ALLIED GEOTECH LTD

GEOTECHNICAL SUITABILITY OF POTENTIAL HOUSE SITE
23 DARWIN ROAD, OUTER KAITI, GISBORNE
GEOTECHNICAL INVESTIGATION REPORT

Report Prepared for: Malcolm Galloway

Date: 09/06/22

AG Ref: 0150 - 2

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1 INTRODUCTION

Allied Geotech Ltd was engaged by Malcolm Galloway to undertake a geotechnical investigation of a potential house site located within 23 Darwin Road, Outer Kati, Gisborne (Figure 1).

Figure 1: Property location (red outline) and surrounding area. Image source: Tairawhiti Maps[1].

The scope and objectives of the investigation included the following:

1. Select an area of land within the property for potential development of one residential dwelling.
2. Determine the nature and strength distribution of the soils beneath the proposed house site.
3. Determine of the stability of the proposed house site under design conditions.
4. Determination preliminary recommendations for site development and foundation design to address potentially compressible ground, low bearing capacity ground, slope instability, expansive soils, and other soils which could have a negative impact on a future dwelling, resulting in excessive differential movement of the structure.
5. Consideration of the potential for liquefaction, and if required, provide recommendations to minimise the potential risk that this presents to the structure.

2 SITE DESCRIPTION

The subject property is located in outer Kaiti, approximately 5km east of the Gisborne City Central Business District. The elevated property comprises a 1659m² parcel of land located on the lower reaches of a north facing elevated hillside. The west part of the lot is occupied by the east flank of a prominent rounded spur landform, which extends down from the property above to the south, and also into the adjacent property to the west. The east part of the lot contains a shallow gully zone, which is an extension of a shallow gully, also extending down from the property above.

[1] https://maps.gdc.govt.nz/H5V2_12/

The backbone of the western spur landform maintains an overall gradient from approximately 15° to 25° in its upper southern part. An area of historic earthworks comprising the development of a low angle to flat farm access track through cut and fill works, has resulted in in localised batter slope (up to some 35°) and low angle farm track at its base (approx. 3° to 6° being developed along the north property boundary. The outside edge of the track is supported by two non-engineered retaining walls.

Below the property, the slope naturally truncates to an angle of approximate 30° which is maintained for some 8m, before reducing in gradient beneath an existing house (21 Darwin Road) and extending out to Gaddums Hill Road.

Evidence of slope instability about the site, comprises undulating/terraced ground above the farm track batter slope, yielding of a non-engineered retaining wall which runs along the north property boundary (above house in 21 Gaddums Hill Road) and undulating ground in the east part of the lot, although some of the undulating ground in in this area appears to be associated with historic earthworks.

At the time of the investigation, the property was under pasture, with a number of small trees located in its central part. A number of large trees are growing along the upper and lower property boundaries, with the branches extending out into the subject lot.

Access to the site is gained via an approximately 50m long driveway which leads up from Darwin Road to the northwest. The driveway is included in the 1659m² parcel size.

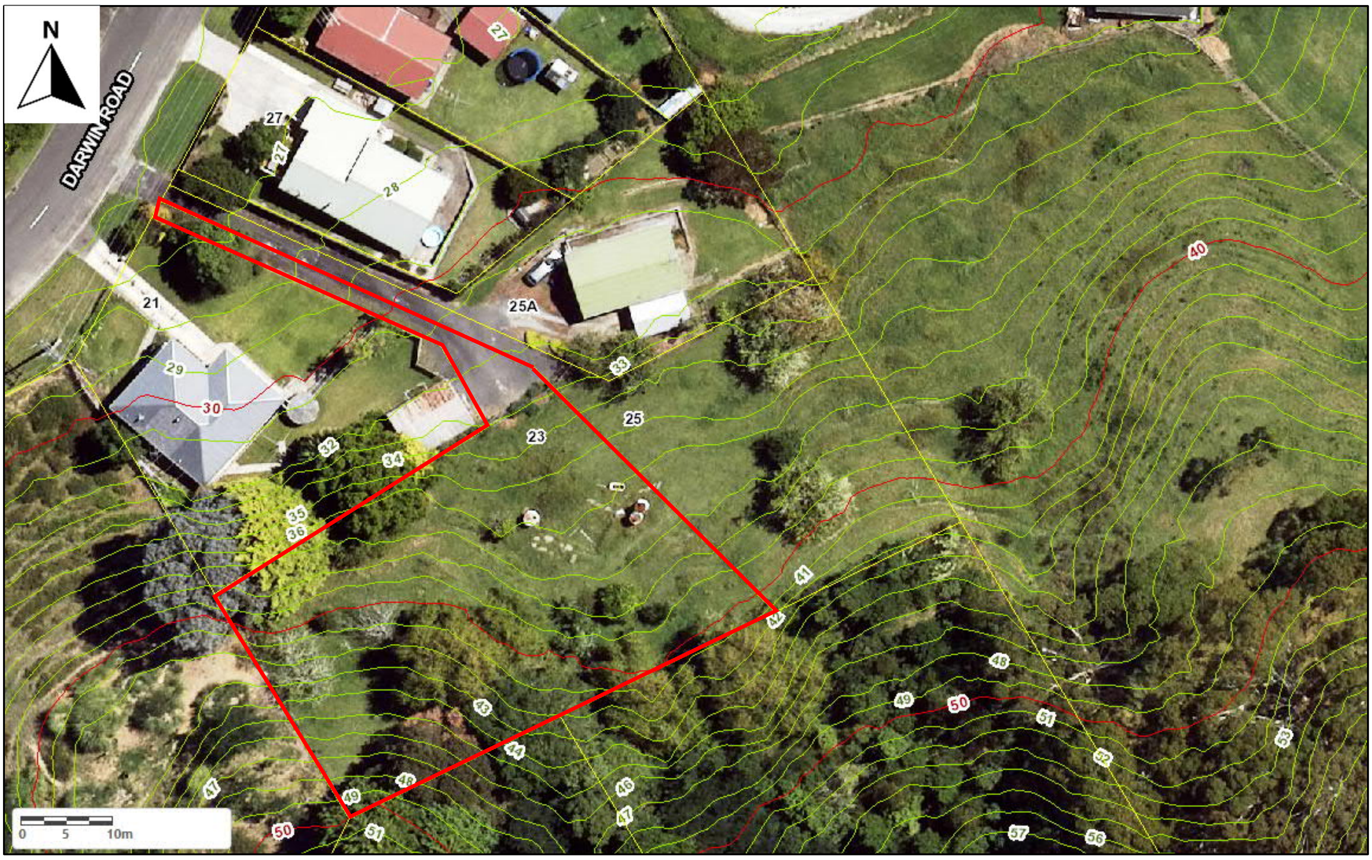

Figure 2: Subject property (indicative boundary location shown in bold red outline) and surrounding area. Fine red and green lines represent LiDAR contour lines at 1m intervals. Image source: Tairawhiti Maps[1].

3 PROPOSED HOUSE SITE

A minimum 150m² house site on the backbone of the spur within the west part of the lot is proposed. It needs to be appreciated that this does not preclude possible development in other parts of the property but forms the focus of this report to confirm the viability of one site for residential development within the lot. Extension of the site proposed, or alternative sites, may be viable.

It also needs to be appreciated that as a particular building proposal does not exist, this report does not extend to a full building consent level investigation report, which can only be completed once the final building proposal is known and building specific testing and reporting can be completed.

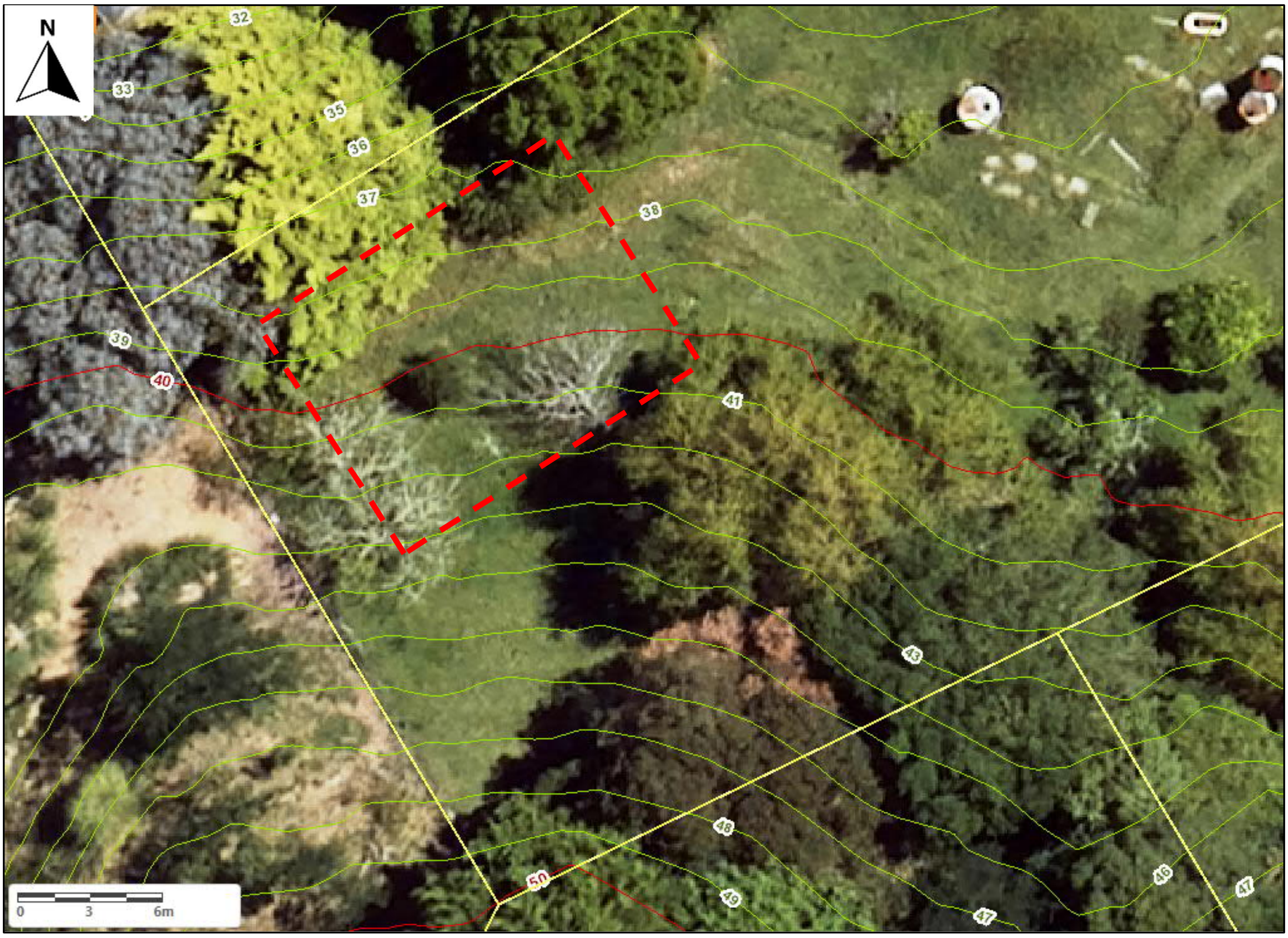

Figure 3: Indicative location of possible house site location (red dashed outline). Property boundary location indicated with fine yellow line. Image source: Tairawhiti Maps[1].

Figure 4: View northeast across historic farm access and lower part of proposed house site. Retaining wall running along approximate north boundary (above 21 Darwin Road) located at extreme left of image with fence attached to top.

4 INVESTIGATIONS

Our investigation of the site included the following work:

1. A walkover geomorphological assessment of the site and surrounding area to determine any surface definitions or geological features which may have an influence on the project and any features which may present a slope instability risk to the proposed development.
2. A review of historic aerial and satellite images dating back to 1942, geological maps, and the Allied Geotech database.
3. Three 50mm hand augered boreholes put down to refusal. Shear vane tests were carried out at 200mm intervals down the soil profile where cohesive soils were encountered.
4. Three dynamic penetrometer tests (DCP's) put down in the base of each borehole to refusal.
5. Slope profiling.
6. Development of a geological model and undertaking of qualitative and quantitative (numeric) stability analyses.

The locations of the site investigations are shown within Figure 5. The site investigation logs are appended.

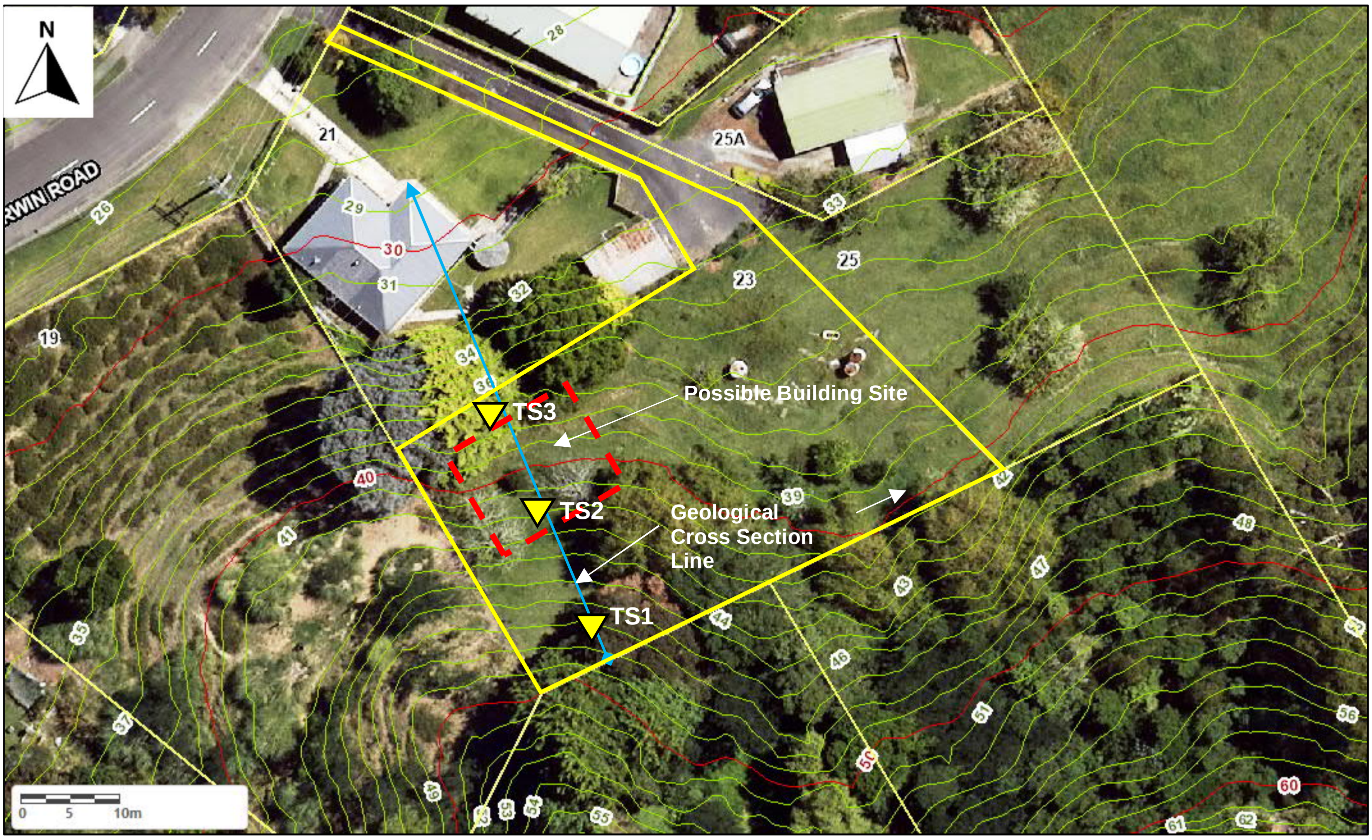

Figure 5: Geotechnical Investigation Plan. Property boundary line indicated with bold yellow line. Approximate position of proposed building site indicated with bold dashed red outline. Slope profile used in numeric stability analyses indicated with blue line. Each test site (yellow triangle) corelates to a hand auger and dynamic cone penetrometer test location. Fine green and red lines correlate to LiDAR contour lines at 1m intervals. Image source: Tairawhiti Maps[1].

5 SUBSURFACE CONDITIONS

5.1 Published Information

The 1:250,0000 geological map of the region[2] shows the site as being underlain by Miocene mudstone, with intercalations of breccia and limestone.

5.2 Soil Profile and Strength

In summary, the investigations encountered a relatively uniform soil profile above and within the proposed house site. The testing generally encountered dark grey clayey silt (Topsoil and/or Topsoil Fill) extending down to between 0.2 and 0.5m depth. The fill was only encountered at TS3 on top of the original topsoil, being located on the outside edge of an historic farm track which runs through the base of site. Undrained shear strength testing in both units returned values ranging between 63 and 170kPa, indicating a variable stiff to very stiff strength regime.

Underlying the fill and topsoil layers, relatively homogenous light brown clayey silt with highly to completely weathered gravel (mudstone residual soils) was generally encountered down to 1.2 to 1.8m depth. Undrained shear strength testing indicates that the unit is high to very high strength, returning values ranging between 73 and in excess of 186kPa, indicating a stiff to very stiff regime. The only outlier to this soil type comprised a 0.4m thick layer of rhyolitic

[2] Mazengarb, C.; Speden, I.G. (compilers) 2000: Geology of the Raukumara area: scale 1:250,000. Lower Hutt: Institute of Geological & Nuclear Sciences Limited. Institute of Geological & Nuclear Sciences 1:250,000 geological map 6.

tephra located under the topsoil on top of the mudstone residual soils within TS3 between 0.7m and 1.1m depth. The material was indicated to be loose to medium dense.

At the base of the mudstone residual soils, an increase in highly to completely weathered mudstone gravel content in the residual soils was identified indicating a transitioning into the underlying mudstone regolith. Due its high strength, undrained shear strength testing generally returned values in excess of 186kPa, or the test was unable to be performed in the unit, indicting a hard regime. Given this, dynamic penetrometer testing was put down in the base of each borehole. Instant refusal (>14 blows/50mm) was returned from TS1 at 1.6m depth put down at the top of the property, indicating the presence of bedrock. Values increasing from 3 blows/50mm from between 1.8 to 2.2m depth, up to refusal (>10 blows/50mm) at 3.2m depth were returned in TS2 and TS3, indicating the grading into bedrock.

5.3 Ground Water

Groundwater was not encountered in the investigation. Given the elevation of the site within the hillside we expect the water table to exist at least 4 to 5m depth beneath the site. The near surface soils (topsoil and fill) are expected to be high in moisture levels in winter and could become saturated following a prolonged/extreme wet weather event. Full saturated of the hill is, however, considered unlikely.

5.4 Seismic Subsoil Classification

Based on the site testing results and the Allied Geotech database, we consider that the proposed building site should be considered a Class C Shallow Soil site as outlined in NZS 1170.5:2004.

6 NATURAL HAZARDS

6.1 Slope Stability

6.1.1 Qualitative Assessment

The hillside which the proposed house site is located on is considered to be fundamentally stable. The site is located on the lower reaches and backbone of a broad hillside spur which extends down from the top of hillside above. Our review of historic aerial photography and satellite imagery taken between 1942 and 2022 identified no obvious evidence of active instability above, within, or below the house site. Evidence of past moderately deep to deep seated instability was not identified.

Prior to establishment of the thick vegetation which now occupies the property up slope of the property, evidence of historic shallow seated instability can be observed in the 1953 aerial photographs in the steeper parts of the hillside to the southeast with some material appearing to come to rest within the subject property in the shallow gully zone below and to the east of the proposed house site. These areas, are however, offset and isolated from the proposed house site. On this basis we consider that the proposed site is at a low risk of being affected by inundation landslipppage from the property above, during the building's design life.

On a localised scale, evidence of shallow seated instability in the form of terracettes can be observed above, within and below the site in the earlier 1953 photography. These are consistent with observations made on site with evidence of shallow seated incipient movement observed within and extending slightly above the batter slope located in the lower part of the site, which may have developed due to loss of slope toe support when the historic farm track was installed.

Minor undulations were observed on-site further upslope of the batter zone; however these were not well defined and are expected to be limited to low risk creep movement the topsoil horizon, which may have been enhanced with animal trafficking. These observations are consistent with the test results, with high strength ground being indicated from 0.2m depth (TS1) in the upper part of the property (near upper south boundary) and from 1 to 1.2m depth in the central and lower parts of the site.

Along the north boundary of the property a set of non-engineered retaining walls comprising a small 0.4m high feature behind an approximately 1 to 1.5m high wall are present, which are likely supporting a wedge of fill placed when the historic farm track was developed immediately above. These walls show evidence of localised yielding (rotation), which is expected given their non-engineered status. The shallow seated instability is expected to be able to be address through isolation of a dwelling and/or site preparation/remediation works. There was no other evidence of instability identified above, within or below the house site within the image review or walkover assessment.

Figure 6: 1953 aerial image of property and surrounding area. Approximate property boundary line position indicated with red line and proposed house site indicated with yellow rectangle.

6.1.2 Numeric Stability Assessment

To confirm the localised stability of the land above, within, and below the proposed house site, we have also undertaken numeric slope stability analyses on the site using specialist geotechnical software (Slide). The assessment was carried on a model developed of the underlying geology, using the site testing data and site profile survey information. The location and orientation of the slope profile analysed is shown in Figure 5. The geological model utilised in the development of the stability model is shown in Figure 7.

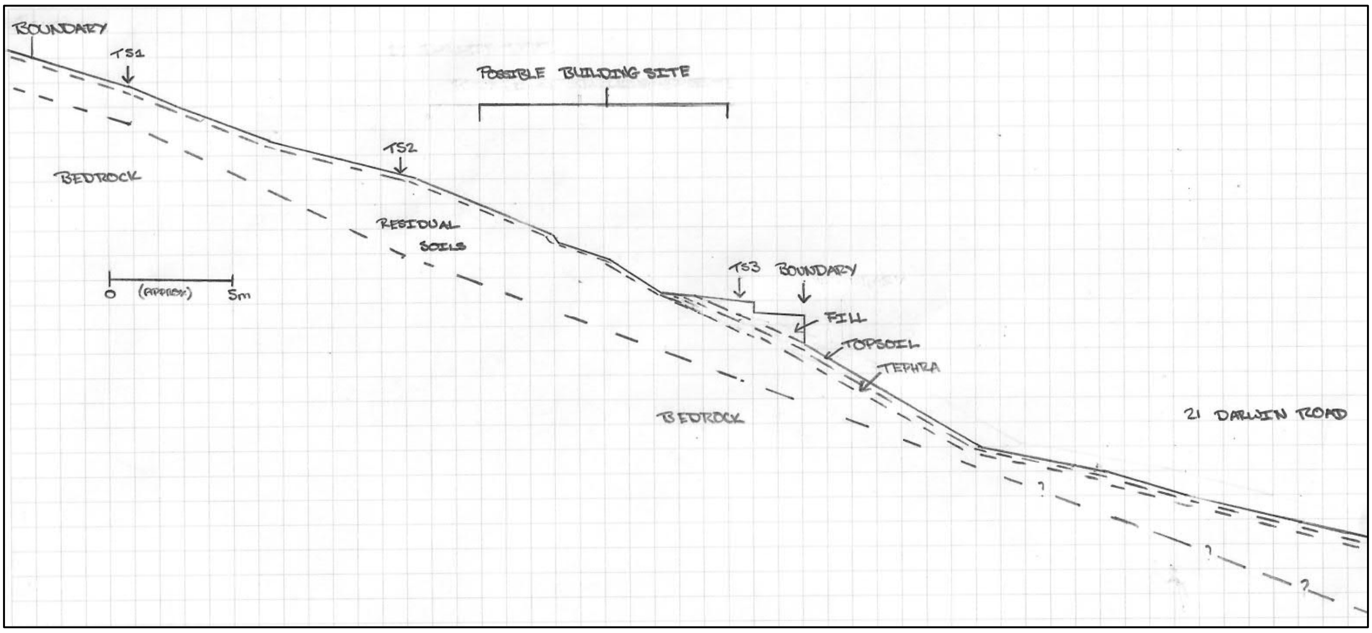

Figure 7: Geological cross section through possible building site.

The analyses included assessment of slope stability under prevailing, worse case groundwater conditions, and SLS and ULS seismic loads. Both circular and non-circular stability modelling has been undertaken, with the non-circular being determined to be the most conservative.

The material parameters given in Table 1 have been used in our analyses of the site. These were derived from published and unpublished correlation charts and papers for the particular materials encountered in the investigation. Undrained shear strength values were utilised in the seismic modelling. A weak soil layer was incorporated into the analyses to model a possible shallow seated slip in the batter slope within the proposed house site. A low strength (1.5KN) micro pile retaining wall was also included in the model to represent the non-engineered retaining wall which runs along the lower north boundary with 21 Darwin Road.

Table 1: Soil Material Parameters

Material	Unit Weight (kN/m³)	C' (kPa)	Ø' (°)	Su (kPa)
Fill & Weak Soil Layers	17	1	24	20
Rhyolitic Tephra	17	1	28	-
Stiff Soils	18	5	30	50
Very Stiff Soils	18	7	32	150
Hard Soils	18	9	34	200
Mudstone	22	Generalised Hoek-Brown Parameters UCS = 3MPa, GSI = 50, mi = 7, D = 0		

Earthquake magnitude and peak ground acceleration parameter selection for seismic modelling is based on that outlined in Cubrinovski et al[3], as per the recommendation of the New Zealand Geotechnical Society. Seismic parameters used for this site for Serviceability Limit State (SLS) and Ultimate Limit State (ULS) modelling at this site are detailed in Table 2.

Table 2: Seismic Parameters

Earthquake Magnitude (M)	Peak Ground Acceleration (PGA)	Design Water Table Depth	Building Design Life	Building Importance Level
SLS = 6.3 (25-year return period) ULS = 7.5 (500-year return period)	SLS=0.12 ULS=0.65	4 to 5m	50 Years	2

Minimum Factor of Safety (FoS) criteria used in the analyses consist of a Factor of safety >1.5 for prevailing groundwater conditions, and >1.2 for extreme groundwater conditions. The criteria used in the seismic modelling were a FoS of >1.0.

In summary, the following results were obtained in the stability analyses:

- Under prevailing ground water conditions whilst failure is not indicated, slip surfaces with marginal FoS values (as low as 1.0) are shown to exist within the batter slope formed above the historic farm track and the non-engineered fill supported by the non-engineered wall at the base of the site (boundary with 21 Darwin Road).
- Under extreme groundwater conditions slip surface FoS values as low as 0.3 are shown, indicating failure. These slip surfaces with FoS values less than 1.2 are shown to be isolated to the batter slope formed above the historic farm track and the non-engineered fill supported by the non-engineered retaining wall at the base of the site (boundary with 21 Darwin Road), which is consistent with site observations.
- Under SLS seismic loads, marginal yielding (FoS =0.99) is indicated in the batter slope formed above the historic farm track.
- Under a significant Ultimate Limit State event, slip surfaces with FoS values less than 1.0 (indicating failure) are shown to exist. These are isolated to the batter slope formed above the historic farm track and the non-engineered fill supported by the non-engineered retaining wall at the base of the site (boundary with 21 Darwin Road).

Based on the stability assessments, relatively shallow seated instability is indicated in two zones, and engineering measures are considered to be required to address these hazards. Recommendations and options regarding these are outlined in Section 7. Summary printouts of the critical stability assessment results are appended to this report.

6.2 Fault Lines

The 1:250,0000 geological map of the region[2] shows no faults running through the property. In addition, the GNS Active Fault Database does not show any active faults running through the property.

There were no obvious geomorphological features which suggest faulting through the site. We therefore consider that the risk of fault rupture to the proposed building site is low.

[3] Cubrinovski M, Bradley B, Wentz F, Balachandra, A (2020). "Re-evaluation of New Zealand seismic hazard for geotechnical assessment and design" *Bulletin of the New Zealand Society for Earthquake Engineering,* Vol 54 No 2. 2021

6.3 Liquefaction

Saturated silts and sands were not encountered under the site and the residual soils (clayey silt) which are indicated to grade into bedrock, are considered to be non-liquefiable. We therefore consider that the site is at a very low risk of being affected by liquefaction.

6.4 Shrink-Swell Soils

Plastic soils can be subject to shrinkage and swelling due to soil moisture content variations which can result in heaving and settlement of buildings, particularly between seasons.

The near surface soils comprise clayey silt and are therefore expected to have a liquid limit of about 50% based on their physical characteristics determined during the investigation. Taking foundations down to a depth where significant changes in moisture content are not expected is recommended to address this hazard (outlined in Section 7).

6.5 Compressible & Low-Density Ground

The topsoil, buried topsoil, fill, and possibly the rhyolitic tephra units within the site are considered to present a consolidation/settlement or bearing capacity failure risk under building loads. Recommendations to address these elements are outlined in Section 7.

6.6 Trees

At the time of the investigation there were a number of small trees located either within or immediately adjacent to the possible building site. These can be easily removed. The branches of a number of large trees were leaning into the subject property over both the upper southern and lower northern property boundaries. These are expected to be able to be pruned back to the boundary lines if required. With the permission of the neighbours any trees exhibiting compromised health or posing a toppling risk to the proposed house site should be removed.

7 PRELIMINARY ENGINEERING RECOMMENDATIONS

7.1 General

Based on the work carried out, we consider that the proposed house site is suitable for residential development. However, measures are required to address:

- The surficial/near surface compressible topsoil/buried topsoil, fill and rhyolitic tephra layers beneath the site.
- The risk of instability of the batter slope within the site and non-engineered fill/retaining wall at the bottom of the site.
- The shrink-swell risk of the near surface soils.

Preliminary site development options and recommendations are given in the following sections.

7.2 Preliminary Site Development Recommendations

The proposed building zone (approximately 15m wide x 10m long) is sloping, with an elevation difference across it of approximately 6m from its top south end down to its lower northern end. Given the fall across the site and with the installation of an historic farm track through its lower part, the site lends itself to being developed for a stepped or split-level type dwelling recessed into, and/or built on the slope. For this option, the section of batter slope which has yielded is recommended to be removed and replaced with engineered fill. It is expected that a block-basement type lower level would be constructed, recessing into the toe of the slope and the yielding section of batter slope above would be removed and replaced with engineered fill as part of standard site preparation works. The south and west walls of the block basement will need to be designed as retaining walls to support the cut faces. In addition, a secondary retaining wall may be required furth up slope to support another cut slope, which may be required to lower the elevation of the building site in this area and allow for the construction of the upper part of a split-level dwelling in this zone. Given the likely height requirements of the raining walls and sloping nature of the land above both possible wall locations, specific engineering design of these walls will likely be required.

In addition, to address the possible evacuation risk of the non-engineered fill supported by a non-engineered retaining wall (which runs along the boundary with 21 Darwin Road), a new retaining wall, or possible palisade wall installed in the ground back from the boundary may be required subject to the final proposed location of the dwelling. It is possible that the in-ground wall could be incorporated into the northern foundation line of the new building, or it could be built independently. Depending on the location of the wall, a retained height of between 1 and 1.7m is expected, although this is subject to confirmation of the wall location and final building footprint and building type proposed. There is a possibility that this could be avoided, although this is expected to minimise the available building area, and or push the building site further back to the south or east.

Other site development options may exist.

7.3 Preliminary Foundation Design Recommendations

Based on the work carried out, and provided that the zones of instability are mitigated through installation or engineered retaining/palisade walls and/or house site isolation from slope hazards, a preliminary minimum foundation depth of 0.6m below ground level into the underlying residual mudstone soils (whichever is deeper) is considered appropriate. At the recommended foundation depth, the compressible soils are expected to be extended through, and significant changes in soil moisture are not expected, thus minimising the risk and potential consequences of shrink/swell activity on the building's foundations. Utilising the bearing capacity verification method B1:VM4 in the New Zealand Building Code, a minimum allowable bearing capacity of 100kPa (FoS of 3) is expected to be available from this depth. NZS3604:2011 foundation solutions may be able to be utilised in part, but specific engineering design is expected to be required for retaining/palisade wall design, above, within and likely below the site, subject to confirmation of the final site development and house proposal. This can be confirmed with the required building specific ground investigation for building consent once the building proposal is known. Subject to the final site development and building proposal, other elements requiring specific engineering design may also be necessary.

7.4 Vegetation

It is important that gardens do not interfere with any ventilation or drainage systems of the future building. Excessive watering of gardens adjacent to building foundations should also be avoided as this can promote settlement and/or erosion.

Trees can remove moisture from the soil for a radius equal to the height of the tree. This can cause expansive soils to shrink to varying degrees, and heave through tree root growth leading to differential settlement occurring under foundations and possible damage to the building superstructure. To reduce this risk, trees should be planted a minimum of 1 times the mature height of the tree away from the foundation. Alternatively, the expertise of an experienced arborist may be sought with regard to the risk a particular tree type may pose to the building.

There is one or two trees above the site, which appear to be in a compromised health and may pose a toppling risk to the proposed house site. We recommend that the neighbours be approached to have these trimmed or removed.

7.5 Surface Water

It is paramount that runoff from roof, and paved areas is collected or disposed of in a suitable location away from buildings. Fully contained, piped discharge to the stormwater intake present at the northeast corner of the site (top of existing metalled driveway) appears suitable, provided that the system can accommodate the calculated discharge volumes. Soak pits are not recommended at this site. Discharge onto or over the bank below the site should be avoided at all costs.

To minimise the potential for foundation settlement, heave and erosion, the stormwater disposal system for the building should be functional as soon as the roof is in place.

8 APPLICABILITY

This report has been prepared for the benefit of Malcolm Galloway with respect to the particular brief given to us. It may not be relied upon in any other context or for any other purpose without out our prior review and written consent.

Recommendations and opinions contained in this report are based on observations, and subsurface investigations put down at point locations. Inferences are made with regard to the continuity of the ground between and beyond the investigation locations. By nature, ground conditions are inherently variable, and it must be appreciated that ground conditions could vary from those assumed. We should be contacted immediately if the conditions are found to differ from that described in this report.

It needs to be appreciated that building specific site testing and reporting needs to be completed for the specific building and site development proposal by a Geotechnical Professional once that proposal is known, and preliminary recommendations made in this report may change. Cut and fill proposals and engineering measures which vary from those recommended herein may alter the findings and recommendations made in this report, thus it is important that this document is reviewed as part of the building specific investigation to confirm if additional stability modelling (and any associated testing) is required to be carried out.

Yours Sincerely

Allied Geotech Ltd

Ross Cumming
MEngNZ
Engineering Geologist
CMEngNZ (PEngGeol)

Attached:

Geotechnical Investigation Logs

Stability Analyses Printouts

https://netorgft8386503-my.sharepoint.com/personal/ross_alliedgeotech_co_nz/Documents/Projects/100 to 199/150 23 and 25 Darwin Road, Gisborne (Galloway)/Report/23 Darwin Road/Allied Geotech 23 Darwin Road, Outer Kaiti Gisborne Geotechnical Investigation Report 09062022.docx

ALLIED GEOTECH LTD	Client: Malcolm Galloway	AG Project No.: 0150	Test No.: TS1
	Project: Confirmation of House Site	Logged By: RGC	Date: 26/05/2022
	Property Location: 23 Darwin Road, Kaiti, Gisborne	Test Site Location: Refer to Site Investigation Plan	
	Test Methods: 50mm Hand Auger, Calibrated Hand-Held Shear Vane, & Dynamic Cone (Scala) Penetrometer		

HANDAUGER BOREHOLE & DYNAMIC CONE PENETROMETER (DCP) TEST LOG

Depth (m)	Colour	Moisture	Strength	Description	Geology
0.0		D-M	VSt	SILT, some clay, some fine roots, dark grey, very stiff, dry to moist	Topsoil
0.1					
0.2		D-M	VSt	SILT, clayey, light brown and light orange brown, very stiff, dry to moist	Mudstone Residual Soil
0.3					
0.4					
0.5					
0.6					
0.7					
0.8					
0.9					
1.0				minor highly to completely weathered fine angular mudstone gravel	
1.1					
1.2		D-M	VSt-H	SILT, clayey, some highly to completely weathered mudstone gravel, light brown to grey, difficult to auger, very stiff to hard, dry to moist	Mudstone regolith
1.3					
1.4				grey	
1.5				End of borehole @ 2.6m	
1.6				Cannot advance through high density ground	
1.7				DCP put down in base to refusal	
1.8				Hole dry on completion	
1.9					
2.0					
2.1					
2.2					
2.3					
2.4					
2.5					
2.6					
2.7					
2.8					
2.9					
3.0					
3.1					
3.2					
3.3					
3.4					
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4.0					
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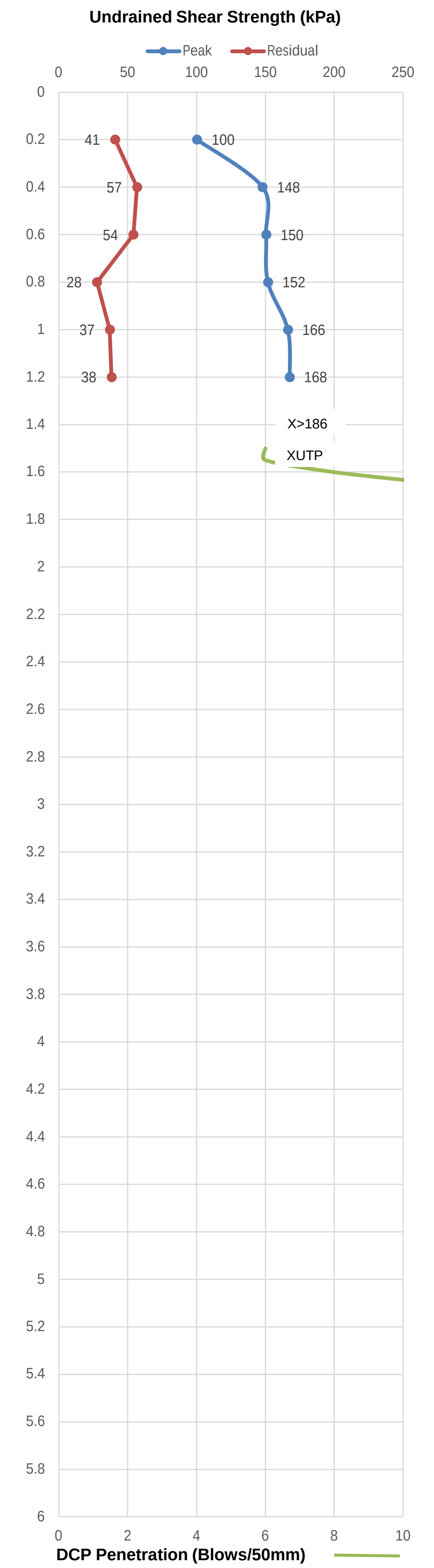

Notes: Soils are logged in general accordance with NZGS field guide sheet description of soil and rock (2005)
Undrained shear strength lines are indicative only.
Undrained shear strength corrected for plasticity (Bjerrum 1973)
UTP = Unable To Penetrate

ALLIED GEOTECH LTD

Client: Malcolm Galloway	AG Project No.: 0150	Test No.: TS2
Project: Confirmation of House Site	Logged By: RGC	Date: 26/05/2022
Property Location: 23 Darwin Road, Kaiti, Gisborne	Test Site Location: Refer to Site Investigation Plan	
Test Methods: 50mm Hand Auger, Calibrated Hand-Held Shear Vane, & Dynamic Cone (Scala) Penetrometer		

HANDAUGER BOREHOLE & DYNAMIC CONE PENETROMETER (DCP) TEST LOG

Depth (m)	Colour	Moisture	Strength	Description	Geology
0.0		D-M	VSt	SILT, some clay, some fine roots, dark grey, very stiff, dry to moist	Topsoil
0.1					
0.2					
0.3					
0.4		D-M	VSt	CLAY, some silt, light brown, plastic, very stiff, moist	Mudstone Residual Soil
0.5					
0.6					
0.7					
0.8					
0.9					
1.0					
1.1					
1.2		D-M	VSt	SILT, clayey, some highly to completely weathered mudstone gravel, light brown to greyish brown, very stiff, dry to moist	Mudstone Regolith
1.3					
1.4					
1.5					
1.6			VSt-H	very stiff to hard	
1.7					
1.8					
1.9					
2.0					
2.1				End of borehole @ 2.1m	
2.2				Cannot advance through high strength contact	
2.3				DCP put down in base to refusal	
2.4				Hole dry on completion	
2.5					
2.6					
2.7					
2.8					
2.9					
3.0					
3.1					
3.2					
3.3					
3.4					
3.5					
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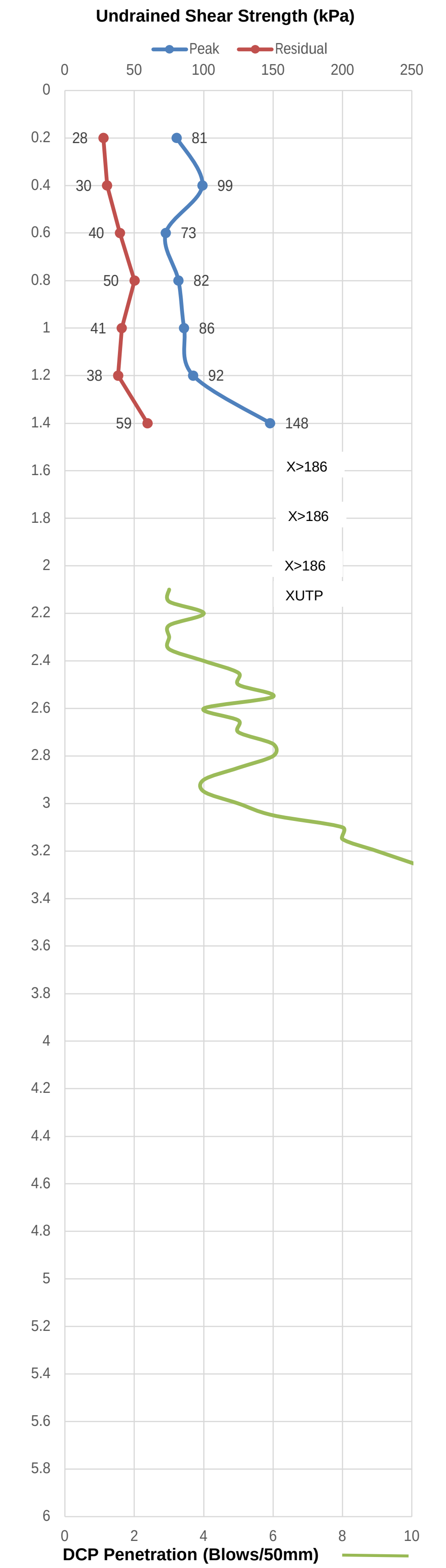
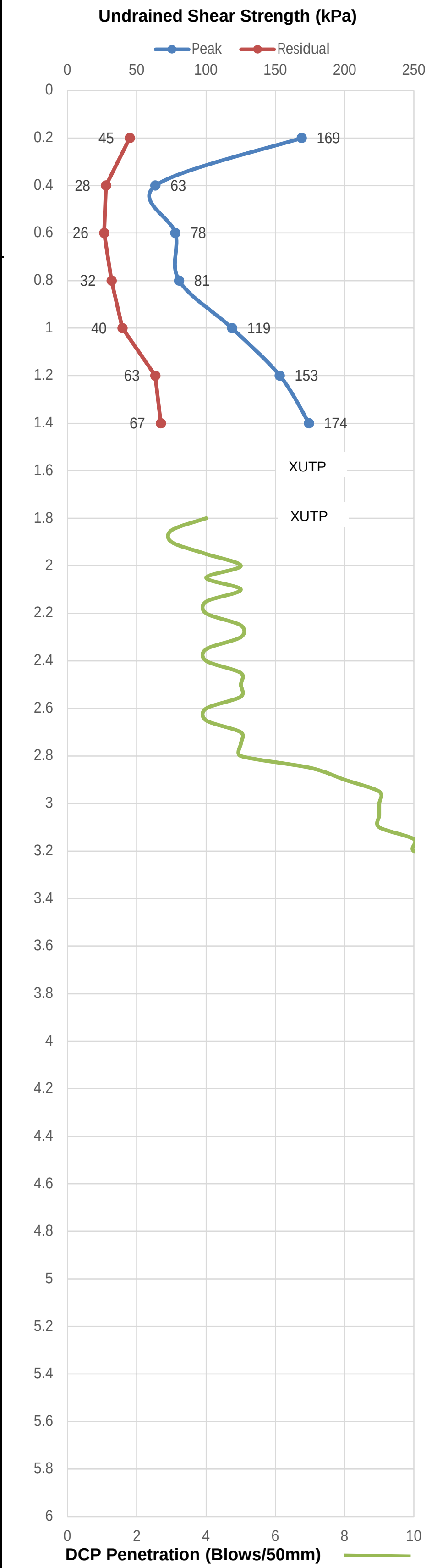


Notes: Soils are logged in general accordance with NZGS field guide sheet description of soil and rock (2005)
Undrained shear strength lines are indicative only.
Undrained shear strength corrected for plasticity (Bjerrum 1973)
UTP = Unable To Penetrate

ALLIED GEOTECH LTD	Client: Malcolm Galloway	AG Project No.: 0150	Test No.: TS3
	Project: Confirmation of House Site	Logged By: RGC	Date: 26/05/2022
	Property Location: 23 Darwin Road, Kaiti, Gisborne	Test Site Location: Refer to Site Investigation Plan	
	Test Methods: 50mm Hand Auger, Calibrated Hand-Held Shear Vane, & Dynamic Cone (Scala) Penetrometer		

HANDAUGER BOREHOLE & DYNAMIC CONE PENETROMETER (DCP) TEST LOG

Depth (m)	Colour	Moisture	Strength	Description	Geology
0.0		D-M	VSt	SILT, some clay, some fine roots, dark grey, very stiff, dry to moist	Topsoil Fill
0.1					
0.2					
0.3					
0.4			St	stiff	
0.5		D-M	St	SILT, minor clay, dark grey, stiff, dry to moist	Buried Topsoil
0.6					
0.7		M	L-MD	SAND (fine to medium), very silty, pumiceous, whitish brown, loose to medium dense, moist	Rhyolitic Tephra
0.8					
0.9					
1.0					
1.1		D-M	VSt	SILT, clayey, some highly to completely weathered mudstone gravel, light brown and light orange brown, very stiff, moist	Mudstone Residual Soil
1.2					
1.3					
1.4					
1.5					
1.6			H	hard	
1.7					
1.8				End of borehole @ 1.8m	
1.9				Cannot advance through high strength contact	
2.0				DCP put down in base to refusal	
2.1				Hole dry on completion	
2.2					
2.3					
2.4					
2.5					
2.6					
2.7					
2.8					
2.9					
3.0					
3.1					
3.2					
3.3					
3.4					
3.5					
3.6					
3.7					
3.8					
3.9					
4.0					
4.1					
4.2					
4.3					
4.4					
4.5					
4.6					
4.7					
4.8					
4.9					
5.0					
5.1					
5.2					
5.3					
5.4					
5.5					
5.6					
5.7					
5.8					
5.9					
6.0					
6.1					
6.2					



Notes: Soils are logged in general accordance with NZGS field guide sheet description of soil and rock (2005)
Undrained shear strength lines are indicative only.
Undrained shear strength corrected for plasticity (Bjerrum 1973)
UTP = Unable To Penetrate

23 DARWIN ROAD, OUTER KAITI, GISBORNE

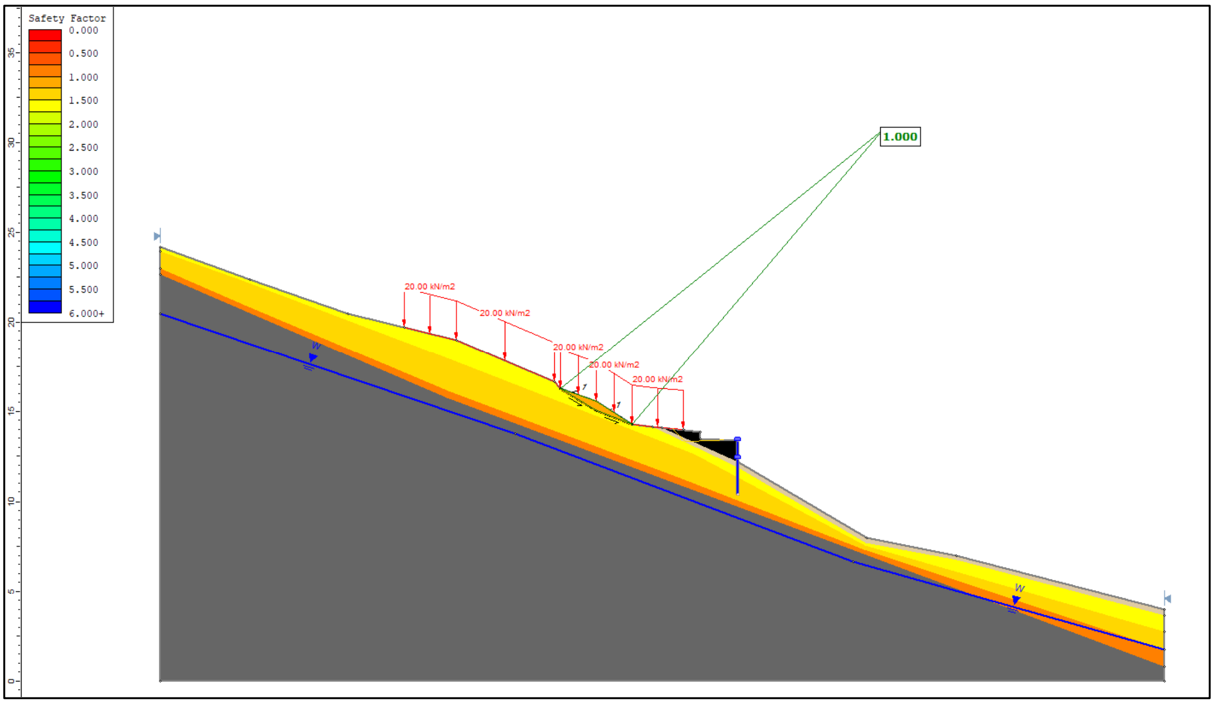
NUMERIC SLOPE STABILITY ANALYSES RESULTS

Table 1: Static Numeric Stability Analyses Strength Criteria

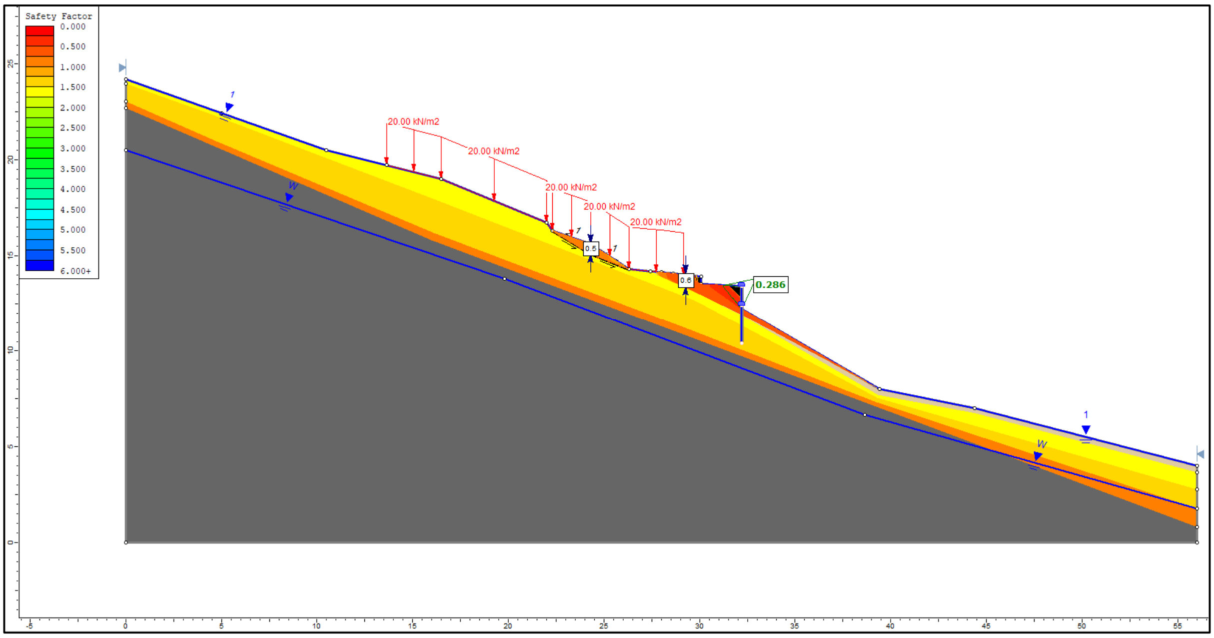
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D
Fill		17	Mohr-Coulomb	1	24				
Rhyolitic Tephra		17	Mohr-Coulomb	1	28				
Stiff Soils		18	Mohr-Coulomb	5	30				
Very Stiff Soils		18	Mohr-Coulomb	7	32				
Hard Soils		18	Mohr-Coulomb	9	34				
Bedrock		20	Generalized Hoek-Brown			3000	50	7	0

Table 2: Seismic Numeric Stability Analyses Strength Criteria

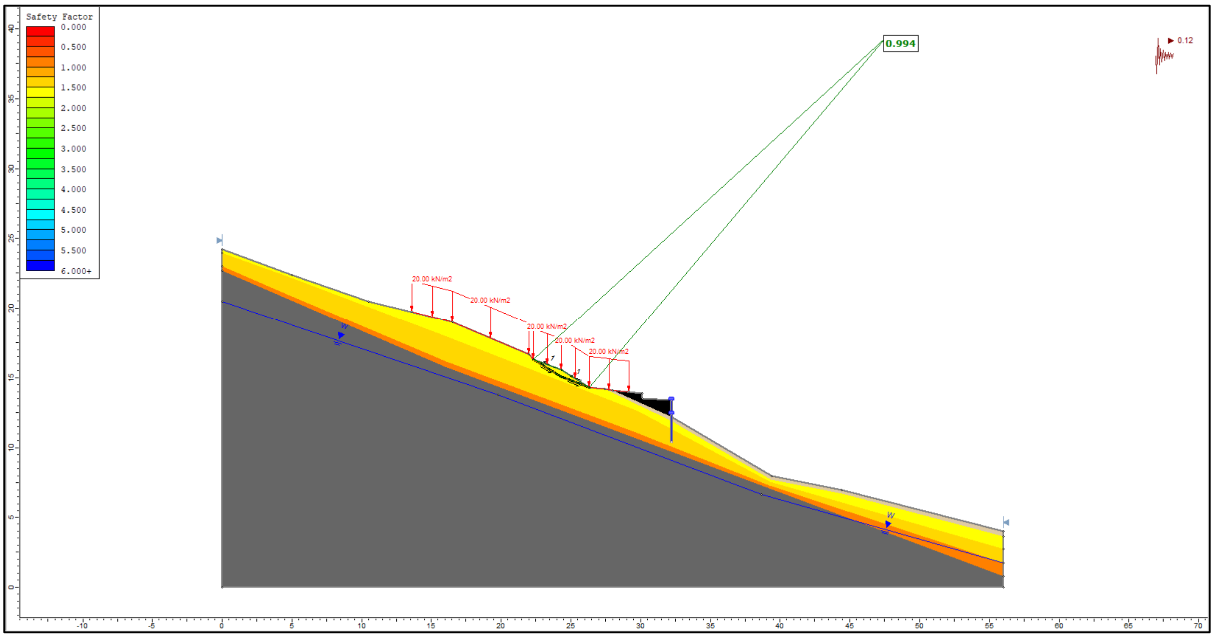
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	UCS (kPa)	GSI	mi	D
Fill		17	Mohr-Coulomb	1	24					
Rhyolitic Tephra		17	Mohr-Coulomb	1	28					
Stiff Soils		18	Undrained	50		Constant				
Very Stiff Soils		18	Undrained	150		Constant				
Hard Soils		18	Undrained	200		Constant				
Bedrock		20	Generalized Hoek-Brown				3000	50	7	0



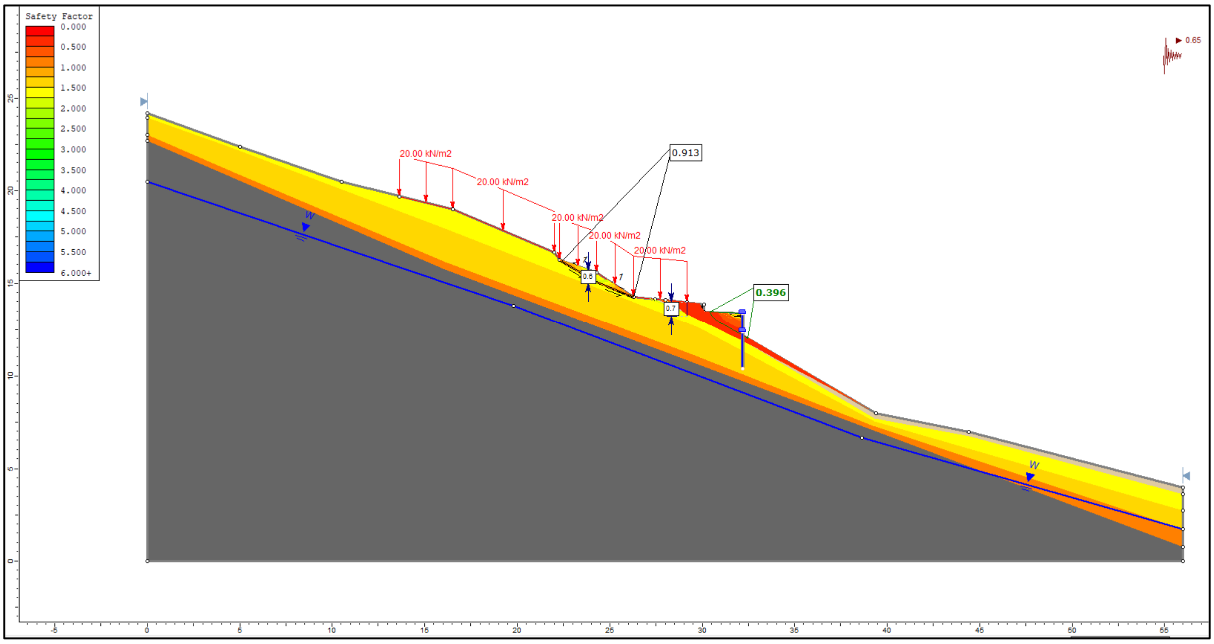
Prevailing groundwater condition model showing slip surface factor of safety values less than 1.5. 20kN/m^2 distributed load represents possible position of building.



Extreme groundwater condition model showing slip surface factor of safety values less than 1.2. 20kN/m^2 distributed load represents possible position of building.



SLS seismic model showing all slip surface factor of Safety values less than 1.0. 20kN/m^2 distributed load represents possible position of dwelling.



ULS seismic model showing all slip surface factor of safety values less than 1.0. 20kN/m^2 distributed load represents possible position of dwelling.