Kahuna No. 1 Pty Ltd

Acid Sulfate Soil Assessment

Proposed Residential Development

52-54 Miles Street, Yamba

Report No. RGS31546.1-AM

5 March 2020

REGIONAL GEOTECHNICAL SOLUTIONS

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Manning-Great Lakes
Port Macquarie
Coffs Harbour

RGS31546.1-AM

5 March 2020

Kahuna No. 1 Pty Ltd
C/o: Garrard Building Pty Limited
PO Box 538
YAMBA NSW 2464

Attention: Neil Garrard

Dear Neil

RE: Proposed Residential Development – 52-54 Miles Street, Yamba
Acid Sulfate Soil Assessment

As requested, Regional Geotechnical Solutions Pty Ltd (RGS) has undertaken an acid sulfate soil assessment for a 20.1ha portion of 52-54 Miles Street, Yamba NSW (Lots 46 and 47 DP751395) where a residential development is proposed on the approximately 42ha lot.

The results of the assessment are presented herein.

If you have any questions regarding this project, please contact the undersigned.

For and on behalf of **Regional Geotechnical Solutions Pty Ltd**

Prepared by

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1 INTRODUCTION

Regional Geotechnical Solutions Pty Ltd (RGS) has undertaken an assessment of a 20.1ha portion of 52-54 Miles Street in Yamba (Lots 46 and 47 DP751395) to assess whether acid sulfate soils are present within the upper soil profile that is to be disturbed as part of the proposed residential development.

The residential development is to involve the placement of between about 1 to 2m of fill across the site. RGS have previously undertaken an acid sulfate soil assessment for a 12ha portion of Lot 46. At the request of Clarence Valley Council, the assessment was limited to the upper 100mm of the soil profile (i.e. the upper 100mm of topsoil that contains organics) that was proposed to be excavated as part of bulk earthworks. The previous assessment concluded that the material is not an actual or potential acid sulfate soil, however, there is actual acidity from other sources and a management plan was prepared.

Presented herein is an assessment for the presence of acid sulfate soils and the need for an acid sulfate soil management plan for the remaining 20.1ha portion of the site that is to be developed. It is understood that Council have stated that the assessment can be limited to testing only the material that is to be disturbed (i.e. the upper approximately 100mm) and that sampling and testing of materials to 1m below the disturbed depth is not required.

Sampling and analysis of the soils along the footprint of a proposed soldier pile wall and adjacent water/sewer lines are to be summarised and discussed in a separate report.

The extents of the area covered by the assessment is presented in Figure 1.

2 METHODOLOGY

The '*National Acid Sulfate Solis Guidance: National acid sulfate soils sampling and identification methods manual*' (2018) indicates for a 20.1ha site that 44 sampling locations are required. The site investigation therefore comprised the following:

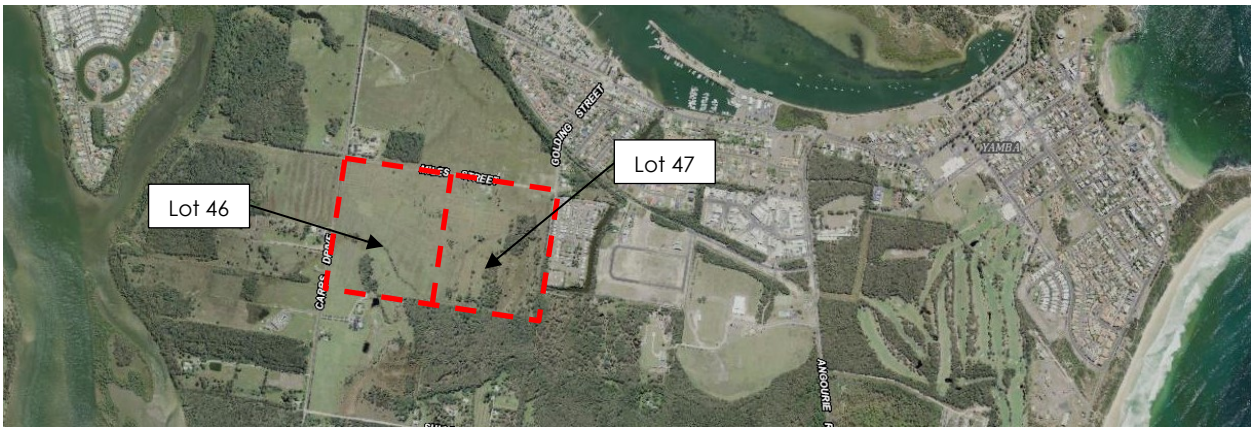
- Observation of site features and surrounding features relevant to the geotechnical conditions of the site;
- Excavation of 44 test pits to a depth of 0.15m with hand tools and the collection of soil samples from each of the test pits; and
- Laboratory testing of the recovered soil samples by a NATA accredited chemical laboratory.

The test locations were recorded with a hand held GPS and are shown on the attached Figure 1.

3 SITE CONDITIONS

3.1 Surface Conditions

The approximately 42ha rectangular site is bound by Miles Street to the north, Carrs Drive to the west, Golding Street to the east, and by rural-residential lots and bushland to the south. A satellite image that illustrates the site location and site setting is shown below.



Site location and setting is illustrated on the NSW Government 'Six Maps'. The approximate boundary of the site is shown by a red box. The extents of the portion of the site covered by this assessment are shown on Figure 1.

The site is located within a region characterised by low lying sand flats with localised swampy areas in lower lying areas and depressions across the site. The provided survey indicates that site levels are generally between about RL1.0 to 1.4m (AHD) with lower lying depressions and drainage lines having elevations of between about 0.5 to 1.0m. The intermittent drainage lines drain to both the northeast towards the Clarence River and to the southwest towards Oyster Channel.

Two single storey residential dwellings and associated sheds/garages of cladded and fibrous sheeting construction are located in the northeast of the site. Timber stockyards, an ageing tractor and cattle troughs are located to the southwest of the dwellings. The remainder of the site (with the exception of that which is outlined below) was being used for grazing purposes.

Fill was being placed and worked on the western portion of Lot 46 during our site visit in January 2020, an area that is not included within the current assessment.

Typical site photographs are presented below.

Looking west from the southeast corner of the site. Groups of trees are scattered across this area.

Looking south across the northwest portion of the site that was being used for grazing purposes in 2018

	
A row of trees can be seen which are located on the edge of a drainage line in the southwest of the site that drains into Oyster Channel	*Looking north from the central portion of the site at open farmland in June 2018*

3.2 Subsurface Conditions & Geology

The 1:25,000 Yamba Quaternary Geology Map indicates that the site is predominantly underlain by a Holocene tidal-delta flat that comprises marine sand, silt, clay, shell and gravel. The lower lying drainage lines that are located at the site are underlain by a Holocene saline swamp that comprises organic mud, peat, clay, silt and sand, that overlies the tidal-delta flat outlined above.

RGS has previously undertaken geotechnical investigations which involved the excavation of eleven test pits. The test pit logs are presented in Report No. RGS31546.1-AB, dated 26 July 2018. The test pits generally encountered up to 0.25m of topsoil (Silty SAND and Sandy SILT with a high organic content and rootlets in the upper approximately 0.1m) that overlies firm alluvial Silty CLAY and medium dense to dense alluvial SAND to at least the maximum depth of the investigation of 1.3m.

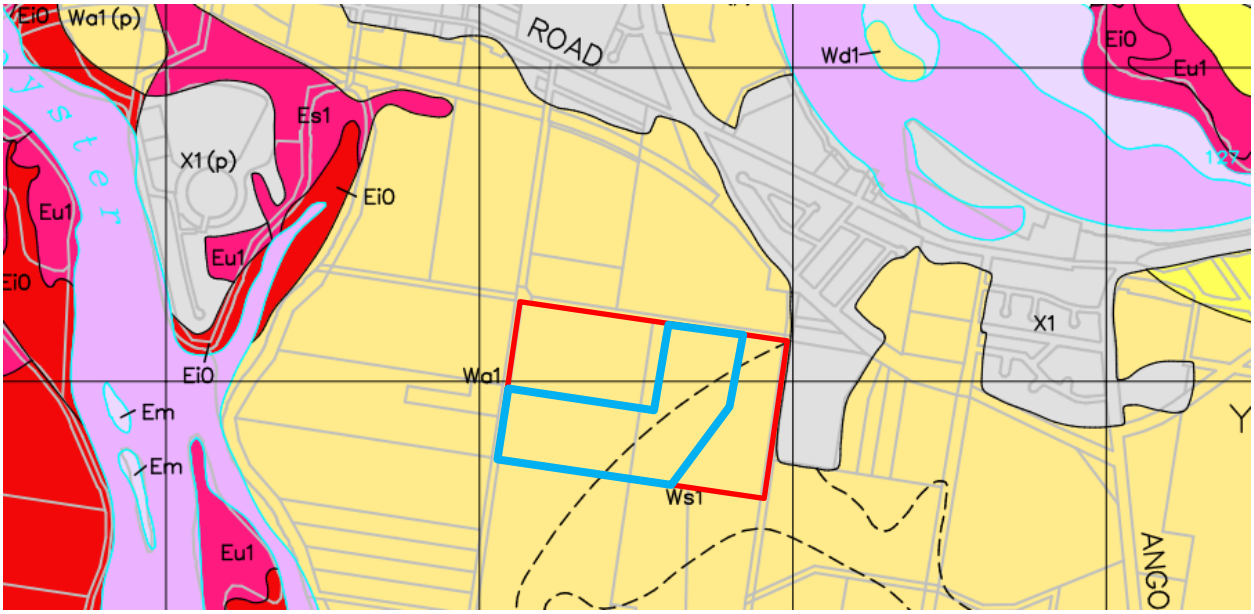
The 2018 investigation was undertaken shortly after a period of high rainfall and groundwater was encountered at a depth of between 0.65 and 1.0m. Subsequent investigations (summarised in report nos. RGS31546.1-AD and RGS31546.1-AG) encountered the groundwater table between 1 and 1.3m depth.

4 DISCUSSION

Acid Sulfate Soils (ASS) produce sulphuric acid when exposed to oxygen due to the presence of iron sulphides in the form of pyrite within the soil matrix. These soils form when iron-rich sediments are deposited in saltwater or brackish water environments. Prior to oxidation, these pyritic soils are referred to as Potential ASS. ASS that have produced acid as a result of oxidation are referred to as Actual ASS. They typically occur in natural, low-lying coastal depositional environments below approximately 5m AHD. In the field ASS are generally identified as saline sediments such as alluvial or estuarine soils or bottom sediments in creeks and estuaries.

The 1:25,000 Yamba Acid Sulfate Soils Map indicates that the site is generally located within a region characterised by an aeolian (wind blown) sand plain that has an elevation of approximately 1 to 2m AHD, while the southeast corner of the site is characterised by swamp

deposits. The risk map indicates that the site has a low probability of occurrence of acid sulfate soil materials within the soil profile within 1m of the ground surface. An extract of the risk map is presented below.



The Yamba Acid Sulfate Soils Map indicates that the site (shown by a red box) is located within an area that has a low probability of occurrence of acid sulfate soil materials within the soil profile within 1m of the ground surface. The extents of the current section are shown by a blue box.

The '*National Acid Sulfate Solis Guidance: National acid sulfate soils sampling and identification methods manual*' (2018) indicates that for a 20.1ha site that 44 sampling locations are required. The manual indicates that for a detailed assessment soil sampling should extend to at least 1m below the maximum depth of disturbance, however, Clarence Valley Council have indicated that the assessment can be limited to testing only the material that is to be disturbed (i.e. the upper approximately 100mm) and that sampling and testing of materials to 1m below the disturbed depth is not required.

44 samples were screened for the presence of Actual or Potential ASS using the methods presented within the manual. The test results are attached. The results indicated:

- The samples revealed pH_F values of 4.82 to 6.95 in distilled water. In this test, pH_F <4 is an indicator of Actual ASS;
- The samples revealed pH_{FOX} values of 1.46 to 4.70 in hydrogen peroxide, with 37 of the results being less than 3. Values of less than 3 are an indicator of Potential ASS, however, these results can also be influenced by the presence of organic matter; and
- The samples showed pH changes (pH_F - pH_{FOX}) of between 2.11 and 3.70. A significant drop in pH between the two tests can be an indicator of Potential ASS, however, these results can also be influenced by the presence of organic matter.

To further assess for the presence of Potential ASS, twenty three samples were submitted to assess the net acidity and extractable sulfur of the soils. The test results are summarised below.

Table 1: Summary of Detailed ASS Analysis Results

Sample	Depth (m)	Texture	Chromium Reducible Sulfur (mol H*/t)	Titratable Actual Acidity (mol H*/t)	Net Acidity (mol H*/t)	KCl – Extractable Sulfur (mol H*/t)	Lime Calculation kg $CaCO_3$/tonne (includes 1.5 safety Factor)
S1	0 – 0.1	Coarse	0	**27**	**27**	2	2
S4	0 – 0.1	Coarse	0	**34**	**39**	1	3
S6	0 – 0.1	Coarse	3	**51**	**65**	1	5
S8	0 – 0.1	Coarse	0	**30**	**30**	1	2
S10	0 – 0.1	Coarse	0	**35**	**40**	1	3
S12	0 – 0.1	Coarse	4	**83**	**99**	3	7
S14	0 – 0.1	Coarse	0	**23**	**23**	1	2
S16	0 – 0.1	Coarse	5	14	**19**	5	1
S19	0 – 0.1	Coarse	3	**94**	**108**	2	8
S20	0 – 0.1	Coarse	0	**38**	**38**	1	3
S22	0 – 0.1	Coarse	0	**47**	**47**	1	4
S23	0 – 0.1	Coarse	0	**40**	**45**	1	3
S24	0 – 0.1	Coarse	7	**71**	**85**	1	6
S25	0 – 0.1	Coarse	4	**47**	**56**	1	4
S28	0 – 0.1	Coarse	5	**49**	**65**	2	5
S30	0 – 0.1	Coarse	0	**33**	**33**	1	3
S32	0 – 0.1	Coarse	0	**47**	**47**	1	3
S34	0 – 0.1	Coarse	0	**50**	**56**	1	4
S36	0 – 0.1	Coarse	4	**72**	**83**	2	6
S38	0 – 0.1	Coarse	4	**57**	**72**	2	5
S39	0 – 0.1	Coarse	0	17	17	1	1
Criteria for ASS (>1,000tonnes of soil) = Net acidity >18moles H+/tonne							

An appraisal of the laboratory test results presented in Table 1 is provided below:

- The pH_F of the soils is >4 and they are not considered Actual ASS;
- 37 of the 44 samples had an oxidised pH value of less than 3 in the screening tests which is considered indicative of Potential ASS, however, the samples comprise topsoil with a high organic matter content which influence the results;
- Detailed analysis revealed trace concentrations of chromium reducible sulfur in the soils (≤7 moles H+/ tonne) but did not exceed ASSMAC Action Criteria for Potential ASS;
- The topsoil samples were estimated to contain up to about 15% organic matter; and
- The net acidity concentrations exceeded the ASS Assessment Guidelines Action Criteria of 18 moles H+/ tonne in 22 of the 23 samples that were analysed, however, extractable sulfate concentrations (S_{KCl}) indicate that the sulfate derived acidity was typically less than 8% of the total acidity present. The origin of the remaining acidity is not known but as the

soils are not Actual ASS based on the initial pH results it is likely that the remaining acidity is derived from other sources such as organic acidity which is a feature of coastal floodplain landscapes, particularly within the topsoil profile which was observed to have a high organic content.

5 ACID SULFATE SOIL MANAGEMENT PLAN

On the basis of the laboratory testing results summarised in Table 1 the net acidity concentrations exceed the ASS Assessment Guideline Action Criteria of 18 moles H+/tonne. In accordance with the '*NSW ASS Manual*' (ASSMAC, 1998) an Acid Sulfate Soils Management Plan (ASSMP) is therefore required for the proposed works. However, as noted above, the origin of the acidity present is likely to be associated with the high organic matter content present in the topsoil profiles that were sampled and not derived entirely from acid sulfate soils.

The '*Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines*' (2014) note that acidic soils with a low extractable sulfur (S_{KCl}) content where the source of the acidity is unclear can be managed as an "acidic soil" rather than ASS.

The purpose of the ASS Management Plan is to consider both the potential on-site and off-site impacts of the disturbance of the soils present, with any potential acid leachate being managed appropriately.

It is therefore recommended that the topsoil be considered an "acidic soil" and that when stripped prior to fill placement should remain on site for use as the final topsoil layer or for landscaping purposes. As the excavated materials are to remain on site it is recommended that the consenting authority consider that neutralisation of all the naturally acidic soils to a pH of 7 in accordance with the *NSW ASS Manual* is not required as the soils are not Potential ASS and will result in the treated soils having a significantly higher pH than the natural alluvial soils present at the site.

Natural ecosystems in the area are adapted to "acidic soils" and excessive liming can result in an increase of pH in the adjacent natural systems which can have detrimental impacts. NSW DPI have also recommended that surface soils should not be limed to achieve a pH of >6 as it may induce deficiency of other plant nutrients (Agfact AC. 19 3rd ed. 2005).

For preliminary planning purposes, the proposed Acid Sulfate Soil Management Plan for the naturally "acidic soils" at the site is summarised below:

1. Prepare stockpile area. This should involve:
    - Construct a bund around the designated area(s). The stockpile area should be at least 50m from any water courses;
    - Spread lime over the exposed soils at a nominal rate of 5kg/m^2;
    - Lightly roll to reduce water infiltration.
2. Strip topsoil and place in designated stockpile. An earthen bund should surround the stockpile to capture any potential leachate. The stockpile area should grade to a low point where potential leachate can be captured within the bunded area for further treatment if required;
3. Spread topsoil over the finished lots and when complete spread lime at a nominal rate of 0.1kg/m^2 across the surface to assist revegetation; and
4. Record details of all earthworks, including temporary stockpile locations, approximate volumes, treatment undertaken, if any, and monitoring results.

The following monitoring regime is recommended:

- Regular visual monitoring during excavation to note the presence of any dark grey sands or dark grey clays that may represent over excavation below the topsoil profile into Potential ASS:
  - *Action – Where encountered excavation works should temporarily cease and an assessment of the excavation be made by a geotechnical professional*;
- Water quality monitoring should be undertaken on any leachate captured within the bunded area.
  - *Action – Where leachate water has a pH < background value it will require neutralisation which can be undertaken using a neutralising agent such as calcined magnesia or hydrated lime. Further pH monitoring of the treated water will be required to ensure neutralisation has occurred. Treated water should be discharged overland, away from surface water bodies, to allow infiltration into the soil;*

6 LIMITATIONS

The findings presented in the report and used as the basis for recommendations presented herein were obtained using normal, industry accepted geotechnical design practises and standards. To our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points. If site conditions encountered during construction vary significantly from those discussed in this report, Regional Geotechnical Solutions Pty Ltd should be contacted for further advice.

This report alone should not be used by contractors as the basis for preparation of tender documents or project estimates. Contractors using this report as a basis for preparation of tender documents should avail themselves of all relevant background information regarding the site before deciding on selection of construction materials and equipment.

If you have any questions regarding this project, or require any additional consultations, please contact the undersigned.

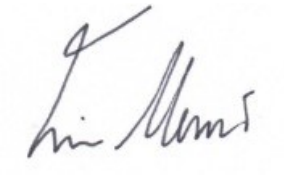
For and on behalf of **Regional Geotechnical Solutions Pty Ltd**

Prepared by

Simon Keen

Senior Geotechnical Engineer

Reviewed by



Tim Morris

Associate Engineering Geologist