Review of Environmental Factors

Drainage Works Tuggerah Pde Long Jetty

Prepared for:

Wyong Shire Council

by:

Beyond Environmental Consulting

March 2015

Document Control

Document type	Review of Environmental Factors	
Project Name	Drainage Works Tuggerah Parade, Long Jetty	
File Name	REFTuggerahDrainageDraft1	
Revision	Date	Prepared by
A	4 March 2015	Carolyn Donnelly

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1 Introduction

1.1 The proposal

Wyong Shire Council (WSC) proposes to upgrade and redesign stormwater outlets along the Tuggerah Lakes foreshore at Long Jetty. Currently, there are about 34 stormwater outlets that take stormwater from Long Jetty centre and urban areas and discharge this water into Tuggerah Lakes through narrow channels that bisect the foreshore parkland. The effectiveness and amenity of these outlets is compromised by the fact that the stormwater pipes leading to the channels are situated lower than the level of the lake. Water from the lake enters the channels and stormwater becomes trapped leading to stagnation and associated amenity and water quality issues.

WSC engaged Storm Consulting to redesign the current outlets and include water sensitive urban design treatments to improve the quality of stormwater entering Tuggerah Lakes. The overall design will also aim to increase the amenity and useful enjoyment of the foreshore for the community.

This proposal focuses on six stormwater outlets adjacent to Tuggerah Parade on the foreshore reserve, between Lake Street and Gladstan Street. The stormwater design for this area and information collected from this environmental assessment would then inform further upgrading of the remainder of the foreshore.

1.2 Location

Tuggerah Lakes is located within the Wyong local government area on the Central Coast of New South Wales (NSW). The proposed location for the works is a section of foreshore reserve on the south east side of the Tuggerah Lakes at Long Jetty. The proposal site includes a section of the foreshore reserve between Lake Street and Gladstan Street, measuring approximately 1.6 ha in area.

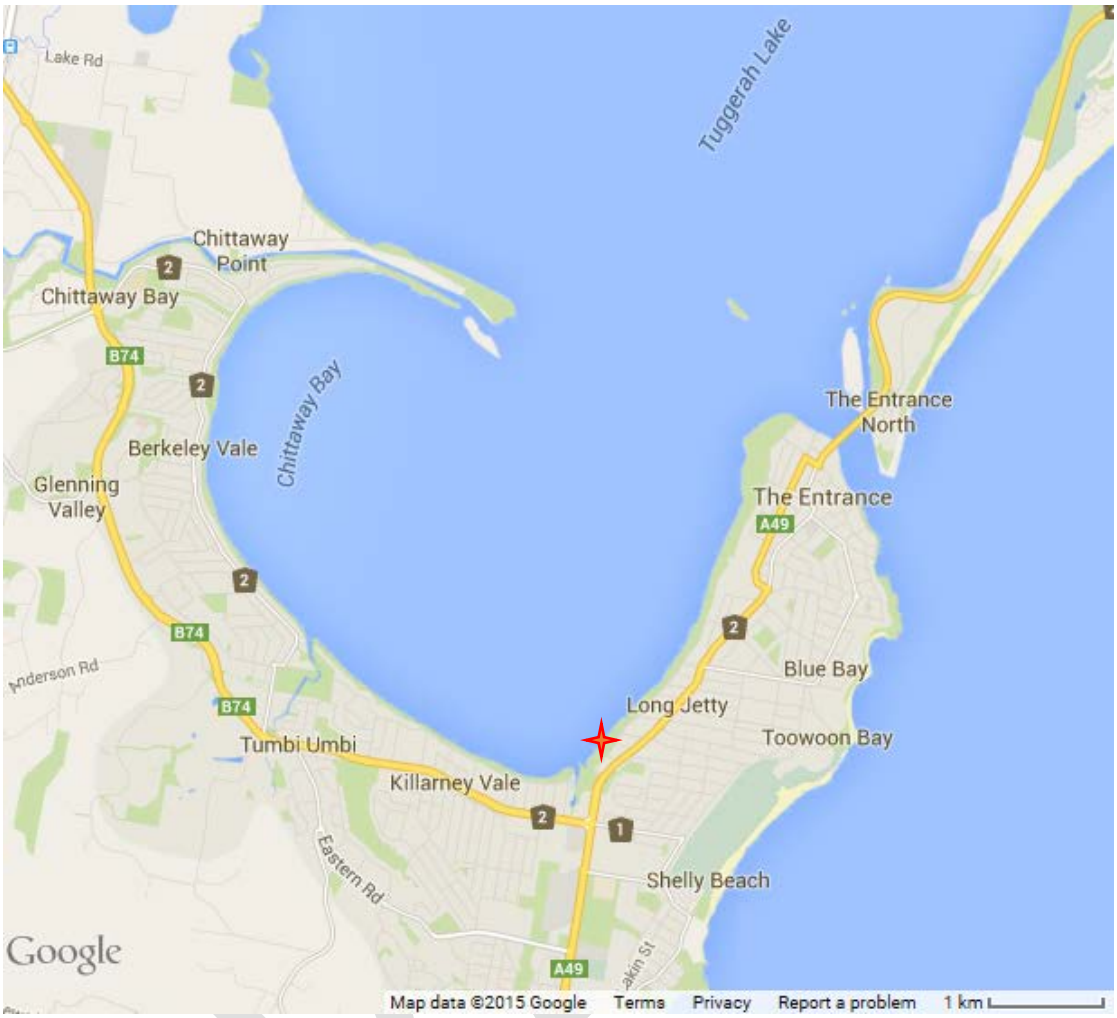

Figure 1: Site location

1.3 Purpose of the report

This Review of Environmental Factors (REF) has been developed by Beyond Environmental Consulting on behalf of WSC. WSC is the proponent and determining authority under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the proposal described in this REF.

The purpose of the REF is to describe the proposal and the potential and likely impacts on the environment and to outline mitigation measures that would be implemented to avoid or reduce those impacts.

This REF addresses WSC's duty to consider environmental impacts as outlined under Section 111 of the EP&A Act and considers the factors of Clause 228 of the Environmental Planning and Assessment Regulation 2000. In order to meet the requirements of S111, the proposal has also been assessed in reference to the requirements of applicable Commonwealth, State and Local Government statutory and planning instruments.

1.4 Delineations

Three terms have been used throughout this document to describe the area covered by the environmental assessment. The 'survey area' describes an area where field surveys and assessments have been undertaken. (See attached Ecological Report for more detail of surveys and survey areas). The 'study locality' describes an area that covers a 5km radius from the study area which has been covered by database searches. 'Proposal site' is the term used to describe the area directly impacted by the proposed works.

Figure 2: Proposal site

2 Proposal description

2.1 Proposal design and activities

The proposed upgrade would involve redirecting stormwater from existing pipes adjacent to Tuggerah Parade to treatment swales. Sediment forebay basins with offtake chambers would divert flows to treatment swales, pollution capture and scour protection.

Outlined below is specific detail about the elements that make up the stormwater treatment. Reference should also be made to detailed design drawings included at Appendix I.

At each existing pipe outlet, adjacent to Tuggerah Parade, a sediment forebay, with an offtake chamber would be installed to divert stormwater to a treatment swale. The forebay basin would include a maintenance access ramp. The stormwater would flow over a weir, through buried pipes connected to the diversion chamber. Where the pipes connect to the treatment swale, there would be an inlet structure comprising a reinforced concrete lined stilling bay with a weir that overflows stormwater to rock scour protection. This would reduce the velocity of the stormwater before it enters the treatment swale.

Three treatment swales would be installed to take water from existing pipe outlets adjacent to Tuggerah Parade. The swales would be 0.4m deep and approximately 7 - 10m wide. The swales would mostly flow adjacent to the lake at a distance of 10m from the lake edge. The 10m buffer would allow for the rehabilitation of the Coastal Saltmarsh community. The treatment swale would be edged with sandstone logs and vegetated with indigenous sedges. Where each swale meets the lake edge, there would be a spillway and rock scour protection.

Additional pipes would be installed to take stormwater from Tuggerah Parade to the treatment swale at four locations. This water would be directed to a galvanised surcharge pit then spilled over scour protection into treatment swales before being discharged to the lake via existing open channels.

Existing channels would be filled where necessary to accommodate the new stormwater treatments. The lower half of existing channels would remain open to be used as overflow channels and to provide refuge for juvenile fish.

The proposal would require clearing of:

- Approximately 200m^2 of intertidal vegetation that is made up of a combination of Coastal Saltmarsh community and exotic grasses and weeds.
- Approximately twenty trees with a dbh greater than 100mm.
- Thinning of *Casuarina glauca* with a dbh less than 150mm, approximately 50% of existing *Casuarina glauca* within the proposal site.

2.2 Construction

2.2.1 Work Methodology and work sequence

2.2.2 Timeframe and Work hours

Construction would take place over a period of approximately 12 weeks, commencing in May 2015 and finishing in July 2015.

All construction would take place during standard work hours:

Monday to Friday:	7:00am – 6:00pm
Saturday:	8:00am-1:00pm
Sunday and public holidays:	no work

2.2.3 Machinery and equipment

The following machinery would be required to construct the proposal:

- 4 tonne excavator
- Tip truck
- Truck mounted forklift
- Pumps and irrigation equipment for dewatering

2.2.4 Cut and Fill

Cut: 750m^3

Fill: 60m^3

Fill material would be reused material excavated from the site that has been tested and treated with lime to address any potential for acidity.

Excess cut material would be disposed of at Buttonderry Waste Management Facility, which is licensed to take such material.

2.3 Ancillary facilities

The following ancillary facilities would be located on site:

Facility	**Activity**
Site caravan	Office activities
Laydown area	Storage of materials used in construction such as sandstone rocks and logs, stormwater pipes and geotextile
Stockpile area	Stockpiling and treatment of potential acid sulfate soil material that has been excavated from the site.
Concrete washout	Washing concrete hand tools, trowels, etc.

Ancillary activities would be undertaken in the areas outlined on the image below and managed in accordance with safeguards outlined in this REF.

Figure 3: Temporary stockpiling areas

3 Justification and options

3.1 Need for the proposal

The proposal aims to address the following issues:

- Stormwater from Long Jetty centre and urban areas discharges to Tuggerah Lakes through narrow channels that bisect the foreshore parkland. Currently, this water does not undergo any treatment. Therefore, pollutants such as sediment, nutrients, hydrocarbons and heavy metals from the town centre, residential premises, roads and car parks are washed directly into the lake during rain events. This can affect the water quality in Tuggerah Lakes and can have a detrimental impact on aquatic life.

- The effectiveness and amenity of the stormwater outlets is compromised by the fact that the stormwater pipes leading to the channels are situated lower than the level of the lake. Stormwater of poor quality becomes trapped leading to stagnation and eutrophication.

- The current channelled flow regime of the stormwater outlets creates turbidity in the lake during discharge. This can affect the growth of seagrasses close to shore. The seagrasses are also susceptible to algal growth which is increased through the release of untreated, nutrient rich stormwater.

- The Coastal Saltmarsh community is listed under both the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This community is fragile and easily impacted through weed incursion, foot traffic and channelled release of stormwater. This vegetation community is currently under considerable pressure from these issues.

- The main natural vegetation community on the foreshore is Swamp Oak Floodplain Forest, a community listed under the NSW *Threatened Species Conservation Act 1995*. This community is dominated by *Casuarina glauca* (Swamp Oak). *C glauca* is an aggressive coloniser and has encroached into the intertidal zone community in some areas, where it is outcompeting the ecologically important and fragile Coastal Saltmarsh community.

- Where reclamation of the foreshore has occurred and mowing is not regularly undertaken, *C. glauca* regrowth forms thick groves. These groves provide little habitat value but create a visual barrier, reducing visual connectivity and resulting in a series of discreet and disconnected areas between stormwater channels.

3.2 Proposal objectives

The proposal aims to facilitate access and enjoyment of the foreshore by the public while maintaining and improving the natural hydrological and ecological functions.

Objectives:

	Flora and Fauna
1	Protect and restore indigenous vegetation where possible, in particular endangered ecological communities

2	Identify existing fauna habitats (both terrestrial and aquatic) and restore and enhance these where possible
3	Water sensitive urban design (WSUD) to protect and enhance existing indigenous vegetation communities and fauna habitats
4	Identify opportunities for increasing the value of the area as a wildlife corridor for resident wildlife and incorporate plantings to meet this aim in the design
	Water Quality
5	WSUD to, as much as possible, remove pollutants from stormwater
6	WSUD to reduce 'channelled flow' effect and provide for increased dissipation of flow to mimic natural overland flow paths
	Soils
7	Minimise disturbance to soils
8	Minimise depth of excavation to avoid ASS and aluminium toxicity
9	WSUD to reduce erosion and turbidity where stormwater discharges to the lake
	Community access and recreation
10	Improve existing community access and recreation opportunities while minimising impact on the natural environment
11	Promote community understanding of the local natural environment
	Visual amenity
12	Retain existing mature indigenous trees adjacent to Tuggerah Parade and scattered through the park
13	Tree removal and plantings to consider overall visual impact on the area
14	WSUD to be visually appealing and fit in with the natural foreshore environment
	Maintenance
15	WSUD and landscaping design to minimise Council maintenance requirements

3.3 Alternatives considered

3.3.1 Do Nothing Option

3.3.1.1 Description

This option would result in no change to the Tuggerah Lakes foreshore between Lake Street and Gladstan Avenue and would not address the issues outlined under 3.1.

3.3.1.2 Advantages

The advantage of not undertaking any work on the foreshore is that there would be no cost. There would also be no clearing of existing of vegetation.

3.3.1.3 Disadvantages

The disadvantages of not undertaking any work on the foreshore would be:

- Continuing discharge of untreated stormwater into Tuggerah Lakes through the stormwater channels between Lake Street and Gladstan Avenue.
- Continuing impact on Coastal Saltmarsh community through channelled flow of stormwater across the intertidal area and competition with *C. glauca*.
- Continuing impact on inshore seagrass communities from turbidity from channelled flow and algal growth
- Reduced amenity of the foreshore due to stagnant water within channels
- Reduced opportunity for a visually appealing foreshore that provides connectivity for the community.
- Ongoing high maintenance for WSC through regular clearing of channels.

3.3.2 Alternative 1 (preferred option)

3.3.2.1 Description

Installation of stormwater detention, treatment swales and scour protection as described under 2.1 and in accordance with design included at Appendix I.

3.3.2.2 Advantages

- Removal of sediment and other pollutants from stormwater prior to discharge into the Tuggerah Lakes at the proposal site, resulting in water quality improvements.
- Improvement in the stormwater flow regime, which would reduce turbidity at discharge points, improving water quality and reducing impact on seagrasses.
- Reduced incidence of water ponding and becoming stagnant and therefore improved amenity.
- Protection of a 10m section of the lake foreshore, the intertidal area, for rehabilitation and restoration of Coastal Saltmarsh.
- Increased community accessibility across the foreshore reserve.

3.3.2.3 Disadvantages

- Disturbance to existing channels would result in short term displacement of juvenile fish that are using the channels as a refuge.
- Removal of some Coastal Saltmarsh would be required to install swale spillways and scour protection.
- Removal of some mature trees would be required to install stormwater treatments.

3.3.3 Alternative 2

3.3.3.1 Description

Installation of upstream inground proprietary gross pollutant trap (GPT).

3.3.3.2 Advantages

The GPT would be unobtrusive and less expensive than the other alternatives.

3.3.3.3 Disadvantages

- The GPT would not reduce the nutrients in the stormwater and therefore would not meet Objective 5 of the proposal as well as other alternatives.
- The GPT would treat a much smaller amount of the catchment area than the proposal outlined in Alternative 1.

3.3.4 Alternative 3

3.3.4.1 Description

Installation of a constructed wetland within the reserve instead of vegetated swales.

3.3.4.2 Advantages

There is no advantage of this option over Alternative 1 as land area is a constraint to constructing a wetland large enough to treat stormwater as effectively as the vegetated swales described in Alternative 1.

3.3.4.3 Disadvantages

- There is not enough available land area to construct wetland of an adequate size to treat the catchment stormwater.
- A smaller wetland would require a deeper excavation. This raises hydraulic issues and would be more expensive to construct.

3.4 Preferred option

The preferred option is Alternative 1.

4 Statutory and planning Framework

4.1 NSW Statutory and Planning Instruments

4.1.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *Environmental Planning and Assessment Regulation 2000* (EP&A Reg) are the main planning instruments under which planning and development is carried out in New South Wales.

Part 5 of the EP&A Act was developed to ensure public authorities fully consider environmental issues before they undertake or approve activities that do not require development consent.

Environmental assessment for the proposal outlined in this REF has been undertaken under Part 5 of this Act. Section111 of Part 5 requires that a determining authority, when considering an activity, examine and take into account to the fullest extent possible all matters affecting or likely to effect the environment, notwithstanding provisions of this or any other Act. Some considerations listed under Section 111 of Part 5 of this Act include (among other things) threatened species, threatened populations and their habitats and any other protected fauna or protected native plants (within the meaning of the *National Parks and Wildlife Act 1974*).

4.1.2 State Environmental Planning Policies

4.1.2.1 State Environmental Planning Policy (Infrastructure) 2007

The *State Environmental Planning Policy (Infrastructure) 2007* (ISEPP) simplifies the process for local and state government for the provision of infrastructure.

Generally, where there is an inconsistency between ISEPP and any other environmental planning instrument, ISEPP applies to the extent of the inconsistency. The exception is where there is an inconsistency between ISEPP and the following State Environmental Policies:

- SEPP No. 14 Coastal Wetlands
- SEPP No. 26 Littoral Rainforests
- SEPP (Major Projects) 2005

ISEPP allows Councils to undertake a range of infrastructure works without consent.

4.1.3 Other State Environmental Planning Policies

A number of State Environmental Planning Policies (SEPPs) have been developed to address issues that relate to the state of NSW. SEPPs are legal instruments and, where they are relevant to a proposal, must be taken into account when undertaking environmental assessment. The following SEPPs should be considered in relation to this proposal:

4.1.3.1 State Environmental Planning Policy 71 – Coastal Protection

The aim of this SEPP is to ensure that development within the NSW coastal zone is appropriate and suitably located and that there is a clear development assessment framework that supports a consistent and strategic approach to coastal planning and management.

SEPP 71 applies to all areas declared as the NSW Coastal Zone under the *Coastal Protection Act 1979*, which includes the entire NSW coastline and shorelines around bays, estuaries, lakes and coastal rivers to the limit of tidal influence.

4.1.4 Coastal Protection Act 1979

The *Coastal Protection Act 1979* (CP Act) aims to provide for the protection of the coastal environment for the benefit of present and future generations through ensuring public access and balanced use of the coastal region and its resources while protecting, enhancing and restoration the environment and ecological systems that support it. This Act allows for the development of coastal zone management plans and coastal zone maps.

4.1.5 Threatened Species Conservation Act 1995

The Threatened Species Conservation Act 1995 (TSC Act) provides for the conservation of threatened species, populations and ecological communities of flora and fauna in NSW and facilitates the appropriate assessment, management and regulation of actions that may impact on threatened species, populations and ecological communities. As part of WSC's (as determining authority) *duty to consider environmental impacts* as outlined under Section 111 of the EP&A Act, the effect on threatened species, populations and ecological communities and their habitats must be assessed as well as whether the proposal would have a significant impact on those aspects. One threat listed species was recorded at the site, the Grey Headed Flying Fox (*Pteropus poliocephalus*). There is potential for further threat listed species to use the site. This is discussed in the attached Ecological Report.

4.1.6 Local Government Act 1993

Division 2 of the Local Government Act 1993 (LG Act) refers to the use and management of community land. Section 35 of the LG Act states that community land must be managed in accordance with a plan of management (PoM) that applies to the land, any law permitting the use of the land for a specified purpose and Division 2 of the LG Act.

Section 36 outlines the requirements for draft PoMs for community land. Section 36 (3) provides a list of requirements that the PoM must identify, which includes objectives and performance targets in respect to the land, how the council will meet the performance targets and how this will be assessed. WSC's *Plan of Management No. 16 – Foreshore Land at The Entrance North to Shelly Beach* covers the Tuggerah Lakes foreshore where the works would take place.

4.1.7 National Parks and Wildlife Act 1974

The National Parks and Wildlife Act 1974 (NPW Act) governs the care, control and management of national parks and other conservation areas. This legislation also covers the protection of native flora and fauna, historic sites, Aboriginal places and objects in NSW. This Act also provides definitions for 'protected fauna' and 'protected native plant' as referred to in the EP&A Act, which has relevance to management requirements on the proposal site.

Protected fauna and protected native plants are clarified in Schedules 11 and 13 of this Act. Essentially, all native fauna, except the dingo, are included as 'Protected fauna'. Schedule 13 lists plants and plant groups that are defined as 'protected native plants' for the purposes of this Act.

4.1.8 Fisheries Management Act 1991

The Fisheries Management Act 1991 (FM Act) applies to all waters in the state of NSW and aims to conserve, develop and share the fishery resources of the state for the benefit of present and future generations. In particular, this Act aims to conserve fish stocks and key fish habitats, threatened species, populations and ecological communities of fish and marine vegetation and to promote ESD and biological diversity.

This Act identifies threatened aquatic species, populations and ecological communities and requires the same test of significance process to be undertaken as is required under the TSC Act. A species impact statement is also required where there could be a significant impact on a threatened species listed under this Act.

To assist in the protection of key fish habitats, this Act also allows the Minister to require Habitat Protection Plans for any fish habitat. Public authorities must have regard to any habitat protection plan that relates to the exercise of their functions and must notify Fisheries regarding any functions that it proposes to undertake that are inconsistent with a Habitat Protection Plan. Two Habitat Protection Plans have relevance for this proposal, *Fish Habitat Protection Plan No.1* and *Fish Habitat Protection Plan No.2: Seagrasses*.

Under the FM Act, an activity undertaken by a local government authority that could harm certain marine vegetation or result in dredging or reclamation requires a permit under Sections 200 and S205 respectively. It is likely that this proposal would trigger the requirement for permits for all three activities: dredging, reclamation and harming marine vegetation.

4.1.9 Water Management Act 2000

This Act sets out a number of principles for managing water. These relate directly to the protection and restoration of floodplains and dependent ecosystems (including groundwater ecosystems), the protection of flora and fauna and their habitats that benefit from the water resource, protection of water quality, management of cumulative impacts on water and their dependent ecosystems, adaptive management that is responsive to monitoring of ecological water requirements and social and economic benefits to the community.

A specific principle relating to drainage management states that floodplain management must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated.

4.1.10 Noxious Weeds Act 1993

The *Noxious Weeds Act 1993* (NW Act) provides for the classification, control and regulation of noxious weeds. This Act also outlines the roles and obligations of public and local authorities and private landholders in the management of noxious weeds on land under their control. As a local government authority, WSC has an obligation under Section 14 of this Act to control noxious weeds that are subject to a control order on land under their control or ownership within the Wyong LGA.

4.1.11 Protection of the Environmental Operations Act 1997

The *Protection of the Environmental Operations Act 1997* (POEO Act) is a key piece of state legislation for the protection of the environment. This Act governs environmental protection licensing, enables the creation of protection of the environmental policies and allows for the regulation of activities that have the potential to pollute the environment.

This Act applies where there are requirements and offences relating to pollution of the environment through dust, emissions, noise, waste management, sediment and other contaminants entering the water and contamination of the land.

4.2 Local Statutory Instruments

4.2.1 Local Environmental Plan

Wyong Local Environmental Plan 2013 (LEP) provides the framework for land use in the Wyong local government area (Wyong LGA). The plan outlines the land use zones and provides the requirements for development in each zone. The land where the development would take place (proposal site) is zoned Public Recreation (RE1). The objects of this zone, as outlined in the LEP, are to:

- To enable land to be used for public open space or recreational purposes.
- To provide a range of recreational settings and activities and compatible land uses.
- To protect and enhance the natural environment for recreational purposes.
- To provide linked open space for ecosystem continuity, public access, local community recreation and waterway protection.
- To provide space for integrated stormwater treatment devices for flow and water quality management.
- To enable ancillary development that complements land zoned for recreational purposes.

4.2.2 Development Control Plans

WSC has a number of DCPs. The purpose of the DCP is to provide further detail and guidance on implementing the LEP. Where there is an inconsistency between the DCPs and the LEP, the LEP prevails. The two DCPs relevant to this study are:

- Development Control Plan No 14 Tree Management
- Wyong Shire Wetland Development Control Plan No 30

The purpose of Development Control Plan No 14 is to protect and enhance the environmental amenity, special landscape characteristics, unique vegetation qualities and ecological values of the shire. This DCP also provides a list of species of local conservation and cultural significance, which should be taken into account in species selection and selective clearing on the foreshore.

Wyong Shire Wetland Development Control Plan No 30 outlines Councils requirements for management of developments near wetlands. It aims:

- To protect important wetland habitat and discourage development proposals that have the potential to fragment, pollute, disturb or diminish the environmental values of such areas.

- To maintain the functions of low lying lands for the purpose of improving downstream water quality for the benefit of the Tuggerah Lakes and Lake Macquarie systems.
- To encourage land use practices and environmental design measures that enhance the sustainability of wetlands functions and values.
- To provide clear information on Council's requirements for the submission of relevant environmental information for development proposals which are affected by Wyong's Wetland Management System.

4.2.3 Draft Plan of Management No.16 Foreshore Land at The Entrance North to Shelly Beach

The LG Act requires councils to prepare a *Draft Plan of Management for Community Land* (PoM) for all land classified as community land. Community land is land owned by the council, which is kept for use by the general public.

The objectives outlined in the PoM for proposal area are:

- To provide high quality open space and facilities requiring a minimum of maintenance.
- To provide public access to community land.
- To provide a healthy environment on the land.
- To provide a broad spectrum of safe, high quality recreational and commercial opportunities.
- Maintain flexibility of future decision making and to allow changes in community preferences.
- To allow for a range of uses (including temporary uses) for the land, provided Council is satisfied that the use does not significantly affect the land.

Further aspects outlined in this plan that are relevant to this study are:

- Natural hydrological processes are to be maintained where possible, including natural vegetation and the flow regimes to maintain creek line stability and health of terrestrial and aquatic plant communities.
- Council is to minimise flow of nutrients to watercourses.
- Acid sulfate soils should preferably be left undisturbed
- Proper management of landscaping measures, trees and vegetation is important to provide a high degree of amenity on the land
- Weed control shall be by both preventative measures and active control measures.
- Landscape design will be in accordance with any design guidelines adopted by the Council
- Gardens may be constructed and maintained on the land.

The PoM provides an overarching guideline for the appropriate use and management of land. However, it does not override the requirements of any other statutory or planning instruments.

4.2.4 Other plans and guidelines applicable to the management of land

Additional WSC plans, policies and strategies pertain to the environmental management of The Tuggerah Lakes foreshore include:

- Estuary Management Study & Tuggerah Lakes Estuary Management Plan

- Long Jetty Village Centre Improvement Master plan

4.3 Commonwealth Legislation

4.3.1 Environmental Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Commonwealth's key piece of environmental legislation. It provides a statutory framework for the protection and management of nationally and internationally important biodiversity and heritage, defined as matters of national environmental significance (MNES).

The EPBC Act requires that potential impacts to Commonwealth land or MNES be considered. Where there is potential for a significant impact on these matters, a referral to the Commonwealth Government is required.

One threat listed species was recorded at the site, the Grey Headed Flying Foxes (*Pteropus poliocephalus*). This species is also listed under the NSW TSC Act. One migratory bird was observed, Caspian Tern (*Hydroprogne caspia*). Threatened species and migratory birds are matters of national environmental significance under the EPBC Act and, therefore, a test of significance has been undertaken for both species to meet the requirements of this legislation.

4.4 Permissibility

This development proposal is assessed under Part 5 of the EP&A Act. The proposal does not require development consent as it comes under the description of development permitted without consent as described under S65(3) of ISEPP.

5 Consultation

5.1 Community consultation

Stakeholder	When	Method	Response	Changes to proposal
Residents	Dec 12 – Jan 13	Survey regarding Long Jetty Improvement Master Plan	Residents indicated that the plan provided a key opportunity for cleaning the lake and improving the foreshore at Long Jetty	None required
Waterwatch group	Apr 14	On site meeting	No issues raised. Positive feedback on the proposal.	None required
Community Environment Network	Nov 14	Information day held on site	No issues raised	None required

5.2 Government consultation

Stakeholder	When	Method	Response	Changes to proposal
DPI Fisheries	Feb 15	Email	The biggest issues appear to be impact on Coastal Saltmarsh and offshore Seagrass communities. These issues seem to be sufficiently addressed through the design.	Non required

5.3 Further Consultation

The following consultation would take place prior to work commencing:

- Letter box drop to advise local residents of work commencement
- Media releases to advise of work to be undertaken and timing
- Advice to key stakeholders prior to commencement of work

6 Environmental Impact Assessment

6.1 Location Description

6.1.1 Catchment and Hydrology

Tuggerah Lakes lies within the Macquarie Tuggerah catchment. This catchment covers an area of 1,630 km^2. A number of east flowing streams border the north. The Sugarloaf Ranges border the catchment to the north-west. The Hawkesbury River provides a boundary to the south and the Hunter Range provides separation from the Mangrove Creek catchment. Wyong River and Ourimbah Creek are the largest sub-catchments and deliver most of the freshwater entering Tuggerah Lakes. Wyong River flows in a south-easterly direction to meet Tuggerah Lakes at Tacoma. Ourimbah Creek flows south-easterly and meets Tuggerah Lake at Chittaway (NOW 2012). Wallarah, Spring, Tumbi and Saltwater Creeks are minor creeks delivering fresh water to the lake. Wide deltas have established where the creeks enter the lake (Dickinson *et al* 2006).

Together with Lake Munmorah and Budgewoi Lake, Tuggerah Lakes makes up a series of three interconnecting coastal lagoons which cover an area of 80 km^2. Tuggerah is the largest of the three lakes with an area of 54 km^2. The average depth of the lakes is 1.9m (Dickinson *et al* 2006).

Tuggerah Lake acts like a large sediment basin slowing flows from the catchment and allowing deposition to occur. Nutrients from the catchment that enter the lake, remain in the lake (Dickinson et al 2006). Limited water exchange occurs between the ocean and the lakes through the narrow channel at the Entrance. This results in a very small tidal influence within the lakes (Scott 1999).

6.1.2 Land uses

The Tuggerah Lakes has been a holiday destination since the late the 1800s. Early records speak of hundreds of people visiting the area in the summer months, staying either in tents on Taylor's property or at the one of the fifteen guesthouses located in the area (Scott 1999 p 9). At the beginning of World War I, in 1914, there were only about fifty permanent residents at the Entrance. The first subdivision at the Entrance occurred in 1920 when Taylor subdivided his property into 200 lots. This heralded the start of residential living in the location (Scott 1999 p 22).

However, it was not until the second half of the 1900s that the area experienced rapid development. The population of the Wyong Shire increased from 13,000 in 1954 to over 100,000 in the 1990s (Scott 1999 p 4). The rapid expansion of development in the catchment lead to considerable impacts on the lakes and surrounding environment. Surrounding wetlands were reclaimed for rural and urban development. There was a substantial loss of native vegetation, particularly riparian vegetation for housing developments. High levels of nutrients entered the lakes from septic systems during the 1960s, 1970s and early 1980s. Urban stormwater runoff carried nutrients, sediment and other pollutants to the lakes during rain events. These activities lead to a great decline in the health of the lakes which resulted in eutrophication, with macroalgae blooms being a common occurrence in the near shore habitats. This was coupled with the impacts from the Munmorah Power Station from 1960s until early 1990s where lake water was used to cool the condenser. This increased the temperature of the lake water and changed the natural circulation patterns (Scott 1999).

In the late 1980s, the government responded to the excessive macroalgal growth in the lakes by undertaking the Tuggerah Lakes Restoration Project. This project involved removal of seagrass and macroalgal growth from the lakes through mechanical means, dredging of the lake, creeks and Entrance channel and reclamation of the lake foreshore. Although this project successfully removed the weed growth and some measures have reduced further growth, sources of the problem were not satisfactorily addressed and the works resulted in further environmental degradation through removal of habitat and release of sulphuric acid from exposed acid sulfate soils (Scott 1999). It is now acknowledged that the quality of the water in Tuggerah Lakes has a much greater dependency on the quality of the water that flows into it from the creeks, rivers and stormwater drains than on flushing of seawater through the Entrance channel. The importance of maintaining and enhancing the native vegetation in the catchment is also recognised (WSC 2006).

The foreshore adjacent to Tuggerah Parade is zoned RE1 Public Recreation. The objectives of this zoning are to:

- enable land to be used for public open space or recreational purposes.
- provide a range of recreational settings and activities and compatible land uses.
- protect and enhance the natural environment for recreational purposes.
- provide linked open space for ecosystem continuity, public access, local community recreation and waterway protection.
- To provide space for integrated stormwater treatment devices for flow and water quality management.
- To enable ancillary development that complements land zoned for recreational purposes.

6.1.3 Geology, topography and soils

The proposal site lies within the Wyong soil landscape. This is a landscape of broad, poorly drained deltaic floodplains and alluvial flats of the Quaternary. The area is associated with wetlands, meander scrolls and oxbows. Low lying, slightly elevated terraces are present in some locations within this landscape (Murphy & Tille 1992, Murphy 1992).

The dominant soil types consist of brownish black pedal loam in the A horizon. This is a black loam to silty clay loam which is usually friable and can be hardsetting when dry. The pH of this topsoil ranges from strongly acid to slightly acid. This topsoil layer has a depth of about 10-40cm (Murphy 1992).

The B horizon consists of mottled brownish grey plastic clay for a depth of 200cm or more. This is a silty to heavy clay with a massive structure when wet. This material is often permanently water logged and ranges from strongly acid (pH 4.0) to slightly acid (pH 6.0) (Murphy 1992 p. 82).

Around the foreshore of lakes and where the banks of the major drainage channels enter the lakes, there are occasional deep deposits of coarse quartz sands which form non-tidal sand flats. In these locations, a dark brown loose loamy sand of an approximate depth of 10-50cm overlies about 10-50cm of grey loose sands. These layers overly more than 200cm of brown waterlogged loose sands (Murphy 1992 p.82).

Landscape limitations include flooding, waterlogging, high water tables and high run on. The soil can be very strongly acid and has a high potential for aluminium toxicity. It has moderate erodibility and low fertility. In addition to these characteristics, the topsoil is often sodic and

has a hardsetting surface. The B horizon also has low permeability, high plasticity and low wet bearing strength (Murphy 1992).

6.1.3.1 Acid Sulfate Soil Potential

The process outlined in the NSW Acid Sulfate Soils Assessment Guidelines (ASS guidelines) was followed to determine the likely presence of acid sulfate soils (ASS) at the proposal site. This involved the following steps:

- Desktop assessment including reference to WSC ASS mapping and soil landscape description
- Site assessment to determine the likelihood of ASS due to geomorphic conditions
- Preliminary geotechnical investigations
- Further, more detailed, geotechnical investigations

Desktop assessment

Reference to soil landscape description provided in Murphy (1992) indicated possible presence of ASS.

Government planning maps available through the WSC website provided further indication that ASS may be present. There are 5 classes of works shown on government planning maps. These are based on level of risk associated with particular works and the probable distribution of ASS. WSC ASS mapping indicates that the proposal site lies within a Class 2 area for works below ground surface. This means that any proposal that involves work below ground surface level or works that are likely to lower the water table in this area could present a risk to the environment and further investigation is required to determine the presence of ASS and whether they would pose a risk to the environment (Ahern *et al* 1998).

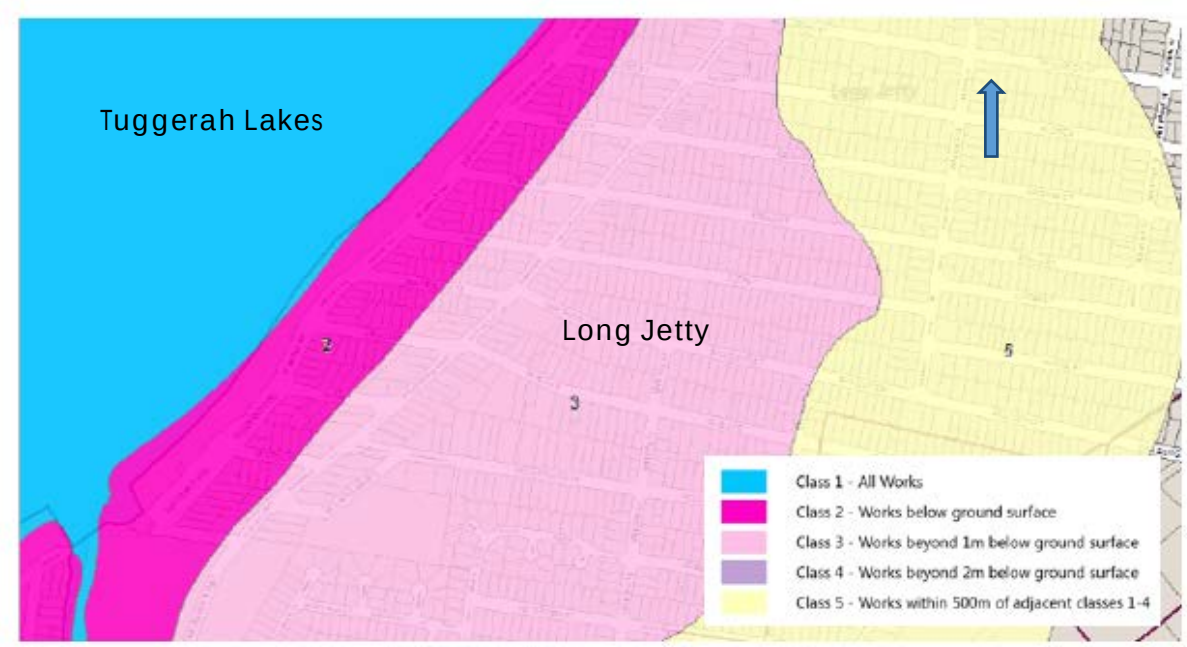

Figure 4: Extract from NSW government planning maps from ASS

Site assessment

The following geomorphic conditions identified at the proposal site during an initial site inspection indicate that ASS are likely to be present:

- Soil horizons less that 5m AHD
- Marine or estuarine sediments and tidal lakes
- Dominant vegetation swamp-tolerant, e.g. Swamp Mahogany (*Eucalyptus robusta*), Broad-leafed Paperbark (*Melaleuca quinquenerva*) and Swamp Oak (*Casuarina glauca*).

(Ahern *et al* 1998)

Preliminary geotechnical investigations

The desktop assessment and site inspection indicated a high probability of ASS being present. Therefore, WSC undertook preliminary geotechnical investigations in December 2014. Core samples were taken from five boreholes drilled at relevant locations across the site. The samples were assessed using the field test procedure outlined in ASS guidelines. The tests found that there is a high likelihood of potential ASS at the proposal site at depths of between 0.5m and 1m. Further testing was recommended (WSC 2014).

Further geotechnical investigations

Further investigations undertaken by Coffey Environments Australia Pty Ltd (Coffey) in January 2015 found that there is a high likelihood of acid sulfate soils occurring from the below the grass cover to depths of at least 0.7m to 0.9m below ground surface. It is likely that these soils would be exposed during construction. An ASS Management Plan has been developed and would be implemented on site during construction. See Appendix III for full report.

6.1.4 Climate

The Central Coast of NSW experiences a warm temperate climate with a maritime influence. Temperature and precipitation is generally influenced by orographic effects and proximity to the coast (Murphy 1992).

The average annual rainfall, recorded from Nora Head station between 1995 and 2014 is 1,168.6mm. Highest monthly rainfall is recorded late autumn and early winter in the months of May and June. The lowest monthly rainfall occurs during spring and early summer (BOM 2014).

Average monthly minimum temperature for that period was 15.1^{o}C and average monthly maximum was 22.1^{o}C (BOM 2014).

6.2 Sedimentation and Erosion

6.2.1 Potential Impacts

The proposed works would involve excavation in order to construct the stormwater treatment swales, forebay basins and other stormwater infrastructure. These activities would result in areas of exposed soil. Excavation for forebay basins would occur within existing stormwater channels and excavation for spillways would occur within the intertidal zones of Tuggerah Lakes. Both of these activities present a high level of risk for sediment potentially entering the lakes.

Stockpiling of loose material such as topsoil, sand, and other materials used in the formation of the swales would be necessary during construction. There is the potential for loose material and sediment to be washed into the lake from the site during rain. This could have a detrimental effect on aquatic life.

6.2.2 Mitigation Measures

1	The works would take place during a period of ongoing dry conditions and when the potential for large rain events and flooding is low.
2	Where construction would take place within or adjacent to waterways, measures would be implemented prior to construction to create a dry work area. Stormwater would be diverted around these work areas within a stabilised flow path. Where works take place in the intertidal area, adequate measures would be taken prior to construction to exclude water from the lake entering work areas.
3	An Erosion and Sediment Control Plan (ESCP) would be developed for the site. The ESCP would outline erosion and sediment control measures that would be implemented and maintained to: a. Prevent sediment moving off-site and sediment laden water entering any watercourse, wetland, drainage line or vegetated area. b. Reduce water velocity and capture sediment as close to the work area as possible. c. Minimise the amount of material transported from the site to surrounding pavement surfaces. d. Divert clean water around exposed areas.
4	The ESCP would be developed in accordance with the Landcom/Department of Housing Managing Urban Stormwater, Soils and Construction Guidelines (the Blue Book)) and would be updated as regularly as necessary to reflect the progression of work activities and to ensure that erosion and sediment controls are adequate.
5	The ESCP would be reviewed by the WSC prior to work commencing.
6	Erosion and sedimentation controls would be checked and maintained on a regular basis (including clearing of sediment from behind barriers) and assessed for their adequacy.
7	Erosion and sediment control measures would not be removed until the works are complete and all areas are stabilised.
8	Work areas would be stabilised progressively during the works where possible to ensure that the total area of disturbance is minimised at all times.
9	Stockpiles of materials would be stored in established stockpile areas.

10	Stockpile areas would be established on flat ground at least 40m from a watercourse, wetland or drainage line.
11	Stockpiles would be managed to control sediment and dust.

6.3 Chemical management and water quality

6.3.1 Potential Impacts

The construction of the forebay basins and associated infrastructure at the pipe outlets would require pouring concrete. Concrete products have a high pH. Alkaline products entering waterways can alter the natural pH can have a detrimental impact on aquatic life. Other chemicals used in the construction process, such as curing compound, can also detrimentally effect aquatic life.

Due to the low lying nature of the land, excavations could potentially fill with groundwater and require dewatering. Dewatering would need to be managed to ensure that any water released to the environment meets appropriate water quality standards, as outlined in the ANZECC Guidelines for aquatic ecosystems.

(Also see Section 5.9.2 for information on the impact from Acid Sulfate Soils).

6.3.2 Mitigation Measures

1	There would be no release of dirty water into drainage lines or waterways.
2	Sediment and erosion control would be implemented in accordance with safeguards outlined in Section 5.2.2 of this REF.
3	Effective measures would be put in place to prevent concrete or concrete leachate from entering waterways. Where concreting would occur adjacent to or within drainage channels and the lake foreshore, an impermeable barrier would be installed prior to work commencing to prevent movement of concrete leachate from the work areas. The barrier would be of an impermeable membrane such as black plastic covered bund. (Sediment fence or sandbags/earth would not provide an adequate barrier and should not be used as a single measure.)
4	Chemicals would be stored within an adequately bunded housing, which is covered to protect them from the weather. When in use on site, they would be stored within a mobile bund.
5	Chemical containers would be correctly labelled.
6	All concrete washout would occur within an adequately sized and bunded receptacle or sump that is lined with an impermeable liner such as plastic.
7	All concrete washouts would be located on flat ground at least 40m away from the waterway and drainage lines and on ground where the likelihood of flooding is low.
8	Concrete washouts would be emptied regularly to maintain capacity and the contents disposed of at a suitably licensed landfill.
9	Concrete washout would be emptied prior to rain events. They would be covered

	when not in use in the event of an unexpected rain event.
10	All relevant staff, including subcontractors, would be advised of the location of the concrete washout and the requirements for its use.
11	A dewatering plan would be developed, as part of the CEMP, that outlines: • How and when dewatering would occur • Where water from excavations would be stored, managed and disposed of • Water quality trigger values based on ANZECC guidelines for aquatic ecosystems – slightly disturbed estuaries in south east Australia. The dewatering plan would be reviewed and approved by WSC prior to work commencing.
12	Any sumps or sediment basins installed to receive water from excavations would be sized to the correct capacity leaving 20% freeboard and would be located on flat land where additional clearing of vegetation would not be required. Any additional clearing not covered by this REF would require further environmental assessment and approval from WSC.

6.4 Contaminated Land and Acid Sulfate Soils

6.4.1 Contaminated Land

To determine the likelihood of contaminated land affecting the proposal site, the following investigations were carried out:

- Search of NSW Contaminated Land Register for Wyong LGA
- Past land uses

The proposal site is not listed on the Contaminated Land Register and there are no listed contaminated sites adjacent to the proposal site.

The foreshore where the works would take place was extended through reclamation, in the early 1990s, to provide additional foreshore reserve to a width of approximately 30 m from the original shoreline (Patterson Britton & Partners 1992). The land has been used as a public reserve since reclamation took place.

6.4.2 Acid Sulfate Soils

To determine the likely presence of ASS at the proposal site, the procedure outlined in the ASS guideline was followed. This procedure is outlined in 6.1.3.1.

Findings indicate that ASS appears to be present in alluvial sands and clays from the below the grass cover to depths of at least 0.7m to 0.9m below ground surface. It is likely that ASS would be disturbed during excavation necessary to undertake the proposed works (Coffey 2015).

6.4.3 Potential impacts

ASS contain iron sulfide or pyrite which generates sulphuric acid when oxidised. This can occur on exposure to oxygen in the presence of moisture. The production of significant amounts of sulphuric acid can occur where disturbance of ASS is not managed well and can

lead to an extreme reduction in soil and water pH of <4. Acidic conditions produce acid salts, resulting in highly saline conditions, and often lead to the release of aluminium, iron and other naturally occurring elements that would normally remain stable within the soil matrices. The combination of these alterations can negatively affect vegetation growth and be detrimental to aquatic ecosystems (Coffey 2015).

In avoiding and mitigating the potential disturbance of ASS, the ASS guidelines recommend that alternative sites, layout designs and other mitigation measures be considered to avoid disturbing PASS. The proposed design, included at Appendix I, has limited excavation depth for the treatment swales and spillways to 400mm to avoid disturbing ASS.

An ASS Management Plan has been developed by Coffey. See Appendix III for full assessment and ASSMP.

6.4.4 Mitigation Measures

1	During construction, ASS is to be managed in accordance with the attached ASS Management Plan. (For information on excavation dewatering see mitigation measures outlined under Section 5.3.2.)

6.5 Waste

6.5.1 Potential Impacts

The proposed works would generate some waste, including vegetative matter removed during clearing, packaging, construction materials, spoil that cannot be reused on site, general waste generated by site staff.

Coffey (2015) undertook an assessment of the waste potential of subsoils at the proposal site. This assessment found that the sand and clay soils to be excavated from the site during construction to a depth of 1.65m below ground surface would be classified as General Solid Waste. No Special Waste, Liquid Waste, Pre-classified waste or material with hazardous characteristics was found to be present at the proposal site (Coffey 2015).

6.5.2 Mitigation measures

1	Waste would be managed in accordance with the waste hierarchy established under the *Waste Avoidance & Resource Recovery Act 2001*: • Avoidance of unnecessary resource consumption. • Resource recovery, including reuse of materials, reprocessing and recycling • Disposal undertaken as a last resort.
2	Receptacles would be available on site during construction to enable easy segregation of wastes, i.e. recycling receptacle, receptacles for waste that can be reused.
3	Indigenous trees removed during clearing would be mulched and the resulting mulch used on site.
4	No waste material, other than vegetation and mulch, would be left on site once the works are complete.

5	Working areas would be maintained and kept free of rubbish and cleaned up at the end of each working day.
6	Excess sand, gravelly sand and clay removed during excavation would be disposed of at a facility licensed to accept general solid waste.

6.6 Biodiversity

The proposal would require clearing of indigenous vegetation as well as non-indigenous vegetation. A biodiversity assessment was undertaken to assess the potential direct and indirect impacts from this clearing on the ecological values. The ecological report is attached at Appendix II.

6.6.1 Methodology

The biodiversity assessment involved a combination of desktop research, literature review and field study as outlined below.

Database and register review:

- Atlas of NSW Wildlife (Bionet)(10 km buffer)
- Commonwealth Protected Matters (10 km buffer)
- DPI Noxious Weed declarations for Wyong LGA
- OEH Biometric Vegetation Types Database
- OEH BioBanking Threatened Species Profile Database
- OEH Critical Habitat Register
- Royal Botanic Gardens Plantnet

Literature review

- OEH Threatened Species Profiles
- Department of Environment Species Profile and Threats Database
- Species Recovery Plans
- Key Threatening Processes (EPBC Act)
- Vegetation reference guides

Mapping Review

- WSC Vegetation Mapping (Bell and Driscoll)

Field Survey

The terrestrial ecological survey was undertaken in accordance with WSC Flora and Fauna Survey Guidelines Version 2 for 'Highly Disturbed Site/Area with habitat' present, as described in Table 2, p.43 and for sites <50 ha in size as described on the same page. This included:

- Identifying / ground-truthing vegetation communities present
- Undertaking a botanical survey of the vegetation proposed for clearing
- Determining habitat potential by assessing key habitat features
- Identifying weeds, in particular, noxious weeds

Aquatic survey involved a habitat assessment and water quality testing in accordance with Wyong Shire Council's Flora and Fauna Survey Guidelines Version 2.0, Table 4, p. 64 Marine or Estuarine environments.

Specific details of the surveys undertaken are outlined in the ecological report, included at Appendix II.

6.6.2 Results

6.6.2.1 Vegetation

Swamp Oak Floodplain Forest

The vegetation along the stormwater drains consists of an Open Forest dominated by Swamp Oak (*Casuarina glauca*) to 12-15m high. The occasional Broad-leaved Paperbark (*Melaleuca quinquenerva*) and Swamp Mahogany (*Eucalyptus robusta*) also occur. This community has a sparse small tree / shrub layer to 5m high of young Swamp Oak as well as Tuckeroo (*Cupaniopsis anacardioides*), River Mangrove (*Aegiceras corniculatum*) and Sweet Pittosporum (*Pittosporum undulatum*). The groundcover layer is dense and dominated by exotic species such as Buffalo Grass (*Stenotaphrum secundatum*) and Pennywort (*Hydrocotyle bonariensis*) as well as the native species Native Reed (*Phragmites australis*) and Sea Celery (*Apium prostratum*). The exotic climber Blue Passionflower (*Passiflora caerulea*) was present at some locations.

This vegetation is consistent with the following NSW, regional and local vegetation communities:

- Forested Wetlands - Coastal Floodplain Wetlands (Keith 2004)
- Swamp Oak – Rushland Forest – Map Unit 40 (NPWS 2000)
- Estuarine Swamp Oak Forest – Map Unit 3 (Bell 2002b)

There are approximately 278.5 ha of this community mapped in Wyong LGA (Bell 2002b).

This community is equivalent to the NSW listed endangered ecological community Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions (Swamp Oak Floodplain Forest).

Coastal Saltmarsh

For a 5-10m wide strip along the reserve foreshore there is a Herbland vegetation community to 0.5m high, which is dominated by a variety of salt tolerant species such as Samphire (*Sarcocornia quinqueflora*), Sea Rush (*Juncus kraussii*), Creeping Brookweed (*Samolus repens*), and Saltwater Couch (*Paspalum vaginatum*). Some exotic species such as *Atriplex prostrata* and Water Buttons (*Cotula coronopifolia*) are present but are not dominant.

This vegetation community is consistent with the following NSW, regional and local vegetation communities:

- Saline Wetlands - Saltmarshes (Keith 2004)
- Mangrove-Estuarine Complex (NPWS 2000)
- Estuarine Mangrove-Saltmarsh Complex – Map Unit 2 (Bell 2002b)

There are approximately 29.8 ha of this community mapped in Wyong LGA (Bell 2002b).

This community is equivalent to the NSW listed endangered ecological community, *Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions* and the Commonwealth EPBC Act listed community, *Subtropical and Temperate Coastal Saltmarsh*. For the purposes of simplification, this community is referred to as Coastal Saltmarsh in this report.

The following vegetation communities, listed as endangered ecological communities under the TSC Act, were identified:

- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions
- Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions

The Coastal Saltmarsh community is also consistent with a threatened community listed under the Commonwealth EPBC Act:

- Subtropical and Temperate Coastal Saltmarsh

Seagrass

A seagrass vegetation community was identified outside the proposal site, between about 50-100m from the lake edge within Tuggerah Lakes. The extent of seagrass can be highly variable seasonally as it dies back during the cooler months and re-establishes during the warmer months. The seagrass consists of just one species in this location, Eelgrass (*Zostera capricornia*). The health of the seagrass varied from a continuous mat, where the leaves of the Eelgrass were about 40cm long to the disturbed perimeter where the Eelgrass did not appear healthy. A high percentage of macroalgae was recorded covering the seagrass closer to shore. The macroalgae prevents light reaching the leaves of the seagrass and indicates high nutrient levels in the water (McQueen 2014).

The seagrass community would not be directly impacted. However, there is the potential for indirect impacts from the proposed works through release of pollutants, such as sediment laden water, during construction.

Threat-listed Flora Species

Of the six threat listed flora species with potential to be present in the area, two species, Magenta Lilly Pilly (*Syzygium paniculatum*) and Biconvex Paperbark (*Melaleuca biconvexa*), have potential inhabit the site. However, these species were not detected during survey.

Proposed Vegetation Clearing

Approximately 2000m^2 of vegetation would be cleared in order to undertake the proposed works. (See Figure 5 for areas proposed for clearing.) Areas proposed to be cleared cover:

- Removal of all *C. glauca* individuals under 150mm dbh
- Approximately 20 mature trees associated with the Swamp Oak Floodplain forest vegetation community.
- Approximately 200m^2 Coastal Saltmarsh
- Disturbed vegetation (weeds only)

Figure 5: Vegetation clearing

6.6.2.2 Threat listed flora communities, Endangered Populations and Critical Habitat

The site contains the following vegetation communities listed under the TSC Act as endangered ecological communities:

- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions
- Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions

and the following threatened community listed under the Commonwealth EPBC Act:

- Subtropical and Temperate Coastal Saltmarsh

There is no Critical Habitat, as defined in the TSC Act, declared over land within a 10km radius of the proposal site.

Two Endangered Populations, listed under TSC Act or EPBC Act, are located within or adjacent to the proposal site. One endangered population is located within 10km radius of the proposal site, *Eucalyptus oblonga population at Bateau Bay, Forresters Beach and Tumbi Umbi in the Wyong local government area*. This population would not be affected by the proposal.

Assessments of Significance have been undertaken for each threat listed vegetation community that would be impacted by the works. These assessments concluded that the proposal would not result in a significant impact to these vegetation communities and that referral to the Commonwealth is not recommended. Assessments of significance are provided in the attached ecological report.

6.6.2.3 Weeds

DPI lists 119 Noxious Weed Declarations for WSC. Two species on the list were identified at the proposal site during the flora survey - Bitou Bush (*Chrysanthemoides monilifera subsp. rotundata*) and Asparagus Fern (*Asparagus aethiopicus*).

The Commonwealth government has identified 32 weeds species as being Weeds of National Significance (WoNS). Many of these weeds are covered by Noxious Weed Declarations in the Wyong LGA. However, a number of WoNS present do not have noxious weed declarations, including *Lantana camara*.

Most of the weeds present at the site have neither Noxious Weed Declarations or appear on the WoNS list. However, these weeds still pose a risk to environmental values. A list of weeds present is provided in the attached ecological report**.**

6.6.2.4 Habitat Condition

The vegetation at the proposal site has been considerably disturbed. The foreshore has been cleared and reclaimed in recent decades. The area consists of cleared, grassed areas with scattered remnant trees, mostly adjacent to Tuggerah Parade, and dense regrowth of *C. glauca* along the stormwater channels.

6.6.2.5 Connectivity

The proposal site forms part of the Stepping Stones Wildlife Corridor, which aims to form a vegetated link between the southern and northern sections of Wyrrabalong National Park. This project is a partnership between the Community Environment Network, WSC, Hunter Rivers Catchment Management Authority with support from the NSW Environmental Trust. The corridor has been a focus of planting and bush regeneration by WSC and bushcare groups since the early 1980s. The mature trees and other vegetation along the foreshore in the proposal area provides stepping stone connectivity between parcels of bushland to the north and south of the proposal site (CEN 2008).

6.6.2.6 Threat listed and Migratory Fauna

Database searches identified 80 threat listed and migratory fauna species that could potentially be present or use the proposal site. An analysis of the likelihood of each species potential to use the proposal site has been provided in the attached ecological report. 10 threat listed or migratory fauna species were considered to have a moderate to high likelihood of presence at the proposal site at some time.

Assessments of Significance have been undertaken for these species and are provided in the attached ecological report. These assessments concluded that the proposal would not result in a significant impact to any species listed under either state or federal legislation. A referral to the Commonwealth for impact on matters of environmental significance has not been recommended.

Potential Impacts

Up to 2000m^2 of native vegetation would be removed for this proposal. Although this assessment has found that a significant impact on threatened flora and fauna is not likely, there may be some negative impact on protected fauna from:

- removal of potential habitat and forage for some native fauna resulting in a net loss of these resources
- possible increases in fragmentation and edge effects
- reduction in refuge areas for juvenile fish
- direct mortality of juvenile fish and other aquatic life through filling of the stormwater channels
- possible minor impacts on connectivity due to removal of trees
- changes in shading regime and temperature of water within the channels due to removal of trees (see Water Quality)
- possible disturbance of ASS and therefore potential release of sulphuric acid (see Water Quality)

Some of these issues would be mitigated through the following design elements:

- Leaving a band of 10m from the lakes edge to allow for natural regeneration of coastal saltmarsh.
- Provision of a planted buffer between the Coastal Saltmarsh and mown exotic grassed areas.
- Provision of delineated access points to the lake and exclusion in other areas (to protect Coastal Saltmarsh from the impacts of foot traffic)
- Upgraded drainage lines designed to include refuge for juvenile fish.
- Treatment swales would be planted at a high density with indigenous macrophytes to minimise weed intrusion and provide habitat for local fauna.

6.6.3 Mitigation Measures

1	Clearing of mature trees would be minimised to that absolutely necessary to undertake the work.
2	Tree cover would be maintained, as much as possible, on the northern side of the stormwater channels to maintain shade over open water.
3	Thinning of *C. glauca* would be restricted to trees with a dbh of 150mm or less.
4	Selective removal of *C. glauca* regrowth would be undertaken to minimise the impact on canopy connection.
5	The area to be cleared would be clearly marked out on the ground and exclusion fencing would be erected prior to clearing to reduce the risk of over clearing.
6	Exclusion fencing or sediment control fencing would be erected around vegetation that adjoins the construction area to minimise damage to vegetation that is retained.

7	Filling of channels would be undertaken with minimal compaction to reduce impact on existing trees adjacent to the channels.
8	All vehicles, construction materials and refuse would be kept within areas approved for construction
9	All contractors, sub-contractors and site personnel would be notified of vegetation protection measures.
10	Machinery used for clearing would be washed prior to entering the site to remove seeds.
11	A pre-clearing inspection would be undertaken immediately prior to clearing any vegetation. Any fauna found would be relocated to a predetermined safe location in adjacent bushland.
12	The final design would incorporate refuge areas at the lower end of existing stormwater channels to provide refuge areas for juvenile fish.
13	Filling of the stormwater channels would occur when the lake level is low and during a period of dry weather to ensure that the minimum amount of water is retained within the channel. Any fish residing in the channels shall be relocated to a predetermined safe location prior to work commencing.
14	Useable trees and shrubs which are felled would be re-used on site, either in log form or as woodchip mulch for erosion control and/or site rehabilitation. Non-salvageable material, such as roots and stumps may only be disposed of at an approved site.
15	Landscaping would include replanting with a diverse range of indigenous species of varying growth forms under and between existing trees to create a dense understorey and mid storey of indigenous plants which connect in a continuous north – south direction link.
16	Landscaping would include planting of indigenous trees identified by WSC as 'keystone species', i.e. *Eucalyptus robusta, Melaleuca quinquenerva, Banksia integrifolia* and *Acacia longifolia*. Other indigenous species that are part of the Swamp Oak Floodplain Forest Community, such as *Glochidian ferdinandi var. ferdinandi* and *Cupaniopsis anacardioides*, would also be planted due to their forage potential.
17	Replanting of indigenous trees to replace mature trees (>150mm dbh) would occur at a minimum of 2 or every 1 tree removed.
18	Planting under existing *C. glauca* that line the channels would be undertaken as part of landscaping for the proposal. Lower storey and groundcover plants would be selected for their ability to exclude weed growth, such *Lomandra longifolia*.
19	All weed material removed would be taken from the site and disposed of at a suitably licensed landfill. No weed material would be used in mulch.
20	Restoration of Coastal Saltmarsh would occur through an ongoing bush regeneration program.

6.7 Non-Aboriginal Heritage

To assess whether the proposed works would impact on Non-Aboriginal heritage, the following databases and plans were referred to:

- NSW Heritage database
- Australian Heritage Database
- Australian Heritage Places Inventory
- LEP heritage items (Schedules 4 and 5)
- Section 170 Register

6.7.1 Potential impacts

There are two heritage items listed by WSC and state agencies within close vicinity of the proposed works, as described below:

Item	Significance	Location / Distance from works	Listing
Amaroo Dwellings	Representative of vernacular holiday units built to service demand of a particular socio-economic class.	156 Gladstan Avenue (Cnr Tuggerah Parade) Long Jetty Within 50m of the proposed works.	LEP
Mr Parry's Jetty	Significant for the major role that the jetty played in communications and primary industry in the early days of settlement.	Tuggerah Parade, Opposite Gladstan Avenue, Long Jetty Within 10m of the proposed works.	LEP

6.7.2 Mitigation Measures

1	Exclusion fencing would be erected around the land based section of Mr Parry's wharf prior to any work commencing.
2	All relevant site staff would be made aware of the wharf structure and its heritage status.
3	If unexpected archaeological remains are uncovered during the works, all works would cease immediately within the vicinity of the material/find and WSC will be contacted immediately.
4	If any items defined as relics under the *NSW Heritage Act 1977* are uncovered during the works, all works must cease in the vicinity of the find and WSC environment officer would be contacted immediately.

6.8 Aboriginal Heritage

At the time of European colonisation, the Central Coast was inhabited by three Aboriginal groups, the Kurringgai, Darkinjung and Awabakal peoples. However, many groups regularly visited the area, including the Pittwater group, the Wollombi group, the Bah Bah group from north Lake Macquarie and the Boun group from Brunkerville Gap (Scott 1999).

Tuggerah Lakes is a significant area for Aboriginal people. Prior to European development, the area was a diverse wetland environment that would have been haven for wildlife, wild plants and, therefore, plentiful food resources. The area was also known as a place for learning and of spiritual importance. It was a traditional meeting place for many tribes (OEH 2013).

The *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South* Wales outlines a process for ensuring that due diligence is applied when carrying out activities that may harm Aboriginal objectives and to determine whether consent is required in the form of an Aboriginal Heritage Impact Permit (AHIP). The generic due diligence process outlined in the guideline has been followed in considering the potential to impact on Aboriginal Heritage from the proposed works.

The foreshore land where the works would take place has been subject to considerable disturbance. In the late 1980s and early 1990s, in order to address pollution issues in the lake, WSC commissioned works to 'clean up' the lakes. The Tuggerah Lakes Improvements Program involved, amongst other things, dredging and reclamation of particular areas around the lake foreshore. The foreshore between Saltwater Creek and Picnic Point was extended through reclamation to provide additional foreshore reserve to a width of approximately 30 m from the original shoreline (Patterson Britton & Partners 1992). The proposed works would be undertaken within this reclaimed foreshore land. Therefore, excavation would occur within fill placed during the 'foreshore improvement works'. All trees removed for the purposes of this proposal would be regrowth that has occurred since reclamation.

To determine whether the proposal site contains any known Aboriginal artefacts or sites, the following information sources were referred to:

- NSW Atlas of Aboriginal Places
- AHIMS Database (Lat, Long -33.3645, 151.4753 to -33.3611, 151.4807 with 50m buffer)

The closest Aboriginal Place is the Tuggerah Lakes Resting Place, an Aboriginal burial site located on the western foreshore of Tuggerah Lakes, just over 7km from the proposal site.

A search of the Office of the Environment and Heritage AHIMS web services has shown that no Aboriginal sites are recorded in or near the location of the proposal site.

6.8.1 Potential Impacts

There is no known Aboriginal heritage within the proposal site. The level of disturbance that has occurred to the foreshore, where the works would take place, makes it unlikely that Aboriginal heritage would be disturbed. Also, excavation to install stormwater infrastructure would be kept to a depth of 0.5m which would reduce the likelihood of disturbing Aboriginal heritage that may have been buried by fill when the lake edge was reclaimed. The following mitigation measures would also be implemented to reduce the risk of harming any sites that may be disturbed.

6.8.2 Mitigation Measures

1	Site staff involved in excavation would be made aware of the requirements for Aboriginal heritage outlined under the NPW Act and mitigation measures 2 and 3 outlined below.
2	If unexpected archaeological remains are uncovered during the works, all works would cease immediately within the vicinity of the material/find and the WSC will be contacted immediately.
3	If any items defined as relics under the *NSW Heritage Act 1977* are uncovered during the works, all works would cease in the vicinity of the find and the WSC will be contacted immediately.

6.9 Noise and Vibration

There are a number of sensitive receivers within 200m radius of the proposed works.

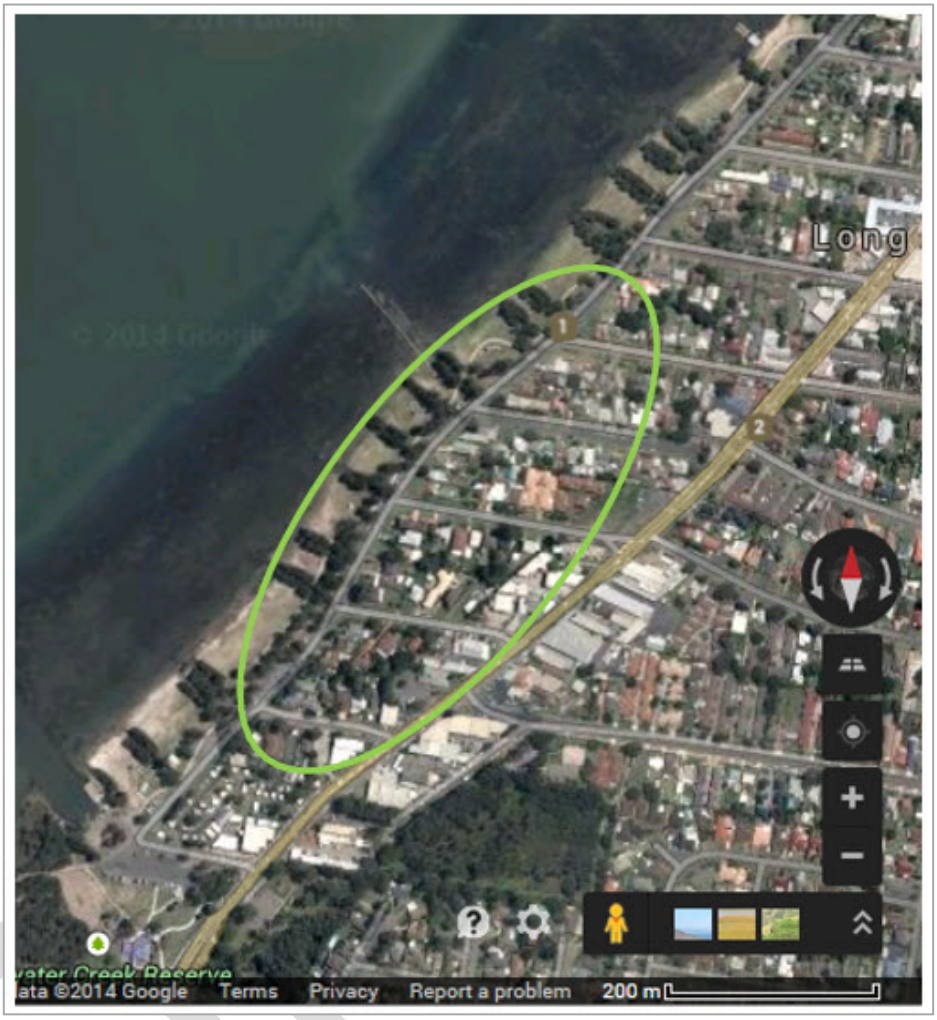

Figure 6: Noise receivers within approximately 200m of proposed works
(Source: Google Maps)

Work would be undertaken during standard working hours.

Monday-Friday:	7am – 6pm
Saturday	8am – 1 pm

No work on Sundays or Public Holidays

6.9.1 Construction Noise and Vibration

6.9.1.1 Potential Impacts

Local residents adjacent to the foreshore reserve could be impacted through construction noise. As the work would take place during standard daytime hours, the potential impact from this is considered to be low.

6.9.1.2 Mitigation measures

1	Consultation with nearby residents and sensitive receivers would be undertaken prior to work commencing.
2	Measures would be undertaken, in accordance with the DECC Interim Construction Noise Management Guideline, by the contractor to reduce noise and vibration where possible. These measures could include such things as: • Selecting lower noise/vibration impact equipment and methods. • Informing potentially noise affected receivers about the nature of the construction stages and the duration of noisier activities. • Turning off plant and equipment when it is not being used. • Ensuring that plant, equipment and vehicles are regularly maintained and repair or replace equipment that becomes noisy. • Arranging the work site to minimise use of movement alarms on vehicles and mobile plant. • Locate noisy plant away from potentially noise affected neighbours or behind barriers such as existing dwellings, compound shed or walls. • Talking to site staff about noise and how it can be reduced.

6.9.2 Operational Noise

6.9.2.1 Potential Impacts

The works would not result in any additional noise once the infrastructure is in operation.

6.10 Air Quality

6.10.1 Potential Impacts

During construction, works would require the use of plant and machinery to undertake various activities that have the potential to create dust, such as excavation for stormwater infrastructure and truck deliveries. There is also likely to be an increase in exhaust emissions during construction due to the activities of construction machinery, equipment and vehicles.

The proposed works could have a temporary impact on air quality in the vicinity of the works and this may impact on the residents adjoining the proposal site. Measures outlined in this REF to address this issue have been devised to minimise these impacts and ensure that any air quality issues as a result of the proposed works are of a minor nature.

6.10.2 Mitigation Measures

1	Dust generating activities would not be undertaken during periods of strong or gusty winds.
2	When required, measures would be taken to minimise dust and other particulates, including covering or spraying exposed areas using a water cart.
3	Stockpiled materials would be managed to suppress dust emissions.
4	No burning would occur on site.
5	Vehicles transporting loose materials or waste would be covered during transportation.
6	Mud and dirt tracked onto sealed surfaces would be regularly removed.
7	Vehicles and machinery used on site would be regularly serviced and maintained.

6.11 Traffic

6.11.1 Potential Impacts

6.11.1.1 Construction

Temporary closure of Tuggerah Parade in vicinity of the works would be necessary during delivery of materials and plant.

6.11.1.2 Operation

No additional impacts are expected on traffic on completion of works.

6.11.2 Mitigation measures

1	Where possible, current traffic movements and property accesses are to be maintained during the works. Any disturbance is to be minimised to prevent unnecessary traffic delays.

6.12 Socio-economics

6.12.1 Potential impacts

An assessment of potential social and economic impacts on the community follows.

Local business	The nearest business operating on the foreshore is the Long Jetty Catamaran and Boat Hire. The works are not expected to have a negative impact on this business.
Quality of life and well-being of local	The proposal aims to improve the reserve for community recreation and enjoyment. There are no detrimental impacts on

people	well-being and quality of life of the local community envisaged.
Places of social significance to the community	The Tuggerah Lakes foreshore is a place of social significance for the local community as it is a popular recreational area. The proposal aims to enhance the use of the area for recreational pursuits.
Transformation of the locality and aesthetics of the area	The proposal aims to have a positive impact on the aesthetics of the locality by improving the quality of stormwater, creating visual connectivity across the foreshore and undertaking landscaping.
Change in beneficial use to the community	The changes to the area from the proposed works would result in greater beneficial by the community through increased access and connectivity.
Community health and safety	The proposal aims to improve the quality of water entering the lakes. This would have a minor impact on water quality in the lake and may reduce the incidence of algal blooms. This would add to a positive cumulative impact when taken into account with other measures being implemented in the catchment to reduce pollutants entering the stormwater.

6.13 Visual Amenity

6.13.1 Potential impacts

6.13.1.1 Construction

During construction there is the potential for negative visual impacts on the foreshore area in the vicinity of the works from ground disturbance, tree removal and presence of construction machinery and equipment. This would be a temporary impact only and would occur during standard daylight hours.

6.13.1.2 Operation

Character of the landscape	The design incorporates measures to maintain the character of the foreshore, i.e. maintaining and enhancing indigenous vegetation communities.
Aesthetics of the landscape	The proposal aims to improve the current aesthetics of the foreshore by improving the quality of water within the channels.
Removal of vegetation or mature trees	The proposal would involve thinning of *Casuarina glauca* regrowth up to a dbh of 150mm. Some mature trees up to 300mm dbh would be removed in order to construct the stormwater infrastructure. This would have some negative visual impact, particularly in the short term.
Light spillage	The proposal does not include any additional lighting.
Intrusion on views of the landscape	The proposal is not expected to result in a greater intrusion on views of the lake or surrounding landscape for either residents or users of the reserve. Views of the lake may increase due to tree thinning.
Intrusion on views of a	One heritage item, Mr Parry's Jetty, is located within the proposal

structure or items of visual or heritage importance	site. There is not expected to be an intrusion on views of this structure. Thinning of trees may increase visibility of the structure.

Visual impacts from the completed works would occur due to tree removal and thinning of vegetation adjacent to the stormwater channels. Landscaping undertaken as part of the proposal is expected to offset this impact and result in a minor short term and positive long term visual impact.

6.13.2 Mitigation measures

1	Landscaping of the foreshore reserve would occur and be designed to provide visual and physical connectivity. Flora species used in landscaping would be indigenous to the area and include keystone species identified by WSC.
2	Indigenous trees would be planted to offset the removal of trees (as outlined under Section 5.5.

6.14 Public Access and Safety

6.14.1 Potential impacts

There would be no negative impact on public access from the proposal. Community access and visual connectively would be improved across the foreshore by thinning *the C. glauca* adjacent to the stormwater channels and landscaping treatments.

There is not expected to be any increase in public safety from the proposal. Stormwater treatment swales would be designed to deliver stormwater across the reserve to the lake. Swales would be planted densely with sedges to remove the presence of open water.

6.15 Cumulative Impacts

Cumulative environmental impacts may be described as the combination of individually minor and incremental impacts over time. Cumulative impacts have the potential to impose substantial negative impacts on the environment because each small impact or decision can be easily missed or dismissed as minor or negligible and not worthy of investigation or mitigation. For this reason, identifying and mitigating cumulative impacts has become an important aspect of environmental assessment and management.

6.15.1 Potential impacts

There would be a positive impact on the amenity of the area due to water quality and landscaping treatments. Water quality entering the lake at the proposal site would be improved as pollutants are filtered through these treatments. Planting of stormwater treatment swales with indigenous vegetation would increase the available area of wildlife habitat. The proposal would also have a positive impact on the Coastal Saltmarsh community in the area due to design measures that are aimed at protecting this community and assisting in its rehabilitation. Together with similar management measures that are being undertaken elsewhere along the Tuggerah Lakes foreshore and planned repetition of such

measures along the foreshore further north of the proposal site, there would be a cumulatively positive impact on water quality, Coastal Saltmarsh and general aesthetics.

There is the potential for short term negative cumulative impacts due to air, water, soil pollution and noise during construction. These impacts would be minimised by the implementation of mitigation measures outlined in the relevant sections of this REF.

Clearing of native vegetation would have a negative cumulative impact on the environment as there would be a net loss of trees and other vegetation that is potentially providing habitat and connectivity for native fauna species. Measures to address these impacts have been included in Section 5.5 of this REF.

6.15.2 Mitigation measures

Mitigation for cumulative impacts has been addressed through the relevant sections of this REF. See Biodiversity, Air Quality, Water Quality, Sediment and Erosion Control and Noise sections.

6.16 Climate change and other natural hazards

6.16.1 Climate Change

Climate change projections for the Central Coast region of New South Wales predict that:

- sea level will rise up to 40cm above 1990 levels by 2050 and 90cm by 2100, altering existing flood patterns;
- temperatures will increase by between 1.5 and 3^{o}C;
- there will be an increase in the number and intensity of very high and extreme fire risk days;
- rainfall will increase in summer by 20-50% and decrease in winter; and
- there will be a greater intensity in rainfall and an increase in number and intensity of storms.
- Rise in sea levels will pose a risk to settlements adjacent to estuaries and beaches as the risk to flooding and erosion will be exacerbated.
- Across NSW there is expected to be an increase in the frequency of very high or extreme fire-risk days (DECC 2008 p.2)

6.16.1.1 Bushfire

WSC Bushfire Prone Lands mapping indicates that the proposal site is not within or adjacent to a bushfire prone area.

6.16.1.2 Flooding

WSC Flood Mapping Precincts map indicates that the proposal site is located within the flood mapping Precinct 4, which is classed as being a 'high hazard' area for flooding. This precinct covers floodways and deep flood storage areas. The description provide for Precinct 4 land includes the following:

- there is a significant danger to personal safety in a 1% AEP flood
- evacuation by trucks is difficult
- able-bodied adults would have difficulty in wading to safety

- there is potential for significant structural damage to buildings

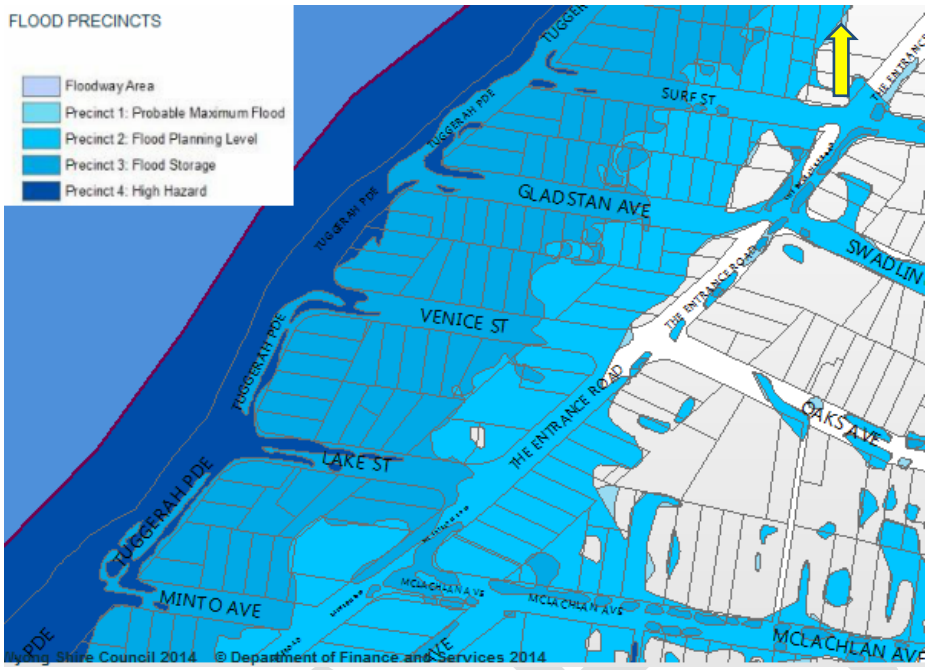

Figure 7: Flood Prone Land

6.16.1.3 Potential Impacts

The proposal does not include the erection of any buildings or other infrastructure that could be damaged structurally due to flooding. The proposal would not reduce the flood storage area or impede the flow of flood water and it would not increase the risk to public safety from flooding.

There is, however, the potential for negative impacts on the environment from flooding if this were to occur during construction. These include an increase in the risk of sediment laden water and chemicals such as concrete products entering the lake.

6.16.2 Mitigation measures

Mitigation measures relevant to this section are also outlined under the sections on 'Soils and Erosion' and 'Waterways and Water Quality'.

1	Construction would be scheduled for a period when there is an expected period of ongoing dry conditions and the potential for large rain events and flooding is low. The construction contractor would make daily reference to weather forecasts and ensure that measures outlined in the ESCP are implemented in the event of unexpected rainfall.

6.17 Greenhouse Gas Emissions

6.17.1.1 Potential Impacts

Small projects can contribute to human induced climate change. During construction, greenhouse gases such as carbon dioxide and nitrous oxide are emitted from the burning of fuel to operate vehicles and machinery and for the mining, transport and manufacture of the products used in construction. Additional waste is also generated during construction. Waste that is not recycled or reused goes to landfill where it emits methane as it breaks down.

6.17.2 Mitigation Measures

Mitigation measures relevant to this section are also outlined under the sections Waste and Air Quality.

1	As much as possible, products used in construction would be sourced locally.
2	Machinery and vehicles would be turned off when not in use to avoid using additional fuel through idling.

6.18 Ecologically Sustainable Development and Sustainability

The National Strategy for Ecologically Sustainable Development was adopted by all levels of government in 1992. It provides a broad framework for the direction of government policy and decision-making. The following table outlines how this proposal is consistent with the principles of ecologically sustainable development.

Sustainability Element	Component	Expected Outcome
Economic	Competitiveness	No business would be provided advantage over another and there would be no impact on the ability of businesses to compete.
	Intergenerational equity	The health, diversity and productivity of the environment would be maintained and enhanced for future generations through care of water quality and maintenance and enhancement of indigenous vegetation communities.
	Cost effectiveness	Environmental and social objectives have been pursued in the most economical way, maximising benefits and minimising costs.
Environmental	Biological diversity and integrity	Biodiversity would be increased due to the introduction of new habitat ad increased diversity in plant species. Biological integrity would be improved through enhancement of the existing wildlife corridor and restoration of Coastal Saltmarsh.
	Ecological processes	Improved ecological processes due to improvement in water quality, increase in habitat diversity and improvement to existing habitats, i.e. restoration of

		Coastal Saltmarsh.
	Improved valuation, pricing and incentive mechanisms	See 'Economic'
	Precautionary principle	Environmental assessment has undertaken careful evaluation of all possible impacts on the environment to avoid the risk of serious or irreversible risks to the environment.
Social	Community access	Unhindered access to the foreshore reserve would be maintained in a manner that ensures ongoing biological diversity and integrity.
	Human health and amenity	Treatment of stormwater would be improved to enhance amenity and contribute to improved water quality in the lake.
	Inter-generational equity	See 'Economic'

7 Recommended Mitigation Measures & Management

7.1 Summary of Mitigation Measures

	Soils and Erosion
1	The works would take place during a period of ongoing dry conditions and when the potential for large rain events and flooding is low.
2	Where construction would take place within or adjacent to waterways, measures would be implemented prior to construction to create a dry work area. Stormwater would be diverted around these work areas within a stabilised flow path. Where works take place in the intertidal area, adequate measures would be taken prior to construction to exclude water from the lake entering work areas.
3	An Erosion and Sediment Control Plan (ESCP) would be developed for the site. The ESCP would outline erosion and sediment control measures that would be implemented and maintained to: e. Prevent sediment moving off-site and sediment laden water entering any watercourse, wetland, drainage line or vegetated area. f. Reduce water velocity and capture sediment as close to the work area as possible. g. Minimise the amount of material transported from the site to surrounding pavement surfaces. h. Divert clean water around exposed areas.
4	The ESCP would be developed in accordance with the Landcom/Department of Housing Managing Urban Stormwater, Soils and Construction Guidelines (the Blue Book)) and would be updated as regularly as necessary to reflect the progression of work activities and to ensure that erosion and sediment controls are adequate.
5	The ESCP would be reviewed by the WSC prior to work commencing.
6	Erosion and sedimentation controls would be checked and maintained on a regular basis (including clearing of sediment from behind barriers) and assessed for their adequacy.
7	Erosion and sediment control measures would not be removed until the works are complete and all areas are stabilised.
8	Work areas would be stabilised progressively during the works where possible to ensure that the total area of disturbance is minimised at all times.
9	Stockpiles of materials would be stored in established stockpile areas.
10	Stockpile areas would be established on flat ground at least 40m from a watercourse, wetland or drainage line.
11	Stockpiles would be managed to control sediment and dust.
	Chemical Management and Water Quality
1	There would be no release of dirty water into drainage lines or waterways.
2	Sediment and erosion control would be implemented in accordance with safeguards outlined in Section 5.2.2 off this REF.

3	Effective measures would be put in place to prevent concrete or concrete leachate from entering waterways. Where concreting would occur adjacent to or within drainage channels and the lake foreshore, an impermeable barrier would be installed prior to work commencing to prevent movement of concrete leachate from the work areas. The barrier would be of an impermeable membrane such as black plastic covered bund. (Sediment fence or sandbags/earth would not provide an adequate barrier and should not be used as a single measure.)
4	Chemicals would be stored within an adequately bunded housing, which is covered to protect them from the weather. When in use on site, they would be stored within a mobile bund.
5	Chemical containers would be correctly labelled.
6	All concrete washout would occur within an adequately sized and bunded receptacle or sump that is lined with an impermeable liner such as plastic.
7	All concrete washouts would be located on flat ground at least 40m away from the waterway and drainage lines and on ground where the likelihood of flooding is low.
8	Concrete washouts would be emptied regularly to maintain capacity and the contents disposed of at a suitably licensed landfill.
9	Concrete washout would be emptied prior to rain events. They would be covered when not in use in the event of an unexpected rain event.
10	All relevant staff, including subcontractors, would be advised of the location of the concrete washout and the requirements for its use.
11	A dewatering plan would be developed, as part of the CEMP, that outlines: • How and when dewatering would occur • Where water from excavations would be stored, managed and disposed of • Water quality trigger values based on ANZECC guidelines for aquatic ecosystems – slightly disturbed estuaries in south east Australia. The dewatering plan would be reviewed and approved by WSC prior to work commencing.
12	Any sumps or sediment basins installed to receive water from excavations would be sized to the correct capacity leaving 20% freeboard and would be located on flat land where additional clearing of vegetation would not be required. Any additional clearing not covered by this REF would require further environmental assessment and approval from WSC.
	Contaminated Land and Acid Sulfate Soils
1	During construction, ASS is to be managed in accordance with the attached ASS Management Plan. (For information on excavation dewatering see mitigation measures outlined under Section 5.3.2.)
	Waste
1	Waste would be managed in accordance with the waste hierarchy established under the *Waste Avoidance & Resource Recovery Act 2001*: • Avoidance of unnecessary resource consumption. • Resource recovery, including reuse of materials, reprocessing and recycling • Disposal undertaken as a last resort.
2	Receptacles would be available on site during construction to enable easy segregation of wastes, i.e. recycling receptacle, receptacles for waste that can be

	reused.
3	Indigenous trees removed during clearing would be mulched and the resulting mulch used on site.
4	No waste material, other than vegetation and mulch, would be left on site once the works are complete.
5	Working areas would be maintained and kept free of rubbish and cleaned up at the end of each working day.
6	Excess sand, gravelly sand and clay removed during excavation would be disposed of at a facility licensed to accept general solid waste.
	Noise and Vibration
1	Consultation with nearby residents and sensitive receivers would be undertaken as early as possible prior to work commencing.
2	Measures would be undertaken, in accordance with the *DECC Interim Construction Noise Management Guideline,* by the contractor to reduce noise and vibration where possible. These measures could include such things as: • Selecting lower noise/vibration impact equipment and methods. • Informing potentially noise affected receivers about the nature of the construction stages and the duration of noisier activities. • Turning off plant and equipment when it is not being used. • Ensuring that plant, equipment and vehicles are regularly maintained and repair or replace equipment that becomes noisy. • Arranging the work site to minimise use of movement alarms on vehicles and mobile plant. • Locate noisy plant away from potentially noise affected neighbours or behind barriers such as existing dwellings, compound shed or walls. • Talking to site staff about noise and how it can be reduced.
	Biodiversity
1	Clearing of mature trees would be minimised to that absolutely necessary to undertake the work.
2	Tree cover would be maintained, as much as possible, on the northern side of the stormwater channels to maintain shade over open water.
3	Thinning of *C. glauca* would be restricted to trees with a dbh of 150mm or less.
4	Selective removal of *C. glauca* regrowth would be undertaken to minimise the impact on canopy connection.
5	The area to be cleared would be clearly marked out on the ground and exclusion fencing would be erected prior to clearing to reduce the risk of over clearing.
6	Exclusion fencing or sediment control fencing would be erected around vegetation that adjoins the construction area to minimise damage to vegetation that is retained.
7	Filling of channels would be undertaken with minimal compaction to reduce impact on existing trees adjacent to the channels.
8	All vehicles, construction materials and refuse would be kept within areas approved for construction
9	All contractors, sub-contractors and site personnel would be notified of vegetation

	protection measures.
10	Machinery used for clearing would be washed prior to entering the site to remove seeds.
11	A pre-clearing inspection would be undertaken immediately prior to clearing any vegetation. Any fauna found would be relocated to a predetermined safe location in adjacent bushland.
12	The final design would incorporate refuge areas at the lower end of existing stormwater channels to provide refuge areas for juvenile fish.
13	Filling of the stormwater channels would occur when the lake level is low and during a period of dry weather to ensure that the minimum amount of water is retained within the channel. Any fish residing in the channels shall be relocated to a predetermined safe location prior to work commencing.
14	Useable trees and shrubs which are felled would be re-used on site, either in log form or as woodchip mulch for erosion control and/or site rehabilitation. Non-salvageable material, such as roots and stumps may only be disposed of at an approved site.
15	Landscaping would include replanting with a diverse range of indigenous species of varying growth forms under and between existing trees to create a dense understorey and mid storey of indigenous plants which connect in a continuous north – south direction link.
16	Landscaping would include planting of indigenous trees identified by WSC as 'keystone species', i.e. *Eucalyptus robusta, Melaleuca quinquenerva, Banksia integrifolia* and *Acacia longifolia*. Other indigenous species that are part of the Swamp Oak Floodplain Forest Community, such as *Glochidian ferdinandi var. ferdinandi* and *Cupaniopsis anacardioides*, would also be planted due to their forage potential.
17	Replanting of indigenous trees to replace mature trees (>150mm dbh) would occur at a minimum of 2 or every 1 tree removed.
18	Planting under existing *C. glauca* that line the channels would be undertaken as part of landscaping for the proposal. Lower storey and groundcover plants would be selected for their ability to exclude weed growth, such *Lomandra longifolia*.
19	All weed material removed would be taken from the site and disposed of at a suitably licensed landfill. No weed material would be used in mulch.
20	Restoration of Coastal Saltmarsh would occur through an ongoing bush regeneration program.
	Non-Aboriginal Heritage
1	Exclusion fencing would be erected around the land based section of Mr Parry's wharf prior to any work commencing.
2	All relevant site staff would be made aware of the wharf structure and its heritage status.
3	If unexpected archaeological remains are uncovered during the works, all works would cease immediately within the vicinity of the material/find and WSC will be contacted immediately.
4	If any items defined as relics under the *NSW Heritage Act 1977* are uncovered during the works, all works must cease in the vicinity of the find and WSC environment officer

	would be contacted immediately.
	Aboriginal Heritage
1	Site staff involved in excavation would be made aware of the requirements for Aboriginal heritage outlined under the NPW Act and mitigation measures 2 and 3 outlined below.
2	If unexpected archaeological remains are uncovered during the works, all works would cease immediately within the vicinity of the material/find and the WSC will be contacted immediately.
3	If any items defined as relics under the *NSW Heritage Act 1977* are uncovered during the works, all works would cease in the vicinity of the find and the WSC will be contacted immediately.
	Construction Noise and Vibration
1	Consultation with nearby residents and sensitive receivers would be undertaken prior to work commencing.
2	Measures would be undertaken, in accordance with the DECC Interim Construction Noise Management Guideline, by the contractor to reduce noise and vibration where possible. These measures could include such things as: • Selecting lower noise/vibration impact equipment and methods. • Informing potentially noise affected receivers about the nature of the construction stages and the duration of noisier activities. • Turning off plant and equipment when it is not being used. • Ensuring that plant, equipment and vehicles are regularly maintained and repair or replace equipment that becomes noisy. • Arranging the work site to minimise use of movement alarms on vehicles and mobile plant. • Locate noisy plant away from potentially noise affected neighbours or behind barriers such as existing dwellings, compound shed or walls. • Talking to site staff about noise and how it can be reduced.
	Air Quality
1	Dust generating activities would not be undertaken during periods of strong or gusty winds.
2	When required, measures would be taken to minimise dust and other particulates, including covering or spraying exposed areas using a water cart.
3	Stockpiled materials would be managed to suppress dust emissions.
4	No burning would occur on site.
5	Vehicles transporting loose materials or waste would be covered during transportation.
6	Mud and dirt tracked onto sealed surfaces would be regularly removed.
7	Vehicles and machinery used on site would be regularly serviced and maintained.
	Traffic
1	Where possible, current traffic movements and property accesses are to be maintained during the works. Any disturbance is to be minimised to prevent unnecessary traffic delays.

	Visual Amenity
1	Landscaping of the foreshore reserve would occur and be designed to provide visual and physical connectivity. Flora species used in landscaping would be indigenous to the area and include keystone species identified by WSC.
2	Indigenous trees would be planted to offset the removal of trees (as outlined under Section 5.5.
	Climate Change and Other Natural Hazards
1	Construction would be scheduled for a period when there is an expected period of ongoing dry conditions and the potential for large rain events and flooding is low. The construction contractor would make daily reference to weather forecasts and ensure that measures outlined in the ESCP are implemented in the event of unexpected rainfall.
	Greenhouse Gas Emissions
1	As much as possible, products used in construction would be sourced locally.
2	Machinery and vehicles would be turned off when not in use to avoid using additional fuel through idling.

7.2 Recommended Management Plans

The following management plans and sub plans are recommended:

- Construction Environmental Management Plan (CEMP)

The CEMP should outline strategies and actions to address mitigation measures outlined in this REF. The following sub plans to the CEMP are recommended in this REF:

- Sediment and Erosion Control Plan
- Dewatering Plan

8 State and Commonwealth Environmental Factors

8.1 Consideration of Clause 228(2) of Environmental Planning & Assessment Regulation 2000

The table below provides an assessment of the factors outlined in Clause 228(2) of the *Environmental Planning & Assessment Regulation 2000* (EP&A Regs). Consideration of likely impacts of the proposal on the natural and built environment is a requirement of this legislation.

Factor	Impact
Any environmental impact on a community?	Minor negative short term. Positive long term.
Any transformation of a locality?	Minor negative short term. Positive long term.
Any environmental impact on the ecosystems of the locality?	Minor negative short term. Positive long term.
Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality?	Minor negative short term. Positive long term.
Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations?	Nil
Any impact on the habitat of protected fauna (within the meaning of the National Parks and Wildlife Act 1974)?	Minor negative short term. Positive long term.
Any endangering of species of animal, plant or other form of life, whether living on land, in water or in the air?	Nil.
Any long-term effects on the environment?	Nil.
Any degradation of the quality of the environment?	Nil.
Any risk to the safety of the environment?	Nil.
Any reduction in the range of beneficial uses of the environment?	Nil.
Any pollution of the environment?	Negligible short term. Positive long term.
Any environmental problems associated with the disposal of waste?	Nil.
Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply?	Nil.
Any cumulative environmental effect with other existing or likely future activities?	Minor negative short term.
Any impact on coastal processes and coastal hazards, including those under project climate change conditions?	Nil.

8.1.1 Matters of National Environmental Significance (EPBC Act)

The EPBC Act requires that the following matters of national environmental significance (MNES) be considered for a development proposal. This consideration assists in determining whether the proposal should be referred to the Commonwealth government as a possible controlled action.

Factor	Impact
Any impact on a World Heritage property?	No
Any impact on National Heritage place?	No
Any impact on a wetland of international importance?	No
Any impact on listed threatened species or communities?	No significant impact
Any impacts on listed migratory species?	No significant impact
Any impact on a Commonwealth marine area?	No
Does the proposal involve a nuclear action (including uranium mining)?	No
Any impact (direct or indirect) on Commonwealth land?	No

9 Conclusion

In considering the proposal to upgrade the stormwater infrastructure at Tuggerah Lakes, Long Jetty, as outlined in this REF, this assessment has taken into account, to the fullest extent possible, all matters affecting or likely to affect the environment from activities associated with the proposal.

This assessment has taken into account the factors outlined under Clause 228 of the *Environmental Planning and Assessment Regulation 2000*. The proposal will have some minor environmental impacts. However, these can be mitigated adequately and it is unlikely that there will be a significant impact to the environment. Therefore, approval is not considered required under Part 5.1 of the *Environmental Planning and Assessment Act*.

Critical habitat would not be impacted by this proposal. The proposal would not have a significant impact on threat listed species, threat listed populations and ecological communities and their habitat. Therefore, a species impact statement would not be required.

The activities described in this REF would not significantly affect Matters of National Environmental Significance or Commonwealth land. Therefore, there is no need to refer the proposal to the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA) for a decision by the Commonwealth Minister for the Environment, Heritage and the Arts and approval is not required under the *Environment Protection and Biodiversity Conservation Act 1999*.

10 Certification

This REF addresses, to the fullest extent possible, all matters affecting or likely to affect the environment as a result of the proposal.

Carolyn Donnelly
Principal Environmental Consultant
Beyond Environmental Consulting

Date:

I have examined this review of environmental factors and accept this document on behalf of Wyong Shire Council.

Sam Budden
Project Manager
Wyong Shire Council

Date:

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12 Acronyms and Terms

ASS	Acid Sulfate Soil
Biometric	The science of measuring and statistically analysing biological data
Blue Book	Landcom/Department of Housing Managing Urban Stormwater, Soils and Construction Guidelines
DCP	Development Control Plan
EP&A Act	*Environmental Planning and Assessment Act 1979*
ESCP	Erosion and Sediment Control Plan
ISEPP	*State Environmental Planning Policy (Infrastructure) 2007*
LEP	Local Environmental Plan
LG Act	*Local Government Act 1993*
MNES	Matter of National Environmental Significance
Mosaic burning	Controlled burning of vegetation to create patches of different fire histories
NPW Act	*National Parks and Wildlife Act 1974*
NSW	New South Wales
NW Act	*Noxious Weeds Act 1993*
Podzolic	Term applied to acid soils with strong texture contrast between sandy or loamy topsoil and clay subsoils. Associated colour descriptor, i.e. yellow or red, refers to dominant colour of subsoil
POEO Act	*Protection of the Environmental Operations Act 1997*
PoM	Draft Plan of Management for Community Land 2011
Proposal Site	The land that would be subject to the activities outlined in the REF.
REF	Review of Environmental Factors
Reg	Regulation
SEPP	State Environmental Planning Policy
Stepping Stones	Isolated patches of vegetation, single trees, wetlands or dams which become a wildlife corridor when the distance between them is small enough for some species to be able to move from one patch to the next.
Threat listed	A species, population or community listed as threatened under legislation
TSC Act	*Threatened Species Conservation Act 1995*
WSUD	Water Sensitive Urban Design

Appendix I: Detailed Design

Appendix II: Ecological Report

Appendix III: Geotechnical Report

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4 February 2015

Our ref: ENAUWARA04586AA-L02 FINAL

Wyong Shire Council
2 Hely Street
WYONG NSW 2259

Attention: Sam Budden

Dear Sam

IN SITU WASTE CLASSIFICATION AND ACID SULFATE SOILS ASSESSMENT
PROPOSED SWALE DRAINS AND GROSS POLLUTANT TRAP
LONG JETTY AND TOUKLEY, NSW

1. Introduction

1.1. General

This letter presents the findings of an In-Situ Waste Classification and Acid Sulfate Soil (ASS) Assessment undertaken by Coffey Environments Australia Pty Ltd (Coffey) for the following proposed works to be carried out by Wyong Shire Council (Council):

- Construction of a series of swale drains at Tuggerah Parade, Long Jetty NSW; and
- Construction of a gross pollutant trap (GPT) at Nicholson Crescent, Toukley NSW.

The works were commissioned by Council following a fee proposal submitted by Coffey (Reference ENAUWARA04586AA-P01 dated 19 December 2014).

The proposed works are designed to improve stormwater drainage along Tuggerah Parade and off Nicholson Crescent. Excavations of up to 1m in depth are proposed at Long Jetty and up to 2m at Toukley.

In order to assist in the offsite disposal of soils that will be excavated, Council requested the following works:

- A waste classification, in accordance with the NSW EPA (2014) *Waste Classification Guidelines*; and
- An ASS assessment, in accordance with the ASSMAC (1998) *Acid Sulfate Soils Manual*.

For the purposes of this assessment, the "sites" are referred to as the proposed construction areas at both Long Jetty and Toukley. The site layouts are shown on Figures 1 and 2, for Long Jetty and Toukley respectively.

1.2. Objectives

The objectives of the work were to:

- Provide a waste classification for soils proposed to be excavated at both sites;
- Provide an ASS assessment for soils proposed to be excavated at both sites; and
- Identify the need for management during excavation works at both sites (such as the need for an acid sulfate soils management plan).

1.3. Scope of works

In order to meet the above objectives, the following works were undertaken:

- A desktop review of the proposed works, ASS risk mapping and geomorphologic setting;
- Drilling of four boreholes at the Long Jetty site (LJHA1 to LJHA4) and one borehole at the Toukley site (THA1), and collection of representative soil samples;
- Laboratory analysis of selected samples for waste classification purposes;
- Field screening and laboratory analysis of selected soil samples for ASS purposes; and
- Preparation of this letter report.

2. Description of sites

2.1. Location and identification of sites

2.1.1. Long Jetty site

The Long Jetty site is located on the banks of Tuggerah Lake, along Tuggerah Parade between Lake Street and Gladstan Avenue, Long Jetty NSW. The site layout is shown on Figure 1 (attached). The site occupies part of Lot 22 DP 237466 and is approximately 8,000m^2 in area.

The Long Jetty site is located in a residential area and is currently used for recreational purposes.

2.1.2. Toukley site

The Toukley site is located off Nicholson Crescent, Toukley NSW. The site layout is shown on Figure 2 (attached). The site occupies part of Lot 537 DP 823164 and is approximately 300m^2 in area.

The Toukley site is located in a section of relic bushland surrounded by residential properties and is currently largely unused.

2.2. Site observations

Field investigations for both sites were carried out by a Coffey Environmental Scientist on 13 January 2015. Features noted at both sites are summarised in the sections below.

2.2.1. Long Jetty site

- The Long Jetty site consists of primarily open grassland with five existing swales located between Tuggerah Parade and Tuggerah Lake.
- Mahogany and eucalyptus trees line each of the swales, and are also present along the eastern boundary (along Tuggerah Parade).
- The site was being used sporadically for recreational purposes during the field investigations.
- The site also consists of a number of covered seating areas.

2.2.2. Toukley site

- The Toukley site is accessed from Nicholson Crescent via a vacant stretch of land between residences at No. 28 and No. 30.
- The site consists of large trees and shrubs, with a grass path located along the southern boundary.
- An open stormwater drain was located along the northern boundary, leading from the bushland to the east of the site. Water in the drain was not flowing during the time of the field investigations.

2.3. Topography and drainage

2.3.1. Long Jetty site

Reference to the Central Coast 1:25,000 Topographic Map indicates that the Long Jetty site is situated in a low-lying alluvial plain on the banks of Tuggerah Lake. The elevation of the site is less than 5m AHD. During the field investigations, the site surface was observed to be relatively flat.

Drainage at the site is anticipated to occur mainly via land infiltration. Excess water generated from heavy rainfall events is anticipated to flow towards the existing swale drains on the site and drain into Tuggerah Lake to the west of the site.

2.3.2. Toukley site

Reference to the Central Coast 1:25,000 Topographic Map indicates that the Toukley site is situated in a low-lying alluvial plain in a residential area north-east of the Toukley town centre. The elevation of the site is less than 10m AHD. During the field investigations, the site surface was observed to be relatively flat.

Drainage at the site is anticipated to occur mainly via land infiltration. Excess water generated from heavy rainfall events is anticipated to flow via the open stormwater drain on the site towards Budgewoi Lake, located approximately 1km west of the site.

2.4. Regional geology

2.4.1. Long Jetty site

Reference to the Gosford 1:100,000 Geological Map indicates that the Long Jetty site is underlain by Quaternary Alluvium deposits consisting of gravels, sands, silts and clays.

2.4.2. Long Jetty site

Reference to the Gosford 1:100,000 Geological Map indicates that the Toukley site is underlain by Quaternary Alluvium deposits consisting of gravels, sands, silts and clays.

2.5. Acid sulfate soil risk mapping

2.5.1. Long Jetty site

Reference to the Wyong ASS Risk Map indicates that the Long Jetty site is located in area of high probability of ASS being encountered within 1m of the ground surface.

2.5.2. Toukley site

Reference to the Toukley ASS Risk Map indicates that the Toukley site is situated in an area of low probability of ASS being encountered between 1m and 3m depth.

2.6. Hydrogeology

2.6.1. Long Jetty site

Groundwater beneath the Long Jetty site is anticipated to flow towards Tuggerah Lake, located along the western boundary of the site. During the field investigations, groundwater was encountered in alluvial sands and clays between 0.6m and 0.8m below ground surface (bgs).

2.6.2. Toukley site

Groundwater beneath the Toukley site is anticipated to flow towards Budgewoi Lake, located approximately 900m west of the site. During the field investigations, groundwater was encountered in gravelly sandy alluvial soils at approximately 0.75m bgs.

3. Background information on acid sulfate soils

3.1. Coastal acid sulfate soils

Coastal ASS are soils which contain significant concentrations of iron sulfide or pyrite which, when exposed to oxygen in the presence of sufficient moisture, oxidises, resulting in the generation of sulfuric acid. Unoxidised pyritic soils are referred to as potential ASS. When the soils are exposed, the oxidation of pyrite occurs and sulfuric acids are generated, and the soils are said to be actual ASS.

Pyritic soils typically form in waterlogged, saline sediments rich in iron and sulfate. Typical environments for the formation of these soils include tidal flats, salt marshes and mangrove swamps below about RL 5m AHD. They can also form as bottom sediments in coastal rivers and creeks.

Pyritic soils of concern on low lying NSW and coastal lands have mostly formed in the Holocene period, (i.e. 10,000 years ago to present day) predominantly in the 7,000 years since the last rise in sea level. It is generally considered that pyritic soils which formed prior to the Holocene period (i.e. >10,000 years ago) would already have oxidised and leached during periods of low sea level which occurred during ice ages, exposing pyritic coastal sediments to oxygen. There is still some potential for these older soils to contain stored acidity that could be released on exposure.

3.2. Significance of coastal acid sulfate soils

Disturbance or poorly managed development and use of coastal ASS can generate significant amounts of sulfuric acid, which can lower soil and water pH to extreme levels (generally <4) and produce acid salts, resulting in high salinity.

The low pH, high salinity soils can reduce or altogether preclude vegetation growth and can produce aggressive soil conditions which may be detrimental to concrete and steel components of structures, foundations, pipelines and other engineering works.

Generation of the acid conditions often releases aluminium, iron and other naturally occurring elements from the otherwise stable soil matrices. High concentrations of some such elements, coupled with low pH and alterations to salinity can be detrimental to aquatic life. In severe cases, affected waters flowing off-site into aquatic ecosystems can have a detrimental effect on aquatic ecosystems.

4. Field investigations and laboratory analysis

4.1. Field investigations

The field investigations were undertaken on 13 January 2015 by a Coffey Environmental Scientist. Table 1 below summarises the field investigations undertaken.

Table 1 – Summary of field investigations

Site	Borehole ID*	Approximate depth (m bgs)	No. of samples collected for waste classification (depths in brackets)	No. of samples collected for ASS field screening (depths in brackets)
Long Jetty	LJHA1	1.65	3 (0.0m, 0.5m, 1.0m)	3 (0.5m, 1.0m, 1.5m)
	LJHA2	1.1	3 (0.0m, 0.5m, 1.0m)	2 (0.5m, 1.0m)
	LJHA3	0.9	2 (0.0m, 0.5m)	2 (0.5m, 0.8m)
	LJHA4	0.8	2 (0.0m, 0.5m)	2 (0.5m, 0.7m)
Toukley	THA1	1.2	3 (0.0m, 0.5m, 1.0m)	2 (0.5m, 1.0m)

**Number of boreholes per site as specified by Council. The approximate locations of the boreholes are shown on Figures 1 and 2 for Long Jetty and Toukley respectively.*

The boreholes were drilled with a hand auger. Samples were collected directly off the auger, which was decontaminated between samples by rinsing with phosphate-free detergent and potable water. Soil samples for waste classification purposes were placed into laboratory-supplied glass jars. Samples collected for ASS purposes were placed into air-tight zip-lock plastic bags for the field screening test. A clean pair of disposable gloves was worn when collecting each sample. The samples were placed immediately on ice after being collected.

The Coffey Environmental Scientist logged each borehole and documented the site features.

4.2. Field screening

The ASS samples were returned to Coffey's Warabrook laboratory at the end of the fieldworks and placed into cold storage. A total of 10 soil samples (two from each borehole) were screened on 15 January 2015 in accordance with the methodology detailed in Appendix 1 of the Assessment Guidelines in the ASSMAC (1998) *Acid Sulfate Soils Manual*.

4.3. Laboratory analysis

4.3.1. Waste classification

The waste classification samples were dispatched to the NATA-accredited Eurofins MGT laboratory in Oakleigh, VIC. Ten samples (two from each borehole) were analysed for the following contaminants:

- Heavy metals;
- Total Recoverable Hydrocarbons (TRH);
- Benzene, Toluene, Ethylbenzene and Total Xylenes (BTEX); and
- Polycyclic Aromatic Hydrocarbons (PAH).

In addition, due to concentrations of benzo(a)pyrene and lead recorded in samples THA1 1.0-1.1 and QC1 respectively, Toxicity Characteristic Leaching Procedure (TCLP) tests were carried out on these samples.

4.3.2. Acid Sulfate Soils

In order to supplement the field screening results, three samples (two from the Long Jetty site and one from the Toukley site) were dispatched to the NATA-accredited Environmental Analysis Laboratory (EAL) in Lismore, NSW. The samples were analysed for ASS properties using the Chromium Reducible Sulfur (S_{CR}) method).

At the request of Council, an additional two samples from the Long Jetty site were analysed for electrical conductivity (EC).

5. Quality assurance / quality control

In order to assess field quality assurance / quality control (QA/QC) procedures for the waste classification component of the assessment, one duplicate sample (QC1) was taken of sample THA1 1.0-1.1. The results of the QA/QC analysis are presented in the attached Table LR2. The results indicated that the Relative Percentage Differences (RPD's) calculated for the contaminants tested were below the control limits of 50% with the exception of zinc, phenanthrene and total PAHs. This is inferred to be due to sample heterogeneity.

The laboratory conducted internal quality control using laboratory duplicates, spikes and method blanks. The laboratory internal quality control showed method blank results below the laboratory limit of reporting, and. spike recoveries within control limits. Laboratory duplicates were within acceptable RPD's.

Based on the review of the QA/QC data, it is considered that the soil results are likely to be representative of conditions at the sampling locations at the time of sampling and are suitable for use in the waste classification component of the assessment.

6. Results of investigation

6.1. Subsurface conditions

The borehole logs are attached. The subsurface conditions encountered at both sites during the assessment are summarised below in Tables 2 and 3.

Table 2 – Summary of subsurface conditions – Long Jetty site

Unit	Soil type	Description	Approximate depth range (m)
1	Alluvium	Sand and gravelly sand, fine to coarse grained, pale to dark brown and yellow (including some shells encountered in LJHA3)	0.0-0.7
2	Alluvium	Sandy Clay, fine to coarse grained, low to medium plasticity, pale grey to grey	0.7->1.65

Table 3 – Summary of subsurface conditions – Toukley site

Unit	Soil type	Description	Approximate depth range (m)
1	Alluvium	Gravelly sand, fine to coarse grained, brown, fine to medium grained gravel	0.0-0.9
2	Alluvium	Clay, low to medium plasticity, black	0.9->1.2

Groundwater inflows were encountered in each of the boreholes, ranging from approximately 0.6m bgs (in LJHA2m LJHA3 and LJHA4) to approximately 0.8m (in LJHA1) at the Long Jetty site, and at approximately 0.75m bgs at the Toukley site. It should be noted that variations in groundwater depth may occur due to factors such as rainfall and climatic conditions and tidal influence.

The target borehole depth of 2m across the two sites was not reached during the drilling due to collapse of the boreholes within the water tables.

6.2. Acid sulfate soil field screening results

The ASS field screening results are attached. The results for both sites are summarised in the sections below.

6.2.1. Long Jetty site

- Samples in a 1:5 mixture with distilled water were generally recorded at a pH of between 5.48 and 6.91 pH Units, being acidic. A pH less than or equal to 4 is likely to indicate the presence of Actual Acid Sulfate Soils (AASS);
- A final pH ranging between 2.41 and 4.65 pH Units, low to high temperatures (<35℃ to >90℃), some visible effervescence, some colour changes, and no odours after oxidation in hydrogen peroxide were observed for the samples. A final pH of less than 3.5 can be indicative of Potential Acid Sulfate Soils (PASS); and
- The total pH drop was in the range of 0.83 and 4.27 pH units.

The field screening results indicated that there was a possibility of ASS being encountered in soils from just below the grass cover to approximately 2m depth. In order to supplement the screening results, two samples were dispatched for laboratory analysis.

6.2.2. Toukley site

- Samples in a 1:5 mixture with distilled water were generally recorded at a pH of between 5.42 and 5.99 pH Units, being acidic. A pH less than or equal to 4 is likely to indicate the presence of Actual Acid Sulfate Soils (AASS);
- A final pH ranging between 2.64 and 3.3 pH Units, low to high temperatures (<40℃), some visible effervescence, some colour changes, and no odours after oxidation in hydrogen peroxide were observed for the samples. A final pH of less than 3.5 can be indicative of Potential Acid Sulfate Soils (PASS); and
- The total pH drop was in the range of 2.12 and 3.35 pH units.

The field screening results indicated that there was a possibility of ASS being encountered in soils from below the grass cover to approximately 2m depth. In order to supplement the screening results, two samples were dispatched for laboratory analysis.

6.3. Laboratory results – waste classification

6.3.1. Long Jetty site

The waste classification laboratory results for the Long Jetty site are presented in Table LR1 (attached). The laboratory report is also attached. The results were compared to the Contaminant Threshold (CT) values for General Solid Waste published in the NSW EPA (2014) *Waste Classification Guidelines – Part 1: Classifying Waste.*

The laboratory results indicated that concentrations of heavy metals, TRH, BTEX and PAH were below the CT values for General Solid Waste.

6.3.2. Toukley site

The waste classification laboratory results for the Toukley site are also included in Table LR1 and the attached laboratory report. The laboratory results indicated that:

- Concentrations of heavy metals, TRH, BTEX and PAH were below the CT values for General Solid Waste in sample THA1 0.0-0.1; and
- Concentrations of benzo(a)pyrene in sample THA 1.0-1.1 were recorded above the CT values for General Soil Waste, but below the CT values for restricted solid waste.

In order to compare the benzo(a)pyrene levels in THA1 1.0-1.1 to the Specific Contaminant Concentration (SCC) values, TCLP testing for benzo(a)pyrene leachability has been arranged. The TCL results were recorded below the SCC criteria for General Solid Waste.

Coffey also notes that while the concentrations of lead in the primary sample THA1 1.0-1.1 were recorded below the CT values for General Solid Waste, the concentrations of lead in the corresponding duplicate sample QC1 were recorded above the CT values (but below the CT values for Restricted Solid Waste). TCLP testing for lead leachability was therefore carried out on sample QC1. The results of the TCLP testing indicate that the lead concentrations were below the Specific Contaminant Concentration (SCC) values for General Solid Waste.

6.4. Laboratory results - acid sulfate soils

6.4.1. Long Jetty site

In order to supplement the ASS field screening results, two samples from the Long Jetty site were submitted for laboratory analysis using the S_{CR} method. The results were compared to the action criteria provided in the ASSMAC (1998) *Acid Sulfate Soils Manual*, based on conservatively greater than 1,000 tonnes of coarse texture soils to be disturbed.

The laboratory report is attached. The results have been summarised below in Table 4.

Table 4 – Summary of acid sulfate soil laboratory results – Long Jetty site

Sample ID	Depth	Laboratory Results				
		pH in KCl	TAA (moles/tonne)	% SCR	Net Acidity (moles/tonne)	Liming Rate (kg $CaCO_3$/tonne)
LJHA2	1.0-1.1	8.38	0	1.886	954	71.5
LJHA4	0.5-0.6	7.43	0	2.078	1154	86.5
ACTION CRITERIA			18	0.03	18	

Note: KCl: potassium chloride solution; TAA: titratable actual acidity; SCR: chromium reducible sulfur. Liming Rates include a Factor of Safety of 1.5. Shaded values exceed the action criteria.

6.4.2. Toukley site

In order to supplement the ASS field screening results, one sample from the Toukley site was submitted for laboratory analysis using the S_{CR} method. The results were compared to the action criteria provided in the ASSMAC (1998) *Acid Sulfate Soils Manual*, based on conservatively greater than 1,000 tonnes of coarse texture soils to be disturbed.

The laboratory report is attached. The results have been summarised below in Table 5.

Table 5 – Summary of acid sulfate soil laboratory results – Toukley site

Sample ID	Depth	Laboratory Results				
		pH in KCl	TAA (moles/tonne)	% SCR	Net Acidity (moles/tonne)	Liming Rate (kg $CaCO_3$/tonne)
THA1	1.0-1.1	4.88	59	0.223	198	14.8
ACTION CRITERIA			18	0.03	18	

6.5. Electrical conductivity results

At Council's request, two samples considered to be representative of the subsurface soils encountered at the Long Jetty site (LHJA1 0.5-0.6 and LJHA3 0.8-0.9) were dispatched to EAL. The laboratory report is attached and Table 6 below summarises the results.

Table 6 – Electrical conductivity results – Long Jetty site

Sample ID	Depth (m bgs)	Material	Electrical conductivity (mS/cm)
LJHA1	0.5-0.6	Sand	0.239
LJHA3	0.8-0.9	Clay	0.198

7. Conclusion and recommendations

7.1. Long Jetty site

7.1.1. Waste classification

According to the procedure outlined in the NSW EPA (2014) *Waste Classification Guidelines*, the following is assessed:

- The material assessed is not a Special Waste;
- The material assessed is not a Liquid Waste;
- The material assessed is not a Pre-classified Waste; and
- The material assessed does not possess hazardous characteristics.

Based on the results of the assessment, the waste classification for the Long Jetty site is provided in Table 7 below.

Table 7 – Waste classification of subsurface soils- Long Jetty site

Material	Approximate depth range (m bgs)	Waste classification	Disposal options
Sand and gravelly sand	0.0-0.7	General Solid Waste	Disposal to facility licensed to accept General Solid Waste
Clay	0.7->1.65	General Solid Waste	Disposal to facility licensed to accept General Solid Waste

Coffey notes that the material contains potential ASS, which will require treatment prior to offsite disposal. This is discussed further in Section 7.1.2 below and in the attached Acid Sulfate Soil Management Plan (ASSMP).

7.1.2. Acid sulfate soils

Based on the field observations and field screening results, supplemented by the laboratory results, potential ASS appear to be present at the site, in alluvial sands and clays from below the grass cover to at least 1.65m bgs. As the ASS is likely to be disturbed during excavation works, an ASSMP is required. An ASSMP is attached to this report.

7.1.3. Electrical conductivity

The electrical conductivity results were compared to the soil salinity classes provided in Table 6.2 of the Department of Land and Water Conservation (2002) *Site Investigations for Urban Salinity*. Table 6.2 indicates that soils with an electrical conductivity level of <2 mS/cm are considered non-saline, and that salinity effects are mostly negligible.

Based on the electrical conductivity results for the Long Jetty site, the soils are not considered to be saline and are therefore not anticipated to have a significant adverse impact on plant growth due to salinity.

7.2. Toukley site

7.2.1. Waste classification

According to the procedure outlined in the NSW EPA (2014) *Waste Classification Guidelines*, the following is assessed:

- The material assessed is not a Special Waste;
- The material assessed is not a Liquid Waste;
- The material assessed is not a Pre-classified Waste; and
- The material assessed does not possess hazardous characteristics.

Based on the results of the assessment, the waste classification for the Toukley site is provided in Table 8 below.

Table 8 – Waste classification of subsurface soils- Toukley site

Material	Approximate depth range (m bgs)	Waste classification	Disposal options
Gravelly sand	0.0-0.9	General Solid Waste	Disposal to facility licensed to accept General Solid Waste
Clay	0.9->1.2	General Solid Waste	Disposal to facility licensed to accept General Solid Waste

Coffey notes that the material contains potential ASS, which will require treatment prior to offsite disposal. This is discussed further in Section 7.2.2 below and in the attached Acid Sulfate Soil Management Plan (ASSMP).

7.2.2. Acid sulfate soils

Based on the field observations and field screening results, supplemented by the laboratory results, potential ASS appear to be present at the site, in alluvial sands and clays from below the grass cover to at least 1.2m bgs, and is anticipated to extend to 2m depth based on the subsurface conditions encountered. As the ASS is likely to be disturbed during excavation works, an ASSMP is required. An ASSMP is attached to this report.

8. Limitations

The extent of testing associated with this assessment is limited to discrete borehole locations, and variations in ground conditions can occur between and away from such locations. If conditions other than those described in this report are encountered during construction, further advice should be sought without delay. This letter should be read in conjunction with the attached sheet entitled *"Important Information about Your Coffey Environmental Report"*.

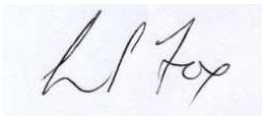
This report was prepared for Wyong Shire Council with the objectives of providing a waste classification for soils proposed to be excavated at both sites, providing an ASS assessment for soils proposed to be excavated at both sites, and identify the need for management during excavation works at both sites (such as the need for an acid sulfate soils management plan). No warranty, expressed or implied, is made as to the information and professional advice included in this report. Anyone using this document does so at their own risk and should satisfy themselves concerning its applicability and, where necessary, should seek expert advice in relation to the particular situation.

This report does not cover hazardous building materials issues. Information within the report including borehole logs should not be used for geotechnical investigation purposes.

If you have any questions regarding this report, please do not hesitate to contact the undersigned on (02) 4016 2300.

For and on behalf of Coffey

Damien Hendrickx
Senior Environmental Scientist



Laurie Fox
Principal Geoenvironmental Scientist

Attachments:
Important Information about your Coffey Environmental Report
Acid Sulfate Soil Management Plan
Table LR1 – Soil Analytical Results
Table LR2 – QA/QC Results
Figure 1 – Sample Plan (Long Jetty)
Figure 2 – Sampling Plan (Toukley)
Borehole Logs
Acid Sulfate Soil Field Screening Results
Laboratory Reports

Important information about your **Coffey** Environmental Report

Introduction

This report has been prepared by Coffey for you, as Coffey's client, in accordance with our agreed purpose, scope, schedule and budget.

The report has been prepared using accepted procedures and practices of the consulting profession at the time it was prepared, and the opinions, recommendations and conclusions set out in the report are made in accordance with generally accepted principles and practices of that profession.

The report is based on information gained from environmental conditions (including assessment of some or all of soil, groundwater, vapour and surface water) and supplemented by reported data of the local area and professional experience. Assessment has been scoped with consideration to industry standards, regulations, guidelines and your specific requirements, including budget and timing. The characterisation of site conditions is an interpretation of information collected during assessment, in accordance with industry practice,

This interpretation is not a complete description of all material on or in the vicinity of the site, due to the inherent variation in spatial and temporal patterns of contaminant presence and impact in the natural environment. Coffey may have also relied on data and other information provided by you and other qualified individuals in preparing this report. Coffey has not verified the accuracy or completeness of such data or information except as otherwise stated in the report. For these reasons the report must be regarded as interpretative, in accordance with industry standards and practice, rather than being a definitive record.

Your report has been written for a specific purpose

Your report has been developed for a specific purpose as agreed by us and applies only to the site or area investigated. Unless otherwise stated in the report, this report cannot be applied to an adjacent site or area, nor can it be used when the nature of the specific purpose changes from that which we agreed.

For each purpose, a tailored approach to the assessment of potential soil and groundwater contamination is required. In most cases, a key objective is to identify, and if possible quantify, risks that both recognised and potential contamination pose in the context of the agreed purpose. Such risks may be financial (for example, clean up costs or constraints on site use) and/or physical (for example, potential health risks to users of the site or the general public).

Limitations of the Report

The work was conducted, and the report has been prepared, in response to an agreed purpose and scope, within time and budgetary constraints, and in reliance on certain data and information made available to Coffey.

The analyses, evaluations, opinions and conclusions presented in this report are based on that purpose and scope, requirements, data or information, and they could change if such requirements or data are inaccurate or incomplete.

This report is valid as of the date of preparation. The condition of the site (including subsurface conditions) and extent or nature of contamination or other environmental hazards can change over time, as a result of either natural processes or human influence. Coffey should be kept appraised of any such events and should be consulted for further investigations if any changes are noted, particularly during construction activities where excavations often reveal subsurface conditions.

In addition, advancements in professional practice regarding contaminated land and changes in applicable statues and/or guidelines may affect the validity of this report. Consequently, the currency of conclusions and recommendations in this report should be verified if you propose to use this report more than 6 months after its date of issue.

The report does not include the evaluation or assessment of potential geotechnical engineering constraints of the site.

Interpretation of factual data

Environmental site assessments identify actual conditions only at those points where samples are taken and on the date collected. Data derived from indirect field measurements, and sometimes other reports on the site, are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact with respect to the report purpose and recommended actions.

Variations in soil and groundwater conditions may occur between test or sample locations and actual conditions may differ from those inferred to exist. No environmental assessment program, no matter how comprehensive, can reveal all subsurface details and anomalies. Similarly, no professional, no matter how well qualified, can reveal what is hidden by earth, rock or changed through time.

The actual interface between different materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but

steps can be taken to reduce the impact of unexpected conditions.

For this reason, parties involved with land acquisition, management and/or redevelopment should retain the services of a suitably qualified and experienced environmental consultant through the development and use of the site to identify variances, conduct additional tests if required, and recommend solutions to unexpected conditions or other unrecognised features encountered on site. Coffey would be pleased to assist with any investigation or advice in such circumstances.

Recommendations in this report

This report assumes, in accordance with industry practice, that the site conditions recognised through discrete sampling are representative of actual conditions throughout the investigation area. Recommendations are based on the resulting interpretation.

Should further data be obtained that differs from the data on which the report recommendations are based (such as through excavation or other additional assessment), then the recommendations would need to be reviewed and may need to be revised.

Report for benefit of client

Unless otherwise agreed between us, the report has been prepared for your benefit and no other party. Other parties should not rely upon the report or the accuracy or completeness of any recommendation and should make their own enquiries and obtain independent advice in relation to such matters.

Coffey assumes no responsibility and will not be liable to any other person or organisation for, or in relation to, any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report.

To avoid misuse of the information presented in your report, we recommend that Coffey be consulted before the report is provided to another party who may not be familiar with the background and the purpose of the report. In particular, an environmental disclosure report for a property vendor may not be suitable for satisfying the needs of that property's purchaser. This report should not be applied for any purpose other than that stated in the report.

Interpretation by other professionals

Costly problems can occur when other professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, a suitably qualified and experienced environmental consultant should be retained to explain the implications of the report to other professionals referring to the report and then review plans and specifications produced to see how other professionals have incorporated the report findings.

Given Coffey prepared the report and has familiarity with the site, Coffey is well placed to provide such assistance. If another party is engaged to interpret the recommendations of the report, there is a risk that the contents of the report may be misinterpreted and Coffey disowns any responsibility for such misinterpretation.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, laboratory data, drawings, etc. are customarily included in our reports and are developed by scientists or engineers based on their interpretation of field logs, field testing and laboratory evaluation of samples. This information should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

This report should be reproduced in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties.

Responsibility

Environmental reporting relies on interpretation of factual information using professional judgement and opinion and has a level of uncertainty attached to it, which is much less exact than other design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. As noted earlier, the recommendations and findings set out in this report should only be regarded as interpretive and should not be taken as accurate and complete information about all environmental media at all depths and locations across the site.

ATTACHMENT 1 – ACID SULFATE SOIL MANAGEMENT PLAN

1. Introduction

The following ASSMP has been prepared for the use of Wyong Shire Council during the following proposed works:

- Construction of a series of swale drains at Tuggerah Parade, Long Jetty NSW; and
- Construction of a gross pollutant trap (GPT) at Nicholson Crescent, Toukley NSW.

This ASSMP should be read in conjunction with the In-Situ Waste Classification and Acid Sulfate Soil Assessment Letter Report prepared by Coffey Environments Australia Pty Ltd (Coffey), reference ENAUWARA04586AA-L01 dated 28 January 2015.

This ASSMP presents the approach and methodology for ASS management at the site to be followed by the contactor and its subcontractors. It provides a basis for specifications for ASS management. However, it is important to note that this document is not a specification.

The objective of the ASSMP is to lower the potential environmental impacts associated with the disturbance of ASS during the proposed excavations. The ASSMP was developed generally in accordance with the Acid Sulfate Soil Manual published by the Acid Sulfate Soils Management Advisory Committee (ASSMAC 1998).

1.1. Occurrence of potential acid sulfate soils at each site

Excavations of up to approximately 1m depth are proposed at the Long Jetty site, and up to approximately 2m at the Toukley site. Potential ASS has been identified by Coffey at both the Long Jetty and Toukley sites, which is likely to be disturbed during construction. The potential ASS was identified in both shallow sandy and gravelly alluvial soils from below the surface grass cover to depths of approximately 0.7m to 0.9m below ground surface (bgs), and in deeper clay alluvial soils.

2. Management of excavated acid sulfate soils

Excavated soils should be either placed in temporary stockpiles or transported directly to a specially prepared treatment area for liming. Based on the proposed excavation areas and depths, we estimate the following in-situ volumes for each site:

- Long Jetty site – 1,000m^3; and
- Toukley site – 20m^3.

These volume estimates do not include a bulking factor and are based on the current level of information. It should be noted that volume estimates could vary and should be considered indicative only.

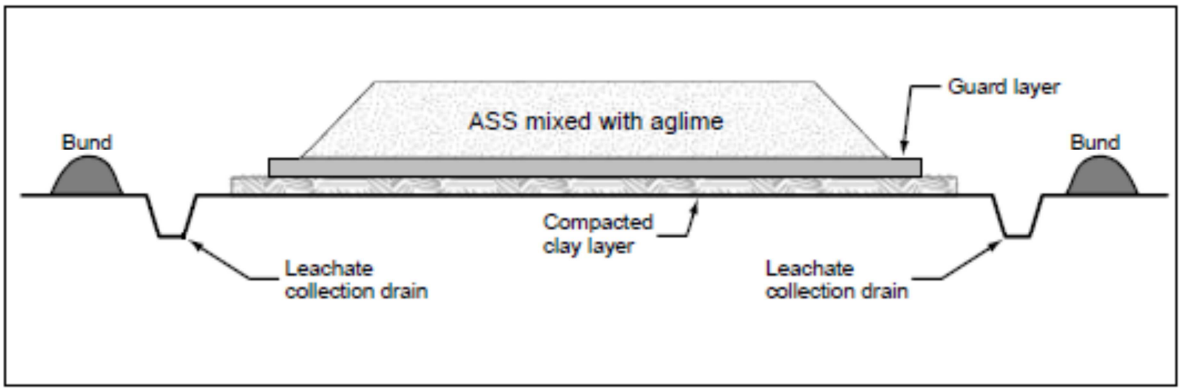
2.1. Establishment of treatment pads

Bunded, impervious treatment areas should be constructed for the purpose of treatment/neutralisation of ASS, or to store ASS material that would remain onsite for longer than 5 days before treatment.

Treatment areas should be constructed using impervious clay or plastic sheeting as a base. The treatment area should be suitably bunded to prevent stormwater from entering or leaving the area.

The treatment area should include installation of a leachate collection settlement pond to collect runoff. The treatment area should be graded towards the leachate pond for efficient drainage. The settlement leachate pond should be designed to capture and store runoff from a 1 in 10 year, 1 hour storm duration event. Leachate runoff collected in the settlement pond should be assessed prior to disposal (refer to the sections below) of the settlement pond. Sediment removed from the leachate pond should also be assessed for the presence of ASS.

The treatment pad should be constructed as per the cross-section below.



Cross-Section: Treatment Pad Design, based on QASSIT (2014) Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines

Notes:

- **Guard layer** consists spreading of lime across the top of compacted clay layer base to minimise vertical infiltration of ASS.
- **Leachate ponds** for both sites should not exceed 2m x 2m x 0.3m deep.
- Material will need to be imported to each site to construct the bunds around the treatment pads given that ASS is present from the surface at each site.

2.2. Temporary stockpiling

Where temporary stockpiling exceeds a few days, the excavated soils should be bunded and covered with plastic to help slow the oxidation process. Where extended periods of stockpiling occur (i.e. greater than one week) the soils should be removed to a treatment area and lime applied. Appropriate stormwater and sediment controls should be in place. Extended periods of stockpiling may require leachate collection and monitoring. Where monitoring of the leachate indicates low pH, the addition of a neutralising agent (eg lime) will be required prior to discharge to stormwater.

Where temporary stockpiles are created, stockpiles should be placed on relatively level ground, and away (e.g. at least 40m) from nearby waterways. Stockpile heights should be kept to a maximum of 2m, and stockpile areas should be bunded with appropriate sediment controls such as silt fences or hay bales.

2.3. Liming methodology

A suitable supply of lime should be available on site during the construction works in order to enable efficient neutralisation of ASS. A lime register should be maintained by the contractor in order to record the amount of lime delivered to the site.

The type and amount of lime to be applied will be such that a neutralising value (NV) of 100 can be achieved. NV relates to the purity of the lime and an NV of 95 to 100 is required to ensure that the lime is effective in neutralising the potential acid. Fine powdered agricultural lime ($CaCO_3$) generally has an NV of 90% to 100% whilst other manufactured forms of lime can have an NV as low as 80%. Where NV is below 100, the factor of safety, hence the amount of lime, will have to be adjusted accordingly.

Liming should be undertaken inside a treatment pad constructed as outlined above. The following liming procedures (or other equivalent) should be undertaken:

- Spreading of the soil in thin (<200mm) layers within the boundary of the site works; and
- Addition of lime followed by mixing, using backhoe bucket or equivalent. The amount of lime to be added has been calculated (from laboratory testing) to be as follows (to account for incomplete mixing):
  - Long Jetty site – Approximately **87 kg $CaCO_3$/tonne.**
  - Toukley site - Approximately **15 kg $CaCO_3$/tonne.**

  We note that this liming rate includes a factor of safety of 1.5.

2.4. Offsite disposal or reuse of acid sulfate soils

2.4.1. Offsite disposal

Once treated with lime the soils may be disposed of to an appropriately licensed landfill. A final pH test should be carried out following liming to verify that the soils have been appropriately treated. A waste classification for the soils proposed to be excavated has been provided in the In-Situ Waste Classification and Acid Sulfate Soil Assessment Letter Report prepared by Coffey, reference ENAUWARA04586AA-L01 dated 28 January 2015. The soils have been classified as General Solid Waste.

Following offsite disposal of the acid sulfate soils, no further testing is required for acid sulfate soil purposes. No verification testing is required for soils that will be disposed to landfill after treatment. The lime register is to be included with the waste classification for presentation at the landfill.

2.4.2. Reuse of treated soils onsite

The following monitoring programme (or other approved equivalent) is recommended for lime treated material where the material is to be reused on site for structural or general filling above the water table, prior to its placement:

- Monitoring of soil pH daily for four weeks. The monitoring frequency may be revised based on the results of the monitoring.

In order to demonstrate that appropriate quantities of lime have been used, a lime register should be maintained by the Contractor. The register shall list all lime delivered to the site, verified by delivery dockets, and where the lime has been used. The lime usage shall quantify areas limed and soil volumes treated, liming rates and quantities of lime used. The lime register shall be a verifiable performance indicator and extracts may be used in a final environmental report.

Verification testing of the soil, using chromium suite analysis, should also be carried out, either during or after the treatment programme. The verification testing should be carried out by a suitably trained environmental consultant.

Material may be reused on site once the above criteria are met.

2.5. Management of Dewatering Activities

Based on the proposed works, groundwater is likely to be encountered and some dewatering may be required from the excavations. Groundwater pH levels should be monitored prior to dewatering.

If there is a potential for the groundwater table to be lowered for considerable period of time (several weeks or months) the Contractor should install and/or employ an appropriate groundwater control system to minimise the ingress of groundwater into the excavation such that the surrounding groundwater table will be maintained. The surrounding groundwater level should be monitored regularly by the Contractor, and this would involve monitoring from nearby existing wells or installation of monitoring wells. The Contractor should also endeavour to minimise the length of dewatering where possible.

Options for disposal of groundwater include:

- Land irrigation;
- Disposal to Tuggerah Lake (for the Long Jetty site) or local stormwater systems (for both sites); and
- Offsite disposal to a wastewater disposal facility.

Coffey considers that the most effective option for the Long Jetty site would be either land irrigation (given the availability of suitable areas) or disposal to Tuggerah Lake (given the proximity of the lake to the site). Disposal options should be based on the results of sampling from both the groundwater and the receiving water. Specific approval from Council or other regulatory authorities may be required for discharge, as well as pH adjustment and regular monitoring of pH levels of the water within Tuggerah Lake.

Coffey considers that the most effective option for the Toukley site would be land irrigation, as there is sufficient available areas to irrigate, as well as assisting in maintaining groundwater levels, approval from Council or other regulatory authorities would not be required, and pH adjustment would not be required. Suitability for irrigation should be based on the results of sampling and analysis of groundwater.

Should groundwater require pH adjustment prior to disposal offsite or to stormwater or nearby water bodies, the following general procedures should be followed:

- Water should be placed in an acid-resistant holding tank or pond, and samples collected to assess the pH, electrical conductivity, chloride sulfate ions, and heavy metals;
- Should pH adjustment be required, a neutralising agent should be added to the water at a rate assessed from the results of the testing and Table 7.1 of Management Guidelines in the ASSMAC (1998) *Acid Sulfate Soils Manual* (a copy is attached);
- Following treatment, the water should be re-sampled and tested again for pH, electrical conductivity and metals to assess the disposal options;
- Depending on the laboratory results, the treated water could either be applied to land, discharged to stormwater or nearby water bodies, or be removed and disposed by a licensed liquid waste contractor. Permission from the relevant regulatory authority (i.e. NSW Office of Water and/or Wyong Shire Council) must be obtained before disposal to stormwater networks or water bodies.

2.6. Monitoring and Reporting

Complete records of all testing, treatment and monitoring should be kept by the contractor including:

- The lime register;
- Results of verification testing; and
- Reports

Attached: Table 7.1 Acid Sulfate Soil Manual (1998)

Table LR1
Soil Analytical Results
Wyong Shire Council Proposed Swales and GPT
ENAUWARA04586AA

						Field_ID	LJHA1_0.0-0.1	LJHA1_1.0-1.1	LJHA2_0.5-0.6	LJHA2_1.0-1.1	LJHA3_0.0-0.1	LJHA3_0.5-0.6	LJHA4_0.0-0.1	LJHA4_0.5-0.6	THA1_0.0-0.1	THA1_1.0-1.1
						Sampled_Date-Time	13/01/2015	13/01/2015	13/01/2015	13/01/2015	13/01/2015	13/01/2015	13/01/2015	13/01/2015	13/01/2015	13/01/2015
						SampleCode	M15-Ja04867	M15-Ja04868	M15-Ja04869	M15-Ja04870	M15-Ja04871	M15-Ja04872	M15-Ja04873	M15-Ja04874	M15-Ja04875	M15-Ja04876
				NSW 2008 General Solid Waste (No Leaching)	NSW 2008 General Solid Waste (with leached)											
Method_Type	**ChemName**	**Units**	**EQL**													
Heavy Metal	Arsenic	mg/kg	2	100	500		<2	2.8	<2	8.7	2.4	<2	3.1	12	2.3	5.9
	Cadmium	mg/kg	0.4	20	100		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
	Chromium	mg/kg	5				<5	<5	<5	13	<5	<5	<5	18	<5	9
	Copper	mg/kg	5				<5	<5	<5	6.6	<5	<5	<5	10	8	17
	Lead	mg/kg	5	100	1500		<5	<5	<5	12	<5	<5	<5	14	24	80
	Lead TCLP (QC1 result)	mg/L	0.01		5		-	-	-	-	-	-	-	-	-	0.14
	Mercury	mg/kg	0.1	4	50		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Nickel	mg/kg	5	40	1050		<5	<5	<5	<5	<5	<5	<5	7.8	<5	5.6
	Zinc	mg/kg	5				5.8	7	<5	31	<5	<5	8	44	49	100
Inorganic	Moisture Content (dried @ 103°C)	%	0.1				12	19	16	39	17	17	26	38	30	35
ESDAT Combined Compounds	Monocylic aromatic hydrocarbons EPAVic	mg/kg					<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
	Polycylic aromatic hydrocarbons EPAVic	mg/kg					<7.5	<7.5	<7.5	<7.5	<7.5	<7.5	<7.5	<7.5	4.25	12.65
	Carcinogenic PAHs as B(a)P TPE	mg/kg					<1.21	<1.21	<1.21	<1.21	<1.21	<1.21	<1.21	<1.21	<1.21	1.386
Organic	Naphthalene	mg/kg	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	TRH C6-C10 less BTEX (F1)	mg/kg	20				<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	TRH >C10-C16 less Naphthalene (F2)	mg/kg	50				<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	TRH C6 - C10	mg/kg	20				<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	TPH >C10 - C16	mg/kg	50				<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	TRH >C16 - C34	mg/kg	100				<100	<100	<100	<100	<100	<100	<100	<100	200	350
	TRH >C34 - C40	mg/kg	100				<100	<100	<100	<100	<100	<100	<100	<100	150	210
	TRH C6 - C9	mg/kg	20	650	650		<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
PAH	Acenaphthene	mg/kg	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Acenaphthylene	mg/kg	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Anthracene	mg/kg	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Benzo(a)anthracene	mg/kg	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.8
	Benzo(a)pyrene	mg/kg	0.5	0.8	10		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.9
	Benzo(a)pyrene TCLP	mg/L	0.001		0.004		-	-	-	-	-	-	-	-	-	<0.001
	Benzo(a)pyrene TEQ (lower bound) *	MG/KG	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.1
	Benzo(a)pyrene TEQ (medium bound) *	MG/KG	0.5				0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	1.4
	Benzo(a)pyrene TEQ (upper bound) *	MG/KG	0.5				1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.7
	Benzo(g,h,i)perylene	mg/kg	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.8
	Benzo(k)fluoranthene	mg/kg	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Chrysene	mg/kg	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.3
	Benzo[b+j]fluoranthene	mg/kg	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6
	Dibenz(a,h)anthracene	mg/kg	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Fluoranthene	mg/kg	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	2.1
	Fluorene	mg/kg	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Indeno(1,2,3-c,d)pyrene	mg/kg	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
	Naphthalene	mg/kg	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Phenanthrene	mg/kg	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.8
	Pyrene	mg/kg	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	2.7
	Total PAHs	mg/kg	0.5	200	200		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1	12
TPH	TRH C10 - C14	mg/kg	20				<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	TRH C15 - C28	mg/kg	50				<50	<50	<50	<50	<50	<50	<50	<50	110	190
	TRH C29 - C36	mg/kg	50				<50	<50	<50	<50	<50	<50	<50	<50	170	260
	TRH C10 - C36 (Sum of total)	mg/kg	50	10,000	10000		<50	<50	<50	<50	<50	<50	<50	<50	280	450
Volatile	Benzene	mg/kg	0.1	10	18		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Ethylbenzene	mg/kg	0.1	600	1080		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Toluene	mg/kg	0.1	288	518		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Xylene (m & p)	mg/kg	0.2				<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Xylene (o)	mg/kg	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Xylene Total	mg/kg	0.3	1000	1800		<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3

Value	Exceeds General Solid Waste (no leaching)
Value	Exceeds General Solid Waste (with leaching)

Criteria:
NSW EPA (2014) Waste Classification Guidelines - Part 1: Classifying Waste

Table LR2
QA/QC Results
Wyong Shire Council Proposed Swales and GPT
ENAUWARA04586AA

Field Duplicates (SOIL)
Filter: SDG in('3460')

SDG	3460	3460	
Field ID	THA1_1.0-1.1	QC1	**RPD**
Sampled Date/Time	13/01/2015	13/01/2015	

Method_Type	ChemName	Units	EQL			
Organic	Naphthalene	mg/kg	0.5	<0.5	<0.5	0
PAH	Naphthalene	mg/kg	0.5	<0.5	<0.5	0
Volatile	Benzene	mg/kg	0.1	<0.1	<0.1	0
	Ethylbenzene	mg/kg	0.1	<0.1	<0.1	0
	Toluene	mg/kg	0.1	<0.1	<0.1	0
	Xylene (m & p)	mg/kg	0.2	<0.2	<0.2	0
	Xylene (o)	mg/kg	0.1	<0.1	<0.1	0
	Xylene Total	mg/kg	0.3	<0.3	<0.3	0
Organic	TRH C6-C10 less BTEX (F1)	mg/kg	20	<20.0	<20.0	0
	TRH >C10-C16 less Naphthalene (F2)	mg/kg	50	<50.0	<50.0	0
	TRH C6 - C10	mg/kg	20	<20.0	<20.0	0
	TPH >C10 - C16	mg/kg	50	<50.0	<50.0	0
	TRH >C16 - C34	mg/kg	100	350.0	430.0	21
	TRH >C34 - C40	mg/kg	100	210.0	230.0	9
	TRH C6 - C9	mg/kg	20	<20.0	<20.0	0
TPH	TRH C10 - C14	mg/kg	20	<20.0	<20.0	0
	TRH C15 - C28	mg/kg	50	190.0	230.0	19
	TRH C29 - C36	mg/kg	50	260.0	320.0	21
	TRH C10 - C36 (Sum of total)	mg/kg	50	450.0	550.0	20
Inorganic	Moisture Content (dried @ 103℃)	%	0.1	35.0	4 1.0	16
Heavy Metal	Arsenic	mg/kg	2	5.9	8.9	41
	Cadmium	mg/kg	0.4	<0.4	<0.4	0
	Chromium	mg/kg	5	9.0	13.0	36
	Copper	mg/kg	5	17.0	22.0	26
	Lead	mg/kg	5	80.0	120.0	40
	Mercury	mg/kg	0.1	<0.1	<0.1	0
	Nickel	mg/kg	5	5.6	6.6	16
	Zinc	mg/kg	5	**100.0**	**170.0**	**52**
PAH	Acenaphthene	mg/kg	0.5	<0.5	<0.5	0
	Acenaphthylene	mg/kg	0.5	<0.5	<0.5	0
	Anthracene	mg/kg	0.5	<0.5	<0.5	0
	Benzo(a)anthracene	mg/kg	0.5	0.8	0.5	46
	Benzo(a)pyrene	mg/kg	0.5	0.9	0.7	25
	Benzo(a)pyrene TEQ (lower bound) *	mg/kg	0.5	1.1	0.8	32
	Benzo(a)pyrene TEQ (medium bound) *	mg/kg	0.5	1.4	1.1	24
	Benzo(a)pyrene TEQ (upper bound) *	mg/kg	0.5	1.7	1.4	19
	Benzo(g,h,i)perylene	mg/kg	0.5	0.8	<0.5	46
	Benzo(k)fluoranthene	mg/kg	0.5	<0.5	<0.5	0
	Chrysene	mg/kg	0.5	1.3	0.7	60
	Benzo[b+j]fluoranthene	mg/kg	0.5	0.6	0.5	18
	Dibenz(a,h)anthracene	mg/kg	0.5	<0.5	<0.5	0
	Fluoranthene	mg/kg	0.5	2.1	1.3	47
	Fluorene	mg/kg	0.5	<0.5	<0.5	0
	Indeno(1,2,3-c,d)pyrene	mg/kg	0.5	0.5	<0.5	0
	Phenanthrene	mg/kg	0.5	**1.8**	**1.0**	**57**
	Pyrene	mg/kg	0.5	2.7	1.7	45
	Total PAHs	mg/kg	0.5	**12.0**	**6.4**	**61**

*RPDs have only been considered where a concentration is greater than 0 times the EQL.
**High RPDs are in bold (Acceptable RPDs for each EQL multiplier range are: 200 (0-10 x EQL); 50 (10-20 x EQL); 30 (> 20 x EQL))
***Interlab Duplicates are matched on a per compound basis as methods vary between laboratories. Any methods in the row header relate to those used in the primary laboratory

revision no.	description	drawn	approved	date
A	ORIGINAL ISSUE			

LEGEND

- APPROXIMATE LOCATIONS OF GEOTECH TESTING
- APPROXIMATE SITE BOUNDARY

NOTE:
ALL LOCATION ARE APPROXIMATE
DIMENSIONS IN METERES.

8 0 8 24 40

Scale (metres) 1:800

drawn	MV
approved	DH
date	20/01/15
scale	AS SHOWN
original size	A3

coffey

client: WYONG SHIRE COUNCIL

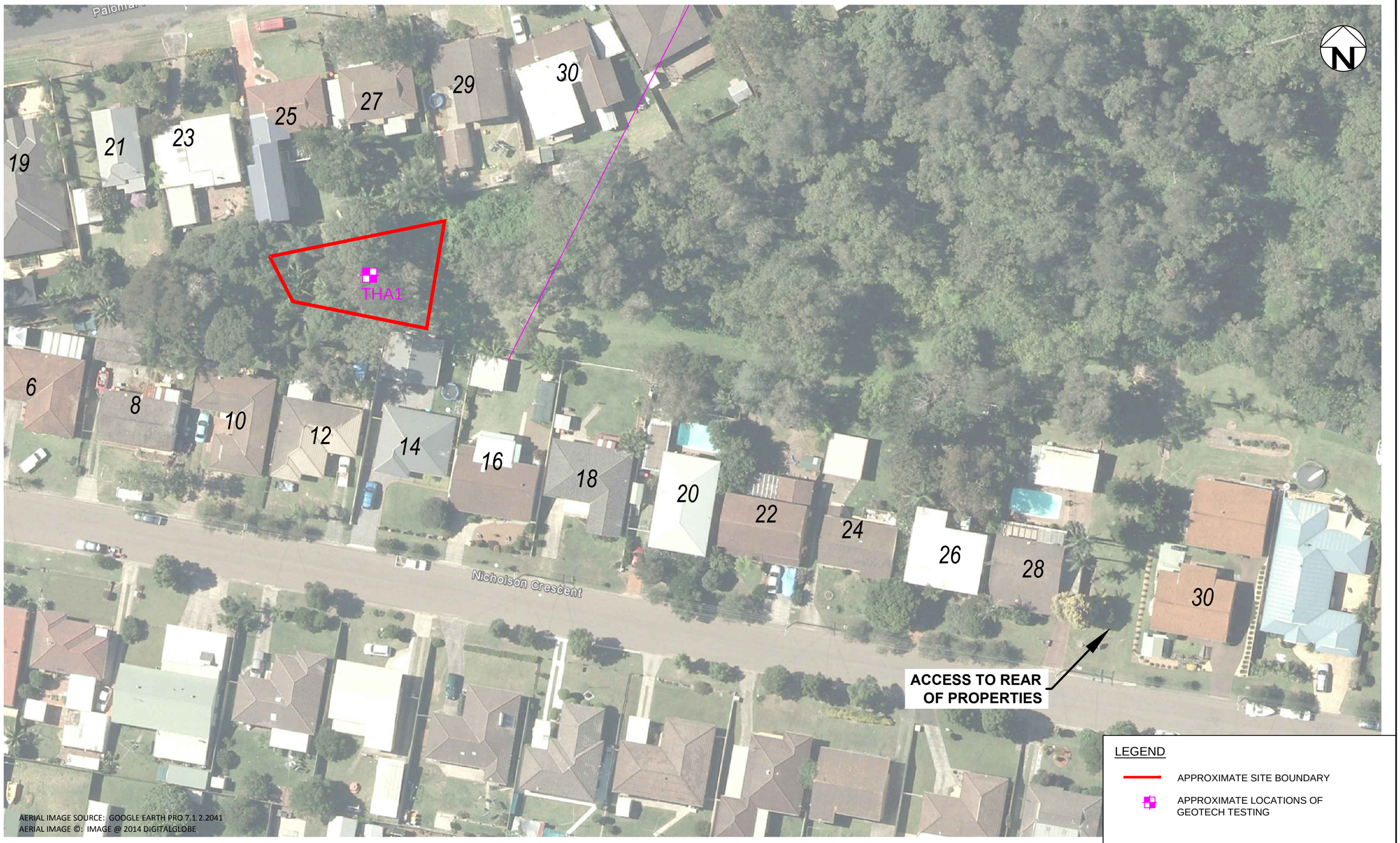
project: PROPOSED SWALES AND GROSS POLLUTANT TRAP, TUGGERAH PARADE, LONG JETTY, NSW

title: SAMPLE PLAN

project no: ENAUWARA04586AA-R01 | figure no: FIGURE 1 | rev: A

DWG FILE: F:\ENV\PROJECTS\OTHER OFFICES\ENAUWARA\ENAUWARA04586AA\ENAURHOD04586AA-R01-D01_LJ.DWG

PLOT DATE: 23/01/2015 10:16:49 AM



LEGEND

- APPROXIMATE SITE BOUNDARY
- APPROXIMATE LOCATIONS OF GEOTECH TESTING

revision no.	description	drawn	approved	date
A	ORIGINAL ISSUE			

NOTE:
ALL LOCATIONS ARE APPROXIMATE
DIMENSIONS IN METRES.

5 0 5 10 15 20

Scale (metres) 1:600

drawn	MV
approved	DH
date	20/01/15
scale	AS SHOWN
original size	A3

coffey

client: WYONG SHIRE COUNCIL

project: PROPOSED SWALES AND GROSS POLLUTANT TRAP, NICHOLSON CRESCENT, TOUKLEY, NSW

title: SAMPLING PLAN

project no: ENAUWARA04586AA-R01 | figure no: FIGURE 2 | rev: A

PLOT DATE: 23/01/2015 10:32:46 AM DWG FILE: F:\ENVIPROJECTS\OTHER OFFICES\ENAUWARA\ENAUWARA04586AA\ENAURHOD04586AA-R01-D01_TOU.DWG

coffey

Engineering Log - Borehole

Borehole No.	**LJHA01**
Sheet	1 of 1
Office Job No.:	**ENAUWARA04586AA**
Client:	**WYONG SHIRE COUNCIL**
Date started:	**13.1.2015**
Principal:	
Date completed:	**13.1.2015**
Project:	**PROPOSED SWALES AND GPT**
Logged by:	**JK**
Borehole Location:	**TUGGERAH PARADE, LONG JETTY**
Checked by:	

drill model and mounting:	Hand Auger		Easting:	332144.7	slope:	-90°	R.L. Surface:
hole diameter:	50 mm		Northing	1512839.1	bearing:		datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
HA				E				SW	**SAND:** fine to coarse grained, pale brown.	M			ALLUVIUM
				E,D		0.5		SW	**SAND:** fine to coarse grained, grey, some medium plasticity clay.				
			►					CH	**Sandy CLAY:** medium plasticity, grey, fine to medium grained sand.	W			
				E,D		1.0							
				D		1.5							
						2.0			Hole collapsing. Borehole LJHA01 terminated at 1.65m				

method

DT	diatube
PT	push tube
SS	soild stem flight auger
HS	hollow stem flight auger
VT	V Bit, T Bit
AH	air hammer
CP	cable percussive
HA	hand auger
NDD	non-destructive digging
RC	rock corer

support

M mud N nil
C casing

penetration

1 2 3 4 — no resistance ranging to refusal

water

10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description
based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey

Engineering Log - Borehole

Borehole No.	**LJHA02**
Sheet	1 of 1
Office Job No.:	**ENAUWARA04586AA**
Date started:	**13.1.2015**
Date completed:	**13.1.2015**
Logged by:	**JK**
Checked by:	

Client: ***WYONG SHIRE COUNCIL***

Principal:

Project: ***PROPOSED SWALES AND GPT***

Borehole Location: ***TUGGERAH PARADE, LONG JETTY***

drill model and mounting:	Hand Auger		Easting:	332141.5	slope:	-90°	R.L. Surface:
hole diameter:	50 mm		Northing	1512841.9	bearing:		datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
HA				E				SP	**Gravelly SAND:** fine to coarse grained, dark brown / brown, fine grained gravel.	M			ALLUVIUM
									Becoming pale brown at 0.25m.				
				E,D		0.5			Becoming grey / pale brown at 0.5m.				
			▶							W			
								CL	**Sandy CLAY:** low plasticity, grey, fine to coarse grained sand.				
				E,D		1.0							
									Hole collapsing. Borehole LJHA02 terminated at 1.1m				
						1.5							
						2.0							

method

DT	diatube
PT	push tube
SS	solid stem flight auger
HS	hollow stem flight auger
VT	V Bit, T Bit
AH	air hammer
CP	cable percussive
HA	hand auger
NDD	non-destructive digging
RC	rock corer

support

M mud N nil
C casing

penetration

1 2 3 4 — no resistance ranging to refusal

water

10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description
based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey

Engineering Log - Borehole

Borehole No.	***LJHA03***
Sheet	1 of 1
Office Job No.:	***ENAUWARA04586AA***
Client:	***WYONG SHIRE COUNCIL***
Date started:	***13.1.2015***
Principal:	
Date completed:	***13.1.2015***
Project:	***PROPOSED SWALES AND GPT***
Logged by:	***JK***
Borehole Location:	***TUGGERAH PARADE, LONG JETTY***
Checked by:	

drill model and mounting:	Hand Auger		Easting:	332140.1	slope:	-90°	R.L. Surface:
hole diameter:	50 mm		Northing	1512842.8	bearing:		datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
HA				E				SW	**Gravelly SAND:** fine to coarse grained, pale brown / yellow, fine to coarse grained gravel.	M			ALLUVIUM
				E,D		0.5				W			Shells present.
								SW	**SAND:** fine to coarse grained, grey.				
				D				CH	**Sandy CLAY:** medium plasticity, grey, fine to coarse grained sand.				
						1.0			Hole Collapsing Borehole LJHA03 terminated at 0.9m				
						1.5							
						2.0							

method

DT	diatube
PT	push tube
SS	solid stem flight auger
HS	hollow stem flight auger
VT	V Bit, T Bit
AH	air hammer
CP	cable percussive
HA	hand auger
NDD	non-destructive digging
RC	rock corer

support

M mud N nil
C casing

penetration

1 2 3 4 no resistance ranging to refusal

water

10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description
based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey

Engineering Log - Borehole

Borehole No.	**LJHA04**
Sheet	1 of 1
Office Job No.:	**ENAUWARA04586AA**
Date started:	**13.1.2015**
Date completed:	**13.1.2015**
Logged by:	**JK**
Checked by:	

Client: ***WYONG SHIRE COUNCIL***

Principal:

Project: ***PROPOSED SWALES AND GPT***

Borehole Location: ***TUGGERAH PARADE, LONG JETTY***

drill model and mounting: Hand Auger | Easting: 332139.3 | slope: -90° | R.L. Surface:

hole diameter: 50 mm | Northing 1512843.7 | bearing: | datum: AHD

drilling information							material substance							
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
HA				E				SW	**Gravelly SAND:** fine to coarse grained, brown / yellow, fine grained gravel.	M			ALLUVIUM
								CH	**Sandy CLAY:** fine to coarse grained, medium plasticity, pale grey				
				E,D		0.5				W			
				D									
									Hole collapsing. Borehole LJHA04 terminated at 0.8m				
						1.0							
						1.5							
						2.0							

method

DT	diatube
PT	push tube
SS	soild stem flight auger
HS	hollow stem flight auger
VT	V Bit, T Bit
AH	air hammer
CP	cable percussive
HA	hand auger
NDD	non-destructive digging
RC	rock corer

support

M mud N nil
C casing

penetration

1 2 3 4 — no resistance ranging to refusal

water

10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description
based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey

Engineering Log - Borehole

Borehole No.	**THA01**
Sheet	1 of 1
Office Job No.:	**ENAUWARA04586AA**
Date started:	**13.1.2015**
Date completed:	**13.1.2015**
Logged by:	**JK**
Checked by:	

Client: ***WYONG SHIRE COUNCIL***

Principal:

Project: ***PROPOSED SWALES AND GPT***

Borehole Location: ***NICHOLSON CRESCENT, TOUKLEY***

drill model and mounting: Hand Auger | Easting: 331544.2 | slope: -90° | R.L. Surface:

hole diameter: 50 mm | Northing 1513254.7 | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
HA				E		0.5		SW	**Gravelly SAND:** fine to coarse grained sand, brown, fine to medium grained gravel.	M			ALLUVIUM
				E,D					Becoming pale grey at 0.75m.	W			
				E,D		1.0		CL	**CLAY:** low to medium plasticity, black.				
						1.5			Hole collapsing Borehole THA01 terminated at 1.2m				
						2.0							

method

DT	diatube
PT	push tube
SS	solid stem flight auger
HS	hollow stem flight auger
VT	V Bit, T Bit
AH	air hammer
CP	cable percussive
HA	hand auger
NDD	non-destructive digging
RC	rock corer

support

M mud N nil
C casing

penetration

1 2 3 4 — no resistance ranging to refusal

water

10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description
based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

BOREHOLE ENAUWARA04586AA.GPJ COFFEY.GDT 28.1.15

Form GEO 5.3 Issue 3 Rev.2

Job Number	ENAUWARA04586AA

Client: **Wyong Shire Council** Date: **15/01/2015**

Principal: Test location: **Warabrook**

Project: **In-Situ Waste Classification and Acid Sulfate Soil Assessment** Tested by: **MW**

Location: **Tuggerah Parade, Long Jetty and Nicholson Crescent, Toukley** Checked by:

Date samples recovered: **13/01/2015** pH meter used: **Horiba D-24** Date of calibration: **15/01/2015**

Hydrogen peroxide pH prior to use: **5.12** Hydrogen peroxide temperature prior to use: 24.8

Sample Number	Depth (m)	Soil description	$_{p}h_{F}$ pH in 1:5 distilled water	$_{p}H_{FOX}$ (oxidation in 30 % hydrogen peroxide)							
				Time (Min)	pH FOX	Temp (°C)	Effeervescence (see note 1 below)	Odour (see note 2 below)	colour change during reaction	Ph Change(ie ph_F-phFox)	Additional comments
LJHA1	0.5-0.6	Sand	5.48	20	4.65	33.1	D	None	None	0.83	
LJHA1	1.5-1.6	Clay	5.95	20	2.69	40.1	D	None	None	3.26	
LJHA2	0.5-0.6	Sand	6.33	20	2.69	37.5	D	None	None	3.64	
LJHA2	1.0-1.1	Clay	6.63	20	2.73	87.5	C	None	Light brown	3.9	
LJHA3	0.5-0.6	Sand	6.91	20	2.67	89.2	C	None	None	4.24	Shells present
LJHA3	0.8-0.9	Clay	6.64	20	2.6	90.1	C	None	None	4.04	
LJHA4	0.5-0.6	Clay	6.68	20	2.41	92.8	C	None	None	4.27	
LJHA4	0.7-0.8	Clay	5.87	20	3.69	37.4	B	None	None	2.18	
THA1	0.5-0.6	Sand	5.42	20	3.3	36.6	B	None	None	2.12	
THA1	1.0-1.1	Clay	5.99	20	2.64	33.2	D	None	Dark brown	3.35	

NOTES:

1. Observed Reaction a. No visible effervescence b. Slight to moderate effervescence

2. Strong Odour c. Vigorous effervescence reaction d. No reaction

eurofins | mgt

Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Coffey Environments Pty Ltd Newcastle
Lot 101, 19 Warabrook Boulevard
Warabrook
NSW 2304

Attention: **Damien Hendrickx**

Report **444432-S**
Project name WYONG SHIRE COUNCIL
Project ID ENAUWARA04586AA
Received Date Jan 15, 2015

Client Sample ID			**LJHA1_0.0-0.1**	**LJHA1_1.0-1.1**	**LJHA2_0.5-0.6**	**LJHA2_1.0-1.1**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins | mgt Sample No.			**M15-Ja04867**	**M15-Ja04868**	**M15-Ja04869**	**M15-Ja04870**
Date Sampled			**Jan 13, 2015**	**Jan 13, 2015**	**Jan 13, 2015**	**Jan 13, 2015**
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	20	mg/kg	< 20	< 20	< 20	< 20
TRH C10-C14	20	mg/kg	< 20	< 20	< 20	< 20
TRH C15-C28	50	mg/kg	< 50	< 50	< 50	< 50
TRH C29-C36	50	mg/kg	< 50	< 50	< 50	< 50
TRH C10-36 (Total)	50	mg/kg	< 50	< 50	< 50	< 50
BTEX						
Benzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Toluene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Ethylbenzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
m&p-Xylenes	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
o-Xylene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Xylenes - Total	0.3	mg/kg	< 0.3	< 0.3	< 0.3	< 0.3
4-Bromofluorobenzene (surr.)	1	%	59	56	68	52
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
TRH C6-C10	20	mg/kg	< 20	< 20	< 20	< 20
TRH C6-C10 less BTEX (F1)[N04]	20	mg/kg	< 20	< 20	< 20	< 20
TRH >C10-C16	50	mg/kg	< 50	< 50	< 50	< 50
TRH >C10-C16 less Naphthalene (F2)[N01]	50	mg/kg	< 50	< 50	< 50	< 50
TRH >C16-C34	100	mg/kg	< 100	< 100	< 100	< 100
TRH >C34-C40	100	mg/kg	< 100	< 100	< 100	< 100
Polycyclic Aromatic Hydrocarbons						
Benzo(a)pyrene TEQ (lower bound) *	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene TEQ (medium bound) *	0.5	mg/kg	0.6	0.6	0.6	0.6
Benzo(a)pyrene TEQ (upper bound) *	0.5	mg/kg	1.2	1.2	1.2	1.2
Acenaphthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Acenaphthylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benz(a)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(b&j)fluoranthene[N07]	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(g.h.i)perylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(k)fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Chrysene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Dibenz(a.h)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5

Client Sample ID			LJHA1_0.0-0.1	LJHA1_1.0-1.1	LJHA2_0.5-0.6	LJHA2_1.0-1.1
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins | mgt Sample No.			M15-Ja04867	M15-Ja04868	M15-Ja04869	M15-Ja04870
Date Sampled			Jan 13, 2015	Jan 13, 2015	Jan 13, 2015	Jan 13, 2015
Test/Reference	LOR	Unit				
Polycyclic Aromatic Hydrocarbons						
Fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Fluorene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Indeno(1.2.3-cd)pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Naphthalene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Phenanthrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Total PAH	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
2-Fluorobiphenyl (surr.)	1	%	102	93	99	89
p-Terphenyl-d14 (surr.)	1	%	126	106	111	88
Heavy Metals						
Arsenic	2	mg/kg	< 2	2.8	< 2	8.7
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	< 5	< 5	< 5	13
Copper	5	mg/kg	< 5	< 5	< 5	6.6
Lead	5	mg/kg	< 5	< 5	< 5	12
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Zinc	5	mg/kg	5.8	7.0	< 5	31
% Moisture	0.1	%	12	19	16	39

Client Sample ID			LJHA3_0.0-0.1	LJHA3_0.5-0.6	LJHA4_0.0-0.1	LJHA4_0.5-0.6
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins | mgt Sample No.			M15-Ja04871	M15-Ja04872	M15-Ja04873	M15-Ja04874
Date Sampled			Jan 13, 2015	Jan 13, 2015	Jan 13, 2015	Jan 13, 2015
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	20	mg/kg	< 20	< 20	< 20	< 20
TRH C10-C14	20	mg/kg	< 20	< 20	< 20	< 20
TRH C15-C28	50	mg/kg	< 50	< 50	< 50	< 50
TRH C29-C36	50	mg/kg	< 50	< 50	< 50	< 50
TRH C10-36 (Total)	50	mg/kg	< 50	< 50	< 50	< 50
BTEX						
Benzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Toluene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Ethylbenzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
m&p-Xylenes	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
o-Xylene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Xylenes - Total	0.3	mg/kg	< 0.3	< 0.3	< 0.3	< 0.3
4-Bromofluorobenzene (surr.)	1	%	73	72	82	82
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
TRH C6-C10	20	mg/kg	< 20	< 20	< 20	< 20
TRH C6-C10 less BTEX (F1)[N04]	20	mg/kg	< 20	< 20	< 20	< 20
TRH >C10-C16	50	mg/kg	< 50	< 50	< 50	< 50
TRH >C10-C16 less Naphthalene (F2)[N01]	50	mg/kg	< 50	< 50	< 50	< 50
TRH >C16-C34	100	mg/kg	< 100	< 100	< 100	< 100
TRH >C34-C40	100	mg/kg	< 100	< 100	< 100	< 100

Client Sample ID			LJHA3_0.0-0.1	LJHA3_0.5-0.6	LJHA4_0.0-0.1	LJHA4_0.5-0.6
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins | mgt Sample No.			**M15-Ja04871**	**M15-Ja04872**	**M15-Ja04873**	**M15-Ja04874**
Date Sampled			**Jan 13, 2015**	**Jan 13, 2015**	**Jan 13, 2015**	**Jan 13, 2015**
Test/Reference	LOR	Unit				
Polycyclic Aromatic Hydrocarbons						
Benzo(a)pyrene TEQ (lower bound) *	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene TEQ (medium bound) *	0.5	mg/kg	0.6	0.6	0.6	0.6
Benzo(a)pyrene TEQ (upper bound) *	0.5	mg/kg	1.2	1.2	1.2	1.2
Acenaphthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Acenaphthylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benz(a)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(b&j)fluoranthene[N07]	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(g.h.i)perylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(k)fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Chrysene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Dibenz(a.h)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Fluorene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Indeno(1.2.3-cd)pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Naphthalene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Phenanthrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Total PAH	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
2-Fluorobiphenyl (surr.)	1	%	105	109	83	100
p-Terphenyl-d14 (surr.)	1	%	118	114	96	112
Heavy Metals						
Arsenic	2	mg/kg	2.4	< 2	3.1	12
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	< 5	< 5	< 5	18
Copper	5	mg/kg	< 5	< 5	< 5	10.0
Lead	5	mg/kg	< 5	< 5	< 5	14
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	7.8
Zinc	5	mg/kg	< 5	< 5	8.0	44
% Moisture	0.1	%	17	17	26	38

Client Sample ID			THA1_0.0-0.1	THA1_1.0-1.1	QC1
Sample Matrix			**Soil**	**Soil**	**Soil**
Eurofins | mgt Sample No.			**M15-Ja04875**	**M15-Ja04876**	**M15-Ja04877**
Date Sampled			**Jan 13, 2015**	**Jan 13, 2015**	**Jan 13, 2015**
Test/Reference	LOR	Unit			
Total Recoverable Hydrocarbons - 1999 NEPM Fractions					
TRH C6-C9	20	mg/kg	< 20	< 20	< 20
TRH C10-C14	20	mg/kg	< 20	< 20	< 20
TRH C15-C28	50	mg/kg	110	190	230
TRH C29-C36	50	mg/kg	170	260	320
TRH C10-36 (Total)	50	mg/kg	280	450	550

Client Sample ID			THA1_0.0-0.1	THA1_1.0-1.1	QC1
Sample Matrix			Soil	Soil	Soil
Eurofins | mgt Sample No.			M15-Ja04875	M15-Ja04876	M15-Ja04877
Date Sampled			Jan 13, 2015	Jan 13, 2015	Jan 13, 2015
Test/Reference	LOR	Unit			
BTEX					
Benzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1
Toluene	0.1	mg/kg	< 0.1	< 0.1	< 0.1
Ethylbenzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1
m&p-Xylenes	0.2	mg/kg	< 0.2	< 0.2	< 0.2
o-Xylene	0.1	mg/kg	< 0.1	< 0.1	< 0.1
Xylenes - Total	0.3	mg/kg	< 0.3	< 0.3	< 0.3
4-Bromofluorobenzene (surr.)	1	%	80	83	50
Total Recoverable Hydrocarbons - 2013 NEPM Fractions					
Naphthalene[N02]	0.5	mg/kg	< 0.5	< 0.5	< 0.5
TRH C6-C10	20	mg/kg	< 20	< 20	< 20
TRH C6-C10 less BTEX (F1)[N04]	20	mg/kg	< 20	< 20	< 20
TRH >C10-C16	50	mg/kg	< 50	< 50	< 50
TRH >C10-C16 less Naphthalene (F2)[N01]	50	mg/kg	< 50	< 50	< 50
TRH >C16-C34	100	mg/kg	200	350	430
TRH >C34-C40	100	mg/kg	150	210	230
Polycyclic Aromatic Hydrocarbons					
Benzo(a)pyrene TEQ (lower bound) *	0.5	mg/kg	< 0.5	1.1	0.8
Benzo(a)pyrene TEQ (medium bound) *	0.5	mg/kg	0.6	1.4	1.1
Benzo(a)pyrene TEQ (upper bound) *	0.5	mg/kg	1.2	1.7	1.4
Acenaphthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5
Acenaphthylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5
Anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5
Benz(a)anthracene	0.5	mg/kg	< 0.5	0.8	0.5
Benzo(a)pyrene	0.5	mg/kg	< 0.5	0.9	0.7
Benzo(b&j)fluoranthene[N07]	0.5	mg/kg	< 0.5	0.6	0.5
Benzo(g.h.i)perylene	0.5	mg/kg	< 0.5	0.8	< 0.5
Benzo(k)fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5
Chrysene	0.5	mg/kg	< 0.5	1.3	0.7
Dibenz(a.h)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5
Fluoranthene	0.5	mg/kg	0.5	2.1	1.3
Fluorene	0.5	mg/kg	< 0.5	< 0.5	< 0.5
Indeno(1.2.3-cd)pyrene	0.5	mg/kg	< 0.5	0.5	< 0.5
Naphthalene	0.5	mg/kg	< 0.5	< 0.5	< 0.5
Phenanthrene	0.5	mg/kg	< 0.5	1.8	1.0
Pyrene	0.5	mg/kg	0.5	2.7	1.7
Total PAH	0.5	mg/kg	1.0	12	6.4
2-Fluorobiphenyl (surr.)	1	%	108	101	82
p-Terphenyl-d14 (surr.)	1	%	124	112	97
Heavy Metals					
Arsenic	2	mg/kg	2.3	5.9	8.9
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	< 5	9.0	13
Copper	5	mg/kg	8.0	17	22
Lead	5	mg/kg	24	80	120
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	5.6	6.6
Zinc	5	mg/kg	49	100	170
% Moisture	0.1	%	30	35	41

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Eurofins | mgt Suite 7			
Total Recoverable Hydrocarbons - 1999 NEPM Fractions	Melbourne	Jan 20, 2015	14 Day
- Method: TRH C6-C36 - LTM-ORG-2010			
BTEX	Melbourne	Jan 20, 2015	14 Day
- Method: TRH C6-C40 - LTM-ORG-2010			
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	Melbourne	Jan 20, 2015	14 Day
- Method: TRH C6-C40 - LTM-ORG-2010			
Polycyclic Aromatic Hydrocarbons	Melbourne	Jan 20, 2015	14 Day
- Method: USEPA 8270 Polycyclic Aromatic Hydrocarbons			
Metals M8	Melbourne	Jan 20, 2015	28 Day
- Method: USEPA 6010/6020 Heavy Metals & USEPA 7470/71 Mercury			
% Moisture	Melbourne	Jan 15, 2015	14 Day
- Method: LTM-GEN-7080 Moisture			

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NATA # 1261 Site # 20794

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Address: Lot 101, 19 Warabrook Boulevard
Warabrook
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Project Name: WYONG SHIRE COUNCIL
Project ID: ENAUWARA04586AA

Order No.:
Report #: 444432
Phone: 02 4016 2300
Fax: 02 4016 2380

Received: Jan 15, 2015 2:51 PM
Due: Jan 22, 2015
Priority: 5 Day
Contact Name: Damien Hendrickx

Eurofins | mgt Client Manager: Mary Makarios

Sample Detail					% Moisture	HOLD	Eurofins | mgt Suite 7
Laboratory where analysis is conducted							
Melbourne Laboratory - NATA Site # 1254 & 14271					X	X	X
Sydney Laboratory - NATA Site # 18217							
Brisbane Laboratory - NATA Site # 20794							
External Laboratory							
Sample ID	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**			
LJHA1_0.0-0.1	Jan 13, 2015		Soil	M15-Ja04867	X		X
LJHA1_1.0-1.1	Jan 13, 2015		Soil	M15-Ja04868	X		X
LJHA2_0.5-0.6	Jan 13, 2015		Soil	M15-Ja04869	X		X
LJHA2_1.0-1.1	Jan 13, 2015		Soil	M15-Ja04870	X		X
LJHA3_0.0-0.1	Jan 13, 2015		Soil	M15-Ja04871	X		X
LJHA3_0.5-0.6	Jan 13, 2015		Soil	M15-Ja04872	X		X
LJHA4_0.0-0.1	Jan 13, 2015		Soil	M15-Ja04873	X		X
LJHA4_0.5-0.6	Jan 13, 2015		Soil	M15-Ja04874	X		X
THA1_0.0-0.1	Jan 13, 2015		Soil	M15-Ja04875	X		X

eurofins | mgt

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NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Company Name: Coffey Environments P/L N'castle
Address: Lot 101, 19 Warabrook Boulevard
Warabrook
NSW 2304

Project Name: WYONG SHIRE COUNCIL
Project ID: ENAUWARA04586AA

Order No.:
Report #: 444432
Phone: 02 4016 2300
Fax: 02 4016 2380

Received: Jan 15, 2015 2:51 PM
Due: Jan 22, 2015
Priority: 5 Day
Contact Name: Damien Hendrickx

Eurofins | mgt Client Manager: Mary Makarios

Sample Detail					% Moisture	HOLD	Eurofins | mgt Suite 7
Laboratory where analysis is conducted							
Melbourne Laboratory - NATA Site # 1254 & 14271					X	X	X
Sydney Laboratory - NATA Site # 18217							
Brisbane Laboratory - NATA Site # 20794							
External Laboratory							
THA1_1.0-1.1	Jan 13, 2015		Soil	M15-Ja04876	X		X
QC1	Jan 13, 2015		Soil	M15-Ja04877	X		X
LJHA1_0.5-0.6	Jan 13, 2015		Soil	M15-Ja04878		X	
LJHA2_0.0-0.1	Jan 13, 2015		Soil	M15-Ja04879		X	
THA1_0.5-0.6	Jan 13, 2015		Soil	M15-Ja04880		X	

Eurofins | mgt Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
4. Results are uncorrected for matrix spikes or surrogate recoveries.
5. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
6. Samples were analysed on an 'as received' basis. 7. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the Sample Receipt Advice.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

****NOTE:** pH duplicates are reported as a range NOT as RPD

UNITS

mg/kg: milligrams per Kilogram

ug/l: micrograms per litre

ppb: Parts per billion

org/100ml: Organisms per 100 millilitres

MPN/100mL: Most Probable Number of organisms per 100 millilitres

mg/l: milligrams per litre

ppm: Parts per million

%: Percentage

NTU: Nephelometric Turbidity Units

TERMS

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery
CRM	Certified Reference Material - reported as percent recovery
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands. In the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
Batch Duplicate	A second piece of analysis from a sample outside of the clients batch of samples but run within the laboratory batch of analysis.
Batch SPIKE	Spike recovery reported on a sample from outside of the clients batch of samples but run within the laboratory batch of analysis.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
ASLP	Australian Standard Leaching Procedure (AS4439.3)
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within
TEQ	Toxic Equivalency Quotient

QC - ACCEPTANCE CRITERIA

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries : Recoveries must lie between 50-150% - Phenols 20-130%.

QC DATA GENERAL COMMENTS

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxophene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxophene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Arochlor 1260 in Matrix Spikes and LCS's.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPD's are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	mg/kg	< 20			20	Pass	
TRH C10-C14	mg/kg	< 20			20	Pass	
TRH C15-C28	mg/kg	< 50			50	Pass	
TRH C29-C36	mg/kg	< 50			50	Pass	
Method Blank							
BTEX							
Benzene	mg/kg	< 0.1			0.1	Pass	
Toluene	mg/kg	< 0.1			0.1	Pass	
Ethylbenzene	mg/kg	< 0.1			0.1	Pass	
m&p-Xylenes	mg/kg	< 0.2			0.2	Pass	
o-Xylene	mg/kg	< 0.1			0.1	Pass	
Xylenes - Total	mg/kg	< 0.3			0.3	Pass	
Method Blank							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
Naphthalene	mg/kg	< 0.5			0.5	Pass	
TRH C6-C10	mg/kg	< 20			20	Pass	
TRH C6-C10 less BTEX (F1)	mg/kg	< 20			20	Pass	
TRH >C10-C16	mg/kg	< 50			50	Pass	
TRH >C16-C34	mg/kg	< 100			100	Pass	
TRH >C34-C40	mg/kg	< 100			100	Pass	
Method Blank							
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	mg/kg	< 0.5			0.5	Pass	
Acenaphthylene	mg/kg	< 0.5			0.5	Pass	
Anthracene	mg/kg	< 0.5			0.5	Pass	
Benz(a)anthracene	mg/kg	< 0.5			0.5	Pass	
Benzo(a)pyrene	mg/kg	< 0.5			0.5	Pass	
Benzo(b&j)fluoranthene	mg/kg	< 0.5			0.5	Pass	
Benzo(g.h.i)perylene	mg/kg	< 0.5			0.5	Pass	
Benzo(k)fluoranthene	mg/kg	< 0.5			0.5	Pass	
Chrysene	mg/kg	< 0.5			0.5	Pass	
Dibenz(a.h)anthracene	mg/kg	< 0.5			0.5	Pass	
Fluoranthene	mg/kg	< 0.5			0.5	Pass	
Fluorene	mg/kg	< 0.5			0.5	Pass	
Indeno(1.2.3-cd)pyrene	mg/kg	< 0.5			0.5	Pass	
Naphthalene	mg/kg	< 0.5			0.5	Pass	
Phenanthrene	mg/kg	< 0.5			0.5	Pass	
Pyrene	mg/kg	< 0.5			0.5	Pass	
Method Blank							
Heavy Metals							
Arsenic	mg/kg	< 2			2	Pass	
Cadmium	mg/kg	< 0.4			0.4	Pass	
Chromium	mg/kg	< 5			5	Pass	
Copper	mg/kg	< 5			5	Pass	
Lead	mg/kg	< 5			5	Pass	
Mercury	mg/kg	< 0.1			0.1	Pass	
Nickel	mg/kg	< 5			5	Pass	
Zinc	mg/kg	< 5			5	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
TRH C6-C9	%	81			70-130	Pass	
TRH C10-C14	%	114			70-130	Pass	
LCS - % Recovery							
BTEX							
Benzene	%	86			70-130	Pass	
Toluene	%	87			70-130	Pass	
Ethylbenzene	%	89			70-130	Pass	
m&p-Xylenes	%	88			70-130	Pass	
Xylenes - Total	%	87			70-130	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
Naphthalene	%	76			75-125	Pass	
TRH C6-C10	%	78			70-130	Pass	
TRH >C10-C16	%	115			70-130	Pass	
LCS - % Recovery							
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	%	86			70-130	Pass	
Acenaphthylene	%	93			70-130	Pass	
Anthracene	%	92			70-130	Pass	
Benz(a)anthracene	%	85			70-130	Pass	
Benzo(a)pyrene	%	82			70-130	Pass	
Benzo(b&j)fluoranthene	%	90			70-130	Pass	
Benzo(g.h.i)perylene	%	83			70-130	Pass	
Benzo(k)fluoranthene	%	85			70-130	Pass	
Chrysene	%	90			70-130	Pass	
Dibenz(a.h)anthracene	%	91			70-130	Pass	
Fluoranthene	%	89			70-130	Pass	
Fluorene	%	89			70-130	Pass	
Indeno(1.2.3-cd)pyrene	%	88			70-130	Pass	
Naphthalene	%	88			70-130	Pass	
Phenanthrene	%	87			70-130	Pass	
Pyrene	%	89			70-130	Pass	
LCS - % Recovery							
Heavy Metals							
Arsenic	%	86			80-120	Pass	
Cadmium	%	96			80-120	Pass	
Chromium	%	102			80-120	Pass	
Copper	%	103			80-120	Pass	
Lead	%	103			80-120	Pass	
Mercury	%	107			75-125	Pass	
Nickel	%	102			80-120	Pass	
Zinc	%	101			80-120	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery									
Polycyclic Aromatic Hydrocarbons				Result 1					
Acenaphthene	M15-Ja04870	CP	%	102			70-130	Pass	
Acenaphthylene	M15-Ja04870	CP	%	105			70-130	Pass	
Anthracene	M15-Ja04870	CP	%	93			70-130	Pass	
Benz(a)anthracene	M15-Ja04870	CP	%	105			70-130	Pass	
Benzo(a)pyrene	M15-Ja04870	CP	%	105			70-130	Pass	
Benzo(b&j)fluoranthene	M15-Ja04870	CP	%	100			70-130	Pass	
Benzo(g.h.i)perylene	M15-Ja04870	CP	%	92			70-130	Pass	
Benzo(k)fluoranthene	M15-Ja04870	CP	%	103			70-130	Pass	
Chrysene	M15-Ja04870	CP	%	97			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Dibenz(a.h)anthracene	M15-Ja04870	CP	%	111			70-130	Pass	
Fluoranthene	M15-Ja04870	CP	%	110			70-130	Pass	
Fluorene	M15-Ja04870	CP	%	104			70-130	Pass	
Indeno(1.2.3-cd)pyrene	M15-Ja04870	CP	%	106			70-130	Pass	
Naphthalene	M15-Ja04870	CP	%	101			70-130	Pass	
Phenanthrene	M15-Ja04870	CP	%	112			70-130	Pass	
Pyrene	M15-Ja04870	CP	%	107			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Arsenic	M15-Ja04870	CP	%	108			75-125	Pass	
Cadmium	M15-Ja04870	CP	%	84			75-125	Pass	
Chromium	M15-Ja04870	CP	%	88			75-125	Pass	
Copper	M15-Ja04870	CP	%	98			75-125	Pass	
Lead	M15-Ja04870	CP	%	85			75-125	Pass	
Mercury	M15-Ja04870	CP	%	109			70-130	Pass	
Nickel	M15-Ja04870	CP	%	85			75-125	Pass	
Zinc	M15-Ja04870	CP	%	89			75-125	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1					
TRH C6-C9	M15-Ja04873	CP	%	96			70-130	Pass	
Spike - % Recovery									
BTEX				Result 1					
Benzene	M15-Ja04873	CP	%	89			70-130	Pass	
Toluene	M15-Ja04873	CP	%	87			70-130	Pass	
Ethylbenzene	M15-Ja04873	CP	%	92			70-130	Pass	
m&p-Xylenes	M15-Ja04873	CP	%	90			70-130	Pass	
o-Xylene	M15-Ja04873	CP	%	88			70-130	Pass	
Xylenes - Total	M15-Ja04873	CP	%	89			70-130	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1					
Naphthalene	M15-Ja04873	CP	%	103			70-130	Pass	
TRH C6-C10	M15-Ja04873	CP	%	107			70-130	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1					
TRH C10-C14	M15-Ja04875	CP	%	102			70-130	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1					
TRH >C10-C16	M15-Ja04875	CP	%	106			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
Polycyclic Aromatic Hydrocarbons				Result 1	Result 2	RPD			
Acenaphthene	M15-Ja04869	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Acenaphthylene	M15-Ja04869	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Anthracene	M15-Ja04869	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benz(a)anthracene	M15-Ja04869	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benzo(a)pyrene	M15-Ja04869	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benzo(b&j)fluoranthene	M15-Ja04869	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benzo(g.h.i)perylene	M15-Ja04869	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benzo(k)fluoranthene	M15-Ja04869	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Chrysene	M15-Ja04869	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Dibenz(a.h)anthracene	M15-Ja04869	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Fluoranthene	M15-Ja04869	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Fluorene	M15-Ja04869	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Indeno(1.2.3-cd)pyrene	M15-Ja04869	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
Polycyclic Aromatic Hydrocarbons				Result 1	Result 2	RPD			
Naphthalene	M15-Ja04869	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Phenanthrene	M15-Ja04869	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Pyrene	M15-Ja04869	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Arsenic	M15-Ja04869	CP	mg/kg	< 2	< 2	<1	30%	Pass	
Cadmium	M15-Ja04869	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	M15-Ja04869	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Copper	M15-Ja04869	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Lead	M15-Ja04869	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Mercury	M15-Ja04869	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Nickel	M15-Ja04869	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Zinc	M15-Ja04869	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Arsenic	M15-Ja04870	CP	mg/kg	8.7	8.1	7.0	30%	Pass	
Cadmium	M15-Ja04870	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	M15-Ja04870	CP	mg/kg	13	14	2.0	30%	Pass	
Copper	M15-Ja04870	CP	mg/kg	6.6	6.7	1.0	30%	Pass	
Lead	M15-Ja04870	CP	mg/kg	12	13	2.0	30%	Pass	
Mercury	M15-Ja04870	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Nickel	M15-Ja04870	CP	mg/kg	< 5	5.0	4.0	30%	Pass	
Zinc	M15-Ja04870	CP	mg/kg	31	33	4.0	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1	Result 2	RPD			
TRH C6-C9	M15-Ja04872	CP	mg/kg	< 20	< 20	<1	30%	Pass	
Duplicate									
BTEX				Result 1	Result 2	RPD			
Benzene	M15-Ja04872	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Toluene	M15-Ja04872	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Ethylbenzene	M15-Ja04872	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
m&p-Xylenes	M15-Ja04872	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
o-Xylene	M15-Ja04872	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Xylenes - Total	M15-Ja04872	CP	mg/kg	< 0.3	< 0.3	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1	Result 2	RPD			
Naphthalene	M15-Ja04872	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
TRH C6-C10	M15-Ja04872	CP	mg/kg	< 20	< 20	<1	30%	Pass	
TRH C6-C10 less BTEX (F1)	M15-Ja04872	CP	mg/kg	< 20	< 20	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1	Result 2	RPD			
TRH C10-C14	M15-Ja04874	CP	mg/kg	< 20	< 20	<1	30%	Pass	
TRH C15-C28	M15-Ja04874	CP	mg/kg	< 50	< 50	<1	30%	Pass	
TRH C29-C36	M15-Ja04874	CP	mg/kg	< 50	< 50	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1	Result 2	RPD			
TRH >C10-C16	M15-Ja04874	CP	mg/kg	< 50	< 50	<1	30%	Pass	
TRH >C16-C34	M15-Ja04874	CP	mg/kg	< 100	< 100	<1	30%	Pass	
TRH >C34-C40	M15-Ja04874	CP	mg/kg	< 100	< 100	<1	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
N01	F2 is determined by arithmetically subtracting the "naphthalene" value from the ">C10-C16" value. The naphthalene value used in this calculation is obtained from volatiles (Purge & Trap analysis).
N02	Where we have reported both volatile (P&T GCMS) and semivolatile (GCMS) naphthalene data, results may not be identical. Provided correct sample handling protocols have been followed, any observed differences in results are likely to be due to procedural differences within each methodology. Results determined by both techniques have passed all QAQC acceptance criteria, and are entirely technically valid.
N04	F1 is determined by arithmetically subtracting the "Total BTEX" value from the "C6-C10" value. The "Total BTEX" value is obtained by summing the concentrations of BTEX analytes. The "C6-C10" value is obtained by quantitating against a standard of mixed aromatic/aliphatic analytes.
N07	Please note:- These two PAH isomers closely co-elute using the most contemporary analytical methods and both the reported concentration (and the TEQ) apply specifically to the total of the two co-eluting PAHs

Authorised By

Mary Makarios	Analytical Services Manager
Carroll Lee	Senior Analyst-Organic (VIC)
Carroll Lee	Senior Analyst-Volatile (VIC)
Emily Rosenberg	Senior Analyst-Metal (VIC)
Huong Le	Senior Analyst-Inorganic (VIC)

Glenn Jackson

National Laboratory Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Uncertainty data is available on request

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Certificate of Analysis

Coffey Environments Pty Ltd Newcastle
Lot 101, 19 Warabrook Boulevard
Warabrook
NSW 2304

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Damien Hendrickx**

Report **445290-L**
Project name WYONG SHIRE COUNCIL
Project ID ENAUWARA04586AA
Received Date Jan 23, 2015

Client Sample ID			**QC1**
Sample Matrix			**TCLP**
Eurofins | mgt Sample No.			**M15-Ja11773**
Date Sampled			**Jan 13, 2015**
Test/Reference	LOR	Unit	
Heavy Metals			
Lead	0.01	mg/L	0.14
USA Leaching Procedure			
Leachate Fluid[C01]		comment	1
pH (initial)	0.1	pH Units	6.6
pH (Leachate fluid)[I11]	0.1	pH Units	4.9
pH (off)	0.1	pH Units	4.9
pH (USA HCl addition)	0.1	pH Units	4.8

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Heavy Metals	Melbourne	Jan 23, 2015	180 Day

- Method: USEPA 6010/6020 Heavy Metals

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NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Company Name:	Coffey Environments P/L N'castle	**Order No.:**		**Received:**	Jan 23, 2015 11:45 AM
Address:	Lot 101, 19 Warabrook Boulevard Warabrook NSW 2304	**Report #:**	445290	**Due:**	Jan 27, 2015
		Phone:	02 4016 2300	**Priority:**	1 Day
		Fax:	02 4016 2380	**Contact Name:**	Damien Hendrickx
Project Name:	WYONG SHIRE COUNCIL				
Project ID:	ENAUWARA04586AA				

Eurofins | mgt Client Manager: Mary Makarios

Sample Detail					Lead	USA Leaching Procedure
Laboratory where analysis is conducted						
Melbourne Laboratory - NATA Site # 1254 & 14271					X	X
Sydney Laboratory - NATA Site # 18217						
Brisbane Laboratory - NATA Site # 20794						
External Laboratory						
Sample ID	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**		
QC1	Jan 13, 2015		TCLP	M15-Ja11773	X	X

Eurofins | mgt Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
4. Results are uncorrected for matrix spikes or surrogate recoveries.
5. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
6. Samples were analysed on an 'as received' basis. 7. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the Sample Receipt Advice.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

****NOTE:** pH duplicates are reported as a range NOT as RPD

UNITS

mg/kg: milligrams per Kilogram

ug/l: micrograms per litre

ppb: Parts per billion

org/100ml: Organisms per 100 millilitres

MPN/100mL: Most Probable Number of organisms per 100 millilitres

mg/l: milligrams per litre

ppm: Parts per million

%: Percentage

NTU: Nephelometric Turbidity Units

TERMS

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery
CRM	Certified Reference Material - reported as percent recovery
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands. In the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
Batch Duplicate	A second piece of analysis from a sample outside of the clients batch of samples but run within the laboratory batch of analysis.
Batch SPIKE	Spike recovery reported on a sample from outside of the clients batch of samples but run within the laboratory batch of analysis.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
ASLP	Australian Standard Leaching Procedure (AS4439.3)
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within
TEQ	Toxic Equivalency Quotient

QC - ACCEPTANCE CRITERIA

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries : Recoveries must lie between 50-150% - Phenols 20-130%.

QC DATA GENERAL COMMENTS

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxophene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxophene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Arochlor 1260 in Matrix Spikes and LCS's.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPD's are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test			Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank									
Heavy Metals									
Lead			mg/L	< 0.01			0.01	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
Heavy Metals				Result 1					
Lead	M15-Ja12055	NCP	%	96			75-125	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Lead	M15-Ja12055	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
C01	Leachate Fluid Key: 1 - pH 5.0; 2 - pH 2.9; 3 - pH 9.2; 4 - Reagent (DI) water; 5 - Client sample, 6 - other
I11	The recommended holding time from field collection to leachate extraction is 7 days for volatiles and 14 days for semi-volatiles. This holding time is 28 days for mercury and 180 days for all other metals.

Authorised By

Mary Makarios	Analytical Services Manager
Emily Rosenberg	Senior Analyst-Metal (VIC)

Glenn Jackson
National Laboratory Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Uncertainty data is available on request

eurofins | mgt

Certificate of Analysis

Coffey Environments Pty Ltd Newcastle
Lot 101, 19 Warabrook Boulevard
Warabrook
NSW 2304

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Damien Hendrickx**

Report **445550-L**
Project name WYONG SHIRE COUNCIL
Project ID ENAUWARA04586AA
Received Date Jan 28, 2015

Client Sample ID			**THA1 1.0-1.1**
Sample Matrix			**TCLP**
Eurofins | mgt Sample No.			**M15-Ja13703**
Date Sampled			**Jan 13, 2015**
Test/Reference	LOR	Unit	
Polycyclic Aromatic Hydrocarbons			
Benzo(a)pyrene	0.001	mg/L	< 0.001
USA Leaching Procedure			
Leachate Fluid[C01]		comment	1.0
pH (initial)	0.1	pH Units	6.5
pH (Leachate fluid)[I11]	0.1	pH Units	4.9
pH (off)	0.1	pH Units	5.0
pH (USA HCl addition)	0.1	pH Units	1.8

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Polycyclic Aromatic Hydrocarbons	Melbourne	Jan 30, 2015	7 Day

- Method: USEPA 8270 Polycyclic Aromatic Hydrocarbons

eurofins | mgt

ABN – 50 005 085 521 e.mail : EnviroSales@eurofins.com.au web : www.eurofins.com.au

Melbourne
3-5 Kingston Town Close
Oakleigh VIC 3166
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Company Name:	Coffey Environments P/L N'castle	**Order No.:**		**Received:**	Jan 28, 2015 10:47 AM
Address:	Lot 101, 19 Warabrook Boulevard Warabrook NSW 2304	**Report #:**	445550	**Due:**	Jan 30, 2015
		Phone:	02 4016 2300	**Priority:**	2 Day
		Fax:	02 4016 2380	**Contact Name:**	Damien Hendrickx
Project Name:	WYONG SHIRE COUNCIL				
Project ID:	ENAUWARA04586AA				

Eurofins | mgt Client Manager: Mary Makarios

Sample Detail					Benzo(a)pyrene	USA Leaching Procedure
Laboratory where analysis is conducted						
Melbourne Laboratory - NATA Site # 1254 & 14271					X	X
Sydney Laboratory - NATA Site # 18217						
Brisbane Laboratory - NATA Site # 20794						
External Laboratory						
Sample ID	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**		
THA1 1.0-1.1	Jan 13, 2015		TCLP	M15-Ja13703	X	X

Eurofins | mgt Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
4. Results are uncorrected for matrix spikes or surrogate recoveries.
5. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
6. Samples were analysed on an 'as received' basis. 7. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the Sample Receipt Advice.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

****NOTE:** pH duplicates are reported as a range NOT as RPD

UNITS

mg/kg: milligrams per Kilogram

ug/l: micrograms per litre

ppb: Parts per billion

org/100ml: Organisms per 100 millilitres

MPN/100mL: Most Probable Number of organisms per 100 millilitres

mg/l: milligrams per litre

ppm: Parts per million

%: Percentage

NTU: Nephelometric Turbidity Units

TERMS

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery
CRM	Certified Reference Material - reported as percent recovery
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands. In the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
Batch Duplicate	A second piece of analysis from a sample outside of the clients batch of samples but run within the laboratory batch of analysis.
Batch SPIKE	Spike recovery reported on a sample from outside of the clients batch of samples but run within the laboratory batch of analysis.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
ASLP	Australian Standard Leaching Procedure (AS4439.3)
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within
TEQ	Toxic Equivalency Quotient

QC - ACCEPTANCE CRITERIA

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries : Recoveries must lie between 50-150% - Phenols 20-130%.

QC DATA GENERAL COMMENTS

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxophene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxophene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Arochlor 1260 in Matrix Spikes and LCS's.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPD's are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Polycyclic Aromatic Hydrocarbons							
Benzo(a)pyrene	mg/L	< 0.001			0.001	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	No
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
C01	Leachate Fluid Key: 1 - pH 5.0; 2 - pH 2.9; 3 - pH 9.2; 4 - Reagent (DI) water; 5 - Client sample, 6 - other
I11	The recommended holding time from field collection to leachate extraction is 7 days for volatiles and 14 days for semi-volatiles. This holding time is 28 days for mercury and 180 days for all other metals.

Authorised By

Mary Makarios	Analytical Services Manager
Carroll Lee	Senior Analyst-Organic (VIC)

Glenn Jackson
National Laboratory Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Uncertainty data is available on request

RESULTS OF ACID SULFATE SOIL ANALYSIS

3 samples supplied by Coffey Geotechnics on 16th January, 2015 - Lab. Job No. D8995

Analysis requested by Damien Hendrickx. **Your Project: ENAUWARA04586AA-Wyo**

(19 Warabrook Boulevard WARABROOK NSW 2304)

required if pH_{KCl} > 6.5

Sample Site	EAL lab code	TEXTURE (note 7)	MOISTURE CONTENT (% moisture of total wet weight)	MOISTURE CONTENT (g moisture / g of oven dry soil)	TITRATABLE ACTUAL ACIDITY (TAA) pH_{KCl}	TITRATABLE ACTUAL ACIDITY (TAA) (To pH 6.5) (mole H^+/tonne)	REDUCED INORGANIC SULFUR (% chromium reducible S) (%Scr)	REDUCED INORGANIC SULFUR (% chromium reducible S) (mole H^+/tonne)	ACID NEUTRALISING CAPACITY (ANC_{BT}) (% $CaCO_3$)	ACID NEUTRALISING CAPACITY (ANC_{BT}) (mole H^+/tonne)	NET ACIDITY Chromium Suite mole H^+/tonne (based on %Scrs)	LIME CALCULATION Chromium Suite kg $CaCO_3$/tonne DW (includes 1.5 safety Factor when liming rate is $^+$ve)
Method Info.					*(ACTUAL ACIDITY-Method 23)*		*(POTENTIAL ACIDITY-Method 22B)*		*(NEUTRALISING CAPACITY)*		*note 5*	*note 4 and 6*
LJHA2 1.0-1.1	*D8995/1*	Fine	38.6	0.6	8.38	0	1.886	1176	1.67	334	954	71.5
LJHA4 0.5-0.6	*D8995/2*	Fine	38.4	0.6	7.43	0	2.078	1296	1.07	214	1154	86.5
THA1 1.0-1.1	*D8995/3*	Fine	52.6	1.1	4.88	59	0.223	139	..	0	198	14.8

NOTE:

1 - All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)

2 - Samples analysed by SPOCAS method 23 (ie Suspension Peroxide Oxidation Combined Acidity & sulfate) and 'Chromium Reducible Sulfur' technique (Scr - Method 22B)

3 - Methods from Ahern, CR, McElnea AE , Sullivan LA (2004). ***Acid Sulfate Soils Laboratory Methods Guidelines.*** QLD DNRME.

4 - Bulk Density is required for liming rate calculations per soil volume. Lab. Bulk Density is no longer applicable - field bulk density rings can be used and dried/ weighed in the laboratory.

5 - **ABA Equation: Net Acidity = Potential Sulfidic Acidity (ie. Scrs or Sox) + Actual Acidity + Retained Acidity - measured ANC/FF (with FF currently defaulted to 1.5)**

6 - The neutralising requirement, lime calculation, includes a 1.5 safety margin for acid neutralisation (an increased safety factor may be required in some cases)

7 - For Texture: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays

8 - .. denotes not requested or required. '0' is used for ANC and Snag calcs if TAA pH <6.5 or >4.5

9 - SCREENING, CRS, TAA and ANC are NATA accredited but other SPOCAS segments are currently not NATA accredited

10- Results at or below detection limits are replaced with '0' for calculation purposes.

11 - Projects that disturb >1000 tonnes of soil, the ≥0.03% S classification guideline would apply (refer to acid sulfate management guidelines).

12 - Results refer to samples as received at the laboratory. This report is not to be reproduced except in full.

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(Classification of potential acid sulfate material if: coarse Scr≥0.03%S or 19mole H^+/t; medium Scr≥0.06%S or 37mole H^+/t; fine Scr≥0.1%S or 62mole H^+/t) - as per QUASSIT Guidelines

checked: .....
Graham Lancaster
Laboratory Manager

RESULTS OF SOIL ANALYSIS

2 samples supplied by Coffey Geotechnics on 16th January, 2015 - Lab Job No. D8994
Analysis requested by Damien Hendrickx. **Your Project: ENAUWARA04586AA-Wyo**
(19 Warabrook Boulevard WARABROOK NSW 2304).

	Method	Sample 1 LJHA1 0.5-0.6	Sample 2 LJHA3 0.8-0.9
	Job No.	*D8994/1*	*D8994/2*
Soil Conductivity (1:5 water dS/m)	Rayment and Lyons 4B1	0.239	0.198

Notes:

1: ECEC = Effective Cation Exchange Capacity = sum of the exchangeable Mg, Ca, Na, K, H and Al
2: Exchangeable bases determined using standard Ammonium Acetate extract (Method 15D3) with no pretreatment for soluble salts. When Conductivity ≥0.25 dS/m soluble salts are removed (Method 15E2).
3. ppm = mg/Kg dried sample
4. Exchangeable sodium percentage (ESP) is calculated as sodium ($cmol^+$/Kg) divided by ECEC
5. All results as dry weight DW - samples were dried at 60°C for 48hrs prior to crushing and analysis.
6. Aluminium detection limit is 0.05 $cmol^+$/Kg; Hydrogen detection limit is 0.1 $cmol^+$/Kg. However for calculation purposes a value of 0 is used.
7. For conductivity 1 dS/m = 1 mS/cm = 1000 μS/cm
8. 1 $cmol^+$/Kg = 1 meq/100g
9. Methods from Rayment and Lyons, Soil Chemical Methods - Australasia
10. Conversion of cmol+/Kg to mg/Kg multiply cmol+/Kg by:
230 for Sodium; 391 for Potassium; 200 for Calcium; 122 for Magnesium; 90 for Aluminium
11. Metals analysed by ICP-MS (Inductively Coupled Plasma - Mass Spectrometry) or ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry)

NATA
WORLD RECOGNISED ACCREDITATION
Accreditation No. 14960.
Accredited for compliance with ISO/IEC 17025.

Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

checked: .....
Graham Lancaster (Nata signatory)
Laboratory Manager

Appendix IV: Heritage Database Search Result

AHIMS Web Services (AWS)
Search Result

Your Ref Number :

Client Service ID : 149915

Beyond Environmental Consulting

95 Lakin Street
Bateau Bay New South Wales 2261

Attention: Carolyn Donnelly

Email: carolyn@beyondenvironmental.com.au

Date: 05 October 2014

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lat, Long From : -33.3645, 151.4753 - Lat, Long To : -33.3611, 151.4807 with a Buffer of 50 meters, conducted by Carolyn Donnelly on 05 October 2014.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.

A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

0	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

If your search shows Aboriginal sites or places what should you do?

- You must do an extensive search if AHIMS has shown that there are Aboriginal sites or places recorded in the search area.
- If you are checking AHIMS as a part of your due diligence, refer to the next steps of the Due Diligence Code of practice.
- You can get further information about Aboriginal places by looking at the gazettal notice that declared it. Aboriginal places gazetted after 2001 are available on the NSW Government Gazette (http://www.nsw.gov.au/gazette) website. Gazettal notices published prior to 2001 can be obtained from Office of Environment and Heritage's Aboriginal Heritage Information Unit upon request

Important information about your AHIMS search

- The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not be made available to the public.
- AHIMS records information about Aboriginal sites that have been provided to Office of Environment and Heritage and Aboriginal places that have been declared by the Minister;
- Information recorded on AHIMS may vary in its accuracy and may not be up to date .Location details are recorded as grid references and it is important to note that there may be errors or omissions in these recordings,
- Some parts of New South Wales have not been investigated in detail and there may be fewer records of Aboriginal sites in those areas. These areas may contain Aboriginal sites which are not recorded on AHIMS.
- Aboriginal objects are protected under the National Parks and Wildlife Act 1974 even if they are not recorded as a site on AHIMS.
- This search can form part of your due diligence and remains valid for 12 months.

PO BOX 1967 Hurstville NSW 2220
43 Bridge Street HURSTVILLE NSW 2220
Tel: (02)9585 6345 (02)9585 6471 Fax: (02)9585 6094

ABN 30 841 387 271
Email: ahims@environment.nsw.gov.au
Web: www.environment.nsw.gov.au

Environment & Heritage

Home > Heritage sites > Searches and directories > NSW heritage search

Search for NSW heritage

Return to search page where you can refine/broaden your search. ItemName 0

Statutory listed items

Information and items listed in the State Heritage Inventory come from a number of sources. This means that there may be several entries for the same heritage item in the database. For clarity, the search results have been divided into two sections.

- **Section 1**. contains items listed by the **heritage council** under the NSW Heritage Act. This includes listing on the state heritage register, an interim heritage order or protected under section 136 of the NSW Heritage Act. This information is provided by the Heritage Branch.
- **Section 2**. contains items listed by **local councils & shires and state government agencies**. This section may also contain additional information on some of the items listed in the first section.

Section 1. Items listed under the NSW Heritage Act.

Your search did not return any matching results.

ItemName 0

Section 2. Items listed by Local Government and State Agencies.

Your search returned 15 records.

Item name	Address	Suburb	LGA	Information source
Amaroo - Dwellings	156 Gladstan Avenue, Cnr Tuggerah Parade	Long Jetty	Wyong	LGOV
Dwelling	142 Tuggerah Parade	Long Jetty	Wyong	LGOV
Dwelling	20 Elsiemer Street	Long Jetty	Wyong	LGOV
Dwelling	6 Gordon Road	Long Jetty	Wyong	LGOV
Dwelling	25-27 Surf Street	Long Jetty	Wyong	LGOV
Dwelling	24 Pacific Street	Long Jetty	Wyong	LGOV
Dwelling	58 Swadling Street	Long Jetty	Wyong	LGOV
Dwellings	129 Tuggerah Parade	Long Jetty	Wyong	LGOV
Group of Trees (Araucaria Heterophylla)	Swadling Reserve Bay Road	Long Jetty	Wyong	LGOV
Long Jetty	Tuggerah Parade, opp Archbold Street	Long Jetty	Wyong	LGOV
Long Jetty Hotel	407 The Entrance Road, Cnr Pacific Street	Long Jetty	Wyong	LGOV
Mr Parry's Jetty	Tuggerah Parade, Opposite Gladstan Avenue	Long Jetty	Wyong	LGOV
Savoy Theatre (former)	391 The Entrance Road, Cnr Thompson Street	Long Jetty	Wyong	LGOV
Shop	264-266 The Entrance Road	Long Jetty	Wyong	LGOV

Water Reservoir	61-67 Gilbert Street	Long Jetty	Wyong	LGOV

There was a total of 15 records matching your search criteria.

Key:
LGA = Local Government Area
GAZ= NSW Government Gazette (statutory listings prior to 1997), HGA = Heritage Grant Application, HS = Heritage Study, LGOV = Local Government, SGOV = State Government Agency.
Note: The Heritage Branch seeks to keep the State Heritage Inventory (SHI) up to date, however the latest listings in Local and Regional Evironmental Plans (LEPs and REPs) may not yet be included. Always check with the relevant local council or shire for the most recent listings.

Environment & Heritage

Amaroo - Dwellings

Item details

Name of item: Amaroo - Dwellings
Other name/s: Holiday Units
Type of item: Built
Group/Collection: Residential buildings (private)
Category: Other - Residential Buildings (private)
Primary address: 156 Gladstan Avenue, Cnr Tuggerah Parade, Long Jetty, NS
Local govt. area: Wyong

All addresses

Street Address	Suburb/town	LGA	Parish	County	Type
156 Gladstan Avenue, Cnr Tuggerah Parade	Long Jetty	Wyong			Primary Address

Statement of significance:

A fine representation of the vernacular holiday units built in the era to accommodate the demand for accommodation. It has local aesthetic significance because of its simple form, economy of use of space and materials, and its adaptive reuse as dwellings. It has local historical significance because it was built to service the tourist demand of a particular socio-economic class. It has local social significance because of the community diversity of the time, and the transitory nature of many community members.

Date significance updated: 14 Sep 09

Note: There are incomplete details for a number of items listed in NSW. The Heritage Branch intends to develop or upgrade statements of significance and other information for these items as resources become available.

Description

Physical description: The buildings are lightweight timber framed construction clad in standard fibro sheeting laid horizontally with timber cover battens to the junctions. The residence for the site manager is a two storey building at the end of the group. The buildings have simple galvanised iron skillion rooves

Physical condition and/or Archaeological potential: Very good

Date condition updated: 14 Oct 09

Historic themes

Australian theme (abbrev)	New South Wales theme	Local theme
8. Culture-Developing cultural institutions and ways of life	Leisure-Activities associated with recreation and relaxation	Holiday letting accommodation near waterfrontage-

Assessment of significance

SHR Criteria a) [Historical significance] It has local historical significance because it was built to service the tourist demand of a particular socio-economic class.

SHR Criteria c) [Aesthetic significance]

	The building group is located on a prominent street corner and addresses the streetscape and takes advantage of water views
SHR Criteria d) [Social significance]	It has local social significance because of the community diversity of the time, and the transitory nature of many community members.
SHR Criteria f) [Rarity]	Groups such as this with the layout, external materials and finishes are rare within the Shire waterfront areas.
SHR Criteria g) [Representativeness]	A good example of the typical holiday accommodation constructed for short letting in waterfront areas during the late 1950's.
Integrity/Intactness:	Very good
Assessment criteria:	Items are assessed against the State Heritage Register (SHR) Criteria to determine the level of significance. Refer to the Listings below for the level of statutory protection.

Recommended management:

Recommendations

Management Category	Description	Date Updated
Statutory Instrument	List on a Local Environmental Plan (LEP)	14 Oct 09
Recommended Management	Consult with owner and/or community	14 Oct 09

Listings

Heritage Listing	Listing Title	Listing Number	Gazette Date	Gazette Number	Gazette Page
Local Environmental Plan			23 Dec 13		
Heritage study					

Study details

Title	Year	Number	Author	Inspected by	Guidelines used
Heritage Assessment and Review of The Entrance Peninsula, Vol. 2	2006	LJ3	Henly Cox		Yes
Wyong Shire Heritage Study Review	2009		David Scobie Architects	David Scobie	Yes

References, internet links & images

None

Note: internet links may be to web pages, documents or images.

(Click on thumbnail for full size image and image details)

Data source

The information for this entry comes from the following source:

Name: Local Government

Database number: 2720217

Return to previous page

Every effort has been made to ensure that information contained in the State Heritage Inventory is correct. If you find any errors or omissions please send your comments to the Database Manager.

Environment & Heritage

Mr Parry's Jetty

Item details

Name of item: Mr Parry's Jetty
Type of item: Built
Group/Collection: Transport - Water
Category: Pier/Jetty
Primary address: Tuggerah Parade, Opposite Gladstan Avenue, Long Jetty, N
Local govt. area: Wyong

All addresses

Street Address	Suburb/town	LGA	Parish	County	Type
Tuggerah Parade, Opposite Gladstan Avenue	Long Jetty	Wyong			Primary Address

Statement of significance:

The jetty has historic significance because of the major role it played in communications and primary industry in the early days of settlement. It is a major local landmark, which has influenced the naming of the area and is highly valued by the community.

Date significance updated: 25 Nov 09

Note: There are incomplete details for a number of items listed in NSW. The Heritage Branch intends to develop or upgrade statements of significance and other information for these items as resources become available.

Description

Physical description: a substantial timber deck on timber piers with a single sided timber rail and balustrading

Physical condition and/or Archaeological potential: Good

Date condition updated: 21 Nov 09

History

Historical notes: Built in 1931 by Stanley E. Parry, to service the sub-division of the estate of George E. Swadling, former Mayor of Canterbury, who settled at Long Jetty in the early 1900s.

Historic themes

Australian theme (abbrev)	New South Wales theme	Local theme
3. Economy-Developing local, regional and national economies	Communication-Activities relating to the creation and conveyance of information	(none)-
3. Economy-Developing local, regional and national economies	Fishing-Activities associated with gathering, producing, distributing, and consuming resources from aquatic environments useful to humans.	(none)-

Assessment of significance

SHR Criteria a)
[Historical significance]

	The jetty has historic significance because of the major role it played in communications and primary industry in the early days of settlement.
SHR Criteria b) [Associative significance]	Mr. Parry
SHR Criteria c) [Aesthetic significance]	There are archaeological and maritime remnants
SHR Criteria d) [Social significance]	The site is highly valued by the community and marked with a plaque
SHR Criteria f) [Rarity]	A private construction designed to add value to speculative real estate
Integrity/Intactness:	Fair
Assessment criteria:	Items are assessed against the State Heritage Register (SHR) Criteria to determine the level of significance. Refer to the Listings below for the level of statutory protection.

Recommended management:

Recommendations

Management Category	Description	Date Updated
Statutory Instrument	List on a Local Environmental Plan (LEP)	21 Nov 09
Recommended Management	Consult with owner and/or community	21 Nov 09

Listings

Heritage Listing	Listing Title	Listing Number	Gazette Date	Gazette Number	Gazette Page
Local Environmental Plan			23 Dec 13		
Heritage study					

Study details

Title	Year	Number	Author	Inspected by	Guidelines used
Wyong Shire Heritage Study Review	2009		David Scobie Architects	David Scobie	Yes

References, internet links & images

None

Note: internet links may be to web pages, documents or images.

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