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ballina shire council

BALLINA SHIRE COUNCIL

North Creek Dredging Scoping Study

July 2016

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Cover Photo: North Creek, looking downstream towards Missingham Bridge

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15-021 – NORTH CREEK DREDGING SCOPING STUDY

REV	DESCRIPTION	AUTHOR	REVIEW	APPROVAL	DATE
0	Draft for Council review	M. Howland, U. Makings	R. Campbell, K. Pratt	M. Howland	15 Dec 2015
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CONTENTS

APPENDICES

TABLES

FIGURES

1. TERMS OF REFERENCE

Hydrosphere Consulting has been engaged by Ballina Shire Council (BSC) to provide project management services in relation to the feasibility assessment and planning approval for dredging in North Creek. This report provides a summary of the proposed activities, environmental and social factors, relevant legislation, the likely planning approval pathway and identification of the information required to determine the feasibility of dredging activities and satisfy approval requirements.

2. PROJECT DESCRIPTION

The primary aims of dredging North Creek are:

1. To provide a sand resource for fill on Council landholdings and possibly for other purposes;
2. To improve the navigability of North Creek to ensure safe boating and recreational activities; and
3. To increase tidal flushing and hence improve water quality within North Creek.

2.1 Extraction Areas and Volumes

A number of dredging scenarios were considered. These included 'minimal navigational' options that addressed small boat navigational needs within the study area (Aim 2), but were not likely to substantially address the other project aims. Conversely, some larger scale options than the ones presented in this document were also investigated but were considered likely to lead to unacceptable environmental or social impacts and were consequently also unlikely to achieve project approval.

The proposed dredging program outlined below is the currently preferred option, although a significant amount of work is still be to undertaken to fully determine the constraints, impacts, offsets and ultimate projects costs.

There are four main areas to be dredged within the study area as shown in Figure 1. The target floor elevation for each cut is -3.0 m AHD, with batters of 1 in 6 on all sides. The typical depth of cut is 1 to 2 m below existing ground surface within the main channel areas, with up to 4 m of material to be taken out from some of the heavily built up areas within North Creek. The four target dredging areas are:

- Area A – Which encompasses approximately 13.7 ha and would involve dredging the North Creek navigation channel on the western foreshore from Missingham Bridge upstream approximately 1 km towards the Martin Street boat ramp;
- Area B - This area encompasses approximately 7 ha of The Serpentine spit (also referred to in other documentation as the 'Middle Shoal'), which is the large sand flat area upstream of Missingham Bridge on the eastern side of North Creek;
- Area C – This area extends approximately 700 m downstream of Prospect Bridge and covers an area of approximately 5.8 ha. Dredging in this area would result in deepening of the main channel linking the deeper water around Prospect Bridge to the deep water near the Martin Street Boat Ramp; and
- Area D – This would involve dredging of the navigation channel from Prospect Bridge approximately 900 m upstream. This would cover an area of approximately 8 ha.

The total in situ volume to be dredged is approximately 575,000 m^3 and has a combined footprint of 34.7 ha (Table 1).

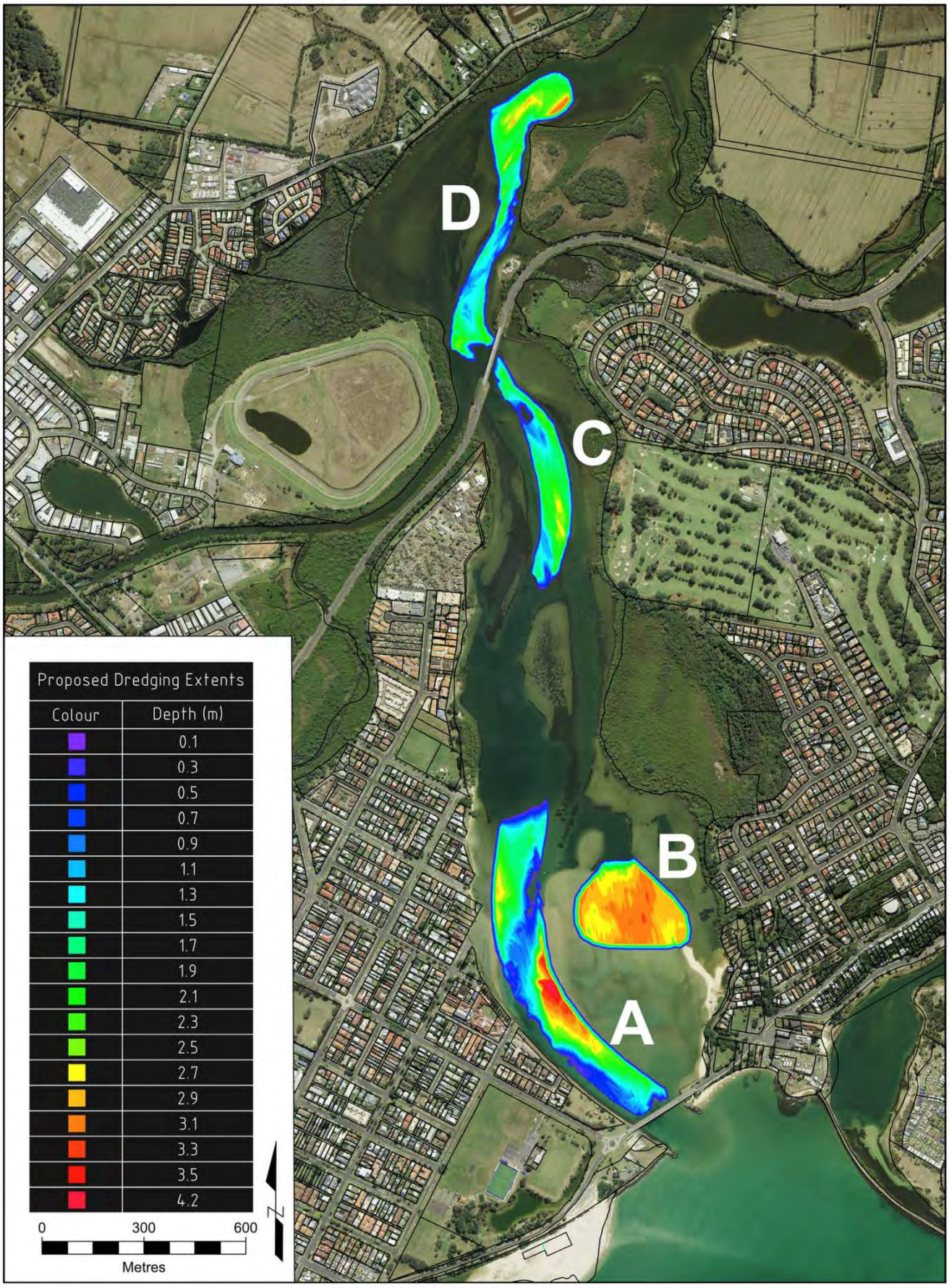

Figure 1. Proposed dredging area showing indicative cut depths.

Table 1. Dredging surface area and in situ volume for the four extraction areas.

Site	*Location*	*Area (ha)*	*Volume (m^3)*
Area A	Lower North Creek Channel	13.68	195,881
Area B	The Serpentine Flats	7.21	178,883
Area C	Lower Prospect Channel	5.71	80,054
Area D	Upper Prospect Channel	8.10	119,820
	Total	*34.70*	*574,638*

The material to be dredged is likely to vary from clean marine sands in the lower reaches of North Creek (Sites A and B) through to silty sands around Prospect Bridge (Sites C and D). No specific sediment investigations have been undertaken for this project to date, but will form part of the scope of works (see section 5).

Dredging is likely to be undertaken by floating suction cutter dredge which will progressively work through the target areas on a sequential basis. With this form of dredging, sediments are gouged from the bed by the cutting head and immediately drawn into the suction pipe by a powerful pump. The entrained sediments typically forming between 10 and 20% of the slurry stream are pumped from the dredge to the deposition site for dewatering.

The timing, sequence and duration of works have not been determined at this stage but it envisaged that the works may extend over several years. As the project is assessed further, operational, environmental or social constraints may be identified that dictate some aspects of project timing.

2.2 Sediment Dewatering

The method of dewatering has not been finalised and will need to be determined with reference to the properties of the material to be dredged, environmental constraints at the site as well as technical and economic considerations. At this stage it is assumed that all dewatering will be undertaken through the use of open bunds, whereby the dredged material is received on site as a slurry. This material fills a large initial bund, whilst the liquid fraction (seawater and fines) flows to subsequent bunds to allow progressive settling of fine material. At the end of the treatment train, surface water is monitored to confirm adherence to discharge requirements and is drawn off the surface from the final collection pond and drained back to the estuary. This method of dewatering requires a significant amount of open space to be undertaken efficiently and is ideally located close to the extraction area (to limit slurry transfer distances) and also where there is a free drainage pathway to allow discharge of supernatant back to the estuary under gravity.

Numerous potential dewatering sites were initially identified, although only three sites were considered to have sufficient space and proximity to the extraction areas to warrant further consideration: Ballina Shire Council Depot 2 - situated on Crown Land, formerly a landfill site and currently used as a Council depot. The depot is located adjacent to North Creek Canal approximately 750 m from North Creek. The slurry transfer pipeline to this site would be between 1 and 3 km in length, depending on the dredge site; and

- Ballina Racecourse – Located on Racecourse Road adjacent to North Creek. The slurry transfer pipeline to this site would be between 1 and 3 km in length, depending on the dredge site; and
- Southern Cross Industrial Estate – Lots 2 and 3 Boeing Ave, approximately 700 m north-west of North Creek. The site is the proposed expansion of the existing Southern Cross industrial Estate. The slurry transfer pipeline to this site would be between 1 and 4 km in length, depending on dredge site.

Depot 2 is currently used by Council for stockpiling of soil, construction fill and road base materials. There is approximately 2 ha of the site that would be suitable for dewatering activities, however the ability to stockpile very large volumes of material at this site would be limited. Fill material won from dredging activities would need to be transferred to the ultimate fill destination (Southern Cross Industrial Estate) by truck. As the site is immediately adjacent to North Creek Canal (aka Fishery Creek Canal), discharge of supernatant from

dewatering activities would be directly to this section of the estuary and is ideal from this perspective. Due to the closer proximity to lower North Creek, which has cleaners sands which may be suitable for higher end uses such as concrete production, it may be desirable to process lower volumes of this type of material at Depot 2 where it can be stockpiled.

Lots 2 and 3, Boeing Avenue at Southern Cross are the intended fill destinations and therefore direct delivery of dredged material to this site would negate the need for additional transportation of the dewatered material. The site is approximately 25 ha and is subject to a number of land zonings under the Ballina LEP (see section 3). The actual area available for dewatering works is around 15 ha. Excess water from the dewatering operation would be discharged to an unnamed drain/creek which originates at the site and drains back towards North Creek over a distance of around 800 m. Given that road transport of fill materials is not required for this option, it is the currently preferred dewatering site for the bulk of the dredged material.

2.3 Transfer Pipelines

Dredged sediment would be pumped via pipelines to the remote site(s) listed above for dewatering. The pipelines are semi-flexible and temporarily installed between the dredge itself and the dewatering site. The pipelines are typically <350mm diameter (designated by internal diameters such as 8" or 10") and can either be supported by buoys to float at the water surface and/or can lay on the bed of the estuary as best minimises the impact of the pipeline within the waterway itself. Several potential slurry transfer pipeline routes have been identified for each potential dewatering site (Figure 2). The routes vary according to the dredge site and dewatering site, but would be located in order to minimise navigational issues and other impacts within the waterway. Typically a single area is dredged at a time and once completed, the pipeline from that area would be dismantled, thereby reducing the length of pipeline in service at any one time.

On landfall, the pipeline may lay on the ground surface or could be buried (temporarily or permanently). Routes generally follow waterways and road reserves. Indicative pipeline routes between the extraction and dewatering sites are shown in Figure 2. In concept, the most direct pipeline route for extraction areas A and B is through a small area of township and then following Little Fishery Creek before landfall at the Depot 2. The most problematic component of this route is the crossing of Cherry Street, where underground services are likely to complicate trenching of the pipe under the road. Although crossings over roads are possible with the provision of ramps, this is only a realistic option for minor streets. Further assessment would need to be undertaken to determine if it was acceptable option in this case. If a suitable crossing method cannot be determined, the default pipeline route will simply follow North Creek and then North Creek Canal to Depot 2.

The upstream extraction sites (C and D) are more central to both potential dewatering sites. From these, a pipeline would either extend along North Creek Canal to make landfall at Depot 2, or alternatively would follow an unnamed drain/creek towards the Southern Cross Industrial Estate for around 200 m, pass under a culvert at North Creek Road and continue to follow the drain/creek for a further 600 m to the dewatering site. This pathway is the same as the intended return discharge waters described in section 2.2 and passes through privately held land. The landholder's representative has indicated agreement to utilise this route and the owner(s) will need to provide consent at the time of submission of the Development Application.

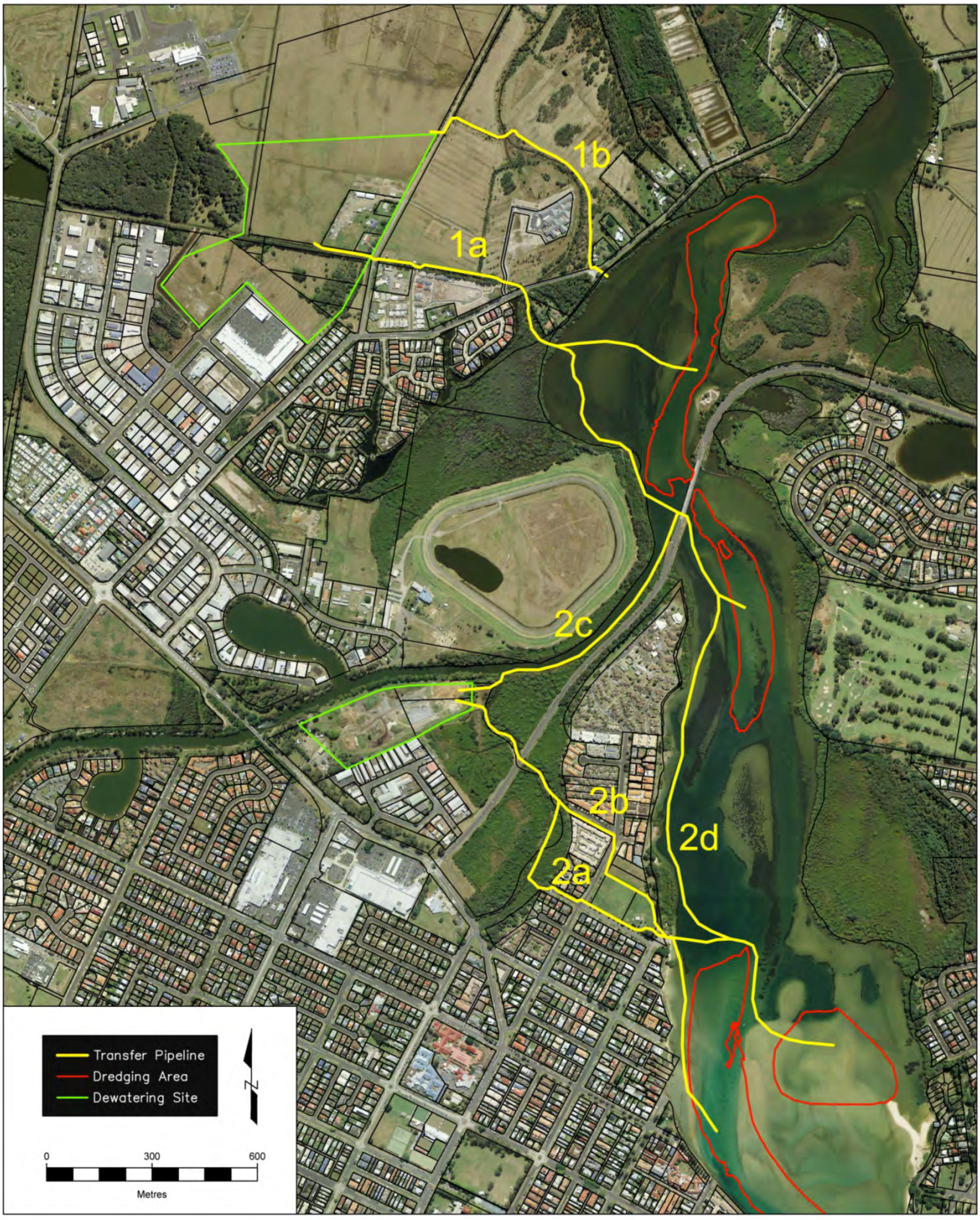

Figure 2. Indicative pipeline route options (numerous combinations are possible)

3. LEGISLATIVE REVIEW

This section is intended to provide an overview of the relevant legislation, identify key legislative requirements in relation to the project and identify the planning approval pathway that will apply.

3.1 Environmental Planning and Assessment Act, 1979 (EP&A Act)

Planning in NSW is governed by the *Environmental Planning and Assessment Act*, *1979* (EP&A Act) and the *Environmental Planning and Assessment Regulation, 2000*. State Environmental Planning Policies (SEPPs) and Local Environmental Plans (LEPs) support the planning structure.

Ballina Local Environmental Plan 2012

The study area is subject to the Ballina LEP (BLEP) 2012. The BLEP zoning for the study area is shown in Figure 3 and is as follows:

- Extraction area: North Creek is zoned Natural Waterways (W1) and the Richmond River is zoned Recreational Waterways (W2); and
- The potential dewatering sites are zoned:
    - Depot 2 – Rural Landscape (RU2);
    - Southern Cross Industrial Estate - Business Development (B5), General Industrial (IN1) and Rural Landscape (RU2); and
    - Racecourse – Public Recreation (RE1); and
- Potential pipeline routes:
    - 1a – Deferred matter (Environmental Protection - Wetlands), Rural Landscape (RU2), Medium Density Residential (R3) and Low Density Residential (R2)
    - 1b – Rural Landscape (RU2), Medium Density Residential (R3)
    - 2a – Public Recreation (RE1), Medium Density Residential (R3) and Deferred Matter (Environmental Protection - Wetlands)
    - 2b - Public Recreation (RE1) and Low Density Residential (R2)
    - 2c – Natural Waterways (W1) and Recreational Waterways (W2)

Under the BLEP, extractive industry means the winning or removal of extractive materials (otherwise than from a mine) by methods such as excavating, dredging, tunnelling or quarrying, including the storing, stockpiling or processing of extractive materials.

Extractive industries are not permitted in W1, W2, B5 or RE1 zones but are permitted with consent in R2, R3, RU2 and IN1 zones. The BLEP 1987 applies to land zoned as Deferred Matter under the BLEP 2012. Under the BLEP 1987 extractive industries are not permitted in Environmental Protection (Wetlands) zones.

The intended fill location (Southern Cross Industrial Estate) has areas zoned Business Development (B5), General Industrial (IN1) and Rural Landscape (RU2). Council intends to rezone parts of this area for future industrial development (IN1 and IN2 zoning). The IN2 zoning is a Council designated zoning and the rezoning application will make provision for extractive industries. Once rezoned, the placement of fill is expected to be permissible with consent.

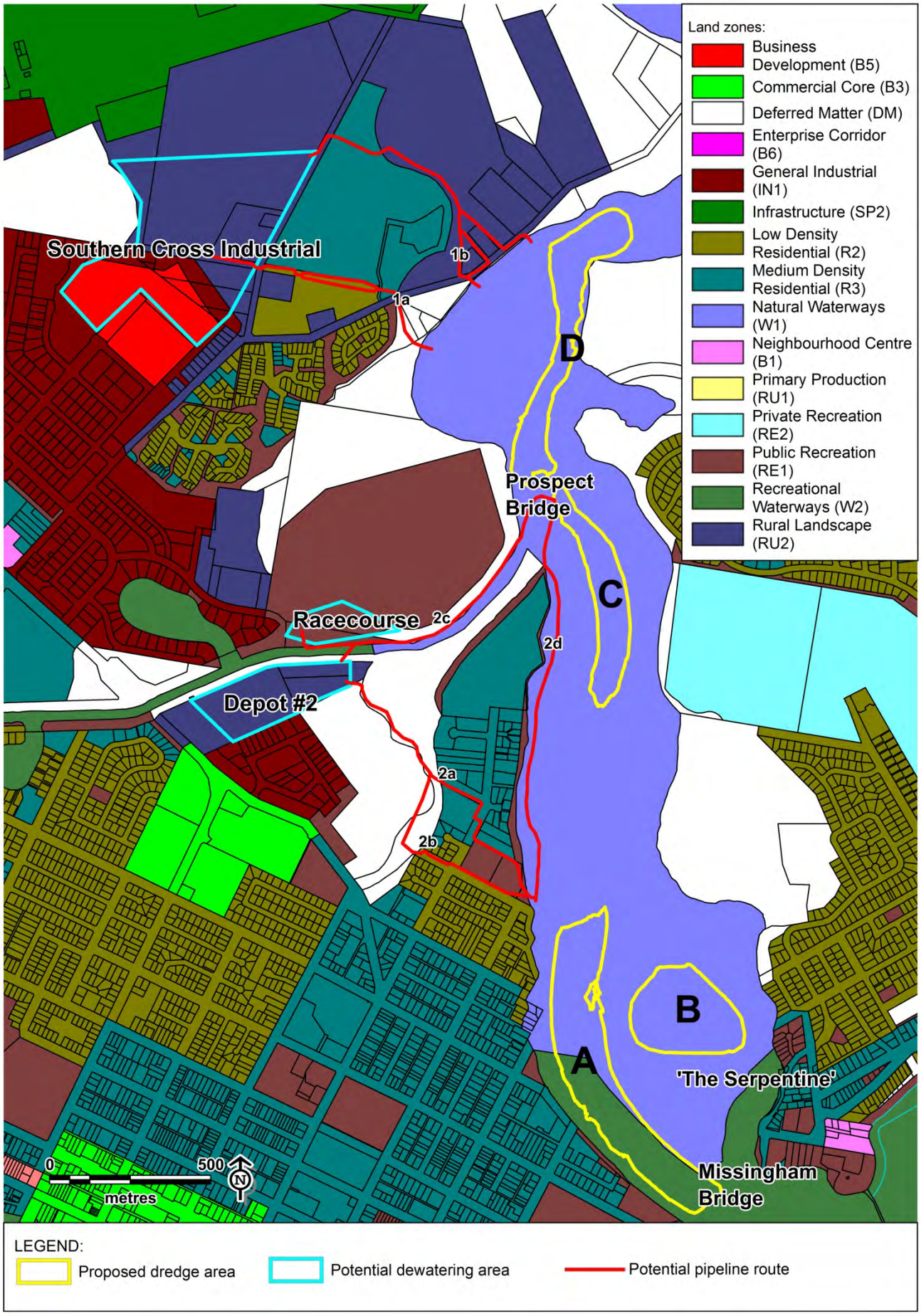

Figure 3: BLEP 2012 land zones

State Environmental Planning Policy (SEPP) (Mining, Petroleum Production and Extractive Industries) 2007

SEPP (Mining, Petroleum Production and Extractive Industries) 2007 aims to provide for the proper management and development of mineral, petroleum and extractive material resources for the social and economic welfare of the State. The Policy establishes appropriate planning controls to encourage ecologically sustainable development.

Section 7 of the SEPP identifies development that is permissible with consent and provides for:

- extractive industry on land on which development for the purposes of agriculture or industry may be carried out (with or without development consent),
- extractive industry in any part of a waterway, an estuary in the coastal zone or coastal waters of the State that is not in an environmental conservation zone as permissible with consent.

The SEPP prevails over the LEP where any of these conditions are met. As the proposed dredging areas are not in an environmental conservation zone (under the BLEP 2012), the activity is permissible with consent. The pipeline routes will likely traverse mangrove creek areas mapped as 7(a) in the BLEP 1987 and areas zoned as RE1 and the racecourse site is zoned RE1. However development for the purposes of agriculture (extensive agriculture in RE1 zones) is permissible with consent in these areas and therefore meets the first condition for Section 7 of the SEPP.

Conversely, a part of the Southern Cross Industrial site is zoned as B5, a land zone that agriculture and industry may not be carried out and therefore extractive industry activities are not permitted within this zone.

State Environmental Planning Policy (Infrastructure) 2007

The aim of this SEPP is to facilitate the effective delivery of infrastructure across the State.

Under Section 68 (2b) of the SEPP, development (including maintenance dredging – Section 68 (5)) carried out by or on behalf of a public authority (i.e. local government) for navigation or emergency response facilities is permitted without consent. A typical application of this SEPP would be Crown Lands maintenance dredging where repeated dredging of a marked navigation channel is undertaken and the dredged material is returned beneficially to the environment (e.g. beach nourishment).

For larger scale operations, beyond the immediate requirements for maintenance dredging and utilisation of the won material on a commercial basis Section 68 (2b) of the Infrastructure SEPP would not apply and the works would require development consent.

State Environmental Planning Policy (SEPP) No. 71 – Coastal Protection

SEPP 71 is designed to protect sensitive coastal values and provide a coordinated assessment and management process for the coastal zone. All development within 100 m below mean high water mark of an estuary is significant coastal development (Clause 9(1)(c)). Where development is a significant coastal development and assessed by a council, the requirements of the Director-General of the Department of Infrastructure, Planning and Natural Resources must also be considered.

The proposal is located within the coastal zone as defined by SEPP 71. Clause 8 of the SEPP provides matters to be taken into account by a consent authority when determining an application to carry out a development in the coastal zone. These include:

- Retaining public access to and along the coastal foreshore for pedestrians;
- Providing opportunities for new public access on the foreshore;
- Any detrimental impact development may have on the amenity of the coastal foreshore;
- The scenic qualities of the NSW coast;
- Measures to conserve threatened animals, plants and fish;

- Protecting existing wildlife corridors; and
- The likely impact of coastal processes and coastal hazards on the development.

State Environmental Planning Policy (State and Regional Development) 2011

The aim of this policy is to identify state significant development and state significant infrastructure.

Under Schedule 1 of the policy, development for the purpose of an extractive industry is considered as state significant development if it:

- Extracts more than 500,000 tonnes of extractive materials per year;
- Extracts from a total resource (the subject of the development application) of more than 5 million tonnes; or
- Extracts from an environmentally sensitive area of State significance. This is defined as:
    - Coastal waters of the State (3 nautical miles seaward of the territorial sea baseline);
    - Land to which *State Environmental Planning Policy No 14 - Coastal Wetlands* or *State Environmental Planning Policy No 26 - Littoral Rainforests* applies;
    - Land reserved as an aquatic reserve under the *Fisheries Management Act 1994* or as a marine park under the *Marine Parks Act 1997*;
    - A declared RAMSAR wetland within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999* of the Commonwealth;
    - A declared World Heritage property within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999* of the Commonwealth;
    - Land identified in an environmental planning instrument as being of high Aboriginal cultural significance or high biodiversity significance;
    - Land reserved as a state conservation area under the *National Parks and Wildlife Act 1974;*
    - Land, places, buildings or structures listed on the State Heritage Register under the *Heritage Act 1977*;
    - Land reserved or dedicated under the *Crown Lands Act, 1989* for the preservation of flora, fauna, geological formations or for other environmental protection purposes; or
    - Land identified as being critical habitat under the *Threatened Species Conservation Act, 1995* or Part 7A of the *Fisheries Management Act, 1994*.

The proposed works include the extraction of approximately 575,000 m³ of sand from North Creek however, it is anticipated that the works will be undertaken over several years and hence will be below the 500,000 m³ threshold. The total resource available for extraction from North Creek is also considered to be less than 5 million tonnes. The extraction will not occur within areas of SEPP 14 wetlands and no areas of critical habitat have been identified within the project area. Therefore the proposed extraction area is not considered to be an environmentally sensitive area and the proposed works are not considered to be state significant development under the SEPP.

State Environmental Planning Policy No. 14 – Coastal Wetlands

The aim of SEPP 14 is to ensure that the coastal wetlands are preserved and protected in the environmental and economic interests of NSW. North Creek includes areas of SEPP 14 wetland and parts of the activity may impact on SEPP 14 wetlands (e.g. transfer pipelines). Works involving clearing, draining, filling or constructing a levee on coastal wetlands cannot be undertaken without consent of the local council (Ballina Shire Council) and the agreement of the Director General. Such development also requires an Environmental Impact Statement (EIS) to be lodged with a DA.

State Environmental Planning Policy No. 62 – Sustainable Agriculture

The main objective of the policy is to encourage sustainable aquaculture, including sustainable oyster aquaculture, in NSW, namely, aquaculture development which uses, conserves and enhances the community's resources so that the total quality of life now and in the future can be preserved and enhanced.

Several aquaculture areas (oyster leases) are located throughout lower North Creek. Before determining a development application for any development, a consent authority must consider whether, because of its nature and location, the development may have an adverse effect on oyster aquaculture development or a priority oyster aquaculture area. Provisions (i.e. water quality criteria) outlined in the *NSW Oyster Industry Sustainable Aquaculture Strategy* must be considered.

Designated Development

Under Schedule 3, Part 1 (19 Extractive Industries) of the *Environmental Planning and Assessment Regulation, 2000* the proposed works are considered as designated development as it:

- Will involve dredging for reuse of more than 30,000 cubic metres of extractive material per year;
- Will disturb a total surface area of more than 2 hectares of land by clearing or excavating; and
- Is located within 40 metres of a natural waterbody, wetland or an environmentally sensitive area.

Designated development is permissible with consent and is assessed under Part 4 of the EP&A Act. A development application (DA) is required for submission to the consent authority. The proposed works are in excess of the above criteria and therefore Section 78A (8A) of the EP&A Act requires that the development application must be accompanied by an EIS.

Under Schedule 4a Part 8 (a) of the EP& A Act, development for the purposes of extractive industries, which meet the requirements for designated development under clause 19 of Schedule 3 to the *Environmental Planning and Assessment Regulation 2000,* regional panels may be authorised to exercise consent authority functions of Council. Therefore the Northern Joint Regional Planning Panel (NJRPP) is the consent authority for the proposed works.

Integrated Development

The proposed works are classified as "integrated development" under Section 91 of the EP&A Act as it requires development consent as well as approvals under the *Fisheries Management Act, 1994* (refer Section 3.5). The relevant agencies must provide their approval requirements to be covered in the EIS.

Under Section 79B (3) of the Act, Council is required to obtain the concurrence of the Chief Executive of the Office of Environment and Heritage before development consent is granted if the development is likely to significantly affect a threatened species, population, ecological community or its habitat (refer Section 3.6).

3.2 Protection of the Environment Operations Act, 1997 (POEO Act)

The POEO Act regulates air, noise, land and water pollution. Under the Act it is an offence to cause pollution.

The Act enables the issue of environment protection licences (EPL) for scheduled development work or activities. Under Schedule 1 Part 1 (19) of the Act scheduled activities include the dredging of more than 30,000 m^3 annually of extractive material for sale or reuse. The proposed works are therefore scheduled works and would require an EPL.

The EPA will assess the Development Application and EIS and either refuse to grant approval or issue it's 'General Terms of Approval'. These terms of approval constitute the general licence conditions for the activity

that is the subject of the development application and, if approval is granted, the EPA is obliged to issue the corresponding EPL. An EPL will not be issued until development consent is obtained.

3.3 Coastal Protection Act, 1979

The Coastal Protection Act provides for the protection of the coastal environment of the State for the benefit of both present and future generations. As the activity requires development consent under the EP&A Act, concurrence of the Minister under the *Coastal Protection Act* is not required (s.37B (a)).

3.4 Crown Lands Act, 1989

The bed and sand bars of North Creek are Crown Land, administered under the *Crown Lands Act,1989*. This Act requires parties undertaking dredging works to obtain the owner's consent from the Department administering the Act (Department of Primary Industries – Lands, NSW Land and Property Management Authority - LPMA) at the development application stage.

A request for landowner's consent from the NSW LPMA is required. The request must outline the details of the site, details of the proposal and planning controls and details of the applicant. A licence is also required before the commencement of works. Before a licence can be issued it is necessary to show evidence that all other relevant agencies have been consulted and concur with the proposal. A licence for extraction can only be obtained once the development has been approved by the consent authority.

3.5 Fisheries Management Act, 1994

The objectives of the *Fisheries Management Act 1994* (FM Act) are to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations. To meet the primary objectives, Part 7 of the FM Act deals with the protection of aquatic habitats and Part 7A deals with threatened species conservation.

Under s201 of the Act, a permit is required for dredging or reclamation work carried out by a local government authority, unless these works are authorised by a relevant public authority (other than a local government authority) or under the *Crown Lands Act 1989*. If any marine vegetation (saltmarshes, mangroves, seagrass and seaweeds) is considered to be affected by the proposal, a permit to harm (cut, remove, damage, destroy, shade, etc.) marine vegetation under s205 would be required. Fisheries NSW policy and guidelines outline that seagrass beds of *Posidonia australis* and seagrass beds of *Zostera, Hetrozostera, Halophila* and *Ruppia* greater than 5m² in area are Type 1 Key Fish Habitats. *Zostera, Hetrozostera, Halophila* and *Ruppia* less than 5m² in area are Type 2 Key Fish Habitats. Seagrass (*Zostera*) mapping from aerial photography (Figure 10) and previous marine vegetation mapping by DPI indicates that Type 1 Key Fish Habitat will be present within the proposed dredging areas.

Generally, Fisheries NSW will not approve any new development or activities that will harm Type 1 and Type 2 marine vegetation without adequate mitigation and compensation measures in place. Further, Fisheries NSW will generally not approve developments or activities that do not incorporate foreshore buffer zones of 50 m – 100 m width adjacent to Type 1 marine vegetation and at least 50 m width adjacent to Type 2 marine vegetation. Fisheries NSW enforces a 'no net loss' habitat policy as a permit condition or condition of consent. This may require proponents to conduct habitat rehabilitation and/or provide environmental compensation.

NSW DPI calculates habitat compensation on a minimum 2:1 basis for all key fish habitat (Type 1-3) to help redress other indirect impacts of development. A greater compensation ratio may be considered if opportunities for compensation are not available in the vicinity of, or of the type of habitat that has been lost. Compensation for disturbance to SEPP 14 coastal wetlands (which may include Type 1 and 2 habitats) requires approval from the Department of Planning and Infrastructure and a ratio of 10:1 generally applies.

3.6 Threatened Species Conservation Act, 1995

The objectives of the *Threatened Species Conservation Act 1995* (TSC Act) are to conserve biological diversity and promote ecologically sustainable development by preventing the extinction and promoting the recovery of threatened species, populations and ecological communities.

Under Section 91 of the Act, a licence would be required for a development likely to result in one or more of the following:

- Harm to any animal that is of, or is part of, a threatened species, population or ecological community;
- The picking of any plant that is of, or is part of, a threatened species, population or ecological community;
- Damage to critical habitat; or
- Damage to habitat of a threatened species, population or ecological community.

Where a development has impacted on, will impact on, or is likely to impact on a species, a population, or an ecological community the assessment of significance under the EP&A Act is the first step in considering potential impacts. For developments likely to affect threatened species, populations or ecological communities, a species impact statement (SIS) is required as outlined in Section 110 of the TSC Act. This must identify the threatened, populations or ecological community to be impacted and outline the expected extent of the impact.

3.7 National Parks & Wildlife Act, 1974

The *National Parks and Wildlife Act, 1974* (NPW Act) provides for the statutory protection of protected flora and fauna and Aboriginal cultural heritage places, objects and features. It is an offence under the NPW Act to cause harm or desecration to any Aboriginal heritage items, objects or places discovered during operations. Under Section 90 of the Act an aboriginal heritage impact permit may be issued where harm to an Aboriginal object or place cannot be avoided.

A search of the Aboriginal Heritage Information Management System (AHIMS) database revealed 14 Aboriginal sites within the vicinity of lower North Creek (Refer Section 4.15). Due diligence should be exercised to determine whether the proposed activity will harm an Aboriginal object or site. The *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW (OEH, 2010)* provides an outline of the relevant due diligence process. The due diligence process informs the initial assessment of the environmental impacts of an activity on Aboriginal heritage. If the initial assessment identifies that Aboriginal heritage is likely to be harmed then further investigation and assessment is required*. Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW (NSW OEH, 2011)* provides guidance on the investigation and assessment of activities on Aboriginal heritage in NSW.

3.8 Heritage Act, 1977

All non-Aboriginal archaeological relics across NSW (including NPWS estate) over 50 years old are managed under the *Heritage Act, 1977*. Any works or activities that may disturb non-Aboriginal archaeological relics must have an Excavation Permit (Section 139), which is a separate approval under the Act. If a place or land is covered by an interim protection order or a State Heritage Register Listing a permit to demolish, move, alter or in some way develop that land or place would be required.

A search of the State Heritage Register has shown that no known sites of State Heritage significance exist in the vicinity of the works. The Ballina Local Environmental Plan (LEP) 2012 lists sites of local heritage significance. Under the Ballina LEP 2012 Lot 284 DP 755684 'Ballina Trophy Guns', the site of Depot 2, is listed as an Archaeological site (See Section 4.15). Under the LEP (Part 5.10 (2c)) , development consent is required for activities disturbing or excavating an archaeological site while 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. The consent authority must, before granting consent under this clause to the carrying

out of development on an archaeological site, notify the Heritage Council of its intention to grant consent, and take into consideration any response received from the Heritage Council within 28 days after the notice is sent.

No other heritage sites listed under the Ballina LEP 2012 are within the vicinity of the proposed works.

3.9 Water Management Act 2000

In stream works are regulated by the controlled activity provisions of the *Water Management Act 2000* (WM Act). The NSW Office of Water administers the WM Act and is required to assess the impact of any proposed controlled activity to ensure that no more than minimal harm will be done to waterfront land as a consequence of carrying out the controlled activity. Waterfront land includes the bed and bank of any river, lake or estuary and all land within 40 metres of the highest bank of the river, lake or estuary.

Under Section 38 of the *Water Management (General) Regulation, 2011* a public authority is exempt from Section 91E (1) of the Act in relation to all controlled activities that it carries out in, on or under waterfront land. However, as part of the approvals process, it is necessary for the NSW Office of Water to be consulted about the proposed works and be provided a copy of the environmental assessment.

3.10 Environment Protection and Biodiversity Conservation Act, 1999 (EPBC Act)

The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places - defined in the EPBC Act as matters of national environmental significance (MNES).

Based on a preliminary search of the EPBC Act Search Tool conducted on the 11th December 2015 for the proposed dredging and dewatering areas the a number of listed species are known to occur or their habitat is known to occur within the vicinity of the study area:

- Dredging areas
    - 1 Critically Endangered, 3 Endangered, 8 Vulnerable and 40 Marine or Migratory species
- Depot 2
    - 1 Endangered, 4 Vulnerable and 8 Marine or Migratory species
- Southern Cross Industrial
    - 1 Endangered, 5 Vulnerable and 6 Migratory species.

For a detailed list of species refer to Appendix 1.

Under the Act a referral is required to the Commonwealth Minister administering the Act for proposed 'actions that have the potential to significantly impact on matters of national environmental significance or the environment of Commonwealth land.' The Minister will decide if the proposed action triggers the *matters protected* by the EPBC Act and requires a formal assessment and approval. If the Minister deems that the proposal is not likely to be significant, approval is not required if undertaken in accordance with the referral or in a 'particular manner'. If the Minister decides that the proposal is likely to be significant, it is considered a 'controlled action' and approval under the Act will be required. The proposal will be subject to a formal assessment and approval process (to be decided by the Minister).

Actions can be assessed using one of the following assessment approaches:

- Accredited assessment (e.g. bilateral agreements);
- Assessment on referral information (assessment undertaken solely on the information provided in the referral form);

- Assessment on preliminary documentation (referral form and any other relevant material identified by the Minister as being necessary to adequately assess a proposed action);
- Assessment by Environmental Impact Statement (EIS) or Public Environment Report (PER); or
- Assessment by public inquiry.

Following the assessment the Minister will decide whether to:

- Approve the proposal;
- Approve the proposal subject to constraints (e.g. will place conditions on the action); or
- Not approve the proposal.

When deciding if a proposed action should be approved, and what conditions to impose, the Minister will consider the impacts of the proposed action on matters protected by the EPBC Act and other economic and social matters. The Minister must take into account:

- The principles of ecologically sustainable development;
- The outcomes of the assessment of the impacts of the proposed action;
- Referral documentation;
- Community and stakeholder comment;
- Any other relevant information available on the impacts of the proposed action; and
- Relevant comments from other Australian Government and state and territory government ministers (such as information on social and economic factors).

3.11 Summary of Legislative Requirements

The following approvals and licences/permits are required for the proposed dredging of North Creek:

- Development consent under Part 4 of the EP&A Act including an EIS;
- Environmental Protection Licence under the POEO Act;
- Landowners owners consent under the *Crown Lands Act*;
- Licence under the *Crown Lands Act*; and
- Permit to harm marine vegetation and undertake dredging and reclamation under the *Fisheries Management Act*.

Other approvals and permits may be required for the proposed works, depending on the outcome of further investigations/studies. These include:

- EPBC Act referral/approval;
- Threatened Species permit under TSC Act;
- Excavation permit under the *Heritage Act*;
- Aboriginal heritage permit under NPW Act

The consent authority for this development is the Northern Joint Regional Planning Panel.

The following table provides a summary of the legislative requirements for the project.

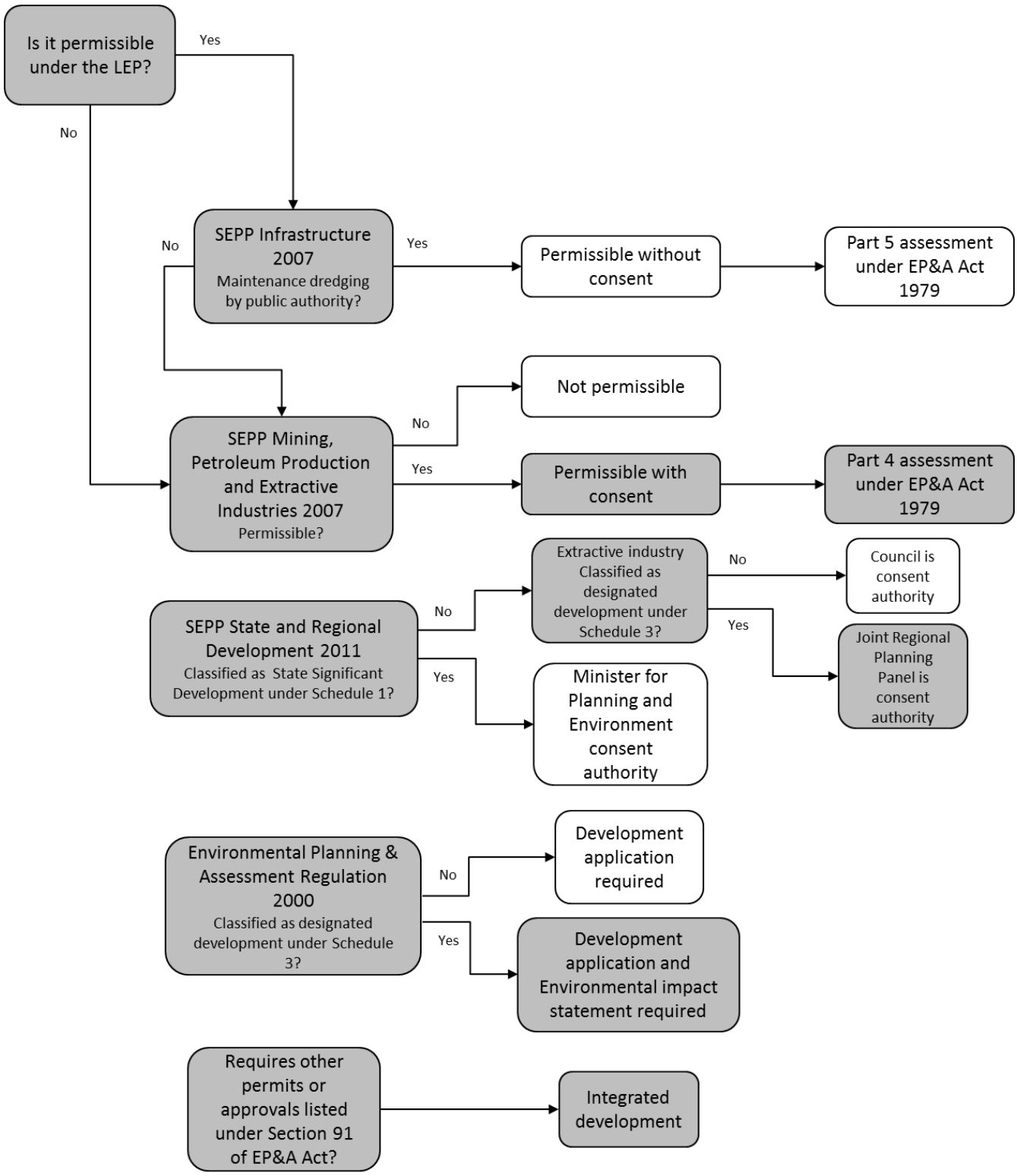

Figure 4: Summary of EP&A Act approvals decision process

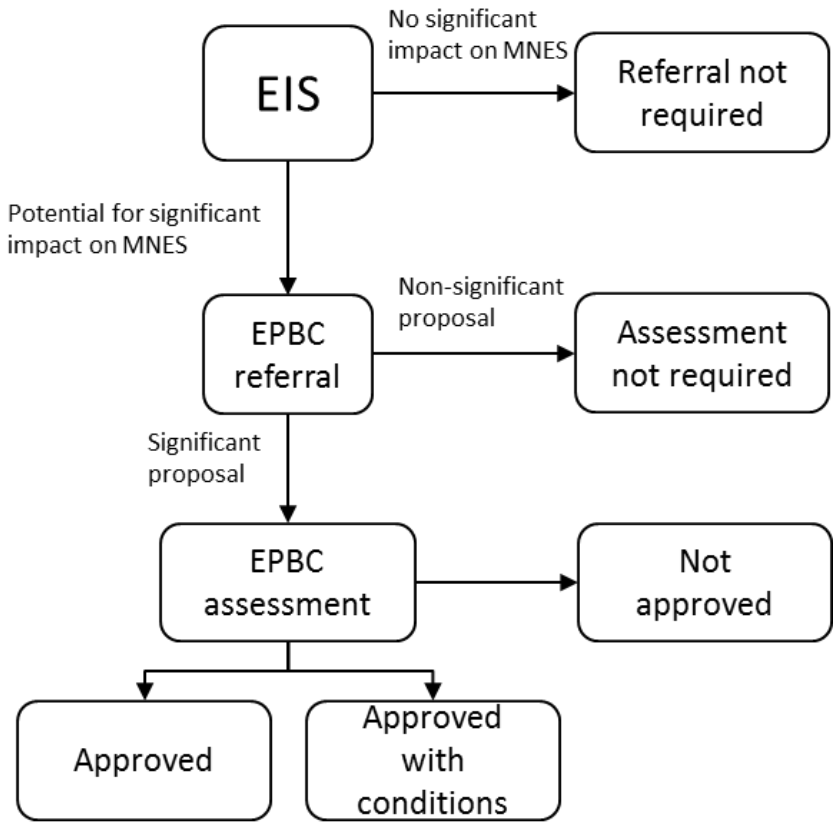

Figure 5: Summary of EPBC Act approval process

Table 2: Summary of relevant legislative requirements and approvals/permits that apply to the proposal

Legislation/Planning Instrument	Relevant Authority	Approval/Permit	Requirement	Trigger	Comments	Approval Required?
State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007	BSC	-	-	Defined as 'extractive industry'	The activity is permissible with consent.	Yes
State Environmental Planning Policy No. 71 – Coastal Protection	Department of Planning and Environment	Concurrence assessment by the Director-General		Where development is significant coastal development	Proposal is located within the coastal zone and is significant coastal development.	Yes
State Environmental Planning Policy No. 14 – Coastal wetlands	Department of Planning and Environment	Council consent and Director General's concurrence.		Clearing of coastal wetlands	Impacts on SEPP 14 wetlands will need to be considered.	Possibly
Environmental Planning and Assessment Act, 1979	NJRPP	Consent Authority approval	Development Application and EIS under Part 4	Extraction >30,000 m^3 therefore classified as designated development.	NJRPP is consent authority, DA and EIS are required for approval by Director General.	Yes
	NSW OEH	Integrated development concurrence by Chief Executive	SIS	Significant impact on a threatened species, population, ecological community or its habitat	For developments likely to affect threatened species, populations or ecological communities, an SIS is required.	Possibly
Protection of the Environment Operations (POEO) Act, 1997	NSW EPA	Environmental Protection Licence	EIS will be reviewed Application	Scheduled activity - dredging of more than 30,000 m^3 annually of extractive material for sale or reuse		Yes

Legislation/Planning Instrument	Relevant Authority	Approval/Permit	Requirement	Trigger	Comments	Approval Required?
Crown Lands Act 1989	NSW DPI - Lands	Owners consent and licence	Application	Works undertaken on Crown land	Owner's consent is required at the approvals stage. Licence is required for the works to commence.	Yes
Fisheries Management Act 1994	Fisheries NSW	Permit to harm marine vegetation	Application detailing nature and extent of marine plants /fisheries habitat to be lost by works	Harming of marine vegetation, works within 50-100 m of Type 1 marine vegetation.	Assessment required.	Yes
	Fisheries NSW	Dredge and reclamation permit	Application	Undertaking dredging or reclamation work		Yes
Threatened Species Conservation Act 1995	NSW OEH	Licence to harm	SIS or application	• Harm to any animal that is of, or is part of, a threatened species, population or ecological community; • The picking of any plant that is of, or is part of, a threatened species, population or ecological community; • Damage to critical habitat; • Damage to habitat of a threatened species, population or ecological community.	Assessment required.	Possibly
National Parks and Wildlife 1974	NSW OEH	Aboriginal heritage impact permit	Application	Works that are likely to harm Aboriginal heritage items	Assessment required.	Possibly

Legislation/Planning Instrument	Relevant Authority	Approval/Permit	Requirement	Trigger	Comments	Approval Required?
Heritage Act 1977	NSW OEH	Excavation permit	Application	Works or activities that may disturb non-Aboriginal archaeological relics	Assessment required.	Possibly
Environment Protection Biodiversity and Conservation Act 1999	Commonwealth Department of Environment	Approval from the Australian Government Minister for the Environment	EPBC Act 1999 referral	Significant impact on matters of national environmental significance (NES)	If EIS determines a significant impact on matters of MNES then the project must be referred to the Minister for assessment.	Possibly

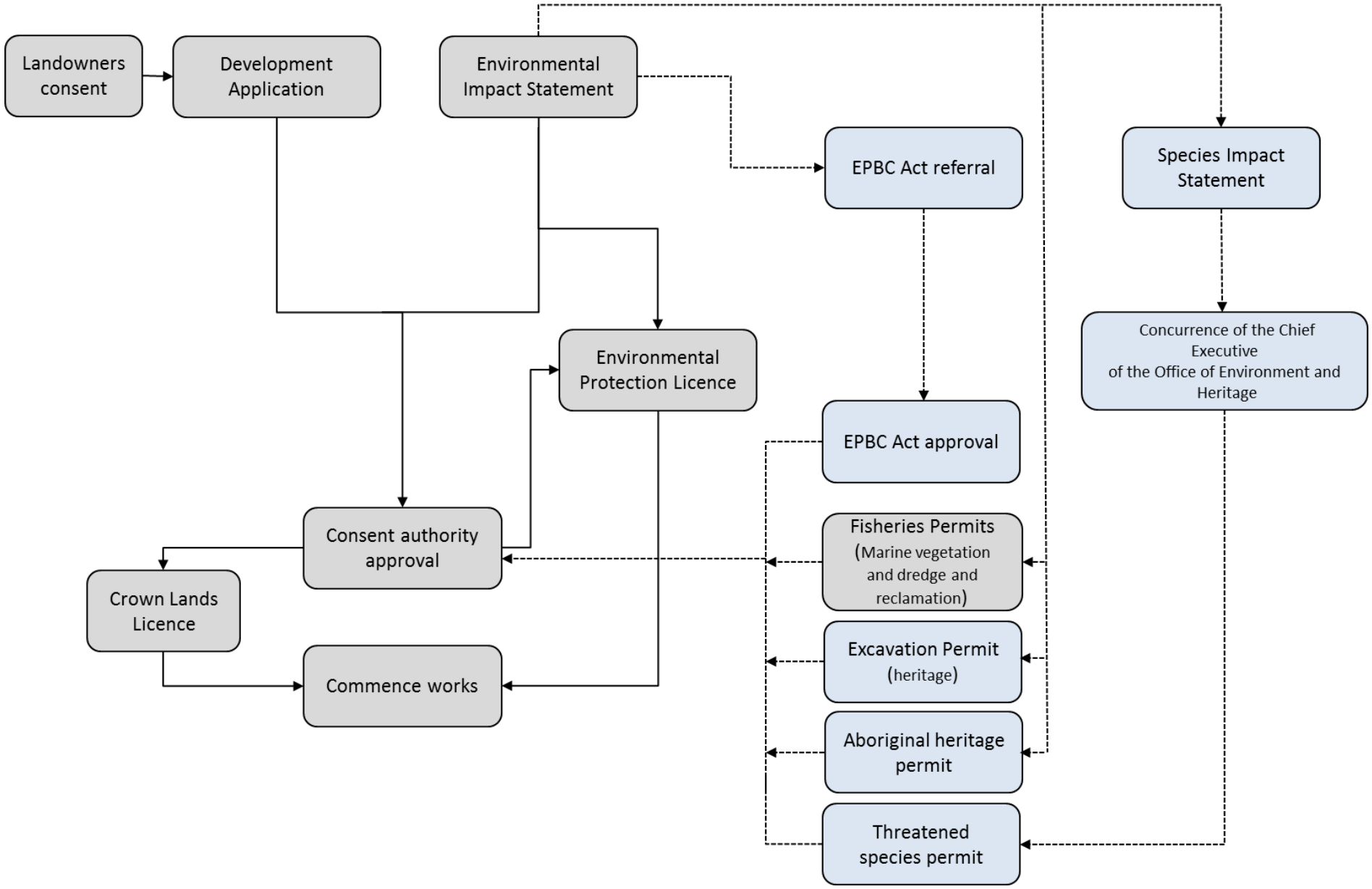

Figure 6: Overview of the North Creek dredging project approvals pathway. Grey - Required approvals, Blue – Approvals that may be required

3.12 Indicative Approvals Timing

The development application and EIS must be made available for public consultation for 30 days (s. 79 (1) EP&A Act). If a submission is made, the consent authority must wait a minimum of 21 days before issuing a decision (s. 80 (9) EP&A Act). If concurrence from a separate authority is required, the concurrence authority must give written notice to the consent authority of its decision on the development application within 21 days after it receives the last of the submissions made during the relevant submission period, or advice from the consent authority that no submissions were made.

A decision on a threatened species permit must be made within 120 days (subject to payment of fee) after the Director General receives a species impact statement or within such further period as may be agreed with the applicant for the licence (s. 99 (2) TSC Act). An Aboriginal Heritage Impact Permit will be determined within 60 days of lodgement if all required accompanying information is provided. A state heritage permit requires assessment of 21 days before deemed refusal (s.141 (1) Heritage Act 1977).

For integrated developments, NSW DPI is required to assess the proposal and provide General Terms of Approval to the Consent Authority within 40 days (unless insufficient information has been provided in which case the 'clock is stopped' until the relevant information is provided).

No minimum time period is provided regarding obtaining owner's consent under the *Crown Lands Act 1989*.

If the works are referred to the Minister administering the EPBC Act, a decision will be made within 20 days. Where works are deemed to be a controlled action requiring assessment and Commonwealth approval, the Minister will make a decision to approve, approve with conditions or not approve the proposed action. The timeframe of decision will depend upon the type of assessment required:

- For assessment by EIS/Public Environmental Report or preliminary documentation, a decision must be made within 40 business days of receiving finalised documentation from the proponent.
- For assessment by inquiry, a decision must be made within 40 business days of receiving an inquiry report.
- For assessment by a state/territory process, a decision must be made within 30 business days of receiving an assessment report.
- For assessment on referral information, a decision must be made within 20 business days of receiving a finalised recommendation report.

3.13 Summary of Project Legislative Constraints

Table 3 provides a summary of the relevant project legislative constraints.

Table 3: Relevant project legislative constraints

Legislation	Relevant constraints	Outcomes
BLEP 2012	• Extractive industries are not permitted in W1, W2, B5 or RE1 zones. • Extractive industries are permitted with consent in R2, R3, RU2 and IN1 zones. • The BLEP 1987 applies to land zoned as Deferred Matter under the BLEP 2012. Under the BLEP 1987 extractive industries are not permitted in Environmental Protection (Wetlands) zones. • However, the Mining, Petroleum Production and Extractive Industries SEPP prevails over the BLEP 2012, only waterways not zoned as Environmental Conservation or land where Agriculture or Industry may be carried out under the LEP is extractive industry permissible under the SEPP.	The proposed activity is not permissible in some zones of the Southern Cross Industrial site although Council's current proposal is to rezone land within the dewatering area to a combination of IN1 and IN2 zoning. IN2 is a Council designated zoning and the rezoning application is to include allowance for extractive industries within this zone. Consequently, the land zoning should not restrict dewatering activities at the fill site.
State Environmental Planning Policy (State and Regional Development) 2011	Development for the purpose of an extractive industry is considered as State significant development if it: • Extracts more than 500,000 tonnes of extractive materials per year. • Extracts from a total resource (the subject of the development application) of more than 5 million tonnes. The total resource available for extraction is less than 5 million tonnes in total	The project is to extract no more than 500,000 tonnes of material per year from a total resource of less than 5 million tonnes in order to not be considered a State significant development.

4. OVERVIEW OF ENVIRONMENTAL FACTORS

The following provides background, preliminary assessment and recommendations in relation to key environmental and social factors related to the proposed activities.

4.1 Study Area

North Creek is a shallow water ecosystem stretching from the marine dominated shoals adjacent to Ballina, through the upper estuarine swamps of the Ballina Nature Reserve, to the extensive freshwater floodplain of Newrybar Swamp. This waterway forms the north-east arm of the Richmond River estuary and separates East Ballina from Ballina Island. Two bridges, Missingham Bridge and Prospect Bridge cross the waterway. The lower section of North Creek (downstream of Prospect Bridge) is bordered by the urban areas of Ballina to the west and East Ballina to the east. The western foreshore is lined with a combination of rock training walls and mangroves with the eastern foreshore dominated by sand flats and mangroves.

The upper North Creek catchment comprises mostly agricultural land use (cane, grazing and increasing areas of macadamia) which is located in the upper parts of the catchment (behind Lennox Head and below Newrybar). The hydrology of this area has been modified by extensive drainage works and levee construction. The Union Drain enters the upper reaches of North Creek and the Newrybar Levee lies north of Ballina Nature Reserve. The urban areas of Ballina including several industrial estates are situated in the lower reaches. The Ballina Wastewater Treatment Plant discharges treated wastewater to North Creek Canal.

The mid and lower reaches of North Creek are valued recreational areas used by local residents and tourists for fishing, boating and swimming. Sandy shoals in lower North Creek adjacent to Ballina provide sheltered and unique environments for recreation. The sand bar at the mouth of North Creek (downstream of Missingham Bridge) and the sand spit (upstream of Missingham Bridge) provide surf breaks. The lower estuary is a designated recreational fishing haven with the exception of the Mullet dig at Missingham Bridge which is fished by commercial fishers at certain times of the year. Commercial oyster culture occurs in North Creek and Mobbs Bay in South Ballina. Boat launch facilities are located on the western bank of North Creek at the intersection of Cawarra and Martin Streets.

Sand and mud flats in lower North Creek also provide important foraging habitat for resident and migrating shorebirds. Many fish species, including recreationally important species such as bream, whiting, flathead and mullet utilise habitats throughout North Creek. Much of the creek, upstream of The Serpentine, is bordered by mangroves and saltmarsh. These areas are classified as *State Environmental Planning Policy (SEPP) No. 14 – Coastal Wetlands.*

Proposed dewatering site Depot 2 is located adjacent to North Creek Canal. North Creek Canal connects Fishery Creek with North Creek and is used for boat passage between the Richmond River and North Creek and for water-based activities such as fishing, kayaking, canoeing and nature appreciation activities.

An unnamed small drainage channel flows through the Southern Cross Industrial Estate which drains areas of the Industrial Estate and grazing land to the north. The lower reaches of this channel are tidal.

4.2 Land Use

4.2.1 North Creek Land Use

Recreational activities including boating, fishing and kayaking are popular throughout North Creek. The lower reaches of the waterway, particularly the sand flats adjacent to The Serpentine are popular for water based recreational activities such as fishing, swimming, paddle-boarding, kayaking, boating, etc. Several oyster leases exist within close vicinity of the proposed dredging (areas B, C and D).

The lower section of North Creek (dredging areas A, B and C) is bordered by residential urban area of Ballina to the west, with residential areas, golf course and large area of mangroves bordering to the east. The western foreshore is lined with a combination of rock training walls and mangroves with the eastern foreshore dominated by sand flats and mangroves.

4.2.2 Dewatering Sites Land Use

Depot 2 has been highly modified by previous landfill activities and historical use as a night soil disposal location. Council currently uses the site for storage and works depot. Cleared, urban and industrial land surrounds the site to the immediate south east, south, west and north (across North Creek Canal). Immediately to the east of the proposed dewatering site within Lot 456 (DP 729144) lie extensive areas of mangroves conserved as SEPP14 areas.

Southern Cross Industrial site is currently used for grazing. The site is located directly adjacent to the Southern Cross Industrial Estate which is located to the south west of the site. Remnant bush land is situated to the west of the site with Ballina Airport located to the north-west. Grazing land borders the northern side of the site with rural residential and residential areas located to the east and south east.

4.2.3 Pipeline Routes Land Use

The majority of the potential pipeline routes are within waterways which are utilised for recreational activities. Upon leaving North Creek routes to the Depot 2 site traverse through road reserve and sporting fields within residential areas. The route also passes through an area of SEPP 14 wetland before entering Little Fishery Creek. The section of the Southern Cross Industrial pipeline route running through the canal is bordered by mangrove areas for the first 150 m. After passing under North Creek Road residential properties border the southern side of the route and potential future residential properties on the northern side. To the west of Corks Lane the route is bordered by a rural residential property to the north and grazing land to the south.

4.3 Topography and Landforms

4.3.1 North Creek Bathymetry

Hydrographic survey was undertaken of lower North Creek in early 2015 to determine the bathymetry of the study area. The bed of North Creek extends to -7.8 m AHD within areas previously subject to dredging, although typical thalweg bed elevations are in the order of -1 m to - 3 m AHD, with numerous inter-tidal shoals and recently increasing development of super-tidal beaches. The mean elevation across the full survey area at the time of survey was -1.0 m AHD.

The bathymetry captured by the 2015 survey is shown in Figure 7.

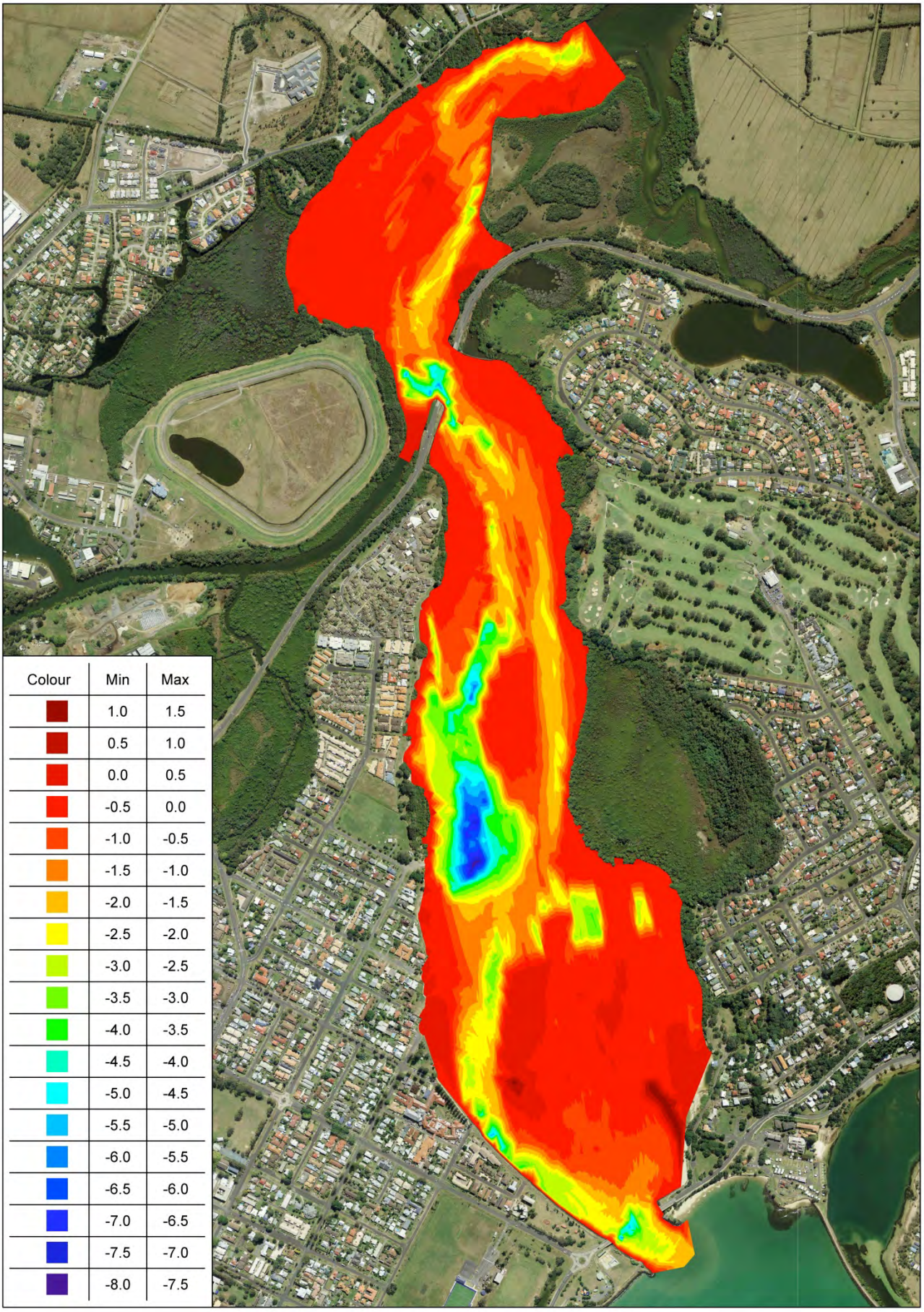

Figure 7. Bathymetry of North Creek captured in 2015 (Elevations relative to AHD).

4.3.2 Dewatering Site Topography and Soils

The Depot 2 dewatering site is relatively flat at an elevation of around 3.5 m AHD. Much of the site has been previously filled through and burial of waste materials and land reclamation activities. The site currently has numerous stockpiles of soil and rock material up to ~8 m AHD. Depot 2 is located close to a geological boundary, between alluvial sediments and coastal and estuarine plain deposits. Typical sediments in these settings include sand, silt, clay, gravel and organic clays. The natural soils at the site include mostly sands, sandy clays and clays, consistent with the regional geology expected. The site has been greatly disturbed by human activity to a depth of at least 1 m (GeoLINK, 2014). Soils are mapped as Class 2 acid sulfate soils.

The Southern Cross Industrial dewatering site is low-lying and generally flat. Soils are mapped as Class 2 acid sulfate soils. No assessment of this site has been conducted to date.

4.4 Coastal Geomorphology

4.4.1 Background

The volume of sand in North Creek and the lower estuary appears to have increased substantially over recent years and sand shoals, particularly in the eastern section of North Creek are highly mobile. Examples demonstrating high sand volumes in the estuary include:

- Significant southward contraction of the navigation channel of lower North Creek;
- Expansion of the beach at The Serpentine;
- Formation of large tracts of intertidal sand shoals in lower North Creek;
- Continued shallowing of the sand bar at the mouth of North Creek and the river channel towards the mouth of the Richmond River;
- Extensive beach and dune development in the lower Richmond River adjacent to the mouth of North Creek;
- Formation of shallow sand bars upstream of Prospect Bridge and narrowing of navigable areas;
- Increased sand propagation into lower tributaries of North Creek including deposits into Chickiba and Prospect Lakes; and
- Sand deposition within Fishery Creek and North Creek Canal (via both the Richmond River and North Creek).

The comparison of the most recent hydrographic survey (2015) with the work undertaken by OEH in 2005 has shown that although the general channel arrangement within North Creek has remained unchanged, there has been approximately 138,000 m³ of infilling within the study area. The highest rate of deposition has been in the lower and middle shoal areas of North Creek (dredging areas A and B), where increased shoaling and channel contraction is visibly noticeable.

It should be noted however that the hydrographic comparison also identifies areas of deepening, or areas that have not changed. Some changes can be attributed to variations in survey methodology, however overall trends in accretion and deposition can be determined:

- The sand shoals in lower North Creek and the beach at The Serpentine are accreting rapidly, but it is notable that previous dredging holes from the 1990's just upstream of here are still visible and have not infilled significantly. This indicates that the high geomorphological activity experienced at the lower end of North Creek diminishes rapidly with distance upstream;
- The main navigation channel upstream of Missingham Bridge is being pushed towards the south western bank, but is constrained in this location by continuous protective rock work along the bank.

Some deepening of this margin appears to be occurring due to scour along the rock boundary, whilst sand continues to push into the channel from the north-eastern side;

- Numerous sand lobes have formed and are slowly migrating upstream along the beach at The Serpentine under the influence of waves propagating into this section of the estuary. This process is gradually widening the beach and extending the length of the beach in a northerly direction;
- The beach on the western bank near Norton Street appears to have extended significantly in recent years;
- A shallow shoal has developed at the confluence of North Creek Canal with North Creek proper. This shoal is marked by a RMS boat speed/hazard buoy; and
- The sand shoal at the upper end of the study area, upstream of Prospect Bridge has shallowed, leading to a virtually continuous shallow, but sub-tidal bar across the waterway at this location.

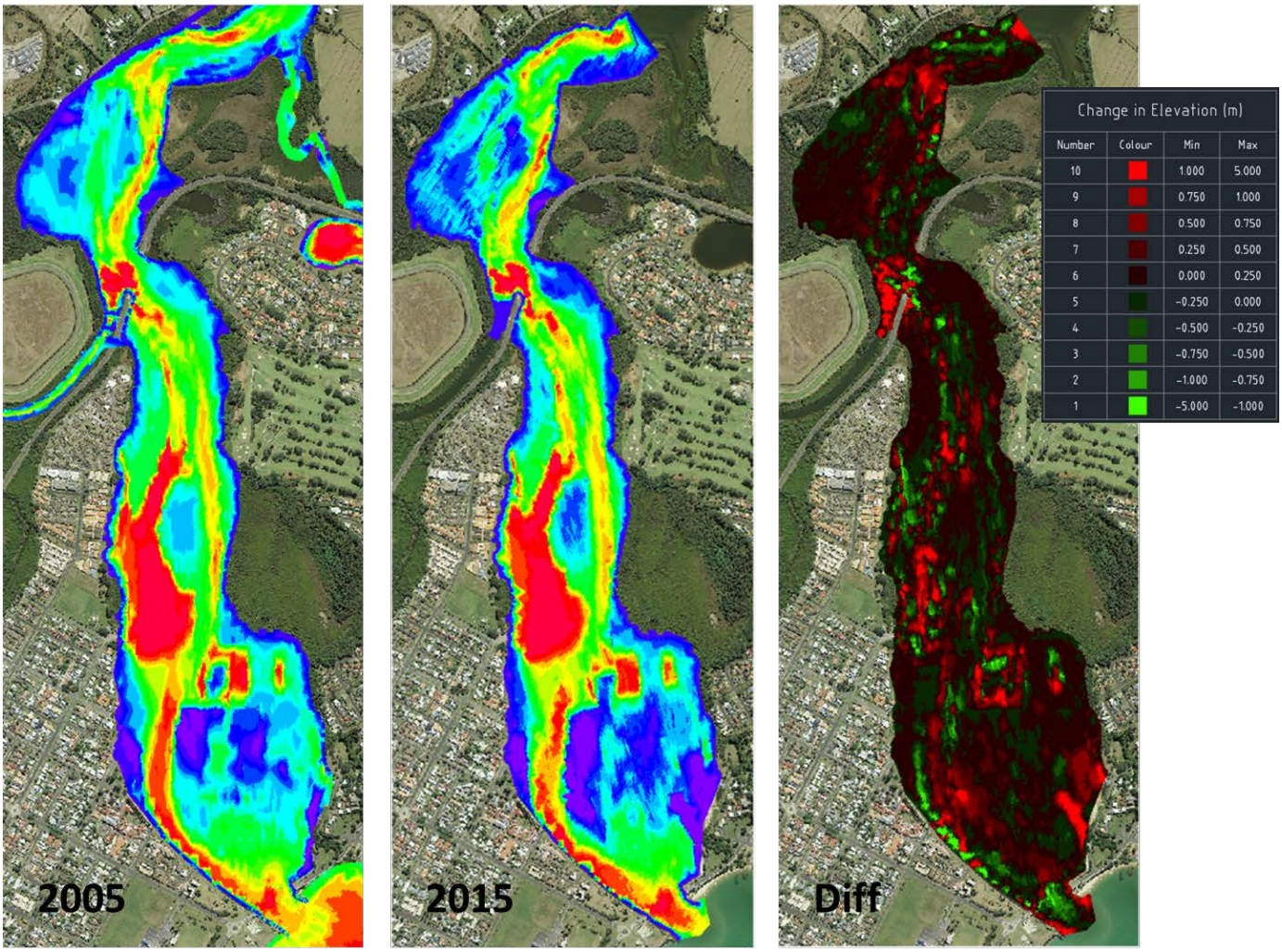

Figure 8. Hydrographic survey differences between 2005 and 2015.

4.4.2 Assessment

The proposed dredging of ~575,000 m³ of material from North Creek represents a large volume that has significant potential to alter local sediment dynamics as well as influence the coastal sediment budget. The current understanding of sediment process in North Creek indicates the following outcomes for the four dredging areas being considered:

- Area A. The target depth of -3.0 m AHD approximates the deep sections of the current ebb-tide channel. The proposed dredging is intended to widen the channel and provide a more consistent longitudinal depth. After dredging, it is likely that some infilling of the channel will occur with sand mobilised by waves propagating under Missingham Bridge. Consequently some loss of sand from the most downstream end of the adjacent shoal is anticipated. There may also be lateral adjustment of the channel post-dredging through increased ebb-tide scour velocities, particularly on the outside (south-western) bend, however this will be mitigated by the existing rockwork protecting this entire bank. The degree to which sediment will be drawn into North Creek from the Richmond River, and ultimately from the littoral sand transport system of the NSW coastline has not been quantified and will require further technical studies. The strong geomorphic connection between lower North Creek and the Richmond River indicates that some effect is probable although the degree of this impact is currently considered likely to be low.
- Area B. This dredging area has been located in a less geomorphologically active area than the downstream wave zone. The extensive shoals downstream of this dredging area will block the majority of wave energy, and the lack of direct connection to the main ebb-tide channel will reduce the influence of tidal scour. Flood-tide transport of sediment across the shoals and into the Area B dredge hole will occur, however the rate of infilling is currently regarded to not threaten the integrity of the remaining shoals or lead to large volumes of sand being drawn out of the coastal sand budget. These assumptions will need to be tested through hydrodynamic and sediment transport modelling.
- Area C. Channel deepening in this zone is unlikely to have a significant influence on the coastal sediment budget, but it is likely that tidal velocities in this zone will increase – leading to potential for localised lateral adjustment of the channel, although the extent of this is likely to be minor as dredging will be following the natural channel form.
- Area D. The removal of shoaling within the main channel upstream of Prospect Bridge will increase tidal flow velocities through this reach and lead to potential for increased bank erosion. This is mainly an issue at a site where erosion of saltmarsh habitat is currently occurring. Dredging close to the bank in this location will most likely exacerbate erosion.

4.4.3 Recommendations

The following aspects are recommended to be undertaken as part of further planning and assessment of this project:

- A hydrodynamic model should be utilised to quantify the likely impact of all dredging components on tidal hydraulics and sediment transport within the study area and into the lower Richmond River. The model should identify areas of likely erosion/deposition following dredging and should, in particular, evaluate:
    - the degree of sediment ingress into North Creek and hence rate of potential depletion of the sand resource in the lower Richmond River;
    - the likely fate of the high tide shoal on the northward side of Area A;
    - geomorphic conditions on the shoals adjoining and downstream of Area B; and
    - the risk of erosion of the northern bank adjacent to Area D.
- Depending on the outcomes of the above, it may also be necessary to determine the degree of connection between the lower Richmond River estuary sand resource and the sand transport past the Richmond River bar in order to determine whether any effect outside of the estuary is likely to occur.
- Given that exacerbation of saltmarsh erosion adjacent to Area D is currently thought to be likely, consideration should be given utilising some dredged material to form a protective beach at this location and adjusting the alignment for Area D dredging to accommodate this.

4.5 Estuarine Sediments and Acid Sulfate Soils

4.5.1 Background

The sand within the lower reaches of North Creek is primarily of marine origin and is pushed into the estuary by incoming tides and wave energy. Ocean waves often penetrate well up North Creek to the extent that surf schools now often utilise breaks upstream of Missingham Bridge when downstream conditions are unsuitable. Although sand is also removed from North Creek through ebb tide scour and flushing during flood events, continued infilling of the North Creek basin has occurred over the decades since the cessation of dredging in the lower estuary. Dredging has occurred in North Creek intermittently over the last several decades with the most recent dredging occurring in the early 1990's for the construction of Prospect Bridge.

Sediments within the dredge areas have not recently been studied. Visual inspection of surface sediments confirms the generally held view that the lower reaches of North Creek, which are subject to significant tidal movement and wave action, are composed almost entirely of sand size fractions (i.e. clean marine sand), whereas further upstream, particularly away from the main ebb-tide channel, the proportion of fines increases. It is assumed that upstream sediments are variable - ranging from sands, silty sands to possible areas of estuarine muds (silt and clay).

WBM (1990) undertook sediment sampling of the shoal in lower North Creek (within the vicinity of dredging area B) which indicated that a thin surface layer of clean sand (typically 20-50 mm) thick was underlain by dark silty sand. Analyses of these samples indicated that the material had a silt/clay content of about 0.6 % by weight with a median sand size of 0.2 mm.

Acid sulfate soil (ASS) is the common name given to naturally occurring soils and sediments that contain iron sulfides, principally pyrite (Ahern *et al*., 1998). Un-oxidised pyritic soils are referred to as potential ASS (PASS). When the soils are exposed, oxidation of sulfides results in the generation of sulfuric acid and acid leachates. The soils are then referred to as actual ASS (AASS). Highly pyritic estuarine sediments are likely to be PASS. If dredged and dewatered this material will oxidise and generate acidic runoff. Sediment investigations for other dredging projects in the Northern Rivers region has shown varying levels of oxidisable sulfur, which is sometimes offset by significant self-neutralising capacity due to embodied carbonate (shell) material.

An acid sulfate soils management plan should be produced for any large scale disturbance or treatment of acid sulfate soils. Various guidelines exist for the preparations of these plans. Although NSW guidelines exist, NSW EPA supports the use of the more comprehensive Queensland guidelines for management of dredging projects in NSW.

4.5.2 Assessment

Visual observations and previous dredging in North Creek indicates that a suitable fill resource is available in North Creek and due to the lack of heavy industry, boat maintenance or other potential contamination sources, it is assumed at this stage that the sediments are uncontaminated. No further assessment regarding sediment quality can be made at this time until testing for the project is undertaken.

It is likely that the some of the finer sediments in upstream reaches contain oxidisable sulfide levels in excess of the ASS action criteria of 0.03%. Under the BLEP 2012 land within the Ballina Shire is classed according to its potential ASS risk (Table 4). All dredge areas are located on Class 1 land and both dewatering sites on Class 2 land (Figure 9).

Table 4: BLEP 2012 ASS soil land classes

Class of land	Works requiring development consent and ASS management plan
1	Any works.
2	Works below the natural ground surface. Works by which the watertable is likely to be lowered.
3	Works more than 1 metre below the natural ground surface. Works by which the watertable is likely to be lowered more than 1 metre below the natural ground surface.
4	Works more than 2 metres below the natural ground surface. Works by which the watertable is likely to be lowered more than 2 metres below the natural ground surface.
5	Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below 5 metres Australian Height Datum and by which the watertable is likely to be lowered below 1 metre Australian Height Datum on adjacent Class 1, 2, 3 or 4 land.

4.5.3 Recommendations

The following aspects are recommended to be undertaken as part of further planning and assessment of this project:

- A sediment investigation program should be undertaken to characterise the sediments within each of the proposed dredging areas. The investigation should:
    - Obtain cores of sediments to determine the stratigraphy of the sediments and the elevations at which sediment characteristics change;
    - Sample all sediment strata likely to be dredged to determine the concentration of contaminants and allow classification of this material;
    - All strata should be tested to determine the concentration of oxidisable sulfur, embodied acid neutralising capacity and the amount of additional neutralising agent that may be required to treat these materials.
- Undertake engineering testing of the material to determine the structural properties of the material and its suitability for construction fill and/or other uses. Tests on sediment blends and consideration of processing of materials to improve desirable qualities may be warranted;
- Map the inferred sediment distribution within North Creek and modify the proposed dredging and dewatering methodology as appropriate for the sediments identified.
- Document an ASS management strategy for dredged sediments as necessary. The strategy should reference both the NSW and Qld guidelines and fully address all aspects relating to disturbance and treatment of acid sulfate soil.

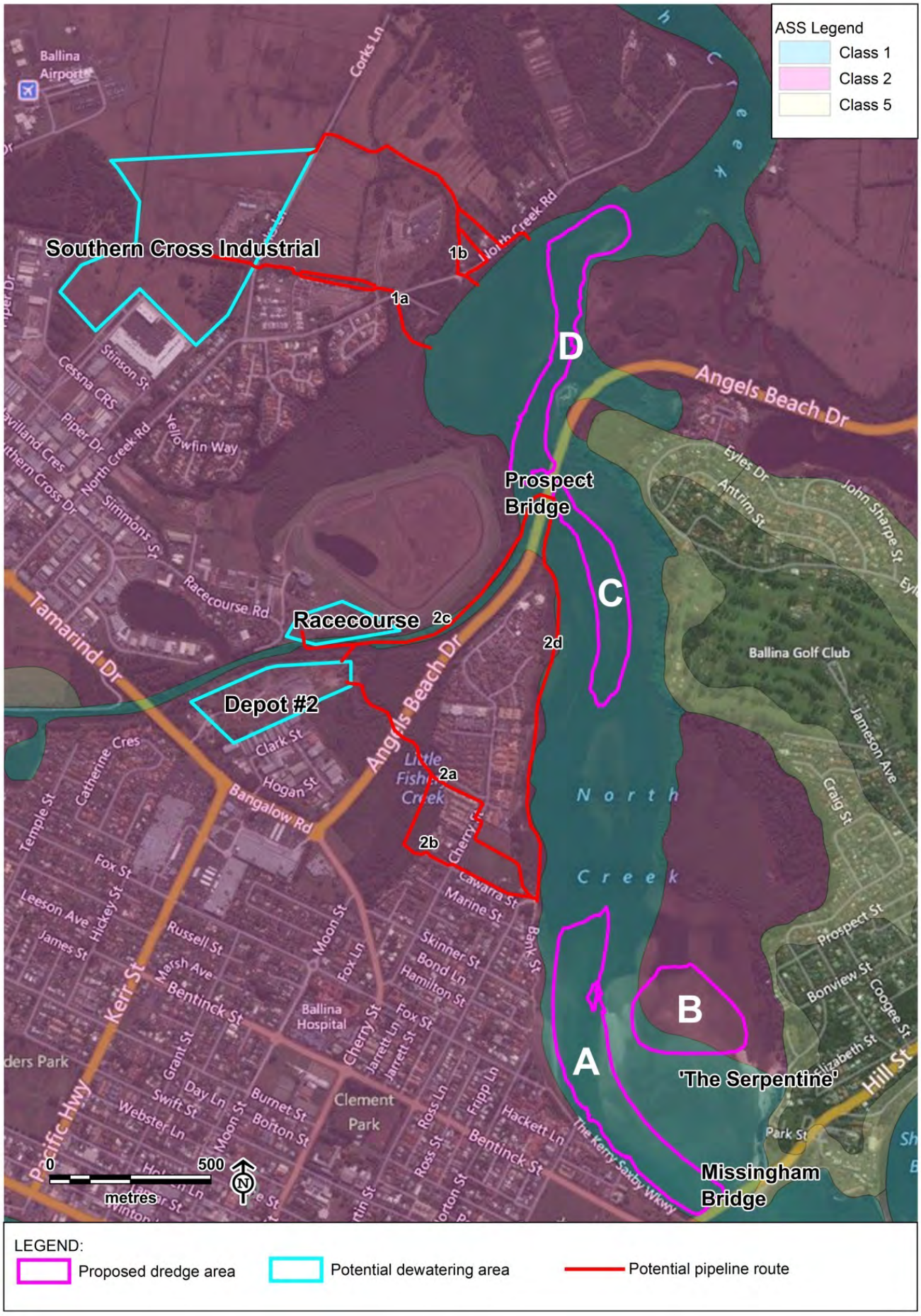

Figure 9: ASS mapping

4.6 Estuarine Vegetation

4.6.1 Background

Estuarine vegetation such as seagrass, saltmarsh and mangrove communities provide a number of important ecological functions for the estuary including nursery and feeding grounds for fish and habitat for a range of other native fauna and flora. Seagrass occurs in the intertidal or sub-tidal (marine) zone and is generally covered with water except during very low tides, mangroves occur in the intertidal zone between low and high tide and saltmarsh communities occur mostly behind mangroves in the upper limits of the intertidal zone and are only inundated briefly on high tides.

4.6.2 Assessment

Estuarine vegetation mapping of lower North Creek conducted by NSW DPI – Fisheries in 2006 (Figure 10) indicates large areas of mangroves present in lower North Creek within the vicinity of the dredge areas. Updated mapping of seagrass undertaken on 2012 aerial photography reveal that relatively large areas of seagrass are likely to occur within and within the proposed dredge areas (Figure 10). Calculations based on this mapping indicate that approximately 6,000 m^2 of seagrass is likely to be directly impacted by the proposed dredging.

4.6.3 Recommendations

The following aspects are recommended to be undertaken as part of further planning and assessment of this project:

- Undertake aerial photography mapping of current seagrass extents using the latest (2015+) aerial photography when available;
- Conduct a field seagrass survey to ground-truth seagrass occurrence, species composition and condition. The field survey should collect DGPS position and elevation of bed margins in proximity to the proposed dredging areas;
- Explore opportunities to create additional surface area for seagrass colonisation at the fringes of dredging areas, particularly dredging Area B. The elevation data collected during the seagrass survey will assist in determining likely seagrass colonisation ranges;
- Evaluate with reference to hydrodynamic modelling – the potential for changes in marine vegetation zonation due to changes in tidal characteristics due to dredging;
- Create an erosion buffer to the loss of saltmarsh to the north of dredging Site D through placement of some dredged material to form a shallow beach at this location. This would necessitate slight alteration of the alignment of dredging at this location to be complementary to this aim;
- Negotiate the compensatory habitat arrangements associated with changes in marine vegetation with Fisheries NSW taking into account all of the above.

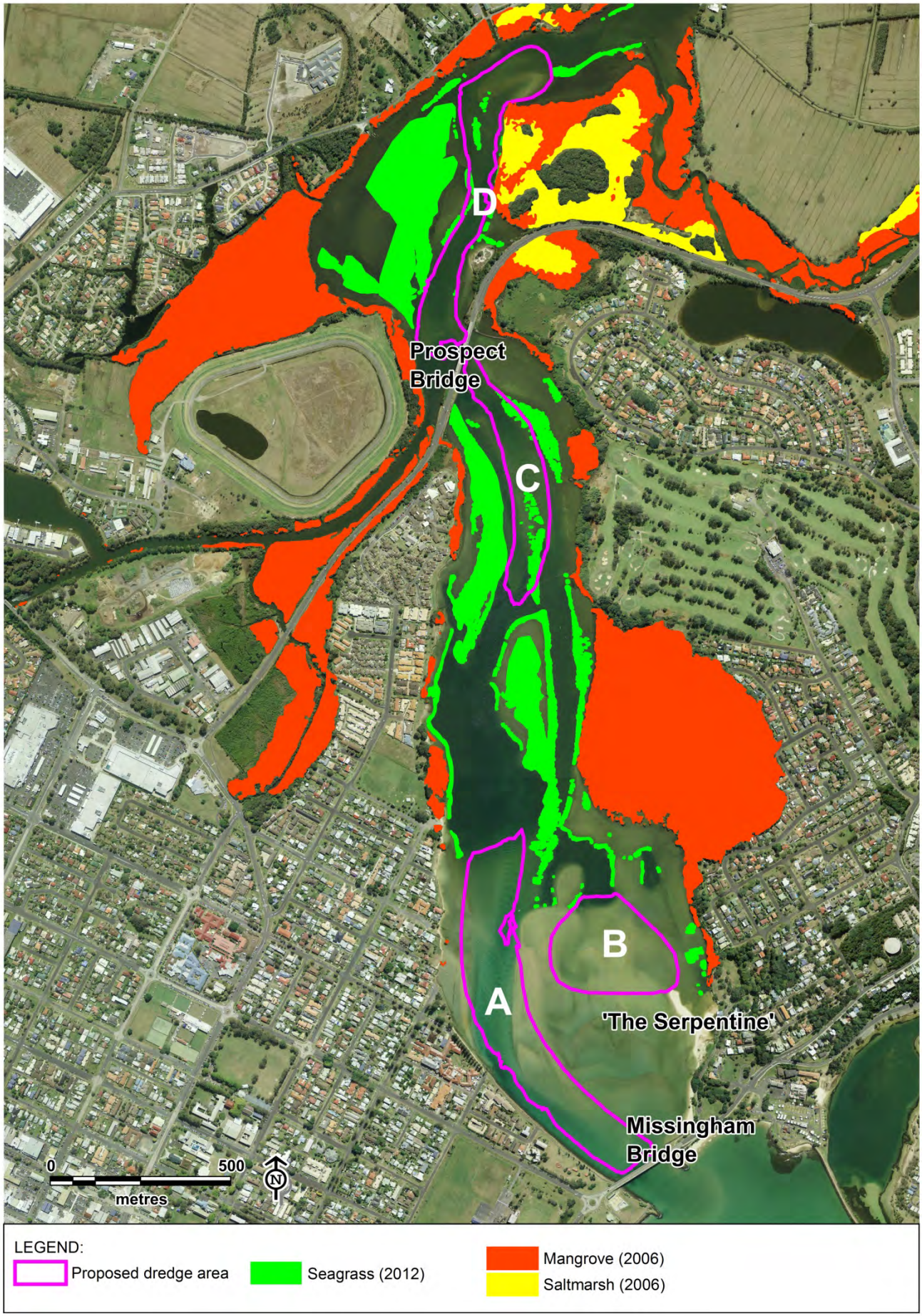

Figure 10: Fisheries NSW estuarine vegetation mapping (2006)

4.7 Water Quality

4.7.1 Background

Water quality within North Creek is influenced by both upstream and marine inputs. Under low rainfall conditions, the water quality within the study area is dominated by oceanic water quality. Poor water quality has been recorded in North Creek, particularly within the mid and upper reaches. Anecdotal reports suggest that tidal exchange, particularly upstream of Prospect Bridge is poor and that poor water quality can persist for significant periods of time following rainfall. The poor water quality is often associated to acid sulfate soil and high organic runoff in the mid and upper reaches. Commercially grown oysters in the lower reaches are often affected by the poor water quality where on occasions export of oysters from North Creek has been stopped due to concerns about poor water quality.

ABER (2008) undertook a review of water quality within the North Creek system. Results from this review indicated that:

- pH generally decreases moving upstream. Low pH levels in the upper estuary a likely driven by acid groundwater discharge.
- Dissolved oxygen (DO) decreases moving upstream driven by low oxygen swamp inputs. DO concentrations in the upper estuary are driven by high dissolved and particulate organic loads associated with 1) humic groundwater inputs; 2) leaf litter fall from fringing vegetation, and 3) deposition of phytoplankton blooms during summer. Longer flushing times most likely exacerbate the hypoxia in the polyhaline reaches (low-mid estuary).
- High nutrient events likely driven by humic-rich or tannin-rich waters from the upper catchment.

BSC have a water quality monitoring site located at The Serpentine as a part of the Beachwatch monitoring program. The State of the Beaches 2014-2015 (NSW OEH, 2015) report indicates that the water quality at The Serpentine is generally good for swimming but the water may be susceptible to pollution from several potential sources of faecal contamination, most notably the Richmond River. Enterococci levels generally increased with increasing rainfall, regularly exceeding safe swimming levels in rainfall events of 20mm or more.

4.7.2 Assessment

One of the aims for the dredging of North Creek is to improve tidal exchange throughout the waterway with the intention of improving water quality in the long-term. The anticipated water quality improvements are likely to result from:

- Increased flushing of the system with ‘clean’ (low turbidity, low nutrient, low pathogen) oceanic water due to reduced resistance to flood-tide penetration of the waterway and increased tidal prism;
- Improved conveyance of flood waters through the system and reduced residence time of poor water quality following catchment rainfall events due to more efficient ebb-tide conveyance;
- Reduction in suspended fine material which can lead to smothering of oysters, seagrass beds, etc.

The degree to which these benefits will be realised is not certain and would require monitoring over a significant period of time to confirm. Such monitoring may not be required if it is generally accepted by stakeholders that improvements are likely and the cost of confirming this outweighs the usefulness of the data.

Although water quality is expected to improve in the longer-term due to dredging, there are short-term risks associated with dredging, dewatering and placement of material. The key risks are:

- Generation of turbid plumes at the dredging location. This is considered low risk if a suction/cutter dredge is utilised for the works as disturbed material is immediately drawn into the suction pipe and transferred away from the dredging area. There is a low risk of pipeline/pump rupture leading to

unintended spills, but constant surveillance by dredge operators and the ability to quickly shut down operations mitigates this risk to very low levels.

- Turbid plume discharge if undertaking placement works within estuary (e.g. creation of bird roosting areas or erosion protection beaches). If these works are undertaken a sand slurry would be pumped to bunds created at the intended placement site. Settlement would occur within the bund however some discharge of turbid water would be unavoidable. The impact of this would be mitigated by adherence to Environmental Protection Licence limits and would need to be assessed with reference to the long-term benefits of the works.
- Discharge of excess water following dewatering of dredged material. Dewatering would be undertaken as a land-based activity (see section 2.2), however the large volume of excess water used to transport the sediment slurry from the dredge to the dewatering site will need to be released back to the environment. The water to be discharged will be a similar salinity to the water at the dredge location and therefore discharge back to the estuary will be necessary. The key water quality risks are increased turbidity, reduced pH and depleted dissolved oxygen and it is likely that these factors will be regulated through the project's Environmental Protection Licence. Turbidity is controlled through appropriate use of settlement ponds, geofabric filters and in rare cases the addition of flocculants prior to release. pH is controlled through the management of acid sulfate soils which requires a specific acid sulfate soils management plan to be implemented for all stages of the works. Dissolved oxygen can be adjusted through aeration or pre-mixing of discharge waters to ensure that the risk of low DO plumes in receiving waters are minimised.
- If the Southern Cross Industrial Estate site is to be used for dewatering, the intention is to release discharge waters to the unnamed drain/creek running approximately 800m from the site back to North Creek. The ecology of the upper reaches of the drain appear to be brackish and some change may occur due to sustained release of higher salinity waters.

4.7.3 Recommendations

The following aspects are recommended to be undertaken as part of further planning and assessment of this project:

- Liaise with oyster lease operators in North Creek to better understand poor water quality events;
- Confirm anticipated tidal exchange characteristics with reference to integrated hydrodynamic modelling (tidal prism, residence times) to be undertaken for the project;
- Evaluate the potential for poor water quality during works and determine mitigation strategies as appropriate;
- Determine the water quality (primarily salinity) and ecological dependencies of the intended discharge drain/creek for the Southern Cross Industrial Estate site and evaluate any potential issues in relation to the ecosystem of this waterway.

4.8 Fish and Fisheries Resources

4.8.1 Background

A range of fish species are likely to utilise the different habitats within the vicinity of the proposed works areas. Recreationally important species, Yellow-fin Bream (*Acanthopagrus australis*), Whitings (mainly *Sillago ciliata*), Flatheads (mainly *Platycephalus fuscus*), Luderick (*Girella tricuspidata*), Mullets (mainly *Mugil cephalus* and *Myxus elongatus* and Trevallys (*Caranx* spp.) utilise sandflats and seagrass beds. Garfish (mainly *Hyporhamphus regularis ardelio*) are strongly associated with seagrass beds. Seagrass, mangroves and saltmarsh areas provide important nursery habitat for many of these species.

Bream, Luderick, Mangrove Jack (*Lutjanus argentimaculatus*) and Flathead also utilise the rocky habitats adjacent to the dredge areas. The deeper rocky habitats, such as the rock walls near Missingham Bridge and Prospect Bridge are also potential habitat for Black Cod (*Epinephuls daemelii*)). Black Cod are listed as a vulnerable species in NSW. They are territorial and reside in rock caves, gutters and beneath bombora on rocky reefs which they often inhabit for life.

A variety of habitats exist within and within the vicinity of the dredge areas. Dredging Areas A and B are dominated by sandy bottom channel and sandflats respectively. Inter and sub-tidal rocky habitat (rockwall) is present directly adjacent to dredge area A (within 30 m).

Sandy and muddy sediments within lower North Creek provide habitat for a range of benthic infauna including crustaceans, polychaetes, bivalves and amphipods. Yabbies (*Trypaea australiensis*) and soldier crabs (*Mictris longicarpus*) are conspicuous across the intertidal sand banks.

4.8.2 Assessment

Intertidal sand flat foraging habitat will be altered as a result of dredging and some direct impact on seagrass is envisaged. Due to the presence of large areas of similar habitat throughout the lower North Creek and Richmond River estuary, the impact on fish species utilising this habitat is considered to be low, although this will need to be confirmed through habitat mapping of the study area. Compensatory habitat provisions will apply to the project and hence offsets to impacts will be provided either directly or indirectly (via payments towards other habitat enhancement projects).

Potential habitat for the threatened Black Cod exists within the vicinity of the dredge area around the rocky habitats adjacent to Missingham Bridge and Prospect Bridge. Dredging is not expected to a have a negative impact on these habitats. Any deepening of these areas may increase areas and/or suitability of potential habitat in these areas and hence result in a positive impact for this species and others utilising similar habitat.

Due to the mobile nature of fish direct harm to fish from the dredge vessel during dredging is not expected. The effect of increased turbidity and sediment deposition within the vicinity of the dredge area is likely to be minimal due to the preferred use of cutter-suction dredging technology. Fish maybe temporarily displaced from within the immediate vicinity of the dredge during operation however this is likely to only a minor temporary impact.

Benthic communities will be impacted by the dredging, both directly (by direct removal) and indirectly by altering the physical characteristics of the area (increasing water depth, change in sediment characteristics). It is likely that the benthic community assemblages will change in some areas following dredging. Areas where sediment characteristics remain relatively similar to pre-dredge conditions, it is expected that benthic communities will recolonise relatively quickly as benthic species encountered in channel habitats (such as parts of dredge areas A, C and D) are relatively mobile species (WBM, 2000). The impacts on benthic communities in areas where post-dredge sediments and/or conditions (i.e. water depth) significantly differ to pre-dredge sediment impacts on benthic communities are expected to be greater. Benthic communities on intertidal sand banks within dredge areas A and B and seagrass areas in areas C and D will be impacted significantly due to the significant change in habitat conditions (i.e. change from intertidal to subtidal habitat and removal of seagrass).

4.8.3 Recommendations

The following aspects are recommended to be undertaken as part of further planning and assessment of this project:

- Broad habitat mapping should be undertaken for the study area to determine the likely degree of gain/loss of relevant intertidal habitat categories due to dredging with reference to water depths, likely sediment dynamics, circulation patterns and proximity to other habitats; and
- Opportunities for creation of offset habitats (seagrass, inter-tidal sediments) should be considered in the proposed dredging configuration.

4.9 Commercial Fisheries and Aquaculture

4.9.1 Background

North Creek contains a number of oyster leases through its mid to lower reaches (Figure 11).

North Creek lies entirely within a Recreational Fishing Haven, which prohibits commercial fishing with only recreational fishing permitted. One exception is commercial sea mullet hauling, which is allowed within the Recreational Fishing Haven – adjacent to Shaws Bay below Missingham Bridge at the mouth of North Creek from 1st April to 31st July each year.

4.9.2 Assessment

Mapping of commercial oyster leases within North Creek indicates that 2 lease areas occur within or within the direct vicinity of the dredge areas.

4.9.3 Recommendations

The following aspects are recommended to be undertaken as part of further planning and assessment of this project:

- Consultation should be undertaken with North Creek aquaculture lease holders and Ballina Fishermen's Cooperative to determine any potential issues with particular reference to:
    - Overlap of proposed dredging footprint and aquaculture lease areas; and
    - Concerns regarding any potential for negative impact on marine vegetation or fisheries resources.

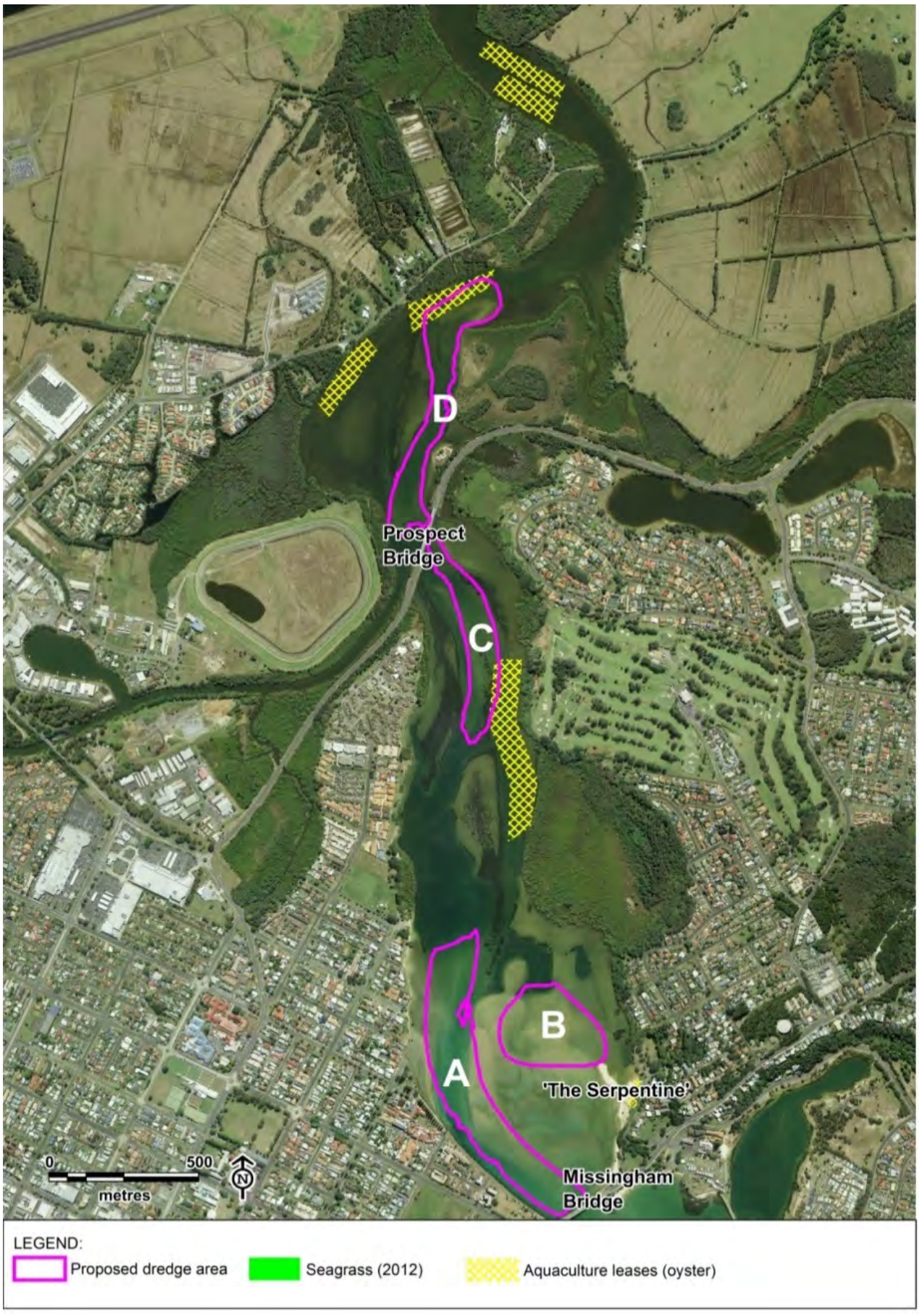

Figure 11: Aquaculture leases within North Creek

4.10 Angling and Other Recreational Activities

4.10.1 Background

Lower North Creek is utilised for many recreational activities, particularly around The Serpentine and nearby sand banks. This area is utilised particularly for swimming, fishing and bait collecting by members of the community. The sandbars located at the mouth of North Creek, both upstream and downstream of Missingham Bridge, are sometimes used for surfing, particularly for learn to surf schools during favourable conditions. Bird watching is also popular at various locations in North Creek.

Angling is popular in North Creek, with target fish species varying according to location/habitat but including Sand Whiting, Dusky Flathead, Yellow-fin Bream, Luderick and Garfish. Mulloway are sometimes captured and other species such as various types of Trevally, Mangrove Jack and occasionally Tailor are also caught. A number of species of Mullet are also prevalent in North Creek but are rarely targeted by anglers. Mud crabs and Blue-swimmer crabs are often captured in 'dilly' nets in upstream reaches.

Bait collection is primarily for yabbies although soldier crabs, various worms and shellfish are also sometimes collected. Most bait collection is in the lower portion of inter-tidal flats away from any wave influence. There are numerous areas where yabbies are prevalent in North Creek and the current level of bait harvest is considered to be low.

4.10.2 Assessment

Dredging has the potential to affect recreational uses in North Creek both in the short and long-term although the overall impact is likely to be low.

The short-term impact will be in a restricted area at any one time as the immediate area of dredge operation will not be accessible to the public and there will be some noise and visual amenity impact. Dredging in other popular estuaries has shown that operations on coming into summer are often curtailed due to high waterway usage and increased public objection to operation during these times. Crown Lands has a policy of not undertaking navigational dredging during public holidays primarily for this reason.

Longer-term impacts on recreational use is more likely to occur in the vicinity of dredging Areas A and B. Changes to Areas C and D are likely to be positive due to improved navigability of these areas and improvements in upstream water quality.

The impacts at Area A include the potential for alteration of the small wave zone upstream of Missingham Bridge, some loss of the island spit adjacent to this location (which is a magnet for family boat users) and some potential for alteration of bird usage patterns and hence bird watching activities. There is also some potential to affect the surf break downstream of Missingham Bridge by Area A acting as a sand 'sink', effectively drawing in the sand from this popular break.

Dredging at Area B will include some of the area currently used for bait collecting and reduction of the size of the potential collecting area is likely although this is not currently thought that this will substantially reduce the ability to collect bait in adjoining areas. This benthic invertebrate resource is also targeted by foraging shorebirds in this area (discussed in section 4.11) and hence some impact of bird usage and hence bird watching may occur.

The creation of additional deeper water habitats (particularly Area B) within easy access for anglers is considered a positive impact. Similarly, it is anticipated that improved water exchange throughout North Creek is likely to have a beneficial impact on water quality and fisheries and may help to promote seagrass condition in upstream reaches of North Creek. It is also likely that some seagrass colonisation of the fringes of dredging areas will occur as has occurred in the past.

4.10.3 Recommendations

The following aspects are recommended to be undertaken as part of further planning and assessment of this project:

- Detailed sediment budget modelling should be undertaken to understand and assess the impact of dredging Area A on the Missingham surf breaks;
- Dredging should not be undertaken during public holidays, long weekends or other times when high community usage of the waterway is envisaged. This restriction should be considered when considering the overall timeframe works;
- Liaison with local angling clubs should be undertaken as part of the stakeholder consultation for this project;
- Broad habitat mapping should be undertaken for the study area to determine the likely degree of gain/loss of relevant intertidal habitat categories due to dredging with reference to water depths, likely sediment dynamics, circulation patterns and proximity to other habitats;
- Opportunities for creation of offset habitats (seagrass, inter-tidal sediments) should be considered in the proposed dredging configuration; and
- Liaison with bird-watching groups should be undertaken to ensure that any concerns are properly considered in the project EIS.

4.11 Shorebirds

4.11.1 Background

Shorebirds (often called waders) are birds that commonly feed by wading in shallow water or saturated substrate along the shores of lakes, rivers and the sea (Geering *et al*. 2007). Shorebirds are generally considered as either resident shorebirds (i.e. do not undertake large-scale migrations) or migratory shorebirds (i.e. undertake large migrations). Many migratory shorebirds that occur in Australia breed in the northern hemisphere during the southern winter before migrating to Australia for the summer to feed before migrating back north before the winter. Shorebirds migrating to and from Australia utilise what is termed the East-Asian Australasian Flyway.

Within North Creek, shorebirds feed and forage on the intertidal sand flats and roost on the higher sand banks and in mangroves during high tide. The intertidal flats situated in lower North Creek are frequently used for foraging by shorebirds. The Richmond River is 'nationally important shorebird habitat' based on the number of regularly occurring shorebirds and a number of species meeting the 0.1% Flyway criteria (Lisson, 2015). DECCW (2010) also recognises the estuary as a Priority 1 site for Greater Sand Plover, Terek Sandpiper, Sanderling and Priority 2 site for Great Knot and lesser Sand Plover, and Priority 3 for Beach Stone-Curlew. The intertidal sandflats (adjacent to The Serpentine) and the mudflats upstream of Prospect Bridge are considered to be high value shorebird foraging habitats and the sandflats in lower North Creek also a high priority management site (Lisson, 2015).

4.11.2 Assessment

Results from Bionet and EPBC Act Search Tool searches indicate that 34 shorebird species have been recorded or their habitat is known to occur within the vicinity of the dredge areas. Of these, there are approximately 30 species of shorebird that may utilise habitats within the vicinity of the dredge areas. Of these, there are 1 Critically Endangered, 3 Endangered, 6 Vulnerable listed species under the TSC Act and 1 Critically Endangered and the majority of species are listed as migratory species under the EPBC Act (See Appendix 1 for full lists). A recent survey by Lisson (2015) recorded 15 shorebird species utilising the sand bar in lower North Creek and 14 species on the mudflats upstream of Prospect Bridge. The sand bar in lower North Creek also supports a high abundance of shorebirds (Lisson, 2015).

The proposed dredging has the potential to impact shorebirds both during dredging (physical disturbance and noise) and over the long term by potentially impacting on foraging and roosting areas (removal of sand from these areas).

4.11.3 Recommendations

The following aspects are recommended to be undertaken as part of further planning and assessment of this project:

- Consideration should be given to the creation of two additional high tide shorebird roosting areas:
    - Creation of an island within the middle shoal area between the two existing dredging holes and north of the proposed dredging Area B; and
    - Addition of sand to fortify the eroding back and loss of saltmarsh to the north of dredging Site D. This would necessitate slight alteration of the alignment of dredging at this location to be complementary to this aim.
- Consider the eastward extension of the Area B dredging to isolate the sand/mud flats to the north from people/pets thus providing a reduced disturbance shorebird habitat at that location;
- Liaison with local bird watching groups to determine key concerns. Relevant local groups include BirdLife Northern Rivers, Ballina BirdLife Shorebird 2020 and Northern Rivers Regional Shorebird Group.
- Evaluation of Shorebird 2020 monitoring data to determine seasonal patterns and long-term trends;
- Mapping and evaluation of changes in inter-tidal estuarine habitat type and area within North Creek;
- Undertake an initial shorebird utilisation survey of roosting areas and adjacent feeding areas within North Creek and also the lower Richmond River to determine the patterns of usage, particularly in relation to tidal stage and assess potential changes to bird usage patterns due to dredging;
- Depending of the outcomes of the above, it may be necessary to refer the project to the Federal Department of the Environment for assessment.

4.12 Turtles and Marine Mammals

4.12.1 Background

Three species of marine turtle may potentially utilise habitats within or within the vicinity of the dredging areas including Loggerhead turtle (*Caretta caretta*); Leatherback turtle (*Dermochelys coriacea*) and Green Turtle (*Chelonia mydas*).

The inshore marine environment and estuaries of Northern NSW are known as feeding and foraging areas for marine turtles. The feeding requirements and foraging habitats vary between species with some species being predominately pelagic feeders in the open ocean (e.g. *D. coriacea*) and others utilising a wide range of habitats including seagrass beds, macroalgae, mangrove bays, mudflats, or hard bottomed habitats such as coral reefs. Green Turtles in particular utilise estuarine habitats for feeding. Their main food items include seagrass, macroalgae, mangrove material and small amounts of animals, such as crabs (Read and Limpus, 2002). Food sources potentially utilised by marine turtles likely to be present within or within the vicinity of the dredge area include seagrass (*Zostera capricorni, Halophila ovalis*), macroalgae (red, green and brown alga), mangroves and crustaceans.

Dolphins inhabit shallow coastal, estuarine, and occasionally riverine habitats, in tropical and subtropical regions. The common dolphin species in northern NSW waters include the Common Dolphin (*Delphinus delphis*) and the Bottlenose Dolphin (*Tursiops aduncus/T. truncatus*). They display no apparent preference for clear or turbid waters, and have been reported in a variety of coastal habitats, from coastal lagoons and

enclosed bays with mangrove forests and seagrass beds through to open coastal waters with rock and/or coral reefs. Dolphins are generally opportunist-generalist feeders, eating a wide variety of coastal and estuarine-associated fishes.

4.12.2 Assessment

The proposed dredging has the potential to affect marine turtles and mammals either directly (i.e. through injuries from vessel strikes) or indirectly (i.e. through loss of habitat or displacement). Potential impacts on marine turtles and mammals include:

- Injury by direct impact with dredge equipment or associated vessels;
- Entanglement or entrapment due to ropes, debris or equipment position;
- Disturbance of feeding or general movements due to dredging related noise; and
- Impacts on turtle foraging habitat (e.g. macroalgae, *Halophila*).

Although marine turtles and mammals are mobile and transient species there is an increased risk of a strike injury occurring due to increased vessel movements and dredging. Although the likelihood of occurrence would be low precautionary measures would need to be undertaken to minimise the risk of vessel strikes.

4.12.3 Recommendations

The following aspects are recommended to be undertaken as part of further planning and assessment of this project:

- The project EIS should consider marine mammals and turtles in assessing risks with the project, however no specific technical studies or surveys are considered necessary in order to complete the EIS.

4.13 Terrestrial Flora and Fauna (Dewatering Sites)

4.13.1 Depot 2

The Council depot site has been historically cleared and is dominated by exotic grasses and weed species with a small number of individual trees interspersed throughout the site including (3) Broad-leaved Paperbark (*Melaleuca quinquenervia*); (approx.3-4 trees) Bleeding Heart Tree (*Homalanthus populifolius*); (approx. 5 small to medium sized trees growing from stockpiles) Acacia sp.; (1) exotic Camphor Laurel (*Cinamonnum camphora*); and (approx. 3 small sized trees growing from stockpiles) exotic Poinciana (*Delonix regia*). Common exotic species throughout the site and concentrated on some stockpiles and along the site perimeter include: Lantana (*Lantana camara*); Umbrella Tree (*Schefflera actinophylla*); Camphor Laurel (*Cinamonnum camphora*); Wild Tobacco Bush (*Solanum mauritianum*); Castor Oil Plant (*Ricinus communis* L.); Alexandra Palm (*Archontophoenix alexandrae*); Senna (Senna pendula); Coastal Morning Glory (*Ipomoea cairica*); Farmers Friends (*Bidens pilosa*); Setaria (*Setaria parviflora*); Para Grass (*Urochloa mutica*); and Rag Weed (*Ambrosia artemisiifolia*).

The northern perimeter of the site is bordered by riparian vegetation along North Creek Canal which consists of mature native tree species including River Mangrove (*Aegiceras corniculatus*); Grey Mangrove (*Avicennia marina var. australasica*); Tuckeroo (*Cupaniopsis anacardioides*); Swamp Oak (*Casuarina glauca*); *Acacia* sp. and a variety of weed species as described above.

The eastern boundary of the site (in the vicinity of the proposed long-term stockpile area) is bordered by an area of exotic grasses and dense weed infestation (typical species as described above) on the disturbed margin of the landfill site. Mature trees exist at the edge of the grass/weed area including Broadleaved Paperbark (*Melaleuca quinquenervia*); Swamp Oak (*Casuarina glauca*); Tuckeroo (*Cupaniopsis anacardioides*) and Acacia sp. Most of these trees are smothered by a dense Morning Glory (*Ipomoea indica*) infestation. A stand of

approximately 3 – 4 Bleeding Heart Trees (*Homalanthus populifolius*) are located to the south of the proposed long-term stockpile area. Morning Glory is also covering a large area of these trees. Extensive mangrove areas lie further to the south and east, extending to Angels Beach Drive. This area is mapped as SEPP14 Wetlands.

Aside from a small number of mature trees remaining on site, the Council depot is generally devoid of any valuable habitat features due to the high level of historical and ongoing disturbance. Searches of the following databases were conducted to assist in evaluating the potential for threatened and protected species to be present within the works area:

- Protected Matters Search Tool (EPBC Act)
- BioNet

Refer to Appendix 1 for full listing of potential species.

4.13.2 Southern Cross Industrial Estate

Geolink (2008) indicated the site was dominated by cleared low grassland with the presence of isolated camphor laurel and *Melaleuca quinquenervia* at the site. The presence of the Wallum Froglet (*Crinia tinnula*) has been identified at a number of locations within and within the vicinity of the site (Geolink, 2008; Bionet search results).

Further, several species under the EPBC Act with habitat known to occur in the area were found during the EPBC Act Search.

Refer to Appendix 1 for search results.

4.13.3 Recommendations:

The following aspects are recommended to be undertaken as part of further planning and assessment of this project:

- Evaluation of existing environmental assessment information for lots 2 and 3 Boeing Avenue and the unnamed drain/creek connecting to North Creek from this site; and
- Site assessment of these areas, considering likely dewatering site layout, land topography and key on-site constraints.

4.14 Boating

4.14.1 Background

Boat navigation in North Creek is restricted by the shallow bar formation downstream of Missingham Bridge as well as significant shoaling throughout much of North Creek itself. Although the downstream entrance to North Creek is hazardous for larger recreational vessels, there is relatively deep (1.5+ m) calm water access between North Creek and the Richmond River via the 3.5km North Creek Canal. Vessel speed in the canal is restricted to 4 knots.

There is one single lane public boat ramp at the end of Cawarra and Martin Streets central to the study area, and another smaller, less used ramp on the northern bank at North Creek Road. The most significant boat ramp in the area is a dual lane facility located at Johnson Drive at the southern end of North Creek Canal. The Lower Richmond River Recreational Boating Study (2005) mentions the shallow nature of North Creek and notes that boating facilities in this section of the estuary are unlikely to experience high demand because of this.

Within North Creek itself, RMS have placed numerous navigational aids to demarcate navigable areas. Sand bar development in the lower reaches of North Creek has progressed so far across the channel from the north that there is very little distance between the starboard marker on this bar and the port marker located adjacent to a stormwater pipe protruding into the channel from the southern bank.

The poorly defined channel in the middle reaches (d/s of Prospect Bridge) of North Creek are poorly defined, with hazard markers only defining some of the shoals. Although the shoals and associated seagrass beds are relatively obvious at low tide levels, at mid-tide in poor visibility conditions there are large areas unsuitable for navigation that cannot be readily identified.

Upstream of Prospect Bridge, there are extensive shoals and seagrass beds, although the channel within the study follows a more defined path along the eastern bank.

4.14.2 Assessment

The proposed dredging will substantially improve the navigability of North Creek by widening the main channel in the lower reaches, creating a more defined, wider and deeper channel upstream and downstream of Prospect Bridge. This will improve safety for boat users and lead to less boat groundings, hence less potential for boat damage and potentially also reducing propeller impacts to seagrass beds.

It is unlikely that boat traffic in North Creek will be greatly increased by these improvements as downstream access for large vessels will still be restricted by the shallow bar downstream of Missingham Bridge, and the 3.5 km speed restricted traverse via North Creek Canal is likely to remain a behavioural barrier to most vessels.

It is concluded therefore that the dredging of North Creek will provide some benefit for small boat users in terms of safety but the relatively low levels of boat traffic will continue and the low key nature of the waterway is unlikely to be affected. No detailed technical studies or surveys are considered necessary in relation to boating to assess the impact the proposed dredging.

4.14.3 Recommendations

The following aspects are recommended to be undertaken as part of further planning and assessment of this project:

- Additional consultation with RMS should be undertaken to optimise the dredged channel configuration and to assess the requirement for additional navigational aids within the study area.

Figure 12. Location of navigational aids within North Creek.

4.15 Cultural Heritage

4.15.1 Background

An extensive search of the OEH Aboriginal Heritage Information Management System has shown that 14 known Aboriginal sites or declared places are recorded in or near the sites of proposed dredging, pipeline route or dewatering/stockpiling.

Rich (1991) undertook an archaeological survey for Aboriginal sites within North Creek and recorded three midden sites within lower North Creek. One site is located on the point on the eastern bank upstream of Prospect Bridge, another located on the western border of the golf course and between Eyles Drive and North Creek upstream of the golf course. Rich (1991) also identified artefacts (pebble tools) associated with the midden sites. Preliminary liaison with Aboriginal community representatives also highlighted the presence of historical rock fish traps within North Creek.

A search of the State Heritage Register has shown that no known sites of State Heritage significance exist in the vicinity of the works. The Ballina Local Environmental Plan (LEP) 2012 lists sites of Local Heritage significance. Under the Ballina LEP 2012 Lot 284 DP 755684 'Ballina Trophy Guns', the site of Depot 2, is listed as an Archaeological site. No other heritage sites listed under the Ballina LEP 2012 are within the vicinity of the proposed works.

Under the BSC Draft Shire Wide Community Based Heritage Study 2008 North Creek has been identified as having local heritage values as a naturally evolved river system while the historic North Creek wharf site at Meldrum Park has been identified as a having significant transport cultural heritage (BSC, 2008). Although the sites are not legally protected they are considered to be significant local cultural heritage sites.

4.15.2 Assessment

The coordinates listed for AHIMS records do not appear to be accurate, with most rounded to the nearest 100 m. This may be deliberate in order to preserve the integrity of key sites and further work will need to be done to evaluate the relevance of any these sites to the current proposal.

4.15.3 Recommendations

The following aspects are recommended to be undertaken as part of further planning and assessment of this project:

- Continued liaison with local Aboriginal community via Council's Aboriginal Community Liaison Committee;
- Seek formal feedback on the proposed dredging and dewatering activities from the Jali Local Aboriginal Land Council;
- Undertake an Aboriginal heritage assessment to determine whether any aspects of Aboriginal heritage are likely to be impacted by the project; and
- Ensure reference to and adherence to the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (OEH, 2010).

4.16 Noise and Vibration

4.16.1 Background

Lower North Creek is bordered by residential areas to both the east and west of the waterway. Residential properties vary in distance from the dredge areas with the closest properties being located approximately 70-80

m to the east of dredge area A. The lower reaches of the creek are also used for passive recreation activities. These areas have the potential to be negatively impacted by noise generated by dredging activities.

4.16.2 Assessment

The proposed works are covered by the *NSW Draft Industrial Noise Guideline (NSW EPA, 2015)* which provides noise level guidelines for noise sources such as industrial premises, extractive industries, commercial premises etc. Under this guideline recommended noise levels for different noise amenity areas and receivers are outlined.

Table 5: Amenity noise levels (NSW EPA, 2015)

Receiver	Noise amenity area	Time of day	L_{Aeq}, dB(A)
(see Table 2.2)			Recommended amenity noise level
Residence	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	See column 4	See column 4	5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day.
School classroom – internal	All	Noisiest 1-hour period when in use	35 (see notes for table)
Hospital ward internal external	 All All	 Noisiest 1-hour Noisiest 1-hour	 35 50
Place of worship – internal	All	When in use	40
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50
Active recreation area (e.g. school playground, golf course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	70
Industrial interface (applicable only to residential noise amenity areas)	All	All	Add 5 dB(A) to recommended noise amenity area

Notes: The recommended amenity noise levels refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

For residences, the amenity noise levels apply at the reasonably most-affected point on or within the residential property boundary or, if this is more than 30 metres from the residence, at the reasonably most-affected point within 30 metres of the residence. This requirement should not be read to infer that the noise limit **only** applies at the 'reasonably worst affected location'.

In assessing amenity noise levels at commercial or industrial premises, the noise level is to be assessed at the reasonably most-affected point on or within the property boundary. Again, this requirement should not be read to infer that the noise limit **only** applies at the 'reasonably worst affected location'.

Where internal amenity noise levels are specified, they refer to the noise level at the centre of the habitable room that is most exposed to the noise and apply with windows opened sufficiently to provide adequate ventilation except where alternative means of ventilation complying with the Building Code of Australia are provided. In cases where the gaining of internal access for monitoring is difficult, then external noise levels 10 dB(A) above the internal levels apply.

In assessing amenity noise levels at passive and active recreational areas, the noise level is to be assessed at the most-affected point within the area that is reasonably expected to be used by people, for example picnic areas, walking tracks etc.

Previous studies (Bray, 2008; GHD, 2009) indicate that noise levels emitted from dredge vessels are within the vicinity of 110 dBA at source with levels decreasing to 50-70 dBA a few hundred metres away (Bray, 2008). These noise levels are indicative of what can be expected from dredges used in North Creek. Booster pumps are required approximately every 1 km along the pipeline to facilitate the flow of slurry through the pipes to the dewatering site. Booster pumps are powered by diesel engines which are likely to emit noise levels in the vicinity of that of excavators. Booster pumps are likely to exceed noise level criteria if placed within the vicinity of residential properties. Residential mufflers for generators (which power the dredge) and for any ancillary booster pumps are likely to be required.

Noise generated by the dredge vessel and booster pump also has the potential to impact both aquatic and terrestrial fauna. Noise associated impacts on fauna are discussed in Sections 4.11 and 4.12.

Machinery used at the dewatering site is likely to include excavators, backhoes and truck and dogs. Typical noise levels for this equipment are outlined in Table 6.

Table 6: Typical noise levels of dewatering site equipment. Source: NSW Public Works (2011)

Construction Equipment	Sound Power Level (SPL)	SPL at 10 m	SPL at 20 m	SPL at 50 m	SPL at 100 m	SPL at 200 m	SPL at 300 m
Excavator	110	82	76	68	62	56	50
Backhoe	107	79	73	65	59	53	47
Delivery truck	117	89	83	75	69	63	57
Light vehicle	98	70	64	56	50	44	38
Tip truck	111	83	77	69	63	57	51

Several potential pipeline routes traverse close to residential properties. The placement and retrieval of pipes may cause some disturbance to residences however would only be a short term minor disturbance. Noise sources during the placement of pipes are likely to include light vehicles, trucks, excavators and backhoes. The pipelines emit a low level of noise when slurry is moving through. This noise may become a nuisance to nearby residences considering the length of time the pipelines will be in place.

4.16.3 Recommendations

The following aspects are recommended to be undertaken as part of further planning and assessment of this project:

- A noise and vibration assessment is required to assess the potential noise and vibration impacts associated with the works on surrounding areas. The assessment would need to include noise and vibration related impacts associated with the dredge area, pipeline route, transport route, dewatering site and placement site; and
- Potential noise impacts on fauna should be included in relevant fauna assessments.

4.17 Traffic

4.17.1 Background

Depot 2 is currently used as a Council depot and stockpile site. Dredged material that is dewatered at this site and is destined for use as fill at the Southern Cross Industrial Estate will need to be transported by road. Typically this would be undertaken by truck and dog, with an indicative capacity of 30 m^3.

4.17.2 Assessment

Extra truck movements to transport dewatered fill material from the site will add to the local traffic load and lead to some disruption. Trucks leaving the site would ideally turn right however current traffic and road conditions may not allow this without modified traffic control. The alternative is for all trucks to turn left onto Tamarind Drive before doing a U-turn (if possible given vehicle turning circles) at the roundabout on the corner of Angels Beach Drive before returning back along Tamarind Drive. Given the indicative truck and dog capacity, there would over 17,000 truck circuits to move the total volume of material to be dredged. Although this may take place over a number of years, this level of transport could result in significant road degradation and is likely to contribute to traffic congestion, particularly during peak periods.

4.17.3 Recommendations

The following aspects are recommended to be undertaken as part of further planning and assessment of this project:

The degree of transport planning required will depend on the dewatering site to be utilised, the fate of this material (i.e. is all destined for the Southern Cross Industrial Estate) and the timeframe over which dewatering operations are to extend. If Depot is to be utilised for dewatering then the following is recommended:

- Development of a detailed transport plan that outlines the route to be taken, frequency and indicative timing of movements, vehicle sizes, turning circles and mass;
- The EIS will need to consider current traffic patterns influenced by the transport plan and determine, with reference to Council and RMS, the impacts and potential mitigation measures relating to increased traffic; and
- The EIS will also need to consider the noise, vibration as well as air quality (dust, vehicle emissions).

4.18 Project Need and Economics

4.18.1 Background

Ballina is a significant economic hub in the Northern Rivers region supporting a large workforce in areas such as tourism, trade, administration, manufacture and industrial processing and primary production. The Ballina CBD and surrounding industrial estates are all low-lying and subject to significant inundation risks during both catchment flooding and ocean related high water levels. Development in these areas generally requires raising of ground levels to meet the Shire's DCP and provide some flood immunity, particular in the face of continued sea-level rise. The expansion of the Southern Cross Industrial Estate is a major initiative by Ballina Shire Council to satisfy demand for commercial/industrial sites and similar to neighbouring areas, requires significant fill volumes to meet ground level requirements. There are various sources of fill available, however the large volumes and associated transport distances represent a significant cost to Council.

4.18.2 Assessment

The need for development fill in Ballina is widely accepted. Council's DCP is supported by significant flood modelling work which demonstrates that the potential for inundation of the low-lying areas in Ballina.

The ability to generate significant volumes of fill material of suitable quality locally through dredging is a significant opportunity for the continued economic growth of Ballina. Preliminary costing for the project indicates that the material can be won at a discount to current source prices. Additional benefits are also anticipated as the creation of additional jobs associated with the dredging work, reduction of road transport issues associated with the import of fill material to the Shire as well as the expected benefits of increased boating safety and improved water quality within North Creek itself.

The potential negative economic impacts are:

- The opportunity cost of utilising a high value resource (clean sand) for lower value uses (general fill);
- Flow on effects due to any impact to fisheries resources, mitigation of erosion related issues; and
- Reduction in jobs in other shires due to satisfying fill requirements locally. This effect is not expected to be significant as there is currently a significant demand for development fill in most coastal centres. Any sales reduction in the market is likely to be taken up by other consumers.

4.18.3 Recommendations

The following aspects are recommended to be undertaken as part of further planning and assessment of this project:

- Detailed sediment investigations need to be undertaken to determine the both the in situ characteristic of the material to be dredged as well as classify this material in terms of suitable end uses. Opportunities to separate high value material (or to create blends to increase the value of this material) should be considered such that the maximum economic benefit of the dredged material can be realised. High value uses may include sand for concrete production, landscaping and engineered fill. Lower value material may be blended with imported to achieve appropriate structural characteristics.
- Undertake detailed project planning, cost estimation and valuation of project benefits to determine the overall economic attractiveness of the project.

5. SCOPE OF INVESTIGATIONS

As outlined in section 3, North Creek dredging project is classified as designated development which is assessed under Part 4 of the EP&A Act. As a part of the assessment process a DA and EIS needs to be prepared and submitted to the consent authority (NRJPP) for approval. An EIS is a comprehensive environmental assessment to determine the impact a project may have on the environment.

Before an EIS is prepared the Director General's requirements for the EIS should be obtained. An application to the Secretary of Department of Environment and Planning outlining the project should be made to request the requirements from the Director General. The Department will liaise with other relevant government agencies and produce a number of requirements for the EIS. These requirements will guide the content of the EIS, relevant studies required and relevant approvals.

Although the scope of the studies below should be confirmed against the Director General's requirements, the recommended studies are based on issues and information gaps identified in review of environmental and social issues above, reference to studies undertaken for other dredging projects, previous guidelines for EIS production in relation to dredging (DUAP 1996) and the *National Assessment Guidelines for Dredging* (DEWHA, 2009).

In general, the content of a dredging EIS would include:

- Details of proposed works;
- Project justification;
- Assessment of alternative options;
- Identification and prioritisation of issues;
- Species Impact Statements (if required)
- Approvals, licence, permits required;
- Environmental issues such as; estuarine processes, flooding issues, coastal issues, flora and fauna; water quality; acid sulfate soil; contaminated soils; air quality; noise, traffic, economic issues, visual impacts, heritage issues, cumulative impacts;
- Mitigation measures; and
- Conclusions.

A preliminary environmental assessment has been undertaken in section 4 to identify the potential environmental issues associated with this project and assist in determining the scope and budget of studies required to support the EIS. The following sections describe these requirements. In addition to these specific studies, numerous other assessments as required by the Director General will be required.

5.1 Sediment Investigations

Study Component:	Sediment Investigations
Scope:	Refer to section 4.5. The characteristics of the sediments to be dredged are to be determined by coring at the four main dredging areas (A, B, C and D) in North Creek. The *National Assessment Guidelines for Dredging* (DEWHA, 2009) recommends minimum numbers of sample locations based on dredging volume, which translates to a total of 76 cores for this project. This level of sampling may not be required and a sampling plan should be developed and optimised in discussion with EPA to reduce overall sample numbers where possible. A statistically based trial study may be the best approach in this regard. All strata encountered for each core should be identified and logged with absolute elevation relative to AHD. Representative samples from all strata should be sampled to determine particle size distribution, presence of contaminants (i.e. ENM suite of tests including pesticides, hydrocarbons, metals, etc.) as well as organotins (TBT) and acid sulfate soil characteristics (CRS, ANC). Samples of key strata should also be subject to a standard suite of engineering tests to determine overall suitability for construction fill and potentially higher value uses such as concrete production. Any guideline exceedances for contaminants may require additional sampling to determine extent of contamination. Such sampling would need to be undertaken in accordance with EPA (1995). All coring information should be presented in as 3D CAD suitable for comparison with hydrographic surfaces and dredge cut configuration.
Outcomes:	Sampling plan EPA concurrence with sampling methodology Detailed sediment stratigraphy and material properties Sediment volumes by type Sediment end use options
Budget:	$138,000

5.2 Hydrodynamic Modelling and Sediment Dynamics

Study Component:	Hydrodynamic Modelling and Sediment Dynamics
Scope:	Refer to sections 4.4, 4.6 and 4.7. An integrated set of hydrodynamic and sedimentological models should be utilised to quantify the likely impact of all dredging components on tidal hydraulics, sediment dynamics and ocean inundation events within the study area. Water velocity and flow patterns within the study area should be determined over a range of tidal states and the influence of each dredging area on changes in hydrodynamics evaluated. Sediment dynamics The sediment dynamic component of the model should also incorporate the lower Richmond River. The model should identify areas of likely erosion/deposition following dredging and should, in particular, evaluate: • the degree of sediment ingress into North Creek and hence rate of potential depletion of the sand resource in the lower Richmond River • the likely fate of the high tide shoal on the northward side of Area A • geomorphic conditions on the shoals adjoining and downstream of Area B • the risk of erosion of the northern bank adjacent to Area D. Depending on the outcomes of the above, it may also be necessary to determine the degree of connection between the lower Richmond River estuary sand resource and the sand transport past the Richmond River bar in order to determine whether any effect outside of the estuary is likely to occur. Changes in tidal prism need to be determined at various locations along the study area. Tidal statistics should highlight the portion of time that each location experiences inundation under astronomical tidal cycles both currently and with sea level rise.
Outcomes:	Clear understanding of changes in estuarine flow velocities and patterns due to dredging over the full range of tidal states; Prediction of sediment erosion and scour areas, with evaluation of likely impact on areas identified as being at risk of erosion Determination of change in tidal prism to assist in evaluation on potential changes in fringing marine vegetation zonation.
Budget:	$175,000

5.3 Resource Value and Project Economic Assessment

Study Component:	Resource Value and Project Economic Assessment
Scope:	Refer to section 4.18 Determine the value of the sediments proposed to be dredged with reference to material classification and engineering assessment. The study should: • Determine the value of the material as construction fill through comparison with other available sources of a similar nature (i.e. large volume availability, similar material properties). Transportation cost of alternative materials should be taken into account. • Investigate whether sediments in certain areas of North Creek (as determined through the sediment investigations) have potential for higher value uses and determine the nature of the market for that material. Where opportunity exists to convert material to a higher value through blending with other local materials (e.g. fine sand with coarse sand to achieve a better concrete consistency), the economic feasibility of this should be evaluated. • Overall cost-benefit analysis of the project.
Outcomes:	A clear understanding of the value of the North Creek resource in comparison to other viable alternatives. Identification of opportunities to increase the value of the North Creek resource Determination of the overall economic attractiveness of dredging North Creek.
Budget:	$15,000

5.4 Shorebirds

Study Component:	Shorebirds
Scope:	Refer to section 4.11 Conduct high and low tide survey of shorebirds in the Richmond Estuary, to determine potential impacts on roost and foraging habitat on shorebirds. It will be necessary to assess the value of these habitat features in a local context and therefore other important sites in the lower Richmond River estuary (Mobbs Bay, RSL sand bar) will also need to be included. Surveys should be distributed between spring and neap tide periods and would include a count of shorebirds at all high tide roosts and major foraging areas as well as direct observation on how shorebirds use The Serpentine intertidal habitat. Data collected are to include species, time of arrival and departure, movement over the intertidal area and foraging behaviour. Additional data on feeding rates to compare with observations at other habitats in the estuary should also be obtained for priority species, such as the Eastern Curlew (EPBC Act: Critically Endangered). Surveys should be undertaken in February to avoid the peak summer holiday period (where disturbance can influence results) and ensure sampling occurs prior to northern migration. Eastern Curlews begin leaving north coast estuaries in the second half of February. Information on the elevation of intertidal habitat at The Serpentine would complement observations on habitat use. Elevation data for The Serpentine roost area would enable determination of how frequently it is inundated and how much space is available at different tides. This would assist in determining its overall importance as a roost in the local context. Similarly, elevation mapping of the key foraging areas would assist in determining the duration of exposure at different tide heights. The scope of the shorebird study should also consider the likely effectiveness of potential offsets that may be utilised in the project (additional shorebird roosting area near Area B and beach formation adjacent to Area D). Some higher resolution topographic information than currently exists would need to be collected to support this study.
Outcomes:	Understanding of the importance of The Serpentine roost and foraging areas for threatened shorebird species in the local context. This information will be required in order to determine the significance of the potential impact on these species. Information collected will provide detailed information that will assist in the design of any roost/foraging area offsets incorporated into the project.
Budget:	$35,000

5.5 Community Consultation

Study Component:	Community Consultation
Scope:	Refer to section 4.7 and 4.10, 4.11 Community input is a mandatory requirement in the preparation of an EIS and a multi-faceted approach is to be employed in order to maximise community awareness and potential for constructive input to the project. The following activities are to be undertaken: Project web page - to provide an avenue for information dissemination, collection community information (e.g. electronic surveys) and provide contact details. Public questionnaire - to gauge community acceptability, identify/confirm key issues, and highlight other project opportunities. Targeted liaison: • Discussions with oyster lease operators in North Creek to better understand poor water quality events and to evaluate the acceptability of the proposed dredging in relation to lease boundaries; • Discussion with the Ballina Fishermen's Cooperative to determine any potential issues with particular reference to the potential influence of the project on marine vegetation or fisheries resources; and • Specific liaison with local angling clubs; • Discussions with relevant local bird advocacy groups including BirdLife Northern Rivers, Ballina BirdLife Shorebird 2020 and Northern Rivers Regional Shorebird Group. • Continued project discussions at Council's Aboriginal Community Liaison Committee meetings; • Other groups as identified during broader stakeholder engagement activities. Public drop-in sessions, where members of the public can meet with the team to discuss the project. Articles to be included in the Advocate and Community Connect newsletters EIS submissions period - where responses to the draft EIS are collected and considered prior to finalising the EIS
Outcomes:	Understanding of views and overall acceptability of the project to the community Identification of key issues to ensure proper consideration in EIS
Budget:	$20,000

5.6 Agency Liaison

Study Component:	Agency Liaison
Scope:	Refer to section 4.14 Obtain Director General's (Department of Planning) requirements to be addressed in the EIS. Liaison with EPA regarding sediment sampling strategy and likely scope of an Environmental Protection Licence. Additional consultation with RMS should be to optimise the dredged channel configuration and to assess the requirement for additional navigational aids within the study area. Determine best pipeline layout configurations to best reduce navigational issues. Continued discussions with Fisheries NSW regarding potential impacts on fisheries resources, Negotiations regarding compensatory habitat measures and offset habitat creation/protection. Assistance in engaging with aquaculture, commercial fisheries and angling groups. Continued liaison with OEH regarding sediment budget and coastal inundation issues. Discussions with NPWS section regarding shorebird issues and mitigation strategies and assistance in identifying key community stakeholders. Continued liaison with Crown Lands in relation to licence conditions and royalties.
Outcomes:	Clear understanding of agency requirements to be addressed in the EIS Ability to 'test the waters' on project issues.
Budget:	$6,000

5.7 Estuarine Habitat Studies

Study Component:	Estuarine Habitat Studies
Scope:	Refer to section 4.6 and 4.10, 4.11. All marine vegetation (saltmarsh, mangroves and seagrass) should be mapped using the latest (2015+) aerial photography when available. Field seagrass survey to ground-truth seagrass occurrence, species composition and condition. The field survey should collect DGPS position and elevation of bed margins in proximity to the proposed dredging areas. Similarly the elevation ranges of key areas of saltmarsh should be determined for reference with the hydrodynamic modelling (tidal prism) results. Quantify, with reference to survey data, current distributions and model results, any anticipated change in marine vegetation and other habitat distribution due to dredging. This will need to consider changes in tidal behaviour, alternation of North Creek bathymetry, changes in flow patterns and geomorphological influences. Evaluate the physical requirements necessary to create additional surface area for seagrass colonisation at the fringes of dredging areas, particularly dredging Area B. The elevation data collected during the seagrass survey will assist in determining likely seagrass colonisation ranges; Determine the desirability of establishing an erosion buffer to the loss of saltmarsh to the north of dredging Site D through placement of some dredged material to form a shallow beach at this location.
Outcomes:	Baseline mapping of estuarine habitat and marine vegetation communities within North Creek and a good understanding of the elevation range occupied by important vegetation types. Understanding of likely changes in estuarine habitat due to dredging which will have implications for the assessment of impacts on shorebirds, commercial and recreational fisheries resources. Information which will assist in the determination of suitable compensatory habitat proposals and a clear understanding of compensatory habitat costs associated with direct destruction of seagrass during dredging.
Budget:	$20,000

5.8 Aboriginal Cultural Heritage Assessment

Study Component:	**Aboriginal cultural heritage assessment**
Scope:	Refer to section 4.15 Detailed information on the requirements of aboriginal cultural heritage assessments is provided in *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH, 2011). Below provides a summary of relevant requirements for aboriginal cultural heritage assessments. Any an activity that may harm an Aboriginal object or a declared Aboriginal place must investigate, assess and report on the harm that may be caused by the activity they propose. The investigation and assessment of Aboriginal cultural heritage is to explore the harm of a proposed activity on Aboriginal objects and declared Aboriginal places and to clearly set out which impacts are avoidable and which are not. Harm to significant Aboriginal objects and declared Aboriginal places should always be avoided wherever possible. Where harm to Aboriginal objects and declared Aboriginal places cannot be avoided, proposals that reduce the extent and severity of harm to significant Aboriginal objects and declared Aboriginal places should be developed. An aboriginal cultural heritage assessment needs encompass all proposed and potential dredge areas, potential pipeline routes, dewatering and stockpile sites. The assessment should include: • A review of relevant background information; • Consultation with relevant aboriginal groups; • Identification and assessment of cultural significance; • Identification of the nature and extent of the proposed activity and assessment of any potential harm to Aboriginal objects and/or declared Aboriginal places; • Development of measures to avoid harm; • Development of strategies to minimise harm; and • Any recommendations The following aspects are recommended to be undertaken as part of further planning and assessment of this project: • Continued liaison with local Aboriginal community via Council's Aboriginal Community Liaison Committee; • Seek formal feedback on the proposed dredging and dewatering activities from the Jali Local Aboriginal Land Council • Undertake an Aboriginal heritage assessment to determine whether any aspects of Aboriginal heritage are likely to be impacted by the project. • Ensure reference to and adherence to the Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW (OEH, 2010).
Outcomes:	Address EIS requirements
Budget:	$10,000

5.9 Dewatering Site Assessment

Study Component:	Dewatering Site Assessment
Scope:	Refer to section 4.7 Assess the impact of dewatering and materials handling at both the Southern Cross Industrial Estate and Depot 2 Dewatering sites. The scope of the assessment should include: • Description and assessment site vegetation to be disturbed • Evaluation of site history and soils and potential influences on dewatering methodology (e.g. bund construction, etc.) • Consideration site hydrology, drainage pathways • Sensitivities regarding noise, dust, etc. • Identify measures to protect the environment as well as other measures to be employed considering nearby landuse (e.g. bird attraction and risk of bird strikes at the airport) Determine the water quality (primarily salinity) and ecological dependencies of the intended discharge drain/creek for the Southern Cross Industrial Estate site and evaluate any potential issues in relation to the ecosystem of this waterway.
Outcomes:	Identification of any site constraints that may impact on dewatering methodology. Feedback to detailed works planning Fulfils assessment requirements for EIS.
Budget:	$10,000

5.10 Noise and Vibration

Study Component:	Noise and Vibration
Scope:	Refer to section 4.16 A noise and vibration assessment is required to assess the potential noise and vibration impacts associated with the works on surrounding areas. The assessment would need to include noise and vibration related impacts associated with the dredge area, pipeline route, transport route, dewatering site and placement site. Expected noise and vibration levels compared to ambient background levels to assess impact of proposed works. To quantify the noise impact, the noise levels from the source at all potentially affected receivers should be predicted, taking account of the a range of parameters including: • all noise sources related to the proposed development, including vehicles that operate on site • source noise levels, site location and effective height of the noise source. References should be provided for all source noise levels used in the assessment (for example, direct measurement, previous EIS, manufacturer's specifications) • all stages of project development • all nearby receivers potentially affected by the development • weather conditions applicable to the site • site features (including natural and constructed, development and surrounding land uses) that affect noise propagation • operating times of the development The following guidelines should be consulted in evaluating noise issues: • Interim Construction noise Guideline • Draft Industrial Noise Guideline (EPA, 2015) • NSW Industrial Noise Policy (EPA, 2000) • Assessing Vibration: a technical guideline (DECC, 2006)
Outcomes:	Assessment of the noise and vibration impacts of the project Noise and vibration conditions and mitigation measures
Budget:	$5,000

5.11 Traffic Planning and Assessment

Study Component:	Traffic Planning
Scope:	Refer to section 4.17 The degree of transport planning required will depend on the dewatering site to be utilised, the fate of this material (i.e. is all destined for the Southern Cross Industrial Estate) and the timeframe over which dewatering operations are to extend. If Depot is to be utilised for dewatering then the following is recommended: • Development of a detailed transport plan that outlines the route to be taken, frequency and indicative timing of movements, vehicle sizes, turning circles and mass. • The EIS will need to consider current traffic patterns influenced by the transport plan and determine, with reference to Council and RMS, the impacts and potential mitigation measures relating to increased traffic. • The EIS will also need to consider the noise, vibration as well as air quality (dust, vehicle emissions).
Outcomes:	Assessment of the noise and vibration impacts of the project Noise and vibration conditions and mitigation measures
Budget:	$5,000

5.12 Detailed Works Planning

Study Component:	**Works Planning**
Scope:	Refer to section 4.10 and 4.11 The following aspects are recommended to be undertaken as part of further planning and assessment of this project: • Opportunities for creation of offset habitats (seagrass, inter-tidal sediments) should be considered in the proposed dredging configuration • Consideration should be given to the creation of two additional high tide shorebird roosting areas: o Creation of an island within the middle shoal area between the two existing dredging holes and north of the proposed dredging Area B. o Addition of sand to fortify the eroding back and loss of saltmarsh to the north of dredging Site D. This would necessitate slight alteration of the alignment of dredging at this location to be complementary to this aim • Consider the eastward extension of the Area B dredging to isolate the sand/mud flats to the north from people/pets thus providing a reduced disturbance shorebird habitat at that location; • Map the inferred sediment distribution within North Creek and modify the proposed dredging and dewatering methodology as appropriate for the sediments identified. • Document an ASS management strategy for dredged sediments as necessary. The strategy should reference both the NSW and Qld guidelines and fully address all aspects relating to disturbance and treatment of acid sulfate soil.
Outcomes:	Optimised dredging design Full description of works and activities for inclusion in the EIS Detailed understanding of the cost of works and implementation schedule taking into account project constraints
Budget:	$15,000

6. PROJECT PLANNING

Dredging of North Creek currently appears feasible. Preliminary production unit cost estimates indicate that fill material can be generated from each of the four target dredging areas at a discount to commercial fill prices. Dredging also has the benefits of reducing significant transport costs for import of this fill and has added benefits to navigational safety in North Creek as well as anticipated improvements in estuarine tidal exchange and water quality benefiting oyster growers.

The legislative review has confirmed that the scale of the project will trigger the requirement for an EIS to accompany a development application for the project.

6.1 Key Project Risks

The large sediment volume targeted for dredging is up to twice the annual littoral sediment transport rate along the Ballina coastline. It is imperative that dredging is undertaken in a way that can be demonstrated to have minimal impact on coastal sediment dynamics. The proposed dredging is considered likely to achieve this however comprehensive hydrodynamic and sediment modelling is required to fully quantify changes in coastal geomorphology and may result in unanticipated results.

Several species of shorebirds utilising the lower reaches of North Creek are protected by State and Federal legislation and are favoured by a range of stakeholders. It will be important for the project to be able to demonstrate that impacts on the populations of these birds will be minimal. Given potential risks to a key roost area as well as nearby foraging grounds, it is considered appropriate to incorporate provision of roosting areas and protection of feeding grounds by alteration of the proposed Area B dredging. Providing this positive offset early in the stakeholder engagement process is likely to be advantageous to the project.

The Southern Cross Industrial Estate is the preferred location for bulk dewatering of fill material. Given that the logical delivery and return drainage route run across privately held land, it is important that agreement is reached with these landholders to utilise this route. Alternative access routes are available but are problematic and not recommended in the first instance.

6.2 Recommendations

It is recommended that Council continues to pursue the proposed dredging of North Creek. The full range of technical studies and detailed discussion of project impacts and benefits will be required as part of the EIS, however the following are regarded as priority actions to progress the project:

1. Obtain Director General's requirements for the EIS.
2. Pumping of dredged material direct to the Southern Cross Industrial Estate site is the recommended dewatering option for all fill materials. This site is advantageous as the site is larger than the Depot 2 alternative and does not require additional road transport to deliver the materials to this fill site. In order to confirm this location, the following needs to be addressed:
    - Agreement with private landowner to utilise the drain/creek alignment for slurry pipeline and return water discharge;
    - Confirm ecological status of drain/creek and acceptability of discharge water releases to this environment; and
    - Ecological and other constraints to dewatering at this site.
3. Commence the seasonally urgent shorebird usage survey and collect additional supporting ground survey data;
4. Undertake sediment investigations as scoped in order to provide certainty on the nature of the resource.

5. Commence targeted stakeholder consultation.
6. Depending of the outcomes of the above, it may be necessary to refer the project to the Federal Department of the Environment for assessment under the EPBC Act due to potential impacts on shorebirds.

6.3 Costs

A summary of the anticipated costs for the required investigations and project approval phases are presented below. Costs do not include the cost of physical works, licences, royalties, etc. Some components (e.g. traffic planning will only apply with certain project options).

Table 7. Project Planning and Approvals Budget

Item	Budget	
Project Management and Coordination	$	50,900
Approvals Documentation (EIS, Tests of Significance, SISs, EPBC Act referral, etc.)	$	40,000
Detailed Investigations/Scopes		
Sediment investigations	$	138,000
Hydrodynamic and sediment modelling	$	175,000
Resource value and economic assessment	$	15,000
Shorebird assessment	$	35,000
Community consultation	$	20,000
Agency consultation	$	6,000
Estuarine habitat studies	$	20,000
Aboriginal cultural heritage assessment	$	10,000
Dewatering site assessment	$	10,000
Noise and vibration assessment	$	5,000
Traffic planning and assessment	$	5,000
Detailed works planning	$	15,000
Other assessments not requiring detailed investigation	$	15,000
Contingency (~30%)	$	168,000
Total	**$**	**727,900**

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Appendix 1: EPBC ACT Protected Matters Search Tool and Bionet Search Results

Table 8: EPBC Act Search Tool Results – Species or species habitat known to occur with the search area

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC
Dredge areas						
Australasian Bittern	*Botaurus poiciloptilus*	Waterbird	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes and spikerushes.	-	Endangered	Endangered
Curlew Sandpiper	*Calidris ferruginea*	Shorebird	This species occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. Curlew Sandpipers forage on mudflats and nearby shallow water. Curlew Sandpipers generally roost on bare dry shingle, shell or sand beaches, sand spits and islets in or around coastal or near-coastal lagoons and other wetlands, occasionally roosting in dunes during very high tides and sometimes in saltmarsh. This species forages mainly on invertebrates, including worms, molluscs, crustaceans, and insects, as well as seeds. Breeds in Siberia, migrating to Australia between August and November for the summer before leaving again between March and mid-April. Occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin.	-	Endangered	Critically Endangered, Migratory
Red Goshawk	*Erythrotriorchis radiatus*	Bird	Occurs over forested and woodland areas close to permanent water. In NSW favoured habitat is mixed subtropical rainforest and melaleuca forest along coastal rivers, often in rugged terrain. Preys almost exclusively on birds.	-	Critically Endangered	Vulnerable
Eastern Curlew	*Numenius madagascariensis*	Shorebird	The Eastern Curlew is found on intertidal mudflats and sandflats, often with beds of seagrass, on sheltered coasts, especially estuaries, mangrove swamps, bays, harbours and lagoons. The Eastern Curlew is a migratory species, moving south by day and night, usually along coastlines, leaving breeding areas from mid-July to late September. They arrive in north-western and eastern Australia mainly in August. Large numbers appear on the east coast from September to November. Most leave again from late February to March. They eat mainly small crabs and molluscs, foraging mudflats by day and night.	-	-	Critically Endangered, Migratory Species

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC
Fairy Prion (southern)	*Pachyptila turtur subantarctica*	Bird	The southern subspecies of the Fairy Prion is a marine bird, found mostly in temperate and subantarctic seas. airy Prions (including other subspecies) are often beach-cast on the south-eastern coast of Australia, and are commonly seen offshore over the continental shelf and over pelagic waters.	-	-	Vulnerable
Koala	*Phascolarctos cinereus*	Mammal	Inhabit eucalypt woodlands and forests	-	-	Vulnerable
Grey-headed Flying-fox	*Pteropus poliocephalus*	Mammal	Occur in rainforest, mangroves, paperbark swamps, wet and dry sclerophyll forests and cultivated areas. Forage on fruits and blossoms of more than 80 species of plants. Prefer eucalypt blossom with native figs being the most popular fruit. Chew leaves and appear to eat the salt glands from mangroves. Congregate in large camps of up to 200,000 individuals from early until late summer usually in gullies close to water.	-	Vulnerable	Vulnerable
Hairy-joint grass	*Arthraxon hispidus*	Plant	Moisture and shade-loving grass, found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps	-	-	Vulnerable
Loggerhead Turtle	*Caretta caretta*	Reptile	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	-	Endangered	Endangered
Green Turtle	*Chelonia mydas*	Reptile	Ocean-dwelling species spending most of its life at sea. Eggs laid in holes dug in beaches throughout their range.	-	Vulnerable	Vulnerable
Leatherback Turtle	*Dermochelys coriacea*	Reptile	A pelagic feeder, found in tropical, subtropical and temperate waters venturing close to shore mainly during the nesting season in which they require sandy beaches to nest.	-	Endangered	Endangered, Migratory, Marine
Hawksbill Turtle	*Eretmochelys imbricata*	Reptile	Hawksbills nest on insular and mainland sandy beaches throughout the tropics and subtropics. They are highly migratory and use a wide range of broadly separated localities and habitats during their lifetimes including major gyre systems, neritic developmental foraging habitat that may comprise coral reefs or other hard bottom habitats, sea grass, algal beds, or mangrove bays and creeks or mudflats.	-	-	Vulnerable

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC
Flatback Turtle	*Natator depressus*	Reptile	The flatback turtle is endemic to Australia and all known breeding sites of this species occur only in Australia. Flatback turtles have a preference for shallow, soft-bottomed sea bed habitats away from reefs. Flatback turtles nest only in northern Australia on inshore islands and the mainland from Mon Repos in southern Queensland to Exmouth in northern Western Australia. On the east coast of Queensland, flatback turtles nest from Mon Repos in the south to Herald Island near Townsville in the north. Major rookeries include four islands on the inner shelf of the southern Great Barrier Reef, Peak, Wild Duck, Avoid and Curtis Islands. Nesting activity reaches a peak between late November and early December, and ceases by late January. Hatchlings emerge from nests from late December until about late March, with most hatching during February. The flatback turtle is carnivorous, feeding mostly on soft bodied prey such as sea cucumbers, soft corals and jellyfish. They feed mainly in subtidal, soft-bottomed habitats.	-	-	Vulnerable, Marine, Migratory
White-throated Needletail	*Hirundapus caudacutus*	Bird	Migratory terrestrial aerial bird that roosts in trees.	-	-	Migratory
Black-faced Monarch	*Monarcha melanopsis*	Bird	Migratory terrestrial bird species found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating.	-	-	Migratory Species
Spectacled Monarch	*Monarcha trivirgatus*	Bird	The Spectacled Monarch prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	-	-	Migratory Species
Rufous Fantail	*Rhipidura rufifrons*	Bird	Occurs in coastal and near coastal areas. Prefers areas of rainforest and sclerophyll forests. Also occur in paperbark and mangrove swamps.	-	-	Marine, Migratory
Common Sandpiper	*Actitis hypoleucos*	Shorebird	In Australia, the Common Sandpiper is found in coastal or inland wetlands, both saline or fresh. It is found mainly on muddy edges or rocky shores. They are migratory, generally breeding in Eurasia during the Australian winter. Eats small molluscs, aquatic and terrestrial insects	-	-	Migratory Species
Great Egret	*Ardea alba*	Waterbird	Migratory wetland bird species that inhabits inland and coastal wetlands and frequents river margins, lakes shores, marshes and flood-plains.	-	-	Migratory Species

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC
Cattle Egret	*Ardea ibis*	Waterbird	The Cattle Egret occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. It is commonly associated with the habitats of farm animals, particularly cattle, but also pigs, sheep, horses and deer. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora. The Cattle Egret roosts in trees, or amongst ground vegetation in or near lakes and swamps. It has also been recorded roosting near human settlement and industrial areas in Murwillumbah	-	-	Migratory Species
Ruddy Turnstone	*Arenaria interpres*	Shorebird	Found in most coastal regions and occasionally inland. Prefers open coastlines and beaches with exposed rock, stony or shell beaches, reefs or wave platforms. Also is known to inhabit estuaries, bays and lagoons. Feeds between lower supra-littoral and lower littoral foreshore zones, with a particular affinity with seaweed wrack.	-	-	Marine, Migratory
Sharp-tailed Sandpiper	*Calidris acuminata*	Shorebird	Prefers the grassy edges of shallow inland freshwater wetlands. It is also found around flooded fields, mudflats, mangroves, rocky shores and beaches. A summer migrant from Arctic Siberia, being found on wetlands throughout Australia.	-	-	Migratory Species
Sanderling	Calidris alba	Shorebird	Found on open sandy beaches at the edge of the waves, on sandbars and spits. They roost on bare sand in the dunes or behind piles of kelp. Migratory species breeding mostly in Siberia, moving south to Australia in mid-July to mid-August, staying for the summer before leaving by May (although some may overwinter in Australia). They eat mainly insects and other arthropods and small crustaceans	-	Vulnerable	Migratory Species
Red Knot	*Calidris canutus*	Shorebird	Red Knot mainly inhabit intertidal mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours; sometimes on sandy ocean beaches or shallow pools on exposed wave-cut rock platforms or coral reefs. They are occasionally seen on terrestrial saline wetlands near the coast, such as lakes, lagoons, pools and pans, and recorded on sewage ponds and saltworks, but rarely use freshwater swamps.	-	-	Endangered, Marine Migratory
Curlew Sandpiper	*Calidris ferruginea*	Shorebird	This species occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. Curlew Sandpipers forage on mudflats and nearby shallow water. Curlew Sandpipers generally roost on bare dry shingle, shell or sand beaches, sand spits and islets in or	-	Endangered	Critically Endangered, Migratory

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC
			around coastal or near-coastal lagoons and other wetlands, occasionally roosting in dunes during very high tides and sometimes in saltmarsh. This species forages mainly on invertebrates, including worms, molluscs, crustaceans, and insects, as well as seeds. Breeds in Siberia, migrating to Australia between August and November for the summer before leaving again between March and mid-April. Occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin.			
Pectoral Sandpiper	*Calidris melanotos*	Shorebird	Breeds in the northern hemisphere, northern Russia and North America, before migrating to Australia for the southern summer. Prefers shallow fresh to saline wetlands hat have open fringing mudflats and low, emergent or fringing vegetation,. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands.	-	-	Marine, Migratory
Red-necked Stint	*Calidris ruficollis*	Shorebird	Mostly found in coastal areas, including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks and, sometimes, on protected sandy or coralline shores. Occasionally they have been recorded on exposed or ocean beaches, and sometimes on stony or rocky shores, reefs or shoals. An omnivorous species, it forages on bare wet mud on intertidal mudflats or sandflats, or in very shallow water on a range of marine worms, molluscs, snails and slugs, shrimps, spiders, beetles, flies and ants.	-	-	Migratory Species
Long-toed Stint	*Calidris subminuta*	Shorebird	Breeds in the northern hemisphere before migrating to Australia for the southern summer. Forages in the shallows of freshwater and brackish wetlands and less commonly in estuaries. More often around cover of low vegetation than on open flats.	-	-	Marine, Migratory
Great Knot	*Calidris tenuirostris*	Shorebird	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. 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.	-	Vulnerable, Protected	Migratory Species (C,J,K)

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC
Double-banded Plover	*Charadrius bicinctus*	Shorebird	found on littoral, estuarine and fresh or saline terrestrial wetlands and also saltmarsh, grasslands, pasture and seagrass areas. The species breeds only in New Zealand in July-September, with part of the population migrating to Australia in non-breeding season. It eats molluscs, insects, worms, crustaceans and spiders and sometimes seeds and fruits	-	-	Migratory Species
Greater Sand Plover, Large Sand Plover	*Charadrius leschenaultii*	Shorebird	The species is almost entirely coastal, inhabiting littoral and estuarine habitats. Breeds in the northern hemisphere and heads south for the boreal winter. Apparently rare on the east coast, usually found singly. In NSW, the species has been recorded between the northern rivers and the Illawarra, with most records coming from the Clarence and Richmond estuaries.Greater Sand Plovers mostly eat molluscs, worms, crustaceans (especially small crabs and sometimes shrimps) and insects.	-	Vulnerable	Vulnerable, Marine, Migratory
Lesser Sand Plover, Mongolian Plover	*Charadrius mongolus*	Shorebird	Usually occurs in coastal littoral and estuarine environments. It inhabits large intertidal sandflats or mudflats in sheltered bays, harbours and estuaries, and occasionally sandy ocean beaches, coral reefs, wave-cut rock platforms and rocky outcrops. Roosts during high tide on sandy beaches, spits and rocky shores; forage individually or in scattered flocks on wet ground at low tide, usually away from the water's edge. Breeds in the northern hemisphere and heads south for the boreal winter. It also sometime occurs in short saltmarsh or among mangroves. It eats invertebrates, such as molluscs (especially bivalves), worms, crustaceans (especially crabs) and insects.	-	Vulnerable	Endangered, Marine, Migratory
Oriental Plover, Oriental Dotterel	*Charadrius veredus*	Shorebird	Breeds in the northern hemisphere before migrating to Australia for the southern summer. Mostly occurs on the north-west coast and at a few scattered sites elsewhere, seldom recorded in southern Australia. Usually forage among short grass or on hard stony bar ground but also on mudflats or beaches.	-	-	Migratory
Latham's Snipe, Japanese Snipe	*Gallinago hardwickii*	Shorebird	They usually inhabit open, freshwater wetlands with low, dense vegetation but can also occur in habitats that have saline or brackish water, such as saltmarsh, mangrove creeks, around bays and beaches, and at tidal rivers. Omnivorous species forages mudflats and shallow water feeding on seeds and plant material as well as invertebrates including insects, earthworms and spiders.	-	-	Migratory Species

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC
Grey-tailed Tattler	*Heteroscelus brevipes*	Shorebird	Forages on mudflats, sandflats, beaches and also rock ledges and reefs. Often perches on branches, seawalls, jetties and pontoons. In Moreton Bay, Queensland, it is most abundant in areas with dense beds of seagrass.	-	-	Marine, Migratory
Wandering tattler	*Tringa incana*	Shorebird	Almost entirely confined to rocky shorelines, wave washed tidal platforms and exposed reefs around headlands or high islands.	-	-	Migratory
Broad-billed Sandpiper	*Limicola falcinellus*	Shorebird	Breeds in northern Siberia before migrating south for the southern summer. In NSW the main site for species is the Hunter River estuary with birds occasionally reaching the Shoalhaven estuary. Favour sheltered parts of the coast such as estuarine sand flats and mudflats, harbours, embayments, lagoons, saltmarshes and reefs as feeding and roosting habitat. Roost on sheltered sand, shell or shingle beaches.	-	Vulnerable	-
Bar-tailed Godwit	*Limosa lapponica*	Shorebird	Migrates from northern hemisphere. Inhabits coastal mudflats, sandbars and shorelines. Prefer exposed sandy substrates on intertidal flats, banks and beaches. Also prefer soft mud, often with beds of eelgrass Zostera or other seagrasses. Roosts on sandy beaches, sandbars, spits and also in near-coastal saltmarsh.	-	-	Marine, Migratory
Black-tailed Godwit	*Limosa limosa*	Shorebird	The species is commonly found in sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats, or spits and banks of mud, sand or shell-grit; occasionally recorded on rocky coasts or coral islets. Forages on wide intertidal mudflats or sandflats, in soft mud or shallow water and occasionally in shallow estuaries. Omnivorous feeding on eating annelids, crustaceans, arachnids, fish eggs and spawn and tadpoles of frogs, and occasionally seeds. Breeds in the northern hemisphere then migrates to Australia in August before leaving again in March. It is most frequently recorded at Kooragang Island (Hunter River estuary), with occasional records elsewhere along the coast, and inland. Frequently recorded in mixed flocks with Bar-tailed Godwits.	-	Vulnerable	Migratory Species

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC
Little Curlew, Little Whimbrel	*Numenius minutus*	Shorebird	Most often found feeding in short, dry grassland and sedgeland, including dry floodplains and blacksoil plains, which have scattered, shallow freshwater pools or areas seasonally inundated. Open woodlands with a grassy or burnt understorey, dry saltmarshes, coastal swamps, mudflats or sandflats of estuaries or beaches on sheltered coasts, mown lawns, gardens, recreational areas, ovals, racecourses and verges of roads and airstrips are also used. The Little Curlew is omnivorous, mainly eating insects, but also seeds and berries	-	-	Migratory Species
Whimbrel	*Numenius phaeopus*	Shorebird	Regular migrant to Australia from breeding grounds in Alaska. Feeds on mudflats of estuaries and lagoons.	-	-	Marine, Migratory
Osprey	*Pandion haliaetus*	Marine Bird	Coastal waters and estuaries	-	-	Migratory Species
Ruff	*Philomachus pugnax*	Shorebird	The Ruff breeds in Europe from north Russia to north-west Kazakhstan before migrating south. It is a rare but common visitor to Australia. The Ruff forages on exposed mudflats, in shallow water and occasionally on dry mud, preferring to roast amongst shorter vegetation.	-	-	Marine, Migratory
Pacific Golden Plover	*Pluvialis fulva*	Shorebird	Inhabits coastal mudflats, sand flats, beaches and saltmarsh. Only rarely occurs inland.	-	-	Marine, Migratory
Grey Plover	*Pluvialis squatarola*	Shorebird	In non-breeding ground in Australia they occur almost entirely in coastal areas, where they usually inhabit sheltered embayments, estuaries and lagoons with mudflats and sandflats, and occasionally on rocky coasts with wave-cut platforms or reef-flats, or on reefs within muddy lagoons. Usually roost in sandy areas on sheltered beaches or estuaries. Forage exposed mudflats and beaches of coastal estuaries and lagoons.	-	-	Migratory Species
Wood Sandpiper	*Tringa glareola*	Shorebird	Breeds in the northern hemisphere before migrating to Australia for the southern summer. Generally found inland around freshwater swamps and wetlands, lakes, flooded pasture- usually well vegetated. Infrequent around brackish water and typically do not frequent coastal flats, occasionally mangroves.	-	-	Marine, Migratory
Common Greenshank	*Tringa nebularia*	Waterbird	Recorded in most NSW coastal regions and is widely distributed west of the Great Dividing Range. On the coast it inhabits sheltered estuaries with extensive mudflats, mangrove swamps and muddy shallows. Inland it inhabits billabongs, swamps and the like.	-	-	Marine, Migratory

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC
Marsh Sandpiper, Little Greenshank	*Tringa stagnatilis*	Shorebird	Lives in permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats and also regularly at sewage farms and saltworks. The Marsh Sandpiper usually forages in shallow water at the edge of wetlands. They probe wet mud of mudflats or feed among marshy vegetation on insects, molluscs and crustaceans.	-	-	Migratory Species
Terek Sandpiper	*Xenus cinereus*	Shorebird	Mostly forages in the open, on soft wet intertidal mudflats or in sheltered estuaries, embayments, harbours or lagoons. Preferring to roost in or among mangroves, birds may perch in branches or roots up to 2 m from the ground. Have been recorded eating crustaceans, insects, seeds, molluscs and arachnids. A rare migrant to eastern and southern Australia. The two main sites for the species in NSW are the Richmond River estuary and the Hunter River estuary.	-	Vulnerable	Migratory Species
Common Sandpiper	Actitis hypoleucos	Shorebird	In Australia, the Common Sandpiper is found in coastal or inland wetlands, both saline or fresh. It is found mainly on muddy edges or rocky shores. They are migratory, generally breeding in Eurasia during the Australian winter. Eats small molluscs, aquatic and terrestrial insects	-	-	Migratory Species
Depot 2						
Australasian Bittern	*Botaurus poiciloptilus*	Waterbird	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes and spikerushes.	-	Endangered	Endangered
Red Goshawk	*Erythrotriorchis radiatus*	Bird	Occurs over forested and woodland areas close to permanent water. In NSW favoured habitat is mixed subtropical rainforest and melaleuca forest along coastal rivers, often in rugged terrain. Preys almost exclusively on birds.	-	Critically Endangered	Vulnerable
Fairy Prion (southern)	*Pachyptila turtur subantarctica*	Bird	The southern subspecies of the Fairy Prion is a marine bird, found mostly in temperate and subantarctic seas. airy Prions (including other subspecies) are often beach-cast on the south-eastern coast of Australia, and are commonly seen offshore over the continental shelf and over pelagic waters.	-	-	Vulnerable

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC
Koala	*Phascolarctos cinereus*	Mammal	Inhabit eucalypt woodlands and forests	-	0	Vulnerable
Grey-headed Flying-fox	*Pteropus poliocephalus*	Mammal	Occur in rainforest, mangroves, paperbark swamps, wet and dry sclerophyll forests and cultivated areas. Forage on fruits and blossoms of more than 80 species of plants. Prefer eucalypt blossom with native figs being the most popular fruit. Chew leaves and appear to eat the salt glands from mangroves. Congregate in large camps of up to 200,000 individuals from early until late summer usually in gullies close to water.	-	Vulnerable	Vulnerable
White-throated Needletail	*Hirundapus caudacutus*	Bird	Migratory terrestrial aerial bird that roosts in trees.	-	-	Migratory Species
Black-faced Monarch	*Monarcha melanopsis*	Bird	Migratory terrestrial bird species found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating.	-	-	Migratory Species
Spectacled Monarch	*Monarcha trivirgatus*	Bird	The Spectacled Monarch prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	-	-	Migratory Species
Rufous Fantail	*Rhipidura rufifrons*	Bird	Occurs in coastal and near coastal areas. Prefers areas of rainforest and sclerophyll forests. Also occur in paperbark and mangrove swamps.	-	-	Marine, Migratory
Great Egret	*Ardea alba*	Waterbird	Migratory wetland bird species that inhabits inland and coastal wetlands and frequents river margins, lakes shores, marshes and flood-plains.	-	-	Migratory Species

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC
Bar-tailed Godwit	*Limosa lapponica*	Shorebird	Migrates from northern hemisphere. Inhabits coastal mudflats, sandbars and shorelines. Prefer exposed sandy substrates on intertidal flats, banks and beaches. Also prefer soft mud, often with beds of eelgrass Zostera or other seagrasses. Roosts on sandy beaches, sandbars, spits and also in near-coastal saltmarsh.	-	-	Marine, Migratory
Osprey	*Pandion haliaetus*	Marine Bird	Coastal waters and estuaries	-	-	Migratory Species
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	Marine Bird	Usually coastal areas including beaches, normally seen perched high in a tree, or soaring over waterways and adjacent land.	-	-	Migratory Species
Southern Cross Industrial						
Australasian Bittern	*Botaurus poiciloptilus*	Waterbird	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes and spikerushes.	-	Endangered	Endangered
Red Goshawk	*Erythrotriorchis radiatus*	Bird	Occurs over forested and woodland areas close to permanent water. In NSW favoured habitat is mixed subtropical rainforest and melaleuca forest along coastal rivers, often in rugged terrain. Preys almost exclusively on birds.	-	Critically Endangered	Vulnerable
Fairy Prion (southern)	*Pachyptila turtur subantarctica*	Bird	The southern subspecies of the Fairy Prion is a marine bird, found mostly in temperate and subantarctic seas. airy Prions (including other subspecies) are often beach-cast on the south-eastern coast of Australia, and are commonly seen offshore over the continental shelf and over pelagic waters.	-	-	Vulnerable
Koala	*Phascolarctos cinereus*	Mammal	Inhabit eucalypt woodlands and forests	-	-	Vulnerable

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC
Grey-headed Flying-fox	*Pteropus poliocephalus*	Mammal	Occur in rainforest, mangroves, paperbark swamps, wet and dry sclerophyll forests and cultivated areas. Forage on fruits and blossoms of more than 80 species of plants. Prefer eucalypt blossom with native figs being the most popular fruit. Chew leaves and appear to eat the salt glands from mangroves. Congregate in large camps of up to 200,000 individuals from early until late summer usually in gullies close to water.	-	Vulnerable	Vulnerable
Hairy-joint grass	*Arthraxon hispidus*	Plant	Moisture and shade-loving grass, found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps	-	-	Vulnerable
White-throated Needletail	*Hirundapus caudacutus*	Bird	Migratory terrestrial aerial bird that roosts in trees.	-	-	Migratory Species
Black-faced Monarch	*Monarcha melanopsis*	Bird	Migratory terrestrial bird species found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating.	-	-	Migratory Species
Spectacled Monarch	*Monarcha trivirgatus*	Bird	The Spectacled Monarch prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	-	-	Migratory Species
Great Egret	*Ardea alba*	Waterbird	Migratory wetland bird species that inhabits inland and coastal wetlands and frequents river margins, lakes shores, marshes and flood-plains.	-	-	Migratory Species
Osprey	*Pandion haliaetus*	Marine Bird	Coastal waters and estuaries	-	-	Migratory Species

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	Marine Bird	Usually coastal areas including beaches, normally seen perched high in a tree, or soaring over waterways and adjacent land.	-	-	Migratory Species

Table 9: Bionet Search Results (Site + 500 m buffer)

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC Act
Dredge Areas						
Scented Acronychia	*Acronychia littoralis*	Plant	Found between Fraser Island in the north and Port Macquarie in the south. Occurs in transition zones between littoral rainforest and swamp sclerophyll forest; between littoral and coastal cypress pine communities; and margins of littoral forest.	-	Endangered	Endangered
Pale-vented Bush-hen	*Amaurornis moluccana*	Bird	A dark olive-brown to dark grey water bird. Inhabits tall dense understorey or ground-layer vegetation on the margins of freshwater streams and natural or artificial wetlands, usually within or bordering rainforest, rainforest remnants or forests.	-	Vulnerable	-
White Lace Flower	*Archidendron hendersonii*	Plant	White Lace Flower occurs in riverine and lowland subtropical rainforest, littoral rainforest, coastal cypress pine forest and their ecotones. It is found on a variety of soils including coastal sands and those derived from basalt and metasediments.	-	Vulnerable	-
Australasian Bittern	*Botaurus poiciloptilus*	Waterbird	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes and spikerushes.	-	Endangered	Endangered

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC Act
Bush stone-curlew	*Burhinus grallarius*	Bird	Inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber. Feed on insects and small vertebrates, such as frogs, lizards and snakes.	-	Endangered	-
Sanderling	*Calidris alba*	Shorebird	Found on open sandy beaches at the edge of the waves, on sandbars and spits. They roost on bare sand in the dunes or behind piles of kelp. Migratory species breeding mostly in Siberia, moving south to Australia in mid-July to mid-August, staying for the summer before leaving by May (although some may overwinter in Australia). They eat mainly insects and other arthropods and small crustaceans	-	Vulnerable	Migratory Species
Curlew Sandpiper	*Calidris ferruginea*	Shorebird	This species occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. Curlew Sandpipers forage on mudflats and nearby shallow water. Curlew Sandpipers generally roost on bare dry shingle, shell or sand beaches, sand spits and islets in or around coastal or near-coastal lagoons and other wetlands, occasionally roosting in dunes during very high tides and sometimes in saltmarsh. This species forages mainly on invertebrates, including worms, molluscs, crustaceans, and insects, as well as seeds. Breeds in Siberia, migrating to Australia between August and November for the summer before leaving again between March and mid-April. Occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin.	-	Endangered	Critically Endangered Migratory Species
Great Knot	*Calidris tenuirostris*	Shorebird	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. 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.	-	Vulnerable,	Critically Endangered, Marine, Migratory

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC Act
Greater Sand Plover, Large Sand Plover	*Charadrius leschenaultii*	Shorebird	The species is almost entirely coastal, inhabiting littoral and estuarine habitats. Breeds in the northern hemisphere and heads south for the boreal winter. Apparently rare on the east coast, usually found singly. In NSW, the species has been recorded between the northern rivers and the Illawarra, with most records coming from the Clarence and Richmond estuaries. Greater Sand Plovers mostly eat molluscs, worms, crustaceans (especially small crabs and sometimes shrimps) and insects.	-	Vulnerable	Vulnerable, Marine, Migratory
Lesser Sand Plover, Mongolian Plover	*Charadrius mongolus*	Shorebird	Usually occurs in coastal littoral and estuarine environments. It inhabits large intertidal sandflats or mudflats in sheltered bays, harbours and estuaries, and occasionally sandy ocean beaches, coral reefs, wave-cut rock platforms and rocky outcrops. Roosts during high tide on sandy beaches, spits and rocky shores; forage individually or in scattered flocks on wet ground at low tide, usually away from the water's edge. Breeds in the northern hemisphere and heads south for the boreal winter. It also sometime occurs in short saltmarsh or among mangroves. It eats invertebrates, such as molluscs (especially bivalves), worms, crustaceans (especially crabs) and insects.	-	Vulnerable	Endangered, Marine, Migratory
Spotted Harrier	*Circus assimilis*	Bird	Occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges. Inhabits grassy open woodland including Acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	-	Vulnerable	-
Barred Cuckoo-shrike	*Coracina lineata*	Bird	Rare in NSW. Rainforest, eucalypt forests and woodlands, clearings in secondary growth, swamp woodlands and timber along watercourses.	-	Vulnerable	-
Stinking Cryptocarya, Stinking Laurel	*Cryptocarya foetida*	Plant	Grows in littoral rainforest between Iluka and Fraser Island	-	Vulnerable	Vulnerable
Varied Sittella	*Daphoenositta chrysoptera*	Bird	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.	-	Vulnerable	-
Black-necked Stork	*Ephippiorhynchus asiaticus*	Waterbird	Particular affinity with floodplains. Feed in floodplain swamps, wetlands, billabongs and watercourses. Construct large nests in tall trees situated close to water.	-	Endangered	-

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC Act
Beach Stone-curlew	*Esacus magnirostris*	Shorebird	Forage almost exclusively within the intertidal zone of beaches and estuaries, on islands, flats, banks and spits of sand, mud, gravel or rock, and among mangroves. Beach Stone-curlews breed above the littoral zone, at the backs of beaches, or on sandbanks and islands, among low vegetation of grass, scattered shrubs or low trees; also among open mangroves.	-	Critically Endangered	Marine
Black Falcon	*Falco subniger*	Bird	Very dark falcon that inhabits woodland, shrubland and grassland in the arid and semi-arid zones, especially wooded watercourses and agricultural land with scattered remnant trees.	-	Vulnerable	-
Mangrove Honeyeater	*Gavicalis fasciogularis*	Bird	The primary habitat of the species is mangrove woodlands and shrublands but Mangrove Honeyeaters also range into adjacent forests, woodlands and shrublands, including casuarina and paperbark swamp forests and associations dominated by eucalypts or banksias. Mangrove Honeyeaters eat nectar, from flowers, and invertebrates, including marine snails and crabs. Breed in late winter and early summer, from about August to December, nearly always building their nests in a densely foliaged mangrove tree.	-	Vulnerable,	-
Pied oystercatcher	*Haematopus longirostris*	Shorebird	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.	-	Endangered,	-
Little Eagle	*Hieraaetus morphnoides*	Bird	Occupies open eucalypt forest, woodland or open woodland.	-	Vulnerable	-
Black Bittern	*Ixobrychus flavicollis*	Waterbird	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.	-	Vulnerable,	-

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC Act
Broad-billed Sandpiper	*Limicola falcinellus*	Shorebird	Breeds in northern Siberia before migrating south for the southern summer. In NSW the main site for species is the Hunter River estuary with birds occasionally reaching the Shoalhaven estuary. Favour sheltered parts of the coast such as estuarine sand flats and mudflats, harbours, embayments, lagoons, saltmarshes and reefs as feeding and roosting habitat. Roost on sheltered sand, shell or shingle beaches.	-	Vulnerable	-
Black-tailed Godwit	*Limosa limosa*	Shorebird	The species is commonly found in sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats, or spits and banks of mud, sand or shell-grit; occasionally recorded on rocky coasts or coral islets. Forages on wide intertidal mudflats or sandflats, in soft mud or shallow water and occasionally in shallow estuaries. Omnivorous feeding on eating annelids, crustaceans, arachnids, fish eggs and spawn and tadpoles of frogs, and occasionally seeds. Breeds in the northern hemisphere then migrates to Australia in August before leaving again in March. It is most frequently recorded at Kooragang Island (Hunter River estuary), with occasional records elsewhere along the coast, and inland. Frequently recorded in mixed flocks with Bar-tailed Godwits.	-	Vulnerable	Marine, Migratory
Green and Golden Bell Frog	*Litoria aurea*	Amphibian	The Green and Golden Bell Frog occur mainly along coastal lowland areas of eastern NSW and Victoria. The species commonly occupies disturbed habitats, and breeds largely in ephemeral ponds.	-	Endangered	Vulnerable
Purple-leaf Muttonwood	*Myrsine richmondensis*	Plant	A very bushy small tree or large shrub, with shiny, wavy edged foliage. Subtropical and dry rainforest and swamp forest on creek flats and slopes on basalt derived soil and alluvial deposits.	-	Endangered	Endangered
Eastern Curlew	*Numenius madagascariensis*	Shorebird	The Eastern Curlew is found on intertidal mudflats and sandflats, often with beds of seagrass, on sheltered coasts, especially estuaries, mangrove swamps, bays, harbours and lagoons. The Eastern Curlew is a migratory species, moving south by day and night, usually along coastlines, leaving breeding areas from mid-July to late September. They arrive in north-western and eastern Australia mainly in August. Large numbers appear on the east coast from September to November. Most leave again from late February to March. They eat mainly small crabs and molluscs, foraging mudflats by day and night.	-	-	Critically Endangered, Migratory

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC Act
Sooty Tern	*Onychoprion fuscata*	Bird	Occasionally seen along coastal NSW, especially after cyclones. Breeds in large colonies in sand or coral scrapes on offshore islands and cays including Lord Howe and Norfolk Islands.	-	Vulnerable	-
Eastern Osprey	*Pandion cristatus*	Marine Bird	Range of habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps, broad rivers, reservoirs and large lakes and waterholes. Construct nests in a variety of natural and artificial sites including in dead or partly dead trees or bushes; on cliffs, rocks, rock stacks or islets; on the ground on rocky headlands, coral cays, deserted beaches, sand hills or saltmarshes; and on artificial nest platforms, pylons, jetties, lighthouses, navigation towers.	-	Vulnerable	Marine, Migratory
Koala	*Phascolarctos cinereus*	Mammal	Inhabit eucalypt woodlands and forests	-	-	Vulnerable
Marbled Frogmouth	*Podargus ocellatus*	Bird	Distributed between about Gladstone and Lismore, and inland to Burnett Range in Queensland and west of the Richmond Range. Prefers subtropical rainforest, particularly in deep, wet, sheltered gullies along creek lines and often containing stands of Bangalow Palms or ferns. In NSW, it is most often found in moist, lowland, mesophyll vine forest.	-	Vulnerable	-
Flat Fork Fern	*Psilotum complanatum*	Plant	The Flat Fork Fern is a bright green, almost leafless epiphyte. In NSW, there is a historic record for Ballina but it has not been seen for many years and may be extinct in NSW.	-	Endangered	-
Gould's Petrel	*Pterodroma leucoptera leucoptera*	Bird	Gould's Petrel is a pelagic marine species, spending much of its time foraging at sea and coming ashore only to breed. The Australian subspecies breeds and roosts on two islands off NSW, Cabbage Tree and Boondelbah Islands, and the at-sea distribution is poorly known	-	Vulnerable	Endangered
Grey-headed Flying-fox	*Pteropus poliocephalus*	Mammal	Occur in rainforest, mangroves, paperbark swamps, wet and dry sclerophyll forests and cultivated areas. Forage on fruits and blossoms of more than 80 species of plants. Prefer eucalypt blossom with native figs being the most popular fruit. Chew leaves and appear to eat the salt glands from mangroves. Congregate in large camps of up to 200,000 individuals from early until late summer usually in gullies close to water.	-	Vulnerable	Vulnerable
Superb Fruit-Dove	*Ptilinopus superbus*	Bird	A small pigeon occurring from north-eastern QLD to north-eastern NSW. 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.	-	Vulnerable	-
Little Shearwater	*Puffinus assimilis*	Bird	0	-	Vulnerable	Marine

Common Name	Species	Type	Habitat & Ecology	FM Act	TSC Act	EPBC Act
Little Tern	*Sternula albifrons*	Shorebird	Coastal, preferring sheltered environments; however may occur several kilometres from the sea in harbours, inlets and rivers (with occasional offshore islands or coral cay records). Nests in small, scattered colonies in low dunes or on sandy beaches just above high tide mark near estuary mouths or adjacent to coastal lakes and islands.	-	Endangered,	-
Red Lilly Pilly	*Syzygium hodgkinsoniae*	Plant	Ranges from The Richmond River in the south to Gympie in the north. Usually found in riverine and subtropical rainforest on rich alluvial or basaltic soils	-	Vulnerable	Vulnerable
Collared Kingfisher	*Todiramphus chloris*	Bird	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 are often seen perched on rock walls, jetties or on the ground on tidal flats. Mostly take food (crustaceans, insects, small fish and lizards) from the ground, from the surface of mud and sand, mainly along seaward fringe of mangroves.	-	Vulnerable	-
Eastern Grass Owl	*Tyto longimembris*	Bird	Eastern Grass Owls are 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.	-	Vulnerable	-
Terek Sandpiper	*Xenus cinereus*	Shorebird	Mostly forages in the open, on soft wet intertidal mudflats or in sheltered estuaries, embayments, harbours or lagoons. Preferring to roost in or among mangroves, birds may perch in branches or roots up to 2 m from the ground. Have been recorded eating crustaceans, insects, seeds, molluscs and arachnids. A rare migrant to eastern dn southern Australia. The two main sites for the species in NSW are the Richmond River estuary and the Hunter River estuary.	-	Vulnerable	Marine, Migratory
Queensland Xylosma	*Xylosma terraereginae*	Plant	Tall shrub or small tree growing to 15 m tall. Found in littoral and subtropical rainforest on coastal sands or soils derived from metasediments	-	Endangered	-

Depot 2						
Magpie Goose	*Anseranas semipalmata*	Bird	Mainly found in shallow wetlands (less than 1 m deep) with dense growth of rushes or sedges. 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	-	Vulnerable	-
Black-necked Stork	*Ephippiorhynchus asiaticus*	Waterbird	Particular affinity with floodplains. Feed in floodplain swamps, wetlands, billabongs and watercourses. Construct large nests in tall trees situated close to water.	-	Endangered	-
Southern Cross Industrial						
Eastern long-eared bat	*Nyctophilus bifax*	Mammal	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.	-	Vulnerable	not listed
Wallum Froglet	*Crinia tinnula*	Amphibian	Wallum Froglets are found in a wide range of habitats, usually associated with acidic swamps on coastal sand plains. They typically occur in sedgelands and wet heathlands. They can also be found along drainage lines within other vegetation communities and disturbed areas, and occasionally in swamp sclerophyll forests.	-	Vulnerable,	-