17 March 2022

36 SANDSPIT ROAD

WARKWORTH

SUPPLEMENTARY GEOTECHNICAL INVESTIGATION REPORT

The Kilns Limited

AKL2021-0060AD Rev 0

AKL2021-0060AD		
Date	**Revision**	**Comments**
14 March 2022	A	Initial draft for internal review
17 March 2022	0	Final issue to support Resource Consent Application

	Name	**Signature**	**Position**
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EXECUTIVE SUMMARY

This report presents supplementary geotechnical investigation and geohazards assessment for the development of the block of land at 34 and 36 Sandspit Road, Warkworth. This report is supplementary to the previously issued Geotechnical Investigation Report for 36 Sandspit Road, Warkworth and should be read in conjunction with the document referenced AKL2021-0060AB Rev 1, dated 8 September 2021.

Topography is dominated by a knoll located centrally within the site with a maximum contour of approximately RL 26.5m. The east and west of the site are bound by gullies / tributary features of the Mahurangi River. The Mahurangi River runs in a west to east direction along the southern section of the site. The site is bound to the north by Sandspit Road. The eastern, western, and southern boundaries of the site are covered by bush/vegetation.

Prior to aerial photo documentation (1931), it is understood that the site was used as a lime quarry, with three kilns, a rail line and an **undefined** quarry area present in the southern portions of the site.

Based upon the investigation results, the site is underlain by Holocene Tauranga Group Alluvium, Colluvium, Mahurangi Limestone of the Northland Allochthon, and Pakiri Formation of the Waitemata Group (found in previous investigations).

Geotechnical aspects of the development are summarised as follows:

- The subsoils encountered as part of this investigation are generally consistent with published geological records. However, Tauranga Group alluvial deposits were encountered during this investigation, which are not included in the published geology for the site.
- The recent alluvial deposits found toward the east of the site are Holocene of geological age and therefore, in terms of geological age, may be susceptible to liquefaction. However, there is a low risk of liquefaction due to the clay-rich consistency of the subsoils.
- Shallow instability is evident around the steep banks above the streams at the southern end of the site. Very stiff transition to bedrock deposits are present at shallow depths and existing instability features are located within the Esplanade Reserve area.
- The southern portion of the site, which is bound by the tidally influenced Mahurangi River, will be subject to some degree of coastal erosion and slope instability. Although this regression may not be as severe as regression on the open coast, erosion around the steeply sloping riverbanks will still occur.
- Stability analyses were carried out for the development with the proposed design levels. Results did not meet the required criteria for the proposed landform around the fringes of the site, therefore a combination of remedial works that may include a combination of in-ground walls, an undercut and the installation of subsoil drainage, will be required here.
- The highly fractured rock mass that will be exposed at finished levels across cut depths greater than approximately 1.2m to 6.5m is susceptible to rapid weathering and infiltration of surface water that could compromise downslope stability conditions. Over-excavation of these deposits to a depth of **<u>0.6m and capping with engineered filling</u>** is a prudent remediation measure where rock mass is exposed.
- Following earthworks, a preliminary geotechnical ultimate bearing pressure of 300kPa should be available for shallow strip and pad foundations constructed within both the natural cut ground and engineered fill areas. This will be further assessed on a platform-by-platform basis at the time of completion reporting for the subdivision.
- On the basis of our visual tactile assessment, results of preliminary laboratory testing and reference to BRANZ Report SR120A, we have assessed the AS2870 Site Class for the site to be between M (moderate) and H2 (high). Further soil classification testing will be carried out at the completion of the subdivision works.

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Appendices

1 INTRODUCTION

1.1 Project Brief

CMW Geosciences (CMW) was engaged by The Kilns Limited to carry out further geotechnical investigation of a site located at 36 Sandspit Road, Warkworth, which is being considered for the construction of a 49-unit residential development with an associated access road and JOALs.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter referenced AKL2021-0060AC Rev 0 dated 5 July 2021.

This report is to support a Resource Consent application to Auckland Council and extends the understanding of site conditions reported in our Geotechnical Investigation Report referenced AKL2021-0060AB Rev 1 dated 8 September 2021.

1.2 Scope of Work

As detailed in our proposal letter, the agreed scope of work to be conducted by CMW was defined as follows.

- Additional site investigation:
    - Logging of two geotechnical test pits within the undefined Historic Quarry area.
    - One machine borehole in the vicinity of the central knoll, drilled to a maximum depth of 15m or refusal, to facilitate logging of the subsoils and installation of a groundwater monitoring standpipe to further measure groundwater levels.
    - Half a day of test pits, excavated to 5m or refusal in the knoll area to assess the excavatability of the limestone and to facilitate compaction curve sampling.
    - Up to four hand auger boreholes drilled to a maximum depth of 5m or refusal, to finalised palisade wall locations and to assist with detailed design.
    - Laboratory testing comprising three expansive soil tests from across the site and compaction curve testing.
    - Groundwater monitoring visits, over approximately a three-month period.
- Design:
    - Earthworks design/stability analyses.
    - Provisional allowance for detailed palisade wall design.
- Reporting:
    - Preparation of a geotechnical report suitable for Resource Consent purposes, with earthworks specifications and a natural hazards assessment for subdivision.
    - Groundwater take assessment.

2 SITE DESCRIPTION

2.1 Site Location

The site comprises a total area of approximately 2.96 hectares and is located at 34 and 36 Sandspit Road, Warkworth, as shown on Figure 1 below.

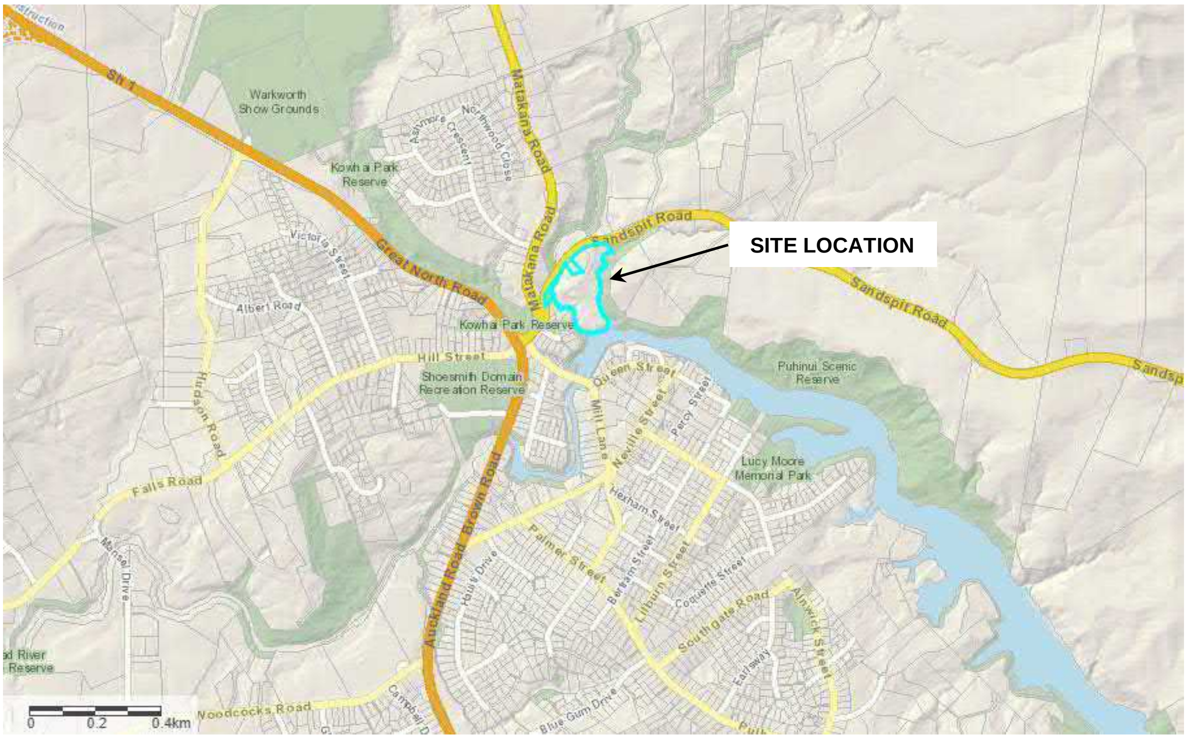

Figure 1: Site Location Plan (Auckland Council Geomaps)

2.2 Landform

The current landform, together with associated features located within and adjacent to the site is presented on the attached Site Investigation Plan as ***Drawing 01*** in ***Appendix A.***

Topography is dominated by a knoll located centrally within the site with a maximum contour of approximately RL 26.5m that grades relatively steeply to the east and west down to gully formations. This knoll then extends in a ridge to the north that grades moderately from approximately RL 22.5m to RL 14m along the northern boundary. The knoll also grades down to the south to a platform at around RL 15m. It then drops off to the south to the Mahurangi River at RL 1m. The gullies that delineate the eastern and western boundaries of the site grade steeply from the principal ridgeline down to RL 10m and RL 4m respectively.

The east and west of the site are bound by gullies / tributary features of the Mahurangi River. The tidally influenced Mahurangi River runs in a west to east direction along the southern section of the site. The site is bound to the north by Sandspit Road and one neighbouring residential property. The eastern, western, and southern boundaries of the site are covered by bush/vegetation.

An existing residential dwelling is located along the northern boundary of the site, with associated sheds, garages and water tanks, which can be accessed from Sandspit Road in two locations. An existing shed and water tank are also present on the central knoll within the site. A relocatable sleepout dwelling is also located below the southern point of the central knoll.

A Significant Ecological Area (SEA) is present along the eastern boundary of the site.

Historical aerial photographs[1] show that the existing principal dwelling was built prior to 1962. They also show a second building that was located on the crest of the ridge/knoll within the centre of the site. This building has since been removed.

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[1] 1931 - Warkworth, IRN 539638, Ref WA-27095-F, Whites Aviation Collection, Alexander Turnbull Library, Sourced from NLNZ; and S/N 1404, Run D1/6,7, Scale 1:8,300, 17/09/1962, S/N 1404, Run E/1, 2, Scale 1:8,100, 27/04/1963, and S/N 5450, Run E/16, 17, Scale 1:8,000, 25/08/1970; Sourced from http://retrolens.nz and licensed by LINZ CC-BY 3.0.

Aerial photos also reveal areas of shallow instability, with areas of slumped ground evident along the slopes of the eastern gully within the site.

Prior to aerial photo documentation (earliest records reviewed were from 1931), it is understood that the site was used as a lime quarry, with three kilns, a rail line and an undefined quarry area present in the southern portions of the site.

3 PROPOSED DEVELOPMENT

The current proposed development, as per the draft scheme plans provided by Pacific Environments Architects NZ Ltd (referenced 21007, sheets A210 and A300 to A302, dated 27 January 2022), includes the formation of 49 residential dwellings comprising 1 to 3-storey terraced houses, duplexes, and standalone houses, with an associated access road and JOALs.

Engineering drawings provided by Airey Civil Structural and Fire Engineers (referenced 85070-01, sheets 200 to 203, 210 to 213, 260, 300 to 303, 310 to 313, and 320 to 321, dated February 2022), show cuts and fills of up to approximately 10m and 4.5m respectively, to form the finished ground profile for the proposed development.

They also depict the construction three retaining walls to support the proposed cuts and fills; two proposed retaining walls are located along the northern boundary of the site with maximum retained heights of up to 5.31m and one within the central portion of the site with a maximum retained height of 3.2m. These drawings also show preliminary locations for in-ground (palisade) walls around the existing instability features onsite, as discussed in our previous report (referenced in Section 4.1 below).

Supplied scheme plans and engineering drawings are attached in ***Appendix B***.

4 INVESTIGATION SCOPE

4.1 Desktop Study

Prior to the most recent site investigations, a desktop review was undertaken of existing geotechnical information, including Auckland Council GIS, aerial photographs, and publicly available information from the NZ Geotechnical Database. A Dial Before You Dig online service search was also undertaken.

A review of the previously completed Geotechnical Investigation Report (GIR) for 36 Sandspit Road, Warkworth (referenced AKL2021-0060AB Rev 1, dated 8 September 2021) was also undertaken. This report is supplementary to the preliminary GIR and should be read in conjunction with the aforementioned report, which incorporated nine hand auger boreholes numbered HA01-21 to HA09-21.

4.2 Field Investigation

Following a Dial Before You Dig search, and onsite service location, the supplementary field investigation was carried out between 10 December 2021 and 14 January 2022. All fieldwork was carried out under the direction of CMW Geosciences in general accordance with the NZGS specifications[2] and logged in accordance with NZGS guidance[3]. The scope of additional fieldwork completed was as follows:

- One machine borehole, denoted MH01-21 was drilled using open barrel and triple tube techniques to depths of up to 12.5m to determine the ground model through and below the proposed earthworks profile. Engineering logs of the boreholes are provided in ***Appendix C***;
- Two test pits, denoted TP01-22 to TP02-22, were excavated using a 5-tonne hydraulic excavator fitted with a 0.3m wide toothed rock bucket to depths of between 3.6m and 3.7m below existing ground levels. Both test pits were terminated at the maximum reach of the excavator. Representative bulk

[2] NZ Geotechnical Society (2017) NZ Ground Investigation Specification, Volume 1 – Master Specification
[3] NZ Geotechnical Society (2005), Field Description of Soil and Rock, Guideline for the field classification and description of soil and rock for engineering purposes.

samples were collected at random depths to provide samples for subsequent laboratory testing. Engineering logs and photographs of the test pits are presented in ***Appendix C***;

- Eight hand auger boreholes, denoted HA10-21 to HA15-21, HA16-22 and HA17-22, were drilled using a 50mm diameter auger to target depths of up to 5.0m below existing ground levels to visually observe the near surface soil profile and to facilitate in-situ vane shear strength testing. Refusal was met in all boreholes, excluding HA15-21, HA16-22 and HA17-22 were conducted as shallow hand augers, drilled through the undefined quarry area to determine if any quarry backfill is present in this area. These boreholes were terminated at 1m each. DCP testing was carried out upon refusal. Engineering logs of the hand auger boreholes, together with peak and remoulded vane shear strengths are presented in ***Appendix C***;
- Groundwater monitoring was undertaken during further visits to the site in February and March 2022, following the initial fieldwork in December 2021, to monitor the groundwater levels in the boreholes. The monitoring results are presented in Section 5.6 below.

The approximate locations of the respective investigation sites referred to above are shown on the Site Investigation Plan as Drawing 01*Error! Reference source not found.*. Test locations were measured using handheld GPS. Elevations were inferred from Auckland Council contour data.

4.3 Laboratory Testing

Laboratory testing was carried out generally in accordance with the requirements of NZS4402[4] (where applicable). Where a test was not covered by a New Zealand standard, a local or International standard was adopted and noted on the laboratory test certificate.

All testing was scheduled by CMW and carried out by Roadtest, an IANZ registered Testing Authority.

The extent of testing carried out to provide the geotechnical parameters required for this study are presented in Table 1.

Table 1: Laboratory Testing Schedule

Type of Test	Test Method	Quantity
Water Content	NZS4402 – 1986 2.1	3
Cone Penetration Limit (Liquid Limit)	NZS4402 – 1986 2.5	3
Linear shrinkage	NZS4402 – 1986 2.6	3
Standard Compaction	NZS4402 – 1986 4.1.1	2

Certificates for the test results outlined above are presented in ***Appendix D***.

[4] New Zealand Standard NZS4402 (1986), Methods of testing soils for civil engineering purposes.

5 GROUND MODEL

5.1 Published Geology

Published geological maps[5] for the area depict the regional geology as comprising Pakiri Formation (Mwp) of the Waitemata Group and Mahurangi Limestone (Omm) of the Northland Allochthon as illustrated in Figure 2 below and in ***Drawing 02 in Appendix A.***

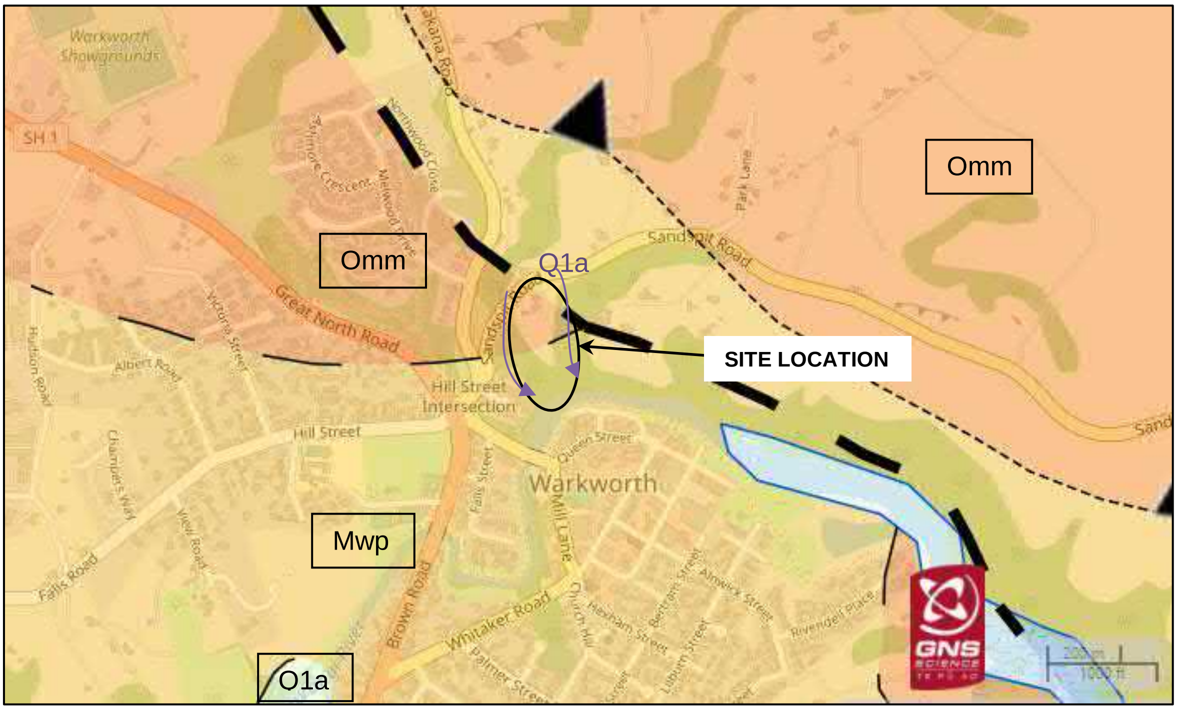

Figure 2: Regional Geology (GNS Science Geology Web Map)

Pakiri Formation rocks are predominantly comprised of volcanic rich thick-bedded sandstone with interbedded siltstone. It typically includes 10-30m thick, graded medium- to coarse-grained sandstone beds ranging from 1m to 4m thick. The sandstones alternate with thinner intervals of laminated siltstone and fine-grained sandstone. Extremely weak sheared surfaces are known within the entire Waitemata Group rocks.

Pakiri Formation rocks typically weather to pink, red or orange, soft to very stiff clays, clay/silt mixtures and sandy clays. The weathered zone will typically be 3m to 15m deep, although a residual soil thickness of 1m to 2m is common on steeper slopes. The weathering profile is often dependent on the underlying structure and can have a sharp transition between residual soils and weathered rock masses. Cut slope failures are common where sharp transitions are exposed and adversely orientated to the cut face.

Mahurangi Limestone is generally older than Pakiri Formation, however, it has been thrust over the top of the younger Pakiri Formation as a result of past tectonic activity, forming the Northland Allochthon. Mahurangi Limestone is generally comprised of blue-grey to white micritic, coccolith foraminiferal, muddy limestone, with some local glauconitic sandstone beds. Mahurangi Limestone is also very commonly shattered, with abundant shear features present throughout the unit. Crystalline limestone is very rare in this formation.

Some colluvium and recent alluvial river deposits were encountered during this investigation, which were not included in the published geology for the site. The alluvium encountered is interpreted to be recent Holocene Tauranga Group (Q1a) river deposits, which flank the streams/gullies to the east and west of the

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

site. These alluvial soil deposits generally comprise sands, silts, muds and clays, with local gravel and peat beds. These deposits are also found to the southeast of the site, along the banks of the Mahurangi River.

Based on the known history of the site and surrounding land levels, some superficial depths of fill should be anticipated.

5.2 Structural Geology

It is evident from historical aerial photographs, geological maps and geomorphology of the surrounding area that the subject site and region are structurally controlled.

An inactive reverse fault, published in 1:250,000 Geological Maps, runs along the northern boundary of the site in an approximate NW/SE orientation. This fault alignment is consistent with ridge and river alignments and extends to the northwest and southeast of the site adjacent to ridgelines and the Mahurangi River respectively. Reactivation of this fault is unlikely given no displacement has been observed for millions of years.

5.3 Geomorphology

The geomorphology of the site was mapped by examination of aerial photographs and during a site walkover, and is shown in the appended Geology and Geomorphology Plan ***Drawing 02*** in ***Appendix A***.

The geomorphology reflects the underlying geology and associated slope processes. The dominant regional structure is evident in the subject and neighbouring sites in the form of features (i.e., persistent alignments of gullies, ridgelines, rivers etc.) oriented approximately N/S and NE/SW.

The subject site is dominated by two north-south trending gullies, the orientation of which is likely to be structurally controlled given that the same orientation is seen in both regional structure and in defects observed. To the south of the site, in the Mahurangi River, sub-horizontal beds of Waitemata Group sandstones and siltstones are visible in the stream bed.

Multiple shallow landslide / slope movement escarpments and mounds are evident around the borders of the site, aligning with steep gully orientations and banks of the Mahurangi River, formed from natural slope processes. Those present in the north-eastern portions of the site appear to be larger and deeper than elsewhere and are present on less steep land, which we consider to be more indicative of moderate depth alluvial soils. Elsewhere, small, shallow landslides are present in steep terrain that are indicative of shallow overburden overlying hard / bedrock deposits close to the existing ground surface.

5.4 Stratigraphic Units

The ground conditions encountered and inferred from the investigation were considered to be generally consistent with the published geology for the area. However, some recent alluvial river deposits and colluvium were encountered, which were not included in the published geology for the area. Geological units are presented on Cross Sections A to D (***Drawing 05 to 08*** in ***Appendix A)*** and can be generalised according to the following subsurface sequences.

5.4.1 Topsoil

Topsoil was encountered in all locations, excluding HA15-21 to HA17-21. Topsoil was encountered to depths of up to 0.4m and generally comprised brown, organic rich silts with low plasticity.

5.4.2 Uncontrolled Fill

A thin veneer of uncontrolled fill was encountered in HA15-21 to 0.1m and generally comprised light grey, gravelly silt. This fill has likely been placed as part of the metalled accessway formation.

Significantly, extensive filling was NOT encountered in our investigations of the historic quarry area.

5.4.3 Colluvium (Landslide Debris)

Colluvium was encountered in TP01-22, HA16-21 and HA17-21 to a depth of 0.6m. Colluvium encountered generally comprised hard to very stiff, light grey to brown, clay/silt mixtures.

5.4.4 Alluvium (River Deposits)

A considerable amount of Tauranga Group alluvium was encountered in the vicinity of the eastern gully within the site. Alluvium was encountered in HA10-21, HA11-21, HA14-21 and HA15-21 to a depth of 5.0m and generally comprised stiff to hard, greenish grey, brown and grey, clays, sand/silt mixtures and clay/silt mixtures.

The shallow slope failures that are present toward the northern section of the site are interpreted as failing along the lower limits of this unit.

5.4.5 Northland Allochthon

5.4.5.1 Residual Soils

Mahurangi Limestone residual soils of the Northland Allochthon were encountered in all investigation locations, excluding HA15-21. These residual soils generally comprised stiff to hard, grey to brown, clays, silts and clay/silt mixtures. SPTs from MH01-21 returned N values of between 3 to 8 within this unit.

5.4.5.2 Completely Weathered to Highly Weathered Bedrock

Mahurangi Limestone bedrock, of the Northland Allochthon, was encountered in MH01-21 and HA11-21 from depths of 5.75m and 2.7m respectively. This unit generally comprised extremely weak to weak, highly sheared, completely to highly weathered, grey siltstone. A band of completely to highly weathered, extremely to very weak, light grey muddy limestone was encountered in MH01-21, from 5.75m to 7m.

SPTs from MH01-21 returned N values of between 39 to greater than 50 within this unit. The majority of this unit was recovered as crushed / highly sheared rock.

5.4.6 Pakiri Formation of Waitemata Group

Although not encountered in this investigation, Pakiri Formation of the Waitemata Group is present in the southern portion of the site (as determined from previous investigations) and is anticipated to underlie the Mahurangi Limestone at depth.

5.4.7 Summary

The distribution of these units is illustrated on the appended Geological Sections A to D and presented below in Table 2.

Table 2: Summary of Strata Encountered

Unit	Depth to base (m)		Thickness (m)*	
	Min	Max	Min	Max
Topsoil[a]	0.1	0.4	0.1	0.4
Uncontrolled Fill[b]	0.1	0.1	0.1	0.1
Colluvium[c]	0.5	0.6	0.4	0.6
Alluvium[d]	0.9	>5.0	0.8	>5.0
Northland Allochthon Residual Soils[a]	2.7	5.75	0.2	5.75
Northland Allochthon Completely to Highly Weathered Bedrock[e]	>2.9	>12.5	-	-

Notes:
(a) Strata not encountered in HA15-21 to HA17-21.
(b) Strata only encountered in HA15-21.
(c) Strata only encountered in TP01-22, HA16-21 and HA17-21.
(d) Strata only encountered HA10-21, HA11-21, HA14-21 and HA15-21.
(e) Strata only encountered in MH01-21 and HA11-21.
* Definitive thickness only recorded where base of strata has been confirmed.

5.5 Laboratory Test Results

Results of the civil engineering laboratory tests provided in ***Appendix D*** are summarised in Table 3 below.

Table 3: Laboratory Test Results

Test Location	Depth (mbgl)	CPL (%)	LS (%)	MC (%)	OMC (%)	MMDD (t/m^2)
HA10-21	0.4 – 0.8	22	5	18.9	-	-
HA11-21	0.4 – 0.8	68	7	37.6	-	-
TP01-22	1.5	108	26	52.9	-	-
TP02-22	1.2	-	-	45.9	43.0	1.18
TP02-22	3.5	-	-	66.2	48.0	1.09

Note: CPL = Cone penetration limit (liquid limit), LS = linear shrinkage, MC = Natural Moisture Content, OMC = Optimum Moisture Content, MMDD = Modified Maximum Dry Density.

5.6 Groundwater

During the investigation, which was completed in summer conditions (December 2021 to January 2022), groundwater was encountered within the machine borehole at the depths provided in Table 4, which also presents the results of groundwater monitoring undertaken following the investigation:

Table 4: Groundwater Monitoring Data

Standpipe	Screen Depth (mbgl)	Screened Formation	2 February 2022		8 February 2022		8 March 2022	
			Depth (mbgl)	Elevation (m RL)	Depth (mbgl)	Elevation (m RL)	Depth (mbgl)	Elevation (m RL)
MH01-21	6.5 – 12	Screened/ Slotted	5.0	19.25	4.81	19.44	5.1	19.15

Note: mbgl = metres below ground level. NE = not encountered.

Groundwater was encountered in HA10-21, HA14-21 and HA15-21 at depths of 2.2m, 3.6m and 3.6m respectively. Groundwater was not encountered in the remaining investigation locations during this investigation.

Given the presence of a variable and clayey soil profile, it is possible that perched groundwater may occur during and following periods of rainfall. Groundwater will also vary seasonally, and with increased or heavy rainfall events.

6 GEOHAZARDS ASSESSMENT

6.1 Context

Section 106 of the Resource Management Act[6] (RMA) requires an assessment of the risk from natural hazards to be carried out when considering the granting of a subdivision consent. S106 RMA specifically states that the assessment must consider the combined effect of the natural hazard likelihood and material damage to land or structures (consequence).

The following sections of this report provide an assessment of the geohazards relevant to this site and provide the basis for the Natural Hazards Risk Assessment presented in ***Appendix E***.

6.2 Fault Rupture

Inactive thrust fault located on the northern boundary of site. However, reactivation is unlikely given no displacement has been observed for millions of years.

6.3 Liquefaction

6.3.1 General

Soil liquefaction is a process where typically saturated, granular soils develop excess pore water pressures during cyclic (earthquake) loading that exceed the effective stress of the soil. In loose soils, some dilation can occur during this process, which can lead to individual soil grains moving into suspension. Following the onset of liquefaction, the shear strength and stiffness of the liquefied soil is effectively lost causing excessive differential settlement of the ground surface, bearing capacity failure and collapse of structures and low-angle lateral spreading of slopes in liquefiable soils.

In accordance with NZGS guidance[7] the liquefaction susceptibility of the soils at this site has been considered with respect to geological age, soil fabric and soil consistency / density.

6.3.2 Geological Age

The vast majority of case history data compiled in empirical charts for liquefaction evaluation come from Holocene deposits or man-made fills[8][9]. Pleistocene aged alluvium (>12,000 years) is also considered to have a very low to low risk of liquefaction[9.]

The recent alluvium found within the eastern gully is of Holocene Epoch and therefore, in terms of geological age, is considered susceptible to liquefaction.

Across the elevated terraces, soils below the water table comprise Waitemata Group and Northland Allochthon deposits. These soils have a dated aged at 16.4Ma to 23.8Ma old and 16.4Ma to 49.0Ma respectively. These deposits are therefore significantly older than what case history data would suggest as being susceptible to liquefaction.

Notwithstanding this, age alone is often debated as being of insufficient evidence to discount liquefaction potential due to its qualitative nature.

6.3.3 Soil Fabric

Soils are also classified with respect to their grain size and plasticity to assess liquefaction susceptibility. Based on more recent case histories, there is general agreement that sands, non-plastic silts, gravels and

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[6] Resource Management Act (1991), as at 29 October 2019

[7] Earthquake Geotechnical Engineering Practice, Module 3: Identification, assessment and mitigation of liquefaction hazards", (May 2016)

[8] Seed, H.B. and Idriss, I.M. (1971) *A simplified procedure for evaluating soil liquefaction potential*, Earthquake Engineering Research Centre, Report No. EERC 70-9, University of California

[9] Youd, T.L. and Perkins, D.M. (1978) Mapping liquefaction-induced ground failure potential, *Journal of the Geotechnical Engineering Division,* ASCE, Vol. 104, No. GT4, Proc Paper 13659, p. 433-446

their mixtures form soils that are susceptible to liquefaction. Clays, although they may significantly soften under cyclic loading, do not exhibit liquefaction features, and therefore are not considered liquefiable.

Although no specific PI testing has been undertaken, soils encountered during investigations across the site for the majority comprise clays and clay/silt mixtures and are not considered to be at risk of liquefaction.

6.4 Slope Stability

6.4.1 Design Criteria

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

Table 5: Slope Stability Factor of Safety Criteria

Condition	Required Factor of Safety
Normal Groundwater Condition	1.5
Extreme (worst credible) groundwater condition	1.3
Seismic condition with 150 yr event (from ACCoPs)	1.2

6.4.2 Shear Strength Parameters

Drained and undrained shear strength parameters for the various geological units that underlie the site were inferred from the field investigation and experience, and are summarised in Table 6 below.

Table 6: Summary of Stress Shear Strength Parameters

Geological Unit	Unit Weight (kN/m^3)	Stress Shear Strength Parameters		
		c' (kPa)	Ø' (deg)	Su (kPa)
Engineered Fill	17.5	5	28	100
Colluvium	17	5	25	50
Alluvium	17	6	26	60
Northland Allochthon Residual Soils	17.5	3	28	100
Northland Allochthon Transition	17.5	2	30	150
Northland Allochthon Bedrock	18	15	35	200
Note: Where c' = effective cohesion, Ø' = effective friction angle, SU = undrained shear strength.				

6.4.3 Slope Stability Analyses

Slope stability analyses were undertaken using the Morgenstern-Price method of slices under both circular and translational failure mechanisms using the proprietary software SLIDE2. Earthquake loads were calculated in accordance with NZS 1170.5 and NZTA Bridge Manual (BM) Section 6.2.2 for earthquake loads for the assessment of slope stability. An ULS design earthquake return period of 150 years as recommended within the Auckland Council Code of Practice (ACCoP) has been assumed in the assessment. The peak ground acceleration (PGA) for stability analyses was calculated as 0.1g.

A stability summary is attached in ***Appendix F*** and results for proposed slopes (un-remediated) are summarised as follows:

Table 7: Slope Stability Analyses Results			
Location	**Slope Stability Factor of Safety**		
	Prevailing	**Transient**	**Seismic**
Geological Section A	1.9	1.2	5.2
Geological Section B	1.3	1.1	4.5
Geological Section D	1.2	1.2	4.0

Results show that for the proposed landform and ground model described above, inadequate slope stability factors of safety are achieved on the steep fringes of the site and will require the implementation of specific remedial earthworks, palisade walls and drainage measures, as described in Section 7 below, with remediated factors of safety presented in Section 7.3.

6.5 Erosion

Erosion of cut/fill batters during earthworks is considered to be a high-risk natural hazard but is easily addressed during earthworks construction. This hazard can be controlled during the design phase by limiting batters to a maximum of 1(v):3(h) gradients and during earthworks vie benches, geotextiles, and stormwater control.

The southern portion of the site, which is bound by the tidally influenced Mahurangi River, will be subject to some degree of coastal erosion. Although this regression will not be as severe as regression on the open coast, erosion around the steeply sloping riverbanks will still occur.

The 20m Esplanade Reserve is considered to be sufficient setback to mitigate any coastal erosion for the proposed development.

6.6 Rockmass Exposure

The execution of the proposed earthworks scheme will expose completely to moderately weathered Northland Allochthon Mahurangi Limestone deposits at design subgrade level around the central knoll portion of the site. This unit is highly sheared/fractured and has open defects and resulting very high rates of permeability that can alter the hydrogeology significantly, and in particular, introduce increased rates / volumes of groundwater into downslope landslide transition zones or be susceptible to significant swelling on weathering.

Earthworks will therefore need to be carefully managed to ensure that stormwater infiltration into the rock mass is minimised. Such techniques could include capping those materials with less permeable cohesive soils (clays) or topsoil.

6.7 Hard Limestone Rock

A layer of muddy limestone is interpreted to be present toward the western portion of the site. The extent of which has been shown on Geological Section B. However, this horizon should be able to be excavated using normal rock breaking plant and equipment, such as a rock pick on an appropriately sized excavator (e.g., 30T).

6.8 Expansive Soils

Seasonal shrinking and swelling results in vertical surface ground movement which can cause significant cracking of floor slabs and walls. There have been instances of concrete floors and/ or foundations that have been poured on dry, desiccated subgrades in summer months on expansive soils and have undergone heaving and cracking requiring extensive repairs or re-building once the soil moisture contents have returned to higher levels. This hazard is addressed by a combination of careful foundation design and site preparation.

NZS 3604:2011[10] excludes from the definition of 'good ground', soils with a liquid limit of more than 50% and a linear shrinkage of more than 15% due to their potential to shrink and swell as a result of seasonal fluctuations in water content. For soils exceeding these limits, NZS 3604 has historically referenced AS 2870[11]. for foundation design advice. However, the November 2019 update of Acceptable Solution B1/AS1[12] provides amendments to NZS 3604 that define a method for testing and classifying the soils and provides foundation designs for specific, simple house configurations across the range of expansive soil conditions.

Nevertheless, there is evidence[13] indicating that the use of the B1/AS1 method of assessment of expansiveness may be inaccurate. Accordingly, our assessments herein have been made in line with our experience, BRANZ Report SR120A[14] and AS2870.

Further commentary on expansive soils is provided in Section 7.6 below.

6.9 Uncontrolled / Uncertified Fills

It is evident that minor amounts of uncertified fill will be present across the site, in areas of past building works, driveway construction or landscaping.

Any existing, non-engineered fills will need to be undercut and replaced or reworked with engineered fill. We anticipate that most of the deposits, other than any organic or contaminated material, should be able to be used as engineered fill once dried and blended.

As mentioned above, backfilling of the historic quarry area does not appear to have occurred within the development area.

6.10 Groundwater Impact Assessment

An assessment has been made of the impact of the proposed works on groundwater conditions in accordance with the requirements of Section E7 of the Auckland Unitary Plan (AuP)[15]. The assessment has considered the impacts of the proposals for taking, using, damming / diversion and drilling activities and the results are contained in the table presented in ***Appendix G***.

Our assessment has indicated that excavations will likely lower natural groundwater levels in the central knoll area of the site. However, groundwater will not be diverted to other catchments or locations surrounding the knoll area and flows at receiving catchments will not be altered.

Any subsoils drains required during earthworks will be installed following existing alignments of surface water channels. All groundwater intercepted will be returned to streams in the same locations as at present.

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[10] Standards New Zealand (2011) Timber-framed buildings, NZS 3604:2011, NZ Standard

[11] Standards Australia Limited (2011) *Residential slabs and footings*, AS 2870-2011, Australian Standard, NSW

[12] Ministry of Business, Innovation and Employment (2019) *Acceptable Solutions and Verification Methods for NZ Building Code Clause B1 Structure,* B1/AS1, Amendment 19

[13] Rogers, N., McDougall, N., Twose, G., Teal, J. & Smith, T. (2020) The Shrink Swell Test: A Critical Analysis, *NZ Geomechanics News,* Issue 99, pages 66-80.

[14] Fraser Thomas Limited (2008) - Addendum Study Report (BRANZ SR120A), Soil Expansivity in the Auckland Region – Final Report

[15] Auckland Unitary Plan Operative in Part (Updated 12 June 2020)

7 GEOTECHNICAL RECOMMENDATIONS

7.1 General

Based on our geotechnical review and site investigation findings, we consider the proposed building platforms are suitable for development provided the following recommendations are implemented.

7.2 Seismic Site Subsoil Category

Based on those ground conditions observed during this investigation, combined with experience in the surrounding areas, the seismic site subsoil category is assessed as being Class C (shallow soil site) for most areas, but Class B (rock) in the knoll cut area in accordance with NZS 1170.5.

7.3 Slope Stability Management

Results of the slope stability analyses discussed in Section 6.4 above demonstrate that design landform gradients through the proposed development will not achieve the requisite slope stability factors of safety around the site fringes.

Significant remedial works, in the form of in-ground (palisade) walls extending into the bedrock will be required in some areas, particularly along the eastern edge of the site.

In other locations, such as around the western fringe of the main knoll cut, earthworks undercuts will be more economic with some regrading of slope crests in combination with in-ground piles. Various palisade wall, undercut and drainage assumptions were further modelled in Slide to assess preliminary remedial design requirements. The expected most economic solutions are presented in our appendices and the results are presented in Table 8 below.

Table 8: Slope Stability Analyses Results – Post Remedial Works

Remedial Works	**Slope Stability Factor of Safety**		
	Prevailing	**Transient**	**Seismic**
Geological Section A (Palisade)	1.9	1.2*	5.2
Geological Section B (Palisade / Regrade)	1.6	1.3	4.5
Geological Section D (**Option 1**:Undercut/Regrade/Setback)	1.2**	1.2**	3.9
Geological Section D (**Option 2**:Palisade)	1.2**	1.2**	3.9

Notes: * Failures located in Esplanade Reserve, below palisade wall.
** Failures located below palisade wall or building extent.

Locations of the geotechnical remediation solutions referred to above and below are detailed on the appended Geotechnical Remediation Plan as ***Drawing 10*** in ***Appendix A***.

Initial analyses of the palisade walls shows they will need to be designed with a minimum shear capacity of 50kN and 100kN (as indicated on Drawing 10), and extend approximately 2m-3.5m (depth varies across the site) into competent bedrock.

Detailed palisade wall design is to be undertaken at a later date.

7.4 Earthworks

7.4.1 General

All earthwork activities must be carried out in general accordance with the requirements of NZS 4431[16] and the requirements of the Auckland Council Infrastructure Development Code under the guidance of a Chartered Professional Geotechnical Engineer.

A Geotechnical Works Specification is provided as ***Appendix H*** and standard detail drawings are provided on ***Drawing 09.*** Between them, these documents provide the requirements for site preparation, fill placement, subsoil drainage, compaction requirements, quality assurance testing and as-built requirements.

Site specific requirements are summarised below.

7.4.2 Excavatability and Rock Breaking

Given the highly fractured nature and completely weathered nature of the soil / rock units that will be encountered within the proposed earthworks cuts, it is expected that excavation of these materials will be readily achieved with normal earthworks plant, such as scrapers and bulldozers with scoops.

The investigation data does not indicate any strong correlations that could be used to definitively predict depths of any hard limestone deposits across the elevated knoll ridge and away from the investigation locations. Accordingly, while the weathering profile typically mimics surface contour, localised variations may be present.

However, as mentioned above, our experience in these materials suggests that the limestone should be able to be excavated using normal rock breaking plant and equipment, such as a rock pick on a 30T excavator.

7.4.3 Stockpiles

Careful consideration must be given to the location of temporary topsoil / unsuitables stockpiles to ensure that they are not located immediately above steep or unstable slopes or immediately above proposed stormwater pond excavations.

The location of all temporary stockpiles must be approved by the Geotechnical Engineer prior to placement. Where stockpiles cannot be avoided above sloping ground, they should be placed over a wide area with the height restricted under the direction of the Geotechnical Engineer.

7.4.4 Underfill Drainage

Underfill drains will need to be installed beneath new fills within low lying tributaries and gully inverts.

Underfill drainage locations will be decide onsite by the Geotechnical Engineer prior to fill placement. Further details are in the Geotechnical Works Specification (***Appendix H***) and in the Underfill Drain Detail (***Drawing 09***).

The function of subsoil drains and their outlets will be protected using restrictions applied in the Geotechnical Completion Report. These may also include foundation piling requirements to prevent settlement of foundations from poorly compacted filling, depending on the type, location and depths of the drains.

7.4.5 Compaction

We have considered two likely fill material scenarios in the preparation of our compaction specification contained in ***Appendix H***:

- **Overburden soils only.** Two compaction tests have been undertaken on these deposits. A significant degree of drying of these deposits by discing and / or by the addition of lime may be required to achieve

[16] Standards New Zealand (1989) Code of practice for earth fill for residential development, incorporating Amendment No. 1, NZS 4431:1989, NZ Standard

compaction specifications as optimum water contents were generally 3%-18% lower than natural water contents.

- **50/50 blend of overburden soils with the underlying rock deposits**. No compaction tests have been undertaken on a 50/50 soil/rock blend fill. If this fill scenario is likely/employed, further compaction testing will be required once earthworks commence.

It is expected that compaction trials early in the earthworks programme would assist the formation of an earthworks methodology that allows the contractor to place the fills consistently to a high standard and in an efficient manner on site.

Earthfill must be placed, spread and compacted in controlled 250mm to 300mm thick (loose) lifts under the direction of a geotechnical engineer. The fill may comprise either granular or cohesive material subject to being free of any organic material and having no particles greater than 150mm diameter.

Most of the proposed cut material, including the natural and existing fill materials should be suitable for reuse as Engineer Certified Fill. Soil textures and moisture contents will however vary widely and careful management, conditioning and compaction control will be required.

All earthfill must be placed to ensure adequate knitting of successive fill lifts by ripping any natural subgrade or fill surfaces that have become dry prior to placing the following fill lift.

7.4.6 Capping Layer

The highly fractured Northland Allochthon rockmass that will be exposed at finished levels across cut depths greater than approximately 1.2m to 6.5m within the central portion of the site, is susceptible to weathering and infiltration of surface water that could compromise downslope stability conditions or can lead to swelling.

Over-excavation of these deposits to a depth of **0.6m and capping with engineered filling** is a prudent remediation measure. Essentially all of the residually weathered deposits encountered in our investigations across the cut areas would be suitable for use as the engineered capping fill for this purpose.

7.5 Civil Works

7.5.1 Subgrade CBR

The subdivision roading is shown as being constructed in a combination of both cut and fill areas, although given the requirement to over-excavate exposed rock deposits, the vast majority will be formed in engineered fills. Typical CBR values of between 5% and 6% should be available in fills. In areas of cut natural ground, CBR values as low as 2% or 3% are likely.

As described for the fills, subgrade improvement with lime (if desired) is expected to provide better results than the use of cement due to the clayey nature of the soils.

7.5.2 Service Trenches

Most of the materials to be exposed during the excavation of service trenches should be readily removed using an excavator.

Services trenches excavated along contour in areas of steep ground may need to be backfilled with engineered filling and if in natural ground, may require a drain coil in the base of the trench connected to the stormwater system. Identification of critical service lines must be made once drawings are available.

7.5.3 Retaining Walls

Design parameters for permanent and temporary retaining walls are summarised in **Error! Reference source not found.**9 below.

<table>
<tr><th colspan="5">Table 9: Retaining Wall Design Parameters</th></tr>
<tr><th>Soil Unit</th><th>ϒ (kN/m^3)</th><th>Ø’ (deg)</th><th>Su (kPa)</th><th>Geotechnical Ultimate Bearing Strength (kPa)</th></tr>
<tr><td>Engineered Fill</td><td>17.5</td><td>28</td><td>100</td><td>600</td></tr>
<tr><td>Colluvium</td><td>17</td><td>25</td><td>60</td><td rowspan="2">300</td></tr>
<tr><td>Alluvium</td><td>17</td><td>26</td><td>60</td></tr>
<tr><td>Northland Allochthon Residual Soils</td><td>17.5</td><td>28</td><td>100</td><td rowspan="3">600</td></tr>
<tr><td>Northland Allochthon Transition</td><td>17.5</td><td>30</td><td>150</td></tr>
<tr><td>Northland Allochthon Bedrock</td><td>18</td><td>35</td><td>200</td></tr>
<tr><td colspan="5">Notes:
1. Refer to Table 2 for definition of soil unit levels
2. ϒ – soil unit weight; Ø’ - angle of internal soil friction; Su – undrained shear strength.
3. The above parameters are based on the condition of a horizontal ground surface behind the retaining structure. Applicable surcharge loads behind the wall must also be considered in the design.</td></tr>
</table>

It is noted that some ground movement will occur behind temporary or permanent retaining walls. By definition, movement of the wall must occur to fully mobilise the active and passive earth pressure coefficients. The extent of this movement is dependent on the height of retaining, type of wall selected and construction methodology. This must be considered during the design and construction of the retaining walls to ensure adjacent facilities are not adversely affected.

At the completion of the development, **Specific Design Zones (retaining)** are expected to be applied in the Geotechnical Completion Report to protect retaining walls from future overloading at the crest or undermining at the toe that could lead to instability. These zones typically extend the same distance as the wall height and where they are present above a wall, require deepening of foundations unless the wall has been designed for future foundation loads. Where they are present below a wall, careful consideration needs to be given to location, depth and timing of any future excavations.

7.5.4 Stormwater Soakage

All of the soils at this site are clayey in nature and have very low coefficients of permeability. Accordingly, rain gardens are not expected to provide any significant ground soakage function.

Where the less weathered rockmass are exposed in the deeper cuts near design subgrade level, significantly higher permeabilities will be available. However, the addition of concentrated water into these deposits is highly undesirable from a slope stability perspective and is not recommended.

7.6 FOUNDATIONS

Given the comprehensive nature of this development, specific consideration will need to be given to individual foundations requirements from localised site gradients or the presence of service lines or in-ground wall structures once earthworks and civil works are nearing completion.

On this site our provisional expectation is that provided earthworks are completed in accordance with the standards and recommendations described herein, the following will apply:

- A preliminary geotechnical ultimate bearing pressure of 300kPa should be available for shallow strip and pad foundations constructed within both the natural cut ground and engineered fill areas, subject to the short axis of those footings measuring no greater than 2.5m in plan.

There may be areas where localised variations in shear strength within the natural cut ground occur, particularly where the depth of cut varies across the building platforms. Further confirmation of available bearing pressures will be addressed at the time of post earthworks soil testing.

- On this basis of our visual tactile assessment, results of preliminary laboratory testing and reference to BRANZ Report SR120A, we have assessed the preliminary AS2870 Site Class for this development to be M (moderate) to H2 (high). Foundation design may be selected in accordance with NZS appropriate solutions for this Class from AS2870 or may be undertaken by specific engineering design.

  Further site class testing will be undertaken on a platform-by-platform basis at the completion of the earthworks for the subdivision.

8 SAFETY IN DESIGN

The design landform requires site excavations that may include geotechnical works such as temporary excavations, retaining and palisade walls, and subsoil drains as specified in the Geotechnical report(s) and on the drawings. Exposure to these works forms a significant safety risk for contractors and inspectors/ testers.

In conducting our scope of work, we have considered and addressed Safety in Design (SiD) aspects relevant to our understanding of the proposed design and construction work. SiD must consider the construction, operation, maintenance, and ultimate demolition phases of the relevant works.

It is noted that CMW are focussed on design aspects, and whilst we have attempted to be comprehensive in our assessment, it is the Contractors responsibility to cover construction related risks in a more comprehensive manner (being the competent party in that respect). The CMW designs/ specifications for undercuts and drainage elements have been made so that no personnel are ever expected to enter unbattered or unprotected excavations to complete the construction. If at any stage a contractor does not consider that a design for excavations can be safely constructed, then CMW must be contacted immediately to discuss alternative design and/ or methods and avoid risk to personnel.

USE OF THIS REPORT

Site subsurface conditions cause more construction problems than any other factor and therefore are generally the largest technical risk to a project. These notes have been prepared to help you understand the limitations of your geotechnical report.

Your geotechnical report is based on project specific criteria

Your geotechnical report has been developed on the basis of our understanding of your project specific requirements and applies only to the site area investigated. Project requirements could include the general nature of the project; its size and configuration; the location of any structures on or around the site; and the presence of underground utilities. If there are any subsequent changes to your project you should seek geotechnical advice as to how such changes affect your report's recommendations. Your geotechnical report should not be applied to a different project given the inherent differences between projects and sites.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface investigation, the conditions may have changed, particularly when large periods of time have elapsed since the investigations were performed.

Interpretation of factual data

Site investigations identify actual subsurface conditions at points where samples are taken. Additional geotechnical information (e.g., literature and external data source review, laboratory testing on samples, etc) are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can exactly predict what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions.

Your report's recommendations require confirmation during construction

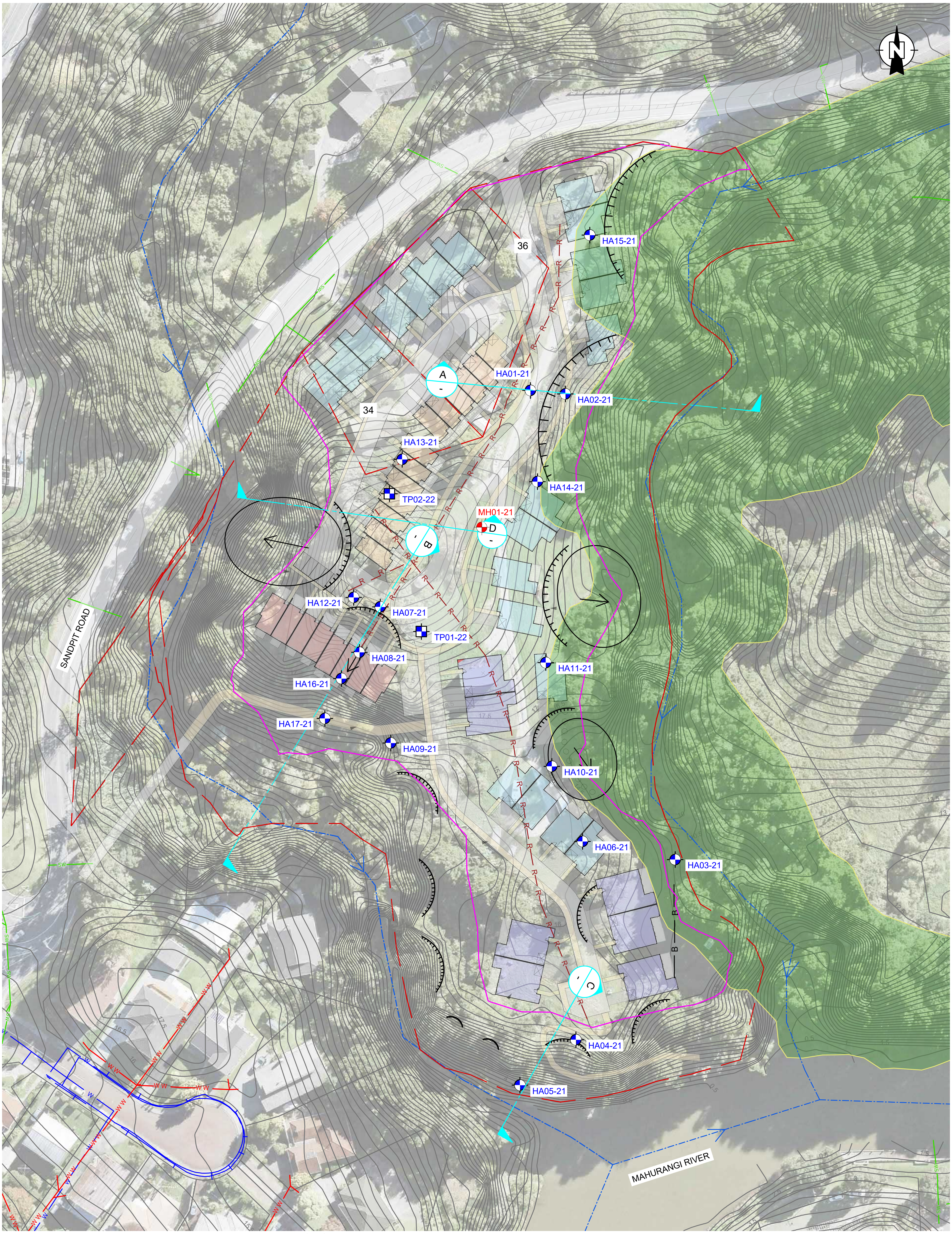
Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced. For this reason, you should retain geotechnical services throughout the construction stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site. A geotechnical designer, who is fully familiar with the background information, is able to assess whether the report's recommendations are valid and whether changes should be considered as the project develops. An unfamiliar party using this report increases the risk that the report will be misinterpreted.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical report. Read all geotechnical documents closely and do not hesitate to ask any questions you may have. To help avoid misinterpretations, retain the assistance of geotechnical professionals familiar with the contents of the geotechnical report to work with other project design professionals who need to take account of the contents of the report. Have the report implications explained to design professionals who need to take account of them, and then have the design plans and specifications produced reviewed by a competent Geotechnical Engineer.

Appendix A: CMW Drawings

Title	Reference No.	Date	Revision
Site Investigation Plan	01	28 Feb 2022	1
Geology and Geomorphology Plan	02	08 Mar 2022	1
Geological Section A	05	28 Feb 2022	1
Geological Section B	06	28 Feb 2022	1
Geological Section C	07	28 Feb 2022	1
Geological Section D	08	28 Feb 2022	0
Underfill Drainage Detail	09	14 Mar 2022	0
Geotechnical Remediation Plan	10	14 Mar 2022	0



LEGEND:

- HA01-21 HAND AUGER (HA) LOCATION
- MH01-21 MACHINE BOREHOLE (MH) LOCATION
- TP01-22 TEST PIT (TP) LOCATION
- SITE BOUNDARY
- WATERMAIN
- STORMWATER LINE
- WASTEWATER LINE
- CROSS SECTION
- 20m ESPLANADE RESERVE
- SIGNIFICANT ECOLOGICAL AREA
- STREAM / GULLY FORMATION
- HEAD SCARP / DEBRIS LOBE
- MID SLOPE BENCH FORMATION
- PROMINENT RIDGE

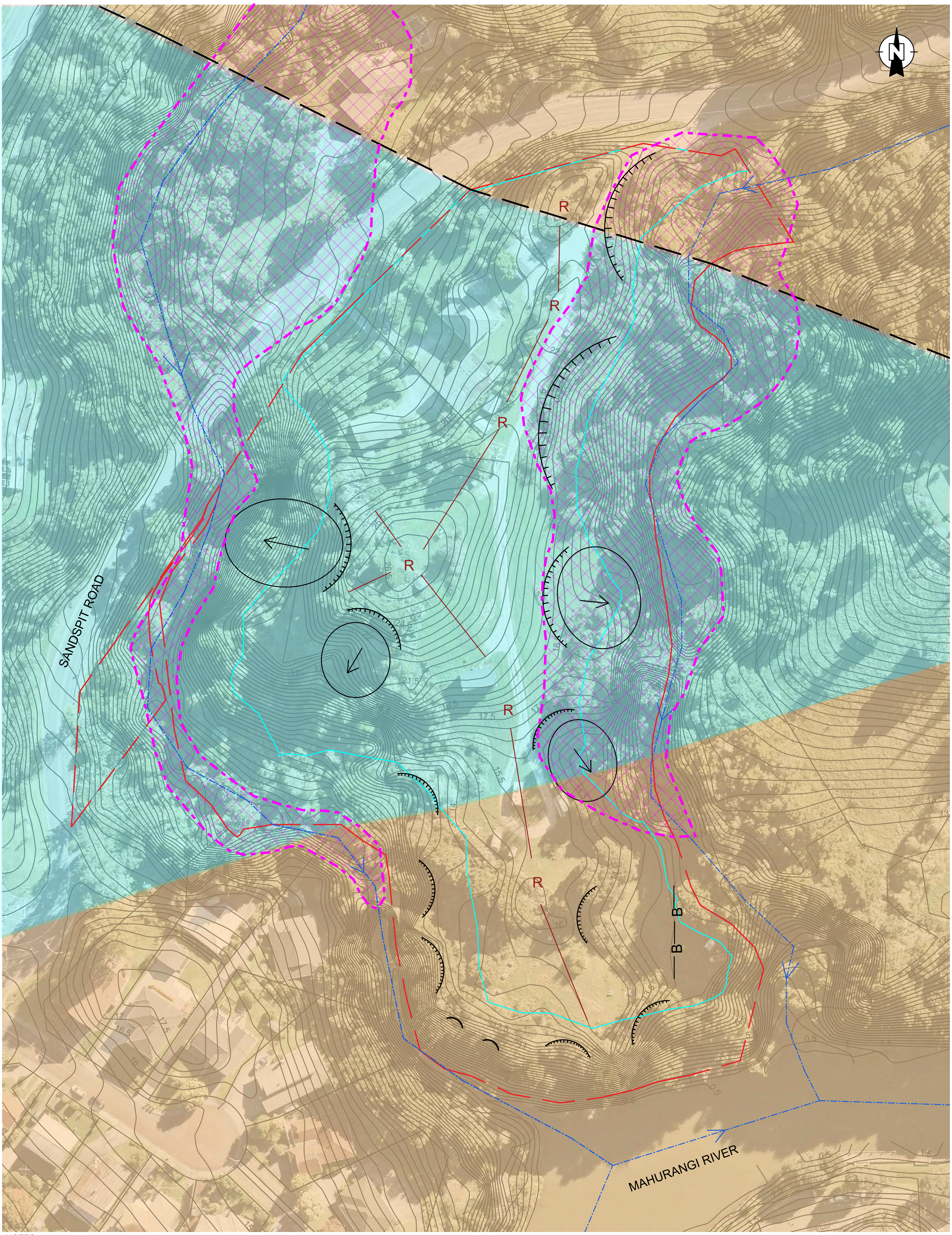
NOTES:

1. BASE PLAN ADAPTED FROM: AUCKLAND COUNCIL GIS AND BUCKTON CONSULTING SURVEYORS LTD SURVEY PLANS.
2. SCHEME PLAN OVERLAY ADAPTED FROM PACIFIC ENVIRONMENTS ARCHITECTS OVERALL PROPOSED SITE PLAN - GROUND FLOOR, REFERENCED 21007, SHEET NO. A210, REV A, DATED 27/01/2022.

1:1000 — 0 10 20 30 40 50 m

CMW Geosciences

CLIENT: THE KILNS LIMITED	DRAWN: HV	PROJECT No: AKL2021-0060
PROJECT: 36 SANDSPIT ROAD WARKWORTH	CHECKED: TE	DRAWING: 01
	REVISION: 1	SCALE: 1:1000
TITLE: SITE INVESTIGATION PLAN	DATE: 28/02/2022	SHEET: A3



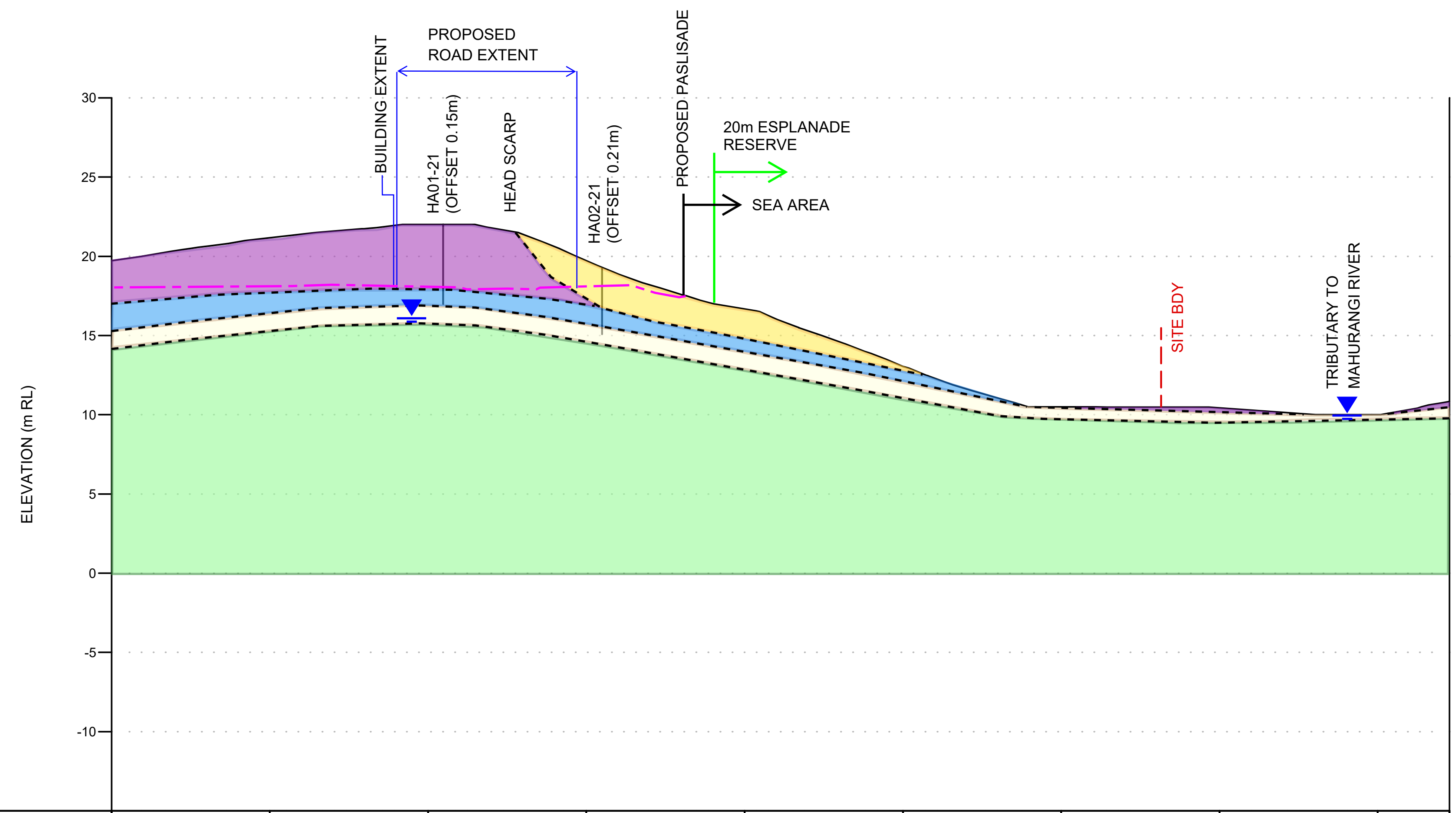
NOTES:
1. BASE PLAN ADAPTED FROM: AUCKLAND COUNCIL GIS
2. GEOLOGY ADAPTED FROM GNS SCIENCE GEOLOGY WEB MAP

0 10 20 30 40 50 m
1:1000

LEGEND:
- SITE BOUNDARY
- TAURANGA GROUP ALLUVIUM
- MAHURANGI LIMESTONE (NORTHLAND ALLOCHTHON)
- PAKIRI FORMATION (WAITEMATA GROUP)
- 20m ESPLANADE RESERVE
- INACTIVE REVERSE FAULT (DEPICTED FROM PUBLISHED INFORMATION)
- STREAM / GULLY FORMATION
- HEAD SCARP / DEBRIS LOBE
- B MID SLOPE BENCH FORMATION
- R PROMINENT RIDGE

CMW Geosciences

CLIENT: THE KILNS LIMITED		DRAWN: TE	PROJECT No: AKL2021-0060
PROJECT: 36 SANDSPIT ROAD WARKWORTH		CHECKED: RK	DRAWING: 02
		REVISION: 1	SCALE: 1:1000
TITLE: GEOLOGY AND GEOMORPHOLOGY PLAN		DATE: 08/03/2022	SHEET: A3



EXISTING GROUND (m RL)	21.17	22.00	19.72	16.67	13.06	10.49	10.43	10.00	10.83
DISTANCE (m)	10	20	30	40	50	60	70	80	85

SECTION-A

LEGEND:

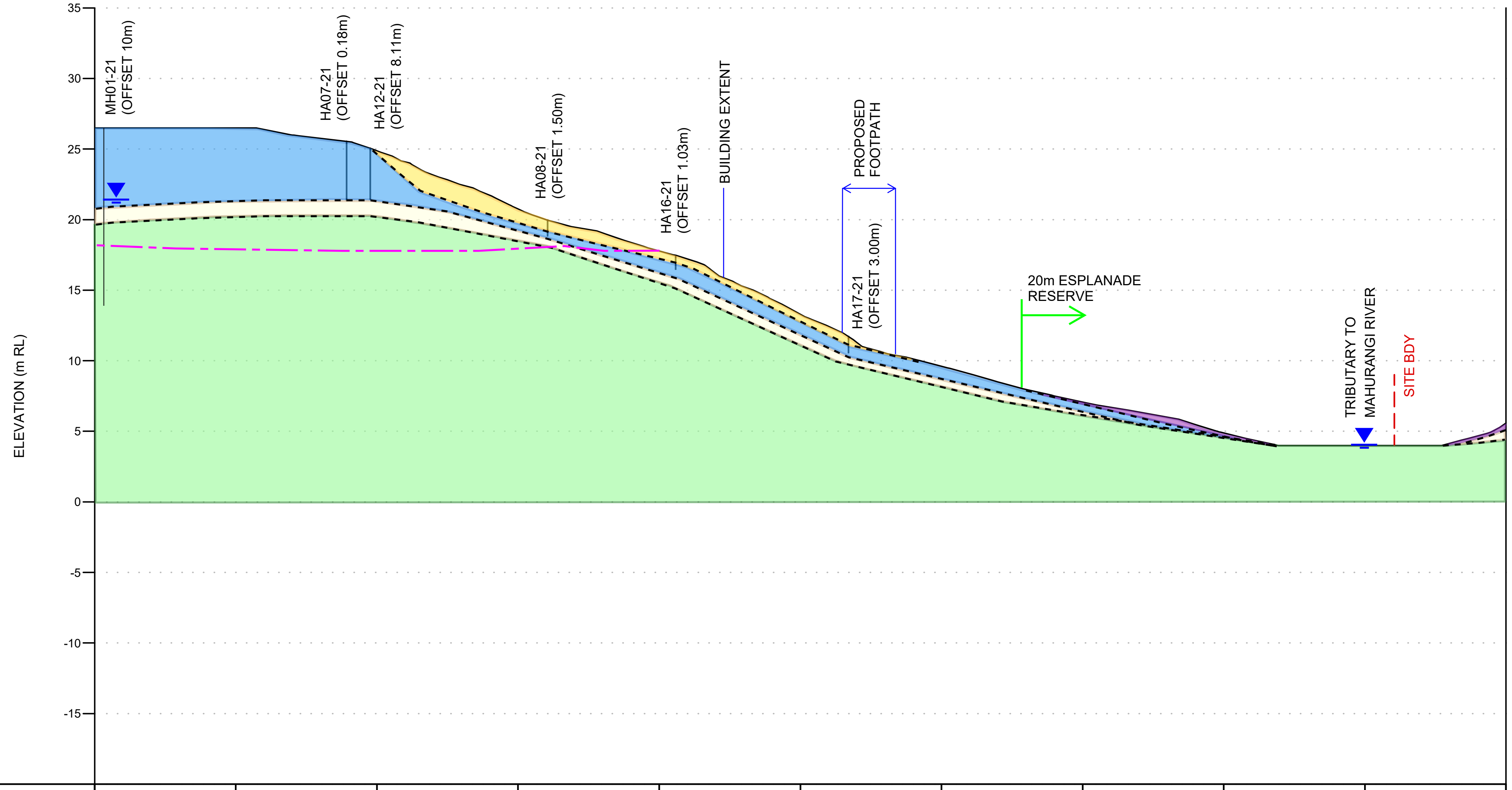
- EXISTING GROUND
- GROUNDWATER
- COLLUVIUM
- ALLUVIUM
- RESIDUAL NORTHLAND ALLOCHTHON
- NORTHLAND ALLOCHTHON TRANSITION (HIGHLY SHEARED)
- NORTHLAND ALLOCHTHON BEDROCK (HIGHLY SHEARED)
- PROPOSED GROUND PROFILE

0 4 8 12 16 20 m

1:400

CMW Geosciences

CLIENT:	THE KILNS LIMITED	DRAWN:	HV	PROJECT:	AKL2021-0060
PROJECT:	36 SANDSPIT ROAD WARKWORTH	CHECKED:	TE	DRAWING:	05
		REVISION:	1	SCALE:	1:400
TITLE:	GEOLOGICAL SECTION-A	DATE:	28/02/2022	SHEET:	A3 L



EXISTING GROUND (m RL)	26.50	24.87	20.75	17.78	13.29	9.61	7.06	4.88	4.00	5.59
DISTANCE (m)	10	20	30	40	50	60	70	80	90	100

SECTION-B

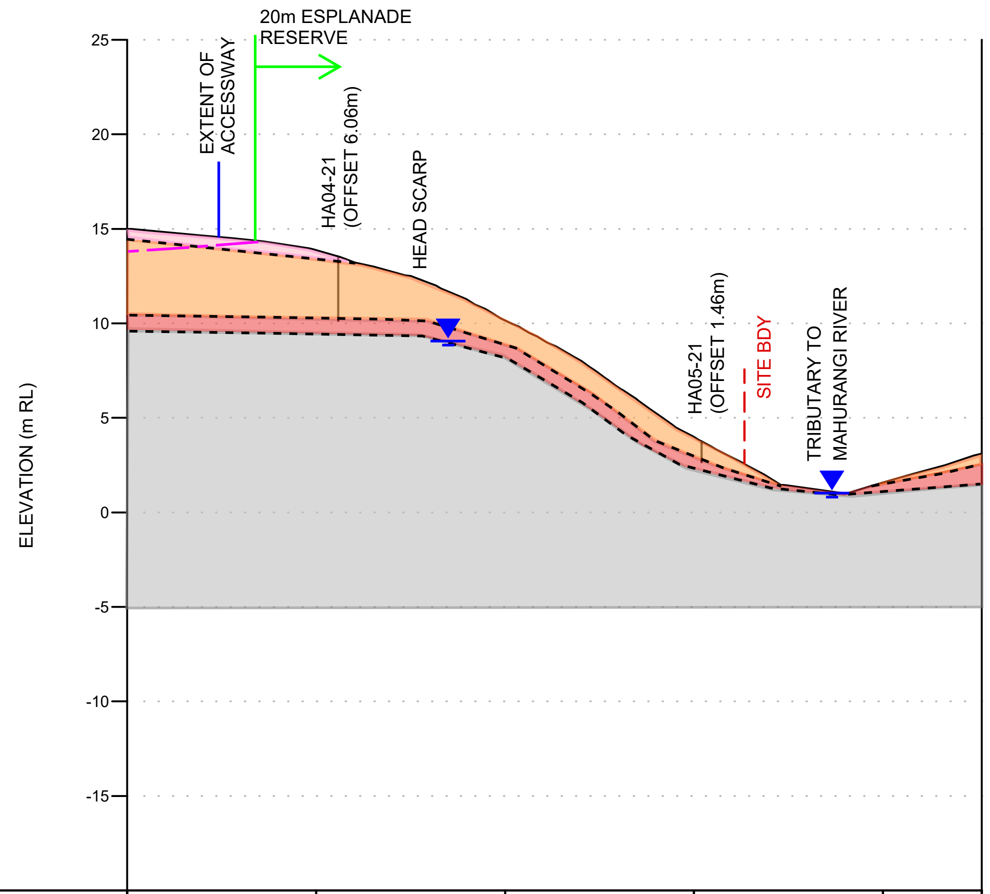
LEGEND:

- EXISTING GROUND
- GROUNDWATER
- COLLUVIUM
- ALLUVIUM
- RESIDUAL NORTHLAND ALLOCHTHON
- NORTHLAND ALLOCHTHON LIMESTONE TRANSITION (HIGHLY SHEARED)
- NORTHLAND ALLOCHTHON SILTSTONE BEDROCK (HIGHLY SHEARED)
- PROPOSED GROUND PROFILE

1:400 — 0 4 8 12 16 20 m

CMW Geosciences

CLIENT:	THE KILNS LIMITED	DRAWN:	HV	PROJECT:	AKL2021-0060
PROJECT:	36 SANDSPIT ROAD WARKWORTH	CHECKED:	TE	DRAWING:	06
		REVISION:	1	SCALE:	1:400
TITLE:	GEOLOGICAL SECTION-B	DATE:	28/02/2022	SHEET:	A3 L



EXISTING GROUND (m RL)	13.87	10.15	3.99	1.58	3.10
DISTANCE (m)	10	20	30	40	45

SECTION-C

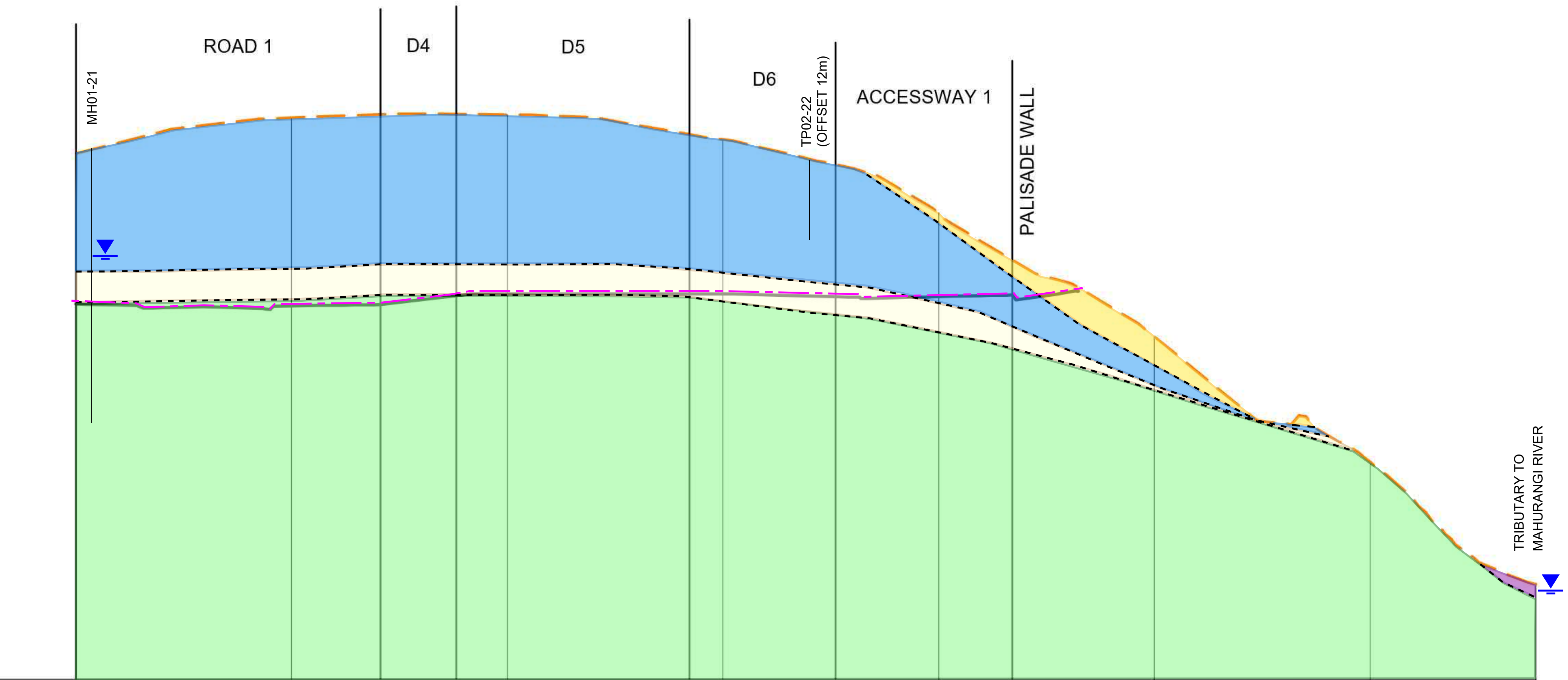
LEGEND:

- EXISTING GROUND
- GROUNDWATER
- UNCONTROLLED FILL
- RESIDUAL PAKIRI FORMATION
- PAKIRI FORMATION TRANSITION
- PAKIRI FORMATION BEDROCK
- PROPOSED GROUND PROFILE

1:400 — 0 4 8 12 16 20 m

CMW Geosciences

CLIENT: THE KILNS LIMITED	DRAWN: HV	PROJECT: AKL2021-0060	
PROJECT: 36 SANDSPIT ROAD WARKWORTH	CHECKED: TE	DRAWING: 07	
	REVISION: 1	SCALE: 1:400	
TITLE: GEOLOGICAL SECTION-C	DATE: 28/02/2022	SHEET: A3 L	



Datum R.L. 0.00

CUT/FILL	-8.72	-8.30	-7.15	-3.88			
NATURAL SURFACE	26.01	26.15	25.00	21.60	15.86	10.08	4.42
DESIGN LEVEL	17.29	17.85	17.85	17.72			
CHAINAGE	10.00	20.00	30.00	40.00	50.00	60.00	67.68

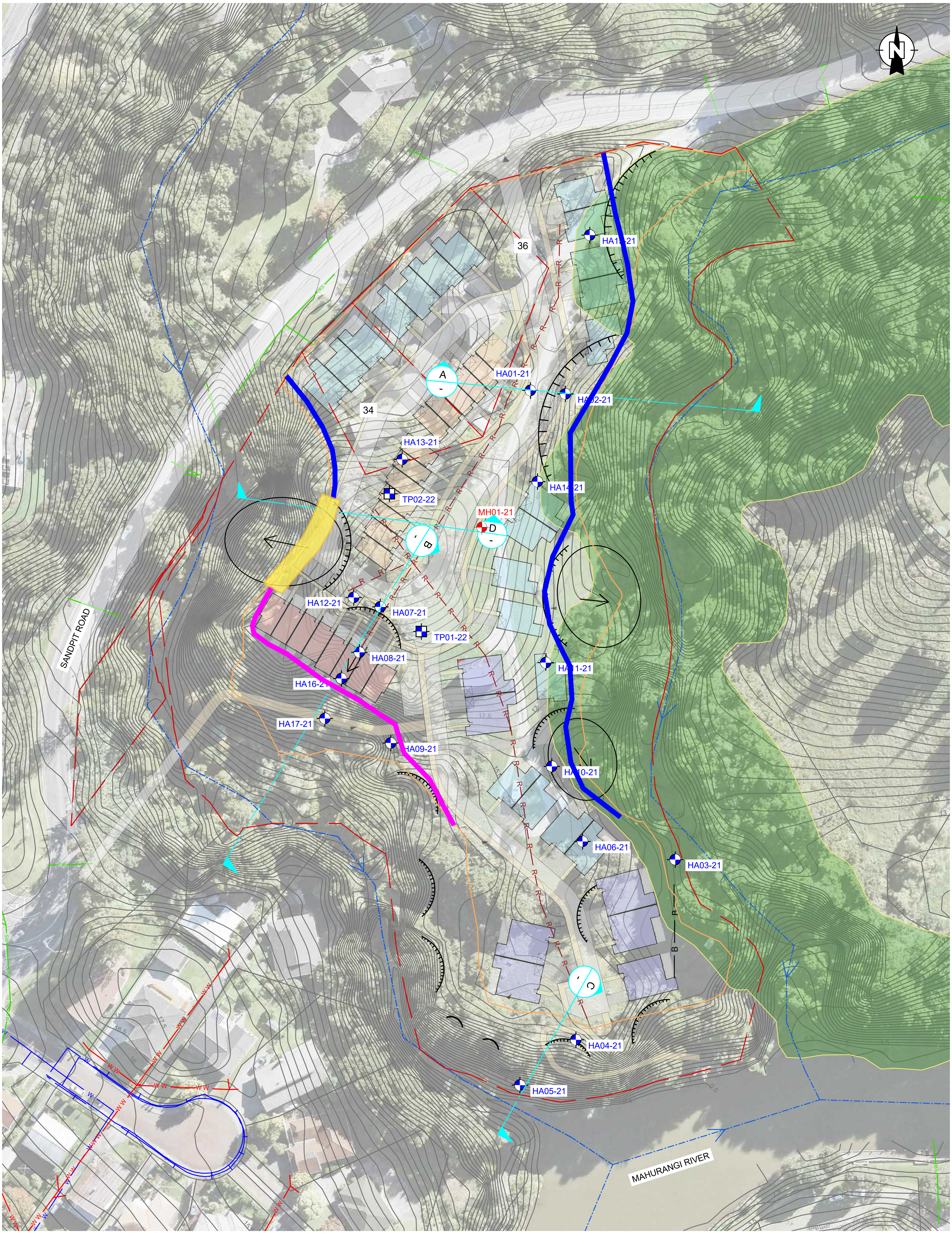
LEGEND:

- EXISTING GROUND
- PROPOSED GROUND PROFILE
- GROUNDWATER
- COLLUVIUM
- ALLUVIUM
- RESIDUAL NORTHLAND ALLOCHTHON
- NORTHLAND ALLOCHTHON LIMESTONE TRANSITION (HIGHLY SHEARED)
- NORTHLAND ALLOCHTHON SILTSTONE BEDROCK (HIGHLY SHEARED)

1:250 — 0 5 10 12.5 m

CMW Geosciences

CLIENT:	THE KILNS LIMITED	DRAWN:	TE	PROJECT:	AKL2021-0060
PROJECT:	36 SANDSPIT ROAD WARKWORTH	CHECKED:	TE	DRAWING:	08
		REVISION:	0	SCALE:	1:250
TITLE:	GEOLOGICAL SECTION-D	DATE:	28/02/2022	SHEET:	A3 L



LEGEND:

- IN-GROUND (PALISADE) WALL - MIN 50kN
- IN-GROUND (PALISADE) WALL - MIN 100kN
- UNDERCUT TO COMPETENT RESIDUAL SOILS AND/OR TRANSITION TO ROCK
- 20m ESPLANADE RESERVE
- SIGNIFICANT ECOLOGICAL AREA
- CROSS SECTION
- STREAM / GULLY FORMATION
- HEAD SCARP / DEBRIS LOBE
- B — MID SLOPE BENCH FORMATION
- R — PROMINENT RIDGE

NOTES:

1. BASE PLAN ADAPTED FROM: AUCKLAND COUNCIL GIS AND BUCKTON CONSULTING SURVEYORS LTD SURVEY PLANS.
2. SCHEME PLAN OVERLAY ADAPTED FROM PACIFIC ENVIRONMENTS ARCHITECTS OVERALL PROPOSED SITE PLAN - GROUND FLOOR, REFERENCED 21007, SHEET NO. A210, REV A, DATED 27/01/2022.

1:1000 — 0 10 20 30 40 50 m

CMW Geosciences

CLIENT:	THE KILNS LIMITED	DRAWN: HV	PROJECT No: AKL2021-0060
PROJECT:	36 SANDSPIT ROAD, WARKWORTH	CHECKED: TE	DRAWING: 10
		REVISION: 0	SCALE: 1:1000
TITLE:	REMEDIATION PLAN	DATE: 14/03/2022	SHEET: A3

Appendix B: Supplied Draft Scheme Plans

Overall Site Plan - Ground Floor 1:1000

DRAFT

The Kilns Development

36 Sandspit Road Warkworth 0982

Resource Consent WIP

Client
The Kilns Ltd

Title
Overall Proposed Site Plan - Ground Floor

Date
27/01/2022

Scale
1:1000 @A3

architects pacific environments NZ Ltd
P.O. Box 8807 Symonds St, Auckland, NZ
Ph (09)308-0070 Email:info@penzl.co.nz

ref no.
21007

sheet no.
A210

revision
A

Detailed Site Plan - Ground Floor 1:500

SITE PLAN KEY:

2A/2B	2-Bed, 2 Storey
3A/3D /3E	3-Bed, 2 Storey
3B/3F	3-Bed, 3 Storey
3C	3-Bed, 1 Storey

- Geotech Orange Zone
- Indicative Palisade walls
- Proposed Lot Boundaries -Refer to Surveyors scheme plans
- Indicative Proposed Contours
- Significant Ecological Areas Overlay
- Ground floor outdoor living

A300 A301 A302

DRAFT

The Kilns Development

36 Sandspit Road Warkworth 0982

Resource Consent WIP

Client
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architects pacific environments NZ Ltd
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Ph (09)308-0070 Email:info@penzl.co.nz

Title
Detailed Site Plan - Ground Floor Part 1

Date
27/01/2022

Scale
1:500, 1:5000 @A3

ref no.
21007

sheet no.
A300

revision
A

Detailed Site Plan - Ground Floor 1:500

SITE PLAN KEY:

2A/2B	2-Bed, 2 Storey
3A/3D/3E	3-Bed, 2 Storey
3B/3F	3-Bed, 3 Storey
3C	3-Bed, 1 Storey

- Geotech Orange Zone
- Indicative Palisade walls
- Proposed Lot Boundaries -Refer to Surveyors scheme plans
- Indicative Proposed Contours
- Significant Ecological Areas Overlay
- Ground floor outdoor living

N

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The Kilns Development

36 Sandspit Road Warkworth 0982

Resource Consent WIP

Client
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architects pacific environments NZ Ltd
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Ph (09)308-0070 Email:info@penzl.co.nz

Title
Detailed Site Plan - Ground Floor Part 2

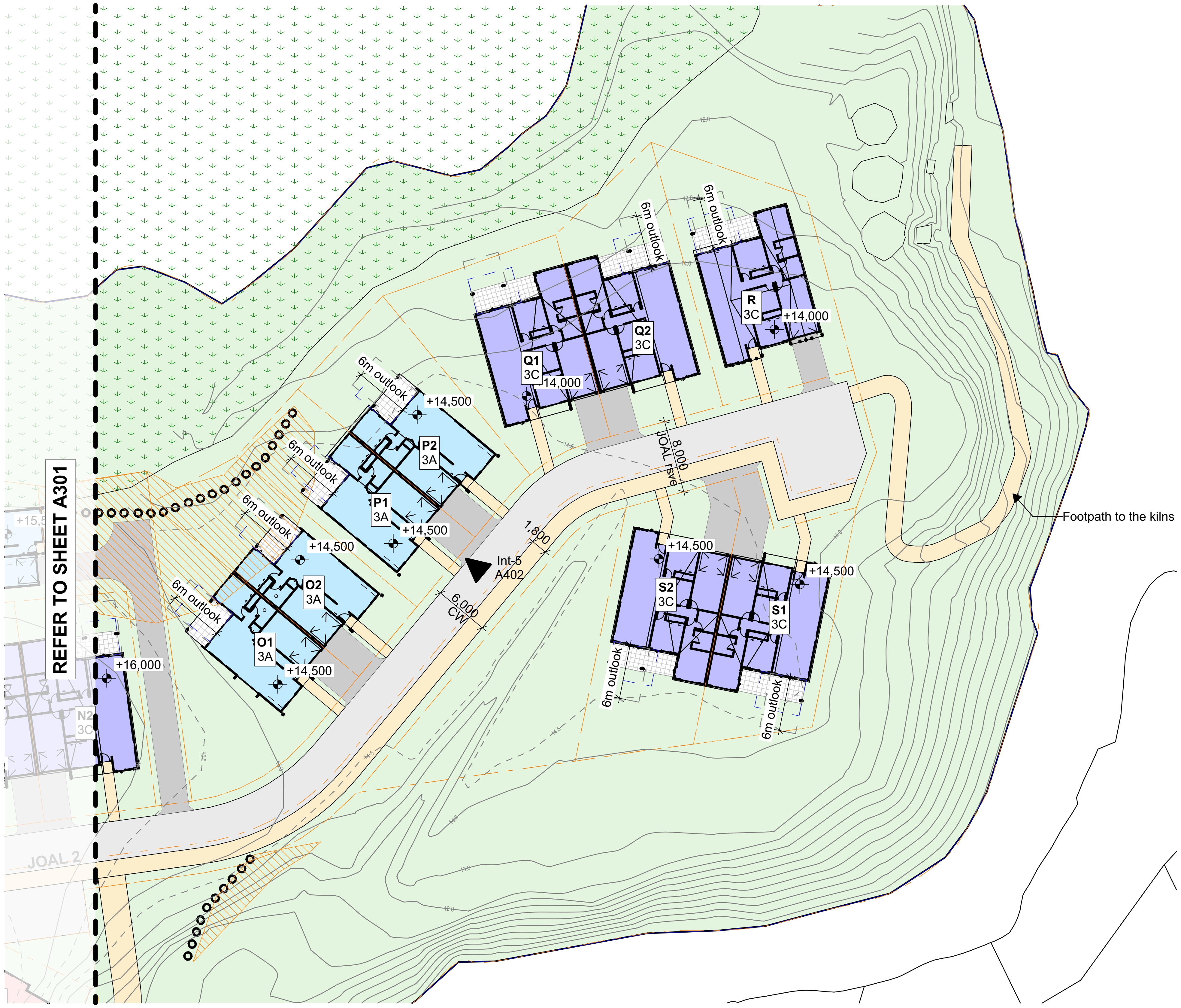
Date
27/01/2022

Scale
1:500, 1:5000 @A3

ref no.
21007

sheet no.
A301

revision
A



SITE PLAN KEY:

2A/2B	2-Bed, 2 Storey
3A/3D /3E	3-Bed, 2 Storey
3B/3F	3-Bed, 3 Storey
3C	3-Bed, 1 Storey
	Geotech Orange Zone
	Indicative Palisade walls
	Proposed Lot Boundaries -Refer to Surveyors scheme plans
	Indicative Proposed Contours
	Significant Ecological Areas Overlay
	Ground floor outdoor living

Detailed Site Plan - Ground Floor 1:500

DRAFT

The Kilns Development

36 Sandspit Road Warkworth 0982

Resource Consent WIP

Title
Detailed Site Plan - Ground Floor Part 3

Date
27/01/2022

Scale
1:500, 1:5000 @A3

Client
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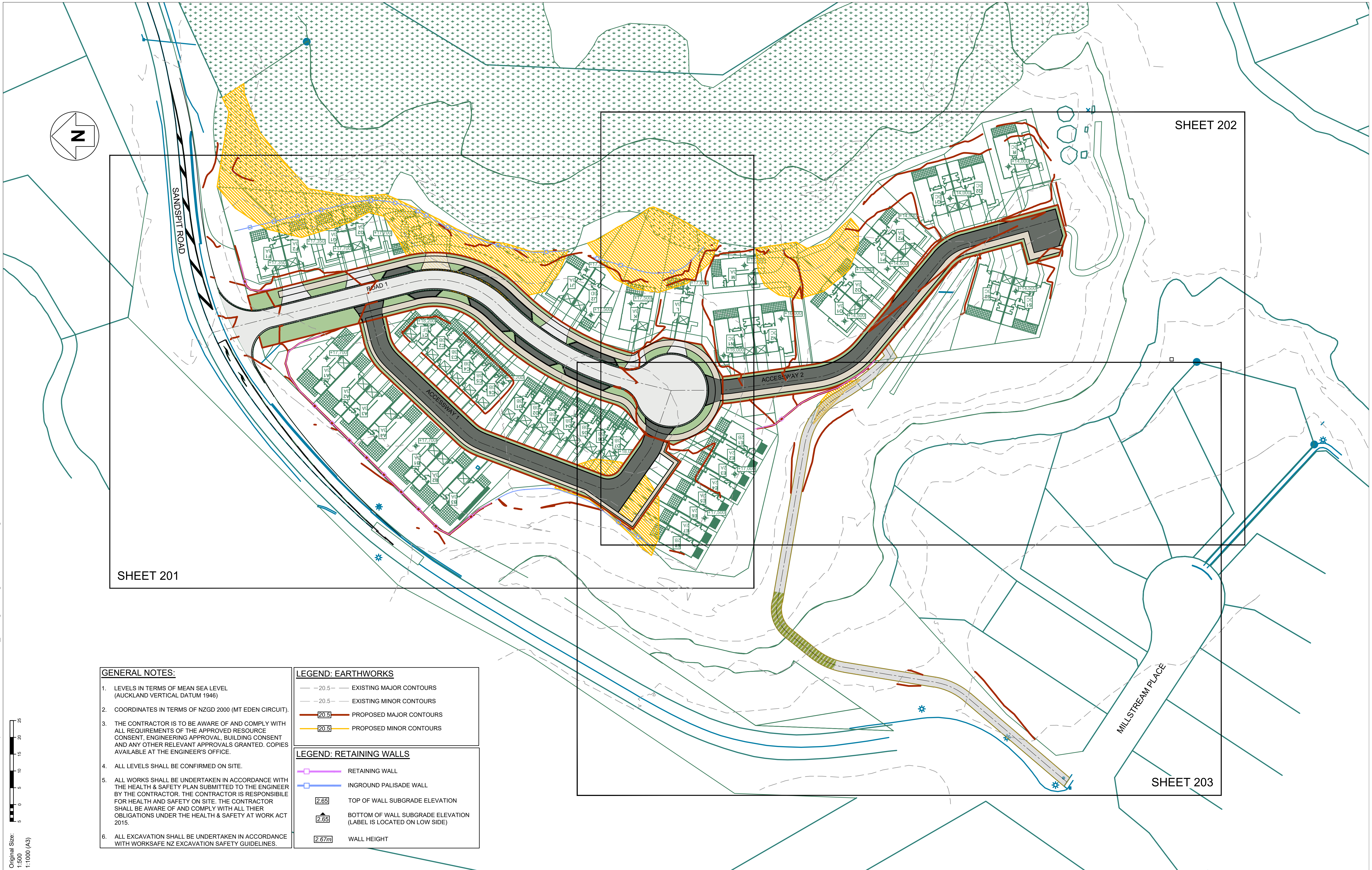
ref no.
21007

sheet no.
A302

revision
A



GENERAL NOTES:

1. LEVELS IN TERMS OF MEAN SEA LEVEL (AUCKLAND VERTICAL DATUM 1946)
2. COORDINATES IN TERMS OF NZGD 2000 (MT EDEN CIRCUIT).
3. THE CONTRACTOR IS TO BE AWARE OF AND COMPLY WITH ALL REQUIREMENTS OF THE APPROVED RESOURCE CONSENT, ENGINEERING APPROVAL, BUILDING CONSENT AND ANY OTHER RELEVANT APPROVALS GRANTED. COPIES AVAILABLE AT THE ENGINEER'S OFFICE.
4. ALL LEVELS SHALL BE CONFIRMED ON SITE.
5. ALL WORKS SHALL BE UNDERTAKEN IN ACCORDANCE WITH THE HEALTH & SAFETY PLAN SUBMITTED TO THE ENGINEER BY THE CONTRACTOR. THE CONTRACTOR IS RESPONSIBILE FOR HEALTH AND SAFETY ON SITE. THE CONTRACTOR SHALL BE AWARE OF AND COMPLY WITH ALL THIER OBLIGATIONS UNDER THE HEALTH & SAFETY AT WORK ACT 2015.
6. ALL EXCAVATION SHALL BE UNDERTAKEN IN ACCORDANCE WITH WORKSAFE NZ EXCAVATION SAFETY GUIDELINES.

LEGEND: EARTHWORKS

20.5	EXISTING MAJOR CONTOURS
20.5	EXISTING MINOR CONTOURS
20.5	PROPOSED MAJOR CONTOURS
20.5	PROPOSED MINOR CONTOURS

LEGEND: RETAINING WALLS

	RETAINING WALL
	INGROUND PALISADE WALL
2.65	TOP OF WALL SUBGRADE ELEVATION
2.65	BOTTOM OF WALL SUBGRADE ELEVATION (LABEL IS LOCATED ON LOW SIDE)
2.67m	WALL HEIGHT

Z:\Jobs 85000-95000\85070 Denis Homer\001 34 & 36 Sandspit Road, Warkworth\002 CAD_working Drawings\85070-01-200.dwg

Original Size: 1:500 1:1000 (A3)

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BOTANY
QUEENSTOWN

CLIENT: THE KILNS LTD

PROJECT TITLE: PROPOSED DEVELOPMENT AT 34 & 36 SANDSPIT ROAD WARKWORTH AUCKLAND

REV	AMENDMENT	DATE	BY
A	DRAFT FOR INFORMATION	FEB 2022	----

DRAWING STATUS:

ISSUE PURPOSE: FOR INFORMATION

DESIGN: SZ
DRAWN: SZ
CHECKED: AW
DATE: 2022-02-15
SCALE: 1:500 (A1) 1:1000 (A3)
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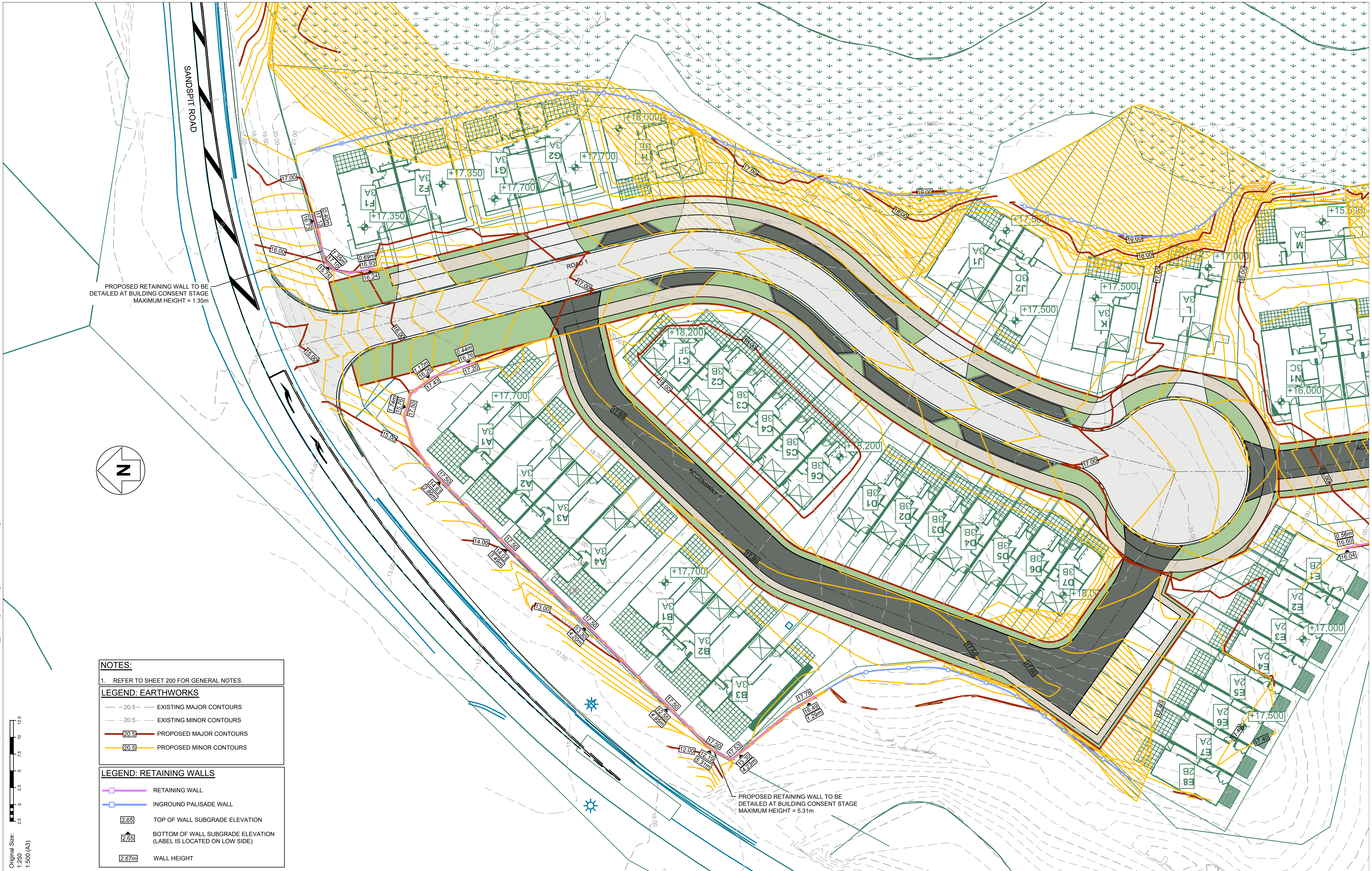
DRAWING TITLE: EXISTING & PROPOSED CONTOURS - OVERALL PLAN

JOB No: 85070-01 SHEET No: 200 REV: A



NOTES:

1. REFER TO SHEET 200 FOR GENERAL NOTES.

LEGEND: EARTHWORKS

20.5	EXISTING MAJOR CONTOURS
20.5	EXISTING MINOR CONTOURS
20.5	PROPOSED MAJOR CONTOURS
20.5	PROPOSED MINOR CONTOURS

LEGEND: RETAINING WALLS

	RETAINING WALL
	INGROUND PALISADE WALL
2.65	TOP OF WALL SUBGRADE ELEVATION
2.65	BOTTOM OF WALL SUBGRADE ELEVATION (LABEL IS LOCATED ON LOW SIDE)
2.67m	WALL HEIGHT

Original Size: 1:250 1:500 (A3)

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DRAWING TITLE: EXISTING & PROPOSED CONTOURS - SHEET 1 OF 3

JOB No: 85070-01 SHEET No: 201 REV: A

NOTES:

1. REFER TO SHEET 200 FOR GENERAL NOTES.

LEGEND: EARTHWORKS

20.5	EXISTING MAJOR CONTOURS
20.5	EXISTING MINOR CONTOURS
20.5	PROPOSED MAJOR CONTOURS
20.5	PROPOSED MINOR CONTOURS

LEGEND: RETAINING WALLS

	RETAINING WALL
	INGROUND PALISADE WALL
2.65	TOP OF WALL SUBGRADE ELEVATION
2.65	BOTTOM OF WALL SUBGRADE ELEVATION (LABEL IS LOCATED ON LOW SIDE)
2.67m	WALL HEIGHT

Original Size: 1:250 1:500 (A3)

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DRAWING TITLE: EXISTING & PROPOSED CONTOURS - SHEET 2 OF 3

JOB No: 85070-01 SHEET No: 202 REV: A

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A	DRAFT FOR INFORMATION	FEB 2022	----

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DRAWING TITLE:

EXISTING & PROPOSED CONTOURS - SHEET 3 OF 3

JOB No: 85070-01
SHEET No: 203
REV: A

Elevations Table					
Number	Min. Elevation (m)	Max. Elevation (m)	Area (m²)	Volume (m³)	Colour
1	-9.98	-8.00	877.11	771.30	
2	-8.00	-6.00	1166.24	2799.60	
3	-6.00	-4.00	3232.02	7157.96	
4	-4.00	-2.00	2838.45	13310.49	
5	-2.00	-0.40	5231.82	17180.17	
6	-0.40	0.00	997.98	5569.37	
7	0.00	0.40	483.85	776.19	
8	0.40	2.00	1283.80	1469.60	
9	2.00	4.50	430.30	423.84	

EARTHWORKS VOLUMES

EARTHWORKS AREA = 16770m^2

EARTHWORKS VOLUME: 44850m^3 (NET)
CUT = 47470m^3
FILL = 2620m^3

NOTE:
EARTHWORKS VOLUME IS MEASURED FROM *EXISTING SURFACE* TO *SUBGRADE SURFACE (ASSUMED 300mm BELOW FINISHED LEVELS).* PAVEMENT AND FOUNDATION THICKNESS SHALL BE CONFIRMED AT EPA/BC STAGE.

GENERAL NOTES:

1. LEVELS IN TERMS OF MEAN SEA LEVEL (AUCKLAND VERTICAL DATUM 1946)
2. COORDINATES IN TERMS OF NZGD 2000 (MT EDEN CIRCUIT).
3. THE CONTRACTOR IS TO BE AWARE OF AND COMPLY WITH ALL REQUIREMENTS OF THE APPROVED RESOURCE CONSENT, ENGINEERING APPROVAL, BUILDING CONSENT AND ANY OTHER RELEVANT APPROVALS GRANTED. COPIES AVAILABLE AT THE ENGINEER'S OFFICE.
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6. ALL EXCAVATION SHALL BE UNDERTAKEN IN ACCORDANCE WITH WORKSAFE NZ EXCAVATION SAFETY GUIDELINES.

EARTHWORKS NOTES:

1. EARTHWORKS SHALL BE UNDERTAKEN IN ACCORDANCE WITH NZS 4431:1989.
2. EARTHWORKS VOLUMES ARE SOLID MEASURE ONLY AND EXCLUDE ANY BULKING OR COMPACTION FACTORS.
3. EROSION AND SEDIMENT CONTROLS IN ACCORDANCE WITH AUCKLAND COUNCIL GD05 SHALL BE INSTALLED PRIOR TO THE COMMENCEMENT OF WORKS ON SITE AND SHALL BE MAINTAINED FOR THE DURATION OF THE WORKS.
4. THE CONTRACTOR SHALL STRIP AND STOCKPILE TOPSOIL PRIOR TO THE COMMENCEMENT OF BULK EARTHWORKS.
5. THE CONTRACTOR SHALL STABILISE ALL EARTHWORKED AREAS IMMEDIATELY FOLLOWING THE COMPLETION OF BULK EARTHWORKS.
6. ALL EARTHWORKS BATTERS SHALL BE MAX 1:3 (VERTICAL : HORIZONTAL).

Z:\Jobs 85000-95000\85070 Denis Horner\001 34 & 36 Sandspit Road, Warkworth\002 CAD_working Drawings\85070-01-210.dwg

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1:1000 (A3)

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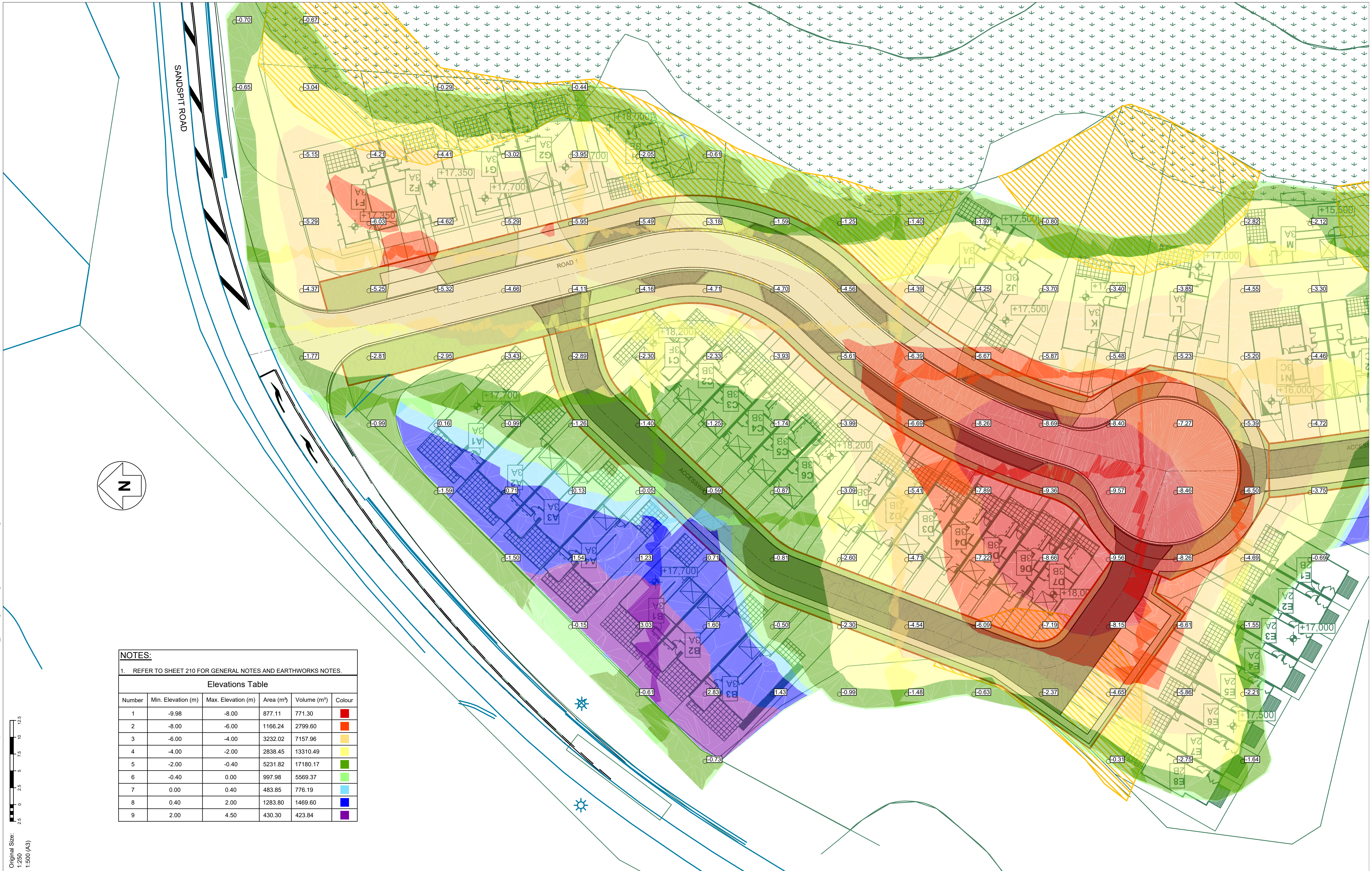
DRAWING TITLE: PROPOSED CUT & FILL - OVERALL PLAN

JOB No: 85070-01 SHEET No: 210 REV: A



NOTES:

1. REFER TO SHEET 210 FOR GENERAL NOTES AND EARTHWORKS NOTES.

Elevations Table

Number	Min. Elevation (m)	Max. Elevation (m)	Area (m²)	Volume (m³)	Colour
1	-9.98	-8.00	877.11	771.30	
2	-8.00	-6.00	1166.24	2799.60	
3	-6.00	-4.00	3232.02	7157.96	
4	-4.00	-2.00	2838.45	13310.49	
5	-2.00	-0.40	5231.82	17180.17	
6	-0.40	0.00	997.98	5569.37	
7	0.00	0.40	483.85	776.19	
8	0.40	2.00	1283.80	1469.60	
9	2.00	4.50	430.30	423.84	

Original Size: 1:250 1:500 (A3)

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REV	AMENDMENT	DATE	BY
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DATE: 2022-02-15
SCALE: 1:250 (A1) 1:500 (A3)
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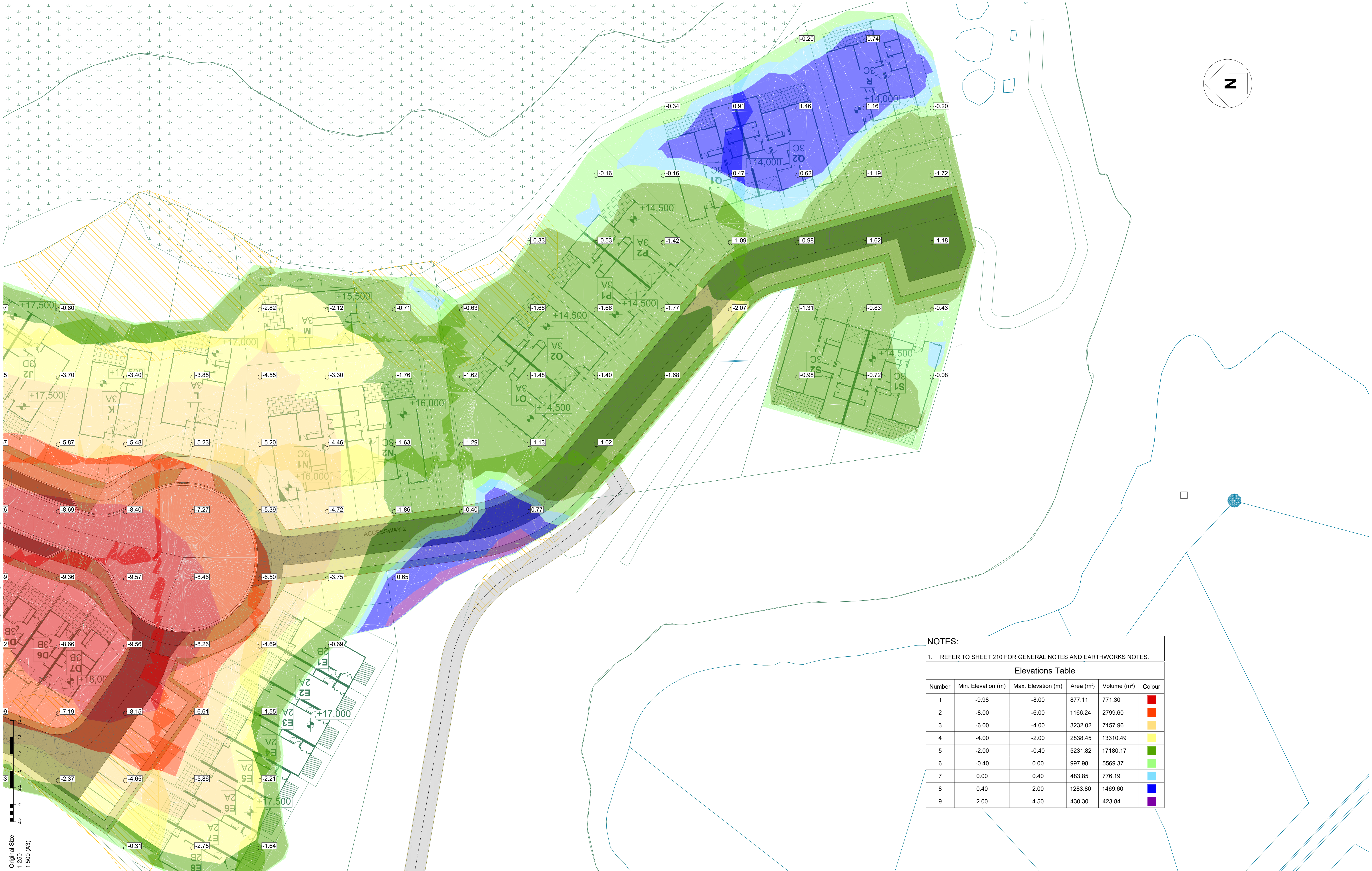
DRAWING TITLE: PROPOSED CUT & FILL - SHEET 1 OF 3

JOB No: 85070-01 SHEET No: 211 REV: A



NOTES:

1. REFER TO SHEET 210 FOR GENERAL NOTES AND EARTHWORKS NOTES.

Elevations Table

Number	Min. Elevation (m)	Max. Elevation (m)	Area (m²)	Volume (m³)	Colour
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2	-8.00	-6.00	1166.24	2799.60	
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5	-2.00	-0.40	5231.82	17180.17	
6	-0.40	0.00	997.98	5569.37	
7	0.00	0.40	483.85	776.19	
8	0.40	2.00	1283.80	1469.60	
9	2.00	4.50	430.30	423.84	

Z:\Jobs 85000-95000\85070 Denis Horne\001 34 & 36 Sandspit Road, Warkworth\002 CAD_working Drawings\85070-01-210.dwg

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CLIENT: THE KILNS LTD

PROJECT TITLE: PROPOSED DEVELOPMENT AT 34 & 36 SANDSPIT ROAD WARKWORTH AUCKLAND

REV	AMENDMENT	DATE	BY
~~A~~--	~~D~~RAFT FOR INFORMATION	FEB 2022	----

DRAWING STATUS:

ISSUE PURPOSE: FOR INFORMATION

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DRAWN: SZ
CHECKED: AW
DATE: 2022-02-15
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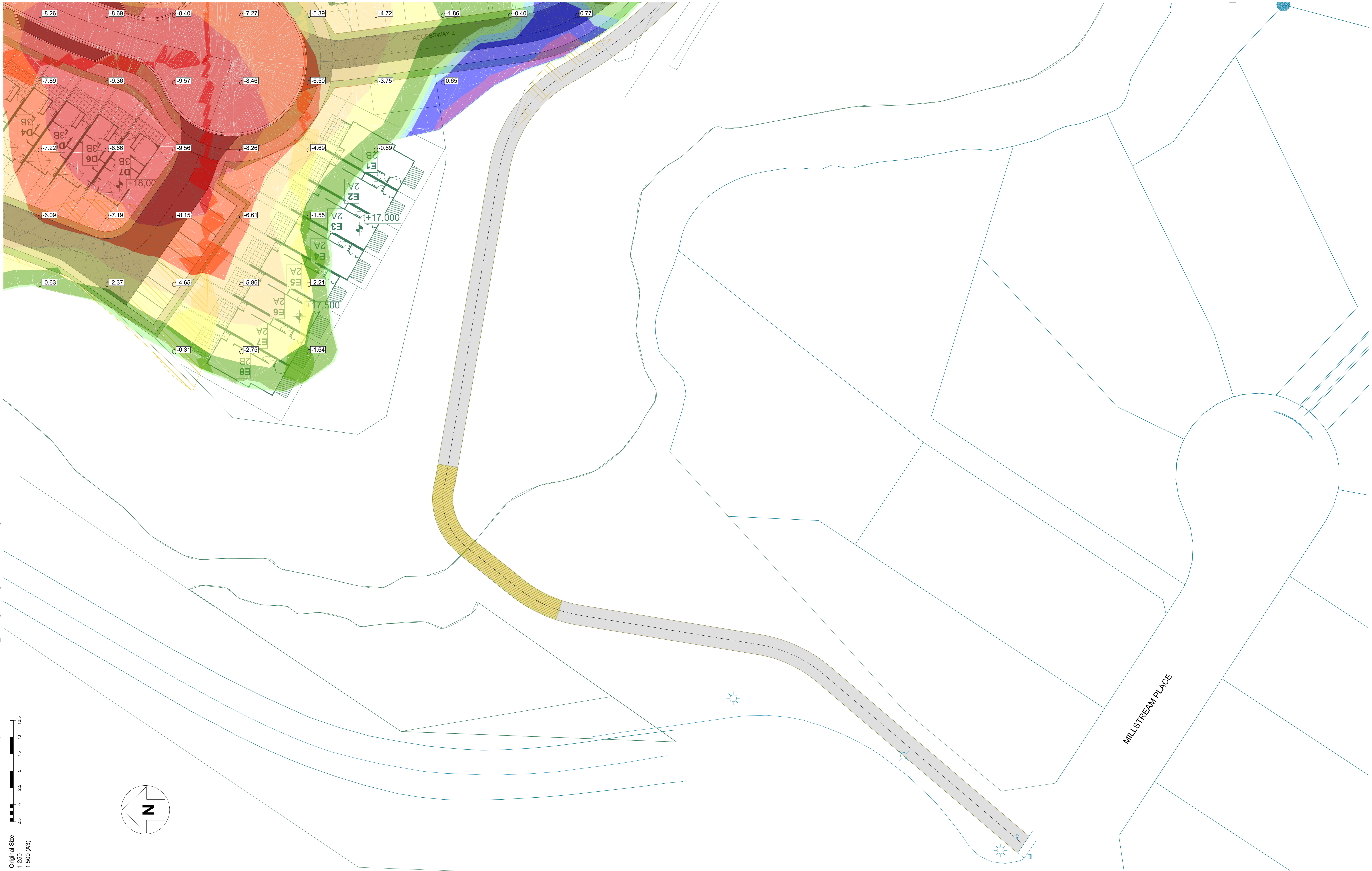
DRAWING TITLE: PROPOSED CUT & FILL - SHEET 2 OF 3

JOB No: 85070-01 SHEET No: 212 REV: A



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Original Size: 1:250 (A1) 1:500 (A3)

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34 & 36 SANDSPIT ROAD
WARKWORTH
AUCKLAND

REV	AMENDMENT	DATE	BY
A--	DRAFT FOR INFORMATION	FEB 2022	----

DRAWING STATUS:

ISSUE PURPOSE:
FOR INFORMATION

DESIGN: SZ
DRAWN: SZ
CHECKED: AW
DATE: 2022-02-15
SCALE: 1:250 (A1) 1:500 (A3)
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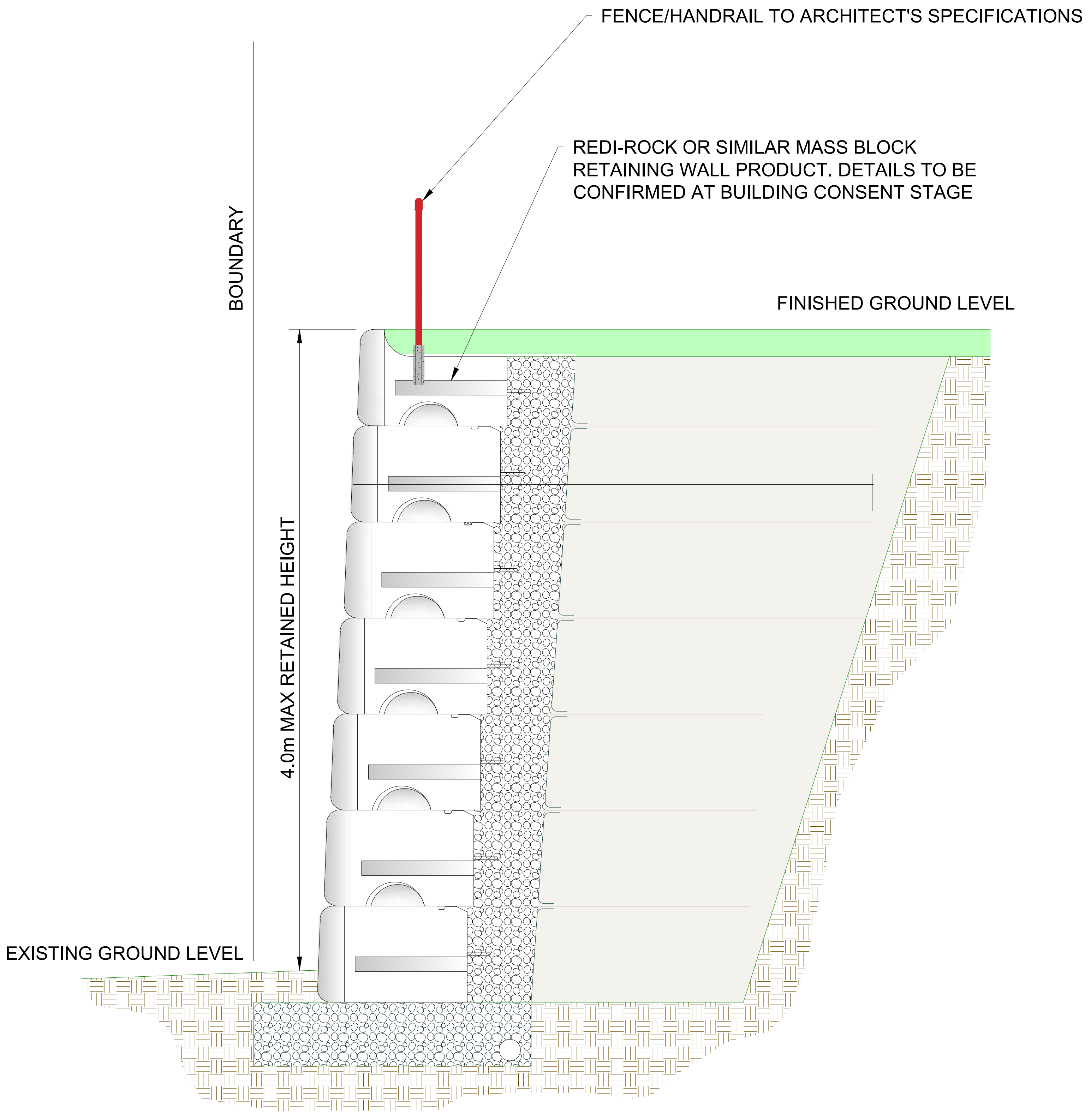
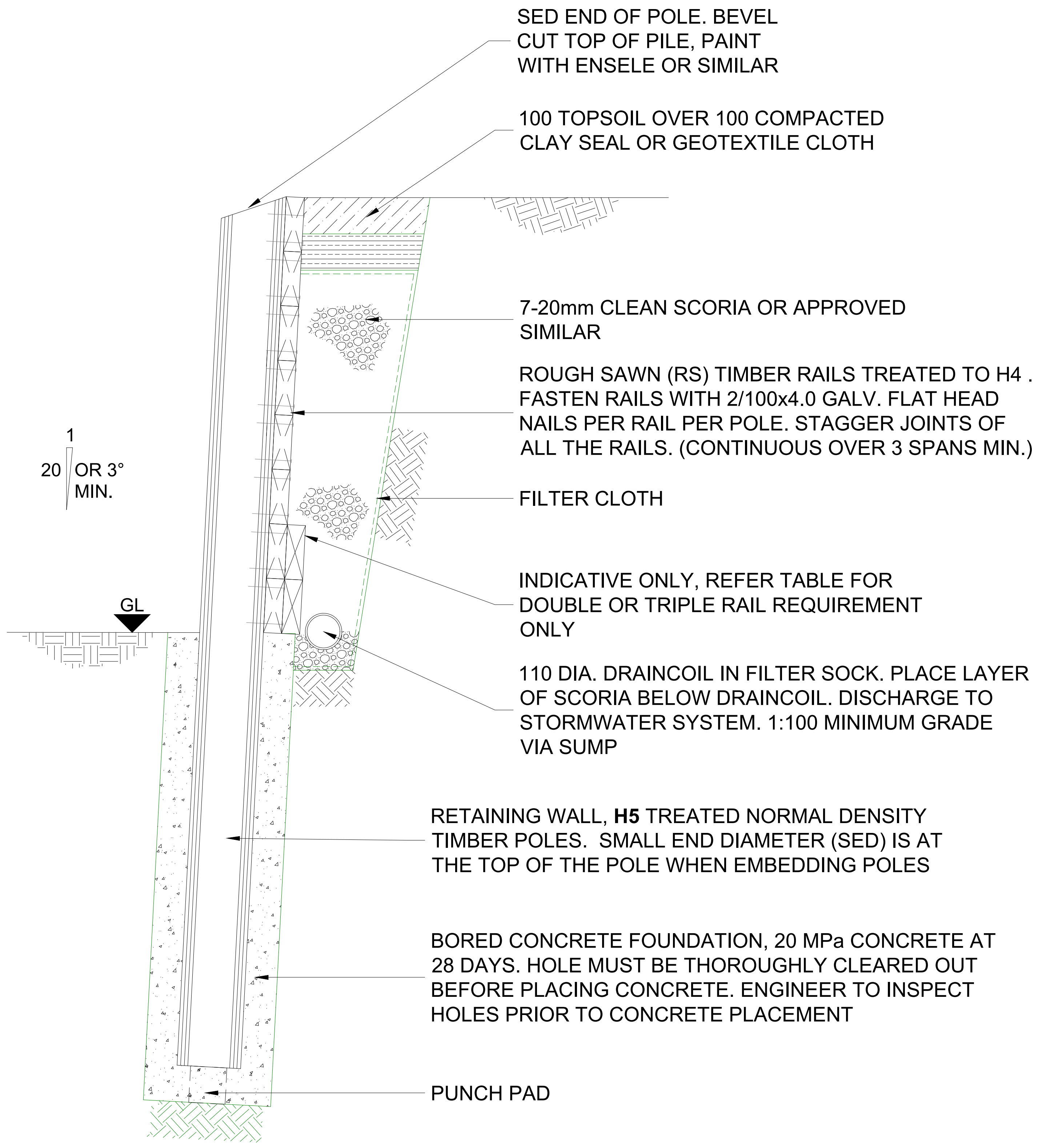
DRAWING TITLE:
PROPOSED CUT & FILL - SHEET 3 OF 3

JOB No: 85070-01
SHEET No: 213
REV: A



RETAINING WALL TYPE A - MASS BLOCK WALL

N.T.S.



RETAINING WALL TYPE B - TIMBER POLE WALL

N.T.S.

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Original Size: 1:25 1:50 (A3)

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PROJECT TITLE: PROPOSED DEVELOPMENT AT 34 & 36 SANDSPIT ROAD WARKWORTH AUCKLAND

REV	AMENDMENT	DATE	BY
A	DRAFT FOR INFORMATION	FEB 2022	----

DRAWING STATUS:

ISSUE PURPOSE: FOR INFORMATION

DESIGN: SZ
DRAWN: SZ
CHECKED: AW
DATE: 2022-02-15
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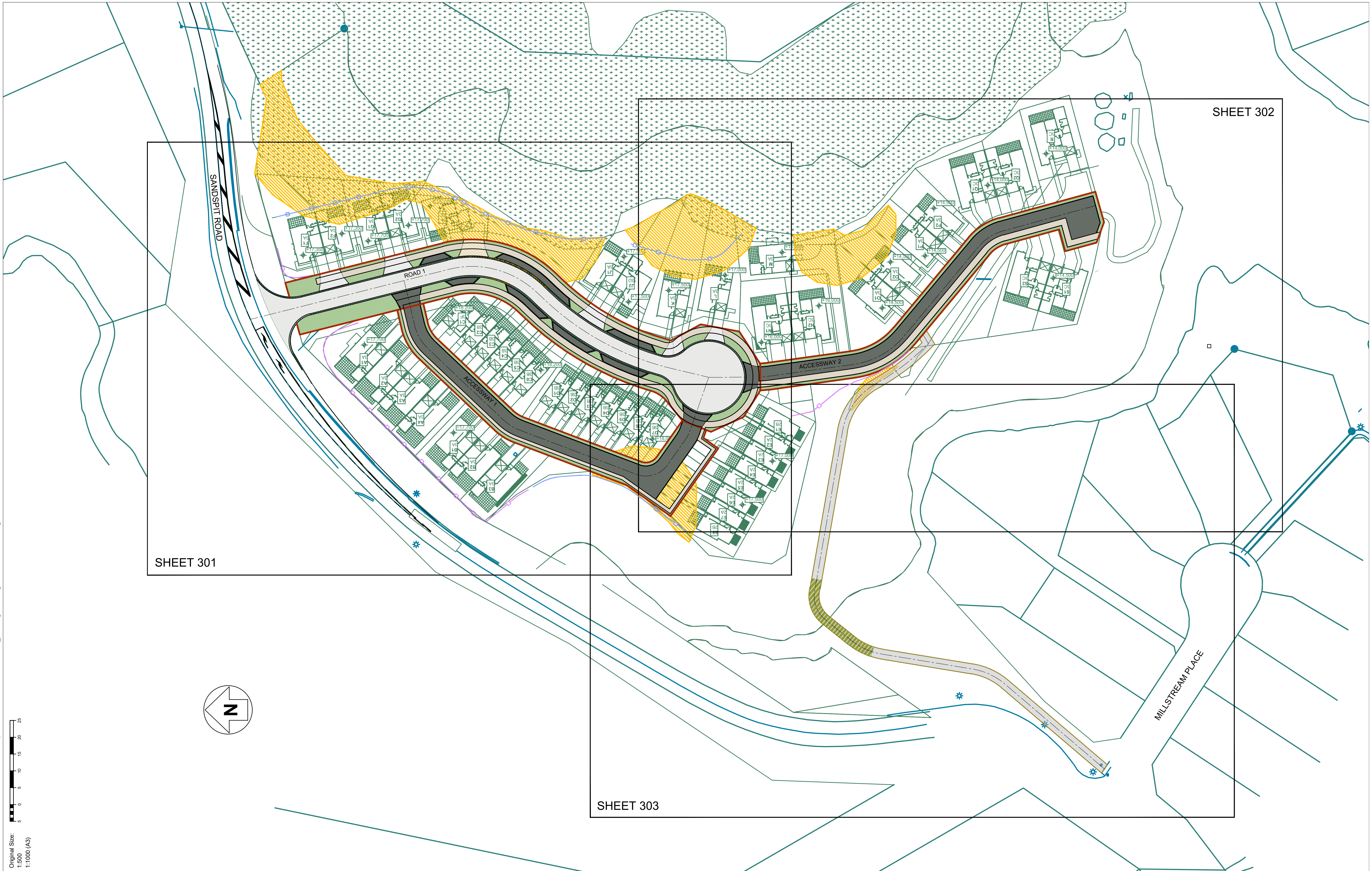
DRAWING TITLE: RETAINING WALL TYPICAL DETAILS

JOB No: 85070-01 SHEET No: 260 REV: A



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CLIENT:

THE KILNS LTD

PROJECT TITLE:

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WARKWORTH
AUCKLAND

REV	AMENDMENT	DATE	BY
A	DRAFT FOR INFORMATION	FEB 2022	----

DRAWING STATUS:

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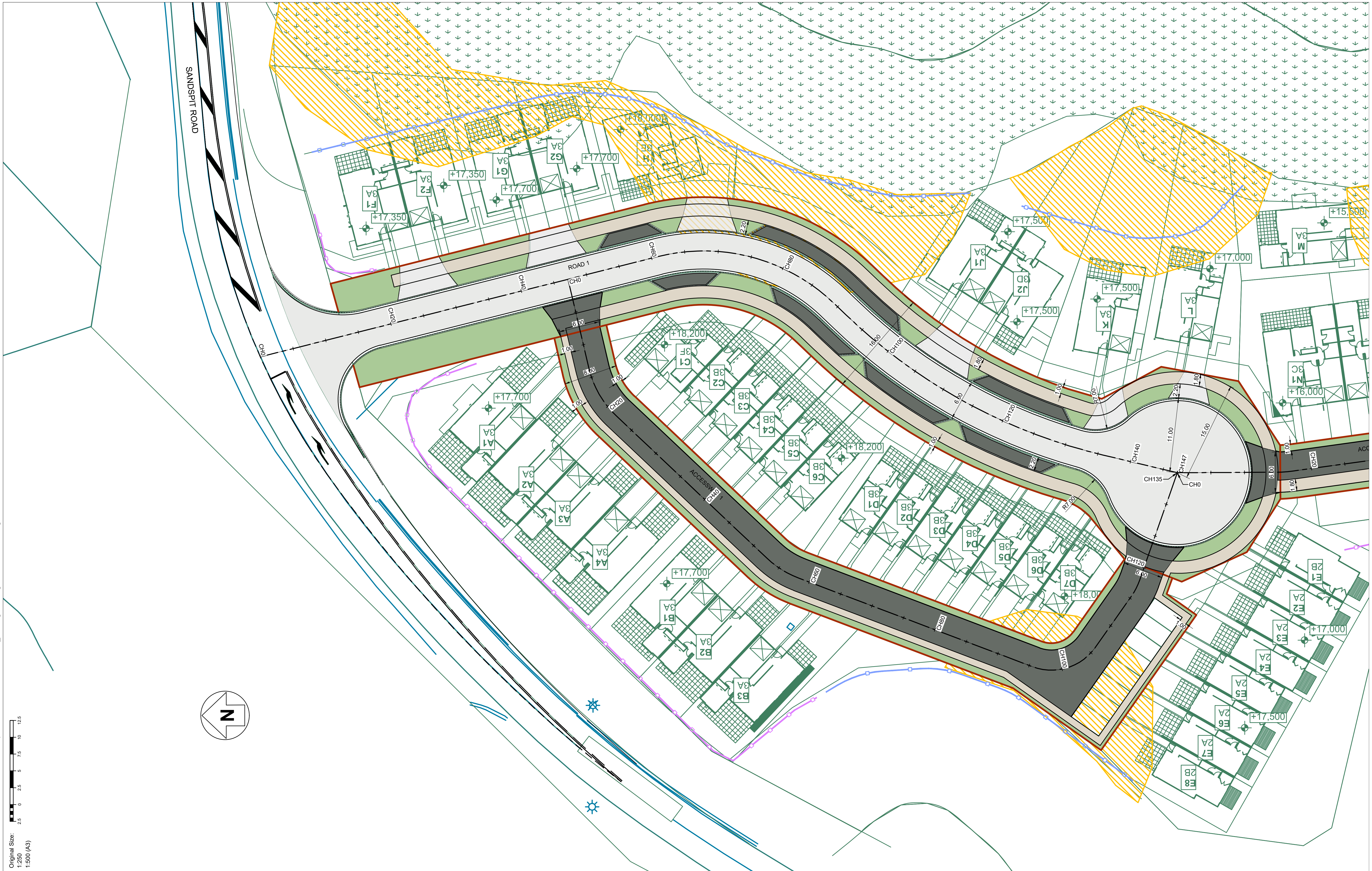
DRAWING TITLE:

ROADING & PATHWAY LAYOUT
OVERALL PLAN

JOB No: 85070-01
SHEET No: 300
REV: A



Z:\Jobs 85000-95000\85070 Denis Horner\001 34 & 36 Sandspit Road, Warkworth\002 CAD_working Drawings\85070-01-300.dwg

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CLIENT:
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PROJECT TITLE:
PROPOSED DEVELOPMENT AT
34 & 36 SANDSPIT ROAD
WARKWORTH
AUCKLAND

REV	AMENDMENT	DATE	BY
A	DRAFT FOR INFORMATION	FEB 2022	----

DRAWING STATUS:

ISSUE PURPOSE:
FOR INFORMATION

DESIGN:	SZ
DRAWN:	SZ
CHECKED:	AW
DATE:	2022-02-15
SCALE:	1:250 (A1) 1:500 (A3)

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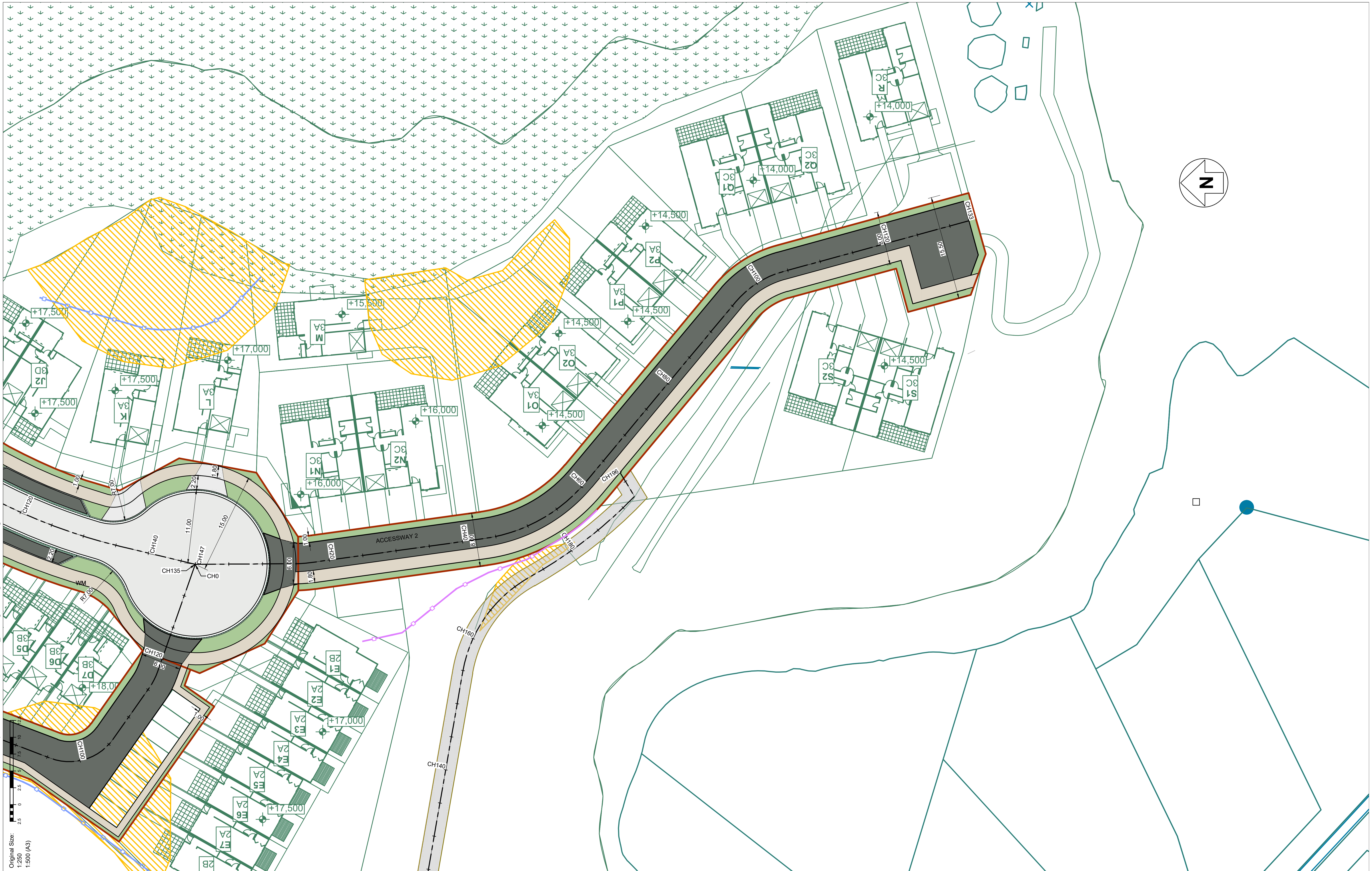
DRAWING TITLE:
ROADING & PATHWAY LAYOUT
PLAN - SHEET 1 OF 3

JOB No: 85070-01 SHEET No: 301 REV: A



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Original Size:
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PROPOSED DEVELOPMENT AT
34 & 36 SANDSPIT ROAD
WARKWORTH
AUCKLAND

REV	AMENDMENT	DATE	BY
A	DRAFT FOR INFORMATION	FEB 2022	----

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DRAWING TITLE:
ROADING & PATHWAY LAYOUT PLAN - SHEET 2 OF 3

JOB No: 85070-01 SHEET No: 302 REV: A

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AUCKLAND

REV	AMENDMENT	DATE	BY
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DATE: 2022-02-15
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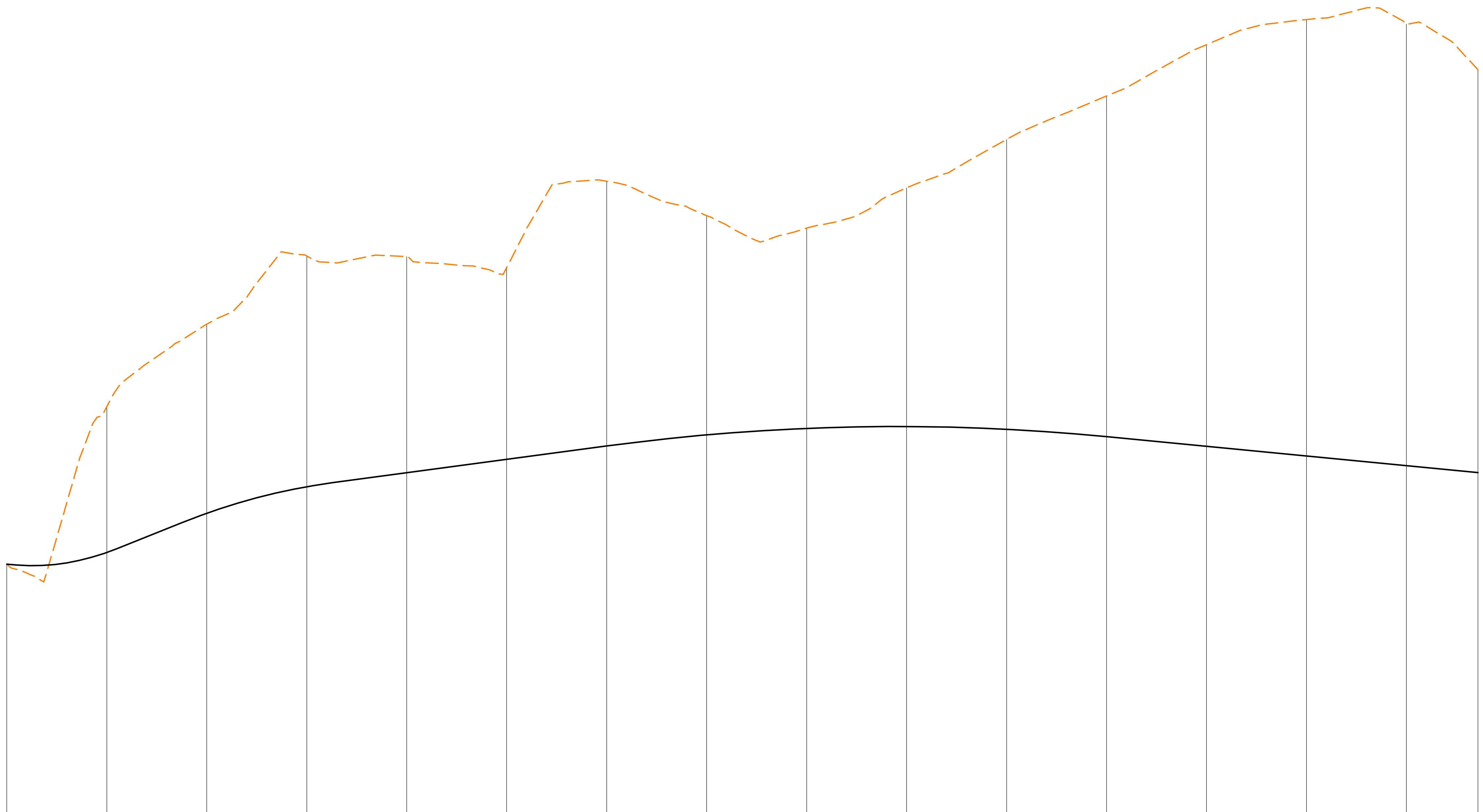
DRAWING TITLE:
ROADING & PATHWAY LAYOUT PLAN - SHEET 3 OF 3

JOB No: 85070-01
SHEET No: 303
REV: A



Datum R.L. 10.00

CUT/FILL	0.00	+0.09	-2.92	-3.19	-3.79	-4.62	-4.32	-3.84	[illegible]	-4.39	-5.80	[illegible]	-8.04	-8.73	-8.83	-8.06
NATURAL SURFACE	14.96	14.86	18.12	18.47	19.77	21.13	21.12	20.90	[illegible]	21.94	23.46	[illegible]	25.36	25.87	25.77	24.86
DESIGN LEVEL	14.96	14.95	15.20	15.27	15.98	16.52	16.79	17.06	[illegible]	17.55	17.66	[illegible]	17.32	17.13	16.94	16.80
VERTICAL GEOMETRY	-1.50%		VC: 10.0m K: 1.05		8.00%	VC: 15.0m K: 2.82	2.68%			VC: 50.0m K: 10.85			-1.93%			
CHAINAGE	0.00	1.00	10.00	11.00	20.00	30.00	40.00	50.00	60.00	70.00	100.00	[illegible]	120.00	130.00	140.00	147.15

Scale Horizontal 1:250 Vertical 1:50 (A1)
Horizontal 1:500 Vertical 1:100 (A3)

ROAD 1 LONGITUDINAL SECTION

Original Size:
1:250
1:500 (A3)

Z:\Jobs 85000-95000\85070 Denis Horner\001 34 & 36 Sandspit Road, Warkworth\002 CAD_working Drawings\85070-01-300.dwg

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REV	AMENDMENT	DATE	BY
A--	DRAFT FOR INFORMATION	FEB 2022	---

DRAWING STATUS:

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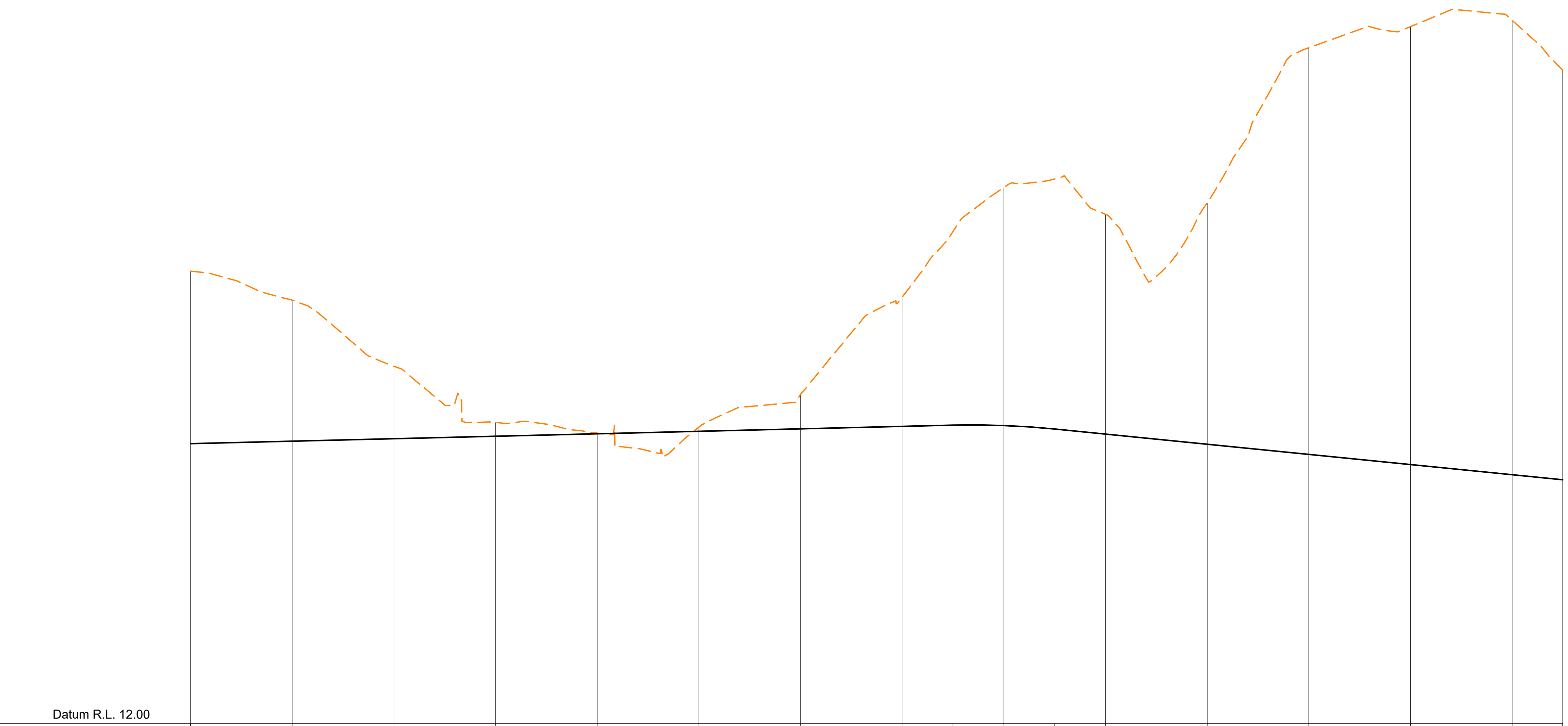
DRAWING TITLE:
ROAD 1 LONG SECTION

JOB No: 85070-01 SHEET No: 310 REV: A



Datum R.L. 12.00

CUT/FILL	-3.40	-2.78	-1.43	-0.27	-0.01	-0.08	-0.68	-2.55	-3.81	-4.69	-4.32	-4.75	-8.01	-8.62	-8.95	-8.06
NATURAL SURFACE	20.91	20.33	19.04	17.93	17.72	17.83	18.49	20.40	21.69	22.56	22.02	22.25	25.30	25.72	25.85	24.86
DESIGN LEVEL	17.51	17.56	17.61	17.66	17.71	17.75	17.80	17.85	17.88	17.87	17.70	17.50	17.30	17.10	16.90	16.80
VERTICAL GEOMETRY	VC: ???m K: ???				0.49%					VC: 10.0m K: 4.02						
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	75.00	80.00	90.00	100.00	110.00	120.00	130.00	134.98

Scale Horizontal 1:250 Vertical 1:50 (A1)
Horizontal 1:500 Vertical 1:100 (A3)

ACCESSWAY 1 LONGITUDINAL SECTION

Original Size:
1:250
1:500 (A3)

2.5 0 2.5 5 7.5 10 12.5

Z:\Jobs 85000-95000\85070 Denis Horner\001 34 & 36 Sandspit Road, Warkworth\002 CAD_working Drawings\85070-01-300.dwg

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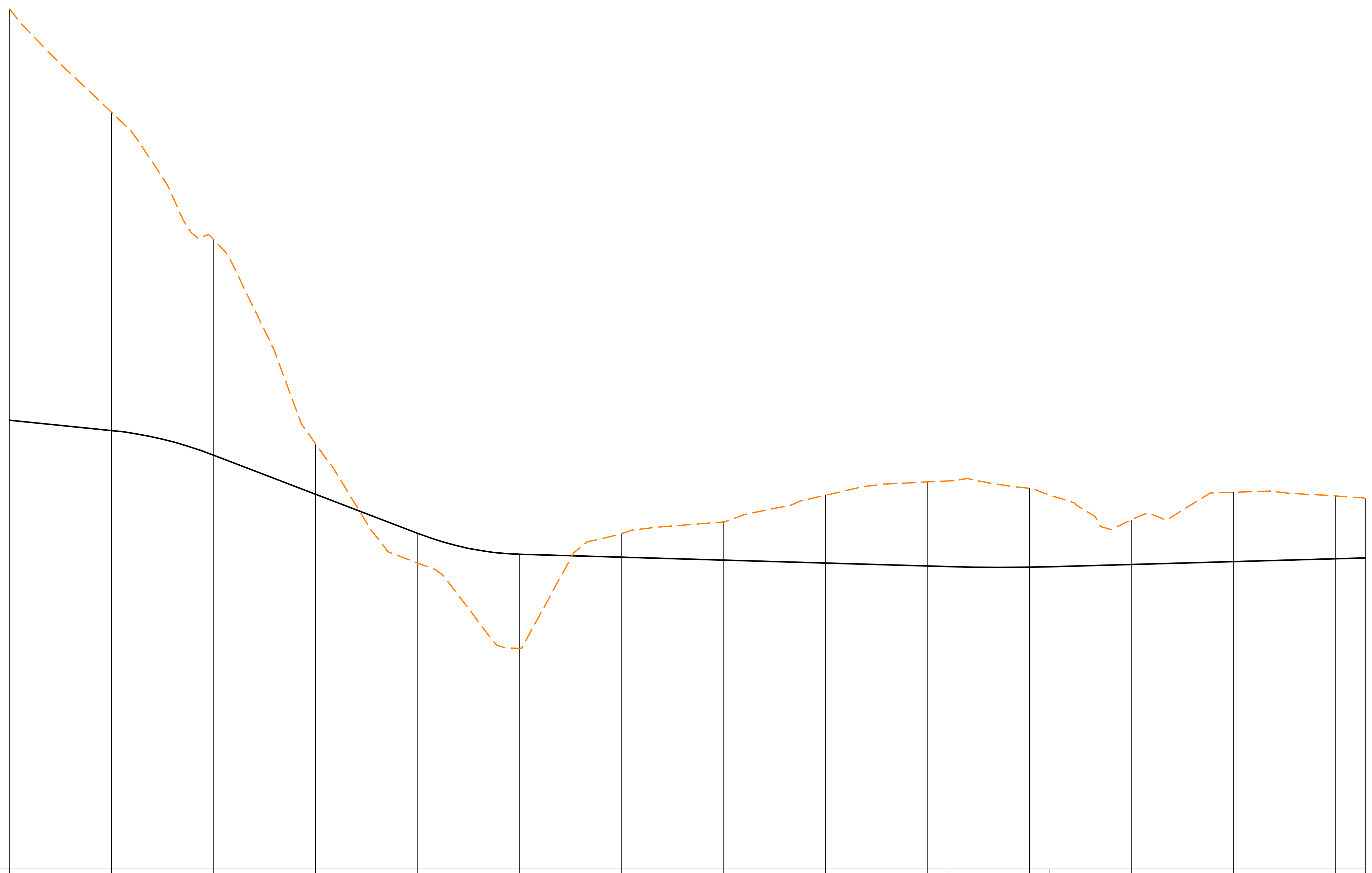
DRAWING TITLE: ACCESSWAY 1 LONG SECTION

JOB No: 85070-01 SHEET No: 311 REV: A



Datum R.L. 8.00

CHAINAGE	CUT/FILL	NATURAL SURFACE	DESIGN LEVEL
0.00	-8.06	24.86	16.80
10.00	-6.24	22.84	16.60
20.00	-4.23	20.35	16.12
30.00	-0.99	16.34	15.35
40.00	+0.58	14.80	14.98
50.00	+1.88	12.33	14.29
60.00	-0.46	14.58	14.11
70.00	-0.75	14.81	14.06
80.00	-1.33	15.33	14.00
90.00	-1.65	15.59	13.94
92.00	-1.68	15.61	13.93
100.00	-1.55	15.46	13.92
102.00	-1.40	15.33	13.93
110.00	-0.87	14.85	13.97
120.00	-1.36	15.39	14.03
130.00	-1.23	15.32	14.08
133.34			

VERTICAL GEOMETRY: -2.00% | VC: 10.0m K: 1.76 | -7.67% | VC: 10.0m K: 1.41 | -0.58% | VC: 10.0m K: 8.82 | 0.56%

Scale Horizontal 1:250 Vertical 1:50 (A1)
Horizontal 1:500 Vertical 1:100 (A3)

ACCESSWAY 2 LONGITUDINAL SECTION

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Original Size: 1:250 1:500 (A3)

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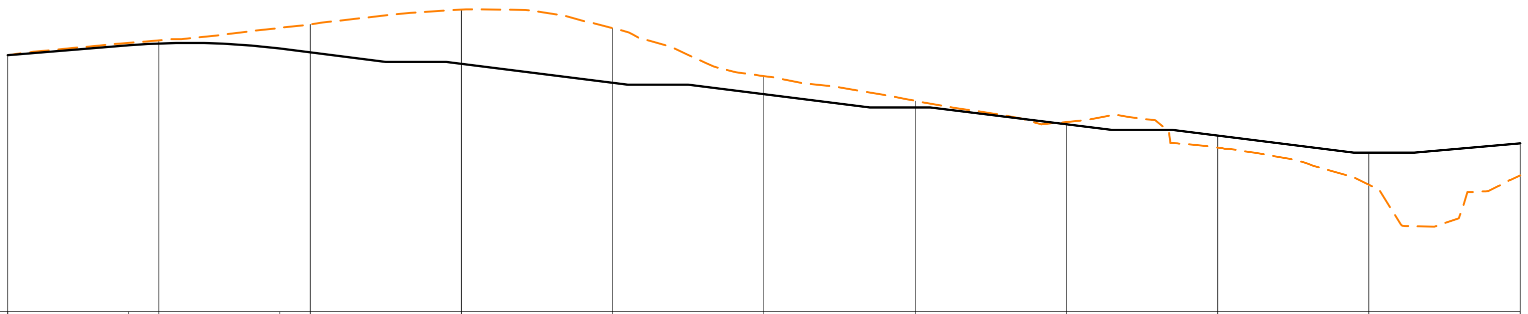
DRAWING TITLE: ACCESSWAY 2 LONG SECTION

JOB No: 85070-01 SHEET No: 312 REV: A



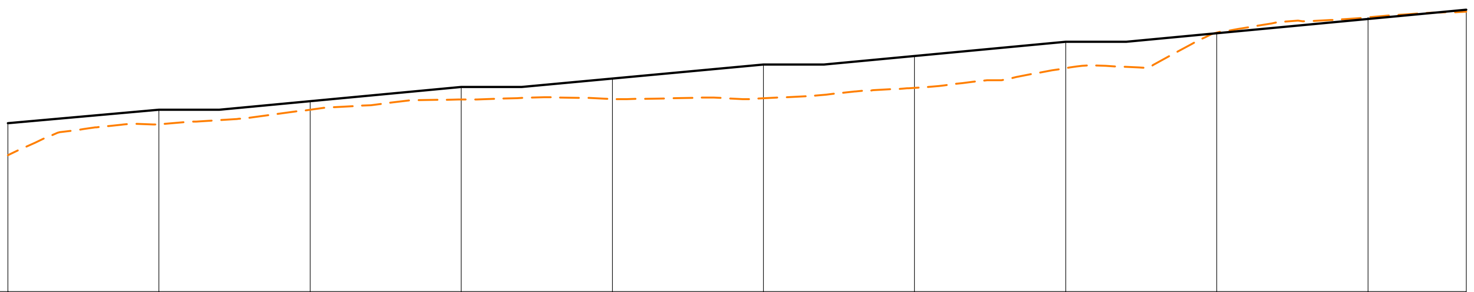
Datum R.L. -4.00

CUT/FILL	0.00	-0.16	-0.21	-1.37	-1.85			-3.58	-3.60			-1.18		-0.42		-0.16			+0.79		+2.12		+2.11
NATURAL SURFACE	12.93	13.75	13.92	14.74	14.97	15.57	15.89	15.95	14.73	14.47	12.95	11.56	10.48	9.92	9.75	8.53	8.96	7.14	6.83	4.87	4.38	1.65	5.01
DESIGN LEVEL	12.93	13.59	13.71	13.38	13.12	12.50	12.50	12.38	11.12	11.00	11.00	10.38	9.50	9.50	9.50	8.38	8.00	8.00	7.62	6.50	6.50	6.50	7.12
CHAINAGE	0.00	8.00	10.00	18.00	20.00	25.00	29.00	30.00	40.00	41.00	45.00	50.00	57.00	60.00	61.00	70.00	73.00	77.00	80.00	89.00	90.00	93.00	100.00

VERTICAL GEOMETRY: 8.21% | VC: 10.0m K: 0.48 | -12.50% | 0.00% | -12.50% | 0.00% | -12.50% | 0.00% | -12.50% | 0.00% | -12.50% | 0.00% | 8.82%

Scale Horizontal 1:250 Vertical 1:50 (A1)
Horizontal 1:500 Vertical 1:100 (A3)

PATHWAY LONGITUDINAL SECTION



Datum R.L. -4.00

CUT/FILL	+2.11	+0.94		+0.55	+0.82		+1.35	+2.24		+2.11	+1.75		-0.05	-0.11	+0.12
NATURAL SURFACE	5.01	7.06	7.33	8.01	8.68	8.78	8.71	8.76	9.00	9.45	10.75	10.83	13.11	14.11	14.49
DESIGN LEVEL	7.12	8.00	8.00	8.56	9.50	9.50	10.06	11.00	11.00	11.56	12.50	12.50	13.06	14.00	14.60
CHAINAGE	100.00	110.00	114.00	120.00	130.00	134.00	140.00	150.00	154.00	160.00	170.00	174.00	180.00	190.00	196.50

VERTICAL GEOMETRY: 8.82% | 0.00% | 9.38% | 0.00% | 9.38% | 0.00% | 9.38% | 0.00% | 9.35%

Scale Horizontal 1:250 Vertical 1:50 (A1)
Horizontal 1:500 Vertical 1:100 (A3)

PATHWAY LONGITUDINAL SECTION (CONTINUED)

Z:\Jobs 85000-95000\85070 Denis Horner\001 34 & 36 Sandspit Road, Warkworth\002 CAD_working Drawings\85070-01-300.dwg

Original Size: 1:250 1:500 (A3)

2.5 0 2.5 5 7.5 10 12.5

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PROJECT TITLE: PROPOSED DEVELOPMENT AT 34 & 36 SANDSPIT ROAD WARKWORTH AUCKLAND

REV	AMENDMENT	DATE	BY
A	DRAFT FOR INFORMATION	FEB 2022	---

DRAWING STATUS:

ISSUE PURPOSE: FOR INFORMATION

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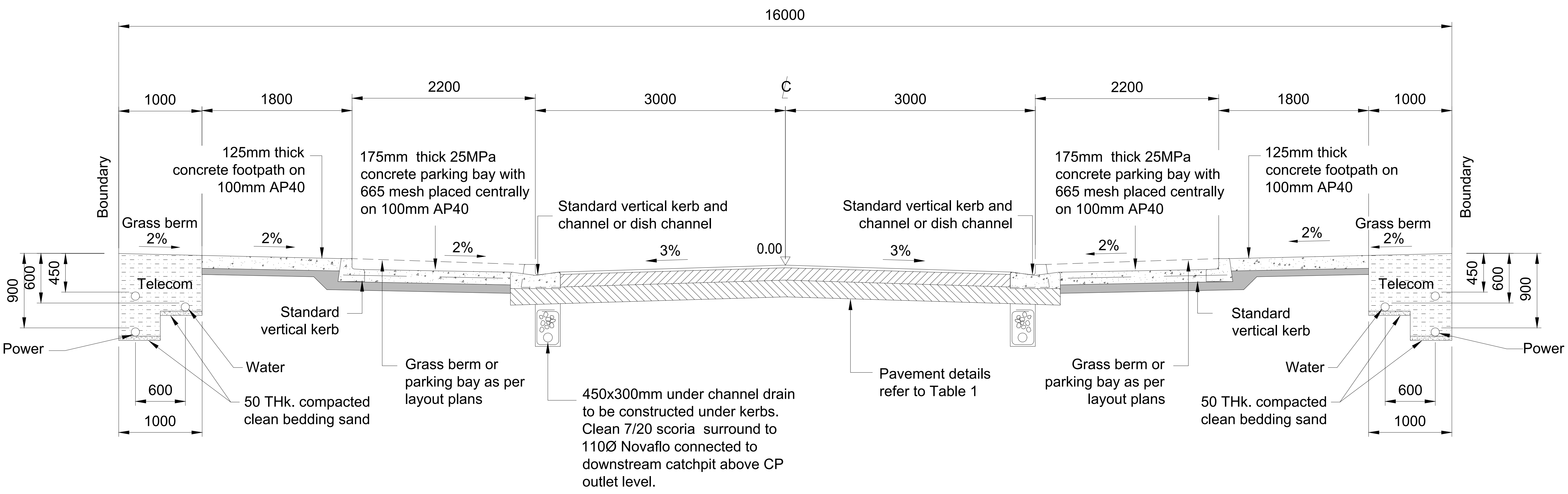
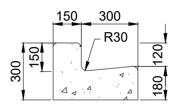
DRAWING TITLE: PATHWAY LONG SECTION

JOB No: 85070-01 SHEET No: 313 REV: A



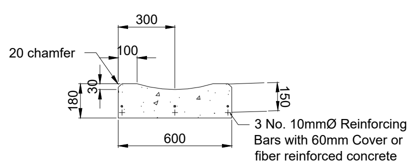
TYPICAL ROAD CROSS-SECTION

SCALE 1:25 (A1), 1:50 (A3)



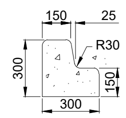
Standard Vertical Kerb and Channel

Detail 02 -
Scale = 1:20



Insitu Dish Channel

Detail 03 -
Scale = 1:20



Standard Vertical Kerb

Detail 01 -
Scale = 1:20

TABLE 1: ROAD PAVEMENT DETAILS	
Subgrade CBR	7
Asphaltic Concrete AC14	40mm
Tack Coat	Yes
Grade 4 Chip Seal	Yes
Basecourse (TNZ M4)	150mm
Subbase (GAP 65)	200mm
Stabilised Subgrade	-
Bidim A44 filter fabric	-

Original Size: 1:25 1:50 (A3)

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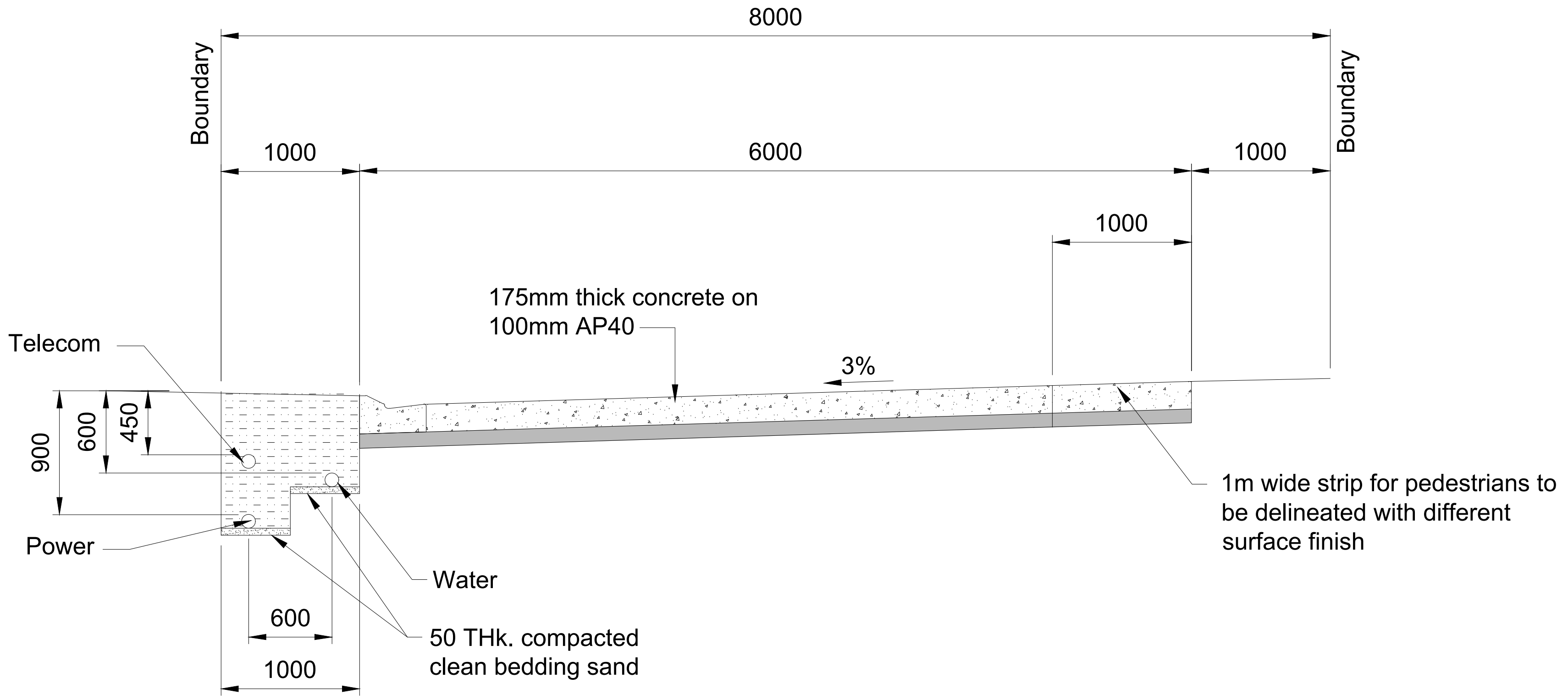
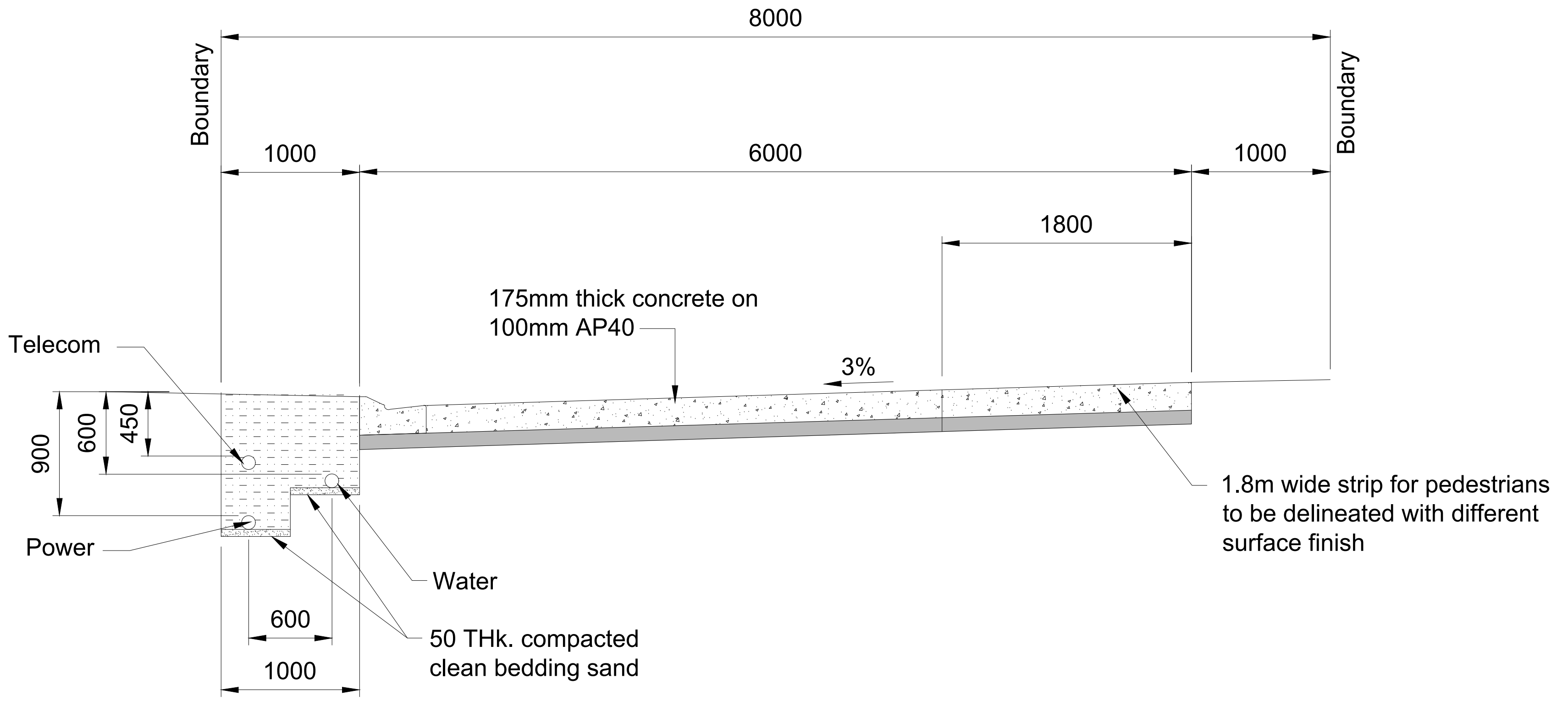
DRAWING TITLE: TYPICAL ROADING CROSS SECTIONS

JOB No: 85070-01 SHEET No: 320 REV: A



TYPICAL PRIVATE ACCESSWAY1 CROSS-SECTION



TYPICAL PRIVATE ACCESSWAY2 CROSS-SECTION

Z:\Jobs 85000-95000\85070 Denis Horner\001 34 & 36 Sandspit Road, Warkworth\002 CAD_working Drawings\85070-01-320.dwg

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1:50 (A3)

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A--	DRAFT FOR INFORMATION	FEB 2022	----

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DATE: 2022-02-15
SCALE: 1:25 (A1) 1:50 (A3)
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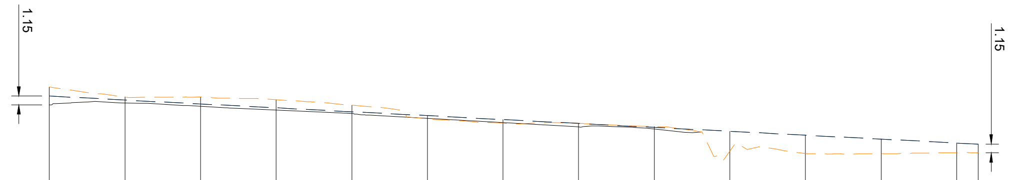
DRAWING TITLE:
TYPICAL ACCESSWAY CROSS
SECTIONS

JOB No: 85070-01 SHEET No: 321 REV: A

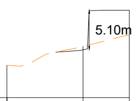


Datum R.L. 2.00

SIGHT LINE - DESIGN LEVEL	+1.15	+0.38	+0.32	+0.30	+0.23	+0.37	+0.41	+0.46	+0.21					
NATURAL SURFACE		16.13	16.11	15.77	15.05	13.24	12.64	12.62	12.20	8.96	8.64	8.60	8.72	
DESIGN LEVEL		15.34	14.89	14.38	13.94	13.28	12.72	12.15	11.89					
SIGHT LINE LEVEL	16.24	15.72	15.20	14.69	14.17	13.65	13.13	12.61	12.09	11.58	11.06	10.54	10.02	9.87
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	122.85

Scale Horizontal 1:500 Vertical 1:100 (A1)
Horizontal 1:1000 Vertical 1:200 (A3)

SIGHT DISTANCE CHECK_L LONGITUDINAL SECTION

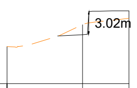


Datum R.L. 6.00

NATURAL SURFACE	10.24	12.74
DESIGN LEVEL		12.30
CHAINAGE	0.00	10.00

Scale Horizontal 1:500 Vertical 1:100 (A1)
Horizontal 1:1000 Vertical 1:200 (A3)

CROSS SECTION_L 1 LONGITUDINAL SECTION



Datum R.L. 8.00

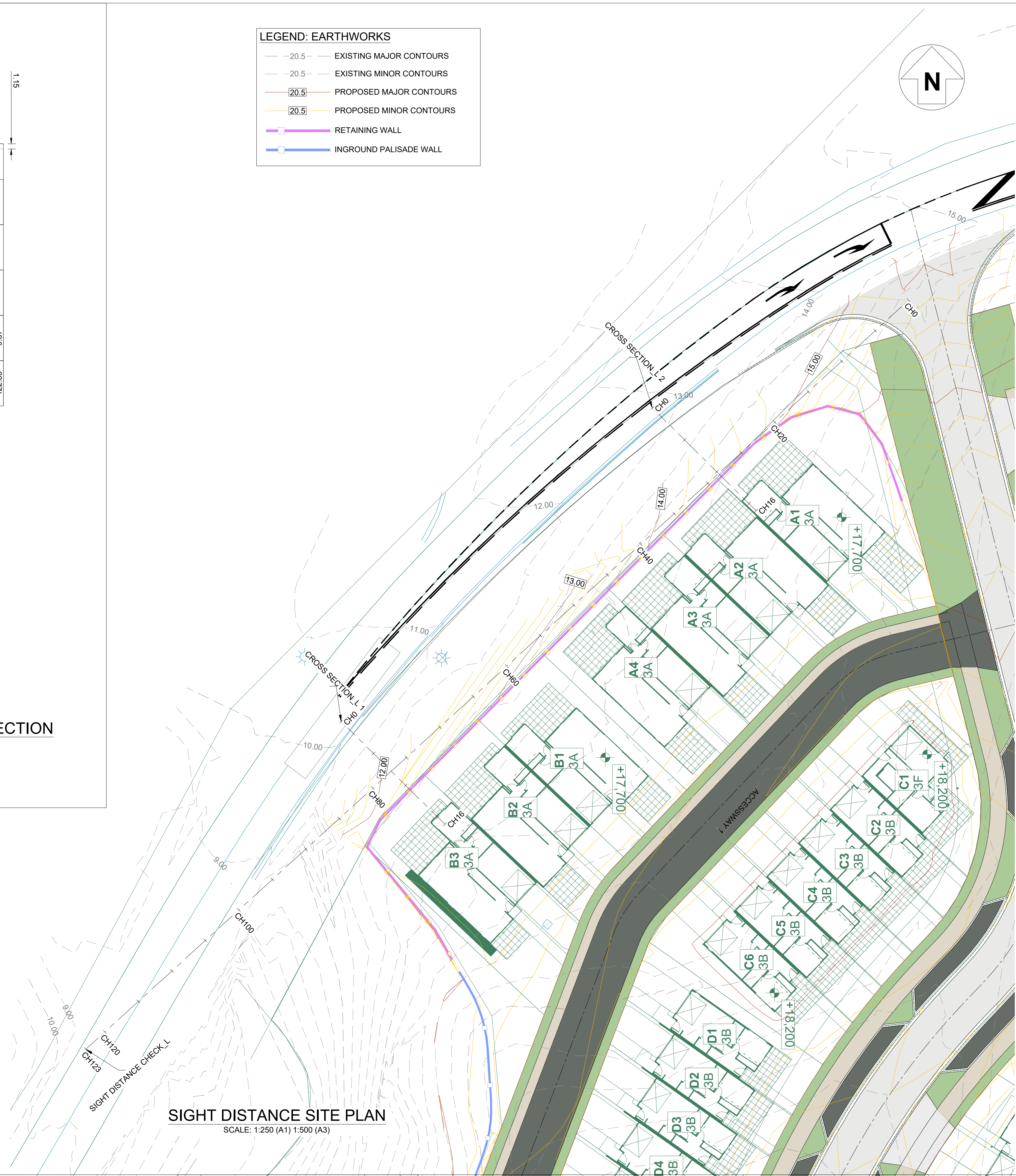
NATURAL SURFACE	12.87	15.76
DESIGN LEVEL		14.43
CHAINAGE	0.00	10.00

Scale Horizontal 1:500 Vertical 1:100 (A1)
Horizontal 1:1000 Vertical 1:200 (A3)

CROSS SECTION_L 2 LONGITUDINAL SECTION

LEGEND: EARTHWORKS

20.5	EXISTING MAJOR CONTOURS
20.5	EXISTING MINOR CONTOURS
20.5	PROPOSED MAJOR CONTOURS
20.5	PROPOSED MINOR CONTOURS
	RETAINING WALL
	INGROUND PALISADE WALL



SIGHT DISTANCE SITE PLAN

SCALE: 1:250 (A1) 1:500 (A3)

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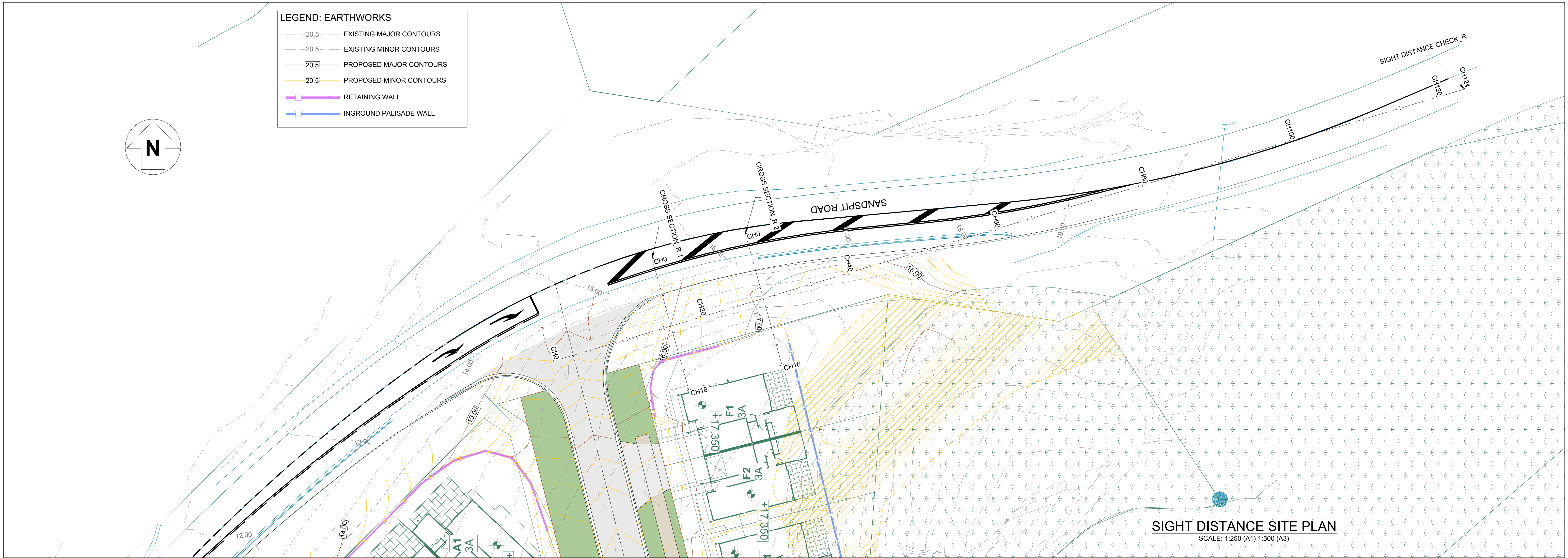
DRAWING TITLE:

SIGHT DISTANCE CHECK - SHEET 1 OF 2

JOB No: 85070-01 SHEET No: 330 REV: A

Z:\Jobs 85000-95000\85070 Denis Horner\001 34 & 36 Sandspit Road, Warkworth\002 CAD_working Drawings\85070-01-300.dwg



SIGHT DISTANCE SITE PLAN
SCALE: 1:250 (A1) 1:500 (A3)

Datum R.L. 10.00

SIGHT LINE - DESIGN LEVEL	+1.15	+1.60	+1.07	+1.03	+1.32									
NATURAL SURFACE		18.90	19.47	18.97	18.24	17.82	18.31	19.01	19.69					
DESIGN LEVEL		15.27	16.41	17.08	17.41									
SIGHT LINE LEVEL	16.24	16.86	17.49	18.11	18.73	19.35	19.97	20.60	21.22	21.84	22.46	23.08	23.71	23.94
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	123.78

Scale Horizontal 1:500 Vertical 1:100 (A1)
Horizontal 1:1000 Vertical 1:200 (A3)

SIGHT DISTANCE CHECK_R LONGITUDINAL SECTION

Datum R.L. 10.00

NATURAL SURFACE	15.60	19.81
DESIGN LEVEL		16.07
CHAINAGE	0.00	10.00

Scale Horizontal 1:500 Vertical 1:100 (A1)
Horizontal 1:1000 Vertical 1:200 (A3)

CROSS SECTION_R 1 LONGITUDINAL SECTION

Datum R.L. 12.00

NATURAL SURFACE	16.29	20.06
DESIGN LEVEL		17.09
CHAINAGE	0.00	10.00

Scale Horizontal 1:500 Vertical 1:100 (A1)
Horizontal 1:1000 Vertical 1:200 (A3)

CROSS SECTION_R 2 LONGITUDINAL SECTION

Original Size: 1:250 1:500 (A3)

Z:\Jobs 85000-95000\85070 Denis Homer\001 34 & 36 Sandspit Road, Warkworth\002 CAD_working Drawings\85070-01-300.dwg

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CLIENT: THE KILNS LTD

PROJECT TITLE: PROPOSED DEVELOPMENT AT 34 & 36 SANDSPIT ROAD WARKWORTH AUCKLAND

REV	AMENDMENT	DATE	BY
A	DRAFT FOR INFORMATION	FEB 2022	----

DRAWING STATUS:

ISSUE PURPOSE: FOR INFORMATION

DESIGN: SZ
DRAWN: SZ
CHECKED: AW
DATE: 2022-02-15
SCALE: AS SHOWN
DO NOT SCALE FROM DRAWINGS

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DRAWING TITLE: SIGHT DISTANCE CHECK - SHEET 2 OF 2

JOB No: 85070-01 SHEET No: 331 REV: A

Appendix C: Investigation Data

BOREHOLE LOG - MH01-21

Client: The Kilns Limited
Project: 36 Sandspit Road
Site Location: Warkworth
Project No.: AKL2021-0060
Date: 10/12/2021
Borehole Location: Refer to Site Plan — Logged by: LSW — Checked by: TE — Scale: 1:50 —

Position: 1749118.0mE; 5970934.0mN — Projection: NZTM
Elevation: 24.25m — Datum: NZVD2016 — Survey Source: Hand Held GPS

Samples & Insitu Tests: Depth	Type & Results	RL (m)	Depth (m)	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support
		24.2		OL: TOPSOIL: Brown.				
		24.0		CH: Silty CLAY: Brown mottled orange. High plasticity. (Maharangi Limestone)			73	OB / PQ3
			1	... *at 1.00m, becoming grey.*				
1.5	SPT = (2,3,5) N* = 8				M			SPT
			2	... *at 1.95m, becoming light grey mottled orange.*			48	OB / PQ3
						St to VSt		
3.0	SPT = (2,3,3) N* = 6	21.2	3	ML: Clayey SILT: Light grey mottled orange. Low plasticity. (Maharangi Limestone)				SPT
			4				100	OB / PQ3
4.5	SPT = (1,1,2) N* = 3				M to W			SPT
			5	... *at 4.80m, becoming grey.*			86	OB / PQ3
		18.8		CH: Silty CLAY: Grey. High plasticity. (Maharangi Limestone)				
		18.5		Completely to highly weathered, extremely to very weak muddy LIMESTONE: Light grey. Weathered to silty clay. (Maharangi Limestone)				
6.0	SPT = (16,19,20) N* = 39		6					SPT
								OB / PQ3
		17.2	7	Completely weathered to highly weathered, extremely weak to very weak SILTSTONE. Dark grey: (Maharangi Limestone)			100	TT / HQ3
				... *from 7.30m to 7.90m, retrieved as crushed rock.*				
8.0	SPT = (23,43,7/20mm) Nc = 50+		8					SPT
				... *from 8.60m to 8.80m, retrieved as crushed rock.*			100	TT / HQ3
			9					
9.5	SPT = (50/130mm,) Nc = 50+							SPT
			10	... *from 9.85m to 9.90m, retrieved as crushed rock.*				

Groundwater: 02/02/2022 (at approx. 5.0m)

Dynamic Cone Penetrometer (Blows/100mm): 5 10 15

Structure & Other Observations: Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks

Termination Reason: Target Depth Reached.
Shear Vane No: — DCP No:

Remarks: One 12.5m deep piezometer screened from 6.5m to 12m bgl.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - MH01-21

Client: The Kilns Limited
Project: 36 Sandspit Road
Site Location: Warkworth
Project No.: AKL2021-0060
Date: 10/12/2021
Borehole Location: Refer to Site Plan   Logged by: LSW   Checked by: TE   Scale: 1:50
Position: 1749118.0mE; 5970934.0mN Projection: NZTM
Elevation: 24.25m   Datum: NZVD2016   Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
							... from 10.70m to 11.00m, retrieved as a crushed rock and clayey SILT mixture.			95	TT / HQ3		
		11.0	SPT = (50/120mm,) Nc = 50+		11						SPT		
					12		... from 12.20m to 12.50m, retrieved as crushed rock.			80	TT / HQ3		
		12.5	SPT = (50/120mm,) Nc = 50+				Borehole terminated at 12.5 m				SPT		
					13								
					14								
					15								
					16								
					17								
					18								
					19								
					20								

Termination Reason: Target Depth Reached.
Shear Vane No: DCP No:
Remarks: One 12.5m deep piezometer screened from 6.5m to 12m bgl.

BOREHOLE CORE PHOTOGRAPHS: MH01-21

Client: The Kilns Limited

Project: 36 Sandspit Road, Warkworth

Location: Warkworth

Project No: AKL2021-0060

Date: 22 December 2021

Sheet No. 1 of 2

Logged by: LSW	Position: 1749118mE, 5970934mN	Hole Diameter: 63mm	Plant: Tractor Mounted Drill Rig
Checked by: TE	Elevation: 24.25m	Angle from Horizontal: 90°	Contractor: ProDrill

MH01-21: 0.0m to 3.50m

MH01-21: 3.50m to 7.20m

This report of boreholes must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

BOREHOLE CORE PHOTOGRAPHS: MH01-21

Client: The Kilns Limited
Project: 36 Sandspit Road, Warkworth
Location: Warkworth
Project No: AKL2021-0060
Date: 22 December 2021

Logged by: LSW	Position: 1749118mE, 5970934mN	Hole Diameter: 63mm	Plant: Tractor Mounted Drill Rig
Checked by: TE	Elevation: 24.25m	Angle from Horizontal: 90°	Contractor: ProDrill

MH01-21: 7.20m to 10.10m

MH01-21: 10.10m to 12.50m

HAND AUGER BOREHOLE LOG - HA10-21

Client: The Kilns Limited
Project: 36 Sandspit Road
Site Location: Warkworth
Project No.: AKL2021-0060
Date: 10/12/2021
Borehole Location: Refer to Site Plan | Logged by: NK | Checked by: TE | Scale: 1:25 | Sheet 1 of 1

Position: 1749141.8mE; 5970870.0mN Projection: NZTM
Elevation: 14.26m | Datum: NZVD2016 | Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15
			14.3		OL: TOPSOIL:			
	0.4-0.8 0.4	Expansive Peak = 55kPa Residual = 27kPa	13.9		ML: Clayey SILT minor fine sand: Brownish grey mottled orange. Low Plasticity. (Alluvium)	M to W	St	
	0.8	Peak = 133kPa Residual = 52kPa				M		
				1			VSt	
	1.2	Peak = 172kPa Residual = 75kPa	13.1		CH: Silty CLAY: Brownish grey mottled orange. High Plasticity. (Alluvium)			
	1.6	Peak = 97kPa Residual = 58kPa				M to W		
	2.0	Peak = 80kPa Residual = 55kPa		2			St	
▼								
	2.4	Peak = >200kPa						
	2.8	Peak = UTP				S	VSt to H	
			11.3	3	SM: Sandy SILT: Grey mottled orange. Low Plasticity. (Northland Allochthon)			
	3.2	Peak = UTP			Borehole terminated at 3.2 m			20
				4				
				5				

Termination Reason: Hand auger refusal at 3.2m on hard ground.
Shear Vane No: 1620 DCP No: 21
Remarks: Groundwater encountered at 2.2m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA11-21

Client: The Kilns Limited
Project: 36 Sandspit Road
Site Location: Warkworth
Project No.: AKL2021-0060
Date: 10/12/2021
Borehole Location: Refer to Site Plan   Logged by: LSW   Checked by: TE   Scale: 1:25   Sheet 1 of 1

CMW Geosciences

Position: 1749142.4mE; 5970898.2mN Projection: NZTM
Elevation: 18.27m   Datum: NZVD2016   Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15
			18.3			OL: TOPSOIL:			
			18.1			CH: Silty CLAY: Brown mottled orange. High Plasticity. (Alluvium)			
	0.4-0.8 0.4	Expansive Peak = 228kPa Residual = 77kPa						H	
	0.8	Peak = 142kPa Residual = 68kPa					M		
				1					
	1.2	Peak = 109kPa Residual = 45kPa							
						... from 1.30m to 1.60m, ...*becoming light greenish grey mottled orange*			
	1.6	Peak = 106kPa Residual = 74kPa	16.7			ML: Sandy SILT: Light brownish grey. Low Plasticity. Sand is fine to medium grain sized. (Northland Allochthon)		VSt	
	2.0	Peak = 158kPa Residual = 77kPa		2			W		
	2.4	Peak = 203kPa Residual = 106kPa							
								VSt to H	
	2.8	Peak = >235kPa	15.6			ML: Completely weathered light grey LIMESTONE: Weathered to SILT minor clay. Low Plasticity. Extremely weak. (Northland Allochthon)	M to W		
						Borehole terminated at 2.9 m			20
				3					
				4					
				5					

Termination Reason: Hand auger refusal at 2.9m on hard ground.
Shear Vane No: 1824   DCP No: 21
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA12-21

Client: The Kilns Limited
Project: 36 Sandspit Road
Site Location: Warkworth
Project No.: AKL2021-0060
Date: 10/12/2021
Borehole Location: Refer to Site Plan | Logged by: NK | Checked by: TE | Scale: 1:25 | Sheet 1 of 1

Position: 1749105.0mE; 5970892.6mN Projection: NZTM
Elevation: 20.70m Datum: NZVD2016 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			20.7	OL: TOPSOIL:			
			20.5	ML: Clayey SILT: Brown mottled orange streaked grey. Low Plasticity. (Northland Allochthon)	M	VSt	
	0.4	Peak = 153kPa Residual = 58kPa					
	0.8	Peak = 181kPa Residual = 103kPa	19.9	CH: Silty CLAY: Light grey mottled orange. High Plasticity. (Northland Allochthon)			
	1.2	Peak = 131kPa Residual = 69kPa	19.5	ML: Clayey SILT trace fine sand: Light brown mottled orange. Low Plasticity. (Northland Allochthon)			
	1.6	Peak = 161kPa Residual = 61kPa					
	2.0	Peak = 99kPa Residual = 19kPa				St	
	2.4	Peak = 103kPa Residual = 66kPa	18.3	ML: Clayey SILT with some fine sand: Light grey mottled orange. Low Plasticity. (Northland Allochthon)		VSt to H	
	2.8	Peak = 131kPa Residual = 66kPa					
			17.7	ML: Clayey SILT: Light grey mottled dark orange. Low Plasticity. (Northland Allochthon)			
	3.2	Peak = >200kPa					
				Borehole terminated at 3.6 m			20

Termination Reason: Hand auger refusal at 3.6 m on hard ground
Shear Vane No: 1620 DCP No: 21
Remarks: Groundwater not encountered.

HAND AUGER BOREHOLE LOG - HA13-21

Client: The Kilns Limited
Project: 36 Sandspit Road
Site Location: Warkworth
Project No.: AKL2021-0060
Date: 10/12/2021
Borehole Location: Refer to Site Plan | Logged by: NK | Checked by: TE | Scale: 1:25 | Sheet 1 of 1

Position: 1749090.6mE; 5970947.2mN Projection: NZTM
Elevation: 22.75m Datum: NZVD2016 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15
			22.8			OL: TOPSOIL:			
	0.4	Peak = >200kPa	22.4			ML: Clayey SILT: Dark brown mottled orange. Low Plasticity. (Northland Allochthon)	M	VSt to St	
	0.8	Peak = 172kPa Residual = 72kPa							
	1.2	Peak = 136kPa Residual = 61kPa	21.8	1		CH: Silty CLAY: Light grey mottled orange streaked dark grey. High Plasticity. (Northland Allochthon)			
	1.6	Peak = 83kPa Residual = 47kPa	21.2			ML: Clayey SILT: Brownish grey mottled orange. Low Plasticity. (Northland Allochthon)		St to VSt	
	2.0	Peak = 142kPa Residual = 72kPa		2					
	2.4	Peak = 142kPa Residual = 52kPa	20.4			ML: Clayey SILT: Light brownish grey. Low Plasticity. (Northland Allochthon)	M to W		
	2.8	Peak = 136kPa Residual = 69kPa		3					
	3.2	Peak = 153kPa Residual = 55kPa	19.6			ML: Clayey SILT: Orange. Low Plasticity. (Northland Allochthon)			
	3.6	Peak = >200kPa							
				4		Borehole terminated at 3.8 m			20
				5					

Termination Reason: Hand auger refusal at 3.8m on hard ground.
Shear Vane No: 1620 DCP No: 21
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA14-21

Client: The Kilns Limited
Project: 36 Sandspit Road
Site Location: Warkworth
Project No.: AKL2021-0060
Date: 10/12/2021
Borehole Location: Refer to Site Plan — Logged by: LSW — Checked by: TE — Scale: 1:25 — Sheet 1 of 1

Position: 1749135.0mE; 5970946.9mN Projection: NZTM
Elevation: 20.85m — Datum: NZVD2016 — Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			20.8		OL: TOPSOIL:			
			20.8		CH: Silty CLAY: Brown mottled orange. High Plasticity. (Alluvium)	M	VSt	
	0.4	Peak = 154kPa Residual = 58kPa						
	0.8	Peak = 138kPa Residual = 71kPa						
			20.0	1	MH: Clayey SILT: Light yellowish grey mottled grey. High Plasticity. (Northland Allochthon)			
			19.8		CH: Silty CLAY: Light grey mottled orange. High Plasticity. (Northland Allochthon)			
	1.2	Peak = >230kPa Residual = 74kPa						
	1.6	Peak = 100kPa Residual = 58kPa	19.2		ML: Clayey SILT: Light grey mottled orange. Low Plasticity. (Northland Allochthon)	M to W	St	
	2.0	Peak = 87kPa Residual = 39kPa		2				
	2.4	Peak = 61kPa Residual = 55kPa						
					... from 2.70m to 3.20m, ...becoming orange mottled light grey	W		
	2.8	Peak = 58kPa Residual = 35kPa		3				
	3.2	Peak = 68kPa Residual = 42kPa			*... from 3.20m to 3.60m, ...becoming grey mottled brown*			
▼	3.6	Peak = 68kPa Residual = 55kPa	17.2		ML: Clayey SILT trace fine sand: Grey mottled brown. Low Plasticity. (Northland Allochthon)	S		
					... from 3.80m to 3.90m, ...becoming brown			
				4	Borehole terminated at 3.9 m			20
				5				

Termination Reason: Hand auger refusal at 3.9m on hard ground.
Shear Vane No: 1824 — DCP No: 21
Remarks: Groundwater encountered at 3.6m.

HAND AUGER BOREHOLE LOG - HA15-21

Client: The Kilns Limited
Project: 36 Sandspit Road
Site Location: Warkworth
Project No.: AKL2021-0060
Date: 17/12/2021
Borehole Location: Refer to Site Plan — Logged by: LSW — Checked by: TE — Scale: 1:25 — Sheet 1 of 1

Position: 1749151.0mE; 5971005.0mN — Projection: NZTM
Elevation: 21.70m — Datum: NZVD2016 — Survey Source: Hand Held GPS

Groundwater	Depth	Type & Results	RL (m)	Material Description	Moisture Condition	Consistency/ Relative Density
			21.7	ML: Gravelly SILT: Light grey. Low plasticity. Gravel is fine to medium grained. Subangular to angular. (Uncontrolled Fill)	M	
			21.6	CH: Silty CLAY: Brown mottled grey and orange. High plasticity. (Alluvium)	M	VSt
	0.4	Peak = 106kPa Residual = 35kPa				
	0.8	Peak = 103kPa Residual = 48kPa		... at 0.80m, becoming light grey mottled brown.		
	1.2	Peak = 116kPa Residual = 58kPa		... from 1.30m to 1.40m, becoming orange.		
	1.6	Peak = 116kPa Residual = 58kPa		... at 1.80m, becoming dark greyish brown.		
	2.0	Peak = 106kPa Residual = 71kPa		... from 2.10m to 2.20m, black organic inclusions.		
				... from 2.30m to 2.40m, limonite clasts.		
	2.4	Peak = 113kPa Residual = 64kPa		... at 2.40m, becoming dark brown with minor black organic inclusions throughout.		
	2.8	Peak = 138kPa Residual = 61kPa			M to W	
	3.2	Peak = 154kPa Residual = 87kPa			M to W	
			18.3	CH: CLAY: Light greenish grey. High plasticity. (Alluvium)	M to W	VSt
▼	3.6	Peak = 106kPa Residual = 77kPa			S	VSt
	4.0	Peak = 84kPa Residual = 58kPa			S	St
				... at 4.20m, becoming dark grey.	S	St
	4.4	Peak = 106kPa Residual = 58kPa			S	VSt
	4.8	Peak = 119kPa Residual = 68kPa			S	VSt
				Borehole terminated at 5.0 m		

Dynamic Cone Penetrometer (Blows/100mm): 5 10 15

Termination Reason: Target Depth Reached
Shear Vane No: 1824 — DCP No:
Remarks: Groundwater encountered at 3.6m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA16-22

Client: The Kilns Limited
Project: 36 Sandspit Road
Site Location: Warkworth
Project No.: AKL2021-0060
Date: 14/01/2022
Borehole Location: Refer to Site Plan | Logged by: HN/AMS | Checked by: TE | Scale: 1:25 | Sheet 1 of 1

Position: 1749070.0mE; 5970893.0mN Projection: NZTM
Elevation: 15.00m Datum: Survey Source: Auckland Council GIS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15
			15.0			CL: Silty CLAY: Dark brown. Low plasticity. (Colluvium) ... at 0.40m, ...becoming streaked light grey and orange.	M	St	
			14.4			ML: SILT with some clay: Light greyish orange brown. Low plasticity. (RS Northland Allochthon)			
				1		Borehole terminated at 1.0 m			
				2					
				3					
				4					
				5					

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:
Remarks: Groundwater not encountered. Hand auger carried out instead of test pit due to difficult accessibility.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA17-21

Client: The Kilns Limited
Project: 36 Sandspit Road
Site Location: Warkworth
Project No.: AKL2021-0060
Date: 14/01/2022
Borehole Location: Refer to Site Plan | Logged by: HN/AMS | Checked by: TE | Scale: 1:25 | Sheet 1 of 1

Position: 1749062.0mE; 5970880.0mN Projection: NZTM
Elevation: 10.00m Datum: Survey Source: Auckland Council GIS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15
			10.0			CL: Silty CLAY: Dark brown. Low plasticity. (Colluvium) ... *at 0.40m, ...becoming streaked light grey and orange.*	M	St	
			9.4			ML: SILT with some clay: Light greyish orange brown. Low plasticity. (RS Northland Allochthon)			
				1		Borehole terminated at 1.0 m			
				2					
				3					
				4					
				5					

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:
Remarks: Groundwater not encountered. Hand auger carried out instead of test pit due to difficult accessibility.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT LOG - TP01-22

Client: The Kilns Limited
Project: 36 Sandspit Road
Site Location: Warkworth
Project No.: AKL2021-0060
Date: 14/01/2022
Test Pit Location: Refer to Site Plan — Logged by: AMS/HN — Checked by: TE — Scale: 1:25 — Sheet 1 of 1

Position: 1749101.7mE; 5970903.9mN Projection: NZTM — Pit Dimensions: 3.0m by 1.5m
Elevation: 23.75m — Datum: NZVD2016 — Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit); Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15 20	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
			23.8		OH: TOPSOIL: (Topsoil)	D			
			23.6		MH: Clayey SILT: Light greyish brown. Low plasticity (Colluvium)	D	H		
	0.4	Peak = UTP							
			23.2		CH: Silty CLAY: Light grey with trace of orange mottles. High plasticity (RS Northland Allochthon)	M to W	VSt		
	0.6	Peak = 161kPa Residual = 36kPa							
				1					
	1.2	Peak = 118kPa Residual = 27kPa	22.6		MH: SILT minor clay: Light greyish brown with minor orange. Low plasticity (RS Northland Allochthon)	M to W	VSt		
	1.5	Expansive							
	2.0	Peak = 109kPa Residual = 33kPa		2			VSt		
	3.0	Peak = 76kPa Residual = 36kPa		3			St		
					... from 3.60m to 3.70m, becoming trace of orange/brown limonite nodules up to coarse gravel				
					Test pit terminated at 3.70 m				
				4					
				5					

Termination Reason: Terminated at 3.7m due to maximum reach of client supplied excavator

Shear Vane No: 2080 DCP No:

Remarks: No ground water encountered

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT LOG - TP02-22

Client: The Kilns Limited
Project: 36 Sandspit Road
Site Location: Warkworth
Project No.: AKL2021-0060
Date: 14/01/2022
Test Pit Location: Refer to Site Plan | Logged by: AMS/HN | Checked by: TE | Scale: 1:25 | Sheet 1 of 1

Position: 1749092.6mE; 5970943.4mN Projection: NZTM | Pit Dimensions: 3.0m by 1.5m
Elevation: 23.50m | Datum: NZVD2016 | Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15 20	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
			23.5		OL: Silty TOPSOIL: Dark brown. Low plasticity. Some rootlets (Topsoil)	D			
	0.3	Peak = UTP	23.3		MH: SILT with trace clay: Dark brown, Low plasticity. Friable. Minor rootlets (RS Northland Allochthon)	D	H		
	0.8	Peak = >219 kPa	23.0	1	CH: Silty CLAY: Light brownish grey with minor mottled light orange/brown. High plasticity (RS Northland Allochthon)				
	1.2 1.2	Block Sample Peak = 146kPa Residual = 57kPa			*... from 1.10m to 2.00m, becoming light greyish brown with minor brownish yellow mottles*		VSt		
	1.5	Peak = 146kPa Residual = 73kPa							
			21.5	2	MH: SILT with minor clay: Light orange/brown with minor light brownish grey streaks. Low plasticity (RS Northland Allochthon)	M			
	3.2	Peak = 73kPa Residual = 36kPa		3			St		
	3.5	Block Sample			*... from 3.50m to 3.60m, becoming orange stained and bedding initiates*				
				4	Test pit terminated at 3.60 m				
				5					

Termination Reason: Terminated at 3.6m due to maximum reach of client supplied excavator
Shear Vane No: 2080 DCP No:
Remarks: At 0.3m rock bucket used (5 tonne digger). No ground water encountered

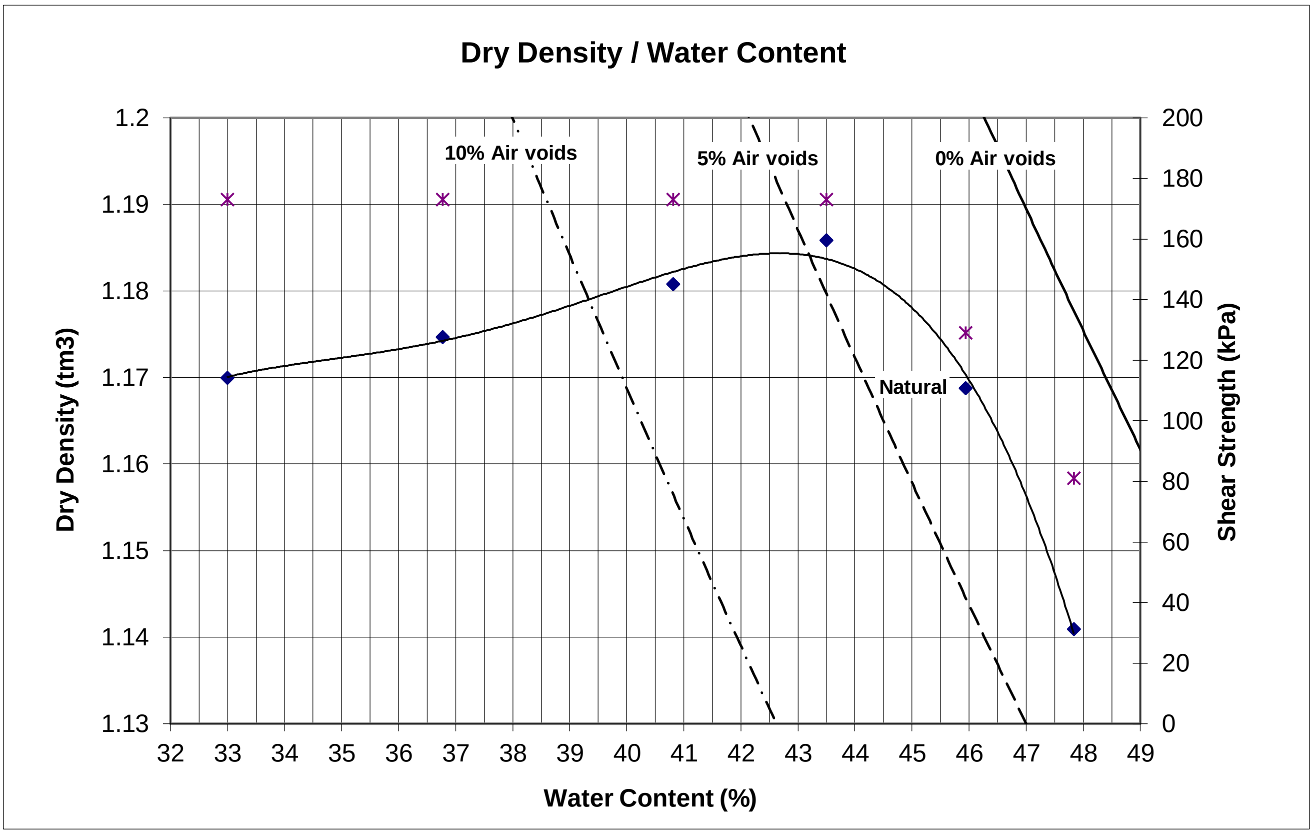
This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

Appendix D: Laboratory Testing Results

RS012
Revision: 2

DETERMINATION OF THE DRY DENSITY / WATER CONTENT RELATIONSHIP
NEW ZEALAND STANDARD COMPACTION
TEST METHOD NZS 4402 : 1986 TEST 4.1.1

Project Name :	**36 Sandspit Road**		
Location:	~~TP05-22~~ 1.2m (TP02-22)	Project No :	22 0001 04
		Page :	1 of 3
Client :	CMW Geosciences Ltd	Date of Order :	18.01.22
Address :	PO Box 300206		
	Albany, Auckland 0754	Sample No.:	475M
		Sample Method :	Hand
Attention :	Tessa Egan	Sample Date :	14.01.22
		Sampled By :	CMW Geosciences Ltd



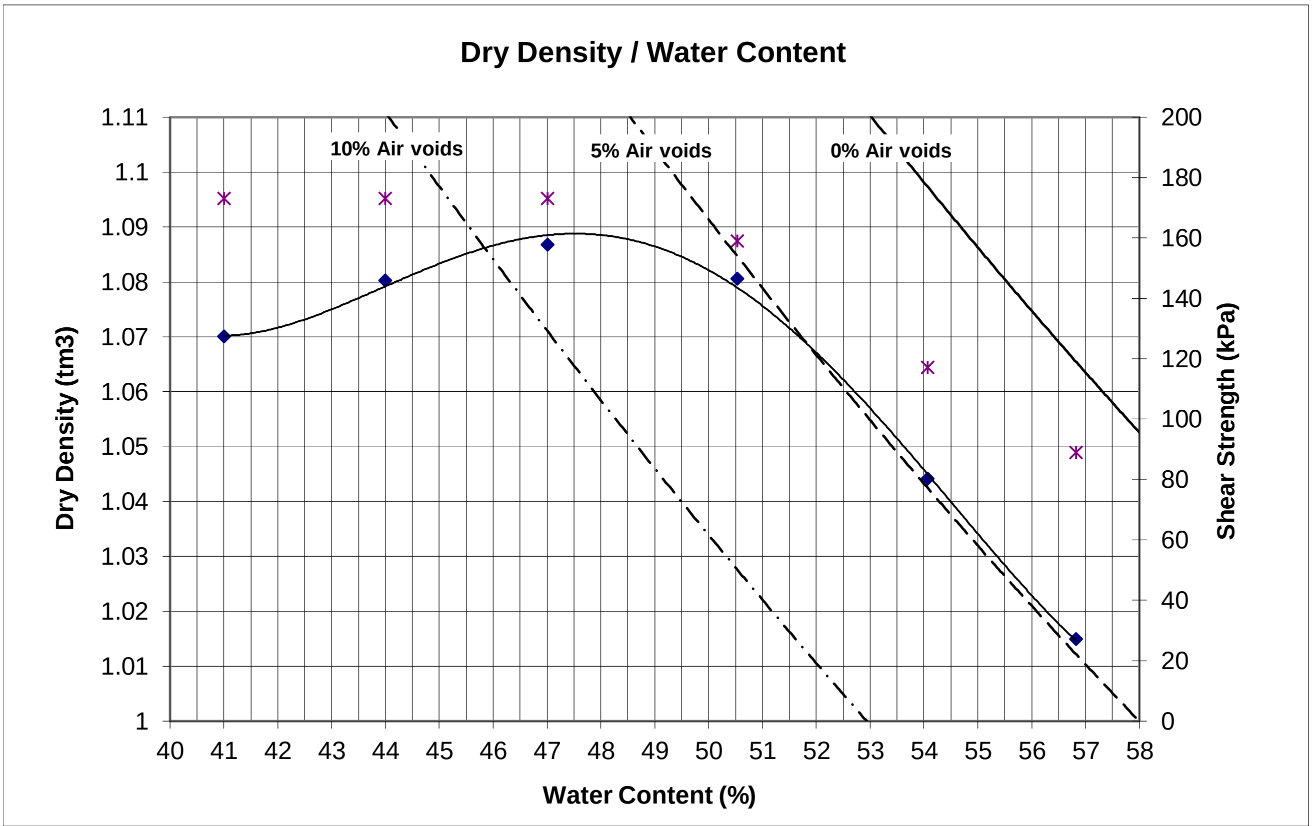
Maximum Dry Density :	**1.18**	t/m^3	Optimum Water Content :	**43.0**	%
Natural Water Content :	45.9	%			
Solid Density of Soil :	2.70	t/m^3	Assumed		
Description of Soil :	-				
Fraction of soil tested :	Passing 19mm sieve		History of sample :	Natural	
Comments :	-				

Tested By:	HC	Date :	25.01.22
Calculated By :	HC	Date :	04.02.22
Checked By :	ZH	Date :	09.02.22

RS012
Revision: 2

DETERMINATION OF THE DRY DENSITY / WATER CONTENT RELATIONSHIP
NEW ZEALAND STANDARD COMPACTION
TEST METHOD NZS 4402 : 1986 TEST 4.1.1

Project Name :	**36 Sandspit Road**		
Location:	~~TP05 - 22~~ 3.5m (TP02-22)	Project No :	22 0001 04
		Page :	2 of 3
Client :	CMW Geosciences Ltd	Date of Order :	18.01.22
Address :	PO Box 300206		
	Albany, Auckland 0754	Sample No.:	476M
		Sample Method :	Hand
Attention :	Tessa Egan	Sample Date :	14.01.22
		Sampled By :	CMW Geosciences Ltd



Maximum Dry Density :	**1.09**	t/m³	Optimum Water Content :	**48.0**	%
Natural Water Content :	66.2	%			
Solid Density of Soil :	2.70	t/m³	Assumed		
Description of Soil :	-				
Fraction of soil tested :	Passing 19mm sieve		History of sample :	Natural	
Comments :	-				

Tested By:	HC	Date :	28.01.22
Calculated By :	HC	Date :	04.02.22
Checked By :	ZH	Date :	09.02.22

Revision: 1

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

Project Name :	**36 Sandspit Road**		
		Project No :	22 0001 04
Client :	CMW Geosciences	Page :	3 of 3
Address :	PO Box 300206	Date of Order :	18.01.22
	Albany, Auckland 0754		
		Sample Method :	Hand auger
Attention :	Tessa Egan	Sample Date :	14.01.22
		Sampled By :	CMW Geosciences

Test Details :

Test performed on : Whole Sample
History : Natural

Sample No.	Location	Depth (m)	Cone Penetration (CPL)	Linear Shrinkage (LS)	Natural Water Content (%)
513M	(TP01-22) ~~TP03-22~~	1.5m	108	26	52.9

Comments :

Tested By:	HC	Date :	27.01.22
Calculated By :	HC	Date :	04.02.22
Checked By :	ZH	Date :	09.02.22

ROADTEST LTD

Revision: 1

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

Project Name : **36 Sandspit Road**

		Project No :	21 0001 165
Client :	CMW Geosciences	Page :	1 of 1
Address :	PO Box 300206 Albany, Auckland 0754	Date of Order :	16.12.21
		Sample Method :	Hand auger
Attention :	Tessa Egan	Sample Date :	10.12.21
		Sampled By :	CMW Geosciences

Test Details :

Test performed on : Whole Sample
History : Natural

Sample No.	Location	Depth (m)	Cone Penetration (CPL)	Linear Shrinkage (LS)	Natural Water Content (%)
384M	HA10-21	-	22	5	18.9
385M	HA11-21	-	68	7	37.6

Comments :

Tested By:	HC	Date :	17.12.21
Calculated By :	HC	Date :	24.12.21
Checked By :	EC	Date :	24.12.21

Appendix E: Natural Hazards Risk Assessment

NATURAL HAZARDS RISK ASSESSMENT FOR LAND SUBDIVISION 36 SANDSPIT ROAD, WARKWORTH

A. CONTEXT

Section 106 of the Resource Management Act (RMA) requires an assessment of the risk from natural hazards to be carried out when considering the granting of a subdivision consent. S106 RMA specifically states that the assessment must consider the combined effect of the natural hazard likelihood and material damage to land, other land or structures (consequence).

Section 2 of the RMA defines natural hazards as any atmospheric or earth or water related occurrence (including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire or flooding) the action of which adversely affects or may adversely affect human life, property, or other aspects of the environment.

This appendix to CMW report reference AKL2021-0060AD Rev 0 sets out the criteria for and presents the results of an assessment of the geotechnical-related natural hazards associated with this proposed subdivision development. The remaining hazards, i.e. tsunami, wind, drought, fire and flooding hazards are not covered by this assessment.

B. BASIS OF ASSESSMENT

B.1. Risk Classification

The occurrence of natural hazards and their potential impacts on the proposed subdivision development is assessed in terms of risk significance, which is based on likelihood and consequence factors. A risk table is used to help assess the likelihood and consequence factors, the form of which used by CMW for this project is presented in Table B1.

Table B1: Natural Hazard Risk Classification

Risk Matrix		Consequence				
		Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Likelihood	Almost Certain 5	Medium 5	High 10	Very high 15	Extreme 20	Extreme 25
	Likely 4	Low 4	Medium 8	High 12	Very high 16	Extreme 20
	Moderate 3	Low 3	Medium 6	Medium 9	High 12	Very high 15
	Unlikely 2	Very low 2	Low 4	Medium 6	Medium 8	High 10
	Rare 1	Very low 1	Very low 2	Low 3	Low 4	Medium 5

B.2. Likelihood

With respect to assessing the likelihood or chance of the risk occurring, the qualitative definitions used by CMW for this project are provided in Table B2 for each likelihood classification.

Table B2: Qualitative Natural Hazard Likelihood Definitions		
1	Rare	The natural hazard is not expected to occur during the design life of the project
2	Unlikely	The natural hazard is unlikely, but may occur during the design life
3	Moderate	The natural hazard will probably occur at some time during the life of the project
4	Likely	The natural hazard is expected to occur during the design life of the project
5	Almost Certain	The natural hazard will almost definitely occur during the design life of the project

B.3. Consequence

In terms of determining the consequence or severity of the natural hazard occurring, the qualitative definitions used by CMW for this project are provided in Table B3 for each consequence classification.

Table B3: Qualitative Natural Hazard Consequence Definitions		
1	Insignificant	Very minor to no damage, not requiring any repair, no people at risk, no economic effect to landowners.
2	Minor	Minor damage to land only, any repairs can be considered normal property maintenance no people at risk, very minor economic effect.
3	Moderate	Some damage to land requiring repair to reinstate within few months, minor cosmetic damage to buildings being within relevant code tolerances, does not require immediate repair, no people at risk, minor economic effect.
4	Major	Significant damage to land requiring immediate repair, damage to buildings beyond serviceable limits requiring repair, no collapse of structures, perceptible effect to people, no risk to life, considerable economic effect.
5	Catastrophic	Major damage to land and buildings, possible structure collapse requiring replacement, risk to life, major economic effect, or possible site abandonment.

B.4. Risk Acceptance

It is recognised that the natural hazard risk assessment provided herein is qualitative and, due to the wide range of possible geohazards that could occur, is somewhat subjective. Other methods are available to quantitatively assess an acceptable level of geotechnical related natural hazard risk, such as defining an acceptable factor of safety with respect to slope stability or acceptable differential ground settlements with respect to recommended building code limits.

Therefore, to give this qualitative natural hazard risk assessment some relevance to more commonly adopted numerical or quantitative geotechnical assessment techniques, a residual risk rating of very low to medium (risk value = 1 to 9 inclusive) is considered an acceptable result for the proposed subdivision development.

A risk rating of high to extreme (risk value ≥ 10) is considered an unacceptable result for the proposed subdivision development.

C. RISK ASSESSMENT

The natural hazards relevant to this proposed subdivision development and adjacent, potentially affected land have been assessed with respect to the criteria outlined above.

Assessment is based on proposed post development ground conditions with and without any geotechnical controls. The latent risk was first assessed with the site in its proposed developed state to consider the risks to the development and surrounding land, including assessment of land modifications from the pre-existing natural state, without any implemented geotechnical controls. The specific geotechnical mitigation measures and engineering design solutions outlined in the table below and CMW report, where relevant, were then considered to determine the natural hazard residual risk remaining after the proposed controls have been implemented.

Results of this assessment are presented in Table C1 below.

Table C1: Natural Hazard Risk Assessment Results

RMA S2 Hazard	Description	Proposed Site Latent Risk of Damage to Land / Structures			Comments and Geotechnical Control	Proposed Site Residual Risk of Damage to Land / Structures OR Acceleration/ Worsening of Hazard with Geotechnical Controls Implemented		
		Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
Earthquake	Fault Rupture	1	5	Medium 5	Inactive thrust fault located on the northern boundary of site. However, reactivation unlikely given no displacement has been observed for millions of years.	1	5	Medium 5
	Liquefaction Induced Flooding and/ or Subsidence	2	4	Medium 8	Depth of cover / foundation design.	2	4	Medium 8
	Lateral Spread	2	4	Medium 8	Flow failure / displacements.	2	4	Medium 8
Volcanic Activity	Ash & Pyroclastic Falls	1	5	Medium 5	Unlikely given low proximity to active volcanic areas.	1	5	Medium 5

	Lava flows & Lahars	1	5	Medium 5	Unlikely given low proximity to active volcanic areas.	1	5	Medium 5
Geothermal Activity	Formation of geysers, hot springs, fumaroles, mud pools	1	5	Medium 5	Unlikely given low proximity to active geothermal areas.	1	5	Medium 5
Erosion	Cut Batters	5	2	High 10	Design limit to max 1:3 gradient, utilise stormwater controls.	2	2	Low 4
	Fill Batters	5	2	High 10	Design limit to max 1:3 gradient, utilise stormwater controls.	2	2	Low 4
	Coastal (cliff top)	4	4	Very High 16	Setback / in-ground (palisade) walls / drainage / 20m Esplanade area may provide enough set back.	2	4	Medium 8
Landslip	Global Slope Instability	3	4	High 12	Limit slope gradient / drainage / in-ground walls / Building Restriction Lines / 20m Esplanade area may provide enough set back around southern portion of site.	1	4	Low 4
	Soil Creep	3	4	High 12	Foundation design / slope gradient / retaining walls.	1	4	Low 4
	Bearing Capacity Failure	2	4	Medium 8	Undercut and replace and soft soils.	1	4	Low 4
	Cut & Fill Batter Instability	2	4	Medium 8	Surface water controls, regrading.	1	4	Low 4
Subsidence	Expansive Soils	5	4	Extreme 20	Foundation design for expansive soils.	1	4	Low 4
	Sinkholes	2	4	Medium 8	None identified in investigations to date. Possible in Limestone geology. Undercut and replace if encountered.	1	4	Low 4
	Soft Soils	2	4	Medium 8	Undercut and remove.	1	4	Low 4
	Effects of Dewatering	3	4	High 12	Monitor groundwater levels. Development likely to intercept top metre of groundwater. Negligible settlement effect post construction, as structures onsite are being removed	1	4	Low 4

					to make way for development. No change to groundwater catchments surrounding site.			
Sedimentation	Rockfall, Debris Inundation	1	4	Low 4	No structures situated below slopes/cliffs.	1	4	Low 4

Notes:

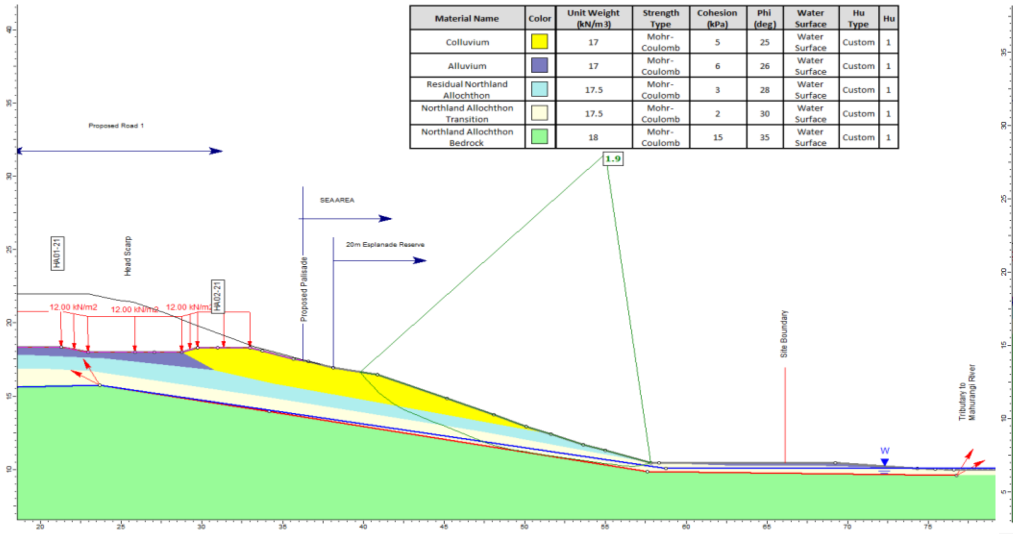
- Assessments include the impact of the proposed subdivision works on adjacent properties.
- The following reference(s) contain information on the hazards contained in this assessment and the non-geotechnical hazards that have not been included:
  - **Auckland**
    https://aucklandcouncil.maps.arcgis.com/apps/MapSeries/index.html?appid=81aa3de13b114be9b529018ee3c649c8

Appendix F: Stability Analyses Summary

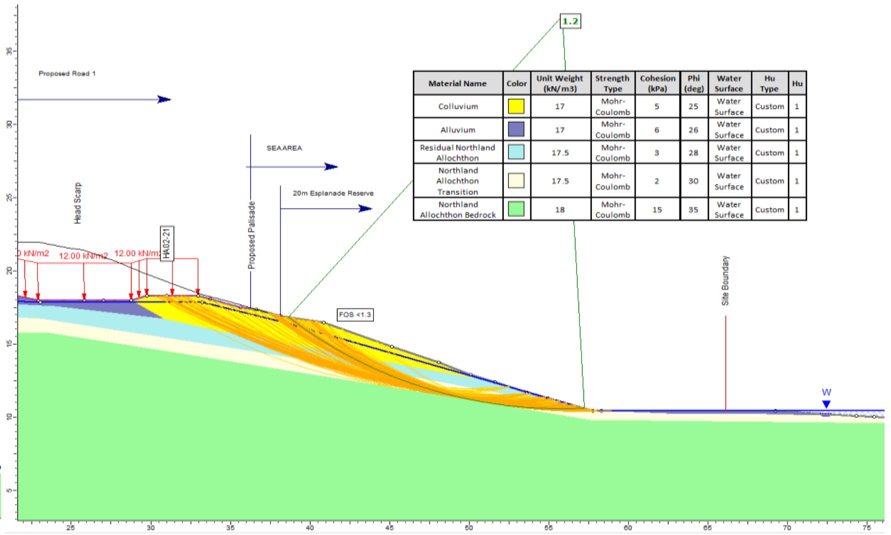
36 Sandspit Road, Warkworth - Stability Analyses Summary

Section	Profile	Analysis	Normal GW	High GW	Seismic	Comments
A (Proposed)	Full Profile	Circular (CA)	2.0	1.2	5.2	
	Full Profile	Planar Block (PB)	1.9	1.2	7.3	
A (Remediated)	Full Profile	Circular	2.0	1.2	5.2	Palisade Wall - min 50kN shear, 3.5m depth. (Failures in Esplande Reserve, below wall)
	Full Profile	Planar Block	1.9	1.1	8.4	

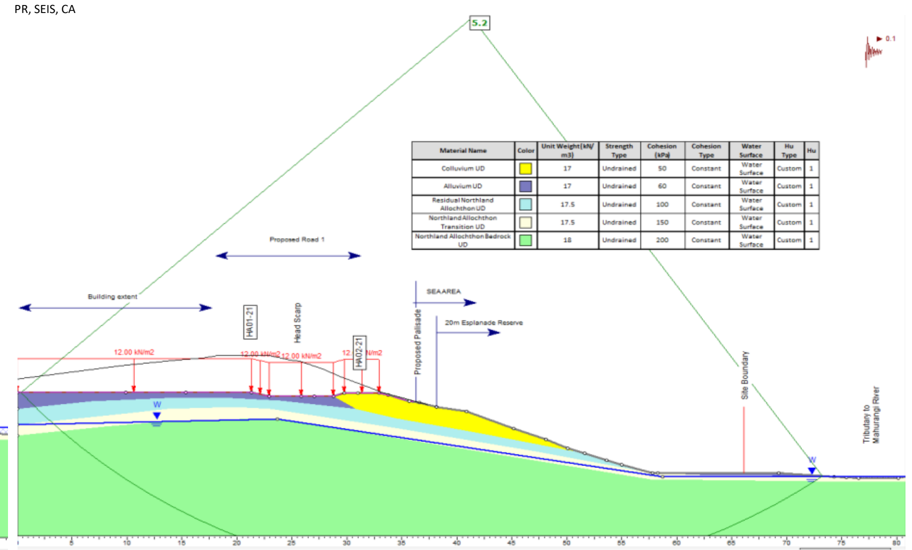
PR, NGW, PB



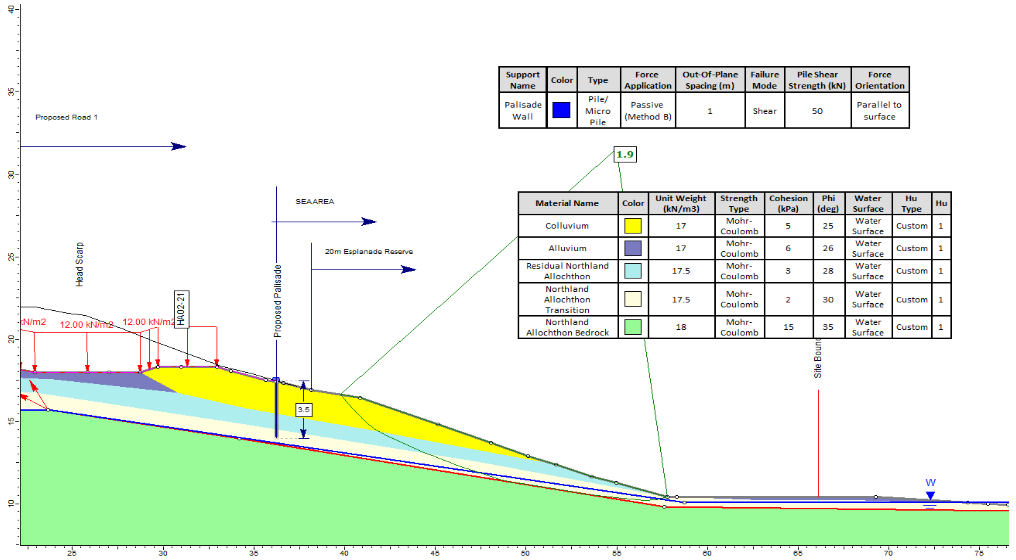
PR, HGW, CA



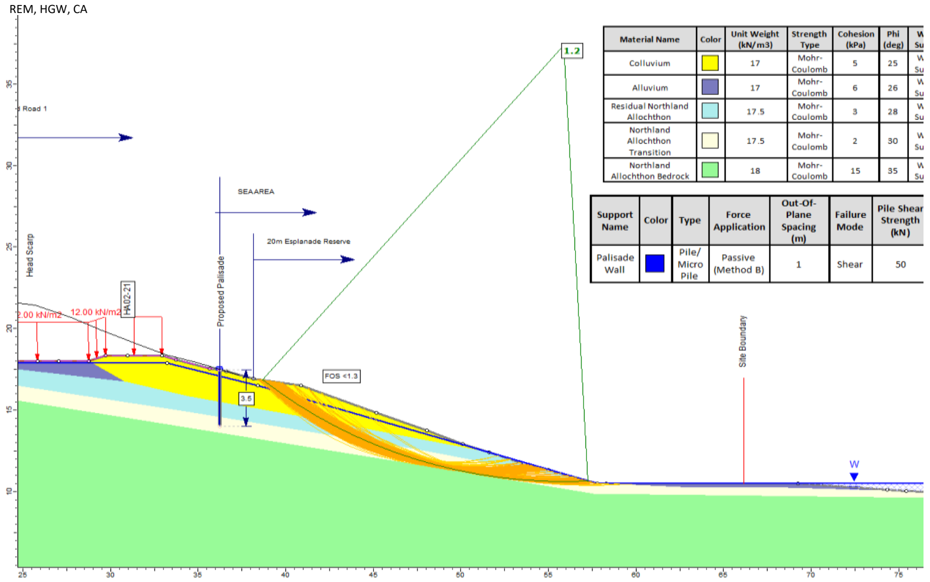
PR, SEIS, CA



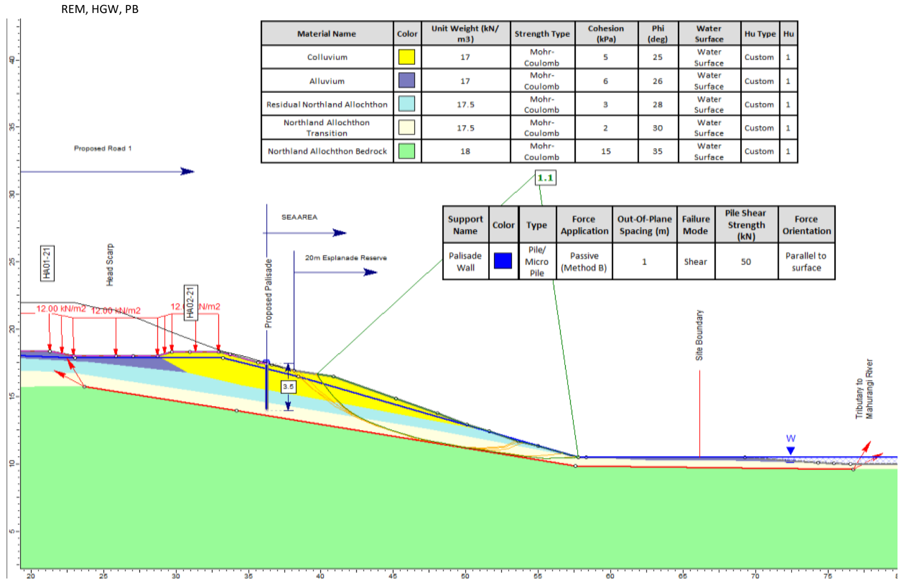
REM, NGW, PB



REM, HGW, CA

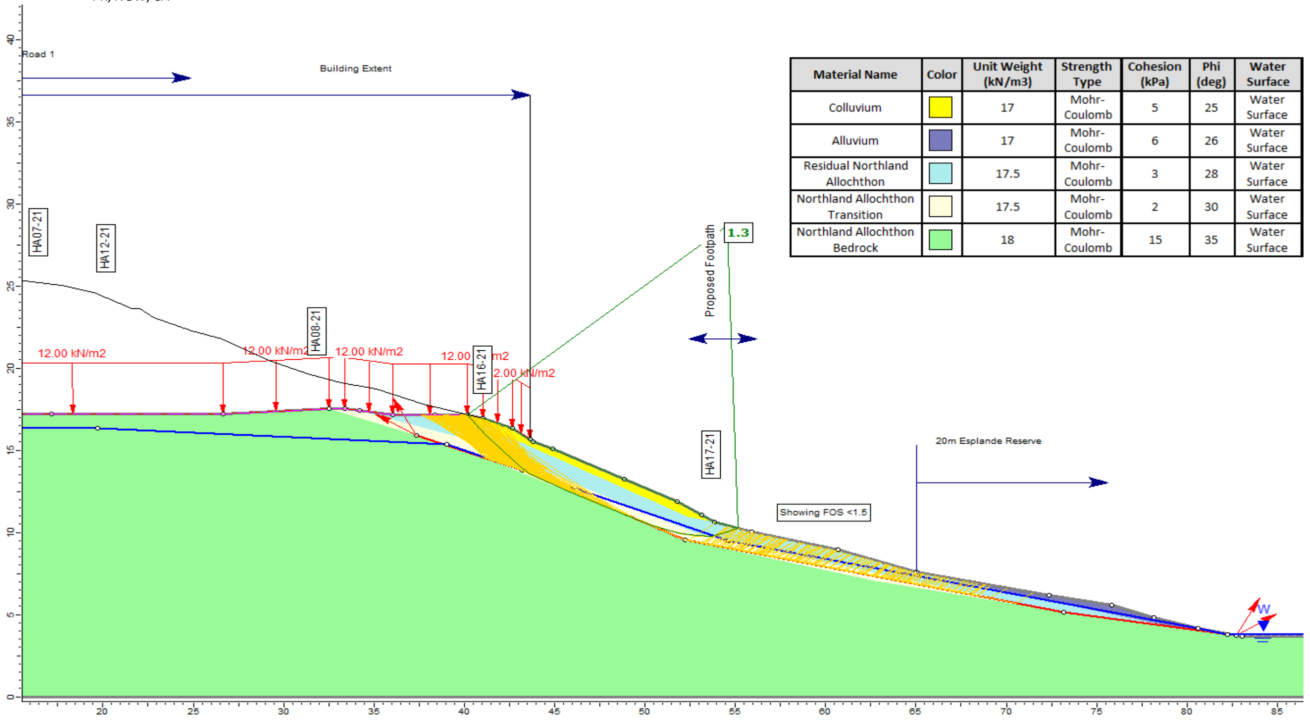


REM, HGW, PB



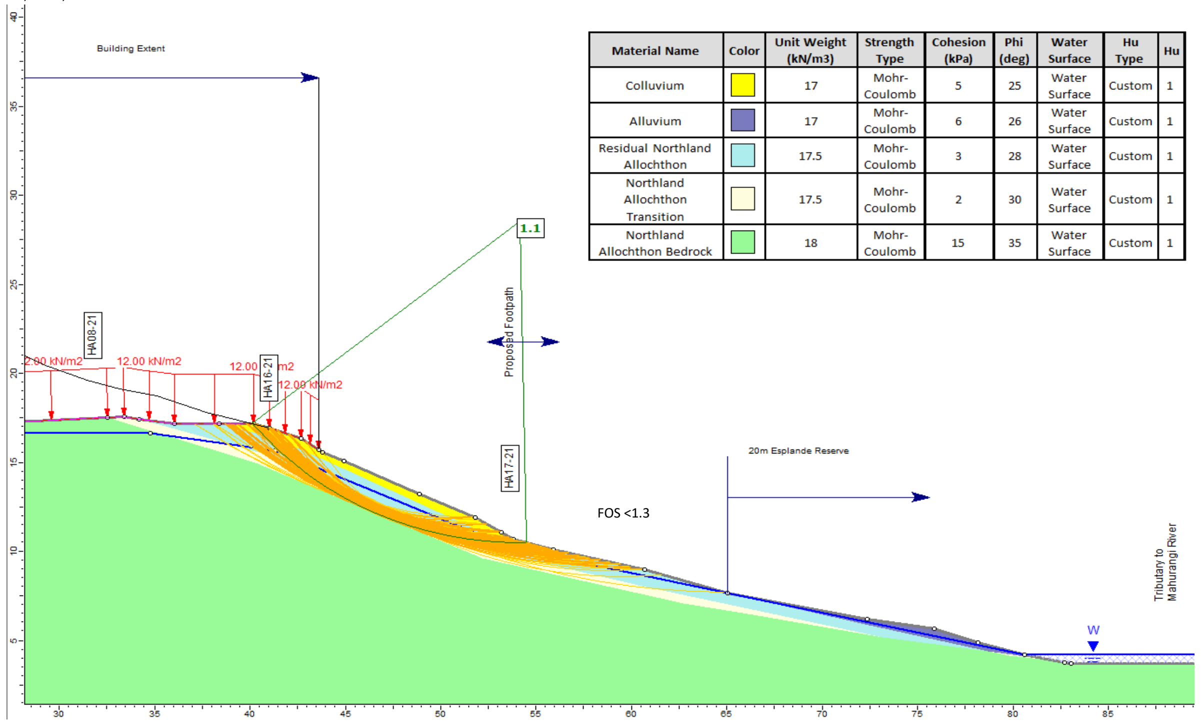
Section	Profile	Analysis	Normal GW	High GW	Seismic	Comments
B (Proposed)	Full Profile	Circular (CA)	1.4	1.1	4.5	
	Full Profile	Planar Block (PB)	1.3	1.1	9.0	
B (Remediated)	Full Profile	Circular	1.6	1.3	4.5	Palisade wall extending to competent bedrock and regrade crest of slope.
	Full Profile	Planar Block	1.6	1.3	9.4	Min. 0.6m undercut at rock interface - cap with clay fill. Palisade Wall - min 100kN shear, >2.5m depth

PR, NGW, CA



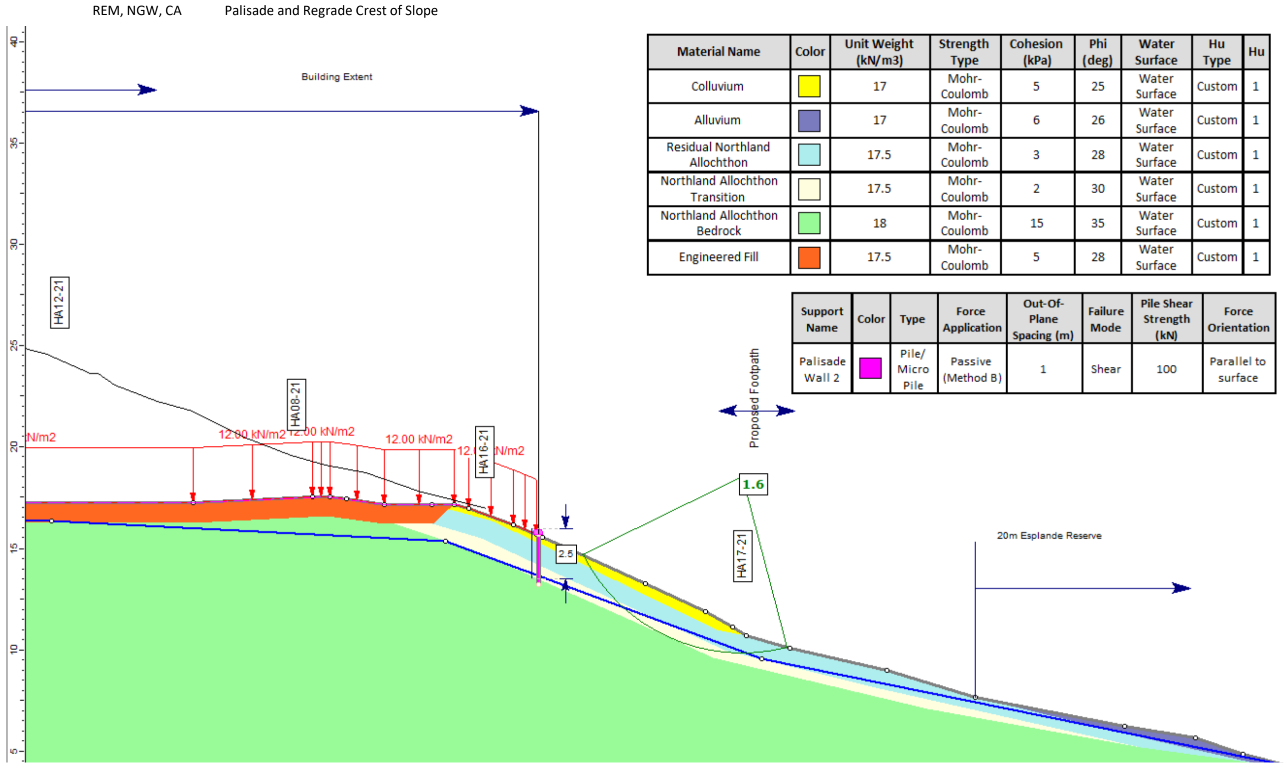
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface
Colluvium		17	Mohr-Coulomb	5	25	Water Surface
Alluvium		17	Mohr-Coulomb	6	26	Water Surface
Residual Northland Allochthon		17.5	Mohr-Coulomb	3	28	Water Surface
Northland Allochthon Transition		17.5	Mohr-Coulomb	2	30	Water Surface
Northland Allochthon Bedrock		18	Mohr-Coulomb	15	35	Water Surface

PR, HGW, CA



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		17	Mohr-Coulomb	5	25	Water Surface	Custom	1
Alluvium		17	Mohr-Coulomb	6	26	Water Surface	Custom	1
Residual Northland Allochthon		17.5	Mohr-Coulomb	3	28	Water Surface	Custom	1
Northland Allochthon Transition		17.5	Mohr-Coulomb	2	30	Water Surface	Custom	1
Northland Allochthon Bedrock		18	Mohr-Coulomb	15	35	Water Surface	Custom	1

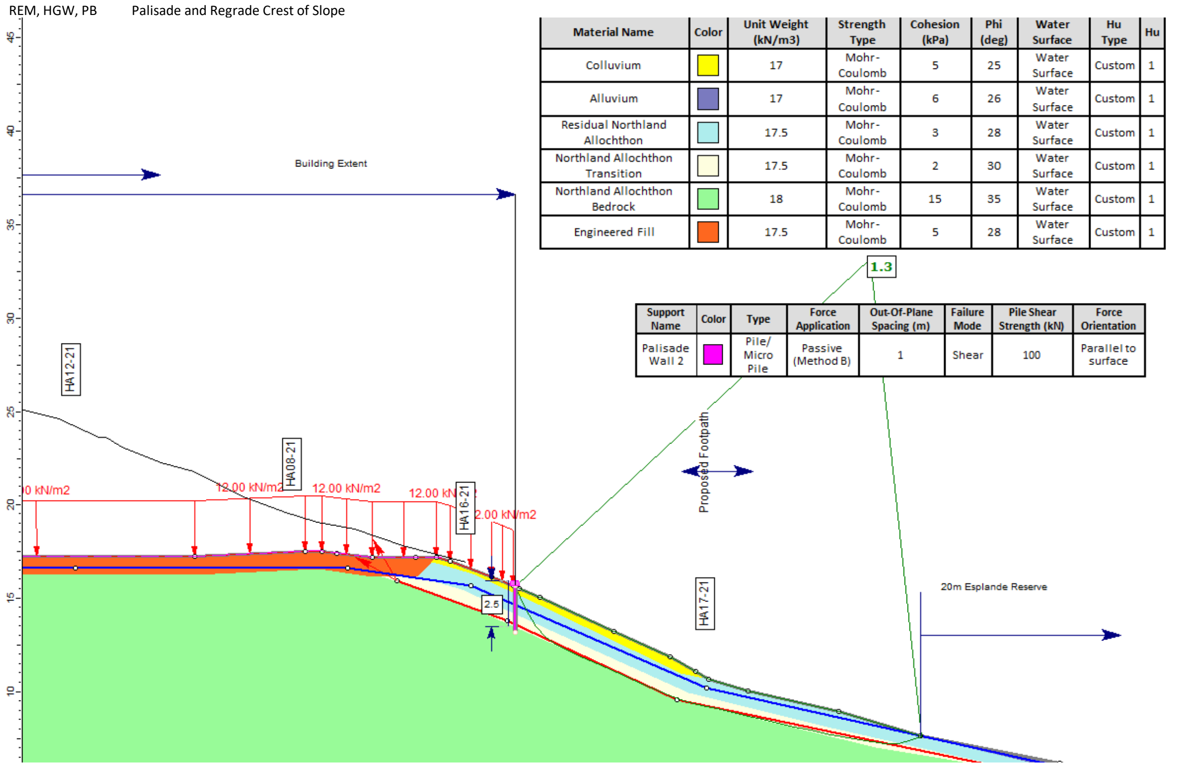
REM, NGW, CA Palisade and Regrade Crest of Slope



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		17	Mohr-Coulomb	5	25	Water Surface	Custom	1
Alluvium		17	Mohr-Coulomb	6	26	Water Surface	Custom	1
Residual Northland Allochthon		17.5	Mohr-Coulomb	3	28	Water Surface	Custom	1
Northland Allochthon Transition		17.5	Mohr-Coulomb	2	30	Water Surface	Custom	1
Northland Allochthon Bedrock		18	Mohr-Coulomb	15	35	Water Surface	Custom	1
Engineered Fill		17.5	Mohr-Coulomb	5	28	Water Surface	Custom	1

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (m)	Failure Mode	Pile Shear Strength (kN)	Force Orientation
Palisade Wall 2		Pile/ Micro Pile	Passive (Method B)	1	Shear	100	Parallel to surface

REM, HGW, PB Palisade and Regrade Crest of Slope



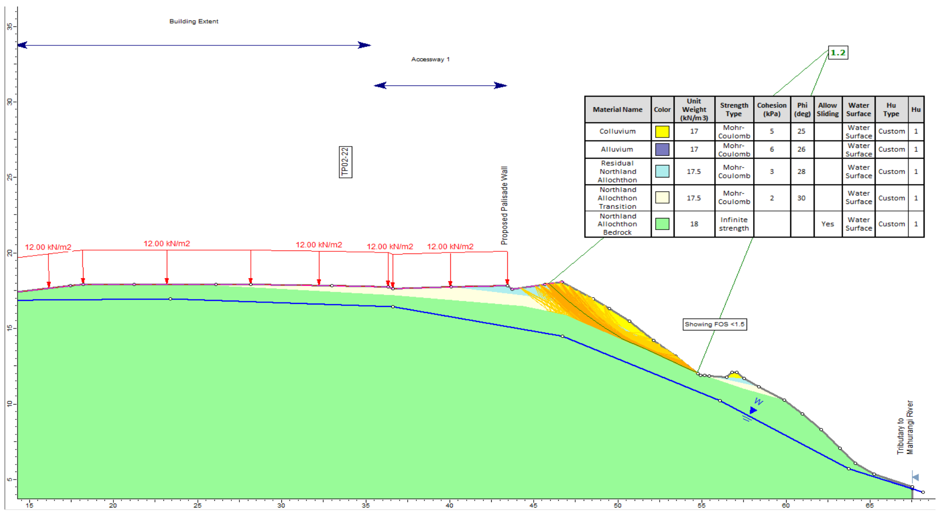
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		17	Mohr-Coulomb	5	25	Water Surface	Custom	1
Alluvium		17	Mohr-Coulomb	6	26	Water Surface	Custom	1
Residual Northland Allochthon		17.5	Mohr-Coulomb	3	28	Water Surface	Custom	1
Northland Allochthon Transition		17.5	Mohr-Coulomb	2	30	Water Surface	Custom	1
Northland Allochthon Bedrock		18	Mohr-Coulomb	15	35	Water Surface	Custom	1
Engineered Fill		17.5	Mohr-Coulomb	5	28	Water Surface	Custom	1

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (m)	Failure Mode	Pile Shear Strength (kN)	Force Orientation
Palisade Wall 2		Pile/ Micro Pile	Passive (Method B)	1	Shear	100	Parallel to surface

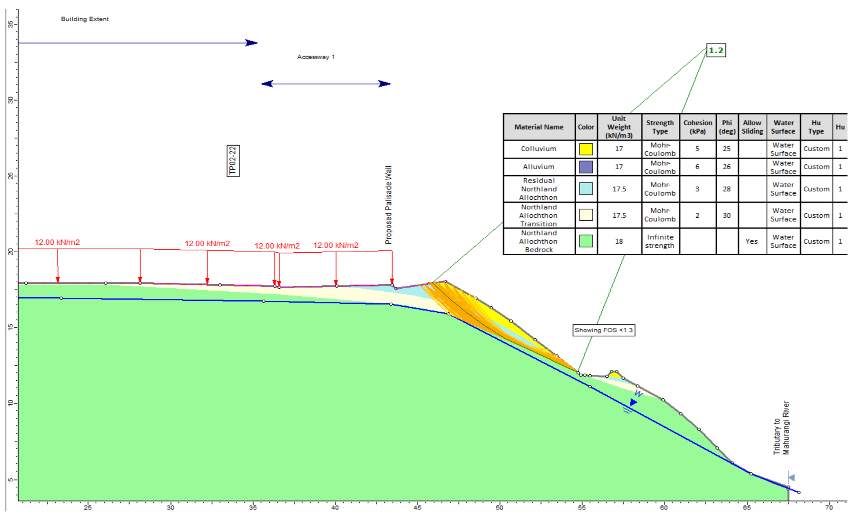
36 Sandspit Road, Warkworth - Stability Analyses Summary

Section	Profile	Analysis	Normal GW	High GW	Seismic	Comments
D (Proposed)	Full Profile	Circular (CA)	1.2	1.2	4.0	
	Full Profile	Planar Block (PB)	1.2	1.2	12.6	
D (Remediated)	Full Profile	Circular	1.2	1.2	3.9	Undercut to rock and replace with Eng Fill. Regrade crest
Option 1	Full Profile	Planar Block	1.2	1.2	13.0	of slope. Min setback 2.5m from crest/cut slope.
D (Remediated)	Full Profile	Circular	1.2	1.2	3.9	Palisade wall extending to competent bedrock and
Option 2	Full Profile	Planar Block	1.2	1.2	12.9	regrade crest of slope. Min. 0.6m undercut at rock interface - cap with clay fill. Palisade Wall - min 50kN shear, >2.0m depth. Failures located below palisade wall.

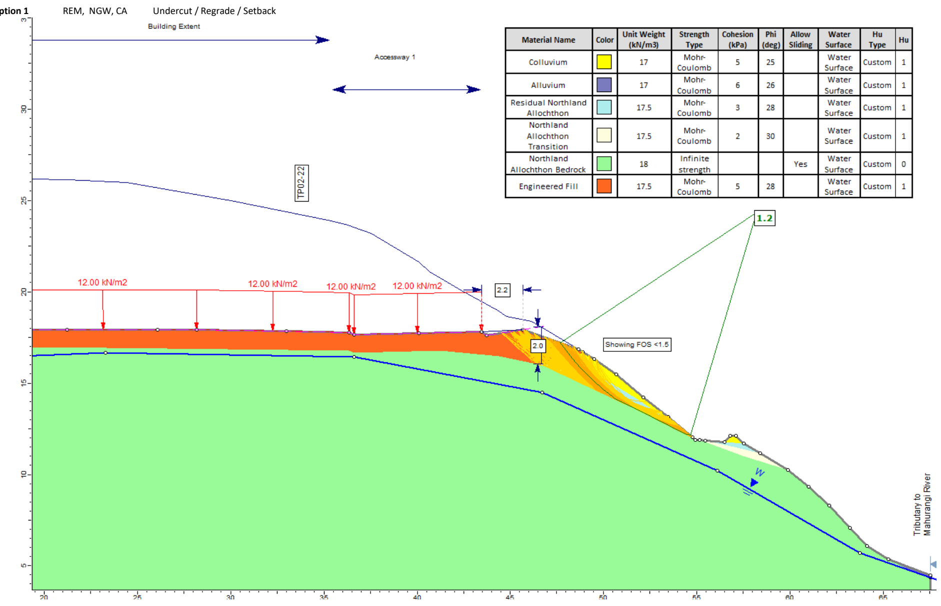
PR, NGW, CA



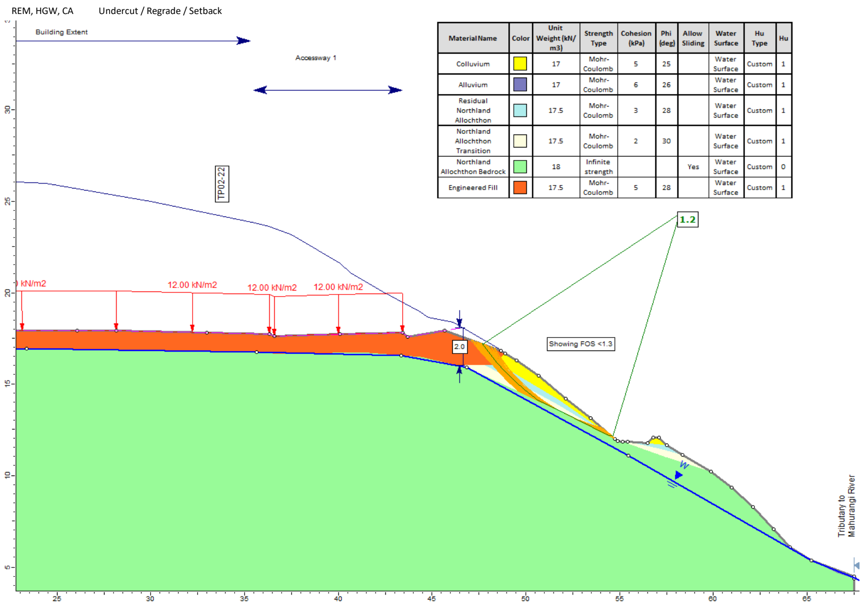
PR, HGW, CA



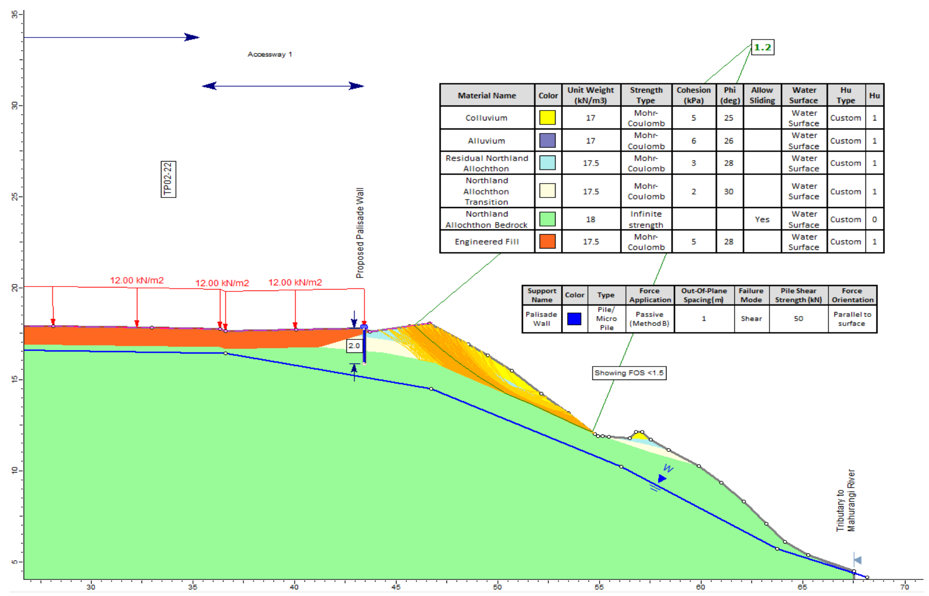
Option 1 REM, NGW, CA Undercut / Regrade / Setback



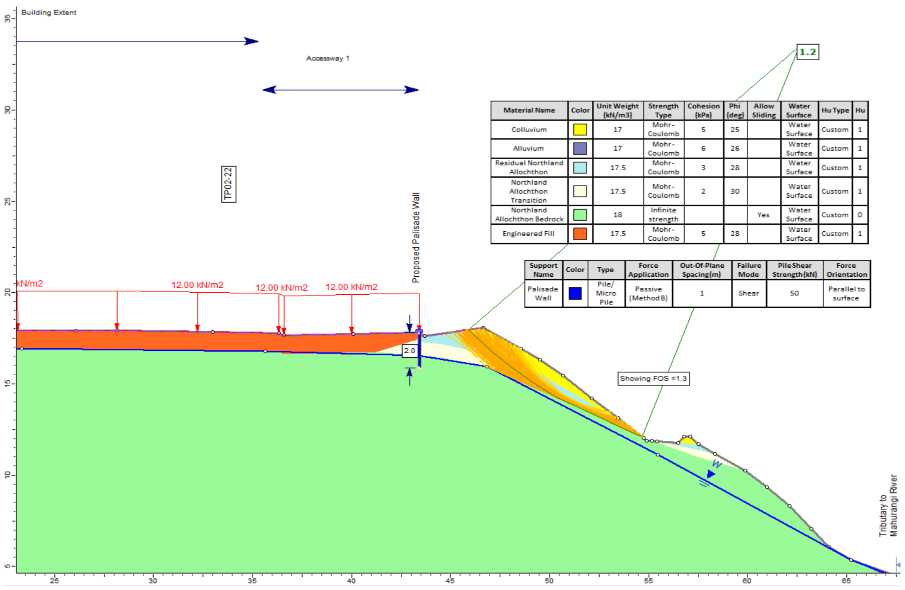
REM, HGW, CA Undercut / Regrade / Setback



Option 2 REM, NGW, CA Palisade



REM, HGW, CA Palisade



Appendix G: Groundwater Impacts Assessment

Project no:

AKL2021-0060

Project name:

36 Sandspit Road, Warkworth

Assessment of geotechnical aspects of proposed development with respect to the Auckland Unitary Plan Operative in Part (Updated 12 June 2020)

Chapter E: Auckland-wide rules, Natural resources»E7 Taking, using, damming and diversion of water and drilling»E7.6. Standards Permitted activities»E7.6.1. Permited activities »E7.6.1.6. Dewatering or groundwater level control associated with a groundwater diversion permitted under Standard E7.6.1.10

Condition		Geotechnical Interpretation of Compliance
1. The water take must not be geothermal water *2. The water take must not be for a period of more than 10 days where it occurs in peat soils, or 30 days in other types of soil or rock* *3. The water take must only occur during construction*	**Non-Compliant**	1. Not wihtin geothermal area - groundwater is not geothermal. 2. There are no peat soils identified on this site. However, groundwater take anticipated to extend beyond 30 days. **Impact Assessment**: Subsoil drains are to be installed that will follow existing alignments of surface water channels. All groundwater intercepted will be returned to streams and/or wetlands in the same locations as present. 3. Refer to impact assessments within this document.

Chapter E: Auckland-wide rules, Natural resources»E7 Taking, using, damming and diversion of water and drilling»E7.6. Standards Permitted activities»E7.6.1. Permited activities »E7.6.1.10. Diversion of groundwater caused by any excavation, (including trench) or tunnel

Condition		Geotechnical Interpretation of Compliance
1.All of the following activities are exempt from the Standards E7.6.1.10(2) – (6) *a. pipes cables or tunnels including associated structures which are drilled or thrust and are less than 1.2m in external diameter* *b. pipes including associated structures up to 1.5m in external diameter where a closed faced or earth pressure balanced machine is used* *c. piles up to 1.5m in external diameter are exempt from these standards* *d. diversions for no longer than 10 days; or* *e. diversions for network utilities and road network linear trenching activities that are progressively opened, closed and stabilised where the part of the trench that is open at any given time is no longer than 10 days*	**Non-Compliant**	a. No pipes greater than 1.2m in diameter are proposed. b. No pipes or structures of this kind are proposed. c. Retaining wall piles less than 1.5m diameter. d. Earthworks excavations will exceed 10 days. **Impact Assessment:** Significant cuts are proposed from the central ridgeline areas of the site that will exceed 10 days of operation. Overall groundwater levels will likely be lowered in these elevated areas as part of these operations, but will not be diverted to other catchments or locations surrounding the ridgeline areas and flows at receiving catchments will not be altered. e. Service trench excavations are to be open no longer than 10 days.
2.Any excavation that extends below natural groundwater level, must not exceed: *a. 1ha in total area; and* *b. 6m depth below the natural ground level*	**Non-Compliant**	a. Excavations below natural groundwater levels will not exceed 1ha. b. Maximum cut depth of 10m proposed. Refer to **Impact Assessment** 1(d) above.
3.The natural groundwater level must not be reduced by more than 2m on the boundary of any adjoining site.	**Compliant**	3. Groundwater drawdown of more than 2m is not anticipated along the boundaries of this site. Main excavations are to be completed in the central portion of the site.
4.Any structure, excluding sheet piling that remains in place for no more than 30 days, that physically impedes the flow of groundwater through the site must not: *a. impede the flow of groundwater over a length of more than 20m; and* *b.extend more than 2m below the natural groundwater level.*	**Compliant**	a. No potentially groundwater impeding structures of this nature are proposed for this site. b. No potentially groundwater impeding structures of this nature are proposed for this site.
5.The distance to any existing building or structu re (excluding timber fences and small structures on the boundary) on an adjoining site from the edge of any: *a.trench or open excavation that extends below natural groundwater level must be at least equal to the depth of the excavation* *b.tunnel or pipe with an external diameter of 0.2 - 1.5m that extends below natural groundwater level must be 2m or greater; or* *c.a tunnel or pipe with an external diameter of up to 0.2m that extends below natural groundwater level has no separation requirement.*	**Compliant**	a. Adjacent infrastructure offset at least the depth of the excavation. b. Adjacent infrastructure offset at least 2m. c. Noted.
6.The distance from the edge of any excavation that extends below natural groundwater level, must not be less than: *a.50m from the Wetland Management Areas Overlay* *b.10m from a scheduled Historic Heritage Overlay; or* *c.10m from a lawful groundwater take.*	**Compliant**	a. Greater than 50m from any Wetland Management Overlays. b. Site incorporates Historic Heritage Overlays. However, the distance of the excavation that is anticipated to intercept natural groundwater levels, will be greater than 10m from any Historic Heritage features present onsite. c. Greater than 10m from any lawful groundwater take.

Appendix H: Geotechnical Works Specification

17 March 2022 Document Ref: AKL2021-0060AF Rev 0

Land Development Geotechnical Works Specification For: 34 & 36 Sandspit Road, Warkworth

1. INTRODUCTION AND SCOPE

This specification covers the geotechnical remediation works and associated earthworks outlined in the CMW Supplementary Investigation Report (GIR), referenced AKL2021-0060AD Rev 0. It supplements the information provided on the standard drawings and GIR. It provides detail on the required specification for:

- Site clearance and preparation including topsoil stripping and stockpiling.
- Undercuts.
- Subsoil drainage installation.
- Cut to fill earthworks operations.
- Fill materials and testing requirements.
- Earthworks finishing and respread of topsoil; and,
- As-built records.

Excluded from the scope are geotextile reinforced slopes with a face and steeper than 30 degrees or retaining structures covered by a building consent. Such works will be carried out in accordance with an independent structure specific specification.

Unless varied onsite by the Geotechnical Engineer, the following specification requirements must be met in order for CMW Geosciences (CMW) to provide a Geotechnical Completion Report for the works.

2. RELEVANT DOCUMENTS

2.1. Standards, Guidelines and Consents

The works shall comply with the relevant sections of the following standards, guidelines, and consents:

1. Health and Safety at Work Act 2015 and Regulations 2016.
2. All Project Resource Consent Conditions and Engineering Works Approvals.
3. The applicable Council Infrastructure Design Standard.

4. The Auckland Council, Erosion and Sediment Control Guidelines – Guidance document 2016/005.
5. NZS 4431:1989 Code of Practice for Earth Fill for Residential Development.
6. NZS 4402: 1986 Methods of Testing Soils for Civil Engineering Purposes; and,
7. NZS 4404: 2010 Code of Practice for Urban Land Subdivision.
8. WorkSafe NZ – Excavation Safety Good Practice Guidelines, July 2016.

2.2. Geotechnical Investigation

Details of the geotechnical investigation, soil and rock conditions encountered, and the design of the geotechnical remedial works are contained in the CMW report AKL2021-0060AD Rev 0. The contractor should be aware of the contents and recommendations contained in that report.

The works shall comply with the recommendations contained in that report.

2.3. Construction Drawings

The works shall comply with the following drawings:

- Airey Civil Structural and Fire Engineers Draft Engineering Drawings referenced 85070-01, sheets 200-203, 210-213, 260, 300-303, 310-213, 320-321 and 330-331, Rev A, dated 15 February 2022.

2.4. Conflicting Information

Where there is any conflict or discrepancy in the requirements of this specification and the documents listed above the matter shall be referred to the Geotechnical Engineer (CMW) for clarification.

3. GEOTECHNICAL OBSERVATION REQUIREMENTS

The following items form hold points in the construction works that require observation, testing and approval by the Geotechnical Engineer (CMW):

1. Foundations for filling once topsoil and unsuitable materials have been stripped prior to fill placement.
2. Undercuts to confirm depth and extents prior to backfilling.
3. Subsoil drain excavations prior to placement of aggregate;
4. Any imported soil fill materials prior to placement on site.
5. Drainage aggregate quality prior to placement.
6. Filling placed at regular intervals to comply with the fill test frequency requirements below.
7. Compaction of backfilling in critical service trenches.
8. Flushing of the subsoil drainage system at the completion of earthworks.
9. Any unforeseen ground conditions that may impact on the construction works or future land use.

It is the contractor’s responsibility to ensure that the Geotechnical Engineer is given reasonable notice and opportunity to observe the above works and that the works do not proceed until approval has been gained from the Geotechnical Engineer.

24 hours is considered reasonable notice.

4. SAFETY IN DESIGN

The design landform requires site excavations that may include geotechnical works such as undercuts, temporary excavations, undercut shear key excavations, subsoil drains as specified in the Geotechnical report(s) and on the drawings. Exposure to these works forms a significant safety risk for contractors and inspectors/ testers.

In conducting our scope of work, we have considered and addressed Safety in Design (SiD) aspects relevant to our understanding of the proposed design and construction work. SiD must consider the construction, operation, maintenance, and ultimate demolition phases of the relevant works.

It is noted that CMW are focussed on design aspects, and whilst we have attempted to be comprehensive in our assessment, it is the Contractors responsibility to cover construction related risks in a more comprehensive manner (being the competent part in that respect). The CMW designs/ specifications for undercuts and drainage elements have been made so that no personnel are ever expected to enter unbattered or unprotected excavations to complete the construction. If at any stage a contractor does not consider that a design for excavations can be safely constructed, then CMW must be contacted immediately to discuss alternative design and/ or methods and avoid risk to personnel.

5. TEMPORARY BATTERS ABD EXCAVATION STABILITY

The temporary stability of the works is the responsibility of the main contractor. All works are to be completed in accordance with the requirements of current safety legislation and WorkSafe NZ.

Slope instability during construction is a significant risk where earthworks may cause changes to slope geometry or groundwater conditions.

The causes of instability during earthworks may include:

- Removal of toe support due to excavation.
- Over steepening of slope angles in temporary batters.
- Geological defects in the soil or rock mass, particularly where these are exposed in excavation faces.
- Elevated groundwater levels following rainfall, perched groundwater or rapid recharge due to the reduced distance to an impermeable layer (i.e. undisturbed rock) due to cut operations; and,
- Additional loading upslope of excavations. i.e. construction equipment or stockpiles.
- To help mitigate these risks the contractor should consider:
- Staging excavations which reduce support to slopes or create temporarily over steepened slopes, to ensure large areas are not left unsupported. The allowable length of excavation to have open at any one time will vary and is dependent on a number of factors such as, local ground conditions, groundwater, length of time the excavation will be open, weather, depth of excavation, geological defects present, and the earthworks equipment and methodology used.
- Ceasing works in excavations during rainfall and assessing stability of excavations following rainfall events prior to resuming work.
- Benching or battering back of excavation faces.
- Ensuring good control of surface water runoff above excavations and batters.
- Covering steep batters with impermeable covers where they may be left without support for any significant period of time.
- Avoiding loading the crests of slopes and excavations (including loading with working plant).
- Putting in place comprehensive risk identification and management procedures and work methodologies for temporary excavation stability.

- Carrying out regular inspections upslope of excavations and of the excavation slope to look for signs of instability such as ground displacement and the development or propagation of cracks; and,
- Seeking advice from the Geotechnical Engineer where there is doubt as to the stability of a slope or excavation.

6. CONSTRUCTION SPECIFICATION

6.1. Site Preparation

The Contractor shall remove all vegetation from the site of the earthworks except for trees indicated for preservation either by marking on the site or noted on the drawings and clear the remainder of the site.

Clearing shall mean the felling of all trees, except those indicated, removal of all growth other than grass and weeds, extraction of tree stumps, demolition of fences and other minor items remaining in the way of site stripping, and the complete disposal of all items. Stumping shall mean the removal of all roots greater than 25mm in diameter.

Cleared areas shall be stripped to remove all turf and organic topsoil to depths designated by the Engineer ahead of or during the stripping operations. Stripping shall also cover picking up any old topsoil stockpiles and any buried topsoil detected during the course of the works. The depth shall be sufficient to remove all materials considered unsuitable as fill or unsuitable to remain beneath fill but will not necessarily extend to the full limit of organic penetration.

6.2. Erosion and Sediment Control

The works shall be carried out in accordance with the project Erosion and Sediment Control Management Plan and associated drawings.

The contractor shall ensure good control of surface water runoff at all times by shaping of the surface in cut and fill areas to prevent ponding during rainfall events.

The location of temporary Sediment Retention Ponds (SRP) on sloping ground shall be decided upon with input from the Geotechnical Engineer. Where comment of SRP stability is sought by Council then all fill materials used to form batters, must be placed as engineered fill and tested accordingly unless advised otherwise by the Geotechnical Engineer.

When decommissioning temporary sediment ponds, all water softened material in the bases and sides of the ponds shall be removed and undercut to the satisfaction of the Geotechnical Engineer. Backfilling of temporary ponds shall be to the compaction standard for general filling unless otherwise specified.

6.3. Stockpiles

Topsoil stockpiles can add significant driving force for slope instability when placed at or near the crest of a slope. The location of all temporary stockpiles must be approved by the Geotechnical Engineer prior to placement. Where stockpiles cannot be avoided above sloping ground, they should be placed over a wide area with the height restricted under the direction of the Geotechnical Engineer.

6.4. Fill Foundations and Benching Slopes

The foundation on which filling is to be placed must be observed by the Geotechnical Engineer following clearing and prior to the placement of any filling to confirm the strength of the underlying soils is sufficient.

Where it is found, after clearing and stripping operations as specified, that the foundation on which filling is to be placed is unstable, or in cuttings if it is found after the excavation has been cut down to the levels shown in the drawings that unstable ground is encountered, then the Engineer may direct that the soft, yielding, or unstable materials causing such instability shall be removed to such depth as directed.

Benching of slopes prior to the placement and compaction of filling should be carried out in accordance with the normal requirements of NZS 4431 and related documents as mentioned above, especially on the steeper areas of the site, to ensure that the filling placed is keyed into the underlying natural ground. This would involve the cutting of benches approximately the width of a bulldozer, with a slight reverse gradient back into the slope. The optimum depth of each bench is best confirmed by careful Engineering inspections during construction.

6.5. Fill Materials and Conditioning

6.5.1. Soil Fill, Rock Fill or Soil and Rock Mixed Fill

Site won materials used as engineered filling shall be free of topsoil, organic matter, rubbish and other unsuitable materials. The maximum particle size for soil and rock blended fill shall be 200mm and mixing and/ or crushing shall be carried in a manner that ensures that significant voids are not present in the filling between rock fragments.

For rock fill without soil blending, crushing is to occur to comply with the requirements for blended fills and needs to ensure that uniform compaction can occur without significant voids between particles in the absence of the soil fill.

6.5.2. Blending of Unsuitables

The blending of 'unsuitables' into structural fills may be undertaken only at the discretion of the Geotechnical Engineer following a request by the contractor and with sufficient time for appropriate consideration. Approval for any such blending must be sought from and provided by the Geotechnical Engineer in writing prior to the commencement of any blending.

In consideration of any such requests, the Geotechnical Engineer will need to be able to assess, et. al., the composition of the materials requested to be blended, the location on the site for the proposed fills, the fill depths and the elevation of the blended materials within the fills and any environmental constraints.

As a minimum, it is expected that any blended fills will be directed to comply with the following conditions:

- All significant, solid inorganics (such as roots and stumps) to be removed prior to blending; and,
- All inclusions of suitable man-made materials (e.g., concrete) and any excavated rock must comply with the normal compaction requirements specified herein in terms of size and ability for appropriate compaction to be achieved in close vicinity to the inclusions.
- All blended materials must be appropriately mixed/ blended normal fill materials to the specified ratio. Un-mixed interlayering of normal engineered filling with unsuitables will not be accepted.
- As a preliminary indication, it is expected that the ratio of unsuitables to suitable fill will not exceed 1 in 10 by volume.

It is expected that the Geotechnical Engineer will also need to apply limits to the location/ depth of blended fills within any specified fill area.

6.5.3. Hardfill

Hardfill used as structural filling shall be a graded, unweathered, durable, crushed rock product approved by the Geotechnical Engineer, with a grading suitable for compaction.

6.5.4. Material Conditioning

The cut materials on site may require some drying prior to compaction to achieve the required specification. This may be done by harrowing (such as with discs) and air drying when conditions permit or by the addition of hydrated lime.

The addition of lime and/or cement to engineered filling in concentrations greater than 3% requires the approval of the Geotechnical Engineer.

All additives such as lime or cement proposed for use in backfill materials for Reinforced Earth Slopes or other materials in contact with geosynthetics must be approved and monitored by the Geotechnical Engineer.

6.6. Fill Placement, Compaction and Testing Requirements

6.6.1. Soil Fill

Soil placed in fills shall be conditioned and compacted until the following conditions are satisfied. Alternative methods based on specified compaction techniques may be selected by the Geotechnical Engineer if the method below is considered inappropriate due to the granular nature of the materials.

There is only one class of filling defined:

- **General Fill**: Structural engineered fill.

It should be noted that the surface of the fill area prior to placement of subsequent fill lifts should be in a state so as not to create a break in the consistency of the fill material between lifts. For example, if surfaces are left to dry out, or rolled to seal them from rainfall infiltration then the surface must be broken up and scarified with rippers or by other means to ensure a good bond between fill lifts.

The maximum lift of filling placed before compaction is dependent on the size and nature of the compaction equipment. Typically, 300mm loose depth is considered the maximum for a Cat 815/820 type compactor. In any event the contractor must ensure that the fill is placed and compacted to achieve even and adequate compaction throughout each layer/lift.

The test criteria and frequency for cohesive materials (Clays & Silts) are set out in Table 1 and 2 below. If non cohesive soils (i.e. Sands) are to be placed as engineered fill the matter should be referred to the Geotechnical Engineer to define the testing requirements.

TABLE 1: COHESIVE MATERIALS (SOIL FILL) COMPACTION TEST CRITERIA FOR ENGINEERED FILLING

	Air Voids (1)		Vane Shear Strength (2)		Moisture Content (3)	Dry Density (3)
	Average	Maximum Single Value	Average	Minimum Single Value	Maximum	Minimum
General Fill	10%	12%	140 kPa	120 kPa	N/A	1.07

Notes: (1) Air Voids Percentage (as defined in NZS 4402:1986).

(2) Undrained Shear Strength (Measured by hand shear vane – calibrated using NZGS 2001 method).

(3) Moisture content and minimum dry density non-compliance may be accepted on site by the Geotechnical Engineer on a case-by-case basis depending on the nature of the material and the other criteria results.

TABLE 2: COHESIVE MATERIALS (SOIL FILL) COMPACTION TESTING FREQUENCIES FOR ENGINEERED FILLING

	Field Density & Air Voids %	Vane Shear Strength	Solid Density	Compaction Curve
General Fill	1 test per 1500m^3 of fill placed with	1 set of tests (4 readings within 1 metre of each	1 test per material type per 50,000m^3	1 test per material type per 30,000m^3

	not less than 1 test per 500mm lift of filling for each area.	other) per 500m^3 of filling placed with not less than 1 test per 500mm lift of filling for each fill area.		

The test criteria and/or frequency may be relaxed at the discretion of the Geotechnical Engineer (CMW) for the project or in a discrete fill area subject to the consistency of the results achieved being acceptable over a specified period of time

6.6.2. Site Won Rock Fill

If site won rock filling is to be used, a compaction specification is to be determined by the Geotechnical Engineer based on site trials.

6.6.3. Compaction Testing Reporting Requirements

1. All test location coordinates to be recorded by handheld GPS with reference to the NZTM projection. Test location coordinates, with date and test number reference are to be provided to the Geotechnical Engineer in electronic (excel) format on a weekly basis. Alternatively, the Geotechnical Engineer may approve the use of site plans to mark the location of tests in lieu of GPS location.
2. The volume of filling placed for each progress claim month (typically ending 20th of the month) including all filling placed (undercut and cut to fill) to be provided to the Geotechnical Engineer monthly by the contractor or Engineer to the Contract to allow assessment of test frequency adequacy.
3. Interim fill test summaries are to be provided to the Geotechnical Engineer for review on a regular basis.

6.6.4. Hardfill

A plateau compaction test shall be carried out on site under the supervision of the Geotechnical Engineer, for each type of hardfill placed to determine the achievable maximum dry density (MDD) with no more than 20% total voids unless a laboratory derived MDD can be provided. The Geotechnical Engineer shall be given the opportunity to approve the size and type of compaction equipment to be used prior to any plateau testing.

Hardfill shall be placed and compacted to 95% of the MDD determined from the plateau test or laboratory MDD. If these conditions are not able to be met, then appropriate adjustment of the moisture content or compaction equipment will be required.

In all cases, the dry density of the compacted fill at any one test site shall be not more than 5% below the minimum and the average of the dry densities of any ten consecutive test sites shall not be less than the specified minimum.

The Geotechnical Engineer may at their discretion, alter the compaction specification to a method compaction specification based on the plateau test result for materials with a maximum particle size greater than 65mm.

The test frequency shall be 1 test per 500m^3 of hardfill placed with not less than 1 test per 500mm lift of filling for each fill area.

The test frequency may be relaxed at the discretion of the Geotechnical Engineer (CMW) for the project or in a discrete fill area subject to the consistency of the results achieved being acceptable over a specified period of time.

6.7. Subsurface Drainage

6.7.1. General

Drainage for shear keys and underfill drains shall be constructed in accordance with the design drawings and standard details. Underfill drains will need to be installed beneath new fills where any groundwater seepage is evident, within low lying tributaries and gully inverts. Subsoil drain locations and requirements will be determined onsite by the Geotechnical Engineer prior to fill placement.

6.7.2. Materials

6.7.2.1. Pipes

Drainage pipes used in subsoil drainage shall be 160mm diameter highway grade drain coil. Drain coil walls shall be perforated or solid as detailed in the design drawings or directed by the Geotechnical Engineer on site. Drain coils shall not have a geofabric filter sock unless requested by the Geotechnical Engineer on site.

6.7.2.2. Aggregate

Auckland Council now generally require that subsoil drainage has a 100-year design life and is essentially maintenance free unless there is an entity such as body corporate or resident’s association that maintenance responsibility can be transferred to. Maintenance by individual owners is not practical as the subsoil drainage systems usually cross over, and generally benefit, multiple lots.

This requires a high-quality drainage aggregate with the following properties:

- Self-filters against the soils present on site preventing loss of permeability over time; or, able to be practically wrapped in a suitable geofabric filter.
- High permeability, which translates to a low fines content; and
- Stable and not subject to crushing, weathering, internal erosion or piping, or significant loss of volume (settlement) over time.

Ideally the drainage aggregate should be a well graded self-filtering material such as a clean (free of significant cohesive fines) scoria SAP50 product or Transit F/2 specification filter media.

Alternatively, for shear key drainage, blanket drains, underfill drainage and all applications where full encapsulation with a geofabric filter cloth can be relatively simply and safely achieved, an open graded product, preferably 27/7 Scoria may be used. Care will need to be taken to ensure that the cloth fully encapsulates the aggregate. Observation of the cloth wrap should form an inspection hold point prior to backfilling over the drain. Drain coils in this instance do not require a filter sock.

For counterfort trench drains and applications where a full filter cloth wrap is not practical to construct, <u>and</u> the performance of the drain is not critical to maintaining slope stability then a SAP20 or SAP50 may be used without a filter cloth wrap. Drains which fall into this category <u>must</u> be defined and confirmed as such by the Geotechnical Engineer. Additionally, where such materials are used, regular visual inspections and approval of the aggregate quality and laboratory grading curves is required. This is to comprise visual inspection of each site stockpile prior to material being placed in the trench. One wet sieve grading curve from each site stockpile per week is required while material is being imported to site to monitor the fines content. Drain coils in this instance do not require a filter sock.

For counterfort trench drains and applications where a full filter cloth wrap is not practical to construct, <u>and</u> the performance of the drain is critical to maintaining slope stability then a TNZ/F2 or (approved) modified F2 aggregate must be used. In conjunction with this an approved high specification drainage pipe with filter cloth surround such as the Megaflo products may be specified.

Light compaction (i.e. tamping with back of excavator bucket) only is to be applied to drainage aggregates.

6.7.2.3. Filter Cloth

Any filter cloth surround specified on the drawings shall meet the requirements of Transit Specification TNZ/F7, Filtration Class 2 and Strength Class B unless otherwise specified on the drawings.

6.7.2.4. Trench Backfill in Service Trenches

It is important on all sloping land that service trenches running parallel to contours are avoided where possible as they can permit the ingress of surface water and/or lateral movement of trench sides that could lead to progressive land slippage, help develop tension cracks and possibly lead to slope and building instability.

Backfilling of all trenches should be to the general fill standard above unless specifically varied in writing by the Geotechnical Engineer and where possible the pipe bedding in all trenches on steep ground should contain a 50mm diameter perforated drain coil that is connected into each manhole on the line. This is to help prevent instability arising from the ingress of surface water and/or lateral movement of trench sides that could lead to progressive land slippage and is especially important where the lines are in close proximity to buildings.

The subdivision drain laying contractor must be made aware of these requirements and of the need to contact us when trench backfilling is to take place.

6.7.3. Depth and Extent

The location, extent and depth of the drainage shown on the design drawings may be varied on site by the Geotechnical Engineer in response to the ground conditions encountered.

6.7.4. Drainage Outlets and Inspection Points

Outlets for subsurface drainage shall be provided at regular intervals as determined on site by the Geotechnical Engineer. Pipe outlets shall be specifically formed structures with adequate protection such as a headwall and/or rock rip rap as shown on the standard detail drawings. The position of all outlets shall be recorded on the asbuilt drawings.

Where possible it is good practice to include additional inspection and/or flushing points in the subsoil drainage system in the event that their performance needs to be confirmed in the future.

In any event, at least one temporary flush point is required for each subsoil drainage system to enable flushing of the system once the earthworks are substantially complete.

The flushing of the subsoil drainage system must be witnessed by the Geotechnical Engineer.

6.8. Finishing Works and Topsoil Spread

6.8.1. Overcut

All areas cut to below finished level should be reinstated with engineered filling to the satisfaction of the Geotechnical Engineer.

6.8.2. Topsoil Depth

Topsoil respread depth should be between 100mm and 300mm, or as directed by the Engineer to the contract. On ground steeper than 1V:3H the surface should be roughened under the supervision of the Geotechnical Engineer prior to topsoil placement.

6.8.3. Unsuitable Materials

At the conclusion of earthworks all surplus unsuitable materials should be removed from site or placed in designated permanent stockpiles. The size and location of such stockpiles must be approved by the Geotechnical Engineer and recorded on the asbuilt drawings.

6.8.4. Road Subgrades

Testing and formation of road subgrades will be carried out as part of the subdivision civil works package.

7. ASBUILT INFORMATION REQUIREMENTS

In order to provide a Geotechnical Completion Report (GCR) certain as-built information must be provided to CMW. It is the contractor's responsibility to ensure that all of the following items are surveyed prior to placing filling. The survey of these items should therefore form a hold point in the construction sequence.

1. The location and invert of all sub surface drainage; and,
2. The depth of filling placed including all benching, undercuts, shear or fill drainage keys and temporary ponds which have been backfilled.

CMW require the following as-built information to be provided for the GCR:

1. Cut and fill depth plan (including undercuts and shear keys).
2. Final contour plan.
3. Drainage locations and inverts (surface and subsurface).
4. Drainage outlet locations (surface and subsurface).
5. Details of any defined overland flow paths.
6. Location and heights of any palisade and retaining walls.
7. Material data for imported products used such as draincoils, aggregates and geofabrics as well as confirmation that products installed comply with the requirements of the project drawings and this specification; and,