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bushfire & ecology

# Ecological Review of Concept Plan

Rezoning Proposal
Mooney Mooney

August 2016
(REF: A16071)

# Ecological Review of of an Indicative Concept Plan

**Mooney Mooney**

**August 2016**


| | |
|---|---|
| Report Authors: | John Travers B. App. Sc. / Ass. Dip. / Grad. Dip. - Director<br>Michael Sheather-Reid B. Nat. Res. (Hons.) - Senior Ecologist<br>Lindsay Holmes B. Sc. – Senior Botanist<br>Corey Mead B. App. Sc. - Fauna Ecologist |
| Plans prepared: | Peter Tolley B. Biotech, M. Sci. & Tech. |
| Approved by: | Michael Sheather-Reid/John Travers |
| Date: | 31/08/16 |
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The mapping is indicative of available space and location of features which may prove critical in assessing the viability of the proposed works. Mapping has been produced on a map base with an inherent level of inaccuracy, the location of all mapped features are to be confirmed by a registered surveyor.


ABN 64 083 086 677
PO Box 7138
Kariong NSW 2250

38A The Avenue
Mt Penang Parklands
Central Coast Highway
Kariong NSW 2250

t: 02 4340 5331
e: info@traversecology.com.au
www.traversecology.com.au

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# List of abbreviations

| | |
|---|---|
| APZ | asset protection zone |
| BPA | bushfire protection assessment |
| CLUMP | conservation land use management plan |
| DCP | Development Control Plan |
| DEC | NSW Department of Environment and Conservation (superseded by DECC from April 2007) |
| DECC | NSW Department of Environment and Climate Change (superseded by DECCW from October 2009) |
| DECCW | NSW Department of Environment, Climate Change and Water (superseded by OEH from April 2011) |
| DEWHA | Commonwealth Department of Environment, Water, Heritage & the Arts (superseded by SEWPAC) |
| DOE | Commonwealth Department of Environment |
| EEC | endangered ecological community |
| EPA | Environmental Protection Agency |
| EP&A Act | *Environmental Planning and Assessment Act* |
| EPBC Act | *Environment Protection and Biodiversity Conservation Act* |
| ESMP | ecological site management plan |
| FF | flora and fauna assessment |
| FM Act | *Fisheries Management Act* |
| FMP | fuel management plan |
| HTA | habitat tree assessment |
| IPA | inner protection area |
| LEP | Local Environment Plan |
| LGA | local government area |
| NES | national environmental significance |
| NPWS | NSW National Parks and Wildlife Service |
| NSW DPI | NSW Department of Industry and Investment |
| OEH | Office of Environment and Heritage (Part of the NSW Department of Premier and Cabinet) |
| OPA | outer protection area |
| PBP | *Planning for bushfire protection 2006* |
| POM | plan of management |
| RF Act | *Rural Fires Act* |
| RFS | NSW Rural Fire Service |
| ROTAP | rare or threatened Australian plants |
| SEARs | *Secretary's Environmental Assessment Requirements* |
| SEPP 44 | *State Environmental Protection Policy No 44 – Koala Habitat Protection* |
| SEWPAC | Commonwealth Dept. of Sustainability, Environment, Water, Population & Communities (superseded by DOE) |
| SIS | species impact statement |
| SULE | safe useful life expectancy |
| TPO | tree preservation order |
| TPZ | tree preservation zone |
| TRRP | tree retention and removal plan |
| TSC Act | *Threatened Species Conservation Act* |
| VMP | vegetation management plan |

# Ecological Study

## 1.0 Background

*Travers bushfire & ecology* has been engaged to undertake an ecological review of proposed rezoning plans within government land located at Mooney Mooney which is approximately 17km south west of Gosford, and 21.5km north north-east of Hornsby, in the local government area (LGA) of Central Coast. The total of lands reviewed along the southern peninsula and inclusive of Peat Island will be referred to as the study area (see Figure 1).


**Figure 1 –** Study area

The proposal seeks to rezone much of the land located within the study area to accommodate a series of pursuits as detailed in section 2.

*Travers bushfire & ecology* has undertaken some desktop analysis, preliminary vegetation surveys and field fauna habitat assessment to identify the potential ecological constraints for future development and advise of areas of high ecological value which should be conserved, and conversely, advise of areas of minimal ecological constraints that could support some forms of future development.

*Travers bushfire & ecology* notes that this report is based on vegetation community verification, habitat assessment and desktop analysis only and consequently fauna survey has not been completed in any comprehensive manner across the study area. All conclusions in this report are based on the habitat present and the suitability of that habitat for threatened flora and fauna species.

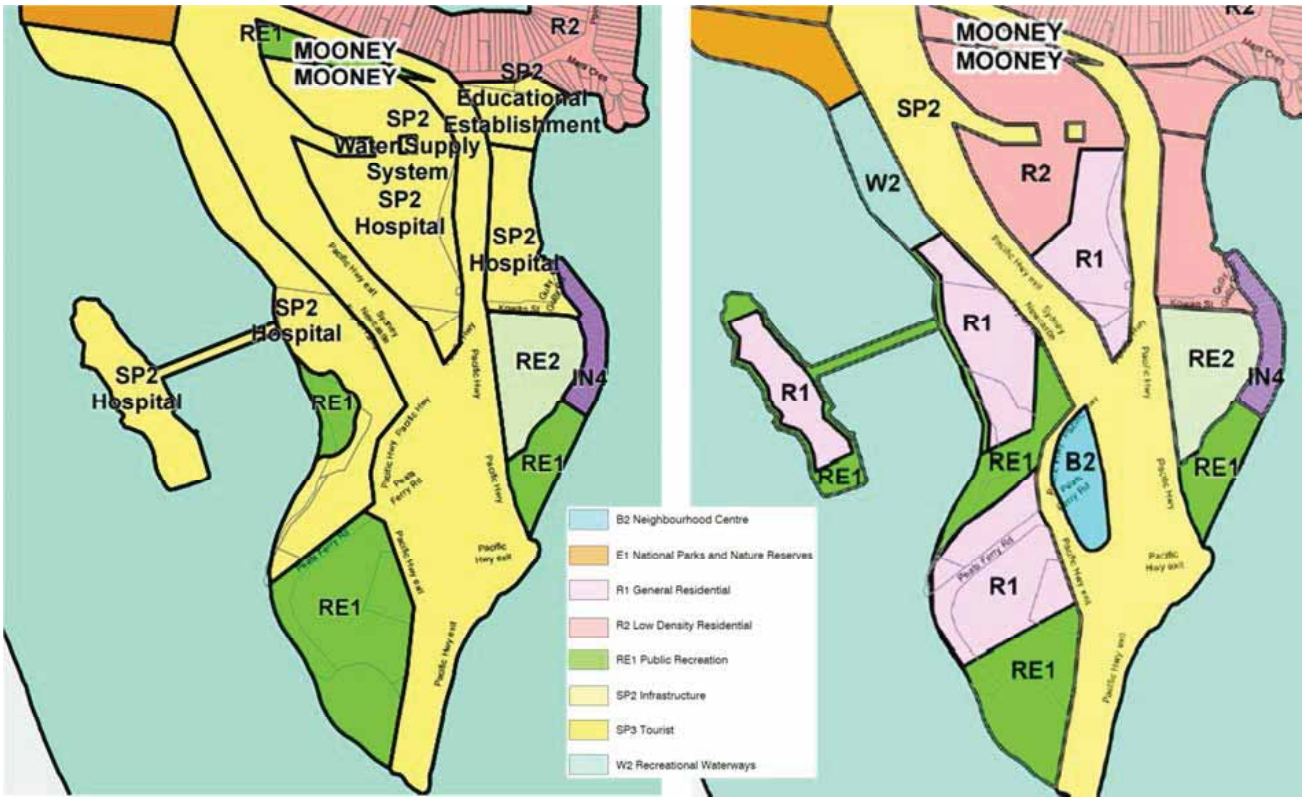
Recommendations for flora and fauna survey and assessment have been included as part of each discussion on flora and fauna matters.

## 1.1 Previous concept plan

Initial advice was given on the previous concept plan after the completion of field studies. Figure 2 was utilised as part of the previous concept plans that were submitted to the Department of Planning and Environment (DPE) for gateway determination. Taking into consideration the input from various disciplines, the proposed concept has been amended as shown in Figure 3. The main changes in the concept plan are as follows:

- The W2 zone has been removed to minimise impacts on sensitive foreshore land.
- The zoning of Peat Island has been changed from R1 General residential to SP3 Tourist.
- The RE1 Public Recreation parcel along the Hawkesbury River foreshore on the western side of the M1 motorway has been increased.
- Steep lands, good quality habitat and vegetation of connective value have been included with land designated as E1 National Parks and Nature Reserves zone.

The capacity and area of the proposed land uses are shown in Table 1 and on Figure 3.




Current zoning Pre-study proposed zoning (2015)

**Figure 2 –** Concept plan for rezoning

## 2.0 Proposed rezoning

The proposal seeks to undertake a rezoning application of surplus government land at Mooney Mooney, NSW. The objective of the rezoning is to facilitate the future development of the land for a mix of residential, community, recreation and employment generating land uses that are economically viable.

The site is currently zoned SP2 Special uses (Hospital), SP2 Educational Establishment, SP2 Water Storage Facility, RE1 Public Recreation and W2 Recreational Waterways (relates to the Hawkesbury River and Mooney Mooney Creek) pursuant to the recently gazette Gosford Local Environment Plan (LEP), 2014.

The Concept Plan (shown in Figure 3) envisages the following land uses across the site:

- ***Community facilities****: Two community buildings will be provided onsite providing over 3,000sqm of space. This will include the existing Chapel, which will be retained in its current location, and the Rural Fire Service (RFS) facilities. These facilities will be upgraded and will accommodate the existing informal community library which will be relocated from its current position within the former Mooney Mooney public school.*
- ***Hotel****: A 93 room hotel will be developed on Peat Island. The development will consist of a new main building connecting to refurbished accommodation buildings of the former Peat Island Hospital. The Hotel will cover approximately 37,172sqm.*

- ***Residential**: A mix of low and medium density dwellings are proposed across the area, including detached and attached housing and residential flat buildings. In total 268 new dwellings are proposed with 82 low density dwellings, 32 townhouses and 154 apartments. The medium density residential development will range from between 1-3 storeys and be located close to the marina.*

- ***Neighbourhood centre**: A new Neighbourhood Centre, covering over 11,000sqm, will be developed to service the needs of the community. The centre will include a car-based service station and retail uses, which may include a convenience store and restaurant/café. The site has strong visual exposure to the M1 Motorway and therefore would benefit from passing trade, as well as providing local convenience retail to service the local catchment.*

- ***Marina**: Wet berths for between 110-130 vessels and dry stack for 60 vessels will be developed along the foreshore towards Peat Island. Associated land based marina uses and marina parking will also be developed along the waterfront.*

- ***Emergency services facilities**: Existing facilities for ambulance, RMS highway services and the rural fire service will be relocated within the site.*

- ***Transport and access**: new vehicle and pedestrian access routes will be provided across the site, including an improved foreshore walk and pedestrian connections. Also new public and private car parking will be provided across the site with upgraded amenity facilities in public areas.*

- ***Landscaping and open space**: Landscaping and open space will be integrated as a defining element of the visual character of the development. In total 23.3ha of open space will be provided across the site, including 11.3ha of National Park, and 12.0ha of Public Recreation space. The key features of the landscaping and open space strategy for the site include:*

    - ***Foreshore Park**: Provision of a large public open space located adjacent to the foreshore opposite Peat Island. This open space will provide opportunities for informal recreational activity. Public car parking will also be made available in this location.*
    - ***Peat Island Park**: Public open space will be located at the southern end of Peat Island. This open space will provide opportunities for public access and informal recreational activity, which is not currently available on the island.*
    - ***Foreshore Access**: Provision of more than 2.75km of public foreshore access around Peat Island and along the river foreshore.*
    - ***Public wharf and boating facilities**: Existing public car and trailer parking and public wharf facilities will be retained at Mooney Mooney Point Reserve.*

All proposed development zoning areas subject to potential direct impacts on existing habitat features will hereafter be referred to generically as the ‘subject site’.

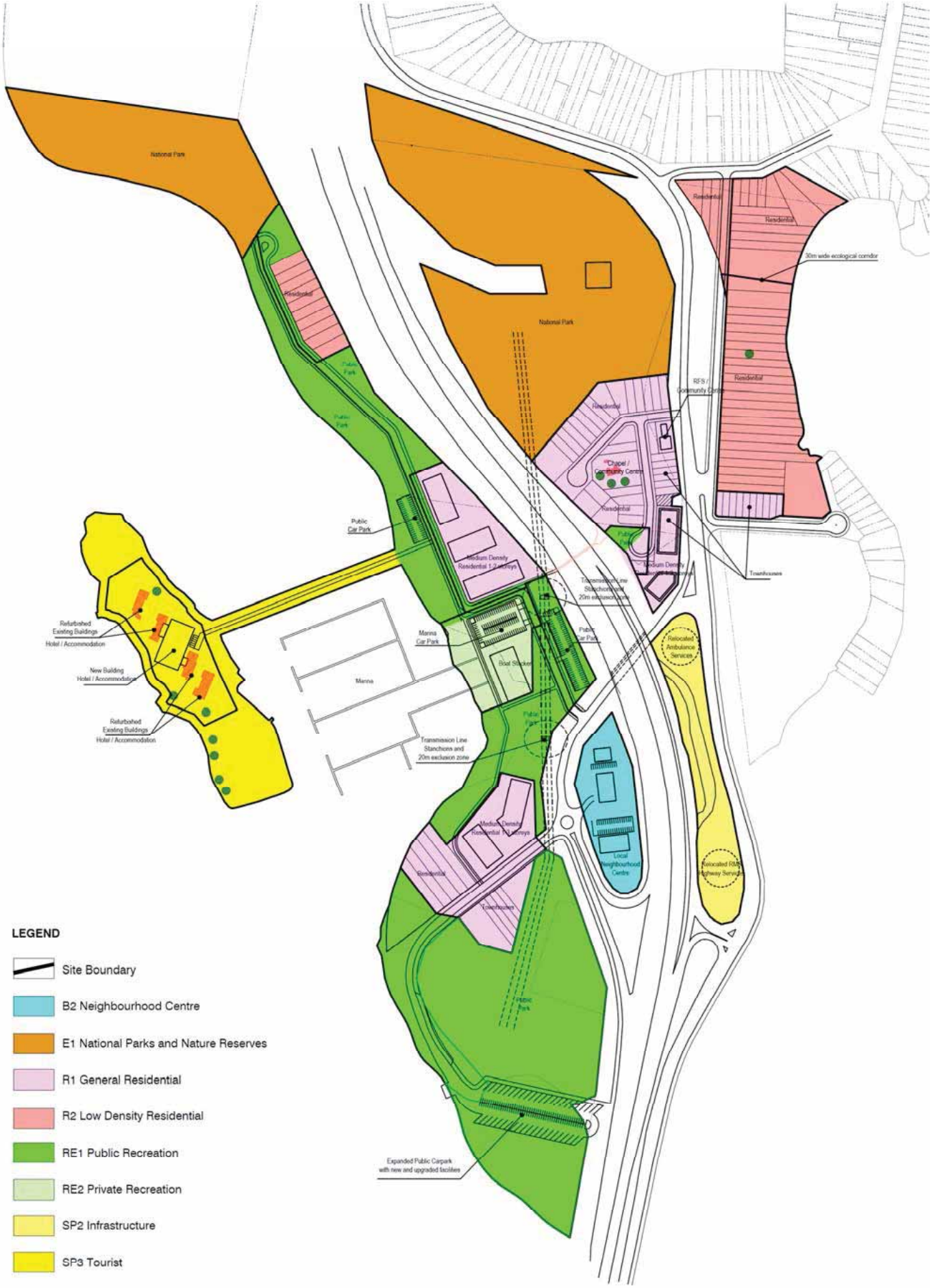



**Figure 3 –** Proposed zoning plan (Urbis, August 2016)

**Table 1 – Proposed land use capacities and areas**

Mooney Mooney Planning Proposal

Indicative Table of Development - Concept Plan Rev F 26/07/2016

| ZONE | Zoning Land Area (sqm) | # Dwellings Residential lots | # Dwellings Townhouse | # Dwellings Apartments | GFA (sqm) | Other (Boats) |
|---|---|---|---|---|---|---|
| R1 - General Residential (including below) | 61,625 | 32 | 22 | 164 | | |
| - Chapel / community centre | 2,271 | | | | | |
| - RFS / community centre | 737 | | | | | |
| R2 Low Density Residential | 46,857 | 50 | | | | |
| Sub-Total | 108,482 | 82 | 22 | 164 | | |
| TOTAL DWELLINGS | | | 268 | | | |
| SP3 Tourist - HOTEL | 37,172 | | | | | |
| *- New building* | | *48* | | | | |
| *- Existing buildings* | | *45* | | | | |
| Sub-Total | | 93 | | | | |
| SP2 - Infrastructure | 15,980 | | | | | |
| RE2 - Private Recreation - Marina & Dry Stack | 9,800 | | | | | |
| - Marina | | | | | | 110-130 |
| - Dry Stack | | | | | 1,750 | 60 |
| B2 - Neighbourhood Centre | 11,024 | | | | 1,000 | |
| E1 - National Park | 112,470 | | | | | |
| RE1 - Public Recreation | 100,427 | | | | | |
| Sub - Total Public Open Space | 212,897 | | | | | |
| TOTAL | 395,355 | | | | | |

## 3.0 Site description

Table 2 provides a summary of the planning, cadastral, topographical, and disturbance details of the subject site relevant to this desktop assessment.

**Table 2 – Site features**

| | |
|---|---|
| **Location** | Mooney Mooney and Peat Island in the Gosford LGA |
| **Size** | 41.62 hectares (from Table 1) |
| **Local government area** | Gosford LGA |
| **Grid reference** | 332800E 6288600N |
| **Topography** | The study area contains some light to gentle slopes closer to the foreshore, and moderate to steep slopes in the northern portion adjacent to the M1 motorway. There is also a knoll in the southern portion zoned for public recreation. |
| **Geology** | Hawkesbury Sandstone, Narrabeen Group Terrigal Formation and Quaternary Group geology. The boundaries and lithology is shown on figure 4. |
| **Catchment and drainage** | Hawkesbury River |
| **Vegetation** | Mangroves align parts of the foreshore edge which may grade to Swamp Oak Floodplain Forest (endangered ecological community). Acacia Woodland aligns part of the foreshore in the southern portion of the study area. A very small pocket of freshwater wetland is present towards to the southern portion of the study area behind of the mangroves. Most footslope to middle slope vegetation is Apple-Redgum Forest whilst the top of the hill near the water tower in the northern portion of the site contains Exposed Hawkesbury Woodland. There is also planted vegetation across the more disturbed parts of the study area. |
| **Existing land use** | Various government buildings, emergency services, housing, ex-hospital and recreational pursuits. |

| | |
|---|---|
| **Clearing** | Clearing has been undertaken on the lower slopes to the foreshore for the aforementioned uses. |
| **Lot and DP of Study Area** | The study area includes the following Lots and DPs:<br>• Lot 2 DP 239249<br>• Lot 7, 8 and 9 DP 1180499<br>• Lot 12, 13 & 14 DP 1158746<br>• Lot 11 DP 1157280<br>• Lot 2 DP 431999<br>• Lot 9, 10, 11 & 12 DP 863305<br>• Lot 7302 DP 1151629<br>• Lot 7011 DP 1057994<br>• Lot 1 DP 597504<br>• Lot 1 DP 431780<br>• Lot 2 DP 1205588<br>• Lot 1 DP 945014<br>• Lot 21 DP 836628 |

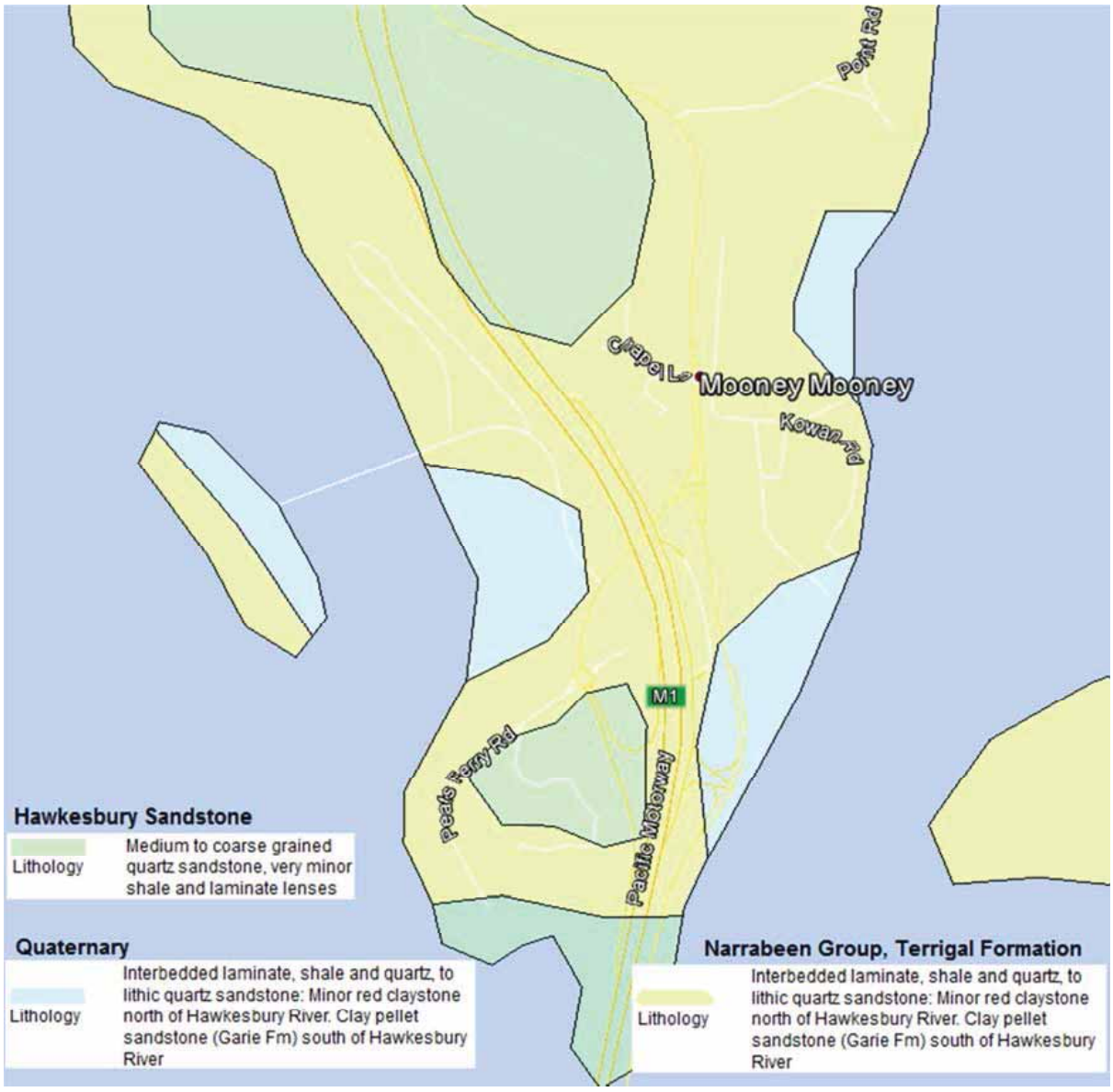



**Figure 4 –** Local geology

# 4.0 Flora

## 4.1 Site assessment

A review of the Atlas of NSW Wildlife (OEH 2016) was undertaken prior to the site visit to determine threatened species previously recorded within 10km of the subject site and likely habitat values which may be either present, marginal or absent from the study area.

Botanical survey was undertaken over approximately 8hrs on 22 April 2016.

Survey is limited to defining the vegetation types present, identifying potential threatened flora habitat, identifying any key specimens of historical or scenic value, identifying endangered ecological communities (EECs) or areas of significant vegetation types, and to identify areas considered to be of low, moderate of high conservation value.

Detailed threatened species survey was not conducted with the intent of identifying any threatened flora species, however incidental searches were included during the investigation. No formal species list was made as the survey is preliminary and consisted of collecting data via undertaking a series of quadrats in order to determine classification of the vegetation community and identification of vegetation community significance. A total of six (6) 0.04 ha quadrats were undertaken to assist in determining the quality, value and type of the vegetation present across the study area.

## 4.2 Vegetation communities

The vegetation communities recorded within the study area include:

- Planted Vegetation (0.48 ha)
- Acacia Woodland (0.49 ha)
- Dharug Footslopes Apple-Redgum Forest (18.56 ha)
- Exposed Hawkesbury Woodland (4.95 ha)
- Mangroves (6.57 ha)
- Freshwater Wetland (0.07 ha) EEC
- Swamp Oak Floodplain Forest (2.46 ha) EEC

Figure 5 shows the location and extent of each vegetation community. These seven communities and their level of conservation significance are detailed below.

**Planted Vegetation**

Areas mapped as planted vegetation occur in the southern portion of the study area adjacent to the M1 Motorway on the western side of the northbound exit. It includes a large planting of Spotted Gums, however there may be some native and locally occurring vegetation in the understorey.

*Conservation significance*

Low conservation significance. It is unlikely to host locally occurring threatened flora species and only has limited potential for significant fauna use given lack of diversity and lack of suitable habitat to support breeding potential. It is somewhat isolated / fragmented due to the high speed of traffic adjacent, people utilising adjacent facilities, and lighting.

*Photo 1 – Majority planted vegetation adjacent to existing toilet facility*

**Acacia Woodland**

Occurs adjacent to the foreshore along Peats Ferry Road. *Acacia implexa* dominant, 8-15m tall. Likely to be a regrowth community at the edge of the Dharug Footslopes Apple-Redgum Forest.

*Conservation significance:*

Low conservation significance. It is unlikely to host locally occurring threatened flora species and has limited potential for significant fauna use given lack of floristic diversity and breeding habitat.

*Photo 2 – Acacia dominated vegetation along Peats Ferry Road*

**Dharug Footslopes Apple-Redgum Forest**

The most common vegetation type within the study area, commonly occurring on the footslopes to middle slopes of the sloping land.

*Canopy – Angophora costata, Angophora floribunda, Corymbia gummifera, Eucalyptus punctata* and seldom *Acacia elata,* to 27m tall and 25-40% projected foliage cover. South or south-westerly facing vegetation tended to be the tallest.

*Mid-storey* – Common species include *Acacia implexa, Glochidion ferdinandi, Elaeocarpus reticulatus, Dodonaea triquetra, Kunzea ambigua, Leptospermum polygalifolium, Alphitonia excelsa, Breynia oblongifolia, Pittosporum undulatum, Acacia falcata, Allocasuarina torulosa, Grevillea sericea, Notelaea longifolia, Pultenaea flexilis, Acacia ulicifolia* and *Bursaria spinosa.*

*Ground layer* – Common species include *Entolasia stricta, Echinopogon caespitosus, Aristida vagans, Themeda triandra, Imperata cylindrica* var. *major, Pandorea pandorana, Pimelea linifolia, Hibbertia diffusa, Kennedia rubicunda, Smilax glyciphylla, Eustrephus latifolius, Geitonoplesium cymosum, Billardiera scandens, Hibbertia aspera, Lomandra longifolia, Dianella caerulea, Lepidosperma laterale* and *Pratia purpurascens.*

*Photo 3 – Footslopes vegetation adjacent to the car park at the southern end of the study area*

*Conservation significance:*

This vegetation community has a medium or high conservation significance, which tempered due to its isolation, connectivity value and quality of the remnant. Some areas are also highly disturbed from previous land uses and from weed invasion. The potential for threatened flora habitat, particularly on the eastern side of M1 Motorway is high given the good quality bushland except for the lower southern slopes due to disturbances and the sheltered aspect. There is a high potential for significant fauna species due to good floristic diversity, varied flowering periods of trees and shrubs, hollows, rock crevices and connectivity to the existing national park.

There is potential for rock falls and erosion if vegetation is removed or modified on the steeper slopes, thus any possible future development of these areas would also be subject to geotechnical assessment at the development application stage.

*Photo 4 – Footslopes vegetation adjacent to M1 Motorway near the emergency braking lane exit*

**Exposed Hawkesbury Woodland**

This vegetation community has several similar plant species described in the previous vegetation community, however the vegetation is typically lower in height and contains a more heath-like structure in the understorey. It occurs on the higher peak at the end of the emergency braking turnoff near the plateau.

*Canopy – Eucalyptus punctata, Corymbia gummifera, Angophora floribunda* and *Eucalyptus piperita,* 11-18m with a projected foliage cover of ~25%.

*Midstorey* – Common species include *Banksia serrata, Acacia ulicifolia, Allocasuarina littoralis, Jacksonia scoparia, Leptospermum trinervium, Banksia ericifolia, Lambertia formosa, Platysace linearifolia, Boronia ledifoliaOzothamnus diosmifolius, Pultenaea flexilis, Pittosporum undulatum, Dodonaea triquetra, Angophora bakeri, Kunzea ambigua, Breynia oblongifolia* and *Exocarpos cupressiformis.*

*Ground layer* – Common species include *Entolasia stricta, Aristida vagans, Anisopogon avenaceus, Themeda triandra, Cymbopogon refractus, Imperata cylindrica* var. *major, Morinda jasminoides, Phyllanthus hirtellus, Grevillea sericea, Dodonaea pinnata, Leucopogon muticus, Pimelea linifolia, Hovea linearis, Hardenbergia violacea, Gahnia aspera, Xanthorrhoea media, Lomandra obliqua, Lomandra multiflora, Lepidosperma laterale, Pomax umbellata* and *Dianella caerulea.*

*Conservation significance:*

The conservation significance of this vegetation community is high due to its quality and composition. There is potential habitat for a number of threatened flora species and it has significant connective value to adjoining national park and extensive bushland. There is a high potential for significant fauna use given variable flowering periods, good vegetation diversity, and presence of hollows, rock overhangs and crevices and as advised, good connectivity to extensive bushland.

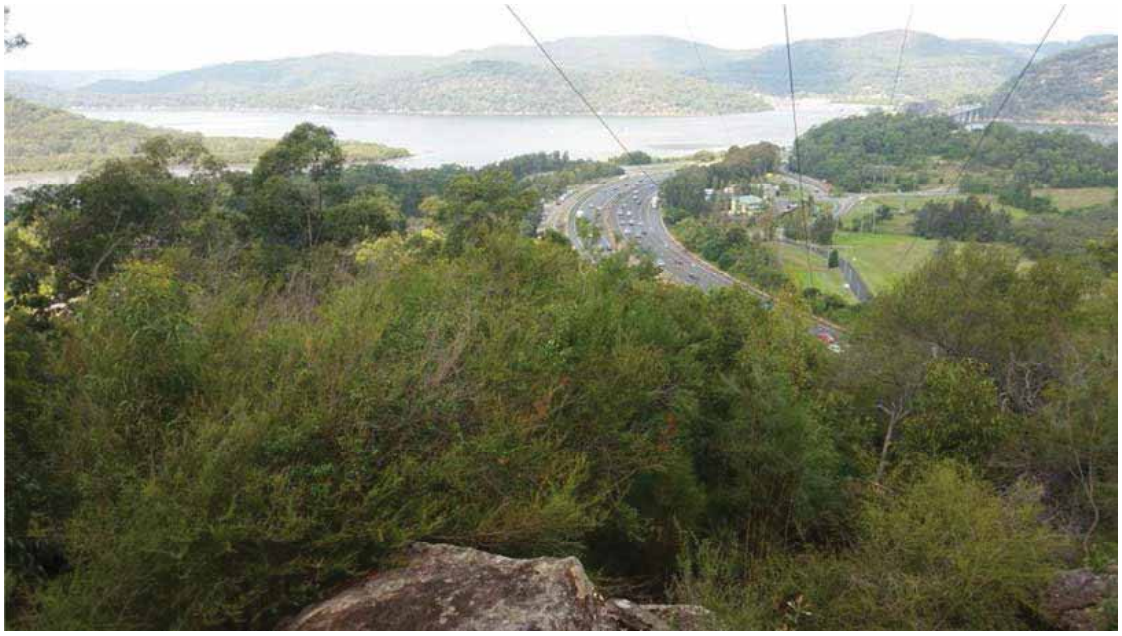


*Photo 5 – Looking south towards the M1 Motorway from the plateau*

*Photo 6 – Northern edge of plateau area adjacent to existing track*

**Mangroves**

The foreshore contains mudflats on very gentle slopes in many locations which are dominated by Mangroves, largely *Avicennia marina.* These are considered a significant community but do not currently fall into any listed EEC.

*Conservation significance:*

High conservation significance as it is listed as a significant vegetation community (not a listed endangered ecological community) as it may be an important breeding or spawning ground for local fish and crustaceans. It may provide good quality habitat for a number of estuarine species including wading birds (threatened and common), but unlikely to host any threatened flora species habitat.

*Photo 7 – Mangroves on the western side of Peat Island*

*Photo 8 – Mangroves on the western side of the study area facing Peat Island*

**Freshwater Wetland**

Further investigation of this small community is required to see if it fits the Scientific Committee's final determinations as an Endangered Protected Wetland and an endangered ecological community as either *Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions* or more likely *Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions*, but as a precautionary measure, we have assumed that the vegetation is a listed EEC.

As this community is also listed as an Endangered Protected Wetland it is required to be assessed and managed in accordance with the NSW Wetlands Policy at the zoning stage. Referral to NSW DPI - Office of Water is recommended.

The dominant species throughout is *Phragmites australis* which can tolerate brackish water, and it adjoins Mangroves on the western side of the study area, opposite the southern tip of Peat Island.

*Photo 9 – Freshwater wetland adjacent to the mangroves*

*Conservation significance:*

The conservation significance of this community is high as it is good quality floodplain habitat which is part of the foreshore connectivity. It is also possibly aligned to EEC vegetation requiring further investigation on salinity for this determination. Whilst unlikely to host threatened flora species habitat for the species considered, it may be important to some fauna groups for foraging.

**Swamp Oak Floodplain Forest**

This vegetation community is an EEC and typically occurs adjacent to the mangroves on relatively flat topography mostly below 5m AHD. This community is also listed as an Endangered Protected Wetland requiring assessment and management in accordance with the NSW Wetlands Policy. Referral to NSW DPI - Office of Water is recommended.

*Casuarina glauca* is the dominant canopy species to 18m tall, and it may grade to mangroves on the coastal side, and Dharug Footslopes Apple Red-gum Forest on the landward side.

*Conservation significance:*

High conservation significance given it is EEC vegetation and on a floodplain. There is limited potential habitat for threatened flora species as it may be located in saline soils / water. There may be small hollows present in trees and some may provide an outlook for fauna species which use the estuary and mudflats adjacent.

*Photo 9 – Patch of Swamp Oak trees adjacent to the foreshore*


## nsert - Threatened Flora Species

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20 x 20m)

**Flora of potential historical value**
- Bunya Pine
- Large Fig
- Norfolk Island Pine

**Vegetation Community**
- Planted Vegetation (0.48ha)
- Acacia Woodland (0.49ha)
- Dharug Footslopes Apple-Redgum Forest (18.56ha)
- Exposed Hawkesbury Woodland (4.95ha)
- Mangroves (6.57)
- Freshwater Wetland (0.07ha) (Endangered Ecological Community)
- Swamp Oak Floodplain Forest (2.46ha)

Aerial sou

## 4.3 Threatened flora species

*Threatened Species Conservation Act (TSC Act)* – A search of the *Atlas of NSW Wildlife* (OEH, 2016) provided a list of threatened flora species previously recorded within a 10km radius of the subject site. These species are listed in Attachment Table A1.1 and are considered for potential habitat within the subject site.

*Environmental Protection and Biodiversity Conservation Act (EPBC Act)* – A review of the schedules of the *EPBC Act* identified a list of threatened flora species or species habitat likely to occur within a 10km radius of the subject site.

**Table 3 – Threatened flora species with suitable habitat present**

| ***Scientific name*** | ***TSC Act*** | ***EPBC Act*** | **Suitable habitat present (✓)** | **Potential to occur** | **Survey required** |
|---|---|---|---|---|---|
| *Acacia bynoeana* | E1 | V | ✓ | low | ✓ |
| *Ancistrachne maidenii* | V | - | marginal | low | ✓ |
| *Callistemon linearifolius* | V | - | x | ✓ | ✓ |
| *Darwinia peduncularis* | V | - | ✓ | ✓ | ✓ |
| *Grammitis stenophylla* | E1 | - | marginal | low | ✓ |
| *Grevillea shiressii* | V | V | ✓ | ✓ | ✓ |
| *Hibbertia procumbens* | E1 | - | marginal | low | ✓ |
| *Kunzea rupestris* | V | V | ✓ | ✓ | ✓ |
| *Melaleuca deanei* | V | V | marginal | low | ✓ |
| *Micromyrtus blakelyi* | V | V | marginal | low | ✓ |
| *Persoonia hirsuta* | E1 | E | ✓ | low | ✓ |
| *Syzygium paniculatum* | V | V | ✓ | limited to sheltered gullies | ✓ |
| *Tetratheca glandulosa* | V | - | ✓ | limited to eastern side of M1 on mid-upper slopes | ✓ |
| E1 = Endangered (state) | | E = Endangered (national) | | V = Vulnerable | |

No threatened flora species have been detected in the current survey. There was however no aim to undertake threatened species survey at the pre-gateway stage, only to define potential habitat for threatened species. Following gateway, it is advised that target searches are undertaken at the next development application stage.

Although the final column denotes survey is required for the species, if the potential habitat is restricted to non-development areas that are upslope (indirect impacts more likely to affect downslope vegetation), then survey for that species may not be required pending final layout.

*Acacia bynoeana* – low potential given only a few records and nearest being 5km away. The Dharug Footslopes and Exposed Hawkesbury Woodland may provide some level of habitat.
*Ancistrachne maidenii* – low potential given that the main population is closer to Berowra Waters, Brooklyn and Wisemans Ferry. The Dharug Footslopes and Exposed Hawkesbury Woodland may provide some level of habitat.

*Callistemon linearifolius* – potential habitat given several local records north and south of the Hawkesbury River. The Dharug Footslopes and Exposed Hawkesbury Woodland may provide some level of habitat.

*Darwinia penduncularis* – potential habitat likely to be mid-slope or higher, particularly on eastern side of M1 Motorway.

*Grammitis stenophylla* – marginal potential habitat with low likelihood of occurrence. More likely to have potential habitat in sheltered positions near drainage lines in the Dharug Footslopes vegetation.

*Kunzea rupestris* – moderate potential habitat but restricted to the most exposed vegetation sites such as the southern edge of the hill, adjacent to the end of emergency braking lane on the eastern side of the M1 Motorway.

*Melaleuca deanei* – marginal habitat only, and limited to the same area description as *Kunzea rupestris.*

*Micromyrtus blakelyi* – marginal habitat only, and limited to the same area description as *Kunzea rupestris.* Quite low likelihood as previous records are limited to the Hornsby and The Hills LGAs.

*Persoonia hirsuta* – suitable habitat on mid-upper slopes generally on eastern side of M1 Motorway in the Dharug Footslopes and Exposed Hawkesbury Woodland. Low likelihood of occurrence considering the low number of recorded specimens locally.

*Syzygium paniculatum* – potential habitat restricted to drainage lines and gullies in sheltered positions, such as south – south-westerly facing slope western side of M1 Motorway near northern study area boundary, and near drainage line eastern side of the northern end of Kowan Road.

*Tetratheca glandulosa* – potential habitat restricted to mid-upper slopes, mostly on eastern side of M1 Motorway, within Dharug Footslopes and Exposed Hawkesbury Woodland vegetation.

## 4.4 Endangered flora populations

No endangered flora populations occur within a 10km radius of the study area.

## 4.5 Endangered ecological communities

*Swamp Oak Floodplain Forest*

Occurs adjacent to mangrove vegetation on very gentle slopes that may be infrequently inundated, generally up to 5m AHD. The dominant species is Swamp Oak, *Casuarina glauca.* Future development of the site would need to retain a good proportion of this EEC and assist in restoration works in those low lying areas unsuitable for development. There may be some removal or impacts upon the vegetation for the construction of a marina, or to provide asset protection zones.

*Freshwater Wetlands*

A precautionary approach has been applied in the naming of this small community which may require further investigation. There is a small area of *Phragmites* dominated vegetation sitting in behind a stand of mangroves near the northern end of Peats Ferry Road that may quality as being part of the Freshwater Wetlands EEC, despite it being brackish. The broader definition of the community does advice that “Freshwater Wetlands is an ecological community associated with periodic, semi-permanent or permanent inundation by freshwater, although there may be minor saline influence in some wetlands.” The location of this is within a reserve, not impacted by development.

## 4.6 Endangered wetland communities

A number of wetland communities are listed as an 'endangered ecological community' under the NSW TSC Act. Those wetland communities must be given due consideration in accordance with the NSW Wetlands Policy (2010) and buffers provided in accordance with the NSW DPI - Office of Water - Controlled Activity Guidelines 2012. These are:

- Artesian springs ecological community - endangered ecological community listing
- Castlereagh swamp woodland community - endangered ecological community listing
- Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing
- Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing
- Kurri sand swamp woodland in the Sydney Basin Bioregion - endangered ecological community listing
- Lagunaria swamp forest on Lord Howe Island - endangered ecological community listing
- Maroota Sands swamp forest - endangered ecological community listing
- Montane peatlands and swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions - endangered ecological community listing
- Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion - endangered ecological community listing
- Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing
- Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological listing
- Sydney Freshwater Wetlands in the Sydney Basin Bioregion - endangered ecological community listing
- The shorebird community occurring on the relict tidal delta sands at Taren Point - endangered ecological community listing
- Upland wetlands of the drainage divide of the New England Tableland Bioregion - endangered ecological community listing.

The following communities observed onsite are recognised as an Endangered Wetland Community:

- Freshwater Wetland
- Swamp Oak Floodplain Forest

In accordance with the NSW DPI - Office of Water - Guidelines for Controlled Activities a standardised buffer of 40m applies to these communities subject to offset provisions. Where they are mostly cleared, highly fragmented or highly disturbed, consolidation and management in accordance with a Vegetation Management Plan is recommended. The

buffers provided are to be considered in the landscape context and consultation with NSW DPI – NSW Office of Water should be undertaken to confirm the appropriateness of setbacks at the DA stage.

## 4.7 Groundwater dependent ecosystems (GDEs)

Groundwater dependent ecosystems are communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater. Some examples of ecosystems which depend on groundwater are:

- wetlands
- red gum forests, vegetation on coastal
- sand dunes and other terrestrial vegetation
- ecosystems in streams fed by groundwater
- limestone cave systems
- springs
- hanging valleys and swamps

The State Groundwater Dependent Ecosystems Policy is specifically designed to protect our valuable ecosystems which rely on groundwater for survival so that, wherever possible, the ecological processes and biodiversity of their dependent ecosystems are maintained or restored, for the benefit of present and future generations. The following five principles are to be applied in the management of groundwater-dependent ecosystems in NSW.

**Principle One**
Groundwater-dependent ecosystems can have important values for groundwater users, ecosystem managers, scientists and the wider community and for the protection of our biodiversity and cultural heritage. These values, and how threats to them may be avoided, should be identified and action taken to ensure that the ecosystems are protected.

**Principle Two**
Groundwater extractions should be managed within the sustainable yield of aquifer systems, so that the ecological processes and biodiversity of their dependent ecosystems are maintained and/or restored. This will involve consideration of threshold levels that are critical for ecosystem health.

**Principle Three**
Priority should be given to ensuring that sufficient groundwater of suitable quality is available at the times when it is needed:

- for protecting ecosystems which are known to be, or are most likely to be, groundwater dependent; and,
- for ecosystems where there is an immediate or high degree of threat.

**Principle Four**
Where scientific knowledge is lacking, the precautionary principle should be applied to protect groundwater dependent ecosystems. The development of adaptive management systems and research to improve understanding of these ecosystems is essential to their management.

**Principle Five**
Planning, approval and management of developments and land use activities should aim to minimise adverse impacts on groundwater systems by:

- maintaining natural patterns of recharge and minimising disruption to groundwater levels that are critical for ecosystems;
- not polluting or causing changes in groundwater quality; and
- rehabilitating degraded groundwater systems where possible.

There are no groundwater dependent ecosystems expected within the study area as the vegetation communities present are expected to be dominantly influenced by surface water and tidal influences. These findings do not conflict with the concept plan proposed.

## 4.8 Significant species

A number of Norfolk Island Pines and Bunya Pines have been planted on the southern end of Peat Island and around the existing Chapel. These trees (see Figure 5) have potential historic and aesthetic values and should potentially be retained within open space where possible.

## 4.9 Recommended flora survey

The proposed rezoning conserves a large portion of bushland east of the M1 Motorway which is to be retained and added to the Popran National Park. This includes the mid and upper slopes of the Dharug Footslopes vegetation and the Exposed Hawkesbury Woodland east of the M1 Motorway and also the northern portion of the site west of the M1 Motorway.

The addition of the higher quality bushland to National Park will limit the amount of future survey required for development assessment purposes but also add value as a biodiversity offset. The vegetation boundaries may need to be refined subject to survey but generally appear representative of the vegetation communities present for rezoning purposes. Quadrats survey may need to be undertaken in the mangroves and Swamp Oak vegetation such that the EEC determination can be properly assessed.

For target threatened flora searches, Section 4.3 lists the threatened species with potential habitat requiring further consideration. If the mid-upper slopes are included within National Park lands, then there is unlikely to be a requirement to survey for *Darwinia penduncularis, Kunzea rupestris, Melaleuca deanei* or *Micromyrtus blakelyi.* Surveys for *Persoonia hirsuta* and *Tetratheca glandulosa* would likely be limited to the small knoll just north of Deerubbin Reserve.

# 5.0 Fauna

## 5.1 Site assessment

A site fauna habitat assessment was undertaken throughout the study area on the 15th April 2016. This did not include formal fauna survey however did contribute to opportunistic recordings of threatened diurnal birds. No targeted diurnal or nocturnal survey effort has therefore been undertaken for threatened species. A review of the Atlas of NSW Wildlife (OEH 2016) was undertaken prior to the site visit for threatened species previously recorded within 10km of the study area. The results of the database searches and field surveys are detailed in the following sections.

## 5.2 Fauna habitat features present

The habitat features for fauna within the study area are relatively diverse over this large area incorporating extensive connective open forest areas down to the estuarine shoreline and including various disturbances between. A few notable landscape features occur within this landscape, which in turn affect the presence of resident and seasonally occurring fauna species. These include:

- the study area is located at the end of an extended 4km long peninsula that extends southward into the Hawkesbury River estuary.
- the peninsula combines with two adjacent islands to provide a high edge ratio of tidal foreshore fringes providing mangroves, sea-grasses, mudflats, sandy and rocky areas.
- the small and developed Peat Island provides a bridge structure with potential roosting habitat for some microbat species. The large freeway bridge may also provide unique structure habitat features.
- Peat Island also has tall planted pines which provide an outlook for birds and in particular a hunting perch and nesting location for Whistling Kite. These trees are the most suitable nesting opportunity for Osprey and may be utilised by the local Sea Eagle pair for roosting also.
- the M1 motorway provides a significant terrestrial barrier for fauna between the eastern and western peninsula areas and also contributes to local compounded noise impacts.
- high slopes of open forest habitat also contain typical Hawkesbury sandstone habitat features grading down to the Narrabeen geology at various aspects.

A summary of the total fauna habitat features present within the study area relevant to threatened species habitat assessment are identified within Table 4.

**Table 4 – Observed fauna habitat**

| | | | | |
|---|---|---|---|---|
| **Topography** | | | | |
| Flat ✓ | Gentle ✓ | Moderate ✓ | Steep ✓ | Drop-offs ✓ |
| **Vegetation structure** | | | | |
| Closed Forest | Open Forest ✓ | Woodland | Heath ✓ | Grassland ✓ |
| **Disturbance History** | | | | |
| Fire ✓ | Under-scrubbing ✓ | Cut and fill works ✓ | | |
| Tree clearing ✓ | Grazing | | | |
| **Soil Landscape** | | | | |
| DEPTH: | Deep ✓ | Moderate ✓ | Shallow ✓ | Skeletal ✓ |
| TYPE: | Clay | Loam ✓ | Sand ✓ | Organic ✓ |
| VALUE: | Surface foraging ✓ | Sub-surface foraging ✓ | Denning/burrowing ✓ | |
| WATER RETENTION: | Well Drained ✓ | Damp / Moist ✓ | Water logged ✓ | Swamp / Soak |
| **Rock Habitat** | | | | |
| CAVES: | Large | Small ✓ | Deep | Shallow ✓ |
| CREVICES: | Large ✓ | Small ✓ | Deep ✓ | Shallow ✓ |
| ESCARPMENTS: | Winter / late sunny aspects ✓ | | Shaded winter / late aspects ✓ | |
| OUTCROPS: | High Surface Area Hides ✓ | Med. Surface Area Hides ✓ | Low Surface Area Hides ✓ | |
| SCATTERED / ISOLATED: | High Surface Area Hides | Med. Surface Area Hides | Low Surface Area Hides | |
| **Feed Resources** | | | | |
| FLOWERING TREES: | Eucalypts ✓ | Corymbias ✓ | Melaleucas ✓ | |
| | Banksias ✓ | Acacias ✓ | | |
| SEEDING TREES: | Allocasuarinas ✓ | Conifers ✓ | | |
| WINTER FLOWERING EUCALYPTS: | C. maculata | E. crebra | E. globoidea ? | E. sideroxylon |
| | E. squamosa | E. grandis | E. multicaulis | E. scias |
| | E. robusta ? | E. tereticornis ? | E. agglomerata | E. siderophloia |
| FLOWERING PERIODS: | Autumn ✓ | Winter ? | Spring ✓ | Summer ✓ |
| OTHER: | Mistletoe ✓ | Figs / Fruit ✓ | Sap / Manna ✓ | Termites ✓ |
| **Foliage Protection** | | | | |
| UPPER STRATA: | Dense ✓ | Moderate ✓ | Sparse ✓ | |
| MID STRATA: | Dense ✓ | Moderate ✓ | Sparse ✓ | |
| PLANT / SHRUB LAYER: | Dense ✓ | Moderate ✓ | Sparse ✓ | |
| GROUNDCOVERS: | Dense ✓ | Moderate ✓ | Sparse ✓ | |
| **Hollows / Logs** | | | | |
| TREE HOLLOWS: | Large ✓ | Medium ✓ | Small ✓ | |
| TEE HOLLOW TYPES | Spouts / branch ✓ | Trunk ✓ | Broken Trunk ✓ | Basal Cavities ✓ Stags ✓ |
| GROUND HOLLOWS: | Large ✓ | Medium ✓ | Small ✓ | |
| **Vegetation Debris** | | | | |
| FALLEN TREES: | Large ✓ | Medium ✓ | Small ✓ | |
| FALLEN BRANCHES: | Large ✓ | Medium ✓ | Small ✓ | |
| LITTER: | Deep ✓ | Moderate ✓ | Shallow ✓ | |
| HUMUS: | Deep ✓ | Moderate ✓ | Shallow ✓ | |
| **Drainage Catchment** | | | | |
| WATER BODIES | Wetland(s) Soak(s) | Dam(s) | Drainage line(s) ✓ | Creek(s) River(s) ✓ |
| RATE OF FLOW: | Still | Slow ✓ | Rapid | |
| CONSISTENCY: | Permanent | Perennial | Ephemeral ✓ | |
| RUNOFF SOURCE: | Urban / Industrial ✓ | Parkland | Grazing | Natural ✓ |
| RIPARIAN HABITAT: | High quality | Moderate quality ✓ | Low quality | Poor quality ✓ |
| **Artificial Habitat** | | | | |
| STRUCTURES: | Sheds ✓ | Infrastructure ✓ | Equipment ✓ | |
| SUB-SURFACE | Pipe / culvert(s) ✓ | Tunnel(s) ✓ | Shaft(s) | |
| FOREIGN MATERIALS: | Sheet ✓ | Pile / refuse ✓ | | |

To inform the development of the proposed concept plan, the combined habitat features above were considered in the preparation of a habitat value conservation map in respect to fauna (provided as Figure 6). This map categorises habitat value into high, medium and low categories.

High quality habitat areas include:

- extensive natural open forest habitat with connectivity value to more extensive habitat to the north and thus likely to support greater fauna species diversity, and/or
- areas containing specific habitat features of potential importance given their location within the undisturbed forest landscape (such as large hollows, rock outcrops and ephemeral drainages.
- non-disturbed stands of mangroves providing important inter-tidal habitat for various wading birds and aquatic species, and/or
- associated tidal mudflats also providing vast foraging opportunity for local and seasonal waders, and/or
- southern aspect sandstone escarpment of Deerubbin Reserve providing the final shelter retreat for forest birds making passage across the Hawkesbury River.

Medium quality habitat areas include:

- the transient habitat areas between high quality habitat areas and the disturbed/fragmented low quality habitat areas.

Low quality habitat areas include:

- disturbed, fragmented or linear parcels of remaining vegetation that are not likely to support a high fauna species diversity and are less likely to support important threatened fauna species habitat.
- this includes roadside linear strips adjacent to the M1 Motorway which is also impacted by subsequent accumulated traffic noise impacts.

## 5.3 Threatened fauna species

*TSC Act* – A search of the *Atlas of NSW Wildlife* (OEH, 2016) provided a list of threatened fauna species previously recorded within a 10km radius of the study area. These species are listed in Attachment 1 (Table A1.2) and are considered for potential habitat within the study area.

*State Environmental Planning Policy No. 44 (SEPP 44) - Koala Habitat Protection* – The study area is required to be considered under SEPP 44 as it falls within the Central Coast (formally Gosford) LGA, which is listed on Schedule 1 of this Policy.

A full assessment in respect to SEPP 44 has not been undertaken however it is anticipated that up to four (4) Koala food tree species as listed on Schedule 2 of SEPP 44 are likely to occur naturally within the study area. Grey Gum (*Eucalyptus punctata)* and Scribbly Gum (*Eucalyptus haemastoma)* were recorded present during preliminary vegetation surveys. There is also potential for Swamp Mahogany (*Eucalyptus robusta*) and Forest Red Gum (*Eucalyptus tereticornis*) to occur. Preliminary observations indicate that Grey Gum does comprised greater than 15% within its constituent community and therefore 'potential Koala habitat' as defined under SEPP 44 is likely to occur.

No Koalas have been previously recorded along the Mooney Mooney peninsula and thus are not expected to occur within the study area. This is particularly given that the M1 Motorway interface has not recorded any Koala encounters and this road will potentially also cause noise impacts on this species.

Koala records do otherwise exist within more extensive forest habitat away from the M1 within Marramarra N.P. on the other side of the Hawkesbury River as well as within Brisbane Water N.P. on the other side of Mooney Mooney Creek.

Therefore a determination of 'core Koala habitat' as defined under SEPP 44 has not been concluded and is not expected to occur. Survey for Koala should be undertaken within parts of the proposed development landscape where suitable feed tree species are present.

*Fisheries Management Act (FM Act)* – No terrestrial aquatic habitats suitable for threatened aquatic species listed under this Act were observed within the terrestrial study area. The indicative layout for the site indicates that a marina is proposed and an environmental impact statement and assessment under the FM Act is required. The impact of stormwater and other works on surrounding fisheries habitat will need to be considered as part of any terrestrial based development applications. This assessment does not consider this aspect on the proposed zoning in any further detail which is more properly assessed under referral to NSW Department of Primary Industries.

*EPBC Act* – A review of the schedules of the *EPBC Act* identified a list of threatened fauna species or species habitat likely to occur within a 10km radius of the subject site. These species have been listed in Attachment 1 (Table A1.2).

In accordance with Table A1.2 the following state and nationally listed threatened fauna species in Table 5 are considered to have potential habitat within the study area. These species are to be considered within the relevant threatened species assessment criteria. Whilst the species listed in Table 5 have varying potential to occur in the study area, their potential to occur within the proposed development landscape (of the subject site) will determine the need for further survey. Hence Table 5 considers the potential habitat present and potential to occur within the subject site based on previous records and quality of habitat.

Whilst a number of these species do have potential to occur within the subject site (proposed development landscape), it should be noted that this habitat may not contain important breeding habitat features, or habitat otherwise of importance. For example important breeding hollows for threatened owls and cockatoos may be present within the study area but are not expected to occur within the areas identified for urban land uses.

**Table 5 – Threatened fauna species with suitable habitat present**

| Common name | TSC Act | EPBC Act | Potential habitat present in subject site? | Potential to occur in subject site |
|---|---|---|---|---|
| Red-crowned Toadlet | V | - | possible | ✓ |
| Eastern Osprey | V | - | ✓ | ✓ |
| Eastern Curlew | - | CE | ✓ | ✓ |
| Glossy Black-Cockatoo | V | - | ✓ | ✓ |
| Little Lorikeet | V | - | ✓ | ✓ |
| Swift Parrot | E | E | possible | ✓ |
| Powerful Owl | V | - | ✓ | ✓ |
| Varied Sittella | V | - | ✓ | ✓ |
| Spotted-tailed Quoll | V | E | ✓ | ✓ |
| Eastern Pygmy Possum | V | - | ✓ | ✓ |
| Grey-headed Flying-fox | V | V | ✓ | ✓ |
| Eastern Bentwing-bat | V | - | ✓ | ✓ |
| Giant Burrowing Frog | V | V | possible | unlikely |
| Green and Golden Bell Frog | E | V | marginal | unlikely |
| Rosenberg's Goanna | V | - | marginal | unlikely |
| Superb Fruit-dove | V | - | sub-optimal | unlikely |

| Common name | TSC Act | EPBC Act | Potential habitat present in subject site? | Potential to occur in subject site |
|---|---|---|---|---|
| Black Bittern | V | - | ✓ | unlikely |
| Little Eagle | V | - | ✓ | unlikely |
| Bush Stone-curlew | E | - | ✓ | unlikely |
| Pied Oystercatcher | V | - | ✓ | unlikely |
| Turquoise Parrot | V | - | sub-optimal | unlikely |
| Barking Owl | V | - | ✓ | unlikely |
| Masked Owl | V | - | ✓ | unlikely |
| Sooty Owl | V | - | sub-optimal | unlikely |
| Regent Honeyeater | E4A | CE | possible | unlikely |
| Painted Honeyeater | V | V | possible | unlikely |
| Scarlet Robin | V | - | ✓ | unlikely |
| Flame Robin | V | - | ✓ | unlikely |
| Squirrel Glider | V | - | possible | unlikely |
| East-coast Freetail Bat | V | - | ✓ | unlikely |
| Large-eared Pied Bat | V | V | ✓ | unlikely |
| Eastern Falsistrelle | V | - | ✓ | unlikely |
| Little Bentwing-bat | V | - | ✓ | unlikely |
| Large-footed Myotis | V | - | ✓ | unlikely |
| Greater Broad-nosed Bat | V | - | ✓ | unlikely |
| Eastern Cave Bat | V | - | ✓ | unlikely |
| New Holland Mouse | - | V | possible | unlikely |
| E4A = Critically Endangered (state) CE = Critically Endangered (national)<br>E = Endangered (national) V = Vulnerable | | | | |

Future fauna surveys within the proposed development precincts should ideally target the above listed threatened species with a specific emphasis on those with most potential to occur. Further survey is considered in Section 5.5. These future surveys are not required for consideration at gateway, and can be undertaken at a later subdivision DA stage.

The potential habitat for protected migratory species listed under the *EPBC Act* is considered in Attachment Table A1.3. Strictly aquatic species listed under this Act (such as marine turtles, dugong, and dolphins) have not been included into the habitat assessment. A number of protected migratory species are considered with potential to occur (see Table A1.3), particularly given the associated habitats of mudflat areas for waders.

The proposed marina has the potential to impact on suitable foraging and potential breeding habitat for a number of these species. Seasonal surveys of the mudflat areas and adjacent coastal mangrove areas to be removed would therefore be required to better determine the true effect on mudflat species. The removal of such habitat may be offset by the enhancement of other aquatic habitat features built into the design of the marina; however such habitat will mostly benefit other aquatics species (see Section 6.1).

Otherwise the proposed zoning on the terrestrial landscape only has potential to impact on the White-bellied Sea Eagle and Eastern Osprey where nesting habitat is located within or close to the remaining proposed development landscape. Both of these species are known to the locality with a White-bellied Sea Eagle nest suspected somewhere nearby based on previous observations. The Eastern Osprey is a state listed threatened species with known local records and is thus considered here also. Given that nests are large for both species; nesting within the subject site is not expected based on observations to date. The raptor nest observed on Peat Island is very consistent with Eastern Osprey but is likely belonging to the non-threatened Whistling Kite. The large planted pines on Peat Island should be retained as being the most suitable nesting opportunity for Osprey in the Mooney Mooney area.

## 5.4 Endangered fauna populations

There are no endangered fauna populations identified within the Central Coast (formerly Gosford patch) LGA which are likely to constrain development within the study area.

## 5.5 Recommended fauna survey for future studies

As part of future survey and assessment of impacts on any national or state listed threatened fauna species, the following survey is advised as a minimum at the next development application stage (subdivision or single development). This may be altered where survey is limited to individual precinct areas where no likely habitat is expected:

- habitat tree surveys where direct connectivity to large open forest habitat exists, with specific consideration to large hollows suitable for Powerful Owl and Glossy Black-Cockatoo;
- seasonal diurnal survey for presence of Little Lorikeet and if recorded subsequent investigations for activity at breeding hollows;
- identification of potentially important winter flowering habitat resources, specifically mapping the occurrence of Swamp Mahogany, Spotted Gum and Forest Red Gum trees. Winter survey at these location where removal is required;
- seasonal wading bird surveys along potentially affected mudflats and mangrove areas;
- frog habitat surveys for Red-crowned Toadlet in the eastern residential areas and for Green and Golden Bell Frog in the western freshwater wetland area. Frog surveys should be undertaken following sufficient rainfall and Green and Golden Bell Frog surveys are to be limited to the calling period (Sept - Dec);
- diurnal bird surveys to identify potential nesting or high use roosting locations for White-bellied Sea Eagle and Eastern Osprey. Also generic diurnal bird census throughout the development landscape;
- habitat searches for shelter opportunities and signs of their use by Spotted-tailed Quoll where direct connectivity to large open forest habitat exists (e.g. large arboreal or terrestrial hollows, caves or latrine sites);
- nocturnal call-playback surveys for Black Bittern throughout potentially affected and adjacent intertidal and mangrove areas. Affected areas include those illuminated by proposed nocturnal lighting, boating noise and other indirect impacts;
- nocturnal call-playback surveys also for large forest owls and Bush Stone-curlew;
- microbat surveys;
- remote camera surveys where any ideal Eastern Pygmy Possum habitat is present adjacent to large connective native vegetation patches, specifically defined by seasonal flowering canopy eucalypts and banksias as well as small hollows/crevices;
- a comprehensive marine study is recommended for the proposed marina and associated facilities and works required to construct the marina;
- trapping survey for Squirrel Glider and/or New Holland mouse is not anticipated but may be required in light of further specific habitat features identified or recorded nocturnal glider calls.

## 5.6 Vegetation connectivity

The vegetation within the study area does not support a local or regional fauna corridor. This is given that the study area is located at the terminal southern end of a terrestrial peninsula. The vegetation within the study area becomes increasingly fragmented towards the southern portions due to the M1 Motorway and previous surrounding clearances for the urban landscape of Mooney Mooney.

The most northern patches of open forest habitat on both sides of the motorway have connectivity values to extensive similar habitat towards the north into Popran and Brisbane Water National Parks. The eastern side has a pinch point immediately north which is also disturbed and characterised as bedrock placed to support the motorway. Thus the western side is more likely to support large terrestrial species activity. There is potential for Spotted-tailed Quoll to frequent these habitat areas based on habitat quality, features (rock outcroppings) and previous local records (including two from within the study area in 1995 & 1998 - see Figure 6).

There are remaining scattered narrow strips of vegetation along the foreshores and adjacent to the M1 Motorway that provides some degree of connectivity between the northern extent of the study area to Deerubbin Reserve in the south. Whilst the vegetation along the margins of the motorway are likely to harbor only noise tolerant species, this vegetation does combine to provide some contribution as a stepping-stone for forest birds making passage to and from Deerubbin Reserve across the Hawkesbury River. Given the concept plan provides for continuous open space along the river foreshore, a level of connectivity will be maintained from the northern extent of the site down to Deerubbin Reserve.

n Stone-curlew
l Woodland Snail
ong
ern Bentwing-bat
ern Curlew
ern Osprey
ern Pygmy-possum
ater Broad-nosed Bat
sy Black-Cockatoo
t Burrowing Frog
t Dragonfly
-headed Flying-fox
en Turtle
a
Eagle
erful Owl
-crowned Toadlet
enberg's Goanna
ent Honeyeater
rrel Glider
ted-tailed Quoll

TBE wildlife data agreement, cies as identified by OEH and stern Osprey, Glossy Black- d Powerful Owl locations cannot None of the species however corded within the study area.

## Insert - Threatened Fauna Species




Aerial sourc

area (88.58ha)
uffer (Insert map)
ur - 10m
value intertidal mudflats (15.22ha)
rtant for wading birds & aquatic wildlife)

**Fauna Habitat Quality**
- High (17.13ha)
- Medium (6.18ha)
- Low (12.84ha)

Norfolk Island Pine (high conservation value)

# 6.0 Ecological management strategy

## 6.1 Marine Zone

The proposed concept plan includes the development of a marina and associated infrastructure. This proposal will involve the dredging of mudflats to the south of the Peat Island access road as well as disturbance of the adjacent shoreline vegetation. This proposal will most likely require an Environmental Impact Study (EIS) subject to the submission requirements specified by DPI (NSW Fisheries). The EIS will likely require appropriate marine surveys to establish current usage by wading birds and other potentially important avifauna, as well as estuarine and marine wildlife.

Whilst a large area of intertidal mudflats providing habitat for associated aquatic species and foraging habitat for wading birds will be removed, the design of the marina infrastructure may replace this loss with aquatic habitat structures to enhance the marine habitat within the marina.

The design may encourage a high surface area substrate for oysters, marine algae and other organisms that may contribute to improve estuarine water quality. Microhabitat for small fish and other aquatic organisms may also be incorporated into the subsurface structure.

Overhead marina walkways permitting high light penetration (and reducing the shadowing effect) will allow the subsurface and inter-tidal substrates to thrive. Such design features need to be appropriately designed to maximise aquatic habitat to offset the loss of mudflats and foreshore vegetation.

This habitat offset, whilst benefitting other aquatic species and processes, will still result in a net loss of mudflat habitat for species dependent on this habitat type specifically. This loss justifies the need for survey and more thorough investigation of likely impacts.

## 6.2 Riparian and foreshore

Setbacks to any riparian and foreshore lines must be considered in light of the NSW DPI - Office of Water Guidelines for Controlled Activities. Typically on the mainland, a 40m buffer may be applied to the mean high tide mark, excluding the provision of services and asset protection zones. Any works required within this zone would need a Controlled Activities Approval (CAA), such as for the construction of any stormwater or foreshore works. Consideration also needs to be given to the FM Act (1994) and Water Management Act (2000) at that particular DA stage. Future DA assessment will require the detailed consideration of riparian setbacks.

## 6.3 Terrestrial

The two (2) most northern patches of consolidated open forest vegetation is proposed to be conserved as National Park areas (under an E1 zoning). This will maintain the natural amenity as both areas are prominent bushland features as seen from the M1 Motorway. Both areas provide the highest potential for use by locally occurring threatened species and will result in a southern extension to Popran N.P. which is located to the immediate north of the study area.

A preliminary field review of these two areas confirms them to contain high quality habitat areas of benefit to conservation. This includes rocky outcrop areas, hollow trees of various types and size classes, a southern sheltered gully forest area with a transition into foreshore mangroves, other long slopes with various aspects catering for diverse plant and tree species for seasonal foraging, a prominent hill in the southern end of the Mooney Mooney peninsula and also existing connectivity north. Both areas do contain weed plumes,

particularly in the southern sheltered areas and these should be subject to restoration works to enhance their conservation value. The western side of the M1 Motorway contains significant rubble going downslope and there are large weed plumes going upslope. The eastern side of the M1 Motorway contains significant edge impacts from current residences and previous land uses such as the previous petrol stations. In this area there is a large tract of Coral Trees, Lantana and invasive vines that would require removal.

The western portion has direct connectivity into Popran N.P. however the eastern portion has reduced connectivity north due to a bottleneck from urban development on the other side of the Pacific Hwy. This eastern portion is however a large consolidated patch in its own right and maintains a degree of current connectivity down to the eastern mangrove foreshores. This connectivity is considered worthy of retention as discussed below.

***Proposed corridor***

The large and prominent eastern hill to be conserved as national park is almost encased by roads. This includes the busy M1 Motorway along the western frontage providing a significant barrier to all terrestrial wildlife, and the Pacific Highway to the east which mainly supports only local traffic.

A strip of lands to the east of the Pacific Hwy currently zoned SP2 for Education Establishment and Hospital is proposed for R2 Low Density Residential housing (see Figure 8). This strip however provides current connectivity benefits between the proposed hill conservation area to the west and the mangrove foreshores to the east. To maintain this connectivity, a 30m wide corridor is proposed for retention through the R2 strip along the complete grading of habitat from shoreline to hill top (see Figure 8 for approximate location).

Given previous clearing and disturbances such as edge effects within the current SP2 strip, this corridor will require vegetation restoration works to enhance its connectivity value. This corridor may also serve as a valuable recipient area for nest boxes to offset the loss of hollows from the proposed development landscape.

Conservation significance was considered for both flora and fauna habitat and was initially separated to identify areas of low, medium and high conservation value based on the vegetation community type, whether it was an EEC, the level of potential for a suite of threatened species, connective value, and specialist habitat resources. The two (2) conservation maps were then overlaid to produce a single conservation significance figure (see Figure 7).