Broadcrest Consulting Pty Ltd

5 Portions, Lovett Bay, Lovett Bay

Geotechnical Investigation and Landslide Risk Assessment

September 2023

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Wastewater | Stormwater | Flood | Environmental | Geotechnical | Acoustic | Structural

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Document controls

Approval and Authorisation

Title	5 Portions, Lovett Bay, Lovett Bay Geotechnical and Landslide Risk Assessment
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Contents

1 INTRODUCTION

1.1 Background

Broadcrest Consulting Pty. Ltd. was engaged by Aero Leplastrier to conduct a Geotechnical Investigation and Landslide Risk Assessment at 5 Portions, Lovett Bay, Lovett Bay (‘the site’) for a proposed residential development. Drawings showing the proposed development are provided in Appendix D. A desktop study was conducted on the 21/09/2023 to identify site features and constraints for the site inspection. A site inspection was carried out on the 22/09/2023 which involved a visual assessment of the site, soil sampling and DCP testing.

1.2 Objectives

The objective of the geotechnical investigation was to determine site classifications in accordance with Australian Standard AS2870 - Residential Slabs and Footings (2011), undertake a landslide risk assessment for the site in accordance with the Australian Geomechanical Society’s 2007 guidelines and provide advice to facilitate structural design of the foundations for proposed structures.

1.3 Scope of works

- A desktop review of the site utilising a Spatial Data report, including geological, acid sulphate, salinity, soil landscape and landslide risk mapping.
- An on-site inspection to make observations of the site surface conditions
- Three boreholes to 1.0m or refusal on weathered material if shallower, using handheld mechanical equipment
- Three dynamic cone penetrometer tests (DCP) to 3.0m or refusal
- Provision of reporting to provide findings of the assessments and comments and recommendations in accordance with the objectives outlined above.

The investigation undertaken was consistent with the above scope of work.

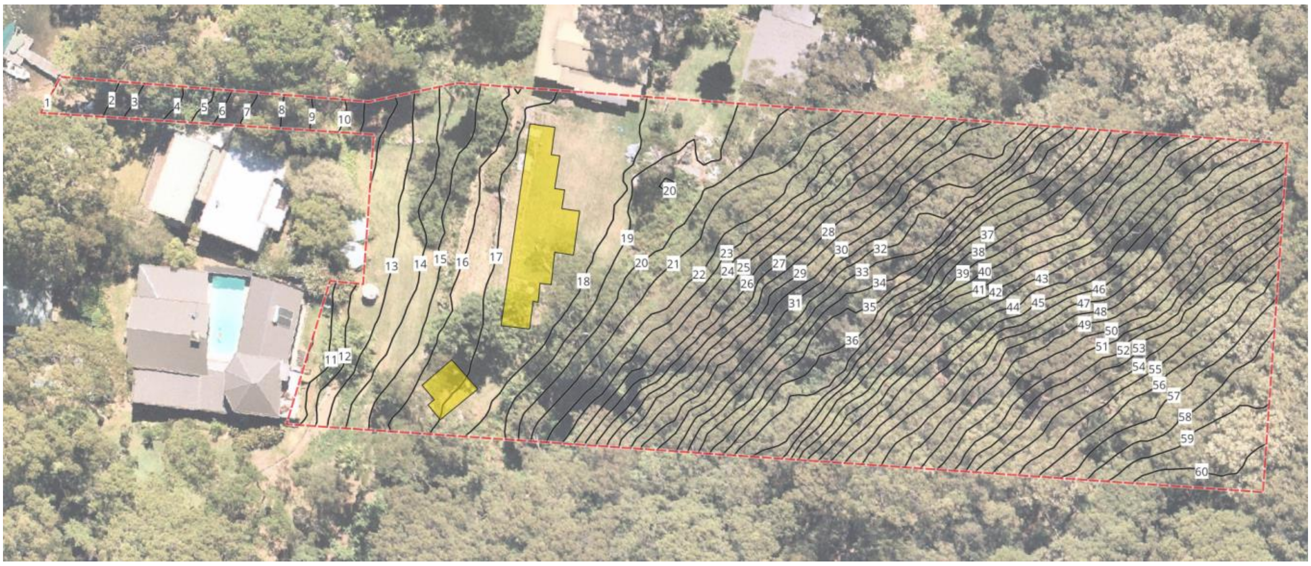


Figure 1.1: Site, 1m contours (AHD – 2011 LiDar)

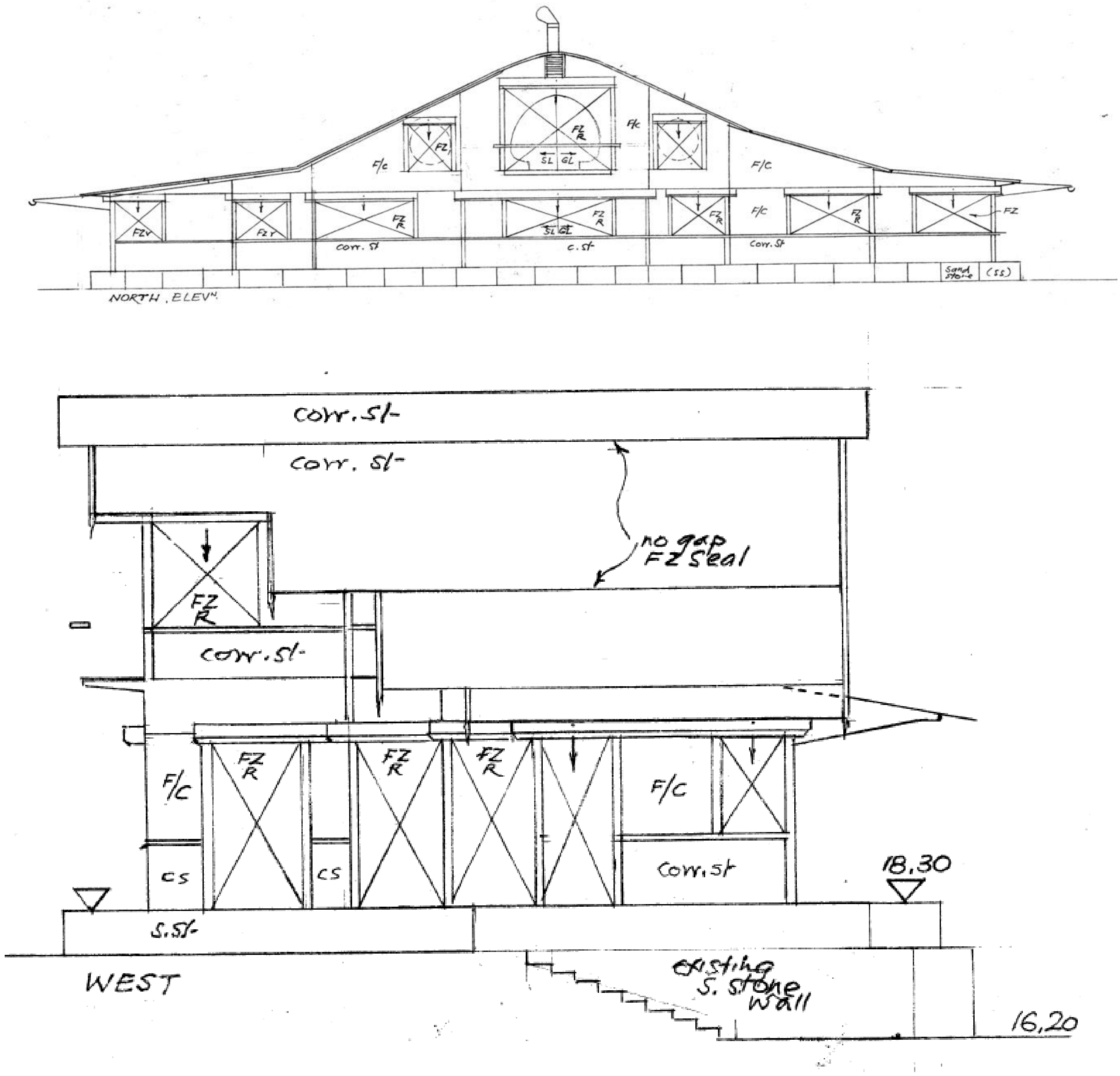


Figure 1.2: Elevations of proposed development – extract of Appending D

2 SITE DESCRIPTION

The proposed development is located at 5 Portions, Lovett Bay, Lovett Bay. The proposal is to construct a residential dwelling and separate studio. The development will be serviced by a rainwater tank and onsite effluent management. The site zoning is within C3 Environmental management.

The building envelope was previously occupied by a residential dwelling which burnt down in the 1994 bushfires. The existing dwelling was connected to a septic tank and absorption trench.

The envelope consists of a levelled pad with stepped retaining walls. Above and below the building envelope the gradient is moderate to steeply inclined side slope (Figure 2.1). Access to the site is via water only, with a walkway and stairs leading up to the building envelope. Existing residential dwellings are located to the east and south of the site, with the western boundary featuring a natural bushland (C1 National Parks and Nature Reserves).

Figure 2.1: Site Location (red)

3 DESKTOP INVESTIGATION

The desktop investigation utilises a combination of public and private data sources to identify features on a site. These features can individually or collectively add geotechnical constraints during a development. Appendix B contains the full set of maps obtained for the review. Analysis of LiDAR data is performed to obtain raw 1m contour lines, slope heat maps, slope landforms and rainfall flow paths. References are provided for all other data sources. The impact rating of a feature is based on pre-existing criteria or through professional judgement and is assessed in context with all other features.

Table 3.0.1: A summary of the general factors assessed during the desktop investigation.

Factor Assessed	Description	Limitation
Slope across site*	Min: 0 ˚ Max: 50.7˚ Average: 26.7 ˚	Major
Landform Morphology	Upper: Linear Planar Mid: Linear planar Bottom: Linear planar	Minor
Rainfall	Monthly evaporation exceeds rainfall for the most of the year, with the exception of April, May, June and July.	Moderate
Geology	**Rnn: Newport formation** Interbedded laminate, shale and quartz sandstone, **Rh: Hawkesbury Sandstone** Medium to coarse grained quartz sandstone, very minor shale and laminate lenses	Minor
Soil Landscape	Watagan	Moderate
Soil Formation	Colluvial	Moderate
Soil Fertility	NIL	NIL
Acid sulphate soils	Not mapped on site. High probability on shoreline	Minor
Salinity	No hydrogeological landscapes within area.	Nil
Run-on	Moderate run on due to impermeable rock shelves and highly permeable soils. Building envelope is located on linear planar slope, outside of watercourses.	Moderate
Site-drainage	The soil permeability is anticipated to be high. Slow run off due to level building envelope	Moderate
Land use	Current: Residential land (unoccupied)	Minor
Cut and Fill	Development proposes construction on existing fill	Moderate
Vegetation	Site is predominantly grass, shrubs, vines and trees	Minor

*Based on 3.0m elements - see section 3.1

Table 3.0.2: Legend for Geotechnical Constraints

Impact	Description
Minor	This feature has been assessed and deemed to have little geotechnical impact
Moderate	This feature requires consideration. It may require detailed investigation or planning
Major	This feature requires careful consideration and evaluation prior to further work

3.1 Slope

The inclination of a slope is the biggest consideration when determining the type(s) of landslide and likelihood. It is closely related to the landform (Section 3.2). Lidar data with a $1m^2$ resolution has been used for the terrain analysis. The slope profile is based on 3.0m elements which reveals an average slope of 38.6° and a maximum slope of 50.7° above the building envelope. Within the building envelope, the average slope is 4.7°.

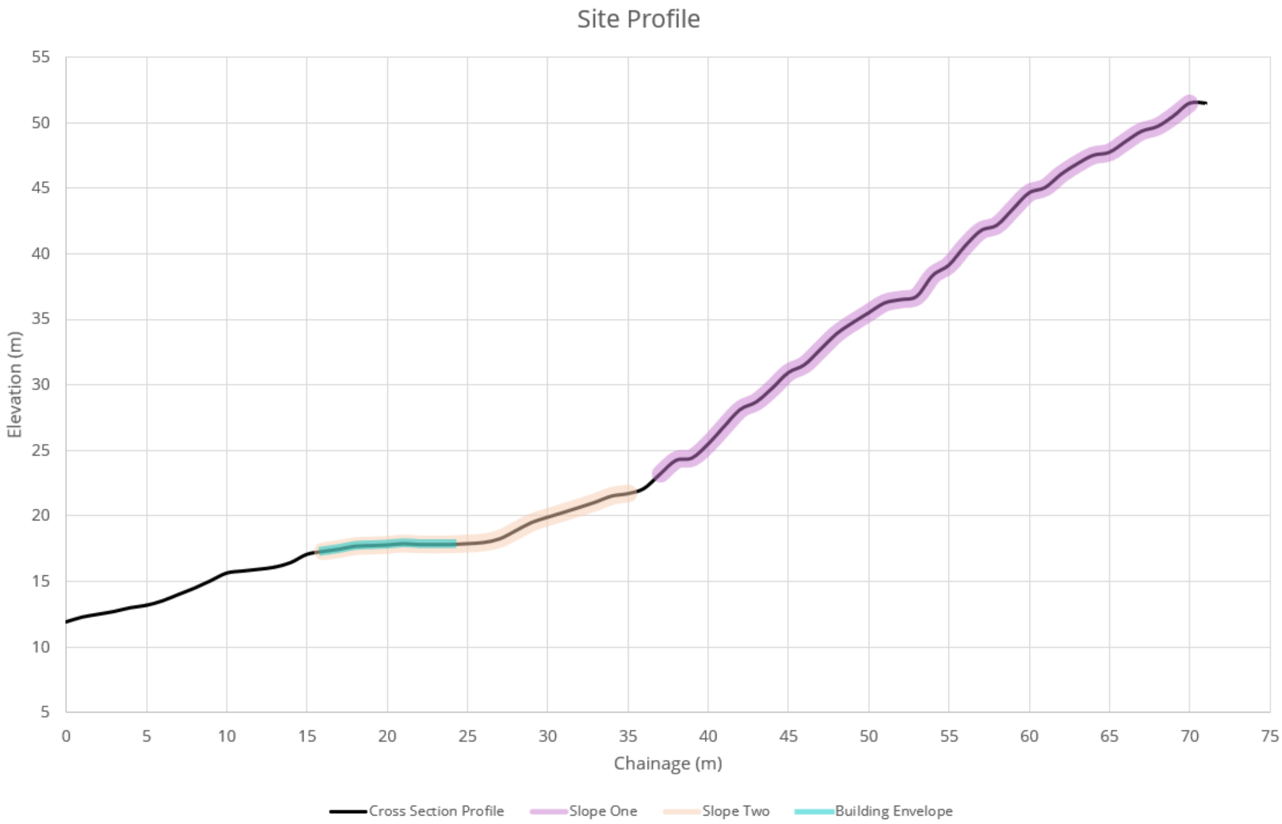


Figure 3.1: Profile Cross-section south to north (site building envelope in blue)

3.2 Landform morphology

A landform is a natural feature of land. Each landform is made unique by its slope, shape, vegetation, and soil among other features. Neighbouring Landforms collectively make up the terrain of a landscape. In respect to landslide, the landform morphology provides insight into the types of movement which can be expected on a site. Table 3.3 shows the site's landforms at different positions on the slope which can be cross referenced with Table 3.4 for correlated movement types.

Table 3.3: Site landforms

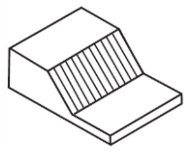
Landform Feature	Morphological Type	Slope Configuration	Diagram
Upper slope Mid Slope Lower Slope	Linear	Planar	

Table 3.4: Slope forming process and their associated landslide movements

Process	Movement Type	Slope description
Morphology	Creep	Convex upwards slope segments
	Slumps	Concave at head of slope, convex at toe
	Rock fall	Causes a tala (scree) slope equal to the angle of repose of the material
Hydrology	Surface Flow	• Aids the development of concave upward profiles in valleys • Convex upward profiles along divides
	Subsurface Flow	• Aids in the formation of earthflows and solifluction • May lead to surface channel formation by piping (sapping). • Aids in eluviation
Climate	Jagged terrain	Typically found in arid environments where mechanical weathering is the primary process
	Rounded terrain	Typically found in humid environments where chemical weathering is the primary process.

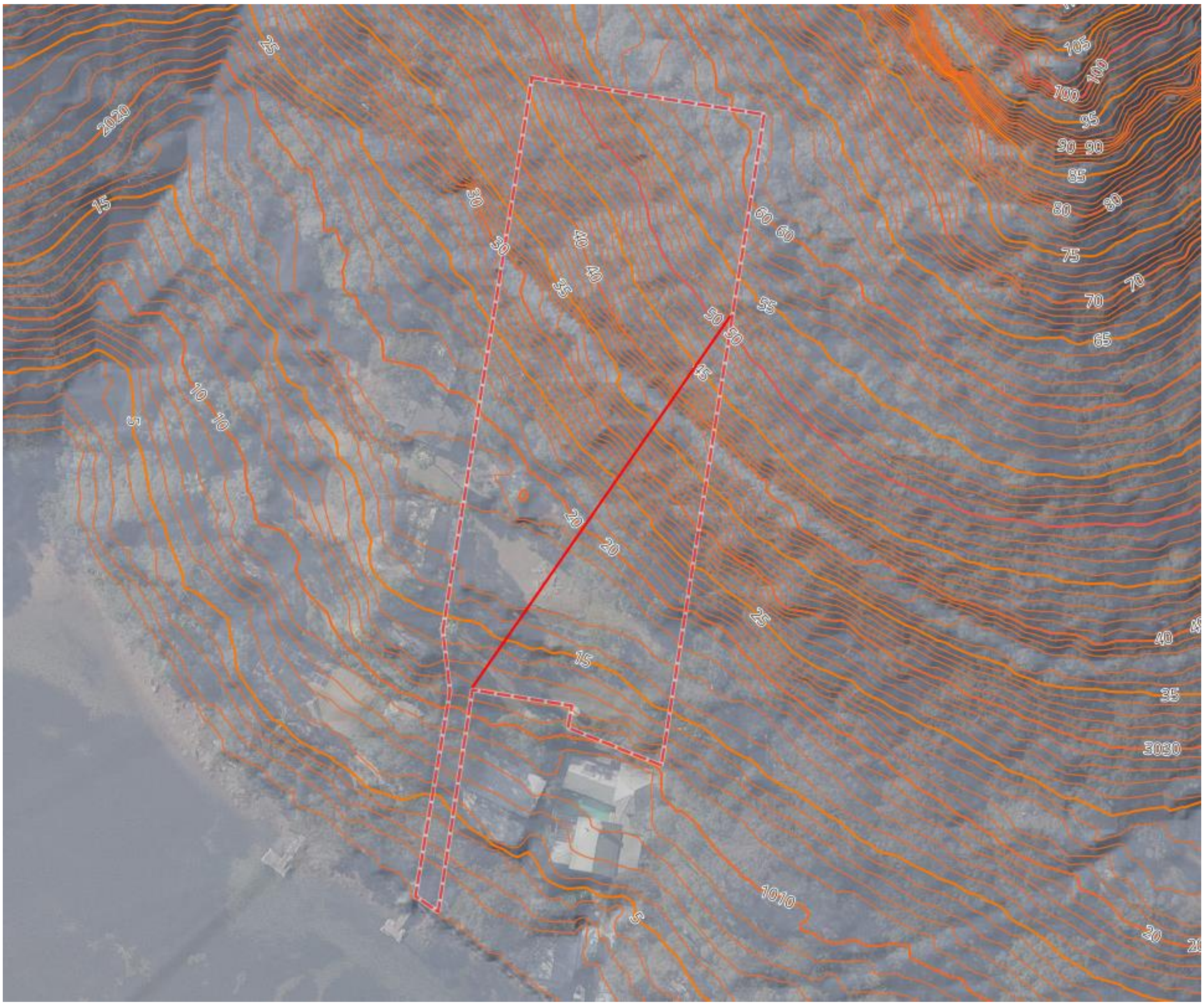


Figure 3.2: Site morphology and slope cross section profile (red line)

3.3 Surface Water and Seepage

Surface water and seepage flow is determined by the catchment preceding the slope, the prevailing landform features, as well as the interaction of soil and site features. A Terraflow analysis (using a 1m digital elevation model from lidar) is performed to identify potential overland flow paths and erosion prone areas.

A general assessment of the likely surface water interaction with the landform is summarised in Table 3.5 below. Figure 3.2 shows the results of the Terra Flow analysis (see Appendix B for the full map). The analysis shows that surface water is most likely to flow south and east of the site.

Table 3.5: Site landforms

Landform Feature	Catchment		Surface Flow		Soil Moisture	Seepage Potential	Limitation
	Size	Surface Coverage	Run-on	Run-off			
Upper slope	Limited	Pervious landscape	Moderate	Fast	--	Moderate	Minor
Mid Slope	Limited	Pervious landscape	Fast	Slow	--	High	Moderate
Lower Slope	Limited	Pervious landscape	Slow	Moderate	--	High	Minor

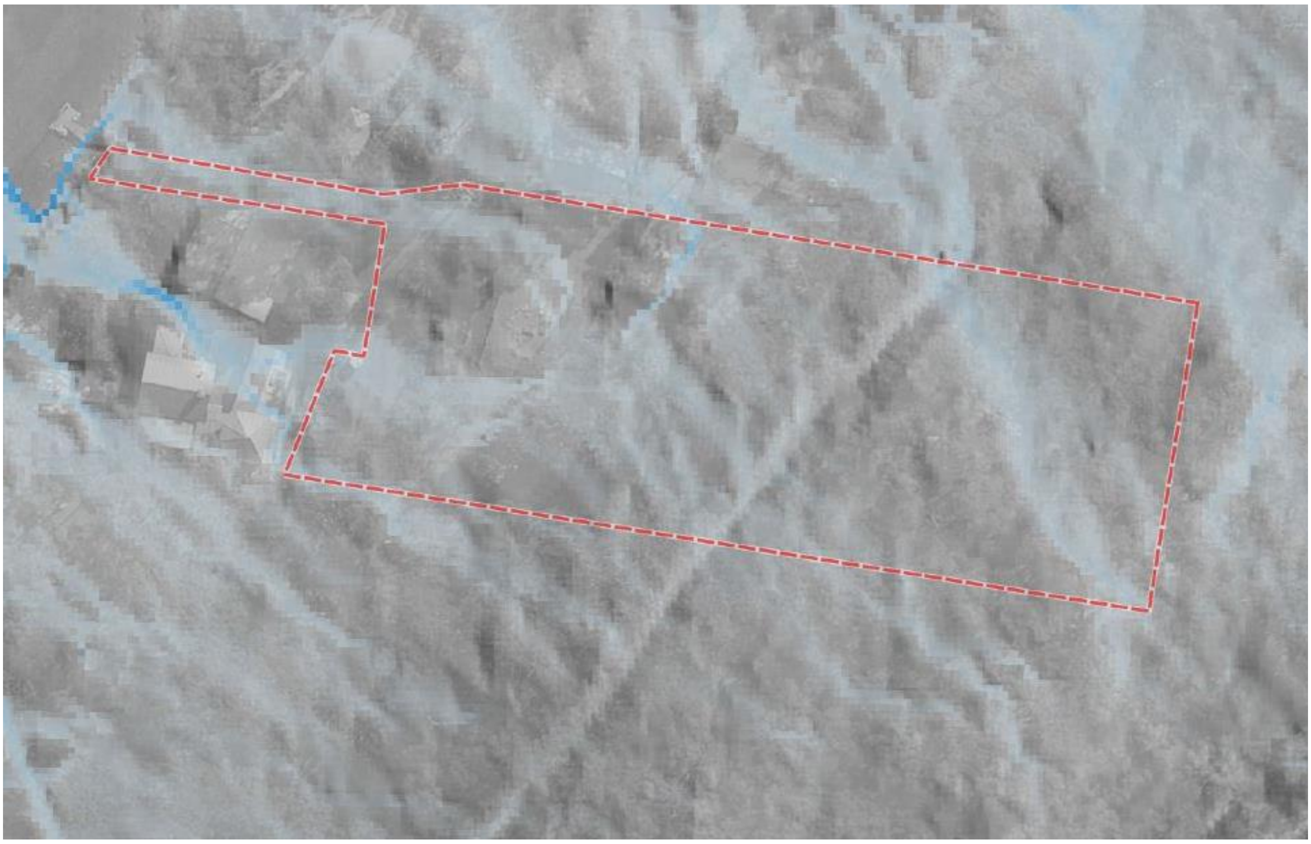


Figure 3.2: Terraflow analysis of the slope terrain – no significant flow paths identified.

3.4 Erosion potential

The extent and severity of erosion and surface soil movement is relative to the surface flow intensity and vegetation coverage. The surface water analysis (Figure 3.2), existing surface coverage, and soil landscape were evaluated as part of the erosion analysis. The following erosion assessment was completed as part of the desktop investigation:

Table 3.6: Site landforms

Landform Feature	Surface Flow Type	Erodibility		Erosion Hazard		Limitation
		Surface Flow	Wind	Surface Flow	Wind	
All	Unconcentrated	Moderate	Low	High	Low	Moderate

3.5 Existing landslides in region

No landslides recorded within the vicinity of the development. The Pittwater Bay region is recognised as a high-risk area for slope instability due to the steep slopes and high rainfall.

4 SITE INSPECTION

4.1 Methodology

A site inspection was conducted on the 22/09/2023 by Broadcrest consulting Engineer Kurtis Ferry. Photographs were taken of the landscape and site features for future reference. The general methodology was as follows:

1. Initial site walk-over
   a. Identification of the development area
   b. Observations of the site landform
   c. Observations of the ground surface conditions
   d. Observations of erosion, overland flow paths and soil displacement
   e. Observations of vegetation, including type, density and spacing
   f. Observations of potential geotechnical limitations
2. Soil sampling
   a. Soil sampling down to 1.0m or refusal using handheld equipment
   b. DCP testing to 3.0m or refusal
   c. Field classification and logging

4.2 Site Observations

4.2.1 Below the building envelope

1. Access to the site is restricted to water vessels.
2. A walkway from the jetty extends up to the building envelope.
3. The slope is steeply inclined, with residential dwellings cut into the slope / on piers.

4.2.1 Building envelope

4. Retaining walls have been used to reduce the slope within the building envelope.
5. The retaining walls consisted of stacked stone 1.0m high, and are estimated to be ~40 years old.
6. Isolated sections of the retaining wall show signs of deformation, requiring remediation.
7. The building envelope consisted of a lawned area with isolate trees.
8. Existing pipes were identified within and around the building envelope, likely from the existing septic and stormwater systems.
9. Sandstone was identified consistently between 1.5 and 1.8m below ground level across the building envelope. It is noted that colluvial material (boulders) may be present in the soil profile.

4.2.1 Upslope of Building envelope

10. Upslope of the proposed development was steeply inclined
11. The slope contained native bushland, with ground cover, shrubs and trees present. It is noted that the tree density appeared to be lower than the surrounding bushland, possibly due to previous clearing.
12. Tree consistently featured bent trunks, indicating soil creep / slides.
13. Boulders were identified at across the slope.
14. Recent back burning had cleared some sections of ground cover and low vegetation.
15. The exposed sands are likely susceptible to erosion.
16. There were not distinct signs of active seepage (springs).

4.3 Subsurface Investigation

Six boreholes were conducted across the site using a handheld auger. Boreholes 1 – 3 were conducted within the building envelope, and boreholes 4-6 for the wastewater disposal. All boreholes were terminated at 1000mm depth. DCP testing of boreholes 1-3 indicate that bedrock is between 1500 and 1900mm BEGL. Given the retaining wall and level building envelope, it is anticipated that fill material has previously been used. The material encountered within the boreholes in and around the building envelope were consistent with the surrounding landscape (fine sand). It is likely any fill material has been sourced on site.

A visual inspection upslope of the development shows extensive rock outcrop. Given the inclination (average of 38.6°) it is anticipated that the soils are likely shallow (<1.0m) and retained by the vegetation root systems and between rock outcrops.

The locations of the boreholes are shown in Figure 4.1 below. The subsurface conditions are summarised in Table 4.1.

Table 4.1: Subsurface profile

Soil Type	Unit Name	General Description	Thickness (m)	R.L (m BEGL)
0	Top Soil	**SAND**, grey, loose, trace silt/clay content, organics	0.2	0 – 0.2
1	Colluvial	**SAND**, grey, loose, trace silt/clay content	0.8	0.2 - 1.0
A	XW	**Sandy CLAY**, brown/yellow/red, firm, trace gravel	0.9	1.0 - 1.9
B	Bedrock	**Bedrock (shale/sandstone)~~-~~,** anticipated low-medium strength	-	-

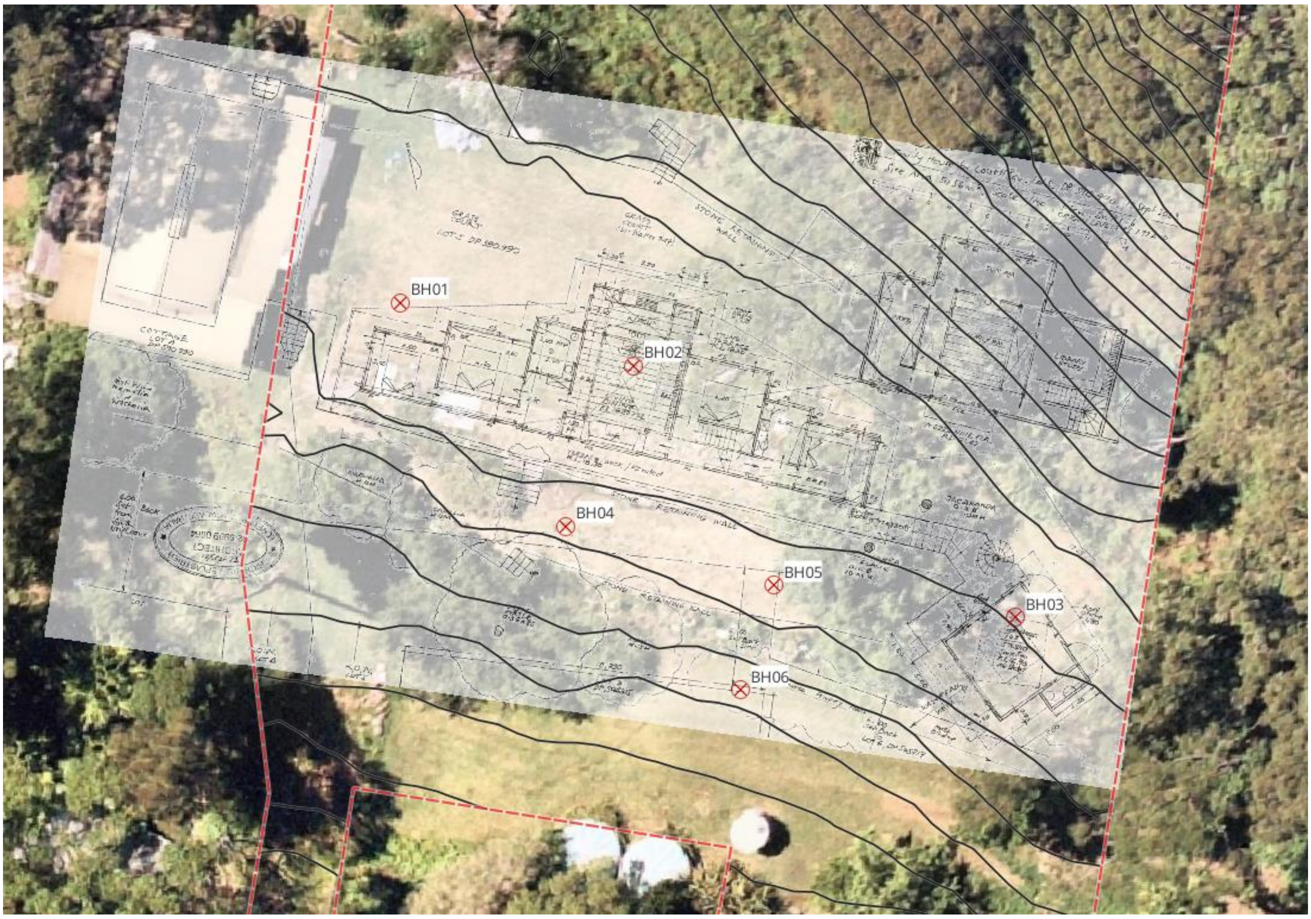


Figure 4.1: Borehole locations

5 LANDSLIDE RISK ASSESSMENT

5.1 Forword

Landslide is a colloquial term used generally for the movement of a mass of rock, debris or earth down a slope. Landslides occur when the soil or rock on a slope change from a stable to an unstable condition. A change in the stability of a slope can be caused by a number of natural factors, including:

- surface and groundwater
- loss or absence of vegetation, soil nutrients, and soil structure
- erosion of the toe of a slope by rivers or ocean waves
- weakening of a slope through saturation from heavy rain and snow melt.

Landslides can also be triggered by human factors, including:

- earthwork which alters the shape of a slope, or which imposes new loads
- vibrations from machinery or traffic
- in shallow soils, the removal of deep-rooted vegetation that binds colluvium to bedrock
- construction, agricultural or forestry activities (logging) which change the amount of water infiltrating the soil.

There are a number of academic ways to classify landslides, such as by material, size, movement type, velocity or destabilising factors. A full list of the landslide types referred to in this report are presented in Appendix C. The assessment is broken into the following four categories:

- bedrock movement
- planar mass movement
- rotational mass movement, and
- material flows.

Each of these categories occur independently of each other under different conditions. Professional experience is required in identifying which type(s) of landslide will affect a development, the source and the runout length. A summary of the common slope forming processes associated with landslide types is provided in Table 3.4 and Appendix C.

5.2 Potential landslide risks

Based on AGS 2007, recent site observations, and the slope conditions in the general area, potential landslide hazards/ events that could affect this site at the time of the assessment include:

- Localised soil creep;
- Localised instability within the building envelope, including failure of retaining walls
- Rock fall (loose boulders)
- Large scale slope instability

5.3 Risk to Property

Risk to property is assessed initially based on the existing conditions and then the proposed conditions of the site, including any risk management implemented as part of the proposed additions to the site. Risk assessment for property loss was undertaken using the Risk Matrix according to AGS (2007). The Risk Matrix defines a qualitative terminology for likelihood, consequence and risk. The frequency estimate is expressed as an annualised probability, considering the probability of spatial impact and is expressed qualitatively as likelihood.

The result of this assessment is summarised in Table 5.1 and are based on an assigned Importance Level of Structure of 'Two' in accordance with AGS, 2007. This level of structure is described as low-rise residential construction. This assessed level of risk after the proposed site works, is based on the advice provided within this report being implemented on the site (refer section 6).

Table 5.1: Landslide Risk to Property Analysis

Event	Likelihood	Consequence	Level of Risk
Present			
1. Localised soil creep	Likely	Minor	Moderate
2. Localised instability	Likely	Minor	Moderate
3. Rock fall	Likely	Medium	High
4. Large scale slope instability	Unlikely	Major	Moderate
Future*			
1. Localised soil creep	Unlikely	Minor	Low
2. Localised instability	Unlikely	Minor	Low
3. Rock fall	Unlikely	Medium	Low
4. Large scale slope instability	Rare	Medium	Low

*It is assumed that the recommendations in section 6 are adopted/implemented.

5.4 Risk to Life

For this assessment, the risk to 'Loss of Life' was considered for the potential landslide events detailed in section 3.2. The vulnerability, spatial and evacuation factors which have been adopted are based on our best professional judgement given the information available.

The annual risk of loss of life for the individual most at risk is given by $R_{(LOL)} = P_{(H)} \times P_{(S:H)} \times P_{(T:S)} \times V_{(D:T)}$ (AGS2007), where:

- $\mathbf{P_{(H)}}$ is the annual probability the failure occurs.
- $\mathbf{P_{(S:H)}}$ is the probability of spatial impact of the hazard impacting a static element at risk (i.e. the building/a person outdoors), taking into account the location, travel distance and direction of the hazard.
- $\mathbf{P_{(T:S)}}$ is the temporal spatial probability of the person most at risk given the spatial impact and allowing for evacuation if there is warning of the hazard event.
- $\mathbf{V_{(D:T)}}$ is the vulnerability of the individual given they are impacted.

The following values have been applied for the assessment:

Table 5.2: Landslide Risk to Property Analysis

Event	$P_{(H)}$	$P_{(S:H)}$	$P_{(S:T)}$	$V_{(D:T)}$	$P_{(LOL)}$
Present					
1. Localised soil creep	10^{-2}	1	0.1	0.05	5.0^{-5}
2. Localised instability	10^{-2}	0.5	0.55	0.3	8.3^{-4}
3. Rock fall[1]	10^{-2}	0.5	0.55	0.5	1.4^{-3}
4. Large scale slope instability	10^{-4}	0.3	0.65	0.9	7.0^{-5}
Future[2]					
1. Localised soil creep	10^{-4}	0.5	0.1	0.05	2.5^{-7}
2. Localised instability	10^{-4}	0.5	0.55	0.3	8.3^{-6}
3. Rock fall[1]	10^{-4}	0.1	0.55	0.5	2.8^{-6}
4. Large scale slope instability	10^{-5}	0.3	0.65	0.9	1.7^{-6}

1) Assessed based upon a person inside the dwelling.
2) It is assumed that the recommendations in section 6 are adopted/implemented.

5.5 Risk Assessment Summary

In summary, the risk in terms of landslide is assessed as follows:

Damage to property: Is currently assessed as 'LOW'. The risk post the development of the site is also assessed as LOW so long as all cut/filled slopes are adequately supported by engineered retaining walls and not left as overly steep slopes. Short term excavated slopes more than 1m in height will also need temporary support. For an Importance Level of Structure 2, the suggested acceptable upper limit of qualitative risk for an existing slope and new development are 'Low' (Table C10, pg 135, AGS 2007). Thus, given the site is typically assessed with a Low risk, the future risk to property is assessed as acceptable.

Loss of life: AGS suggested a tolerable loss of life of 10^{-5} per annum for newly developed/ constructed slope sites and 10^{-4} for existing slopes. For acceptable losses this risk reduces to 10^{-6} and 10^{-5} respectively. The site is classed as an existing slope with a new development. Thus, the current risk is assessed as within the Tolerable and **the future risk is assessed as just within the acceptable range if the recommendations in this report are adopted.**

The options for managing landslide risk are to reduce the frequency of sliding or to reduce the potential impact on the building (or its occupants) because of a landslide. This means putting in place stabilisation measures to control the initiating circumstances during and after development, placing vulnerable structures/individuals at greater distance from a potential slide, and/or reducing the likelihood of impact through mechanical means.

Even with recommendations and measures within this report in place, it does not mean that the risk of landslide is removed, and that failure will never occur. The approach adopted is to reduce and maintain the risk associated with landslide at a low and tolerable levels.

6 COMMENTS AND RECOMMENDATIONS

6.1 Landslide

Guidance on the good hill side practice for residential developments on sloping site is provided in LR08 AGS guide (refer Appendix F). This recommends the following:

- Water should not be allowed to discharge straight on to the hill side. Roadways and parking areas should incorporate kerbs and stormwater drainage;
- Stormwater from the roof should be discharged into the bay where practical. If not practical, concentrated flows should be avoided/
- Clearance of vegetation should be kept to a minimum. Large scale clearing can increase the likelihood of slope failure (eg landslide).
- Retaining walls shall be design by competent engineers to consider the effects of sloping ground.
- Light weight flexible structures are preferable because they can tolerate reasonable movement with minimal signs of distress and maintain their functionality.
- Foundation should be taken to a depth which is below the level at which a landslide is likely to occur. In natural conditions, it is preferable to support foundations in rock.
- Loose rocks and boulders should be removed from the site during the site preparation.

To attain and maintain the risk at low levels (in respect of the consequences of landslide events after redevelopment of the site), specific risk management practices as detailed in the following sections based on the above must be adopted for the site.

6.2 Site Preparation

Ground preparation should allow for the stripping of topsoil from structural footprints. Stripped soil would not be suitable for structural fill and must be processed to exclude cobbles and then used for landscape applications if determined to be suitable for this purpose. Surplus excavated materials may need to be disposed of off-site.

No filling, greater than 0.2m depth, should be undertaken on the site without further geotechnical advice.

Removal of soil overburden should be performed in a manner that reduces the risk of sedimentation occurring in nearby waterways and on neighbouring land. All spoil on site should be properly controlled by soil erosion control methods in accordance with Landcom (2004) to prevent transportation of sediments off-site.

6.3 Excavation and Vibration

Topsoil can be readily excavated using conventional earthmoving equipment. All excavation work should be completed with reference to the Code of Practice 'Excavation Work' (Oct 2013) by Safe Work Australia. Excavation method statements will need to be prepared by the excavation contractor prior to the issue of a CC.

If compacting sand using vibration compactors, careful consideration must be given to any surrounding structures and slopes. Further geotechnical advice should be sought.

Any excavation greater than 1.0m (other than temporary pier footings) will require an appropriate shoring system.

6.4 Retaining Structures

The existing retaining walls showed signs of localised deformation. At the time of inspection, the client was aware of the deformation and had plans to carry out remediation works as part of the development.

The existing retaining walls should be restored to as new condition. If the configuration of the wall will change, an engineer should be engaged to design and check the wall. The wall should be checked on a bi-yearly basis by the owner to look for signs of deformation. If identified, advice should be sought regarding the remediation of the wall by a competent engineer.

All excavations into soil exceeding 1.0m depth should be supported by suitably designed and installed system (in accordance with AS4678 Earth Retaining Structures). The soil pressure can be calculated by:

a) A qualified and suitably experienced engineer using the Rankine formula. The Engineer must include the ground water pressure in their capacity calculations unless a suitable external dewatering system is used and maintained.
b) The ground inclination shall be considered for the active and passive sides.

Alternatively, excavations may be battered back at slopes of no greater than 1V:2H for temporary slopes (unsupported for less than 1 month) and 1V:3H for longer term unsupported slopes (up to 6 months). Suitable erosion, sediment and rilling prevention plans should be designed and implemented for all unsupported slopes.

6.5 Groundwater

Given the shallow sandy soils across the site, standing ground water is unlikely to pose a significant issue. Water seepage through the soil during and after rainfall is expect to be rapid, and will likely resolve as seepage to the surface.

In order to prevent run-on from the slope saturating the building envelope, it is recommended an upslope diversion bund is installed to redirect excess surface water around the development (see section 6.10 for alternate solution). The exit point of any such bund should prevent concentrated flows through the use of a level spreader or rock riffraff.

6.6 Surface water erosion and vegetation

Exposed soil should be protected from erosion, by means of directing surface water to the lower part of the slope and revegetating the surface with grasses or small to medium sized plants. Sick or dying trees, which may fall, should be removed before they can impact on the slope. It is recommended that the slope above the building envelope is revegetated as required to maintain full coverage.

6.7 Storm Water management

Design of onsite stormwater storage detention systems is advisable to manage stormwater flows. On site stormwater detention (rainwater tanks and OSDs) should be designed so that any stormwater which overflows from these is the same or lower than the current stormwater surface or subsurface discharges on the site. All roof-water not stored for reuse, and surface run-off, should be piped to the lower slopes to the south of the proposed dwelling.

On site stormwater infiltration trenches are permissible on the site but should be located remote from structures on the lower slopes (including the sewer) if space is available.

Careful consideration must be given to ensure nuisance flows are not generated which may impact down-stream residences.

6.8 Footings

6.8.1 Site class

Based on the encountered conditions and AS 2870 the site is a class P classification, due to the existing infrastructure, cut and fill works and slope. Where piers are taken to bedrock, reactivity is not anticipated (A classification). Where pad-footings are used, reactivity is expected to be in the range of a class S or M classification (ys 20-40mm).

The above site classifications and footing recommendations are for the site conditions advised at the time of fieldwork. Consequently, the site classification may need to be reviewed if the proposed earthworks are changed (eg the site is filled or cut by more than 200mm).

Loose stones and boulders were identified across the site. The presence of these suggests the slope may contain buried rocks and boulders in the form of colluvial material. Special attention should be given during the site preparation for the foundations to ensure the foundations are bearing on bedrock and not buried boulders.

6.8.3 Footing design parameters

It is recommended that:

- All topsoil and soft spots are stripped from below proposed footings (where required);
- All footings should be designed by a competent structural engineer with reference to the guidelines in AS 2870-2011, Residential Slabs and Footings, for Class P sites for sites.
- All footings for the same structure should be founded on strata of similar stiffness and reactivity to minimise the risk of differential movements, with articulation provided where appropriate.
- No further fill is to be imported onto the site without further consultation with a geotechnical engineer. Importation of fill may change the site classification and may increase the risk associated with soil slippage on a sloping site.
- All footings should be designed and constructed in accordance with AS 2870-2011, Residential Slabs and Footings, with consideration to the site classifications presented in Section 6.8.1.
- Footings are expected to comprise of pier/pad footings. Pad footings shall be taken to extremely weathered material at a depth of at least 1.2m. Piers shall be taken to low strength bedrock. We recommend socketing at least 500mm for low strength material. If medium strength rock is encountered, this can be reduced to 300mm.
- The extremely weathered material (Sandy CLAY) is anticipated to have an allowable bearing capacity of 100kPA when using a 1x1m pad footing.
- The low strength Sandstone Is anticipated to have an allowable bearing capacity of 300kPA when using a 400mm diameter pier.
- All footings should be inspected by a suitably qualified and experienced person (e.g a geotechnical engineer) after drilling and prior to pouring. The footings should be constructed with minimal delay following excavation. Water that has ponded in the base of excavations and any resultant softened material is to be removed prior to footing construction.
- If a delay in construction is anticipated, we recommend that a concrete blinding layer of at least 50 mm thickness is placed to protect the foundation material. Any water in pile holes is to be pumped out prior to concrete pouring. Alternatively, a tremie pipe can be utilised.

6.8.3 Footing maintenance

Appendix B of AS 2870-2011 indicates that to reduce but not eliminate the possibility of damage, trees should be restricted to a distance from the building ¾ × the mature height. Where rows or groups of trees are proposed, the distance from the building should be increased.

Designs and design methods presented in AS 2870-2011 are based on the performance requirement that significant damage can be avoided if site conditions are properly maintained. Performance requirements and foundation maintenance are outlined in Appendix B of AS 2870.

To minimise potential impacts, details on appropriate site and foundation maintenance practices are presented in Appendix B of AS 2870-2011 and in CSIRO Information Sheet BTF 18, Foundation Maintenance and Footing Performance: A Homeowner's Guide, which is attached as Appendix E.

6.9 Recommended mode of construction

Due to the sloping nature of the site, light weight structures would be best suited to the site. Where masonry structures are proposed with reduced flexibility, articulation should be provided to allow for differential settlement and all footings should be supported on hard extremely weathered material or preferably, low to medium strength rock.

6.10 Rockfall Ditch

It is recommended that a rockfall ditch is installed at the base of the slope north of the proposed development. The ditch shall be 1.0m deep and 2.0m wide. The ditch may be used to divert the stormwater around the development to satisfy the recommendations of section 6.5. Figure 6.1 provides a diagram show the position and angle of the ditch. The ditch should be formed to stop and absorb the moment from falling rocks. Careful attention is required to ensure the ditch does not act as a ramp which could launch falling rocks.

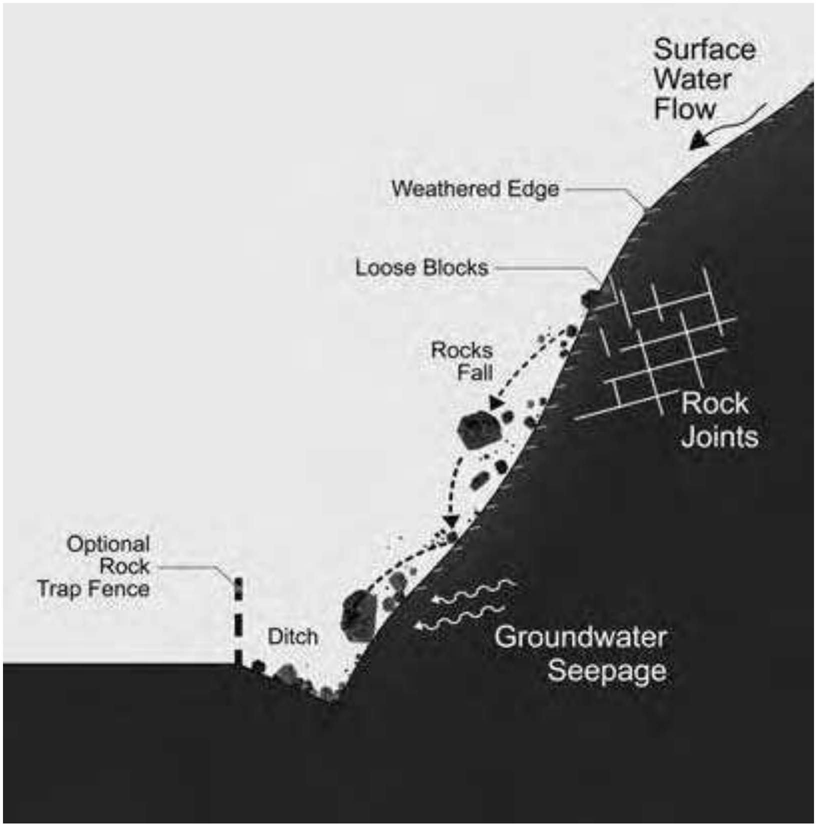


Figure 6.10 – Rockfall ditch positioning[1]

[1] Handbook of Geotechnical Investigation and design tables – Burt G Look – 2007 - Taylor & Francis

7 LIMITATIONS OF THIS REPORT

This report has been prepared subject to a number of limitations. These include:

The application of conditions of approval or impacts of unanticipated future events could modify the outcomes described in this document. In particular, the occurrence of earthquakes of any magnitude, extreme rainfall events or the effects of climate change have not been considered but should they occur, may have a significant impact on the site. The client agrees that such events are possible but nevertheless accepts the risk that they pose;

The findings contained in this report are the result of discrete/specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site in question. Under no circumstances, however, can it be considered that these findings represent the actual state of the site/sites at all points;

In preparing this report, Broadcrest Consulting Pty Ltd has relied upon certain verbal information and documentation provided by the client and/or third parties. Broadcrest Consulting Pty Ltd did not attempt to independently verify the accuracy or completeness of that information. To the extent that the conclusions and recommendations in this report are based in whole or in part on such information, they are contingent on its validity. Broadcrest Consulting Pty Ltd assume no responsibility for any consequences arising from any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to Broadcrest Consulting Pty Ltd; and

This report is not to be relied upon for any purpose other than that defined in this report.

8 REFERENCES

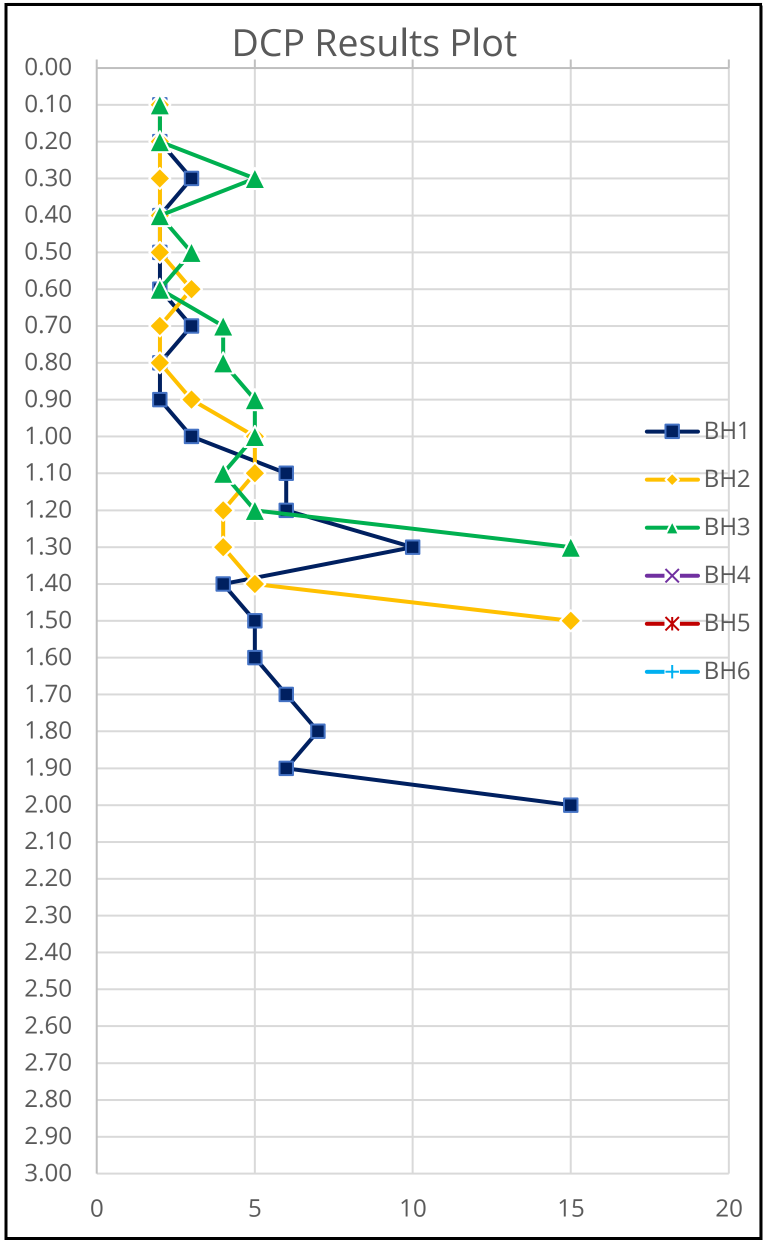
- Australian Standard 1726 (2017) Geotechnical site investigations.
- Australian Standard 2159 (2009) Piling – Design and installation.
- Australian Standard 2870 (2011) Residential slabs and footings.
- Australian Standard 3600 (2009) Concrete structures.
- Australian Standard 4678 (2002) Earth-retaining structures.
- Australian Standard 3798 (2007) Guidelines on earthworks for commercial and residential developments.
- Bertuzzi, R. & Pells, P.J.N. (2002) Geotechnical parameters of Sydney sandstone and shale, Australian Geomechanics, Vol. 37, No 5, pp 41-54.
- P.J.N Pells (1989 et al) Engineering Geology of the Sydney Region.
- Safe Work Australia (July, 2014) Code of Practice 'Excavation Work.
- Australian Geomechanics Society Volume 42 No 1 March 2007 - "Practice Note Guidelines for Landslide Risk Management 2007"

Appendix A: Bore logs and DCP results

Broadcrest Consulting Pty Ltd - DCP RESULTS

Depth			Blows / 100mm					
Depth			BH1	BH2	BH3	BH4	BH5	BH6
0.00	-	0.10	2	2	2			
0.10	-	0.20	2	2	2			
0.20	-	0.30	3	2	5			
0.30	-	0.40	2	2	2			
0.40	-	0.50	2	2	3			
0.50	-	0.60	2	3	2			
0.60	-	0.70	3	2	4			
0.70	-	0.80	2	2	4			
0.80	-	0.90	2	3	5			
0.90	-	1.00	3	5	5			
1.00	-	1.10	6	5	4			
1.10	-	1.20	6	4	5			
1.20	-	1.30	10	4	15			
1.30	-	1.40	4	5				
1.40	-	1.50	5	15				
1.50	-	1.60	5					
1.60	-	1.70	6					
1.70	-	1.80	7					
1.80	-	1.90	6					
1.90	-	2.00	15					
2.00	-	2.10						
2.10	-	2.20						
2.20	-	2.30						
2.30	-	2.40						
2.40	-	2.50						
2.50	-	2.60						
2.60	-	2.70						
2.70	-	2.80						
2.80	-	2.90						
2.90	-	3.00						
20th Percentile			**2**	**2**	**2**			

Soil Classification					
BH1	BH2	BH3	BH4	BH5	BH6
MS	MS	MS	MS	MS	MS
S	S	S	S	S	S
		CL	CL		
	CL		T	T	T
CL		R			
	R				
R					



S = Sand, C = Clay, O = Organic, M = Silt, G = Gravel, L = Low Plasticity, H = High Plasticity, x,X Sub-type,PRIMARY-TYPE

Appendix B: Spatial Data Report

Broadcrest Consulting
MAPPING & SPATIAL SERVICES

LOCATION: 5 LOVETT BAY, LOVETT BAY

REPORT 3258

DATE 25.9.2023

SITE AREA 0.5515 ha (approx)

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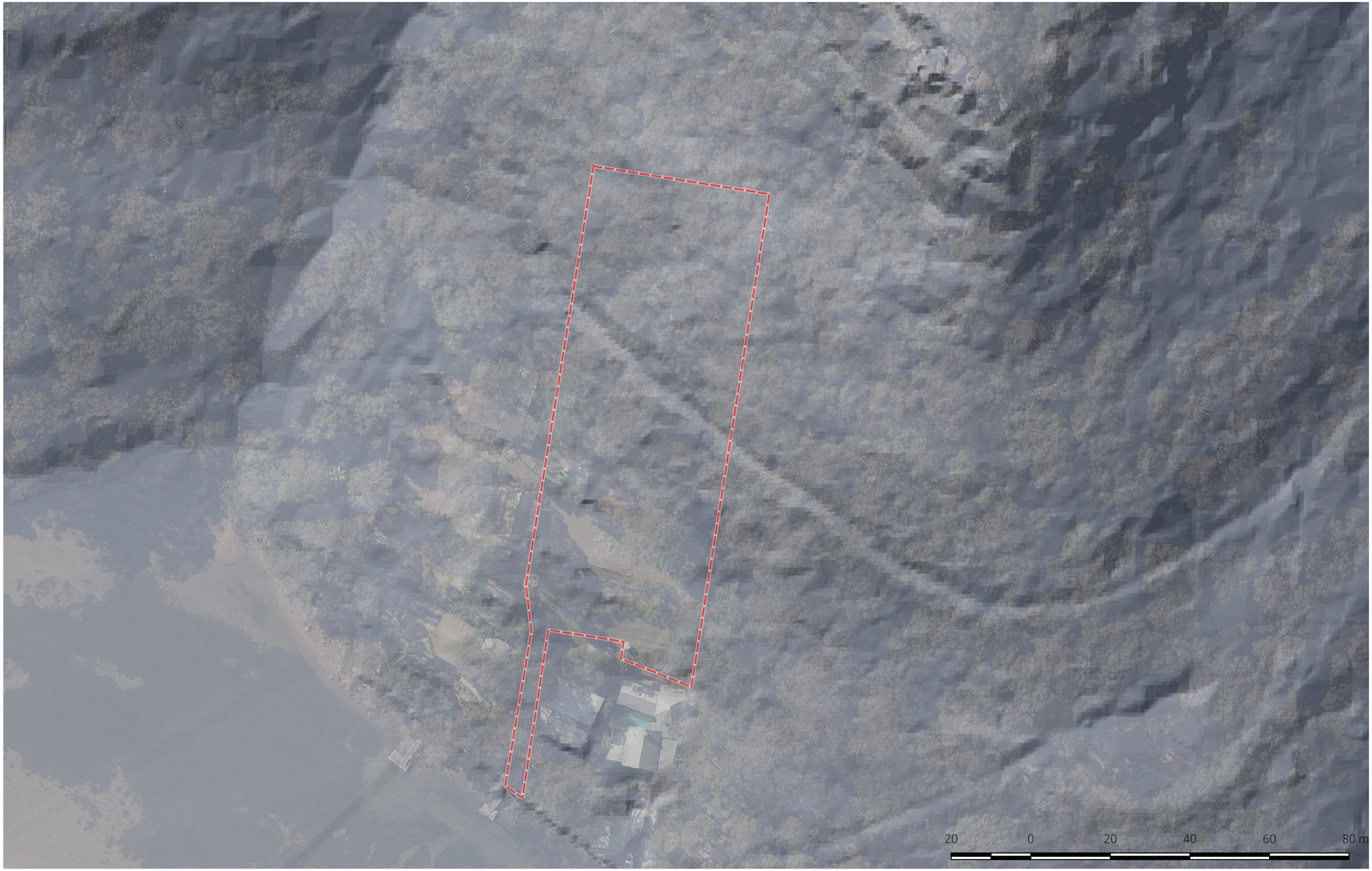
MAPPING & SPATIAL SERVICES
broadcrest.com.au | contact@broadcrest.com.au
1300 554 945
Broadcrest Consulting Pty Ltd |
ABN: 622 508 187

Client Aero Leplastrier	Map Site Aerial Photograph
Location 5 LOVETT BAY, LOVETT BAY LOT: 5 DP 5909900	LGA NORTHERN BEACHES COUNCIL

Data Source	Scale 1:1,500
Base map DFSI Spatial Services Imagery | © Department of Finance, Services & Innovation 2017 Open Street Maps | Creative Commons 3.0 - OpenStreetMap Contributors	Project 3258



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MAPPING & SPATIAL SERVICES
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Broadcrest Consulting Pty Ltd | ABN: 622 508 187

Client Aero Leplastrier	Map Site Location with Terrain
Location 5 LOVETT BAY, LOVETT BAY	LGA NORTHERN BEACHES COUNCIL

Data Source
Geoscience Australia | Obtained on 18.07.2018
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Base map
DFSI Spatial Services Imagery | © Department of Finance, Services & Innovation 2017
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Scale
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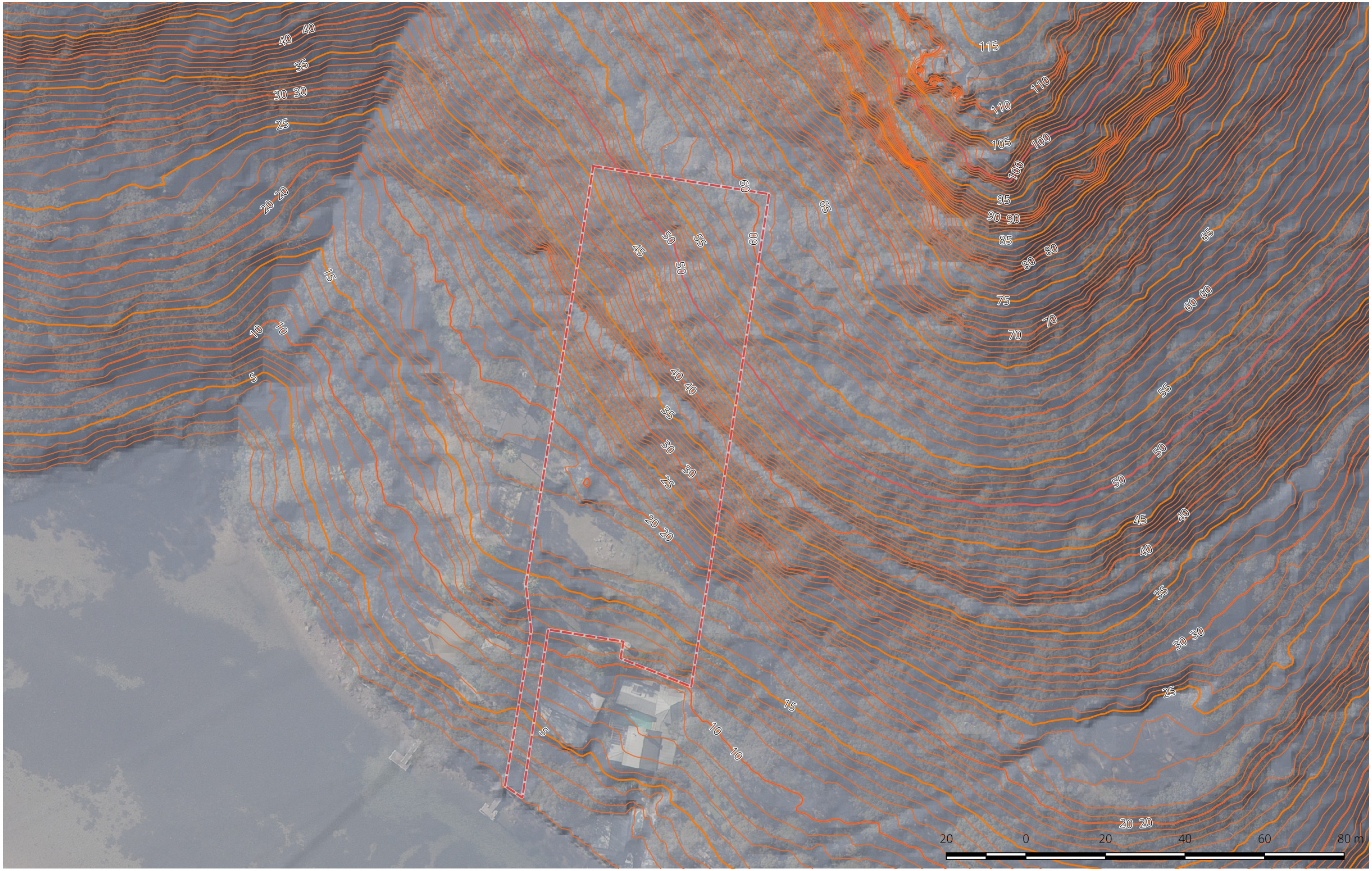

BROADCREST MAPPING & SPATIAL SERVICES broadcrest.com.au | contact@broadcrest.com.au | 1300 554 945 Broadcrest Consulting Pty Ltd | ABN: 622 508 187	Client Aero Leplastrier	Map Topography	Data Source Derived from LiDAR Data | Geoscience Australia | Obtained on 18.07.2018 Creative Commons 3.0 - Commonwealth of Australia	Scale 1:1,000
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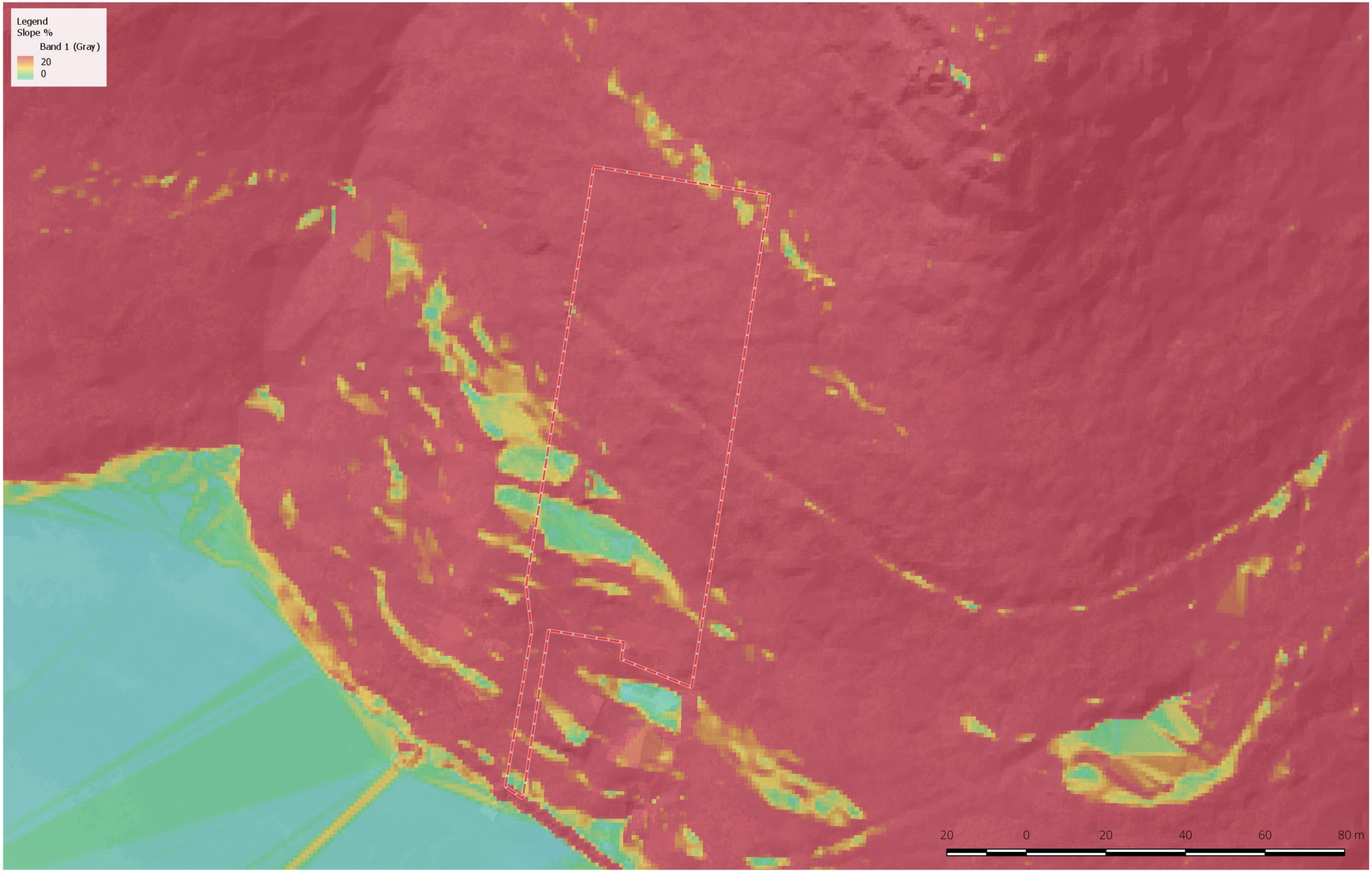
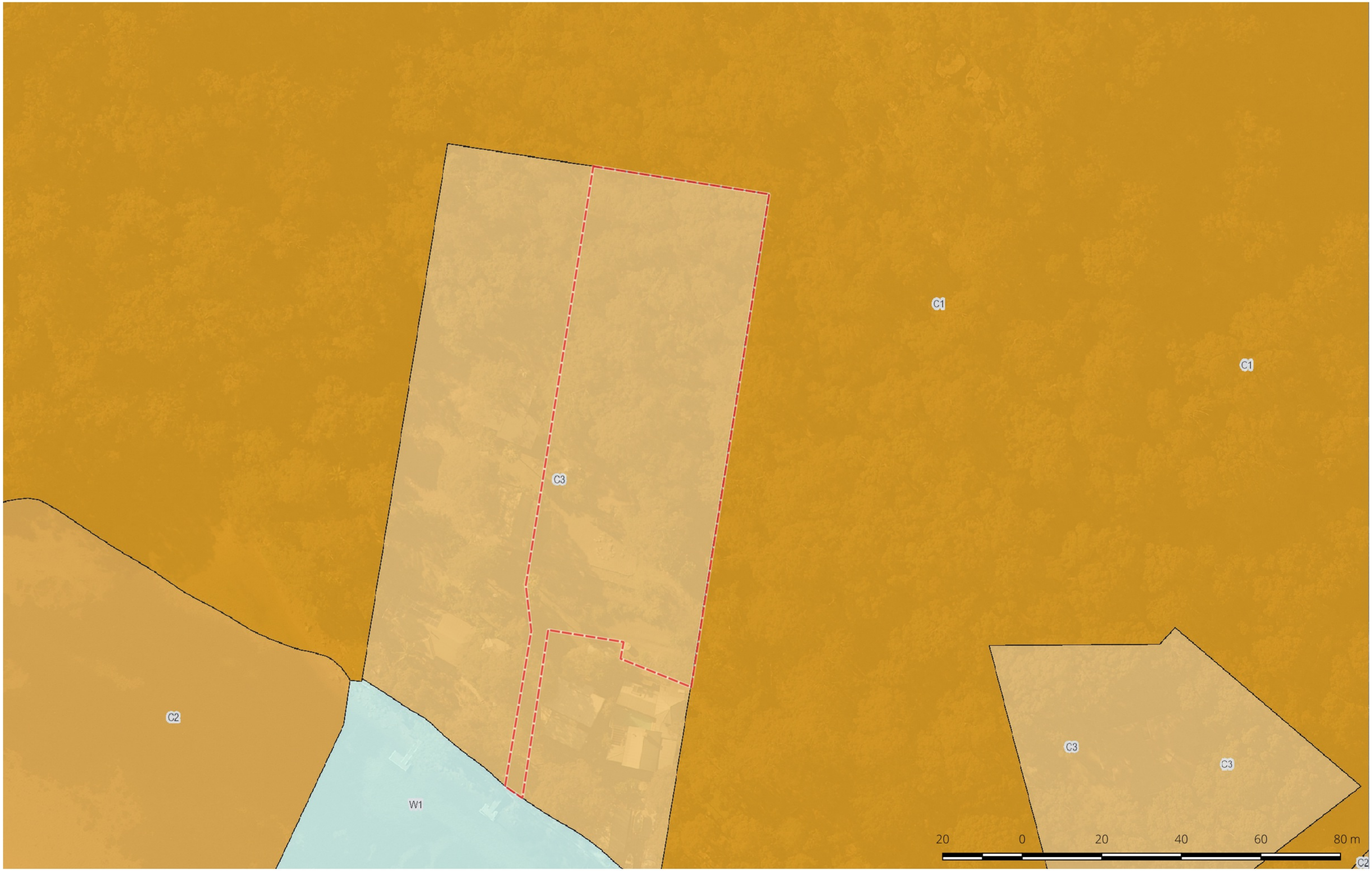


BROADCREST MAPPING & SPATIAL SERVICES	Client	Map	Data Source	Scale
broadcrest.com.au | contact@broadcrest.com.au | 1300 554 945	Aero Leplastrier	Slope Heat Map	Derived from LiDAR Data | Geoscience Australia | Obtained on 18.07.2018 Creative Commons 3.0 - Commonwealth of Australia	1:1,000
Broadcrest Consulting Pty Ltd | ABN: 622 508 187	Location	LGA	Base map	Project
	5 LOVETT BAY, LOVETT BAY	NORTHERN BEACHES COUNCIL	DFSI Spatial Services Imagery | Obtained on 25.9.2023 © Department of Finance, Services & Innovation 2017	3258



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Client Aero Leplastrier	Map Land Zone Map
Location 5 LOVETT BAY, LOVETT BAY	LGA NORTHERN BEACHES COUNCIL

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Client Aero Leplastrier	Map Heritage Listed Sites
Location 5 LOVETT BAY, LOVETT BAY	LGA NORTHERN BEACHES COUNCIL

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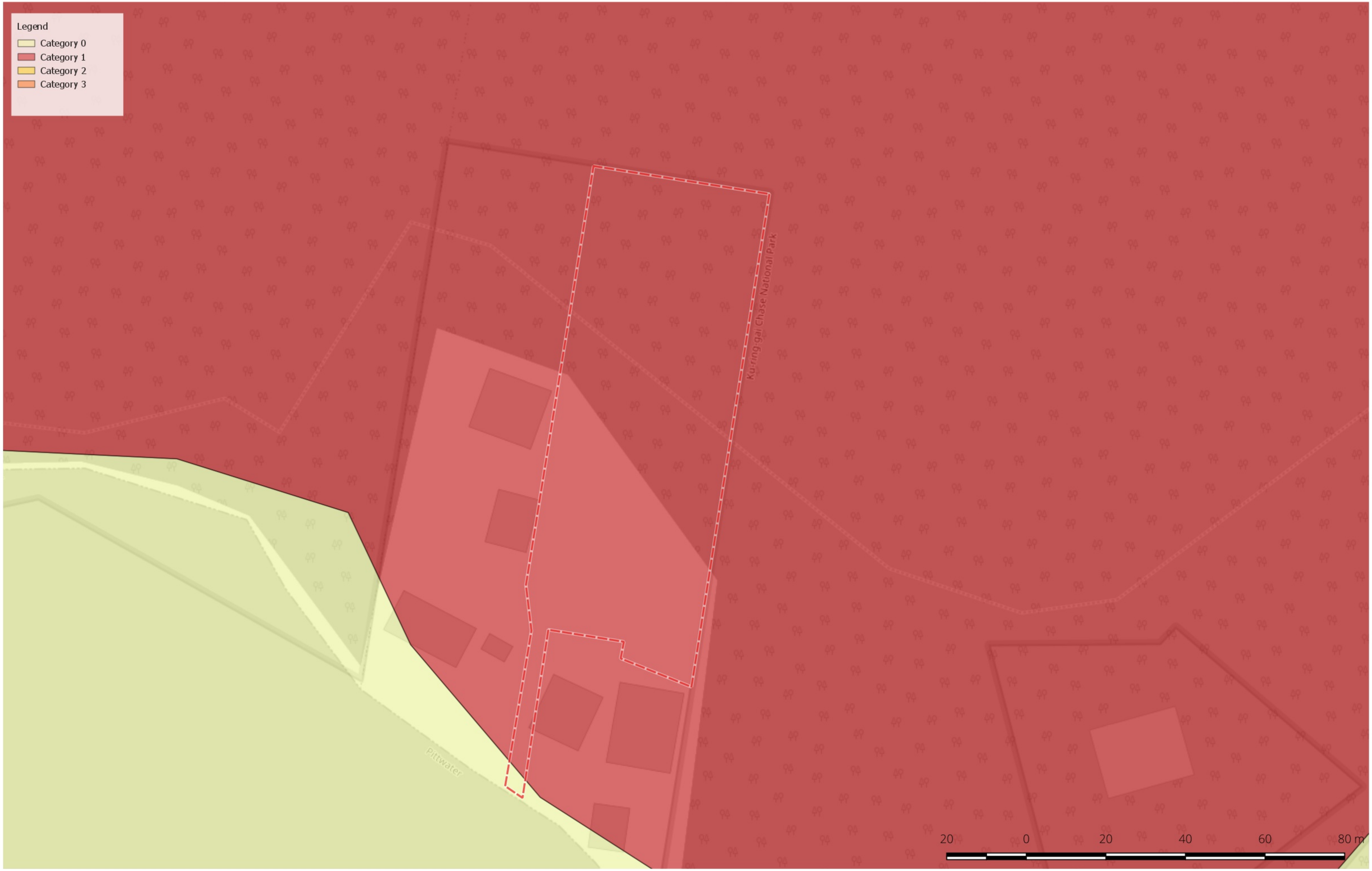

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Client Aero Leplastrier	Map Bushfire Prone Land
Location 5 LOVETT BAY, LOVETT BAY	LGA NORTHERN BEACHES COUNCIL

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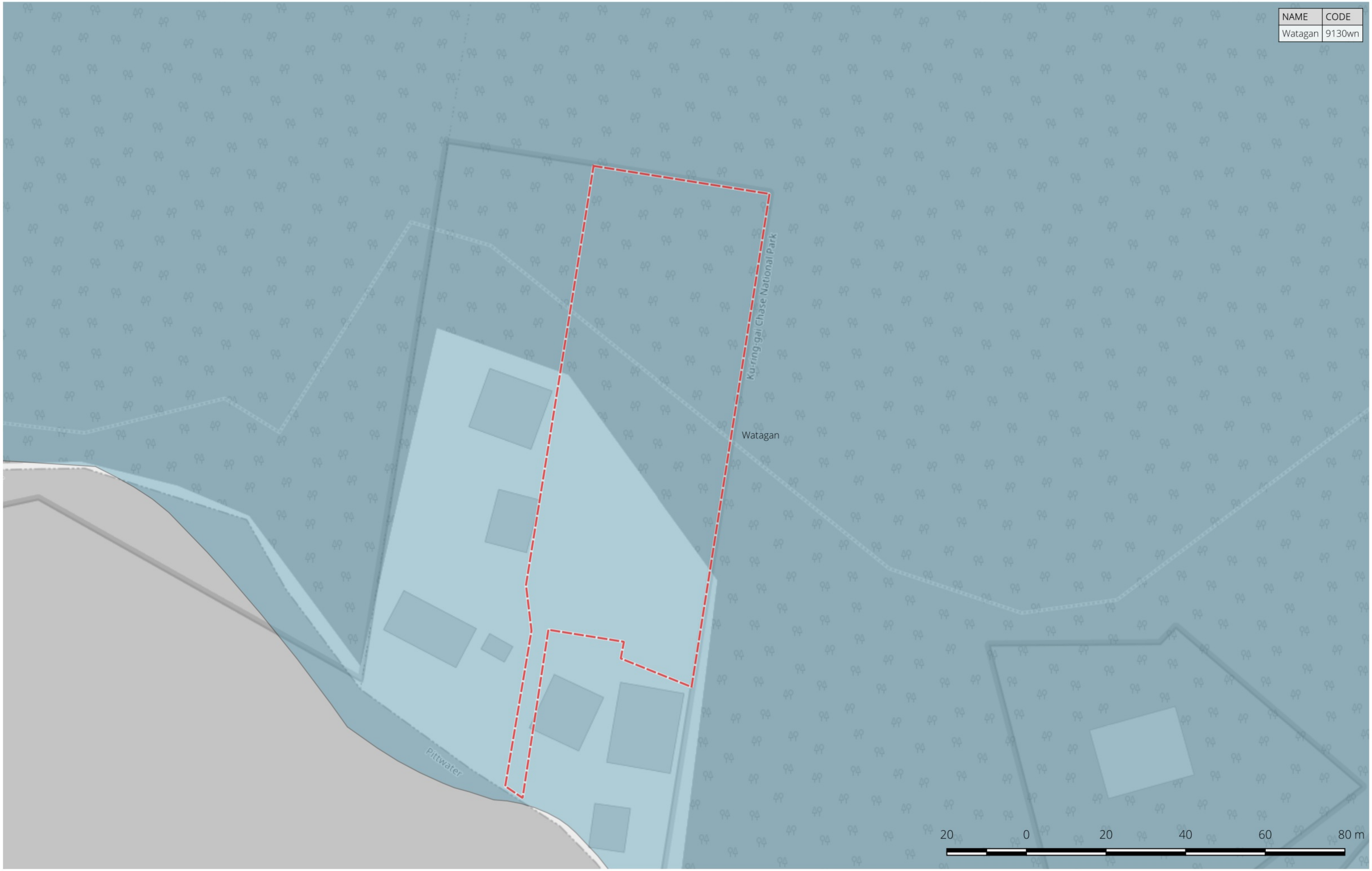

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Client	Map
Aero Leplastrier	Soil Landscapes
Location	LGA
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Data Source
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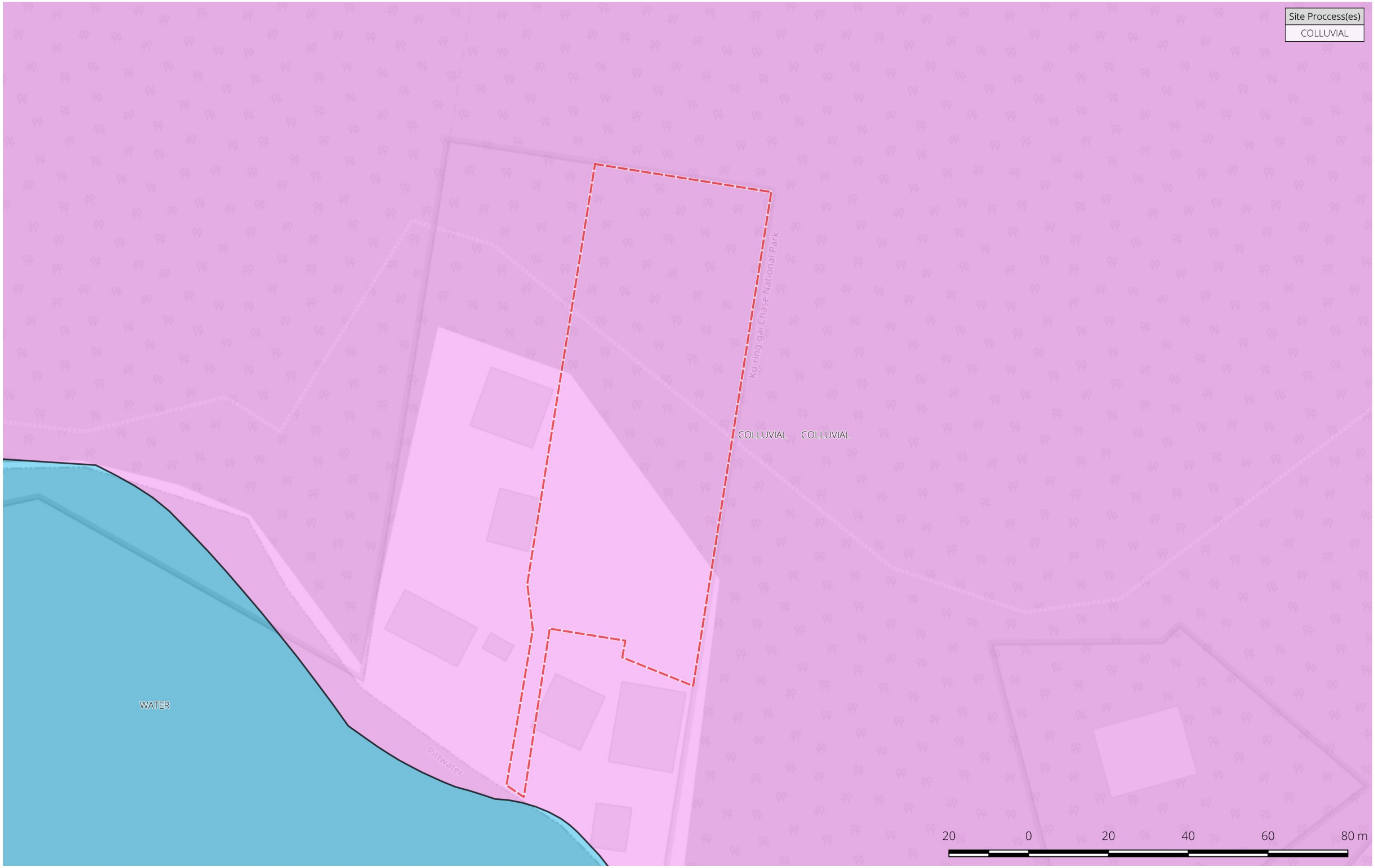

BROADCREST MAPPING & SPATIAL SERVICES broadcrest.com.au | contact@broadcrest.com.au | 1300 554 945 Broadcrest Consulting Pty Ltd | ABN: 622 508 187	Client Aero Leplastrier	Map Soil Formation
	Location 5 LOVETT BAY, LOVETT BAY	LGA NORTHERN BEACHES COUNCIL

Data Source Office of Environment and Heritage | Obtained on 18.07.2018 Creative Commons 3.0 - State of NSW and Office of Environment and Heritage	Scale 1:1,000
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Code	Group	Formation	Lithology
Rh	NULL	NULL	Medium to coarse grained quartz sandstone, very minor shale and laminate lenses
Rnn	Narrabeen Group	Newport Formation and Garie Formation	Interbedded laminate, shale and quartz, to lithic quartz sandstone: Minor red claystone north of Hawkesbury River. Clay pellet sandstone (Garie Fm) south of Hawkesbury River
water	NULL	NULL	NULL

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Client: Aero Leplastrier

Map: Geology (1:100,000 Mapping)

Location: 5 LOVETT BAY, LOVETT BAY

LGA: NORTHERN BEACHES COUNCIL

Data Source: NSW Planning and the Environment | Obtained on 18.07.2018
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Base map: Open Street Maps | Obtained on 25.9.2023
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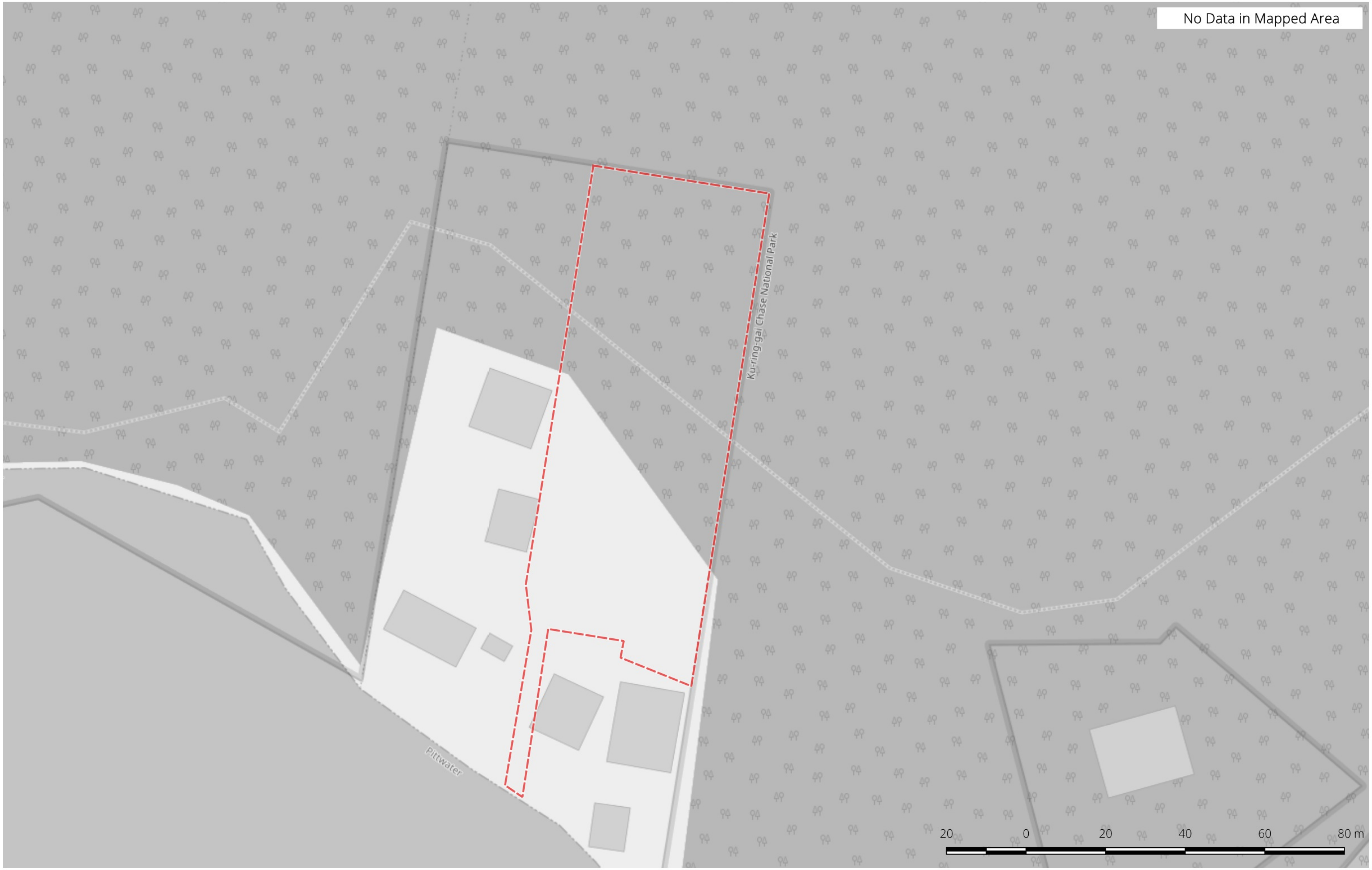
Scale: 1:1,000

Project: 3258



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Broadcrest Consulting Pty Ltd | ABN: 622 508 187

Client
Aero Leplastrier

Map
Hydrogeological Landscapes

Location
5 LOVETT BAY, LOVETT BAY

LGA
NORTHERN BEACHES COUNCIL

Data Source
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Base Map
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Scale
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Project
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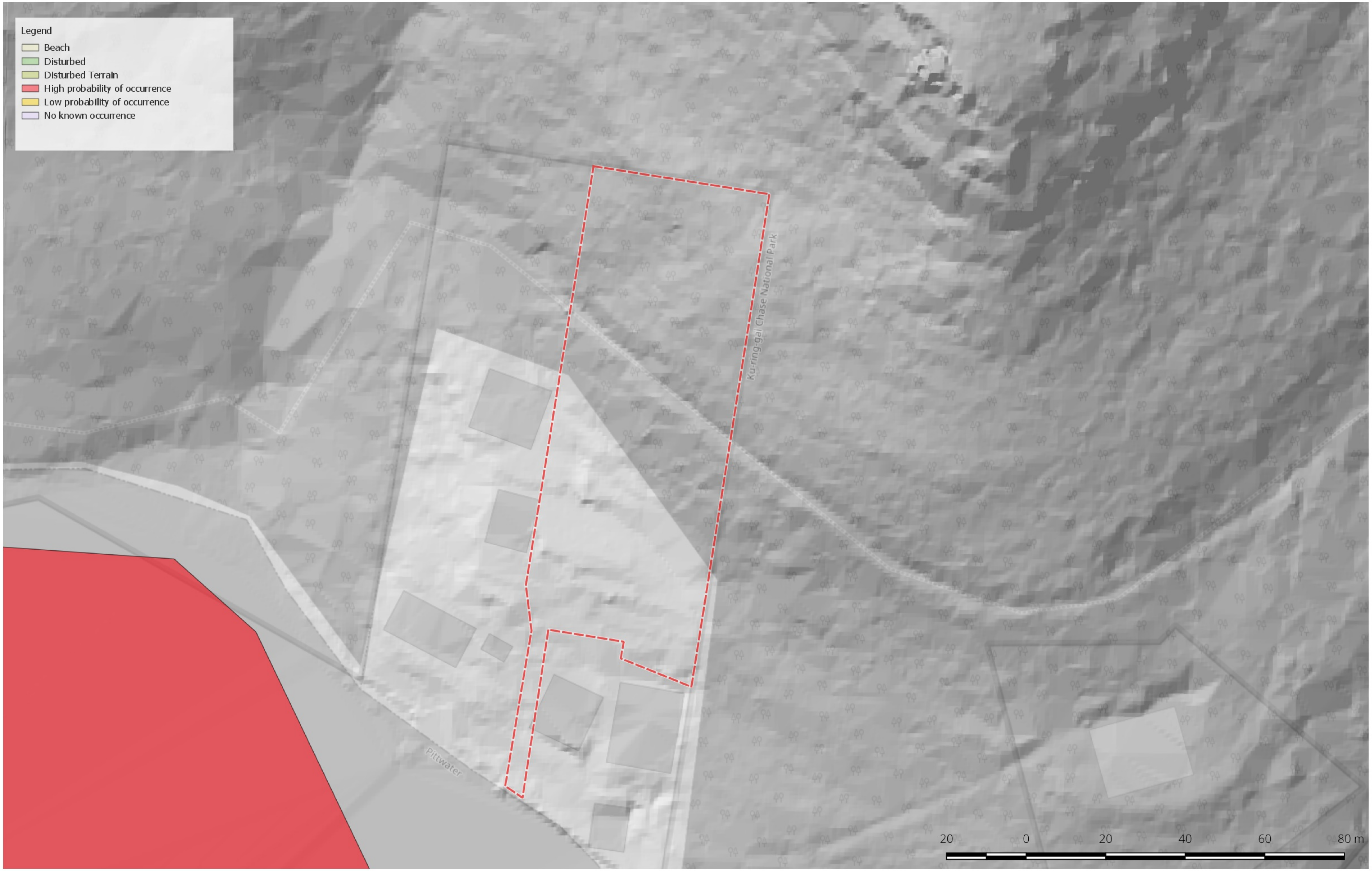

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Client Aero Leplastrier	Map Acid Sulfate Risk map
Location 5 LOVETT BAY, LOVETT BAY	LGA NORTHERN BEACHES COUNCIL

Data Source
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Project
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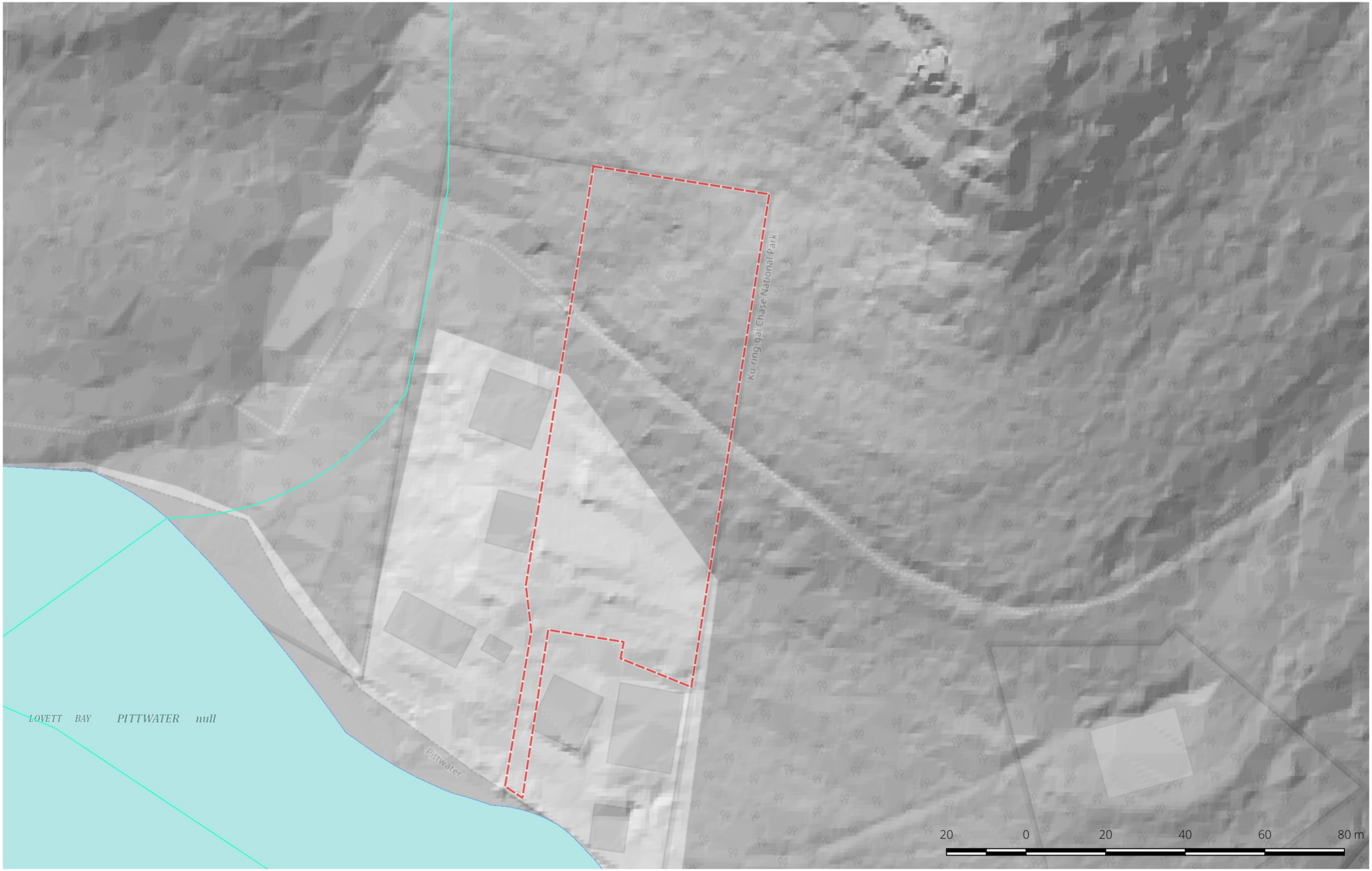

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Broadcrest Consulting Pty Ltd |
ABN: 622 508 187

Client	Map
Aero Leplastrier	Watercourses and Hydrology
Location	**LGA**
5 LOVETT BAY, LOVETT BAY	NORTHERN BEACHES COUNCIL

Data Source
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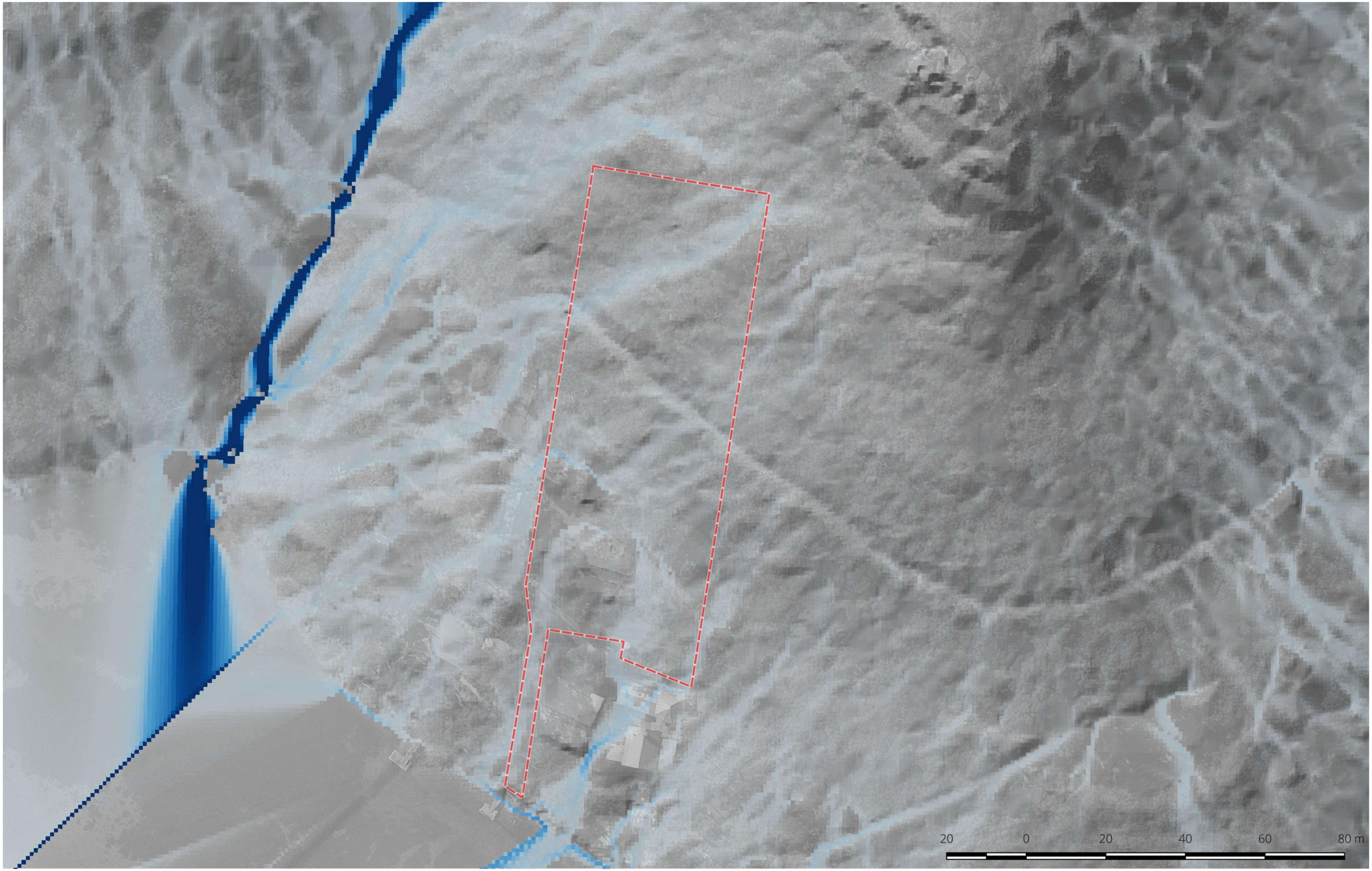

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MAPPING & SPATIAL SERVICES
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| 1300 554 945
Broadcrest Consulting Pty Ltd |
ABN: 622 508 187

Client	Map
Aero Leplastrier	Rainfall Overland Flow Paths
Location	**LGA**
5 LOVETT BAY, LOVETT BAY	NORTHERN BEACHES COUNCIL

Data Source
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Scale
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Project
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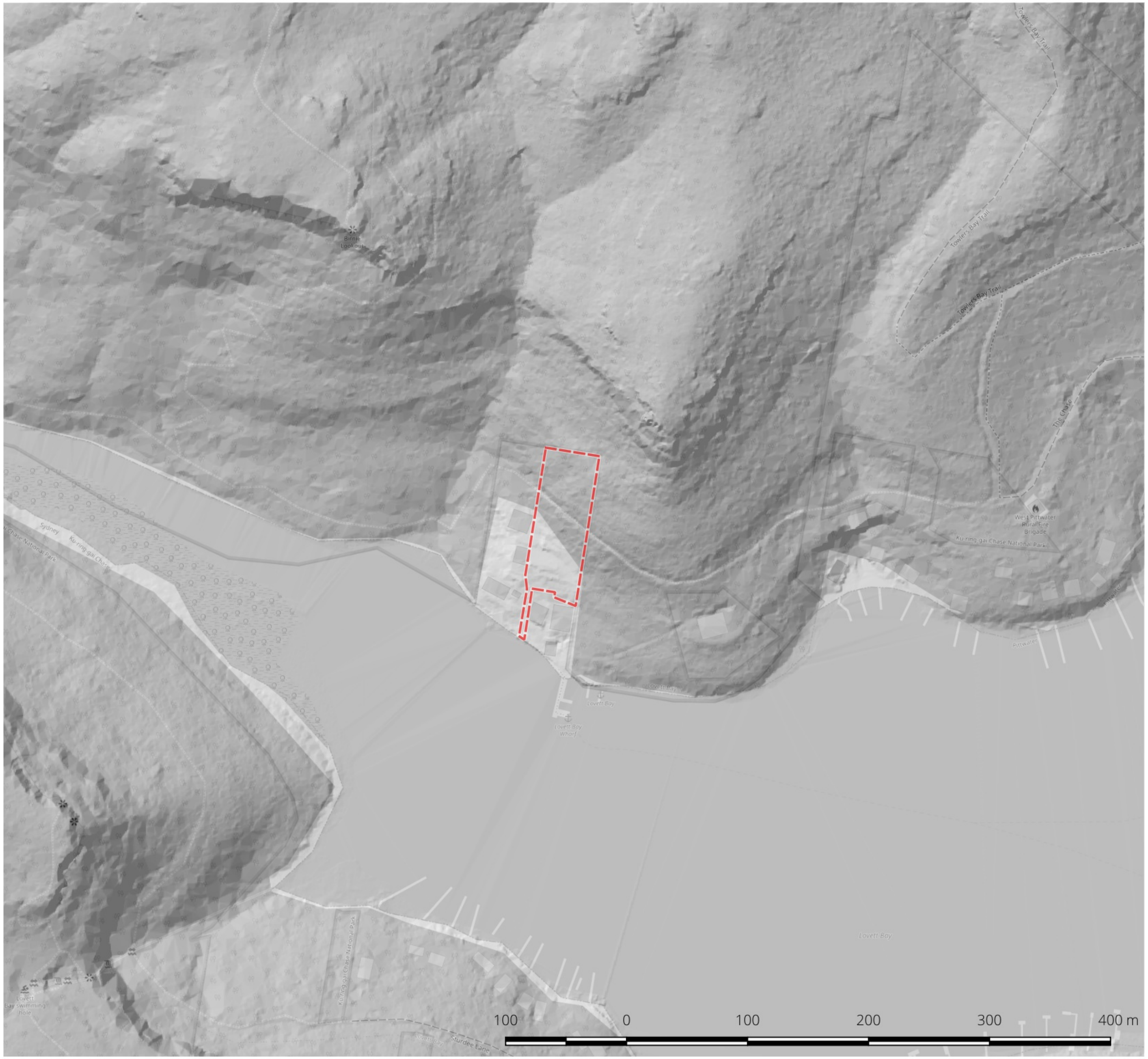
HydroCode	Depth	Strata Description	Bore Data
No data in mapped area.			



BROADCREST MAPPING & SPATIAL SERVICES broadcrest.com.au | contact@broadcrest.com.au | 1300 554 945 Broadcrest Consulting Pty Ltd | ABN: 622 508 187	Client Aero Leplastrier	Map Groundwater Bores	Data Source NSW Planning and the Environment | Obtained on 18.07.2018 Creative Commons 3.0 - Commonwealth of Australia	Scale 1:4,000
	Location 5 LOVETT BAY, LOVETT BAY	LGA NORTHERN BEACHES COUNCIL	Base map Open Street Maps | Obtained on 25.9.2023 Creative Commons 3.0 - OpenStreetMap Contributors	Project 3258

Appendix C: Landslide Types

Table C1: Landslide types and their general descriptions.

Type	Name	Description	Typical Velocity
Bedrock movement	Rock Falls	Falls are abrupt movements of masses of geologic materials, such as rocks and boulders, that become detached from steep slopes or cliffs.	Very – Extremely Rapid
	Rock Topples	Toppling failures are distinguished by the forward rotation of a unit or units about some pivotal point, below or low in the unit, under the actions of gravity and forces exerted by adjacent units or by fluids in cracks	Very – Extremely Rapid
	Rock Block Slides	A block slide is a translational slide in which the moving mass consists of a single unit or a few closely related units that move downslope as a relatively coherent mass	Rapid – Extremely Rapid
Planar Mass Movement	Translational Slides	In this type of slide, the landslide mass moves along a roughly planar surface with little rotation or backward tilting	Moderate – Rapid
	Debris Avalanches	This is a very rapid to extremely rapid variety of debris flow, often with the potential to carry higher volumes of material downslope.	Moderate – Very Rapid
	Soil Block Slides	See Rock Block Side	Very slow - Moderate
Rotational Mass Movement	Slumps	This is a slide in which the surface of rupture is curved concavely upward and the slide movement is roughly rotational about an axis that is parallel to the ground surface and transverse across the slide	Slow – Moderate
	Slip Circles	A rapid variety of slumps.	Moderate – Very Rapid
Material Flow	Debris Flow	Debris flows are commonly caused by intense surface-water flow, due to heavy precipitation or rapid snowmelt, that erodes and mobilizes loose soil or rock on steep slopes.	Slow - Moderate
	Earth Flow	Usually occurs in fine-grained materials or clay-bearing rocks on moderate slopes and under saturated conditions.	Extremely slow - Moderate
	Lateral Spread	The failure is caused by liquefaction triggered by rapid ground motion. While earthquakes are a low risk in Australia, they can also be caused by artificial means, such as construction equipment and railways.	Slow - Moderate
	Soil Creep	Creep is the imperceptibly slow, steady, downward movement of slope-forming soil or rock. Movement is caused by shear stress sufficient to produce permanent deformation, but too small to produce shear failure.	Extremely slow – Very slow

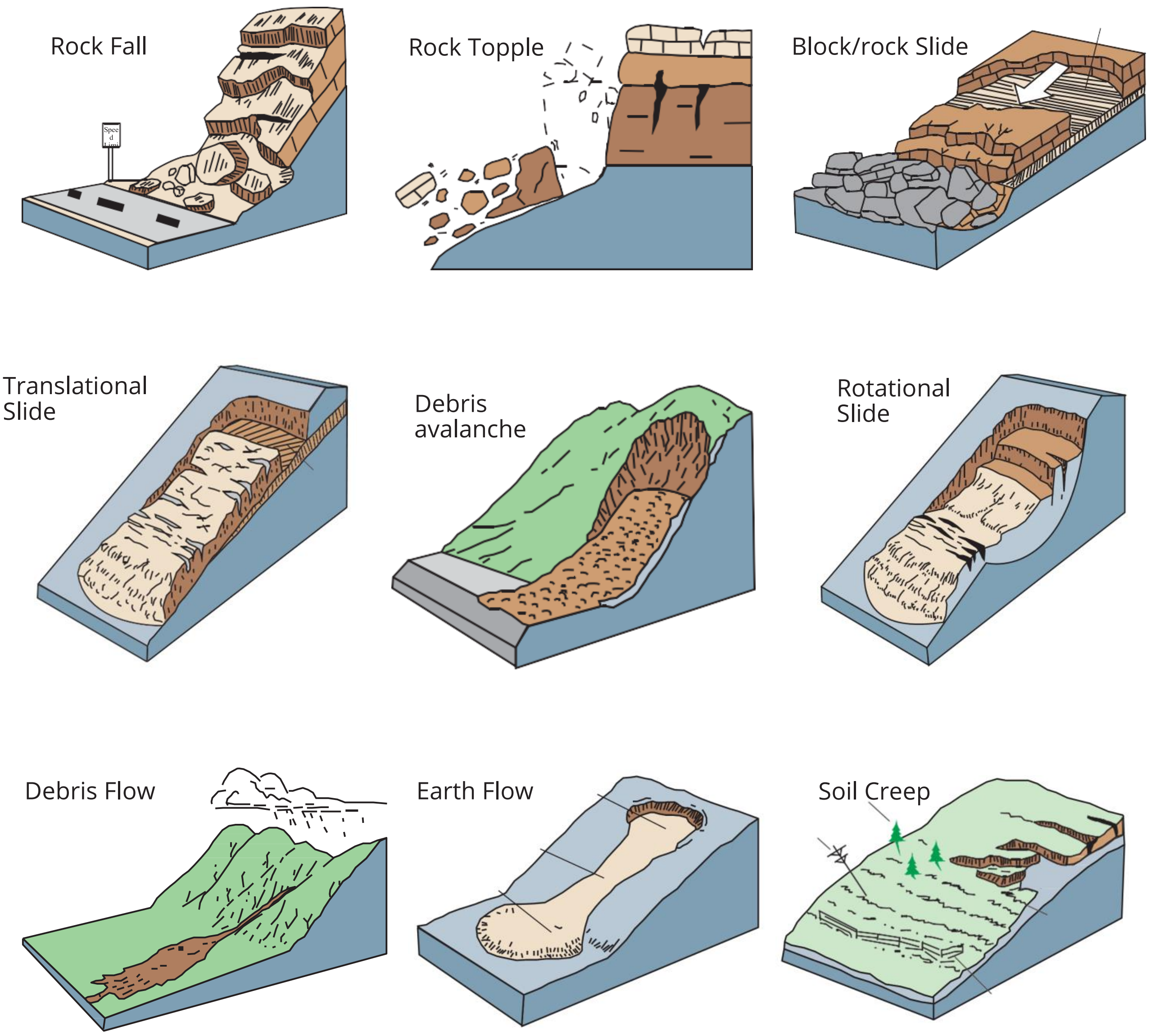


Figure C1: Diagrams of typical landslide types.

Table C2: Typical landslide dimensions in soils (Skempton and Hutchinson, 1969).

Landslide type	Depth/Length ratio (%)	Slope inclination lower limit (Deg.°)
Planar mass movement	5–10	22–38
Rotational Mass Movement	15–30	8–16
Material Flow	0.5–3.0	3–20

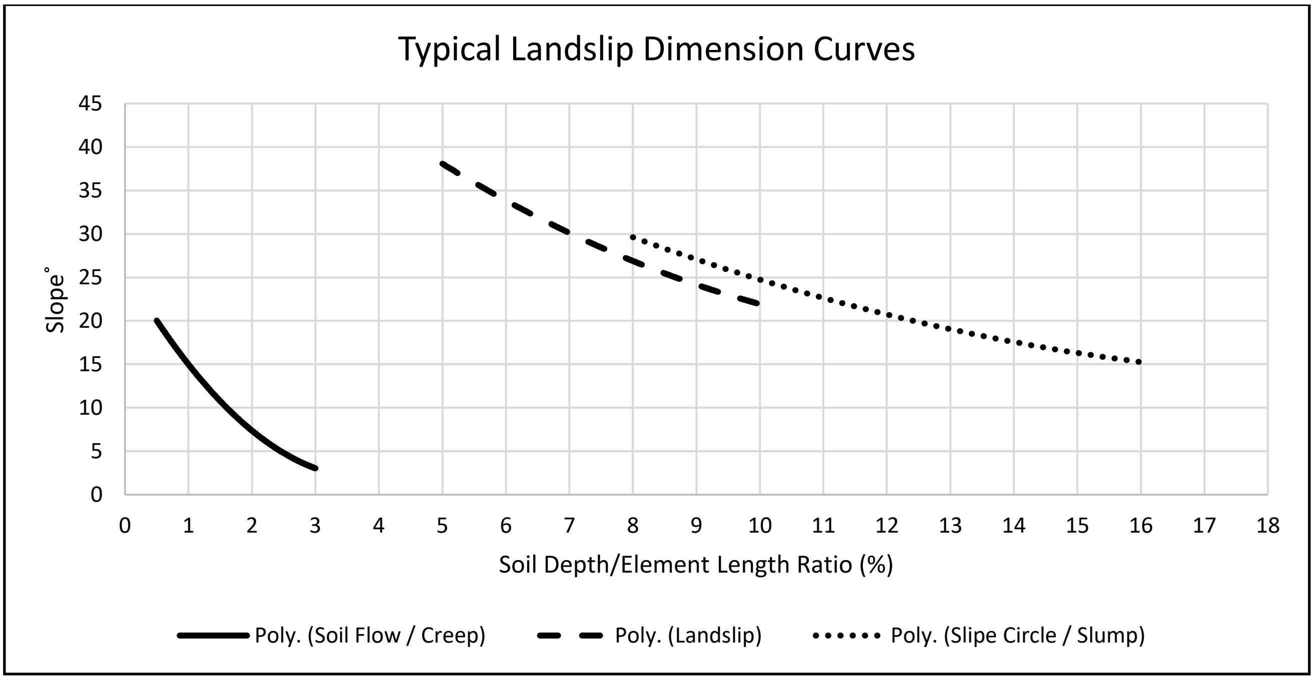
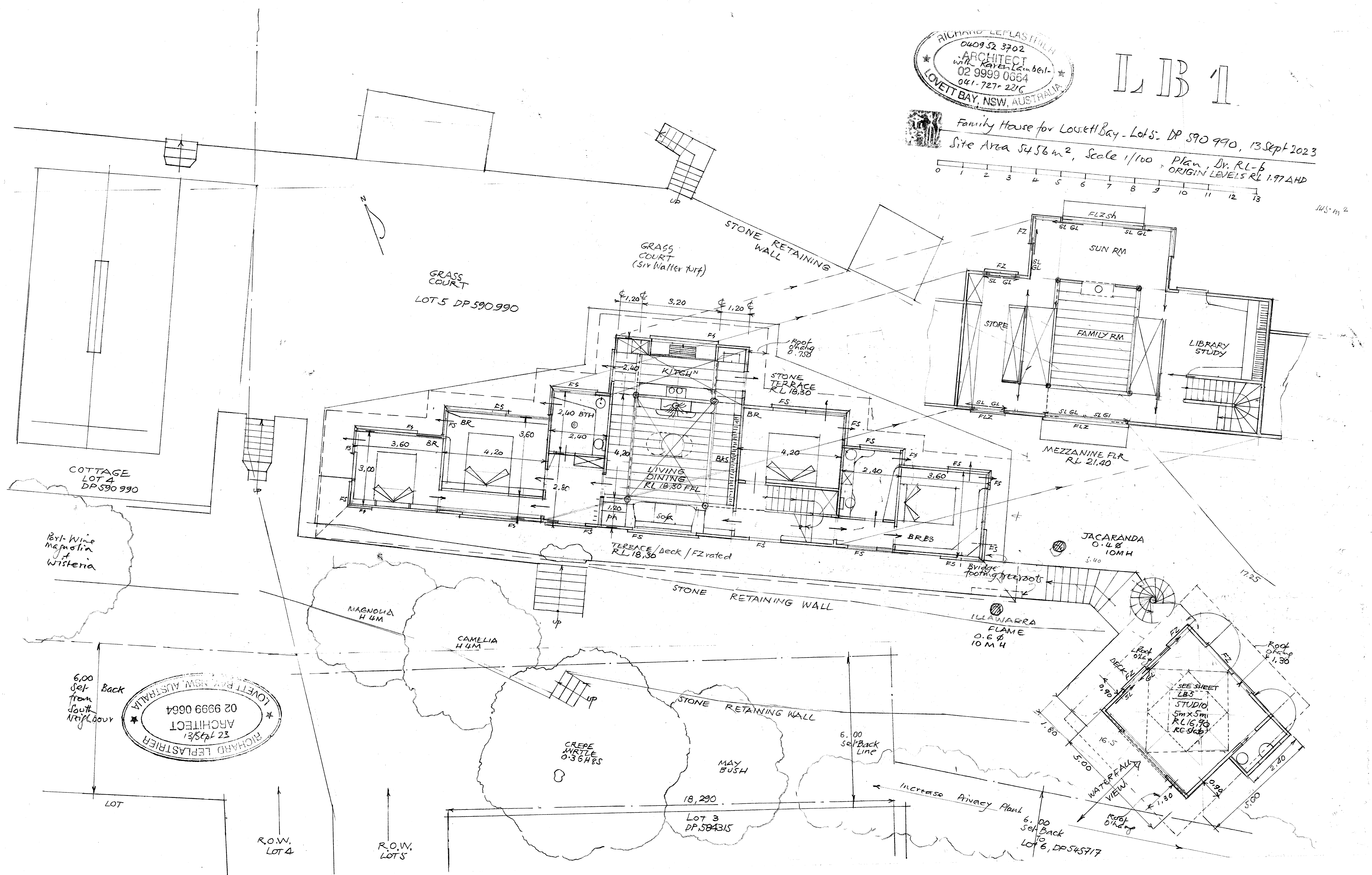


Figure C2: Typical landslip dimension curves. Each curve shows the slope inclination threshold before a landslide becomes likely under adverse conditions. Adapted from Skempton and Hutchinson, 1969.

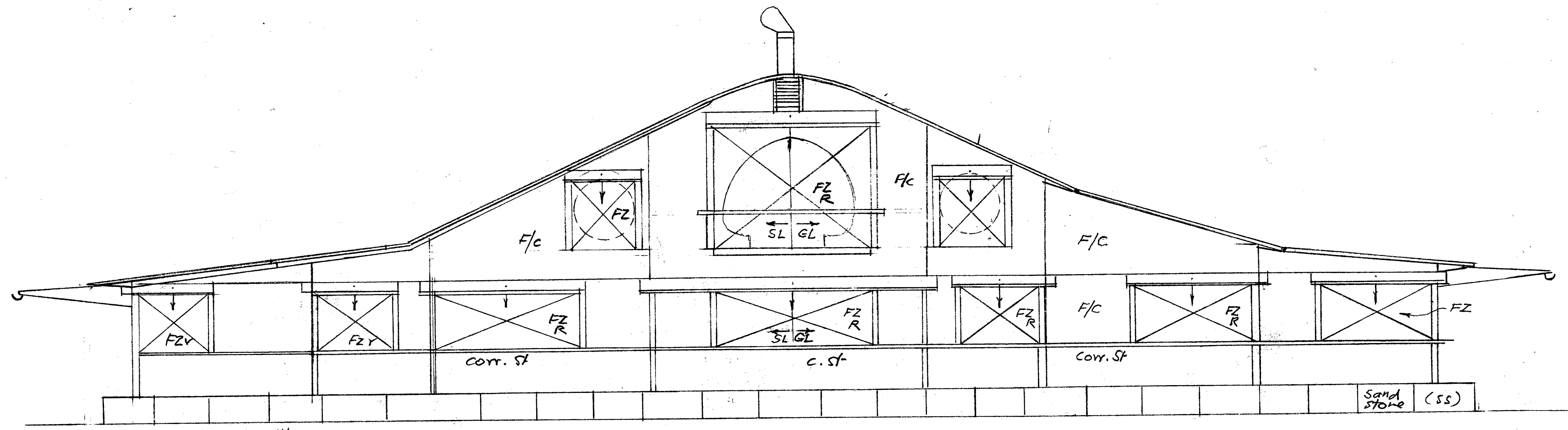
Table C3: Landslide velocity scale (Cruden and Varnes, 1996).

Description	Velocity (mm/s)	Typical velocity	Probable destructive significance
Extremely rapid	5×10^{3}	5 m/second	Catastrophe of major violence; buildings destroyed by impact of displaced material; many deaths, escape unlikely.
Very rapid			Some lives lost; velocity too great to permit all persons to escape.
Rapid	5×10^{1}	3 m/minute	Escape evacuation possible; structures, possessions, and equipment destroyed.
	5×10^{-1}	1.8 m/hour	
Moderate			Some temporary and insensitive structures can be temporarily maintained.
	5×10^{-3}	13 m/month	
Slow	5×10^{-5}	1.6 m/year	Remedial construction can be undertaken during movement; insensitive structures require frequent maintenance work if total movement is not large during a particular acceleration phase.
Very slow			Some permanent structures undamaged by movement.
Extremely slow	$<5 \times 10^{-7}$	16 mm/year	Imperceptible without instruments; construction possible with precautions.

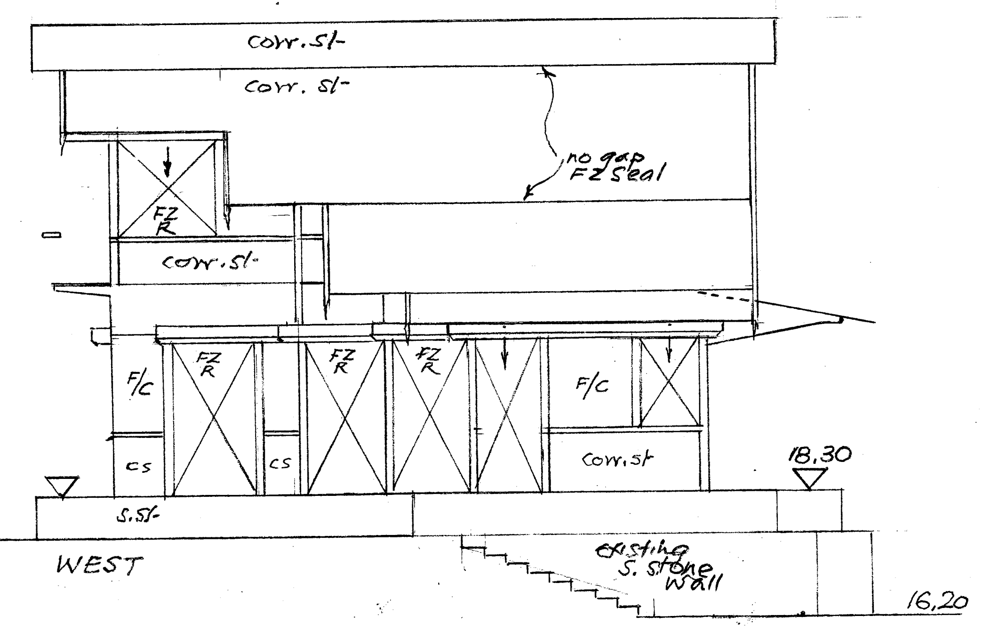
Appendix D: Site Survey and Proposed Layout



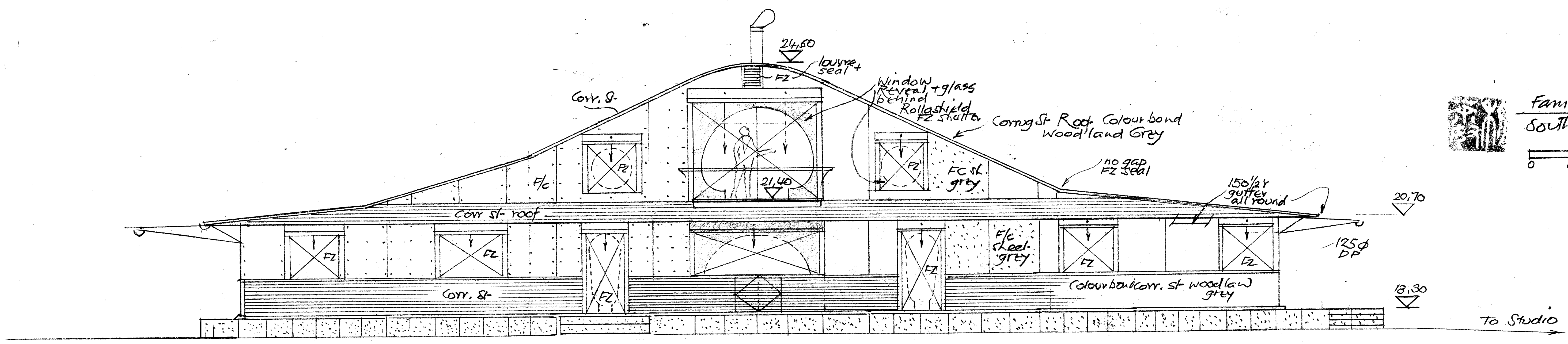
RICHARD LEPLASTRIER ARCHITECT 02 9999 0664 LOVETT BAY, NSW, AUSTRALIA
0409 52 3702
with Karen Lambert
041-727-2216
LB 1
Family House for Lovett Bay - Lots: DP 590 990, 13 Sept 2023
Site Area 5456 m², Scale 1/100, Plan, Dr. RL-6
ORIGIN LEVELS RL 1.97 AHD
0 1 2 3 4 5 6 7 8 9 10 11 12 13
N
STONE RETAINING WALL
GRASS COURT (Sir Walter turf)
GRASS COURT
LOT 5 DP 590 990
COTTAGE LOT 4 DP 590 990
UP
SUN RM
STORE
FAMILY RM
LIBRARY STUDY
MEZZANINE FLR RL 21.40
KITCHN
Roof o'hang 0.750
STONE TERRACE RL 18.30
BTH
LIVING DINING RL 18.30 FFL
BR
Sofa
Bks
TERRACE RL 18.30 / Deck / FZ rated
JACARANDA 0.48 10M H
Bridge footing treeroots
ILLAWARRA FLAME 0.6 Ø 10 M H
Port-Wine Magnolia + Wisteria
MAGNOLIA H 4M
CAMELIA H 4M
STONE RETAINING WALL
CREPE MYRTLE 0.36 H 8S
MAY BUSH
6.00 Set Back from South Neighbour
6.00 Set Back Line
18,290
Lot 3 DP 584315
LOT
R.O.W. LOT 4
R.O.W. LOT 5
Increase Privacy Plant
6.00 Set Back to LOT 6, DP 545717
SEE SHEET LB5
STUDIO 5m x 5m RL 16.90 RC Slab
DECK
Roof O'hang 1.30
WATERFALL VIEW
Roof O'hang
RICHARD LEPLASTRIER ARCHITECT 02 9999 0664 LOVETT BAY, NSW, AUSTRALIA 13/Sept 23



NORTH ELEVN.



WEST



SOUTH ELEVN.

LB 3

Family House for LOT 5 DP590990 Lovett Bay 2105
South, North, West Elevations, Scale 1/100 Dn. RLP

0 1 2 3 4 5 6 7 8 9 10 11 12

RICHARD LEPLASTRIER
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ARCHITECT
041-727-2216
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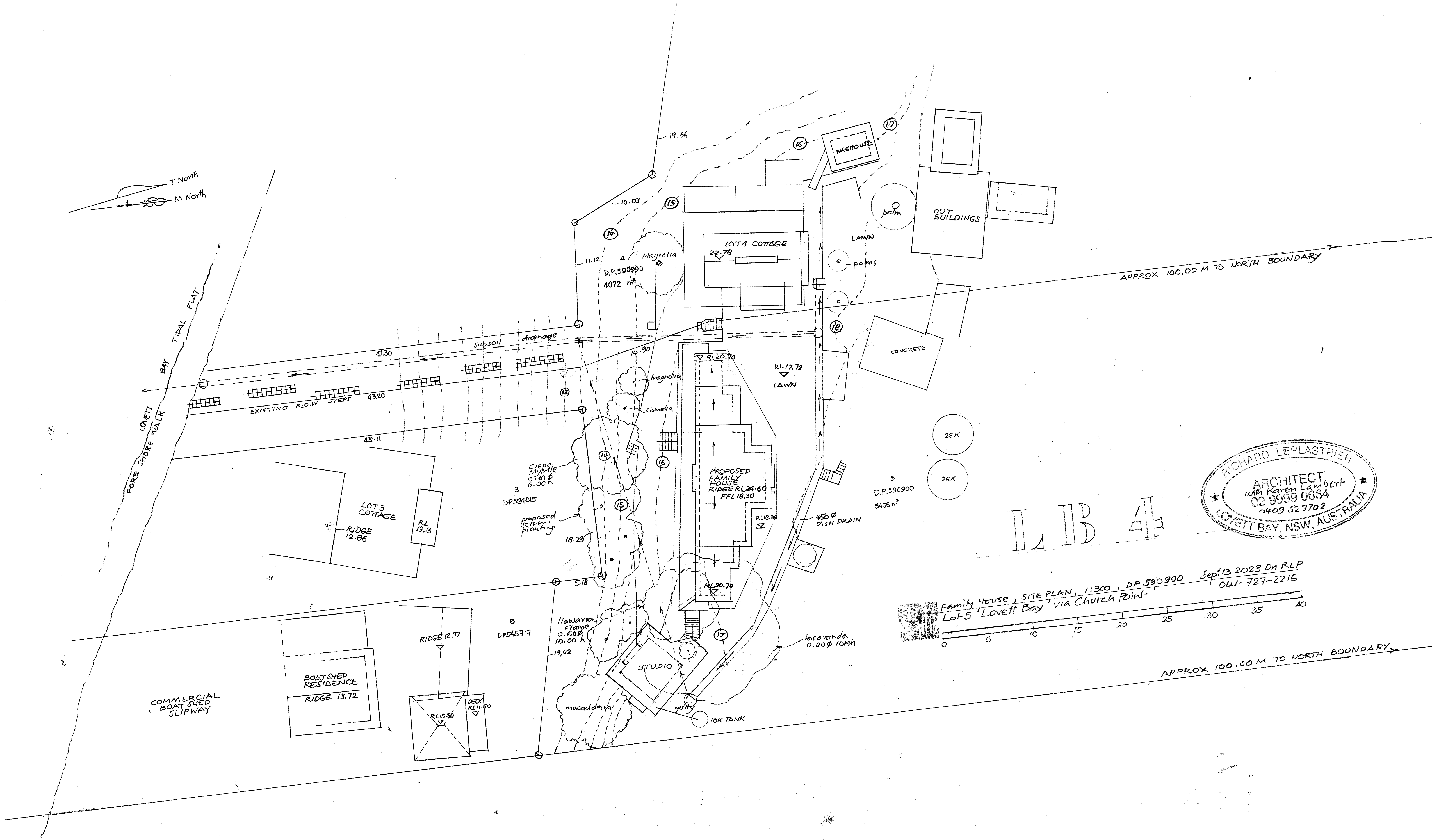
0409 52 3702
LOVETT BAY, NSW, AUSTRALIA

13 Sept 2023



T North
M. North
LOT4 COTTAGE
22.78
WASHOUSE
OUT BUILDINGS
LAWN
palm
palms
Magnolia
4
D.P. 590990
4072 m²
19.66
10.03
11.12
14.90
41.30
43.20
45.11
5.18
19.02
18.29
Subsoil drainage
EXISTING R.O.W STEPS
LOVETT BAY TIDAL FLAT
FORE SHORE WALK
APPROX 100.00 M TO NORTH BOUNDARY
CONCRETE
RL 17.72
LAWN
RL 20.70
magnolia
Camelia
PROPOSED FAMILY HOUSE
RIDGE RL 24.60
FFL 18.30
RL 18.30
450 Ø DISH DRAIN
26K
26K
5
D.P. 590990
5456 m²
Crepe Myrtle
0.30 Ø
6.00 h
3
DP584815
proposed screen planting
LOT3 COTTAGE
RIDGE 12.86
RL 13.13
Illawarra Flame
0.60 Ø
10.00 h
5
DP545717
RIDGE 12.97
BOAT SHED RESIDENCE
RIDGE 13.72
RL 15.80
DECK RL 11.60
COMMERCIAL BOAT SHED SLIPWAY
macaddamia
STUDIO
gully
10K TANK
Jacaranda
0.40 Ø 10Mh
LB 4
RICHARD LEPLASTRIER
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with Karen Lambert
02 9999 0664
0409 523702
LOVETT BAY, NSW, AUSTRALIA
Family House, SITE PLAN, 1:300, DP 590990
Sept 13 2023 Dn RLP
041-727-2216
Lot 5 'Lovett Bay' via Church Point
0 5 10 15 20 25 30 35 40

Appendix E: Practice Notes for Foundation Maintenance

Foundation Maintenance and Footing Performance: A Homeowner's Guide

BTF 18 replaces Information Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction
There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion
All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation
This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil
All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure
This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

Tree root growth

Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation

Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

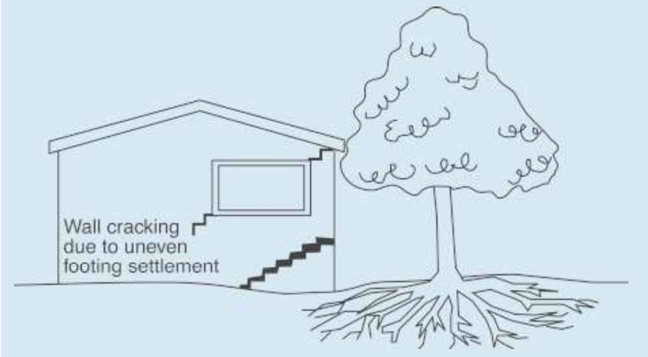
Seasonal swelling/shrinkage in clay

Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

Trees can cause shrinkage and damage



As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots

In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself

Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures

Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures
Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures
Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.
Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing
Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage
In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

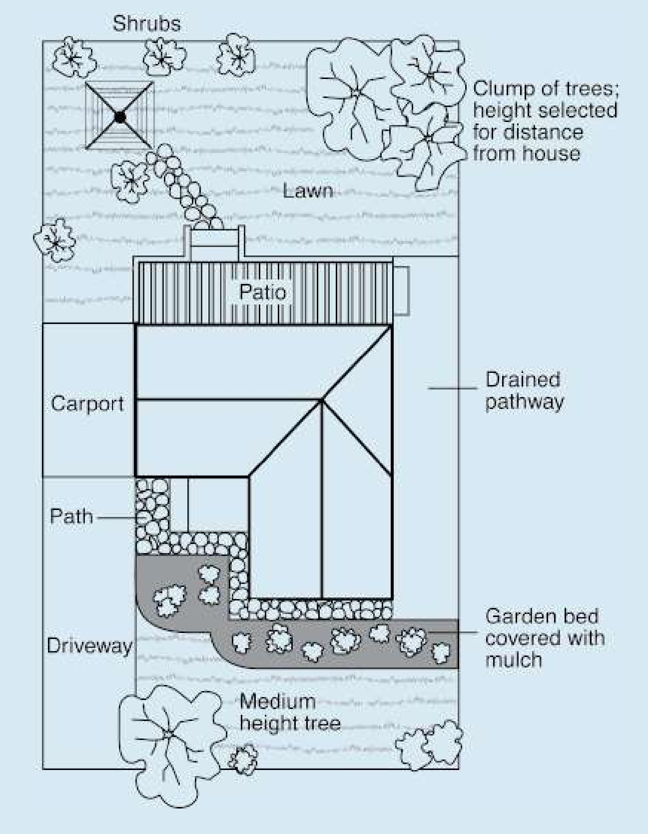
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15–25 mm but also depend on number of cracks	4

Gardens for a reactive site



should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

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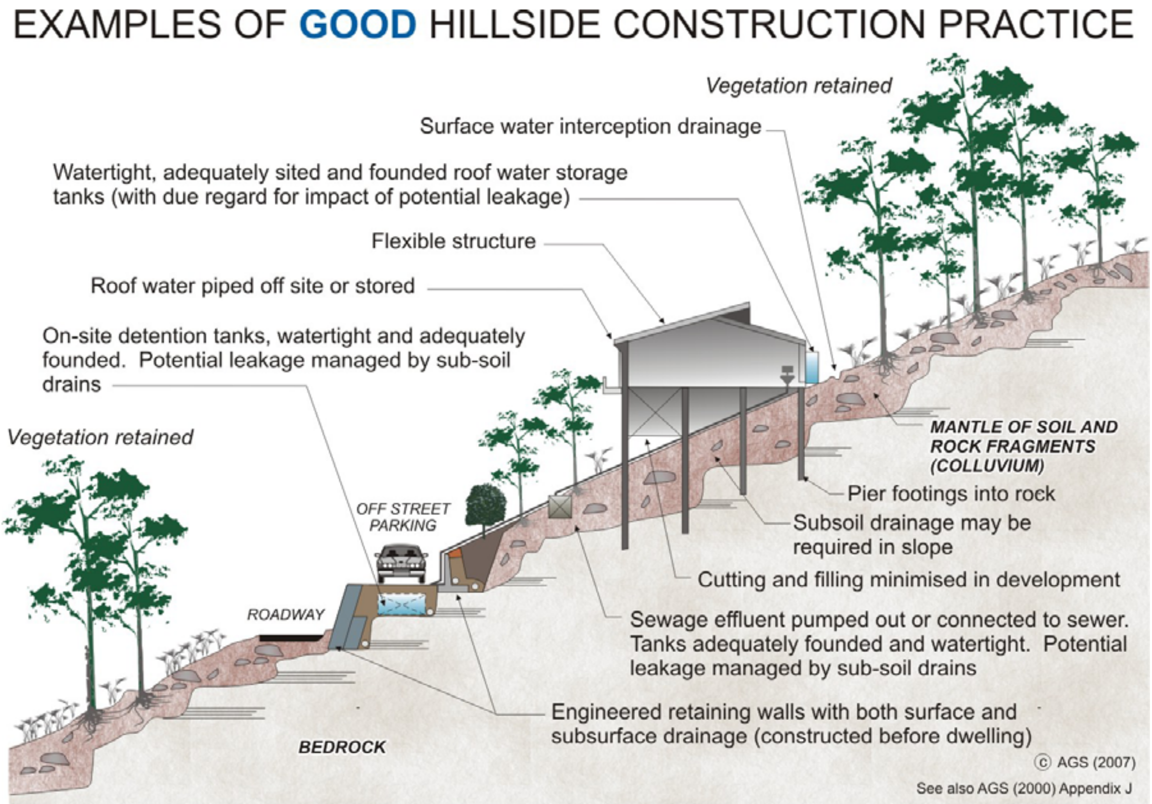
Appendix F: Australian Geoguide LR8

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

HILLSIDE CONSTRUCTION PRACTICE

Sensible development practices are required when building on hillsides, particularly if the hillside has more than a low risk of instability (GeoGuide LR7). Only building techniques intended to maintain, or reduce, the overall level of landslide risk should be considered. Examples of good hillside construction practice are illustrated below.



WHY ARE THESE PRACTICES GOOD?

Roadways and parking areas - are paved and incorporate kerbs which prevent water discharging straight into the hillside (GeoGuide LR5).

Cuttings - are supported by retaining walls (GeoGuide LR6).

Retaining walls - are engineer designed to withstand the lateral earth pressures and surcharges expected, and include drains to prevent water pressures developing in the backfill. Where the ground slopes steeply down towards the high side of a retaining wall, the disturbing force (see GeoGuide LR6) can be two or more times that in level ground. Retaining walls must be designed taking these forces into account.

Sewage - whether treated or not is either taken away in pipes or contained in properly founded tanks so it cannot soak into the ground.

Surface water - from roofs and other hard surfaces is piped away to a suitable discharge point rather than being allowed to infiltrate into the ground. Preferably, the discharge point will be in a natural creek where ground water exits, rather than enters, the ground. Shallow, lined, drains on the surface can fulfil the same purpose (GeoGuide LR5).

Surface loads - are minimised. No fill embankments have been built. The house is a lightweight structure. Foundation loads have been taken down below the level at which a landslide is likely to occur and, preferably, to rock. This sort of construction is probably not applicable to soil slopes (GeoGuide LR3). If you are uncertain whether your site has rock near the surface, or is essentially a soil slope, you should engage a geotechnical practitioner to find out.

Flexible structures - have been used because they can tolerate a certain amount of movement with minimal signs of distress and maintain their functionality.

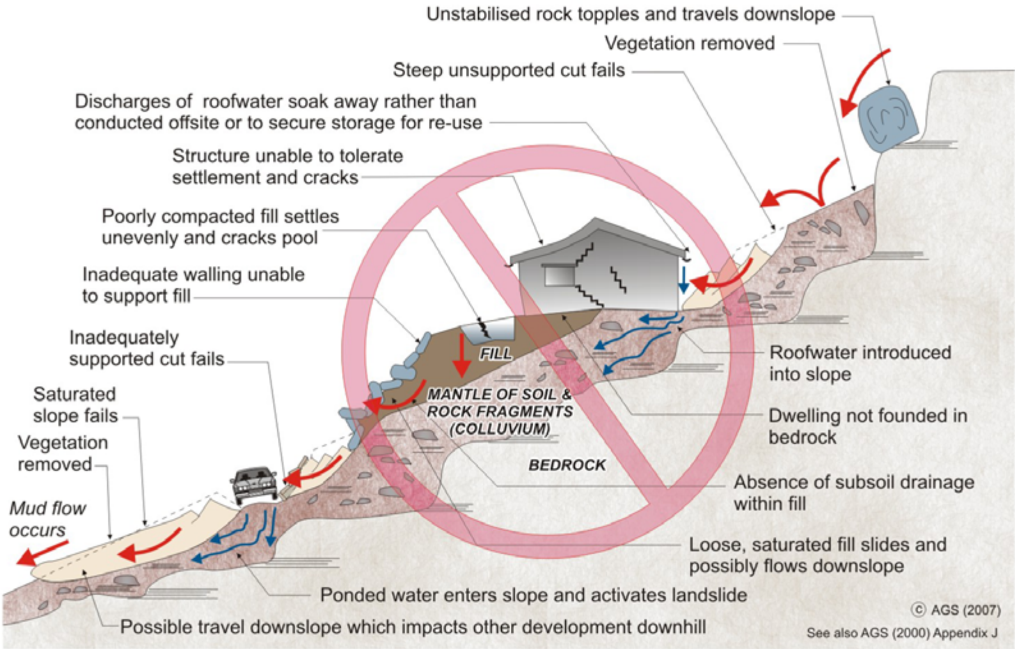
Vegetation clearance - on soil slopes has been kept to a reasonable minimum. Trees, and to a lesser extent smaller vegetation, take large quantities of water out of the ground every day. This lowers the ground water table, which in turn helps to maintain the stability of the slope. Large scale clearing can result in a rise in water table with a consequent increase in the likelihood of a landslide (GeoGuide LR5). An exception may have to be made to this rule on steep rock slopes where trees have little effect on the water table, but their roots pose a landslide hazard by dislodging boulders.

Possible effects of ignoring good construction practices are illustrated on page 2. Unfortunately, these poor construction practices are not as unusual as you might think and are often chosen because, on the face of it, they will save the developer, or owner, money. You should not lose sight of the fact that the cost and anguish associated with any one of the disasters illustrated, is likely to more than wipe out any apparent savings at the outset.

ADOPT GOOD PRACTICE ON HILLSIDE SITES

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

EXAMPLES OF POOR HILLSIDE CONSTRUCTION PRACTICE



WHY ARE THESE PRACTICES POOR?

Roadways and parking areas - are unsurfaced and lack proper table drains (gutters) causing surface water to pond and soak into the ground.

Cut and fill - has been used to balance earthworks quantities and level the site leaving unstable cut faces and added large surface loads to the ground. Failure to compact the fill properly has led to settlement, which will probably continue for several years after completion. The house and pool have been built on the fill and have settled with it and cracked. Leakage from the cracked pool and the applied surface loads from the fill have combined to cause landslides.

Retaining walls - have been avoided, to minimise cost, and hand placed rock walls used instead. Without applying engineering design principles, the walls have failed to provide the required support to the ground and have failed, creating a very dangerous situation.

A heavy, rigid, house - has been built on shallow, conventional, footings. Not only has the brickwork cracked because of the resulting ground movements, but it has also become involved in a man-made landslide.

Soak-away drainage - has been used for sewage and surface water run-off from roofs and pavements. This water soaks into the ground and raises the water table (GeoGuide LR5). Subsoil drains that run along the contours should be avoided for the same reason. If felt necessary, subsoil drains should run steeply downhill in a chevron, or herring bone, pattern. This may conflict with the requirements for effluent and surface water disposal (GeoGuide LR9) and if so, you will need to seek professional advice.

Rock debris - from landslides higher up on the slope seems likely to pass through the site. Such locations are often referred to by geotechnical practitioners as "debris flow paths". Rock is normally even denser than ordinary fill, so even quite modest boulders are likely to weigh many tonnes and do a lot of damage once they start to roll. Boulders have been known to travel hundreds of metres downhill leaving behind a trail of destruction.

Vegetation - has been completely cleared, leading to a possible rise in the water table and increased landslide risk (GeoGuide LR5).

DON'T CUT CORNERS ON HILLSIDE SITES - OBTAIN ADVICE FROM A GEOTECHNICAL PRACTITIONER

More information relevant to your particular situation may be found in other Australian GeoGuides:

- GeoGuide LR1 - Introduction
- GeoGuide LR2 - Landslides
- GeoGuide LR3 - Landslides in Soil
- GeoGuide LR4 - Landslides in Rock
- GeoGuide LR5 - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR7 - Landslide Risk
- GeoGuide LR9 - Effluent & Surface Water Disposal
- GeoGuide LR10 - Coastal Landslides
- GeoGuide LR11 - Record Keeping

The Australian GeoGuides (LR series) are a set of publications intended for property owners; local councils; planning authorities; developers; insurers; lawyers and, in fact, anyone who lives with, or has an interest in, a natural or engineered slope, a cutting, or an excavation. They are intended to help you understand why slopes and retaining structures can be a hazard and what can be done with appropriate professional advice and local council approval (if required) to remove, reduce, or minimise the risk they represent. The GeoGuides have been prepared by the Australian Geomechanics Society, a specialist technical society within Engineers Australia, the national peak body for all engineering disciplines in Australia, whose members are professional geotechnical engineers and engineering geologists with a particular interest in ground engineering. The GeoGuides have been funded under the Australian governments' National Disaster Mitigation Program.

Appendix G: Pittwater form no. 1 & 1a

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Broadcrest Consulting Pty Ltd

By email to: kurtis@broadcrest.com.au

Independent Geotechnical Peer Review (Broadcrest Report ref: 3258-GEO-01-A)

Site Address: 5 Portions Lovett Bay, Lovett Bay NSW

Dear Sir/Madam

1. Introduction

AscentGeo has carried out an independent geotechnical engineering peer review to assess the general adequacy of the geotechnical investigation report undertaken by Broadcrest Consulting Pty Ltd for the proposed development at 5 Portions Lovett Bay, Lovett Bay (the site), and to assess compliance of the investigation and report with Northern Beaches Council requirements.

The review work documented herein has been undertaken in general accordance with our emailed proposal, dated 25 September 2023.

2. Background Information

Documents available to AscentGeo to facilitate review include:

- Geotechnical Investigation and Landslide Risk Assessment, by Broadcrest Consulting Pty Ltd ref: 3258-GEO-0, dated 27 September 2023 ('the Broadcrest Report')
- Architectural drawings prepared by Richard Leplastrier, drawings LB1, LB3, & LB4, dated 13 September 2023
- Georeferenced site photos provided by Broadcrest
- Spatial Data Report prepared by Broadcrest
- Northern Beaches Council – Pittwater Local Environment Plan (LEP) 2014 and Pittwater Development Control Plan (DCP) 2014
- Appendix 5 (to Pittwater P21) Geotechnical Risk Management Policy for Pittwater – 2009.

3. Location, Subsurface Conditions

The site is located within the Northern Beaches Council LGA, where published geological mapping data and the Broadcrest Report indicate the site is underlain by colluvial soils and minor filling over Hawkesbury Sandstone, and Newport Formation bedrock, comprised predominantly of sandstone and shale.

4. Review Outcomes

The Broadcrest Report contains the results of subsurface investigations at the site and provides geotechnical recommendations for the proposed works including consideration of potential geotechnical and hydrogeological impacts on surrounding property and infrastructure related to the proposed development. A summary of our peer review as it relates to Council Requirements is presented in Table 1 below.

Table 1: Summary of Review Outcomes

Requirement	Satisfied?	Review Comment
Detailed site description and assessment	✓	Included in Broadcrest Report Section 2.
Site specific risk assessment	✓	Broadcrest Report includes risk assessment using Australian Geomechanics Society (March 2007), Landslide Risk Management Guidelines. Section 5
Results of geotechnical subsurface investigations carried out including boreholes, penetrometer tests and groundwater testing (where required)	✓	Ground testing carried out is considered appropriate for the site, and the proposed works. No groundwater was encountered during testing; permanent groundwater is below final excavation level. There is a very low risk that groundwater will be significantly affected by the proposed works, hence groundwater monitoring is considered unnecessary. Section 4.
Recommended pertinent geotechnical design parameters for shoring systems, footings and stormwater management	✓	Included in Broadcrest Report Section 6.
Recommendations for appropriate plant, equipment and construction methodology.	✓	Included in Broadcrest Report Section 6.

5. Review Conclusion

AscentGeo has reviewed the Broadcrest Report and considers that, in general, the Report:

- Meets the standard expected of a Professional Engineer by their engineering peers and the community in fulfilling their duties as a provider of factual and interpretive reporting and related design advice; and
- Satisfies the intent of Appendix 5 (to Pittwater P21) Geotechnical Risk Management Policy for Pittwater – 2009.

5.1 General Limitations

This assessment is limited in scope and coverage and is not designed or capable of identifying all subsurface conditions, which can vary even over short distances and with time. The advice given in this assessment is based on the assumption that the available information is representative of the overall ground conditions. However, it should be noted that actual conditions in some parts of the site might differ from those found. If excavations reveal ground conditions significantly different from those shown in our findings, Broadcrest must be consulted.

The scope and the coverage of services are described in the assessment and are subject to restrictions and limitations. Broadcrest has not performed a complete assessment of all possible conditions or circumstances that may exist at the site. If a service or issue is not expressly indicated as being considered, then do not assume it has been addressed. If a matter is not addressed, do not assume that any determination has been made by Broadcrest with regards to it.

Where data has been supplied by the client or a third party, it is assumed that the information is correct unless otherwise stated. No responsibility is accepted by AscentGeo for incomplete or inaccurate data supplied by others. Any drawings or figures presented in the report should be considered only as pictorial evidence of the work. Therefore, unless otherwise stated, any dimensions should not be used for accurate calculations or dimensioning.

If you have any questions or require any clarification, please call us on **9913 3179.**

For and on behalf of **AscentGeo**,

REGISTERED PROFESSIONAL GEOSCIENTIST
AUSTRALIAN INSTITUTE OF GEOSCIENTISTS
BENJAMIN J. MORGAN
RPGeo No: 10269

Ben Morgan BScGeol MAIG RPGeo
Managing Director| Engineering Geologist

GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER

FORM NO. 1 – To be submitted with Development Application

Development Application for Aero Leplastrier
Name of Applicant

Address of site 5 Portions Lovett Bay, Lovett Bay NSW

Declaration made by geotechnical engineer or engineering geologist or coastal engineer (where applicable) as part of a geotechnical report

I, Ben Morgan (insert name) *on behalf of* AscentGeo Geotechnical Consulting (Trading or Company Name)

on this the 29.09.2023 certify that I am a geotechnical engineer or engineering geologist or coastal engineer

as defined by the Geotechnical Risk Management Policy for Pittwater - 2009 and I am authorised by the above organisation/company to issue this document and to certify that the organisation/company has a current professional indemnity policy of at least $2 million.

Please mark appropriate box

☐ Prepared the detailed Geotechnical Report referenced below in accordance with the Australia Geomechanics Society's Landslide Risk Management Guidelines (AGS 2007) and the Geotechnical Risk Management Policy for Pittwater - 2009

☒ I am willing to technically verify that the detailed Geotechnical Report referenced below has been prepared in accordance with the Australian Geomechanics Society's Landslide Risk Management Guidelines (AGS 2007) and the Geotechnical Risk Management Policy for Pittwater - 2009

☐ Have examined the site and the proposed development in detail and have carried out a risk assessment in accordance with paragraph 6.0 of the Geotechnical Risk Management Policy for Pittwater - 2009. I confirm the results of the risk assessment for the proposed development are in compliance with the Geotechnical Risk Management Policy from Pittwater - 2009 and further detailed geotechnical reporting is not required for the subject site.

☐ Have examined the site and the proposed development/alteration in detail and am of the opinion that the Development Application only involves Minor Development/Alterations that do not require a Detailed Geotechnical Risk Assessment and hence my report is in accordance with the Geotechnical Risk Management Policy for Pittwater – 2009 requirements for Minor Development/Alterations.

☐ Have examined the site and the proposed development/alteration is separate form and not affected by a Geotechnical Hazard and does not require a Geotechnical report or Risk Assessment and hence my Report is in accordance with the Geotechnical Risk Management Policy for Pittwater – 2009 requirements

☐ Provided the coastal process and coastal forces analysis for inclusion in the Geotechnical Report

Geotechnical Report Details:

Report Title: Geotechnical Investigation and Landslide Risk Assessment (ref: 3258-GEO-0)
Report Date: 29 September 2023
Author: Kurtis Ferry
Author's Company/Organisation: Broadcrest Consulting Pty Ltd

Documentation which relate to or are relied upon in report preparation:

Architectural design plans prepared by Richard Leplastrier, drawings LB1, LB3, & LB4, dated 13 September 2023

Geotechnical Investigation and Landslide Risk Assessment report technically reviewed and verified by Ben Morgan, AscentGeo, 29 September 2023.

I am aware that the above Geotechnical Report, prepared for the abovementioned site is to be submitted in support of a Development Application for this site and will be relied on by Northern Beaches Council as the basis for ensuring that the Geotechnical Risk Management aspects of the proposed development have been adequately addressed to achieve an "Acceptable Risk Management" level for the life of the structure, taken as at least 100 years unless otherwise stated and justified in the Report and that reasonable and practical measures have been identified to remove foreseeable risk.

Signature

Name Ben Morgan

Chartered Professional Status MAIG RPGeo (Geotechnical & Engineering)

Membership No. 10269

Company AscentGeo Geotechnical Consulting

GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER

FORM NO. 1(a) - Checklist of Requirements for Geotechnical Risk Management Report for Development Application

Development Application for Aero Leplastrier
Name of Applicant
Address of site 5 Portions Lovett Bay, Lovett Bay NSW

The following checklist covers the minimum requirements to be addressed in a Geotechnical Risk Management Geotechnical Report. This checklist is to accompany the Geotechnical Report and its certification (Form No. 1).

Geotechnical Report Details:

Report Title: Geotechnical Investigation and Landslide Risk Assessment (ref: 3258-GEO-0)
Report Date: 29 September 2023
Author: Kurtis Ferry
Author's Company/Organisation: Broadcrest Consulting Pty Ltd

Please mark appropriate box

☒ Comprehensive site mapping conducted 22/09/2023 (date)
☒ Mapping details presented on contoured site plan with geomorphic mapping to a minimum scale of 1:200 (as appropriate)
☒ Subsurface investigation required
  ☐ No Justification ....
  ☒ Yes Date conducted 22/09/2023
☒ Geotechnical model developed and reported as an inferred subsurface type-section
☒ Geotechnical hazards identified
  ☐ Above the site
  ☒ On the site
  ☐ Below the site
  ☐ Beside the site
☒ Geotechnical hazards described and reported
☒ Risk assessment conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
  ☒ Consequence analysis
  ☒ Frequency analysis
☒ Risk calculation
☒ Risk assessment for property conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
☒ Risk assessment for loss of life conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
☒ Assessed risks have been compared to "Acceptable Risk Management" criteria as defined in the Geotechnical Risk Management Policy for Pittwater - 2009
☒ Opinion has been provided that the design can achieve the "Acceptable Risk Management" criteria provided that the specified conditions are achieved.
☒ Design Life Adopted:
  ☒ 100 years
  ☐ Other .... specify
☒ Geotechnical Conditions to be applied to all four phases as described in the Geotechnical Risk Management Policy for Pittwater – 2009 have been specified
☒ Additional action to remove risk where reasonable and practical have been identified and included in the report.
☒ Risk Assessment within Bushfire Asset Protection Zone

I am aware that Pittwater Council will rely on the Geotechnical Report, to which this checklist applies, as the basis for ensuring that the geotechnical risk management aspects of the proposal have been adequately addressed to achieve an "Acceptable Risk Management" level for the life of the structure, taken as at least 100 years unless otherwise stated, and justified in the Report and that reasonable and practical measures have been identified to remove foreseeable risk.

Signature

Name Ben Morgan

Chartered Professional Status MAIG RPGeo (Geotechnical & Engineering)

Membership No. 10269

Company AscentGeo Geotechnical Consulting

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