EDH Group

285 - 305 Pacific Hwy Lake Munmorah
Preliminary Geotechnical Investigation

February 2019

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1. Introduction

GHD Pty Ltd (GHD) was engaged by EDH Group (EDH) to undertake a combined preliminary geotechnical and contamination assessment of a roughly 23 hectare parcel of land located at 285 -305 Pacific Highway, Lake Munmorah NSW (the site). It is understood that the assessment is required as part of a planning proposal for subdivision and rezoning.

This report presents the findings of the preliminary geotechnical assessment for the site. The finding of the contamination site assessment are presented under separate cover as GHD report '2219867-REP-0_285 -305 Pacific Hwy Lake Munmorah Contaminated Site Assessment'.

Preliminary geotechnical assessment is required to confirm the geological and geotechnical characteristics and constraints related to future development of the site.

This assessment consisted of:

- An assessment of soil and geological characteristics relating to suitability of the site for development.
- A visual assessment of soil susceptibility to erosion, identifying where appropriate controls would be needed to minimise the risk of erosion.
- A geotechnical terrain map identifying areas of actual or potential instability, high erosion or acid sulfate soil (ASS) conditions that may render that area of the site unsuitable for residential development.
- Recommendation for future geotechnical investigation in areas considered suitable for development.

This report should be read in conjunction with the General Notes provided in Appendix B.

1.1 Limitations

This report: has been prepared by GHD for EDH Group and may only be used and relied on by EDH Group for the purpose agreed between GHD and the EDH Group as set out in this report.

GHD otherwise disclaims responsibility to any person other than EDH Group arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on:

- Conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.
- Assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by EDH Group and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Methodology

The scope of works for this preliminary geotechnical assessment included a desk based review of information pertaining to the site, followed by a site visual walkover inspection to ground truth the desktop review findings. Note that no subsurface investigations were undertaken as part of this assessment.

2.1 Desktop review

A review of the following desktop information sources was undertaken as part of the desktop study:

- Council information, including the LEP and land zoning maps.
- Historical aerial photographs of the site, which were used to assist in establishing the physical patterns of development over time and previous land uses.
- Review of published geological, acid sulfate soils and soil landscape maps
- Mine working records available through NSW Government's 'MinView' website

2.2 Site inspection

A visual walkover inspection of the site was conducted by a Senior Engineering Geologist from GHD on 6 December 2018. The purpose of the walkover was to identify key geotechnical surface features of the site with respect the proposed development. Figure 6 in Appendix A shows the surface mapping undertaken for the site as well as the locations and directions of photographs taken during the site visit. Site photographs are presented in Appendix C.

3. Investigation findings

3.1 Desktop review

3.1.1 Regional geology

Reference to the 1:100,000 scale Regional Geology Sheet for Gosford-Lake Macquarie (Sheet 9131, 9231) shows that the site is underlain by two geological units as shown in Figure 1 in Appendix A and summarised in Table 3-1.

Table 3-1 Regional geology

Geological unit	General Occurrence	Summary Description
Quaternary Alluvium	Minor portions in the NE and NW of site	Typically comprising gravel, sand, silt and clay
Munmorah Conglomerate	Majority of the site	Typically comprising conglomerate, pebbly sandstone, grey to green shale

The map also shows a dyke running across the site from roughly the NW to SE corners of the block. No further details are available relating to the dyke.

3.1.2 Soil landscapes

Reference to the 1:100,000 Soil Landscape Map and Report for Gosford-Lake Macquarie shows that the site is covered by two soil landscape units, as shown on Figure 2 in Appendix A and summarised in Table 3-2.

Table 3-2 Soil Landscapes

Soil landscape unit	General Occurrence
Wyong	Minor portions in the NE and NW of site
Doyalson	Majority of the site

The characteristic of the identified soil landscape groups are summarised as follows:

- The Wyong landscape is characterised by poorly drained deltaic floodplains and alluvial flats of Quaternary aged sediments on the Central Coast lowlands. Slope gradients are typically <3% with local relief <10 m. The typical soil profile consists of a brownish black loam to silty clay loam topsoil overlying a silty clay subsoil. Associated soils (shown as likely to be encountered close to the lake) include dark brown loose loamy sand topsoil overlying grey loose sand and brown waterlogged sand. Limitations include the possible presence of acid sulfate soils, high potential for aluminium toxicity, very strongly acid, moderate erodiblity and localised shrink-swell and low wet bearing strength.
- The Doyalson soil landscape is characterised by gently undulating rises on Munmorah Conglomerate. Slope gradients are typically <10% with local relief up to 30 m. The typical soil profile consists of loose loamy sand overlying a hard setting clayey sand, sandy clay loam and/or clay. Total soil depth ranges between 0.5 and 1.5 m (but deeper in drainage lines) and is underlain by sandstone and conglomerate, and/or siltstones and claystone. Limitations include high erosion hazard, localised foundation hazard, strongly acid soils, and stoniness.

3.1.3 Acid sulfate soils

Reference to the 1:25,000 Acid Sulfate Soil Risk Map for Catherine Hill Bay shows that the majority of the site has no mapped occurrence of acid sulfate soils. There is a minor section in the north east of No. 305, which is mapped as being an alluvial backswamp having a low probability of occurrence between 1 m and 3 m below the ground surface, as shown on Figure 3 in Appendix A. Although not marked on the risk map, the presence of quaternary alluvium located in the north west corner of No. 285 could potentially be a source of ASS soils and should be assessed further as part of the field testing.

Reference to the Wyong Local Environmental Plan 2013 Acid Sulfate Soils Map Sheet (Figure 4 in Appendix A) ASS_018 shows that the majority of the site has been classified as "Class 5" with a small portion of "Class 3" extending into the north east of the site.

Class 5 is defined in the "Wyong Local Environment Plan 2013 as "*Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below 5 metres Australian Height Datum and by which the watertable is likely to be lowered below 1 metre Australian Height Datum on adjacent Class 1, 2, 3 or 4 land."*

Class 3 is defined in the "Wyong Local Environment Plan 2013 as *"Works more than 1 metre below the natural ground surface. Works by which the watertable is likely to be lowered more than 1 metre below the natural ground surface."*

3.1.4 Mine Subsidence

The site is located within the Swansea – North Entrance mine subsidence district with past mining occurring beneath the site within the Great Northern Seam typically at depths of 170 m to 200 m below ground level (refer Figure 5 in Appendix A). Mining methods used were *"bord and pillar mining, including pillar extraction"* (Mannering MOP, 2017).

The entire site is located within Consolidated Coal Lease (CCL) 719, which is currently held by Centennial Mannering Pty Ltd. The existing lease expires in 2020, however this can be renewed in the future. No mining has occurred beneath the site since 1992 when the site was operated by Newvale Colliery.

With respect to the development planning purposes, the entire site is classified by Subsidence Advisory NSW as "Surface Development Guideline 2" (included in Appendix D). Guideline 2 is applied to properties assessed to be at risk of damage due to trough subsidence. Trough subsidence forms as a result of the presence of underlying, potentially unstable, abandoned coal mine workings.

Under Guideline 2, all development applications can be assessed by the Council or Accredited Certifier for guideline compliant development, or by the Subsidence Advisory NSW for non-compliant guideline development.

Guideline 2 compliant building construction comprised of "Single or two storey brick veneer on AS 2870 footings/slabs. Maximum length of 24 m and maximum footprint of 400 sqm".

3.2 Site walkover inspection

3.2.1 Site description

The site is located on the northern side of the Pacific Highway, which passes along the site frontage in a roughly east-west direction. The site is approximately 23 hectares in size and is bounded by the Pacific Highway road reserve to south, cleared and residential land to the east and bushland to the north and west.

The site consists of three (3) properties (285, 295 and 305 Pacific Hwy) which include a number of buildings and sheds. There are four (4) dams located on the site, with one located on No. 285 (Photo 2), two located on No. 295 (Photos 8 & 9) and one located on No. 305 (Photo 17).

The topography of the site consists of a broad rounded ridge feature which forms the highest portion of the site and runs in a roughly NNE direction through the central eastern boundary of No. 285 and into the north west corner of No. 295.

From this higher portion of the site the ground slopes gently down to the north west at 2° to 3° on No. 285 and to the east north east at 3° to 4° on No. 295 through to No. 305.

A natural drainage depression exists on the eastern boundary of No. 285 (Photos 14, 15, 18, 19 & 20) and continues towards the north east corner through the centre of No. 305. The drainage depression side slopes range from about at 2° to 4°.

Figure 6 in Appendix A shows the surface mapping undertaken for the site as well as the locations and directions of site photographs. Site photographs are presented in Appendix B.

3.2.2 Surface Soils

Surface soils across the site generally consisted of sandy soils (Photo 4). Soils within the drainage depression located within No. 305 consisted of damp to wet silt mixtures with high organic content (Photo 20).

3.2.3 Surface water

A seepage point is evident on No. 305 (Photo 16) immediately to the east of the northern dam located on No. 295. The drainage path continues towards the north east corner of No. 305 into a drainage basin with dense reeds and saturated ground (Photo 19). Free water was observed ponding in areas along the drainage depression and within the basin area, however no flowing water was observed during this inspection.

3.2.4 Fill/stockpiles

A number of fill stockpiles are located within the boundary of the No. 295. Crushed sandstone and concrete/bricks forms what appears to be an old bike track and other randomly placed fill stockpiles up to about 1.5 m high in the north west of lot (Photo 10 -12). Numerous cut down tree and mulch piles are located throughout the property and generally located within central west and south west of lot (Photo 6, 7 & 13).

No. 285 includes a small fill area up to 0.5 m high located centrally along the western boundary, with some plastic and cloth evident on the surface (Photo 3).

3.2.5 Vegetation

The vegetation varies across the site, from open mature eucalypts (Photo 2), open juvenile eucalypts (Photo 5), grassed paddocks (Photos 2 &18) and sparse bushland (Photo 7 & 10).

4. Preliminary discussion and recommendations

4.1 General

Details of the proposed development, such as depths of cuttings, excavations or fill platforms are currently not known. The following discussion is therefore considered general and preliminary in nature. Any recommendations provided should be verified by further geotechnical investigation and assessment as concept options are developed for the site.

4.2 Site preparation

Site preparation should comprise stripping to remove vegetation, topsoil, 'uncontrolled' fill, saturated, root affected or other potentially deleterious material.

Particular care will be required to remove unsuitable materials where it is proposed to backfill existing farm dams.

Where required to raise site levels, engineered fill should be placed, compacted and tested in accordance with the requirements of AS 3798-2007 'Guidelines for Earthworks for Commercial and Residential Developments'. General fill should be placed in layers not exceeding 300 mm loose thickness and compacted to a minimum 95% Standard maximum dry density ratio (SMDDR) and 98% in the upper 1 m beneath proposed structures. Clay fill should be and maintained at -3% to +1% of Standard optimum moisture content (SOMC).

It is recommended that 'Level 1' inspection and testing be undertaken by a geotechnical testing and inspection authority (GITA) during filling operations required to support structures, pavements or other significant loads (i.e. engineered fill). 'Level 1' is defined in AS 3798 and includes full time supervision during material placement and compaction by a GITA.

4.3 Excavation conditions

Based on the desktop assessed surface/subsurface conditions, it is anticipated that excavations required for general (shallow) site preparation works and shallow footings will be achievable using conventional earthmoving equipment. Deeper cutting or excavations, including those into bedrock, will require specific geotechnical investigation and assessment (which is beyond the scope of this preliminary assessment).

Excavations greater than 1.5 m deep should either be supported by temporary shoring or benched/battered. Temporary shoring should comply with Australian Standard AS 4744.1-2000 'Steel shoring and trench lining – Design'. Temporary excavation batters in site soils should be constructed at no steeper than 1H:1V. Steeper batters may be achievable but would need to be assessed by a geotechnical engineer during construction.

All excavations should satisfy the requirements of relevant workplace health and safety legislation, including WorkCover NSW "Code of Practice Excavation".

Subject to construction techniques, virgin excavated natural material (VENM) other than topsoil may be considered for re-use as engineered general fill. Such materials may require moisture conditioning prior to re-use.

4.4 Existing uncontrolled fill

The presence of uncontrolled fill/fill stockpiles poses risks to development associated with unknown composition, density (i.e. level of compaction), stiffness (elastic modulus), and strength. The inherent variability of an uncontrolled or non-engineered fill makes it difficult to reliably assess its engineering properties using geotechnical investigation techniques.

Further investigation will be required to assess the suitability of the existing fill materials for re-compaction and/or the characteristics of the underlying natural strata.

4.5 Acid sulfate soils

Residual soils which cover the majority of the site, by their nature, are not considered to be actual or potential acid sulfate soils since they are not "associated with sediments formed by natural processes when certain conditions existed in the Holocene geological period (last 10,000 years)" (ASSMAC 1998).

Laboratory testing will be required to confirm if sulphides are present in the alluvial soils associated with the basin swamp area in the NE, within the drainage depression located within No. 305 and the north west corner of No. 285. At this stage, the alluvial soils should be treated as potential ASS, until such time as a more detailed assessment can be undertaken for this area (if disturbance of existing soil is proposed).

4.6 Foundations

A preliminary allowable bearing capacity for shallow footings for the natural (undisturbed) sandy soils across the site of 100 kPa is considered appropriate for footings design in accordance with AS2870. Further assessment is required for any proposed foundations, which may intersect the drainage pathway through No. 305. The above bearing capacity should be confirmed through subsequent subsurface geotechnical investigations for the site.

4.7 Pavement design

Due to the generally sandy nature of the soil across the site, preliminary pavement design(s) for the site could be undertaken on the basis of a preliminary (conservative) California Bearing Ratio (CBR) of 5 %. This CBR does not apply for pavements located within the vicinity of the drainage pathway through No. 305 or the drainage basin area. Confirmation of the subgrade CBR(s) across the site should be undertaken as part of future geotechnical subsurface investigations.

4.8 Recommendations for further work

To further develop the concept design, it is recommended a series of shallow boreholes or test pits be drilled/excavated to confirm appropriate founding levels/conditions for residential buildings and pavement design. Laboratory testing of samples would also be required to confirm conditions at the site.

Test locations for proposed pavement should be spaced at nominally 50 m centres, while the locations for proposed footings/lot classification should be conducted at spacing recommended in AS2870 (but typically 1 borehole or test pit per 3 residential lots).

Typical testing would include:

- California Bearing Ratio (CBR)
- Standard compaction
- Atterberg limits

- Moisture content
- Emerson class number (dispersion)
- ASS field screening test

4.9 Geotechnical constraints mapping

The geotechnical constraints have been assessed and mapped based on the following general zone descriptions:

- Constrained land (not recommended for residential development)
- Encumbered land (developable, but with specific requirements to address geotechnical issues)
- Developable land (no special geotechnical constraints)

The geotechnical constraint zones are mapped on Figure 7 in Appendix A.

Constrained land, from a geotechnical perspective, is limited to the portion of land at the north-east corner of the site which is mapped as potentially including ASS and also categorised as a 'back-swamp' terrain unit.

Encumbered land, from a geotechnical perspective, includes:

- All areas of identified uncontrolled filling across the site (excluding mulch, tree stumps etc.).
- Potential (unmapped) ASS area at the NW corner of the site.
- Existing farm dams.
- The drainage depression leading to the drainage basin in No. 305.

5. References

Acid Sulfate Soils (ASS) 1:25 000 Risk Map for Chain Valley Bay, Department of Land, Land Water Conservation (1997).

Department of Mineral Resources – Gosford-Lake Macquarie 1:100,000 geological series sheet 9131-9231.

Geological Series Sheet 9131 and 9231, Gosford – Lake Macquarie 1:100 000.

Dept. of Primary Industries, NSW, (2006).Newcastle Coalfield Regional Geology 1:100 000, 1st edition. Geological Series Sheet 9231 and part of 9131, 9132 and 9232. Geological Survey of NSW, (1995).

Soil Landscapes of the Gosford – Lake Macquarie 100,000 Sheet, Soil Conservation service of NSW, (1993).

NSW Department of Planning and Environment, Minview Geoscientific Database.

Appendices

Appendix A – Figures

Figure 1 – Regional Geology

Figure 2 – Soil Landscape Map

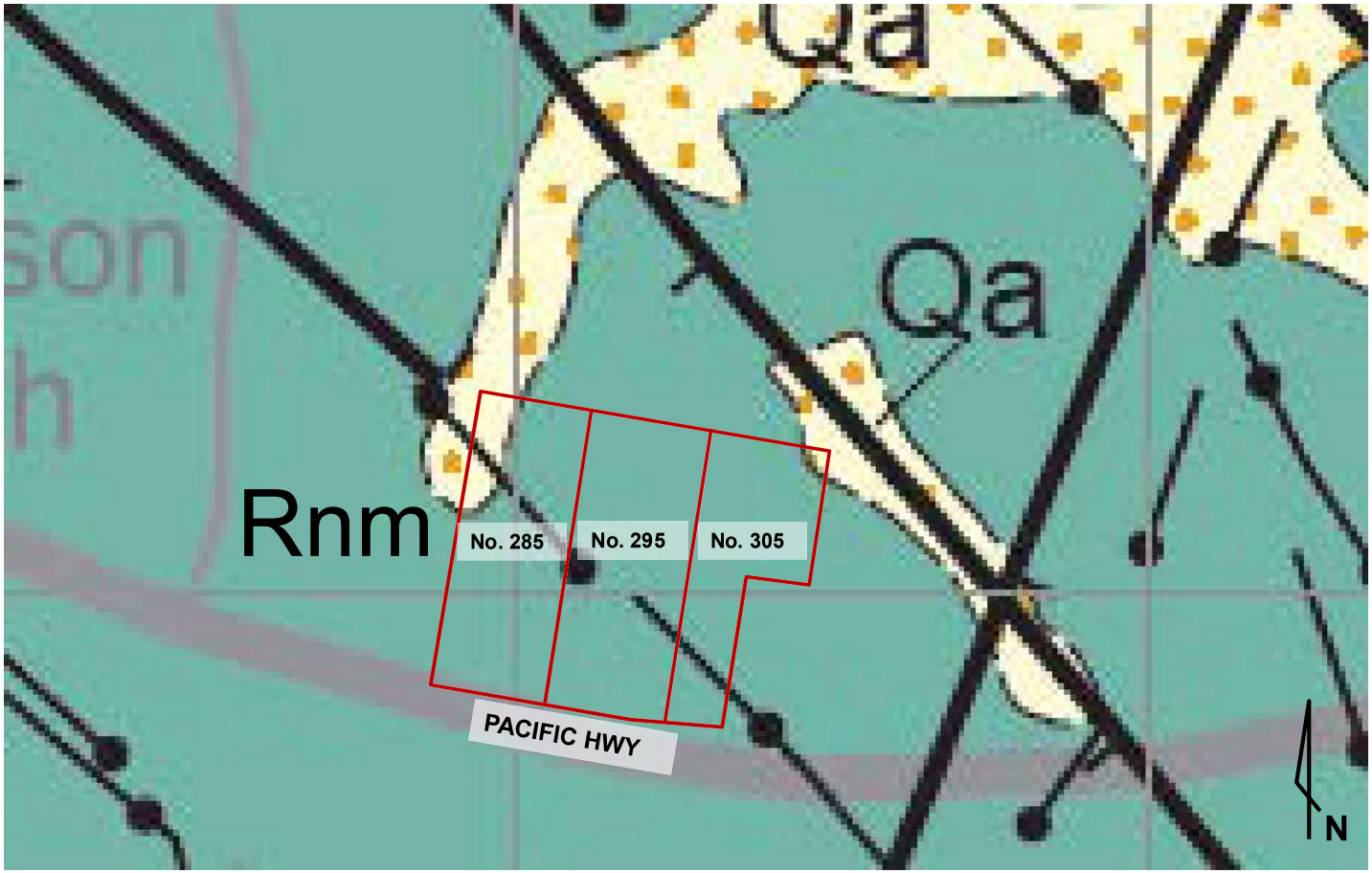
Figure 3 – Acid Sulfate Soils Risk Map

Figure 4 – Acid Sulfate Soils Classification Wyong LEP 2013

Figure 5 – Historical Mine Workings

Figure 6 – Site Mapping of Key Surface Features

Figure 7 – Geotechnical Constraints Map



Source – Geological Series Sheet 9131 and 9231, Gosford – Lake Macquarie 1:100 000 Provisional

0 200 m

LEGEND

- Lot Boundary
- Rnm – Munmorah Conglomerate
- Fault
- Qa – Gravel and sand
- Dyke (from mine workings / Geophysics)

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Regional Geology

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job no | 22-19867
file ref | 22-19867_FIG1

Figure 1

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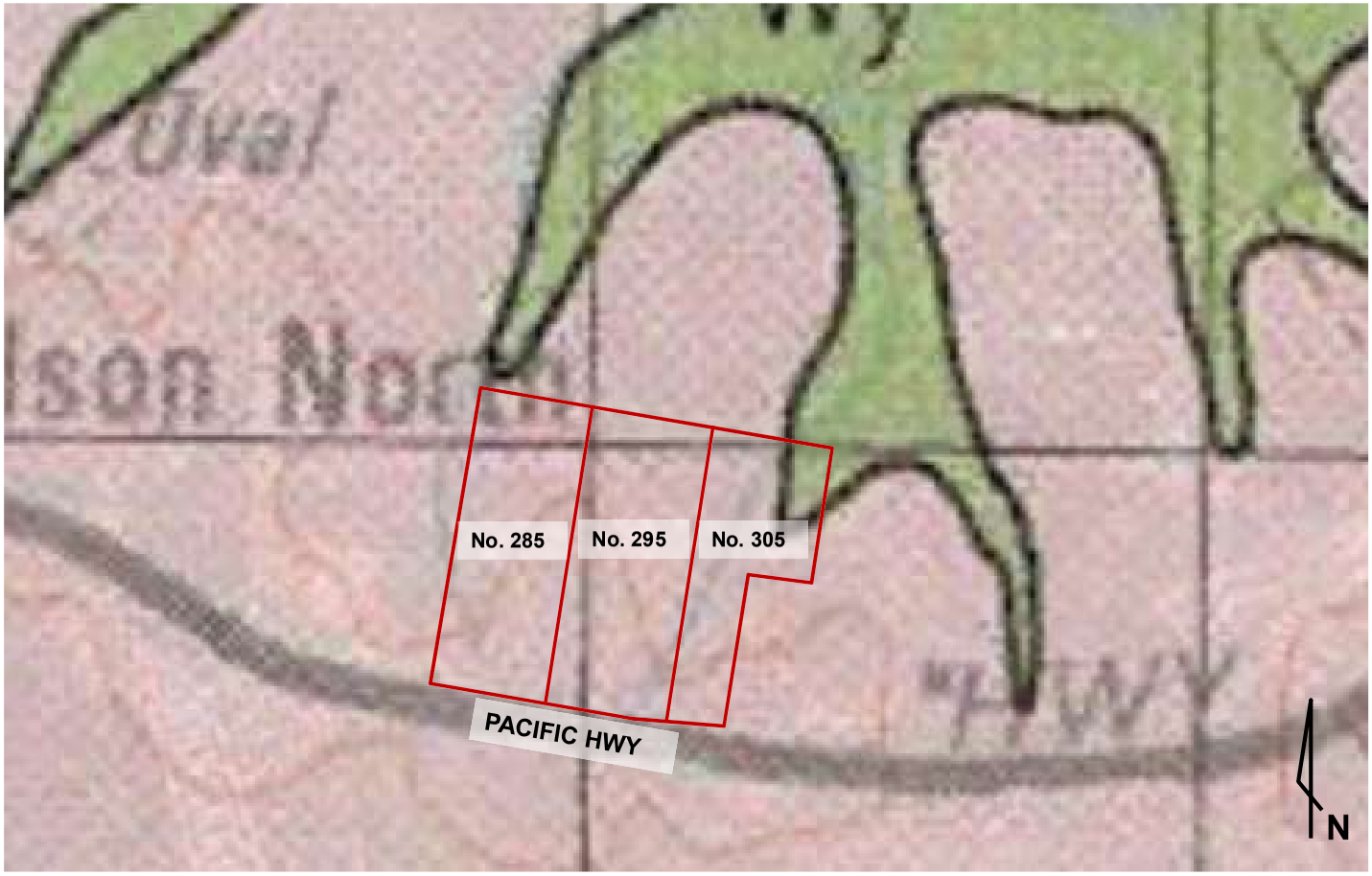

Source – Soil Landscapes of the Gosford – Lake Macquarie 100,000 Sheet, Soil Conservation service of NSW, (1993)

0 200 m

LEGEND

Lot Boundary

Doyalson – erosional soil landscape

Wyong – alluvial soil landscape

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Soil landscape map

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file ref | 22-19867_FIG2

Figure 2

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Source – NSW Department of Planning and Environment (2018)

0 200 m

LEGEND

Lot Boundary

Alluvial back-swamp – low probability between 1 and 3 m below ground surface

Estuarine lagoon – high probability at or near ground surface

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Acid Sulfate Soils

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job no | 22-19867

file ref | 22-19867_FIG3

Figure 3

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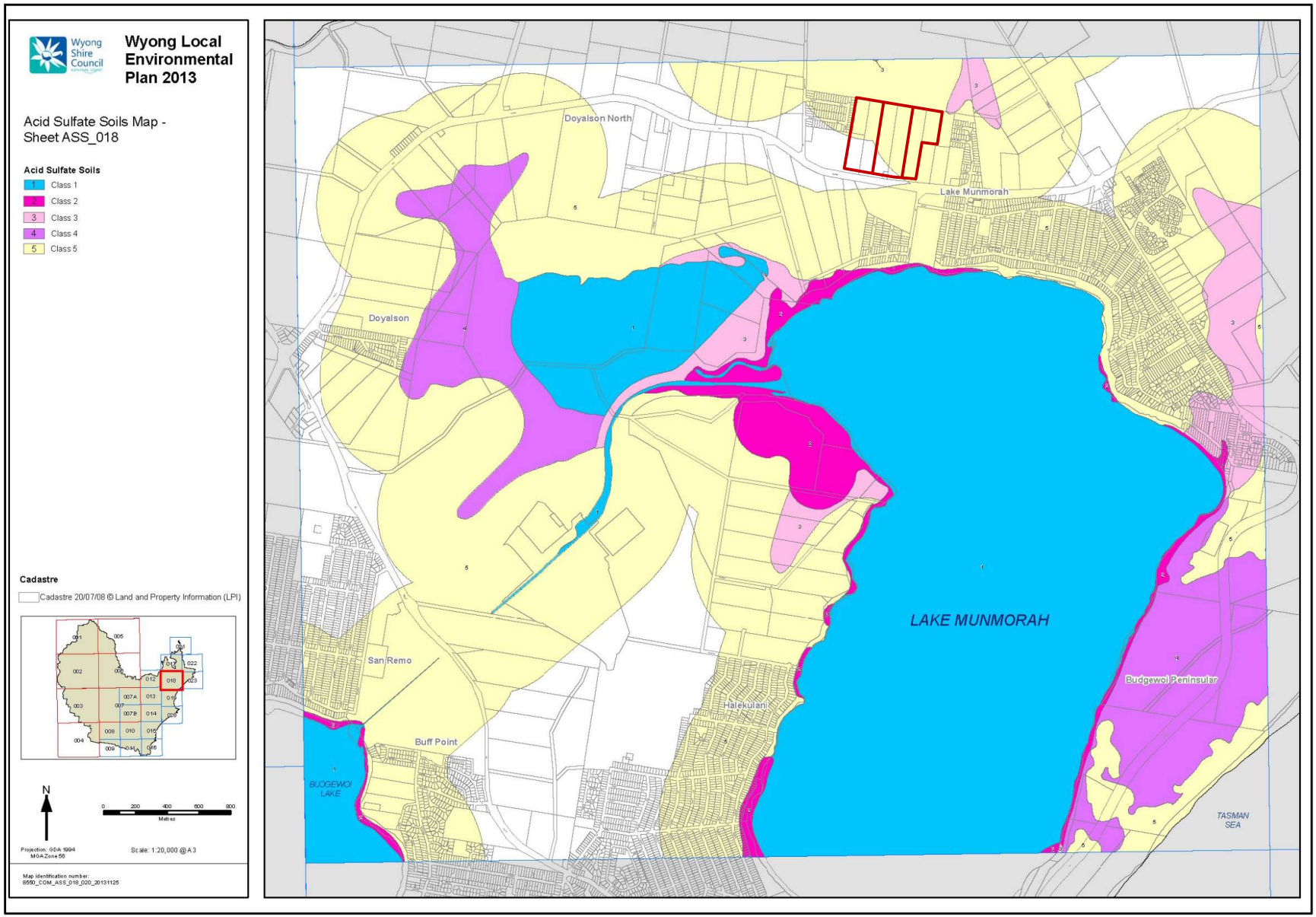

Source – Wyong Local Environment Plan 2013

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Acid Sulfate Soils Classification Wyong LEP 2013

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job no | 22-19867

file ref | 22-19867_FIG4

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Figure 4

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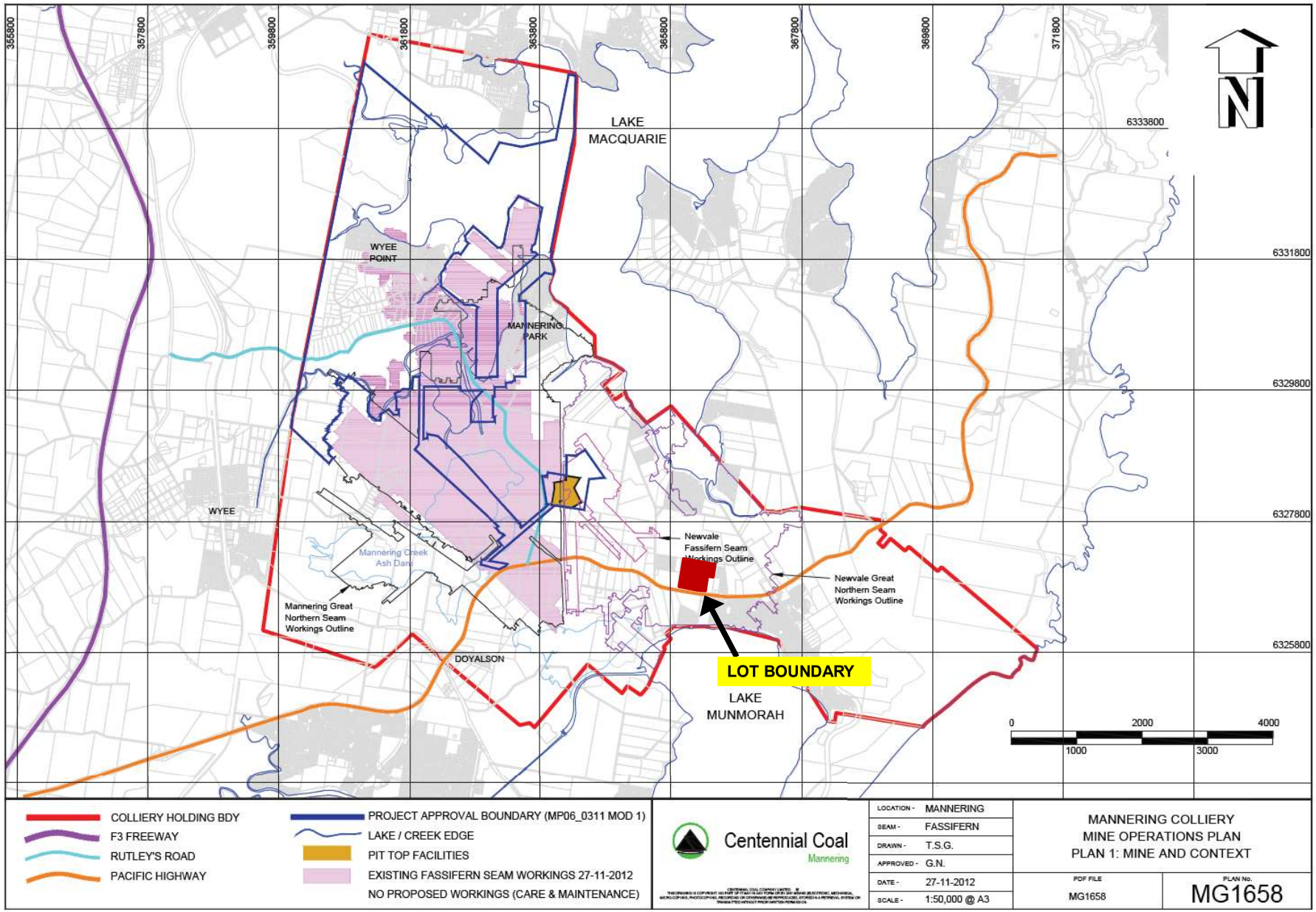

Source – Mannering Colliery Mine Operations Plan 1 Jan 2013 – 31 Dec 2017

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Historical mine workings

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job no | 22-19867

file ref | 22-19867_FIG5

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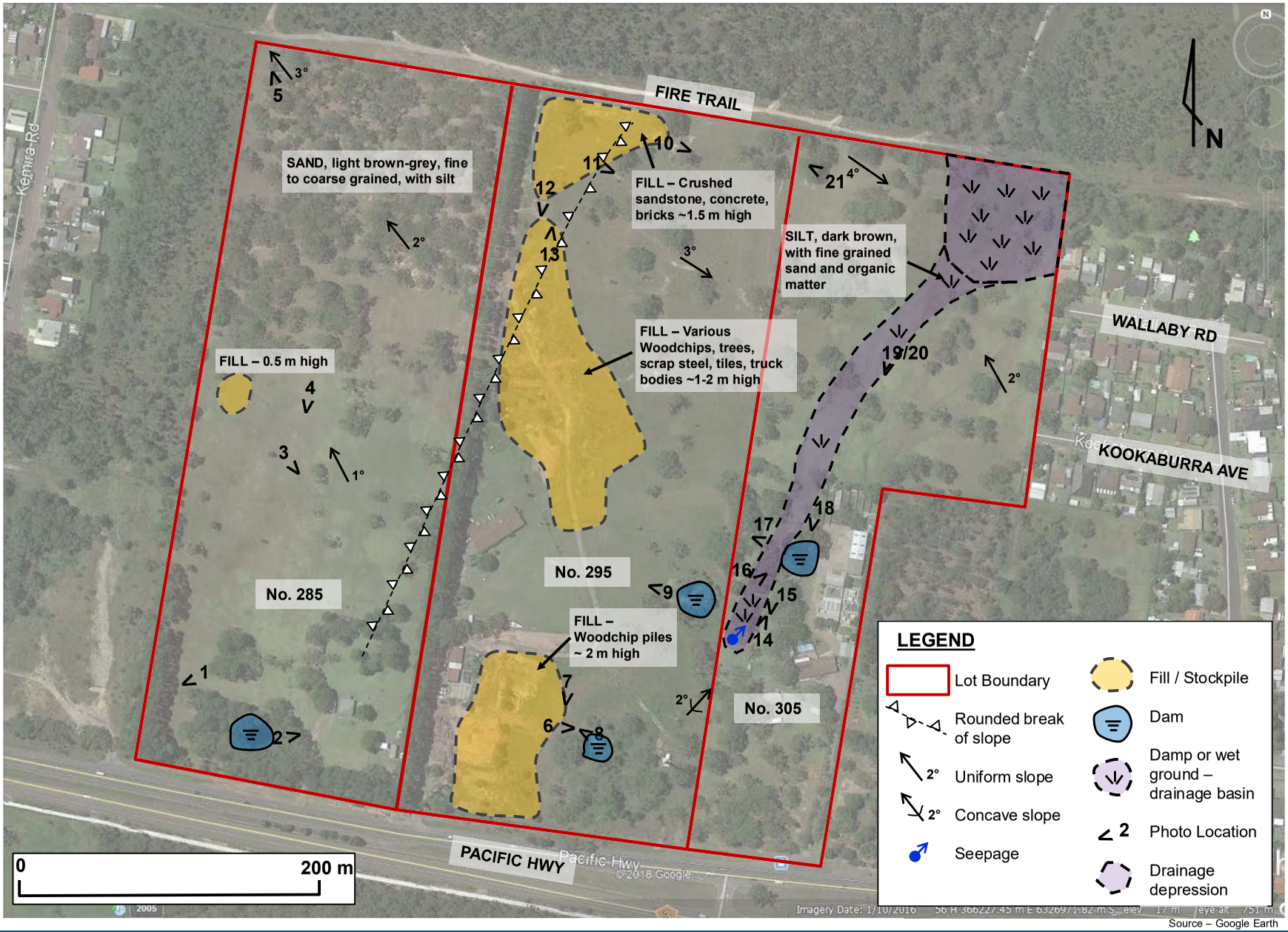
Figure 5



Source – Google Earth

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Site mapping of key surface features

scale | As Annotated date | December 2018

job no | 22-19867

file ref | 22-19867_FIG6

Figure 6

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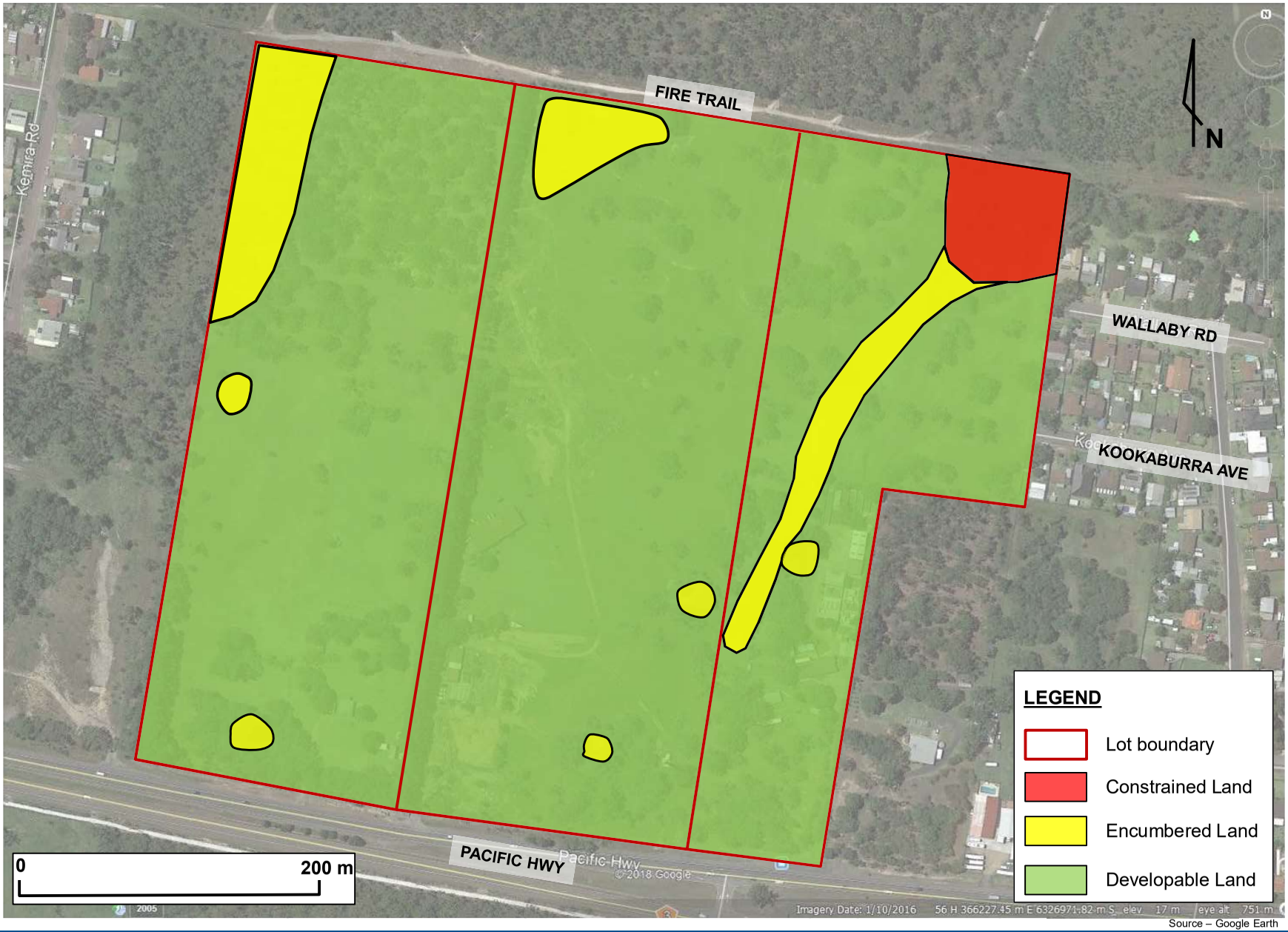

Source – Google Earth

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Geotechnical Constraints Mapping

scale | As Annotated date | December 2018

job no | 22-19867

file ref | 22-19867_FIG7

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Figure 7

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Appendix B – Standard notes

GENERAL NOTES

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The report contains the results of a geotechnical investigation or study conducted for a specific purpose and client. The results may not be used or relied on by other parties, or used for other purposes, as they may contain neither adequate nor appropriate information. In particular, the investigation does not cover contamination issues unless specifically required to do so by the client.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the report are excluded unless they are expressly stated to apply in the report.

TEST HOLE LOGGING

The information on the test hole logs (boreholes, test pits, exposures etc.) is based on a visual and tactile assessment, except at the discrete locations where test information is available (field and/or laboratory results). The test hole logs include both factual data and inferred information. Moreover, the location of test holes should be considered approximate, unless noted otherwise (refer report). Reference should also be made to the relevant standard sheets for the explanation of logging procedures (Soil and Rock Descriptions, Core Log Sheet Notes etc.).

GROUNDWATER

Unless otherwise indicated, the water depths presented on the test hole logs are the depths of free water or seepage in the test hole recorded at the given time of measuring. The actual groundwater depth may differ from this recorded depth depending on material permeabilities (i.e. depending on response time of the measuring instrument). Further, variations of this depth could occur with time due to such effects as seasonal, environmental and tidal fluctuations or construction activities such as a change is ground surface level. Confirmation of groundwater levels, phreatic surfaces or piezometric pressures can only be made by appropriate surveys, instrumentation techniques and monitoring programmes.

INTERPRETATION OF RESULTS

The discussion or recommendations contained within this report normally are based on a site evaluation from discrete test hole data, often with only approximate locations (e.g. GPS). Generalised, idealised or inferred subsurface conditions (including any geotechnical cross-sections) have been assumed or prepared by interpolation and/or extrapolation of these data. As such these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in ground conditions do occur in the natural environment, particularly between discrete test hole locations or available observation sites. Additionally, certain design or construction procedures may have been assumed in assessing the soil-structure interaction behaviour of the site. Furthermore, conditions may change at the site from those encountered at the time of the geotechnical investigation through construction activities and constantly changing natural processes.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed or reported should be referred to GHD for appropriate assessment and comment.

GEOTECHNICAL VERIFICATION

Verification of the geotechnical assumptions and/or model is an integral part of the design process - investigation, construction verification, and performance monitoring. Variability is a feature of the natural environment and, in many instances, verification of soil or rock quality, or foundation levels, is required. There may be a requirement to extend foundation depths, to modify a foundation system and/or to conduct monitoring as a result of this natural variability. Allowance for verification by appropriate geotechnical personnel must be recognised and programmed for construction.

FOUNDATIONS

Where referred to in the report, the soil or rock quality, or the recommended depth of any foundation (piles, caissons, footings etc.) is an engineering estimate. The estimate is influenced, and perhaps limited, by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The material quality and/or foundation depth remains, however, an estimate and therefore liable to variation. Foundation drawings, designs and specifications should provide for variations in the final depth, depending upon the ground conditions at each point of support, and allow for geotechnical verification.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in our geotechnical report, or other technical information, for the inclusion in contract documents or engineering specification of the subject development, such reproductions must include at least all of the relevant test hole and test data, together with the appropriate Standard Description sheets and remarks made in the written report of a factual or descriptive nature.

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Ref: DS5.5.1 Issue 0 Date: 05/10/2018

SOIL DESCRIPTION AND CLASSIFICATION

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Soil is described in general accordance with Australian Standard AS 1726-2017 (Geotechnical Site Investigations) in terms of visual and tactile properties, with potential refinement by laboratory testing. AS 1726 defines soil as particulate materials that occur in the ground and can be disaggregated or remoulded by hand in air or water without prior soaking. Classification of the soil is undertaken following description.

SOIL DESCRIPTION

The soil description includes a) Composition, b) Condition, c) Structure, d) Origin and e) Additional observations. 'FILL', 'TOPSOIL' or a 'MIXTURE OF SOIL AND COBBLES / BOULDERS' (with dominant fraction first) is denoted at the start of a soil description where applicable.

a) Soil Composition (soil name, colour, plasticity or particle characteristics, secondary and then minor components)

Soil Name: A soil is termed a *coarse grained soil* where the dry mass of sand and gravel particles exceeds 65% of the total. Soils with more than 35% fines (silt or clay particles) are termed *fine grained soils*. The soil name is made up of the primary soil component (in BLOCK letters), prefixed by applicable secondary component qualifiers. Minor components are applied as a qualifiers to the soil name (using the words 'with' or 'trace').

Particles are differentiated on the basis of size. 'Boulders' and 'cobbles' are outside the soil particle range, though their presence (and proportions) is noted. While individual particles may be designated as silt or clay based on grain size, fine grained soils are characterised as silt or clay based on tactile behaviour or Atterberg Limits, and not the relative composition of silt or clay sized particles.

Colour: The prominent colour is noted, followed by (spotted, mottled, streaked etc.) then secondary colours as applicable. Roughly equally proportioned colours are prefixed by (spotted, mottled, streaked etc.). Colour is described in its moist condition, though both wet and dry colours may also be provided if appropriate.

Plasticity: Fine grained soils are designated within standard ranges of plasticity based on tactile assessment or laboratory assessment of the Liquid Limit.

Particle Characteristics: The particle shape, particle distribution and particle size range within a coarse grained soil is described using standard terms. Particle composition may be described using rock or mineral names, with specific terms for carbonate soils.

Secondary and Minor Components: The primary soil is described and modified by secondary and minor components, with assessed ranges as tabulated.

Carbonate Soils: Carbonate content can be assessed by use of dilute '10%' HCl solution. Resulting clear sustained effervescence is interpreted as a *Carbonate soil* (approximately >50% carbonate), while weak or sporadic effervescence indicates *Calcareous soil* (< 50% carbonate). No effervescence is interpreted as a non-calcareous soil.

Organic and Peat Soils: Where identified, organic content is noted. *Organic soil* (2% to 25% organic matter) is usually identified by colour (usually dark grey/black) and odour (i.e. 'mouldy' or hydrogen sulphide odour). *Peat* (>25% organic matter) is identified by a spongy feel and fibrous texture. Peat soils' decomposition may be described as '*fibrous*' (little / no decomposition), '*pseudo-fibrous*' (moderate decomposition) or '*amorphous*' (full decomposition).

Fraction	Components		Particle Size (mm)
Oversize	BOULDERS		> 200
	COBBLES		63 - 200
Coarse grained soil particles	GRAVEL	Coarse	19 - 63
		Medium	6.7 -19
		Fine	2.36 - 6.7
	SAND	Coarse	0.6 - 2.36
		Medium	0.21 - 0.6
		Fine	0.075 - 0.21
Fine grained soil particles	SILT		0.002 - 0.075
	CLAY		< 0.002

Plasticity Terms (Fine Grained Soils)		Laboratory Liquid Limit Range
Silt	Clay	
N/A	N/A	(Non Plastic)
Low Plasticity	*Low Plasticity*	≤ 35%
	Medium Plasticity	> 35% and ≤ 50%
High Plasticity	*High Plasticity*	> 50%

Particle Distribution Terms (Coarse Grained Soils)	
Well graded	good representation of all particle sizes
Poorly graded	one or more intermediate sizes poorly represented
Gap graded	one or more intermediate sizes absent
Uniform	essentially of one size

Particle Shape Terms (Coarse Grained Soils)		
Rounded	*Sub-angular*	*Flaky or Platy*
Sub-rounded	*Angular*	*Elongated*

Secondary and Minor Components for Coarse Grained Soils			
Fines (%)	Modifier (as applicable)	Accessory coarse (%)	Modifier (as applicable)
≤ 5	*'trace silt / clay'*	≤ 15	*'trace sand / gravel'*
> 5, ≤ 12	*'with clay / silt'*	> 15, ≤ 30	*'with sand / gravel'*
> 12	*prefix 'silty / clayey'*	> 30	*prefix 'gravelly / sandy'*

Secondary and Minor Components for Fine Grained Soils	
% Coarse	Modifier (as applicable)
≤ 15	add *"trace sand / gravel"*
> 15, ≤ 30	add *"with sand / gravel"*
> 30	prefix soil *"sandy / gravelly"*

SOIL DESCRIPTION AND CLASSIFICATION

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b) Soil Condition (moisture, relative density or consistency)

Moisture: Fine grained soils are described relative to plastic or liquid limits, while coarse grained soils are assessed based on appearance and feel. The observation of seepage or free water is noted on the test hole logs.

Moisture - Coarse Grained Soils		
Term		Tactile Properties
Dry	*('D')*	Non-cohesive, free running
Moist	*('M')*	Feels cool, darkened colour, tends to stick together
Wet	*('W')*	Feels cool, darkened colour, tends to stick together, free water forms when handling

Moisture - Fine Grained Soils		
Term		Tactile Properties
Moist, dry of plastic limit	*('$w < PL$')*	Hard and friable or powdery
Moist, near plastic limit	*('$w \approx PL$')*	Can be moulded
Moist, wet of plastic limit	*('$w > PL$')*	Weakened, free water forms on hands with handling
Wet, near liquid limit	*('$w \approx LL$')*	Highly weakened, tends to flow when tapped
Wet, wet of liquid limit	*('$w > LL$')*	Liquid consistency, soil flows

Relative Density (Non Cohesive Soils): The Density Index is inherently difficult to assess by visual or tactile means, and is normally assessed by penetration testing (e.g. SPT, DCP, PSP or CPT) with published correlations. Assessment may be affected by moisture and *in situ* stress conditions. Density Index assessment may be refined by combination of *in situ* density testing and laboratory reference maximum and minimum density ranges.

Consistency (Cohesive Soils): May be assessed by direct measurement (shear vane, CPT etc.), or approximate tactile correlations. Cohesive soils include fine grained soils, and coarse grained soils with sufficient fine grained components to induce cohesive behaviour. A 'design shear strength' must consider the mode of testing, the *in situ* moisture content and potential for variations of moisture which may affect the shear strength.

Relative Density (Non-Cohesive Soils)		
Term and (Symbol)		Density Index (%)
Very Loose	*(VL)*	≤ 15
Loose	*(L)*	> 15 and ≤ 35
Medium Dense	*(MD)*	> 35 and ≤ 65
Dense	*(D)*	> 65 and ≤ 85
Very Dense	*(VD)*	> 85

Consistency assessment can be influenced by moisture variation.

Consistency (Cohesive Soils)			
Term and (Symbol)		Tactile Properties	Undrained Shear Strength
Very Soft	*(VS)*	Extrudes between fingers when squeezed	< 12 kPa
Soft	*(S)*	Can be moulded by light finger pressure	12 - 25 kPa
Firm	*(F)*	Can be moulded by strong finger pressure	25 - 50 kPa
Stiff	*(St)*	Cannot be moulded by fingers	50 - 100 kPa
Very Stiff	*(VSt)*	Can be indented by thumb nail	100 - 200 kPa
Hard	*(H)*	Can be indented with difficulty by thumb nail	> 200 kPa
Friable	*(Fr)*	Easily crumbled or broken into small pieces by hand	-

c) Structure (zoning, defects, cementing)

Zoning: The *in situ* zoning is described using the terms below. *'Intermixed'* may be used for an irregular arrangement.

'layer' (a continuous zone across the exposed sample)

'lens' (a discontinuous layer with lenticular shape)

'pocket' (an irregular inclusion of different material).

'interbedded' or *"interlaminated"* (alternating soil types)

Defects: Described using terms below, with dimension orientation and spacing described where practical.

'parting' (an open or closed surface or crack sub parallel to layering with little / no tensile strength - open or closed)

'fissure' (as per a parting, though not parallel or sub parallel to layering – may include desiccation cracks)

'sheared seam' (zone of sub parallel near planar closely spaced intersecting smooth or slickensided fissures dividing the mass into lenticular or wedge shaped blocks)

'sheared surface' (a near planar, curved or undulating smooth, polished or slickensided surface, indicative of displacement)

'softened zone' (in clayey soils, usually adjacent to a defect with associated higher moisture content)

'tube' (tubular cavity, singly or one of a large number, often formed from root holes, animal burrows or tunnel erosion)

'tube cast' (an infilled tube – infill may vary from uncemented through to cemented or have rock properties)

'infilled seam' (sheet like soil body cutting through the soil mass, formed by infilling of open defects)

Cementation: Soils may be cemented by various substances (e.g. iron oxides and hydroxides, silica, calcium carbonate, gypsum), and the cementing agent shall be identified if practical. Cemented soils are described as:

'weakly cemented'	easily disaggregated by hand in air or water
'moderately cemented'	effort required to disaggregate the soil by hand in air or water

Materials extending beyond '*moderately cemented*' are encompassed within the rock strength range. Where consistent cementation throughout a soil mass is identified as a duricrust, it is described in accordance with duricrust rock descriptors. Where alternate descriptors of cementation development are applied for consistency with regional practices or geology, or client requirements, these are outlined separately.

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d) Origin

An interpretation is provided based on observations of landform, geology and fabric, and may further include assignment of a stratigraphic unit. The use of terms 'possibly' or 'probably' indicates a higher degree of uncertainty regarding the assessed origin or stratigraphic unit. Typical origin descriptors include:

Residual	Formed directly from in situ weathering with no visible structure or fabric of the parent soil or rock.
Extremely weathered	Formed directly from in situ weathering, with remnant and/or fabric from the parent rock.
Alluvial	Deposited by streams and rivers (may be applied more generically as transported by water).
Estuarine	Deposited in coastal estuaries, including sediments from inflowing rivers, streams, and tidal currents.
Marine	Deposited in a marine environment.
Lacustrine	Deposited in freshwater lakes.
Aeolian	Transported by wind.
Colluvial and Slopewash	Soil and rock debris transported down slopes by gravity (with or without assistance of water). Colluvium is typically applied to thicker / localised deposits, and slopewash for thinner / widespread deposits.
TOPSOIL	Surficial soil, typically with high levels of organic material. Topsoils buried by other transported soils are termed *'remnant topsoil'*. Tree roots within otherwise unaltered soil does not characterise topsoil.
FILL	Any material which has been placed by anthropogenic processes (i.e. human activity).

e) Additional Observations

Additional observations may be included to supplement the soil description. Additional observations may consist of notations relating to soil characteristics (odour, contamination, colour changes with time), inferred geology (with delineation of soil horizons or geological time scale) or notes on sampling and testing application (including the reliability, recovery, representativeness, or condition of samples or test conditions and limitations). If the material is assessed to be not representative, terms such as 'poor recovery', 'non-intact', 'recovered as' or 'probably' are applied.

SOIL CLASSIFICATION

Classification allocates the material within distinct soil groups assigned a two character Group Symbol:

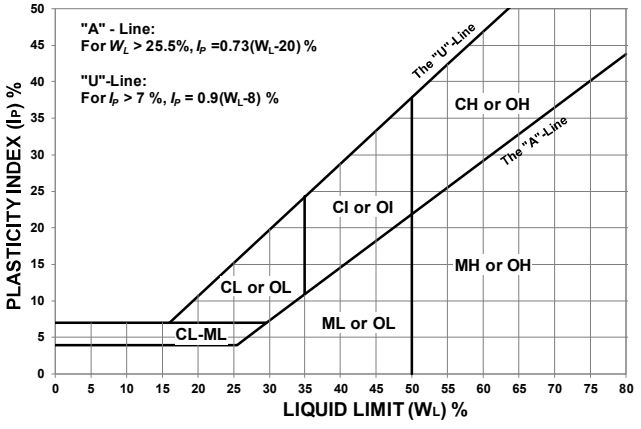
Coarse Grained Soils (sand and gravel: more than 65% of soil coarser than 0.075 mm)		
Major Division	**Group Symbol**	**Soil Group**
GRAVEL (more than half of the coarse fraction is > 2.36 mm)	GW	GRAVEL, well graded
	GP	GRAVEL, poorly graded
	GM	Silty GRAVEL
	GC	Clayey GRAVEL
SAND (more than half of the coarse fraction is < 2.36 mm)	SW	SAND, well graded
	SP	SAND, poorly graded
	SM	Silty SAND
	SC	Clayey SAND

Fine Grained Soils (silt and clay: more than 35% of soil finer than 0.075 mm)		
Major division	**Group Symbol**	**Soil Group**
SILT and CLAY (low to medium plasticity)	ML	SILT, low plasticity
	CL	CLAY, low plasticity
	CI	CLAY, medium plasticity
	OL	Organic SILT
SILT and CLAY (high plasticity)	MH	SILT, high plasticity
	CH	CLAY, high plasticity
	OH	Organic CLAY / SILT
Highly Organic	Pt	PEAT

Coarse grained soils with fines contents between 5% and 12% are provided a dual classification comprising the two group symbols separated by a dash, e.g. for a poorly graded gravel with between 5% and 12% silt fines (poorly graded 'GRAVEL with silt'), the classification is GP-GM.

For the purpose of classification, *poorly graded, uniform,* or *gap graded* soils are all designated as poorly graded. Soils that are dominated by boulders or cobbles are described separately and are not classified.

Classification is routinely undertaken based on tactile assessment with the soil description. Refinement of soil classification may be applied using laboratory assessment, including particle size distribution and Atterberg Limits. Atterberg Limits testing is applied to the sample portion finer than 0.425 mm. Fine grained soil components are assessed on the basis of regions defined within the Modified Casagrande Chart.



Appendix C – Site Photographs

Photo 1 – Looking north east across No. 285

Photo 2 – Dam located on the southern boundary of No. 285

Photo 3 – Looking north west on No. 285 towards 0.5 m fill (slight rise in background)

Photo 4 – Typical sandy surface soils

Photo 5 – Looking south along western boundary of No. 285

Photo 6 – Looking west across No. 295 at woodchip piles

Photo 7 – Looking north across No. 295

Photo 8 – Dam 1 (southern dam) located toward the south of No. 295

Photo 9 – Dam 2 (northern dam) located on the eastern boundary of No. 295

Photo 10 – showing fill piles in the foreground and background of the north west corner of No. 295

Photo 11 – Showing crushed concrete north west corner No. 295

Photo 12 – Typical crushed sandstone fill north west corner No. 295

Photo 13 – Looking south at various fill piles on the central western boundary of No. 295

Photo 14 – Looking south along drainage line No. 305.

Photo 15 – Looking north along drainage line on No. 305

Photo 16 – Saturated ground (seepage point) on No. 305 east of Dam 2 (northern dam) located on No. 295

Photo 17 – Dam on No. 305 located centrally beside existing building

Photo 18 – Looking north down No. 305 the darker green grass generally indicates the drainage flow path

Photo 19 – Looking north east toward drainage basin in north east corner of No. 305

Photo 20 – Typical wet silty soil with high organic content within drainage channel

Photo 21 – Looking south east across drainage path on No. 305

Appendix D – Surface Development Guideline 2

Surface Development Guideline 2 – Potential subsidence risk non-active workings

Requirements, information and guidance for development on properties over non-active coal mine workings

SUBSIDENCE ADVISORY NSW

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1. Introduction

Subsidence Advisory NSW (SA NSW) is the NSW Government agency responsible for regulating and administering the mine subsidence compensation system in NSW.

SA NSW has developed and applied surface development guidelines (Guidelines) in accordance with the *Coal Mine Subsidence Compensation Act 2017*, to support, inform, and guide prospective home builders, property developers, local councils and other stakeholders to mitigate or eliminate the damage to surface structures from mine subsidence within proclaimed mine subsidence districts.

In areas within active mining leases, the development guidelines are designed to effectively balance the interests of property owners and coal mine proprietors, providing mitigation measures against subsidence damage without imposing unreasonable costs and restrictions on the landowner or unreasonably sterilising coal resources.

2. Surface Development Guidelines

One of eight guidelines was applied to each property within a mine subsidence district. The guideline applied depends on the subsidence risks at each property as detailed below:

Guideline 1. Non-active mine workings at risk of pothole subsidence
Guideline 2. Non-active mine workings possible subsidence risk
Guideline 3. Non-active mine workings remote subsidence risk
Guideline 4. Active mining areas – high predicted subsidence impact
Guideline 5. Active mining areas – moderate predicted subsidence impact
Guideline 6. Active mining areas – minimal predicted subsidence impact
Guideline 7. On Application
Guideline 8. No Restrictions

3. Objective of Guideline 2

This guideline explains what home builders and property developers must do in relation to obtaining approval for their development under the:

- *Coal Mine Subsidence Compensation Act 2017* (the Act)
- *Coal Mine Subsidence Compensation Regulation 2017* (the Regulation)

Compliance with this guideline is a requirement for persons planning to develop property within a mine subsidence district that has been assigned **Guideline 2**.

Guideline 2 applies to properties within proclaimed mine subsidence districts assessed by SA NSW to be at risk of damage due to trough subsidence. Trough subsidence forms as a result of the presence of underlying, potentially unstable, abandoned coal mine workings.

The purpose of **Guideline 2** is to:

- prevent or minimise damage to a residential building should subsidence occur on the site
- ensure the residential building remains safe to persons inhabiting the residence

- ensure that when residential construction in abandoned mining affected areas occurs, compliance with the Act and Regulation is as simple and inexpensive for the home builder as practicable.

4. Areas where this guideline applies

Areas subject to Guideline 2 are identified on the NSW Planning Portal at www.planningportal.nsw.gov.au/find-a-property.

Guideline 2 is applied to properties that have been:

- undermined by coal mine workings in the past
- assessed by SA NSW as having the potential to be impacted by subsidence due to historical coal mine workings.

5. Allowable residential construction

Guideline 2 applies to applications for up to two residential buildings that conform with the following description. Commercial buildings or applications for more than two separate residential buildings will be assessed on merit.

The following residential construction is permitted within areas subject to **Guideline 2** without further approval from SA NSW:

Single or two storey brick veneer residential developments erected on reinforced concrete footings/slab to comply with AS 2870. These improvements are limited to a maximum length of 24 metres and maximum footprint size of 400m².

- The buildings are to be designed and constructed in accordance with the current editions of AS1684, AS 2870, AS3600, AS3700, AS4773, the Building Code of Australia, any other relevant applicable Australian Standards and good engineering practice. Ignore class “P” under AS2870 on this site.
- Masonry is to be articulated, in accordance with the current editions of Australian Standards AS3700 and AS4773.
- Both slab on ground and lightweight bearers and joists permitted.

The following are not permitted:

- Basements
- Suspended slabs

Masonry internal walls

An application for approval must be lodged in accordance with Section 22 of the Act.

6. Other allowable additions and improvements

SA NSW also allows the below types of additions and improvements on properties subject to **Guideline 2**:

- Concrete / fibreglass swimming pools, both in-ground and above-ground
- Retaining walls designed and constructed in accordance with relevant applicable Australian Standards and good engineering practice.

7. Who can assess whether development complies with Guideline 2

The relevant council or an accredited certifier as defined in the *Environmental Planning and Assessment Act 1979* assesses whether development complies with **Guideline 2**.

8. Proposed developments that do not comply with the guideline

Proposed improvements that do not comply with the guideline for the property must be assessed by SA NSW risk engineers on merit.

Depending on the type of construction and nature of the mine workings, SA NSW may require specific engineering design measures to be applied to the improvement, further geotechnical investigation to better understand the subsidence risk, or stabilisation of the mine workings.

9. Certification requirements

Following construction, a certifier must be engaged to certify that an improvement has been constructed in accordance with **Guideline 2**. A copy of this certification must be provided to SA NSW.

10. How this guideline was developed

SA NSW's development guidelines were developed by SA NSW in consultation with an expert reference group comprising of structural engineers, mining experts and key mining and development industry stakeholders.

11. Disclaimer

Please note SA NSW's surface development guidelines are subject to change.

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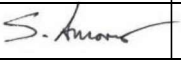
Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	M. Reynolds	S. Amoroso	*S. Amoroso*	S. Amoroso	*S. Amoroso*	20/12/2018
1	M. Reynolds	S. Amoroso		S. Amoroso		27/02/2019

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