K200826-1C

28 August 2024

GEOTECHNICAL INVESTIGATION REPORT
PROPOSED SUBDIVISION
2127 KAIPARA COAST HIGHWAY
MAKARAU

Prepared For:

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REPORT ISSUE AUTHORISATION

Geotechnical Investigation Report
Proposed Subdivision
2127 Kaipara Coast Highway
Makarau

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EXECUTIVE SUMMARY

Geotechnical Investigation Report

Proposed Subdivision

2127 Kaipara Coast Highway

Makarau

SUBSOIL CONDITIONS (See borehole logs for details)	**Geology**	Waitemata Group Soils
	Lithology	Clay, Silt and Sand
	Groundwater depth	0.5 m – 4.5 m
	Shrink/swell classification (NZBC Structure B1/AS1)	Highly Reactive (Class H)
	Soil classification as per NZS 1170.5:2004	Shallow Soil (Class C)
SITE STABILITY COMMENT	The results of the global stability analyses indicate that the site is currently stable. However, we will need to further assess the stability once the subdivision earthwork plans are finalised due to the sloping nature of the site and subsurface conditions encountered during this investigation. Site specific stability analysis must be reviewed on each Lot at Building Consent phase of the development on each individual Lot.	
SITE FORMATION RECOMMENDATIONS	• Where excavations (cutting) are required, any exposed non-engineered fill material and/or material that contains excess organics that are deemed unsuitable, should be removed and the ground reinstated with engineered fill. • Where filling formation works are required, suitable material won from the cut portions of the works may be used as engineered fill, so long as it is constructed in accordance with NZS4431:2022 and the Auckland Council Code of Practice, 2013. Any non-engineered fill must be placed so it does not result in or exacerbate any instability on the slopes - KGA must be consulted prior to placement of fill.	
PRELIMINARY FUTURE LOT DEVELOPMENT RECOMMENDATIONS (see Section 14 and 15 for complete text)	• The recommendations provided herein are provisional only and must be subject to a design review once subdivision plans are finalised. • Provided all earthworks on building platforms have been certified as comprising engineered fill which was constructed in accordance with NZS4431:2022, then for the purposes of design, the soil underlying the proposed building platforms are generally considered to comprise 'good ground' in accordance with NZS3604:2011, Timber Framed Building, with the exception of expansive properties, where it does not comprise 'good ground'. • Piles or retaining walls are likely to be required on the downslope side of some buildings to counteract soil creep effect. • The extent and geotechnical design parameters of any proposed in-ground wall should be assessed as part of the design of final subdivision plans and will require additional geotechnical investigation to confirm rock head depth.	
FUTURE WASTEWATER DISPERSAL COMMENT	Preliminary calculations have been undertaken for Resource Consent purposes only, to determine the area available on each Lot for on-site wastewater dispersal capacity. Restrictions and requirements of the wastewater dispersal areas are discussed in detail within Section 14.	
REPORT DISTRIBUTION	A full copy of this report must be provided to all relevant parties involved in the project. This should include, but not be limited to, owner, architectural designers, engineers (civil and structural) and the earthworks/building contractor.	

CONTENTS

APPENDICES

1. INTRODUCTION

At the instruction of Mr. Hari De Alwis on behalf of Goodland Group Limited (GGL), KGA Geotechnical Group Limited (KGA) has carried out a geotechnical engineering investigation at 2127 Kaipara Coast Highway, Makarau, in support of a proposed 25 Lot rural residential subdivision.

The scope of our investigation was to carry out a review of any available existing geotechnical information, examine Geographical Information System (GIS) data pertaining to the site, undertake a visual inspection of the site and investigate the subsurface soil and groundwater conditions with the use of hand-operated equipment. The information obtained has been applied within this report to:

- Confirm safe and stable all weather vehicle access is present to each Lot, or that such can feasibly be formed.
- Confirm safe and stable building platform areas are present on each Lot, or that such can feasibly be formed.
- Identify the potential areas available for individual Lot on site domestic wastewater dispersal/disposal (and communal disposal area for community hall).

This report comprises a revision and update of our report K200826-1B, dated 1 March 2024, and therefore supersedes our earlier report. This report includes an updated wastewater assessment as requested by Auckland Council in a Resource Consent Application Section 92 Request for Further Information (RFI) letter from Auckland Council (AC), dated 27 June 2024.

This report presents our findings and conclusions and has been prepared in support of a Resource Consent application only and for use in engineering design. It is not deemed suitable for submission as part of a Building Consent application without further geotechnical assessment once detailed development plans are available.

2. SITE DESCRIPTION

2.1 Legal Description

The site at 2127 Kaipara Coast Highway, Makarau is legally described as 4B Block and Section 1 Survey Office Plan 328127, and Part Section 50 Block II Kaipara Survey District and has a total plan area of approximately 138.0722 Ha, and is hereinafter referred to as 'the site'. The site is irregular in plan shape and accessed via Kaipara Coast Highway on the northeast boundary. The site is bound by rural residential properties to the north, Makarau Stewardship Area (currently used as pastoral farmland) to the west, Pareparea Burial Reserve to the south, and Makarau River/Makarau Bridge reserve to the east. An indication of the site boundaries relative to Kaipara Coast Highway is indicated in Figure 1 below, and shown on our Site Plan presented in Appendix A.

Figure 1: Screenshot of site boundaries from Auckland Council Geomaps Website. (Not to Scale)

2.2 Geomorphic Description

Topographically the site is variable but can be generally characterised by a localised high point in the northeast portion of the site, which extends into a ridge feature that runs in a general north to south orientation. The ground on the eastern portion of the ridge is generally steeply sloping down towards Makarau River, while the ground of the western side is generally gently to moderately sloping towards the west. A number of gully features have been incised into westward facing slopes with overland flow paths generally flowing to the west. The slopes on the western extent of the site abruptly steepen to form a coastal cliff-like feature above the near level flood plains to the west.

Near the centre of the site are the remnants of a disused aggregate quarry. The quarry is northwest facing with an approximately 20 m high, exposed andesite rock face. A pond feature is located at its base.

Several features of note were observed during our walkover which are reminiscent of historic shallow land-sliding morphology. Notably, we observed several amphitheatre shaped areas of land which contained a notable steep sloping portion upslope of a more gently sloping but hummocky/benched area. In many of these locations, the land downslope of the hummocky/benched areas were noted to fall steeply again. Further, in some places there was a notable 'back-slope' to some of the benches (where the surface of a bench locally falls back towards the overall slope), and also localised concentrations of hydrophilic vegetation (rushes) were observed. An example of this type of morphology can be seen in Figure 2 below.

Figure 2: Example of observed historic landslide morphology northeast of the proposed Lot 8.

We observed historic instability on site which typically comprised minor shallow soil creep across much of the site's sloping ground. No obvious evidence of deep-seated slope instability was identified during our site observations.

It should be noted that following the Auckland Anniversary Floods and Cyclone Gabrielle (12 February 2023), KGA revisited the site to conduct a detailed walkover and observe any potential changes to the site. During this walkover, one additional shallow soil slip was observed on the eastern sloping ground (on the other side of the main ridge line from the proposed development). No evidence of significant or minor slope instability was observed on the western slopes.

2.3 Site Cover and Usage Description

The current land-use of the site is pastoral farming and is divided into a number of paddocks. An existing dwelling is located on the northern corner of the site and a number of farm sheds and other structures are located north of the high point of the site. A gravel accessway allows vehicle access to the dwelling and the farm sheds where a turnaround bay is located. Farm tracks are spread across the site, generally along local ridge lines. The heavily used farm tracks were observed to be highly disturbed and 'boggy' from the stock movement through the wet season. Several large stands of bush, and Significant Ecological Areas (SEA) are present on the property, particularly on the more steeply sloping eastern side of the ridge, and within the larger, western sloping gully features. The gently sloping areas on the western side of ridge are noted to contain some shallow drainage channels and abundant growth of hydrophilic vegetation (rushes), as is evident in Figure 3.

Figure 3: Gently sloping land and hydrophilic vegetation in the western part of the site proper

3. PROPOSED DEVELOPMENT

KGA are in receipt of a set of subdivision scheme plans by Survey Worx, entitled “Goodland – 2127 Kaipara Coast Highway, Kakanui”, reference No SP495, dated July 2023, and a concept layout plan by Kaipara Coast Landscape Architecture (KCA) entitled “Goodland Coastal Farm Plan”, dated July 2023. For reference, copies of the plans provided to us are presented in Appendix B.

The plans show a proposed 25 Lot subdivision with each Lot size ranging from approximately 0.26 ha to 0.4 ha. The Lots are located on the lower portions of the western facing slopes. A series of accessways are proposed along the existing farm tracks to service the proposed Lots. These proposed accessways generally follow the natural ridgelines onsite.

The plans also indicate the proposed permitted building area on each Lot, which are all generally located on the highest/flattest portions of each Lot, and often close to, or adjacent the proposed accessway. The exception being Lots 7, 14, and 25 where the building platforms are proposed on the flattest areas of these Lots, away from the proposed accessway and will be connected via private right of ways. The permitted building areas have been indicated on each Lot, and we understand dwelling construction will be restricted to these areas and is part of the conditions of purchase.
The subdivision plans provided indicate that the site formation works will largely be limited to the formation of the accessway. The drawings show potential excavations of up to approximately 3 m, and the placement of fill up to 6 m thick. Batter slopes and retaining walls are also proposed to form the accessways, with batter slopes generally indicated to be finished at a grade of 1 vertical on 3 horizontal. The proposed retaining wall locations detailed in plans are preliminary only, and are to be confirmed following specific engineering design.

The main accessway into the site is proposed to cross a wetland area east of the current site access. The new site access is required to comply with NZTA Traffic Standards. Correspondence with the Crang Civil Consultants Limited (CCC) suggest that this access will be formed by placing up to 4.0 m of fill, which will be retained using either Mechanically Stabilised Earth (MSE) structures, or Gabion Wall Structures. These retaining structures will be subject to specific investigation and design at Building Consent stage.

Correspondence with GGL has indicated that on-site wastewater dispersal is required for each Lot, with a wastewater effluent dispersal field to be designed to recommendations/conditions in this report.

4. DESKTOP STUDY

4.1 Introduction

We have reviewed the findings of a previous geotechnical report prepared by KR Miller & Associates Report entitled “Geological Investigation of Aggregate Resources on the Goodland Group Property, Makarau”, dated November 2004, which presented the findings of an investigation of the aggregate deposits on the property.

We have also assessed the Geographic Information System (GIS) data available through the Auckland Council GIS website, Geomaps, and the publicly available information through Land Information New Zealand (LINZ). We have also undertaken an Aerial Photograph Interpretation (API) exercise using stereo pairs of historic aerial photographs that cover’s the general area of the site. Lastly, we have reviewed the published geologic maps that cover the greater Helensville area.

4.2 KR Miller & Associates Report, dated November 2004

This report was prepared to investigate the aggregate deposits on the property and determine the technical feasibility of developing a new quarry. The key points from their investigation which are relevant to this investigation are as follows:

- The site was determined to be underlain by geology of the Helensville Conglomerate with outcrops of lava flow around the existing quarry area.
- The material quarried onsite was previously described as andesite breccia.
- As part of their investigation seven machine boreholes were drilled around the quarry outcrop to depths ranging from 29.5 m to 52.6 m.
- Mudstone and andesite material was encountered within 3 m of ground surface within each borehole.

A copy of the referenced report in presented in Appendix B.

4.3 GIS Information & Stereoscopic Aerial Photograph Interpretation

Our interpretation of the GIS information for the site generally confirmed our on-site observations. In particular, the data available helped to confirm the presence and location of historic landslide head-scarp features, including those that were otherwise obscured by vegetation, or were not readily apparent by ground surface observation while on site. A 3D perspective of the site using a hillshader algorithm applied to the Digital Elevation Model (DEM) of the site, which is publicly available LINZ data, is presented in Figure 4 below for perspective.

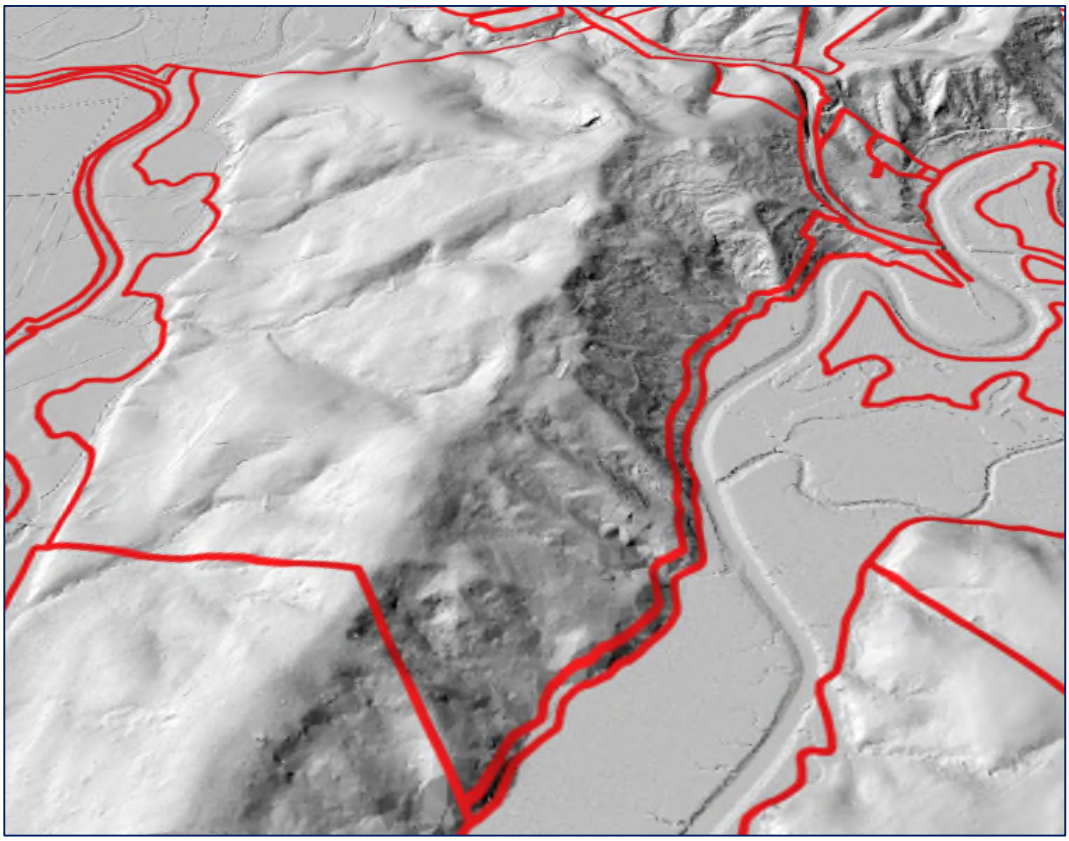

Figure 4: 3D perspective of the site elevation (data from LINZ). Looking from South to North.

Our interpretation of the hillshader model generally confirms the observations made during the reconnaissance walkover, and indicates historic land slippages across the site, particularly in the eastern portion. However, no evidence of recent or on-going, deep-seated slope instability was interpreted.

The hillshader model and aerial photograph interpretation also suggest the southern portion of the site is underlain by a mass block of Waitemata Group Formation Rock which is dipping westward. A westward tilting block would result in the eastern slopes having favourable geology and may be the reason the eastern escarpment is so steep and only exhibiting minor shallow soil failures compared to the remainder of the site. This would also explain why the drainage patterns in the western portion of the site are generally towards the west.

5. GEOLOGY

The geology of the site and surrounding area is detailed on the Helensville Geological Map, Sheet, Q10, Helensville (Scale 1:50,000). This shows the site to be underlain geology of the Waitemata Group, and recent alluvial deposits, specifically (in stratigraphic sequence, youngest to oldest, based on Schofield 1989):

- Holocene River Deposits
- Swanson Mudstone
- Helensville Conglomerate
- Paremoremo Formation

5.1 Holocene River Deposits

The near level flood plains on the western extent of the site are shown to be underlain by stream alluvium. Alluvial deposits are variable in composition and contain alternating very thin to thick beds of clays, silts and sands of variable consistency. Alluvial deposits are typically found along stream channels and flood plains of rivers, or along localised gully features.

5.2 Swanson Mudstone and Helensville Conglomerate

The western slopes of the site are shown to be underlain by soils of the Swanson Mudstone and Helensville Conglomerate. The Swanson Mudstone comprises soft, non-calcareous mudstone and sandstone, finely interbedded, with rare pebble beds. The Helensville Conglomerate comprises well rounded, mainly andesitic conglomerate with boulders up to 2 m in diameter, and rare lava flows.

5.3 Paremoremo Formation

The steeply sloping ground on the eastern side of the site is shown to be underlain by mudstone and graded sandstone of the Paremoremo Formation, part of the Waitemata Group. In an unweathered state (depths usually greater than 5 to 8 m) the Formation comprises alternating beds of siltstone and sandstone. The material weathers naturally to produce stiff clays and silts in the completely decomposed state. At intermediate depths, the moderately to highly weathered materials comprise slightly cemented silty fine sand and fine sandy silt with the original bedding remaining visible.

5.4 Faulting

The geological map also shows an inactive fault immediately east of the site. This fault trends northeast to southwest and runs through the centre of the Makarau River mouth. The fault is dipping eastward indicating the western side (of the fault) has been uplifted.

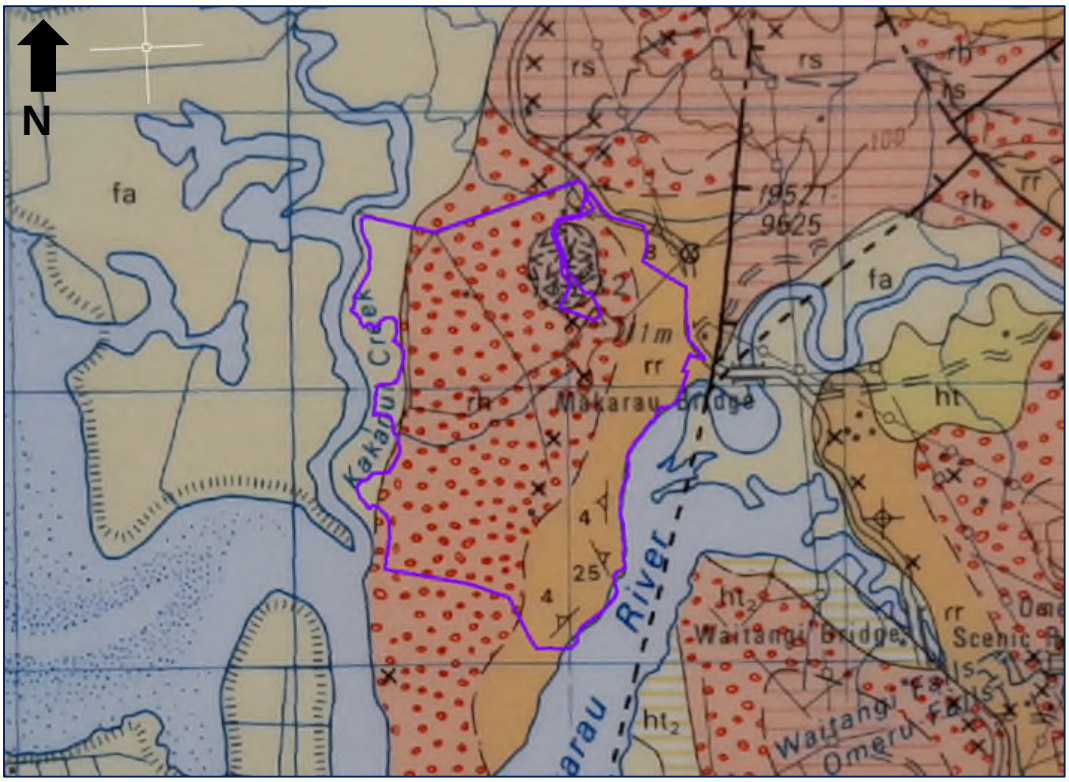

Figure 5 - Excerpt from Helensville Geologic Map, Sheet Q10 (not to scale). The subject site boundaries (in purple) relative to the mapped geologic units and features are indicative and approximate only.

We point out that the geologic map used in this investigation is regional in scale and as such is only useful as an approximate indication as to the material that may underline the site. The presence or absence of any material can only be confirmed by undertaking site specific investigation.

6. FIELD EXPLORATION

The subsurface ground conditions within the proposed Lots, accessway and sloping ground across the site were explored by drilling 38 hand-auger boreholes, AH1 to AH38, and 18 wastewater hand-auger boreholes (WWAH1 to WWAH18). The borehole locations are shown on our Site Plan, presented in Appendix A. The borehole locations were selected to provide a representative indication of the subsurface ground conditions across the site.

The boreholes were advanced using a 50 mm diameter hand-auger and were designated to be undertaken to depths of 5 m (standard investigation boreholes) and 1.2m (wastewater boreholes), or until effective refusal was reached, whichever being shallower. The subsurface conditions encountered in each borehole locations were logged in general accordance with “The guidelines for the classification and description of soil and rock for engineering purposes”, December 2005 as outlined by New Zealand Geotechnical Society.

A calibrated shear vane, used in general accordance with “New Zealand Geotechnical Society Guidelines for Hand-Held Shear Vane Tests”, 2001, was used at regular depths of 0.5 m in the drilled holes to measure soil strengths, both in situ and remoulded. The vane shear strengths shown on the attached logs have been corrected in terms of BS1377:1990.

Scala penetrometer testing was subsequently undertaken through the base of the standard investigational boreholes (AH1 to AH38) with a view of establishing a general indication of soil penetration resistance for a further 2 m beyond the base of each borehole, or until effective refusal was encountered, whichever being encountered first.

Scala penetrometer testing was also conducted along the proposed accessway to a maximum depth of 2 m, or effective refusal, to obtain preliminary California Bearing Ratios (CBRs) for use in accessway design.

The site was subsequently revisited on 11 May 2021, in order to check boreholes AH1 to AH32 for standing groundwater, after the effects of drilling have dissipated. Where encountered, the measured depths to standing groundwater levels are shown in Table 1. Groundwater was not remeasured within Boreholes AH33 to AH38 and WWAH1 to WWAH18, as they were drilled at a later date.

The detailed hand-auger borehole logs including Scala penetrometer results and the accessway Scala penetrometer results are presented in Appendix A.

7. SUBSURFACE CONDITIONS

The subsurface ground conditions encountered in the exploratory boreholes are summarised below, with the measured information summarised in Table 1. For a detailed description of the subsoils encountered on site, reference should be made to the attached borehole logs.

We point out that, in order to prepare a subsurface model of the site, the subsoil conditions have been inferred between our investigation points. It must be accepted that the conditions are likely to vary between each investigation location, particularly when the distance between the points is great. Additionally, considering the discrete nature of the information obtained compared to the overall area of the site, assumptions have been made for those parts of the site where subsurface information is currently sparse.

Topsoil

A thin veneer of topsoil was encountered at the surface in every borehole.

Colluvium

Colluvial material sourced from the underlying Waitemata group soils was encountered beneath the topsoil in borehole AH04. This material comprised clayey silt with organic inclusions. The shear strengths within this material range from 120 kPa to greater than 220 kPa.

Waitemata Group Soil

Soils derived from the in situ weathering of the Waitemata Group materials were encountered within each borehole beneath topsoil or colluvial material (AH04). This material comprised stiff to very stiff, clay, silt and sand. The vane shear strength readings within this material ranged from 50 kPa to greater than 220 kPa.

Inferred Dense Material

The Scala penetrometer testing encountered effective refusal beneath boreholes AH1 to AH10, AH12 and AH15 to AH34. From the results, it can be assumed that denser material underlies the logged material onsite within approximately 6 m of present ground surface.

Groundwater

Groundwater was identified in most boreholes at the time of drilling, and the site was subsequently revisited on 11 May 2021 to measure groundwater once the effects of drilling had dissipated. Boreholes AH33 and AH38 were not remeasured as they were drilled at later dates.

Table 1: Summary of the Subsurface Investigation Borehole Logs

Sample ID	Topsoil	Colluvium	Waitemata Group Soil	Scala Penetrometer Range	Groundwater	
					During Drilling	After Drilling
AH01	0.00 - 0.30	--	0.30 - 2.40*	2.40 - 3.10	--	0.1
AH02	0.00 - 0.20	--	0.20 - 1.20*	1.20 - 1.65	--	0.25
AH03	0.00 - 0.30	--	0.30 - 2.10*	2.10 - 3.50	--	1.47
AH04	0.00 - 0.30	0.30 - 1.80	1.80 - 5.00*	5.00 - 6.20	--	--
AH05	0.00 - 0.20	--	0.20 - 5.00*	5.00 - 5.85	--	--
AH06	0.00 - 0.20	--	0.20 - 1.00*	1.00 - 1.05	--	0.77
AH07	0.00 - 0.20	--	0.20 - 0.80*	0.80 - 0.85	--	--
AH08	0.00 - 0.20	--	0.20 - 1.30*	1.30 - 1.45	--	N/A
AH09	0.00 - 0.20	--	0.20 - 5.00*	5.00 - 6.50	--	--
AH10	0.00 - 0.20	--	0.20 - 5.00*	5.00 - 6.15	4.9	4.55
AH11	0.00 - 0.30	--	0.30 - 5.00*	5.00 -6.95 T	--	--
AH12	0.00 - 0.20	--	0.20 - 5.00*	5.00 - 6.50	--	--
AH13	0.00 - 0.30	--	0.30 - 5.00*	5.00 - 6.90 T	--	--
AH14	0.00 - 0.10	--	0.10 - 3.00*	1.20 - 3.00 T	--	--
AH15	0.00 - 0.10	--	0.10 - 5.00*	5.00 - 5.75	--	--
AH16	0.00 - 0.20	--	0.20 - 1.70*	1.70 - 1.90	1.2	1.37
AH17	0.00 - 0.20	--	0.20 - 4.00*	4.00 - 5.45	--	--

Sample ID	Topsoil	Colluvium	Waitemata Group Soil	Scala Penetrometer Range	Groundwater	
					During Drilling	After Drilling
AH18	0.00 - 0.20	--	0.20 - 2.90*	2.90 - 4.80	--	--
AH19	0.00 - 0.30	--	0.30 - 5.00*	5.00 - 5.85	--	--
AH20	0.00 - 0.10	--	0.10 - 3.20*	3.20 - 3.25	--	--
AH21	0.00 - 0.20	--	0.20 - 3.10*	3.10 - 4.65	--	--
AH22	0.00 - 0.20	--	0.20 - 0.90*	0.90 - 0.95	--	--
AH23	0.00 - 0.10	--	0.10 - 2.00*	2.00 - 2.75	--	--
AH24	0.00 - 0.10	--	0.10 - 1.60*	1.60 - 1.80	--	--
AH25	0.00 - 0.20	--	0.20 - 4.60*	4.60 - 5.10	--	4.45
AH26	0.00 - 0.30	--	0.30 - 4.70*	0.40 - 1.90 4.75 - 5.65	--	--
AH27	0.00 - 0.30	--	0.30 - 1.70*	1.70 - 3.40	--	--
AH28	0.00 - 0.20	--	0.20 - 5.00*	5.00 - 5.60	--	4.71
AH29	0.00 - 0.10	--	0.10 - 0.60*	0.60 - 0.85	--	--
AH30	0.00 - 0.20	--	0.20 - 5.00*	5.00 - 5.40	--	--
AH31	0.00 - 0.30	--	0.30 - 5.00*	5.00 - 5.90	--	4.74
AH32	0.00 - 0.20	--	0.20 - 1.80*	1.80 - 1.85	--	1.8
AH33	0.00 – 0.20pl	--	0.20 - 4.80*	4.80 – 5.25		N/A
AH34	0.00 – 0.20	--	0.20 - 2.70*	2.70 – 2.95	--	N/A
AH35	0.00 – 0.30	0.30 – 0.60	0.60 - 3.20*	3.20 - 4.45	--	N/A
AH36	0.00 – 0.10	--	0.10 - 3.00*	3.00 – 3.75	1.70	N/A
AH37	0.00 – 0.30	--	0.30 - 5.00*	5.00 - 6.30	--	N/A
AH38	0.00 – 0.20	--	0.20 - 5.00*	5.00 - 6.30	2.70	N/A
WWAH1	0.00 – 0.40	--	0.40 – 1.20*	N/A	--	N/A
WWAH2	0.00 – 0.40	--	0.40- 1.20*	N/A	--	N/A
WWAH3	0.00 – 0.30	0.30 – 0.60	0.60 – 1.20*	N/A	--	N/A
WWAH4	0.00 – 0.40	0.40 – 0.60	0.60 -1.20*	N/A	--	N/A

Sample ID	Topsoil	Colluvium	Waitemata Group Soil	Scala Penetrometer Range	Groundwater	
					During Drilling	After Drilling
WWAH5	0.00 – 0.30	--	0.30 – 1.20*	N/A	--	N/A
WWAH6	0.00 – 0.30	0.30 – 0.50	0.50 – 1.20*	N/A	--	N/A
WWAH7	0.00 – 0.40	--	0.40 – 1.20*	N/A	--	N/A
WWAH8	0.00 – 0.30	--	0.30 – 1.20*	N/A	--	N/A
WWAH9	0.00 – 0.30*	--	0.30 – 0.70*	N/A	--	N/A
WWAH10	0.00 – 0.30	--	0.30 – 1.20*	N/A	--	N/A
WWAH11	0.00 – 0.30	--	0.30 – 1.20*	N/A	--	N/A
WWAH12	0.00 – 0.30*	--	--	N/A	--	N/A
WWAH13	0.00 – 0.10*	--	--	N/A	--	N/A
WWAH14	0.00 – 0.40	--	0.40 – 1.20*	N/A	--	N/A
WWAH15	0.00 – 0.30	--	0.3 – 1.50*	N/A	--	N/A
WWAH16	0.00 – 0.20	--	0.20 – 1.50*	N/A	--	N/A
WWAH17	0.00 – 0.10	--	0.10 – 1.50*	N/A	--	N/A
WWAH18	0.00 – 0.30	--	0.30 – 1.50*	N/A	--	N/A

Note: All measurements are in metres
T = Refusal not encountered
-- = Material/groundwater not encountered
N/A = Groundwater not measured

8. SITE CLASSIFICATIONS

8.1 Expansive Classification

Our experience of similar soils encountered elsewhere in the Auckland region indicates that the near surface clayey silt materials of the weathered Waitemata Group Formation, as noted in the boreholes, are susceptible to swelling and shrinking under seasonal variations of water content.

The assessment of the shrink-swell potential at the site has been undertaken in accordance with NZBC B1/AS1 and NZS3604:2011. According to our investigation logs, most of the near surface soils are silt dominant, with moderate to high plasticity. As such, for the purposes of design, the site may be designated as Highly reactive (Class H). Soils within this Expansive Soil Class may be assumed to have an SLS 500-year return design characteristic surface movement (y_s) of 66 mm. It is important to note that this classification is for preliminary design only. Shrink/swell and Atterberg limits laboratory testing should be conducted following the completion of the site formation works to confirm the expansive nature of the soils within the building platforms prior to Building Consent design.

8.2 Seismic Design Classification

From our site subsurface investigation, the following has been noted:

- The site is not Class A or B.
- The subsoils comprised of clayey silt/silty clay of alluvial deposition.
- Undrained shear strengths measured within the boreholes were all greater than 12.5 kPa, therefore the site is not Class E.
- The subsoil strata do not exceed the maximum soil depth highlighted in Table 3.2 of NZS1170.5.

Based on the above, the site can be classified as Class C (Shallow Soil Site) in accordance with NZS1170.50.2004 Section 3.1.3.

9. SLOPE STABILITY

9.1 Slope Stability Assessment

The visual assessment undertaken on the sloping ground within the site identified evidence of shallow soil failures/creeps. However, no deep-seated failures were observed. In conjunction with our visual assessment, we have used 1 m contours from the Auckland Council Web application ‘GeoMaps’, in order to prepare a series of representative cross-sections for use in a slope stability analysis of the existing ground, see attached cross-sections A-A’ to N-N’.

The subsurface conditions modelled in the analyses are based upon the results of our subsurface investigation.

Details of the cross-sections are shown in the slope stability calculations presented in Appendix C. the analyses were undertaken using the computer-based programme “SLIDE2” by RocScience.

In carrying out our analyses, we have modelled the existing ground surfaces on all sections, the proposed ground surfaces on selected critical sections where slopes were considered unstable or significant site formation earthworks is required. The sections have been modelled utilising three separate load case scenarios:

- Measured groundwater conditions (based on field measurements);
- Assumed raised groundwater conditions (which was modelled to reflect a hypothetical, critical case situation following a period of prolonged, intense rainfall); and,
- A seismic scenario (which modelled the measured groundwater conditions with an added seismic horizontal acceleration coefficient of 0.19g, based on a 500yr earthquake return period as per NZGS Module 1 (Rev A) – November 2021.

For all scenarios modelled we have assessed potential circular and non-circular surfaces using the Spencer method of calculating the interslice forces. The geotechnical parameters used in the analyses are presented in Table 2.

Table 2: Geotechnical parameters used in Stability Analysis

Stratum	Bulk Unit Weight γ (kN/m^3)	Effective Stress Parameters		Hoek Brown USC (kPa)
		Cohesion c’ (kPa)	Angle of Friction Ø’	
Colluvium	18	2	23	N/A
Engineered Fill	18	7	32	N/A
Waitemata Group Soil	18	5	30	N/A
Waitemata Group Transitional Material	20	10	34	N/A
Inferred Bedrock	20	N/A	N/A	1500

A summary of Factor of Safety results from the analyses are presented in Table 3 below. For detailed results, however, please refer to Appendix C.

Table 3: Factor of Safety obtained in Stability Analysis

Cross-Section Surface Model		Factor of Safety (FOS)		
		Measured Groundwater	Raised Groundwater	Seismic
A-A' Existing Ground	Circular	1.6 ✓	1.4 ✓	1.1 ✓
	Non-Circular	1.6 ✓	1.5 ✓	1.1 ✓
B-B' Existing Ground	Circular	2.3 ✓	2.0 ✓	1.1 ✓
	Non-Circular	2.2 ✓	2.1 ✓	1.1 ✓
B-B' Proposed Ground	Circular	2.3 ✓	2.1 ✓	1.1 ✓
	Non-Circular	2.2 ✓	2.0 ✓	1.1 ✓
C-C' Existing Ground	Circular	1.6 ✓	1.4 ✓	1.1 ✓
	Non-Circular	1.6 ✓	1.4 ✓	1.1 ✓
C-C' Proposed Ground	Circular	1.6 ✓	1.6 ✓	1.1 ✓
	Non-Circular	1.6 ✓	1.6 ✓	1.1 ✓
D-D' Existing Ground	Circular	2.2 ✓	2.1 ✓	1.1 ✓
	Non-Circular	2.2 ✓	2.1 ✓	1.1 ✓
D-D' Proposed Ground	Circular	2.2 ✓	2.1 ✓	1.1 ✓
	Non-Circular	2.2 ✓	2.1 ✓	1.1 ✓
E-E' Existing Ground	Circular	2.3 ✓	2.2 ✓	1.2 ✓
	Non-Circular	2.3 ✓	2.2 ✓	1.2 ✓
E-E' Proposed Ground	Circular	2.3 ✓	2.3 ✓	1.2 ✓
	Non-Circular	2.3 ✓	2.2 ✓	1.4 ✓
F-F' Existing Ground	Circular	3.1 ✓	2.6 ✓	1.4 ✓
	Non-Circular	3.1 ✓	2.6 ✓	1.4 ✓
F-F' Proposed Ground	Circular	2.9 ✓	2.7 ✓	1.4 ✓
	Non-Circular	3.1 ✓	2.6 ✓	1.4 ✓
G-G' Existing Ground	Circular	2.5 ✓	2.1 ✓	1.3 ✓
	Non-Circular	2.5 ✓	2.0 ✓	1.3 ✓
G-G'	Circular	2.5 ✓	2.3 ✓	1.3 ✓

Cross-Section Surface Model		Factor of Safety (FOS)		
		Measured Groundwater	Raised Groundwater	Seismic
Proposed Ground	Non-Circular	2.5 ✓	2.1 ✓	1.3 ✓
H-H' Existing Ground	Circular	1.9 ✓	1.9 ✓	1.1 ✓
	Non-Circular	1.9 ✓	1.9 ✓	1.1 ✓
H-H' Proposed Ground	Circular	1.9 ✓	1.8 ✓	1.1 ✓
	Non-Circular	1.9 ✓	1.8 ✓	1.1 ✓
I-I' Existing Ground	Circular	2.0 ✓	1.9 ✓	1.1 ✓
	Non-Circular	2.0 ✓	1.9 ✓	1.1 ✓
I-I' Proposed Ground	Circular	2.0 ✓	2.0 ✓	1.1 ✓
	Non-Circular	2.0 ✓	2.0 ✓	1.1 ✓
J-J' Existing Ground	Circular	2.6 ✓	2.5 ✓	1.3 ✓
	Non-Circular	2.6 ✓	2.4 ✓	1.3 ✓
K-K' Measured Ground	Circular	1.7 ✓	1.5 ✓	1.1 ✓
	Non-Circular	1.7 ✓	1.5 ✓	1.1 ✓
K-K' Proposed Ground	Circular	1.5 ✓	1.3 ✓	1.0 ✓
	Non-Circular	1.5 ✓	1.3 ✓	1.0 ✓
L-L' Existing Ground	Circular	1.6 ✓	1.4 ✓	1.1 ✓
	Non-Circular	1.6 ✓	1.3 ✓	1.1 ✓
L-L' Proposed Ground	Circular	1.6 ✓	1.4 ✓	1.1 ✓
	Non-Circular	1.6 ✓	1.3 ✓	1.1 ✓
M-M' Existing Ground	Circular	1.8 ✓	1.7 ✓	1.0 ✓
	Non-Circular	1.8 ✓	1.7 ✓	1.0 ✓
M-M' Proposed Ground	Circular	1.8 ✓	1.7 ✓	1.0 ✓
	Non-Circular	1.8 ✓	1.7 ✓	1.0 ✓
N-N' Existing Ground + Accessway Surcharge	Circular	1.2 ✗	1.2 ✗	--
	Non-Circular	1.2 ✗	1.2 ✗	--

Cross-Section Surface Model		Factor of Safety (FOS)		
		Measured Groundwater	Raised Groundwater	Seismic
N-N' Existing Ground Minimum FoS within Proposed Accessway	Circular	1.5 ✓	1.5 ✓	--
	Non-Circular	1.6 ✓	1.6 ✓	--
Council Accepted Minimum Factor of Safety		**1.5**	**1.3**	**1.2**

✗ = unsatisfactory result, ✓ = satisfactory result

9.2 Stability Assessment Conclusions

As discussed in Section 4, we have interpreted the eastern slopes to have favourable geology with the underlying Waitemata Group material tilting westward. The stability assessment of Cross-Section N-N' indicated failures below the required FoS. The models however indicate the closest failure surfaces below the Council FoS requirements was 5.5 m from the accessway extent. As such we consider the proposed location of the accessway along the crest of the eastern slopes to be safe and stable.

We have interpreted the eastern slopes to have favourable geology with the underlying Waitemata Group material tilting westward. However, due to the results of Cross-Section N-N' we recommend retaining be installed on the eastern side of the accessway to allow for any potential minor creep movement on the sloping ground to the east. The extent and geotechnical design parameters of any proposed in-ground wall should be assessed as part of the specific design stage and may require additional geotechnical investigation to confirm rock head depth. This is discussed further in Sections 11 and 12.

With the exception of Cross-Section N-N', the remaining stability analyses indicate that the site is currently safe and stable, and that a majority of the lateral creep movement observed on-site is likely to be shallow seated. Provided our recommendations below are adhered to by the future developers of the site, we consider that the site and the development will remain safe and stable over the intended design life of the proposed subdivision.

As discussed in Section 3, we have only been provided with preliminary layout plans that do not include proposed building platforms or any individual Lot's site formation works. As such, we recommend that site specific investigation and stability assessments are conducted for each Lot when the finalised earthwork plans are ready for submission to Council.

10. SUBDIVISION FORMATION WORKS

10.1 Excavations and Batter Slopes

As discussed in Section 3, the scheme plans indicate that the site formation works will potentially involve excavations of up to approximately 3 m and the placement of fill up to 6m thick in discrete parts of the site to form the accessways. Batter slopes are also proposed to form the downslope sides of sections of the accessways. Currently these batters are proposed at an approximate slope gradient of 1 vertical on 3 horizontal and are considered safe and stable.

10.2 Provisional Bulk Earthworks Specifications

Where filling formation works are proposed, the ground should be stripped of topsoil and any low strength materials, then appropriately benched prior to any filling being undertaken. The soils removed during the excavation phase of the works may be re-used as engineered fill, provided it is placed in accordance with NZS4431:2022 "Engineering fill construction for lightweight structures". All engineered fill must be constructed so that the fill does not result in, exacerbate, or contribute towards any instability on the site.

All earthworks on the site must be carried out in accordance with NZS4431:2022 "Engineering fill construction for lightweight structures". For this, we recommend that the works are carried out during the dryer months of summer when the prevailing weather conditions are more conducive for undertaking such works. For compaction control criteria, we recommend using the compaction control criteria summarised in Tables 4 and 5 below.

All shear vanes used for measuring in situ soil strengths must be used in accordance with the New Zealand Geotechnical Society Guideline for Hand Held Shear Vane Test, 2001.

Table 4: Compaction Control Criteria Cohesive Material Summarised from Table A1, NZS4431:2022

Material Type	Test (and Method)	Minimum Test frequency	Normal Acceptance Criteria	Notes
Cohesive Material (Fine to medium grained)	Filed water content and density (NZS4402 test 2.1 and NZS4407 tests 4.1, 4.2, or 4.3)	2 per 1,000m3 (Minimum 2 per lift)	≥ 95% maximum dry density < 10% air voids	--
	Shear Strength (NZGS Guideline for handheld shear vane test)	2 per 1,000m3 (Minimum 2 per lift)	Lowest value > 150kPa	--
	Plate load test (DIN 18134)	As specified by the certifier	≥ 300kPa ultimate bearing capacity < 25mm settlement at 300kPa	Typical frequency 1 per lot at completion of final lift

Table 5: Compaction Control Criteria Granular Material Summarised from Table A1, NZS4431:2022

Material Type	Test (and Method)	Minimum Test frequency	Normal Acceptance Criteria	Notes
Granular Material (GAP 40, GAP 65, and GAP 100)	For coarse-grained soils with maximum particle size < 65mm, test field water content and density (NZS4402 Test 2 1 and NSZ4407 tests 4.1, 4.2 or 4.3)	2 per 1,000m3 (Minimum 2 per lift)	≥ 95% maximum dry density < 15% air voids	--
	For coarse-grained soils with maximum particle size from 65mm to 250mm, proof-roll to target maximum calibrated dynamic response modulus or relative density (CEN/TS 17006)	Ongoing continuous compaction control	Target minimum calibrated compaction machine specific dynamic response modulus or minimum 80% relative density	Target minimum modulus set by correction with plate load test(s) or as otherwise defined by the certifier
	Dynamic cone penetrometer	1 per 500m^3 for full depth of lift (Minimum 2 per lift)	≥ 5 blows per 100 mm	DCP locations as directed by the certifier This test is indicative only and should not be used alone for compaction compliance
	Impact test – 4.5kg hammer (ASTM D5874)	1 per 50m^3 on each compacted layer (Minimum 2 for each lift of fill)	IV > 25	Impact test locations as directed by the certifier This test is indicative only and should not be used alone for compaction compliance
	Plate load test (DIN 18134)	As specified by the certifier	≥ 300kPa ultimate bearing capacity < 25mm settlement at 300 kPa	Typical frequency 1 per lot at completion of final lift

10.3 Potential Consent Requirements

We anticipate that Council will likely impose specific Conditions on the Resource Consent for the project that will require the earthworks to be observed and certified on completion as being suitable for its intended purpose. In this respect, periodic geotechnical observations of the earthworks in progress are recommended to ensure that sufficient quality control is exercised so that there will be no constraints to the issuing of any required certification documentation.

11. ACCESSWAY DESIGN

Based on the results of our subsurface investigation as indicated on the equivalent CBR results presented in Appendix B, the proposed accessways may utilise a design CBR values of 1-2% for pavement design. This should be confirmed onsite at the time of accessway formation.

As discussed in Section 9.2, due to the results of Cross-Section N-N' modelling the accessway on the crest of the eastern slopes, we have recommended an in-ground wall be installed on the eastern side of the accessway to allow for any potential minor creep movement on the sloping ground to the east. The extent and geotechnical design parameters of any proposed in-ground wall should be assessed as part of the specific design stage and will require additional geotechnical investigation to confirm rock head depth.

12. ACCESSWAY RETAINING WALLS

As discussed in Section 3, the proposed drawings provided indicate that a number of retaining walls will be built to support cut faces and filled ground along the accessways. At the time of preparing this report, no detailed retaining wall plans have been provided. However, we have assumed that they comprise timber pole retaining walls.

For design of the timber pole retaining walls, the following geotechnical parameters may be adopted:

- Bulk unit weight (γ) for the retained soils 18 kN/m^3
- Undrained shear strength (s_u) 60 kPa
- Cohesion (c') 0 kPa

- Internal friction angle (Ø') 28°
- Coefficient of active earth pressure (K) 0.5

Appropriate drainage measures must be installed behind all retaining walls to ensure that hydrostatic pressures cannot build up behind them. We point out, however, that the retained soils strength parameters provided above are given assuming that granular drainage measures will be installed behind all retaining walls. These particular parameters must be reconsidered should alternatively types of drainage measures, such as narrow, expanded polystyrene boards, be detailed by the wall designers instead.

All retaining walls must also be designed in accordance with the latest Auckland Council Note AC2231 (Construction of Retaining Walls V5), particularly where any walls are likely to be affected by building, property boundary and accessway surcharges. In this respect, AC2231 provides guidance as to the appropriate surcharge values to be incorporated into the design of the affected walls.

Any sloping ground that is present, either above or below any retaining walls, along with any proposed filling must be taken into consideration during the detailed design of the retaining wall.

13. DEVELOPMENT FEASIBILITY & DRAWING REVIEW

Our investigation and slope stability assessment suggest that the proposed subdivision concept is feasible from a geotechnical perspective. Development recommendations have been provided within this report. However, if any significant site formation works in excess of our assumptions indicated in Section 10.1 are proposed after the issuing of this report, said works must be subject to further computational slope stability analyses in order to confirm or otherwise that the proposed works do not adversely affect the current state of stability on the site.

14. FUTURE INDIVIDUAL LOT WASTEWATER TREATMENT AND DISPERSAL

As discussed in Section 3, GGL has indicated that individual on-site wastewater management is proposed for each Lot. The soil classification used in this assessment has been interpreted from the boreholes drilled as part of this investigation. The boreholes are spread across the site, and it must be accepted that the conditions are likely to vary between each investigation location. As such, the following is intended for provisional design purposes only, site-specific assessments will be required at Building Consent stage for individual Lot development. The individual lot designs must follow the recommendations/conditions made within this report.

14.1 TP58 Soil Category

The subsurface conditions encountered within the boreholes generally comprised clay, silt and sand derived from the residual weathering of the Waitemata Group materials. For the purposes of this Resource Consent application, the soils have been defined as Category 6 in accordance with Table 5.1 of Auckland Regional Council Technical Publication 58 (TP58) and we recommend an areal loading rate no greater than 2.5 mm/day (2.5 L/m^2/day).

14.2 Assumptions for Preliminary Wastewater Treatment and Dispersal Design

We have undertaken preliminary calculations (as per TP58, Table 6.2) in order to gain an idea of the potential volume of wastewater that could be produced, and associated area that would be available on each Lot for wastewater dispersal purposes. From the subdivision scheme plan provided to KGA, we have made the following assumptions for future houses within the development:

- Modern wastewater treatment system to produce at a minimum advanced secondary level quality effluent.
- Based on an areal loading rate of 2.5 mm per day, for pressure compensating dripper irrigation disposal network (PCDI). This dispersal type has been chosen due to the sloping nature of the Lots.
- Standard fixtures with no garbage grinder and water tank supply = 200 L of water use per person per day.
- For subdivisions consent requirements, demonstrate that a reserve area of 100% of the primary field area is also available.

The flow volumes are based on bedroom numbers (with equivalent bedrooms also included in the calculation). A such, houses with 1 to 5 bedrooms/equivalent bedrooms (sewing rooms, studies, libraries, pool rooms, rumpus rooms etc) will require the following dispersal field areas summarised in Table 6 below:

Table 6: Required dispersal areas of each Lot base of the assumption outlined in Section 14.2.

Number of bedrooms	Number of occupants	Total wastewater flow allowance (L/day)	Total area required for primary field (m^2)	Total area required on each Lot (m^2)
1	2	400	160	320
2	4	800	320	640
3	5	1000	400	800
4	6	1200	480	960
5	8	1600	640	1280
Community Hall*	~50	1000	400	800

**Community hall is assumed to have a maximum occupancy of 50 people. With on-site roof water tank supply and a flow allowance of 20L/day/person (banqueting as per Table 6.2 of TP58).*

If future houses were to have more or less bedrooms/equivalent bedrooms, or the use of alternative water use fixtures and/or tertiary level wastewater treatment then the area or available site area required will change accordingly.

We recommend a minimum of advanced secondary level of effluent treatment is adopted, due to the presence of nearby flow path features.

Due to the position of the proposed lots and wastewater fields and the soil loading rate recommended above, we do not deem that wastewater dispersal will raise groundwater levels or adversely affect global and local slope instability across the site.

14.3 Set-Back Distances

In order to determine the area available for dispersal on each Lot, we have observed the set-back distances provided in Table 5.2 of TP58. For an advanced secondary level of treatment, the main separation distances are as follows:

- 1.5 m from houses - building platforms indicated on the KCA plans were used for ease of delineation at this time.
- 1.5 m from Lot boundaries and accessway boundaries.
- 15 m from surface water, flow paths, wetlands – locations taken from Wildlands Limited Report entitled “Ecological Impact Assessment for a Proposed Subdivision at 2127 Kaipara Coast Highway, Makarau”, reference No. 5807, July 2023.
- 15 m from proposed roadway stormwater swales (dispersal areas are located closer when entirely downslope)
- 0.6 m from winter groundwater table.
- Dispersal fields are not to be located on areas of proposed fill earthworks.

A copy of the Wildlands report has not been including in this report as it is assumed to be available to all relevant parties.

14.4 Preliminary Onsite Wastewater Dispersal Areas

Based on our assumptions and the TP58 defined set back distances, we have produced a Potential Wastewater Dispersal Areas plan, Drawings KGA 2, and 2A to 2F, presented in Appendix A, using the following equation to solve for the approximate area available on each Lot for on-site domestic wastewater dispersal, with the results summarised in Table 7 below:

Area available on each Lot for on-site domestic wastewater dispersal = (Total Lot area) – (building platform area) – (areas of land that are steeper than 25°) – (areas included within set-back distances).

The table below also takes into account the area that may also be taken up on each Lot for driveways/accessways, areas of bulk subdivision fill (limited to within the proposed building platforms).

Table 7: Areas available and maximum allowed number of bedrooms for onsite WW field dispersal

Lot No.	Area designated for onsite wastewater dispersal (m^2)	Maximum allowed number of bedrooms (as per Table 4)	Comments
1	1,475	5	--
2	1,600	5	--
3	1,345	5	--
4	1,280	5	--
5	1,350	5	--
6	1,370	5	--
7	1,280	5	--
8	1,310	5	--
9	1,970	5	--
10	975	4	Not enough area at RC stage for 5-bedroom house (standard fixtures), but suitable for 4 bedrooms ($960m^2$).
11	1,040	4	Not enough area at RC stage for 5-bedroom house (standard fixtures), but suitable for 4 bedrooms ($960m^2$). No planting to be undertaken within the Lot during subdivision works, however, final Wastewater dispersal areas must be planted.
12	740	2	Not enough area at RC stage for 5-bedroom house (standard fixtures), but suitable for 2 bedrooms ($640m^2$).
13	1,115	4	Not enough area at RC stage for 5-bedroom house (standard fixtures), but suitable for 4 bedrooms ($960m^2$).
14	1,250	4	Not enough area at RC stage for 5-bedroom house (standard fixtures), but suitable for 4 bedrooms ($960m^2$).
15	860	3	Not enough area at RC stage for 5-bedroom house (standard fixtures), but suitable for 3 bedrooms ($800m^2$).
16	1,290	5	--
17	2,680	5	No planting to be undertaken within the Lot during subdivision works, however, final Wastewater dispersal area must be planted.
18	1,220	4	Not enough area at RC stage for 5-bedroom house (standard fixtures), but suitable for 4 bedrooms ($960m^2$).
19	650	2	Not enough area at RC stage for 5-bedroom house (standard fixtures), but suitable for 2 bedrooms ($640m^2$).

Lot No.	Area designated for onsite wastewater dispersal (m^2)	Maximum allowed number of bedrooms (as per Table 4)	Comments
20	1,290	5	--
21	1,285	5	--
22	800	3	Not enough area at RC stage for 5-bedroom house (standard fixtures), but suitable for 3 bedrooms (800m^2).
23	960	4	Not enough area at RC stage for 5-bedroom house (standard fixtures), but suitable for 4 bedrooms (960m^2). -
24	870	3	--
25	1340	5	--
Community Hall	880	--	More area is available; however, the plans show the proposed dispersal area for a community hall with a maximum occupancy of 50 people.

** The above assessment is considered preliminary only and further site-specific assessment will be required at the Building Consent stage once details of individual dwellings are known. Dependant on final Lot configurations, treatment level and water producing fixtures, more or less area may or may not be available of future wastewater dispersal.*

14.5 Preliminary Comment of Dispersal Field Design

The preliminary wastewater dispersal assessment conducted in this report indicates adequate area for wastewater discharge on each Lot, which are shown in Table 7 above. We consider the assessment was carried out to meet the requirements of TP58 and is anticipated to comply as a permitted activity in accordance with AUP standards E5.6.1 and E5.6.2.1.

A number of treatment packages are available on the market; to produce advanced secondary level effluent. However, the chosen package is highly recommended to have been through the Onsite Effluent National Testing Programme (OSET NTP) to certify the treatment quality.

Natural in-land wetlands defined in Section 52 of the Resource Management (National Environmental Standards for Freshwater) Regulations, 2020 have been identified onsite, with a majority of the Lot located with the minimum 100m setback distance. As the development cannot comply with this standard, the Lots may require Discharge Consent under the NES-F, however we note the Ministry for the Environment (MfE) have recently stated to the Regulatory Review Committee that the intent of the NES-F "… was not to regulate individual instances of housing with septic tanks. The policy was designed to regulate large flows of water that might increase or decrease wetland levels", and that there was "…need to be very clear in the regulations that we are not are not addressing discharge contaminates, because…there are already very good plan rules around this". As such, it can be concluded MfE did not intend for the NES-F to be used to control on site wastewater discharges and that they consider the regional plan rules (i.e., TP58) to provide adequate control.

As such, our assessment has assumed the currently accepted 15m setback from surface water (as per Table 5.2 of TP58) from any wetlands in order to minimise any potential environmental effects. In addition, the following mitigating factors are to be followed, which will, in our opinion result in negligible impacts on the wetlands:

- Minimum of Advanced Secondary Treatment is adopted which will reduce nitrogen and total suspended solids.
- Number of bedrooms restricted to those indicated in Table 6 for each Lot (without site specific design).
- Onsite wastewater will be dispersed using PCDI with a low areal loading rate of 2.5mm/day, resulting in very low discharge volumes.
- Wetland areas and overland flow path areas are planned to be completely revegetated as per KCA plans.
- Preliminary dispersal fields are to be located within the proposed vegetated areas for each Lot (planted at subdivision stage). If the reserve fields indicated on our plans are utilised in the future, these areas should be planted, which will aid in further nitrogen reduction and assist in evapotranspiration.

It should be noted that the above potential dispersal areas and bedroom numbers are **preliminary only (for RC purposes)** and there may be a suitable dispersal area on each Lot for larger bedroom dwellings and/or upmarket fixtures. Additionally, the detailed wastewater dispersal field design for each Lot must consider final boundary layout, use of bush, position of building platforms, slope of ground, accessway drainage channels and stormwater overflow devices. Care must be taken during the site formation works to ensure no stockpiling of fill, or any driving over the proposed dispersal areas with compaction equipment occurs.

We are available to offer services of detailed wastewater treatment and dispersal design at Building Consent Stage for each Lot.

15. SITE SPECIFIC GEOTECHNICAL AND WASTEWATER INVESTIGATION

The general sloping nature of the site must be taken into account in any future development. Therefore, we recommend that each new Lot be subject to specific geotechnical investigation and design at the Building Consent stage. We anticipate that the investigation for site formation earthworks and new building to be constructed on each Lot would, as a minimum, take the form of a geotechnical review letter to assess the potential geotechnical implications of the proposed future developments. Additional stability assessments will need to be undertaken to ensure that the proposed formation works and wastewater dispersal fields will not negatively impact site stability.

16. LIMITATIONS

The conclusions made in this report are based upon the results of hand auger boreholes spaced about the site as appeared appropriate at the time the field exploration was carried out. We also point out that the holes were extended as deep as reasonably possible with hand operated equipment, but they could not and did not penetrate into the underlying slightly weathered materials. We are therefore not able to report on the potential of any deep-seated bedding plane defect or other adverse lithological feature in the underlying parent rock.

This report was prepared in the context defined in Section 1 above and must not be relied upon by any other party other than our Client, for whom it was prepared, and the relevant Territorial Authority. It has been compiled with respect to the brief given to us and must not be relied upon in any other context, recreated for any other purpose, or used by any person who is not our Client without first obtaining our written permission.

The recommendations given in this report are provided as an overall strategy to minimise risks from geotechnical hazards. It should be noted that they are unlikely to remain effective if they are adopted in a piecemeal manner.

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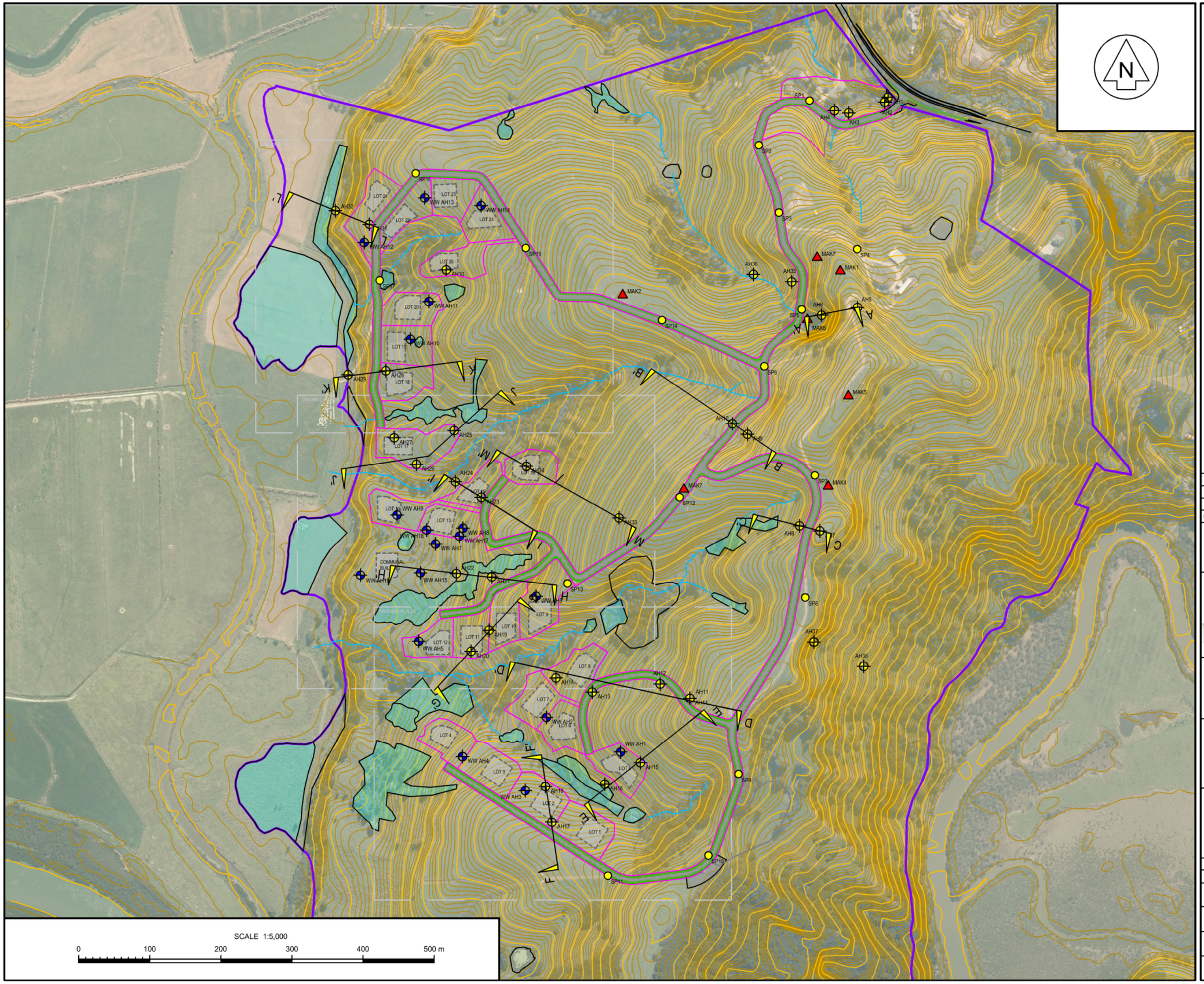
APPENDIX A

KGA Drawings and Subsurface Investigational Borehole Logs



LEGEND

- NATURAL INLAND WETLAND AREAS
- PROPOSED BUILDING PLATFORMS
- AH1 — 2022 - KGA - HAND AUGER BOREHOLE
- SP1 — 2022 - KGA - SURFACE SCALA PENETROMETER
- AH1 — 2024 - KGA - ASTEWATER HAND AUGER BOREHOLE
- MHK1 — HAND AUGER BOREHOLE
- SITE BOUNDARY
- NEIGHBOURING BOUNDARIES
- PROPOSED LOT BOUNDARIES
- OVERLAND FLOWPATH
- 31 — EXISTING TOPOGRAPHIC CONTOURS, MAJOR INTERVAL = 5.0 M
- A A' — CROSS SECTION

NOTES

1. LOCATIONS OF FEATURES AND GROUND INVESTIGATION POINTS ARE APPROXIMATE ONLY.
2. AERIAL IMAGE SOURCED FROM AUCKLAND COUNCIL GEOMAPS WEBSITE.
3. CONTOURS SOURCED FROM AUCKLAND COUNCIL GEOMAPS WEBSITE.
4. PROPOSED LAYOUT SOURCED FROM CONCEPT DEVELOPMENT PLAN BY VAUGHAN CRANG AND KAIPARA COAST, DATED NOVEMBER 2023.

REV	DATE	REVISION DESCRIPTION	BY	CHK	APP
B	AUG-24	RFI AMENDMENTS	TR	AF	YC
B	FEB-24	RFI AMENDMENTS	TR	TP	YC
A	JUL-23	REPORT ISSUE	TR	TP	YC

Auckland | Christchurch
09 478 6655 | 03 343 5302
www.kga.co.nz
KGA GEOTECHNICAL

CLIENT
GOODLAND GROUP LIMITED

PROJECT TITLE
RURAL RESIDENTIAL SUBDIVISION
2127 KAIPARA COAST HIGHWAY
MAKARAU

DRAWING TITLE
GLOBAL SITE PLAN

DESIGNED	TR	DATE	JUL-23	CHECKED	TP	DATE	JUL-23
DRAWN	TR	DATE	JUL-23	APPROVED	YC	DATE	JUL-23

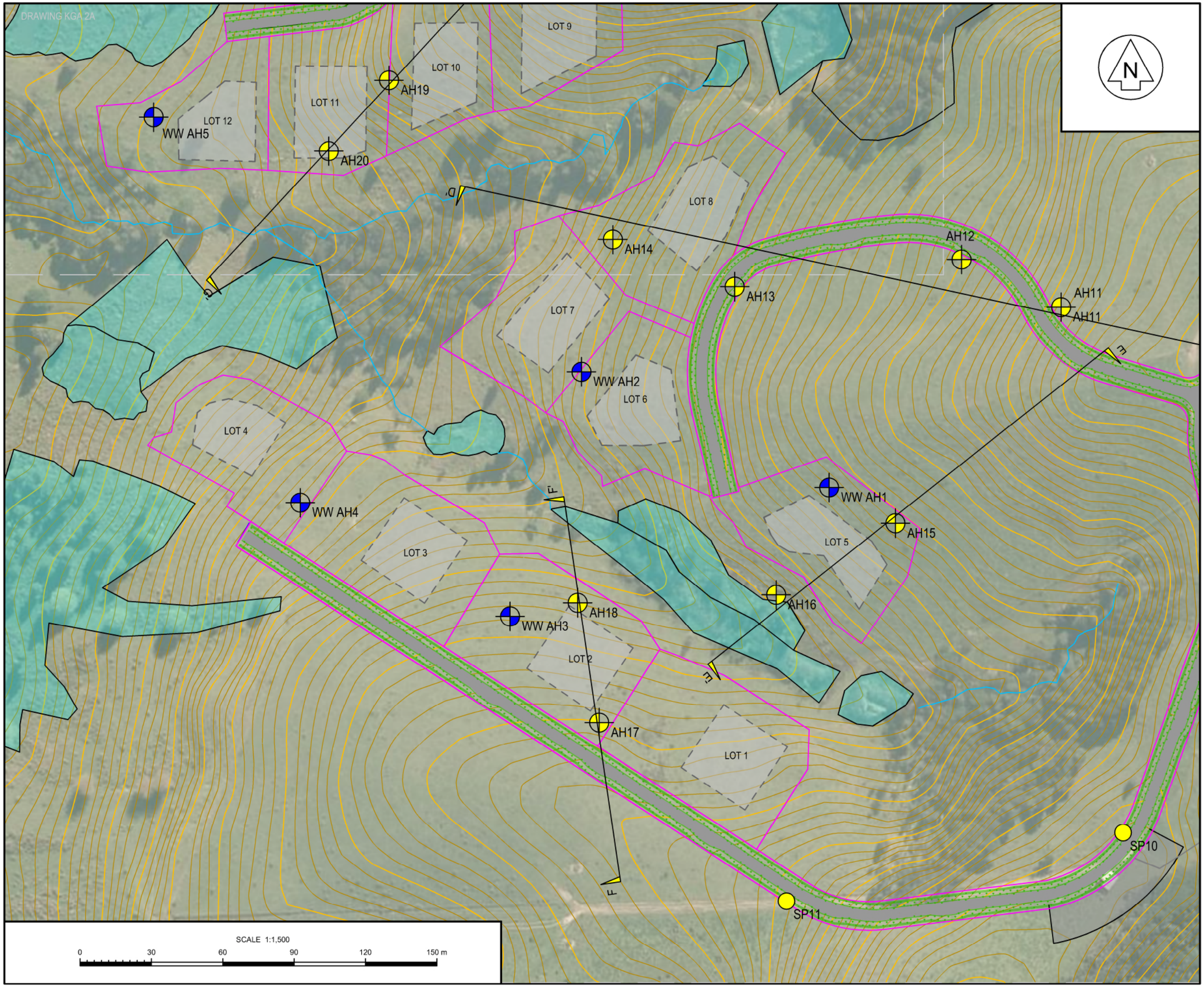
STATUS: RESOURCE CONSENT

SCALE	SIZE
1:5,000	A3

COORDINATE SYSTEM	HEIGHT DATUM
NZTM	AKL 1946

PROJECT NUMBER	DRAWING NUMBER	REVISION
K200826	KGA 2	C

DRAWING KGA 2A



LEGEND

- NATURAL INLAND WETLAND AREAS
- PROPOSED BUILDING PLATFORMS
- AH1 — 2022 - KGA - HAND AUGER BOREHOLE
- SP1 — 2022 - KGA - SURFACE SCALA PENETROMETER
- AH1 — 2024 - KGA - ASTEWATER HAND AUGER BOREHOLE
- MHK1 — HAND AUGER BOREHOLE
- SITE BOUNDARY
- NEIGHBOURING BOUNDARIES
- PROPOSED LOT BOUNDARIES
- OVERLAND FLOWPATH
- 31 — EXISTING TOPOGRAPHIC CONTOURS, MAJOR INTERVAL = 1.0M
- A A' — CROSS SECTION

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C	AUG-24	RFI AMENDMENTS	TR	AF	YC
B	FEB-24	RFI AMENDMENTS	TR	TP	YC
A	JUL-23	REPORT ISSUE	TR	TP	YC
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2127 KAIPARA COAST HIGHWAY
MAKARAU

DRAWING TITLE
SITE PLAN - LOTS 1 TO 8

DESIGNED	TR	DATE	JUL-23	CHECKED	TP	DATE	JUL-23
DRAWN	TR	DATE	JUL-23	APPROVED	YC	DATE	JUL-23

STATUS
RESOURCE CONSENT

SCALE	SIZE
1:1,500	A3

COORDINATE SYSTEM	HEIGHT DATUM
NZTM	AKL 1946

PROJECT NUMBER	DRAWING NUMBER	REVISION
K200826	KGA 2A	C