BMT WBM

Review of Environmental Factors: Tallow Creek Entrance Opening – Vol. 2

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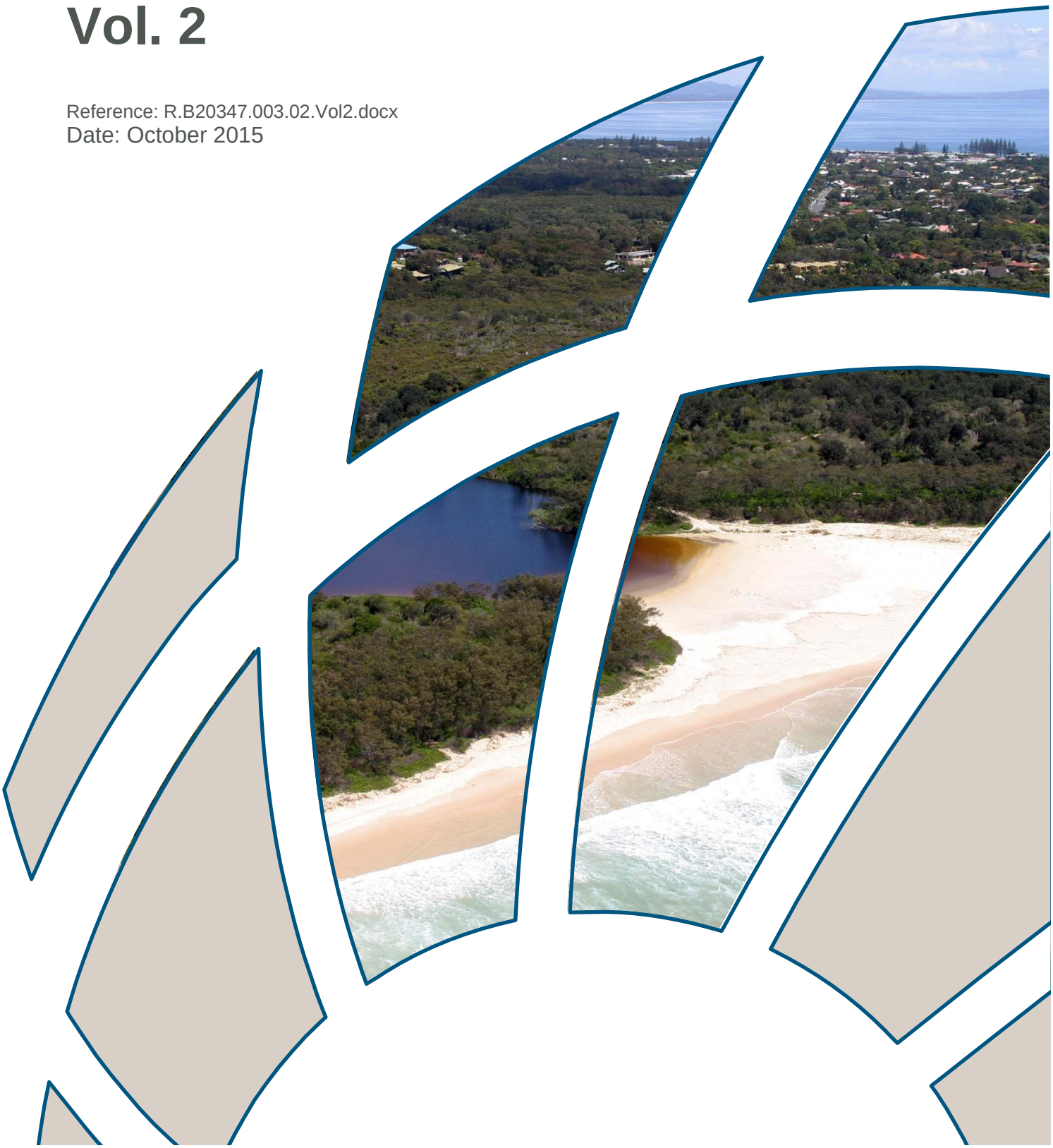
Date: October 2015



Review of Environmental Factors: Tallow Creek Entrance Opening – Vol. 2

Prepared for:	Byron Shire Council
Prepared by:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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Document:	R.B20347.003.02.Vol2.docx
Title:	Review of Environmental Factors: Tallow Creek Entrance Opening – Vol. 2
Project Manager:	Damion Cavanagh
Author:	Damion Cavanagh, Jeremy Visser, Suanne Richards, Jane Ainsworth (Ainsworth Heritage)
Client:	Byron Shire Council
Client Contact:	James Flockton
Client Reference:	

Synopsis: **This report presents a Review of Environmental Factors (REF) for the opening of the Tallow Creek entrance to manage flood levels and/or water quality within the Tallow Creek catchment, in accordance with the Interim Management Plan provided within Council's Tallow Creek Floodplain Risk Management Study and Plan. Volume 1 contains the REF text, while Volume 2 contains supporting materials to the REF, such as predating correspondence and reports.**

REVISION/CHECKING HISTORY

Revision Number	Date	Checked by		Issued by	
0	20/4/2015	J. Visser		D. Cavanagh	
1	15/06/2015	J. Visser		D. Cavanagh	
2	9/10/2015	J. Visser		D. Cavanagh	

DISTRIBUTION

Destination	Revision										
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Contents

1 Supporting Material

Supporting documentation is included in this volume as detailed below:

Correspondence:

- Letter from Council to Planning and Infrastructure regarding requirements for an EIS (5/11/13).
- Letter from Planning and Infrastructure to Council regarding requirements for an EIS (18/11/13).
- Letter from Council to MPA/NPWS/Arakwal Corporation seeking in-principle support for the preparation of a Review of Environmental Factors (19/5/2014).
- Letter from DPI (covering both Fisheries NSW and the Marine Park Authority) to Council providing in-principle support to prepare the REF (28/5/2014).
- Letter from NPWS to Council providing in-principle support to prepare the REF (i.e. this document) (26/6/2014).
- Response from Arakwal Corporation to Council identifying in-principle support for the preparation of a Review of Environmental Factors (30/9/2014).
- Letter of concurrence from Arakwal Corporation to Council with respect to the Cultural Heritage Assessment prepared by Ainsworth Heritage.

Reports:

- Ainsworth Heritage, 2015, Cultural Heritage Assessment, Tallow Creek Opening, report prepared for Byron Shire Council, Ainsworth Heritage, Byron Bay.
- BMT WBM 2013a, Tallow's Creek Proposed Artificial Opening – Threatened Species and Communities Data Review, report prepared for Byron Shire Council, BMT WBM, Brisbane.
- BMT WBM 2013b, Tallow Creek Entrance 7 Part Tests, report prepared for Byron Shire Council, BMT WBM, Brisbane.
- BMT WBM 2014, Tallow Creek Flora and Fauna Habitat Assessment, report prepared for Byron Shire Council, BMT WBM, Brisbane.

BSC File No: #E2013/70159
Your ref:
Contact: James Flockton

5 November 2013

Regional Director - Northern Region
Department of Planning
Locked Bag 9022
GRAFTON NSW 2460

Attention: Steve Murray

Dear Mr Murray

Proposed opening of Tallow Creek

The purpose of this letter is to seek Planning and Infrastructure's exemption from the need to prepare an EIS for the proposed opening of Tallow Creek.

Tallow Creek is an intermittently closed and open lake lagoon (ICOLL) system that lies between the township of Byron Bay and Suffolk Park and like many ICOLLS in NSW, residential development has occurred within its catchment. Consequently, Tallow Creek (again like many other ICOLLs) requires periodical opening of the entrance sandbar to alleviate potential flood impacts on adjacent low-lying housing.

Over the past few years, Byron Shire Council has developed a REF for the proposed opening of Tallow Creek. A draft version of the REF was provided to the NSW NPWS in early 2010, to which NPWS responded to Council by letter on 27 July 2010. The main item raised in the letter from NPWS is quoted as follows.

> *"Council will need to discuss its request for an exemption from the preparation of an EIS with the Department of Planning as the proposal 'drains a SEPP14 wetland'. National Parks and Wildlife Service and Marine Parks Authority (NPWS MPA) have no role in exempting Council as the matter relates to a SEPP14 wetland off park."*

Firstly, for the purposes of background information, a summarised description of the proposed activity is provided in the following table (extracted from the 2010 draft REF).

Description of proposed activity(s)	The proposed activity is to use mechanical intervention to reduce sand levels at the mouth (entrance) of Tallow Lake when the prescribed trigger levels are met. The degree of intervention (amount of sand to be relocated) will depend on the circumstances (height and area of the sandbar at the time). An opening will be triggered should Tallow Lake level reach or go beyond 2.2m AHD. An opening will be triggered at 1.8 m AHD or above should the lake water quality results prove to be a hazard to health. The sandbar will have a small strip (maximum 2m wide) skimmed or excavated from the ocean toward the sandbar, using the level and height of the water to guide the last height to be excavated from the sandbar. The sandbar will be reduced to allow natural opening to occur if sufficient rain falls are predicted, and to allow the artificially created channel to scour out the sandbar as naturally as possible. A forced opening will be needed should no rain fall be predicted.
	The proposed activity is to be undertaken in accordance with Byron Shire Council's Tallow Creek Floodplain Risk Management Study and Plan, and the Arakwal National Park Plan of Management (PoM) and any conditions imposed under a marine parks permit or National Parks and Wildlife Service consent determination.
	The extent of Tallow Lake and the effects of lowering lake level will affect a greater area than the National Park and Marine Park. Approximately 40% is National Park/Marine Park and 60% is private or Council land. Therefore, this Review of Environment Factors and associated documents will consider environments within and outside the Arakwal National Park and Cape Byron Marine Park.
Estimated commencement date?	Day / month / year: the commencement date(s) for the proposed activity will vary and be in response to water levels and health risks. The proposed activity will be undertaken as soon as practicable following trigger levels as identified in the Byron Shire Council's Tallow Creek Floodplain Risk Management Study and Plan.
Estimated completion date?	The works will be completed on the same day as commencement. It is estimated that the works will take approximately one (1) hour to complete. The approval is sought for the period of the Interim Sandbar Management Plan in the Tallow Creek Floodplain Risk Management Study and Plan, until such time as the Final Management Strategy and Plan is developed and approved.

As stated earlier, Byron Shire Council wishes to obtain an exemption from the need to prepare an EIS. The main concerns raised to date by others which suggest an EIS may be required include:

1. Draining of Tallow Creek (SEPP 14 coastal wetland) – raised by NPWS

2. The opening is designated development as it is considered to be an extractive industry – raised initially through Council staff discussions; and

3. As a precaution for nearby SEPP14 coastal wetlands – raised by NPWS.

Council's position is that an EIS is not required for the reasons outlined below.

Draining of Tallow Creek

Previous advice from the (then) Department of Planning was that constraints imposed by SEPP-14 can only be applied to land gazetted under that Policy. This holds true irrespective if works outside the wetland have an indirect impact on gazetted SEPP-14 wetland areas.

Extractive Industry
Extractive industries involve the winning or removal of extractive material – the proposed works do not involve removal, but rather, just localised relocation of material, and as such would be more regarded as earthworks than an extractive industry. The very small quantities and intermittent nature of the works involved are also unlikely to support a classification as extractive industry.

Precaution to Protect SEPP 14 Wetlands
The 2010 draft REF prepared by Council incorrectly identified that a Species Impact Statement (SIS) was required as the proposal was (then) considered likely to have a significant effect on threatened species, and ecological communities or their habitats.

The 2010 draft of the REF stated that, "*it has been decided that there is likely to be a significant effect on threatened species, and ecological communities or their habitats and a SIS has been prepared*".

However, the 2010 draft REF did not provide any Assessment of Significance supporting this decision (it simply refers to the SIS). Upon review, the SIS has been found to be largely incomplete in respect to assessment of impacts on threatened species, EECs and habitats, as per the requirements of s5A of the EP & A Act.

These issues in the draft REF and supporting Assessment of Significance prompted Council to review these elements to determine if the proposed activity (ie entrance opening) was likely to have a significant effect on threatened species, and ecological communities or their habitats. In this regard, Council commissioned local consultants BMT WBM Pty Ltd to complete studies to identify the geographic zone of influence of the proposed entrance opening, which included machinery access, beach works and effects on the flora and fauna of the Tallow Creek resulting from the activity. This investigation identified some 44 species of birds, mammals, frogs, reptiles, invertebrates, fish, flora and communities requiring assessment under 7 Part Tests, which were subsequently completed by BMT WBM. The Executive Summary of this report is provided as follows.

> *"A number of 7-Part tests (i.e. Assessments of Significance) have been completed as part of this study and have considered species identified in an earlier BMT WBM report (completed August 2013) which identified the threatened species, populations and ecological communities which may be affected directly or indirectly, by the proposed artificial opening of the Tallows Creek entrance. The 7-part tests did not identify that the proposed activity was likely to present any significant impacts to the species considered. However, a number of species including the Beach Stone Curlew, Pied Oyster Catcher, Little Tern, Loggerhead Turtle, Green Turtle and Sand Spurge may be impacted by activities associated with the physical entrance opening works that allow Tallow Creek to drain to the ocean.*
> *Consequently, pre-disturbance ecological surveys in consultation with the relevant authorities would be required to locate any threatened species and their presence in the beach areas to be impacted. Utilising information derived from the surveys more suitable approaches may be determined to minimise species impact.*
> *Such requirements for survey, and potential alternative opening options would necessarily be documented in an environmental management plan which would be applied to the entrance opening."*

Council's current position, based on the outcomes of these studies, is that no significant impacts are likely to the identified threatened species (as per the 7 Part Tests), subject to the establishment of suitable pre-disturbance survey and management procedures, and hence no SIS is required, or associated EIS.

BMT WBM has also advised Council that the issue of artificial entrance management within National Parks / Marine Parks / SEPP-14 is not unique to Tallow Creek, and precedence is likely to be well established at other locations (for example Mummaga Lake at Dalmeny).

An REF for opening of ICOLL entrances in Eurobodalla National Park was prepared in 2007. It concluded that the artificial opening of the entrances would not have any significant environmental impacts provided mitigation measures were followed. This is also considered to be the case for Tallow Creek.

Based on the above, it is considered that an EIS is not required, and that the existing REF is sufficient to fulfil environmental assessment processes.

We look forward to your comments in due course.

Yours sincerely

Phillip Holloway
Executive Manager
Community Infrastructure

NSW GOVERNMENT | Planning & Infrastructure

Mr Ken Gainger
General Manager
Byron Shire Council
PO Box 219
MULLUMBIMBY NSW 2482

Our ref: 13/01011
Your ref: #E2013/70159

Attention: James Flockton

Dear Mr Flockton

Subject: Proposed Opening of Tallow Creek

I refer to your letter dated 5 November 2013 and our recent discussions regarding the subject proposed works.

You have advised that the proposal will be determined as an activity under Part 5 of the *Environmental Planning & Assessment (EP&A) Act 1979*.

Under Part 5 of the EP&A Act 1979 the determining authority has a duty to consider the likely environmental impacts of granting any approval. If the impacts of a proposed activity are likely to significantly affect the environment, then an Environmental Impact Statement (EIS) must be prepared.

In response to the matters raised in your letter regarding *State Environmental Planning Policy (SEPP) 14 – Coastal Wetland* we provide the following comments.

SEPP 14 Coastal Wetland derives from Part 4 of the EP&A Act, not Part 5. This policy only applies to the following types of development within gazetted mapped SEPP 14 coastal wetland areas:

- Clearing – any manner of destruction or removal of native plants including trees, shrubs, ferns, vines, herbs and grasses.

- Levee Construction – construction, enlargement or extension of an earthwork, bund wall or similar structure which changes or impedes surface drainage or tidal action.

- Draining – draining includes construction, deepening, extending, installing or laying any canal, drain or pipe in or on the wetland.

- Filling – raising the ground level of the wetland by disposal of spoil from any landfill method including mining, dredging or refuse dumping. This includes erection of buildings, pylons, new roads.

The preparation of an EIS, the consent of Council under Part 4 of the EP&A Act and the concurrence of the Director General of the Department of Planning and Infrastructure are required where any of the above development types are proposed directly within a SEPP 14 coastal wetland area.

It is not possible for the department to issue an exemption for the preparation of an EIS under Part 4 of the EP&A Act.

Notwithstanding, this policy does not apply to any works outside of mapped SEPP 14 coastal wetland areas.

Should you have any further enquiries about this matter please contact Luke Blandford in the Department's Northern Region Office on telephone number (02) 6641 6614.

Yours sincerely

15/11/2013

Luke Blandford
Planning Officer
Northern Region

BSC File No: #E2014/32380
Contact:

19 May 2014

Mr Andrew Page
Manager Cape Byron Marine Park
NSW Department of Primary Industries
PO Box 127
BYRON BAY NSW 2481

Dear Mr Page

Opening Tallow Creek

As per our recent meeting with you on Thursday 15 May regarding a permit application to open Tallow Creek in accordance with the 'Interim Management Strategy' that is within the Council adopted Tallow Creek Floodplain Risk Management Study and Plan 2009.

Council now seeks in principal support from the Marine Parks Authority to apply for a permit to open Tallow Creek in accordance with the 'Interim Management Strategy'.

If you have any questions please call me on 02 6626 7158.

Yours sincerely

James Flockton
Flood and Drainage Engineer

cc. Pat Dwyer, Fisheries, NSW Department of Primary Industries

NSW GOVERNMENT | Department of Primary Industries

Our Ref: C14/218

The General Manager
Byron Shire Council
PO Box 219
MULLUMBIMBY NSW 2482

28 May 2014

Attention: Mr James Flockton

Dear Mr Flockton

Re: Proposal to Manage the Entrance of Tallow Creek in Cape Byron Marine Park

I refer to a meeting on 15 May at the Arakwal Depot and to your letter of 19 May 2014 seeking in-principle support to prepare a Review of Environmental Factors (REF) prior to applying for approvals to manage the entrance of Tallow Creek. It is understood that the management of the entrance of Tallow Creek will be undertaken in accordance with the "Interim Management Strategy" described in the *Tallow Creek Floodplain Risk Management Study and Plan 2009.*

Tallow Creek is within Cape Byron Marine Park so formal approval under the *Marine Parks Act 1997* will be required for any "works" to manage the entrance of the creek. In addition, Fisheries NSW is also responsible for ensuring that fish stocks are conserved and that there is "no net loss" of key fish habitats upon which they depend. To achieve this, the Aquaculture and Aquatic Ecosystems Unit assesses activities under Part 5 of the *Environmental Planning and Assessment Act 1979* in accordance with the objectives of the *Fisheries Management Act 1994*, the aquatic habitat protection and threatened species conservation provisions in Parts 7 and 7A of the Act, and the Policy and Guidelines for Fish Habitat Conservation and Management (2013 Update). Fisheries NSW is also responsible for ensuring the sustainable management of commercial, quality recreational fishing and viable aquaculture within NSW.

At this stage, in-principle support to prepare an REF to inform the application for approvals to manage the entrance of Tallow Creek is granted by both Fisheries NSW and the Marine Park Authority.

Division of Primary Industries, Fisheries NSW
1243 Bruxner HWY WOLLONGBAR NSW 2477
Tel: 02 6626 1397 Fax: 02 6626 1377 ABN 72 189 919 072 www.dpi.nsw.gov.au

If you require further information or clarification of any of the issues raised above with respect to Cape Byron Marine Park please contact Andrew Page on Ph 6620 93305, or myself in relation to any Fisheries issues on (02) 6626 1397.

Yours sincerely

Patrick Dwyer
Regional Assessments Officer (North)

Division of Primary Industries, Fisheries NSW
1243 Bruxner HWY WOLLONGBAR NSW 2477
Tel: 02 6626 1397 Fax: 02 6626 1377 ABN 72 189 919 072 www.dpi.nsw.gov.au

Office of Environment & Heritage
NSW National Parks & Wildlife Service

Date: 26 June 2014
Your reference: #E2014/32374
Our reference: 10/3560
Contact: Sue Walker
0266209300

Mr Ken Gainger
General Manager
Byron Shire Council
PO Box 219
MULLUMBIMBY NSW 2482

Attention: James Flockton
Flood and Drainage Engineer

Dear Sir

PROPOSAL TO MANAGE THE ENTRANCE OF TALLOW CREEK IN ARAKWAL NATIONAL PARK

Reference is made to the meeting between Byron Shire Council officers, Council's consultants and Office of Environment & Heritage (OEH) officers on 15 May 2014 at the National Parks and Wildlife Service (NPWS) Byron Coast Area Office. NPWS is in receipt of Council's letter dated 19 May 2014 in which Council seeks in-principle support from NPWS to undertake works to manage the entrance to Tallow Creek in Arakwal National Park. NPWS understands that Council proposes to manage the creek entrance in accordance with the 'Interim Management Strategy' described in the *Tallow Creek Floodplain Risk Management Study and Plan 2009*.

As you are aware, formal approval for Council's proposed works is required from NPWS in accordance with the *National Parks & Wildlife Act 1974* (NPW Act). At this stage NPWS is able to provide Council with in-principle support for the proposal to permit preparation of a Review of Environmental Factors (REF), which is required as the works constitute an activity under Part 5 of the *Environmental Planning & Assessment Act 1979* (EP&A Act). If the REF is favourably determined Council will also be required to enter into a formal licence agreement with NPWS.

To assist proponents undertaking activities on land managed under the NPW Act to prepare REFs, OEH has produced the *Proponents Guidelines for the Review of Environmental Factors* and a standard template for preparing an REF. These documents are available at: <www.environment.nsw.gov.au/protectedareas/developmntadjoiningdecc.htm>. OEH policies are addressed in these publications which include hyperlinks to enable viewing of specific policies.

The *Arakwal National Park Plan of Management* (NPWS 2007) must be considered when preparing the REF and is available at: <www.environment.nsw.gov.au/parkmanagement/ParkAndFireManagementPlansByCategory.htm>.

A fee of $170 is required with lodgement of the REF with NPWS and a final fee is also applicable. Refer to Section 2.4.2 of the *Proponents Guidelines* for details of how final fees are calculated.

NPWS requires 4 hard copies of the REF and any supporting information and an electronic copy in accordance with Section 2.5 of the *Proponents Guidelines*.

PO Box 127 Byron Bay NSW 2481
Tallow Beach Road Byron Bay NSW
Tel: (02) 6620 9300 Fax: (02) 6620 9333
ABN 30 841 387 271
www.environment.nsw.gov.au

NPWS will generally determine an REF within 40 days of receipt if additional information is not required from the proponent. Refer to Section 2.3 of the *Proponent Guidelines* for further information regarding matters which may affect timeframes.

Background

Tallow Creek is classified as an ICOLL (an Intermittently Closed and Open Lake or Lagoon). OEH understands that Byron Shire Council is currently investigating the possibility of artificially opening Tallow Creek to the ocean by scraping the berm at the ocean (downstream) end of the creek, as a management response to the ongoing threat of flooding of upstream properties during high rainfall events. It is further understood that the water quality of Tallow Creek is somewhat degraded as a result of historic incompatible land use, such as sand mining, and therefore, the mechanical opening of the creek is hoped to have a positive effect on water quality. Improved water quality is a long expressed desire and request of the local Aboriginal people.

Previous assessments of the opening of Tallow Creek have raised concerns about the likely impact of the works on threatened shorebirds. This will continue to be a key consideration during the current environmental assessment. Additional considerations are documented below and in Attachment 1.

Tenure

Tallow Creek is located within Arakwal National Park which was gazetted on 26 October 2001 under an Indigenous Land use Agreement (ILUA) between the NSW State Government and the Arakwal Aboriginal Corporation that represents the rights and interests of the Byron Bay Arakwal people. This agreement was the result of the partial resolution of a Native Title Determination Application under the Commonwealth *Native Title Act 1993*. The Arakwal ILUA recognises the Byron Bay Arakwal people as the traditional owners of an area that is now the Park. The Byron Bay Arakwal and other Bundjalung people have been associated with the coastal landscape around Byron Bay for at least 22,000 years. The parts of Tallow Beach and Tallow Creek within the Park are particularly important landscapes to the traditional owners. They contain many special places and wild resources that are important to maintain their connection with Country and exercise their rights and roles as traditional owners.

The estuarine areas and waters below mean high water mark within Tallow Creek form part of the Cape Byron Marine Park. Tallow Creek forms a Special Purpose Zone within the Cape Byron Marine Park and, according to page 4 of the Cape Byron Marine Park Operational Plan, this zone provides for the traditional use and rehabilitation of the Creek. In addition, SEPP 14 wetland number 109 exists over the mid and upstream parts of Tallow Creek (outside of Arakwal National Park), covering a total area of approximately 25 hectares.

Zoning

The land subject to the proposed works is zoned E1 – National Parks and Nature Reserves, in accordance with *Byron Local Environment Plan 2014*. Land use authorised under the *National Parks and Wildlife Act 1974* (NPW Act) is permissible without consent.

National Parks and Wildlife Act 1974 - Permissibility

The proposed works would involve the mechanical lowering of the Tallow Creek berm to allow the overtopping and running of creek water to the ocean, which in turn, will allow marine water intrusion into Tallow Creek from incoming tides.

The proposed opening of Tallow Creek is consistent with the stated Management Principles listed at Section 30E of the NPW Act, including the conservation of places, objects, features and landscapes of cultural value as well as the maintenance of ecosystem function, the protection of geological and geomorphological features and natural phenomena and the maintenance of natural landscapes. The proposal is also supported by the Arakwal Vision for country *"Let the creek run out into the ocean and make*

it clean, running, Teatree water", as stated on Page 38 of the *Arakwal National Park Plan of Management*. Hence, given the consistency of the proposed works with national park management principles and the support of the Plan of Management, it appears that the proposed works are a permissible activity under this Section of the NPW Act. However, before works can proceed, and only upon completion of the appropriate level of environmental impact assessment, a consent in accordance with Clause 17(1)(c) of the National Parks and Wildlife Regulation 2009 (NPW Regulation) would be required to be issued by the National Parks and Wildlife Service (as a delegate to the Minister for the Environment).

Cape Byron Marine Park – Permissibility

With respect to works within a Marine Park, consent may be granted by permit to carry out certain activities within Cape Byron Marine Park that are otherwise prohibited. The circumstances in which approval may be given are set out in the *Marine Parks (Zoning Plans) Regulation 1999* and the process for applying for approval is included in the *Marine Parks Regulation 2009*. An approved marine parks permits policy has been developed which clarifies administrative arrangements, processes and approval parameters for the issuing of permits and is available on the Marine Parks Authority website for applicants' information. It will therefore be vital to establish the precise cadastral location of work, to determine whether or not an approval in accordance with the Marine Parks legislation will be necessary, and to determine the relevant determining authority/ies.

Environmental Impact Assessment Requirements

Despite the anticipated outcomes of the opening of Tallow Creek, a comprehensive environmental assessment in accordance with Section 111 of Part 5 of the *Environmental Planning and Assessment Act 1979* will be required. Provided as Attachment 1 to this memo is a list of requirements that have been developed to ensure that the necessary Review of Environmental Factors (REF) examines and takes into account to the fullest extent possible, matters affecting or likely to affect the environment as a result of the artificial opening of Tallow Creek. Please note there may be additional matters requiring consideration than those listed in Attachment 1.

If you require further information about matters relating to Arakwal National Park please contact myself or Norm Graham, Ranger, on 0266209300. Inquiries regarding other matters for consideration in the preparation of the REF should be addressed to Mr Dimitri Young, Senior Team Leader, Planning North East Region, OEH Regional Operations and Heritage on 0266598272.

Yours sincerely

SUE WALKER
Area Manager Byron Coast
Northern Rivers Region
National Parks and Wildlife Service

Attachment 1 - Scope of environmental assessment: opening of Tallow Creek – Arakwal National Park

OEH's primary interest in the proposal relates to potential impacts on biodiversity, Aboriginal cultural heritage values, historic heritage, coasts, estuaries and floodplains and National Parks and Wildlife estate. It is recommended that the REF give particular consideration to the following:

1. Description of the proposal

The objectives of the proposal should be clearly stated and refer to the:

- anticipated frequency and duration of the proposed opening of Tallow Creek – frequency of mechanical opening will have implications on upstream water dependant environments
- all anticipated environment impacts, both direct and indirect, including level of vegetation and habitat clearing, removal, inundation and/or drainage, as well as potential exposure of acid sulfate soils as a result of falling groundwater levels
- the anticipated level of performance in meeting required environmental standards
- threatened species, populations, ecological communities and / or habitats affected
- the staging and timing of the proposal and
- the proposal's relationship to any other proposal and/or development.

2. The Project Area

The REF should fully identify all of the processes and activities intended for the site and during the life of the project, including details of:

- the location of the proposal and details of the surrounding environment
- the proposed management and layout of the site
- land tenure and zoning
- ownership details of any residence and/or land likely to be affected by the proposal
- maps/diagrams showing the location of residences and properties likely to be affected and other industrial developments, conservation areas, wetlands, etc in the locality that may be affected
- all equipment proposed for use at the site
- chemicals, including fuel, used on the site and proposed methods for the transportation, storage, use and emergency management
- waste generation, storage and disposal
- a plan showing the distribution of any threatened flora or fauna species and the vegetation communities on the subject site, and the extent of vegetation proposed to be cleared should be provided and
- methods to mitigate any expected direct and indirect environmental impacts of the proposal.

3. Aboriginal Cultural Heritage

Given the high significance of Tallow Creek and its surrounds to Aboriginal people, the REF should contain the following, determined by the respectful engagement of and consultation with the relevant Aboriginal stakeholder groups, including the Bundjalung of Byron Bay Arakwal group:

- A description of any Aboriginal objects and declared Aboriginal places located or associated with the area of the proposal.

- A description of the cultural heritage values, including the significance of the Aboriginal objects and declared Aboriginal places, that exist across the whole area that will be affected by the proposal, and the significance of these values for the Aboriginal people who have a cultural association with the land.
- A description of how the requirements for consultation with Aboriginal people as specified in clause 80C of the National Parks and Wildlife Regulation 2009 (NPW Regulation) have been met.
- The views of those Aboriginal people regarding the likely impact of the proposal on their cultural heritage. If any submissions have been received as a part of the consultation requirements, then the report must include a copy of each submission and your response.
- A description of the actual or likely harm posed to the Aboriginal objects or declared Aboriginal places from the proposed activity, with reference to the Aboriginal cultural heritage values identified.
- A description of any practical measures that may be taken to protect and conserve those Aboriginal objects or declared Aboriginal places.
- A description of any practical measures that may be taken to avoid or mitigate any actual or likely harm, alternatives to harm or, if this is not possible, to manage (minimise) harm.

In addressing these requirements, the applicant must refer to the following documents:

a. *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (OEH 2010) - <www.environment.nsw.gov.au/resources/cultureheritage/ddcop/10798ddcop.pdf> These guidelines identify the factors to be considered in Aboriginal cultural heritage assessments for proposals under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

b. *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (OEH 2010) - <www.environment.nsw.gov.au/licences/consultation.htm>. This document further explains the consultation requirements that are set out in clause 80C of the NPW Regulation 2009. The process set out in this document must be followed and documented in the EIA.

c. *Code of Practice for the Archaeological Investigation of Aboriginal Objects in New South Wales* (OEH 2010) - <www.environment.nsw.gov.au/licences/archinvestigations.htm>. The process described in this Code should be followed and documented where the assessment of Aboriginal cultural heritage requires an archaeological investigation to be undertaken.

Notes:

An Aboriginal Site Impact Recording Form (<www.environment.nsw.gov.au/licences/DECCAHIMSSiteRecordingForm.htm>) must be completed and submitted to the Aboriginal Heritage Information Management System (AHIMS) Registrar, for each AHIMS site that is harmed through archaeological investigations required or permitted following the determination of the proposal.

Under Section 89A of the NPW Act, it is an offence for a person not to notify OEH of the location of any Aboriginal object the person becomes aware of, not already recorded on the Aboriginal Heritage Information Management System (AHIMS). An AHIMS Site Recording Form should be completed and submitted to the AHIMS Registrar (<www.environment.nsw.gov.au/contact/AHIMSRegistrar.htm>), for each Aboriginal site found during investigations.

An initial point of contact for the Bundjalung of Byron Bay Aboriginal Corporation (Arakwal) is Mr Gavin Brown, General Manager (ph. 0266858746).

4. Biodiversity

The REF must detail the existing environment including discussion on flora and fauna characteristics that are likely to be directly and indirectly affected by the proposed opening of Tallow Creek. The following

requirements should be addressed at a level of investigation appropriate to the site's current condition. Attention is also drawn to the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999.* If any species requiring consideration under this legislation may be affected by the proposal, approval for the works may also be required from the Department of Environment.

Flora

A comprehensive description of the vegetation of all areas likely to be directly and indirectly affected by the proposed activity should be prepared. This will include an assessment of the condition of the plant communities present, including the designation of conservation significance at a local, regional and State level, and an assessment of the likely occurrence of any threatened species, populations and / or ecological communities listed under Schedules 1 or 2 of the *Threatened Species Conservation Act 1995* and any Rare or Threatened Australian Plant (ROTAP) species, including those upstream ecosystems that are flood and groundwater dependant.

OEH is aware that there are numerous records of threatened flora in the locality of Tallow Creek including, but not limited to:

- Dark Greenhood (*Pterostylis nigricans*)
- Stinking Cryptocarya (*Cryptocarya foetida*).

Also, the vegetation of the nearby SEPP 14 wetland (number 109) is likely to comprise an Endangered Ecological Ecosystem. This requires verification, particularly considering the potential for indirect hydrological impacts on this vegetation as a result of the proposed creek opening.

A plan showing the distribution of any threatened species and the vegetation communities on the subject site, and the extent of vegetation proposed to be affected, if any, should be provided. This plan should be at the same scale as the plan of the area subject to the proposal, and preferably showing the footprint of the proposal superimposed on the vegetation, in order to assist in the assessment of impacts on existing vegetation.

Where the assessment concludes that threatened species, populations or their habitats, or endangered ecological communities exist on or are in close proximity to the subject site, the effect of the proposal should be determined by an assessment pursuant to Section 5A of the EP&A Act. An assessment of the impact of the proposal on the plant communities and / or ROTAP species should also be provided. A description of the measures proposed to mitigate and / or ameliorate the impact of the proposal on the plant communities, threatened and ROTAP species.

Fauna

A fauna survey to identify the distribution and abundance of fauna species known or likely to use the subject site should be undertaken. This should include a description of available fauna habitats and an assessment of the conservation status of each of the faunal components at a local, regional and State level.

A plan showing the results of the above survey should be provided. The plan should be at the same scale as (or as an overlay to) the plan of the proposal footprint and overall site, to assist in the assessment of potential impacts of the proposal on fauna.

An assessment of the potential impact of the proposal on fauna should be provided. OEH is aware that there are numerous records of threatened species in the locality of Tallow Creek including, but not limited to:

- Eastern Chestnut Mouse (*Pseudomys gracilicaudatus)*
- Eastern Osprey (*Pandion cristatus*)
- Mitchell's Rainforest Snail (*Thersites mitchellae*)
- Green and Golden Bell Frog (*Litoria aurea*)
- Wallum Froglet (*Crinia tinnula*)
- Beach Stone Curlew (*Esacus magnirostris*)

- Pied Oystercatcher (*Haematopus longirostris*)
- Sooty Term (*Onychoprion fuscata*).

An assessment of the occurrence or likely occurrence of threatened species or populations, or their habitats, on the subject land should be provided. Where the assessment concludes that threatened species or populations, or their habitats, exist on or in close proximity to the subject site, the effect of the proposal should be determined in accordance with an assessment pursuant to Section 5A of the EP&A Act. A description of the measures proposed to mitigate and/or ameliorate the impact of the proposal on fauna should be provided.

Surveys and Assessments

Records of flora and fauna on or near the subject site can be obtained from:

- The Wildlife Atlas <wildlifeatlas.nationalparks.nsw.gov.au/wildlifeatlas/watlas.jsp>.
- Rare or Threatened Australian Plants (ROTAP) database.
- Threatened Species, Populations & Ecological Communities of NSW Catchments <www.threatenedspecies.environment.nsw.gov.au>.

It should be noted that these databases are not comprehensive, should only be used as a guide and do not negate the need for specific site investigations.

To address likely impacts on threatened species (including their habitat), populations and ecological communities, the proponent will need to engage a suitably qualified environmental consultant to conduct an appropriate flora and fauna survey and provide an assessment report. This report will need to evaluate and mitigate any adverse impacts on such species, populations and communities on the subject site and within the immediate vicinity. Surveys and assessments should not be confined to the immediate footprint of the proposal, but also include any areas where ancillary works may be undertaken, for example, any upgrade in site access roads or other supporting infrastructure.

Surveys should be undertaken in accordance with OEH's Threatened Species survey and assessment guidelines (available at <www.environment.nsw.gov.au>)

Surveys are required to be undertaken during optimal climatic and seasonal conditions for all potentially occurring flora and fauna species and need to consider issues such as migratory species movements, the availability of shelter, breeding, pollination patterns and prerequisites, and also the relative availability of food resources and habitat.

5. Historic Heritage

The REF should address the following:

- The heritage significance of the site and any impacts the proposal may have upon this significance should be assessed. This assessment should include natural areas and places of Aboriginal, historic or archaeological significance. It should also include a consideration of wider heritage impacts in the area surrounding the site.

- The Heritage Council maintains the State Heritage Inventory which lists some items protected under the *Heritage Act 1977* and other statutory instruments. This register can be accessed through the Heritage Branch home page on the internet (<www.heritage.nsw.gov.au>). In addition, lists maintained by the National Trust, any heritage listed under the Australian Government's EPBC Act and the local council should be consulted in order to identify any known items of heritage significance in the area affected by the proposal. These lists are constantly evolving and items with potential heritage significance may not yet be listed.

- Non-Aboriginal heritage items within the area affected by the proposal should be identified by field survey. This should include any buildings, works, relics (including relics underwater), gardens, landscapes, views, trees or places of non-Aboriginal heritage significance. A statement of significance

and an assessment of the impact of the proposal on the heritage significance of these items should be undertaken. Any policies/measures to conserve their heritage significance should be identified. This assessment should be undertaken in accordance with the guidelines in the NSW Heritage Manual. The field survey and assessment should be undertaken by a qualified practitioner/consultant with historic sites experience. The Manager, OEH Heritage Division Conservation Team, can be contacted on telephone (02) 9873 8599 for a list of suitable consultants.

6. Coast, Estuaries and Floodplains

The REF should address the following (where applicable):

- The NSW Government Flood Prone Land Policy which aims to reduce the impacts of flooding and flood liability on individual owners and occupiers, and reduce private and public losses resulting from flooding. Relevant objectives are set out in the NSW Government Floodplain Development Manual.
- The NSW Coastal Policy 1987, which has as its central focus the ecologically sustainable development of the NSW coast.
- The Estuary Management Policy, with the general goal to achieve an integrated, balanced, responsible and ecologically sustainable use of the State's estuaries, which form a key component of coastal catchments.
- The Coastline Hazard Policy 1988, with the primary objective to reduce the impact of coastal hazards on individual owners and occupiers, and to reduce private and public losses resulting from natural coastal forces.
- Relevant Coastal Zone and /or Estuary Management Plans.

(Note: Where no plans are in place setback from coastal erosion escarpments should be established in consultation with OEH).

It is understood that Byron Shire Council is currently in negotiations with Mr Toong Chin and Mr Ben Fitzgibbon of the OEH's Regional Operations Water, Floodplains and Coast in relation to this matter.

7. National Parks and Wildlife Service Estate

The REF should consider potential direct and indirect impacts on Arakwal National Park and surrounding recognised areas of high conservation value.

Without limiting the matters to be considered in the REF, OEH requires the following matters to receive particular attention:

- an adaptive management strategy to avoid impacts on nesting threatened and/or migratory shorebirds and if it is not possible to avoid impacts, how these impacts will be minimised or mitigated, including consideration of offsets, if appropriate.
- the potential impacts of vehicles using the beach to access the creek entrance
- preparation of an Environmental Management Plan (EMP) to provide further detail of the proposed activity. A copy of the EMP should be provided to NPWS for consideration as part of the NPWS approval process for the activity.

<u>Adaptive management</u>

The following matters were discussed at the recent meeting and are recommended for inclusion in the proposed adaptive management strategy:

- NPWS will periodically monitor the creek entrance for nesting bird activity if Council notifies NPWS when the water level reaches 1.8 metres AHD.
- Council is to engage an ecological specialist to provide Council with further advice if NPWS observes threatened and/or migratory birds.
- In circumstances when berm management is required and nest/s are present the aim is to promote a natural opening that maintains the nest/s in situ. NPWS does not support relocation of nests/eggs of threatened and /or migratory species due to the propensity for abandonment and loss of progeny.

Beach Access

NPWS recommends that the activity utilise of one of the following beach accesses:

- from Clifford Street Suffolk Park
- from the Broken Head day use area in Broken Head Nature Reserve
- from Tallows Beach car park in Cape Byron State Conservation Area.

Final selection of a beach access point would depend on suitability at the time works are proposed. Accessing the beach and National Park from Ocean Street Byron Bay should only be considered in an emergency situation as there is no formal vehicle access in place.

BUNDJALUNG OF BYRON BAY ABORIGINAL CORPORATION (ARAKWAL) **ICN: 2663**
Po Box 1555, Byron Bay NSW. 2481.
Phone: 0266 858746 Fax: 0266 858726
ABN: 99 508 925 629

James Flockton
Flood and Drainage Engineer
Byron Shire Council
PO Box 219
Mullumbimby NSW 2482

30th September 2014

Dear James,

The Bundjalung of Byron Bay Aboriginal Corporation (Arakwal) acknowledges your correspondence dated 19th May 2014 seeking this corporation in principle support to apply for a permit to open Tallow creek in accordance with the 'Interim Management Strategy".

I confirm that the Bundjalung of Byron Bay Aboriginal Corporation (Arakwal) Board of Directors endorsed their in principle support at a board meeting held on the 13th June 2014.

We do request that this corporation is consulted prior to the opening Tallows creek occurs.

I am contactable on the listed number should you require further correspondence.

Yours Sincerely,

Gavin Brown
General Manager
Bundjalung of Byron Bay Aboriginal Corporation (Arakwal)

BUNDJALUNG OF BYRON BAY ABORIGINAL CORPORATION (ARAKWAL) **ICN: 2663**
Po Box 1555, Byron Bay NSW. 2481.
Phone: 0266 858746 Fax: 0266 858726
ABN: 99 508 925 629

Jane Ainsworth
Consultant Archaeologist
Ainsworth Heritage
PO Box 385
Billinudgel NSW 2483

29th July 2015

Dear Jane,

I confirm that I attended a consultation meeting on the 17th December to discuss the process of approval required by Byron Shire Council to manually open the creek mouth of Tallows Creek situated (described as Lot 437; DP 729107) at the ocean entrance of Tallows Creek as it adjoins Tallows Beach, south of Byron Bay.

This workshop included representatives from Byron Shire Council, National Parks and Wildlife, BMT WBM and from Ainsworth Heritage

As a consequence Mr Brian Kelly, a representative of the Bundjalung of Byron Bay Aboriginal Corporation (Arakwal) attended the Aboriginal Cultural Heritage assessment on the 4th February 2015 at Tallows creek alongside representatives from the Arakwal NPWS office.

I have since perused the draft report and generally concur with the findings contained in the report.

However I do note that your historical reference on page 22 in the cultural heritage assessment is incorrect.

Your reference should be to Jimmy and Linda Kay who are the daughter and son in law of Harry and Clara Bray.

Jimmy and Linda lived in the hut North of Tallow Creek and their children Lorna Kelly and Linda Vidler were raised there.

This error is repeated on page 59 of volume 1 of the Review of Environmental Factors.

It must also be reinterated that the primary concern of our Arakwal representatives I have spoken to is the health and well being of the creek and its capacity to become a better pristine environment than it is at present.

This area does have a great deal of historical significance to the Bundjalung of Byron Bay Arakwal people and should there be changes then we request to be notified for further assessment.

I am contactable on the above listed number should you require further correspondence.

Yours Sincerely,

Gavin Brown
General Manager
Bundjalung of Byron Bay Aboriginal Corporation (Arakwal)

AINSWORTH heritage

Cultural Heritage Assessment:

Tallow Creek Opening, Byron Bay

FINAL REPORT_VERSION B

June 2015

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Document Name	Tallow Creek Opening_Cultural Heritage Assessment_Final Report Version B_June 2015		
Ainsworth Heritage Project No.	14-005	**Client Project No.**	
Version/Date	**Author/s**	**Date Reviewed**	**Reviewer**
Draft Report March 2015	Jane Ainsworth Ainsworth Heritage	March 2015	Damion Cavangah
Final Report April 2015	Jane Ainsworth Ainsworth Heritage	April 2015	Damion Cavangah
Final Report Version B June 2015	Jane Ainsworth Ainsworth Heritage	N/A	N/A

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1 Introduction

1.1 Preamble

BMT WBM Pty Ltd commissioned Ainsworth Heritage to undertake this Cultural Heritage Assessment on behalf of Byron Shire Council (Council). Council is seeking approval (i.e. licence) from the National Parks and Wildlife Service (NPWS), part of the Office of Environment and Heritage (OEH) to undertake works to manage the entrance to Tallow Creek in Arakwal National Park. The proposed artificial opening of the Tallow Creek is for the prevention of potential flooding and/or adverse health risks arising to the residents of Suffolk Park from the elevated waters within Tallow Creek.

The proposed work would be undertaken to manage the creek entrance in accordance with the 'Interim Management Strategy' described in the *Tallow Creek Floodplain Risk Management Study and Plan 2009*. The aim of the works is to manage flood levels within the Tallow Creek catchment area within acceptable levels.

OEH has provided Council with in-principle support for the proposal and to permit preparation of a Review of Environmental Factors (REF). The REF is required because the works constitute an activity under Part 5 of the *Environmental Planning & Assessment Act, 1979* (EP&A Act). If the REF is favourably determined, Council will also be required to enter into a formal licence agreement with NPWS. This Cultural Heritage Assessment will inform the heritage components of the REF.

1.2 Project Aims & Methodology

1.2.1 Historic (non-Aboriginal) Heritage

A preliminary heritage register search indicates that the project area is not listed on any statutory registers (such as the NSW State Heritage Register, the Byron Shire Council Local Environmental Plan Heritage Schedule or the National Trust of Australia (NSW) heritage register [which is a non-statutory register]).

Accordingly, we propose to undertake a brief Heritage Assessment and Statement of Heritage Impact to ensure that there are no previously unrecorded items of historic heritage significance or any potential to disturb historical archaeological (sub-surface) resources on the site. Our methodology for this approach is outlined below:

1. **Understand the site and its significance:**
    - Review any available documents to understand the history of the site, including heritage register searches, early parish maps, historical photos and aerial images, analysis of the Byron Shire community Based Heritage Study and the review of historical and heritage reports related to the project area (Ainsworth Heritage holds extensive records relating to the history of the Byron and Northern Rivers area);
    - Undertake a brief physical assessment of the site to establish if there are any surface historical archaeological features or areas of potential historic heritage significance; and

- Prepare an Archaeological Summary for the site and its historic heritage potential, in accordance with the NSW Heritage Act's criteria for assessing heritage significance.

2. Understand the proposed development:

- Review the statutory obligations arising from NPWS' requirements and any potential historic heritage significance of the site;
- Outline the proposed project and its parameters; and
- Provide an overview of the potential design options (if more than one design is being prepared).

3. Understand the heritage impact of the proposed development:

- Outline the potential heritage impacts of each design option as they relate to historic heritage;
- Undertake a risk assessment for each option and its impacts (mitigated and unmitigated) on any heritage values of the site;
- Recommend mitigation measures for each design (if necessary);
- Outline a Statement of Heritage Impact; and
- Develop appropriate management recommendations for any future development.

The methodology used for this project is consistent with the *Australia ICOMOS Burra Charter* and the NSW Department of Planning – Heritage Branch publications *Assessing Heritage Significance* and *Statements of Heritage Impact*.

1.2.2 Aboriginal Heritage

The proposed project does not require, at this stage, an Aboriginal Heritage Impact Permit (AHIP). Nonetheless, an Aboriginal heritage assessment is required and it is the approach of Ainsworth Heritage to follow the best practice guidelines for such assessments. In addition, NPWS has required that consultation in accordance with clause 80C of the *National Parks and Wildlife Regulation, 2009 (*NPW Regulation) is undertaken.

Consequently, the following methodology is adapted from the OEH's *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (the Code) in guiding the assessment and assisting in determining the eventual recommendations. However, it includes additional consultation with the Traditional Owners recognised in the Arakwal Indigenous Land Use Agreement (ILUA) to ensure that the Arakwal people are properly consulted regarding their wishes for Tallow Creek and its management.

The Due Diligence Assessment will consist of the following steps:

1. Understand the site

A desktop study of reports and other materials will be examined to develop an Aboriginal site history and description, utilising available OEH reports and search results of OEH's Aboriginal Heritage Information Management System (AHIMS) register, the existing Plan of Management and other archaeological and heritage reports that have been prepared for the area.
Additionally, Ainsworth Heritage maintains a large amount of in-house information and resources regarding Aboriginal heritage and the Byron area and will utilise this already existing material to minimise costs.

2. Determinations

The Due Diligence guidelines require that assessments determine if the development:

- Is Part 3A, Exempt or of Negligible Impact;
- If it may impact a known site or place; or
- If it is recognised as Low Impact.

3. Consultation

Although not required by the Due Diligence process, OEH and relevant Local Aboriginal Land Councils (LALCs) look favourably on those assessments that have asked for additional site location data from local Aboriginal sources (to overcome the limited nature of the AHIMS database and its highly incomplete datasets). In addition, the specific requirement from NPWS note that,

> "*Given the high significance of Tallow Creek and its surrounds to Aboriginal people, the REF should contain the following, determined by the respectful engagement of and consultation with the relevant Aboriginal stakeholder groups, including the Bundjalung of Byron Bay Arakwal group*."

Accordingly, consultation would be carried out in accordance with OEH's *Aboriginal Cultural Heritage Consultation Requirements for Proponents (2010).* It should be noted that the timeframes indicated are those specified by NPWS – these may be minimised in agreement with Aboriginal parties at the start of consultation. The following summarises the consultation process:

Step 1: Project Notification

Ainsworth Heritage compiles a list of relevant knowledge holders who may wish to be consulted.

Ainsworth Heritage then writes directly to the knowledge holders and advertises the project in the local newspapers.

Aboriginal parties would have 14 days from the date of notification to register an interest for being consulted.

Step 2: Presentation of Proposed Project

Ainsworth Heritage provides a face-to-face presentation of the proposed project scope and assessment methodology to the registered parties.

The registered parties then have 28 days to provide comment on the proposed scope and methodology.

Step 3: Information Gathering

Ainsworth Heritage consults the registered parties regarding cultural information that they may be willing to share, relating to the site and its environs.

4. Site Assessment

In accordance with the Due Diligence guidelines, Ainsworth Heritage undertakes an assessment of the site to establish the following:

- Previous land use and levels of site disturbance;

- Undertake a landscape analysis via a desktop investigation of the landforms of the site. This data would be compared with site data from the AHIMS search to determine the likelihood of Aboriginal sites being present. Additionally, we would use our in-house predictive model for the site to assist in determining features where archaeology could have the potential to be found;
- A surface survey would be undertaken to determine if any surface archaeology was present. The site survey would aim to investigate areas of higher potential within the project area as identified by the probability model and, should time permit, investigate areas of lesser probability. We would record any located sites according to the new OEH *Code of Practice for Archaeological Investigations of Aboriginal Objects in NSW (OEH; 2010)*. We also recommend that a member of the local LALC attend the site inspections, as input at this stage would be incorporated into the final report and add weight to any conclusions and recommendations made.
- A brief assessment of significance for any Aboriginal sites located within the project areas would be prepared.

5. Impact Assessment

- Ainsworth Heritage completes anassessment of the project's potential impacts upon any Aboriginal cultural heritage significance;
- Ainsworth Heritage determines appropriate management and mitigation measures for known sites and areas where the potential for additional sites exists. These would provide the client with practical means to avoid impact upon known and potential Aboriginal cultural heritage sites and areas.

After completion, Ainsworth Heritage will compile a written report for the project in accordance with the OEH *Code of Practice for Archaeological Investigations in NSW*, synthesising the results of the above steps.

Ainsworth Heritage will issue a copy of the draft Assessment to the registered parties for their review, which they must provide within 28 days of receipt. Their comments will be incorporated into the Final Assessment.

1.3 Site Location

The site (described as Lot 437; DP 729107) is located at the ocean entrance of Tallows Creek as it adjoins Tallows Beach, south of Byron Bay on the Far North Coast of NSW (shown on Figure 1.1). It is approximately 700m east of the road entrance to St Finbarrs Primary School and Byron Bay High School (at intersection with Bangalow Road). The site is to the south of Byron Bay and to the north of Suffolk Park.

A zone depicting the potential location of opening is shown on Figure 1.2. This zone is much larger than the area required for actual opening as it accounts for the potential migration of the entrance across this area. The exact location of the entrance (and hence location required for opening) depends on a complex mixture of environmental factors (i.e. catchment hydrology and hydraulic processes, as well as ocean and coastal processes) which govern where the creek is located at the time of breaching.

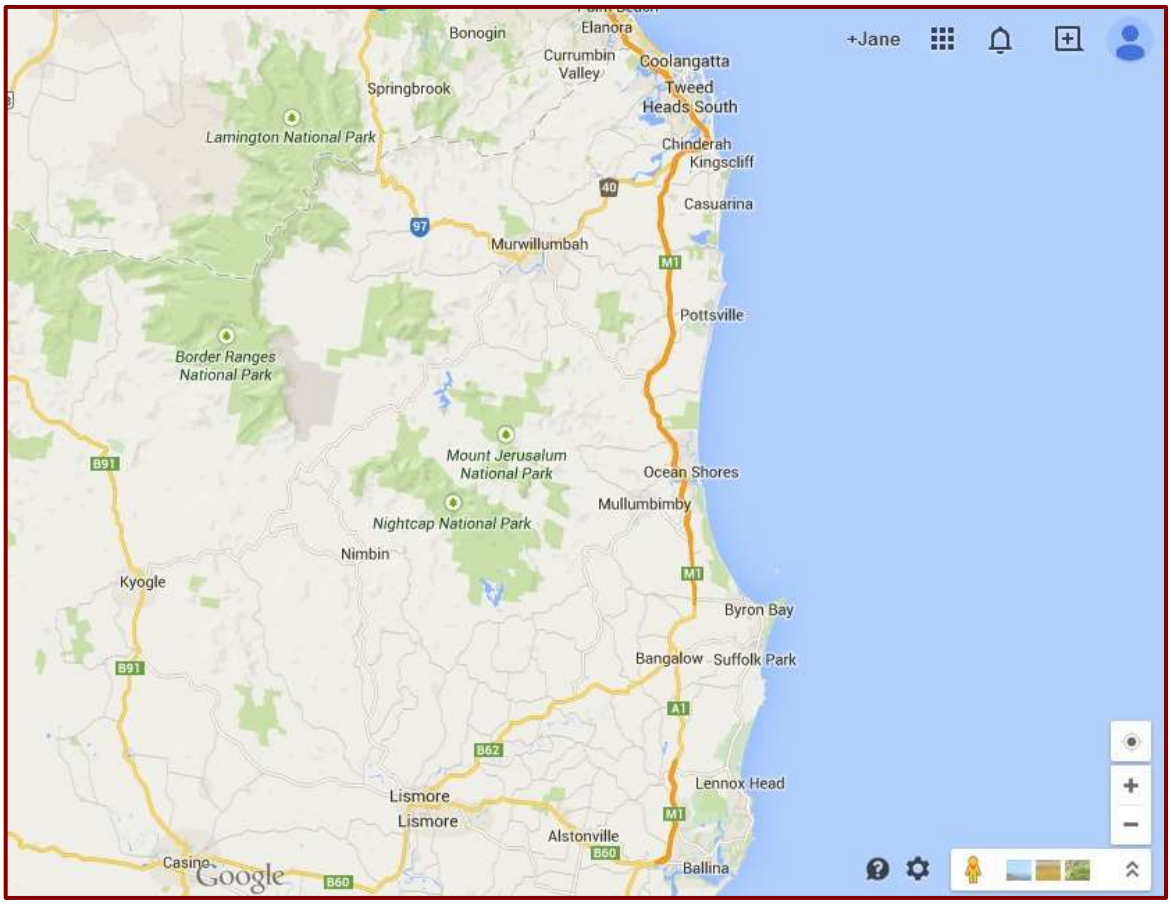

Figure 1.1: The location of Byron Bay in relation to the main Far North Coast of NSW towns (Google Earth).

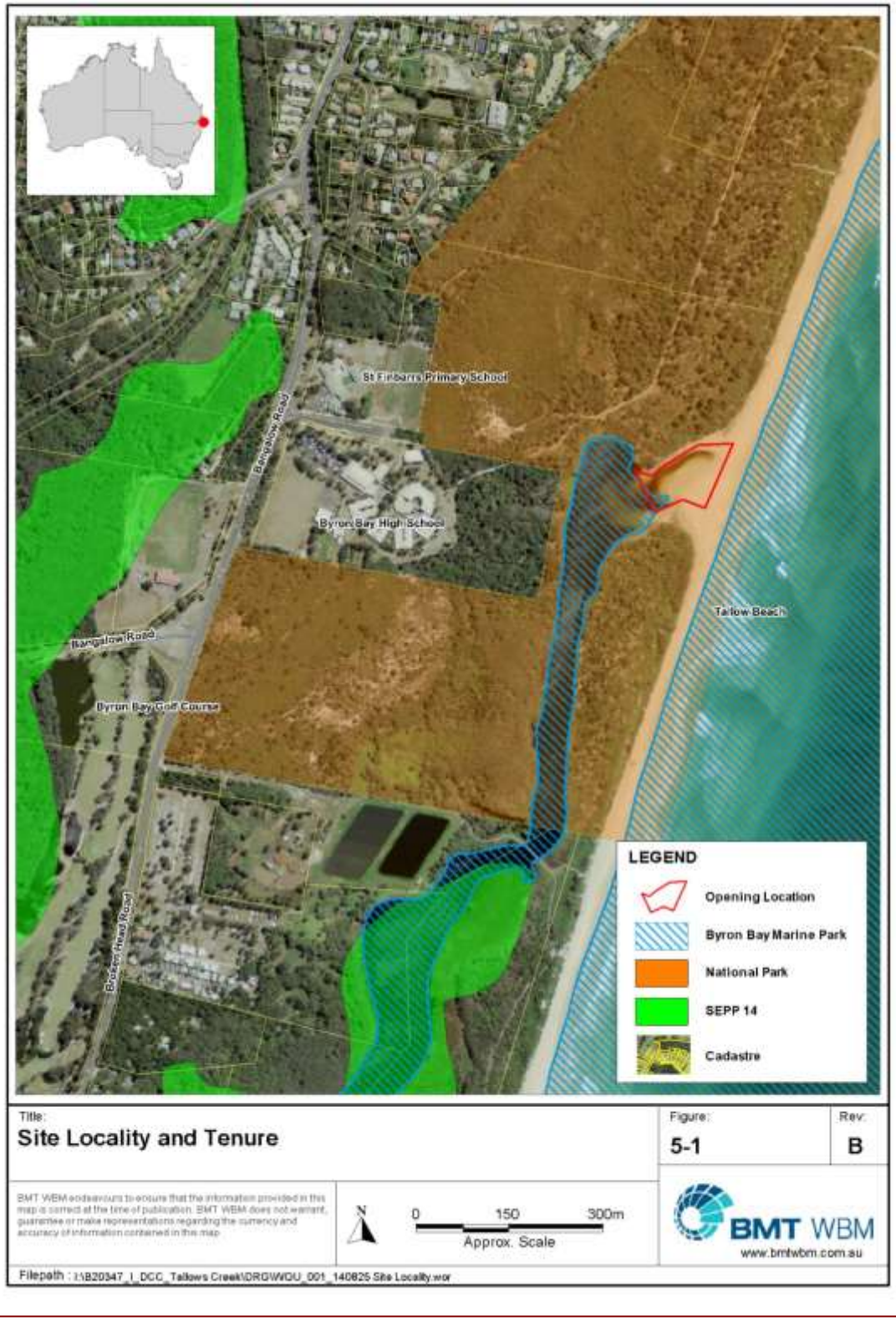

Figure 1.2: The subject site and its curtilage (map courtesy of BMT WBM Pty Ltd).

1.5 Statutory Framework

1.5.1 Historic Heritage

The subject site is not listed as an individual heritage item on any statutory or non-statutory heritage register nor is it located within a heritage conservation area. There are no listed historic heritage sites in the general vicinity of the subject site.
There are several pieces of historic heritage legislation that could be triggered by the work, which are detailed in the table below.

Legislation	Section	Details	Triggers
National Parks and Wildlife Act, 1978	30 F – Historic Sites	1. The purpose of reserving land as a historic site is to identify, protect and conserve areas associated with a person, event or historical theme, or containing a building, place, feature or landscape of cultural significance so as to enable those areas to be managed in accordance with subsection (2). 2. A historic site is to be managed in accordance with the following principles: a. the conservation of places, objects, features and landscapes of cultural value, b. the conservation of natural values, c. provision for sustainable visitor or tourist use and enjoyment that is compatible with the conservation of the historic site's natural and cultural values, d. provision for the sustainable use (including adaptive reuse) of any buildings or structures or modified natural areas having regard to the conservation of the historic site's natural and cultural values, (da) provision for the carrying out of development in any part of a special area (within the meaning of the Hunter Water Act 1991) in the historic site that is permitted under section 185A having regard to the conservation of the historic site's natural and cultural values, e. the promotion of public appreciation and understanding	This would only be triggered if OEH declared the project area a "historic site." Likelihood: Very low.

Legislation	Section	Details	Triggers
		of the historic site's natural and cultural values, f. provision for appropriate research and monitoring.	
NSW Heritage Act, 1977	Part 6, Division 9- Protection of certain relics	139 Excavation permit required in certain circumstances (1) A person must not disturb or excavate any land knowing or having reasonable cause to suspect that the disturbance or excavation will or is likely to result in a relic being discovered, exposed, moved, damaged or destroyed unless the disturbance or excavation is carried out in accordance with an excavation permit. (2) A person must not disturb or excavate any land on which the person has discovered or exposed a relic except in accordance with an excavation permit. (3) This section does not apply to a relic that is subject to an interim heritage order made by the Minister or a listing on the State Heritage Register.	This would only be triggered if historic relics were found in the project area, in which case a permit would be needed to undertake the proposed work. Likelihood: Very low.
NSW Heritage Act, 1977	Part 3C - Protection of Historic Shipwrecks	47: Definitions "historic shipwreck" means the remains of any ship (including any articles associated with the ship): a. that have been situated in State waters, or otherwise within the limits of the State, for 75 years or more, or b. that are the subject of a historic shipwrecks protection order. 51: 51 Movement, damage or destruction of historic shipwrecks. 1. A person must not move, damage or destroy any historic shipwreck otherwise than in accordance with a historic shipwrecks permit. 2. This section does not apply to a historic shipwreck that is subject to an interim heritage order made by the Minister or a listing on the State Heritage Register. 3. This section does not prevent a person from moving, damaging	This would only be triggered if a shipwreck, or elements associated with a shipwreck that was at least 75 years old were located within the project area. Likelihood: Very low.

Legislation	Section	Details	Triggers
		or destroying a historic shipwreck situated in any land in accordance with an excavation permit in force in respect of that land. 4. It is a defence to proceedings for an offence under this section if the defendant establishes that the act giving rise to the offence was done for the purpose of: a. saving human life, or b. securing the safety of a ship where the ship was endangered by stress of weather or by navigational hazards, or c. dealing with an emergency involving a serious threat to the environment.	

1.5.2 Aboriginal Heritage

The project area does not contain any known Aboriginal cultural heritage objects nor are there any in the vicinity. Nonetheless, there is legislation to manage the potential for such objects to exist and to manage the effects of the project on the surrounding Aboriginal cultural landscape. This legislation is detailed in the following table.

Legislation	Section	Details	Triggers
National Parks and Wildlife Act, 1978	Part 6	6 - Harming or desecrating Aboriginal objects and Aboriginal places (1) A person must not harm or desecrate an object that the person knows is an Aboriginal object. (2) A person must not harm an Aboriginal object. (3) For the purposes of this section, "circumstances of aggravation" are: a. that the offence was committed in the course of carrying out a commercial activity, or b. that the offence was the second or subsequent occasion	If there is a known aboriginal object in the project area or if there is high likelihood for an aboriginal object to be discovered during proposed works, a permit under the Act would be required. Only when consent has been granted to a person by OEH can

Legislation	Section	Details	Triggers
		on which the offender was convicted of an offence under this section. (4) A person must not harm or desecrate an Aboriginal place. NB: If a person can show they have exercised due diligence to ensure that there are no objects, or the likelihood of objects is low, then they cannot be prosecuted under the Act. An Assessment such as this provides such defence.	any of the above actions be undertaken. OEH can at any time grant or withdraw a permit should they believe it necessary to do so. Likelihood: Low.

1.6 Study Team & Report Authors

This Cultural Heritage Assessment was prepared by Jane Ainsworth (archaeologist and heritage consultant) of Ainsworth Heritage. A site inspection was undertaken on Wednesday, 15 February, 2015, with representatives from the Bundjalung of Byron Bay (Arakwal) people.

The draft report was reviewed by the Bundjalung of Byron Bay (Arakwal) people and their input was incorporated into the final report.

2 Site History & Description

This section describes the context of the project area by outlining the Aboriginal history of the region, the Aboriginal use of the area, and the European history and use of the area. It then provides a description of the project area. This contextual information assists an Assessment by providing clues to the significance of the area and indications for its likelihood to contain historic or Aboriginal cultural objects.

2.1 Aboriginal History

2.1.1 The Local Area

The local Aboriginal people of the Byron coastal region belong to the Bundjalung Nation, a large language group of inter-related tribes that stretches from the Logan River in the North to the Clarence River in the South. Norman Tindale, in his 1974 map (see Figue2.1 below), identified several tribal groups in the area but did not identify the larger Bundjalung nation at that time within the map itself[1]. However, his map did indicate the group "Arakwal" who were located around the Byron coast.

Figure 2.1: Extract from Tindale's 1974 map, showing his analysis of tribal boundaries on the NSW North Coast and South East Queensland (South Australian Museum).

Later research has shown that a series of Tribes existed within the larger Bundjalung nation. These tribes were closely associated with specific parts of the region however they were interrelated and saw much interaction with each other.[2]

[1] http://www.samuseum.sa.gov.au/page/default.asp?site=2&page=TIN_Tribal. Accessed 02/08/2010
[2] Pers Comm John Roberts.

The map compiled by the Richmond River Historical Society (Figure 2.3 below), shows the tribal lands of the Bundjalung from north of the Clarence River to the Queensland border, expanding on Tindale's map and providing greater detail. This map omits the Arakwal land (which was shown on the Tindale map as being near Byron Bay), and moves the borders between tribes, as well as using alternative names for some of the tribes, a common occurrence over time[3]. However, this map does not appear to encompass the full extents of the wider Bundjalung lands.

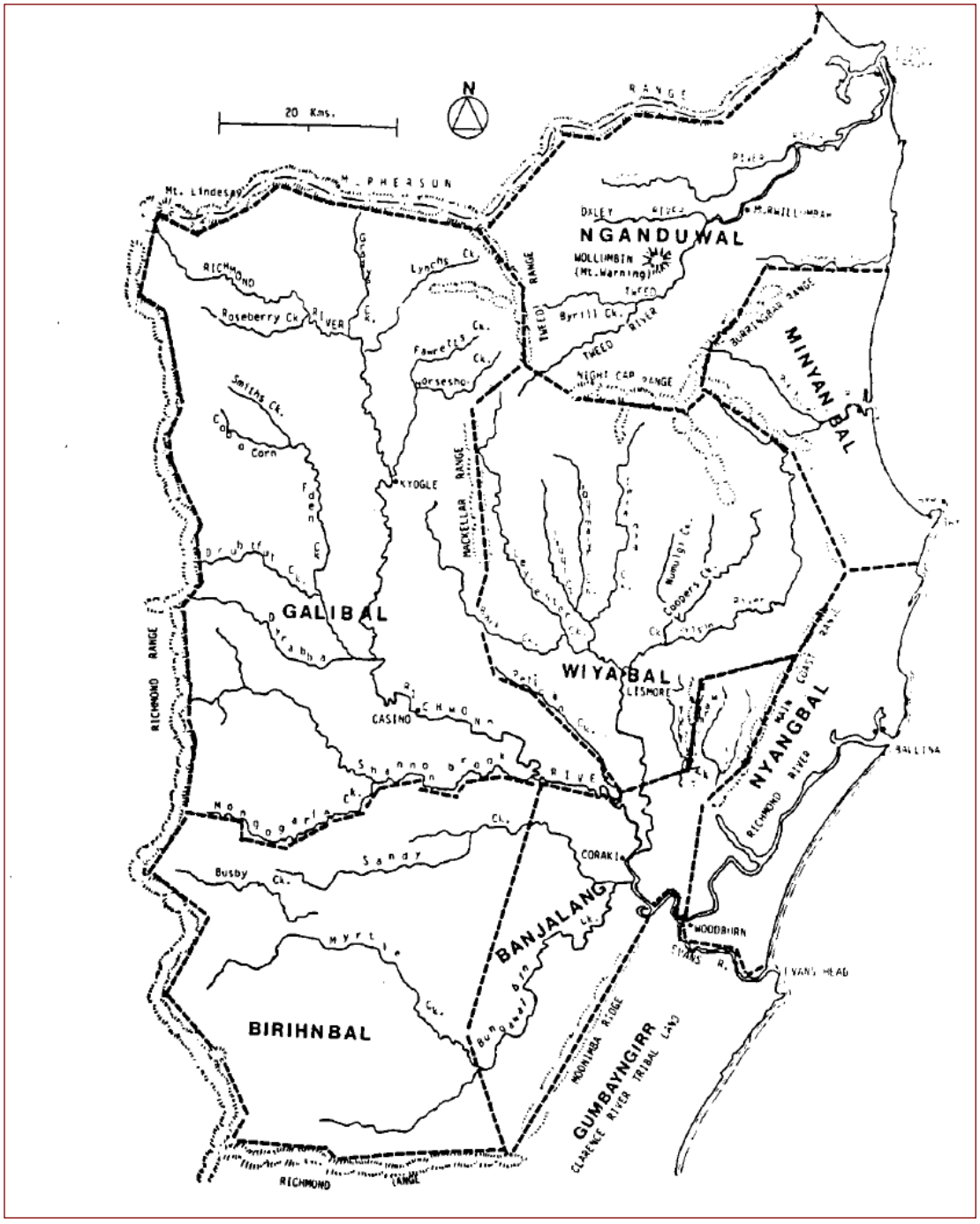

Figure 2.2: Map of the Tribes of the Lismore Area (Oaks. M. J.).

[3] Oakes. M. J. 1988. *The Aborigines of the Richmond Area*. Richmond River Historical Society.

The major Aboriginal settlement of the Northern Rivers region has been dated to approximately 6,000ya (years ago), although dates as old as 22,000ya have been hypothesised for the region[4]. There was an increase in the area's population, which many coastal areas underwent following the end of the last major glaciation, around 4-6,000ya, which causes an increased number of sites created by the larger populations at this time. The local area's linguistic group, the Arakwal, was one of approximately twenty separate tribes within the larger Bundjalung Nation.

The length of the occupation of the area by the Bundjalung is also supported by the stories of *Nguthungulli* (Julian Rocks). *Nguthungulli* is said to have lived under the rocks in a cave, with the spirit of his dead bother Wao coming down to the coast from the mountains near Woodenbong as he followed a path laid out by two emus. Wao was met by *Nguthungulli*, who gave Wao a song to take back to his own people. This story pre-dated the discovery of caves under Julian Rocks by European divers, indicating that the local people may possess knowledge dating back to before the inundation of the coast around 5,000-10,000 years ago.[5]

The region that is ascribed as being part of the Bundjalung Nation has been identified in the archaeological record through the absence (rather than the occurrence) of certain tools commonly found within other groups[6]. The lack of large amounts of equipment was commented on by early settlers, as such items were common elsewhere (such as in coastal groups like the Biripi of the Taree region). These items included multi-pronged spears, bone hooks, woomeras and spears with barbed points.[7] Part of the reason for the lack of specialised tools and equipment may be due to the immense quantity and easily gathered riches of the region (as opposed to areas with limited resources where more specialised tools were required for the gathering of resources).[8]

The region was recognised from the earliest times of white settlement to have supported a large Aboriginal population, especially along the coastal fringe. Early settlers, such as James (Jed) Ainsworth, recorded numbers of up to 500 individuals close to Ballina[9]. Although the numbers for the inland tribes are assumed to be lower than those of the coast, an overall population of the Bundjalung could well be in the vicinity of 2-3,000+.[10]

The Tribes of the Bundjalung are known to have maintained contact with each other and to have come together for ceremonial purposes throughout the years. Some ceremonies were dictated by the cycle of local or regional resources, such as the tri-annual gathering in Queensland for the Bunya Festival, or gathering on the coast for the seasonal harvest of sea foods[11]. Additionally, the men of the various tribes would take wives from outside of their own tribe, often from some distance away, thus increasing the inter-relationships between all the tribes.[12] However, other information says that this practice did not occur as Aboriginal people from different tribes would have distinctly different dialects and thus would not have been able to communicate.[13] It is possible that some tribes inter-married whereas others did not, but as the information is in conflict, the actual practice may be a combination of both. Further evidence for inter-Tribal communication comes from the archaeological record, where stone materials from the Tweed

[4] Collins. J. P. 1993. *Lismore Flood Levee System: An Archaeological Assessment*. WBM Oceanics Australia. p.12.
[5] Ainsworth Heritage. *2009. Archaeological Zoning Plan for Cape Byron Lightstation Precinct, Byron Bay, New South Wales*. p.9.
[6] Collins. J. P. 1993. *Lismore Flood Levee System: An Archaeological Assessment*. WBM Oceanics Australia. p.14.
[7] Ainsworth Heritage.. 2010. *Old Bar Precinct 3: Aboriginal Heritage Assessment*. Ainsworth Heritage. Part 4.
[8] Piper, A. 2000. *An Archaeological Assessment of the Skyline Road/Durheim Road, Monaltrie, Lismore, NSW.* p. 12.
[9] Ainsworth. J. 1922. *Reminisces 1847-1922*. Beacon Printery. 1922. p.28.
[10] Collins. *Ibid*. p.12.
[11] Piper. *Ibid*.
[12] Pers Comm John Roberts.
[13] Pers Comm Gilbert King.

and Clarence River areas, used for the manufacture of axe heads, have been found within the Richmond Valley area[14].

Within the larger Tribal divisions of the greater Bundjalung nation, smaller sub-tribes (sometimes called Clans or Hordes) were responsible for the maintenance of various distinct geographic areas within the larger tribal area. It appears that apart from the major ceremonial times and large resource festivals, local groups led a semi-sedentary lifestyle, which was possible due to the wealth of local resources. The population of the region was believed to have been quite high, with some estimates placing it in the region of 5,000 individuals. Several large groups of Aboriginals were noted in the various historical sources, with one instance recording 200 and another 600 in one camp, enormous numbers for that period.[15]

The project area is at the confluence of, or close to, several major ecological areas, as well as being well watered: factors which would have led to a vast array of natural resources being present for use. The additional benefit of the excellent local volcanic and metamorphic stone only added to the wealth of the region.

The vast resources of the local sub-tropical forest, such as the Kurrajong, Swamp Mahogany and Swamp Turpentine, were heavily utilised for wooden implements and bark for items such as shields and huts[16]. Additional food resources, such as sea foods, native fruits, nuts and vegetables, would also have been easily accessible and in great supply. Native fauna, such as various reptiles, birds and smaller animals would have been readily available in such an environment.

2.1.2 Material Culture

The material culture of the Aboriginal people of the Tweed, Richmond and Clarence Rivers is marked by an absence of certain tools commonly found within other groups, particularly notable in the case of fishing technology. The multi-pronged fishing spear and the shellfish hook are both absent from this region, fish having been caught in nets or speared in the shallows.[17] The spears used in this area were single pointed fire hardened weapons, of both a lighter and heavier variety. Additionally, the woomera and other technology used to launch spears in other parts of Australia were not used in this area.[18] The range of materials used locally is considered much fewer than central Australian tribes, with fewer all-purpose items, few composite tools and a greater number which were developed to suit specific tasks. It is suggested that this was an outcome of a more sedentary lifestyle facilitated by the region's rich resource base.[19]

The archaeological evidence suggests changes to a simpler stone technology took place only centuries before European settlement and the stone tools in use immediately prior to European settlement show little typological sophistication and did not demand highly skilled craftsmanship to manufacture.[20] These stone tools, along with shell tools, were used in the manufacture of all wooden weapons and implements. As shell was an easily procurable commodity on the coast, it has been suggested that it was often used in preference to stone.[21] Early European reports mention the use of edge ground axes, which were generally hafted to wooden handles with

[14] Binns, R. A and McBryde. I. 1972. *A Petrological Analysis of Ground-edge* Artefacts from Northern NSW. A.I.A.S. Canberra. p.81.
[15] Piper, A. 1999 . *An Archaeological Assessment At The Kings Forest Development Kingscliff North Coast N. S. W*. Narui Gold Coast Pty Ltd.
[16] Pers Comm John Roberts.
[17] Piper, A. 2000. *An Archaeological Assessment of the Skyline Road/Durheim Road, Monaltrie, Lismore, NSW.* p. 14.
[18] *Ibid*.
[19] Collins. J. P. 1992. *Byron Shire Aboriginal Heritage Study.* Prepared for Byron Council. p. 22.
[20] Piper. A. *Ibid*.
[21] Collins. J. P. *Ibid*. p.24.

string and grass tree gum or bees wax. These were used to cut toe holds when climbing or to cut possums and bee hives from trees.[22] They were also used to cut out and shape weapons and implements such as shields, spears and boomerangs, and to cut bark and other materials for dwellings and canoes. On the Northern Rivers, ground-edged knives were also manufactured and apparently used for everyday tasks such as skinning animals and cutting meat.[23]

The resources of sub-tropical rainforests were used extensively by local Aboriginal people. Bark was used for containers and vegetation was used to manufacture items such as bags, rope, pouches and netting.[24] The process of manufacturing string from bark was described by Dawson: "*The bark was soaked in water, chewed, then twisted and rolled on the thigh, the result being excellent string almost as tough as whipcord".*[25] Dilly bags were woven from rushes and grasses and containers for liquids were fashioned from the leaves of the Bangalow Palm.[26] Nets for both the capture of game and fishing were manufactured from fibres. Fishing nets consisted of finely meshed netting made around two meters long, with a stick at each end and bent into the shape of a bow.[27] These were used individually, or in combination, with many of the same when larger areas needed to be netted.[28] Jed Ainsworth describes fibre nets used for capturing game as follows: "*...constructed in long sections, four foot in width, which, when joined together for the purpose of the chase, would extend sometimes to a mile and a half in length...".*[29]

Rainforest timbers were used to manufacture spears, a variety of clubs, shields, boomerangs and digging sticks.[30] Boomerang manufacture has been described by Dawson: *"The boomerang tree had symmetrically curved, thin slabby roots or hips above ground from which boomerangs could easily be cut with the right curve or shape needing only to be trimmed down to the correct thickness and weight. After being scraped down, the boomerang was dried and hardened over a fire."*[31] On the Richmond – Tweed, non-returning boomerangs were used for hunting small marsupials, flying foxes and birds, as well as for combat.[32] Another important tool made from timber, usually mangrove wood, was the pademelon stick or throwing stick, used chiefly for hunting small animals and sometimes in tribal conflict.[33]

The women's digging stick was another important tool that could be applied to many tasks. The digging stick was constructed from a similar hardwood to that of spears, with digging sticks reportedly being between 1.8 and 2 metres long, pointed at both ends, and specially hardened by being placed on the fire.[34] These were used to dig out yams and other vegetables, to kill small animals and as a women's weapon in conflict. A similar tool, used by males, was the nulla-nulla. Nulla-nullas, or clubs, employed both hardwood and stone in their manufacture. Stone chips or bits of bone were embedded or attached to the head of the club using an adhesive agent, making it a more formidable weapon.[35]

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[22] *Ibid*.
[23] *Ibid*.
[24] Gorman. A. C. 1998. *An Archaeological Survey at the NRTV Broadcast Site, Parrott's Nest, Near Lismore, NSW.* University of New England. p.6.
[25] Dawson. R. L. 1935. *Aboriginal Words and Place Names of the Lower Clarence River District.* Quoted in Collins. J. P. 1992. *Byron Shire Aboriginal Heritage Study.* Prepared for Byron Council. p. 24.
[26] *Ibid*.
[27] *Ibid*.
[28] Piper. A. *Ibid*. p.13.
[29] Ainsworth. J. 1922. *Reminiscences 1847-1922.* Beacon Printery, Ballina. p. 17.
[30] *Ibid*.
[31] Dawson. R. L. 1935. *Aboriginal Words and Place Names of the Lower Clarence River District.* Quoted in Collins. J. P. 1992. *Byron Shire Aboriginal Heritage Study.* Prepared for Byron Council. p. 23.
[32] *Ibid*.
[33] Collins. J. P. *ibid*. p.23.
[34] *Ibid*. p. 23.
[35] *Ibid*. p. 24.

Conflict played a significant part in traditional Aboriginal life with a number of weapons manufactured specifically for use in battle. Spears, boomerangs, nulla-nullas and digging sticks performed dual roles, being used for food gathering and warfare, whilst shields and battle axes were primarily constructed for combat. Dawson describes battleaxes: "*…a battle axe of flat hardwood curved at one end and pointed, and a battle axe of round wood curved at one end and pointed and used like a pick."*[36] Shields were manufactured from the wood of a tree called the Yahroohgul Tree, which grew mostly in the forest country of the Richmond and is described as, "*…deciduous, its wood soft and heavy; it cuts like cheese when green but dries hard and tough."*[37] The shield was trimmed to an oval shape and shaped convex on the front side with the reverse left flat. On the back side the hand grip was cut out when the wood was green and soft. The complete shield was then smoke dried and the convex side was rubbed with bees wax and polished so that flying missiles would be deflected off it.[38]

2.1.3 Interaction Between Aboriginal People and European Settlers

The first European people that the local Aborigines experienced contact with are likely to have been convicts from the penal settlement at Moreton Bay (established in 1826), who had absconded while working on the Tweed River cutting timber. More substantial contact began in the 1850s, as cedar getters moved into the area to exploit the large stands of cedar along the waterways and edges of the Big Scrub. The relationships that formed as a result of this contact were largely cordial, as the cedar getters used the local knowledge of the Bundjalung to locate stands of valuable timber.[39]

As the pace of white settlement increased through the 1880s, the impact of European settlement on the Bundjalung peoples' traditional lifestyle increased, as it became increasingly difficult to maintain hunting and ceremonial practices. The initial settlement of large stations increased the contact and this again accelerated once towns and ports were incorporated and the region began to be rapidly developed by Europeans.

Aboriginal people began to camp on the outskirts of white settlements, as had happened in other parts of NSW settled earlier. The *Aboriginal Protection Board* (APB) had been formed with the task of creating and implementing policies designed to mitigate against conflict occurring between Aboriginal people and the newcomers.

As part of the process of contact, the inevitable massacres of the local Aboriginal peoples occurred, as it had in every region into which the European settlers had moved. Although relations were often cordial at first, once settlers began to take up land and begin keeping stock, conflicts would begin. These conflicts could arise from the hunting of stock by the Aboriginal peoples, anger at their sites being interfered with or just simple competition for ever decreasing natural resources as the native landscape was cleared. The massacre of over 100 Aboriginals at Ballina in 1846 was only one such example within the Bundjalung lands, with another massacre on the Orara further south another recorded example of the growing friction between the two peoples. Massacres were not just perpetrated with guns, as often whole families and clans were eliminated using arsenic infused damper, or individuals and small families would be eliminated, with no or little record kept of their deaths.[40]

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[36] Dawson. R. L. 1935. *Aboriginal Words and Place Names of the Lower Clarence River District.* Quoted in Collins. J. P. 1992. *Byron Shire Aboriginal Heritage Study.* Prepared for Byron Council. p. 23.
[37] *Ibid*.
[38] *Ibid*.
[39] Ainsworth Heritage. 2010. *Old Bar Precinct 3: Aboriginal Heritage Assessment*. Ainsworth Heritage. p.30.
[40] Elder, B. 2002. *Blood on the Wattle: Massacres and Maltreatment of Aboriginal Australians Since 1788.* New Holland Publishers (Australia) Pty Ltd, Sydney. p.235.

2.2 Aboriginal Use of the Site and Immediate Area

The Arakwal people are the traditional custodians of the area extending from Seven Mile Beach south of Broken Head to the Brunswick River up north, out to the escarpment west of Byron Bay, and east out into the Tasman Sea. The following map shows the extent of the Arakwal area.

Figure 2.3: Map of the Arakwal area (http://arakwal.com.au/).

Tallow Creek, which includes the project area, comprises small lakes and wetlands, and is located south of Cumbebin (Byron Bay) behind the dunal area along Tallow Beach where it flows intermittently into the Pacific Ocean. The Arakwal people have occupied and used the greater Byron Bay area (including Tallow Creek) for thousands of years.

The first sighting of Aboriginal people in the area by Europeans was by Captain James Cook in May 1770, in the vicinity of Wooyung (approximately 25kms north of Tallows Creek). Cook also sighted approximately 20 Aboriginal people on 7 Mile Beach just south of Broken Head.

In 1842, European cedar getters arrived in the area and, by 1845, the Richmond River was the centre of the cedar trade for NSW. However, by 1869 the Byron Bay and Broken Head areas were still free from permanent European settlement. The first selector did not select land in Byron Bay until 1881 and settlement didn't start in earnest until at least 1883.

The NSW Aboriginal Protection Board (which was created in 1882) established an Aboriginal Reserve near Tallow Creek in September 1908 (Reserve Number 43074/5). The Reserve was an official reserve until 1916, when it was revoked. During this time, many of the Arakwal people were moved into the Reserve and remained there for many years. Harry and Clara Bray, Arakwal elders, lived there in a hut north of Tallow Creek and raised their family in the surrounding land. Their grandchildren Lorna Kelly and Linda Vidler were born and raised on the land there – Elder Aunty Linda Vidler described the area as:

> *"This is our stomping ground as you'd call it. We live just up the hill up here. And this area, we used to come for our natural food: fish and crabs and eels, in this little creek here. In the morning before the birds got here, we used to come and get prawns by our hands, because we lived naturally, and we just took what we wanted for a feed. Every day we'd come down."*

Although the Reserve was revoked in 1916 and the area heavily sand mined from the 1920s, the Arakwal used the dunal area around Tallow Creek extensively. It was and remains an area where the families gather, a place of remembrance and spirituality, a vital part of their history and an integral part of their cultural landscape.

2.3 European Use of the Site

In 1927, an application was made for sand mining of Tallow Beach. The Byron Shire Community Based Heritage Study states that:

> It is uncertain when mining extended beyond Broken Head, onto Tallow Beach, and into Byron Shire. A correspondent to the Town and Country Journal, travelling south from the Tweed River in May 1871, camped on the beach between Cape Byron and Broken Head, but made no mention of miners. After rounding the Three Mile Scrub, however, he encountered 'several mining parties' at work on Seven Mile Beach, one at the north end. It seems probable that mining began on Tallow Beach soon afterwards, in the early 1870s. Indeed, mining had extended northward to Currumbin Creek, beyond the Tweed River, by 1878. It seems probable, also, that mining had been completed on Tallow Beach by the late 1880s, and certainly by the mid-1890s. Carne, in 1895, described Tallow Beach, with Seven Mile Beach, as being 'especially distinguished by their original richness', but added that 'for a considerable time past little actual beach mining has been done'. Although the main beach deposits were worked out rapidly, mining continued intermittently for many years as storms periodically exposed or accumulated new seams, or as minor deposits, initially considered unprofitable, were worked for the first time, perhaps using better technology.

Figure 2.4: Sandmining at Tallows Beach in the 1960s, showing the extent of landscape change (image courtesy of Byron Shire Council).

Sand mining continued on and off until the 1960s and drastically changed the shape of the landscape along the coast south of Cape Byron, flattening dune systems and removing vegetation. A race course was gazetted to the north west of the project area, however this was never developed. Over recent years, the suburban subdivision of Suffolk Park occurred to south and south west, and the southern areas of Byron Bay (around Pacific Vista Drive) to the north were also developed.

Byron Bay's sewerage treatment works also contributed to the change of the landscape, straightening the former serpentine shaped Tallow Creek and impacting the health of the creek. The sewerage treatment works were closed approximately 10 years and it appears that the health of the creek and its ecosystem is returning.

The Arakwal National Park (which the project area is part of) was established through the Arakwal Indigenous Land Use Agreement. This agreement is between the Arakwal custodians, the NSW Government and the local community. The agreement was registered in August 2001, following almost seven years of negotiations. The park is jointly managed by the Byron Bay Arakwal People and the NPWS. The Park is an important part of Aboriginal heritage and a haven for migratory birds and animals.

2.4 Site Description

2.4.1 Soils, Geology and Coastline

Wide bays were formed along the east coast after the melting of the Pleistocene icecaps. In the Byron area, the coast formed approximately 6,000 years ago. It now consists of sandy beaches stretching between rocky headlands.

The project area, within Arakwal National Park and comprising a small area at the mouth of Tallow Creek and Tallow Beach, is composed of Mesozoic sandstones. These were covered in places by Basalts during the middle Tertiary era, which originated in Mt Warning - these basalts outcrop to form the promontory of Broken Head. However, the majority of the project area has poor sandy or clay soils.

Early reports suggest the area as a region of rich coastal and riverine resources which was able to support a dense Aboriginal population. The area offered Aboriginal people a range of open beaches and rock platforms, as well as associated woodland and rainforest resources. The mild, well watered climate in proximity to these landscapes provided dense resources to sustain sizable populations.

2.4.2 Current Description

The project area (illustrated in Figure 1.2) comprises the opening of Tallow Creek where it meets Tallow Beach. It is a sandy riparian environment. The creek is classified as an ICOLL (an Intermittently Closed and Open Lake or Lagoon) and can open naturally at times of high catchment rainfall.

Tallow Lake is a brown brackish freshwater lagoon surrounded by a catchment of cleared and drained Melaleuca swamp. The catchment to Tallow Lake is largely developed, comprising predominantly residential development. The Byron Shire Councils Flora and Fauna Study identified the catchment as important with extremely high biodiversity.

Byron Shire Council's Tallow Creek Flood Risk Management Study and Plan (2009) described the area as follows:

> Tallow Lake is a typical inter-dunal lake and is classified as a small Intermittently Closed and Opened Lake/Lagoon (ICOLL) which lies between the near-coastal dune systems. It has a surface area of approximately 14ha, and stores approximately 180-200ML of water under typical storage levels (say 1.5m AHD). The lake has a relatively narrow natural entrance and is separated from the Pacific Ocean by a sand dune system. Tallow Creek gradients downstream of Broken Head Road are very flat. Therefore, depending on the build-up of sand at the entrance, water can pond behind the sand dune for some distance upstream and will exacerbate flooding on local properties.

Figure 2.5: The subject site looking east from Tallow Lake (Ainsworth Heritage).

Figure 2.6: The subject site looking south from the north side of the creek (Ainsworth Heritage).

Figure 2.7: Looking west from the subject site to Tallow Lake (Ainsworth Heritage).

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3 Consultation

3.1 Background

The OEH *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* does not require consultation with Aboriginal Groups to be undertaken. Nonetheless, for Due Diligence assessment to be as accurate as possible, it is advisable to seek advice from the Local Aboriginal Land Council (LALC). In addition, the Byron Coast Area Manager of OEH requirements for this project's REF required that interested Aboriginal parties are consulted.

In order to meet these consultation requirements, the following steps were undertaken and the following input offered by the registered party.

3.2 Initial Consultation

An advert was placed in the Northern Star newspaper on Saturday 18th October 2014, describing the proposed creek opening works and asking any interested Aboriginal groups or individuals to register an interest if they wished to be consulted.

The only group to respond was the Bundgalung of Byron Bay (Arakwal) Inc, who offered in principle support of the project but requested that they be consulted prior to any works being undertaken.

A meeting was subsequently held at the National Parks office (in the Arakwal National Park) on the 17th December 2014, to discuss the background to the project, the cultural heritage assessment and the proposed methodology. This meeting was attended by the following people:

- Ainsworth Heritage – Jane Ainsworth;
- BMT WBM - Damion Cavanagh;
- Byron Shire Council – James Flockton;
- Bundjalung of Byron Bay (Arakwal) – Gavin Brown; and
- National Parks – Delta Kay, Sue Walker, Diane Kay and Norm Graham.

At this meeting, the Bundjalung of Byron Bay (Arakwal) requested that a sites officer accompany Ainsworth Heritage on the site inspection. The main discussion at the meeting was that the Bundjalung of Byron Bay (Arakwal) support the need to intermittently, manually open the creek mouth. Their main concern is for the continued enhancement of the creek's health, so that traditional fishing of the area can be re-established. They also discussed the importance of the creek within the larger landscape and their cultural history.

3.3 Site Inspection

A site inspection was carried out on Wednesday 4th February, 2015. The inspection was attended by Jane Ainsworth (Ainsworth Heritage), Brian Kay (Arakwal elder), Delta Kay (National Parks) and Norm Graham (National Parks). The team inspected the creek opening, Tallow Lake and Tallow Creek, and the area immediately surrounding the opening and creek.
The Arakwal representatives reiterated their strong wish for the health of Tallow Creek (which they noted has improved substantially since the closing of the sewage treatment plant) to

continue to improve so that it can support traditional fishing practices and re-establish the cultural use of the creek by the Arakwal. They discussed the integral part that the creek and lake form within the wider cultural heritage landscape, as a place they have lived, used and visited for many years.

3.4 Draft Report Review

A Draft of this report was provided to the Budjalung of Byron Bay (Arakwal) for their review and comment via email by Ainsworth Heritage on the 16 April 2015. No comments or amendments were received.

4 Due Diligence Assessment

As the earlier steps identified that a Due Diligence assessment was required, the OEH *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* was used to guide the following steps.

4.1 Ground Disturbance and Marked Trees

The first step in the Due Diligence process is to determine if the proposed development will harm any known marked tree or if ground disturbance will be undertaken. Ground disturbance by machines or otherwise has a higher likelihood of disturbing Aboriginal sites, as sites can be laid down over successive generations, leaving deposits at depths that can remain undisturbed even in heavily modified areas. Even in areas where disturbance has occurred, Aboriginal objects are still protected from harm.

As the development will cause ground disturbance, an AHIMS search must be undertaken (Go to 4.2).

No known marked trees are present within the subject area.

4.2 AHIMS Search

The OEH AHIMS (Aboriginal Heritage Information Management System) database contains information on the known Aboriginal sites within NSW, with new sites reported to AHIMS as they are discovered. AHIMs can be a useful tool or a guide to providing archaeological context for an area, as well as assisting in determining if there are known sites within the development's footprint. However, the AHIMS database is also recognised to have many data gaps as it only records sites for area that have been actively surveyed.

An AHIMS search was undertaken for an area around the site, extending out to 10km, and returned 21 sites which are listed in the following table:

Site ID	Site name	Easting	Northing	Site features	Site types
04-5-0076	B.H. 5	559220	6824650	Artefact	Isolated Find
04-5-0079	B.H. 6	559180	6824450	Artefact	Open Camp Site
04-5-0080	B.H. 7	558470	6824270	Artefact	Open Camp Site
04-5-0081	Tallow Creek; Tallow Beach	559700	6827620	Burial	Burial/s
04-4-0036	Byron Urban Areas 4;Byron Bay	557700	6829280	Shell; Artefact	Midden
04-5-0103	Kays Campsite	559900	6828400	Artefact	Open Camp Site
04-5-	Stone Circles	558110	6825680	Stone Arrangement : -	Stone Arrangement

Site ID	Site name	Easting	Northing	Site features	Site types
0112					
04-5-0113	Grooves in rocks	558250	6825600	Art (Pigment or Engraved)	Rock Engraving
04-5-0114	Caves	558250	6825650	Artefact	Shelter with Deposit
04-5-0115	Suffolk Beach; Byron Bay	559300	6827100	Ceremonial Ring (Stone or Earth)	Bora/Ceremonial
04-5-0141	Cocked Hat Rocks	560500	6824200	Aboriginal Ceremony and Dreaming	Aboriginal Place, Natural Mythological (Ritual)
04-5-0036	Byron Bay; Skinners Shoot Road	557400	6829500	Artefact	Open Camp Site
04-5-0056	Byron Bay; Skinners shoot Road	557750	6829350	Artefact	Open Camp Site
04-5-0058	Tallow Beach; Byron Bay	560500	6828800	Ceremonial Ring (Stone or Earth)	Bora/Ceremonial
04-5-0060	Suffolk Beach, Tallow Creek	559300	6827100	Buria	Burial/s
04-5-0033	Suffolk Beach;	559300	6827100	Artefact	Open Camp Site
04-5-0034	B.H. 19	558820	6824210	Artefact	Unknown
04-5-0035	Ironbark AVE/Kays Campsite	560104	6828834	Habitation Structure	Potential Archaeological Deposit (PAD)
04-5-0161	Tallow Creek Camp	560460	6828610	Habitation Structure	Potential Archaeological Deposit (PAD)
04-5-0175	Hayters 1	558539	6826887	Artefact : 1	Unknown
04-5-0176	Byron Bay; Skinners Shoot Road	557400	6829600	Artefact : -	Open Camp Site

The table shows that the majority of sites (approximately 85%) located contain artefactual materials, with other site types showing a range of site types. This would indicate that within the project area, if sites were encountered they would be likely to contain artefacts.

As none of the sites are located near the project area, a very low potential exists for any AHIMS sites to be impacted by the proposed development works.

4.3 Landscape Analysis and Predictive Model

A landscape analysis has been undertaken to determine if the area of the development footprint is one in which additional Aboriginal objects are likely to be found. Certain landscapes, especially those in proximity to water, are more likely to contain sites than other landscapes and therefore this step is used to determine the potential for the proposed project area to contain additional sites.

The OEH *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* notes that areas of development that are within certain landscape features are likely to contain additional materials. These areas are:

Criteria	Site Notes
Within 200m of waters	The project area is within 200m of water
Located within a sand dune system	The project area is within a dune system
Located on a ridge top, ridge line or headland	Not applicable
Located within 200m below or above a cliff face	Not applicable
Within 20m of or in a cave, rock shelter, or a cave mouth	Not applicable

Using this model, only two of the five environmental factors which indicate a higher likelihood of sites being encountered are met. This would indicate a moderate-low probability of the proposed works disturbing previously unrecorded or unknown sites.

4.4 Previous Reporting

The AHIMS database also links into the OEH's library of previous Archaeological reports, many of which can be accessed for use in assessments. The reports provide a more detailed contextual overview of the nearby area and allow for further investigation into the proposed development's potential to contain additional Aboriginal Cultural Heritage.

Several previous studies, which had investigated areas in the general region in which the proposal lies (but not within the project area as no archaeological or heritage studies had been undertaken there in the past), were examined.

The most thorough and important study was the 1992 study by Collins, which focused on the Byron Shire. This study looked at site distribution and typology of sites across the entire North Coast, noting at the time that approximately 1,000 sites had been located within the entire region.[41] Collins describes the following general site types encountered in the region and their distribution:

- Rockshelters and Art – The report noted that several shelters had been recorded, and that the volcanic and rugged plateau was an ideal place for their location. The report also noted that art sites were extremely rare in the region;
- Open Campsites – These were determined to be one of the most common site types in the northern rivers, accounting for 31% of all recorded sites;
- Middens – These accounted for another 32% of sites types but were concentrated along the coast, however many have been lost to sand mining, development and erosion;
- Quarry Sites - Although only two were noted in the report, at Doon Doon, east of Dunoon and at Murwillumbah, they were noted to have the potential to be far more numerous in the volcanic plateau areas;
- Carved and Scarred Trees - At the time of the report, only one scarred tree was noted, however, other reports have found scarred trees since that time;
- Burials – Twenty burials were noted in the report, with half along the coast and half within the hinterland. The report does not mention whether these were single or

[41] Collins, J. 1992. *Byron Shire Aboriginal Heritage Study*. Byron Shire Council. p.37.

multiple burials. Practices noted were of bodies buried in an tightly bound upright position, sometimes wrapped in bark and at times marked with earth or stone mounds;

- Bora Grounds – Twenty-two were mentioned in the report, spread across the region, with most consisting of a pair of rings, one larger than the other and both connected with a pathway. The report noted that all the known rings at the time of the report had been destroyed over time;
- Stone Arrangements – Two stone arrangements have been noted in the region but none have survived development activities;
- Grinding Grooves - The report noted that only one groove site had been located in the region at the time; and
- Natural Mythological Sites – These sites, of which 16 were recorded at the time of the report were scattered across the landscape and related to important natural features such as Nimbin Rocks or Wollumbin (Mt. Warning).

It is apparent from the reporting reviewed above that there is likelihood for coastal locations in the Byron Shire area to contain additional sites of Aboriginal cultural heritage significance. However, there have been very few sites found in the areas which were sand mined in the 1900s and which were later impacted by development. Further, the Arakwal indicated that during their many expeditions through the area, no sites or Aboriginal objects, in or within the immediate vicinity of the project area, have been encountered.

If sites were to be encountered, the review of previous reports indicates that expected site types for the survey include open campsites, artefact scatters (primarily of chalcedony, chert, greywacke, volcanics, silcrete and beach pebble), isolated artefacts, middens (with mainly pipi and oyster shell) and potential archaeological deposits.

4.5 Site Survey

In order to assess the proposed project area, a surface survey of the route areas was undertaken on Wednesday, 4th of February, 2015.

4.5.1 Methodology

The field survey aimed to investigate the project area and immediate environs. The project area was inspected and recorded using GPS and digital photography and no Aboriginal objects or sites were located during the survey.

4.5.2 Constraints

The site survey was constrained by the following conditions:

- Vegetation and grasses that caused ground surface visibility to be less than 10% in many of the surrounding areas;
- Water was flowing through the creek mouth in the exact location of the project area; and
- No sub-surface excavations were undertaken.

Site inspection results, when combined with predictive modelling, is a common way to determine the archaeological potential of a site, as it is a very rare site in the Northern Rivers in which visibility and site access allow for greater than 25% effective area coverage. The combination of a well-built predictive model and good management for future works, combined with the survey itself, provide the consent authority with enough information to determine the proposed development's viability and the future management needs of the site with regards to cultural heritage.

With this information, it can be determined that past Aboriginal use of the site would have been on and around the lake and dune areas. The dune areas would have seen more extensive use, however, due to the heavy disturbance of the original dune systems by sandmining, the exact areas of higher use cannot be determined.

4.5.3 Results

The survey did not locate any Aboriginal cultural heritage objects or sites. Nor did the survey locate any items of historic (European) heritage or any objects which may have been associated with historic shipwrecks.

4.7 Archaeological Summary

The dune areas have been extensively disturbed by sand mining, development and recreational use. In addition, the proposed project area and level of activity is contained in a very small, discrete area. Although there is a moderate likelihood for objects of Aboriginal or European heritage to be exposed along this area of coastline, there is very low potential for them to occur within the project area.

4.8 Impact Assessment

Consequently, this assessment finds that the proposed works will have very little impact on cultural heritage.

Following the steps of the Due Diligence process, it has been determined that the proposed development could 'Proceed with Caution'. Therefore, Ainsworth Heritage believes that the proponent should be allowed to Proceed with Caution, as long as the Proceed with Caution guidelines (presented in the following Chapter) are strictly followed as part of any works on site.

As part of the guidelines, advice is provided regarding unexpected finds and the requirements for AHIPs, should such a find be made on the site. The proponent will need to ensure that they are familiar with the Proceed with Caution guidelines and when and where AHIPS and Stop Work Procedure are to be implemented.

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5 Proceed With Caution Management Guide

The following Management Guide for Proceeding With Caution is designed to ensure that Byron Shire Council undertake the proposed works without impacting upon Aboriginal or non-Aboriginal heritage.

5.1 Training and Communication

All on site workers and managers need to be provided with this section of the assessment in order to assure that they are familiar with the site, its potential cultural heritage and how to avoid impacting upon that cultural heritage.

In order to assure this is done, a register of workers will need to be kept, recording their inductions and including the signatures of the workers involved. The inductions will need to address all of the material covered in this chapter prior to an individual or group commencing work on the site.

5.2 Continued Consultation

Consultation with the Arakwal should continue. Regular (i.e. annual) updates on the status of the permit and its implementation should be offered. In addition, should the permit need to be used and the creek mouth manually opened, the Arakwal should be notified before works occur and offered the opportunity to attend on site works.

5.3 Stop Work Procedure

Heritage and archaeological assessments may, at times, fail to identify a heritage issue and this normally relates to potential (sub-surface) archaeological resources or those that could not be located due to site or survey constraints. Note that any works which may reveal or disturb archaeological resources require an AHIP from OEH.

If any unexpected archaeological resources, whose disturbance is not covered under a current AHIP, the following Stop Work Procedure should be followed:

STOP WORK	Immediately
CONTACT	A qualified archaeologist as soon as possible
NOTIFY	The archaeologist should notify the Council's Heritage Officer, the Aboriginal Stakeholder Groups and OEH
ASSESS	The archaeologist in conjunction with OEH and the Aboriginal Stakeholder Groups should assess the significance of the resource and recommend a course of action eg: • Protect and avoid; or • Investigate, record and remove; or

	• Excavate, record and preserve
APPLY	To OEH for an AHIP if necessary
RECOMMENCE	Only when OEH has approved a course of action

Should the work being undertaken be of a large nature, it is possible in some instances to isolate the discovered site and continue working without further disturbing the site.

5.4 Arakwal Review

Ainsworth Heritage recommends that proponent forward this draft assessment to the Arakwal for comment and input before finalisation to ensure that the local Aboriginal people have the opportunity to provide input into the management of Aboriginal cultural heritage on their traditional lands.

5.5 Sites Types for Unexpected Finds

If unexpected sites were encountered during works, even though there is a low probability for this to happen, the following site types are the most likely to be encountered. This information can be used by the proponent to guide their response should any unexpected sites ever be encountered.

Artefact Concentration, Isolated Artefacts and Open Campsites

These sites represent places of aboriginal occupation. "*These sites are mostly surface scatters of stone, sometimes near fireplaces. Recent studies have shown them to have significant scientific and cultural value.*[42] These sites can also indicate where further sub-surface archaeological materials may be encountered,

Should a concentration of artefacts or an isolated artefact be identified, follow the Stop Works Procedures. Additionally, any work with the potential to impact the site should also stop until the site can be properly investigated and the standard Stop Work Policy followed, until such time as it is properly recorded and OEH has agreed to the planned management and/or mitigation of impact to the site.

These sites are often the location of a Potential Archaeological Deposit (PAD) and should be treated as such until test pitting can determine if a PAD is present or not.

Middens

Middens are amongst the most import of Aboriginal sites, especially from an archaeological perspective. Investigation of midden deposits allows for a detailed picture of the land use of the local area by Aboriginal peoples to be investigated. Middens often contain shells and shell fragments of one or more species, artefacts, vertebrate bones and sometime human remains.

Should shell or shell fragments be located during any phase of works, the Stop Work Policy must be put into effect immediately and all work with 50 meters must stop at once until the site has been investigated.

[42] *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW*.

Burials

Should any human remains or any unidentifiable bone material be encountered during any works on the project area, **all work must stop immediately** and the site should be protected from additional disturbance.

The NSW Police should be contacted and the Police will then work with OEH to determine whether or not the remains are of Aboriginal origin. Further works on site will need to be undertaken in accordance with Police and/or OEH guidance and, in the case that the remains are Aboriginal, the local Aboriginal groups.

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Legislation and Standards

Australia ICOMOS *Burra Charter;*

Byron Shire Community Based Heritage Study. Site Card 1260205

OEH's *Aboriginal Cultural Heritage Standards & Policies Kit;*

OEH's *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW;*

OEH's *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010;*

OEH's *Draft Code of Practice for Archaeological Investigation in NSW;*

James Semple Kerr's *The Conservation Plan*

The NSW Heritage Branch's *Conservation Management Documents*; and

The NSW Heritage Branch's *Assessing Heritage Significance.*

National Parks and Wildlife Regulation 2009, Section 80B

NSW National Parks and Wildlife Act 1974

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http://www.legislation.nsw.gov.au/viewtop/inforce.

http://www.samuseum.sa.gov.au/page/default.asp?site=2&page=TIN_Tribal.

Personal Communications

John Roberts

Gilbert King

Consultation Log

Date	In/Out	Type	To	Contact	Notes
30/09/2014	In	Letter	Byron Shire Council	Gavin Brown	Letter to Byron Shire Council from Gavin Brown (of BUNDJALUNG OF BYRON BAY ABORIGINAL CORPORATION (ARAKWAL) INC) stating request to be consulted
Unknown	Out	Advert	General	NA	Advertisement in Byron Shire Echo newspaper
19/09/2014	Out	Letter	Registrar of the National Native Title Tribunal	NA	Initial Consultation Letter - requesting registration of interest if wishing to be consulted & asking for contact details
19/09/2014	Out	Letter	National Native Title Tribunal	NA	Initial Consultation Letter - requesting registration of interest if wishing to be consulted & asking for contact details
19/09/2014	Out	Letter	NTS Corp	NA	Initial Consultation Letter - requesting registration of interest if wishing to be consulted & asking for contact details
19/09/2014	Out	Letter	Office of Environment and Heritage	NA	Initial Consultation Letter - requesting registration of interest if wishing to be consulted & asking for contact details
19/11/2014	Out	Phone Call	Arakwal Inc	Gavin Brown	Initial contact call about meeting and attendance - no answer, left message.
20/11/2014	Out	Phone Call	Arakwal Inc	Gavin Brown	Initial contact call about meeting and attendance - no answer, left message.
20/11/2014	Out	Phone Call	Arakwal Inc	Gavin Brown	Initial contact call about meeting and attendance - brief discussion of attendance at meeting, Gavin requested an email to be sent so that he can talk to his board
24/03/2014	Out	Email	Arakwal Inc	Gavin Brown	Email regarding a potential date for the initial meeting
22/01/2015	Out	Email	Arakwal Inc	Gavin Brown	Email regarding a potential date for the site visit
22/01/2015	In	Email	Arakwal Inc	Gavin Brown	Email advising the names of National Park staff to be invited to the site visit
22/01/2015	Out	Email	National Parks	Norman Graham; Delta Kay; Diane Mackey	Email inviting National Parks to the site visit and advising proposed date
22/01/2015	In	Email	National Parks	Delta Kay	Confirms date and attendance for site visit
22/01/2015	In	Email	National Parks	Diane Mackey	Advises non-attendance for site visit
22/01/2015	In	Email	National Parks	Norman Graham	Confirms date and attendance for site visit

Date	In/Out	Type	To	Contact	Notes
23/01/2015	Out	Email	National Parks	Norman Graham; Delta Kay; Diane Mackey	Confirms date and attendance for site visit
23/01/2015	Out	Email	Arakwal Inc	Gavin Brown	Confirms date and attendance for site visit
28/01/2015	In	Email	Arakwal Inc	Gavin Brown	Advises that Brian Kelly will be the Arakwal representative for the site visit
28/01/2015	Out	Email	Arakwal Inc	Gavin Brown	Acknowdleges that Brian Kelly will be the Arakwal representative for the site visit
15/04/2015	Out	Email	Arakwal Inc	Gavin Brown	Email with draft report attached, requesting comments or input regarding the draft report

BMT WBM

Tallow's Creek Proposed Artificial Opening - Threatened Species and Communities Data Review

Reference: R.B20347.001.03.docx
Date: October 2015
Confidential

Tallow's Creek Proposed Artificial Opening - Threatened Species and Communities Data Review

Prepared for:	Byron Shire Council
Prepared by:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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Title:	Tallow's Creek Proposed Artificial Opening - Threatened Species and Communities Data Review
Project Manager:	Damion Cavanagh
Author:	Suanne Richards, Paul Dubowski, Damion Cavanagh
Client:	Byron Shire Council
Client Contact:	James Flockton
Client Reference:	

Synopsis: **This report identifies a potential zone of impact associated with the Tallow Creek Entrance Opening. Subsequently, a review of threatened species that may occur within this zone of impact, that require consideration under the 7 Part Test, has been performed. Finally, a list of recommended species for further assessment is provided.**

REVISION/CHECKING HISTORY

Revision Number	Date	Checked by		Issued by	
0	1st August 2013	DCC		SR	
1	12th August 2013	DCC		SR	
2	15th June 2015	DCC		SR	
3	9 October 2015	DCC		SR	

DISTRIBUTION

Destination	Revision										
	0	1	2	3	4	5	6	7	8	9	10
Byron Shire Council	PDF	PDF	PDF	PDF							
BMT WBM File	PDF	PDF	PDF	PDF							
BMT WBM Library	PDF	PDF	PDF	PDF							

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1 Introduction

In order to satisfy the requirements of the *Threatened Species Conservation Act* (1995) (TSC Act), BMT WBM propose to conduct Assessments of Significance or '7 part tests' of the potential impacts of the proposed Tallow Creek Mouth Opening to determine if the planned development or activity is likely to have any impact on a threatened species or community. If the impacts are likely to be significant, or if critical habitat is affected, the proponent will need to prepare a species impact statement (SIS) in addition to the Assessment of Significance (7 part test).

The Assessment of Significance is applied to species, populations and ecological communities listed on Schedules 1, 1A and 2 of the TSC Act and Schedules 4, 4A and 5 of the *Fisheries Management Act 1994* (FM Act). This report identifies the threatened species, populations and ecological communities which may be affected directly or indirectly, by the proposed artificial opening of the Tallows Creek entrance, and which may be subject to '7 part tests'.

Rationale has been provided to demonstrate how this list was derived based on perceived impacts on habitat type. Where adequate information is available to demonstrate that a species does not occur in the study area, or if not resident, will not utilise habitats on site on occasion or be influenced by impacts of the activity, that species does not have to be considered. Otherwise all species likely to occur in the study area (based on general species distribution information), and known to utilise habitat types to be impacted by the proposal, should be subject to the '7 part test'.

2 Methodology

The first component of the study has been to define the zone of potential impact, i.e. the physical region which may be affected by the adoption of the proposed entrance opening regime. This has been achieved by examining coverage of inundation within Tallow Creek for different water levels relevant to the proposed opening methodology, the spatial extent of wetland vegetation communities and expected inundation frequency. This information has been overlaid to provide a potential area of impact, as shown in Figure 2-1. It should be noted that for the purposes of identifying threatened flora and fauna species a slightly broader (more conservative) "study area" has been defined.

Specifically, the zone of impact has been determined from:

(1) Extents of wetland vegetation communities (those communities reliant on regular inundation) located between 1.8m AHD and 3.0m AHD (where 1.8m AHD was determined to be the lowest elevation of potential impact, and 3.0m was determined to be the lowest elevation of potential impact, this is discussed further in later sections of the document);

(2) Where no mapped wetland vegetation communities exist between 1.8m AHD and 3.0m AHD, a buffer area of approximately 20m has been assumed around the periphery of the average standing water level;

(3) Aerial photography which defines the assumed average standing water level; and

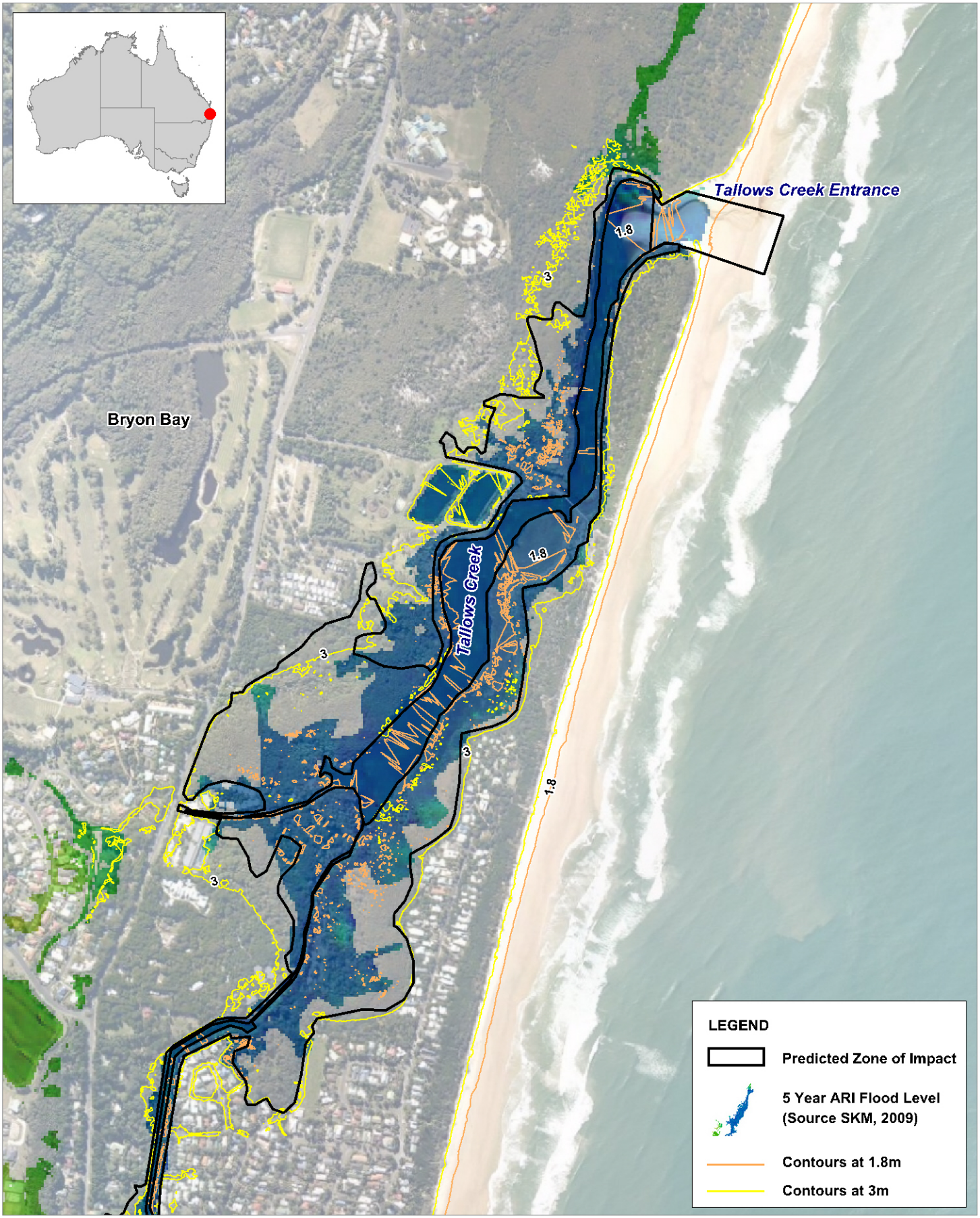
(4) The 1 in 5 year ARI flood event which helps to define a point where vegetation communities would no longer be reliant on flooding from Tallow Creek. It is acknowledged that a more frequent flood event would be more useful in this regard but preparation of such mapping was not a relevant requirement of previous flood assessment work. A conservative approach has been taken in the use of the 1 in 5 year ARI flood inundation level.

All possible access routes have also been considered although as the final approach by machinery to undertake works is yet to be determined, these tracks have not been reflected on Figure 2-1.

Potential and known threatened species, populations and ecological communities which may occur in this determined zone of impact (i.e. study area) and which may be subject to '7 part tests' were identified based on a review of the following data sources:

- Byron Shire Council Ecological Datasets (provided 26th June, 2013). Includes: Wildlife Corridors, Koala Habitat, Threatened Species, HCV Vegetation, Species Sightings, SEPP14, Eco Wetlands, Vegetation 2007, Threatened Fauna Habitat). (BSC, 2013).
- Baker, A. 2009. Vegetation and Flora of Cape Byron State Conservation Area and Arakwal National Park. Unpublished report to the Department of Environment and Climate Change (NSW). Wildsite Ecological Services Pty. Ltd., Mullumbimby.
- Searches of the NSW DECC databases (NSW DECC, 2013) and the EPBC online report tool (DSEWPC, 2013).
- Final Draft Review of Environmental Factors (Byron Shire Council, 2010). (BSC, 2010).

- Draft Species Impact Statement: Ecological Assessment and Environmental Management Plan for the proposed Artificial Entrance Opening at Tallow Creek Suffolk Park (Maria Matthes, 2010).
- EPBC Matters Search Results as included in Appendix B, this provides a listing of all the migratory species potentially occurring in the area.



Title:

Area of Impact Assessed

Figure: 2-1

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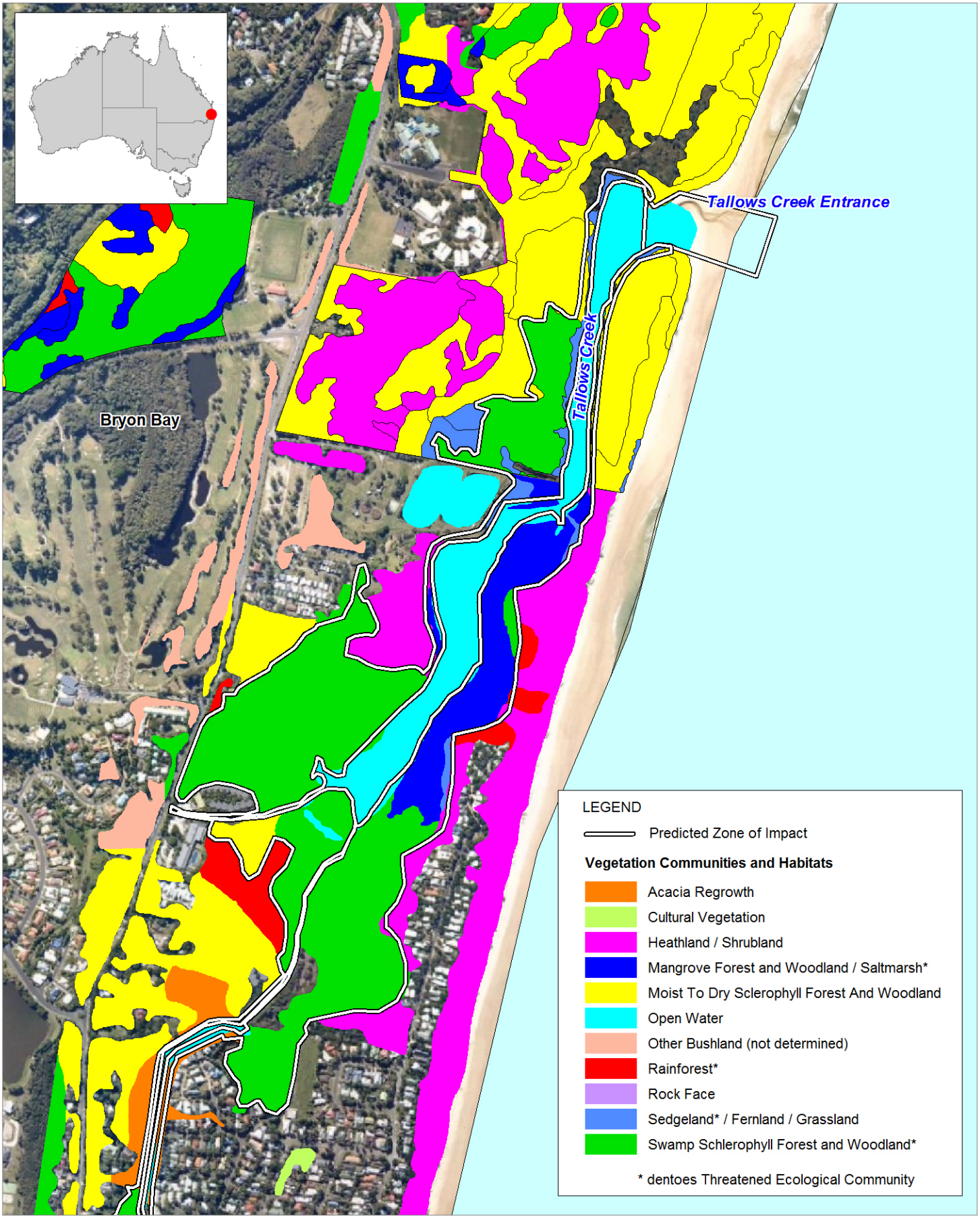
3 Habitats of the Study Area

Eleven broad habitat types have been mapped in the study area and surrounds (Byron Shire Council, 2007 and Baker, 2009). These are summarised in Table 3-1 and their distribution within the study area and surrounds is shown in Figure 3-1.

Table 3-1 Habitats of the Study Area and Surrounds (Based on Byron Shire Council, 2007 and Baker, 2009)

Community	Community Sub-Types (if present)
Beach	N/A
Marine Open Water	N/A
Estuarine Open Water	N/A
Heathland / Shrubland	Dominated by (after BSC, 2007): • Bitou Bush, Coastal Wattle and Coast Banksia • Teatree • Coast Banksia • Wallum Banksia, Dwarf Banksia and Coast Banksia • Wallum Banksia and Scribbly Gum • Horsetail Sheoak, Coast Banksia-Bitou Bush
Moist to Dry Sclerophyll Forest and Woodland.	Dominated by (after BSC, 2007): • Scribbly Gum and Red Bloodwood • Blackbutt • Coast Banksia • Cyperus Pine
Swamp Sclerophyll Forest and Woodland	Generally dominated by broad-leaved paperbark
Mangrove Forest and Woodland and Saltmarsh	Estuarine wetlands
Sedgeland /Fernland/Grassland	Freshwater wetlands
Rainforest	Floodplain and littoral communities
Disturbed Communities	Cultural Vegetation (includes landscaping and urban bushland mosaic), and mixed regrowth (often dominated by Acacia).
Other Bushland	Composition not determined



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Vegetation Communities and Habitats

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4 Known and Potential Threatened Species and Communities

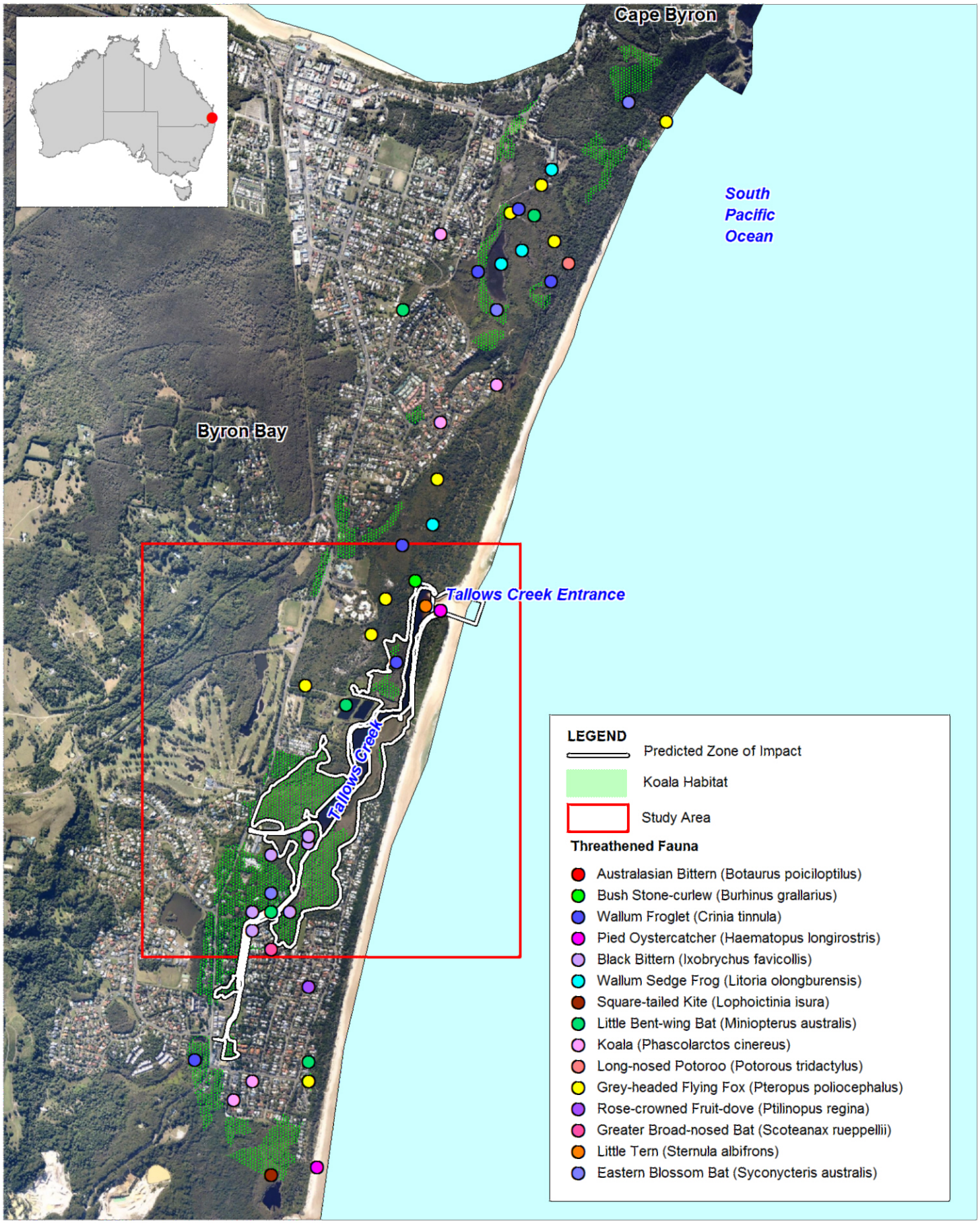
Appendix A provides a list of threatened species and communities known to occur within the region, their preferred habitats and potential to occur in the study area based on a review of available information. Figure 4-1 and Figure 4-2 show the known location of threatened species records. Based on the available vegetation mapping provided by Byron Shire Council and the NSW Office of Environment and Heritage, Table 4-1 and Figure 4-3 summarise the extent and distribution of threatened communities mapped in the Tallows Creek catchment and the proportion of these habitats to be potentially impacted by the proposal.

Table 4-1 Extent of Threatened Ecological Communities in Catchment and Potential Impact Zone

Threatened Ecological Community	Extent within Tallows Creek Catchment (Ha)	Extent within Potential Impact Zone (Ha)	% Total Habitat Within Potential Impact Zone
Byron Bay Dwarf Graminoid Clay Heath	7.68	0	0
Coastal Saltmarsh	6.12	5.96	97
Freshwater wetlands	11.67	1.59	14
Littoral Rainforest	39.45	0	0
Lowland Rainforest	3.56	0.11	3
Swamp oak floodplain forest	0.62	0.28	45
Swamp sclerophyll forest	93.21	27.89	30
Themeda Grassland on seacliffs and coastal headlands	1.56	0	0
Total Area	163.87	35.83	

Figure 4-4 shows the extent of vegetation communities mapped in the predicted impact zone based on field survey (refer to BMT WBM 2015b.) Based on this local scale mapping, approximately 4.2 Ha of Coastal saltmarsh, 2.5 Ha of Freshwater wetlands and 31.9 Ha of Swamp sclerophyll forest have been mapped in the predicted impact zone.

Figure 4-5 shows the extent of SEPP 14 wetlands mapped in the predicted impact zone based on the current SEPP 14 wetland boundary. The mapping identifies that 17.5 Ha of these wetland are within the predicted impact zone.



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Threatened Fauna Records for the Study Area

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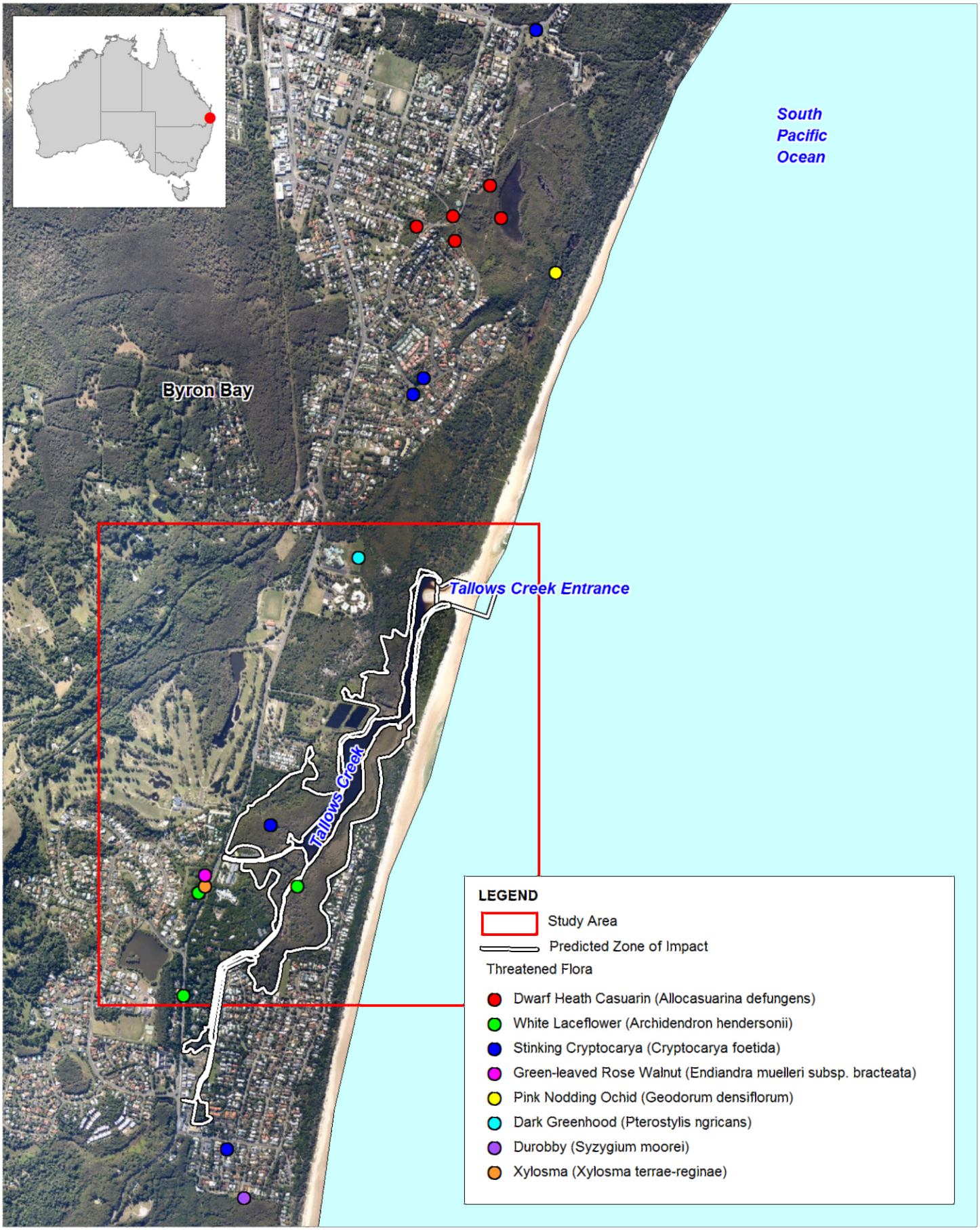

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Threatened Flora Records for the Study Area

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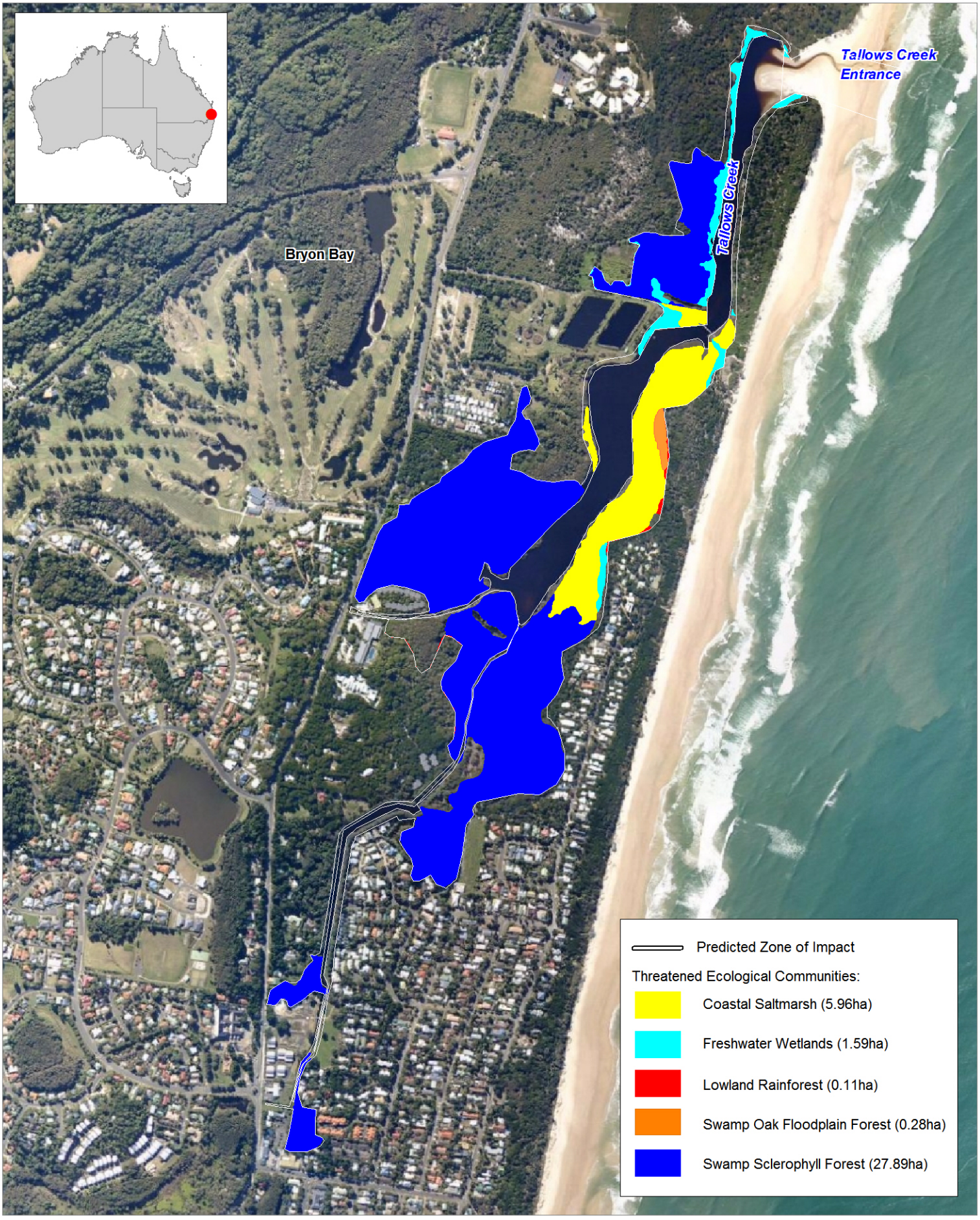

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Threatened Ecological Communities

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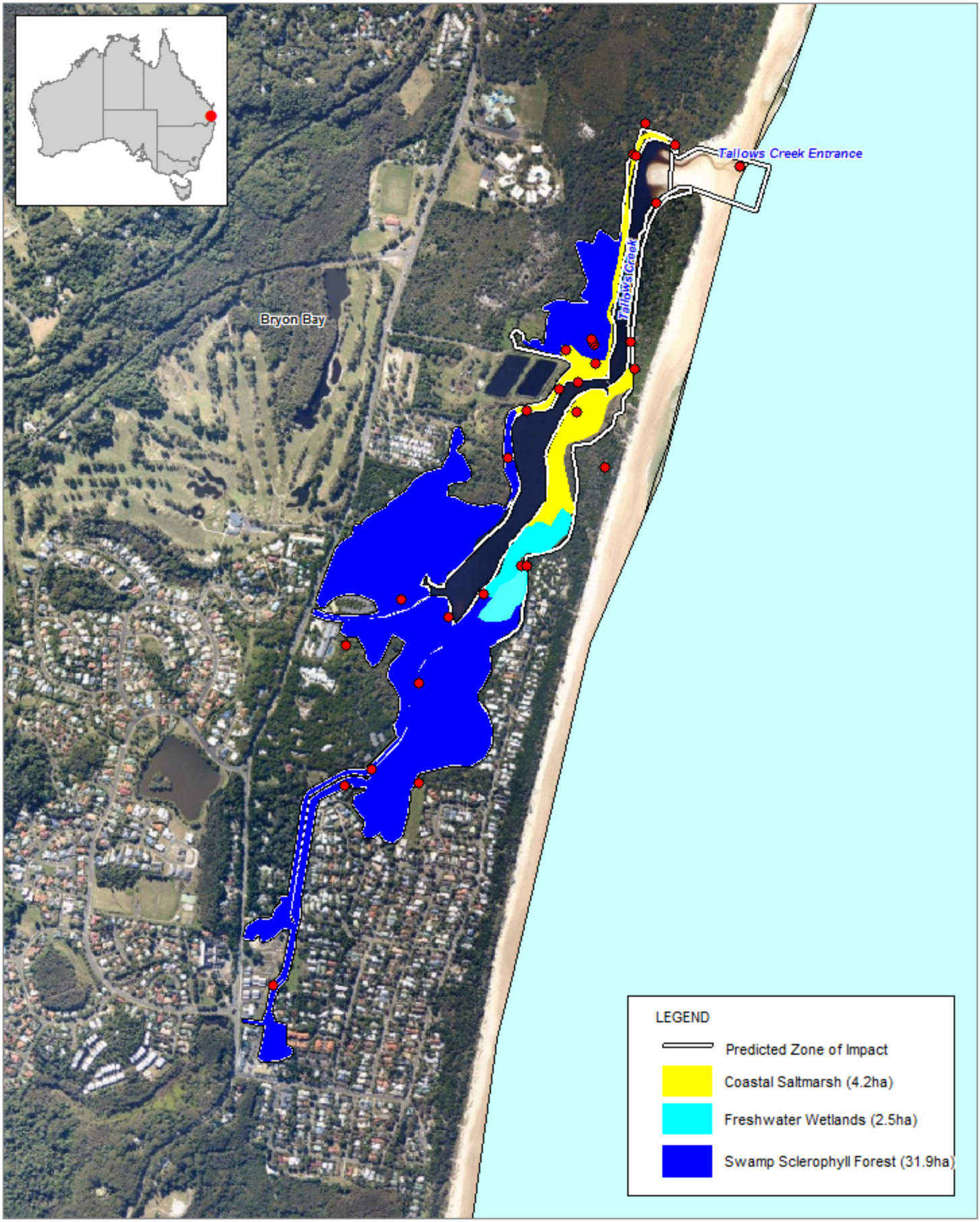

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Threatened Ecological Communities based on Field Survey

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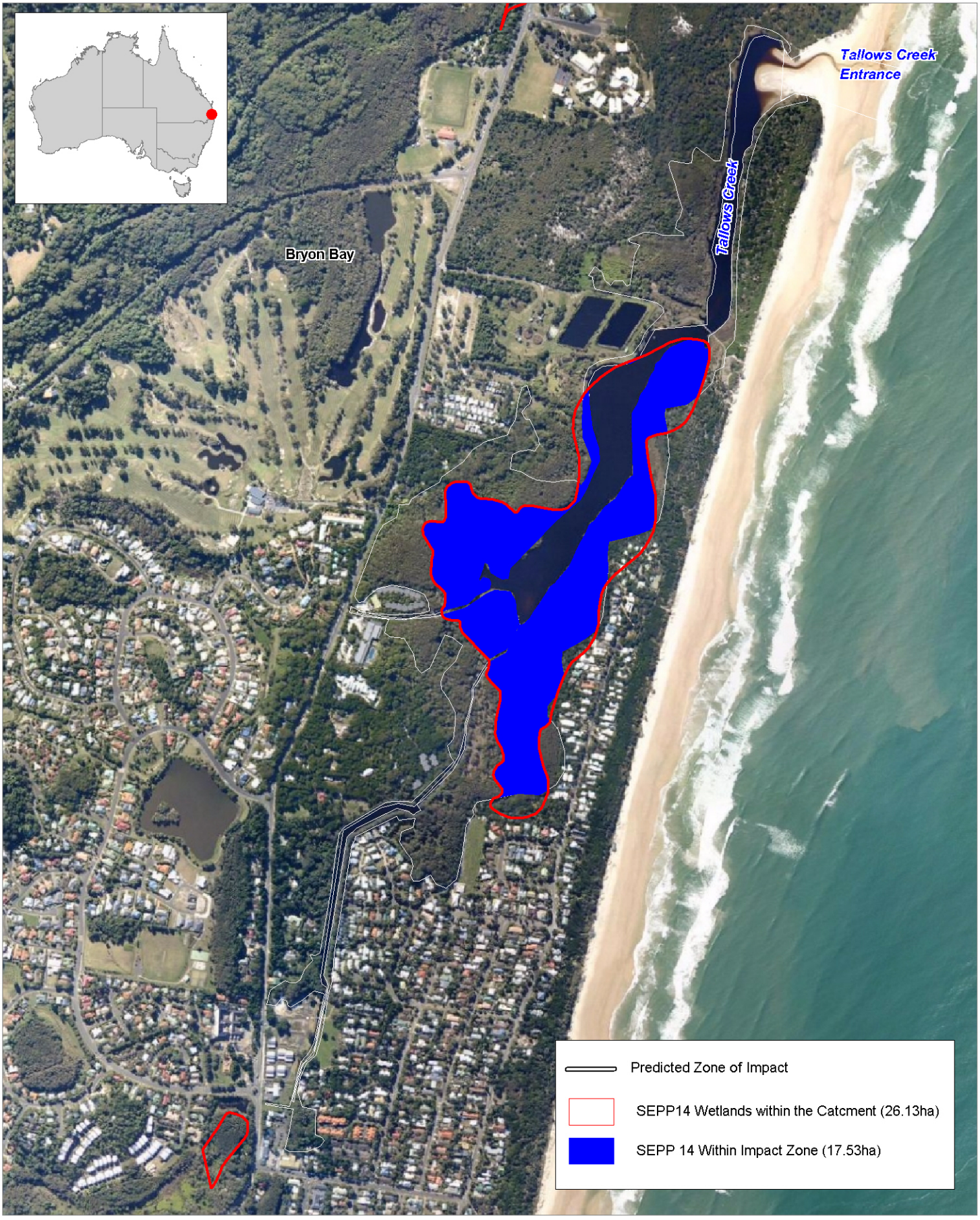

Title:

SEPP 14 Wetlands

Figure: 4-5

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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Approx. Scale

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5 Potential Impacts of the Proposal on Physical and Water Quality Properties of the Estuary

An artificial opening will be triggered should water levels in Tallow Creek mouth level reach or exceed 2.2m AHD (the flood trigger). An artificial opening will also be triggered at 1.8 m AHD or above should the creek water quality results prove to be hazardous to human health (the water quality trigger). The proposed activity is to:

(1) Use mechanical intervention to reduce sand levels at the mouth (entrance) of Tallow Creek when the prescribed trigger levels are met. The sandbar will be reduced to allow natural opening to occur if sufficient rainfalls occur, and to allow the artificially created channel to scour out the sandbar as naturally as possible; and

(2) Skim or excavate a narrow pilot channel (approximately 2m wide) from the ocean toward the sandbar to artificially create a channel which will then widen naturally as water escapes the creek further scouring out the sandbar.

5.1 Physical Impacts

Direct physical disturbance will occur during:

(1) Access and egress by machinery to/from the mouth of Tallow Creek. According to the draft Review of Environmental Factors (Byron Shire Council, 2010) access is proposed either via:

  (a) The Suffolk Park Vehicle Access Point (Clifford Street Suffolk Park). This would require machinery to cross the beach access and travel approximately 2.6 km to the sandbar;

  (b) Ocean Street Byron Bay through the Arakwal National Park along the management trail and then along the track to the sandbar; and

  (c) Alcorn Street Suffolk Park along the cycleway-walkway and across the dunes at the emergency access point south of Arakwal National Park.

Using smaller machinery (e.g. either a single or multiple dingos or bobcats (or combination thereof), increases the likelihood of accessing via option b. or c and minimises risks to threatened fauna;

(2) Works associated with the lowering (scraping) of the top of the berm;

(3) Works associated with the excavation of the 2m wide pilot channel; and

(4) The widening of the channel by water flowing out of the creek.

5.2 Estuary Water Level Impacts

Based on the past 7 years of experience of Byron Shire Council, natural breaching of the creek typically occurs between 2.2m AHD and 2.4m AHD (Pers. Comm. Flockton, 2013). Therefore, the flood trigger reflects typical natural breaching levels of Tallow Creek.

Given the highly variable natural conditions in Tallow Creek and the natural breaching between 2.2 m and 2.4m AHD, any artificial breaching in accordance with the 2.2m AHD trigger level is unlikely

to impact any species or ecological communities. It is however acknowledged that the natural berm level can exceed 2.4m AHD when coastal conditions allow for a sufficient buildup of sand, and dry weather has negated the need for a forced opening.

In November 2004 for example, when the last artificial breach was undertaken, the berm was at 2.5m AHD following an extended dry period. While most ICOLL's in NSW are located near headlands and naturally break out between 2 and 2.5m AHD, Tallows Creek is located midway along the beach (i.e. not adjacent to a headland). This means that the beach is exposed to a wide spectrum of wave directions and energies and that the entrance berm could build to reasonably high levels ~3m AHD, especially during dry periods when opening would not occur very often.

Based on water levels alone therefore, it is feasible that preventing the creek from reaching its natural maximum water level could impact vegetation within a band around the foreshore between any adopted artificial breakout level and the natural maximum water level (up to approximately 3.0m AHD). If this was to occur, the vegetation communities (and the fauna which depend upon them) could tend towards more dryland species. Considering water levels alone however, does not provide a complete picture of potential changes.

Figure 2-1 identifies that there is a limited area of wetland vegetation communities located between 1.8m AHD (lowest suggested breakout level) and 3.0m AHD (upper limit of potential impact). Further, it should not be strictly assumed that the vegetation communities within this band will be impacted by adoption of a 1.8m or 2.2m AHD artificial breakout level. By cross referencing the vegetation communities shown on Table 3-1, it can be seen that there are distinct vegetation communities within this band including:

(1) Swamp sclerophyll forest and woodland comprised predominantly of Melaleuca *quinquenervia*; and

(2) Swamp sclerophyll forest and woodland comprised predominantly of Swamp Mahogany/Swamp Box.

Swamp Mahogany and Swamp Box tend to occur on alluvial slopes adjacent to M. *quinquenevia* dominated communities and do not tolerate the levels or duration of waterlogging tolerated by M. *quinquenervia*. It cannot be assumed that the inundation upon which these communities depend comes from Tallow Creek itself. These vegetation communities are often associated with high groundwater tables and a high level of organic matter in the upper soil profile (which would help to retain moisture). It is feasible therefore, that there could be sufficient moisture from groundwater, direct rainfall and overland flow to support these communities without any dependence on inundation from Tallow Creek.

The flood levels (shown on Figure 3-1) indicate that the water level in Tallow Creek during a 1 in 5 year ARI event is at 2.25m AHD. As wetland species require significantly more frequent wetting, any species or vegetation community located above 2.25m AHD is unlikely to be reliant on regular inundation from Tallow Creek for survival. This suggests that the *Melaleuca quinquenervia* and Swamp Mahogany/Swamp Box communities which occur above the 2.2m AHD level (and most likely those above the 1.8m AHD level) are unlikely to be impacted by the proposed artificial breaching levels.

Both considerations will be assessed when determining the likelihood and magnitude of an impact for species requiring 7 part test. In deciding which species should be progressed to that stage however, any likelihood of an impact is a sufficient measure. The impact area for this preliminary assessment is therefore maintained between 1.8m AHD (lower limit of potential impact) and 3.0m AHD (upper limit of potential impact).

5.3 Water Quality Impacts

ICOLLs are extremely dynamic and therefore complex systems and knowledge on the impact of artificial opening on water quality is limited. The Department of Primary Industries (DPI) (DPI, 2013) states that:

> *"Just because an ICOLL is closed, does not necessarily mean that it has poor water quality. Many closed ICOLLs maintain good water quality and remain suitable for swimming, water sports and fishing for long periods of time. Furthermore, artificially opening an ICOLL entrance will not always improve the water quality due to the limited tidal movement or 'flushing' in most ICOLLs."*

Fish kills have however historically occurred in Tallow Creek following periods of intense rainfall when natural opening has not occurred. Intense rainfall following a dry season can result in the high biochemical oxygen demand associated with either the direct mobilisation of organic-rich detritus into Tallow Creek, or indirect detrital input from phytoplankton assemblages and/or light-dependent benthic algae. The decomposition of organic matter from these organisms can result in dissolved oxygen concentrations dropping to lethal levels causing anoxic or hypoxic conditions and fish kills.

Furthermore, respiration by phytoplankton and/or light-dependent benthic algae can result in excessive consumption of oxygen when there is insufficient light for photosynthesis and if that demand exceeds available oxygen in the water column, other aquatic organisms can also perish. The respiration by anaerobic organisms involved in the biodegradation of organic matter can also result in the release of hydrogen sulphide and/or ammonia gas which are toxic to aquatic organisms (Johnston and Sheaves, 2006).

Following a review of ICOLL water quality data however, Haines (2008) concluded that *"water quality within an ICOLL can change significantly as a result of an entrance breakout event".*

Given that the proposed 2.2m AHD flood trigger would increase the frequency of breakout, more frequent declines in water quality following artificial breakouts, or as result of skimming to 2.2m AHD, could result if Tallow Creek was representative of the broadscale review by Haines. Haines also cautioned however that, *"water quality data for ICOLLs should be used with caution, particularly when used to justify particular management regimes (artificially opening an entrance for example)."*

In considering whether there is an improvement or decline in water quality and wetland dependent habitat is likely, a range of factors specific to Tallow Creek need to be considered including:

- Unlike some ICOLL's, Tallow Creek is fed by a catchment which does assist in flushing it out, although these flows may also contribute to increased risks from deoxygenation and/or release of toxic gases;

- Fish kills have historically occurred in Tallow Creek following periods of intense rainfall when natural opening has not occurred although the cause/s of associated fish kills are unconfirmed;
- Historic water quality trends were not available for this study;
- The 2.2m AHD flood trigger level is within the natural range for openings during “typical” climatic conditions although the frequency of opening is likely to increase. The water quality impacts associated with these more frequent openings are difficult to estimate. Typically more frequent openings result in more frequent connection of ocean and ICOLLs resulting in more marine conditions within the ICOLL. Counteracting this effect, is the possibility that reduced heights of opening lessen the scouring that occurs, potentially resulting in a shallower connection channel that occludes faster compared to deeper natural channel. If this effect occurred, it would result in in an overall reduction in the period of ocean connection;
- The existing aquatic and fringing ecological communities have adapted to the naturally variable environmental conditions and are not expected to change significantly; and
- Species and communities dependent on regular inundation will continue to be regularly inundated as discussed in Section 5.2.

Given the lack of sufficient data, it is unrealistic to make firm conclusions as to the likely change in water quality as a result of artificially breaching and skimming. In considering which threatened species and communities should proceed to a 7 part test therefore, a precautionary approach has been taken i.e. it has been assumed that there could be some unquantified change in water quality and any threatened species potentially impacted by such a change should proceed to the 7 part test.

6 Ecological Impacts

6.1 Beach Habitat and Threatened Species

The most significant ecological impact associated with the proposal is likely to be the direct physical impact through the excavation of the estuary channel and disturbance during transportation of equipment to and from this site. It is understood that access to the entrance will involve transportation of equipment along Tallow Beach and/or through Arakwal National Park.

The greatest ecological risk during mobilisation and excavation works would be for fauna utilising the upper beach and berm. Most fauna would be able to move out of the way of equipment and works without any significant impact. However, there may be an issue if sensitive fauna, in particular sea turtles and birds, are nesting at these sites. Refer to Table 3-1 for a list of threatened species potentially using beach habitat in the study area.

These impacts could be avoided / mitigated by minimising the extent of travel along the beach and if possible, by avoiding works at times when target species are nesting (refer to Table 3-1 for turtle and bird nesting details). In addition, the use of smaller equipment such as a backhoe should also be employed to minimise the area of disturbance.

Pre-disturbance ecological surveys in consultation with the relevant authorities would be required to locate any threatened species and their nesting sites in the beach areas to be impacted. If nests are located along the access route, then alternative routes should be sought. If nests are located in the estuary mouth, these may need to be relocated in consultation with the relevant authorities (approvals and permits will be required under the TSC Act and EPBC Act). Surveys may however need to be undertaken on short notice (following unexpectedly high rainfall for example) potentially limiting opportunities for consultation.

In the event the mouth is required to be opened at short notice, for example to reduce flash flooding impacts, contingency measures will need to be in place to appropriately manage sensitive beach fauna. For example it may be necessary to engage local wildlife catchers and spotters to survey and relocate species on short notice. The contingency plan will need to be developed in consultation with, and approved by, the relevant authorities.

Identified species are included in Table 7-1 for assessment.

6.2 Wetland Habitat and Threatened Species

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the

change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

Identified species are included in Table 7-1 for assessment.

6.3 Terrestrial Habitat and Threatened Species

Terrestrial vegetation adjacent to wetland communities fringing the estuary may expand as a result of the proposed estuary opening. As a result of reduced inundation, some terrestrial species (including invasive and introduced species) may expand into habitats previously occupied by wetland species. This is most likely to occur at the ecotones between swamp sclerophyll forest / woodland with moist/ dry sclerophyll communities, heath, littoral rainforest and disturbed habitats. Although the extent of terrestrial vegetation expansion is expected to be minor (in the order of metres) any expansion of disturbed habitat is likely to result in increased weed invasion in wetland communities.

As there is expected to be a net gain in terrestrial habitat (i.e. expansion of sclerophyll woodlands and heath), it could be assumed that any threatened species associated with these habitats would benefit. However, given the minor habitat interchanges anticipated (in the order of metres) the impacts on threatened species populations are expected to be minor.

Identified species are included in Table 7-1 for assessment.

6.4 Threatened Communities

Eight threatened ecological communities are known from the region. These include:

- Coastal saltmarsh in NSW North Coast;
- Littoral Rainforest and Coastal Vine Thickets in the NSW North Coast Bioregion (Endangered Ecological Community under the TSC Act (EEC) and Critically Endangered under the EPBC Act);
- Swamp Sclerophyll Forest on Coastal Floodplains (EEC);
- Swamp Oak Floodplain Forest in the NSW North Coast Bioregion (EEC);
- Coastal Cypress Pine Forest in the NSW North Coast Bioregion (EEC);
- Byron Bay Dwarf Graminoid Clay Heath (EEC);
- Themeda Grassland on Seacliffs and Coastal Headlands in the NSW North Coast (EEC); and
- Freshwater Wetlands on Coastal Floodplains (EEC).

Available habitat mapping indicates that five of these communities occur in the study area and may be impacted by the proposal (refer to Figure 4-3):

- 5.96 Ha of Coastal Saltmarsh;

- 1.59 Ha of Freshwater Wetlands;
- 0.11 Ha of Lowland Rainforest;
- 0.28 Ha of Swamp Oak Floodplain Forest; and
- 27.89 Ha of Swamp Sclerophyll Forest.

These communities will be subject to the '7 part tests' as outlined in Table 7-1.

7 Summary

Based on the review of available information, '7 Part Tests' will be required for the threatened species and communities known from the region which prefer beach and freshwater and estuarine wetland communities with similar habitat characteristics to those habitats which may be impacted by the proposal, as detailed in Table 7-1. Refer to Appendix A for a summary of habitat features for these species.

Table 7-1 Species Recommended for Assessment under 7 Part Test

Birds	
Amaurornis olivaceus	Bush Hen
Ansranus semipalmata	Magpie Goose
Botaurus poiciloptilus	Australasian Bittern
Burhinus grallarius	Bush Stone-curlew
Calidris tenuirostris	Great Knot
Ephippiorhynchus asiaticus	Black-necked Stork
Erythrotriorchis radiatus	Red Goshawk
Esacus neglectus	Beach-stone Curlew
Haematopus fuliginosus	Sooty Oystercatcher
Haematopus longirostris	Pied Oystercatcher
Ixobrychus flavicollis	Black Bittern
Limosa limosa	Black-tailed Godwit
Monarcha leucotis	White-eared Monarch
Pandion haliaetus	Osprey
Sterna albifrons	Little Tern
Todiramphus chloris	Collared Kingfisher
Mammals	
Chalinolobus nigrogriseus	Hoary Wattled Bat
Miniopterus australis	Little Bent-wing Bat
Miniopterus schreibersii	Common Bent-wing Bat
Myotis adversus	Large-footed Myotis
Nyctophilus bifax	Eastern Long-eared Bat
Phascolarctos cinereus	Koala
Planigale maculatus	Common Planigale
Potorous tridactylus	Long-nosed Potoroo
Pseudomys gracilicaudatus	Eastern Chestnut Mouse
Pteropus poliocephalus	Grey-headed Flying Fox
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat

Scoteanax rueppelli	Greater Broad-nosed Bat
Syconycteris australis	Eastern Blossom Bat
Frogs	
Crinia tinnula	Wallum Froglet
Litoria olongburensis	Wallum Sedge Frog
Reptiles	
Caretta caretta	Loggerhead Turtle
Chelonia mydas	Green Turtle
Invertebrates	
Argyreus hyperbius	Australian Fritillary Butterfly
Petalura gigantea	Giant Dragonfly
Thersites mitchellae	Mitchells' Rainforest Snail
Fish	
Maccullochella ikei	Eastern Freshwater Cod
Nannoperca oxleyana	Oxleyan Pygmy Perch
Flora	
Archidendron hendersonii	White Lace Flower
Chamaesyce psammogeton	Sand Spurge
Cordyline congesta	Tooth-leaved Palm Lily
Cryptocarya foetida	Stinking Cryptocarya
Geodorum densiflorum	Pink Nodding Orchid
Phaius australis	Swamp Orchid
Threatened Communities	
Coastal Saltmarsh in the NSW North Coast Bioregion	
Freshwater Wetlands on Coastal Floodplains	
Swamp Sclerophyll Forest on Coastal Floodplains	
Swamp Oak Floodplain Forest in the NSW North Coast Bioregion	
Lowland Rainforest in the NSW North Coast	

Based on the available information to date, it is predicted that the proposed artificial opening of the estuary will result in:

- No change in the frequency opening up to 2.2m AHD and cessation of openings above this level;
- An unquantified, but likely insignificant change in the water quality characteristics of Tallow Creek;

- Potential disturbance of fauna occupying the entrance berm and immediate environs, or the access route for equipment; and
- Minor estuarine habitat interchanges anticipated (in the order of metres) with minor impacts (including potential benefits) on threatened species populations expected.

The greatest ecological risk during mobilisation and excavation works associated with the proposal would be to nesting marine turtles and birds using the beach. However, it is expected that the direct impacts associated with artificial entrance management on these species could be mitigated through appropriate protocols and work procedures in consultation with the relevant authorities and with reference to relevant management plans.

Given that no major changes to flow velocities, volumes or quality are expected, it is very unlikely that the proposed scheme will have any major impact on threatened flora and fauna within and directly adjacent to the estuary waterway on the basis that:

- The estuary is subject to variations in water quality and flow and supports a mix of estuarine dependant species tolerant of periodic inundation and drying which are likely to tolerate the predicted changes in inundation.
- Estuarine and floodplain communities generally recover quickly after periodic individual floods or periods of no flow.

The proposal is unlikely to have a major effect on threatened vegetation communities or species in and adjacent to the estuary waterway. It is not anticipated that the proposal will significantly alter the chemical or physical characteristics of the water to an extent that will significantly alter current habitat conditions causing extinction of habitat types from the estuary, alterations to life-history and fauna behaviour.

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Appendix A Known and Potential Species of the Study Area and Surrounds (Based on BSC (2010 and 2013); Baker (2009); NSW DEC (2013); DSEWPC, 2013))

Species	Common Name	TSC Act Code	EPBC Act Code	FM Act Code	ROTAP	Preferred Habitat	Recorded in Study Area and Surrounds	Potential Habitat in the Zone of Impact	7 Part Test Required	Reference
Birds										
Amaurornis olivaceus	Bush Hen	V2				Partly terrestrial species with wide habitat tolerances. Prefers dense vegetation on margins of freshwater creeks, rivers and wetlands, margins of rainforest to forest regrowth, rank grass or reeds, weed thickets and farmland.		Freshwater Wetland	yes	NSW SCIENTIFIC COMMITTEE Bush-hen *Amaurornis olivaceus.* Review of Current Information in NSW. August 2008
Ansranus semipalmata	Magpie Goose	V2				Mainly found in shallow wetlands (less than 1 m deep) with dense growth of rushes or sedges		Freshwater Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10056.
Botaurus poiciloptilus	Australasian Bittern	V2				Inhabits temperate freshwater wetlands and occasionally estuarine reedbeds. The species favours permanent shallow waters, or edges of pools and waterways, with tall, dense vegetation such as sedges, rushes and reeds on muddy or peaty substrate	*	Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/determinations/austbitternFD.htm
Burhinus grallarius	Bush Stone-curlew	E1				Broad habitat usage. In estuarine areas, this species has been recorded in *Casuarina glauca* groves, saltmarsh, mangroves and *Melaleuca quinquinervia* woodlands.	*	Freshwater and Estuarine Wetland	yes	Department of Environment and Conservation NSW 2006, *NSW Recovery Plan for the Bush Stone-curlew Burhinus grallarius. DEC, Sydney.*
Calidris tenuirostris	Great Knot	V				Occurs within sheltered, coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons. Often recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms.		Beach and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10128
Ephippiorhynchus asiaticus	Black-necked Stork	E				Mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands. They also forage within or around estuaries and along intertidal shorelines, such as saltmarshes, mudflats and sandflats, and mangrove vegetation.		Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10275
Erythrotriorchis radiatus	Red Goshawk	CE	V			Inhabit open woodland and forest, preferring a mosaic of vegetation types, a large population of birds as a source of food, and permanent water, and are often found in riparian habitats along or near watercourses or wetlands. In NSW, preferred habitats include mixed subtropical rainforest, *Melaleuca* swamp forest and riparian *Eucalyptus* forest of coastal rivers.		Freshwater Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10279
Esacus neglectus	Beach-stone Curlew	E1				Nest on beaches and in estuaries and forage between the high and low water mark.		Beach and Estuarine Wetland	yes	*Best practice guidelines* Managing threatened beach-nesting shorebirds. Department of Environment and Climate Change NSW.
Haematopus fuliginosus	Sooty Oystercatcher	V2				Nest on beaches and in estuaries and forage between the high and low water mark.		Beach and Estuarine Wetland	yes	*Best practice guidelines* Managing threatened beach-nesting shorebirds. Department of Environment and Climate Change NSW.
Haematopus longirostris	Pied Oystercatcher	V2				Nest on beaches and in estuaries and forage between the high and low water mark.	*	Beach and Estuarine Wetland	yes	*Best practice guidelines* Managing threatened beach-nesting shorebirds. Department of Environment and Climate Change NSW.
Ixobrychus flavicollis	Black Bittern	V2				Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water in flooded grassland, forest, woodland, rainforest and mangroves.	*	Freshwater and Estuarine Wetland	yes	Threatened Species Informations. NSW NPWS. September 1999.
Limosa limosa	Black-tailed Godwit	V				Found along the coast on sand spits, lagoons and mudflats. However, the species also occurs inland on mudflats and in those portions of large muddy lakes and swamps (freshwater or brackish) where the water is less than 10 cm deep during suitable conditions (i.e. receding water). Individuals have also been observed in wet meadows and sewerage treatment works.		Beach, Freshwater and Estuarine Wetland	yes	NSW NPWS Threatened Species Profile Black-tailed Godwit. September 1999.

Species	Common Name	TSC Act Code	EPBC Act Code	FM Act Code	ROTAP	Preferred Habitat	Recorded in Study Area and Surrounds	Potential Habitat in the Zone of Impact	7 Part Test Required	Reference
Lophoictinia isura	Square-tailed Kite	V2				Inhabits coastal and subcoastal, eucalypt-dominated open forests and woodlands, coastal heathlands, and often near openings and edges of forest.	*	No habitat available.	no	NSW SCIENTIFIC COMMITTEE Square-tailed Kite *Lophoictinia isura.* Review of Current Information in NSW. June 2009
Monarcha leucotis	White-eared Monarch	V2				Occur in littoral rainforest, dry sclerophyll forests, swamp forest and regrowth. Prefer ecotone between rainforest and open areas.		Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10540
Pandion haliaetus	Osprey	V2				Forages over estuarine and inshore marine waters and coastal rivers, and nests in tall (usually dead or dead-topped) trees in coastal habitats from open woodland to open forest, within 1-2 km of water.		Estuarine Wetland	yes	NSW SCIENTIFIC COMMITTEE Eastern Osprey *Pandion cristatus.* Review of Current Information in NSW. June 2009
Pomatostomus temporalis temporalis	Grey-crowned Babbler	V2				Inhabits open Box Woodlands on alluvial plains.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10660
Ptilinopus regina	Rose-crowned Fruit-dove	V2				Occur mainly in sub-tropical and dry rainforest and occasionally in moist eucalypt forest and swamp forest, where fruit is plentiful.	*	No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10708
Ptilinopus superbus	Superb Fruit-dove	V2				Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10709
Sterna albifrons	Little Tern	E1				Nest on beaches at or near estuary openings and generally forage between the high and low water mark.	*	Estuarine Wetland	yes	*Best practice guidelines* Managing threatened beach-nesting shorebirds. Department of
Todiramphus chloris	Collared Kingfisher	V				Restricted to mangrove associations of estuaries, inlets, sheltered bays and islands, and the tidal flats and littoral zone bordering mangroves. They sometimes occur in terrestrial forests or woodlands bordering mangroves, where they will nest in holes in trees or in arboreal termitaria.		Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10810
Tyto capensis	Grass Owl	V2				Found in areas of tall grass, including grass tussocks, in swampy areas, grassy plains, swampy heath, and in cane grass or sedges on flood plains. Always breeds on the ground. Nests are found in trodden grass, and often accessed by tunnels through vegetation.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10819
Tyto novaehollandiaea	Masked Owl	V2				Eucalypt forests and woodlands on the coast.		No habitat available.	no	Department of Environment and Conservation (NSW) (2006). NSW Recovery Plan for the Large Forest Owls: Powerful Owl (Ninox strenua), Sooty Owl (Tyto tenebricosa) and asked Owl (Tyto novaehollandiae) DEC, Sydney.
Mammals										
Chalinolobus nigrogriseus	Hoary Wattled Bat	V2				Occurs in dry open eucalypt forests, favouring forests dominated by Spotted Gum, boxes and ironbarks, and heathy coastal forests where Red Bloodwood and Scribbly Gum are common.		Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10158
Megaptera novaeangliae	Humpback Whale	V2				They are regularly observed in NSW waters in June and July, on northward migration and October and November, on southward migration		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10914
Miniopterus australis	Little Bent-wing Bat	V2				Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, *Melaleuca* swamps, dense coastal forests and banksia scrub. Roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats.	*	Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10533
Miniopterus schreibersii	Common Bent-wing Bat	V2				Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Hunt in forested areas.		Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10534

Species	Common Name	TSC Act Code	EPBC Act Code	FM Act Code	ROTAP	Preferred Habitat	Recorded in Study Area and Surrounds	Potential Habitat in the Zone of Impact	7 Part Test Required	Reference
Myotis adversus	Large-footed Myotis	V2				Roosts close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage and forages over streams and pools.		Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10549
Nyctophilus bifax	Eastern Long-eared Bat	V2				Lowland subtropical rainforest and wet and swamp eucalypt forest, extending into adjacent moist eucalypt forest. Coastal rainforest and patches of coastal scrub are particularly favoured.		Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10567
Phascolarctos cinereus	Koala	V2				Inhabits eucalypt forest and woodland.	*	Koala habitat mapped in study area.	yes	Threatened Species Information: Koala. NSW NPWS, September 1999.
Planigale maculatus	Common Planigale	V2				Inhabit rainforest, eucalypt forest, heathland, marshland, grassland and rocky areas where there is surface cover, and usually close to water.		Freshwater Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10635
Potorous tridactylus	Long-nosed Potoroo	V2				Inhabits coastal heaths and dry and wet sclerophyll forests.	*	Heath	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10662
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	V2				Found in low numbers in heathland but most common in dense, wet heath and swamps. Optimal habitat is vigorously regenerating heathland.		Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10687
Pteropus poliocephalus	Grey-headed Flying Fox	V2	V			Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located close to water, in vegetation with a dense canopy.	*	Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10697
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat	V2				Forages in most habitats across its very wide range, with and without trees. Roosts in tree hollows and buildings and mammal burrows.		Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10741
Scoteanax rueppelli	Greater Broad-nosed Bat	V2				Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Usually roosts in tree hollows, it has also been found in buildings.	*	Freshwater Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10748
Syconycteris australis	Eastern Blossom Bat	V2				Core foraging undertaken in Banksia woodlands, Melaleuca and swamp forests, while roosting occurs in littoral rainforests.	*	Freshwater and Estuarine Wetland	yes	Byron Shire Threatened Species Profile Eastern Blossom Bat - *Syconycteris australis January 2010.*
Frogs										
Crinia tinnula	Wallum Froglet	V2				Found in a wide range of habitats, usually associated with acidic swamps on coastal sand plains. They occur in sedgelands, wet heathlands, paperbark swamps and drainage lines within other vegetation communities. They will also persist in disturbed areas. Breeds in swamps with permanent water as well as shallow ephemeral pools and drainage ditches.	*	Freshwater Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10183
Litoria olongburensis	Wallum Sedge Frog	V2	V			Paperbark swamps and sedge swamps of *Banksia* dominated lowland heath ecosystem characterised by acidic waterbodies (wallum).	*	Freshwater Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10489
Reptiles										
Caretta caretta	Loggerhead Turtle	E1				Lays eggs on beach foredunes during summer and forages all year in marine waters.		Beach	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10146
Chelonia mydas	Green Turtle	V2				Lays eggs on beach foredunes during summer and forages all year in marine waters. May occur in estuaries during warmer months.		Beach	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10901
Invertebrates										
Argyreus hyperbius	Australian Fritillary Butterfly	E1				Found in open swampy coastal habitat and eggs laid on the Native Violet (*Viola betonicifolia*). The food plant occurs in ground level vegetation in swampy areas beneath grasses and mat-rushes (Lomandra spp.).		Freshwater Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10064
Petalura gigantea	Giant Dragonfly	E1				Live in permanent swamps and bogs with some free water and open vegetation.		Freshwater Wetland	yes	Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10600

Species	Common Name	TSC Act Code	EPBC Act Code	FM Act Code	ROTAP	Preferred Habitat	Recorded in Study Area and Surrounds	Potential Habitat in the Zone of Impact	7 Part Test Required	Reference
Thersites mitchellae	Mitchells' Rainforest Snail	E1	Critically Endangered			Remnant areas of lowland subtropical rainforest and swamp forest on alluvial soils. Slightly higher ground around the edges of wetlands with palms and fig trees are particularly favoured habitat.		Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10801
Fish										
Carcharias taurus	Grey Nurse Shark		Critically Endangered	E 4		Marine waters along the length of the NSW coast.		No habitat available.	no	http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0016/208213/PD-Grey-Nurse-Shark.pdf
Carcharodon carcharias	Great White Shark		V	V 5		Marine waters along the length of the NSW coast.		No habitat available.	no	http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/208249/FR2-great-white-shark.pdf
Maccullochella ikei	Eastern Freshwater Cod		Endangered	E 4		Clear rocky streams and rivers with low flow velocity and abundant instream cover of rocks, timber or tussocks. Associated with deeper parts of the river near cover, especially around rocky islands, large boulders and pools in fast-flowing water. Large woody debris and rocky overhangs may provide shelter and important spawning sites).		Open Freshwater	yes	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=26170#habitat
Nannoperca oxleyana	Oxleyan Pygmy Perch		Endangered	E 4		Specific habitat requirements include fresh, acidic waters and abundant aquatic vegetation. Generally occur in acidic freshwater systems which drain through sandy coastal *Banksia spp* -dominated heath or wallum vegetation assemblages. Have also been recorded from an intermediate eucalypt forest/heath community, rainforest/melaleuca swamp and from among saltrushes in an estuarine creek with high salt levels.		Freshwater Wetland	yes	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64468#habitat
Flora										
Acronychia bauerlenii	Byron Bay Acronychia				3RC-	Grows in subtropical and warm-temperate rainforest in the Lismore to Byron Bay to the McPherson Range area. Also recorded from Iluka.		No habitat available.	no	http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Acronychia~baeuerlenii
Acianthus amplexicaulis	Terrestrial Orchid				3RC-	Locally common in littoral rainforest and sheltered locations in dry sclerophyll forest on sand.		No habitat available.	no	
Acronychia littoralis	Scented Acronychia	E	E		3ECi	A range of littoral rainforest communities on sand and meta-sedimentary clays, and also Brush Box wet sclerophyll forest on meta-sedimentary clays		No habitat available.	no	Baker (2009) and Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10030
Allocasuarina defungens	Dwarf Heath Casuarina	E	E		2E	Grows mainly in tall heath on sand, but can also occur on clay soils and sandstone. Also extends onto exposed nearby-coastal hills or headlands adjacent to sandplains.	*	No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10037
Archidendron hendersonii	White Laceflower	V				In New South Wales is restricted to the lowlands of the Richmond and Tweed catchments found in riverine and lowland subtropical rainforest	*	No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/determinations/ArchidendronHendersoniiVulSpListing.htm
Archidendron muellerianum	Veiny Laceflower				3RCa	Grows chiefly in subtropical and littoral rainforest, north from Alstonville district.		No habitat available.	no	http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Archidendron~muellerianum
Callerya australis	Blunt-leaved Wisteria				3RC-+	Grows in warmer rainforest on the coast and adjacent ranges, not common; north from Port Macquarie		No habitat available.	no	http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Callerya~australis
Chamaesyce psammogeton	Sand Spurge	E				Grows on fore-dunes, pebbly strandlines and exposed headlands, often with Spinifex (*Spinifex sericeus*) and Prickly Couch (*Zoysia macrantha*)		Beach Foredune	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10160
Cordyline congesta	Tooth-leaved Palm Lily				2RC-	On coastal lowlands north of the Clarence River.		Freshwater Wetland	yes	http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Cordyline~congesta
Cryptocarya foetida	Stinking Cryptocarya	V	V		3VCi	Found in littoral rainforest, usually on sandy soils, but mature trees are also known on basalt soils.	*	No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10186
Diuris byronensis	Byron Bay Diuris	E				Restricted to graminoid clay heath and associated woodlands and forests on meta-sedimentary clays.		No habitat available.	no	Baker (2009).
Drynaria rigidula	Basket fern	E				Only recorded from Grey Ironbark wet sclerophyll forest on meta-sedimentary clays.		No habitat available.	no	Baker (2009).

Species	Common Name	TSC Act Code	EPBC Act Code	FM Act Code	ROTAP	Preferred Habitat	Recorded in Study Area and Surrounds	Potential Habitat in the Zone of Impact	7 Part Test Required	Reference
Elaeocarpus williamsianus	Hairy Quandong	E	E		2ECi	Subtropical to warm temperate rainforest, including regrowth areas where it has apparently regrown from root suckers after clearing. Soils are derived from metasediments.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10262
Endiandra floydii	Crystal Creek Walnut	E	E		2VC-	Warm temperate or subtropical rainforest with Brush Box overstorey, and in regrowth rainforest and Camphor Laurel forest.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10269
Endiandra hayesii	Rusty Rose Walnut	V	V		3VC-	Sheltered moist gullies in lowland subtropical and warm temperate rainforest on alluvium or basaltic soils.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10270
Endiandra muelleri ssp. *bracteata*	Green-leaved Rose Walnut	E				Subtropical rainforest or wet eucalypt forest, chiefly at lower altitudes.	*	No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10271
Floydia praealta	Ball Nut	V	V		3VC-	Inhabits floristically-rich, tall, closed riverine to subtropical rainforest or coastal scrub.		No habitat available.	no	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=15762#habitat
Geodorum densiflorum	Pink Nodding Orchid	E				Dry eucalypt forest and coastal swamp forest at lower altitudes, often on sand.	*	Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10349
Macadamia tetraphylla	Rough-shelled Bush Nut	V	V		2VC-	Subtropical rainforest and complex notophyll vineforest, at the margins of these forests and in mixed sclerophyll forest.		No habitat available.	no	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=15762#habitat
Niemeyera whitei	Rusty Plum	V			3RCa	Rainforest and the adjacent understorey of moist eucalypt forest.		No habitat available.	no	Specie profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10044
Owenia cepiodora	Onion Cedar	V	V		2VCi	Subtropical and dry rainforest on or near soils derived from basalt.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10579
Phaius australis	Swamp Orchid	E	E		3VCa	Swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas.		Freshwater Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10610
Pterostylis nigricans	Dark Greenhood	V			3V	Coastal heathland with Heath Banksia (*Banksia ericifolia*), and lower-growing heath with lichen-encrusted and relatively undisturbed soil surfaces, on sandy soils.	*	No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10703
Syzygium hodgkinsoniae	Red Lilly Pilly	V	V		3VC-	Usually found in riverine and subtropical rainforest on rich alluvial or basaltic soils.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10792
Syzygium moorei	Durobby	V	V		2VCi	Found in subtropical and riverine rainforest at low altitude. Often occurs as isolated remnant paddock trees.	*	No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10793
Tinospora tinosporoides	Arrowhead Vine	V	V		3RC-	Wetter subtropical rainforest, including littoral rainforest, on fertile, basalt-derived soils.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10809
Xylosma terrae-reginae	Xylosma	E				Littoral and subtropical rainforest on coastal sands or soils derived from metasediments	*	No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10846
Threatened Communities										
Littoral Rainforest and Coastal Vine Thickets in the NSW North Coast Bioregion		Endangered Ecological Community under the TSC Act (EEC)	Critically Endangered					no	no	
Coastal Saltmarsh in the NSW North Cooast Bioregion		EEC						yes	yes	
Swamp Sclerophyll Forest on Coastal Floodplains		EEC						yes	yes	
Swamp Oak Floodplain Forest in the NSW North Coast Bioregion		EEC						yes	yes	
Coastal Cypress Pine Forest in the NSW North Coast Bioregion		EEC						no	no	

Species	Common Name	TSC Act Code	EPBC Act Code	FM Act Code	ROTAP	Preferred Habitat	Recorded in Study Area and Surrounds	Potential Habitat in the Zone of Impact	7 Part Test Required	Reference
Byron Bay Dwarf Graminoid Clay Heath		EEC						no	no	
Themeda Grassland on Seaclifs and Coastal Headlands in the NSW North Coast		EEC						no	no	
Freshwater Wetlands on Coastal Floodplains		EEC						yes	yes	

Species	Common Name	TSC Act Code	EPBC Act Code	FM Act Code	ROTAP	Dune/ swale & lagoon near opening	Potentially Flooded Vegetated habitat	Lagoon waterbody and edge	Access Track
Birds									
Sterna albifrons	Little Tern	E1				X			
Haematopus longirostris	Pied Oystercatcher	V2				X			
Haematopus fuliginosus	Sooty Oystercatcher	V2				X			
Esacus neglectus	Beach-stone Curlew	E1				X			
Pandion haliaetus	Osprey	V2				X	X Roost /nest in trees	X	
Ansranus semipalmata	Magpie Goose	V2				X			
	Plumed Whistling Duck							X	
Burhinus grallarius	Bush Stone-curlew	E1					X		
Amaurornis olivaceus	Bush Hen	V2					X	X	
Ixobrychus flavicollis	Black Bittern	V2					X	X	
Botaurus poiciloptilus	Australasian Bittern	V2					X	X	
Lophoictinia isura	Square-tailed Kite	V2				X		X	X
Tyto capensis	Grass Owl	V2							
Tyto novaehollandiaea	Masked Owl	V2					X		
Monarcha leucotis	White-eared Monarch	V2					X		
Pomatostomus temporalis temporalis	Grey-crowned Babbler	V2					X		
Ptilinopus regina	Rose-crowned Fruit-dove	V2					X		
Ptilinopus superbus	Superb Fruit-dove	V2					X		
Mammals									
Planigale maculatus	Common Planigale	V2					X		
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	V2					X		
Potorous tridactylus	Long-nosed Potoroo	V2					X		
Phascolarctos cinereus	Koala	V2					X		
Myotis adversus	Large-footed Myotis	V2				X		X	
	Eastern Bloosom Bat					X banksias on dunes	X		
Miniopterus australis	Little Bent-wing Bat	V2					X		
Miniopterus schreibersii	Common Bent-wing Bat	V2					X		
Chalinolobus nigrogriseus	Hoary Wattled Bat	V2					X		
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat	V2					X		
Scoteanax rueppelli	Greater Broad-nosed Bat	V2					X		
Nyctophilus bifax	Eastern Long-eared Bat	V2					X		
Pteropus poliocephalus	Grey-headed Flying Fox	V2	V				X		
Megaptera novaeangilae	Humpback Whale	V2				X			
Frogs									
Crinia tinnula	Wallum Froglet	V2					X	X	
Litoria olonburensis	Wallum Sedge Frog	V2	V					X	
Reptiles									
Caretta caretta	Loggerhead Turtle	E1				X			
Chelonia mydas	Green Turtle	V2				X			
Invertebrates									
Thersites mitchellae	Mitchells' Rainforest Snail	E1	Critically Endangered				X		
Petalura gigantea	Giant Dragonfly	E1				X		X	
Argyreus hyperbius	Australian Fritillary Butterfly	E1					X		
Fish									
Carcharias taurus	Grey Nurse Shark			E 4					
Maccullochella ikei	Eastern Freshwater Cod			E 4					
Nannoperca oxleyana	Oxleyan Pygmy Perch			E 4					
Carcharodon carcharias	Great White Shark			V 5					
Flora									
Acronychia bauerlenii	Byron Bay Acronychia				3RC-		X		X
Acronychia littoralis	Scented Acronychia	E	E		3ECi		X		X
Archidendron hendersonii	White Laceflower	V					X		X
Archidendron muellerianum	Veiny Laceflower				3RCa		X		X
Callerya australis	Blunt-leaved Wisteria				3RC-+		X		X
Chamaesyce psammogeton	Sand Spurge	E				X			X
Cordyline congesta	Tooth-leaved Palm Lily				2RC-		X		X
Cryptocarya foetida	Stinking Cryptocarya	V	V		3VCi		X		X
Elaeocarpus williamsianus	Hairy Quandong	E	E		2ECi		X		X
Endiandra floydii	Crystal Creek Walnut	E	E		2VC-		X		X
Endiandra hayesii	Rusty Rose Walnut	V	V		3VC-		X		X
Endiandra muelleri ssp. *bracteata*	Green-leaved Rose Walnut	E					X		X
Floydia praelta	Ball Nut	V	V		3VC-		X		X
Macadamia tetraphylla	Rough-shelled Bush Nut	V	V		2VC-		X		X
Niemeyera whitei	Rusty Plum						X		X
Owenia cepiodora	Onion Cedar	V	V		2VCi		X		X
Phaius australis	Swamp Orchid	E	E		3VCa		X		X
Pterostylis nigricans	Dark Greenhood	V			3V		X		X
Syzygium hodgkinsoniae	Red Lilly Pilly	V	V		3VC-		X		X
Syzygium moorei	Durobby	V	V		2VCi		X		X
Tinospora tinosporoides	Arrowhead Vine	V	V		3RC-		X		X
Xylosma terra-reginae	Xylosma	E					X		X

Species	Common Name	TSC Act Code	EPBC Act Code	FM Act Code	ROTAP	Recorded in Study Region	Preferred Habitat	Potential Habitat Impacts Associated with Artificial Entrance Opening	Reference
Birds									
Sterna albifrons	Little Tern	E1				*	Nest on beaches at or near estuary openings and generally forage between the high and low water mark.		*Best practice guidelines* Managing threatened beach-nesting shorebirds. Department of
Haematopus longirostris	Pied Oystercatcher	V2				*	Nest on beaches and in estuaries and forage between the high and low water mark.		*Best practice guidelines* Managing threatened beach-nesting shorebirds. Department of Environment and Climate Change NSW.
Haematopus fuliginosus	Sooty Oystercatcher	V2					Nest on beaches and in estuaries and forage between the high and low water mark.		*Best practice guidelines* Managing threatened beach-nesting shorebirds. Department of Environment and Climate Change NSW.
Esacus neglectus	Beach-stone Curlew	E1					Nest on beaches and in estuaries and forage between the high and low water mark.		*Best practice guidelines* Managing threatened beach-nesting shorebirds. Department of Environment and Climate Change NSW.
Pandion haliaetus	Osprey	V2					Forages over estuarine and inshore marine waters and coastal rivers, and nests in tall (usually dead or dead-topped) trees in coastal habitats from open woodland to open forest, within 1-2 km of water.		NSW SCIENTIFIC COMMITTEE Eastern Osprey *Pandion cristatus.* Review of Current Information in NSW. June 2009
Ansranus semipalmata	Magpie Goose	V2					Mainly found in shallow wetlands (less than 1 m deep) with dense growth of rushes or sedges		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10056.
Burhinus grallarius	Bush Stone-curlew	E1				*	Broad habitat usage. In estuarine areas, this species has been recorded in *Casuarina glauca* groves, saltmarsh, mangroves and *Melaleuca quinquinervia* woodlands.		Department of Environment and Conservation NSW 2006, *NSW Recovery Plan for the Bush Stone-curlew Burhinus grallarius. DEC, Sydney.*
Amaurornis olivaceus	Bush Hen	V2					Partly terrestrial species with wide habitat tolerances. Prefers dense vegetation on margins of freshwater creeks, rivers and wetlands, margins of rainforest to forest regrowth, rank grass or reeds, weed thickets and farmland.		NSW SCIENTIFIC COMMITTEE Bush-hen *Amaurornis olivaceus.* Review of Current Information in NSW. August 2008
Ixobrychus flavicollis	Black Bittern	V2				*	Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water in flooded grassland, forest, woodland, rainforest and mangroves.		Threatened Species Informations. NSW NPWS. September 1999.
Botaurus poiciloptilus	Australasian Bittern	V2				*	Inhabits temperate freshwater wetlands and occasionally estuarine reedbeds. The species favours permanent shallow waters, or edges of pools and waterways, with tall, dense vegetation such as sedges, rushes and reeds on muddy or peaty substrate		Species profile at http://www.environment.nsw.gov.au/determinations/austbitternFD.htm
Lophoictinia isura	Square-tailed Kite	V2				*	Inhabits coastal and subcoastal, eucalypt-dominated open forests and woodlands, coastal heathlands, and often near openings and edges of forest.		NSW SCIENTIFIC COMMITTEE Square-tailed Kite *Lophoictinia isura.* Review of Current Information in NSW. June 2009
Tyto capensis	Grass Owl	V2					Found in areas of tall grass, including grass tussocks, in swampy areas, grassy plains, swampy heath, and in cane grass or sedges on flood plains. Always breeds on the ground. Nests are found in trodden grass, and often accessed by tunnels through vegetation.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10819
Tyto novaehollandiaea	Masked Owl	V2					Eucalypt forests and woodlands on the coast.		Department of Environment and Conservation (NSW) (2006). NSW Recovery Plan for the Large Forest Owls: Powerful Owl (Ninox strenua), Sooty Owl (Tyto tenebricosa) and asked Owl (Tyto novaehollandiae) DEC, Sydney.
Monarcha leucotis	White-eared Monarch	V2					Occur in littoral rainforest, dry sclerophyll forests, swamp forest and regrowth. Prefer ecotone between rainforest and open areas.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10540
Pomatostomus temporalis temporalis	Grey-crowned Babbler	V2					Inhabits open Box Woodlands on alluvial plains.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10660
Ptilinopus regina	Rose-crowned Fruit-dove	V2				*	Occur mainly in sub-tropical and dry rainforest and occasionally in moist eucalypt forest and swamp forest, where fruit is plentiful.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10708
Ptilinopus superbus	Superb Fruit-dove	V2					Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10709
Mammals									
Planigale maculatus	Common Planigale	V2					Inhabit rainforest, eucalypt forest, heathland, marshland, grassland and rocky areas where there is surface cover, and usually close to water.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10635
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	V2					Found in low numbers in heathland but most common in dense, wet heath and swamps. Optimal habitat is vigorously regenerating heathland.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10687
Potorous tridactylus	Long-nosed Potoroo	V2				*	Inhabits coastal heaths and dry and wet sclerophyll forests.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10662
Phascolarctos cinereus	Koala	V2				*	Inhabits eucalypt forest and woodland.		Threatened Species Information: Koala. NSW NPWS, September 1999.
Myotis adversus	Large-footed Myotis	V2					Roosts close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage and forages over streams and pools.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10549
Syconycteris australis	Eastern Blossom Bat	V2				*	Core foraging undertaken in Banksia woodlands, Melaleuca and swamp forests, while roosting occurs in littoral rainforests.		Byron Shire Threatened Species Profile Eastern Blossom Bat - *Syconycteris australis January 2010.*
Miniopterus australis	Little Bent-wing Bat	V2				*	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, *Melaleuca* swamps, dense coastal forests and banksia scrub. Roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10533
Miniopterus schreibersii	Common Bent-wing Bat	V2					Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Hunt in forested areas.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10534
Chalinolobus nigrogriseus	Hoary Wattled Bat	V2					Occurs in dry open eucalypt forests, favouring forests dominated by Spotted Gum, boxes and ironbarks, and heathy coastal forests where Red Bloodwood and Scribbly Gum are common.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10158
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat	V2					Forages in most habitats across its very wide range, with and without trees. Roosts in tree hollows and buildings and mammal burrows.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10741
Scoteanax rueppelli	Greater Broad-nosed Bat	V2				*	Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Usually roosts in tree hollows, it has also been found in buildings.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10748
Nyctophilus bifax	Eastern Long-eared Bat	V2					Lowland subtropical rainforest and wet and swamp eucalypt forest, extending into adjacent moist eucalypt forest. Coastal rainforest and patches of coastal scrub are particularly favoured.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10567
Pteropus poliocephalus	Grey-headed Flying Fox	V2	V			*	Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located close to water, in vegetation with a dense canopy.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10697
Megaptera novaeangliae	Humpback Whale	V2					They are regularly observed in NSW waters in June and July, on northward migration and October and November, on southward migration		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10914

Species	Common Name	TSC Act Code	EPBC Act Code	FM Act Code	ROTAP	Recorded in Study Region	Preferred Habitat	Potential Habitat Impacts Associated with Artificial Entrance Opening	Reference
Frogs									
Crinia tinnula	Wallum Froglet	V2				*	Found in a wide range of habitats, usually associated with acidic swamps on coastal sand plains. They occur in sedgelands, wet heathlands, paperbark swamps and drainage lines within other vegetation communities. They will also persist in disturbed areas. Breeds in swamps with permanent water as well as shallow ephemeral pools and drainage ditches.		Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10183
Litoria olonburensis	Wallum Sedge Frog	V2	V			*	Paperbark swamps and sedge swamps of *Banksia* dominated lowland heath ecosystem characterised by acidic waterbodies (wallum).		Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10489
Reptiles									
Caretta caretta	Loggerhead Turtle	E1					Lays eggs on beach foredunes during summer and forages all year in marine waters.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10146
Chelonia mydas	Green Turtle	V2					Lays eggs on beach foredunes during summer and forages all year in marine waters. May occur in estuaries during warmer months.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10901
Invertebrates									
Thersites mitchellae	Mitchells' Rainforest Snail	E1	Critically Endangered				Remnant areas of lowland subtropical rainforest and swamp forest on alluvial soils. Slightly higher ground around the edges of wetlands with palms and fig trees are particularly favoured habitat.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10801
Petalura gigantea	Giant Dragonfly	E1					Live in permanent swamps and bogs with some free water and open vegetation.		Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10600
Argyreus hyperbius	Australian Fritillary Butterfly	E1					Found in open swampy coastal habitat and eggs laid on the Native Violet (*Viola betonicifolia*). The food plant occurs in ground level vegetation in swampy areas beneath grasses and mat-rushes (Lomandra spp.).		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10064
Fish									
Carcharias taurus	Grey Nurse Shark		Critically Endangered	E 4			Marine waters along the length of the NSW coast.		http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0016/208213/PD-Grey-Nurse-Shark.pdf
Maccullochella ikei	Eastern Freshwater Cod		?	E 4			Clear rocky streams and rivers with low flow velocity and abundant instream cover of rocks, timber or tussocks. Associated with deeper parts of the river near cover, especially around rocky islands, large boulders and pools in fast-flowing water. Large woody debris and rocky overhangs may provide shelter and important spawning sites).		http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=26170#habitat
Nannoperca oxleyana	Oxleyan Pygmy Perch		?	E 4			Specific habitat requirements include fresh, acidic waters and abundant aquatic vegetation. Generally occur in acidic freshwater systems which drain through sandy coastal *Banksia spp* -dominated heath or wallum vegetation assemblages. Have also been recorded from an intermediate eucalypt forest/heath community, rainforest/melaleuca swamp and from among saltrushes in an estuarine creek with high salt levels.		http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64468#habitat
Carcharodon carcharias	Great White Shark		V	V 5			Marine waters along the length of the NSW coast.		http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/208249/FR2-great-white-shark.pdf
Flora									
Acronychia bauerlenii	Byron Bay Acronychia				3RC-		Grows in subtropical and warm-temperate rainforest in the Lismore to Byron Bay to the McPherson Range area. Also recorded from Iluka.		http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Acronychia~baeuerlenii
Acronychia littoralis	Scented Acronychia	E	E		3ECi		Grows in littoral rainforest on sand		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10030
Allocasuarina defungens	Dwarf Heath Casuarina	E	E			*	Grows mainly in tall heath on sand, but can also occur on clay soils and sandstone. Also extends onto exposed nearby-coastal hills or headlands adjacent to sandplains.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10037
Archidendron hendersonii	White Laceflower	V				*	In New South Wales is restricted to the lowlands of the Richmond and Tweed catchments found in riverine and lowland subtropical rainforest		Species profile at http://www.environment.nsw.gov.au/determinations/ArchidendronHendersoniiVulSpListing.htm
Archidendron muellerianum	Veiny Laceflower				3RCa		Grows chiefly in subtropical and littoral rainforest, north from Alstonville district.		http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Archidendron~muellerianum
Callerya australis	Blunt-leaved Wisteria				3RC-+		Grows in warmer rainforest on the coast and adjacent ranges, not common; north from Port Macquarie		http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Callerya~australis
Chamaesyce psammogeton	Sand Spurge	E					Grows on fore-dunes, pebbly strandlines and exposed headlands, often with Spinifex (*Spinifex sericeus*) and Prickly Couch (*Zoysia macrantha*)		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10160
Cordyline congesta	Tooth-leaved Palm Lily				2RC-		On coastal lowlands north of the Clarence River.		http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Cordyline~congesta
Cryptocarya foetida	Stinking Cryptocarya	V	V		3VCi	*	Found in littoral rainforest, usually on sandy soils, but mature trees are also known on basalt soils.		Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10186
Elaeocarpus williamsianus	Hairy Quandong	E	E		2ECi		Subtropical to warm temperate rainforest, including regrowth areas where it has apparently regrown from root suckers after clearing. Soils are derived from metasediments.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10262
Endiandra floydii	Crystal Creek Walnut	E	E		2VC-		Warm temperate or subtropical rainforest with Brush Box overstorey, and in regrowth rainforest and Camphor Laurel forest.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10269
Endiandra hayesii	Rusty Rose Walnut	V	V		3VC-		Sheltered moist gullies in lowland subtropical and warm temperate rainforest on alluvium or basaltic soils.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10270
Endiandra muelleri ssp. bracteata	Green-leaved Rose Walnut	E				*	Subtropical rainforest or wet eucalypt forest, chiefly at lower altitudes.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10271
Floydia praealta	Ball Nut	V	V		3VC-		Inhabits floristically-rich, tall, closed riverine to subtropical rainforest or coastal scrub.		http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=15762#habitat
Geodorum densiflorum	Pink Nodding Orchid	E				*	Dry eucalypt forest and coastal swamp forest at lower altitudes, often on sand.		Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10349
Macadamia tetraphylla	Rough-shelled Bush Nut	V	V		2VC-		Subtropical rainforest and complex notophyll vineforest, at the margins of these forests and in mixed sclerophyll forest.		http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=15762#habitat
Niemeyera whitei	Rusty Plum	V			3RCa		Rainforest and the adjacent understorey of moist eucalypt forest.		Specie profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10044
Owenia cepiodora	Onion Cedar	V	V		2VCi		Subtropical and dry rainforest on or near soils derived from basalt.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10579
Phaius australis	Swamp Orchid	E	E		3VCa		Swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas.		Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10610
Pterostylis nigricans	Dark Greenhood	V			3V	*	Coastal heathland with Heath Banksia (*Banksia ericifolia*), and lower-growing heath with lichen-encrusted and relatively undisturbed soil surfaces, on sandy soils.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10703
Syzygium hodgkinsoniae	Red Lilly Pilly	V	V		3VC-		Usually found in riverine and subtropical rainforest on rich alluvial or basaltic soils.		Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10792
Syzygium moorei	Durobby	V	V		2VCi	*	Found in subtropical and riverine rainforest at low altitude. Often occurs as isolated remnant paddock trees.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10793
Tinospora tinosporoides	Arrowhead Vine	V	V		3RC-		Wetter subtropical rainforest, including littoral rainforest, on fertile, basalt-derived soils.		Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10809
Xylosma terrae-reginae	Xylosma	E				*	Littoral and subtropical rainforest on coastal sands or soils derived from metasediments		Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10846

Species	Common Name	Preferred Habitat	Potential Habitat in Study Area	Reference	Recorded in Study Region
Birds					
Amaurornis olivaceus	Bush Hen	Partly terrestrial species with wide habitat tolerances. Prefers dense vegetation on margins of freshwater creeks, rivers and wetlands, margins of rainforest to forest regrowth, rank grass or reeds, weed thickets and farmland.	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland / Rainforest /Disturbed Communities and other Bushland	NSW SCIENTIFIC COMMITTEE Bush-hen *Amaurornis olivaceus.* Review of Current Information in NSW. August 2008	
Ansranus semipalmata	Magpie Goose	Mainly found in shallow wetlands (less than 1 m deep) with dense growth of rushes or sedges	Swamp Sclerophyll Forest and Woodland / Sedgeland–Fernland-Grassland	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10056.	
Botaurus poiciloptilus	Australasian Bittern	Inhabits temperate freshwater wetlands and occasionally estuarine reedbeds. The species favours permanent shallow waters, or edges of pools and waterways, with tall, dense vegetation such as sedges, rushes and reeds on muddy or peaty substrate	Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland–Fernland-Grassland	Species profile at http://www.environment.nsw.gov.au/determinations/austbitternFD.htm	*
Burhinus grallarius	Bush Stone-curlew	Broad habitat usage. In estuarine areas, this species has been recorded in *Casuarina glauca* groves, saltmarsh, mangroves and *Melaleuca quinquinervia* woodlands.	Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland –Fernland-Grassland	Department of Environment and Conservation NSW 2006, *NSW Recovery Plan for the Bush Stone-curlew Burhinus grallarius. DEC, Sydney.*	*
Calidris tenuirostris	Great Knot	Occurs within sheltered, coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons. Often recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms.	Beach / Mangrove Forest and Woodland / Saltmarsh	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10128	
Ephippiorhynchus asiaticus	Black-necked Stork	Mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands. They also forage within or around estuaries and along intertidal shorelines, such as saltmarshes, mudflats and sandflats, and mangrove vegetation.	Heathland- Shrubland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland –Fernland-Grassland	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10275	
Erythrotriorchis radiatus	Red Goshawk	Inhabit open woodland and forest, preferring a mosaic of vegetation types, a large population of birds as a source of food, and permanent water, and are often found in riparian habitats along or near watercourses or wetlands. In NSW, preferred habitats include mixed subtropical rainforest, *Melaleuca* swamp forest and riparian *Eucalyptus* forest of coastal rivers.	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10279	
Esacus neglectus	Beach-stone Curlew	Nest on beaches and in estuaries and forage between the high and low water mark.	Beach / Mangrove Forest and Woodland / Saltmarsh	*Best practice guidelines* Managing threatened beach-nesting shorebirds. Department of Environment and Climate Change NSW.	
Haematopus fuliginosus	Sooty Oystercatcher	Nest on beaches and in estuaries and forage between the high and low water mark.	Beach / Mangrove Forest and Woodland / Saltmarsh	*Best practice guidelines* Managing threatened beach-nesting shorebirds. Department of Environment and Climate Change NSW.	
Haematopus longirostris	Pied Oystercatcher	Nest on beaches and in estuaries and forage between the high and low water mark.	Beach / Mangrove Forest and Woodland / Saltmarsh	*Best practice guidelines* Managing threatened beach-nesting shorebirds. Department of Environment and Climate Change NSW.	*
Ixobrychus flavicollis	Black Bittern	Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water in flooded grassland, forest, woodland, rainforest and mangroves.	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland –Fernland-Grassland / Rainforest	Threatened Species Informations. NSW NPWS. September 1999.	*
Limosa limosa	Black-tailed Godwit	Found along the coast on sand spits, lagoons and mudflats. However, the species also occurs inland on mudflats and in those portions of large muddy lakes and swamps (freshwater or brackish) where the water is less than 10 cm deep during suitable conditions (i.e. receding water). Individuals have also been observed in wet meadows and sewerage treatment works.	Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland –Fernland-Grassland	NSW NPWS Threatened Species Profile Black-tailed Godwit. September 1999.	
Lophoictinia isura	Square-tailed Kite	Inhabits coastal and subcoastal, eucalypt-dominated open forests and woodlands, coastal heathlands, and often near openings and edges of forest.	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Rainforest	NSW SCIENTIFIC COMMITTEE Square-tailed Kite *Lophoictinia isura.* Review of Current Information in NSW. June 2009	*
Monarcha leucotis	White-eared Monarch	Occur in littoral rainforest, dry sclerophyll forests, swamp forest and regrowth. Prefer ecotone between rainforest and open areas.	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10540	
Pandion haliaetus	Osprey	Forages over estuarine and inshore marine waters and coastal rivers, and nests in tall (usually dead or dead-topped) trees in coastal habitats from open woodland to open forest, within 1-2 km of water.	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / RainforestBushland	NSW SCIENTIFIC COMMITTEE Eastern Osprey *Pandion cristatus.* Review of Current Information in NSW. June 2009	
Pomatostomus temporalis temporalis	Grey-crowned Babbler	Inhabits open Box Woodlands on alluvial plains.	Moist to Dry Sclerophyll Forest and WoodlandWater	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10660	
Ptilinopus regina	Rose-crowned Fruit-dove	Occur mainly in sub-tropical and dry rainforest and occasionally in moist eucalypt forest and swamp forest, where fruit is plentiful.	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10708	*
Ptilinopus superbus	Superb Fruit-dove	Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees.	Moist to Dry Sclerophyll Forest and Woodland / Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10709	
Sterna albifrons	Little Tern	Nest on beaches at or near estuary openings and generally forage between the high and low water mark.	Beach / Mangrove Forest and Woodland / Saltmarsh	*Best practice guidelines* Managing threatened beach-nesting shorebirds. Department of Environment and Climate Change NSW.	*

Species	Common Name	Preferred Habitat	Potential Habitat in Study Area	Reference	Recorded in Study Region
Todiramphus chloris	Collared Kingfisher	Restricted to mangrove associations of estuaries, inlets, sheltered bays and islands, and the tidal flats and littoral zone bordering mangroves. They sometimes occur in terrestrial forests or woodlands bordering mangroves, where they will nest in holes in trees or in arboreal termitaria.	Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10810	
Tyto capensis	Grass Owl	Found in areas of tall grass, including grass tussocks, in swampy areas, grassy plains, swampy heath, and in cane grass or sedges on flood plains. Always breeds on the ground. Nests are found in trodden grass, and often accessed by tunnels through vegetation.	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland / Disturbed Communities	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10819	
Tyto novaehollandiaea	Masked Owl	Eucalypt forests and woodlands on the coast.	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland	Department of Environment and Conservation (NSW) (2006). NSW Recovery Plan for the Large Forest Owls: Powerful Owl (Ninox strenua), Sooty Owl (Tyto tenebricosa) and asked Owl (Tyto novaehollandiae) DEC, Sydney.	
Mammals					
Chalinolobus nigrogriseus	Hoary Wattled Bat	Occurs in dry open eucalypt forests, favouring forests dominated by Spotted Gum, boxes and ironbarks, and heathy coastal forests where Red Bloodwood and Scribbly Gum are common.	Moist to Dry Sclerophyll Forest and Woodland	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10158	
Megaptera novaeangliae	Humpback Whale	They are regularly observed in NSW waters in June and July, on northward migration and October and November, on southward migration	Marine Open Water	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10914	
Miniopterus australis	Little Bent-wing Bat	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, *Melaleuca* swamps, dense coastal forests and banksia scrub. Roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats.	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10533	*
Miniopterus schreibersii	Common Bent-wing Bat	Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Hunt in forested areas.	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10534	
Myotis adversus	Large-footed Myotis	Roosts close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage and forages over streams and pools.	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10549	
Nyctophilus bifax	Eastern Long-eared Bat	Lowland subtropical rainforest and wet and swamp eucalypt forest, extending into adjacent moist eucalypt forest. Coastal rainforest and patches of coastal scrub are particularly favoured.	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10567	
Phascolarctos cinereus	Koala	Inhabits eucalypt forest and woodland.	Moist to Dry Sclerophyll Forest and Woodland	Threatened Species Information: Koala. NSW NPWS, September 1999.	*
Planigale maculatus	Common Planigale	Inhabit rainforest, eucalypt forest, heathland, marshland, grassland and rocky areas where there is surface cover, and usually close to water.	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland / Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10635	
Potorous tridactylus	Long-nosed Potoroo	Inhabits coastal heaths and dry and wet sclerophyll forests.	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10662	*
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	Found in low numbers in heathland but most common in dense, wet heath and swamps. Optimal habitat is vigorously regenerating heathland.	Heathland- Shrubland / Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10687	
Pteropus poliocephalus	Grey-headed Flying Fox	Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located close to water, in vegetation with a dense canopy.	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland –Fernland-Grassland / Rainforest / Disturbed Communities	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10697	*
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat	Forages in most habitats across its very wide range, with and without trees. Roosts in tree hollows and buildings and mammal burrows.	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland –Fernland-Grassland / Rainforest / Disturbed Communities	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10741	
Scoteanax rueppelli	Greater Broad-nosed Bat	Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Usually roosts in tree hollows, it has also been found in buildings.	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland –Fernland-Grassland / Rainforest / Disturbed Communities	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10748	*
Syconycteris australis	Eastern Blossom Bat	Core foraging undertaken in Banksia woodlands, Melaleuca and swamp forests, while roosting occurs in littoral rainforests.	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland –Fernland-Grassland / Rainforest	Byron Shire Threatened Species Profile Eastern Blossom Bat - *Syconycteris australis January 2010.*	*
Frogs					
Crinia tinnula	Wallum Froglet	Found in a wide range of habitats, usually associated with acidic swamps on coastal sand plains. They occur in sedgelands, wet heathlands, paperbark swamps and drainage lines within other vegetation communities. They will also persist in disturbed areas. Breeds in swamps with permanent water as well as shallow ephemeral pools and drainage ditches.	Heathland- Shrubland / Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10183	*
Litoria olongburensis	Wallum Sedge Frog	Paperbark swamps and sedge swamps of *Banksia* dominated lowland heath ecosystem characterised by acidic waterbodies (wallum).	Heathland- Shrubland / Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10489	*
Reptiles					

Species	Common Name	Preferred Habitat	Potential Habitat in Study Area	Reference	Recorded in Study Region
Caretta caretta	Loggerhead Turtle	Lays eggs on beach foredunes during summer and forages all year in marine waters.	Beach / Marine Open Water	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10146	
Chelonia mydas	Green Turtle	Lays eggs on beach foredunes during summer and forages all year in marine waters. May occur in estuaries during warmer months.	Beach / Estuarine Open Water / Marine Open Water	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10901	
Invertebrates					
Argyreus hyperbius	Australian Fritillary Butterfly	Found in open swampy coastal habitat and eggs laid on the Native Violet (*Viola betonicifolia*). The food plant occurs in ground level vegetation in swampy areas beneath grasses and mat-rushes (Lomandra spp.).	Swamp Sclerophyll Forest and Woodland /Sedgeland –Fernland-Grassland	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10064	
Petalura gigantea	Giant Dragonfly	Live in permanent swamps and bogs with some free water and open vegetation.	Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland	Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10600	
Thersites mitchellae	Mitchells' Rainforest Snail	Remnant areas of lowland subtropical rainforest and swamp forest on alluvial soils. Slightly higher ground around the edges of wetlands with palms and fig trees are particularly favoured habitat.	Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland / Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10801	
Fish					
Carcharias taurus	Grey Nurse Shark	Marine waters along the length of the NSW coast.	Marine Open Water	http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0016/208213/PD-Grey-Nurse-Shark.pdf	
Carcharodon carcharias	Great White Shark	Marine waters along the length of the NSW coast.	Marine Open Water	http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/208249/FR2-great-white-shark.pdf	
Maccullochella ikei	Eastern Freshwater Cod	Clear rocky streams and rivers with low flow velocity and abundant instream cover of rocks, timber or tussocks. Associated with deeper parts of the river near cover, especially around rocky islands, large boulders and pools in fast-flowing water. Large woody debris and rocky overhangs may provide shelter and important spawning sites).	Estuarine Open Water	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=26170#habitat	
Nannoperca oxleyana	Oxleyan Pygmy Perch	Specific habitat requirements include fresh, acidic waters and abundant aquatic vegetation. Generally occur in acidic freshwater systems which drain through sandy coastal *Banksia spp* -dominated heath or wallum vegetation assemblages. Have also been recorded from an intermediate eucalypt forest/heath community, rainforest/melaleuca swamp and from among saltrushes in an estuarine creek with high salt levels.	Heathland- Shrubland / Swamp Sclerophyll Forest and Woodland	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64468#habitat	
Flora					
Acronychia bauerlenii	Byron Bay Acronychia	Grows in subtropical and warm-temperate rainforest in the Lismore to Byron Bay to the McPherson Range area. Also recorded from Iluka.	Rainforest	http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Acronychia~baeuerlenii	
Acianthus amplexicaulis	Terrestrial Orchid	Locally common in littoral rainforest and sheltered locations in dry sclerophyll forest on sand.			
Acronychia littoralis	Scented Acronychia	A range of littoral rainforest communities on sand and r	Rainforest	Baker (2009) and Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10030	
Allocasuarina defungens	Dwarf Heath Casuarina	Grows mainly in tall heath on sand, but can also occur on clay soils and sandstone. Also extends onto exposed nearby-coastal hills or headlands adjacent to sandplains.	Heathland- Shrubland	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10037	*
Archidendron hendersonii	White Laceflower	In New South Wales is restricted to the lowlands of the Richmond and Tweed catchments found in riverine and lowland subtropical rainforest	Rainforest	Species profile at http://www.environment.nsw.gov.au/determinations/ArchidendronHendersoniiVulSpListing.htm	*
Archidendron muellerianum	Veiny Laceflower	Grows chiefly in subtropical and littoral rainforest, north from Alstonville district.	Rainforest	http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Archidendron~muellerianum	
Callerya australis	Blunt-leaved Wisteria	Grows in warmer rainforest on the coast and adjacent ranges, not common; north from Port Macquarie	Rainforest	http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Callerya~australis	
Chamaesyce psammogeton	Sand Spurge	Grows on fore-dunes, pebbly strandlines and exposed headlands, often with Spinifex (*Spinifex sericeus*) and Prickly Couch (*Zoysia macrantha*)	Beach	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10160	
Cordyline congesta	Tooth-leaved Palm Lily	On coastal lowlands north of the Clarence River.	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland / Rainforest	http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Cordyline~congesta	
Cryptocarya foetida	Stinking Cryptocarya	Found in littoral rainforest, usually on sandy soils, but mature trees are also known on basalt soils.	Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10186	*
Diuris byronensis	Byron Bay Diuris	Restricted to graminoid clay heath and associated woodlands and forests on meta-sedimentary clays.	Heathland- Shrubland	Baker (2009).	
Drynaria rigidula	Basket fern	Only recorded from Grey Ironbark wet sclerophyll forest on meta-sedimentary clays.	Moist Sclerophyll Forest	Baker (2009).	
Elaeocarpus williamsianus	Hairy Quandong	Subtropical to warm temperate rainforest, including regrowth areas where it has apparently regrown from root suckers after clearing. Soils are derived from metasediments.	Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10262	
Endiandra floydii	Crystal Creek Walnut	Warm temperate or subtropical rainforest with Brush Box overstorey, and in regrowth rainforest and Camphor Laurel forest.	Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10269	
Endiandra hayesii	Rusty Rose Walnut	Sheltered moist gullies in lowland subtropical and warm temperate rainforest on alluvium or basaltic soils.	Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10270	

Species	Common Name	Preferred Habitat	Potential Habitat in Study Area	Reference	Recorded in Study Region
Endiandra muelleri ssp. *bracteata*	Green-leaved Rose Walnut	Subtropical rainforest or wet eucalypt forest, chiefly at lower altitudes.	Moist to Dry Sclerophyll Forest and Woodland / Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10271	*
Floydia praealta	Ball Nut	Inhabits floristically-rich, tall, closed riverine to subtropical rainforest or coastal scrub.	Rainforest	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=15762#habitat	
Geodorum densiflorum	Pink Nodding Orchid	Dry eucalypt forest and coastal swamp forest at lower altitudes, often on sand.	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10349	*
Macadamia tetraphylla	Rough-shelled Bush Nut	Subtropical rainforest and complex notophyll vineforest, at the margins of these forests and in mixed sclerophyll forest.	Moist to Dry Sclerophyll Forest and Woodland / Rainforest	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=15762#habitat	
Niemeyera whitei	Rusty Plum	Rainforest and the adjacent understorey of moist eucalypt forest.	Moist to Dry Sclerophyll Forest and Woodland / Rainforest	Specie profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10044	
Owenia cepiodora	Onion Cedar	Subtropical and dry rainforest on or near soils derived from basalt.	Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10579	
Phaius australis	Swamp Orchid	Swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas.	Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10610	
Pterostylis nigricans	Dark Greenhood	Coastal heathland with Heath Banksia (*Banksia ericifolia*), and lower-growing heath with lichen-encrusted and relatively undisturbed soil surfaces, on sandy soils.	Heathland- Shrubland	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10703	*
Syzygium hodgkinsoniae	Red Lilly Pilly	Usually found in riverine and subtropical rainforest on rich alluvial or basaltic soils.	Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10792	
Syzygium moorei	Durobby	Found in subtropical and riverine rainforest at low altitude. Often occurs as isolated remnant paddock trees.	Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10793	*
Tinospora tinosporoides	Arrowhead Vine	Wetter subtropical rainforest, including littoral rainforest, on fertile, basalt-derived soils.	Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10809	
Xylosma terrae-reginae	Xylosma	Littoral and subtropical rainforest on coastal sands or soils derived from metasediments	Rainforest	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10846	*

Species	Common Name	Potential Habitat in Study Area
Birds		
Amaurornis olivaceus	Bush Hen	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland / Rainforest /Disturbed Communities and other Bushland
Ansranus semipalmata	Magpie Goose	Swamp Sclerophyll Forest and Woodland / Sedgeland–Fernland-Grassland
Botaurus poiciloptilus	Australasian Bittern	Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland–Fernland-Grassland
Burhinus grallarius	Bush Stone-curlew	Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland –Fernland-Grassland
Calidris tenuirostris	Great Knot	Beach / Mangrove Forest and Woodland / Saltmarsh
Ephippiorhynchus asiaticus	Black-necked Stork	Heathland- Shrubland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland –Fernland-Grassland
Erythrotriorchis radiatus	Red Goshawk	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Rainforest
Esacus neglectus	Beach-stone Curlew	Beach / Mangrove Forest and Woodland / Saltmarsh
Haematopus fuliginosus	Sooty Oystercatcher	Beach / Mangrove Forest and Woodland / Saltmarsh
Haematopus longirostris	Pied Oystercatcher	Beach / Mangrove Forest and Woodland / Saltmarsh
Ixobrychus flavicollis	Black Bittern	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland –Fernland-Grassland / Rainforest
Limosa limosa	Black-tailed Godwit	Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland –Fernland-Grassland
Lophoictinia isura	Square-tailed Kite	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Rainforest
Monarcha leucotis	White-eared Monarch	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Rainforest
Pandion haliaetus	Osprey	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / RainforestBushland
Pomatostomus temporalis temporalis	Grey-crowned Babbler	Moist to Dry Sclerophyll Forest and WoodlandWater
Ptilinopus regina	Rose-crowned Fruit-dove	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Rainforest
Ptilinopus superbus	Superb Fruit-dove	Moist to Dry Sclerophyll Forest and Woodland / Rainforest
Sterna albifrons	Little Tern	Beach / Mangrove Forest and Woodland / Saltmarsh
Todiramphus chloris	Collared Kingfisher	Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland
Tyto capensis	Grass Owl	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland / Disturbed Communities

Species	Common Name	Potential Habitat in Study Area
Tyto novaehollandiaea	Masked Owl	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland
Mammals		
Chalinolobus nigrogriseus	Hoary Wattled Bat	Moist to Dry Sclerophyll Forest and Woodland
Megaptera novaeangliae	Humpback Whale	Marine Open Water
Miniopterus australis	Little Bent-wing Bat	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Rainforest
Miniopterus schreibersii	Common Bent-wing Bat	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Rainforest
Myotis adversus	Large-footed Myotis	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Rainforest
Nyctophilus bifax	Eastern Long-eared Bat	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Rainforest
Phascolarctos cinereus	Koala	Moist to Dry Sclerophyll Forest and Woodland
Planigale maculatus	Common Planigale	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland / Rainforest
Potorous tridactylus	Long-nosed Potoroo	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	Heathland- Shrubland / Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland
Pteropus poliocephalus	Grey-headed Flying Fox	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland –Fernland-Grassland / Rainforest / Disturbed Communities
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland –Fernland-Grassland / Rainforest / Disturbed Communities
Scoteanax rueppelli	Greater Broad-nosed Bat	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland –Fernland-Grassland / Rainforest / Disturbed Communities
Syconycteris australis	Eastern Blossom Bat	Heathland- Shrubland / Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Mangrove Forest and Woodland / Saltmarsh / Sedgeland –Fernland-Grassland / Rainforest
Frogs		
Crinia tinnula	Wallum Froglet	Heathland- Shrubland / Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland
Litoria olongburensis	Wallum Sedge Frog	Heathland- Shrubland / Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland
Reptiles		
Caretta caretta	Loggerhead Turtle	Beach / Marine Open Water
Chelonia mydas	Green Turtle	Beach / Estuarine Open Water / Marine Open Water

Species	Common Name	Potential Habitat in Study Area
Invertebrates		
Argyreus hyperbius	Australian Fritillary Butterfly	Swamp Sclerophyll Forest and Woodland /Sedgeland –Fernland-Grassland
Petalura gigantea	Giant Dragonfly	Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland
Thersites mitchellae	Mitchells' Rainforest Snail	Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland / Rainforest
Fish		
Carcharias taurus	Grey Nurse Shark	Marine Open Water
Carcharodon carcharias	Great White Shark	Marine Open Water
Maccullochella ikei	Eastern Freshwater Cod	Estuarine Open Water
Nannoperca oxleyana	Oxleyan Pygmy Perch	Heathland- Shrubland / Swamp Sclerophyll Forest and Woodland
Flora		
Acronychia bauerlenii	Byron Bay Acronychia	Rainforest
Acianthus amplexicaulis	Terrestrial Orchid	
Acronychia littoralis	Scented Acronychia	Rainforest
Allocasuarina defungens	Dwarf Heath Casuarina	Heathland- Shrubland
Archidendron hendersonii	White Laceflower	Rainforest
Archidendron muellerianum	Veiny Laceflower	Rainforest
Callerya australis	Blunt-leaved Wisteria	Rainforest
Chamaesyce psammogeton	Sand Spurge	Beach
Cordyline congesta	Tooth-leaved Palm Lily	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland / Rainforest
Cryptocarya foetida	Stinking Cryptocarya	Rainforest
Diuris byronensis	Byron Bay Diuris	Heathland- Shrubland
Drynaria rigidula	Basket fern	Moist Sclerophyll Forest
Elaeocarpus williamsianus	Hairy Quandong	Rainforest
Endiandra floydii	Crystal Creek Walnut	Rainforest
Endiandra hayesii	Rusty Rose Walnut	Rainforest
Endiandra muelleri ssp. *bracteata*	Green-leaved Rose Walnut	Moist to Dry Sclerophyll Forest and Woodland / Rainforest
Floydia praealta	Ball Nut	Rainforest
Geodorum densiflorum	Pink Nodding Orchid	Moist to Dry Sclerophyll Forest and Woodland / Swamp Sclerophyll Forest and Woodland
Macadamia tetraphylla	Rough-shelled Bush Nut	Moist to Dry Sclerophyll Forest and Woodland / Rainforest
Niemeyera whitei	Rusty Plum	Moist to Dry Sclerophyll Forest and Woodland / Rainforest
Owenia cepiodora	Onion Cedar	Rainforest
Phaius australis	Swamp Orchid	Swamp Sclerophyll Forest and Woodland / Sedgeland –Fernland-Grassland
Pterostylis nigricans	Dark Greenhood	Heathland- Shrubland
Syzygium hodgkinsoniae	Red Lilly Pilly	Rainforest
Syzygium moorei	Durobby	Rainforest
Tinospora tinosporoides	Arrowhead Vine	Rainforest
Xylosma terrae-reginae	Xylosma	Rainforest

Birds	
Amaurornis olivaceus	Bush Hen
Ansranus semipalmata	Magpie Goose
Botaurus poiciloptilus	Australasian Bittern
Burhinus grallarius	Bush Stone-curlew
Calidris tenuirostris	Great Knot
Ephippiorhynchus asiaticus	Black-necked Stork
Erythrotriorchis radiatus	Red Goshawk
Esacus neglectus	Beach-stone Curlew
Haematopus fuliginosus	Sooty Oystercatcher
Haematopus longirostris	Pied Oystercatcher
Ixobrychus flavicollis	Black Bittern
Limosa limosa	Black-tailed Godwit
Monarcha leucotis	White-eared Monarch
Pandion haliaetus	Osprey
Sterna albifrons	Little Tern
Todiramphus chloris	Collared Kingfisher
Mammals	
Chalinolobus nigrogriseus	Hoary Wattled Bat
Miniopterus australis	Little Bent-wing Bat
Miniopterus schreibersii	Common Bent-wing Bat
Myotis adversus	Large-footed Myotis
Nyctophilus bifax	Eastern Long-eared Bat
Planigale maculatus	Common Planigale
Pseudomys gracilicaudatus	Eastern Chestnut Mouse
Pteropus poliocephalus	Grey-headed Flying Fox
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat
Scoteanax rueppelli	Greater Broad-nosed Bat
Syconycteris australis	Eastern Blossom Bat
Frogs	
Crinia tinnula	Wallum Froglet
Litoria olongburensis	Wallum Sedge Frog
Reptiles	
Caretta caretta	Loggerhead Turtle
Chelonia mydas	Green Turtle
Invertebrates	
Argyreus hyperbius	Australian Fritillary Butterfly
Petalura gigantea	Giant Dragonfly
Thersites mitchellae	Mitchells' Rainforest Snail
Fish	
Maccullochella ikei	Eastern Freshwater Cod
Nannoperca oxleyana	Oxleyan Pygmy Perch
Flora	
Chamaesyce psammogeton	Sand Spurge
Cordyline congesta	Tooth-leaved Palm Lily
Geodorum densiflorum	Pink Nodding Orchid
Phaius australis	Swamp Orchid
Threatened Communities	
Coastal Saltmarsh in the NSW North Cooast Bioregion	
Swamp Sclerophyll Forest on Coastal Floodplains	
Swamp Oak Floodplain Forest in the NSW North Coast Bioregion	
Freshwater Wetlands on Coastal Floodplains	

Amaurornis olivaceus	Bush Hen
Ansranus semipalmata	Magpie Goose
Botaurus poiciloptilus	Australasian Bittern
Burhinus grallarius	Bush Stone-curlew
Calidris tenuirostris	Great Knot
Ephippiorhynchus asiaticus	Black-necked Stork
Erythrotriorchis radiatus	Red Goshawk
Esacus neglectus	Beach-stone Curlew
Haematopus fuliginosus	Sooty Oystercatcher
Haematopus longirostris	Pied Oystercatcher
Ixobrychus flavicollis	Black Bittern
Limosa limosa	Black-tailed Godwit
Monarcha leucotis	White-eared Monarch
Pandion haliaetus	Osprey
Sterna albifrons	Little Tern
Todiramphus chloris	Collared Kingfisher
Chalinolobus nigrogriseus	Hoary Wattled Bat
Miniopterus australis	Little Bent-wing Bat
Miniopterus schreibersii	Common Bent-wing Bat
Myotis adversus	Large-footed Myotis
Nyctophilus bifax	Eastern Long-eared Bat
Phascolarctos cinereus	Koala
Planigale maculatus	Common Planigale
Potorous tridactylus	Long-nosed Potoroo
Pseudomys gracilicaudatus	Eastern Chestnut Mouse
Pteropus poliocephalus	Grey-headed Flying Fox
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat
Scoteanax rueppelli	Greater Broad-nosed Bat
Syconycteris australis	Eastern Blossom Bat
Crinia tinnula	Wallum Froglet
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Geodorum densiflorum	Pink Nodding Orchid
Phaius australis	Swamp Orchid
Coastal Saltmarsh in the NSW North Coast Bioregion	
Swamp Sclerophyll Forest on Coastal Floodplains	
Swamp Oak Floodplain Forest in the NSW North Coast Bioregion	
Freshwater Wetlands on Coastal Floodplains	

Appendix B EPBC Matters Search Results

Australian Government

Department of the Environment

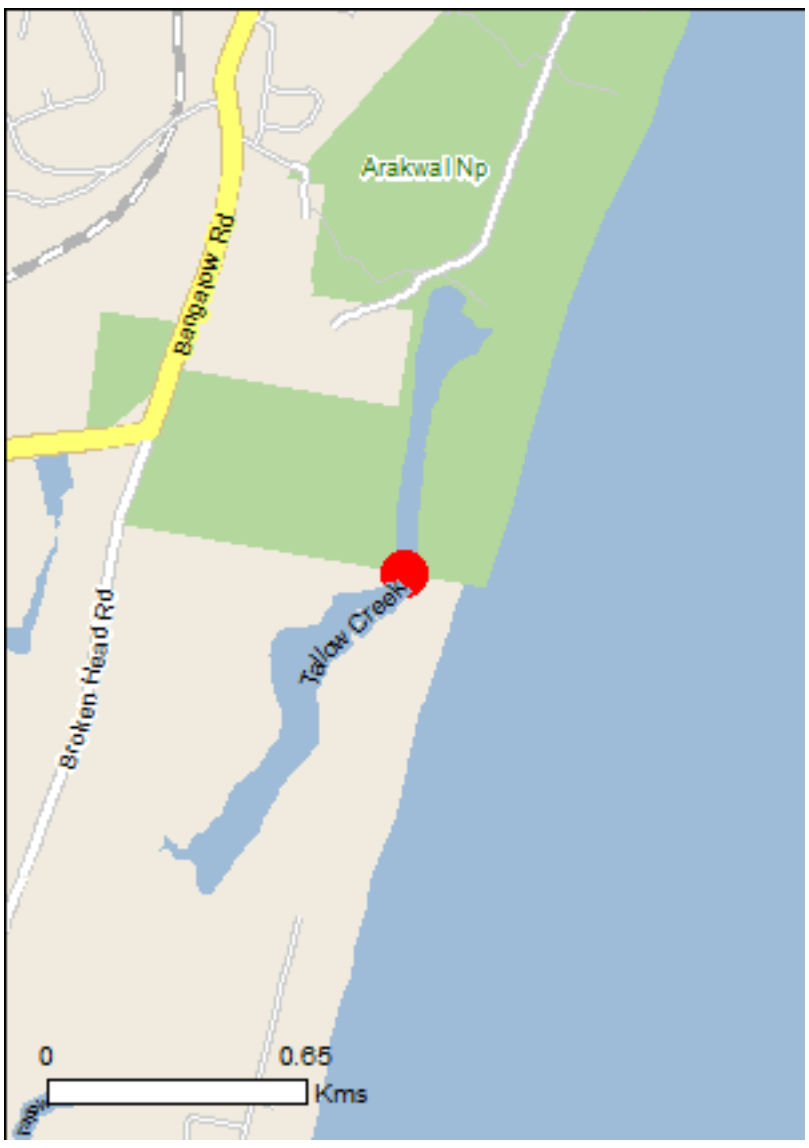
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 27/04/15 10:05:45



Coordinates

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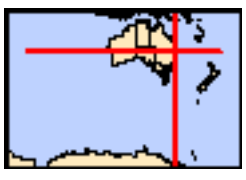

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	33
Listed Migratory Species:	21

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	22
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	1
Invasive Species:	37
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Anthochaera phrygia		
Regent Honeyeater [82338]	Endangered	Species or species habitat likely to occur within area
Botaurus poiciloptilus		
Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Erythrotriorchis radiatus		
Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Lathamus discolor		
Swift Parrot [744]	Endangered	Species or species habitat may occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Turnix melanogaster		
Black-breasted Button-quail [923]	Vulnerable	Species or species habitat may occur within area
Frogs		
Litoria aurea		
Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat may occur within area
Litoria olongburensis		
Wallum Sedge Frog [1821]	Vulnerable	Species or species habitat known to occur within area
Mammals		
Chalinolobus dwyeri		
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area
Dasyurus maculatus maculatus (SE mainland population)		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat likely to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Potorous tridactylus tridactylus		
Long-nosed Potoroo (SE mainland) [66645]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
[Pseudomys novaehollandiae](#) New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat likely to occur within area
[Pteropus poliocephalus](#) Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
[Xeromys myoides](#) Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat likely to occur within area
Other		
[Thersites mitchellae](#) Mitchell's Rainforest Snail [66774]	Critically Endangered	Species or species habitat known to occur within area
Plants		
[Acronychia littoralis](#) Scented Acronychia [8582]	Endangered	Species or species habitat likely to occur within area
[Allocasuarina defungens](#) Dwarf Heath Casuarina [21924]	Endangered	Species or species habitat may occur within area
[Arthraxon hispidus](#) Hairy-joint Grass [9338]	Vulnerable	Species or species habitat likely to occur within area
[Cryptocarya foetida](#) Stinking Cryptocarya, Stinking Laurel [11976]	Vulnerable	Species or species habitat may occur within area
[Cryptostylis hunteriana](#) Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat may occur within area
[Davidsonia jerseyana](#) Davidson's Plum [67219]	Endangered	Species or species habitat may occur within area
[Endiandra floydii](#) Floyd's Walnut [52955]	Endangered	Species or species habitat likely to occur within area
[Phaius australis](#) Lesser Swamp-orchid [5872]	Endangered	Species or species habitat may occur within area
[Streblus pendulinus](#) Siah's Backbone, Sia's Backbone, Isaac Wood [21618]	Endangered	Species or species habitat likely to occur within area
[Syzygium hodgkinsoniae](#) Smooth-bark Rose Apple, Red Lilly Pilly [3539]	Vulnerable	Species or species habitat likely to occur within area
[Thesium australe](#) Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat may occur within area
Reptiles		
[Caretta caretta](#) Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
[Chelonia mydas](#) Green Turtle [1765]	Vulnerable	Breeding likely to occur within area
[Dermochelys coriacea](#) Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area

Name	Status	Type of Presence
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Breeding likely to occur within area
Lepidochelys olivacea		
Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding likely to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Breeding likely to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Puffinus carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Sterna albifrons		
Little Tern [813]		Species or species habitat may occur within area
Migratory Marine Species		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Breeding likely to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Breeding likely to occur within area
Lepidochelys olivacea		
Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding likely to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Breeding likely to occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundapus caudacutus		
White-throated Needletail [682]		Species or species habitat known to occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis		
Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus		
Spectacled Monarch [610]		Species or species habitat known to occur within area
Myiagra cyanoleuca		
Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons		
Rufous Fantail [592]		Species or species

Name	Threatened	Type of Presence
		habitat likely to occur within area
Migratory Wetlands Species		
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Pandion cristatus Eastern Osprey [82411]		Breeding known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Endangered	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
Myiagra cyanoleuca		
Satin Flycatcher [612]		Species or species habitat known to occur within area
Pandion haliaetus		
Osprey [952]		Breeding known to occur within area
Puffinus carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Rhipidura rufifrons		
Rufous Fantail [592]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato)		
Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Sterna albifrons		
Little Tern [813]		Species or species habitat may occur within area
Reptiles		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Breeding likely to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Breeding likely to occur within area
Lepidochelys olivacea		
Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding likely to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Breeding likely to occur within area

Extra Information

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
North East NSW RFA	New South Wales

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		

Name	Status	Type of Presence
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Lonchura punctulata Nutmeg Mannikin [399]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus plumosus Climbing Asparagus-fern [48993]		Species or species habitat likely to occur within area
Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera subsp. rotundata Bitou Bush [16332]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Protasparagus densiflorus Asparagus Fern, Plume Asparagus [5015]		Species or species habitat likely to occur within area
Protasparagus plumosus Climbing Asparagus-fern, Ferny Asparagus [11747]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar		Species or species

Name	Status	Type of Presence
Groundsel [2624]		habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-28.67217 153.61841

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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BMT WBM

Tallows Creek Entrance 7 Part Tests

Reference: R.B20347.002.01.docx
Date: October 2015
Confidential

Tallows Creek Entrance 7 Part Tests

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Prepared by:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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Synopsis: **In accordance with the requirements of the Threatened Species Conservation Act (1995) (TSC Act) this report provides completed Assessments of Significance or '7 part tests' of the potential impacts of the proposed Tallow Creek Mouth Opening to determine if the activity is likely to have any impact on a threatened species or community.**

REVISION/CHECKING HISTORY

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Executive Summary

A number of 7-Part tests (i.e. Assessments of Significance) have been completed as part of this study and have considered species identified in an earlier BMT WBM report (completed August 2013) which identified the threatened species, populations and ecological communities which may be affected directly or indirectly, by the proposed artificial opening of the Tallows Creek entrance.

The 7-part tests did not identify that the proposed activity was likely to present any significant impacts to the species considered. However, a number of species including the Beach Stone Curlew, Pied Oyster Catcher, Little Tern, Loggerhead Turtle, Green Turtle and Sand Spurge may be impacted by activities associated with the physical entrance opening works that allow Tallow Creek to drain to the ocean.

Consequently, pre-disturbance ecological surveys in consultation with the relevant authorities would be required to locate any threatened species and their presence in the beach areas to be impacted. Utilising information derived from the surveys more suitable approaches may be determined to minimise species impact.

Such requirements for survey, and potential alternative opening options would necessarily be documented in an environmental management plan which would be applied to the entrance opening.

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1 Introduction

In order to satisfy the requirements of the *Threatened Species Conservation Ac*t (1995) (TSC Act), this report provides completed Assessments of Significance or '7 part tests' of the potential impacts of the proposed Tallow Creek Mouth Opening to determine if the planned development or activity is likely to have any impact on a threatened species or community.

The Assessments of Significance have been applied to species, populations and ecological communities listed on Schedules 1, 1A and 2 of the TSC Act and Schedules 4, 4A and 5 of the *Fisheries Management Act 1994* (FM Act). The *Tallow's Creek Proposed Artificial Opening – Threatened Species and Communities Data Review* also prepared by BMT WBM, identified the threatened species, populations and ecological communities which may be affected directly or indirectly, by the proposed artificial opening of the Tallows Creek entrance, and which would require '7 part tests'. This report provides the completed 7 part tests.

2 7 Part Tests

2.1 Species and Communities Requiring Assessment

7 Part Tests are required for the threatened species and communities known from the region which prefer beach and freshwater and estuarine wetland communities with similar habitat characteristics to those habitats which may be impacted by the proposal. Table 2-1 provides a summary of species and communities requiring assessments of significance.

Table 2-1 Species and Communities Requiring Assessment under 7 Part Test

Species	Common Name
Birds	
Amaurornis olivaceus	Bush Hen
Ansranus semipalmata	Magpie Goose
Botaurus poiciloptilus	Australasian Bittern
Burhinus grallarius	Bush Stone-curlew
Calidris tenuirostris	Great Knot
Ephippiorhynchus asiaticus	Black-necked Stork
Erythrotriorchis radiatus	Red Goshawk
Esacus neglectus	Beach-stone Curlew
Haematopus fuliginosus	Sooty Oystercatcher
Haematopus longirostris	Pied Oystercatcher
Ixobrychus flavicollis	Black Bittern
Limosa limosa	Black-tailed Godwit
Monarcha leucotis	White-eared Monarch
Pandion haliaetus	Osprey
Sterna albifrons	Little Tern
Todiramphus chloris	Collared Kingfisher
Mammals	
Miniopterus australis	Little Bent-wing Bat
Miniopterus schreibersii	Common Bent-wing Bat
Myotis adversus	Large-footed Myotis
Nyctophilus bifax	Eastern Long-eared Bat
Phascolarctos cinereus	Koala
Planigale maculatus	Common Planigale
Potorous tridactylus	Long-nosed Potoroo
Pseudomys gracilicaudatus	Eastern Chestnut Mouse
Pteropus poliocephalus	Grey-headed Flying Fox
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat
Scoteanax rueppelli	Greater Broad-nosed Bat
Syconycteris australis	Eastern Blossom Bat

Species	Common Name
Frogs	
Crinia tinnula	Wallum Froglet
Litoria olongburensis	Wallum Sedge Frog
Reptiles	
Caretta caretta	Loggerhead Turtle
Chelonia mydas	Green Turtle
Invertebrates	
Argyreus hyperbius	Australian Fritillary Butterfly
Petalura gigantea	Giant Dragonfly
Thersites mitchellae	Mitchells' Rainforest Snail
Fish	
Maccullochella ikei	Eastern Freshwater Cod
Nannoperca oxleyana	Oxleyan Pygmy Perch
Flora	
Archidendron hendersonii	White Lace Flower
Chamaesyce psammogeton	Sand Spurge
Cryptocarya foetida	Stinking Cryptocarya
Geodorum densiflorum	Pink Nodding Orchid
Phaius australis	Swamp Orchid
Threatened Communities	
Coastal Saltmarsh in the NSW North Coast Bioregion	
Lowland Rainforest in NSW North Coast Bioregion	
Swamp Sclerophyll Forest on Coastal Floodplains	
Swamp Oak Floodplain Forest in the NSW North Coast Bioregion	
Freshwater Wetlands on Coastal Floodplains	

2.2 Potential Impacts of Proposed Estuary Opening

The *Tallow's Creek Proposed Artificial Opening – Threatened Species and Communities Data Review* prepared by BMT WBM, describes potential ecological and environmental impacts of the proposed artificial opening and should be read in conjunction with this report.

2.3 Bush Hen (*Amaurornis olivaceus*)

The Bush Hen is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes freshwater wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Bush Hen are known (based on species information at http://www.environment.nsw.gov.au):

- Inhabits dense vegetation on the margins of freshwater creeks, rivers and natural or artificial wetlands;
- Occurs on the margins of rainforest to forest regrowth, rank grass or reeds, thickets of weeds, and farmland and occasionally dense gardens around human habitation;
- Key habitat elements are dense undergrowth 2-4 m tall, within 300 m of water;
- Habitat tolerance is much broader than that of specialised birds of natural wetlands (e.g. bitterns); and
- Species is partly terrestrial.

Identified threats to the species include:

- Clearing, filling and draining of wetlands;
- Pollution of wetlands from agricultural, urban and industrial run-off (e.g. herbicides and pesticides);
- Weed invasion;
- Loss of the shrub layer in areas developed for human settlements; and
- Predation by foxes and feral cats.

Given the habitat tolerance of this species, the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the freshwater habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat

(either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara;* and

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.4 Magpie Goose (*Ansranus semipalmata*)

The Magpie Goose is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes freshwater wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Magpie Goose are known (based on species information at http://www.environment.nsw.gov.au):

- Mainly found in shallow wetlands (less than 1 m deep) with dense growth of rushes or sedges;
- Equally at home in aquatic or terrestrial habitats; often seen walking and grazing on land; feeds on grasses, bulbs and rhizomes;
- Activities are centred on wetlands, mainly those on floodplains of rivers and large shallow wetlands formed by run-off; breeding can occur in both summer and winter dominated rainfall areas and is strongly influenced by water level; most breeding now occurs in monsoonal areas; nests are formed in trees over deep water; breeding is unlikely in south-eastern NSW; and
- Often seen in trios or flocks on shallow wetlands, dry ephemeral swamps, wet grasslands and floodplains; roosts in tall vegetation.

Identified threats to the species include:

- Inappropriate hydrological regimes of wetland habitats through drainage of swamps, ponds, dams and other wetlands for agricultural and other human purposes;
- Degradation of habitat through water pollution (e.g. salinity, chemicals, eutrophication);
- Modification of habitat and nest loss from trampling and overgrazing;
- Predation on eggs and goslings; and
- Too-frequent burning of wetlands.

Given the habitat tolerance of this species, the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the freshwater habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat

and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical **habitat for this species has been declared.**

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.5 Australasian Bittern (*Botaurus poiciloptilus*)

The Australasian Bittern is currently listed as Endangered under the TSC Act.

Potential habitat for the species in the study area includes freshwater and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Australasian Bittern are known (based on species information at http://www.environment.nsw.gov.au):

- Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spikerushes (*Eleocharis* spp.).
- Hides during the day amongst dense reeds or rushes and feeds mainly at night on frogs, fish, yabbies, spiders, insects and snails.
- Feeding platforms may be constructed over deeper water from reeds trampled by the bird; platforms are often littered with prey remains.
- Breeding occurs in summer from October to January; nests are built in secluded places in densely-vegetated wetlands on a platform of reeds; there are usually six olive-brown eggs to a clutch.

Identified threats to the species include:

- Drainage of wetlands and ponds;
- Reduced water quality due to siltation, pollution and salinity;
- Predation by foxes and cats;
- Use of herbicides, pesticides and other chemicals near wetland areas; and
- Grazing and associated frequent burning of wetland areas.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the freshwater habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.6 Bush Stone-curlew (*Burhinus grallarius*)

The Bush Stone-curlew is currently listed as Endangered under the TSC Act.

Potential habitat for the species in the study area includes freshwater and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Bush Stone-curlew are known (based on species information at http://www.environment.nsw.gov.au):

- Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber;
- Largely nocturnal, being especially active on moonlit nights;
- Feed on insects and small vertebrates, such as frogs, lizards and snakes;
- Nest on the ground in a scrape or small bare patch;
- Two eggs are laid in spring and early summer;
- Identified threats to the species include:
    - Predation by foxes and cats;
    - Trampling of eggs by cattle;
    - Clearance of woodland habitat for agricultural and residential development;
    - Modification and destruction of ground habitat through removal of litter and fallen timber, introduction of exotic pasture grasses, grazing and frequent fires; and
    - Disturbance in the vicinity of nest sites.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the freshwater habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The proposed artificial opening of the Tallows Creek estuary is not in-consistent with the Department of Environment and Conservation NSW 2006, NSW Recovery Plan for the Bush Stone-curlew *Burhinus grallarius*. DEC, Sydney.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.7 Great Knot (*Calidris tenuirostris*)

The Great Knot is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes beach and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Great Knot are known (based on species information at http://www.environment.nsw.gov.au):

- Occurs within sheltered, coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons;
- Often recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms;
- Migrates to Australia from late August to early September, although juveniles may not arrive until October-November;
- Most birds return north in March and April, however some individuals may stay over winter in Australia; and
- Forages for food by methodically thrusting its bill deep into the mud to search for invertebrates, such as bivalve molluscs, gastropods, polychaete worms and crustaceans.

Identified threats to the species include:

- Hydrological changes to inland lakes may modify or remove important areas of suitable habitat for those individuals that overwinter in in Australia.
- Tourism or agricultural developments that reduce coastal and inland habitat areas.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

The greatest ecological risk during mobilisation and excavation works for artificial opening of the estuary would be for fauna utilising the upper beach and berm. Most fauna would be able to move out of the way of equipment and works without any significant impact. These impacts could be avoided / mitigated by minimising the extent of travel along the beach. In addition, the use of smaller equipment such as a backhoe should also be employed to minimise the area of disturbance.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the freshwater habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and
- The Proposal is not inconsistent with a recovery plan for the species.

2.8 Black-necked Stork (*Ephippiorhynchus asiaticus*)

The Black-necked stork is currently listed as Endangered under the TSC Act.

Potential habitat for the species in the study area includes freshwater and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Black-necked stork are known (based on species information at http://www.environment.nsw.gov.au):

- Black-necked Storks are mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands. They also forage within or around estuaries and along intertidal shorelines, such as saltmarshes, mudflats and sandflats, and mangrove vegetation.
- They mainly forage in shallow, still water, preferring open wetlands, and taking a variety of prey, including eels and other fish, frogs, turtles, snakes, and invertebrates (such as crabs and insects). Vertebrates form the main mass of the diet, with medium-sized eels contributing the greatest biomass and were also the only food seen to be delivered to nestlings.
- In NSW, Black-necked Storks breed in late spring and summer.
- In NSW, breeding activity has been recorded in most months, with activities from nest construction to fledging of young recorded from May to January. Most activity, however, takes place between June and December, and clutches are usually present from May to September. In NSW, Storks usually nest in a tall, live and isolated padock tree, but also in other trees,

including dead trees and paperbarks, or even lower shrubs within wetlands. The nest is a large platform, 1-2 m in diameter, made in a live or dead tree, in or near a freshwater swamp.

- The clutch-size of nests in NSW is not properly known, but nests have been observed with from one to three young in the nest. Broods of four young have been recorded in northern Queensland.

Identified threats to the species include:

- Powerlines, especially close to wetlands or over floodplains, are a significant cause of mortality of Storks and one of the most critical threats to the species in NSW.
- Modification or degradation of wetlands through changes in natural water flows. It is important to maintain or reintroduce flows to provide wetland habitats suitable for foraging by Storks as they require large amounts of vertebrate prey from such habitats.
- Loss of wetland habitat through clearing and draining for flood mitigation, agriculture and residential development.
- Degradation of wetland habitats through pollution and salinisation.
- Loss of paddock trees used for nesting, or potentially providing nesting sites for Black-necked Storks.

Given the habitat tolerance of this species, the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the freshwater habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat. (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and
- The Proposal is not inconsistent with a recovery plan for the species.

2.9 Red Goshawk (*Erythrotriorchis radiatus*)

The Red Goshawk is currently listed as Critically Endangered under the TSC Act.

Potential habitat for the species in the study area includes freshwater wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The following ecological characteristics of the Red Goshawk are known (based on species information at http://www.environment.nsw.gov.au):

- Red Goshawks inhabit open woodland and forest, preferring a mosaic of vegetation types, a large population of birds as a source of food, and permanent water, and are often found in riparian habitats along or near watercourses or wetlands. In NSW, preferred habitats include mixed subtropical rainforest, *Melaleuca* swamp forest and riparian *Eucalyptus* forest of coastal rivers.
- Adults appear to occupy territories throughout the year and breeding territories are traditionally used from year to year. Adults have large home-ranges, estimated in the Northern Territory to be as great as about 120 km^2 for females and 200 km^2 for males.
- Red Goshawks mainly eat medium to large birds, including species as large as Australian Brush-turkeys *Alectura lathami*, but they also take mammals, reptiles and insects.
- Red Goshawks usually hunt from concealed or, less often, exposed perches, but also fly close above or through forest or woodland searching for prey. They often hunt from perches early in the morning and late in the day and tend to hunt more on the wing at other times of the day.
- The breeding behaviour of Red Goshawks is not well known. Breeding is likely to be in spring and summer in southern Queensland and NSW (if they breed in the state at all). The birds lay clutches of 1-2 eggs, in a stick nest in a tall tree (>20 m tall) within 1 km of a watercourse or wetland.

- In winter in eastern Australia, the birds appear to move from nesting sites in the ranges to coastal plains, where they are associated with permanent wetlands.
- The age at which Red Goshawks first breed is not known, nor is the life expectancy. Young remain with their parents for at least 70-80 days after they leave the nest and may remain with their parents for 4-5 months.

Identified threats to the species include:

- Clearing and fragmentation of riparian forests and woodlands. Nests are particularly vulnerable to clearing of habitat, and even where riparian strips are not cleared, Red Goshawks usually nest in the tallest trees, which are exposed to storm damage and other disturbance when surrounding vegetation removed. Widespread clearing of vegetation is thought to be reason for historical declines in eastern and north-eastern NSW.
- Loss or degradation of sources of permanent water through draining of wetlands.
- Disturbance of habitat, particularly breeding habitat resulting in breeding failure, from forestry activities, fires or burning of nesting trees.
- Disturbance of nesting sites and breeding failure from illegal egg-collecting.
- Intentional shooting by pigeon and poultry owners, and possibly secondary poisoning through pest-control activities, are thought to kill a few individuals and may cause local scarcity.
- Use of persistent pesticides may result in pesticide contamination sufficient to cause eggshell thinning and breeding failure, though this is not certainly known to be implicated in past declines in eastern Australia or to be affecting current breeding.
- Inappropriate fire and land management regimes may have altered the availability of prey for this species.
- Random events, such as drought and fire, or occurrence of disease, that may have exaggerated impacts upon an already depleted population.
- Genetic bottlenecks may restrict gene flow affecting an already small population.

Given the habitat tolerance of this species, the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the freshwater habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and
- The Proposal is not inconsistent with a recovery plan for the species.

2.10 Beach-stone Curlew (*Esacus neglectus*)

The Beach-stone Curlew is currently listed as Endangered under the TSC Act.

Potential habitat for the species in the study area includes beach and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The following ecological characteristics of the Beach-stone Curlew are known (based on species information at http://www.environment.nsw.gov.au):

- Occurs on open, undisturbed beaches, islands, reefs and estuarine intertidal sand and mudflats;
- Prefers beaches with estuaries or mangroves nearby;
- Frequents river mouths, offshore sandbars associated with coral atolls, reefs and rock platforms and coastal lagoons;
- Forages on large, intertidal mudflats, sandflats, sandbanks and sandpits exposed by low tide;
- Diet consists of crabs and other marine invertebrates;
- Breeding season in temperate Australia lasts from September to November;
- Nests may be located on sandbanks, sandspits or islands in estuaries, coral ridges, among mangroves or in the sand surrounded by short grass and scattered casuarinas; and

- Incubation period lasts at least 30 days and both parents care for the young until independence is reached at 7-12 months.

Identified threats to the species include:

- Loss of habitat due to residential and industrial development;
- Susceptible to human disturbance through beach-combing, boating and 4WD vehicles;
- Predation by raptors, cats and dogs;
- Nest destruction by pigs;
- High tides may wash the eggs from the nest; and
- Nest desertion.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

The most significant ecological impact associated with the proposal is likely to be the direct physical impact through the excavation of the estuary channel and disturbance during transportation of equipment to and from this site. It is understood that access to the entrance will involve transportation of equipment along Tallow Beach and/or through Arakwal National Park.

The greatest ecological risk during mobilisation and excavation works would be for fauna utilising the upper beach and berm. Most fauna would be able to move out of the way of equipment and

works without any significant impact. However, there may be an issue if sensitive fauna, such as the Beach-stone Curlew, are nesting at these sites. These impacts could be avoided / mitigated by minimising the extent of travel along the beach and if possible, by avoiding works at times when target species are nesting. In addition, the use of smaller equipment such as a backhoe should also be employed to minimise the area of disturbance.

Pre-disturbance ecological surveys in consultation with the relevant authorities would be required to locate any threatened species and their nesting sites in the beach areas to be impacted. If nests are located along the access route, then alternative routes should be sought. If nests are located in the estuary mouth, these may need to be relocated in consultation with the relevant authorities (approvals and permits will be required under the TSC Act and EPBC Act). Surveys may however need to be undertaken on short notice (following unexpectedly high rainfall for example) potentially limiting opportunities for consultation.

In the event the mouth is required to be opened at short notice, for example to reduce flash flooding impacts, contingency measures will need to be in place to appropriately manage Beach-stone Curlew. For example it may be necessary to engage local wildlife catchers and spotters to survey and relocate species on short notice. The contingency plan will need to be developed in consultation with, and approved by, the relevant authorities.

Provided the above recommendations are carried out, the proposed artificial opening of the estuary will have a minor impact on Beach-stone Curlew nesting habitats of the study area. The proposal will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat.

(either directly or indirectly)

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara;* and
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and
- The Proposal is not inconsistent with a recovery plan for the species.

2.11 Sooty Oystercatcher (*Haematopus fuliginosus*)

The Sooty Oystercatcher is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes beach and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Sooty Oystercatcher are known (based on species information at http://www.environment.nsw.gov.au):

- Favours rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries;
- Forages on exposed rock or coral at low tide for foods such as limpets and mussels; and
- Breeds in spring and summer, almost exclusively on offshore islands, and occasionally on isolated promontories. The nest is a shallow scrape on the ground, or small mounds of pebbles, shells or seaweed when nesting among rocks.

Identified threats to the species include:

- Disturbance to coastal feeding, nesting and roosting areas through beach-combing, fishing, dog-walking, horse-riding and 4WD vehicles;
- Predation of eggs and chicks by foxes, dogs, cats, rats and raptors;
- Habitat destruction as a result of residential, agricultural and tourism developments; and
- Hydrological changes to estuaries and similar water bodies causing modification or removal of important areas of suitable habitat.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

The most significant ecological impact associated with the proposal is likely to be the direct physical impact through the excavation of the estuary channel and disturbance during transportation of equipment to and from this site. It is understood that access to the entrance will involve transportation of equipment along Tallow Beach and/or through Arakwal National Park.

The greatest ecological risk during mobilisation and excavation works would be for fauna utilising the upper beach and berm. Most fauna, including the sooty Oystercatcher, would be able to move out of the way of equipment and works without any significant impact. These impacts could be avoided / mitigated by minimising the extent of travel along the beach. In addition, the use of smaller equipment such as a backhoe should also be employed to minimise the area of disturbance.

Provided the above recommendations are carried out, the proposed artificial opening of the estuary will have a minor impact on Sooty Oyster Catchers utilising the beach. The proposal will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara;* and
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and
- The Proposal is not inconsistent with a recovery plan for the species.

2.12 Pied Oystercatcher (*Haematopus longirostris*)

The Pied Oystercatcher is currently listed as Endangered under the TSC Act.

Potential habitat for the species in the study area includes beach and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Pied Oystercatcher are known (based on species information at http://www.environment.nsw.gov.au):

- Favours intertidal flats of inlets and bays, open beaches and sandbanks;
- Forages on exposed sand, mud and rock at low tide, for molluscs, worms, crabs and small fish. The chisel-like bill is used to pry open or break into shells of oysters and other shellfish;
- Nests mostly on coastal or estuarine beaches although occasionally they use saltmarsh or grassy areas. Nests are shallow scrapes in sand above the high tide mark, often amongst seaweed, shells and small stones; and
- Two to three eggs are laid between August and January. The female is the primary incubator and the young leave the nest within several days.

Identified threats to the species include:

- Disturbance to coastal feeding, nesting and roosting areas through beach-combing, fishing, dog-walking, horse-riding and 4WD vehicles;
- Predation of eggs and chicks by foxes, dogs, cats, Australian Ravens, raptors and artificially high populations of Silver Gulls;
- Habitat destruction as a result of residential, agricultural and tourism developments;
- Hydrological changes to estuaries and similar water bodies causing modification or removal of important areas of suitable habitat;
- A key food source, the Pipi, has undergone long-term decline as a result of over-harvesting; and
- Silver gulls / ravens depredating and disturbing nests, reducing reproductive success / recruitment.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

The most significant ecological impact associated with the proposal is likely to be the direct physical impact through the excavation of the estuary channel and disturbance during transportation of equipment to and from this site. It is understood that access to the entrance will involve transportation of equipment along Tallow Beach and/or through Arakwal National Park.

The greatest ecological risk during mobilisation and excavation works would be for fauna utilising the upper beach and berm. Most fauna would be able to move out of the way of equipment and works without any significant impact. However, there may be an issue if sensitive fauna, such as the Pied Oystercatcher, are nesting at these sites. These impacts could be avoided / mitigated by minimising the extent of travel along the beach and if possible, by avoiding works at times when target species are nesting. In addition, the use of smaller equipment such as a backhoe should also be employed to minimise the area of disturbance.

Pre-disturbance ecological surveys in consultation with the relevant authorities would be required to locate any threatened species and their nesting sites in the beach areas to be impacted. If nests are located along the access route, then alternative routes should be sought. If nests are located in the estuary mouth, these may need to be relocated in consultation with the relevant authorities (approvals and permits will be required under the TSC Act and EPBC Act). Surveys may however need to be undertaken on short notice (following unexpectedly high rainfall for example) potentially limiting opportunities for consultation.

In the event the mouth is required to be opened at short notice, for example to reduce flash flooding impacts, contingency measures will need to be in place to appropriately manage Pied Oystercatcher. For example it may be necessary to engage local wildlife catchers and spotters to survey and relocate species on short notice. The contingency plan will need to be developed in consultation with, and approved by, the relevant authorities.

Provided the above recommendations are carried out, the proposed artificial opening of the estuary will have a minor impact on Pied Oystercatcher nesting habitats of the study area. The proposal will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara;* and
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and
- The Proposal is not inconsistent with a recovery plan for the species.

2.13 Black Bittern (*Ixobrychus flavicollis*)

The Black Bittern is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes freshwater and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Black Bittern are known (based on species information at http://www.environment.nsw.gov.au):

- Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves;
- Feeds on frogs, reptiles, fish and invertebrates, including snails, dragonflies, shrimps and crayfish, with most feeding done at dusk and at night;
- During the day, roosts in trees or on the ground amongst dense reeds. When disturbed, freezes in a characteristic bittern posture (stretched tall, bill pointing up, so that shape and streaked

pattern blend with upright stems of reeds), or will fly up to a branch or flush for cover where it will freeze again;

- Generally solitary, but occurs in pairs during the breeding season, from December to March; and
- Like other bitterns, but unlike most herons, nesting is solitary. Nests, built in spring are located on a branch overhanging water and consist of a bed of sticks and reeds on a base of larger sticks. Between three and five eggs are laid and both parents incubate and rear the young.

Identified threats to the species include:

- Clearing of riparian vegetation;
- Predation by foxes and feral cats on eggs and juveniles; and
- Grazing and trampling of riparian vegetation by stock.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on

regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the freshwater habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;

- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and
- The Proposal is not inconsistent with a recovery plan for the species.

2.14 Black-tailed Godwit (*Limosa limosa*)

The Black-tailed Godwit is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes beach, freshwater and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Black-tailed Godwit are known (based on species information at http://www.environment.nsw.gov.au):

- Primarily found along the coast on sand spits, lagoons and mudflats;
- Also occurs inland on mudflats and in those portions of large muddy lakes and swamps (freshwater or brackish) where the water is less than 10 cm deep during suitable conditions (i.e. receding water);
- Individuals have also been observed in wet meadows and sewerage treatment works;
- Diet includes a variety of invertebrates such as insects and larvae, earthworms, crustaceans, molluscs, spiders, spawn and tadpoles of frogs and fish eggs; and
- Seeds and berries are important food sources when the species is in the northern hemisphere, especially after breeding and before migration.

Identified threats to the species include:

- Hydrological changes to inland lakes may modify or remove important areas of suitable habitat for those individuals that remain in Australia over winter; and
- Tourism or agricultural developments reducing coastal and inland habitat areas.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The most significant ecological impact associated with the proposal is likely to be the direct physical impact through the excavation of the estuary channel and disturbance during transportation of equipment to and from this site. It is understood that access to the entrance will involve transportation of equipment along Tallow Beach and/or through Arakwal National Park.

The greatest ecological risk during mobilisation and excavation works would be for fauna utilising the upper beach and berm. Most fauna, including the Black-tailed Godwit, would be able to move out of the way of equipment and works without any significant impact. These impacts could be avoided / mitigated by minimising the extent of travel along the beach. In addition, the use of smaller equipment such as a backhoe should also be employed to minimise the area of disturbance.

Provided the above recommendations are carried out, the proposed artificial opening of the estuary will have a minor impact on Black-tailed Godwit utilising the beach. The proposal will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara;* and
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and
- The Proposal is not inconsistent with a recovery plan for the species.

2.15 White-eared Monarch (*Monarcha leucotis*)

The White-eared Monarch is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the White-eared Monarch are known (based on species information at http://www.environment.nsw.gov.au):

- Occurs in rainforest, especially drier types, such as littoral rainforest, as well as wet and dry sclerophyll forests, swamp forest and regrowth forest;
- Prefer the ecotone between rainforest and other open vegetation types or the edges of rainforest, such as along roads;
- They eat insects, but their diet is not well studied; and
- They breed from about September to March, usually nesting high in the canopy, and often at the edge of patches of rainforest.

Identified threats to the species include:

- Clearing and increasing fragmentation and isolation of habitat, especially low-elevation subtropical rainforest, littoral rainforest and wet sclerophyll forest, through agricultural, tourist and residential development or forestry activities;
- Forest management that results in conversion of multi-aged forests to young, even-aged stands
- Invasion of forests by weeds;
- Inappropriate fire regimes that degrade habitat or allow invasion by weeds; and
- Degradation or loss of habitat through grazing of stock.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and
- The Proposal is not inconsistent with a recovery plan for the species.

2.16 Osprey (*Pandion haliaetus*)

The Osprey is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Osprey are known (based on species information at http://www.environment.nsw.gov.au):

- Forages over clear estuarine and inshore marine waters and coastal rivers, and nests in tall (usually dead or dead-topped) trees in coastal habitats from open woodland to open forest, within 1-2 km of water.
- Species is increasingly seen making use of artificial structures for nest sites and lookout perches (e.g. power pylons, towers, bridges) and purpose-built nest platforms on poles.
- Eggs are laid in winter, with a single attempt per season. The incubation period is about 38 days, the nestling period 9-11 weeks, and the post-fledging dependence period lasts two to three months.
- Feed mostly on surface-swimming, schooling fish caught by diving into water.
- Occur solitarily, in pairs, or family groups of parents and dependent juveniles.
- Resident pairs defend exclusive breeding territory against conspecifics and other raptors. In NSW, neighbouring nests are rarely less than 1 km apart and more often are between 1-3 km apart. Parents range at least 3 km from the nest to forage.

Identified threats to the species include:

- Loss of breeding habitat and nest trees;
- Pollution of foraging habitat and prey with agricultural and industrial chemicals;
- Entanglement in fishing gear; and

- Increased turbidity of coastal waters, from sediment loads entering streams, may hinder foraging.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and
- The Proposal is not inconsistent with a recovery plan for the species.

2.17 Little Tern (*Sterna albifrons*)

The Little Tern is currently listed as Endangered under the TSC Act.

Potential habitat for the species in the study area includes beach and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Little Tern are known (based on species information at http://www.environment.nsw.gov.au):

- Almost exclusively coastal with sheltered environments preferred. May also occur several kilometres from the sea in harbours, inlets and rivers. May be recorded on offshore islands or coral cays.
- Nests in small, scattered colonies on sandy beaches or shingle pits. These nesting sites are particularly vulnerable to human disturbance, predation and natural catastrophes.
- Species is carnivorous, preferring small fish but also eating crustaceans, insects, annelids and molluscs.
- Forages by plunging in the shallow water of channels and estuaries and in the surf on beaches.
- Nesting has been recorded at 60 sites along the NSW coastline but only about half of these have been used recently (1990).
- Both parents incubate a clutch of 1-3 eggs for a period of 17-22 days. The newly hatched young are also cared for by both parents during the fledging period of 17–19 days.

Identified threats to the species include:

- Nesting at flood-prone locations;
- Predation of eggs and chicks by a range of species including foxes, silver gulls, ravens and whimbrels;
- Human disturbance by coastal recreational activities;
- Nest disturbance, Adults leave nests when approached resulting in the chicks or eggs being exposed and vulnerable; and
- 4WDs, trail-bikes and walkers may crush nests, eggs and chicks.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

The most significant ecological impact associated with the proposal is likely to be the direct physical impact through the excavation of the estuary channel and disturbance during transportation of equipment to and from this site. It is understood that access to the entrance will involve transportation of equipment along Tallow Beach and/or through Arakwal National Park.

The greatest ecological risk during mobilisation and excavation works would be for fauna utilising the upper beach and berm. Most fauna would be able to move out of the way of equipment and works without any significant impact. However, there may be an issue if sensitive fauna, such as the Little Tern, are nesting at these sites. These impacts could be avoided / mitigated by minimising the extent of travel along the beach and if possible, by avoiding works at times when target species are nesting. In addition, the use of smaller equipment such as a backhoe should also be employed to minimise the area of disturbance.

Pre-disturbance ecological surveys in consultation with the relevant authorities would be required to locate any threatened species and their nesting sites in the beach areas to be impacted. If nests are located along the access route, then alternative routes should be sought. If nests are located in the estuary mouth, these may need to be relocated in consultation with the relevant authorities (approvals and permits will be required under the TSC Act and EPBC Act). Surveys may however need to be undertaken on short notice (following unexpectedly high rainfall for example) potentially limiting opportunities for consultation.

In the event the mouth is required to be opened at short notice, for example to reduce flash flooding impacts, contingency measures will need to be in place to appropriately manage Little Tern. For example it may be necessary to engage local wildlife catchers and spotters to survey and relocate species on short notice. The contingency plan will need to be developed in consultation with, and approved by, the relevant authorities.

Provided the above recommendations are carried out, the proposed artificial opening of the estuary will have a minor impact on Little Tern nesting habitats of the study area. The proposal will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The proposed artificial opening of the Tallows Creek estuary is not inconsistent with the NSW National Parks and Wildlife Service (2003) Little Tern (*Sterna albifrons*) Recovery Plan.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara;* and
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and
- The Proposal is not inconsistent with a recovery plan for the species.

2.18 Collared Kingfisher (*Todiramphus chloris*)

The Collared Kingfisher is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Collared Kingfisher are known (based on species information at http://www.environment.nsw.gov.au):

- Collared Kingfishers are virtually restricted to mangrove associations of estuaries, inlets, sheltered bays and islands, and the tidal flats and littoral zone bordering mangroves.
- They sometimes occur in terrestrial forests or woodlands bordering mangroves, where they will nest in holes in trees or in arboreal termitaria. They are sometimes seen in streets or gardens in built-up areas bordering mangrove vegetation.
- Nests are usually in holes in trunks of large, live or dead mangrove trees, though they sometimes nest in hollows or in arboreal termite nests in large eucalypts or paperbarks adjacent to mangroves or estuarine foraging habitats.
- They are often seen perched on rock walls, jetties, piles or on the ground on tidal flats. They also sometimes occur in parks and gardens along foreshores.
- Mostly take food from the ground, from the surface of mud and sand, mainly along seaward fringe of mangroves. Sometimes take food from shallow water or from air.
- The diet consists mostly of crustaceans, especially crabs, but they also take insects, small fish, and lizards. They have also been reported to occasionally take young birds.
- Breeding is usually in spring and summer, with clutches observed in NSW in September to December, and young birds from October to January. Birds usually lay three eggs, but clutches of two to four recorded. Young leave the nest about 1 month after hatching.

Identified threats to the species include:

- Clearing of old stands of mangroves.
- Loss of large terrestrial trees in vegetation bordering mangroves or foraging habitat of Collared Kingfishers containing hollows or termite nests suitable for nesting. Such loss occurs through residential and infrastructure development.
- Pollution of estuaries and accumulation of agricultural and urban herbicide and pesticide residues, and through the use of pesticides to protect tourist and residential developments. Use of pesticides may also lead to depletion of prey stocks for the Kingfisher.
- Failure to recruit sufficient old trees to the population in mangrove and adjacent forests, depriving the Kingfishers of nesting sites.
- The main threat to this species in NSW is the very small population confined to a restricted range at the southern limit of the distribution of the species. It is thus subject to declines resulting from unpredicted and random events.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and
- The Proposal is not inconsistent with a recovery plan for the species.

2.19 Little Bent-wing Bat (*Miniopterus australis*)

The Little Bent-wing Bat is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes freshwater and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Little Bent-wing Bat are known (based on species information at http://www.environment.nsw.gov.au):

- Prefers moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, *Melaleuca* swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas.
- Roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats.

- Often share roosting sites with the Common Bentwing-bat and, in winter, the two species may form mixed clusters.
- In NSW the largest maternity colony is in close association with a large maternity colony of Eastern Bentwing-bats (*Miniopterus schreibersii*) and appears to depend on the large colony to provide the high temperatures needed to rear its young.
- Maternity colonies form in spring. Males and juveniles disperse in summer.
- Only five nursery sites /maternity colonies are known in Australia.

Identified threats to the species include:

- Disturbance of colonies, especially in nursery or hibernating caves, may be catastrophic.
- Destruction of caves that provide seasonal or potential roosting sites.
- Changes to habitat, especially surrounding maternity/nursery caves and winter roosts.
- Use of pesticides.
- Predation from foxes, particularly around maternity caves, winter roosts and roosts within culverts, tunnels and under bridges.
- Introduction of exotic pathogens, specifically known White-nosed fungus.
- Hazard reduction fires during the breeding season will disturb bats.
- Potential for large scale wildfire to impact on foraging resources in surrounding habitat.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and
- The Proposal is not inconsistent with a recovery plan for the species.

2.20 Common Bent-wing Bat (*Miniopterus schreibersii*)

The Common Bent-wing Bat is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes freshwater and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Common Bent-wing Bat are known (based on species information at http://www.environment.nsw.gov.au):

- Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.
- Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young.
- Maternity caves have very specific temperature and humidity regimes.
- At other times of the year, populations disperse within about 300 km range of maternity caves.
- Cold caves are used for hibernation in southern Australia.
- Breeding or roosting colonies can number from 100 to 150,000 individuals.
- Hunt in forested areas, catching moths and other flying insects above the tree tops.

Identified threats to the species include:

- Disturbance by recreational cave climbers and general public accessing the cave and adjacent areas particularly during winter or breeding.
- Loss of foraging habitat.
- Loss of food resources and indirect poisoning of individuals from nearby use of herbicides / insecticides.

- Predation by feral cats and foxes.
- Introduction of exotic pathogens, specifically known White-nosed fungus.
- Threat of cave entrances being blocked for human safety reasons. Also, vegetation encroaching and blocking cave entrances.
- Potential for large scale wildfire to impact on resource availability in surrounding habitat. Direct threats at caves from fire.
- Weeds (blackberry) encroaching over cave entrances restrict access; need to ensure sympathetic control techniques for blackberry.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the

main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and
- The Proposal is not inconsistent with a recovery plan for the species.

2.21 Large-footed Myotis (*Myotis adversus*)

The Large-footed Myotis is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes freshwater and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Large-footed Myotis are known (based on species information at http://www.environment.nsw.gov.au):

- Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage.
- Forage over streams and pools catching insects and small fish by raking their feet across the water surface.
- In NSW females have one young each year usually in November or December.

Identified threats to the species include:

- Loss or disturbance of roosting sites;
- Clearing adjacent to foraging areas;
- Application of pesticides in or adjacent to foraging areas; and
- Reduction in stream water quality affecting food resources.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.22 Eastern Long-eared Bat (*Nyctophilus bifax*)

The Eastern Long-eared Bat is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes freshwater and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Eastern Long-eared Bat are known (based on species information at http://www.environment.nsw.gov.au):

- Habitat includes lowland subtropical rainforest and wet and swamp eucalypt forest, extending into adjacent moist eucalypt forest.
- Coastal rainforest and patches of coastal scrub are particularly favoured.
- Roosts in tree hollows, the hanging foliage of palms, in dense clumps of foliage of rainforest trees, under bark and in shallow depressions on trunks and branches, among epiphytes, in the roots of strangler figs, among dead fronds of tree ferns and less often in buildings.

Identified threats to the species include:

- Clearing, fragmentation and isolation of lowland subtropical rainforest, wet and swamp eucalypt forest and coastal scrub, particularly forest and scrub close to the coast, for agricultural, residential and other development.
- Loss of hollow-bearing trees and stands of palms and rainforest trees used for roosting and maternity sites.
- Invasion of habitat by weeds, particularly by Bitou Bush on the coast.
- Use of pesticides.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.23 Koala (*Phascolarctos cinereus*)

The Koala is currently listed as Vulnerable under the TSC Act.

Koala habitat has been mapped in the study area.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Koala are known (based on species information at http://www.environment.nsw.gov.au):

- Inhabit eucalypt woodlands and forests.

- Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species.
- Inactive for most of the day, feeding and moving mostly at night.
- Spend most of their time in trees, but will descend and traverse open ground to move between trees.
- Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size.
- Generally solitary, but have complex social hierarchies based on a dominant male with a territory overlapping several females and sub-ordinate males on the periphery.
- Females breed at two years of age and produce one young per year.

Identified threats to the species include:

- Loss, modification and fragmentation of habitat;
- Predation by feral and domestic dogs;
- Intense fires that scorch or kill the tree canopy;
- Road-kills; and
- Human-induced climate change, especially drought.

Given the extensive habitat features present in the Study Area and Locality, and the negligible impacts to foraging resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on koala habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The proposed artificial opening of the Tallows Creek estuary is not inconsistent with the Recovery Plan for the Koala (*Phascolarctos cinereus*) DECC, 2008.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be negligible;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.24 Common Planigale (*Planigale maculatus*)

The Common Planigale is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes freshwater wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Common Planigale are known (based on species information at http://www.environment.nsw.gov.au):

- Inhabit rainforest, eucalypt forest, heathland, marshland, grassland and rocky areas where there is surface cover, and usually close to water.
- They are active at night and during the day shelter in saucer-shaped nests built in crevices, hollow logs, beneath bark or under rocks.
- They are fierce carnivorous hunters and agile climbers, preying on insects and small vertebrates, some nearly their own size.
- They breed from October to January.
- The female builds a nest lined with grass, eucalypt leaves or shredded bark.

Identified threats to the species include:

- Predation by foxes and cats.
- Predation and poisoning by cane toads.
- Loss and fragmentation of habitat through clearing for agriculture and development in coastal areas.
- Frequent burning that reduces ground cover such as hollow logs and bark.
- Over grazing that reduces ground cover.
- Disturbance of vegetation surrounding water bodies.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.25 Long-nosed Potoroo (*Potorous tridactylis*)

The Long-nosed Potoroo is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes heath.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The following ecological characteristics of the Long-nosed Potoroo are known (based on species information at http://www.environment.nsw.gov.au):

- Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature.
- The fruit-bodies of hypogeous (underground-fruiting) fungi are a large component of the diet of the Long-nosed Potoroo. They also eat roots, tubers, insects and their larvae and other soft-bodied animals in the soil.
- Often digs small holes in the ground in a similar way to bandicoots.
- Mainly nocturnal, hiding by day in dense vegetation - however, during the winter months animals may forage during daylight hours.
- Individuals are mainly solitary, non-territorial and have home range sizes ranging between 2-5 ha.
- Breeding peaks typically occur in late winter to early summer and a single young is born per litter. Adults are capable of two reproductive bouts per annum.

Identified threats to the species include:

- Habitat loss and fragmentation from land clearing for residential and agricultural development.
- Predation from foxes, dogs and cats.
- Too frequent fires or grazing by stock that reduce the density and floristic diversity of understorey vegetation.
- Logging regimes or other disturbances that reduce the availability and abundance food resources, particularly hypogenous fungi, and ground cover.
- Removal of wild dogs and dingoes potentially exposes potoroos to other threats (competition from other species of wallaby / fox predation) due to removal of top order predator.
- Unplanned clearing in areas where the species occurs on private property is likely to degrade the species' habitat.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to habitat resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

Terrestrial vegetation, including heath, adjacent to wetland communities fringing the estuary may expand as a result of the proposed estuary opening. As a result of reduced inundation, some terrestrial species (including invasive and introduced species) may expand into habitats previously occupied by wetland species. This is most likely to occur at the ecotones between swamp sclerophyll forest / woodland with moist/ dry sclerophyll communities, heath, littoral rainforest and disturbed habitats. Although the extent of terrestrial vegetation expansion is expected to be minor (in the order of metres) any expansion of disturbed habitat is likely to result in increased weed invasion in wetland communities.

As there is expected to be a net gain in terrestrial habitat (i.e expansion of sclerophyll woodlands and heath), it could be assumed that any threatened species associated with these habitats would benefit. However, given the minor habitat interchanges anticipated (in the order of metres) the impacts on threatened species populations are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the heath habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and

- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.26 Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*)

The Eastern Chestnut Mouse is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes heath, freshwater and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Eastern Chestnut Mouse are known (based on species information at http://www.environment.nsw.gov.au):

- In NSW the Eastern Chestnut Mouse is mostly found, in low numbers, in heathland and is most common in dense, wet heath and swamps. In the tropics it is more an animal of grassy woodlands.
- Optimal habitat appears to be in vigorously regenerating heathland burnt from 18 months to four years previously. By the time the heath is mature, the larger Swamp Rat becomes dominant, and Eastern Chestnut Mouse numbers drop again.
- Feeds at night via runways through the grassy and sedge understorey, within an area of less than half a hectare. It has a broad diet of grass stems, invertebrates, fungi and seeds, with the relative significance of each component varying seasonally.
- Up to three litters are produced from spring to autumn; this strategy allows rapid build-up of numbers in years following fire.

Identified threats to the species include:

- Long-term fire exclusion from its habitat heavily favours the competing Swamp Rat;
- Loss of natural swampland and heathland to agriculture, mining, and urban development;

- Predation by Red Fox;
- Feral pigs; and
- Direct predation on adults by cats and dogs.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to habitat resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

Terrestrial vegetation, including heath, adjacent to wetland communities fringing the estuary may expand as a result of the proposed estuary opening. As a result of reduced inundation, some terrestrial species (including invasive and introduced species) may expand into habitats previously occupied by wetland species. This is most likely to occur at the ecotones between swamp sclerophyll forest / woodland with moist/ dry sclerophyll communities, heath, littoral rainforest and disturbed habitats. Although the extent of terrestrial vegetation expansion is expected to be minor (in the order of metres) any expansion of disturbed habitat is likely to result in increased weed invasion in wetland communities.

As there is expected to be a net gain in terrestrial habitat (i.e expansion of sclerophyll woodlands and heath), it could be assumed that any threatened species associated with these habitats would benefit. However, given the minor habitat interchanges anticipated (in the order of metres) the impacts on threatened species populations are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland and heath habitats of the study area, will not fragment or isolate potential habitat from other areas of

habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara; and*
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.27 Grey-headed Flying Fox (*Pteropus poliocephalus*)

The Grey-headed Flying Fox is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes freshwater and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Grey-headed Flying Fox are known (based on species information at http://www.environment.nsw.gov.au):

- Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops.
- Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.
- Individual camps may have tens of thousands of animals and are used for mating, and for giving birth and rearing young.
- Annual mating commences in January and conception occurs in April or May; a single young is born in October or November.
- Site fidelity to camps is high; some camps have been used for over a century.
- Can travel up to 50 km from the camp to forage; commuting distances are more often <20 km.
- Feed on the nectar and pollen of native trees, in particular *Eucalyptus, Melaleuca* and *Banksia*, and fruits of rainforest trees and vines.
- Also forage in cultivated gardens and fruit crops.

Identified threats to the species include:

- Loss of foraging habitat;
- Loss and disturbance of roosting sites;
- Unregulated shooting;
- Electrocution on powerlines, entanglement in netting and on barbed-wire;
- Competition with Black Flying-foxes;
- Negative public attitudes and conflict with humans;
- Impacts from climate change; and
- Disease.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on potential habitat features for this species within the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The proposed artificial opening of the Tallows Creek estuary is not inconsistent with the Department of Environment, Climate Change and Water NSW. 2009. Draft National Recovery Plan for the Grey-headed Flying-fox Pteropus poliocephalus. Prepared by Dr Peggy Eby. Department of Environment, Climate Change and Water NSW, Sydney.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.28 Yellow-bellied Sheath-tail Bat (*Saccolaimus flaviventris*)

The Yellow-bellied Sheath-tail Bat is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes freshwater and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Yellow-bellied Sheath-tail Bat are known (based on species information at http://www.environment.nsw.gov.au):

- Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows.
- When foraging for insects, flies high and fast over the forest canopy, but lower in more open country.

- Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory.
- Breeding has been recorded from December to mid-March, when a single young is born.
- Seasonal movements are unknown; there is speculation about a migration to southern Australia in late summer and autumn.

Identified threats to the species include:

- Disturbance to roosting and summer breeding sites;
- Foraging habitats are being cleared for residential and agricultural developments, including clearing by residents within rural subdivisions;
- Loss of hollow-bearing trees; clearing and fragmentation of forest and woodland habitat; and
- Pesticides and herbicides may reduce the availability of insects, or result in the accumulation of toxic residues in individuals' fat stores.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to

the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on potential habitat features for this species within the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;

- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.29 Greater Broad-nosed Bat (*Scoteanax rueppell*i)

The Greater Broad-nosed Bat is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes freshwater and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Greater Broad-nosed Bat are known (based on species information at http://www.environment.nsw.gov.au):

- Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest.
- Although this species usually roosts in tree hollows, it has also been found in buildings.
- Forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 - 6 m.
- Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species.
- Little is known of its reproductive cycle, however a single young is born in January; prior to birth, females congregate at maternity sites located in suitable trees, where they appear to exclude males during the birth and raising of the single young.

Identified threats to the species include:

- Disturbance to roosting and summer breeding sites;
- Foraging habitats are being cleared for residential and agricultural developments, including clearing by residents within rural subdivisions;
- Loss of hollow-bearing trees;
- Pesticides and herbicides may reduce the availability of insects, or result in the accumulation of toxic residues in individuals' fat stores; and
- Changes to water regimes are likely to impact food resources, as is the use of pesticides and herbicides near waterways.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on potential habitat features for this species within the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.30 Eastern Blossom Bat (*Syconycteris australis*)

The Eastern Blossum Bat is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes freshwater and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Eastern Blossum Bat are known (based on species information at http://www.environment.nsw.gov.au):

- Common Blossom-bats often roost in littoral rainforest and feed on nectar and pollen from flowers in adjacent heathland and paperbark swamps. They have also been recorded in a range of other vegetation communities, such as subtropical rainforest, wet sclerophyll forest and other coastal forests.
- They generally roost individually in dense foliage and vine thickets of the sub-canopy, staying in the same general area for a season. They change roost sites daily, but each roost site is generally only 50m or so away from other recent roosts.
- Favoured feeding sites are repeatedly visited on consecutive nights within a flowering season and revisted over several years.
- They require a year round supply of nectar and pollen which is gathered from a mosaic of coastal complex vegetation types. When these vegetation types are in short supply of nectar and pollen (Nov/Dec in northern NSW) Common Blossom-bats have been known to utilise riverine areas containing Black Bean, Silky Oak and Weeping Bottlebrush.

Identified threats to the species include:

- Clearing of coastal habitat for urban development or sandmining.
- Weeds, such as Bitou Bush, that suppress the regeneration of key food trees, such as Coastal Banksia.
- Predation by foxes and feral cats may occur whilst the bat is feeding on low hanging flowers and fruit.
- Inappropriate fire regimes applied in heathland habitats leading to reduced flowering of *Banksia, Callistemon* and *Melaleuca* species.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to foraging and roosting resources expected as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on potential habitat features for this species within the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.31 Wallum Froglet (*Crinia tinnula*)

The Wallum Froglet is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes freshwater wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Wallum Froglet are known (based on species information at http://www.environment.nsw.gov.au):

- Wallum Froglets are found in a wide range of habitats, usually associated with acidic swamps on coastal sand plains. They occur in sedgelands, wet heathlands, paperbark swamps and drainage lines within other vegetation communities. They will also persist in disturbed areas.
- The species breeds in swamps with permanent water as well as shallow ephemeral pools and drainage ditches. Breeding peaks in the colder months, but can occur throughout the year following rain. Eggs of 1.1-1.2 mm are deposited in water with a pH of <6 and tadpoles take 2-6 months to develop into frogs.
- The Wallum Froglet is nocturnal, terrestrial and cryptic. They shelter during the day under leaf litter or other debris or in burrows of other species. Males call from secluded sites at the water's edge or from vegetation, such as sedges, near water level.

Identified threats to the species include:

- Destruction and degradation of coastal wetlands as a result of roadworks, coastal developments and sandmining.
- Reduction of water quality and modification to acidity in coastal wetlands.
- Grazing and associated frequent burning of coastal wetlands.

- Impact of pest vertebrate species.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to habitat resources within the study area as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will

not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camera;* and
- Predation by *Gambusia holbrooki* Girard, 1859 (plague minnow or mosquito fish).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.32 Wallum Sedge Frog (*Litoria olongburensis*)

The Wallum Sedge Frog is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes freshwater wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Wallum Sedge Frog are known (based on species information at http://www.environment.nsw.gov.au):

- Paperbark swamps and sedge swamps of the coastal "wallum" country. Wallum is a *Banksia* dominated lowland heath ecosystem characterised by acidic waterbodies.
- Olongburra Frogs are usually found amongst sedges and rushes in coastal wetlands.

Identified threats to the species include:

- Destruction and degradation of coastal wallum and coastal wetlands for roadworks, coastal developments and sand mining.
- Reduction of water quality and changes to acidity in coastal wetlands.
- Grazing and associated frequent burning of coastal wetlands.
- Impacts by vertebrate pest species.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to habitat resources within the study area as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara;* and
- Predation by *Gambusia holbrooki* Girard, 1859 (plague minnow or mosquito fish).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.33 Loggerhead Turtle (*Caretta caretta*)

The Loggerhead Turtle is currently listed as Endangered under the TSC Act.

Potential habitat for the species in the study area includes beach.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Loggerhead Turtle are known (based on species information at http://www.environment.nsw.gov.au):

- Loggerhead Turtles are ocean-dwellers, foraging in deeper water for fish, jellyfish and bottom-dwelling animals. The female comes ashore to lay her eggs in a hole dug on the beach in tropical regions during the warmer months.

Identified threats to the species include:

- Marine traffic colliding with turtles.
- Incidental catches when turtles are caught up in nets, traps, longlines and other fishing gear or netting from shark control programs.
- Marine debris, particularly plastic, which can cause suffocation, abrasion, infection or blockages in the turtle's system when swallowed.
- Disturbance to nest sites.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to beach habitat as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

The most significant ecological impact associated with the proposal is likely to be the direct physical impact through the excavation of the estuary channel and disturbance during transportation of equipment to and from this site. It is understood that access to the entrance will involve transportation of equipment along Tallow Beach and/or through Arakwal National Park.

The greatest ecological risk during mobilisation and excavation works would be for fauna utilising the upper beach and berm. Most fauna would be able to move out of the way of equipment and works without any significant impact. However, there may be an issue if sensitive fauna, such as the Loggerhead Turtle, are nesting at these sites. These impacts could be avoided / mitigated by minimising the extent of travel along the beach and if possible, by avoiding works at times when target species are nesting. In addition, the use of smaller equipment such as a backhoe should also be employed to minimise the area of disturbance.

Pre-disturbance ecological surveys in consultation with the relevant authorities would be required to locate any threatened species and their nesting sites in the beach areas to be impacted. If nests are located along the access route, then alternative routes should be sought. If nests are located in the estuary mouth, these may need to be relocated in consultation with the relevant authorities (approvals and permits will be required under the TSC Act and EPBC Act). Surveys may however need to be undertaken on short notice (following unexpectedly high rainfall for example) potentially limiting opportunities for consultation.

In the event the mouth is required to be opened at short notice, for example to reduce flash flooding impacts, contingency measures will need to be in place to appropriately manage Loggerhead Turtles. For example it may be necessary to engage local wildlife catchers and spotters to survey and relocate species on short notice. The contingency plan will need to be developed in consultation with, and approved by, the relevant authorities.

Provided the above recommendations are carried out, the proposed artificial opening of the estuary will have a minor impact on Loggerhead Turtle nesting habitats of the study area. The proposal will

not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.34 Green Turtle (*Chelonia mydas*)

The Green Turtle is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes beach.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Green Turtle are known (based on species information at http://www.environment.nsw.gov.au):

- Ocean-dwelling species spending most of its life at sea.
- Carnivorous when young but as adults they feed only on marine plant material.
- Eggs laid in holes dug in beaches throughout their range.
- Scattered nesting records along the NSW coast.

Identified threats to the species include:

- Collision with boats and other marine traffic.
- Accidental entanglement in shark nets, traps, longlines and other fishing gear.
- Marine debris, particularly plastic, which is mistaken for jellyfish and can cause asphyxiation, abrasion, infection and blockages in the turtle's system when swallowed.
- Predation at nest site by feral pigs and foxes.
- Disturbance to nest sites.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to beach habitat as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

The most significant ecological impact associated with the proposal is likely to be the direct physical impact through the excavation of the estuary channel and disturbance during

transportation of equipment to and from this site. It is understood that access to the entrance will involve transportation of equipment along Tallow Beach and/or through Arakwal National Park.

The greatest ecological risk during mobilisation and excavation works would be for fauna utilising the upper beach and berm. Most fauna would be able to move out of the way of equipment and works without any significant impact. However, there may be an issue if sensitive fauna, such as the Green Turtle, are nesting at these sites. These impacts could be avoided / mitigated by minimising the extent of travel along the beach and if possible, by avoiding works at times when target species are nesting. In addition, the use of smaller equipment such as a backhoe should also be employed to minimise the area of disturbance.

Pre-disturbance ecological surveys in consultation with the relevant authorities would be required to locate any threatened species and their nesting sites in the beach areas to be impacted. If nests are located along the access route, then alternative routes should be sought. If nests are located in the estuary mouth, these may need to be relocated in consultation with the relevant authorities (approvals and permits will be required under the TSC Act and EPBC Act). Surveys may however need to be undertaken on short notice (following unexpectedly high rainfall for example) potentially limiting opportunities for consultation.

In the event the mouth is required to be opened at short notice, for example to reduce flash flooding impacts, contingency measures will need to be in place to appropriately manage Green Turtles. For example it may be necessary to engage local wildlife catchers and spotters to survey and relocate species on short notice. The contingency plan will need to be developed in consultation with, and approved by, the relevant authorities.

Provided the above recommendations are carried out, the proposed artificial opening of the estuary will have a minor impact on Green Turtle nesting habitats of the study area. The proposal will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.35 Australian Fritillary Butterfly (*Argyreus hyperbius*)

The Australian Fritillary Butterfly is currently listed as Endangered under the TSC Act.

Potential habitat for the species in the study area includes freshwater wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Australian Fritillary Butterfly are known (based on species information at http://www.environment.nsw.gov.au):

- Laced Fritillary is found in open swampy coastal habitat.
- Eggs are laid singly on a leaf of the caterpillar's food plant, the Native Violet (*Viola betonicifolia*).
- The food plant occurs in ground level vegetation in swampy areas beneath grasses and mat-rushes (*Lomandra* spp.).
- Many former sites have been destroyed and records now only occur from a few widely separated sites.
- Adults feed from flowers of various plants in vegetation surrounding breeding habitat (possibly up to 1km).

Identified threats to the species include:

- Weed invasion which threatens the food plant and its habitat.
- Clearing, draining and development of coastal wetland habitat.
- Burning of coastal wetland habitat.
- Over-collection of adults by butterfly enthusiasts.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to habitat resources within the study area as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.36 Giant Dragonfly (*Petalura gigantea*)

The Giant Dragonfly is currently listed as Endangered under the TSC Act.

Potential habitat for the species in the study area includes freshwater wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Giant Dragonfly are known (based on species information at http://www.environment.nsw.gov.au):

- Live in permanent swamps and bogs with some free water and open vegetation.
- Adults emerge from late October and are short-lived, surviving for one summer after emergence.
- Adults spend most of their time settled on low vegetation on or adjacent to the swamp. They hunt for flying insects over the swamp and along its margins.
- Adults fly over the swamp and along its margins hunting for flying insects.
- Males sometimes congregate waiting for females to mate with.
- Females lay eggs into moss, under other soft ground layer vegetation, and into moist litter and humic soils, often associated with groundwater seepage areas within appropriate swamp and bog habitats. The species does not utilise areas of standing water wetland, although it may utilise suitable boggy areas adjacent to open water wetlands.
- Larvae dig long branching burrows under the swamp. Larvae are slow growing and the larval stage may last 10 years or more.
- It is thought that larvae leave their burrows at night and feed on insects and other invertebrates on the surface and also use underwater entrances to hunt for food in the aquatic vegetation.

Identified threats to the species include:

- Changes to natural fire regimes, and disturbances associated with bushfire hazard reduction activities such as construction of access tracks and fuel breaks, slashing, mowing and frequent hazard reduction burning.
- Clearing and development of land resulting in loss of habitat and habitat degradation such as erosion, sedimentation, eutrophication and weed invasion.
- Weed invasion, especially by Lippia and African Boxthorn, but including others such as encroachment by *Pinus radiata* wildlings from nearby plantations.
- Damage to habitat by feral pigs and domestic stock.
- Decreasing water quality of swamps through pollution, eutrophication and sedimentation.
- Application of pesticides on or adjacent to swamps.
- Factors that impact on swamp hydrology such as longwall mining, groundwater extraction, construction of roads, tracks and establishment of plantations.
- Overuse of walking trails and unauthorised use of off-road vehicles, including trail bikes.
- Climate change effects such as reduced groundwater and increases in fire frequency and intensity.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to habitat resources within the study area as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara;* and
- Predation by *Gambusia holbrooki* Girard, 1859 (plague minnow or mosquito fish).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.37 Mitchells' Rainforest Snail (*Thersites mitchellae*)

The Mitchells' Rainforest Snail is currently listed as Endangered under the TSC Act.

Potential habitat for the species in the study area includes freshwater wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Mitchells' Rainforest Snail are known (based on species information at http://www.environment.nsw.gov.au):

- Remnant areas of lowland subtropical rainforest and swamp forest on alluvial soils. Slightly higher ground around the edges of wetlands with palms and fig trees are particularly favoured habitat.
- Typically found amongst leaf litter on the forest floor, and occasionally under bark in trees.
- Active at night and feeds on leaf litter, fungi and lichen.

Identified threats to the species include:

- Clearing of lowland rainforest, swamp forest and wetland margins for urban development and agriculture.
- Damage to remnant areas of habitat by fire, weed invasion and grazing by stock.
- Predation of snails by introduced rats.
- Use of herbicides and pesticides in and near areas of habitat.
- Dieback caused by root rot fungus (*Phytophthora cinnamomi*).
- Edge effects are significant given the small size and shape of remnant habitat patches, increasing the severity of disturbance from fire, weeds, predation by introduced rats and the chance of dessication from habitat degradation.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to habitat resources within the study area as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The proposed artificial opening of the Tallows Creek estuary is not inconsistent with the NSW National Parks and Wildlife Service (2001). Mitchell's Rainforest Snail *Thersites mitchellae* recovery plan. NPWS, Hurstville, NSW.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- Foraging, roosting and shelter habitats are widespread;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.38 Eastern Freshwater Cod (*Maccullochella ikei*)

The Eastern Freshwater Cod is currently listed as Endangered under the TSC Act.

Potential habitat for the species in the study area includes open freshwater.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Eastern Freshwater Cod are known (based on species information at http://pas.dpi.nsw.gov.au):

- Eastern freshwater cod are often found in clear, flowing streams with rocky beds and deep holes. They are generally found in areas that have plenty of boulders or large woody debris (snags). Riparian vegetation, large boulders and snags provide a complex array of habitats for each stage of the cod life cycle and influence the quality and quantity of food and shelter.
- Eastern freshwater cod are sexually mature at 4 or 5 years old, when 700g to 1.5kg. The breeding season is in spring and spawning commences when water temperatures rise above 16°C. Breeding fish are territorial and aggressive. Cod lay large (3mm) strongly adhesive eggs onto hard surfaces, probably rocks and logs in the wild. The number of eggs produced is relatively low and similar to Murray cod (3.2 – 7.6 eggs/gram of female bodyweight). Hatching begins at 8 days and is complete 12 days after fertilisation at 17°C – 20°C. Larvae start feeding on zooplankton 12 days after hatching.
- Eastern freshwater cod prey upon other fish, frogs, crustaceans and snakes. Zooplankton and aquatic insects are the main food source for eastern cod larvae.

Identified threats to the species include:

- Historical decline of eastern freshwater cod is thought to have been caused by a combination of over-fishing, including by the use of explosives, with a series of catastrophic natural events where heavy rains followed severe bushfires, causing a deterioration of water quality and leading to widespread fish kills.

- Releases of contaminated water from tailings dams at gold and tin mines are also thought to have caused the death of cod and other freshwater fish in parts of the Clarence system.
- River regulation and water extraction reduce flows and can affect seasonality of flows, detrimentally impacting on the fish.
- Habitat degradation including reduction of in-stream woody debris, sedimentation of deeper holes, changes to stream substrates suitable for invertebrate production, and reduction of aquatic vegetation.
- Barriers such as weirs, dams, road crossings and farm tracks can prevent fish access to spawning and feeding areas, fragment fish populations, and interrupt exchange of genetic material.
- Loss of riparian vegetation contributing to reduced bank stability, reduction in water quality, reduced shading, increased water temperatures, and reduced habitats for terrestrial and aquatic plants and animals.
- Introduced species such as Murray cod and banded grunter may pose threats from disease, competition, predation, and habitat degradation.
- Illegal fishing practices directly reduce eastern cod numbers, remove breeding age adults, and can disturb breeding activities including egg guarding, leading to increased predation of eggs and juveniles by eels.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to habitat resources within the study area as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the quality and spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of habitat and temporary changes to water quality, this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat changes anticipated, the impacts on threatened species populations reliant on these habitats are expected to be minor.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands; and
- Predation by *Gambusia holbrooki* Girard, 1859 (plague minnow or mosquito fish).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to freshwater habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.39 Oxleyan Pygmy Perch (*Nannoperca oxleyana*)

The Oxleyan Pygmy Perch is currently listed as Endangered under the TSC Act.

Potential habitat for the species in the study area includes freshwater wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Oxleyan Pygmy Perch are known (based on species information at

- Oxleyan pygmy perch are mainly carnivorous, feeding on small crustaceans, aquatic insects, diatoms and filamentous algae.
- In aquaria, sexual maturity is reached in four to five months, when females are around 30 mm and males around 27 mm. In the wild, all females and males over 30mm are mature. However, fish can reach maturity at lengths as small as 20mm.
- They have an extended breeding season from early spring through to late autumn, although spawning is concentrated from October to December, when water temperatures exceed 20ºC. A few eggs are laid daily over a period of several days, and are scattered over the bottom substrate or aquatic vegetation. At 25 ºC, the eggs of aquarium-reared fish hatch in approximately two days and begin feeding five days after hatching.
- A few eggs are laid each day over several days, and are scattered over the bottom. Eggs hatch in three to four days and the larvae begin feeding in another day or two.
- Populations are most common on the coastal floodplains of NSW where they disperse between water bodies during localised flood events.
- They seem to prefer slow-moving or still waters with plenty of shelter in the form of dense aquatic vegetation (e.g. sedges) or undercut, root-filled banks.

Identified threats to the species include:

- Coastal development (e.g. housing, roads, sand-mining, agriculture, forestry), resulting in habitat disturbance, erosion, siltation and water quality decline.
- Competition from introduced fish species such as the plague minnow, *Gambusia holbrooki.*
- Collection for aquaria.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to habitat resources within the study area as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the quality and spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of habitat and temporary changes to water quality, this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat changes anticipated, the impacts on threatened species populations reliant on these habitats are expected to be minor.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands; and
- Predation by *Gambusia holbrooki* Girard, 1859 (plague minnow or mosquito fish).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to freshwater habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.40 White Lace Flower (Archidendron hendersonii)

The White Lace Flower is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes lowland rainforest.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the White Lace Flower are known (based on species information at http://www.environment.nsw.gov.au).

The species occurs in riverine and lowland subtropical rainforest, littoral rainforest, coastal cypress pine forest and their ecotones on a variety of soils including coastal sands and those derived from basalt and metasediments. Although the species flowers and fruits well, it is often represented by only single trees per stand and seedlings are rare.

Given the small size of known populations, and the small size of the stands of rainforest in which they are found the species is at risk from further rainforest fragmentation and habitat degradation from weed invasion and disturbance. Other threats include iIllegal collection of seeds for horticulture, trampling by domestic stock, saltwater intrusion and increased intensity of storms/winds, disturbance from road and track maintenance activities and inappropriate fire regimes.

Given the anticipated minor impacts to habitat resources within the study area as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

The most significant ecological impact associated with the proposal is likely to be the direct physical impact through the excavation of the estuary channel and disturbance during transportation of equipment to and from this site. These actions will not directly impact on habitat potentially suitable for the White Lace Flower.

Wetland communities fringing the estuary, such as swamp sclerophyll, saltmarsh and possibly mangroves, that rely on regular inundation will be most vulnerable to impacts associated with artificial opening of the estuary mouth. It is not anticipated that the proposed works will profoundly change water levels to the extent that floodplain vegetation communities and their associated habitats, including lowland rainforest, are impacted.

The proposed artificial opening of the estuary will have a negligible impact on the lowland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;

- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara;* and
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- The habitat most at risk from impacts associated with artificial opening of the estuary is not suitable for the White Lace Flower and no habitat considered to be important for the long-term survival of the species occurs within the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.41 Sand Spurge (*Chamaesyce psammogeton*)

The Sand Spurge is currently listed as Endangered under the TSC Act.

Potential habitat for the species in the study area includes beach.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Sand Spurge are known (based on species information at http://www.environment.nsw.gov.au):

- Grows on fore-dunes, pebbly strandlines and exposed headlands, often with Spinifex (*Spinifex sericeus*) and Prickly Couch (*Zoysia macrantha*);
- Flowering recorded in spring and summer;
- Sand Spurge seeds float, so some dispersal between beaches may occur;
- Longevity of the species is approximately 5 – 30 years with a primary juvenile period of less than 1 year; and
- Plant growth occurs in spring and summer.

Identified threats to the species include:

- Coastal developments may increase visitor pressure on populations;
- Off-road driving is a threat to Sand Spurge;

- Bitou Bush (*Chrysanthemoides monilifera*) invades Sand Spurge habitat and smothers the species;
- Excessive pedestrian trampling may cause erosion of dunes and loss of Sand Spurge habitat;
- Sea level rise and storm surge;
- Substrate disturbance and removal of dune structure to make way for airport development;
- Little recent survey has meant that the species' distribution and abundance is relatively unknown; and
- Dune Thistle, Primrose, Sea rocket, Scaevola and Bitou bush directing outcompeting the species.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to habitat resources within the study area as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

The most significant ecological impact associated with the proposal is likely to be the direct physical impact through the excavation of the estuary channel and disturbance during transportation of equipment to and from this site. It is understood that access to the entrance will involve transportation of equipment along Tallow Beach and/or through Arakwal National Park.

The greatest ecological risk during mobilisation and excavation works would be for flora on the upper beach and berm. These impacts could be avoided / mitigated by minimising the extent of

works along the beach and berm. In addition, the use of smaller equipment such as a backhoe should also be employed to minimise the area of disturbance.

Pre-disturbance ecological surveys in consultation with the relevant authorities would be required to locate any threatened species in the beach areas to be impacted. If the species is located along the access route, then alternative routes should be sought. Plants may need to be relocated in consultation with the relevant authorities (approvals and permits will be required under the TSC Act and EPBC Act).

Provided the above recommendations are carried out, the proposed artificial opening of the estuary will have a minor impact on Sand Spurge. The proposal will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara;* and
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;

- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.42 Stinking Cryptocarya (Cryptocarya foetida)

Stinking Cryptocarya is currently listed as Vulnerable under the TSC Act.

Potential habitat for the species in the study area includes lowland rainforest.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of Stinking Cryptocarya are known (based on species information at http://www.environment.nsw.gov.au).

The species is found in littoral, warm temperate and subtropical rainforest, wet sclerophyll forest and Camphor laurel forest on sandy soils. Mature trees are also known on basalt soils. Though seedlings can be fairly numerous, few mature trees are known. Seeds are readily dispersed by fruit-eating birds and seedlings and saplings have been recorded in unsuitable habitat where they are unlikely to develop to maturity.

Identified threats to the species include:

- Risk of local extinction to small populations.
- Clearing and fragmentation of habitat for development.
- Clearing and fragmentation of habitat for agriculture.
- Infestation of habitat by weeds.
- Clearing and disturbance as a result of roadworks and track maintenance.
- Inappropriate fire regime.
- Trampling by visitors when accessing beach areas through littoral rainforest.
- Trampling by domestic stock.
- Inappropriate fire regime altering habitat and destroying individuals.

Given the anticipated minor impacts to potential habitat resources within the study area as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

The most significant ecological impact associated with the proposal is likely to be the direct physical impact through the excavation of the estuary channel and disturbance during transportation of equipment to and from this site. These actions will not directly impact on habitat potentially suitable for stinking Cryptocarya.

Wetland communities fringing the estuary, such as swamp sclerophyll, saltmarsh and possibly mangroves, that rely on regular inundation will be most vulnerable to impacts associated with artificial opening of the estuary mouth. It is not anticipated that the proposed works will profoundly change water levels to the extent that floodplain vegetation communities and their associated habitats, including lowland rainforest, are impacted.

The proposed artificial opening of the estuary will have a negligible impact on the lowland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;

- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara;* and
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- The habitat most at risk from impacts associated with artificial opening of the estuary is not suitable for Stinking Cryptocarya and no habitat considered to be important for the long-term survival of the species occurs within the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.43 Pink Nodding Orchid (*Geodorum densiflorum*)

The Pink Nodding Orchid is currently listed as Endangered under the TSC Act.

Potential habitat for the species in the study area includes freshwater and estuarine wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Pink Nodding Orchid are known (based on species information at http://www.environment.nsw.gov.au):

- Dry eucalypt forest and coastal swamp forest at lower altitudes, often on sand.

Identified threats to the species include:

- Clearing and fragmentation of habitat for urban development;
- Invasion of habitat by introduced weeds such as Bitou Bush;
- Trampling by bushwalkers and fishers; and
- Illegal collection of orchids.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to habitat resources within the study area as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.44 Swamp Orchid (*Phaius australis*)

The Swamp Orchid is currently listed as Endangered under the TSC Act.

Potential habitat for the species in the study area includes freshwater wetland.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The following ecological characteristics of the Swamp Orchid are known (based on species information at http://www.environment.nsw.gov.au):

- Swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas.

Identified threats to the species include:

- Illegal collection for horticulture or cut flowers. This showy species is highly sought after;
- Small population size;
- Drainage of swamps, or pollution from nutrient run-off;
- Frequent fire;
- Grazing and trampling by domestic stock and feral pigs;
- Invasion of habitat by introduced weeds;
- Trail bike riders disturbing substrate and destroying plants;
- Rubbish dumping and other disturbance due vehicles and/or people; and
- Clearing and fragmentation of habitat for development, agriculture and roadworks.

Given the extensive habitat features present in the Study Area and Locality, and the minor impacts to habitat resources within the study area as a result of artificial opening of the estuary, it is unlikely that the proposal would place a viable population of this species at risk of extinction.

) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened species population which could be supported by the estuary over the long term. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened species populations reliant on these habitats are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat(either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers; and
- Invasion, establishment and spread of *Lantana camara.*

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the species, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- The habitat to be impacted is not considered to be important for the long-term survival of the species in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for the species.

2.45 Coastal Saltmarsh in the NSW North Coast Bioregion

Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions is currently listed as an Endangered Ecological Community under the TSC Act.

This community occurs in the intertidal zone within the Tallows Creek estuary.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

The following ecological characteristics of coastal saltmarsh are known (based on information at http://www.environment.nsw.gov.au):

- Occurs in the intertidal zone on the shores of estuaries and lagoons that are permanently or intermittently open to the sea.
- Frequently found as a zone on the landward side of mangrove stands.
- Characteristic species include *Baumea juncea*, Sea Rush (*Juncus kraussii subsp. australiensis*), Samphire (*Sarcocornia quinqueflora subsp.quinqueflora*), Marine Couch (*Sporobolus virginicus*), Streaked Arrowgrass (*Triglochin striata*), Knobby Club-rush (*Ficinia nodosa*), Creeping Brookweed (*Samolus repens*), Swamp Weed (*Selliera radicans*), Seablite (*Suaeda australis*) and Prickly Couch (*Zoysia macrantha*).
- Occasionally mangroves are scattered through the saltmarsh and tall reeds may also occur, as well as salt pans.

Identified threats to the community include:

- In-filling for development, including roads, residential, industrial, recreational, waste disposal and agricultural purposes.
- Modification of tidal flows as a consequence of artificial structures being erected.
- Alteration of salinity and increasing nutrient levels resulting from the discharge of stormwater into saltmarshes.

- Weed invasion, particularly by *Juncus acutus*.
- Physical damage from human disturbance, domestic and feral animals.
- Dumping of rubbish and pollution from oil or chemical spills from shipping or road accidents; catchment runoff of nutrients and agricultural chemicals.
- Invasion by mangroves.
- Inappropriate fire regimes.

Given the minor impacts to saltmarsh habitat within the study area as a result of artificial opening of the estuary, it is unlikely that the proposal would have an adverse effect on the extent or composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species and communities which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened community. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened communities are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this species has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara;* and
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the community, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- The habitat to be impacted is not considered to be important for the long-term survival of the community in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for this community.

2.46 Lowland Rainforest in the NSW North Coast

Lowland Rainforest in the NSW North Coast is currently listed as an Endangered Ecological Community under the TSC Act.

This community occurs on the floodplains of the Tallows Creek estuary.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

The following ecological characteristics of Lowland Rainforest in the NSW North Coast are known (based on information at http://www.environment.nsw.gov.au):

Lowland Rainforest may be associated with a range of high-nutrient geological substrates, notably basalts and fine-grained sedimentary rocks, on coastal plains and plateaux, footslopes and foothills. In a relatively undisturbed state, this community has a closed canopy characterised by a high diversity of species.

Identified threats to this community include: fragmentation and loss of connectivity, weed invasion particularly vines and scramblers, inappropriate fire regimes, grazing, climate change, soil compaction, pathogen spread, clearing of understorey and inappropriate collection of plant species.

Given the minor impacts anticipated within the floodplain and adjacent landward communities as a result of artificial opening of the estuary, it is unlikely that the proposal would have an adverse effect on the extent or composition of this ecological community such that its local occurrence is likely to be placed at risk of extinction.

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

The most significant ecological impact associated with the proposal is likely to be the direct physical impact through the excavation of the estuary channel and disturbance during transportation of equipment to and from this site. These actions will not directly impact on Lowland Rainforest habitat.

Wetland communities fringing the estuary, such as swamp sclerophyll, saltmarsh and possibly mangroves that rely on regular inundation will be most vulnerable to impacts associated with artificial opening of the estuary mouth. It is not anticipated that the proposed works will profoundly change water levels to the extent that floodplain and adjacent habitats, including lowland rainforest, will be impacted.

The proposed artificial opening of the estuary will have a negligible impact on the lowland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this community has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for this community.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara;* and
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed).

The Proposal has the potential to increase the above KTPs towards this community, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on this community, as:

- The habitat most at risk from impacts associated with artificial opening of the estuary is not suitable for Lowland Rainforest and no habitat considered to be important for the long-term survival of this community occurs within the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for this community.

2.47 Swamp Sclerophyll Forest on Coastal Floodplains

Swamp Sclerophyll Forest on Coastal Floodplains is currently listed as an Endangered Ecological Community under the TSC Act.

This community occurs on the floodplains of the Tallows Creek estuary.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

The following ecological characteristics of swamp sclerophyll forest are known (based on information at http://www.environment.nsw.gov.au):

- Has an open to dense tree layer of eucalypts and paperbarks, a layer of small trees may be present and the groundcover is composed of abundant sedges, ferns, forbs, and grasses.
- Associated with humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains.
- Generally occurs below 20 m (though sometimes up to 50 m) elevation.
- The composition of the community is primarily determined by the frequency and duration of waterlogging and the texture, salinity nutrient and moisture content of the soil, and latitude. The composition and structure of the understorey is influenced by grazing and fire history, changes to hydrology and soil salinity and other disturbance, and may have a substantial component of exotic grasses, vines and forbs.

Identified threats to the community include:

- Further clearing for urban and rural development, and the subsequent impacts from fragmentation;
- Flood mitigation and drainage works;
- Management of water and tidal flows;
- Landfilling and earthworks associated with urban and industrial development;
- Grazing and trampling by stock and feral animals (particularly pigs);
- Changes in water quality, particularly increased nutrients and sedimentation;
- Weed invasion;
- Climate change;
- Activation of acid sulfate soils;
- Removal of dead wood;
- Rubbish dumping; and

- Frequent burning which reduces the diversity of woody plant species.

Given the minor impacts to swamp sclerophyll habitat within the study area as a result of artificial opening of the estuary, it is unlikely that the proposal would have an adverse effect on the extent or composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands.

Estuaries are inherently highly dynamic environments and the species and communities which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened community. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened communities are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this community has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for the community.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara;* and
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the community, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- The habitat to be impacted is not considered to be important for the long-term survival of the community in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for this community.

2.48 Swamp Oak Floodplain Forest in the NSW North Coast Bioregion

Swamp Oak Floodplain Forest in the NSW Coast Bioregion is currently listed as Endangered under the TSC Act.

This community occurs on the floodplains of the Tallows Creek estuary.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

The following ecological characteristics of Swamp Oak Floodplain Forest (based on information at http://www.environment.nsw.gov.au):

- Is found on the coastal floodplains of NSW.
- It has a dense to sparse tree layer in which *Casuarina glauca* (swamp oak) is the dominant species.
- The understorey is characterised by frequent occurrences of vines, a sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter.
- The composition of the ground stratum varies depending on levels of salinity in the groundwater.
- Associated with grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains

Identified threats to the community include:

- Clearing for urban and rural development, and the subsequent impacts from fragmentation;
- Flood mitigation and drainage works;
- Grazing and trampling by stock;
- Grazing and trampling by feral animals (eg. pigs);
- Activation of acid sulfate soils;
- Landfilling and earthworks associated with industrial development;
- Pollution from urban and agricultural runoff;
- Rubbish dumping;
- Climate change;
- Localised areas, particularly those within urbanised regions, may also be exposed to frequent burning which reduces the diversity of woody plant species; and
- Weed invasion, particularly vines and Lantana.

Given the minor impacts to Swamp Oak Floodplain Forest habitat within the study area as a result of artificial opening of the estuary, it is unlikely that the proposal would have an adverse effect on the extent or composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands including saltmarsh.

Estuaries are inherently highly dynamic environments and the species and communities which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened community. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened communities are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this community has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for this community.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara;* and
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the community, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- The habitat to be impacted is not considered to be important for the long-term survival of the community in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for this community.

2.49 Freshwater Wetlands on Coastal Floodplains

Freshwater Wetlands on Coastal Floodplains in the NSW Coast Bioregion is currently listed as an Endangered Ecological Community under the TSC Act.

This community occurs on the floodplains of the Tallows Creek estuary.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

N/A

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

The following ecological characteristics of freshwater wetlands on coastal floodplains (based on information at http://www.environment.nsw.gov.au):

- Associated with coastal areas subject to periodic flooding and in which standing fresh water persists for at least part of the year in most years.
- Typically occurs on silts, muds or humic loams in low-lying parts of floodplains, alluvial flats, depressions, drainage lines, backswamps, lagoons and lakes but may also occur in backbarrier landforms where floodplains adjoin coastal sandplains.
- Dominated by herbaceous plants and have very few woody species. The structure and composition of the community varies both spatially and temporally depending on the water regime.

Identified threats to the community include:

- Land clearing;
- Continuing fragmentation and degradation;
- Flood mitigation and drainage works;
- Filling associated with urban and industrial development;
- Pollution and eutrophication from urban and agricultural runoff;
- Weed invasion;
- Overgrazing, trampling by livestock;
- Soil disturbance by pigs;
- Activation of acid sulfate soils;
- Dumping of landfill, rubbish and garden refuse;
- Native fauna is threatened by predation, particularly by mosquito fish and cane toads; and
- Anthropogenic climate change.

Given the minor impacts to freshwater floodplain wetland habitat within the study area as a result of artificial opening of the estuary, it is unlikely that the proposal would have an adverse effect on the extent or composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii)the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.

It is not anticipated that the proposed works will profoundly change water levels to the extent that vegetation communities and their associated habitats are removed from the study area. However, the proposal is likely to prevent very occasional inundation of wetland habitats and this may lead to the expansion of some terrestrial species. Wetland communities fringing the estuary that rely on regular inundation that will be most vulnerable to impacts associated with artificial opening of the estuary mouth include freshwater and estuarine wetlands.

Estuaries are inherently highly dynamic environments and the species and communities which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. As the main ecological impact resulting from artificial opening of the estuary mouth is likely to be the change in net extent of swamp sclerophyll, saltmarsh and possibly mangrove habitat (depends on changes in salinity levels), this could alter the size of a threatened

community. However, given the minor habitat interchanges anticipated (in the order of metres), the impacts on threatened communities are expected to be minor.

The proposed artificial opening of the estuary will have a negligible impact on the wetland habitats of the study area, will not fragment or isolate potential habitat from other areas of habitat and will not impact on the long-term survival of the species, population or ecological community in the Locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General maintains a Register of critical habitat. To date, no critical habitat for this community has been declared.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date, there is no recovery plan or threat abatement plan for this community.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed artificial estuary opening may directly or indirectly cause the following impacts which are currently listed as key threatening processes (KTP's) in NSW under the TSC Act:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- Invasion and establishment of exotic vines and scramblers;
- Invasion, establishment and spread of *Lantana camara;* and
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed).

The Proposal has the potential to increase the above KTPs towards the species, but impacts are expected to be minor.

Conclusion

The Proposal is not considered likely to result in a significant impact on local population(s) of the community, as:

- Extensive areas of potential habitat occur in the Study Area and Locality;
- The habitat to be impacted is not considered to be important for the long-term survival of the community in the Locality;
- Potential impacts to habitats are likely to be minor;
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly); and,
- The Proposal is not inconsistent with a recovery plan for this community.

BMT WBM

Tallows Creek Flora and Fauna Habitat Assessment

Reference: R.B20347.004.00.docx
Date: October 2014

Tallows Creek Flora and Fauna Habitat Assessment

Prepared for:	Byron Shire Council
Prepared by:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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Client Reference:	

Synopsis: **This report presents the findings of BMT WBM's desktop and field based investigations undertaken to addresses biodiversity elements outlined in the OEH (NPWS) assessment requirements associated with the REF for the proposed entrance opening.**

REVISION/CHECKING HISTORY

Revision Number	Date	Checked by		Issued by	
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BMT WBM File	PDF										
BMT WBM Library	PDF										

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1 Introduction

Byron Shire Council (BSC) proposes to increase periodic opening of Tallows Creek, an intermittently closed and open lake or lagoon (ICOLL), to reduce potential flooding impacts in the lower catchment (i.e. surrounding Tallow lagoon). To address potential ecological impacts associated with this proposal, BMT WBM prepared the *Tallow's Creek Proposed Artificial Opening – Threatened Species and Communities Data Review* in August 2013 (BMT WBM, 2013a).

The data review identified the threatened species, populations and ecological communities which may be affected either directly or indirectly, by the proposed artificial opening of the entrance. The review also included an assessment of species, populations and ecological communities listed in Schedules 1, 1A and 2 of the TSC Act and Schedules 4, 4A and 5 of the *Fisheries Management Act 1994* (FM Act) would require '7–part tests' to satisfy the requirements of the *Threatened Species Conservation Ac*t (1995) (TSC Act).

Based on the limited availability of survey data, a precautionary principle was adopted when identifying species and communities to be assessed. On this basis, BMT WBM completed 'Assessments of Significance' or '7–part tests' of the potential impacts of the proposed Tallow Creek mouth opening. This included assessment of twenty–eight (28) threatened species and four (4) threatened ecological communities (refer to BMT WBM, 2013b).

In June 2014, the Office of Environment and Heritage (OEH) provided a "*Scope of environmental assessment: opening of Tallow Creek – Arakwal National Park*," which detailed the OEH's requirements for a Review of Environmental Factors (REF) of the proposed artificial opening. As per the OEH requirements, BMT WBM was engaged by BSC to support the REF by:

- assessing the ecological values and condition of habitats which would be potentially impacted by the proposal;
- assessing potential impacts to locally occurring common and threatened species and communities; and
- validating the 7–part tests completed for the project.

This report provides the findings of the field survey undertaken to satisfy these requirements. The objectives of the field survey were to provide the following:

- a comprehensive description of the vegetation of all areas likely to be directly and indirectly affected by the proposed activity including an assessment of the condition of the plant communities present;
- a habitat and condition assessment of *State Environmental Planning Policy* (SEPP) *14* wetlands and Threatened Ecological Communities (TECs) likely to be impacted by the proposal;
- a fauna habitat survey to identify the potential distribution of fauna species known or likely to use habitats to be potentially impacted;
- an assessment of the potential impact of the proposal on fauna; and
- preparation of a vegetation and habitat map showing the results of the above survey.

Introduction

The survey conducted provides the results to achieve the overall aim of the 'Assessment of Significance' which according to the guidelines, is to, "*determine whether a proposed development, activity or action is likely to have a significant effect on threatened biodiversity*" (DEC, 2004).

2 Methodology

OEH's Threatened Species survey and assessment guidelines (*DEC), 2004*) state that "*it is intended that the Threatened Biodiversity Survey and Assessment Guidelines (the Guidelines) be adapted to fit the requirements of individual animal and plant surveys*." This allows for some flexibility in the survey design based on available knowledge of values, threats, risks and mitigation measures.

Given the level of information available, a flora and habitat assessment was considered adequate to provide the requisite level of information to support the existing information prepared as part of the 7–part tests and to address the survey requirements of OEH. The survey did not include targeted fauna field survey techniques (such as call playback / trapping etc.), as this would have provided little additional data given the existing knowledge of values, threats, risks and mitigation measures as documented in the 7–part tests report.

Based on the comprehensive desktop analysis outlined in the data review (BMT WBM, 2013), field assessments of the flora and fauna habitat values with the study area were undertaken by qualified ecologists. The surveys were conducted 25 – 26th August 2014 to ground-truth the information collated and ascertain the condition of reported environmental values.

The survey was conducted to describe the vegetation communities and fauna habitats within riparian, floodplain and aquatic habitats to be directly or potentially impacted by periodic opening of the Tallows Creek entrance. Habitats surveyed and the location of specific survey sites are described below and shown in Figure 3-1.

The ground-truthing recorded the following features within each vegetation community and habitat:

- an inventory of the main flora species located within sampling sites, including weed species;
- record of dominant species for each strata present at the sampling sites in order of dominance with their height and cover/abundance measured;
- presence of fauna habitat features such as: habitat trees (i.e. trees with nests or hollows); feed trees (particularly for gliders and koalas); water bodies; wetlands;
- presence or potential occurrence of threatened flora and fauna species;
- verification of mapped SEPP wetlands and TECs; and
- presence of significant species or communities sensitive to altered hydrological regimes.

The survey targeted the TECs and potential habitat for threatened species outlined in Appendix A as originally identified in BMT WBM, 2013a.

2.1 Survey Conditions

Tallows Creek and its catchment experienced heavy rainfall prior to the survey with approximately three times the long term median rainfall falling in the month of August. The high rainfall resulted in natural breaching of the mouth causing Tallows Creek lagoon to partially drain prior to the survey. This provided the study team a good appreciation of potential impacts from future artificial openings of the mouth of the creek. Rainfall records for the region are presented below.

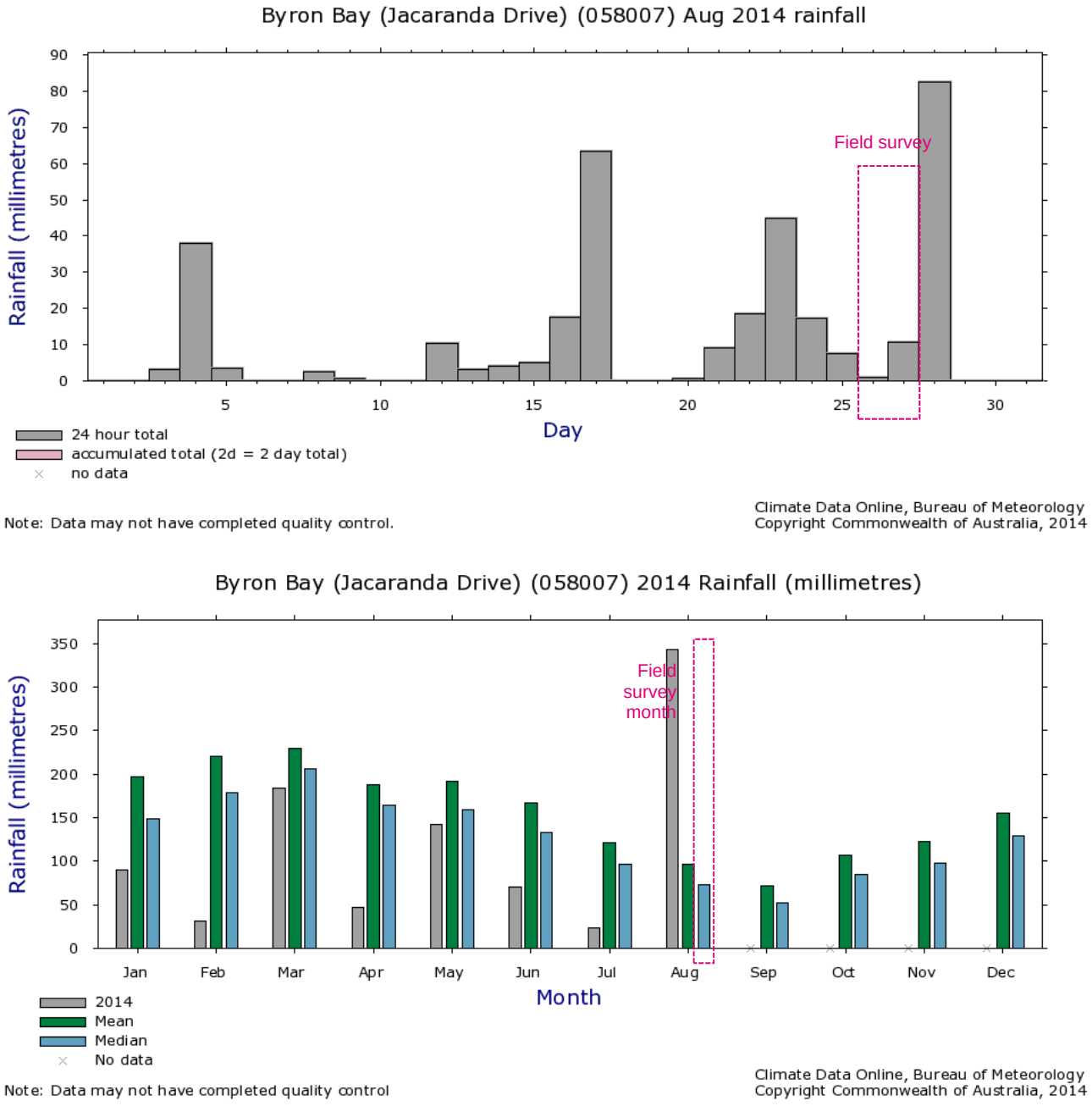


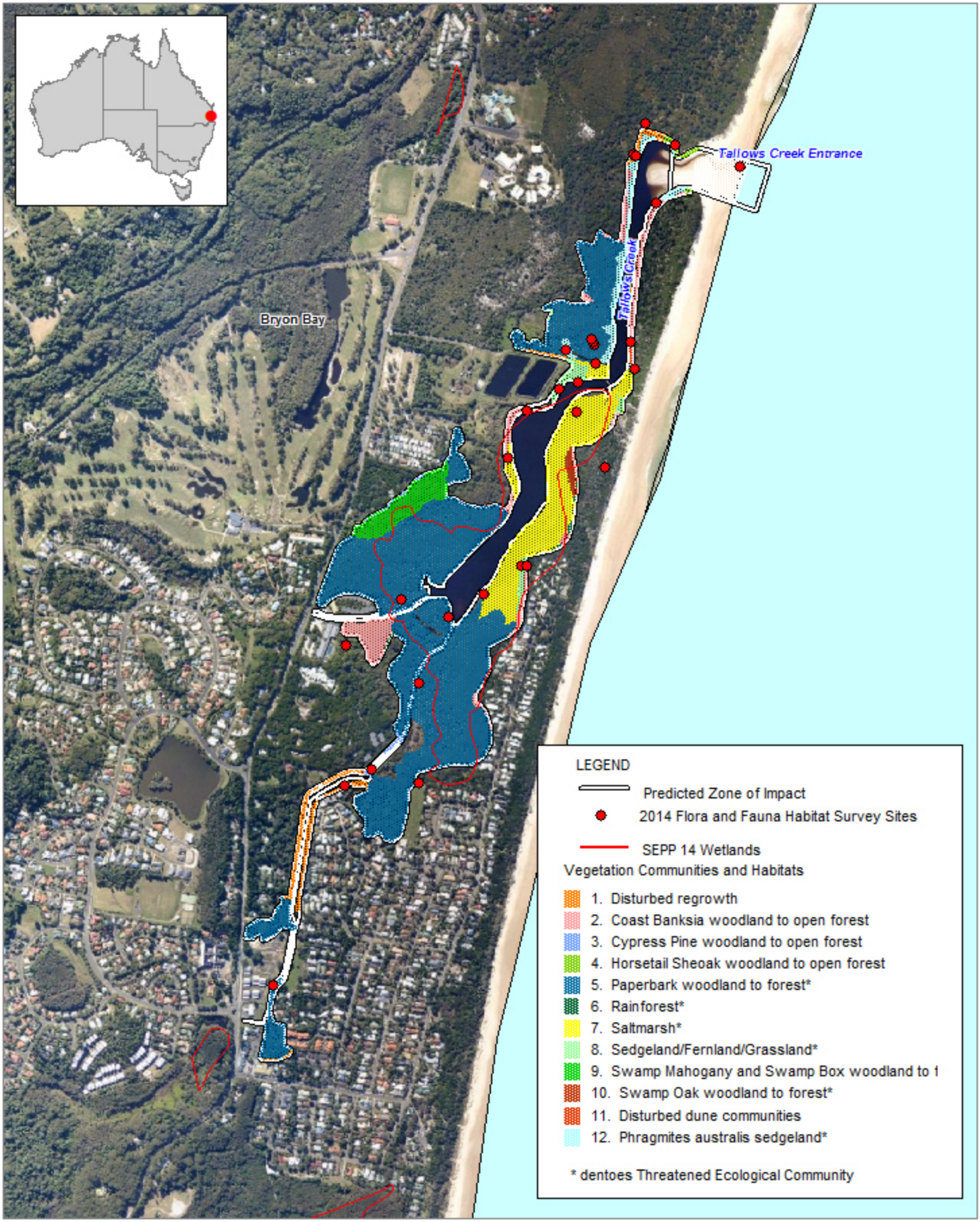
Figure 2-1 August 2014 Rainfall Records for the Region (Source: Bureau of Meteorology)

2.2 Assumptions and Limitations

It should be noted that the apparent absence of some species, or its habitat, during field surveys does not unequivocally determine that the species does not occur or utilise the site. It is not possible to identify all species present on a site during surveys due to seasonal patterns in activity or the cryptic nature of some species. For this reason, the precautionary principle has been adopted to ascertain the likelihood of a species occurring at a site given the preferences of that species, the available habitat on the site and historic records for the species.

3 Results

Figure 3-1 and Figure 3-2 show the type and extent of vegetation community and habitat within the potential impact zone based on available mapping and field survey, respectively. The flora and fauna habitat characteristics of each type based on field survey are described below.



Title:

Vegetation Communities and Habitats within the Potential Impact Zone (based on available mapping)

Figure: 3-1

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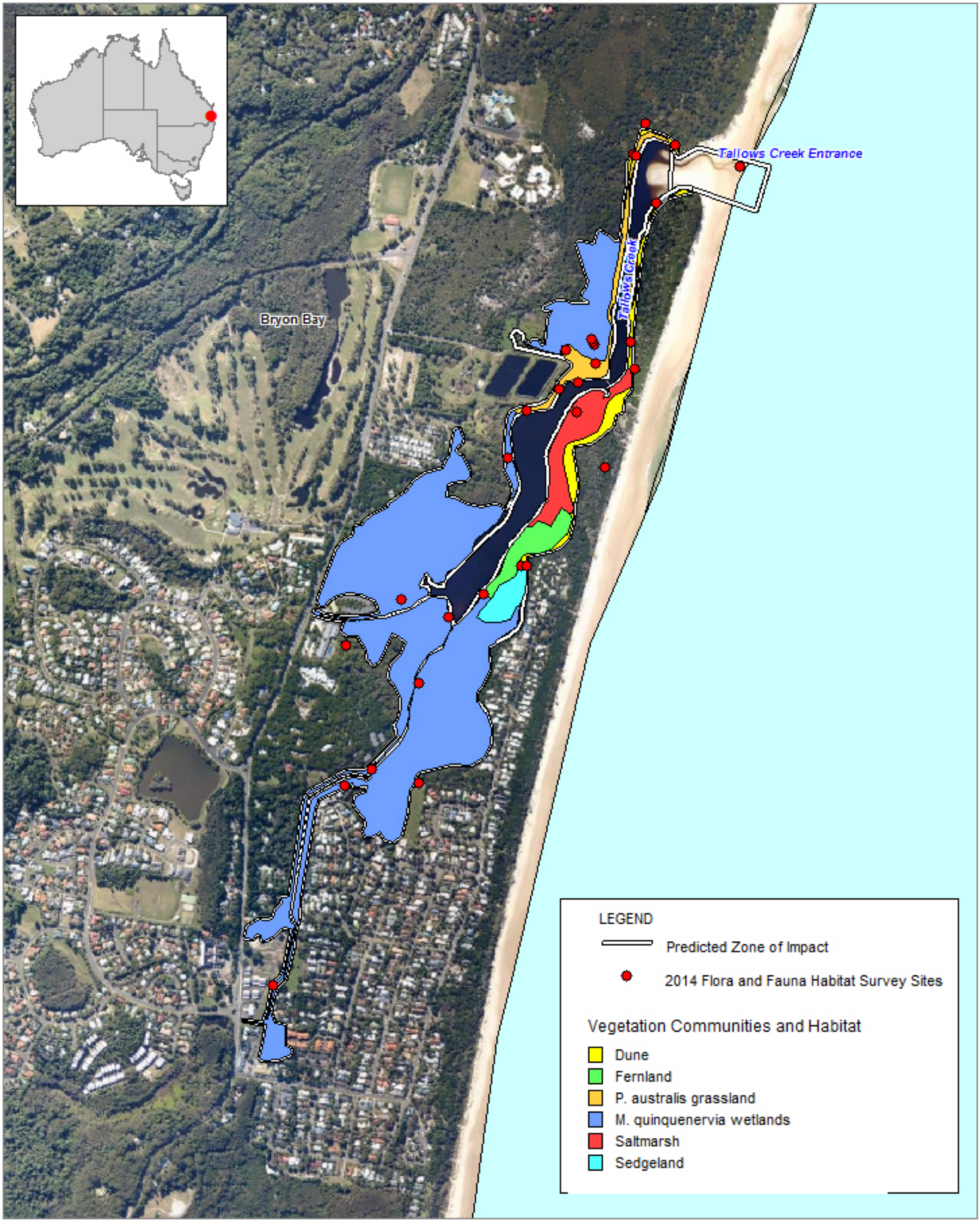

Title:

Vegetation Communities and Habitats based on Field Survey

Figure: 3-2

Rev: A

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3.2 Beach, Estuary Entrance, Open Water and Sedimentary Habitats

Whilst not observed during the survey, Tallows Beach provides potential feeding and/or nesting habitat for several threatened species including *Sterna albifrons* (little tern), *Burhinus grallarius* (Bush Stone-curlew) and *Haematopus longirostris* (pied oystercatcher). Other species potentially occurring on the beach include *Caretta caretta* (loggerhead turtle), *Chelonia mydas* (green turtle), *Calidris tenuirostris* (great knot), *Esacus neglectus* (beach-stone curlew), *Haematopus fuliginosus* (sooty oystercatcher) and *Limosa limosa* (black-tailed godwit).

Pandion haliaetus (osprey) may feed in the open waters of the estuary. There is limited data on the fish and prawn species occurring within Tallows Creek but species assemblages of the open waters are likely to vary between periods of prolonged closure and periodic opening. Tallows Creek is likely to support a range of estuarine species including those that need to migrate to the sea to complete their breeding cycle and some which can reproduce in intermittently closed and open lakes and lagoons (ICOLLs).

Prior to the survey, there was significant catchment runoff into Tallows Creek with approximately three times the long term median rainfall occurring in the month of August. This resulted in water levels rising in the lagoon which scoured the entrance channel through the beach and resulted in reopening of the ICOLL to the ocean following an earlier opening observed by the survey team in September 2013.

Tallows Creek Entrance 25th August, 2014

Tallows Creek Entrance 22nd September, 2013

Tallows Creek Entrance 25th August, 2014

Tallows Creek Entrance 22nd September, 2013

Figure 3-3 Tallows Creek Entrance 2013 and 2014

Opening of Tallows Creek at the time of survey resulted in the exposure of some areas of sediment including periodically dry intertidal flats supporting *Ruppia* sp. seagrass (refer to Figure 3-4). Prolonged exposure may result in some dieback in these small areas of seagrass leading to localised reductions in water quality. These exposed intertidal flats are likely to support important feeding habitat for a number of bird species such as little tern and pied oystercatcher.

The intertidal habitats in the upper estuary supported a small area of canopy dieback, probably *Melaleuca quinquenervia*, which may have been a result of prolonged waterlogging following a long period of lagoon closure (refer Figure 3-4).

Exposed intertidal sand flats

Tree canopy dieback in upper estuary

Exposed Ruppia beds

Figure 3-4 Intertidal Sedimentary Habitats

3.3 Common Reed Grassland

Tallows Creek Lagoon was bounded by *Phragmites australis* grassland averaging 80% groundcover in a 3-4m wide riparian zone. Other salt tolerant species in the groundlayer included *Cyperus exaltatus, Crinum pedunculatum, Fimbristylis dichotoma, Baloskion pallens, Baumea juncea* and *Juncus* spp.. Sparse weed patches of *Bryophyllum* sp., *Erythrina crus-galli, Chrysanthemoides monilifera, Schefflera actinophylla* and *Opuntia* sp. were noted.

These grasslands may provide habitat for the threatened species *Amaurornis olivaceus* (bush hen) and *Ansranus semipalmata* (magpie goose).

This community could be classified as part of the Coastal Saltmarsh in the NSW North Coast Bioregion TEC.

Figure 3-5 Common Reed Sedgelands

3.4 Saltmarsh

The low lying habitats of the estuary prone to infrequent freshwater inundation during floods, rapid drying following opening of the estuary mouth and occasional tidal inundation at high tides when the estuary is open, support a low diversity of species tolerant of a wide range of environmental conditions. These habitats supported extensive saltmarsh dominated by a dense groundcover (90-100% cover) of *Sesuvium portulacastrum* (refer Figure 3-6). Other species on slightly higher ground included *Fimbristylis dichotoma, Baumea juncea, Phragmites australis, Ficinia nodosa, Bacopa monnieri* and *Crinum pedunculatum. Avicennia marina* averaging 4m in height occurred as isolated emergents fringing the lagoon. The saltmarsh habitat was most extensive in the lower reaches to the east of the lagoon but minor patches occurred throughout the riparian zone.

The exposed intertidal saltmarsh may provide marginal feeding habitat for a number of bird species such as little tern and pied oystercatcher.

Coastal Saltmarsh is a Threatened Ecological Community under the NSW Threatened Species Conservation Act 1995 (TEC) and a Vulnerable community under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC).

Sesuvium saltmarsh following estuary flooding and drainage August 2014

Sesuvium saltmarsh after prolonged estuary closure September 2013

Sesuvium saltmarsh following estuary flooding and drainage August 2014

Saltmarsh and isolated mangroves

Figure 3-6 Saltmarsh and Mangroves

3.5 Paperbark Woodland to Forest

Melaleuca quinquenervia wetlands dominated the low-lying sites subject to infrequent freshwater inundation during floods but above the extent of prolonged tidal inundation. These communities are groundwater dependant ecosystems and their composition and extent is closely associated with groundwater levels and quality.

The lower lying sands and alluvia supported a *M. quinquenervia* canopy averaging 4-7m in height and 50-70% canopy cover (refer Figure 3-7). The groundlayer was highly variable depending on level of inundation, salinity exposure (both soil and water) and groundwater influence. Sites subject to prolonged freshwater inundation supported a dense layer of *Lepironia articulata* or *Typha* sp.. Areas of open fresh water supported sparse patches of the aquatic weed *Salvinia molesta*. *Phragmites australis, Acrostichum speciosum, Fimbristylis dichotoma, Crinum pedunculatum, Bacopa monnieri, Cyperus exaltatus, Baumea juncea* and *Sesuvium portulacastrum* dominated the groundlayer in sites subject to saline soils or infrequent tidal inflows. Other widespread groundcovers included *Gahnia sieberiana* and the weed *Sphagneticola trilobata*. A patch of *M. quinquenervia* dieback observed in a low lying site to the west of the lagoon directly adjacent to the intertidal zone may be a result of prolonged inundation.

The higher sands and alluvial slopes surrounding the estuary, outside the saline influence, supported a taller canopy of *M. quinquenervia* ranging from 8-15m in height and 50-80% cover over a dense fern groundcover (70-90% cover) of *Histiopteris incisa*.

***M. quinquenervia* with fern understorey on higher ground**

***M. quinquenervia* with sedge understorey on lower ground**

***M. quinquenervia* dieback**

***M. quinquenervia* lined channels in the upper estuary**

Open pools bounded by *M. quinquenervia* and sedges

Figure 3-7 Paperbark Woodland to Open Forest

Freshwater channels in the upper catchment were lined with a closed canopy of *M. quinquenervia* ranging from 4-5m to 10-15m in height and 50-80% canopy cover (refer Figure 3-8). The groundcover generally comprised localised patches of *Phragmites australis, Lepironia articulata, Acrostichum speciosum, Fimbristylis dichotoma, Crinum pedunculatum, Bacopa monnieri and Cyperus exaltatus* depending on the level, period and quality of inundation. Riparian corridors in

close proximity to urban development generally supported a highly modified groundcover dominated by exotic grasses and weeds.

M. quinquenervia wetlands are listed as *Swamp sclerophyll forest on coastal floodplains and / or freshwater wetlands on coastal floodplains* TECs. Some areas of wetland are also zoned SEPP 14 Wetlands (refer BMT WBM, 2013a).

Whilst not observed during the survey, the freshwater wetlands on sand may provide habitat for the threatened plants *Geodorum densiflorum* (pink nodding orchid), *Cordyline congesta* (tooth-leaved palm lily) and *Phaius australis* (swamp orchid).

It is highly improbable that the threatened fish *Maccullochella ikei* (eastern freshwater cod) occurs in the lower or upper reaches of the estuary as this species uses clear rocky streams and rivers with low flow velocity and abundant instream cover of rocks, timber or tussocks.

The threatened fish *Nannoperca oxleyana* (oxleyan pygmy perch) requires fresh, acidic waters and abundant aquatic vegetation. Whilst they generally occur in acidic freshwater systems which drain through sandy coastal Banksia spp-dominated heath or wallum vegetation assemblages, they have been recorded in eucalypt forest/heath community, rainforest/melaleuca swamp and from among saltrushes in an estuarine creek with high salt levels. On this basis, the freshwater wetland habitats of the study areas may provide habitats for this species.

Crinia signifera (common froglet)*, Limnodynastes peronii* (striped marsh frog) and *Litoria freycineti* (Freycinet's frog) were recorded in the open pools of the wetland areas. The acidic pools of the wetlands may also provide habitat for *Crinia tinnula* (wallum froglet) and *Litoria olongburensis* (wallum sedge frog), however none were recorded at the time of survey.

The Melaleuca wetlands may provide pollen and nectar for a number of threatened mammals including *Chalinolobus nigrogriseus* (hoary wattled bat), *Miniopterus australis* (little bent-wing Bat), *Miniopterus schreibersii* (common bent-wing bat), *Myotis adversus* (large-footed myotis), *Nyctophilus bifax* (eastern long-eared bat), *Pteropus poliocephalus (*grey-headed fying fox), *Saccolaimus flaviventris* (yellow-bellied sheath-tail bat) and *Syconycteris australis* (eastern blossom bat). Whilst optimal habitat for *Pseudomys gracilicaudatus* (eastern chestnut mouse) is vigorously regenerating heathland it may also occur in the swamps of the study area. *Planigale maculatus* (common planigale) and *Erythrotriorchis radiates* (red goshawk) may also utilise the wetlands of the study area.

The wetlands may also provide habitat for threatened invertebrates including *Argyreus hyperbius* (Australian fritillary butterfly) and *Petalura gigantea* (giant dragonfly).

A small patch of *Archontophoenix cunninghamiana* dominated lowland rainforest occurs to the west of the lagoon. This rainforest may provide habitat for the threatened *Thersites mitchellae (*Mitchells' rainforest snail). This patch of rainforest is considered part of the lowland rainforest on floodplain in the NSW North Coast Bioregion TEC and as an EPBC critically endangered - *Lowland rainforest of subtropical Australia*.

Figure 3-8 Upper Catchment Channels

3.6 Sedgeland and Fernland

Low lying habitats to the east of the lagoon prone to freshwater waterlogging and infrequent tidal inundation on the fringes supported extensive *Fimbristylis dichotoma* sedgelands with occasional *Sesuvium portulacastrum* and *Phragmites australis* Sparse stunted *M. quinquenervia* averaging 2-4m in height occurred in the canopy. Some areas of low (averaging 4m in height) *M. quinquenervia* dieback was observed in this area and may be a result of prolonged inundation. The sedgeland was bounded to the north by extensive *Acrostichum speciosum* fernlands (refer Figure 3-9). The extent of these communities may be a result of historical fire.

The sedgelands and fernlands may be considered part of the *Freshwater wetlands on coastal floodplains* TEC.

The sedgelands may provide habitat for the threatened species *Amaurornis olivaceus* (bush hen) and *Ansranus semipalmata* (magpie goose).

Extensive *Acrostichum speciosum* fernlands

Sedgelands with *M. quinquenervia* dieback

Figure 3-9 Sedgelands and Fernlands

A small patch of *Casuarina glauca* forest averaging 10-12m in height and 70-90% canopy cover was recorded in the east of the survey area adjacent to the fernlands (refer Figure 3-10). These communities generally occur where the groundwater is saline and on waterlogged or periodically inundated flats.

Swamp Oak Floodplain Forest in the NSW North Coast Bioregion is listed as a TEC.

Figure 3-10 Swamp Oak Forest

3.7 Swamp Mahogany/ Swamp Box Woodland to Forest

Higher ground adjacent to *M. quinquenervia* wetlands in the north west of the study area supported a small area of *Eucalyptus robusta* open forest averaging 20m in height and 60-70% canopy cover (refer Figure 3-11). The shrub and groundcover was heavily disturbed due to the proximity of clearings and urban development.

Whilst not observed during the survey this small area of eucalypt woodland in the potential impact zone may provide habitat for *Phascolarctos cinereus* (koala).

Figure 3-11 Swamp Box Forest

3.8 Dune Vegetation

Sand dunes adjacent to the estuary comprised a mix of communities depending on historical mining, clearing and revegetation efforts.

Relatively undisturbed aeolian dunes supported a canopy of *Banksia integrifolia, Casuarina equisetifolia* and *Cupaniopsis anacardioides* averaging 6m in height and 60-70% canopy cover over a low tree layer of *Hibiscus tiliaceus*, *Acacia* spp. and *Acacia sophorae* averaging 3-4m in height and 30-50% canopy cover. Other canopy species included *Acronychia littoralis, Pandanus tectorius, Lophostemon confertus, Endiandra sieberi, Banksia serrata, Glochidion sumatranum, Leptospermum laevigatum, Mallotus philippensis, Myoporum acuminatum, Monotoca scoparia,* and *Polyscias elegans.* The sparse shrub layer comprised *Austromyrtus dulcis*, *Lantana camara* and isolated *Senna pendula* var. *glabrata*. The groundcover varied from 10-90% cover comprising *Lomandra longifolia, Imperata cylindrica, Cyperus difformis, Tetragonia tetragonioides*, *Bacopa monnieri* and *Sesuvium portulacastrum.*

The threatened dune plant *Chamaesyce psammogeton* was not identified during the survey.

The undisturbed dunes may provide pollen and nectar for a number of threatened mammals including hoary wattled bat, little bent-wing bat, common bent-wing bat, large-footed myotis, eastern long-eared bat, grey-headed flying fox, yellow-bellied sheath-tail bat, eastern blossom bat and Eastern chestnut mouse may also occur.

Previously cleared and mined dunes supported a shrublayer of *Chrysanthemoides monilifera, Lantana camara* and *Acacia sophorae* with a groundcover of *Melinis minutiflora, Setaria sphacelata* and *Ipomoea* spp.. Previously mined dunes also supported low *Casuarina equisetifolia* woodlands.

Sand hills in the south west of the study area supported minor areas of *Callitris columellaris* woodland with occasional *M. quinquenervia*. *Lantana camara* was common in the shrublayer over a groundcover of *Blechnum indicum* and *Pteridium esculentum*.

Figure 3-12 Dune Woodland to Open Forest

3.9 SEPP 14 Wetlands

SEPP 14 Wetlands are protected under State Environmental Planning Policy 14. Tallows Creek Estuary supports 25.3 ha of SEPP 14 Wetland (No. 31) and 17.53 ha of this lies within the predicted zone of impact.

4 Discussion

ICOLLs are separated from the ocean by a sand beach barrier or berm which form and breach irregularly depending on sand distribution by waves, tides, wind and floods. Prior to the survey there was significant catchment runoff into Tallows Creek with approximately three times the long term median rainfall falling in the month of August. This resulted in water levels rising in the lagoon, as evidenced by flooding impacts within the saltmarsh directly adjacent the mouth.

The force of the backed up water in the lagoon scoured the entrance channel through the beach and resulted in reopening of the ICOLL to the ocean. The sand beach barrier will reform depending on sand accumulation as a result of waves and tides, however the timing for this is not known. There is no available data on the duration or frequency with which Tallows Creek opens and closes, but it is common for many ICOLLs to remain closed for several years at a time with 70% of the ICOLLs in NSW being closed for the majority of the time (DPI, 2014).

4.1 Artificial Opening Scenarios

An occasional artificial opening of the Tallows Creek entrance within its natural range is not likely to have a significant environmental impact since it is likely to fall within the expected natural variation and the species within are adapted to these conditions. In the short term, more frequent openings could lead to increased exposure and death of aquatic vegetation with resulting impacts on levels of dissolved oxygen and a higher incidence of fish kills. Over the longer term, numerous artificial openings especially at low water levels would be likely to have a significant environmental impact since the natural frequency and duration of opening and closing to the ocean would be significantly altered. This could lead to shifts in the structure and distribution of fringing riparian vegetation communities.

These scenarios are not anticipated as artificial opening of Tallows Creek is proposed to only occur when water levels or water quality trigger an opening with the aims of minimising catchment flooding and public health issues. In accordance with the Interim Management Plan (SKM. 2009) an artificial opening will be triggered should water levels in Tallow Creek mouth level reach or exceed 2.2m AHD (the flood trigger). Also, an artificial opening will also be triggered at 1.8 m AHD or above should the creek water quality results prove to be hazardous to human health (the water quality trigger). Based on the past seven years of experience of Byron Shire Council, natural breaching of the creek has occurred below 2.2m AHD as there has been no artificial opening since November 2004 and it is known that the creek has opened to the ocean on numerous occasions. Therefore, the flood trigger appears to reflect the typical upper level at which natural breaching occurs in Tallow Creek, although additional data which is planned to be collected in the future will help to refine these levels over time.

Given the highly variable natural conditions in Tallow Creek and the natural breaching typically below 2.2 m any artificial breaching in accordance with the 2.2m AHD trigger level is unlikely to impact any species or ecological communities. It is however acknowledged that the natural berm level can exceed 2.2m AHD when coastal conditions allow for a sufficient build-up of sand, and dry weather has negated the need for a forced opening. Tallows Beach is exposed to a wide spectrum of wave directions and energies and the entrance berm could build to reasonably high levels ~3m AHD, especially during dry periods when opening would not occur very often (BMT WBM, 2013).

4.2 Riparian Vegetation

When ICOLLs are closed for long periods, riparian flora may be subject to prolonged waterlogging depending on catchment runoff. Conversely, when open, the riparian zone may be subject to periodic drying and tidal inundation. As a result, the riparian zone in ICOLLs may comprise a low diversity of species adapted to a wide range of soil and water salinities, drying regimes and waterlogging.

The riparian corridor of Tallows Creek is currently dominated by a low diversity of groundcover species notably *Phragmites australis* and *Sesuvium portulacastrum*. Sparse mangroves are located on the riparian fringe in the lower estuary adjacent to the mouth and sparse low *Melaleuca quinquenervia* line the lagoon in the upper estuary. Several sites and individuals of mangrove and melaleuca tree canopy dieback were observed in the lower and upper estuary reaches of Tallows Creek, respectively. The dieback may have been a result of prolonged waterlogging following a long period of lagoon closure as a result of drought, although there is insufficient data to correlate this finding.

4.3 Intertidal Habitats

Opening of Tallows Creek at the time of survey resulted in the exposure of some areas of sediment including periodically dry intertidal flats supporting *Ruppia* sp. seagrass. Prolonged exposure may result in some dieback in these small areas of seagrass leading to localised reductions in water quality. However, given the small areas impacted the effect of this is likely to be minor and will not result in major ecological effects such as fish kills.

4.4 Aquatic Fauna

There is limited data on the fish and prawn species occurring within Tallows Creek but species assemblages are likely to vary between periods of prolonged closure and periodic opening. ICOLLS can support a range of estuarine species including those that need to migrate to the sea to complete their breeding cycle and some which can reproduce in ICOLLs (DPI, 2014). Long periods (i.e. 3 to 4 years or more) of entrance closure may restrict the recruitment of certain fish species to ICOLLs (DPI, 2014). The impact of artificially opening ICOLL entrances on fish species and their habitats is not well understood, however, recruitment is likely to be dependent upon climatic factors, as well as a number of other environmental variables (DPI, 2014).

4.5 Terrestrial Fauna

In addition to the water quality and hydrology changes within the lagoon, proposed artificial opening will result in direct physical disturbance to the upper beach and berm through excavation of the sand berm and disturbance during transportation of equipment to and from this site. Most fauna will be able to move out of the way of equipment and works without any significant impact. There may be an issue if sensitive fauna, in particular sea turtles and birds, are nesting at these sites. However, given the high level of pedestrian traffic in this area there is a low likelihood this site provides an important nesting habitat for these species and therefore disturbance to their breeding patterns is not anticipated to occur. .

4.6 Threatened Species and Communities

Whilst Tallows Creek supports several TECs and potentially supports a number of threatened species across various habitats, the lagoon is an inherently highly dynamic environment and the species which occur there are generally well adapted to deal with changes in the spatial arrangement of their habitats. On this basis, provided artificial openings occur within the natural range only minor habitat interchanges are anticipated and the impacts on threatened species populations reliant on these habitats are expected to be minor. A recommendation of this investigation is for the collection of water level data and electrical conductivity to begin to quantify estuary opening frequency and duration. Electrical conductivity data (optional) will provide further insight into the salt content of the water within Tallow Creek which adds further understanding to the catchment / oceanic influences at different times.

The 7-part tests completed for this study (BMT WBM, 2014b) did not identify that the proposed activity was likely to present any significant impacts to the species considered.

4.7 Management of Artificial Opening

To ensure the artificial entrance openings are managed within natural range, a long-term strategy outlining clear criteria for where, when and under what conditions to artificially open the Tallows Creek entrance should be developed. Criteria should include the following (based on DPI, 2014):

(1) a preset water level above which a breach is recommended;

(2) a preset range between which a breach is recommended if heavy rainfall is predicted;

(3) a preset duration of high water level and or wetland inundation over which a breach may be recommended; and

(4) other environmental parameters (e.g. avoiding the breeding season of threatened birds such as the Little Tern).

In relation to point 2, it is acknowledged that further data, particularly water levels correlated with catchment rainfall, would be required to set these criteria. The collection of data is a recommendation for Council to pursue over time.

In relation to point 3, inundation events should also be investigated to ascertain effects on vegetation dieback and the significance of this in a dynamic estuarine environment which naturally experiences a wide range of conditions. Insufficient information is available to instigate openings on the basis of duration of inundation at this stage.

In relation to point 4, provided there is minimal interference to the entrance and openings are managed to occur within its natural range, the ecological values of the Tallows Creek ICOLL are unlikely to be adversely impacted by the proposed artificial openings.

4.8 Water Quality

When open, parts of Tallows Creek become tidal with salinity and water levels fluctuating with the tide. There is no current data on tidal movement or its effect on water quality in Tallows Creek, but riparian species composition suggests saline intrusion extends throughout the lagoon, with freshwater catchment runoff influencing riparian vegetation in the upper channels.

Discussion

When closed and in the absence of high freshwater catchment runoff, the water level and quality of Tallows Creek will fluctuate depending on rainfall, catchment inflows and evaporation. Generally after heavy rainfall, water quality in a closed ICOLL can temporarily worsen as a result of poor catchment runoff containing sediment, nutrients and pollutants (DPI, 2014). In many instances increasing the frequency and duration of ICOLL openings will not improve water quality which may be more effectively managed by improving catchment inputs (DPI, 2014). Whilst there is a lack of data for Tallows Creek to substantiate this, it does suggest that artificially opening the estuary is not anticipated to have a substantial impact on long term water quality in the lagoon.

5 Summary

It is predicted that the proposed artificial opening of the estuary will result in:

- no change in the frequency of opening up to 2.2m AHD and cessation of openings above this level;
- an unquantified, but likely insignificant change in the water quality characteristics of Tallow Creek;
- potential disturbance of fauna occupying the entrance berm and immediate environs, or the access route for equipment; and
- minor estuarine habitat interchanges anticipated with minor impacts on threatened species and populations within the bounds of natural variability.

7-part tests completed for this study (BMT WBM, 2014b), did not identify that the proposed activity was likely to present any significant impacts to the species considered. However, a number of beach dwelling species may be impacted by activities associated with the physical entrance opening works that allow Tallow Creek to drain to the ocean.

Pre-disturbance ecological surveys in consultation with the relevant authorities would be required to locate any threatened species and their presence in the beach areas to be impacted prior to excavation. However, it is expected that the direct impacts associated with artificial entrance management on these species could be mitigated through appropriate protocols and work procedures in consultation with the relevant authorities and with reference to relevant management plans.

Given that no major changes to flow velocities, volumes or quality are expected, it is very unlikely that the proposed scheme will have any major impact on threatened flora and fauna within and directly adjacent to the estuary waterway on the basis that:

- the estuary is subject to variations in water quality and flow and supports a mix of estuarine dependant species tolerant of periodic inundation and drying which are likely to tolerate the predicted changes, provided artificial opening occurs within the natural range
- estuarine and floodplain communities generally recover quickly after periodic individual floods or periods of no flow.

The proposal is unlikely to have a major effect on threatened vegetation communities or species in and adjacent to the estuary waterway. It is not anticipated that the proposal will significantly alter the chemical or physical characteristics of the water to an extent that will significantly alter current habitat conditions causing either extinction of habitat types from the estuary or alterations to life-history and fauna behaviour.

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Appendix A Threatened Species and Communities (Based on BSC, 2010, 2013; Baker, 2009; NSW DEC, 2013; DSEWPC, 2013)

Species	Common Name	TSC Act Code	EPBC Act Code	FM Act Code	ROTAP	Preferred Habitat	Recorded in Study Area and Surrounds	Potential Habitat in the Zone of Impact	7 Part Test Required	Reference
Birds										
Amaurornis olivaceus	Bush Hen	V2				Partly terrestrial species with wide habitat tolerances. Prefers dense vegetation on margins of freshwater creeks, rivers and wetlands, margins of rainforest to forest regrowth, rank grass or reeds, weed thickets and farmland.		Freshwater Wetland	yes	NSW SCIENTIFIC COMMITTEE Bush-hen *Amaurornis olivaceus.* Review of Current Information in NSW. August 2008
Ansranus semipalmata	Magpie Goose	V2				Mainly found in shallow wetlands (less than 1 m deep) with dense growth of rushes or sedges		Freshwater Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10056.
Botaurus poiciloptilus	Australasian Bittern	V2				Inhabits temperate freshwater wetlands and occasionally estuarine reedbeds. The species favours permanent shallow waters, or edges of pools and waterways, with tall, dense vegetation such as sedges, rushes and reeds on muddy or peaty substrate	*	Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/determinations/austbitternFD.htm
Burhinus grallarius	Bush Stone-curlew	E1				Broad habitat usage. In estuarine areas, this species has been recorded in *Casuarina glauca* groves, saltmarsh, mangroves and *Melaleuca quinquinervia* woodlands.	*	Freshwater and Estuarine Wetland	yes	Department of Environment and Conservation NSW 2006, *NSW Recovery Plan for the Bush Stone-curlew Burhinus grallarius. DEC, Sydney.*
Calidris tenuirostris	Great Knot	V				Occurs within sheltered, coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons. Often recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms.		Beach and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10128
Ephippiorhynchus asiaticus	Black-necked Stork	E				Mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands. They also forage within or around estuaries and along intertidal shorelines, such as saltmarshes, mudflats and sandflats, and mangrove vegetation.		Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10275
Erythrotriorchis radiatus	Red Goshawk	CE	V			Inhabit open woodland and forest, preferring a mosaic of vegetation types, a large population of birds as a source of food, and permanent water, and are often found in riparian habitats along or near watercourses or wetlands. In NSW, preferred habitats include mixed subtropical rainforest, *Melaleuca* swamp forest and riparian *Eucalyptus* forest of coastal rivers.		Freshwater Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10279
Esacus neglectus	Beach-stone Curlew	E1				Nest on beaches and in estuaries and forage between the high and low water mark.		Beach and Estuarine Wetland	yes	*Best practice guidelines* Managing threatened beach-nesting shorebirds. Department of Environment and Climate Change NSW.
Haematopus fuliginosus	Sooty Oystercatcher	V2				Nest on beaches and in estuaries and forage between the high and low water mark.		Beach and Estuarine Wetland	yes	*Best practice guidelines* Managing threatened beach-nesting shorebirds. Department of Environment and Climate Change NSW.
Haematopus longirostris	Pied Oystercatcher	V2				Nest on beaches and in estuaries and forage between the high and low water mark.	*	Beach and Estuarine Wetland	yes	*Best practice guidelines* Managing threatened beach-nesting shorebirds. Department of Environment and Climate Change NSW.
Ixobrychus flavicollis	Black Bittern	V2				Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water in flooded grassland, forest, woodland, rainforest and mangroves.	*	Freshwater and Estuarine Wetland	yes	Threatened Species Informations. NSW NPWS. September 1999.
Limosa limosa	Black-tailed Godwit	V				Found along the coast on sand spits, lagoons and mudflats. However, the species also occurs inland on mudflats and in those portions of large muddy lakes and swamps (freshwater or brackish) where the water is less than 10 cm deep during suitable conditions (i.e. receding water). Individuals have also been observed in wet meadows and sewerage treatment works.		Beach, Freshwater and Estuarine Wetland	yes	NSW NPWS Threatened Species Profile Black-tailed Godwit. September 1999.

Lophoictinia isura	Square-tailed Kite	V2				Inhabits coastal and subcoastal, eucalypt-dominated open forests and woodlands, coastal heathlands, and often near openings and edges of forest.	*	No habitat available.	no	NSW SCIENTIFIC COMMITTEE Square-tailed Kite *Lophoictinia isura.* Review of Current Information in NSW. June 2009
Monarcha leucotis	White-eared Monarch	V2				Occur in littoral rainforest, dry sclerophyll forests, swamp forest and regrowth. Prefer ecotone between rainforest and open areas.		Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10540
Pandion haliaetus	Osprey	V2				Forages over estuarine and inshore marine waters and coastal rivers, and nests in tall (usually dead or dead-topped) trees in coastal habitats from open woodland to open forest, within 1-2 km of water.		Estuarine Wetland	yes	NSW SCIENTIFIC COMMITTEE Eastern Osprey *Pandion cristatus.* Review of Current Information in NSW. June 2009
Pomatostomus temporalis temporalis	Grey-crowned Babbler	V2				Inhabits open Box Woodlands on alluvial plains.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10660
Ptilinopus regina	Rose-crowned Fruit-dove	V2				Occur mainly in sub-tropical and dry rainforest and occasionally in moist eucalypt forest and swamp forest, where fruit is plentiful.	*	No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10708
Ptilinopus superbus	Superb Fruit-dove	V2				Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10709
Sterna albifrons	Little Tern	E1				Nest on beaches at or near estuary openings and generally forage between the high and low water mark.	*	Estuarine Wetland	yes	*Best practice guidelines* Managing threatened beach-nesting shorebirds. Department of
Todiramphus chloris	Collared Kingfisher	V				Restricted to mangrove associations of estuaries, inlets, sheltered bays and islands, and the tidal flats and littoral zone bordering mangroves. They sometimes occur in terrestrial forests or woodlands bordering mangroves, where they will nest in holes in trees or in arboreal termitaria.		Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10810
Tyto capensis	Grass Owl	V2				Found in areas of tall grass, including grass tussocks, in swampy areas, grassy plains, swampy heath, and in cane grass or sedges on flood plains. Always breeds on the ground. Nests are found in trodden grass, and often accessed by tunnels through vegetation.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10819
Tyto novaehollandiaea	Masked Owl	V2				Eucalypt forests and woodlands on the coast.		No habitat available.	no	Department of Environment and Conservation (NSW) (2006). NSW Recovery Plan for the Large Forest Owls: Powerful Owl (Ninox strenua), Sooty Owl (Tyto tenebricosa) and asked Owl (Tyto novaehollandiae) DEC, Sydney.
Mammals										
Chalinolobus nigrogriseus	Hoary Wattled Bat	V2				Occurs in dry open eucalypt forests, favouring forests dominated by Spotted Gum, boxes and ironbarks, and heathy coastal forests where Red Bloodwood and Scribbly Gum are common.		Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10158
Megaptera novaeangliae	Humpback Whale	V2				They are regularly observed in NSW waters in June and July, on northward migration and October and November, on southward migration		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10914
Miniopterus australis	Little Bent-wing Bat	V2				Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, *Melaleuca* swamps, dense coastal forests and banksia scrub. Roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats.	*	Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10533
Miniopterus schreibersii	Common Bent-wing Bat	V2				Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Hunt in forested areas.		Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10534
Myotis adversus	Large-footed Myotis	V2				Roosts close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage and forages over streams and pools.		Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10549

Nyctophilus bifax	Eastern Long-eared Bat	V2				Lowland subtropical rainforest and wet and swamp eucalypt forest, extending into adjacent moist eucalypt forest. Coastal rainforest and patches of coastal scrub are particularly favoured.		Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10567
Phascolarctos cinereus	Koala	V2				Inhabits eucalypt forest and woodland.	*	Koala habitat mapped in study area.	yes	Threatened Species Information: Koala. NSW NPWS, September 1999.
Planigale maculatus	Common Planigale	V2				Inhabit rainforest, eucalypt forest, heathland, marshland, grassland and rocky areas where there is surface cover, and usually close to water.		Freshwater Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10635
Potorous tridactylus	Long-nosed Potoroo	V2				Inhabits coastal heaths and dry and wet sclerophyll forests.	*	Heath	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10662
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	V2				Found in low numbers in heathland but most common in dense, wet heath and swamps. Optimal habitat is vigorously regenerating heathland.		Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10687
Pteropus poliocephalus	Grey-headed Flying Fox	V2	V			Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located close to water, in vegetation with a dense canopy.	*	Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10697
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat	V2				Forages in most habitats across its very wide range, with and without trees. Roosts in tree hollows and buildings and mammal burrows.		Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10741
Scoteanax rueppelli	Greater Broad-nosed Bat	V2				Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Usually roosts in tree hollows, it has also been found in buildings.	*	Freshwater Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10748
Syconycteris australis	Eastern Blossom Bat	V2				Core foraging undertaken in Banksia woodlands, Melaleuca and swamp forests, while roosting occurs in littoral rainforests.	*	Freshwater and Estuarine Wetland	yes	Byron Shire Threatened Species Profile Eastern Blossom Bat - *Syconycteris australis January 2010.*
Frogs										
Crinia tinnula	Wallum Froglet	V2				Found in a wide range of habitats, usually associated with acidic swamps on coastal sand plains. They occur in sedgelands, wet heathlands, paperbark swamps and drainage lines within other vegetation communities. They will also persist in disturbed areas. Breeds in swamps with permanent water as well as shallow ephemeral pools and drainage ditches.	*	Freshwater Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10183
Litoria olongburensis	Wallum Sedge Frog	V2	V			Paperbark swamps and sedge swamps of *Banksia* dominated lowland heath ecosystem characterised by acidic waterbodies (wallum).	*	Freshwater Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10489
Reptiles										
Caretta caretta	Loggerhead Turtle	E1				Lays eggs on beach foredunes during summer and forages all year in marine waters.		Beach	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10146
Chelonia mydas	Green Turtle	V2				Lays eggs on beach foredunes during summer and forages all year in marine waters. May occur in estuaries during warmer months.		Beach	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10901
Invertebrates										
Argyreus hyperbius	Australian Fritillary Butterfly	E1				Found in open swampy coastal habitat and eggs laid on the Native Violet (*Viola betonicifolia*). The food plant occurs in ground level vegetation in swampy areas beneath grasses and mat-rushes (Lomandra spp.).		Freshwater Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10064
Petalura gigantea	Giant Dragonfly	E1				Live in permanent swamps and bogs with some free water and open vegetation.		Freshwater Wetland	yes	Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10600
Thersites mitchellae	Mitchells' Rainforest Snail	E1	Critically Endangered			Remnant areas of lowland subtropical rainforest and swamp forest on alluvial soils. Slightly higher ground around the edges of wetlands with palms and fig trees are particularly favoured habitat.		Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10801
Fish										
Carcharias taurus	Grey Nurse Shark		Critically Endangered	E 4		Marine waters along the length of the NSW coast.		No habitat available.	no	http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0016/208213/PD-Grey-Nurse-Shark.pdf
Carcharodon carcharias	Great White Shark		V	V 5		Marine waters along the length of the NSW coast.		No habitat available.	no	http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/208249/FR2-great-white-shark.pdf

Maccullochella ikei	Eastern Freshwater Cod		Endangered	E 4		Clear rocky streams and rivers with low flow velocity and abundant instream cover of rocks, timber or tussocks. Associated with deeper parts of the river near cover, especially around rocky islands, large boulders and pools in fast-flowing water. Large woody debris and rocky overhangs may provide shelter and important spawning sites).		Open Freshwater	yes	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=26170#habitat
Nannoperca oxleyana	Oxleyan Pygmy Perch		Endangered	E 4		Specific habitat requirements include fresh, acidic waters and abundant aquatic vegetation. Generally occur in acidic freshwater systems which drain through sandy coastal *Banksia spp* -dominated heath or wallum vegetation assemblages. Have also been recorded from an intermediate eucalypt forest/heath community, rainforest/melaleuca swamp and from among saltrushes in an estuarine creek with high salt levels.		Freshwater Wetland	yes	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64468#habitat
Flora										
Acronychia bauerlenii	Byron Bay Acronychia				3RC-	Grows in subtropical and warm-temperate rainforest in the Lismore to Byron Bay to the McPherson Range area. Also recorded from Iluka.		No habitat available.	no	http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Acronychia~baeuerlenii
Acianthus amplexicaulis	Terrestrial Orchid				3RC-	Locally common in littoral rainforest and sheltered locations in dry sclerophyll forest on sand.		No habitat available.	no	
Acronychia littoralis	Scented Acronychia	E	E		3ECi	A range of littoral rainforest communities on sand and meta-sedimentary clays, and also Brush Box wet sclerophyll forest on meta-sedimentary clays		No habitat available.	no	Baker (2009) and Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10030
Allocasuarina defungens	Dwarf Heath Casuarina	E	E		2E	Grows mainly in tall heath on sand, but can also occur on clay soils and sandstone. Also extends onto exposed nearby-coastal hills or headlands adjacent to sandplains.	*	No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10037
Archidendron hendersonii	White Laceflower	V				In New South Wales is restricted to the lowlands of the Richmond and Tweed catchments found in riverine and lowland subtropical rainforest	*	No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/determinations/ArchidendronHendersoniiVulSpListing.htm
Archidendron muellerianum	Veiny Laceflower				3RCa	Grows chiefly in subtropical and littoral rainforest, north from Alstonville district.		No habitat available.	no	http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Archidendron~muellerianum
Callerya australis	Blunt-leaved Wisteria				3RC-+	Grows in warmer rainforest on the coast and adjacent ranges, not common; north from Port Macquarie		No habitat available.	no	http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Callerya~australis
Chamaesyce psammogeton	Sand Spurge	E				Grows on fore-dunes, pebbly strandlines and exposed headlands, often with Spinifex (*Spinifex sericeus*) and Prickly Couch (*Zoysia macrantha*)		Beach Foredune	yes	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10160
Cordyline congesta	Tooth-leaved Palm Lily				2RC-	On coastal lowlands north of the Clarence River.		Freshwater Wetland	yes	http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Cordyline~congesta
Cryptocarya foetida	Stinking Cryptocarya	V	V		3VCi	Found in littoral rainforest, usually on sandy soils, but mature trees are also known on basalt soils.	*	No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10186
Diuris byronensis	Byron Bay Diuris	E				Restricted to graminoid clay heath and associated woodlands and forests on meta-sedimentary clays.		No habitat available.	no	Baker (2009).
Drynaria rigidula	Basket fern	E				Only recorded from Grey Ironbark wet sclerophyll forest on meta-sedimentary clays.		No habitat available.	no	Baker (2009).
Elaeocarpus williamsianus	Hairy Quandong	E	E		2ECi	Subtropical to warm temperate rainforest, including regrowth areas where it has apparently regrown from root suckers after clearing. Soils are derived from metasediments.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10262
Endiandra floydii	Crystal Creek Walnut	E	E		2VC-	Warm temperate or subtropical rainforest with Brush Box overstorey, and in regrowth rainforest and Camphor Laurel forest.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10269
Endiandra hayesii	Rusty Rose Walnut	V	V		3VC-	Sheltered moist gullies in lowland subtropical and warm temperate rainforest on alluvium or basaltic soils.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10270
Endiandra muelleri ssp. *bracteata*	Green-leaved Rose Walnut	E				Subtropical rainforest or wet eucalypt forest, chiefly at lower altitudes.	*	No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10271

Floydia praealta	Ball Nut	V	V		3VC-	Inhabits floristically-rich, tall, closed riverine to subtropical rainforest or coastal scrub.		No habitat available.	no	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=15762#habitat
Geodorum densiflorum	Pink Nodding Orchid	E				Dry eucalypt forest and coastal swamp forest at lower altitudes, often on sand.	*	Freshwater and Estuarine Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10349
Macadamia tetraphylla	Rough-shelled Bush Nut	V	V		2VC-	Subtropical rainforest and complex notophyll vineforest, at the margins of these forests and in mixed sclerophyll forest.		No habitat available.	no	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=15762#habitat
Niemeyera whitei	Rusty Plum	V			3RCa	Rainforest and the adjacent understorey of moist eucalypt forest.		No habitat available.	no	Specie profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10044
Owenia cepiodora	Onion Cedar	V	V		2VCi	Subtropical and dry rainforest on or near soils derived from basalt.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10579
Phaius australis	Swamp Orchid	E	E		3VCa	Swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas.		Freshwater Wetland	yes	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10610
Pterostylis nigricans	Dark Greenhood	V			3V	Coastal heathland with Heath Banksia (*Banksia ericifolia*), and lower-growing heath with lichen-encrusted and relatively undisturbed soil surfaces, on sandy soils.	*	No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10703
Syzygium hodgkinsoniae	Red Lilly Pilly	V	V		3VC-	Usually found in riverine and subtropical rainforest on rich alluvial or basaltic soils.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10792
Syzygium moorei	Durobby	V	V		2VCi	Found in subtropical and riverine rainforest at low altitude. Often occurs as isolated remnant paddock trees.	*	No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10793
Tinospora tinosporoides	Arrowhead Vine	V	V		3RC-	Wetter subtropical rainforest, including littoral rainforest, on fertile, basalt-derived soils.		No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10809
Xylosma terrae-reginae	Xylosma	E				Littoral and subtropical rainforest on coastal sands or soils derived from metasediments	*	No habitat available.	no	Species profile at http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10846
Threatened Communities										
Littoral Rainforest and Coastal Vine Thickets in the NSW North Coast Bioregion		Endangered Ecological Community under the TSC Act (EEC)	Critically Endangered					no	no	
Coastal Saltmarsh in the NSW North Cooast Bioregion		EEC						yes	yes	
Swamp Sclerophyll Forest on Coastal Floodplains		EEC						yes	yes	
Swamp Oak Floodplain Forest in the NSW North Coast Bioregion		EEC						yes	yes	
Coastal Cypress Pine Forest in the NSW North Coast Bioregion		EEC						no	no	
Byron Bay Dwarf Graminoid Clay Heath		EEC						no	no	
Themeda Grassland on Seaclifs and Coastal Headlands in the NSW North Coast		EEC						no	no	
Freshwater Wetlands on Coastal Floodplains		EEC						yes	yes	

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