INITIA
GEOTECHNICAL SPECIALISTS

Azuma Property Limited
Attention: Kallam Brown
By email: s 9(2)(a)

Our Reference: P -002658
31 January 2025

Dear Kallam

Waipiro Marina, Waipiro Bay, Bay of Islands
Geotechnical Desktop Assessment Report

1. Introduction

Initia Limited (Initia) has been engaged to undertake a preliminary desktop geotechnical assessment in relation to the proposed Waipiro Marina at Waipiro Bay in the Bay of Islands. This report is based on a review of publicly available information together and that held by Initia and provides comment on anticipated geotechnical considerations and risks for the development and associated potential mitigation measures. Recommendations for future work are also presented. Detailed geotechnical investigations and analysis will be required to characterise geotechnical conditions at the site and support all stages of design and construction.

2. Site Description

Waipiro Bay is located in the south-eastern part of the Bay of Islands approximately 9.5km east of Russell. The bay is east facing, with the proposed marina located in the western end of the bay. The site location is surrounded by steep, typically bush clad slopes to the north, west and south. The surrounding land is sparely developed with some residential developments together with accessways. The entrance road to the Omarino community runs north-south to the west of the site and forms the main site access. Based on the available Linz chart for the Bay of Islands, most of the marina is located above Chart Datum, with the eastern extent of the marina having a seabed about 3m below Chart Datum.

Based on a review of aerial photography the site has a broad intertidal zone with recent marine deposits exposed across most of the site at low tide.

3. Proposed Development

Based on the Bay of Islands Marina Consultant Briefing Document provided to us, dated May 2024, the project involves a 200+ berth marina, public boat launching and trailer parking, carparking and a marina building. The project involves a significant reclamation in the shallow intertidal zone together with dredging for the marina basin, berths and channel.

Figure 1: Proposed Marina Development

4. Published Geology

Based on the 1:250,000 geological map for the area, the land surrounding the site is mapped as Waipapa Group Sandstone and Siltstone (Greywacke), described as massive to thin bedded, lithic volcaniclastic metasandstone and argillite, with tectonically enclosed basalt, chert and siliceous argillite.

Greywacke rock is typically highly fractured and weathers to very stiff to hard silts and sandy silts near surface.

5. Anticipated Subsurface Conditions

No subsurface geotechnical investigation information is available at the site. Two well logs are available from the New Zealand Geotechnical Database approximately 900m to the north of the site at Pareanui Bay. These record Greywacke at depth. The Marina site itself is expected to be underlain by recent marine sediments of varying thickness (increasing in thickness away from the shoreline), overlying Greywacke rock at depth. Determining the thickness and nature of the marine sediments will be of primary importance for assessing geotechnical risks to the development and associated mitigation / design measures.

6. Significant Geotechnical Considerations and Further Work

This section discusses anticipated significant geotechnical considerations for the development together with recommendations for further geotechnical investigations to support design. It is noted

that no geotechnical investigation information available and, accordingly, the discussion below is of a general, conceptual nature only. The following geotechnical considerations are discussed below:

- Site seismicity and Liquefaction;
- Proposed Reclamation earthworks and stability;
- Consolidation settlement;
- Further work.

6.1 Site Seismicity and liquefaction

Northland is considered to be a low seismic hazard area. No active faults are mapped within the region, with it is generally considered to be tectonically stable. Accordingly geotechnical risks associated with seismic hazards are also considered to be low. It is noted however that currently accepted New Zealand standards and guidelines require designing for a minimum seismic hazard level, regardless of location within New Zealand. This minimum level is still relatively low, but significantly higher than the seismic hazard at the subject site. The most significant potential geotechnical risk for the development associated with seismic hazard is liquefaction.

Liquefaction is triggered by earthquake shaking and can occur in saturated, loose sandy deposits. Liquefaction results in a significant loss of soil strength and can lead to settlement, lateral ground movement and slope instability. The marine sediments at the site may be susceptible to liquefaction; this will need to be confirmed by specific geotechnical investigations. Based on the actual seismicity at the site, the liquefaction risk is expected to be low, however it is possible that liquefaction in the marine sediments could be triggered under the minimum seismic hazard level earthquake required to be considered for design. If a potential liquefaction hazard is confirmed, the most significant consequence that will require consideration is stability of the proposed reclamation batter slopes during earthquake shaking. If considered necessary, various design details or ground improvement methods are available to mitigate this risk, depending on the specific geotechnical conditions encountered. Likely mitigation measures could include:

- Sub excavation/dredging of potentially liquefiable deposits beneath the reclamation. It is likely that, if required such works would be limited to a zone/strip around the reclamation perimeter. The feasibility of this option would depend on the depth of liquefiable deposits.
- Perimeter ground improvement beneath the outer batters of the reclamation. This could include the installation of a grid of stone columns or other rigid inclusions, or alternatively dynamic compaction could be considered.

The choice of appropriate ground improvement technique depends on the nature and depth of the deposits being treated and the level of improvement required. Following geotechnical investigations, various options would be able to be confirmed in more detail. A combination of options may also be able to be considered.

6.2 Proposed Reclamation Earthworks and Stability

A significant reclamation is proposed as part of the development. No earthworks volumes or levels have been developed at this stage, reclamation in the tens of thousands of cubic metres is anticipated. Fill material for the reclamation is expected to be derived either from the required dredging of the marina basin, or offsite (or from a combination of the two).

Where site won marine sediments are used in the reclamation it is likely that, at least in part, these will require improvement/conditioning for placement. Typically this involves the addition of cement to the dredgings to form a soil cement slurry (commonly termed Mudcrete). Cement dosage rates are material dependent and so would be confirmed following laboratory testing and site trials. Cement dosage rates can also be varied by zoning the reclamation, with higher dosage rates typically around the

perimeter where higher strengths are required, and lower (or no) treatment within the centre of the reclamation.

Imported fill materials would likely be supplied from a local quarry or borrow area. Hard rock from surrounding greywacke sources (e.g. the Russell Quarry) would likely be suitable for all components of the reclamation. Typically coarser graded, higher quality material would be used in the base of the reclamation, where compaction is more difficult, with a wider variety of materials able to be used higher up within the reclamation, depending on specific design requirements.

Stability of the reclamation batters will be subject to detailed analysis during the design phase of the project. Depending on the natural of the subgrade materials on which the reclamation is placed, no specific ground improvement or stabilisation measures of the underlying soils may be required for stability. However, if the underlying soils are soft clays, some perimeter treatment may be required. This could include sub-excavation/dredging (similar to the mitigation measure described for liquefaction mitigation above). Alternatively driven timber piles around the perimeter may be a suitable stabilisation option (as has been used recently at a marina project in Northland on very soft, deep alluvial deposits).

6.3 Settlement

The proposed reclamation will impose significant loads on the underlying marine sediments which may give rise to consolidation settlement. This will depend on the nature and thickness of the underlying deposits. Given the reclamation is predominantly to be used for carparking and access, significant settlement may be able to be tolerated provided it is adequately designed for (e.g. by allowing for sufficient grades on gravity stormwater/wastewater services). Alternatively, it may be sufficient to undertake settlement monitoring of the reclamation following bulk filling, with the installation of underground services and surfacing of the pavement delayed until settlement has ceased or rates are sufficiently low.

Various ground improvement techniques to mitigate settlement risk are also available, and design of these would be subject to analysis following geotechnical investigations.

6.4 Further Work

As presented above, a number of significant geotechnical considerations have been identified, which are primarily associated with the proposed reclamation. Various conventional construction and ground improvement techniques are available to address these risks, should they be confirmed, with the selection of appropriate design and ground improvement details dependant on the results of specific geotechnical investigations (as well as consideration of other project requirements such as programme). In order to progress the design a comprehensive geotechnical investigation will be required, and is expected to include:

- Machine boreholes to recover continuous core samples of the underlying soil and rock units;
- Cone Penetration tests (CPTs) to allow an assessment of liquefaction susceptibility and to also provide information for the assessment of settlement and reclamation stability;
- Shallow investigations (e.g. using hand augers or machine excavated test pits) to supplement the above deep investigations;
- Laboratory testing to classify the encountered materials and to aid in liquefaction, stability and settlement analyses. Laboratory testing will also be of value in assessing the dredge material for use as fill within the reclamation.

7. Applicability

This letter has been prepared for Azuma Property Limited, with respect to the brief provided to us. The advice and recommendations presented in this report should not be applied to any other project or used in any other context without prior written approval from Initia Limited.

Your sincerely,

Matthew Wansbone
Senior Geotechnical Engineer