 190m³ REQUIRED TOTAL STORAGE VOLUME FOR 7600m² CONTRIBUTING CATCHMENT WITH 2.5% STORAGE.
- TO BE CONSTRUCTED WITH FOREBAY AND EROSION CONTROL FLOC BOX OR SIMILAR TO BE USED FOR FLOCCULATION.
- SINGLE T BAR DECANT TO BE USED AS PER AUCKLAND COUNCIL GD05 STANDARDS.
- TYPICAL POND DIMENSIONS: 23m LONG x 7m WIDE x 1.50m TOTAL DEPTH.
- REFER DRAWING EW-118 FOR DETAILS.

SEDIMENT RETENTION POND 3 NOTES:

- 140m³ REQUIRED TOTAL STORAGE VOLUME FOR 7000m² CONTRIBUTING CATCHMENT WITH 2% STORAGE.
- TO BE CONSTRUCTED WITH FOREBAY AND EROSION CONTROL FLOC BOX OR SIMILAR TO BE USED FOR FLOCCULATION.
- SINGLE T BAR DECANT TO BE USED AS PER AUCKLAND COUNCIL GD05 STANDARDS.
- TYPICAL POND DIMENSIONS: 23m LONG x 7m WIDE x 1.50m TOTAL DEPTH.
- REFER DRAWING EW-119 FOR DETAILS.

LEGEND

- EXISTING CONTOUR (MAJOR)
- EXISTING CONTOUR (MINOR)
- DIRTY WATER DIVERSION
- CLEAN WATER DIVERSION
- SEDIMENT RETENTION POND
- DECANTING EARTH BUND
- SUPER SILT FENCE
- EXTENT OF SITE WORKS
- STABILISED CONSTRUCTION ACCESS
- PROPOSED EFFLUENT DISPOSAL AREAS

EROSION & SEDIMENT CONTROL NOTES:

1. EROSION & SEDIMENT CONTROL IN ACCORDANCE WITH GD05 AND TO BE CONFIRMED ON-SITE.
2. EARTHWORKS TO BE COMPLETED DURING PERIODS OF FINE DRY WEATHER WHERE POSSIBLE.
3. EXPOSED SUBGRADE TO BE LIMITED AND PROGRESSIVE STABILISATION TO BE IMPLEMENTED WHERE POSSIBLE.
4. EARTHWORK AREAS OUTSIDE OF EROSION & SEDIMENT CONTROL STAGES INVOLVING MINOR EARTHWORKS AND WILL BE COMPLETED UTILISING A CUT AND COVER METHODOLOGY. ANY EXPOSED SUBGRADE WILL BE SIMULTANEOUSLY STABILISED WITH METAL OR TOPSOILED, GRASS SEEDED AND HESSIAN MATTING PINNED.
5. REFER DRAWING EW-117 - EW-119 FOR SEDIMENT CONTROL DETAILS.

| No. | Revision | Drawn | Chk. | Appd. | Date |
|---|---|---|---|---|---|
| E | CATCHMENT AREA & BUND NOTE ADDED | MS | PF | IH | MAR 2022 |
| D | EDA AREAS ADDED | MS | PF | IH | MAR 2022 |
| C | SRP 1 & 3 REVISED DIMENSIONS | MS | PF | IH | MAR 2022 |
| B | DEB'S CHANGED TO SEDIMENT PONDS | MS | PF | IH | MAR 2022 |
| A | SEDIMENT CONTROL DETAILS REVISED | MS | PF | IH | FEB 2022 |

Hutchinson
PO Box 150, Orewa 0946
154 Centreway Road, Orewa 0931
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| | | |
|---|---|---|
| Design | M. SYMONS | FEB 2022 |
| Drawn | M. SYMONS | FEB 2022 |
| Checked | P. FARLEY | FEB 2022 |
| Approved | L HUTCHINSON | FEB 2022 |
| Scale | 1:1,500 @ A3 | |
| Scale vert. exag. | | |

Project: CABRA RURAL DEVELOPMENTS & RAHOPARA FARMS LTD
PALLISER DOWNS STAGE 2 (2021)
PALLISER DOWNS DRIVE
WAINUI
ENGINEERING PLAN APPROVAL

Title: ROAD 1 EROSION & SEDIMENT CONTROL PLAN

Sheet No.: EW-114

Job No.: A3-24066 EPA

Rev.: E

CMW Geosciences
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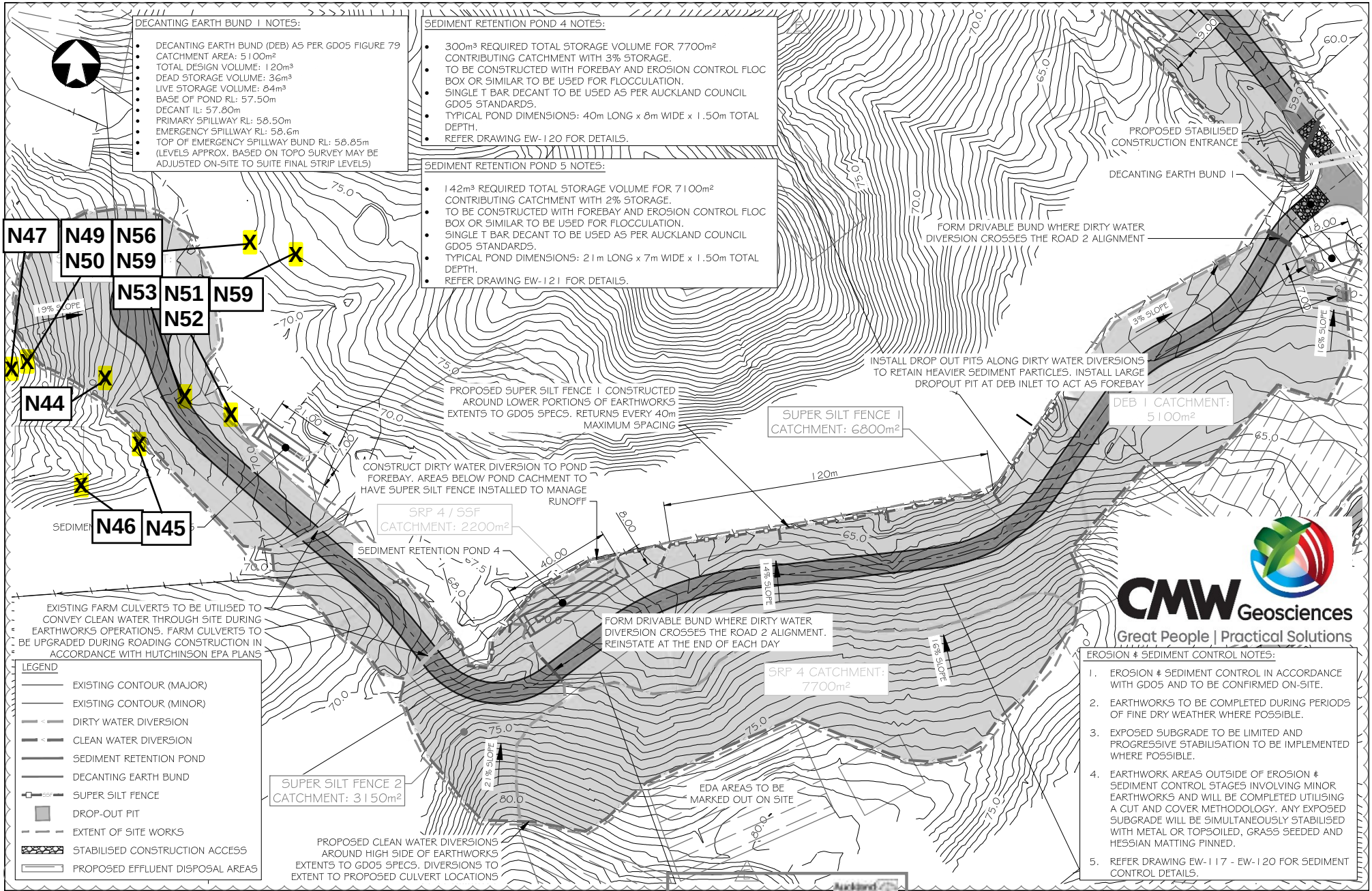


| No. | Revision | Drawn | Chk. | Appd. | Date |
|---|---|---|---|---|---|
| E | EDA AREAS ADDED | MS | PF | IH | MAR 2022 |
| D | SRP 4 & SILT FENCE CATCHMENTS CLOSED UP | MS | PF | IH | MAR 2022 |
| C | DEB 1 DROP OUT PIT & DRIVEABLE BUNDS ADDED. EXISTING CULVERTS TO BE UTILISED FOR CLEAN WATER | MS | PF | IH | MAR 2022 |
| B | DEB 4 UPDATED TO SEDIMENT POND 5 | MS | PF | IH | MAR 2022 |
| A | SEDIMENT CONTROL DETAILS REVISED | MS | PF | IH | FEB 2022 |

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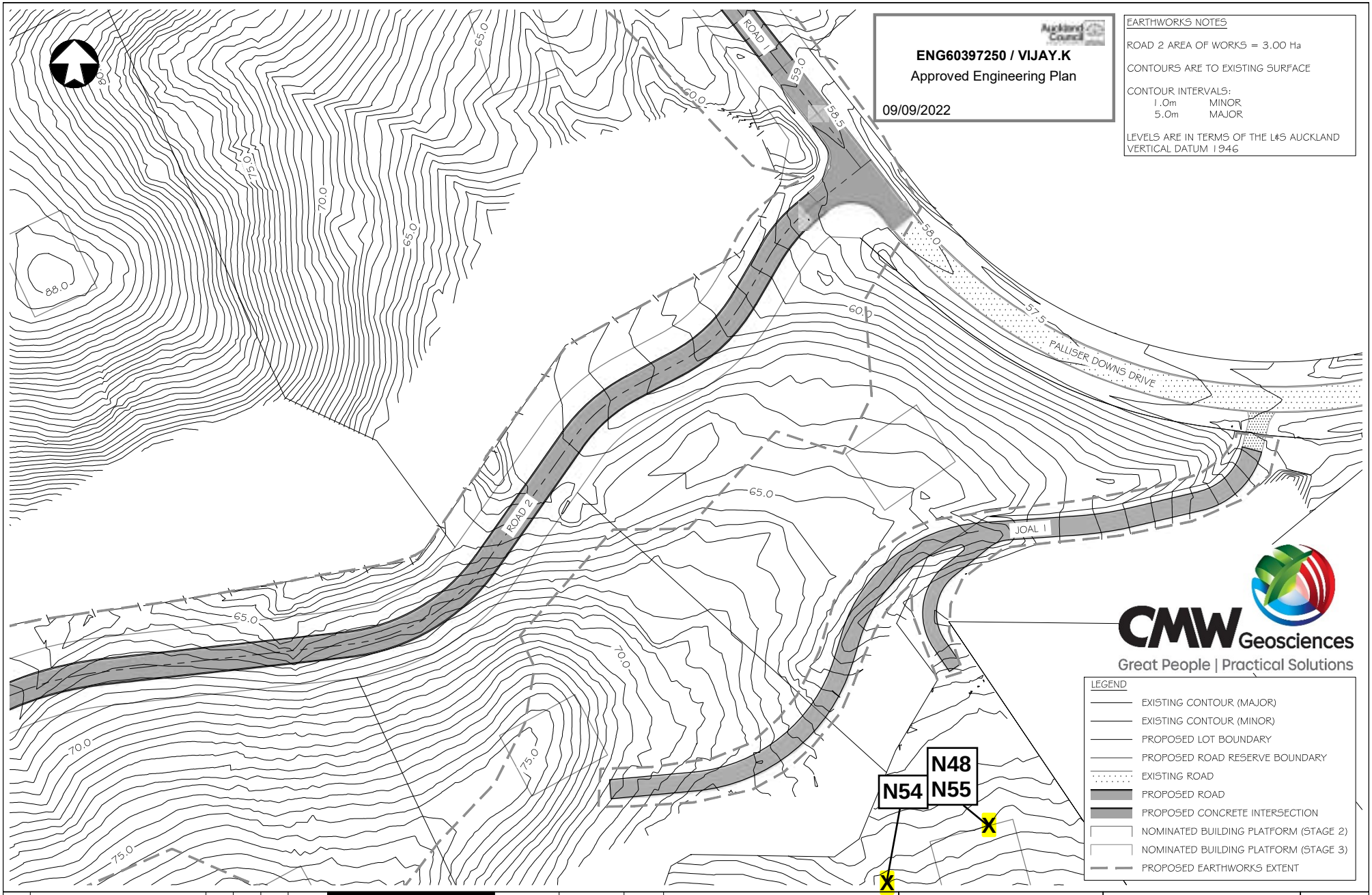
| | | |
|---|---|---|
| Design | M. SYMONS | FEB 2022 |
| Drawn | M. SYMONS | FEB 2022 |
| Checked | P. FARLEY | FEB 2022 |
| Approved | I. HUTCHINSON | FEB 2022 |
| Scale | 1:1250 @ A3 | |
| Scale vert. exag. | | |

Auckland Council
ENG60397250 / VIJAY.K
Approved Engineering Plan
09/09/2022

| | |
|---|---|
| Project | CABRA RURAL DEVELOPMENTS & RAHOPARA FARMS LTD PALLISER DOWNS STAGE 2 (2021) PALLISER DOWNS DRIVE WAINUI ENGINEERING PLAN APPROVAL |
| Title | ROAD 2 EROSION & SEDIMENT CONTROL PLAN |
| Sheet No. | EW-115 |
| Job No. | A3-24066 EPA |
| Rev. | E |




| No. | Revision | Drawn | Chk. | Appd. | Date |
|---|---|---|---|---|---|
| - | ISSUE FOR EPA APPROVAL | - | - | - | FEB 2022 |

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| Design | M. SYMONS | FEB 2022 |
| Drawn | M. SYMONS | FEB 2022 |
| Checked | P. FARLEY | FEB 2022 |
| Approved | L HUTCHINSON | FEB 2022 |
| Scale | 1:1000 @ A3 | |
| Scale vert. exag. | | |

Project
CABRA RURAL DEVELOPMENTS & RAHOPARA FARMS LTD
PALLISER DOWNS STAGE 2 (2021)
PALLISER DOWNS DRIVE
WAINUI
ENGINEERING PLAN APPROVAL

Title
ROAD 2 EXISTING CONTOUR PLAN - SHEET 1 OF 2

Sheet No.
EW-103

Job No.
A3-24066 EPA

Rev.
-

# LF14 Dynamic Cone Penetration (DCP) Test Report (Rev 16)

NZS 4402: 1988 Test 6.5.2

| | |
|---|---|
| **Project:** | Palliser Downs |
| **Project No:** | AKL2019-0017 |
| **Location:** | Wainui |
| **Report No:** | AKL2019-0017LAE Rev.1 |
| **Test Date:** | 16/03/2023 |
| **Tested By:** | PH/DW |
| **Client:** | Cabra Rural Developments Limited |
| **Client Address:** | 3 Alice Ave, Orewa 0931 |
| **CBR Test Calculation:** | Austroads (2010) (fine grained cohesive) |


Auckland Laboratory
CMW Geotechnical NZ Limited
11/63, Arrenway Drive, Rosedale, NZ 0632
PO Box 300206, Albany, Auckland, NZ 0752
Phone: +64 (09) 4144 632


Testing Locations Selected By: CMW Field Staff

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

*** Equivalent CBR Values are not accredited and are outside the scope of the laboratory's accreditation**

| Test No | 11 | | 12 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Location | Road 2 | | Road 2 | | | | | | | |
| Chainage & Offset | CH580 +5m KL R | | CH600 +1.5m KL C | | | | | | | |
| Material & Layer | Post Stabilised | | Post Stabilised | | | | | | | |
| Depth (mm) | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* |
| 0 - 100 | 7 | 15 | 8 | 18 | | | | | | |
| 100 - 200 | 4 | 8 | 6 | 13 | | | | | | |
| 200 - 300 | 4 | 8 | 4 | 8 | | | | | | |
| 300 - 400 | 3 | 6 | 3 | 6 | | | | | | |
| 400 - 500 | 2 | 4 | 2 | 4 | | | | | | |
| 500 - 600 | 2 | 4 | 2 | 4 | | | | | | |
| 600 - 700 | 2 | 4 | 2 | 4 | | | | | | |
| 700 - 800 | 2 | 4 | 2 | 4 | | | | | | |
| 800 - 900 | 2 | 4 | 2 | 4 | | | | | | |
| 900 - 1000 | | | | | | | | | | |

| Test No | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Location | | | | | | | | | | |
| Chainage & Offset | | | | | | | | | | |
| Material & Layer | | | | | | | | | | |
| Depth | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* |
| 0 - 100 | | | | | | | | | | |
| 100 - 200 | | | | | | | | | | |
| 200 - 300 | | | | | | | | | | |
| 300 - 400 | | | | | | | | | | |
| 400 - 500 | | | | | | | | | | |
| 500 - 600 | | | | | | | | | | |
| 600 - 700 | | | | | | | | | | |
| 700 - 800 | | | | | | | | | | |
| 800 - 900 | | | | | | | | | | |
| 900 - 1000 | | | | | | | | | | |

This report replaces reports numbered AKL2019-0017LAD Rev.0 - **Master Site Plan updated, no change to point location**

Created by: RS Date: 20/03/2023

Checked by: JP Date: 6/03/2024

Authorised Signatory (KTP): JLM Date: 6/03/2024



* Equivalent CBR values are taken from Fig 5.3, Austroads Guide to Pavement Technology, Part 2: Pavement Structural Design, Austroads 2010. Values are relevant to fine grained soils only.

# LF14 Dynamic Cone Penetration (DCP) Test Report (Rev 16)

NZS 4402: 1988 Test 6.5.2

| | |
|---|---|
| **Project:** | Palliser Downs |
| **Project No:** | AKL2019-0017 |
| **Location:** | Wainui |
| **Report No:** | AKL2019-0017LAE Rev.1 |
| **Test Date:** | 16/03/2023 |
| **Tested By:** | PH/DW |
| **Client:** | Cabra Rural Developments Limited |
| **Client Address:** | 3 Alice Ave, Orewa 0931 |
| **CBR Test Calculation:** | Austroads (2010) (fine grained cohesive) |


Auckland Laboratory
CMW Geotechnical NZ Limited
11/63, Arrenway Drive, Rosedale, NZ 0632
PO Box 300206, Albany, Auckland, NZ 0752
Phone: +64 (09) 4144 632


Testing Locations Selected By: CMW Field Staff

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

*** Equivalent CBR Values are not accredited and are outside the scope of the laboratory's accreditation**

| Test No | 1 | | 2 | | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Location | Road 2 | | Road 2 | | Road 2 | | Road 2 | | Road 2 | |
| Chainage & Offset | CH400 R | | CH420 +1.5m L | | CH440 +1.5m R | | CH460 +1.5m L | | CH480 +1.5m R | |
| Material & Layer | Post Stabilised | | Post Stabilised | | Post Stabilised | | Post Stabilised | | Post Stabilised | |
| Depth (mm) | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* |
| 0 - 100 | 8 | 18 | 12 | 20+ | 9 | 20 | 7 | 15 | 10 | 20+ |
| 100 - 200 | 5 | 10 | 6 | 13 | 5 | 10 | 5 | 10 | 5 | 10 |
| 200 - 300 | 5 | 10 | 4 | 8 | 3 | 6 | 4 | 8 | 5 | 10 |
| 300 - 400 | 4 | 8 | 3 | 6 | 3 | 6 | 4 | 8 | 3 | 6 |
| 400 - 500 | 3 | 6 | 2 | 4 | 2 | 4 | 3 | 6 | 2 | 4 |
| 500 - 600 | 2 | 4 | 2 | 4 | 1 | 2 | 2 | 4 | 2 | 4 |
| 600 - 700 | 3 | 6 | 2 | 4 | 1 | 2 | 2 | 4 | 2 | 4 |
| 700 - 800 | 2 | 4 | 2 | 4 | 1 | 2 | 1 | 2 | 2 | 4 |
| 800 - 900 | 2 | 4 | 2 | 4 | 1 | 2 | 1 | 2 | 2 | 4 |
| 900 - 1000 | 2 | 4 | 2 | 4 | 1 | 2 | | | | |

| Test No | 6 | | 7 | | 8 | | 9 | | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Location | Road 2 | | Road 2 | | Road 2 | | Road 2 | | Road 2 | |
| Chainage & Offset | CH500 +1.5m L | | CH520 +1.5m L | | CH450 +1.5m R | | CH560 C | | CH580 +5m KL L | |
| Material & Layer | Post Stabilised | | Post Stabilised | | Post Stabilised | | Post Stabilised | | Post Stabilised | |
| Depth | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* | Blow Count | Equiv CBR* |
| 0 - 100 | 8 | 18 | 8 | 18 | 11 | 20+ | 6 | 13 | 8 | 18 |
| 100 - 200 | 5 | 10 | 4 | 8 | 6 | 13 | 4 | 8 | 4 | 8 |
| 200 - 300 | 4 | 8 | 3 | 6 | 4 | 8 | 3 | 6 | 3 | 6 |
| 300 - 400 | 3 | 6 | 3 | 6 | 4 | 8 | 3 | 6 | 3 | 6 |
| 400 - 500 | 2 | 4 | 2 | 4 | 4 | 8 | 2 | 4 | 2 | 4 |
| 500 - 600 | 2 | 4 | 2 | 4 | 3 | 6 | 2 | 4 | 2 | 4 |
| 600 - 700 | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 4 |
| 700 - 800 | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 4 |
| 800 - 900 | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 4 |
| 900 - 1000 | | | 2 | 4 | 2 | 4 | 2 | 4 | | |

This report replaces reports numbered AKL2019-0017LAD Rev.0 - **Master Site Plan updated, no change to point location**

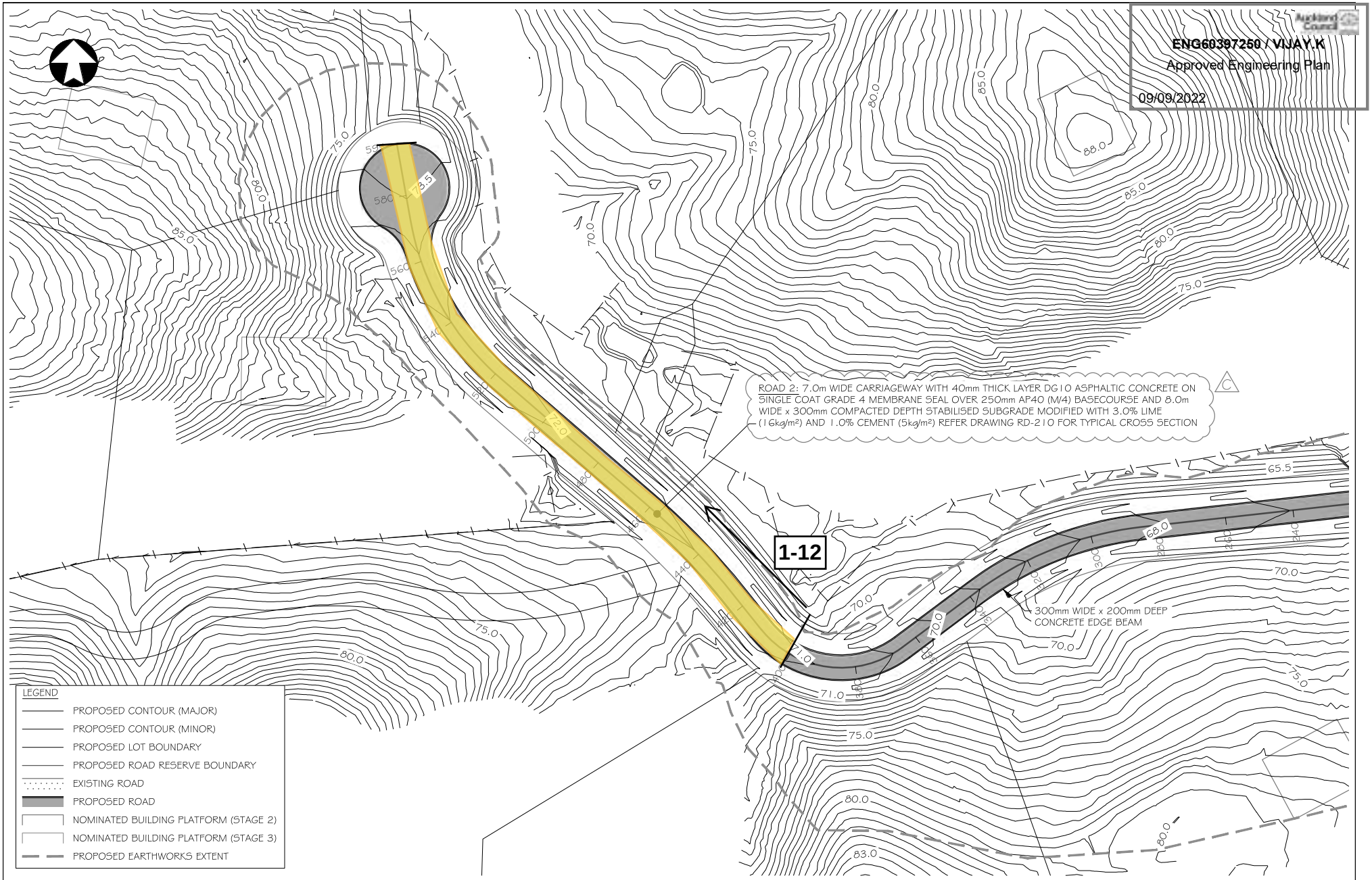
This report should only be reproduced in full

Created by: RS Date: 20/03/2023

Checked by: JP Date: 6/03/2024

Authorised Signatory (KTP): JLM Date: 6/03/2024

* Equivalent CBR values are taken from Fig 5.3, Austroads Guide to Pavement Technology, Part 2: Pavement Structural Design, Austroads 2010. Values are relevant to fine grained soils only.




| No. | Revision | Drawn | Chk. | Appd. | Date |
|---|---|---|---|---|---|
| C | BASECOURSE DEPTH INCREASED TO 250mm | MS | PF | IH | AUG 2022 |
| B | AC MIX CHANGED FROM DG10 TO DG10 | MS | PF | IH | MAY 2022 |
| A | ROAD 2 REVISED LEVELS | MS | PF | IH | APR 2022 |
| - | ISSUE FOR EPA APPROVAL | - | - | - | FEB 2022 |

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154 Centreway Road, Orewa 0931
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| | | |
|---|---|---|
| Design | M. SYMONS | FEB 2022 |
| Drawn | M. SYMONS | FEB 2022 |
| Checked | P. FARLEY | FEB 2022 |
| Approved | L HUTCHINSON | FEB 2022 |
| Scale | 1:1000 @ A3 | |
| Scale vert. exag. | | |

Project
CABRA RURAL DEVELOPMENTS & RAHOPARA FARMS LTD
PALLISER DOWNS STAGE 2 (2021)
PALLISER DOWNS DRIVE
WAINUI
ENGINEERING PLAN APPROVAL

Title
PROPOSED ROAD 2 LAYOUT PLAN - SHEET 2 OF 2

Sheet No.
RD-204

Job No.
A3-24066 EPA

Rev.
C

# APPENDIX F: STABILITY SUPPLEMENT

| SITE INVESTIGATION AND SLOPE STABILITY ASSESSMENT | | | |
|---|---|---|---|
| **Project:** | Palliser Downs Stage 1A | **Job Number:** | AKL2019-0017 |
| **Site Address:** | Palliser Downs Drive, Wainui | **Client:** | Cabra Rural Developments Limited/Rahopara Farms Limited |
| **Prepared by:** | Navneel Karan | **Reviewed by:** | Richard Knowles |

# 1 INTRODUCTION

CMW Geosciences (CMW) was engaged by Cabra Rural Developments Limited / Rahopara Farms Limited to carry geotechnical investigations of a site located at Palliser Downs, which is being considered for a rural subdivision, in particular Lots 33 to 37 comprising Stage 1A, to verify earthworks meet geotechnical requirements.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter referenced AKL2019-0017AB, Rev. 0 dated 31 May 2021.

This report is to support a resource consent application to Auckland Council and provides the basis for elements of the Statement of Professional Opinion provided in the Geotechnical Completion Report AKL2019-0017AF Rev. 0, dated 6 September 2023.

# 2 SITE DETAILS

The site comprises an area of approximately 111,1260 $m^2$ and is located Palliser Downs Drive, Weranui as shown in ***Figure 1.***

Details of the site are as follows:

- Legal description is Lot 1 DP 556774, Lot 2 DP 556774.
- Lots 33 to 37 at the southern end of the development comprise Stage 1A .
- The site is bound by Palliser Downs Drive and residential dwellings east, rural land to the north, west and south.
- Historical aerial photographs[1] show the site remained rural and farmland up until the current development.

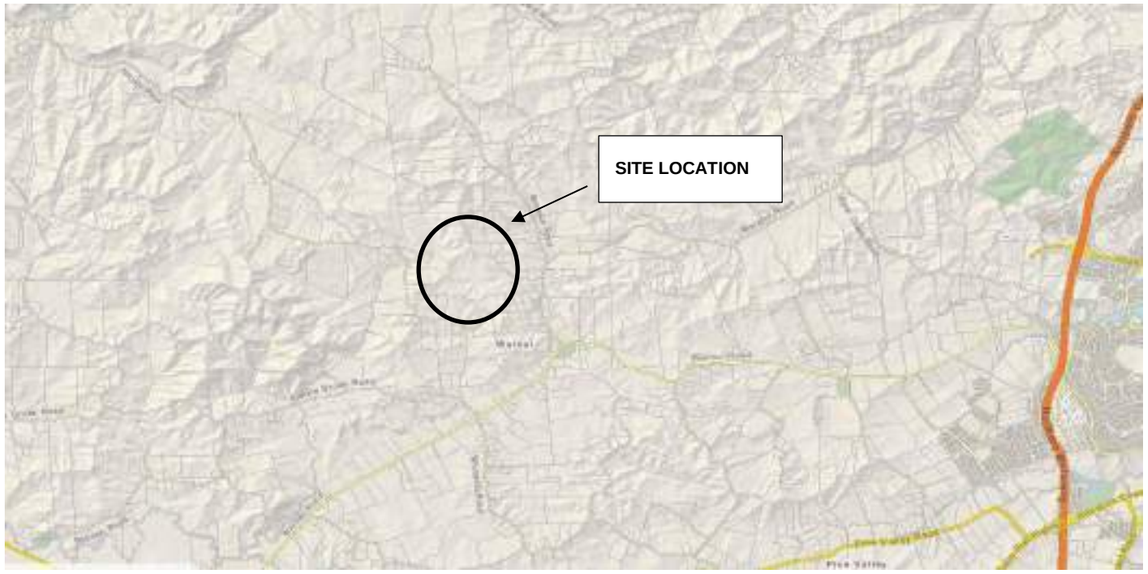



**Figure 1:** Site Location Plan (Auckland Council GIS Geomaps)

[1] Retrolens website, Sourced from http://retrolens.nz and licensed by LINZ CC-BY 3.0

# 3 INVESTIGATION

## 3.1 Field Investigation

The field investigation was carried out in two phases in November 2021 and June 2023 during summer and winter weather conditions. The scope of fieldwork completed is shown below:

| Investigation Summary | | | |
|---|---|---|---|
| **Test ID** | **Test Type** | **Depth (m)** | **Samples[1]** |
| **HA09-21 to HA13-21** | Hand Auger Boreholes | 2.2-3.9 | - |
| **GCR01-23 to GCR08-23** | Geotechnical Completion Report (GCR) Hand Auger Borehole | 2.0 | 4 x Expansives |
| **HA01-24 to HA05-24** | Hand Auger Boreholes | 2.0 | - |
| **Notes:** [1]Refer Section 6.3 for details | | | |

Engineering logs of the relevant investigations are appended.

The approximate locations of the respective investigation sites referred to above are shown in ***Figure 2.***

# 4 GEOLOGY

## 4.1 Published Geology

Published geological maps[2] for the area depict the regional geology for the area as comprising Hukerenui Mudstone (Mangakahia Complex) of the Northland Allochthon Group with Alluvium found in gullies and streams as illustrated in *Error! Reference source not found.**3***.

The main geohazards associated with these geological units are presented below:

| Published Geology Summary | | | |
|---|---|---|---|
| **Geological Unit** | **Location** | **Behaviour** | **Principal Potential Geohazards** |
| **Tauranga Group Alluvium/ Colluvium** | Mapped in low-lying areas around adjacent streams | Unconsolidated organic deposits and clays will usually subside if unsupported or overloaded.<br>Susceptible to soil creep and shallow flows on gentle slopes, particularly when saturated. | Load-induced settlement |
| **Hukerenui Mudstone**<br>**(part of the Mangakahia Complex of the Northland Allochthon)** | Predominant geology as per published maps. | High plasticity clays prone to debris sliding and deep-seated creep, even on gentle slopes. | Landslips |

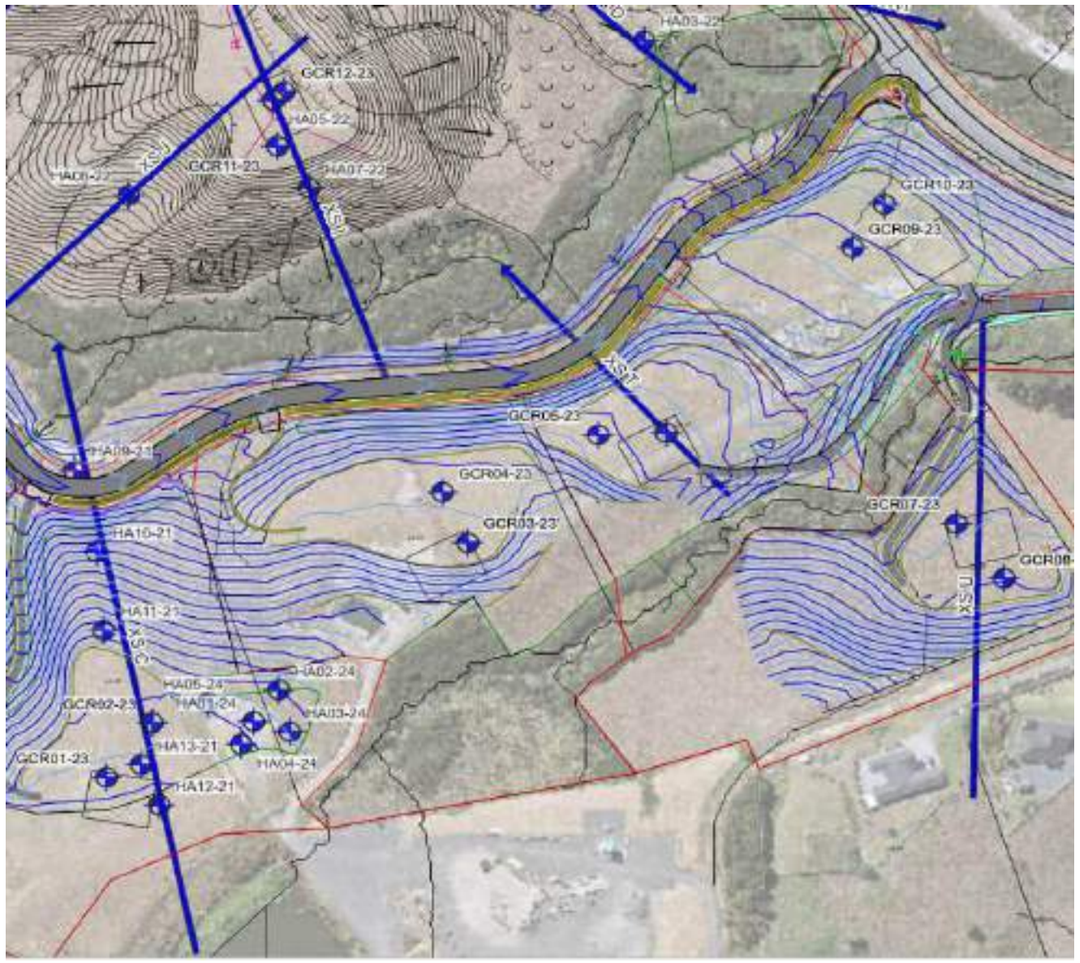



**Figure 2:** Site Investigation Plan

[2] Edbrooke, S. W. (compiler) 2001: Geology of the Auckland area. Institute of Geological & Nuclear Sciences 1:250 000 geological map 3. 1 sheet +74 p. Lower Hutt, New Zealand. Institute of Geological & Nuclear Sciences.

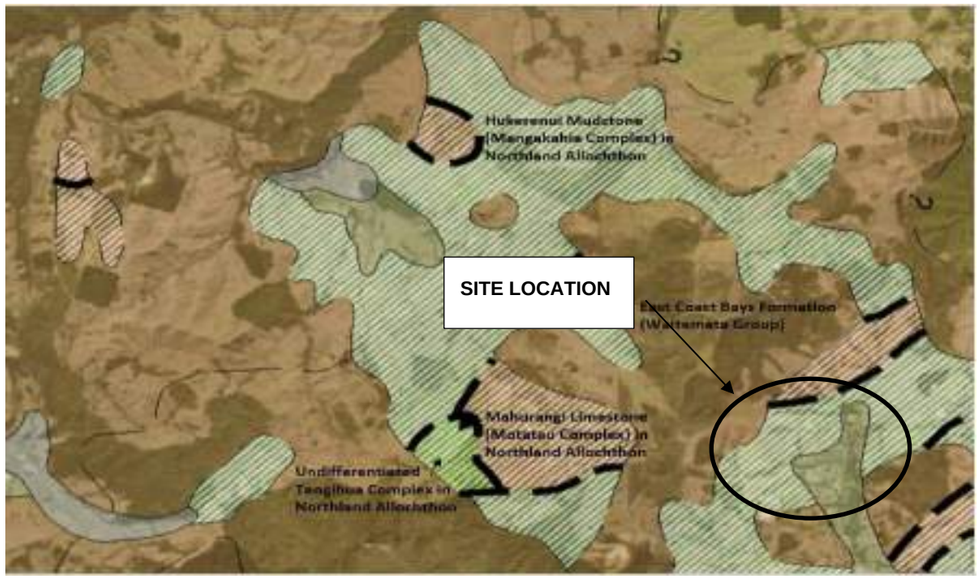



**Figure 3:** Regional Geological Map (GNS Geology)

# 5 DESIGN CRITERIA

The stability of cut batters and fill embankments under a range of design conditions is expressed in terms of a factor of safety, which is defined as the ratio of forces resisting failure to the forces causing failure. The following performance standards are recommended for slope stability assessment:

| Slope Stability Minimum Factor of Safety Criteria | | |
|---|---|---|
| **Condition** | **Building Platforms** | **Amenity or Low Risk Areas** |
| **Normal Groundwater Condition** | 1.5 | 1.2 |
| **Extreme (worst credible) groundwater condition** | 1.3 | 1.1 |
| **Seismic condition for ULS PGA (calculated as 0.19g)** | 1.0 | N/A or 1.0 |

# 6 DESIGN PARAMETERS

| Geotechnical Design Parameters | | | | | |
|---|---|---|---|---|---|
| **Unit Description** | **Strength Range** | **γ (kN/m³)** | **c´ (kPa)** | **ϕ´ (deg)** | **$S_u$ (kPa)** |
| **Engineered Fill** | 100-200kPa | 17.5 | 8 | 28 | 100 |
| **Alluvium (Tauranga Group)** | 60-90kPa | 18 | 4 | 22 | 60 |
| **Hukerenui Residual Soils (Northland Allochthon)** | 89 – 120 kPa | 17 | 5 | 26 | 60 |
| **Hukerenui Transition Zone (Northland Allochthon)** | 15-20 blows/ 100mm | 18 | 6 | 12 | 125 |
| **Hukerenui Parent Rock (Northland Allochthon)** | N = 50+ | 20.5 | 20 | 28 | 150 |

Notes: γ = soil unit weight (conservative value determined from typical published values for similar soil types)
c´ = effective cohesion (conservative industry accepted values, CMW laboratory testing records and back analysis)
ϕ´ = effective friction angle (conservative industry accepted values, CMW laboratory testing records and back analysis)

# 7 METHODOLOGY

- Slope stability analyses were undertaken using the Morgenstern-Price method of slices under complex failure mechanisms using the proprietary software SLIDE Version 6.

# 8 INITIAL RESULTS

Slope stability analyses were undertaken on Sections C-C, T-T and U-U (see ***Figure 2).***

Results are appended to this memo and are summarised below for the proposed landform.

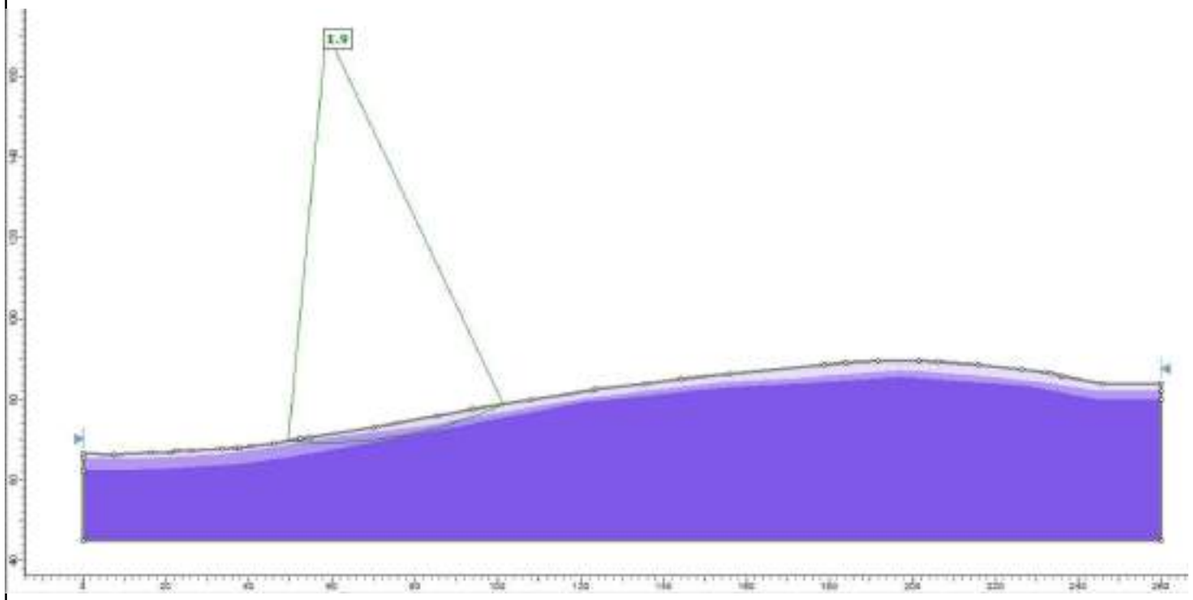
| Slope Stability Analysis Results – Minimum Factors of Safety | | | | | | |
|---|---|---|---|---|---|---|
| **Section** | **Stable Building Platforms** | | | **Amenity Areas** | | |
| | **Prevailing** | **Transient** | **Seismic** | **Prevailing** | **Transient** | **Seismic** |
| C-C | 2.6 | 1.9 | 2.1 | 1.3 | 1.1 | - |
| T-T | 1.6 | 1.5 | 2.2 | - | - | - |
| U-U | 2.1 | 1.8 | 2.2 | 1.4 | 1.2 | - |

Based on the slope stability analysis, required factors of safety were met for all three sections for all cases. The slip surface for Section C-C is striking through an area outside the building platform. In regard to the low factor of safety numbers for the normal groundwater and high groundwater case for Section U-U, are outside of the building platform and are considered to be within appropriate limits. No remediation required.

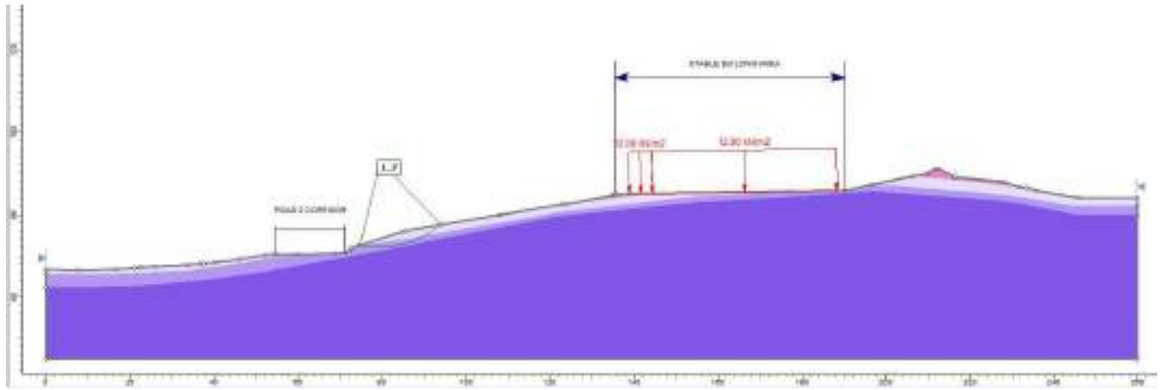
## Stability Analysis Summary Table

| | |
|---|---|
| Client: | Cabra Rural Developments Limited / Rahopara Farms Limited |
| Project: | Palliser Downs |
| Project Number | AKL2019-0017 |
| Date: | 25/09/2023 |
| Notes: | NGW = Normal Groundwater — Target minimum FoS = 1.5 |
| | HGW = High Groundwater (worst credible) — Target minimum FoS = 1.3 |
| | SEIS = Seismic — Target minimum FoS = 1.0 |

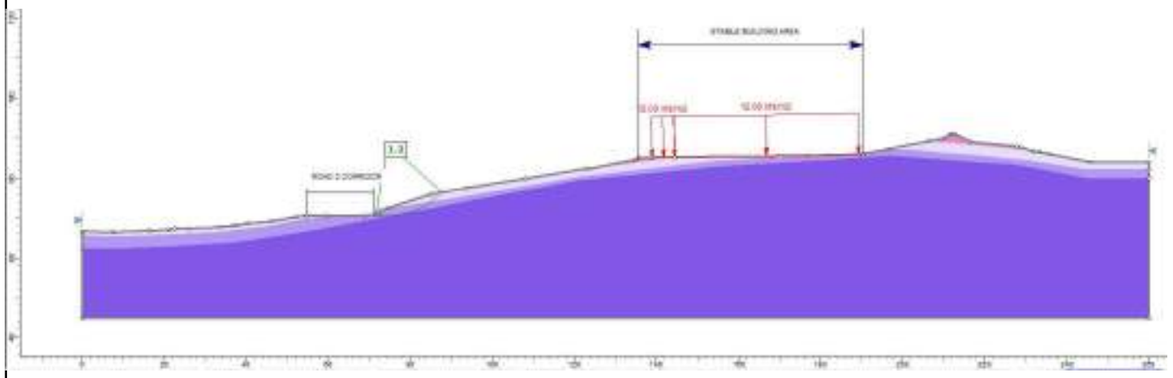
| Cross Section | Profile | Design Case | Analysis Type | Factor of Safety | Printout Included | Additional Comments |
|---|---|---|---|---|---|---|
| **Section C** | Back Analysis | HGW | Circular | 1.9 | ✓ | |
| | Proposed | NGW | Circular | 1.7 | ✓ | Meets FoS requirements |
| | | HGW | Circular | 1.2 | ✓ | Failing on area outside building platform |
| | | SEIS | Circular | 1.2 | ✓ | Meets FoS requirements |
| **Section C** | Back Analysis | HGW | Non-Circular (Block) | 1.9 | ✓ | |
| | Proposed | NGW | Non-Circular (Block) | 1.6 | ✓ | Meets FoS requirements |
| | | HGW | Non-Circular (Path) | 1.5 | ✓ | Meets FoS requirements |
| | | SEIS | Non-Circular (Path) | 2.1 | ✓ | Meets FoS requirements |
| **Section C** | Back Analysis | HGW | Non-Circular (Cuckoo) | 1.7 | ✓ | |
| | Proposed | NGW | Non-Circular (Cuckoo) | 1.3 | ✓ | Failing on area outside building platform |
| | | HGW | Non-Circular (Cuckoo) | 1.1 | ✓ | Failing on area outside building platform |
| | | SEIS | Non-Circular (Cuckoo) | 2.1 | ✓ | Meets FoS requirements |



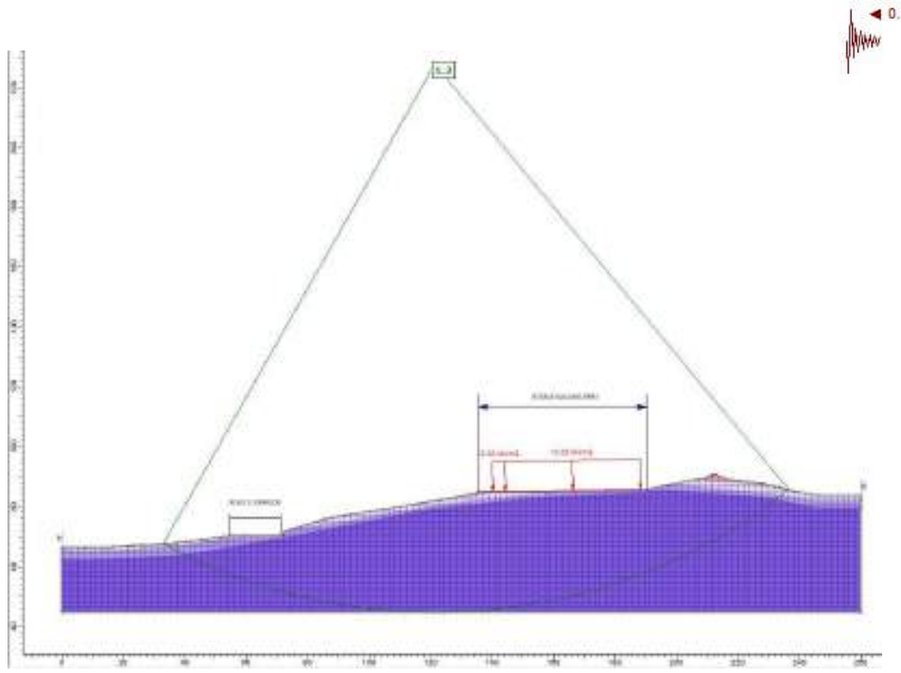

Section C - Back Analysis (Worst Case Scenario) (Circular)




Proposed Section C - Normal Groundwater Conditions (Circular)




Proposed Section C - High Groundwater Conditions (Circular)




Proposed Section C - Seismic Event (Circular)

| | | | |
|---|---|---|---|
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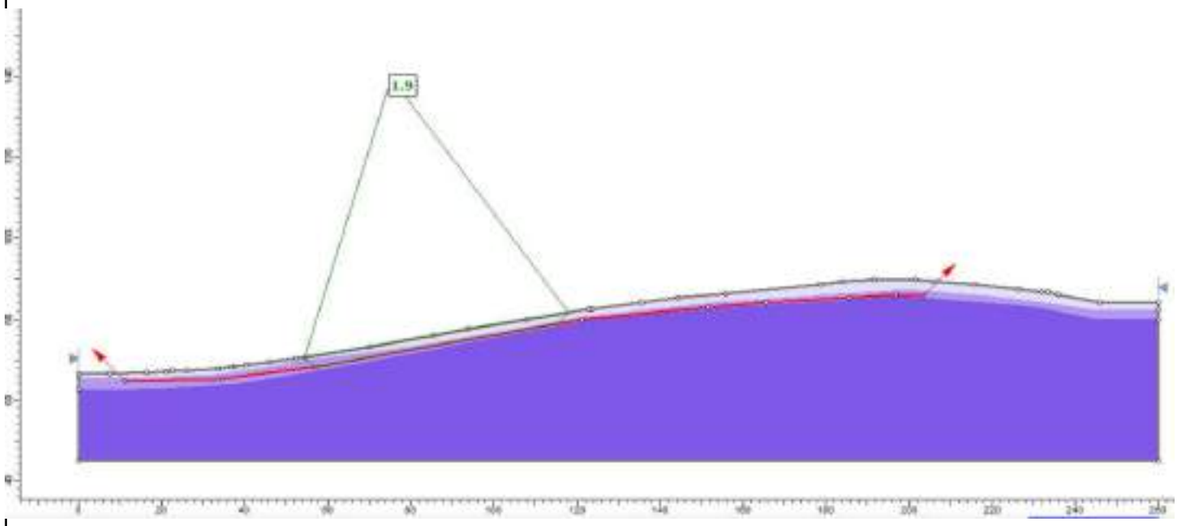
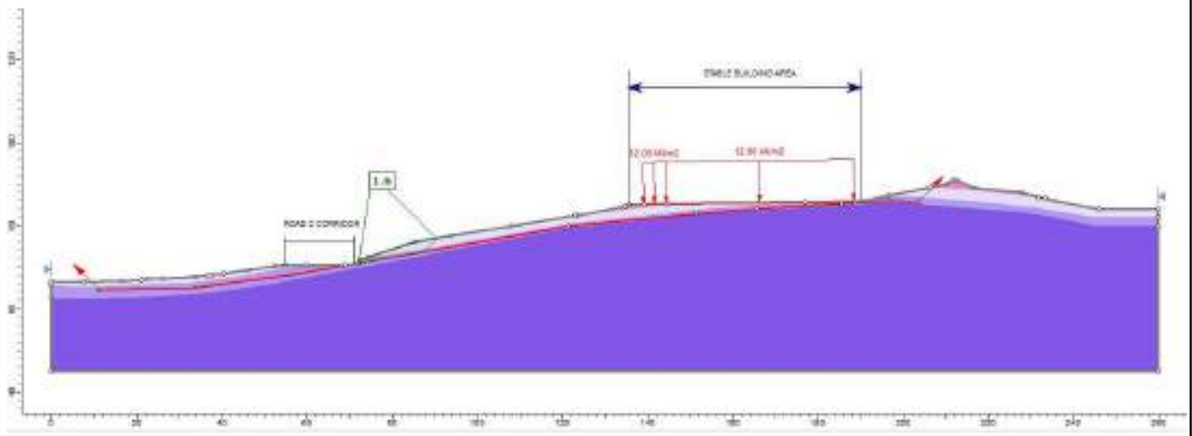
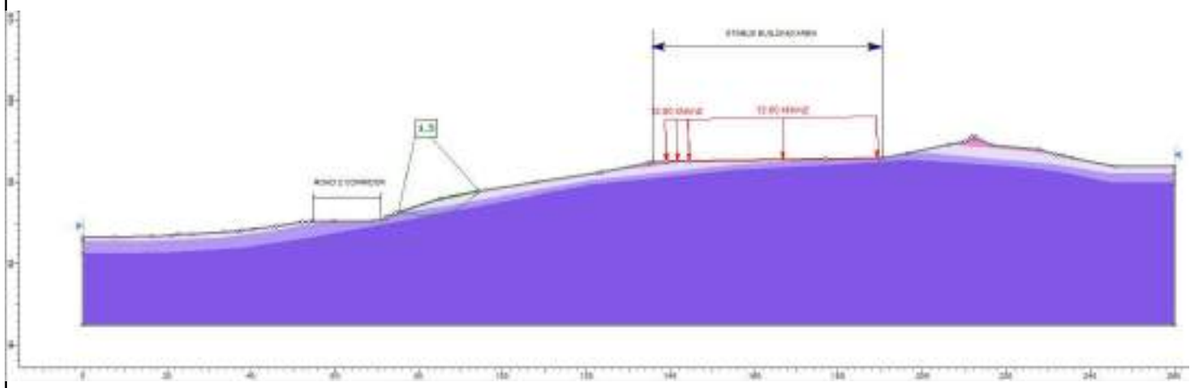
| | *Title* Section C | *Date* 18/10/2023 | *Drawing* STAB 01 |



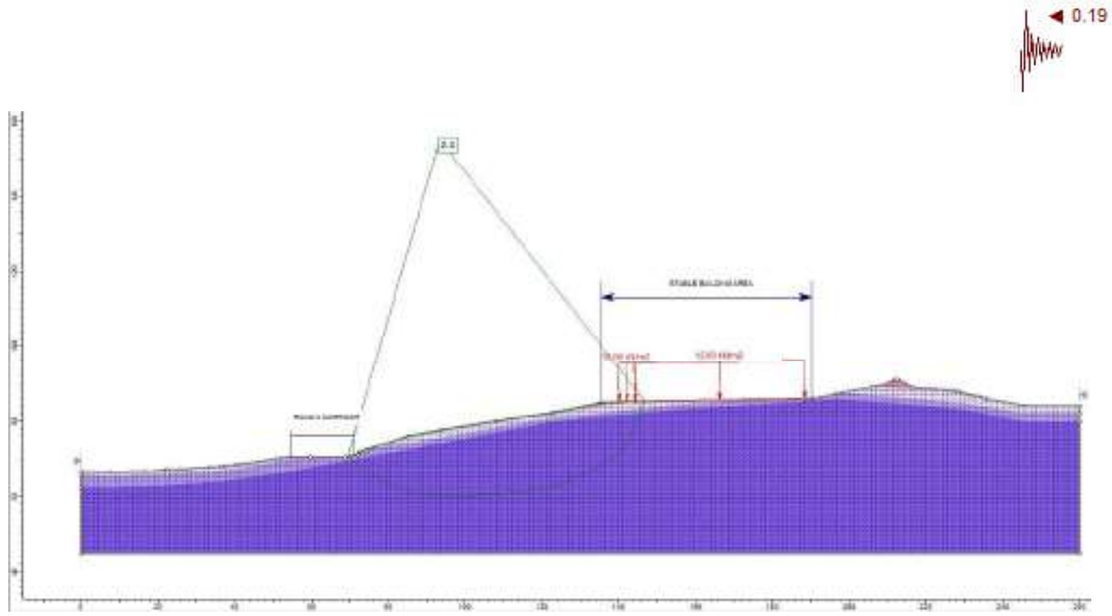

Section C - Back Analysis (Worst Case Scenario) (Non-circular, Block)




Proposed Section C - Normal Groundwater Conditions (Non-circular, Block)




Proposed Section C - High Groundwater Conditions (Non-circular, Block)




Proposed Section C - Seismic Event (Non-circular, Block)

| | | | |
|---|---|---|---|
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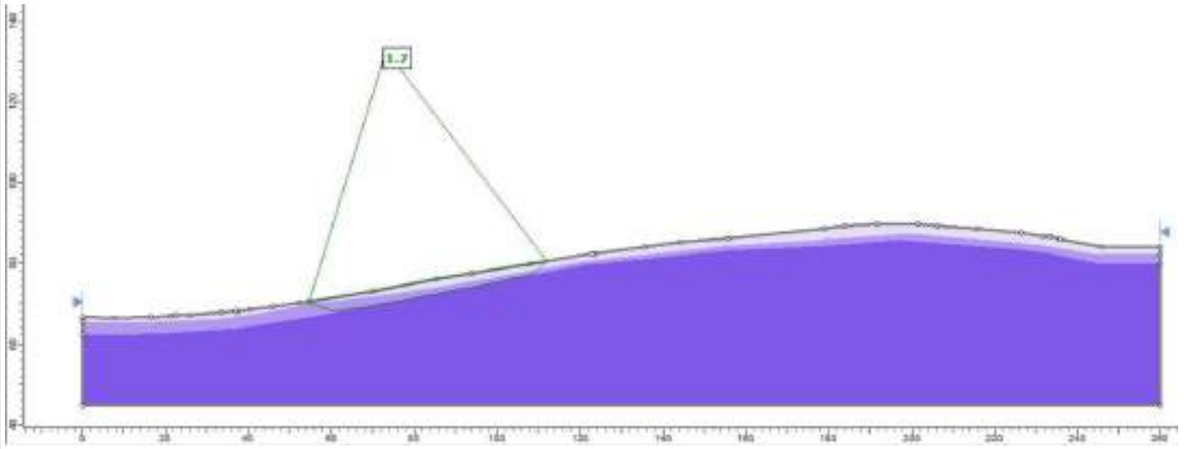
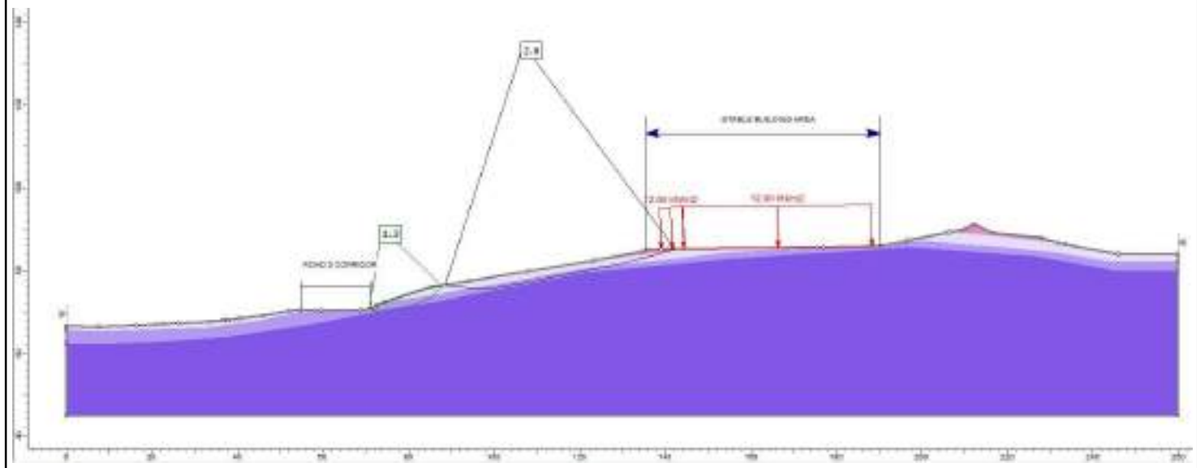
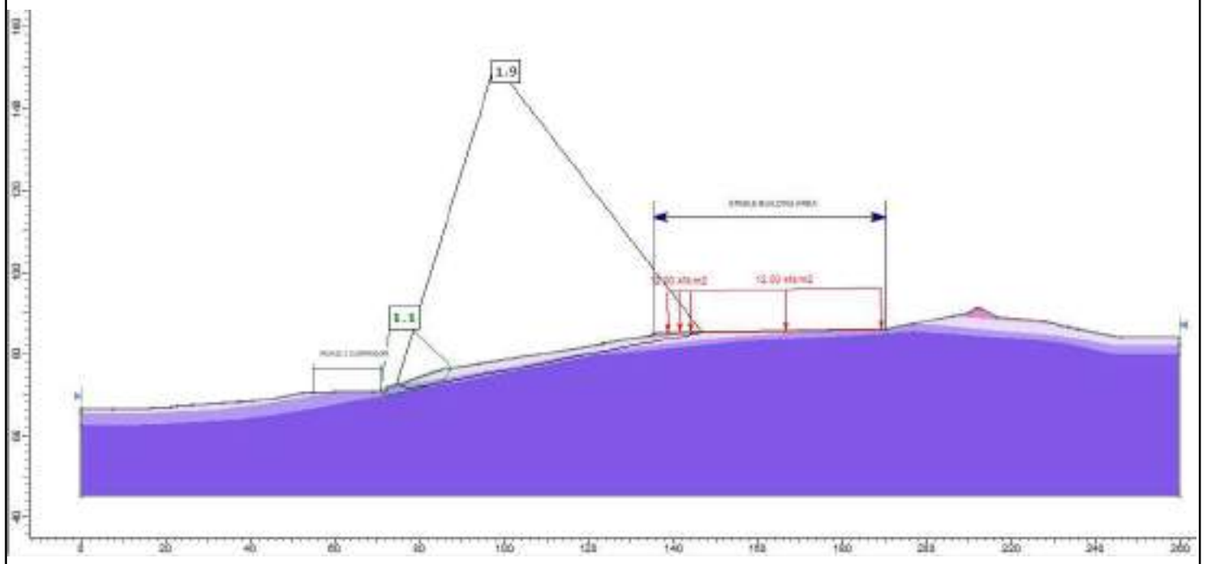
| | *Title*<br>Section C | *Date*<br>18/10/2023 | *Drawing*<br>STAB 02 |



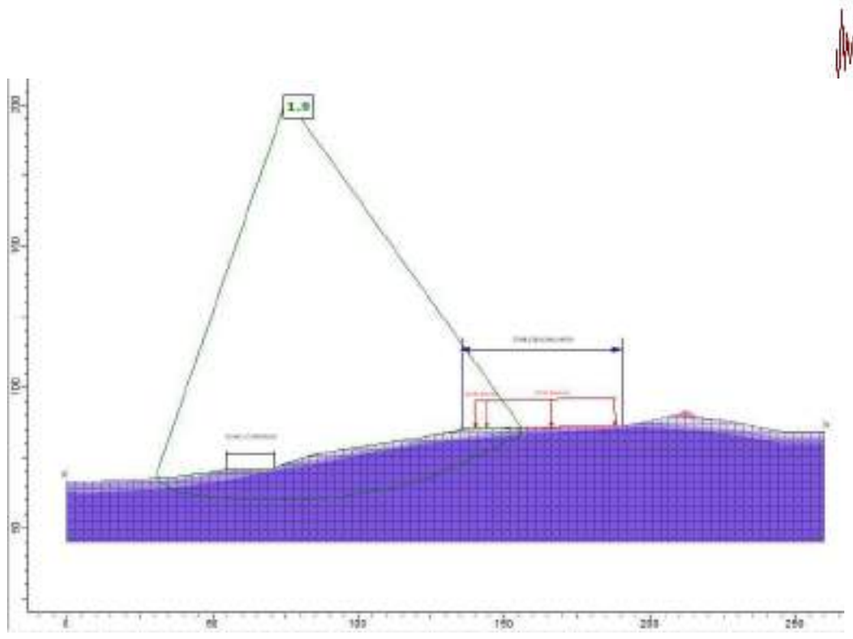

Section C - Back Analysis (Worst Case Scenario) (Non-circular, Cuckoo)




Proposed Section C - Normal Groundwater Conditions Non-circualr, Cuckoo)




Proposed Section C - High Groundwater Conditions (Non-circular, Cuckoo)




Proposed Section C - Seismic Event (Non-circular, Cuckoo)

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| | | |
|---|---|---|
| *Project* Palliser Downs | *Analysis* Non-circular (Cuckoo) | *Project No.* AKL2019-0017 |
| *Title* Section C | *Date* 18/10/2023 | *Drawing* STAB 03 |

| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (°) | Ru Value |
|---|---|---|---|---|---|---|
| Engineered Fill | | 18 | Mohr-Coulomb | 8 | 28 | 0.05 |
| Hukerenui Mudstone (NA) Residual Soils | | 17 | Mohr-Coulomb | 5 | 26 | 0.02 |
| Hukerenui Mudstone (NA) Transition Zone | | 18 | Mohr-Coulomb | 6 | 12 | 0.05 |
| Hukerenui Mudstone (NA) Parent Rock | | 20.5 | Mohr-Coulomb | 20 | 28 | 0 |

**Normal Groundwater Conditons Parameters**

| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (°) | Ru Value |
|---|---|---|---|---|---|---|
| Engineered Fill | | 18 | Mohr-Coulomb | 8 | 28 | 0.2 |
| Hukerenui Mudstone (NA) Residual Soils | | 17 | Mohr-Coulomb | 5 | 26 | 0.5 |
| Hukerenui Mudstone (NA) Transition Zone | | 18 | Mohr-Coulomb | 6 | 12 | 0.2 |
| Hukerenui Mudstone (NA) Parent Rock | | 20.5 | Mohr-Coulomb | 20 | 28 | 0 |

**High Groundwater Conditions Parameters**

| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Cohesion Type | Shear/ Normal Function | Ru Value |
|---|---|---|---|---|---|---|---|
| Engineered Fill (Undrained) | | 18 | Undrained | 100 | Constant | | 0.05 |
| Hukerenui Mudstone (NA) Residual Soils (Undrained) | | 17 | Undrained | 60 | Constant | | 0.2 |
| Hukerenui Mudstone (NA) Transition Zone (Undrained) | | 18 | Undrained | 125 | Constant | | 0.05 |
| Hukerenui Mudstone (NA) Parent Rock (Undrained) | | 20.5 | Shear/ Normal Function | | | Shear Normal | 0 |

**Seismic Parameters**

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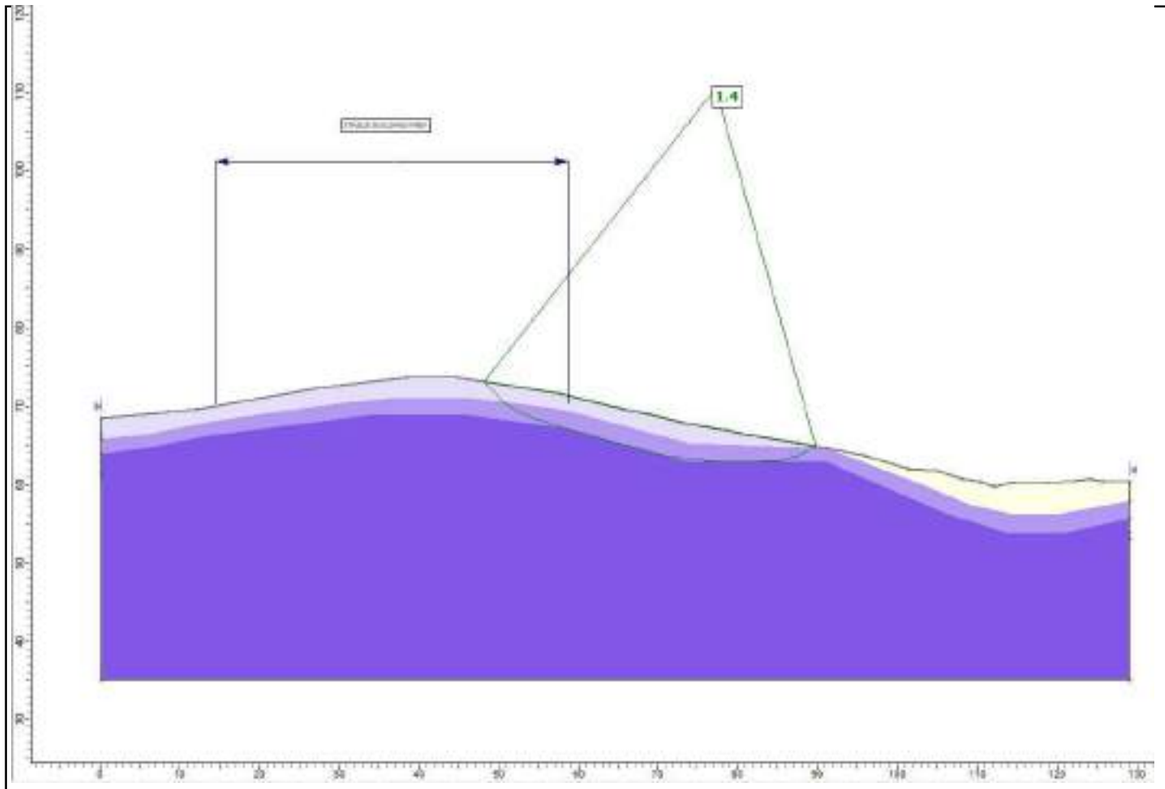
| | | | |
|---|---|---|---|
| *Project* Palliser Downs | *Analysis* | *Project No.* AKL2019-0017 | |
| *Title* Section C Parameters | *Date* 18/10/2023 | *Drawing* STAB 0 | |

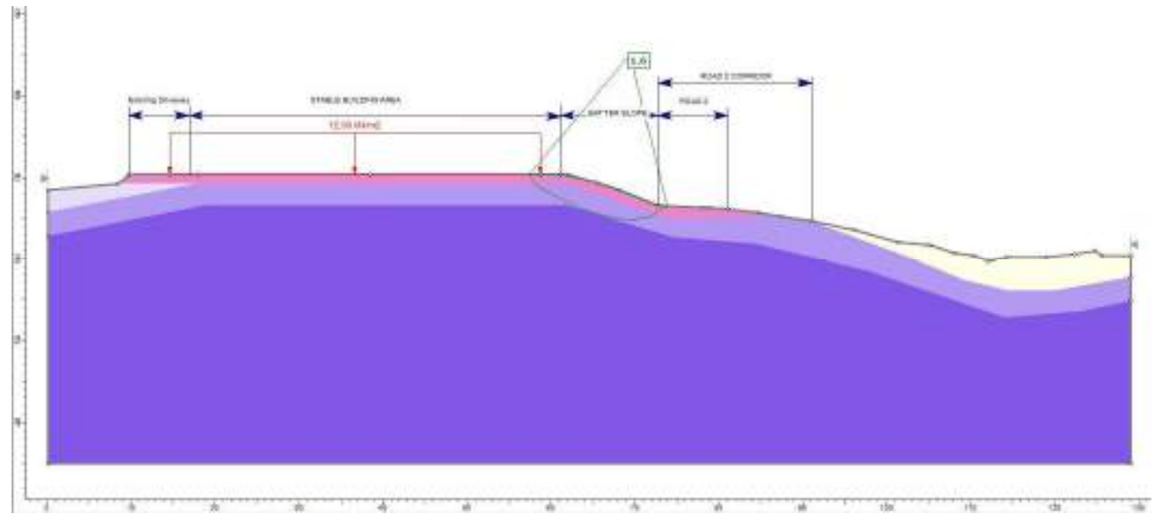
## Stability Analysis Summary Table

| | |
|---|---|
| Client: | Cabra Rural Developments Limited / Rahopara Farms Limited |
| Project: | Palliser Downs |
| Project Number | AKL2019-0017 |
| Date: | 25/09/2023 |
| Notes: | NGW = Normal Groundwater — Target minimum FoS = 1.5 |
| | HGW = High Groundwater (worst credible) — Target minimum FoS = 1.3 |
| | SEIS = Seismic — Target minimum FoS = 1.0 |

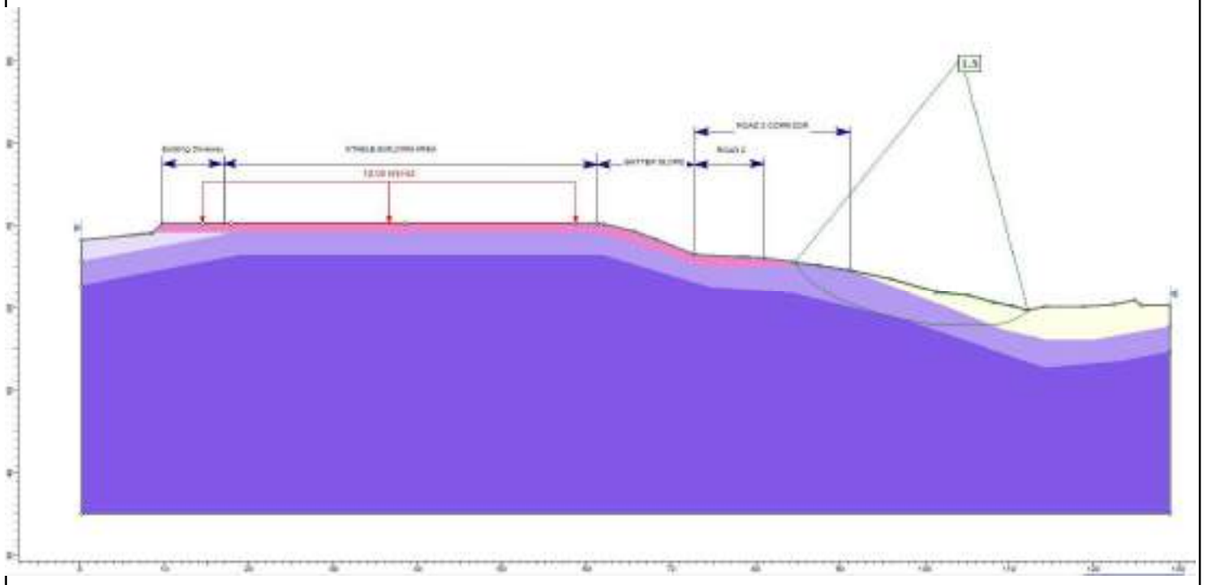
| Cross Section | Profile | Design Case | Analysis Type | Factor of Safety | Printout Included | Additional Comments |
|---|---|---|---|---|---|---|
| **Section T** | Back Analysis | HGW | Non-Circular | 1.4 | ✓ | |
| | Proposed | NGW | Non-Circular | 1.6 | ✓ | Fos required met |
| | | HGW | Non-Circular | 1.4 | ✓ | |
| | | SEIS | Non-Circular | 2.2 | ✓ | |
| **Section U** | Back Analysis | HGW | Non-Circular | 1.2 | ✓ | |
| | Proposed | NGW | Non-Circular | 1.4 | ✓ | Failure circles less than target minimum outside of building platform (Ammenity area) |
| | | HGW | Non-Circular | 1.2 | ✓ | |
| | | SEIS | Non-Circular | 2.2 | ✓ | |



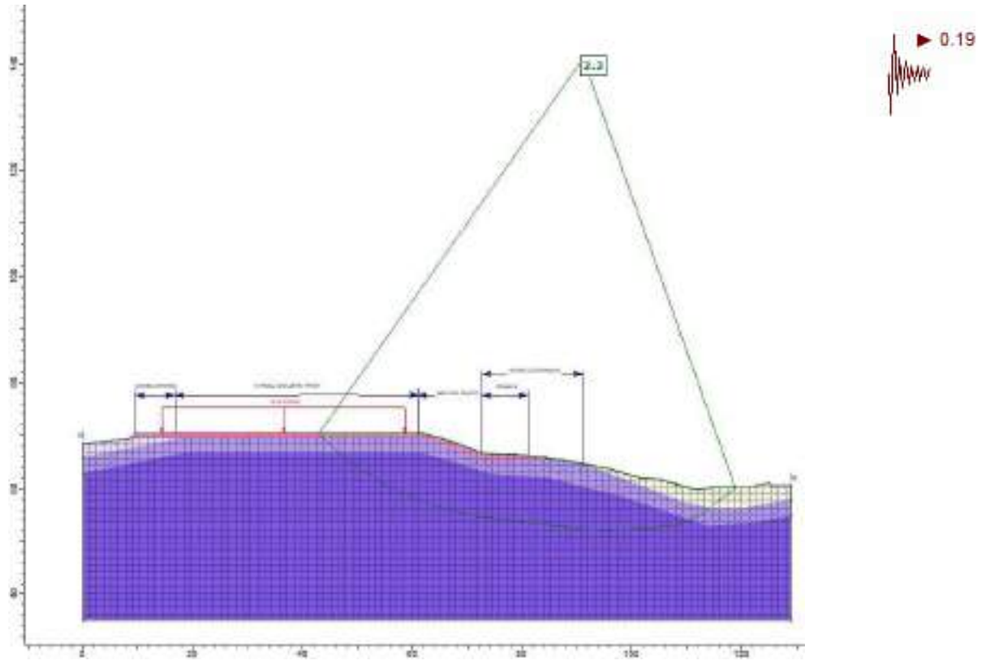

**Section T - Back Analysis (Worst Case Scenario)**




**Proposed Section T - Normal Groundwater Conditions**




**Proposed Section T - High Groundwater Conditions**




**Proposed Section T - Seismic Event**

| | | | |
|---|---|---|---|
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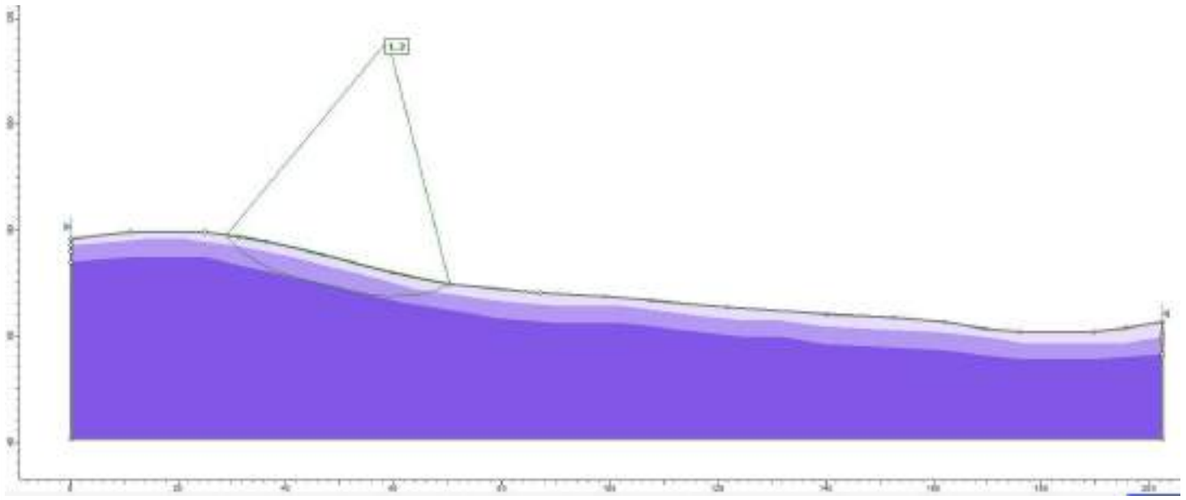
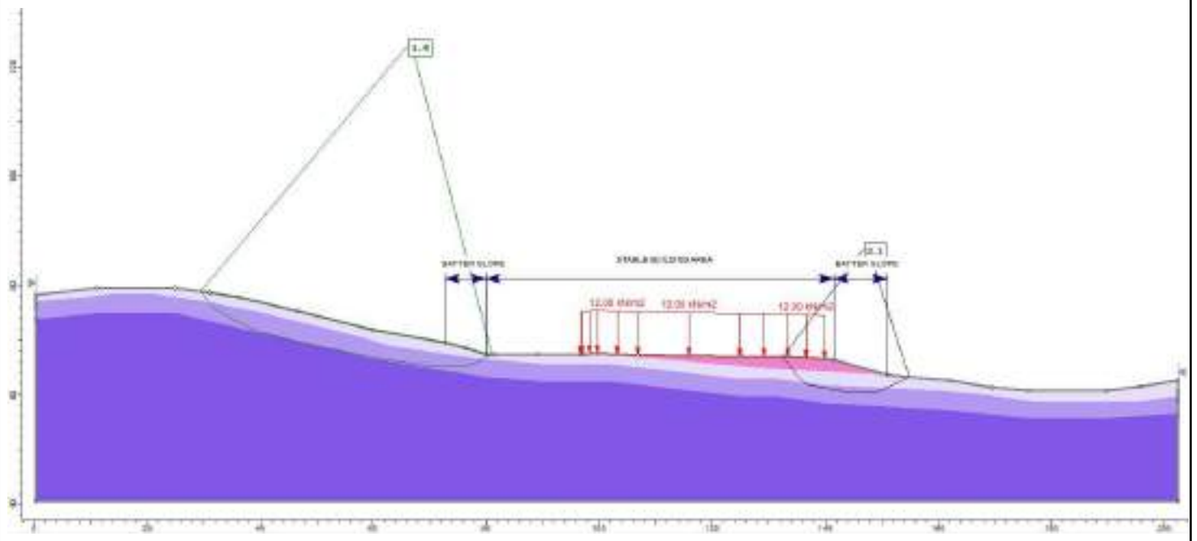
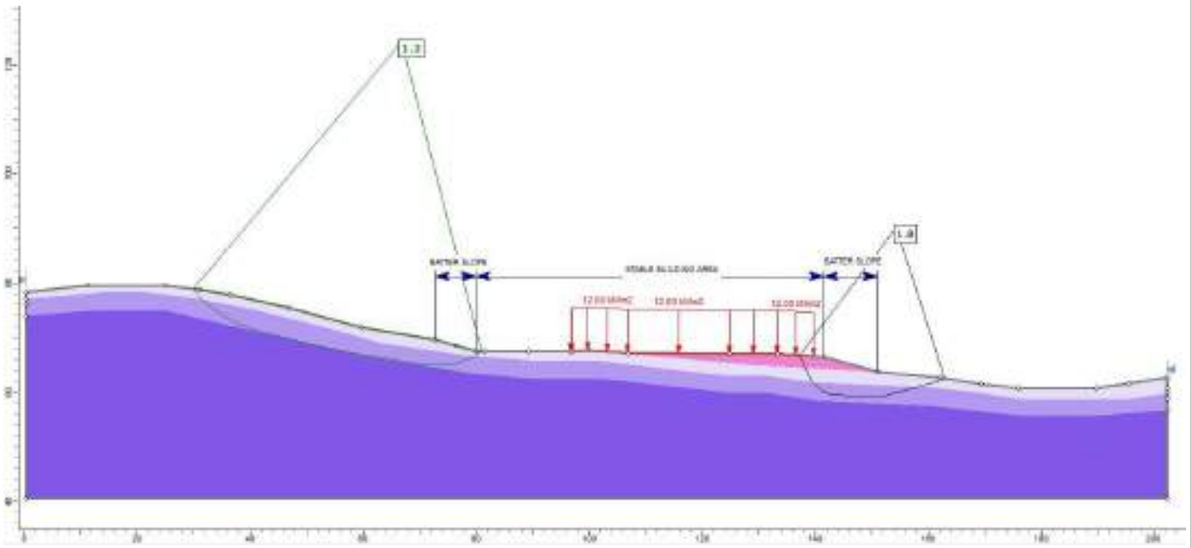
| | *Title* Section T | *Date* 18/10/2023 | *Drawing* STAB 01 |



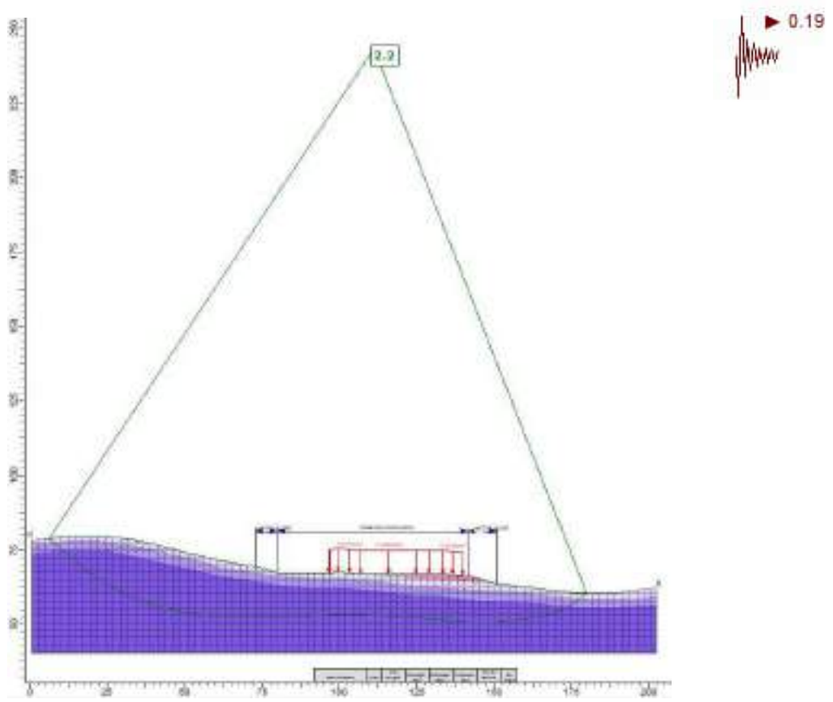
Section U - Back Analysis (Worst Case Scenario)



Proposed Section U - Normal Groundwater Conditions



Proposed Section U - High Groundwater Conditions




Proposed Section U - Seismic Event

| | | | |
|---|---|---|---|
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| | *Title*<br>Section U | *Date*<br>18/10/2023 | *Drawing*<br>STAB 02 |

| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (°) | Ru Value |
|---|---|---|---|---|---|---|
| Fill | | 17.5 | Mohr-Coulomb | 8 | 28 | 0.05 |
| Alluvium | | 18 | Mohr-Coulomb | 4 | 22 | 0.2 |
| Hukerenui Mudstone (NA) Residual Soils | | 17 | Mohr-Coulomb | 5 | 26 | 0.2 |
| Hukerenui Mudstone (NA) Transition Zone | | 18 | Mohr-Coulomb | 6 | 12 | 0.05 |
| Hukerenui Mudstone (NA) Parent Rock | | 20.5 | Mohr-Coulomb | 20 | 28 | 0 |

**Normal Groundwater Parameters**

| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (°) | Ru Value |
|---|---|---|---|---|---|---|
| Fill | | 17.5 | Mohr-Coulomb | 8 | 28 | 0.2 |
| Alluvium | | 18 | Mohr-Coulomb | 4 | 22 | 0.5 |
| Hukerenui Mudstone (NA) Residual Soils | | 17 | Mohr-Coulomb | 5 | 26 | 0.5 |
| Hukerenui Mudstone (NA) Transition Zone | | 18 | Mohr-Coulomb | 6 | 12 | 0.2 |
| Hukerenui Mudstone (NA) Parent Rock | | 20.5 | Mohr-Coulomb | 20 | 28 | 0 |

**High Groundwater Parameters**

| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Cohesion Type | Shear/ Normal Function | Ru Value |
|---|---|---|---|---|---|---|---|
| Fill (Undrained) | | 20 | Undrained | 100 | Constant | | 0.05 |
| Alluvium (Undrained) | | 18 | Undrained | 60 | Constant | | 0.2 |
| Hukerenui Mudstone (NA) Residual Soil (Undrained) | | 20 | Undrained | 60 | Constant | | 0.2 |
| Hukerenui Mudstone (NA) Transition Zone (Undrained) | | 18 | Undrained | 125 | Constant | | 0.05 |
| Hukerenui Mudstone (NA) Parent Rock (Undrained) | | 20.5 | Shear/ Normal Function | | | Shear Normal | 0 |

**Seismic Parameters**

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| | | | |
|---|---|---|---|
| *Project* Palliser Downs | *Analysis* | *Project No.* AKL2019-0017 | |
| *Title* Parameters | *Date* 18/10/2023 | *Drawing* STAB 03 | |