ENVIRONMENTAL INVESTIGATION SERVICES

17 May 2012
Ref: E20345Klet3 rev1

Bluestone Capital Ventures No.1 Pty Ltd
C/- JBA Planning
PO Box 375,
North Sydney
NSW 2059

Attention: Mr Gordon Kirkby

CONCEPTUAL ACID SULFATE SOIL MANAGEMENT PLAN
CRONULLA SHARKS REDEVELOPMENT,
461 CAPTAIN COOK DRIVE, WOOLOOWARE

1. INTRODUCTION

Bluestone Capital Ventures No.1 Pty Ltd commissioned Environmental Investigation Services (EIS), a division of Jeffery & Katauskas Pty Ltd (J&K), to prepare a conceptual Acid Sulfate Soil Management Plan (ASSMP) for the proposed Cronulla Sharks Redevelopment, 461 Captain Cook Drive, Woolooware. The site locality is shown on Figure 1.

The preparation of the ASSMP was undertaken as a variation to EIS proposal (Ref: EP5250K2 29 June 2011). EIS were commissioned by e-mail dated 17 May 2012.

EIS recommend that further investigation is undertaken for acid sulfate soil conditions so that this Conceptual ASSMP can be reviewed and updated with a more detailed dataset once construction plans have been finalised.

1.1. Proposed Development Details

The proposed mixed use redevelopment of the Cronulla Sutherland Leagues Club site including a new neighbourhood retail centre, residential development and upgrades to the sports facilities, including the Toyota Stadium, will create a long term sustainable and viable solution for the Club as well as create a new centre and destination location that meets the needs of the surrounding community. The Concept Plan prepared for the site is seeking to develop the site in three stages, being:

- Stage 1 – New Neighbourhood Retail Centre, Medical and Leisure facilities on the eastern car park site and redevelopment of the Leagues Club facilities ;

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- Stage 2 - Residential Masterplanned Estate on the western car park and field area; and
- Stage 3 - Extension and improvement of the Sharks playing field facilities including grandstand extensions.

EIS understand that the proposed re-development is likely to include capping the east and west sections of the site. It is considered likely that the buildings will be constructed on piles. All car parking will be above ground and there will be no significant excavation of the site.

1.2. Objectives

The primary objectives of the ASSMP was to provide a conceptual management plan based on limited data collected from previous investigations.

2. ACID SULFATE SOILS

Acid sulfate soils (ASS) is the common term for naturally occurring soil and sediment that contains iron sulfides which, when exposed to oxygen generate sulfuric acid. These soils are formed from iron rich alluvial sediments and sulfate (found in seawater) in the presence of sulfate reducing bacteria and plentiful organic matter. These conditions are generally found in mangroves, salt marsh vegetation or tidal areas and at the bottom of coastal rivers and lakes.

Disturbance and exposure to air of these sulfides, commonly through drainage or excavation, causes oxidation and the eventual production of sulfuric acid. This sulfuric acid can then drain into waterways through groundwater and surface flows. The impacts of acid drainage can include fish kills and cause disease, oyster damage and mortality, adverse impacts on soil structure and stability and damage to steel and concrete structures including bridge and building footings and corrosion of underground pipes.

The NSW government formed the Acid Sulfate Soils Management Advisory Committee (ASSMAC) in 1994 to coordinate a response to acid sulfate soil issues. In 1998 this group released the Acid Sulfate Soil Manual providing best practice advice for planning, assessment, management, laboratory methods, drainage, groundwater and the preparation of acid sulfate soil management plans.

3. SITE INFORMATION

The site identification details are summarised below:

Site Owner:	Cronulla-Sutherland Leagues Club Ltd
Site Address:	461 Captain Cook Drive, Woolooware
Lot & Deposited Plan:	Lot 11 in DP526492 and Lot 20 in DP529644
Local Government Authority:	Sutherland Shire Council
Current Zoning:	Private Recreation
AHD:	Approximately 2.5m to 7.5m
Geographical Location (MGA):	N: 6232100 E: 328300 (approximately)
Site Locality Plan:	Refer to Figure 1
Site Layout Plan	Refer to Figure 2

The Cronulla Sutherland Leagues Club site is legally described as Lot 11 DP 526492 and Lot 20 DP 529644 and is known as 461 Captain Cook Drive, Woolooware. Three lots owned by Sutherland Shire Council (being Lot 21 DP 529644, Lot 1 DP 711486 and Lot 1 DP 501920) are also included within the proposed scheme.

The site is located on the northern side of Captain Cook Drive approximately 1.5 kilometres from Caringbah (to the south west) and 2 kilometres from Cronulla (to the south east). The site is bounded by the Solander playing fields to the west, Woolooware Bay to the north, and a service station and gymnasium to the east. The Woolooware Golf Club and the Captain Cook Oval are located to the south of the site across Captain Cook Drive.

The overall site is irregular in shape with an area of approximately 10 hectares, of which approximately 6ha is occupied by Toyota Stadium, Leagues Club building and the eastern carpark and 4ha is occupied by the western training fields and car park.

Toyota Stadium (also known as Endeavour Field and Shark Park) and the Cronulla Sutherland Leagues Club building occupy the central portion of the site, and represent a major community and entertainment hub within the region. The western playing fields within the site are private open space used as training fields for the Cronulla Sharks and for local games by the Cronulla Caringbah Junior Rugby League Football Club, whilst the remainder of the site is occupied by car parking.

The Taren Point Employment Area is located approximately 200 metres to the northwest of the site and occupies land located generally between the waterfront, Taren Point Road and the Captain Cook Bridge. Woolooware Railway Station is located 1 kilometre to the south west of the site, and Caringbah Town Centre is approximately 3 kilometres by road to the south west.

The site is located to the south of Woolooware Bay which forms part of the north boundary of the site investigation area. The regional topography falls gently towards the Bay to the north, apart from the golf course to the south of Captain Cook Drive that was generally at a lower level than the site. Sections of the site appear to have been filled above surrounding levels including the spectator areas. Regional drainage patterns are generally toward Woolooware Bay to the north via a stormwater channel located between the east and west sections of the site. Due to previous grading of the site some sections drain locally toward Captain Cook Drive toward the south rather than Woolooware Bay. An easement for transmission lines is located across the north section of the site.

For descriptive purposes the site can be divided into three principal sections (as shown on Figure 2):

- The western section that is occupied by open, grassed playing fields and an on-grade car park (which located to the south of the playing fields);
- The central section that is occupied by the Toyota Park stadium and club house (which is located to the east of the stadium); and
- The eastern section that is occupied by an on-grade car park.

3.1. Regional Geology and Hydrogeology

The 1:100,000 geological map of Wollongong-Port Hacking (Map 9029-9129, 1:100,000 Department of Mineral Resources –1985) indicates the site to be underlain by manmade fill which typically consists of dredged estuarine sand and mud, coal washing, industrial and household waste. The fill is typically underlain by Quaternary aged deposits of organic rich, mostly "muddy" marine sand with Hawkesbury Sandstone at greater depths.

Department of Natural Resources (DNR) records were researched for the previous investigations and indicated that two registered groundwater bores lie within 1km of the site. The details are summarised below:

Ref No	Approx. distance from site(m)	Approx. direction from site	Depth(m)	Registered Purpose
GW011287	800m	East	15.30m	Recreational (irrigation)
GW011287	850	East	19.00m	Industrial

The stratigraphy of the site is expected to consist of relatively high permeability alluvial sandy soil overlying deep bedrock. Based on these conditions, groundwater may be considered to be a significant resource in the area, although use of the resource in the immediate area of the site may be reduced by the moderate salinity levels associated with tidal salt water intrusion from Woolooware Bay.

3.2. Acid Sulfate Soil Risk Map

The acid sulfate soil (ASS) risk maps indicate areas of high risk, low risk and no known occurrence of acid sulfate soils. The ASS Risk Map for Wollongong - Port Hacking (Acid Sulfate Soil Risk Map- 9129 N4 edition 2, December 1997, 1:25000, Department of Land and Soil Conservation) indicates that the site is located at the boundary of two areas as summarised below:

- The majority of the site lies within an area classified as "disturbed terrain" which is indicated to extend to depths of approximately 1m to 4m. Disturbed terrain may include filled areas, often associated with reclamation of low lying swamps for urban development, mined or dredged areas, or areas of heavy ground disturbance associated with the construction of dams and levees. Soil investigation is commonly necessary to assess acid sulfate soil conditions in these areas; and
- The area immediately to the north of the site (ie the mangrove area beyond the filled areas) is classified as being of "high probability" of ASS occurrence at or near the ground surface. This classification is typically associated with estuarine swamps, intertidal flats and supratidal flats. There is considered to be a significant environmental risk associated with this classification if ASS materials are disturbed by activities such as shallow drainage, excavation or clearing.

4. PREVIOUS REPORTS

EIS have previously prepared the following environmental assessment/investigation reports for various sections of wider Leagues Club site. A number of investigations have been undertaken over the years for a variety of different proposed developments. The reports that have included testing for acid sulfate soils are:

1. "*Report to Cronulla Sharks Rugby Leagues Club on Environmental Site Screening for Shark Park Redevelopment at Cronulla Leagues Club, Captain Cook Drive, Woolooware*", Ref: E15009FRPT/2, dated 29 November 2000;
   This investigation included a desk top site history assessment together with an additional ten boreholes drilled across the site. The limited site history indicated that:
   - The site was mangrove swamp in the 1950s and was gradually backfilled in the 1960s and 1970s;
   - By 1978 the basic current layout of the site was complete;
   - Council records indicated that Council had purchased the land in the 1950s with the intention of filling the low lying areas with non-putrescible waste;
   - The Leagues Club and Stadium area of the site were sold by tender to the Cronulla Sutherland Leagues Club in 1968 with an agreement that the council

would fill the remainder of the site and transfer the ownership to the Leagues Club;

- Development of the stadium and other club facilities was undertaken in a number of stages with approval for the main Club building obtained in 1973. Approval for spectator seating, change rooms and amenities facilities was obtained in 1979 and extensions to the club and spectator facilities were undertaken in 1981; and
- A fill mound approximately 6m above the field level was constructed in the north section of the stadium on 1981. Records indicate that approval for this development was not sought from the council. This mound extended beyond the Leagues Club land into Woolooware Bay. Council subsequently ordered that stabilisation works be undertaken.

Of the ten boreholes, four were drilled in the western playing fields, four were drilled in the eastern car park and two were drilled in the area to the north of the stadium. The boreholes in the western playing fields encountered up to 3.2m of fill, the boreholes in the eastern car park encountered 3.4 to 4.5m of fill and the boreholes drilled to the north of the stadium encountered greater than 6m of fill (these two boreholes were drilled in the spectators hill).

Three of the deeper natural soil samples (estuarine clayey silt/silty clay) were screened for potential ASS conditions using the POCAS analytical technique. The samples were all considered to be potential ASS (PASS).

2. "*Report to Cronulla Sutherland Leagues Club on Further Environmental Site Assessment for Proposed Cronulla Leagues Club Rezoning at Captain Cook Drive, Woolooware*", Ref: E17119FK-rpt, dated October 2002;
   This investigation included ten boreholes across the eastern car park for a proposed basement and two boreholes on the west side of the western playing fields for a proposed power easement. The fill depths in the eastern car park ranged from approximately 2.0m in the south west corner of the car park to approximately 4.5m along the north boundary. The depth of fill encountered in the two boreholes drilled on the west boundary of the western playing fields ranged from approximately 1m to 2m.

   Twenty two of the underlying natural samples were analysed for potential acid sulfate soil. The results indicated that the underlying natural soil were considered to be potential acid sulfate soils.

   Groundwater in the boreholes was measured up to 26 hours after completion of drilling at depths that ranged from 2.4m to 3.2m below the existing ground levels.

3. "*Report to Cronulla-Sutherland District Rugby League Football Club on Environmental Site Assessment for Proposed Upgrade Works at Toyota Park, 461 Captain Cook Drive, Woolooware*", Ref: E20345FJ-RPT, dated August 2006.
   This investigation was confined to the the south section of the western playing fields and the accessible open areas adjacent to the north, south and west of the stadium. The depth of fill in the south section of the western playing fields ranged from 1.6m to 4.3m. The depth of fill in the accessible areas adjacent to the west and south of the stadium ranged from 1.1m to 4.2m. The depth of fill in the area to the north of the stadium ranged from 1.4m to 8.6m (it should be noted that these boreholes were drilled in the hill located to the north of the stadium).

A summary of the acid sulfate soil results from the most recent (2006) investigation is provided below:

- The site assessment included the drilling of a total of seven boreholes within the southern section of the stadium. The boreholes generally encountered fill material to depths of 2.1m to 3.8m below existing ground levels. The fill material comprised of silty sand, silty clayey sand, silty gravely sand and silty sandy clay. The fill material was underlain by natural estuarine soils, generally consisting of organic clay overlying silty sand, clayey sand and sandy clay soils. Shell fragments were encountered in some areas. Groundwater seepage was encountered during drilling at depths of approximately 0.95m to 2.4m below existing ground levels.
- The assessment included sampling and analysis of soils obtained from three locations within the proposed area of disturbance. A total of one fill sample and twelve natural estuarine soil samples were analysed using laboratory sPOCAS methods to assess soil characteristics.
- The silty sandy clay, silty sand, organic clay and silty clay samples analysed for this area were not considered to be actual acid sulfate soils (ie acidic in their current undisturbed state). The pH of the soils prior to oxidation varied from 5.5 to 9.4.
- Oxidation of the samples resulted in pH values of 2.1 to 2.6 in five of the samples. The remaining samples had a pH in the range of 6.5 to 8.4. The total potential acidity closely matched the total sulfidic acidity results indicating that the acidic samples were associated with potential acid sulfate soils. Potential acidity levels in the five acidic samples varied from 260mol H^+/tonne of soil to 1400mol H^+/tonne soil.
- The Spos% values for all samples varied from 0.088% to 2.6%, all above the adopted site assessment criteria of 0.03%.
- Based on the laboratory analysis results a liming rate of up to 120kg lime/tonne of soil was considered necessary to neutralise the potential acid release following disturbance of the soil at the site.

- As the proposed development works would be undertaken in an area of known acid sulfate soil conditions and were likely to include disturbance of affected soils, preparation and implementation of an acid sulfate soil management plan was considered necessary as part of construction works.

5. ACID SULFATE SOIL MANAGEMENT PLAN

5.1. Introduction

The most effective management strategy for dealing with PASS is to avoid disturbing the material. If this is not a viable option then the ASSMP should be implemented.

The objective of the ASSMP is to reduce the potential on-site and off-site environmental impacts associated with disturbance of PASS/ASS identified at the site. The ASSMP has been prepared generally in accordance with the ASS Manual 1998. Reference has also been made to the Queensland Acid Sulfate Soil Technical Manaual v 3.8[1].

The following issues are addressed in the ASSMP:

- Strategies for the management of ASS/PASS during development;
- Implementation of a soil and groundwater monitoring program; and
- Contingency procedures to be implemented in the event of the failure of management strategies.

EIS understand that the proposed development will not include any significant deep excavations. The principal sources of Acid Sulfate soil that will require management will be piling spoil and excavations for service trenches.

5.2. Management of Excavated Material

Potential acid generation is typically managed by the addition of lime to neutralise acid that may be generated during and after the excavation works. The treated material should then be assigned a waste classification and disposed of to an appropriate landfill. Prior to disposal, a waste classification assessment should be undertaken in accordance with *NSW DECC Waste Classification Guidelines* (2009[2]).

A slightly alkaline, low solubility product such as agricultural lime should be used. This form of lime is chemically stable and any excess lime takes a significant period of time (years) to influence soil pH beyond the depth of mixing. The lime particles eventually become coated

[1] *Queensland Acid Sulfate Soil Technical Manual. Soil Management Guidelines* version 3.8

[2] *Waste Classification Guidelines, Part 1: Classifying Waste,* NSW DECC, 2009 (Waste Classification Guidelines 2009)

with an insoluble layer of ferrihydrite ($Fe[OH]_3$) that inhibits further reaction. Long term alteration of groundwater conditions is not expected to occur as a result of the use of lime during the proposed development works.

The following procedures should be implemented:

- A treatment area for the mixing of excavated soil with agricultural lime should be established. The 'treatment area' must include a relatively impermeable surface for treatment or alternatively be covered with a pad of lime to act as a "guard layer". The pad of lime should be at least 100mm thick and this thickness should be maintained for the duration of treatment works. The purpose of this "guard layer" is to minimise the risk of acidic water leaching from the base of the treatment area into the groundwater;

- The treatment area should be designed to retain any water run-off from the treated materials. This could comprise of: a compacted clay bund (constructed of non-ASS material); sandbags filled with a mixture lime and sand; or skip bins if only relatively small quantities of soil require treatment;

- All water should be diverted to a detention tank or constructed pond for assessment and treatment prior to disposal. Lime can be incorporated into artificial drainage lines and treatment ponds to aid in the neutralisation of any acidic run-off. The application of neutralising agents into natural water bodies or water courses should be avoided unless carefully planned and approved;

- Dependent upon the rate of spoil generation, several bunded treatment areas may be necessary for stockpiling and treatment. An earthworks strategy should be prepared to ensure that sufficient space is available on–site to accommodate treatment of the ASS;

- PASS/ASS soils disturbed during development works should be immediately transferred to the designated treatment area and spread out in layers 150mm to 300mm thick. If possible the layers should be allowed to dry in order to aid the mixing process. The layers should then be interspersed with the appropriate amount of lime to aid in the effective mixing of lime and soil. Lime should be applied to the excavated material within the treatment area as soon as possible;

- Additional field testing should be undertaken to confirm the quantity of lime that is appropriate for neutralisation of the soils;

- A backhoe or suitable equipment should be used to thoroughly mix the lime through the soil. Alternatively use of a pug mill may be considered dependent upon the volume of soil to be treated in a timely fashion;

- If circumstances prevent the spreading and treatment of the materia,l the surface area of the stockpile should be minimised by forming a relatively high coned shape and avoiding and "spreading-out" of the stockpile. This will limit the surface area exposed to oxidation. Water infiltration should be minimised by covering the stockpile during wet weather. This will limit the formation and transport of acid leachate due to rainfall. The stockpile should be bunded to prevent erosion of the PASS/ASS and any movement of potentially acid leachate. Upstream surface runoff water should also be diverted around the stockpile;

- Monitoring should be undertaken by qualified personnel to ensure the mixing is undertaken to a suitable extent as the success of the neutralisation method relies on the effectiveness of the mixing process;

- Field pH measurements should be undertaken to confirm that PASS/ASS have been neutralised by lime addition. If required, additional lime should be added to the soil and additional mixing undertaken. Following treatment with lime the pH of the soil should be in the 5.5 to 8.5 range;

- Following treatment the material should be tested and assigned a waste classification in accordance with the *Waste Classification Guidelines 2009*; and

- All neutralised material should be disposed of off-site to a NSW EPA landfill licensed to accept treated ASS.

5.3. Groundwater Seepage and Dewatering

As the development does not require any significant excavation dewatering of excavations is considered to be unlikely. In the event that de-watering of excavations is required during construction, management of the pumped out water and conditions within the surrounding ASS will be required.

Water pumped from the excavation should be placed in a portable tank, or open 'skip bin', where samples can be obtained for field testing. The water should be in the pH range of 6.5 to 8.5 (*Schedule 5 of Protection of the Environment Operations (General) Regulation* 2009[3]). If the pH is outside of this range, treatment will be necessary prior to disposal of the water, either as stormwater, irrigation or to the sewer. Reference should be made to the local council and other relevant authority's approval requirements for further information in relation to disposal of water to either the sewer or stormwater systems.

[3] Schedule 5 Prescribed matter for the definition of water pollution, *Protection of Environment Operations (General) Regulation,* NSW Government, 2009 (POEO Regulation 2009)

In the event that extended pumping of water is necessary during the construction period, the quality of the groundwater should be monitored on a regular basis over the entire construction period. The pH will be measured and recorded. Immediate advice is to be sought from an experienced consultant if the pH at any location is not within 10% of the initial pH at the commencement of pumping. If required, corrective action should be taken as soon as possible. Laboratory analysis will be required on water samples as part of the corrective action to assess the quantity of neutralising agents required if treatment is necessary.

5.4. Contingency Plan

In the event the results of soil neutralisation or groundwater monitoring tests indicate a significant change in acidic conditions, the contingency plan should be implemented.

If soil monitoring indicates the presence of significantly more acidic material than expected or water monitoring indicates that the pH of the pumped water has become significantly more acidic, all excavation works should be placed on hold until further action is taken to limit the oxidation of PASS/ASS soils in the area of development works. Contingency works will be undertaken as follows:

- The depth to groundwater (ie the extent of de-watering) in the area of excavation will be measured;
- The pH of soils exposed to oxygen within the excavation will be measured to establish the source of the acidic conditions;
- Material found to be acidic will be excavated and neutralised in accordance with the methods presented in **Section 5.2; and**
- Where suitable, in-place treatment involving lime addition and mixing may by adopted.

6. LIMITATIONS

The conclusions presented in this letter are based on site conditions which existed at the time of the previous site assessment s/investigations and the objectives of the review as referenced previously in this letter. They are based on investigation of conditions at specific locations, chosen to be as representative as possible under the given circumstances, and visual observations of the site and vicinity, together with the interpretation of available information and documents reviewed as described in this report.

The preparation of this letter has been undertaken in accordance with accepted practice for environmental consultants, with reference to applicable environmental regulatory authority and industry standards, guidelines and the assessment criteria outlined previously in this report.

Where information has been provided by third parties, EIS has not undertaken any verification process, except where specifically stated.

Subsurface soil and rock conditions encountered between investigation locations may be found to be different from those expected. Groundwater conditions may also vary, especially after climatic changes.

EIS accept no responsibility for potentially asbestos containing materials that may exist at the site. These materials may be associated with demolition of pre-1970 constructed buildings or fill material at the site.

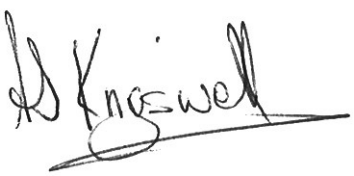
EIS have not and will not make any determination regarding finances associated with the site.

During development works, soil, fill and any unsuspected materials that are encountered should be monitored by qualified environmental and geotechnical engineers to confirm assumptions made on the basis of the limited investigation data, and possible changes in site level and other conditions since the investigation.

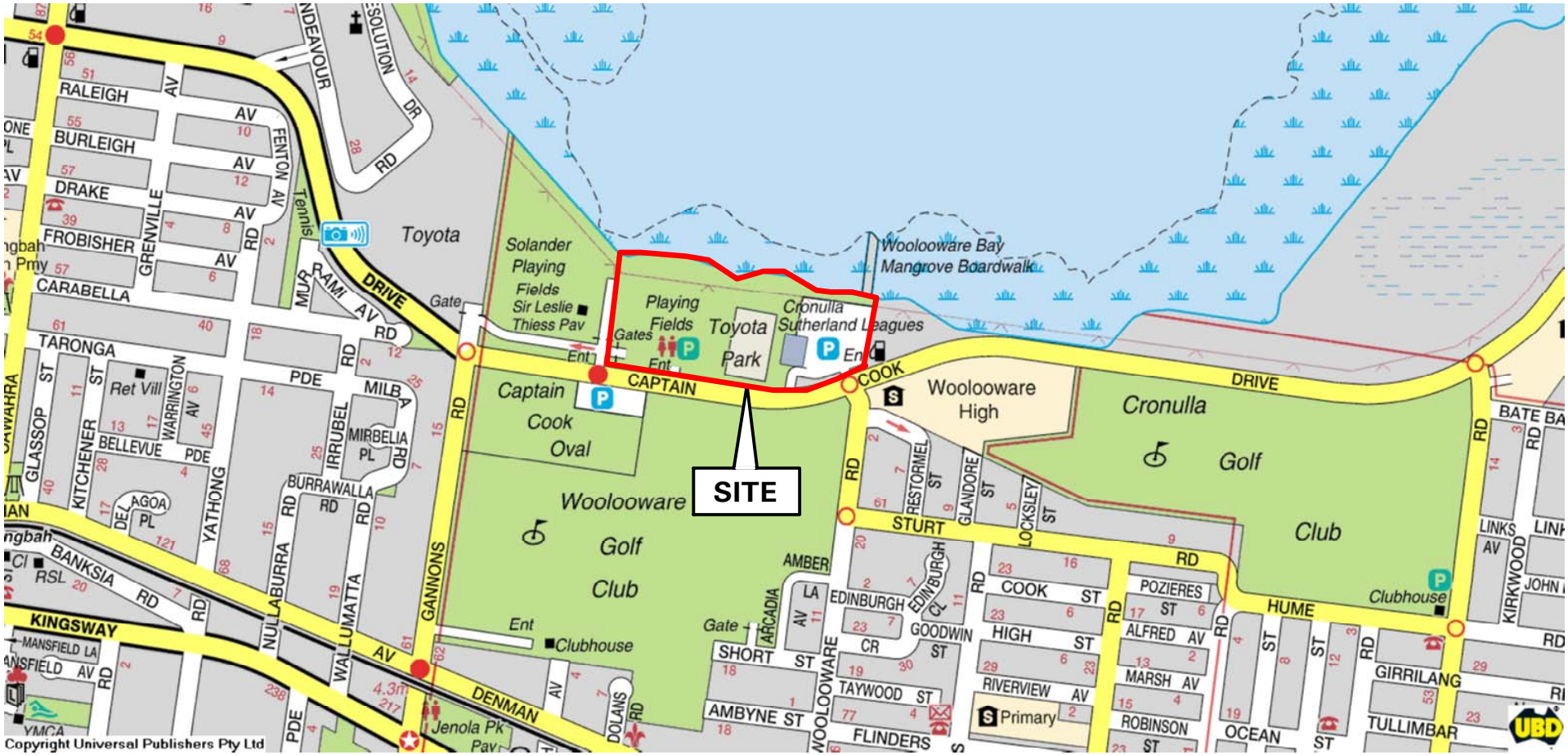
This letter has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. Copyright in this report is the property of EIS. EIS has used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report.

Should you require any further information regarding the above, please do not hesitate to contact us.

Yours faithfully
ENVIRONMENTAL INVESTIGATION SERVICES



Adrian Kingswell
Senior Associate



NOTES:
Figure 1 has been recreated from UBD on disc (version 5.0). Figure is not to scale.

UBD Map ref: 334 K5

Reference should be made to the report text for a full understanding of this plan.

ENVIRONMENTAL INVESTIGATION SERVICES	Project Number: **E20345K**	Title: **SITE LOCATION PLAN**
	Figure: **1**	Address: **CRONULLA LEAGUES CLUB, CAPTAIN COOK DRIVE. WOOLOOWARE, NSW**