PRELIMINARY ACID SULPHATE SOIL ASSESSMENT

PRELIMINARY ACID SULPHATE REPORT

Proposed Residential Sub-Division
45/49 Warriewood Road, Warriewood, NSW

Report To:

Mikara Developments Pty Ltd $^{C}/_{O}$

CPS

Report By:

NG Child & Associates

16 November 2021

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TABLE OF CONTENTS

APPENDICES

LIST OF DIAGRAMS

LIST OF TABLES

1 INTRODUCTION

1.1 INTRODUCTION

Creative Planning Solutions (CPS), on behalf of its client Mikara Developments Pty Ltd, is coordinating the planning and prospective delivery of a residential sub-division and development at 45/49 Warriewood Road, Warriewood, NSW.

The proposed development site is described in 1.2 to 1.5 below.

The proposed development is subject to the regulatory control of the Northern Beaches Council, and relevant NSW Government departments and agencies.

Northern Beaches Council is the consent authority for the development.

CPS has engaged NG Child & Associates to prepare this revised version of a Preliminary Acid Sulphate Soil Assessment of the site to originally undertaken in February 2020 as part of a process to confirm the suitability of soil quality at the site for the proposed residential land use.

This revised report includes the final plans and drawings for the development and will form part of the Development Application (DA) for the project.

Noel Child of NG Child & Associates is an appropriately qualified and experienced person to undertake the work required.

His experience and qualifications are summarised in Appendix C.

This document described the Preliminary Acid Sulphate Soil Assessment undertaken at the 45/49 Warriewood Road Warriewood site and presents its findings and recommendations.

1.2 PROPOSED LOCATION

Recent satellite views and street maps showing the location of the proposed development are provided in Figures 1.1 and 1.2 respectively on the following page.

The direction of north is towards the top of both diagrams.

The site area is shown shaded in blue in both diagrams.

The proposed development site is bounded by Warriewood Road to the north; by prospective or existing residential developments to the east and west, and by Narrabeen Creek to the south and south-west.

The closest major road is Pittwater Road, some 50 metres to the east of the site.

Figure 1.1 – Aerial View of the Proposed Development Site

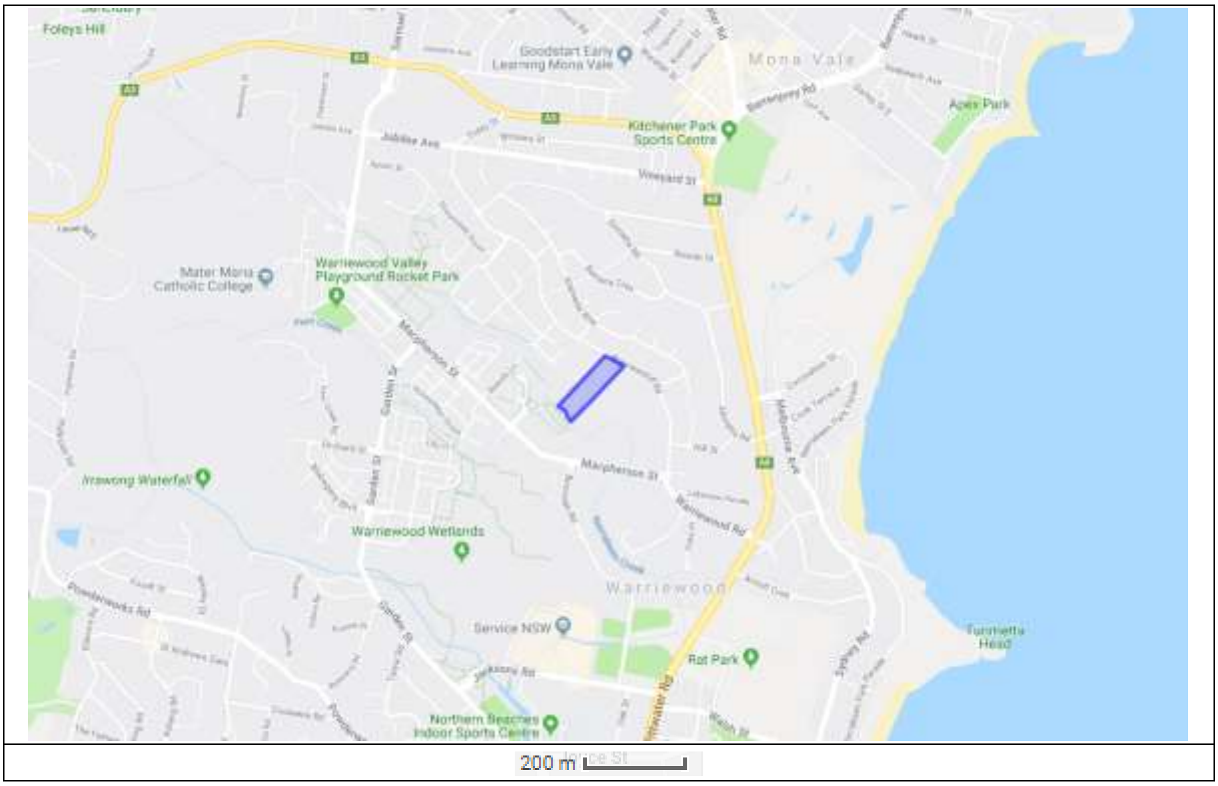


Figure 1.2 – Street Map Showing the Site Location

Views of the site from Warriewood Road, are provided in Figures 1.3 and 1.4, below.

Figure 1.3 – Existing Buildings and Structures on 49 Warriewood Road

Figure 1.4 – Existing Buildings and Structures on 45 Warriewood Road

1.3 ZONING

The zoning of the proposed development site, and surrounding properties, is shown in Figure 1.4, below.

Figure 1.5 – Land Zoning Diagram

The diagram provided in Figure 1.4 is sourced from the current Northern Beaches Local Environment Plan. The site is shown at the approximate centre of Figure 1.4 and is zoned R3 Medium Density Residential.

Immediate surrounding land is also zoned R3 Medium Density Residential, with R2 low density residential land present on the opposite (northern) side of Warriewood Road, and a strip of public recreation land along the creek line bordering the site to the south.

1.4 PROPERTY DETAILS

Survey details of the site are provided for reference in Figures 1.5 and 1.6, on the following pages. The site formally comprises Lots 1 & 2 in Deposited Plan (DP) 349085 and Lot 2 in DP 972209, and is known as 43, 35 & 49 Warriewood Road, Warriewood.

The aggregate site has an approximate area of 21,500 square metres.

2 PROJECT DESCRIPTION & PLAN

This proposed development involves a residential subdivision and development.

Site survey details are as follows:

Figure 2.1	Site Survey (Sheet 1 of 2)
Figure 2.2	Site Survey (Sheet 2 of 2)
Figure 2.3	Site Analysis
Figure 2.4	Site Plan
Figure 2.5	Basement Plan
Figure 2.6	Ground Floor Plan
Figure 2.7	First Floor Plan
Figure 2.8	Second Floor Plan
Figure 2.9	Roof Plan
Figure 2.10	Elevations 01
Figure 2.11	Elevations 02
Figure 2.12	Elevations 03
Figure 2.13	Section AA
Figure 2.14	Section BB
Figure 2.15	Demolition Plan
Figure 2.16	3D Height Envelope
Figure 2.17	Views

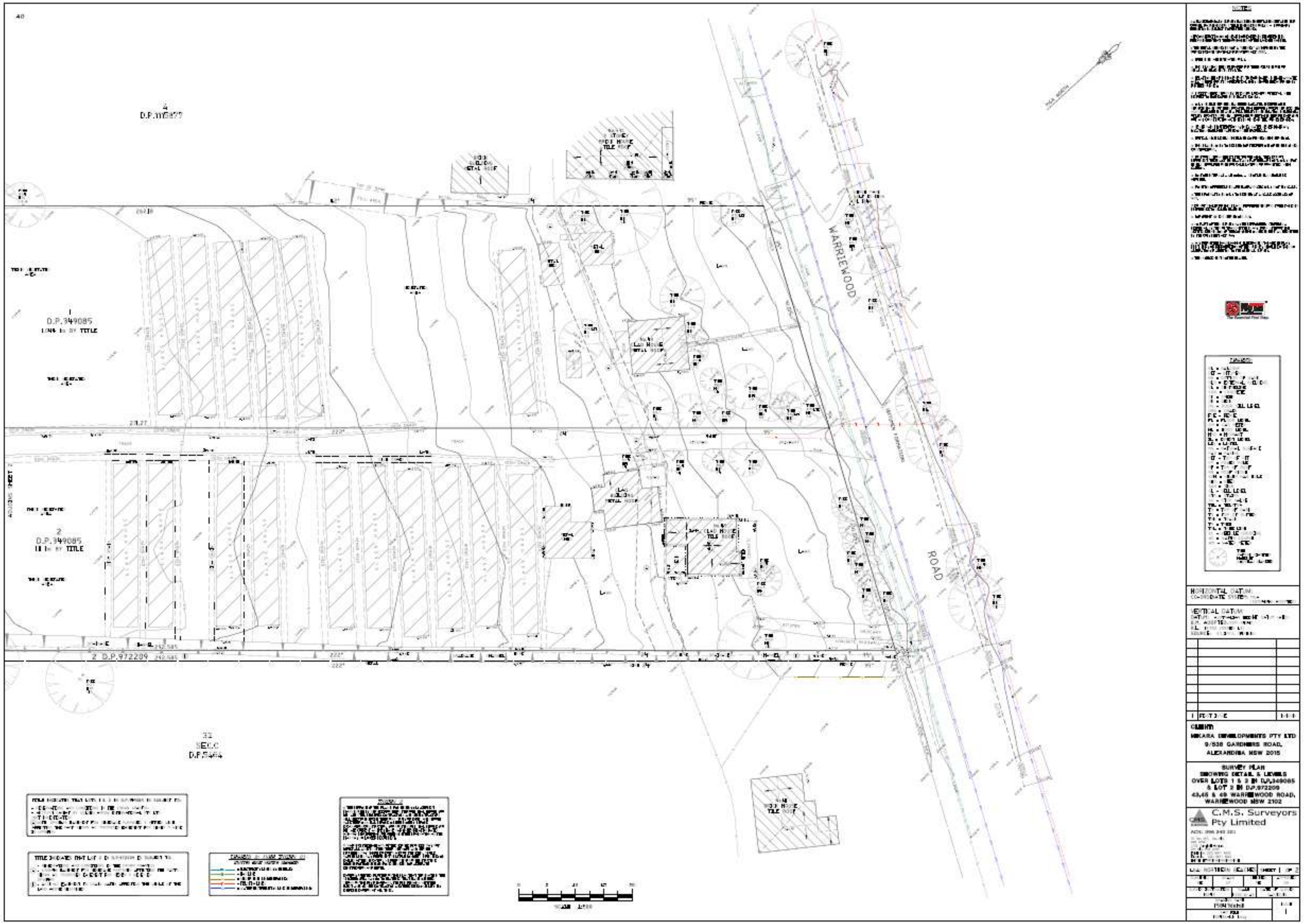


Figure 2.1 – Site Survey (Sheet 1 of 2)

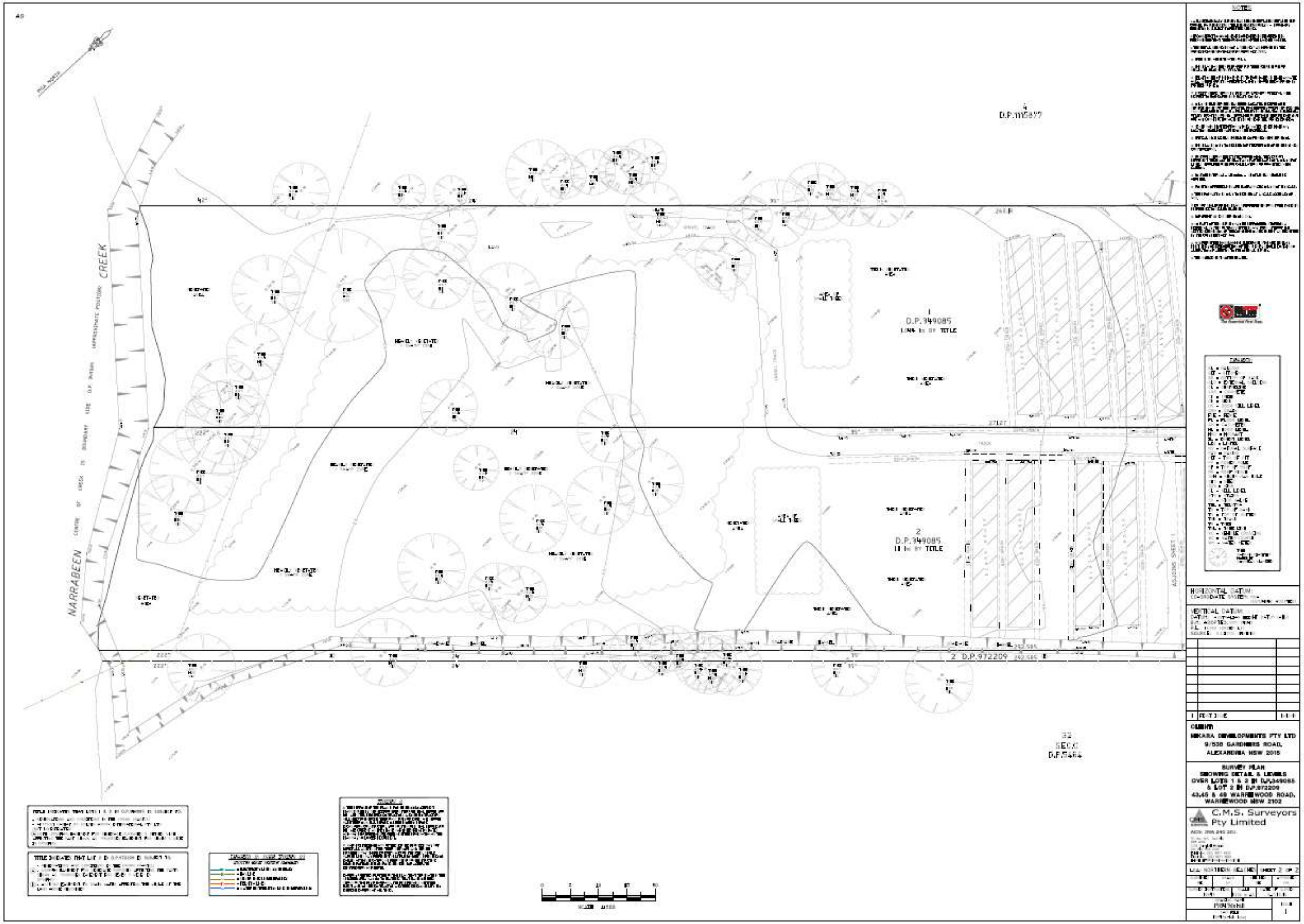


Figure 2.2 – Site Survey (Sheet 2 of 2)

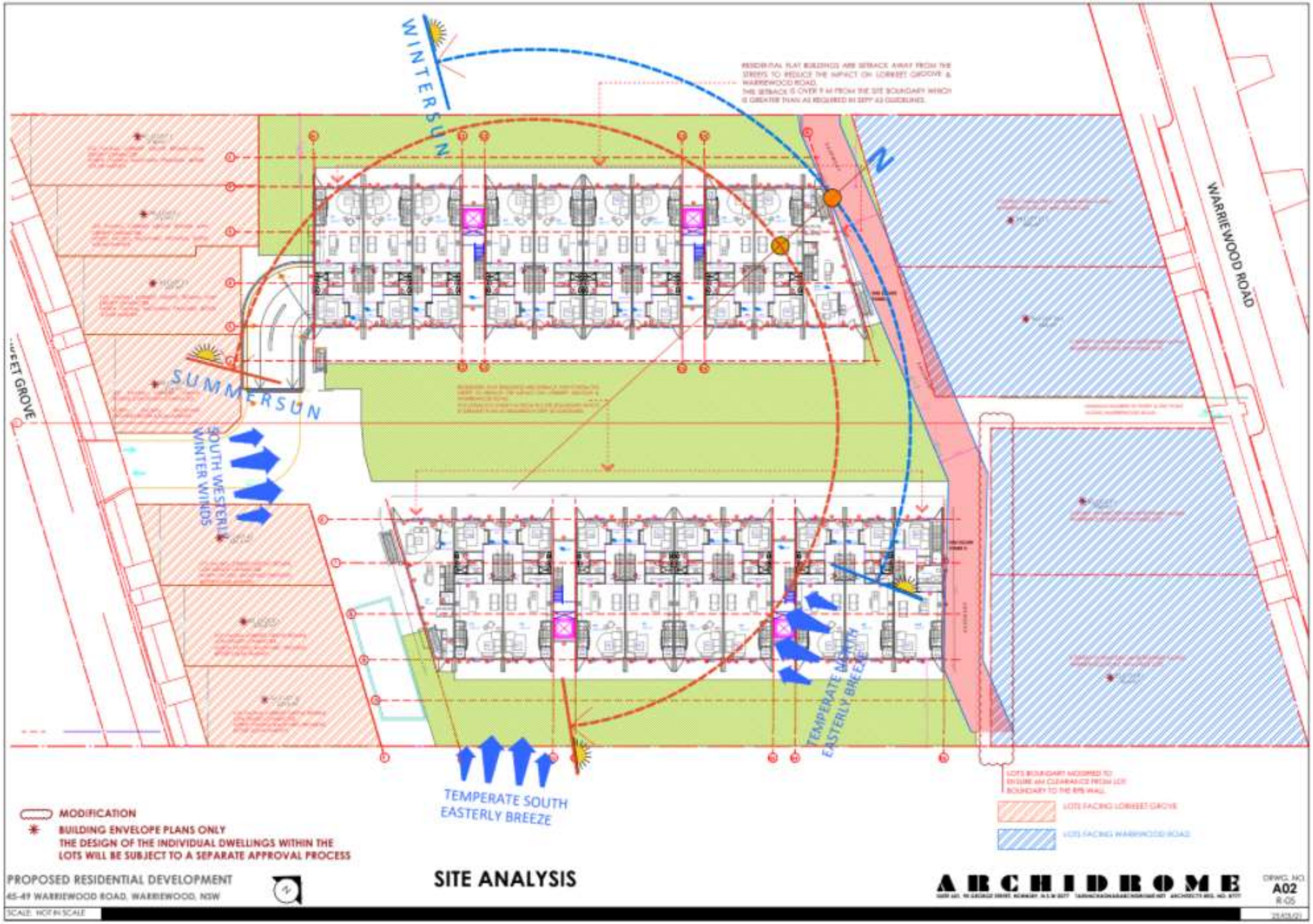


Figure 2.3 – Site Analysis

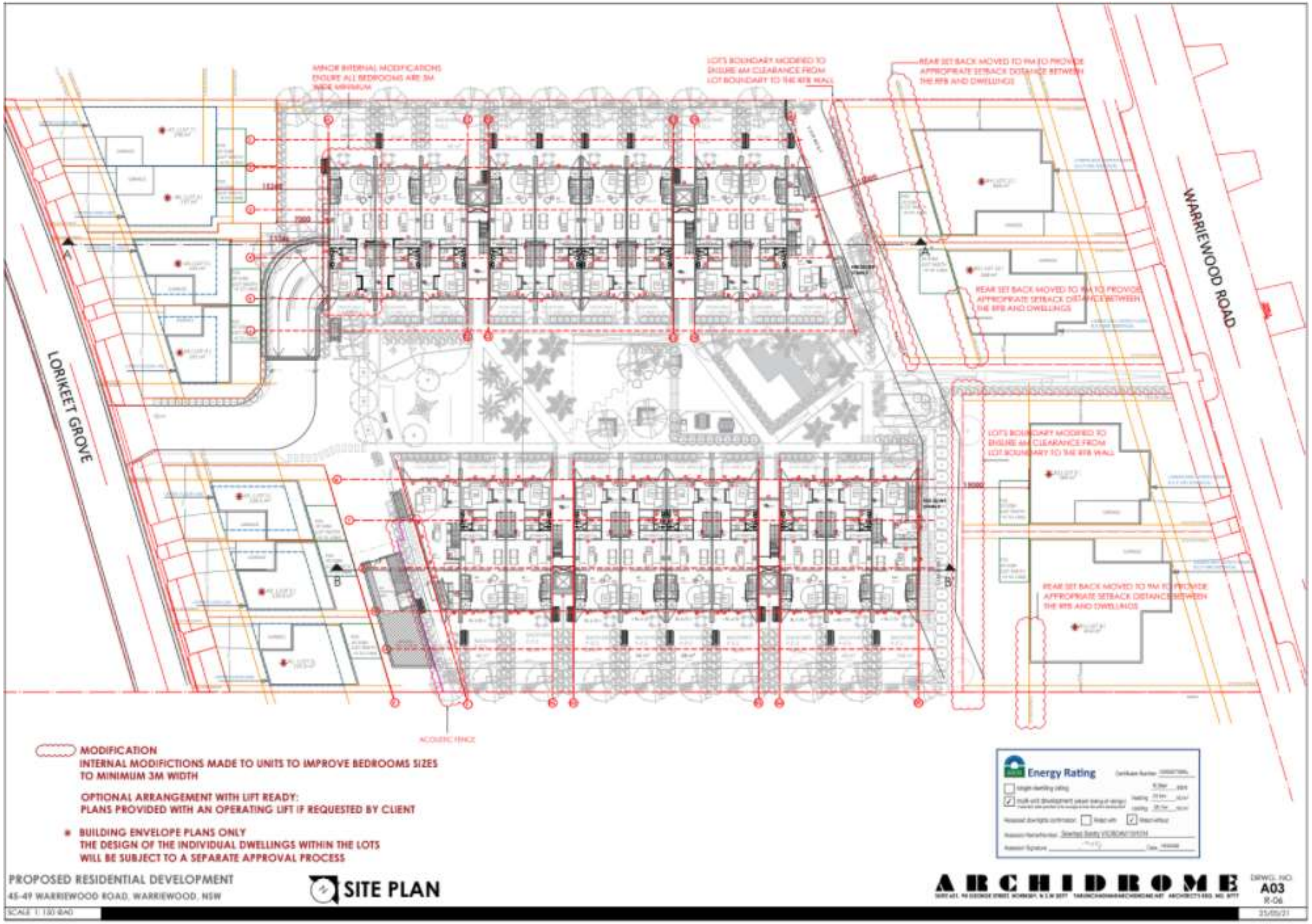


Figure 2.4 – Site Plan

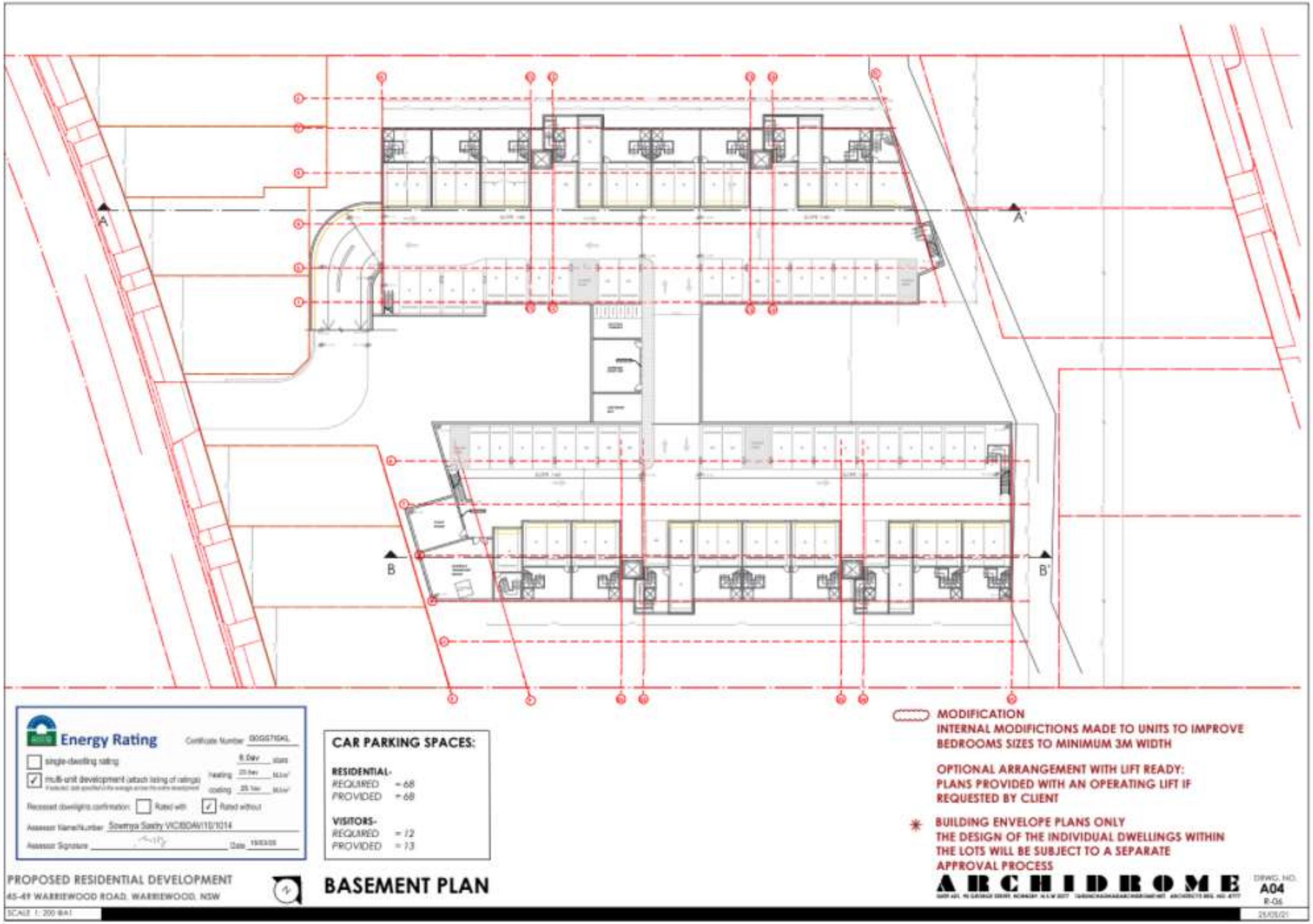


Figure 2.5 – Basement Plan

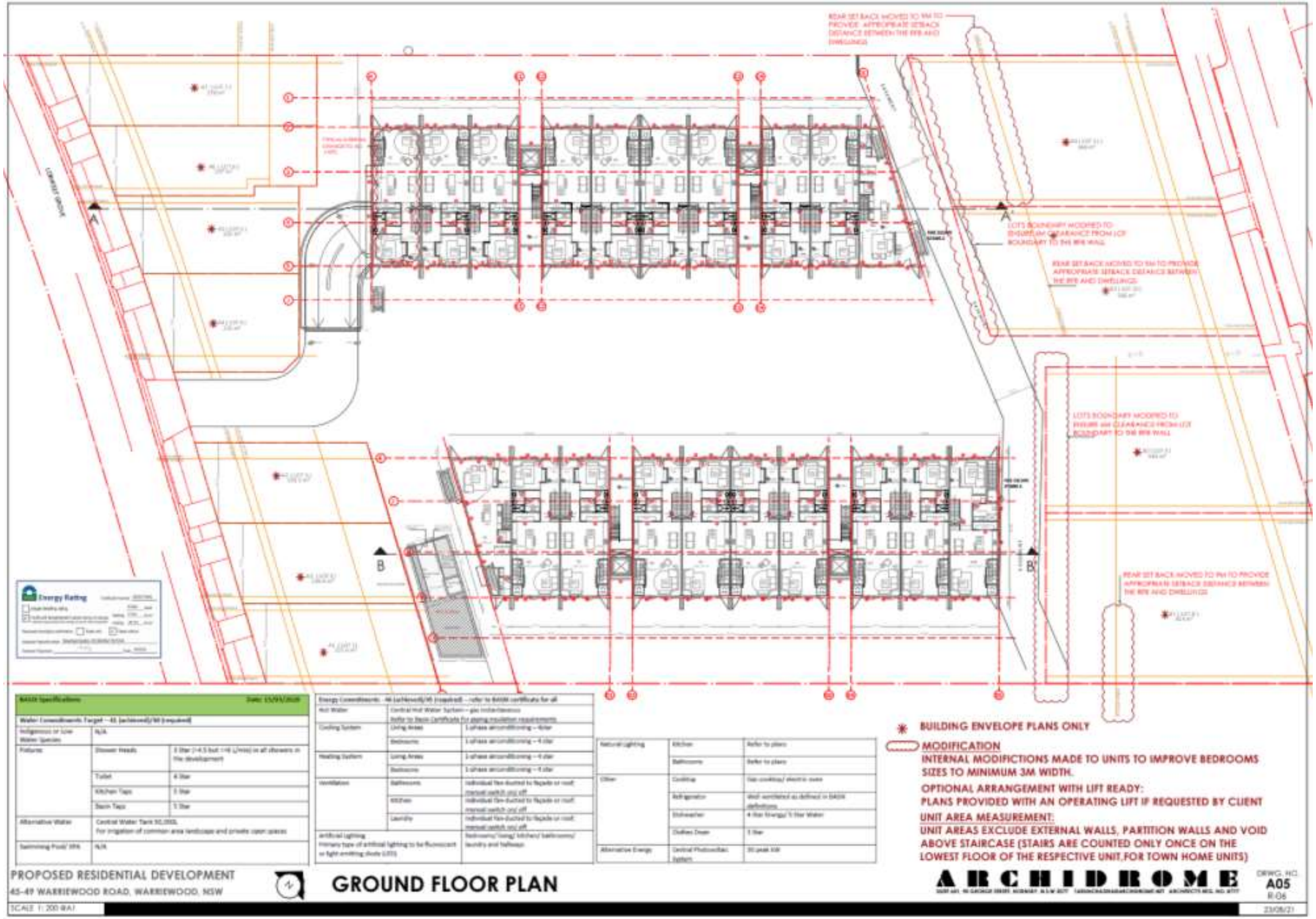


Figure 2.6 – Ground Floor Plan

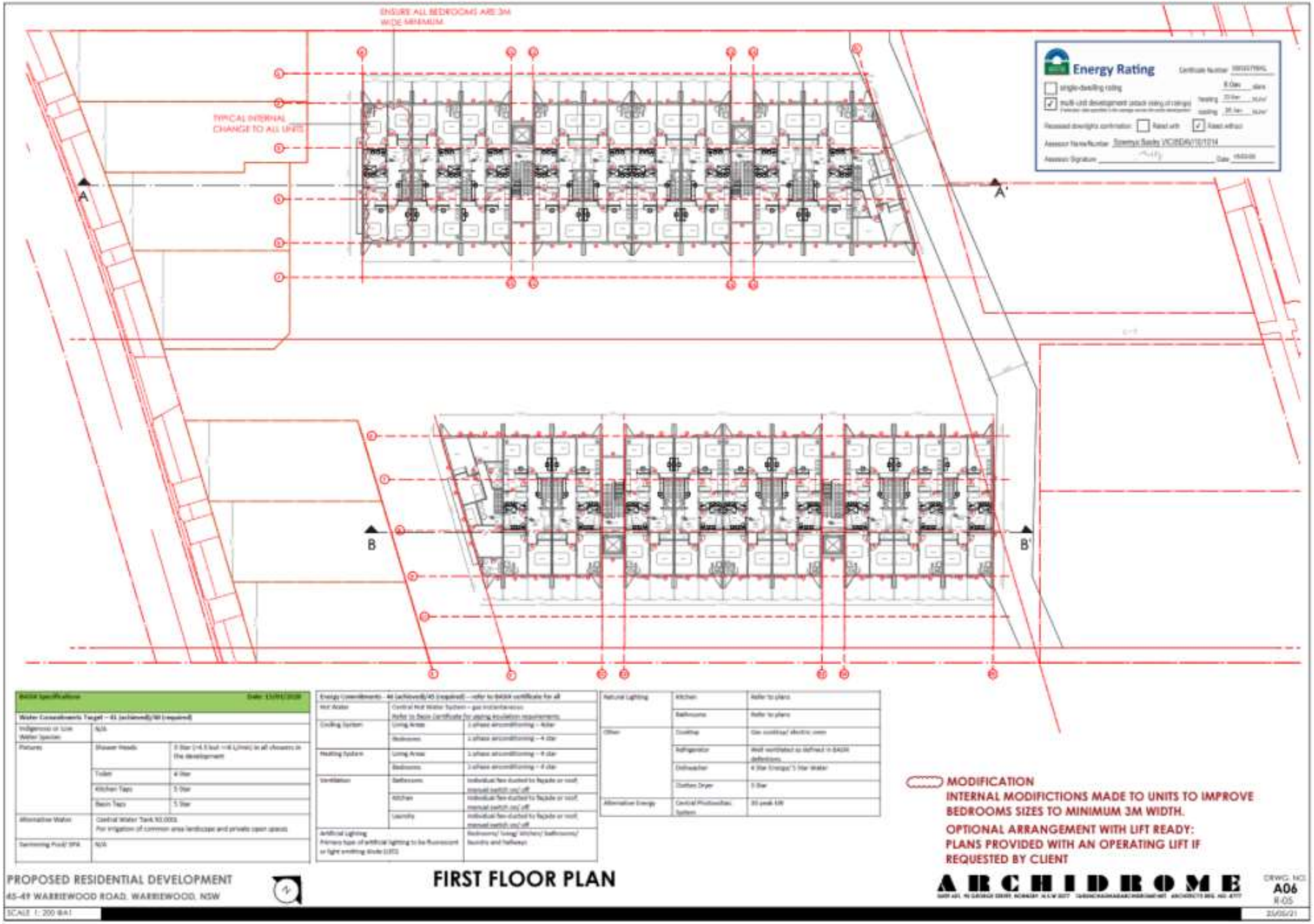


Figure 2.7 – First Floor Plan

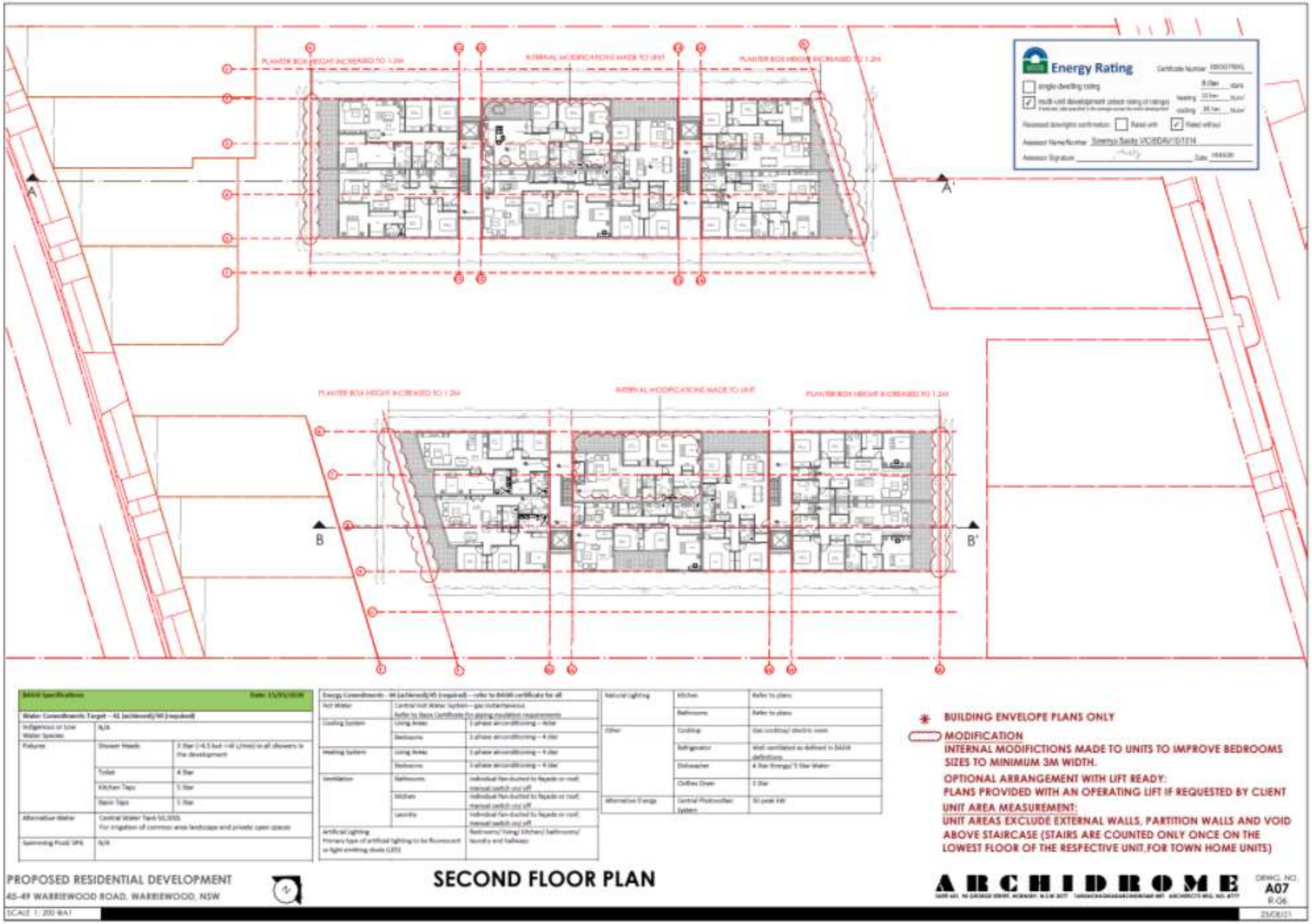


Figure 2.8 – Second Floor Plan

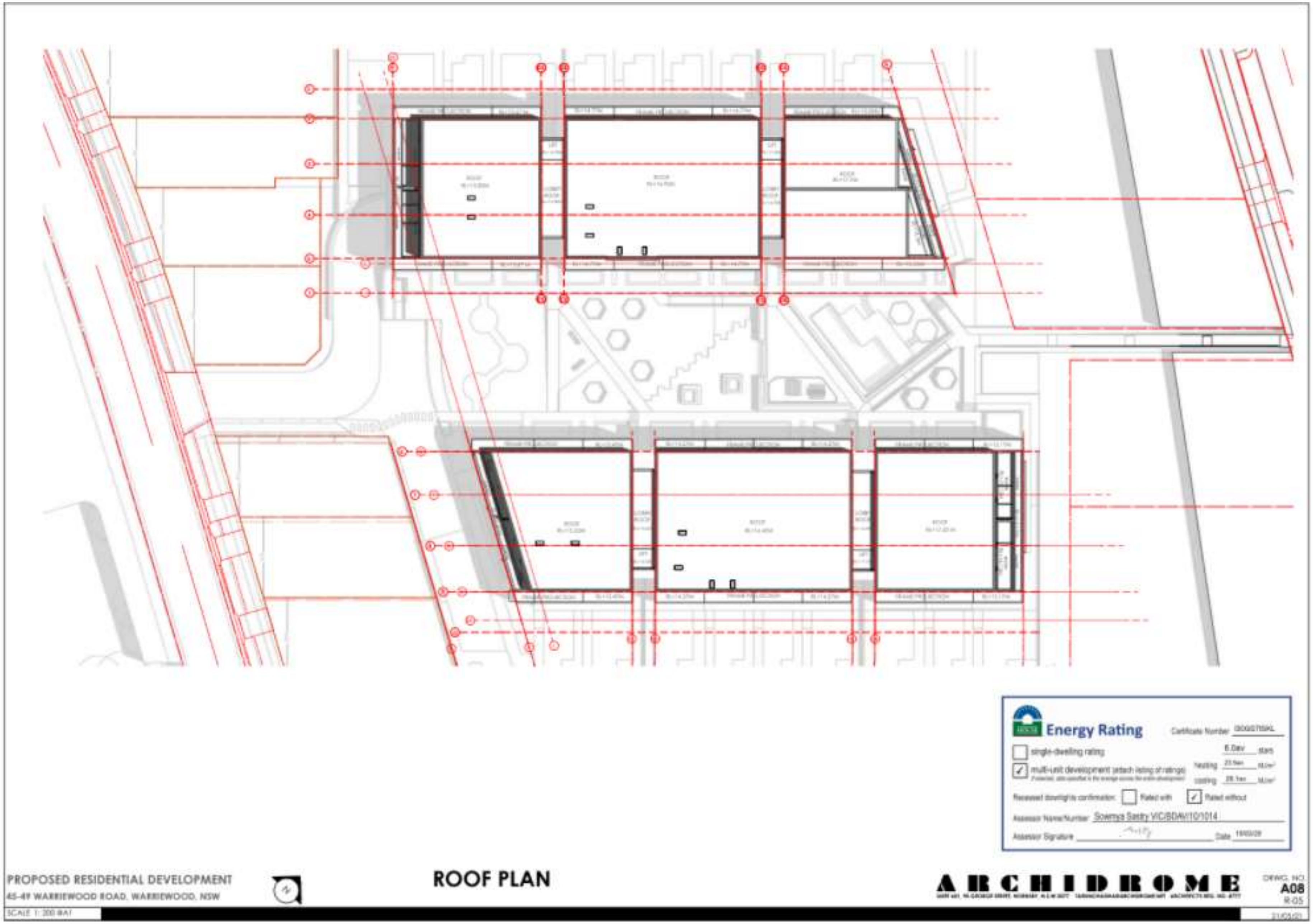


Figure 2.9 – Roof Plan

Figure 2.10 – Elevations 01

Figure 2.11 – Elevations 02

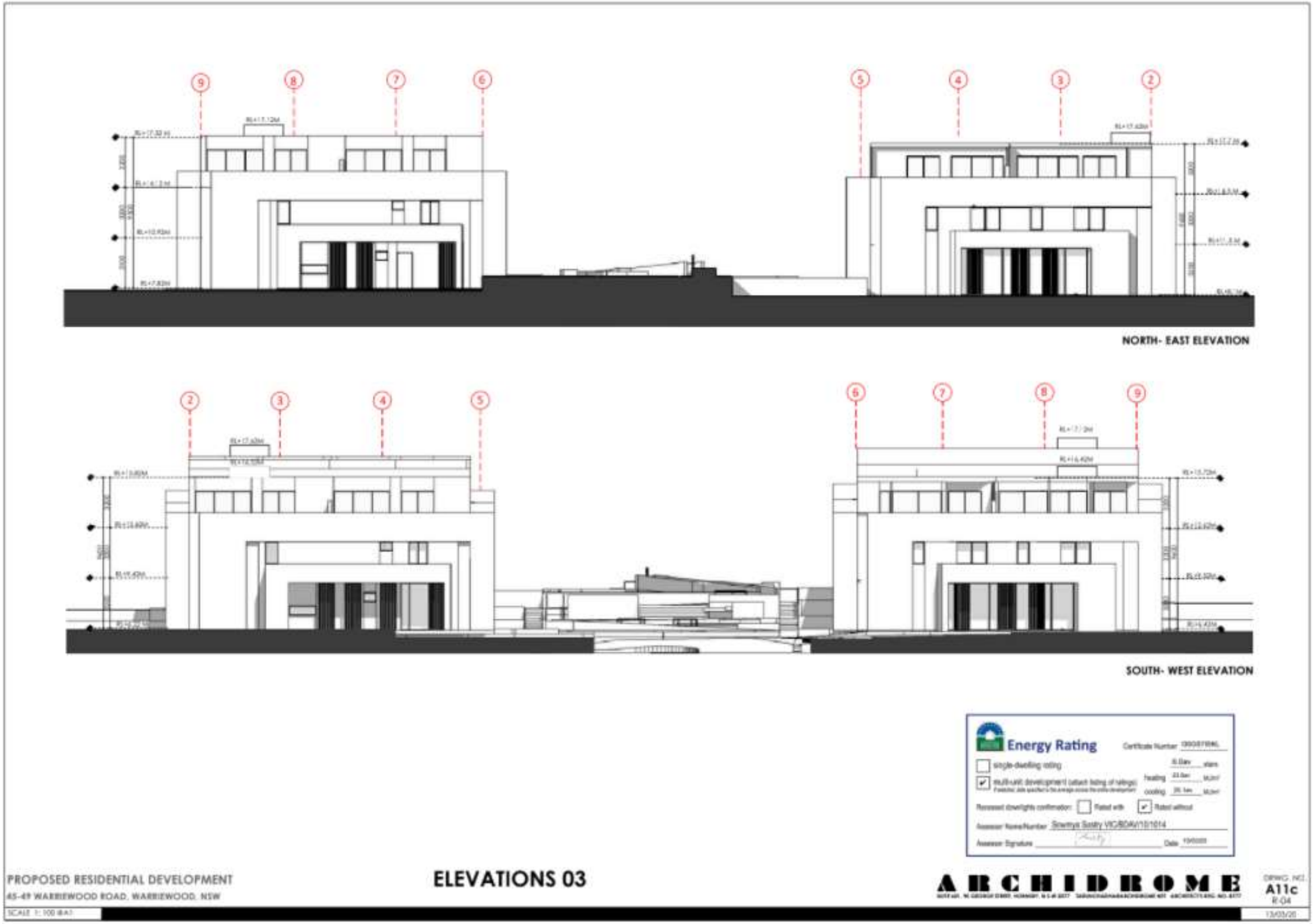


Figure 2.12 – Elevations 03

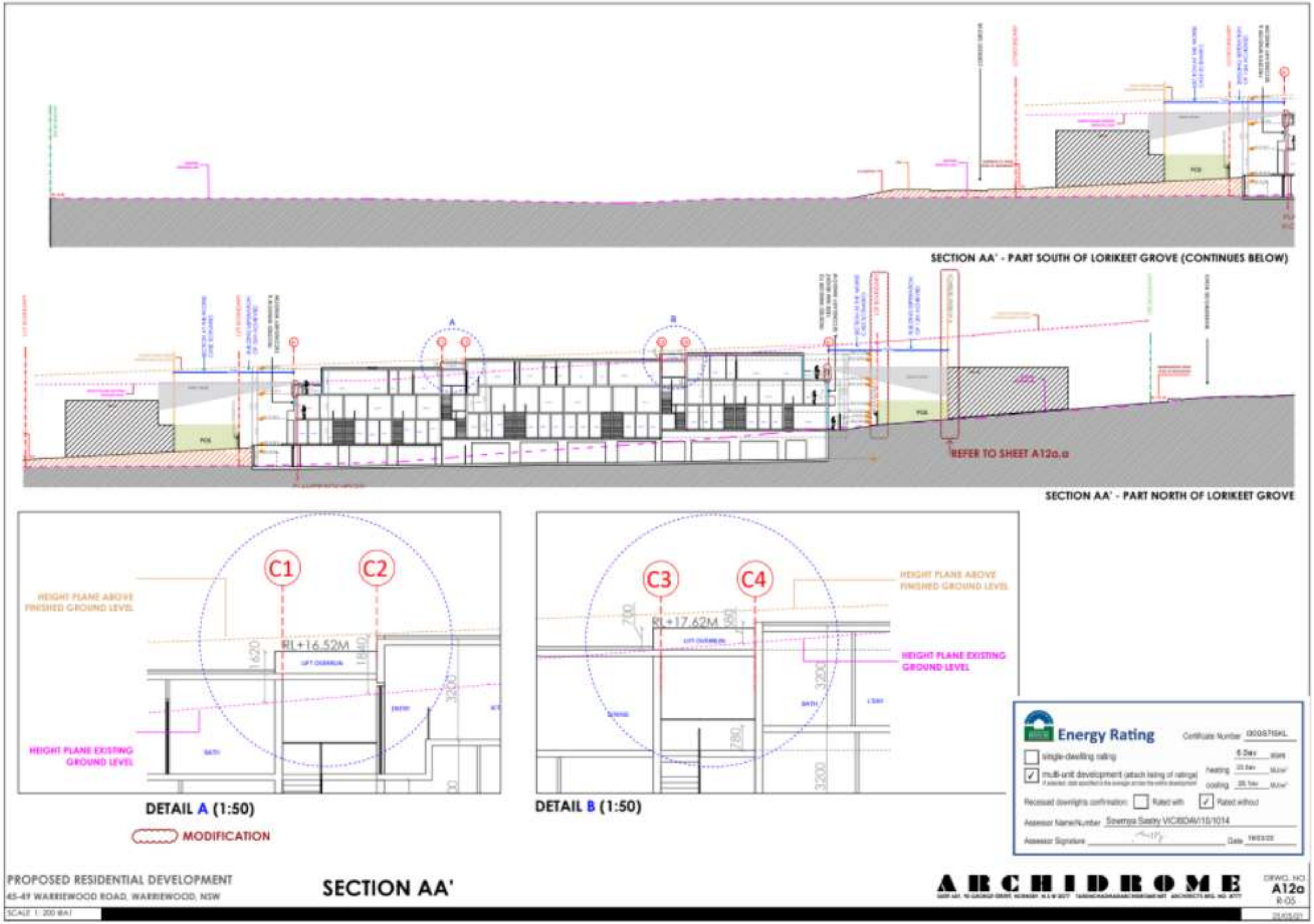


Figure 2.13 – Section AA

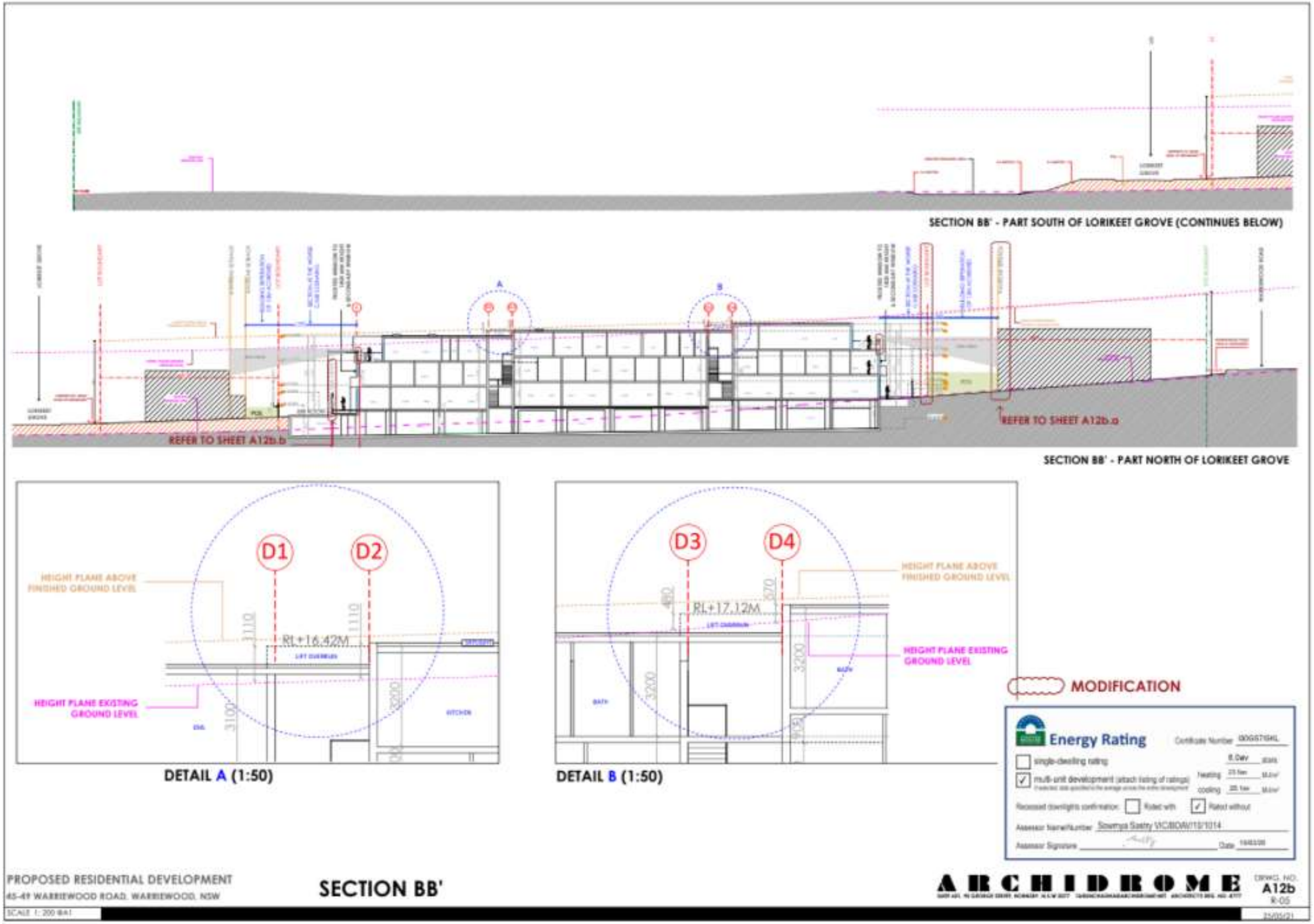


Figure 2.14 – Section BB

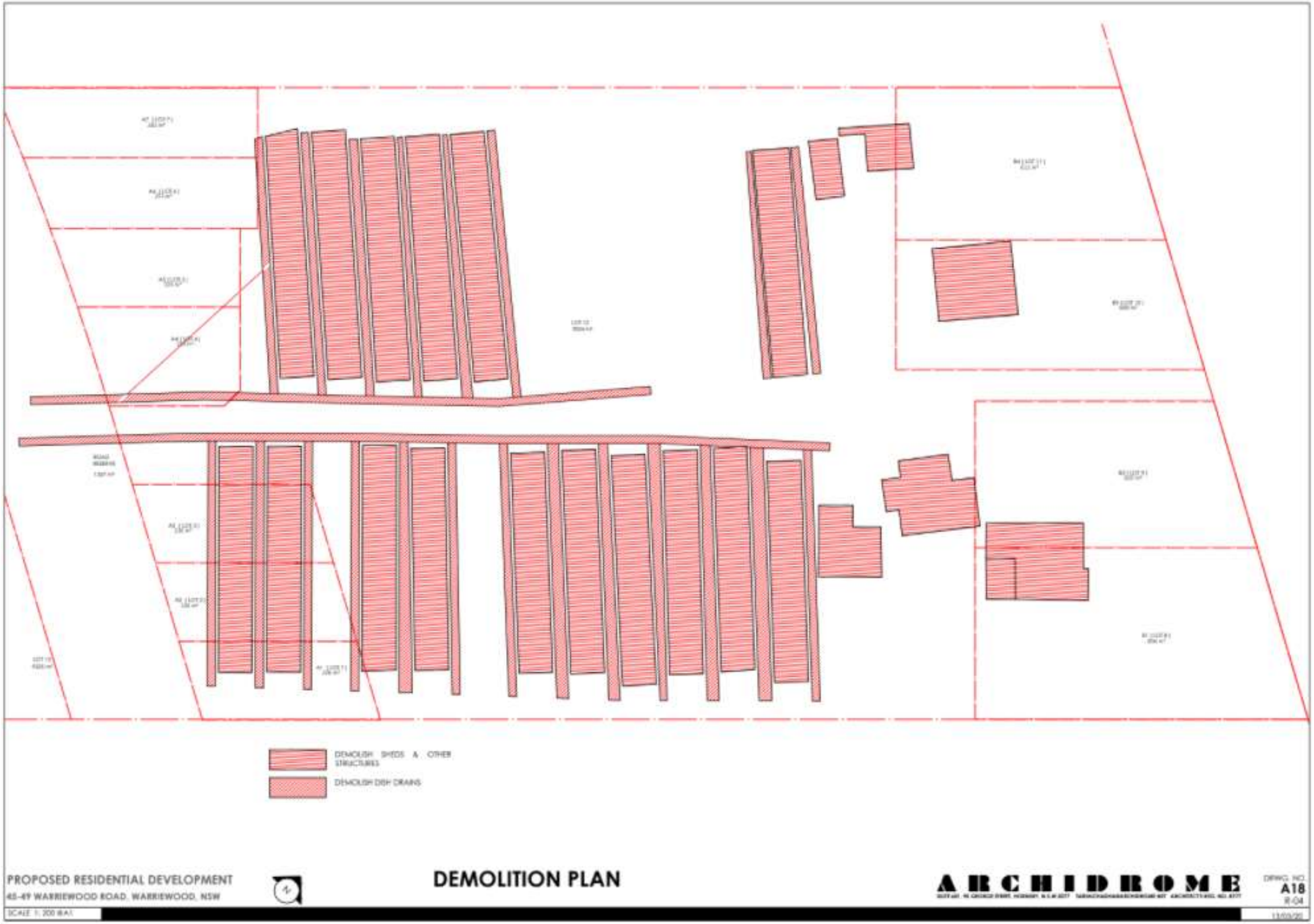


Figure 2.15 – Demolition Plan

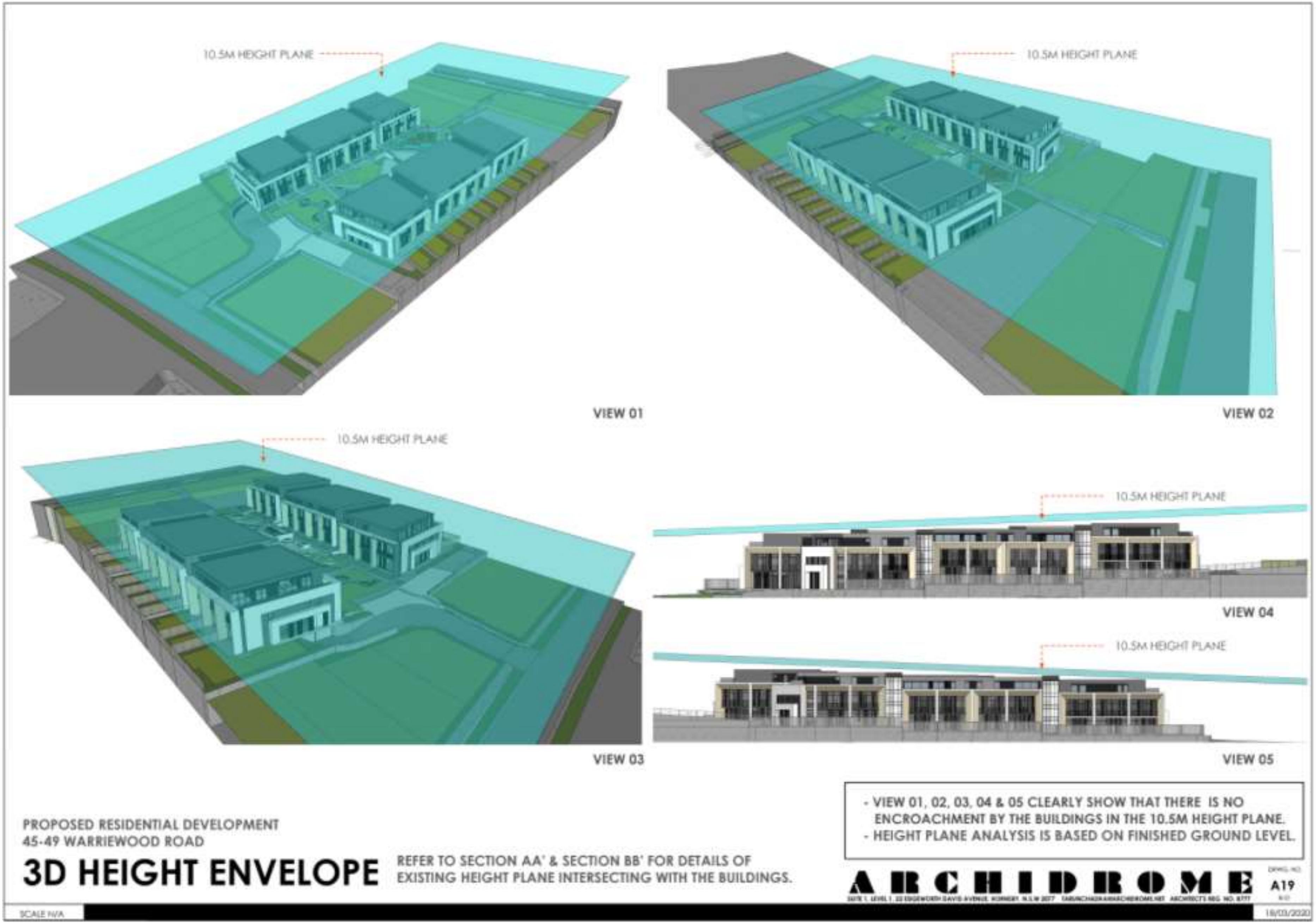


Figure 2.16 – 3D Height Envelope

Figure 2.17 – Views

3 PURPOSE & SCOPE

3.1 SITE INVESTIGATION

An acid sulphate soil assessment involves both physical (background investigations and site inspections) and chemical (laboratory) assessments. Background investigation and site inspection tasks include:

- Careful inspection of the entire site surface to identify any physical indications of acid sulphate soil (refer Section 2);
- Review and consideration of any past uses or activities that may involve risks or acid sulphate soil generation; and
- Physical examination and testing of soil samples in the field.

3.2 SUPPORTING LABORATORY ANALYSIS

Supporting laboratory analysis includes:

- Soil sampling to appropriate depth at five representative locations throughout the site; and
- Supporting laboratory analysis for chemical indicators of acid sulphate soil in accordance with the guidelines *Environment Protection Authority document Acid Sulphate Soils: Assessment and Management Technical – Ac. Acid Sulphate Manual 1998* and *NSW Acid Sulphate Soil Management Advisory Committee – Acid Sulphate Soil Manual* which indicate that indicate the oxidation of pyrite (or actual acid sulphate (AASS) soil conditions) occur when the pH of soil in water is less than 4.0 and potential for forming acidic conditions is present when the pH in peroxide is less than 3.0 or when the difference between the pH of soils in water and peroxide is greater than 1. Chemical analysis will therefore involve:

EA029-A: pH Measurements
pH KCl (23A)
pH OX (23B)
EA029-B: Acidity Trail
Titratable Actual Acidity (23F)
Titratable Peroxide Acidity (23G)
Titratable Sulfidic Acidity (23H)
sulfidic - Titratable Actual Acidity (s-23F)
sulfidic - Titratable Peroxide Acidity (s-23G)
sulfidic - Titratable Sulfidic Acidity (s-23H)
E029C: Sulphur Trail
KCl Extractable Sulfur (23Ce)
Peroxide Sulphur (23d)
Peroxide Ooxidisable Sulphur (23e)
acidity – peroxide oxidisablke sulphur (a-23e)
Calcium Values
KCl Extractable Calcium (23Vh)
Peroxide Calcium (23Wh)
Acid Reacted Calcium (23X)
Acidity – Acid Reacted Calcium (a-23X)
Sulphidic – Acid Reacted calcium (s-23X)
Magnesium Values
KCl Extractable Magnesium (23Sm)
Peroxide Magnesium (23Tm)
Acid Reacted Magnesium (23U)
Acidity – Acid Reacted Magnesium (a-23U)
Sulphidic – Acid Reacted Magnesium (s-23U)
EA 029H: Acid based Accounting
CAN Fineness Factor
Net Acidity – Sulphur Units
Net Acidity – Acidity Units
Net Acidity excluding ANC – Sulphur Units
Net Acidity excluding ANC – Acidity Units
Limiting Rate excluding ANC

4 ASSESSMENT GUIDELINES

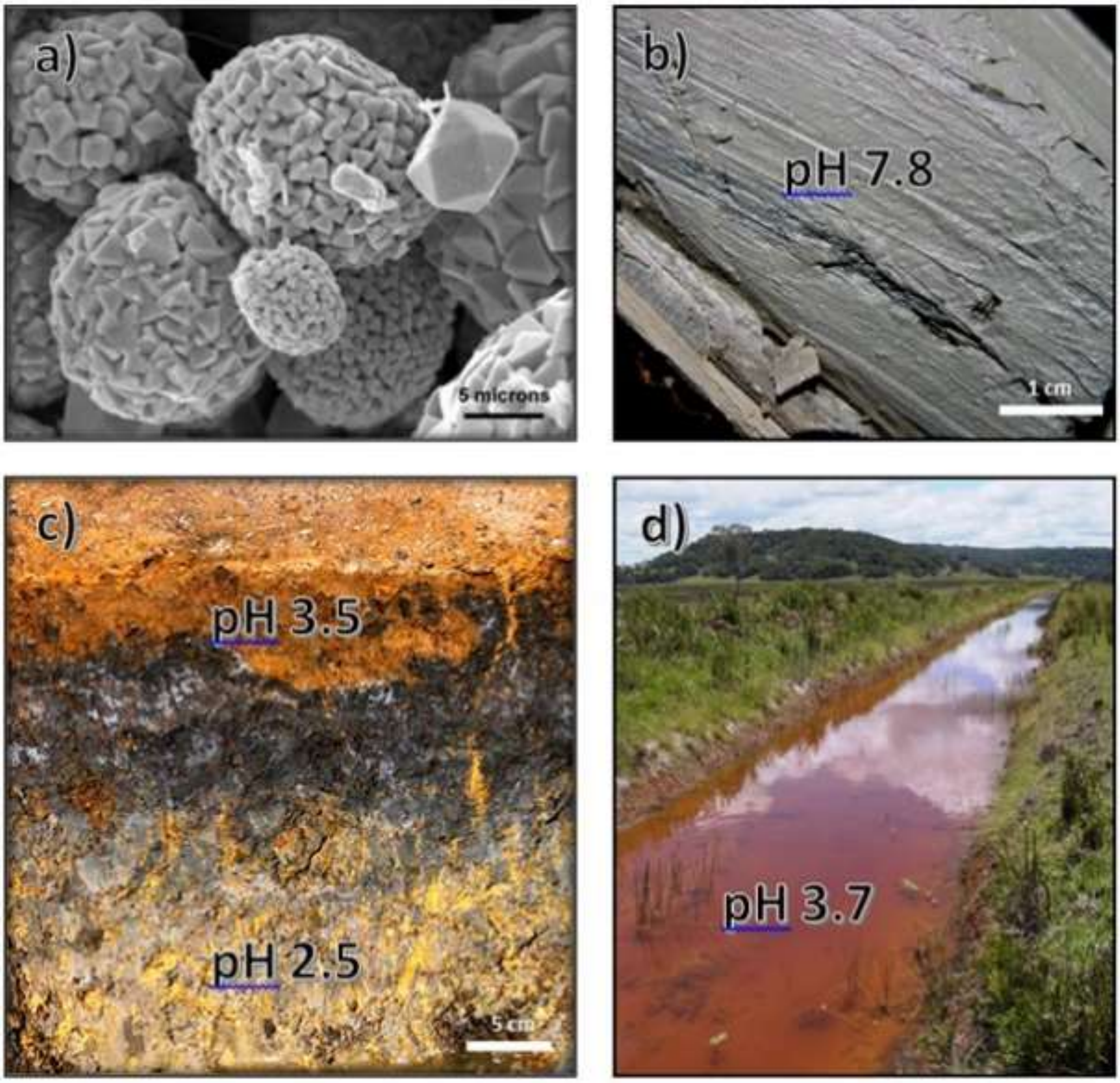
4.1 INTRODUCTION

Guidelines for the acid sulphate soil assessment of land are presented in the Australian Government document *National Acid Sulphate Soils Guidance: National acid sulphate soils sampling and identification methods manual; Water Quality Australia; June 2018*.

Those guidelines have been taken into account in this preliminary assessment.

4.2 DEFINING ACID SULPHATE SOILS

Acid sulphate soil (ASS) materials are distinguished from other soil or sediment materials (referred to as "soil materials" in this document) by having properties and behaviour that have either: 1) been affected considerably by the oxidation of Reduced Inorganic Sulphur (RIS), or 2) the capacity to be affected considerably by the oxidation of their RIS constituents (Figure 4.1). The factor common to all ASS materials is that RIS components have either had, or may have, a major influence on the properties or behaviour of these soil materials. These soils are typically found in low-lying coastal areas and saline inland areas however, they have been identified in a wide range of environmental settings.



Note: a) PASS containing framboidal pyrite (FeS_2) crystals. b) Blue-greenish grey PASS. c) AASS profile showing surficial iron oxide and yellow jarosite segregations. d) Iron staining (by schwertmannite and goethite) of a drain in an ASS landscape. Source: National Acid Sulphate Soils Guidance

Figure 4.1 - Examples of Acid Sulphate Soils

In a waterlogged anoxic state (that is depleted of dissolved oxygen), these materials remain benign and do not pose a significant hazard to human health or the environment. However, ASS disturbance, and exposure to oxygen, may result in a wide range of environmental hazards, including:

- severe acidification of soil and drainage waters (below pH 4 and often pH less than 3),
- mobilisation of metals (for example iron, aluminium, copper, cobalt, zinc), metalloids (for example arsenic), nutrients (for example phosphate) and rare earth elements,
- deoxygenation of water bodies, • production of noxious gases (for example hydrogen sulfide),
- production of greenhouse gases, and
- scalding (that is de-vegetation) of landscapes.

These hazards have the potential to cause a number of significant environmental and economic impacts such as fish kills, loss of biodiversity in wetlands and waterways, contamination of groundwater resources, loss of agricultural productivity, and corrosion of concrete and steel infrastructure.

Acid sulphate soil materials include Potential acid sulphate soils (PASS or sulfidic soil materials) and Actual acid sulphate soils (AASS or sulfuric soil materials).

These are often found in the same profile, with AASS overlying PASS.

- Potential acid sulphate soils (PASS) are soil materials which contain RIS such as pyrite (for example Figure 4.1a). The field pH of these soils in their undisturbed state is usually more than pH 4 and is commonly neutral to alkaline (pH 7–9) (for example Figure 4.1b). These soil materials are invariably saturated with water in their natural state. Their texture may be peat, clay, loam, silt or sand and is often dark grey in colour and soft in consistence (for example Figure 4.1b), but these materials may also exhibit colours that are dark brown, or medium to pale grey to white.

- Actual acid sulphate soils (AASS) are soil materials which contained RIS such as pyrite that have undergone oxidation. This oxidation results in low pH (that is pH less than 4) and often a yellow (jarosite) and/or orange to red mottling (ferric iron oxides) in the soil profile (for example Figure 4.1c). Actual ASS contains Actual Acidity, and commonly also contains RIS (the source of Potential Sulfuric Acidity) as well as Retained Acidity.

Projects involving the disturbance of ASS materials must assess the hazards associated with disturbance and consider potential impacts. Activities with a potential to disturb ASS materials, either directly, or by lowering the water table, need to be managed appropriately to avoid environmental harm.

Successful management of ASS materials depends on a detailed investigation to determine the nature of the hazards presented by these soil materials and hence a determination of the most appropriate management strategy.

Wherever possible, management measures should be governed by the guiding principle of avoiding disturbance of ASS materials.

4.3 "ACID" SOIL AND "ACID SULPHATE" SOILS

The acidity hazard of soil materials that are strongly acidic due to processes other than RIS oxidation is not considered an ASS acidity hazard. While Actual ASS and sulfuric soil materials are acid soil materials, not all acid soil materials are Actual or sulfuric ASS materials.

Naturally-occurring acidic soils are not considered an environmental hazard and indeed are usually part of acidophilic ecosystems whose health depends on maintaining an acidic environment. As an example, many soil materials in naturally acidic landscapes, such as acidic peatlands and coastal heaths, often have low pH values and high acidities.

If it can be demonstrated the majority of the acidity of acidic soil materials is not or could not be derived from the oxidation of RIS, then these materials should not be treated as if they were ASS materials. To do so may result in the liming of naturally acidic ecosystems.

This could lead to unnaturally alkaline environments resulting in severe ecological damage to the acidophilic organisms that relied on the acidic nature of these ecosystems.

Field investigation can help determine whether acidic soil materials are ASS materials or not. The presence of jarosite in a soil material, or adjacent soil material, is strong evidence of prior oxidation of RIS. Documented jarosite, along with field pH's less than 4, can be used to identify these soil materials as Actual ASS materials rather than just acid soil materials. Further information is provided in the National Acid Sulphate Soils Identification and Laboratory Methods Manual (Sullivan et al, 2018b) to help distinguish naturally-occurring acidic soil materials from Actual ASS materials.

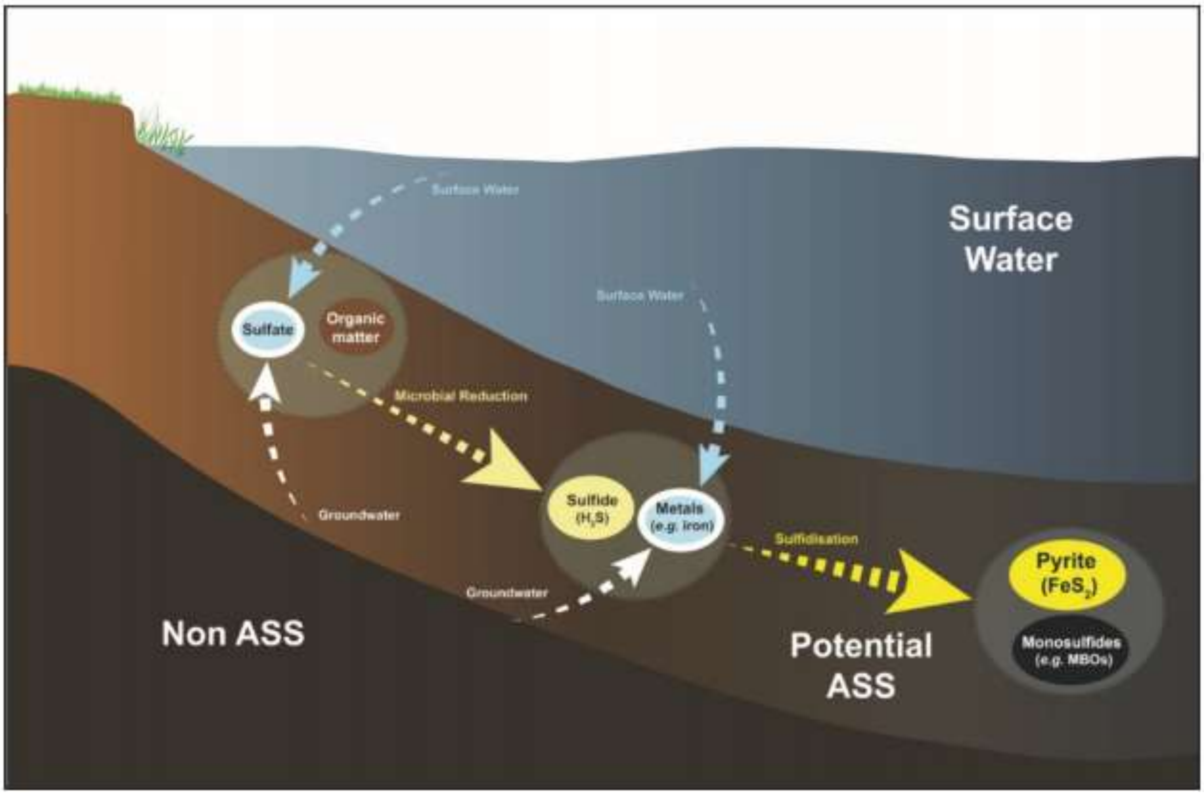
4.4 ACID SULPHATE SOIL FORMATION

The formation of acid sulphate soils (ASS) materials occurs under waterlogged conditions in the presence of no or minimal oxygen.

Under these anaerobic conditions, sulphate-reducing bacteria in the soil materials convert dissolved sulphate present in the pore water into Reduced Inorganic Sulfur (RIS). The RIS produced then reacts with metals, particularly iron, resulting in the formation of metal sulfides (principally pyrite). A supply of easily decomposable organic matter (such as decaying vegetation) is also required to provide sufficient energy for the bacteria to convert the sulphate into RIS. Under favourable environmental conditions iron monosulphides (for example FeS) may form, sometimes resulting in the accumulation of monosulphides black ooze (MBO).

Figure 4.2 summarises the key processes leading to the formation and accumulation of ASS materials.

For further details on the formation and accumulation of MBO see the Overview and Management of Monosulphidic Black Ooze (MBO) Accumulation in Waterways.



Note: not to scale.
Source: Adapted from EPHC & NRMMC (2011) and Ward et al. (2013).

Figure 4.2 - Formation and Accumulation of ASS Materials

Highly favourable conditions for RIS formation and the accumulation of ASS materials were widespread following the last major sea level rise and resulted in the accumulation of extensive deposits of Holocene age (less than 10 000 years BP) ASS materials in coastal floodplains and intertidal swamps worldwide (Dent 1986). Pyrite (the most common form of RIS in ASS materials) is also found in older sediments in Australia (that is Pleistocene age) and continue to form and accumulate in coastal and inland environments where suitable conditions for their formation exist. While ASS materials can be found in a wide variety of areas, some of the general situations where ASS materials are found are listed in Table 4.1, on the next page.

Table 4.1 - Areas Where ASS Materials are Generally Found

a) Areas depicted on geology and/or geomorphological maps as 'geologically recent' such as:

- shallow tidal flats or tidal lakes, • shallow estuarine, or shallow marine deposits,
- stranded beach ridges and adjacent swales,
- interdune swales or coastal sand dunes,
- coastal alluvial valleys,
- wetlands (groundwater dependent and perched),
- floodplains,
- waterlogged areas,
- scalded areas,
- sump land,
- marshes, and
- swamps.

b) Areas depicted in vegetation mapping as:

- mangroves,
- wetland-dependent vegetation such as reeds and paperbarks (Melaleuca spp.), and
- areas where the dominant vegetation is tolerant of salt, acid and/or waterlogged conditions for example mangroves, salt couch, swamp-tolerant reeds, rushes, paperbarks and swamp oak (Casuarina spp.).

c) Areas identified in geological descriptions or in maps as:

- bearing iron sulfide minerals,
- former marine or estuarine shales and sediments,
- coal deposits, and
- mineral sand deposits.

d) Areas known to contain peat or a build-up of organic material.

e) Areas where the highest known water table level is within 3 metres of the surface.

f) Land with elevation less than 5 metres above Australian Height Datum (AHD).

g) Any areas (including inland areas) where a combination of all the following pre-disposing factors exist:

- organic matter,
- iron minerals,
- waterlogged conditions or a high water table, and
- sulfidic minerals.

4.5 ACID SULPHATE SOIL DISTURBANCE PROCESSES AND IMPACTS

In a waterlogged anoxic state potential acid sulphate soils (PASS) materials are benign. However, when these soil materials are drained or excavated, oxygen from the atmosphere reacts with the RIS in the soil resulting in the production of sulfuric acid. This acidity releases constituents such as metals and nutrients from the soil which may also be transported to waterways, wetlands and groundwater systems, often with adverse environmental and economic impacts.

Development projects may adversely disturb ASS materials where they involve temporary or permanent lowering of the water table, excavation, compaction of saturated soil materials, and/or lateral displacement of previously saturated soil materials. A list of some of these types of developments is provided in Figure 4.2.

The disturbance of ASS materials can adversely affect soil, water and biota, and have a detrimental impact on agriculture, fishing, aquaculture, recreation and tourism, as well as on human health and visual amenity. The impacts of ASS leachate may persist over a long time, or peak seasonally with the first drought-breaking rains after extended dry periods. For example, in some areas of Australia, ASS materials drained 100 years ago are still releasing acid.

5 PRELIMINARY ASSESSMENT

5.1 INTRODUCTION

This report sets out the details of a preliminary assessment of acid sulphate risks and exposures at the 45/49 Warriewood Road Warriewood site.

It is understood that no basement areas, for carparking or other purposes, is currently proposed as part of the development.

It is assumed that foundations will be provided by concrete slabs, and that otherwise exposure of the subsurface at the site will be limited to construction and service trenching requirements.

The objective of the work described in this report has been to undertake an acid sulphate soil assessment for soils on the site.

This report was undertaken with reference to *Environment Protection Authority document Acid Sulphate Soils: Assessment and Management Technical – Ac. Acid Sulphate Manual 1998 and NSW Acid Sulphate Soil Management Advisory Committee – Acid Sulphate Soil Manual*.

This report should be read in conjunction with the attached “Limitations of Geotechnical Assessment”.

5.2 SITE DESCRIPTION

The proposed site falls within the local government area of Northern Beaches Council, and relevant local government consents and approvals regarding site and the proposed development reside with that Council.

Details have been provided in Section 1 of this report.

5.3 ASSOCIATED SITE INVESTIGATIONS

Two other associated investigations site investigations have been undertaken that are relevant to this preliminary acid sulphate soil investigation.

These are:

> *Preliminary Site Investigation: Proposed Residential Sub-Division 45/49 Warriewood Road, Warriewood NSW (NG Child & Associates; Version 1; February 28th, 2020); and*
>
> *Preliminary Groundwater Assessment & Monitoring Program: Proposed Residential Sub-Division 45/49 Warriewood Road, Warriewood, NSW (NG Child & Associates; Version 1; February 28th, 2020).*

Input from these reports has been used for reference purposes in this document.

5.4 GEOLOGICAL SETTING

The geological setting for the subject site is described in the report *Preliminary Site Investigation: Proposed Residential Sub-Division 45/49 Warriewood Road, Warriewood NSW (NG Child & Associates; Version 1; February 28th, 2020)*, based on soil bores undertaken as part of that investigation.

5.5 LOCAL AREA ACID SULPHATE SOIL RISKS

Assessed acid sulphate soil risk associated with the general site area is provided in the mapping associated with the current Northern Beaches Council Local Environment Plan (LEP).

Acid sulphate soil conditions are described in Figures 5.1 and 5.2, below.

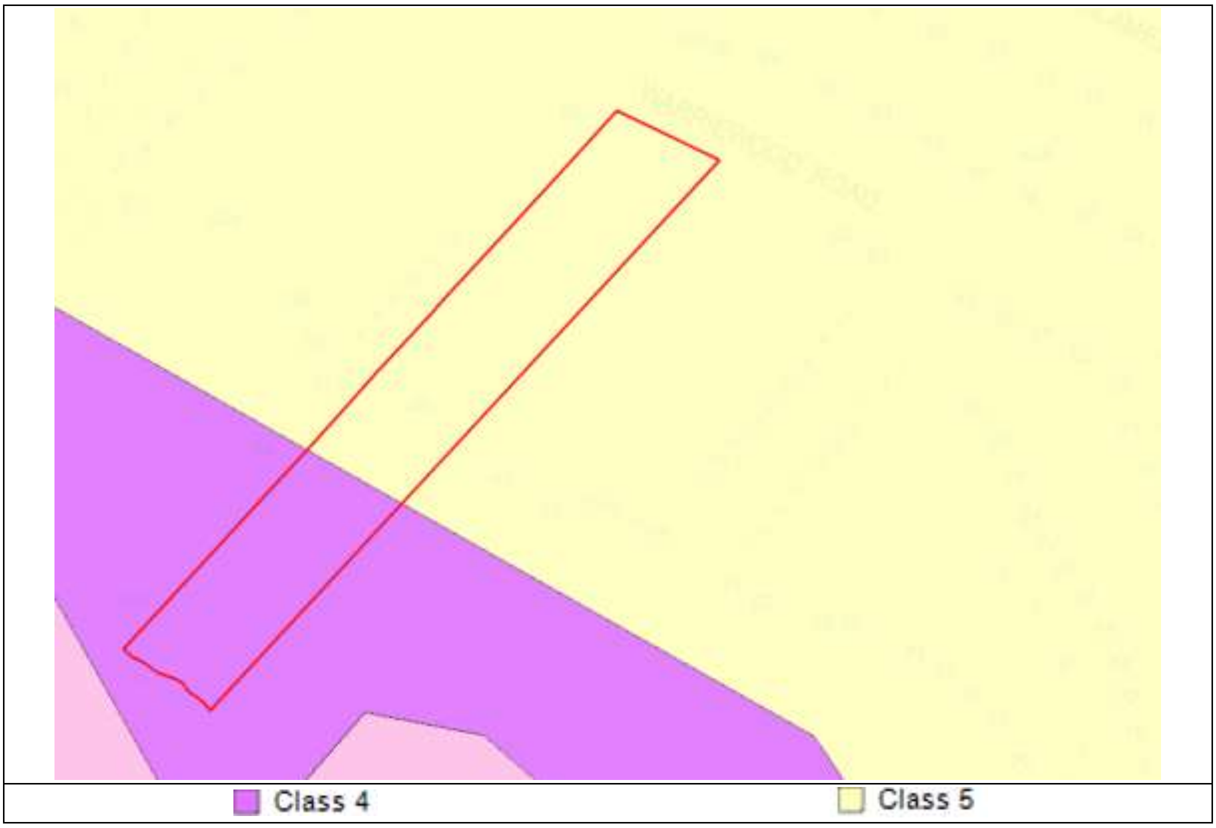


Figure 5.1 – Acid Sulphate Soil Risk Diagram 49 Warriewood Road

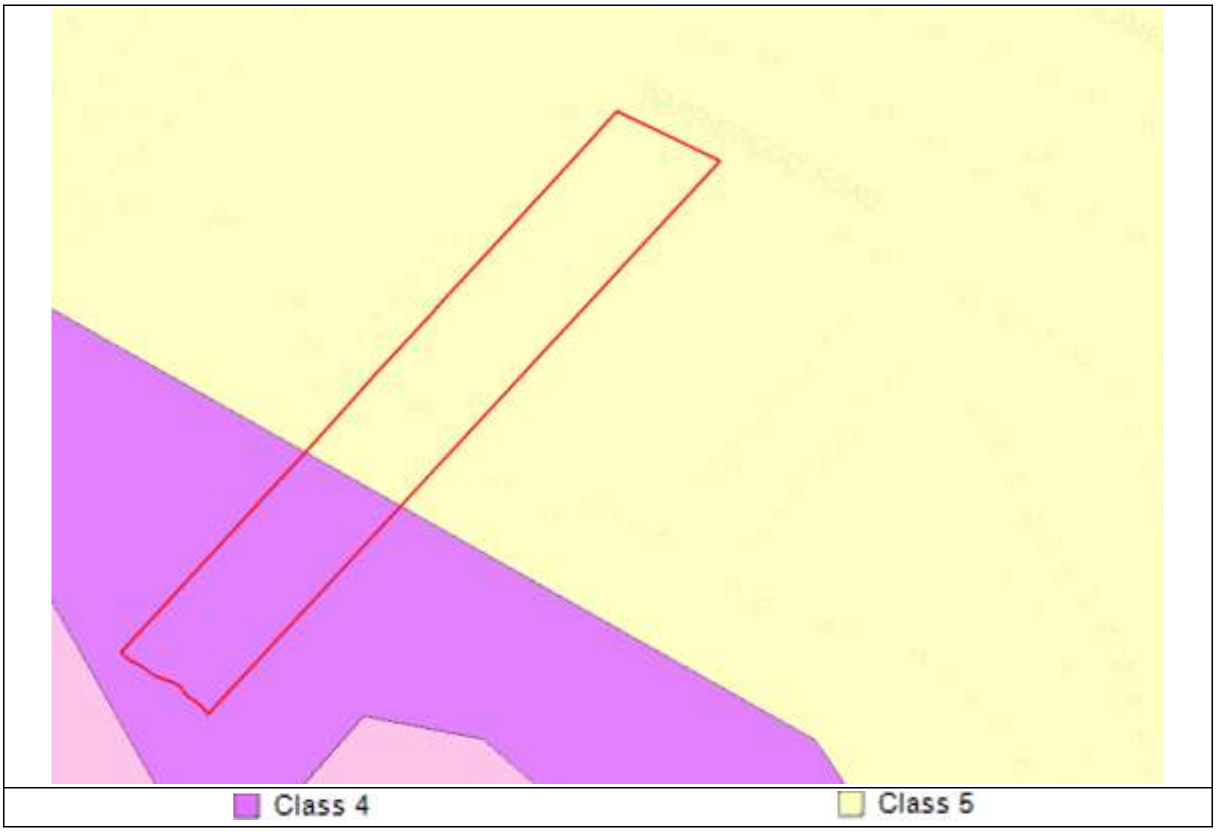


Figure 5.2 – Acid Sulphate Soil Risk Diagram 45 Warriewood Road

Acid sulfate soils have been classified based on the likelihood of the acid sulfate soils being present in particular areas and at certain depths.

There are five classifications. The five classifications, with conventional colour codes used, are as follows:

Class 1 - Acid sulfate soils in a class 1 area are likely to be found on and below the natural ground surface. Any works[2] will trigger the requirement for assessment and may require management.

Class 2 - Acid sulfate soils in a class 2 area are likely to be found below the natural ground surface. Any works[2] beneath the natural ground surface, or works[2] which are likely to lower the water table, will trigger the requirement for assessment and may require management.

Class 3 - Acid sulfate soils in a class 3 area are likely to be found beyond 1 metre below the natural ground surface. Any works[2] that extend beyond 1 metre below the natural ground surface, or works[2] which are likely to lower water table beyond 1 metre below the natural ground surface, will trigger the requirement for assessment and may require management.

Class 4 - Acid sulfate soils in a class 4 area are likely to be found beyond 2 metres below the natural ground surface. Any works[2] that extend beyond 2 metres below the natural ground surface, or works[2] which are likely to lower the water table beyond 2 metres below the natural ground surface, will trigger the requirement for assessment and may require management.

Class 5 - Acid sulfate soils are not typically found in Class 5 areas. Areas classified as Class 5 are located within 500 metres on adjacent class 1,2,3 or 4 land. Works[2] in a class 5 area that are likely to lower the water table below 1 metre AHD[1] on adjacent class 1, 2, 3 or 4 land will trigger the requirement for assessment and may require management.

Note: [1] Australian Height Datum, and [2] 'work' is defined as any works that disturb more than one (1) tonne of soil or lower the water table.

In this case the bulk of the site involves Class 5 risk land, where acid sulphate soils are not typically found.

Approximately one third of each of the two constituent properties (45 and 49 Warriewood Road) comprising land closest to Narrabeen Creek to the rear or south-west property boundaries involves the second lowest acid sulphate soil risk, Class 4, where acid sulphate soils are not anticipated within two metres of the land surface.

5.6 SOIL SAMPLING & ANALYSIS

Locations of the five soil bores associated with the Preliminary Site Investigation are shown in Figure 5.3, on the following page.

Refrigerated, stored soil samples from this preliminary site investigation were also used for laboratory analysis for acid sulphate soil parameters in this preliminary investigation.

Figure 5.3 – Soil Sampling Locations

Soil samples from varying depths at each of the five sampling locations were submitted to a NATA accredited laboratory for analysis for a range of chemical parameters associated with the presence of acid sulphate soils.

Key parameters included the measurement of pH (acidity) in both water (H_2O) and hydrogen peroxide (H_2O_2)

Detailed results of the laboratory analyses are provided in the laboratory report attached for reference at Appendix C, and are summarised in Table 5.1, below.

Table 5.1 – Summary of Laboratory Analysis Results

Sample Location	Depth (m)	Description	pH in H_20	pH in H_20_2	pH in H_2O ph in H_2O_2
	Acid Sulphate Criteria		<4	<3	>1
1	1.0	Soil	4.7	4.3	0.3
2	0.5	Soil	4.7	4.4	0.3
3	1.5	Soil	4.6	4.3	0.3
4	1.5	Soil	4.6	4.3	0.3
5	2.0	Soil	4.5	4.2	0.3

ASS Present		ASS Absent	

5.7 DISCUSSION OF RESULTS

Implications of the results of physical observations during the soil sampling process, and the laboratory results summarised in 5.7 above, are considered to be as follows:

5.7.1 Physical Indicators

The physical indicators of acid sulphate soil as described in Section 4 were not noted by Noel Child of NG Child & Associates in any of the soil sampling bores at the site during field work undertaken as part of the associated preliminary site investigation.

No physical indication of the presence of acid sulphate soils was noted during the preliminary site investigation.

5.7.2 Chemical Indicators

The guidelines (*Environment Protection Authority document Acid Sulphate Soils: Assessment and Management Technical – Ac. Acid Sulphate Manual 1998 and NSW Acid Sulphate Soil Management Advisory Committee – Acid Sulphate Soil Manual*) indicate the oxidation of pyrite (or actual acid sulphate (AASS) soil conditions) occurs when the pH of soil in water is less than 4.0 and potential for forming acidic conditions is present when the pH in peroxide is less than 3.0 or when the difference between the pH of soils in water and peroxide is greater than 1.

On this basis, analysis of five representative soil samples from the site indicates the absence of acid sulphate soils.

Soils from the site were noted to be relatively consistent between all of the soil sampling locations, which suggests that the results from five representative locations can reasonably be anticipated to be indicative of the overall site.

5.7.3 Overall Finding

Physical observations and laboratory test results indicate that there are no actual acid sulphate soils (AASS) present at the site.

Acid sulphate risk maps indicate that Class 4 risk soils are present on the approximate one-third of the overall site area closest to the Narrabeen Creek or rear site boundary.

It is possible that acid sulphate soils may be encountered in excavation deeper than 2.0 metres in this area.

Accordingly, it is recommended that all soil quantities greater that one tonne removed from depths greater than 2.0 metres in this area of the site, and required for re-use at the site, be treated by the addition of lime to neutralize any possible acid generating potential of the soil.

It is also recommended that the bases and walls of any service trenches dug at depths greater than 2.0 metres in this rear area of the site are treated with lime to similarly neutralize any possible acid generating potential of the soil.

This requirement does not apply to any excavated material removed from the site, subject to the recommendations included in Section 6, below.

6 FINDINGS & RECOMMENDATIONS

It is our understanding that other than for possible service trenches, excavations deeper than 2.0 metres will not be required at the site.

For this reason and based on the acid sulphate soil assessment presented in Section 5, no significant acid sulphate soil risk is considered to apply at the site.

However, the following precautionary recommendations are made:

- During excavations for services, keep the volume of soil removed to a minimum.
- Any excavated soils from depths greater than 2.0 metres in the rear one-third of the site area, as indicated by the diagrams in this report, shall be stockpiled and covered to reduce exposure to the elements, including cover with suitable material and construction of earth bunds around each pile if required to prevent run-off from the pile spreading to adjacent areas.
- If physical indications of acid sulphate soils (or other contaminants are noted), appropriate advice and instructions should be sought from and provided by a suitably qualified and experienced person.
- Excavated soils to be removed from the site shall be assessed by a suitably qualified and experienced person to ensure that no acid sulphate or other contamination issues apply.
- If soils to be exported from the site are assessed as other than Virgin Excavated Natural Material (VENM), appropriate classification and disposal practices should be applied.
- Any soils excavated from depths greater than 2.0 metres in the rear one-third of the site (as indicated by the diagrams in this report) to be reused on-site shall be treated with lime (neutralized) as a precautionary measure before being utilized as fill on site.
- Neutralising shall be based on the mixture of one (1) x 20 kg bags of fine agricultural lime per fifteen (15.0) m^3 of excavated soil.
- Mix the lime thoroughly with any soil to be utilized as fill. This prevents acid being generated and leachate migrating from the site.
- Materials placed as fill on site after mixing shall be compacted (in maximum 200mm deep layers) to minimize the entry of air and water.

The original version of this report was completed in February 2020. This updated version includes the final plans and drawings for the proposed development. The overall findings and recommendations of the February 2020 report have been reviewed and remain valid and applicable at the date of this revised report.

7 AUTHORISATION

This report is based on a limited site assessment. We draw your attention to the attached notes “Limitations of Preliminary Acid Sulphate Soil Assessment”. Any site conditions noted during any future development on the site, that are different from those described in this report should be referred to the undersigned for assessment. Should you have any queries please contact the undersigned.

Noel Child
Principal
NG Child & Associates
16 November 2021

APPENDIX A

Soil Bore Locations

Figure A1 – Location of Soil Bores & Sampling Locations

APPENDIX B

Laboratory Report

Environmental
CERTIFICATE OF ANALYSIS

Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

Work Order	CA/20/126-2702	Page	1 of 4
Client	NG Child & Associates	Laboratory	Environmental Division Brisbane
Contact	Dr Noel Child	Contact	ALS
Address	22 Britannia Road Castle Hill 2154 NSW	Address	Environmental Division Brisbane
Telephone	+61 02 9899 1968	Telephone	+61-7-3243 7222
Project	CA/20/126-2702	Date Samples Received	April 19 2019
Order number	n/a	Date Analysis Commenced	April 22 2019
C-O-C number	n/a	Issue Date	May 1 2019
Sampler	Noel Child	Laboratory	Environmental Division Brisbane
Site	45/40 Warriewood Road Warriewood NSW	Contact	ALS
Quote number	n/a		
No. of samples received	5		
No. of samples analysed	5		
Client	NG Child & Associates		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments:
Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification:

Signatories

This document has been electronically signed by the authorized signatories below.

Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
ALS	Senior Acid Sulphate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

RIGHT SOLUTIONS | RIGHT PARTNER

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key :

CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- EA029 (SPOCAS): Retained Acidity not required because pH KCl greater than or equal to 4.5
- ASS: EA029 (SPOCAS): Excess ANC not required because pH OX less than 6.5.
- ASS: EA029 (SPOCAS): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from kg/t dry weight to kg/m3 in-situ soil, multiply reported results x wet bulk density of soil in t/m3.

Page	3 of 3
Work Order	CA 20/126-2702
Client	NG Child & Associates
Project	CA 20/126-2702

Analytical Results

		Sampling Time /Date:	19 April 2019 Sample 1 Result	19 April 2019 Sample 2 Result	19 April 2019 Sample 3 Result	19 April 2019 Sample 4 Result	19 April 2019 Sample 4 Result
	LOR	Unit					
EA029-A: pH Measurements							
pH KCl (23A)	0.1	pH Unit	4.7	4.7	4.6	4.6	4.5
pH OX (23B)	0.1	pH Unit	4.3	4.4	4.3	4.3	4.2
EA029-B: Acidity Trail							
Titratable Actual Acidity (23F)	2	mole H+ / t	21	20	23	20	23
Titratable Peroxide Acidity (23G)	2	mole H+ / t	28	29	31	30	28
Titratable Sulfidic Acidity (23H)	2	mole H+ / t	7	8	8	9	7
sulfidic - Titratable Actual Acidity (s-23F)	0.020	% pyrite S	0.022	0.024	0.022	0.022	0.024
sulfidic - Titratable Peroxide Acidity (s-23G)	0.020	% pyrite S	0.048	0.050	0.046	0.050	0.047
sulfidic - Titratable Sulfidic Acidity (s-23H)	0.020	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
E029C: Sulphur Trail							
KCl Extractable Sulfur (23Ce)	0.020	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Sulphur (23d)	0.020	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Ooxidisable Sulphur (23e)	0.020	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity – peroxide oxidisablke sulphur (a-23e)	10	mole H+ / t	<10	<10	<10	<10	<10
Calcium Values							
KCl Extractable Calcium (23Vh)	0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Calcium (23Wh)	0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
Acid Reacted Calcium (23X)	0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
Acidity – Acid Reacted Calcium (a-23X)	10	mole H+ / t	<10	<10	<10	<10	<10
Sulphidic – Acid Reacted calcium (s-23X)	0.020	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Magnesium Values							
KCl Extractable Magnesium (23Sm)	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Magnesium (23Tm)	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Acid Reacted Magnesium (23U)	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Acidity – Acid Reacted Magnesium (a-23U)	10	mole H+ / t	<10	<10	<10	<10	<10
Sulphidic – Acid Reacted Magnesium (s-23U)	0.020	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA 029H: Acid based Accounting							
CAN Fineness Factor	0.5	-	1.2	1.2	1.3	1.1	1.2
Net Acidity – Sulphur Units	0.02	%S	0.03	0.03	0.04	0.03	0.03
Net Acidity – Acidity Units	10	mole H+ / t	18	20	20	18	17
Net Acidity excluding ANC – Sulphur Units	0.020	% S	0.3	0.3	0.3	0.3	0.3
Net Acidity excluding ANC – Acidity Units	10	mole H+ / t	17	19	20	18	17
Limiting Rate excluding ANC	1	Kg $CaCO_3$/t	2	2	2	2	2

APPENDIX C

Noel Child CV

1 PERSONAL DETAILS

Full Name:	Noel George CHILD
Profession:	Consultant in Environmental Assessment and Management
Date of Birth:	6th December 1946
Nationality:	Australian
Experience:	> 30 Years
Address:	22 Britannia Road, Castle Hill, NSW, 2154
Contact:	**Phone**: 61 2 9899 1968 **Fax**: 61 2 9899 1797 **Mobile:** 0409 393024

2 CAPABILITY AND EXPERIENCE - SHORT SUMMARY

Noel Child is a successful and experienced commercial and technical professional with over 30 years' experience in a variety of senior level appointments and assignments, within both the corporate and private sectors, with a particular focus on strategic, infrastructure and environmental applications.

Noel's experience includes senior management at both the State and National levels in the Australian petroleum industry, and a number of senior consultancies for both government and corporate clients. His record reflects the ability to develop and achieve positive commercial outcomes through effective planning and communication; critical and objective analysis; and quality task completion and delivery at both the personal and team level.

His management responsibilities have included transport, environmental, safety, and general operational activities at a national level, while his formal professional training includes strategic management, environmental, engineering and business disciplines. He has undertaken a number of senior corporate appointments with distinction and been successfully involved in the ownership and operation of a major petroleum distribution and marketing company in regional Australia. More recently, working through his own businesses Environment Australia and NG Child & Associates, he has applied his knowledge and experience in the areas of strategic management, infrastructure development, energy and the environment on a consultancy and contractual basis to a number of private and public-sector clients, both nationally and internationally.

Noel has had post-graduate training in several technical and commercial disciplines, and provides specialised teaching input, by invitation, to post graduate engineering and business management courses conducted by the Faculties of Business and Engineering at Sydney's University of Technology. He has strong affiliations with a number of international corporations and agencies and has worked closely with both the regulators and the regulated in a number of aspects of environmental management, assessment and performance. He has also been recognised as an independent expert on engineering, and environmental issues by the Land and Environment Court of NSW.

Noel has a detailed understanding of environmental engineering and associated processes and has specific experience and expertise in the fields of acoustics, air quality, electromagnetic field assessment, electrolysis and stray current assessment, contaminated site assessment, and liquid and solid waste management. He also provides post graduate teaching input on environmental engineering issues to post graduate courses at the University of Technology, Sydney, and La Trobe and Monash Universities in Melbourne.

3 EDUCATION, QUALIFICATIONS AND AFFILIATIONS

BE, PhD (Chemical Engineering), UNSW, Sydney
Master of Business Studies, University of New South Wales, Sydney
B.Sc. (Hons) Applied Chemistry (Environmental), University of Technology, Sydney
Graduate Diploma (Environmental Engineering and Management), UNSW, Sydney
Qualified Environmental Auditor, Standards Australia
Member, Royal Australian Chemical Institute, 1972/2020
Member, Institution of Engineers, Australia, 1972/2020
Member, Clean Air Society of Australia and New Zealand, 1992/2020
Member, Australian Natural Gas Vehicle Council, 1996/2004
Executive Director, Australasian Natural Gas Vehicles Council, 2003/2004
Visiting Fellow, Institute for Sustainable Futures, UTS, 1995/2002
Research Fellow, Faculty of Civil & Environmental Engineering, UTS, 1996/2020
Research Associate, New York Academy of Sciences, 2000/2020

4 RECENT ASSIGNMENTS & EXPERIENCE

Kaunitz Yeung Architecture (2016) – Electromagnetic field and air quality assessments of a childcare centre development project at 60 Dickson Avenue Artarmon NSW.

Australian Consulting Architects (Current) – Electromagnetic, stray current and electrolysis assessments of development projects a Field Place Telopea; Windsor Road Vineyard; Camden Valley way Horningsea Park and others.

Futurespace/Renascent (Current) – Environmental assessment of proposed childcare centre development at Waterloo Road Macquarie park and Cleveland Street Strawberry Hills, including general environmental, acoustic assessment, air quality and electromagnetic field assessment.

Thyssen Transrapid Australia (Current) – Adviser on technical and operational issues associated with the development and construction of a high-speed magnetic levitation train systems within the People's Republic of China, and elsewhere, including electrolysis, electromagnetic and stray field effects.

Trumen Corporation (Current) – Environmental assessment, including acoustic and contamination assessment and certification, of mixed use and childcare centre development projects at Waine Street Freshwater, Fitzroy Street Marrickville, and at Huntley Street Alexandria, NSW.

Commonwealth Bank (Current) – Environmental assessment, including general, acoustic, air quality, electromagnetic field and wind impact assessment, of a new childcare centre development to be located on Level 2 of Darling Park Power 2, Sussex Street, Sydney.

First Impressions Property – Environmental assessment of a proposed childcare centre at Ralph Street Alexandria NSW, including Preliminary (Stage 1) Site Contamination Assessment, and Electromagnetic Field Assessment.

LEDA Holdings – Environmental Assessment of a proposed childcare centre at 32 Cawarra Road Caringbah NSW, including general environmental, acoustic, air quality and electromagnetic field assessments.

Universal Property Group (Current) – Environmental assessment of a proposed multi building, multi-level residential development at Garfield Street, Wentworthville NSW, including general environmental, site and soil contamination and preliminary geotechnical assessments.

McCormack (Current) – Stage 2, 3 and 4 Environmental Site Assessment of 7,9 & 11 Bayard Street, Mortlake, NSW as part of the process of assessing the site for medium density residential development and obtaining a site audit statement confirming the suitability of the site for this purpose. Work inclusive of the assessment of all relevant environmental impacts.

Gundagai Meat Processors (Current) – Review and enhancement of solid and liquid waste processing and management systems at GMP's Gundagai abattoir, including the on-site treatment of waste streams from meat processing and other operations.

Campbelltown City Council (Current) – Peer review of acoustic assessments submitted to Campbelltown City Council regarding assessment of the acoustic impacts of developments including a major truck maintenance facility and the expansion of Macarthur Square shopping centre, including the conduct of noise measurements.

Brenchley Architects (2009 - Current) – Acoustic assessments of proposed residential and commercial developments at Elizabeth Street Sydney; Spit Road Mosman, Botany Road Waterloo, Cranbrook Street, Botany and Bellevue Hill Road, Bellevue Hill NSW.

BJB Design (2009 - Current) – Acoustic, air quality and odour assessments of residential and commercial developments at Botany Road, Botany and Cranbrook Street Botany.

Bovis Lend Lease (Current) – Environmental assessment of a major development site at Darling Walk, Darling Harbour NSW, including a detailed review of air quality, electromagnetic field and acoustic issues for review by the NSW Department of Planning.

Penrith City Council (2012/13) – Preparation of the Penrith City Council response to the NSW Government Long Term Transport Plan, including consideration of transport and associated environmental issues affecting the Penrith Local Government Area.

Harry Azoulay & Michael Bell Architects (2012) – Assessment of the environmental impacts on and from a proposed childcare and early learning centre at Chatswood, NSW. Assessments lodged with and adopted by Willoughby City Council.

Wollondilly Shire Council (2012) – Preliminary environmental assessment and review of the development of a second Sydney airport at Wilton, including a preliminary assessment of acoustic impacts.

White Horse Coffee (2011) – Air quality and odour assessment regarding a boutique coffee roasting and drying operation at 7/3-11 Flora Street, Kirrawee, and NSW.

Sydney Skips & Galaxy Waste (Current) – Environmental assessment of a proposed waste recycling facility to be located on a potentially contaminated site at Stephen Road, Botany, NSW, including a detailed review of all relevant engineering and environmental issues, and the preparation of relevant documentation including assessment reports for review by Botany City Council.

Michael Bell Architects & Clients (2004 to Current) – Assessment of the environmental impacts, including acoustic impacts, associated with various childcare centre applications in suburban Sydney, and the Sydney CBD, including the development of plans for the management and control of such impacts.

ABC Learning Centres Pty Ltd (2005 - Current) – Provision of professional services re the environmental assessment of prospective childcare centre developments, including issues relating to acoustics, air quality, odour, soil, and groundwater contamination.

NSW Roads & Traffic Authority (2004 to Current) – Review of international technologies, systems & applications in relation to the treatment of motor vehicle exhaust emissions and associated air pollution within and discharged from road tunnels, in accordance with the conditions of approval for the M5 East Motorway

Federal Airports Corporation (1995/1996) – Preliminary environmental and ground transport studies for the proposed Sydney West Airport, including consideration of all relevant environmental issues.

Isuzu-GM (2003 to Current) – Representations to Environment Australia and the Department of Transport and regional Services regarding the emission performance standards of Japanese sourced medium and heavy natural gas trucks, with the aim of having the current Japanese emission standard accepted within the Australian design Rule 80 series of vehicle emission standards.

City of Sydney (2005 - 2007) – Assessment of air quality and odour issues associated with a proposed redevelopment of craft studios and associated facilities at Fox Studios, Moore Park, Sydney, and review of air quality monitoring stations in the Sydney CBD area, in part as a basis for monitoring the air quality and potential health cost impacts of transport congestion and modes.

Warren Centre for Advanced Engineering, University of Sydney (2000 to 2003) – Contribution to the report "Sustainable Transport for Sustainable Cities", a major government and private enterprise funded study into the future sustainability of transport in Sydney and adjoining regions, including in particular a review of associated environmental issues. Study received the 2003 Bradfield Award for Engineering Excellence from the Australian Institute of Engineers.

United Kingdom Department of the Environment (1994) – Contribution to the development of revised environmental guidelines for air, soil and groundwater water quality.

United States Environmental Protection Agency (1994) - Contribution to an international team developing strategies for the control and management of air pollution in seven major US cities.

5 CORPORATE EXPERIENCE

NG Child & Associates

- **1992--Present**, Managing Principal - Responsible for all aspects of the conduct of a private engineering and environmental consultancy, including administration, marketing, team coordination and technical and professional delivery.

Western Fuel Distributions Pty Limited, Australia

- **1984-92** Managing Principal. - Responsible for all aspects of the management and development of one of the largest private petroleum distributorships then operating in Australia, with a peak annual sales volume of 70 million litres, turnover of $30 million per annum, a direct staff of thirty, and a network of some 40 retail and wholesale agency outlets. This position included direct personal accountability for all aspects of storage, distribution and environmental performance.

Caltex Oil Australia Limited

- **1982-84** General Manager, Marketing and Operations. Responsible for the management and operation of Caltex Australia's marketing, storage, warehousing, distribution, environmental and safety functions, including seaboard terminal and marine operations.
- **1980-82** National Consumer Marketing Manager. Responsible for Caltex Australia's national consumer, industrial and distributor marketing activities.

Golden Fleece Petroleum Limited

- **1977 - 1980** Manager Operations, NSW. Responsible for the overall management of the distribution, warehousing, seaboard terminal and lubricant production activities of Golden Fleece Petroleum in New South Wales, including environmental, occupational health and safety matters.

Esso Australia Limited

- **1976-77** SA Manager, Marketing and Operations. Responsible for all aspects of the management of Esso's petroleum, lubricant and LPG storage, distribution and marketing throughout South Australia.
- **1975-76** Refinery Manager. Responsible for all engineering, operational and environmental aspects of the joint Esso/Mobil refinery at Port Stanvac in South Australia.
- **1975** Manager, Process Operations, Port Dixon Refinery, Malaysia. Six-month special assignment at the Esso Petroleum Refinery, Port Dixon, Malaysia.
- **1971-75** Senior Analyst, Logistics and Corporate Strategy Departments, Esso Sydney Head office.

6 SOME REPORTS & PUBLICATIONS

- **High Speed Rail – Benefits for the Nation,** Keynote address at the UNSW Institute of Environmental and Urban Studies International High-Speed Rail Seminar, August 2013.
- **High Speed Trains in Australia: Connecting Cities and Energising Regions**; with the Hon Peter Nixon AO, October 2010.
- **Sydney's High Residential Growth Areas: Averting the Risk of a Transportation Underclass**, World Transport & Environmental Forum, Reims France, June 2006.
- **The M5 East Road Tunnel: Implications for Ventilation, Air Quality and Emission Treatment Systems**, International Road Transport and Tunneling Forum, Graz Austria, May 2006.
- **Transport Fuels in Australia: The Folly of Australia's Increasing Reliance on Imported Crude Oil**, Submission to the Australian Senate Rural and Regional Affairs and Transport Committee Inquiry into Australia's Future Oil Supply and Alternative Transport Fuels, February 2006.
- **The Japan 2003 CNG Emission Standard & the Emission Performance of the Isuzu 4HF-1-CNG: The Case for Acceptance under ADR80**. Submission on behalf of Isuzu GM Australia to the Commonwealth Department of Transport and Regional Services, June 2004.
- **M5 East Freeway: A Review of Emission Treatment Technologies, Systems and Applications**, NSW RTA and NSW Department of Planning, April 2004.
- **Future Directions: Challenges & Opportunities in the Australian CNG Vehicle Industry**, ANGVC, December 2002
- **High Speed Rail in Australia: Beyond 2000** (with the Hon Peter Nixon), November 2000
- **Review of Options for the Treatment or "Filtration" of Tunnel Gases and Stack Emissions**, City of Sydney. January 2003
- **A Comparative Analysis of Energy and Greenhouse Performance: Austrans Ultras Light Rail System**, Bishop Austrans Limited, January 2003
- **Engineering and Environmental Aspects of Enclosing the Cahill Expressway Cutting**, City of Sydney, May 2001.
- **M5 East Motorway: Proposed Single Emission Stack at Turrella – Review of Air Quality Impacts and Consideration of Alternative Strategies**, Canterbury City Council, February 1999

7 PERSONAL & PROFESSIONAL REFERENCES

- The Hon Peter Nixon AO, Former Federal Transport Minister
- John Black, Professor Emeritus of Civil & Transport Engineering, University of NSW
- Mr Stephen Lye, Development Manager, Trumen Corporation, Sydney.
- Mr Peter Han, Project Director, Commonwealth Bank, Sydney
- Mr Michael Bell, Principal, Michael Bell Architects, Sydney.
- Mr Barry Babikian, Brenchley Architects
- Mr Luke Johnson, Assistant General Manager, Wollondilly Shire Council
- Mr Bernie Clark, Chief Executive, Thyssen Australia
- Mr Alan Ezzy, Former Chairperson, NSW Flood Mitigation Authority.
- Professor Vigid Vigneswaran, Faculty of Civil & Environmental Engineering, University of Technology, Sydney.
- Mr Merv Ismay, General Manager, Holroyd City Council, Sydney NSW
- Dr Jack Mundey, Past Chairman Historic Houses Trust, Environmentalist
- Alex Mitchell, Journalist

Noel G Child
16 November 2021

ATTACHMENT A
Client Reference List

Acre Woods Childcare Pty Ltd
Australian Commonwealth Environmental Protection Agency
Australian Consulting Architects
Australian Federal Airports Corporation
Australian Federal Department of Transport and Regional Development
Bovis Lend Lease
Brenchley Architects
Campbelltown City Council
Canterbury City Council, Sydney, NSW
Commonwealth Banking Corporation
Environment Protection Authority of NSW
Exxon Chemical
Fairfield City Council, Sydney, NSW
First Impressions Property
FreightCorp, Sydney, NSW
Futurespace
GM - Isuzu
Guangxi Environment Protection Bureau
Gundagai Meat Processors
Hong Kong Department of the Environment
Hornsby and Ku-ring-gai Councils, Sydney, NSW
John McCormack
Kaunitz Yeung Architecture
LEDA Holdings
Michael Bell Architects
Minter Ellison
Mobil Oil Australia Associated
NSW Roads & Traffic Authority
Ove Arup & Partners
Qantas Airways
Queensland Ports Corporation
Renascent
Salibeau Pty Ltd
Shell Australia
Sinclair Knight Merz
Skouras and Mabrokardatos
Southern Sydney Regional Organisation of Councils (SSROC)
State Rail Authority of NSW
Stephen Davidson Property Investments
Sydney Skips & Galaxy Waste
The City of Sydney
The Western Sydney Alliance of Mayors
Thyssen Krup Transrapid Australia
Tom Howard QC
Trumen Corporation
UK Department of the Environment
United States Environment Protection Agency
University of Technology, Sydney
Warren Centre for Advanced Engineering, University of Sydney
Waverley Council, Sydney, NSW
Western Sydney Parklands Trust
Wollondilly Shire Council

APPENDIX D

Limitations of Assessment

LIMITATIONS OF PRELIMINARY ACID SULPHATE ASSESSMENT

Geotechnical Assessment

Geotechnical engineering Is based extensively on judgment and opinion. It is far less exact than other engineering disciplines. Geotechnical engineering reports are prepared to meet the specific needs of individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor or even some other consulting engineer. This report was prepared expressly for the Client and expressly for the purposes indicated by the Client or his representative. The Client should not use this report for other than Its intended purpose without seeking additional geotechnical advice.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. NG Child & Associates assumes no responsibility and wit[not be liable to any other person or organisation for *or* In relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation for or in relation to matters *dealt* with *or* conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of NG Child & Associates or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed In the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own inquires and obtain independent advice in relation to such matters.

Scope of Services

This preliminary acid sulphate soil assessment has been prepared in accordance with the scope of services set out in the proposal, or as otherwise agreed, between the Client and NG Child & Associates. In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

Reliance on Data

In preparing the report, NG Child & Associates has relied upon the data which are referred to in the report. Except as otherwise stated in the report, CSG Engineers Pay Ltd has not verified the accuracy or completeness the extent that the statements, opinion\s, facts, information, conclusions and/or recommendations in the report ("conclusions' are based in whole or part ort the data, those conclusions are dependent upon the accuracy and completeness of the data. CSG Engineers Pty' Ltd will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to NG Child & Associates.

This Geotechnical Report is Based on Project Specific Factors

This geotechnical engineering report is based on a subsurface assessment which was designed for project-specification factors, including the nature of any development, its size and configuration, the location of any development on the site and its orientation, and the location of access roads and parking areas.

Unless further geotechnical advice is obtained this preliminary acid sulphate soil report cannot be used when the nature of any proposed development is changed; or when the size, configuration location or orientation of any proposed development is modified. This geotechnical engineering report cannot be applied to an adjacent site.

Limitations of This Report

In making an assessment of a site from a limited number of boreholes or test pits there is the possibility that variations may occur between test locations. Site investigation identifies specific subsurface conditions only at those points from which samples have been taken. The risk that variations will not be detected can be reduced by Increasing the frequency of test locations, however this often does not result in any overall cost savings for the pro{act. The assessment program undertaken is a professional estimate or scope of work required by the client at the time of engagement to provide a general profile of the subsurface condition. The data derived from the site assessment program and subsequent laboratory testing are extrapolated across the site to form an inferred geological model and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. . Despite assessment that actual conditions at the she might be different from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal alt subsurface details and anomalies.

Borehole logs should not be regarded as definitive statements or subsurface conditions at a particular location. They are in fact the subjective interpretations of trained personnel and these interpretations are limited by the method of assessment. For example, inspection of an excavation or test pit allows a greater area of the subsurface profile to be inspected Man borehole assessment, however, such methods are limited by depth and site disturbance restrictions. In borehole assessment the actual interface between materials may be *more* gradual or abrupt than a report indicates.

Sub Surface Conditions may Undergo Variations with Time

Subsurface conditions may be modified by changing natural forces or man-made influences, A geotechnical engineering report is based on conditions which existed at the time of subsurface exploration. Natural events such as Goods, or groundwater fluctuations, or construction operations at or adjacent to the site, may affect subsurface conditions, and thus the continuing adequacy *of* a geotechnical report. The geotechnical engineer should be kept informed of any such events and should be consulted to determine if additional tests are necessary.

LIMITATIONS OF PRELIMINARY ACID SULPHATE ASSESSMENT
(Continued)

Avoid Misinterpretation

A geotechnical engineer should be retained to work with other appropriate design professionals explaining relevant geotechnical findings and in reviewing the adequacy of their plans and specifications relative to geotechnical issue

Bore/Profile Logs Should not be Separated from the Report

Final bore/profile logs are developed by geotechnical engineers based upon their interpretation of field logs and laboratory evaluation of field samples. Customarily, only the final bore/profile logs are Included in geotechnical engineering reports. These logs should riot under any circumstances be redrawn for inclusion in architectural or other design drawings. To minimise the *likelihood* of bore/profile log misinterpretation, contractors should be given access to the complete geotechnical engineering report prepared or authorised for their use. Providing the best available information to contractors helps prevent costly construction problems. For further information on this matter reference should be' made to “Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by the Institution of Engineers Australia, National Headquarters. Canberra 1987.

Geotechnical Involvement during Construction

During construction, excavation is frequently undertaken which exposes the actual subsurface conditions. For this reason geotechnical consultants should be retained through the construction stage, to-identify variations if they are exposed and to conduct additional tests which may be required and to deal quickly with geotechnical problems if they arise.

Other Limitations

NG Child & Associates will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

APPENDIX E

Design & Site Management Precautions

NG Child & Associates

DESIGN & SITE MANAGEMENT PRECAUTIONS FOR CONSTRUCTION ON REACTIVE SOILS

GENERAL DESIGN PRECAUTIONS

These procedures generally apply to single storey, brick residential buildings, or as specified in the design/report, founded on reactive, clay soils. Such soils are prone to heave/shrink movements due to moisture variations (either by natural or artificial causes). It must be accepted that some minor masonry cracking can occur with these soils, despite the listed precautions and associated foundation design. However, the basic design philosophy is to minimize any cracking and provide a serviceable structure. It is thus a compromise between economy and performance.

The following procedures are considered supplementary to any other foundation recommendations given in the design/report:

- All surface water runoff must be directed away from the building by appropriate grading, in order to prevent bonding near foundations. Site drainage must form part of the building contract.
- Peripheral impermeable pathways should be provided around the building. This action supplements site drainage and assists in the stabilisation of moisture conditions near foundations.
- All brickwork should be suitably articulated into discrete units to accommodate the expected movements. In particular, brickwork over doors and windows should be avoided.
- Internal and external walls should be arranged. along straight lines.
- All house drains and water pipes must be provided with sufficient flexibility to accommodate the expected differential movements (between foundation and uncovered outside area) at the level of service.
- The extension of services through slabs should be avoided, where possible, in order to prevent hidden leaks under the slab area. Most plumbing fixtures can be arranged to exit through outside walls.
- Septic systems must not be located within any influence (preferably downhill) of the house or neighbouring foundations. Alternatively, a pump-out system must be employed.
- Subgrades beneath elevated and well ventilated floors should be covered with an impermeable liner (with protective soil blanket) to minimize excessive desiccation.

In addition, certain other 'site management' precautions must be adhered to during the life of the structure, as given on our standard sheet. These precautions generally relate to the control of abnormal moisture variations due to the effects of drainage and vegetation.

SITE MANAGEMENT PRECAUTIONS

These precautions are considered supplementary to any structural and/or foundation design measures for the subject building and are intended for distribution to the prospective house Owner.

Reactive clays are prone to heave/shrink movements with changes in soil moisture content, due to natural or artificial means. The basic design philosophy employed for the dwelling, is to provide a foundation/superstructure adequate to accommodate ground movements, due to extreme seasonal moisture changes only. The possibility of other abnormal and/or localised moisture changes (the cause of most housing distress) has been assumed to be controlled by the following 'site management' procedures:-

In particular, leaking plumbing or blocked drains should be repaired promptly and site grading maintained to prevent ponding near foundations. Garden watering, particularly by fixed systems, should be controlled carefully to avoid gross over watering. On. the other hand, proper garden maintenance should produce year round uniform moisture conditions.

Trees and some shrubs can cause a substantial drying of the soil and associated shrinking of reactive clays. This effect is most likely to result in damage when added to the drying from a drought or a long dry spell. The problem can be minimized by planting trees at substantial distances from the house. The distance depends upon the species and soil conditions, but generally °/4 of the mature tree height is a minimum.

Problems during drought can be minimized by extensive pruning (thus reducing water "demand) and/or providing trees with adequate water. This watering can be achieved by boreholes or trenches dug well into the clay between the tree and the footing.

This action should also be immediately undertaken by the Owner if brickwork cracking due to tree drying is noticed. Most reactive clay failures can be avoided or minimised by controlling the combined drying effects of trees and drought.

The Owner should also appreciate that on reactive clays it is virtually impossible to design an economic foundation system that will totally prevent movement. Some minor aesthetic cracking, while undesirable, will occur in a significant proportion of houses. In addition, some minor problems should be expected with jamming of windows and doors especially during the settling in period or following a major drought and any repairs should be regarded as part of normal house maintenance. Even significant masonry cracking with widths over hmm usually has no influence on the function of the wall and only presents an aesthetic problem. Just as it is difficult to design an immovable footing system, it is almost impossible to provide remedial measures that will prevent further movements if distress does occur. Consequently, extreme remedial measures should not be undertaken for minor problems.