flora species (Briggs and Leigh 1996), as well as any other species deemed to be of local importance.

Based on the environmental units and vegetation communities present, targeted searches were conducted for those species deemed as having the potential to occur on the site. Targeted searches were undertaken throughout the site for these species during the survey period (with the exception of *Cryptostylis hunteriana*). Refer to Table 3-1 for flowering periods of threatened flora species which have potential to occur within the Nords Wharf Site.

3.2.5.1 Orchid Surveys

A review of the Wyong Ground Orchid Survey (Gunninah 2003) has revealed that the following threatened and some undescribed orchids have potential habitat within the Nords Wharf site:

- *Thelymitra* sp. aff*. purpurata*
- Diuris sp. aff. alba
- *Calochilus* sp. aff*. paludosus*
- *Caladenia catenata* var*. 'warnervalensis*
- *Caladenia* sp. aff*. Fuscata*
- *Caladenia* sp. aff. *catenata A* (sp complex);
- *Diuris* sp. aff*. aurea/ Diuris* sp. aff*. chrysantha*;

Table 3-1: Threatened Flora Species Techniques Analysis

Threatened Flora Species	TSC listed	EPBC listed	Habitats (But not confined to) Map units REMS	Targeted Survey Notes (LHCC Flora and Fauna Survey Guidelines 2002)	Flowering Period (Best time to Survey) in Months of the Year											
					J	F	M	A	M	J	J	A	S	O	N	D
Acacia bynoeana			26, 30, 31, 48	Rm, Safr.	■	■	■						■	■	■	■
Caladenia sp. aff. catenata A (sp. complex)	-	-									■	■	■			
Caladenia tessellata	V	V	34	Rm, Sfr. Recently burnt areas of note.								■	■	■		
Callistemon linearifolius	V	-	25, 37	Rm, Sa.	■							■	■	■	■	■
Cryptostylis hunteriana	V	V	30, 31, 32, 33	Rm or Rq, Sfr.										■	■	■
Cynanchum elegans	E	E	6	Rm, Sa.								■	■	■	■	
Dendrobium melaleucaphilum	V	-	Alluvial, *Melaleuca stypheli oides*	Rm - epiphytic orchid *M. stypheliioides* of note, Sa.							■	■	■	■	■	
Diuris sp. aff. aurea/ Diuris sp. aff. chrysantha	-	-										■	■			
Diuris praecox	V	V	15, 30, 51	Rm, Sfr.								■	■			
Syzygium paniculatum			1,4,5,6,50	Rm, Sa (flowering specimens preferential for ID)										■	■	■
Tetratheca juncea			5, 11, 15, 17, 30, 31, 34, 34a, 37, 40a, 43, 44, 48	Rm – creekflat to ridgetop. Sfr - two surveys are required; spaced two months apart.	■								■	■	■	■

Rm = Random meander, Rq = Replicated Quadrats, Sa = Survey anytime, Safr = Survey anytime, flowering period recommended, Sfr = Survey within flowering period required.

3.2.6 Significant Flora Survey

Seasonal surveys were undertaken to maximise the detection of all threatened flora species (Table 3-3). The following sections details specific targeted surveys which were undertaken for each species.

Diuris praecox

Two ecologists undertook targeted searches (Refer to Table 3-3) within the Development Estate at Nords Wharf. Parallel transects (Cropper 1993) which were spaced at approximately 25 m intervals was utilised for searches across the survey area. The locations of all individuals were recorded by the use of a Trimble GeoXH GPS with sub-metre accuracy.

Tetratheca juncea

Six ecologists undertook targeted searches and the survey dates are listed in Table 3-3. Parallel transects were utilised and were spaced at 10 to 15m intervals. The transects were performed from creekline to ridgetop as recommended by Payne (2000). The area surveyed included the entire Development Estate, and partial survey of the Offset Lands to the south of the Development Estate (Refer to Figure 4-2 for area surveyed). The standardised method as set out by Payne *et al.* (2002) for counting *Tetratheca juncea* clumps involves the delineation of each plant clump by a distance of 30cm. The locations of all individuals were recorded by the use of a Trimble GeoXH GPS with sub-metre accuracy.

Other Cryptic Orchids

Several cryptic orchid species have potential habitat within the Nords Wharf site. The majority of the orchids, which have potential habitat, flower in September. This coincides with the flowering period for *Tetratheca juncea.* Therefore whilst these surveys were being undertaken these orchids were also targeted. The following orchids were surveyed during the targeted orchid surveys:

- *Caladenia* sp. aff. *catenata A* (sp complex)*;
- ***Caladenia tessellata* (Thick Lip Spider Orchid);**
- *Diuris sp. aff. aurea/ Diuris sp. aff. chrysantha*;*

Two of the above orchids (marked with an asterisk '*') are undescribed and are not listed on the *TSC Act* (1995) or the *EPBC Act* (1999) but are considered to be regionally rare by Wyong Shire Council. As several of these orchids are undescribed, it would be difficult to ascertain their presence within the site. However, it must be noted that the site provides potential habitat for these undescribed orchids. The remaining species in bold *Caladenia tessellata* is listed on the *TSC Act 1995* and/or the *EPBC Act 1999*.

Other Threatened Flora Species

The remaining threatened flora species were also surveyed for opportunistically whilst performing the initial vegetation survey and during the *Tetratheca juncea* targeted searches. The following species were surveyed for:-

- *Acacia bynoeana;*
- *Callistemon linearifolius;*
- *Dendrobium melaleucaphilum;*
- *Eucalyptus camfieldii;*
- *Melaleuca biconvexa; and*
- *Syzygium paniculatum.*

3.2.7 Fauna Assessments

The fauna survey methodology initially consisted of the production of an Expected Fauna Species List for the area (Appendix 3) and an assessment of the potential use of the site by threatened fauna species (as listed under the *TSC Act 1995* and *EPBC Act 1999*)

identified from the vicinity of the site. This was achieved by undertaking literature and database reviews followed by confirmation through targeted field surveys. Additional species observed were also noted on the list.

Diurnal Birds

General and targeted searches were undertaken across the entire site during the survey period.

Trap lines were targeted as survey locations within the site through incidental observations during trapping, and targeted bird census surveys were undertaken for a period of 20 minutes at each survey site on at least two separate mornings.

Surveys included targeted searches for threatened species listed as having potential to occur within the site, including the seasonally occurring Swift Parrot and Regent Honeyeater. Targeted searches for Glossy Black Cockatoo were undertaken that included searches for chewed (*Allo*) C*asuarina* cones indicative of past feeding by this species.

For diurnal surveys, emphasis was placed on peak activity periods, i.e. dawn and dusk, to maximise chances of species encountered. Birds were identified by direct observation, by recognition of calls or distinctive features such as nests, feathers etc. Furthermore, whenever other survey work was conducted, during both diurnal and nocturnal day periods, opportunistic observations of those bird species encountered were recorded.

Targeted Swift Parrot Surveys

Swift Parrot surveys were undertaken within proposed Conservation Lands and Development Estates during June 2008. The survey period coincided with known Swift Parrot movements into south-eastern Australia. Surveys encompassed two different methodologies to ensure adequate coverage of potential Swift Parrot habitat was made, and included:

Targeting of small discrete vegetation community areas containing potential foraging species, such as occur in riparian zones; and

Traverses through more widespread foraging habitat to locate indicators (foraging aggregations of Honeyeaters / Lorikeets or the presence of blossom) that specific areas may have the potential to attract Swift Parrots during the current season.

As a component of the survey and in lieu of surveys across the entire Swift Parrot season, habitat evaluation was also undertaken to determine if and where the most favourable areas of potential Swift Parrot habitat occur across the Coal & Allied Lands.

Nocturnal Birds

Pre-recorded calls of owl species with the potential to occur within the site were broadcast in an effort to elicit vocal responses from the owls or to attract an owl to the playback site. The calls were broadcast through an amplification system (loud haler) designed to project the sound for at least 1km under still night conditions. As described by Kavanagh and

Peake (1993), Debus (1995), and NPWS (1997), the call of each species was broadcast for at least five minutes, followed by five minutes of listening, and stationary spotlighting. Following the final broadcast and listening, the area was spotlighted on foot. Species surveyed included *Ninox strenua* (Powerful Owl), *Ninox connivens* (Barking Owl), *Tyto tenebricosa* (Sooty Owl) and *Tyto novaehollandiae* (Masked Owl). Nocturnal surveys were carried out across the site over a period of five continuous nights. The callback locations were selected in areas where calls could be broadcast across large areas of the site. The broadcast location selection process was also informed by survey stratification units.

Arboreal and Terrestrial Mammals

A total of 5 Trap lines were set for a period of 4 nights during July 2007 (Table 3-3). Trap lines consisted of 25 Terrestrial Elliot A traps, 5 Terrestrial Elliot B traps, 5 Arboreal Elliot B traps, 5 Terrestrial Elliot E traps and a Cage Trap. This equates to 100 Terrestrial Elliot A trap nights, 20 Terrestrial Elliot B trap nights, 20 Arboreal Elliot B trap nights, 20 Terrestrial Elliot E trap nights and 4 Cage trap nights per trap line.

Spotlighting was undertaken on site via the use of 75-Watt hand-held spotlights and head torches during walking. This was undertaken within each of the habitat assemblages identified, with priority given to those areas that were deemed most likely to contain nocturnal species, particularly arboreal and terrestrial mammals. Two ecologists undertook nocturnal surveys concurrently for duration of four hours per night over five consecutive nights, giving a total of forty hours of spotlighting.

The potential presence of Yellow-bellied Glider was targeted by call playback through an amplified system at each of the nocturnal survey points during the fieldwork period.
The presence of Koala was assessed through the identification of potential Koala food trees, followed by inspection for signs of Koala usage. Trees were inspected and identified for the presence of Koalas, characteristic scratch and claw marks on the trunk and scats around the base of each tree. Koala was also targeted through spotlight surveys and the use of call playback through an amplified system.

Opportunistic sightings of secondary indications (scratches, scats, diggings, tracks etc.) of resident fauna were noted. Such indicators included:

- Distinctive scats left by mammals. Any scats unable to be positively identified in the field were collected for further analysis, and scats of predator species containing fur / bones were sent for analysis if appropriate;
- Scratch marks made by various types of arboreal animals;
- Scats consistent with Koalas; and
- Feeding scars on *Eucalyptus* trees made by Gliders.

Any other incidental observations of fauna were recorded during all phases of fieldwork.

Refer to Figure 3-1 for fauna survey locations.

Micro-chiropteran Bats

Bat echolocation call recording was undertaken across the site within each stratification unit over the survey period for a total duration of 80 hours.

Bat echolocation calls were recorded using an Anabat II Bat Detector. Emphasis was placed on those areas deemed likely to provide potential hunting sites for bats, including flyways, ecotones, forested areas and waterbodies. Anabat call detection was undertaken during trapping periods and nocturnal fieldwork and was carried out via both stationary and mobile forays. The recorded calls were given to a recognised expert in bat species call identification for analysis.

Mega-chiropteran Bats

These species, specifically the Grey-headed Flying Fox, were surveyed via targeted searches for suitable camp and / or day roost locations. Surveys for primary and secondary indications for this species were undertaken during both diurnal and nocturnal surveys.

Herpetofauna

Specific herpetofauna (frog and reptile) searches were carried out at each of the survey points and significant habitat areas present. Diurnal searches were made in areas of appropriate habitat. Such habitat included areas of thicker vegetation, in ground litter, near and under fallen timber, around piles of refuse / dumped rubbish, and wet / damp areas such as drainage lines and areas of poor infiltration capacity and / or periodic inundation.

Reptile searches were largely concentrated to the hottest part of the day (early afternoon). Frog searches were largely concentrated to nocturnal survey periods and/or periods of wet weather. Physical frog searches were augmented by call recognition. Any calls unable to be clarified in the field were recorded for later comparison with commercially available recordings.

3.2.8 Habitat Assessments

An assessment of the relative value of the habitat present on the site was carried out. This assessment focused primarily on the identification of specific habitat types and resources on the site favoured by known threatened species from the region.

Key features assessed for flora habitat included vegetation type and stratification, soil type, depth and drainage, landform pattern, aspect and past disturbance including fire regime. Habitat key features assessed for fauna type at each survey point included hollow bearing tree density, feed tree density, diversity and density of Proteaceae species, Eucalypt diversity, vegetation strata number and density of dead wood debris across the ground as outlined in Table 3-2 below. The assessment also considered the potential value of the site (and surrounds) for all major guilds of native flora and fauna.

Table 3-2: Ecological / Environmental Attributes Collected within Flora Survey Points

Feature	Variables	Value
Hollow Bearing Tree Density	• Low Density • Moderate Density • High Density	Determine the density and distribution of denning and roosting habitat for native fauna species across the site.
Eucalypt diversity	• Low Density • Moderate Density • High Density	Determine the diversity of Eucalypt feeding opportunities for native fauna species across the site.
Allocasuarina sp.	• Low Density • Moderate Density • High Density	Determine the density and distribution of this habitat resource across the site, particularly as a forage plant species for Glossy Black-Cockatoo.
Proteaceae sp.	• Low Density • Moderate Density • High Density	Determine the density and diversity of Proteaceae species across the site, as an indicator of winter foraging resources for threatened arboreal mammals, such as the Squirrel Glider and potentially the Pygmy Possum.
Structural Diversity	• Low (1 layer) • Moderate (2 layers) • High (3+ layers)	A measure of habitat quality across the site, particularly as an indicator of microhabitat diversity and niche opportunity for bird species, potential threatened terrestrial mammals and the prey species of forest owls.
Fallen Timber	• Low (few or none) • Moderate (scattered) • High (intact)	A measure of habitat quality across the site, particularly as an indicator of microhabitat diversity and niche opportunity for bird species, potential threatened terrestrial mammals and the prey species of forest owls.

The assessment was also based on the specific habitat requirements of each threatened fauna species in regards to home range, feeding, roosting, breeding, movement patterns and corridor requirements. Consideration was given to contributing factors including topography, soil, light and hydrology for threatened flora and assemblages.

TITLE: FIGURE 3-1 FAUNA SURVEY LOCATIONS

LOCATION: NORDS WHARF

DATUM: DATUM
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 23/3/2010
PURPOSE: EAR

LAYOUT REF: FIG3-1 FAUNA SURVEY LOCATION-A4
VERSION (PLAN BY): A (A.P-M.D)

CLIENT: COAL & ALLIED INDUSTRIES LTD
JOB REF: 24530-1

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4940 4200 F: 02 4961 6794 www.rpsgroup.com.au

RPS

3.3 Survey Dates, Type and Prevailing Conditions

The following table depicts the dates, survey type and prevailing weather during the ecological investigations conducted during the survey period.

Table 3-3: Development Estate Survey Dates, Types & Prevailing Weather

DATE	SURVEY TYPE	WEATHER					
		Temperature	Rain (24 hrs to 9:00am)	Sun		Moon	
				Rise	Set	Rise	Set
Vegetation Surveys							
23/07/07	Quadrat and Transect Survey	3 – 15^{0}C	0mm	6:51	17:09	11:20	00:35
24/07/07	Threatened Species Search Random Meander Survey Habitat Assessment	3 – 18^{0}C	0mm	6:51	17:10	11:52	1:33
07/08/07	Targeted *Diuris praecox* searches	3 – 18^{0}C	0mm	6:40	17:19	1:21	11:25
28/08/07		9 – 24^{0}C	0mm	6:17	17:33	17:21	6:02
19/09/07	Targeted *Tetratheca juncea* searches and cryptic orchid search [1]	6 – 24^{0}C	0mm	5:48	17:47	09:47	00:07
04/10/07		12 – 21^{0}C	0mm	5:28	17:57	01:21	11:10
05/10/07		6 – 24^{0}C	0mm	5:26	17:58	02:07	12:17
Trapping							
02/07/07	Trapping Line (10)	9 – 18^{0}C	0mm	16:57	18:29	8:18	6:58
03/07/07		9 – 21^{0}C	0mm	6:58	16:58	19:36	8:58
04/07/07		9 – 21^{0}C	0mm	6:57	16:58	20:43	9:32
05/07/07		9 – 15^{0}C	0mm	6:57	16:59	21:48	10:03
10/07/07	Trapping Line (11)	6 – 12^{0}C	10mm	6:56	17:01	2:19	12:43
11/07/07		6 – 15^{0}C	0mm	6:56	17:02	3:31	13:29
12/07/07		3 – 15^{0}C	0mm	6:56	17:02	4:42	14:24
13/07/07		3 – 15^{0}C	0mm	6:56	17:03	5:47	15:27
16/07/07	Trapping Line (7, 8, 9)	0 – 12^{0}C	0mm	6:55	17:05	8:11	18:48
17/07/07		0 – 12^{0}C	0mm	6:54	17:05	8:43	19:51
18/07/07		3 – 12^{0}C	0mm	6:54	17:06	9:11	20:51
19/07/07		6 – 12^{0}C	0mm	6:53	17:06	9:37	21:47
Fauna Surveys							
25/06/07	Diurnal opportunistic	9 – 15^{0}C	5mm	6:57	16:55	12:51	1:49
26/06/07		12 – 15^{0}C	10mm	6:57	16:55	13:21	2:46
27/06/07		6 – 18^{0}C	0mm	6:49	17:11	14:09	4:30
28/06/07		6 – 12^{0}C	0mm	6:57	16:56	14:36	4:45
29/06/07		3 – 15^{0}C	0mm	6:47	17:13	16:15	6:13
02/07/07	Diurnal opportunistic Diurnal Bird Survey Trapping Lines – Trapping Lines (10) Diurnal Herpetological Survey	9 – 18^{0}C	0mm	6:58	16:57	18:29	8:18
03/07/07		9 – 21^{0}C	0mm	6:58	16:58	19:36	8:58
04/07/07		9 – 21^{0}C	0mm	6:57	16:58	20:43	9:32
05/07/07		9 – 15^{0}C	0mm	6:57	16:59	21:48	10:03
10/07/07	Diurnal opportunistic	6 – 12^{0}C	10mm	6:56	17:01	2:19	12:43
11/07/07		6 – 15^{0}C	0mm	6:56	17:02	3:31	13:29
12/07/07		3 – 15^{0}C	0mm	6:56	17:02	4:42	14:24

DATE	SURVEY TYPE	WEATHER					
		Temperature	Rain (24 hrs to 9:00am)	Sun		Moon	
				Rise	Set	Rise	Set
13/07/07		3 – 15^{0}C	0mm	6:56	17:03	5:47	15:27
16/07/07		0 – 12^{0}C	0mm	6:55	17:05	8:11	18:48
17/07/07		0 – 12^{0}C	0mm	6:54	17:05	8:43	19:51
18/07/07		3 – 12^{0}C	0mm	6:54	17:06	9:11	20:51
19/07/07		6 – 12^{0}C	0mm	6:53	17:06	9:37	21:47
29/07/07	Diurnal Bird Survey Diurnal Herpetological Survey – Trapping Lines (10, 8) Nocturnal Survey	3 – 15^{0}C	0mm	6:47	17:13	16:15	6:13
30/07/07	Diurnal Bird Survey Diurnal Herpetological Survey – Trapping Lines (9, 7) Nocturnal Survey	3 – 15^{0}C	0mm	6:47	17:13	17:23	6:55
31/07/07	Diurnal opportunistic Diurnal Bird Survey Diurnal Herpetological Survey Nocturnal Survey	3 – 18^{0}C	0mm	6:46	17:14	18:31	7:31
1/08/07	Diurnal Bird Survey – Trapping Lines (1, 2) Diurnal Herpetological Survey Nocturnal Survey	6 – 21^{0}C	0mm	6:45	17:15	19:38	8:04
2/08/07	Nocturnal Survey	12 – 24^{0}C	0mm	6:44	17:15	20:45	8:34
7/08/07	Diurnal Bird Survey (8)	3 – 18^{0}C	0mm	6:40	17:19	1:21	11:25
Audit Works							
2/10/08	Ecological Audits	15-17^{0}C	0mm	5;:59	18:26	7:35	21:51
3/10/08	Ecological Audits	14 - 20^{0}C	0mm	5:57	18:26	8:10	22:50

Source:
Australian Government – Geoscience Australia [http://www.ga.gov.au/geodesy/astro/.jsp]
National Rainfall and Temperature Map Archives [http://www.bom.gov.au/silo/products/ClimMaps.shtml]
Note 1: *Tetratheca juncea* surveys included cryptic orchids listed in Section 3.2.6.

3.4 Limitations

Limitations associated with the EAR are presented herewith. The limitations have been taken into account throughout this assessment specifically in relation to threatened species assessments, results and conclusions.

In these instances, a precautionary approach has been adopted; as such 'assumed presence' of known and expected threatened species, populations and ecological communities has been made where relevant to ensure a holistic assessment.
Seasonality

Timing limitations are always encountered during ecological assessment surveys due to the seasonal variations across the broad spectrum of flora and fauna species to be studied. Preliminary surveys were carried out during March, targeted searches for threatened flora and fauna were undertaken during June - September. As such there was

less survey work undertaken during times when migratory bird or bat species would have a higher probability for presence on the site and when some reptile and amphibian species might exhibit greater activity.

Most notably, several threatened flora species, particularly cryptic orchids, should be surveyed within their respective flowering periods. Several of the threatened orchids, which have potential habitat, could not be comprehensively surveyed to provide information on whether they occur within the site. Therefore, these threatened orchids cannot be discounted as occurring within the site.

The flowering and fruiting plant species that attract some nomadic or migratory threatened species, often fruit or flower in cycles spanning a number of years. Furthermore, these resources might only be accessed in some areas during years when resources more accessible to threatened species fail. As a consequence threatened species may be absent from some areas where potential habitat exists for extended periods and this might be the case for the above-mentioned species. Again, this has been taken into account in the habitat assessment phase, although ongoing surveys, conducted during a range of seasonal periods, are designed to elucidate any potential significance the Coal & Allied lands might represent for seasonal species.

In addition, the seasonality of the surveys also places limits on the number of flora species identified in the site as the optimum time to survey would be Spring to Summer when the majority of flora species flower.

Data Availability & Accuracy

- The collated threatened flora and fauna species records provided by the NPWS for the region are known to vary in accuracy and reliability. Traditionally this is due to the reliability of information provided to the NPWS for collation and/or the need to protect specific threatened species locations. For the purposes of this assessment this information has been considered to have an accuracy of ± 1km.
- Threatened flora and fauna records within the region were predominantly sourced from the DECCW Atlas of Wildlife Database and a DEWHA Protected Matters Search. Other sources such as Birdata and HBOC were also utilised. Limitations are known to exist with regards to these data sources and their accuracy.

Note: Data recorded by RPS during the survey period, has been undertaken with a Trimble GeoXH GPS unit, which is capable of sub-metre accuracy following post processing.

Access

The survey over the Development Estate was somewhat limited by access due to wet weather and track deterioration (some tracks have been severely degraded or remain blocked off by fallen timber). In some areas the topography or density of flora (i.e. *Lantana camara* tangles) restricted access to some parts of the site.

Survey guidelines

The identification of stratification units was varied from the DEC (2004) guidelines as previous preliminary ground truthing had been performed and stratification of the flora habitats was solely based upon vegetation communities. This stratification resulted in more stratification units and more frequent sampling as the biophysical attributes varied very little over the site. The stratification was mainly based upon vegetation structure and floristics and this ensured a greater area was sampled.

To ensure adequate survey effort was employed within the Nords Wharf site a species area curve was plotted to ensure the number of plots were adequate to represent the floristic composition of the vegetation sampled. Figure 3-2: is the species area curve plotting number of species against number of quadrats. Note that the curve has not quite reached its asymptote, but the transect data was not included within this data set. The curve however does show that a levelling off which is an indication that the survey effort was adequate to ensure the majority of plant species were detected.

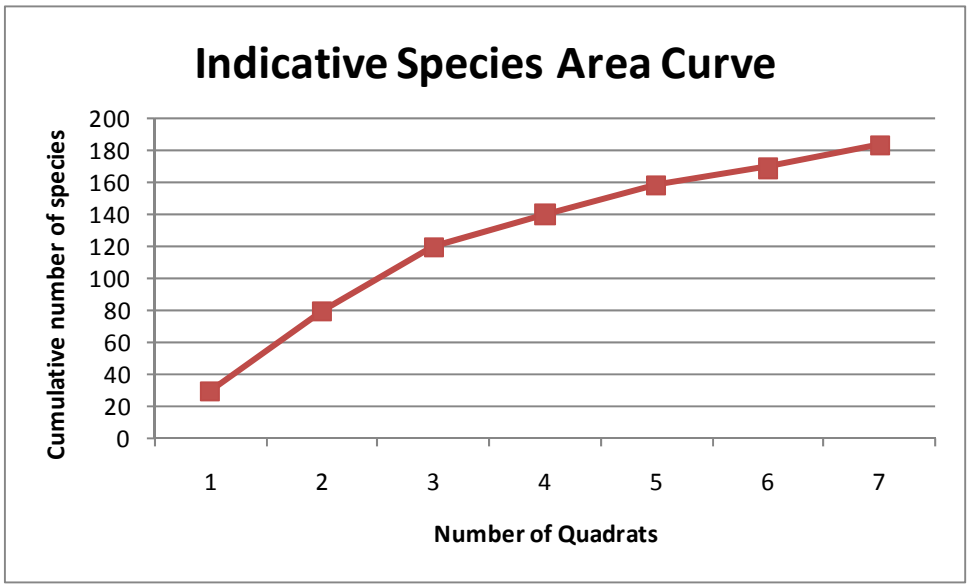


Figure 3-2: Indicative Species Area Curve for Nords Wharf

The flowering period for *Cryptostylis hunteriana* is late November to early December and thus survey for this species was not performed. However, potential habitat for this species occurs in both the Development Estate and the Offset Lands of the site.

Several of the undescribed orchids (listed in Section 3.5.2.1) cannot be discounted as occurring within the Development Estate or the Offset Areas. The Nords Wharf site has potential habitat for these undescribed orchid species and several of these orchids have been found within the vicinity of the site (Gunninah 2003) in similar habitats.

Fauna

Fauna survey effort varied according to the standards set within the DEC Biodiversity Survey Guidelines due to the following reasons:

- Seasonal constraints as outlined above.

- Diurnal Birds - Habitat assessment and previous records and reporting were used to determine the probability of site use. Bird census surveys outlined in Section 3.2.7 in combination with opportunistic surveys conducted during other fieldwork were considered as representing a wider and more thorough coverage of the site than short periods over limited transects. Survey coverage was determined by stratification units designed to represent other fauna guilds and flora surveys.
- Nocturnal Birds – Number of nights surveyed for nocturnal birds was less than required, as a consequence, assessment of development impact was based upon the mobility of local species, local records and habitat opportunities.
- Herpetofauna – Given the seasonal constraints, the majority of local frog species were torpid at the time of survey and hence results varied. Note: Surveys were conducted during the optimal season for the threatened Wallum Froglet. The same seasonal limitations constrained the extent of reptile activity observed during fauna surveys.

Despite the apparent deficiencies, suitable coverage of the site is considered to have been accomplished, particularly as potential occurrences of likely species is assumed (precautionary approach) in light of habitat assessment, previous local records, seasonality deficiencies, the known movements of locally occurring threatened species and the combined authors local knowledge and experience.

4 Results

4.1 Flora

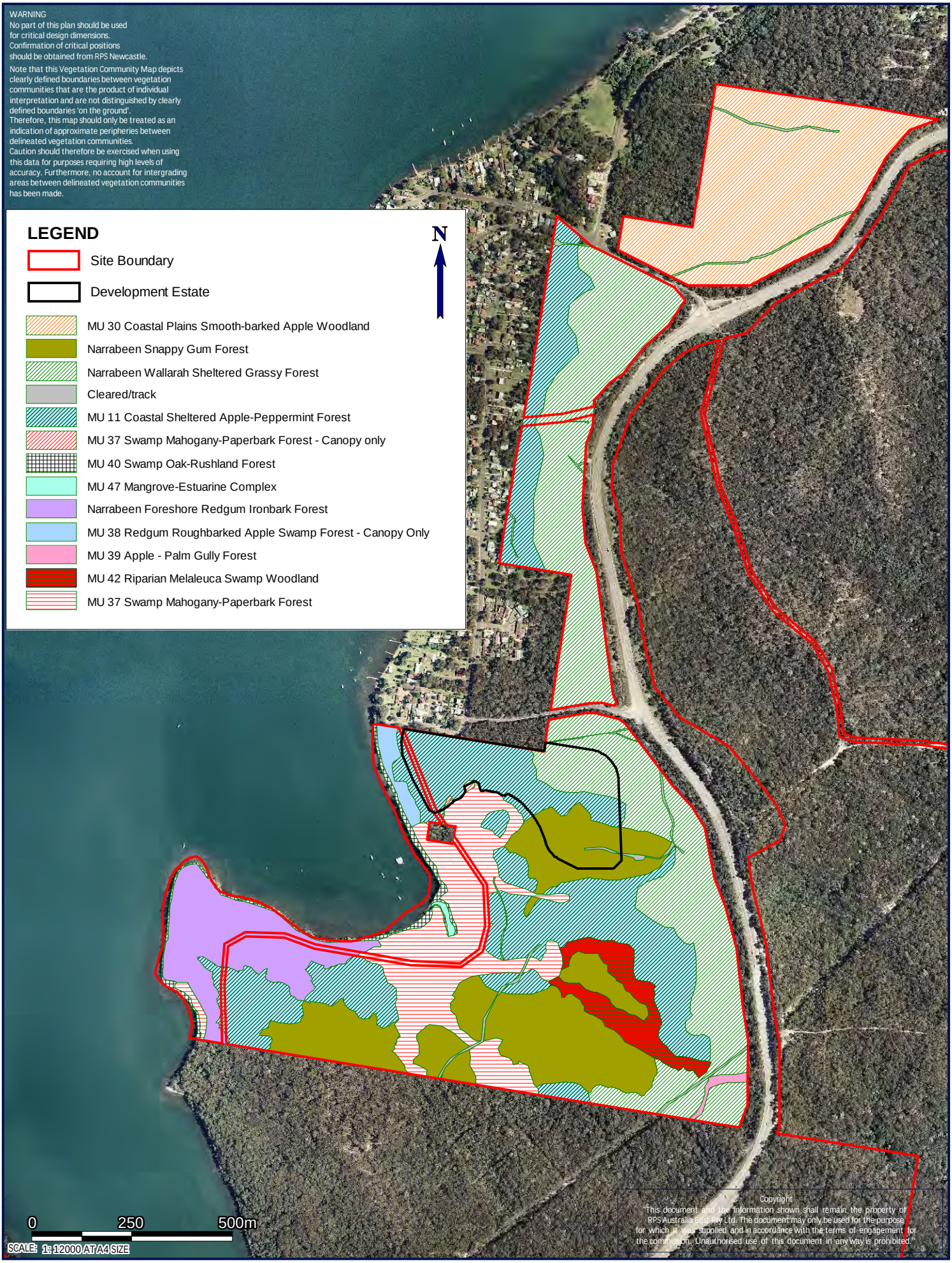
A total of 220 flora species were identified during the survey period over the Nords Wharf site within the quadrats, transects and random meander surveys. Additional orchids have also been added which were detected during the targeted *Tetratheca juncea* surveys. A complete list of the flora species identified is provided in Appendix 2 of this report.

4.1.1 Vegetation Community Delineation

A description of each community and classification into both adopted regional vegetation classifications; being Lower Hunter and Central Coast Regional Biodiversity Strategy (LHCCREMS 2000; House 2003) and the Natural Vegetation of the Wyong Local Government Area (Bell 2002), is provided below.

Five vegetation communities have been delineated as occurring within the Nords Wharf site (Figure 4-1), as listed below:

1. Coastal Plains Smooth-barked Apple Woodland;
2. Coastal Sheltered Apple – Peppermint Forest;
3. Narrabeen Foreshore Redgum Ironbark Forest;
4. Narrabeen Snappy Gum Forest;
5. Apple – Palm Gully Forest
6. **Redgum Roughbarked Apple Swamp Forest (EEC – River Flat Eucalypt Forest on Coastal Floodplains); and**
7. **Riparian Melaleuca Swamp Forest (EEC – Swamp Sclerophyll Forest on Coastal Floodplains).**
8. **Swamp Oak Rushland Forest (EEC – Swamp Oak Floodplain Forest);**
9. **Swamp Mahogany – Paperbark Forest (EEC – Swamp Sclerophyll Forest on Coastal Floodplains); and**
10. Narrabeen Wallarah Sheltered Grassy Forest.



TITLE: FIGURE 4-1 VEGETATION MAP
LOCATION: NORDS WHARF
DATUM: DATUM
PROJECTION: MGA ZONE 56 (GDA 94)
DATE: 31/3/2010
PURPOSE: EAR
LAYOUT REF: 24530\DRAFT\ECO\SOUTH\ALL\2010\NORDS WHARF\ FIGURE 4-1 VEGETATION MAP 2010
VERSION (PLAN BY): A (A.P-M.D)

CLIENT: COAL & ALLIED INDUSTRIES LTD
JOB REF: 24530-1

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RPS

1 Coastal Plains Smooth-barked Apple Woodland.

This vegetation community occurs within a small section of the offsets in the northern portion of the site and encompasses 20.32ha. This vegetation community is not commensurate with any vegetation communities described by the natural Vegetation of the Wyong Local Government Area (Bell, 2002) however; this community is commensurate with MU 30 Coastal Plains Smooth-barked Apple Woodland as described by LHCCREMS (NPWS 2000; House 2003). The threatened flora species Tetratheca juncea was recorded within this community. A small patch of Coastal Plains Scribbly Gum Woodland occurs on the ridge tops, these variations have the structure of woodland with a grassy understorey.

Upper Stratum – 15 to 18 m with a PFC of 20% to 40%, the dominant species being *Angophora costata* (Smooth-barked Apple*), Corymbia gummifera* (Red Bloodwood) *Eucalyptus capitellata* (Brown Stringybark), *Eucalyptus umbra* subsp. *umbra* (Broad-leafed Mahogany) and occasionally *Eucalyptus signata* (Scribbly Gum).

Mid Stratum 1 – 4 m to 5 m with a PFC 20% to 40%, the dominant species being *Allocasuarina littoralis* (Black She-oak), juvenile *Eucalyptus capitellata* (Brown Stringybark), and *Corymbia gummifera* (Red Bloodwood).

Mid Stratum 2 – 1m to 2 m with a PFC of 20% to 40%, the dominant species being *Dillwynia retorta* (Eggs and Bacon), *Leptospermum trinervium* (Paperbark Tea-tree), *Pultenaea paleacea*, *Persoonia levis* (Smooth Geebung) and *Acacia myrtifolia* (Myrtle Wattle).

Lower Stratum – to 1m with a PFC of 30% to 70% the dominant species being *Lepidosperma laterale*, *Xanthorrhoea latifolia* (Forest Grass Tree), *Poa labillardieri* var. *labillardieri* (Tussock Grass), *Themeda australis* (Kangaroo Grass), *Entolasia stricta* (Wiry Panic) and *Lomandra obliqua* (Fish Bones).

2 Coastal Sheltered Apple – Peppermint Forest

This vegetation community occurs the majority of the Nords Wharf Site and encompasses 51.04 ha. This vegetation community is commensurate with MU 29 – Narrabeen Coastal Sheltered Apple - Peppermint Forest as described by the natural Vegetation of the Wyong Local Government Area (Bell, 2002) and with MU 11 Coastal Sheltered Apple-Peppermint Forest as described by LHCCREMS (NPWS 2000; House 2003). This community varies with the addition of *Eucalyptus signata* (Scribbly Gum) in the canopy layer of that described in the regionally mapping. In the south western portion of this community *Eucalyptus signata* (Scribbly Gum) becomes a co-dominant with *Eucalyptus piperita* (Sydney Peppermint). The Grey Gum *Eucalyptus punctata* is also present within the northern sections of this community. This community ecotones in the southern portions of the site with the Narrabeen Wallarah Sheltered Grassy Forest. Kanangra Scout Camp is currently operated within the western portion to the south of Government Road, and the understorey has been removed and the groundlayer has pasture weed incursions.

Upper Stratum – 18 to 22 m with a PFC of 30% to 50%, the dominant species being *Eucalyptus piperita* (Sydney Peppermint), *Angophora costata* (Smooth-barked Apple), *Eucalyptus signata* (Scribbly Gum*), Eucalyptus punctata* (Grey Gum) and in the moist gullies *Eucalyptus resinifera* (Red Mahogany).

Mid Stratum 1 – 4 m to 8 m with a PFC of 20%, the dominant species being *Allocasuarina torulosa* (Forest She-oak), *Allocasuarina littoralis* (Black She-oak), and juvenile *Eucalyptus punctata* (Grey Gum), *Eucalyptus piperita* (Sydney Peppermint) and *Angophora costata* (Smooth-barked Apple).

Mid Stratum 2 – 2 m to 3 m with a PFC of 20% to 50%, the dominant species being *Dodonaea triquetra* (Common Hop Bush), *Dillwynia retorta* (Eggs and Bacon), *Leptospermum trinervium* (Paperbark Tea-tree), *Pultenaea paleacea*, *Persoonia levis* (Smooth Geebung) and *Acacia myrtifolia* (Myrtle Wattle).

Lower Stratum – to 1m with a PFC of 30% to 70%, the dominant species being *Lepidosperma laterale, Xanthorrhoea latifolia* (Forest Grass Tree), *Poa labillardieri* var. *labillardieri* (Tussock Grass), *Themeda australis* (Kangaroo Grass), *Entolasia stricta* (Wiry Panic) and *Lomandra obliqua* (Fish Bones).

3 Narrabeen Foreshore Redgum-Ironbark Forest

This vegetation community occurs along the southern section within Browns Point within the exposed areas along the foreshore of Lake Macquarie and encompasses 11.23ha. This vegetation community is commensurate with MU 24 Narrabeen Foreshore Redgum-Ironbark Forest as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002) however; this community is not commensurate with any vegetation communities as described by LHCCREMS (NPWS 2000; House 2003). This community had severe incursions of *Lantana camara* (Lantana) and *Chrysanthemoides monilifera* subsp. *rotundata* (Bitou Bush) throughout. Evidence of changes in fire regimes is exhibited by the dominance of native pioneer species such as *Imperata cylindrica* var. major (Blady Grass) and *Dodonaea triquetra* (Common Hop Bush).

Upper Stratum – to 20m with a PFC of 30% to 50%, the dominant species being *Eucalyptus tereticornis* (Forest Redgum), *Eucalyptus paniculata* subsp. *paniculata* (Grey Ironbark) and occasionally *Angophora costata* (Smooth-barked Apple).

Mid Stratum 1 – 4 m to 6m with a PFC of 10% to 20%, the dominant species being *Allocasuarina littoralis* (Black She-Oak) and *Exocarpus cupressiformis* (Cherry Ballarat).

Mid Stratum 2 – 1 m to 3 m with a PFC of 80%, the dominant species being *Acacia longifolia* var. *longifolia* (Sydney Golden Wattle), *Notelaea longifolia* (Mock Olive), *Acrotriche divaricata*, *Chrysanthemoides monilifera* subsp*. rotundata* (Bitou Bush), *Lantana camara* (Lantana), *Dodonaea triquetra* (Common Hop Bush), *Acacia falcata* (Sickle Wattle) and *Acacia irrorata* subsp. *irrorata*.

Lower Stratum – to 1 m with a PFC of 40% to 80%, the dominant species being *Imperata cylindrica* var. major (Blady Grass), *Oplismenus aemulus* (Basket Grass), *Hardenbergia violacea* (Native Sarsaparilla), *Pratia purapescens* (Whiteroot), *Centella asiatica* (Swamp Pennywort), *Cassytha pubescens* (Common Devil's Twine).

4 Narrabeen Snappy Gum Forest

This community occurs on higher slopes and ridges of the site below Coastal Plains Scribbly Gum Woodland and above Coastal Sheltered Apple – Peppermint Forest where it covers an area of approximately 20.33ha. This vegetation community is commensurate with MU 32 'Narrabeen Snappy Gum Forest' as described in 'The natural vegetation of the Wyong Local Government Area, Central Coast, NSW' (Bell 2002). The dominant components of the canopy layer are *Eucalyptus ramosa* (Snappy Gum), *Angophora costata* (Smooth-barked Apple) and *Corymbia gummifera* (Red Bloodwood), but there are areas where *E. resinifera* (Red Mahogany), *E. capitellata* (Brown Stringybark) and / *or E. piperita* occur as co-dominant species. The community contains a mid-storey of juvenile eucalypts, *Allocasuarina littoralis* (Black She Oak) and *Persoonia linearis* (Narrow-leaf Geebung). The lower understorey is characterised by a low diversity of shrubs, dominated by *Dodonaea triquetra* (Common Hop Bush) and *Pultenaea villosa*, due to recent intense fires. *Cassytha glabella* (Devil's Twine) is common within the understorey with *Entolasia stricta* (Wiry Panic) and *Patersonia sericea* (Silky Purple Flag) common in the ground-cover layer.

Upper Stratum – 20 m with a PFC varying between 40% to 50%, the dominant species being *Eucalyptus ramosa* (Snappy Gum), *Angophora costata* (Smooth-barked Apple) and *Corymbia gummifera* (Red Bloodwood), with *E. resinifera* (Red Mahogany), *E. capitellata* (Brown Stringybark) and / or *E. piperita* occurring spasmodically as co-dominant species.

Mid Stratum –2 to 5 m with a PFC of 20% to 30%, the dominant species being *Allocasuarina littoralis* (Black She Oak), juvenile Eucalyptus species and *Persoonia linearis* (Narrow-leaf Geebung).

Lower Stratum – 0 to 2 m with a PFC of 80% to 90%, the dominant species being *Dodonaea triquetra* (Common Hop Bush), *Pultenaea villosa*, *Cassytha glabella* (Devil's Twine), *Entolasia stricta* (Wiry Panic) *Lomandra obliqua* (Fish Bones), *Lindsaea linearis* (Screw Fern) and *Acianthus fornicatus* (Pixie Orchid).

5 Palm Gully Forest

This vegetation community was located in one of the drainage lines within the south eastern portion of the site and covers an area of approximately 0.32ha. This vegetation community is commensurate with MU 25 Munmorah Palm-Apple Dry Drainage Line Forest as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002). This community is also commensurate with MU 39 Apple - Palm Gully Forest as described by LHCCREMS (NPWS 2000; House 2003). Structurally this community is generally of an open forest nature. This vegetation community has some affinities with the endangered ecological community of 'Lowland Rainforest in the NSW North Coast and

Sydney Basin Bioregion' but the dominance of Eucalypts and the variable canopy cover makes this vegetation community more of a open forest than rainforest. Whilst this vegetation community had a wide diversity of moist species but due to the high number of Eucalypts and variable canopy cover it is considered not to be commensurate with this EEC.

Upper Stratum – 20 to 25 m with a PFC of 50% to 70%, the dominant species being *Livistona australis* (Cabbage Tree Palm), *Angophora costata* (Smooth-barked Apple), and *Eucalyptus resinifera* subsp. *resinifera* (Red Mahogany).

Mid Stratum 1 – 10 to 15 m with a PFC of 40% to 70%, the dominant species being, *Callistemon salignus* (Willow Bottlebrush), *Glochidion ferdinandi* (Cheese Tree), and *Allocasuarina torulosa* (Forest She-oak).

Mid Stratum 2 – 2 to 3 m with a PFC to 30%, the dominant species being, *Backhousia myrtifolia* (Grey Myrtle), *Melaleuca linearifolia* (Snow-in-Summer), *Elaeocarpus reticulatus* (Blueberry Ash) and *Leptospermum polygalifolium* (Lemon-scented Tea Tree).

Lower Stratum – to 1 m with a PFC of 20% to 30%, the dominant species being *Doodia apsera* (Rasp Fern), *Schoenus melanostachys*, *Adianthum aethiopicum* (Common Maidenhair), *Adianthum formosum* (Giant Maidenhair), *Blechnum indicum*, *Gahnia clarkei* (Tall Saw Sedge), *Gahnia melanocarpa* (Black-fruit Saw-sedge), *Smilax australis* (Lawyer Vine), *Cissus hypoglauca* (Native Grape), *Morinda jasminoides* (Jasmine Morinda), *Calochlaena dubia* (False Bracken) and *Gymnostachys anceps* (Settlers Flax).

6 Redgum Roughbarked Apple Swamp Forest

This community occurs on foreshore flats within the Nords Wharf site and covers an area of approximately 0.89ha. This vegetation community is commensurate with LHCCREMS MU 38 'Redgum Rough-barked Apple Swamp Forest' and with the alluvial variant of Narrabeen Foreshore Redgum-Ironbark Forest as described in 'The natural vegetation of the Wyong Local Government Area, Central Coast, NSW' (Bell, 2002). The community is characterised by *Eucalyptus tereticornis* and *Angophora floribunda* in the canopy stratum. This community does not occur within inundated lowland areas, but upon narrow linear lakeside benches perched above the direct influence of estuarine and freshwater communities. The immediate edges of the lake are colonised by a narrow band of *Casuarina glauca*, with *E. tereticornis* occurring immediately behind this band, often within a couple of metres of the lake's edge. This community is canopy dominant with the majority of the understorey being managed by the Scout camp.

Upper Stratum –15 to 20 m with a PFC of 30% to 40%, the dominant species being *Eucalyptus tereticornis* (Forest Red Gum) and *Angophora floribunda* (Rough-barked Apple).

Mid Stratum 1 – 3 to 5 m with a PFC of < 5%, the dominant species *Glochidion ferdinandi* (Cheese Tree).

Mid Stratum 2 – 1 to 3 m with a PFC to 20-30%, the dominant species being, *Acacia longifolia* var. *sophorae* (Sydney Golden Wattle), *Chrysanthemoides monilifera* ssp. *rotunda* (Bitou Bush), and *Breynia oblongifolia* (Coffee Bush).

Lower Stratum – to 1 m with a PFC of 70% to 90%, the dominant species being *Stenotaphrum secundatum* (Buffalo Grass), *Pennisetum clandestinum* (Kikuyu Grass), *Imperata cylindrica* var. *major* (Blady Grass), *Oplismenus aemulus* (Basket Grass), *Dichondra repens* (Kidney Weed), *Dianella caerulea* ssp. *producta* (Blue Flax Lily), *Echinopogan caespitosus* (Hedgehog Grass), *Trifolium repens* (white clover), *Hypericum gramineum* (St Johns Wort), *Plantago debilis*, *Cynodon dactylon* (Couch grass), *Chrysanthemoides monilifera* ssp. *rotunda* (Bitou Bush), *Stephania japonica* (Snake Vine), *Parsonsia straminea* (Monkey Rope) and *Cayratia clematidea* (Slender Grape).

7 Riparian Melaleuca Swamp Forest

This community occurs on drainage lines on the site's eastern slopes extending down onto the flats where it merges with other Swamp Sclerophyll vegetation associations and covers an area of approximately 3.66 ha. This vegetation community is commensurate with MU 42 'Riparian Melaleuca Woodland' as described in 'LHCCREMS Vegetation Mapping'. Drainage lines occurring on the upper slopes of the site are largely characterised by a mid-storey layer dominated by *Leptospermum polygalifolium* and associated with varying densities of *Melaleuca sieberi*. The lower strata are more or less dominated by *Gahnia clarkei* and / or *Schoenus melanostachys*. The close proximity of adjacent vegetation communities influence the species occurring in the canopy with a range of different species occurring along with the more consistently occurring *Eucalyptus resinifera* (Red Mahogany). Occasionally, dense patches of *Glochidion ferdinandi* (Cheese Tree) saplings occur within some areas with mid-strata plants, such as *Banksia spinulosa* (Hairpin Banksia), *Cryptocarya microneura* (Murrogun) and *Notelaea longifolia* (Mock Olive), occurring spasmodically from neighbouring or upslope communities. In its lower reaches this community merges with Swamp Mahogany-Paperbark Forest and *E. robusta* occurs within the community as a canopy species in these areas.

Upper Stratum –15 to 20 m with a PFC of 25% to 35%, the dominant species being *Eucalyptus resinifera* (Red Mahogany) and *Eucalyptus robusta* (Swamp Mahogany) with *Eucalyptus punctata* (Grey Gum), *Angophora costata* (Smooth-barked Apple), *Eucalyptus piperita* (Sydney Peppermint) and *Eucalyptus ramosa* (Snappy Gum) occurring as ecotonal influences from neighbouring communities.

Mid Stratum 1 –3 to 5 m with a PFC of 50% to 70%, the dominant species being *Leptospermum polygalifolium* (Lemon-scented Tea Tree), *Melaleuca sieberi* (Sieber's Paperbark), *Allocasuarina littoralis* (Black She Oak), *Glochidion ferdinandi* (Cheese Tree) and *Callistemon salignus* (Willow Bottlebrush).

Mid Stratum 2 – 1 to 3 m with a PFC to 40 – 60%, the dominant species being *Leptospermum polygalifolium* (Lemon-scented Tea Tree), *L. juniperinum* (Prickly Tea Tree), *L. trinervium* (Paperbark Tea Tree), *Melaleuca sieberi* (Sieber's Paperbark) and *Glochidion ferdinandi* (Cheese Tree).

Lower Stratum – to 1 m with a PFC of 30% to 100%, the dominant species being *Schoenus melanostachys* and *Gahnia clarkei* (Tall Saw Sedge), with a number of other species showing higher or lower densities in patchy areas, including, *Imperata cylindrica* var. *major* (Blady Grass), *Adiantum aethiopicum* (Common Maidenhair), *Lomandra longifolia* (Mat Rush), *Polyscias sambucifolia* (Elderberry Panax), *Pratia purpurascens* (White Root) and *Brunoniella australis* (Blue Trumpet).

8 Swamp Oak Rushland Forest (EEC – Swamp Oak Floodplain Forest)

This vegetation community occurs along the foreshore of Lake Macquarie along Browns point and extends in a northern direction to South Beach Wharf. This community also extends along the creekline to the north of Browns Point. This vegetation community encompasses approximately 3.12ha and is commensurate with MU 3 – Estuarine Swamp Oak Forest as described by the natural Vegetation of the Wyong Local Government Area (Bell, 2002) and MU 40 Swamp Oak Sedge Forest as described by LHCCREMS (NPWS 2000; House 2003).

Upper Stratum – 10 m to 15 m with a PFC of 30% to 40%, the dominant species being *Casuarina glauca* (Swamp Oak) and *Avicennia marina* (Grey Mangrove).

Mid Stratum – to 3 m with a PFC of 10% to 20%, the dominant species being *Chrysanthemoides monilifera* subsp*. rotundata* (Bitou Bush), *Suaeda australis* (Austral Seabite) and *Acacia longifolia* var. *sophorae* (Coastal Wattle).

Lower Stratum – to 1m with a PFC of 80% to 90%, the dominant species being *Juncus kraussii* subsp. *australiensis* (Sea Rush), *Baumea juncea*, *Stenotaphrum secundatum* (Buffalo Grass) and *Sporobolus virginicus* (Sand Couch).

9 Swamp Mahogany - Paperbark Forest (EEC Swamp Sclerophyll Forest on Coastal Floodplains)

This vegetation community occurs in the lower lying estuarine drainage lines, adjoining the Swamp Oak Rushland Forest and the Coastal Sheltered Peppermint – Apple Forest. This vegetation community encompasses 15.34ha and is commensurate with MU 10 – Coastal Sand Mahogany – Paperbark Forest as described by the natural Vegetation of the Wyong Local Government Area (Bell, 2002) and MU 37 Swamp Mahogany – Paperbark Forest as described by LHCCREMS (NPWS 2000; House 2003).

Upper Stratum – 20 m to 25 m with a Projected Foliage Cover (PFC) of 50% to 70%, the dominant species being *Eucalyptus robusta* (Swamp Mahogany), *Melaleuca quinquinervia* (Broad-leaved Paperbark) and occasionally *Alphitonia excelsa* (Red Ash).

Mid Stratum 1 – 4 m to 8m with a PFC of 10% to 20%, the dominant species being *Melaleuca linearifolia* (Snow-in Summer), *Callistemon salignus* (Willow Bottlebrush) and *Glochidion ferdinandi* (Cheese Tree).

Mid Stratum 2 – 2 m to 3m with a PFC of 10% to 30%, the dominant species being *Lantana camara* (Lantana), *Goodenia ovata* (Hop Goodenia), *Livistonia australis* (Cabbage Tree Palm) and *Polyscias sambucifolia* (Elderberry Panax).

Lower Stratum – to 1.5m with a PFC of 30% to 50%, the dominant species being *Gahnia clarkei* (Tall Saw Sedge), *Hydrocotyle peduncularis*, *Viola hederacea* (Native Violet), *Dioscoria transversa* (Pencil Yam), *Marsdenia suaveolens* (Scented Marsdenia), *Oplismenus aemulus* (Basket Grass), and *Lomandra longifolia* (Mat Rush).

10 Narrabeen Wallarah Sheltered Grassy Forest

This vegetation community occurs on the upper slopes and ridges adjoining the Pacific Highway in the north of the site and encompasses 31.36 ha. This vegetation community is commensurate with MU 33 – Narrabeen Wallarah Sheltered Grassy Forest as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002). However, this vegetation community is not commensurate with any vegetation units as described by LHCCREMS (NPWS 2000; House 2003). This community was difficult to delineate due to the variable canopy layer in which no species was dominant. The presence of *Eucalyptus globoidea* (White Stringybark) and *Allocasuarina torulosa* (Forest She-oak) separates this community from both the Coastal Plains Smooth-barked Apple and Coastal Sheltered Peppermint – Apple Forest. The south eastern corner of the site is dominated by Ironbarks whilst the northern section is dominated by grey gums and scribbly gums.

Upper Stratum – 16 to 20 m with a PFC of 30% to 50% the dominant species being *Eucalyptus paniculata* (Grey Ironbark), *Eucalyptus punctata* (Grey Gum), *Eucalyptus globoidea* (White Stringybark), *Allocasuarina torulosa* (Forest She-oak), *Corymbia gummifera* (Red Bloodwood), *Eucalyptus piperita* (Sydney Peppermint), *Angophora costata* (Smooth-barked Apple), *Eucalyptus signata* (Scribbly Gum), *Eucalyptus racemosa* (Snappy Gum) and in the moist gullies *Eucalyptus resinifera* (Red Mahogany).

Mid Stratum 1 – 8 m to 12 m with a PFC of 20%, the dominant species being *Allocasuarina torulosa* (Black She-oak).

Mid Stratum 2 – 1 m to 4 m with a PFC of 10% to 30%, the dominant species being *Dodonaea triquetra* (Common Hop Bush), *Bursaria spinosa* (Blackthorn), *Polyscias sambucifolia* (Elderberry Panax), *Podolobium ilicifolium* (Native Holly) and *Acrotriche divaricata.*

Lower Stratum – to 1m with a PFC of 30% to 50%, the dominant species being *Lepidosperma laterale*, *Xanthorrhoea latifolia* (Forest Grass Tree), *Themeda australis* (Kangaroo Grass), *Entolasia stricta* (Wiry Panic), *Pratia purpurascens* (White Root) and *Dianella caerulea* var. *producta* (Blue Flax Lily).

4.1.2 Conservation Status of Vegetation Communities

Two EEC's that are listed under the *TSC Act 1995* occur within two delineated vegetation communities extant on the Nords Wharf site. These two communities are listed below:

- The vegetation community delineated as Swamp Oak Rushland Forest is commensurate with 'Swamp Oak Floodplain Forest in the NSW North Coast, Sydney Basin and South East Corner Bio-regions'; and
- The vegetation community delineated as Swamp Mahogany - Paperbark Forest is commensurate with 'Swamp Sclerophyll Forest on Coastal Floodplains in the NSW North Coast, Sydney Basin and South East Corner Bio-regions'.

4.1.3 Regionally Significant Vegetation Communities within Lake Macquarie LGA

The Lake Macquarie Flora and Fauna Guidelines have several different levels of communities which are considered to be of conservation significance within the Lake Macquarie LGA. The following vegetation communities, which occur within the site, are considered to be conservation significance:-

- Narrabeen Foreshore Redgum Ironbark Forest;
- Swamp Mahogany Paperbark Forest (Listed as EEC);
- Swamp Oak Rushland Forest (Swamp Oak Floodplain Forest - listed as EEC);
- Narrabeen Wallarah Sheltered Grassy Forest;
- Narrabeen Snappy Gum Forest; and
- *Eucalyptus piperita/ Angophora costata/ Eucalyptus resinifera* open forest equivalent to Coastal Sheltered Apple-peppermint Forest.

4.1.4 Regionally Significant Flora Species

No ROTAP listed species (Briggs and Leigh, 1996) were identified within the Nords Wharf site. However, Lake Macquarie Flora and Fauna Guidelines (2001) contain a list of regionally significant flora species and three of these were identified within the site as follows:

- *Eucalyptus robusta* Swamp Mahogany
- *Eucalyptus signata* Scribbly Gum
- *Xanthorrhoea fulva*

4.1.5 Desktop Assessment – Threatened Flora Search Results

The results of this search indicated numerous threatened flora species have been previously recorded within the locality and/ or have potential habitat within the site. The following have been recorded within 10km (DECCW Wildlife Atlas 2010) of the site:

- *Acacia bynoeana*
- *Angophora inopina* (Charmhaven Apple)
- *Caladenia tessellata* (Thick Lip Spider Orchid)

- *Callistemon linearifolius* (Netted Bottle Brush)
- *Chamaesyse psammogeton* (Sand Spurge)
- *Corybas dowlingii* (Red Helmet Orchid)
- *Cynanchum elegans* (White-flowered Cynanchum)
- *Cryptostylis hunteriana* (Leafless Tongue Orchid)
- *Dendrobium melaleucaphilum* (Spider Orchid)
- *Diuris praecox* (Rough Double Tail)
- *Eucalyptus camfieldii* (Camfield's Stringybark)
- *Eucalyptus parramattensis* subsp. *decadens* (Drooping Red Gum)
- *Genoplesium insignis* (Variable Midge Orchid)
- *Grevillea parviflora* ssp *parviflora* (Little-flower Grevillea)
- *Melaleuca groveana* (Grove's Paperbark)
- *Pultenaea maritima* (Coastal Headland Pea)
- *Rutidosis heterogama* (Heath Wrinklewort)
- *Syzygium paniculatum* (Magenta Lilly Pilly)
- *Tetratheca glandulosa*
- *Tetratheca juncea* (Black-eyed Susan)

In addition, to the above threatened flora species recorded on the DECCW Wildlife Atlas, it was considered that *Melaleuca biconvexa, Caladenia porphyrea and Microtis angusii* have potential habitat within the site and should be considered within this assessment.

Threatened Flora Species with potential to occur

In summary 11 threatened flora species have potential to occur, these species and their preferred habitat within the site are listed below:

- *Caladenia porphyrea* - Potential habitat for this species occurs within the coastal habitats of Narrabeen Wallarah Sheltered Grassy Forest, Narrabeen Foreshore Redgum Ironbark Forest, Narrabeen Snappy Gum Forest and Coastal Sheltered Apple – Peppermint Forest.
- *Caladenia tessellata* – Potential habitat within both the Coastal Plains Smooth-barked Apple Woodland and the Coastal Sheltered Apple – Peppermint Forest within the site. Recorded within Munmorah State Conservation Area to the south east of the site;
- *Callistemon linearifolius* – Potential habitat within the ecotone between the Swamp Mahogany Paperbark Forest and the Dry Sclerophyll Forest within the site;
- *Cryptostylis hunteriana* – Highly cryptic orchid found in flat plains in coastal areas. Potential habitat within the both the Coastal Plains Smooth-barked Apple Woodland and the Coastal Sheltered Apple – Peppermint Forest within the site;

- *Diuris praecox* – Potential habitat exists for this species within both the Coastal Plains Smooth-barked Apple Woodland and the Coastal Sheltered Apple – Peppermint Forest vegetation communities;
- *Genoplesium insignis* - Potential habitat for this species occurs within Narrabeen Snappy Gum Forest
- *Melaleuca biconvexa* – Potential habitat within the Riparian Zones of the site. However, closest record is approximately 16 km (DECCW Atlas) to the south of the site;
- *Microtis angusii* - Potential habitat for this species occurs within Narrabeen Snappy Gum Forest
- *Syzygium paniculatum* – Record to the north of Cams Wharf from NPWS database. Potential habitat in the riparian zones within the site;
- *Tetratheca glandulosa* - this species has habitat within the Coastal Plains Smooth-barked Apple Woodland, Coastal Sheltered Apple – Peppermint Forest and Narrabeen Snappy Gum Forest.; and
- *Tetratheca juncea* – Shrub mostly found on south facing slopes, this species has habitat within the Coastal Plains Smooth-barked Apple Woodland and Coastal Sheltered Apple – Peppermint Forest.

4.1.6 Threatened Cryptic Orchid Species

Following the precautionary approach, areas of vegetation communities that have been known to support these cryptic orchids have been included in calculations of potential habitat within the Nords Wharf lands.

Caladenia tessellata

Potential habitat for this species occurs within Narrabeen Snappy Gum Forest, Coastal Sheltered Apple – Peppermint Forest, Coastal Plains Smooth-barked Apple Woodland, Narrabeen Foreshore Redgum Ironbark Forest and Narrabeen Wallarah Sheltered Grassy Forest at the Nords Wharf site. Approximately 10.1 ha (9%) of potential habitat for this species will be removed for proposal within the Development Estate at Nords Wharf. However, over 102.51 ha (91%) of habitat will be retained as part of the Nords Wharf Conservation Lands. Thus whilst it cannot be determined if this species is present within the Development Estate without numerous return surveys over many years, as there are large tracks of habitat to be retained within the conservation lands the proposal is unlikely to have a significant impact upon this species.

Caladenia porphyrea

Potential habitat for this species occurs within the coastal habitats of Narrabeen Wallarah Sheltered Grassy Forest, Narrabeen Foreshore Redgum Ironbark Forest, Narrabeen Snappy Gum Forest and Coastal Sheltered Apple – Peppermint Forest. Approximately 10.1 ha (11%) of potential habitat for this species will be removed as part of the development proposal. However, over 82.18 ha (89%) of habitat for this species is being retained within the Conservation Lands. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Cryptostylis hunteriana

Potential habitat for this species occurs within the Nords Wharf site. Potential habitat for this species occurs within Narrabeen Snappy Gum Forest, Coastal Plains Smooth-barked Apple Woodland, Coastal Sheltered Apple – Peppermint Forest and Narrabeen Wallarah Sheltered Grassy Forest. Approximately 10.1ha (10%) of potential habitat for this species will be removed for the proposal at Nords Wharf. However, over 93.89 ha (90%) of potential habitat for this species will be retained within the Conservation Lands. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Diuris praecox

Potential habitat for this species occurs within Coastal Plains Smooth-barked Apple Woodland, Narrabeen Snappy Gum Forest, Coastal Sheltered Apple – Peppermint Forest and the Narrabeen Wallarah Sheltered Grassy Woodland vegetation communities within the Nords Wharf site. Approximately 10.1ha (10%) of potential habitat for this species will be removed for the proposal at Nords Wharf. However, over 93.89 ha (90%) of potential habitat for this species will be retained within the Conservation Lands. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Genoplesium insignis

Potential habitat for this species occurs within Narrabeen Snappy Gum Forest within the Nords Wharf site. It is proposed to remove 2.35 ha (12%) of potential habitat for this species as part of the proposal. However, over 17.98 ha (88%) of potential habitat for this species will be retained within the Conservation Lands at Nords Wharf. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Microtis angusii

Potential habitat for this species occurs within Narrabeen Snappy Gum Forest within the Nords Wharf site. It is proposed to remove 2.35 ha (12%) of potential habitat for this species as part of the proposal. However, over 17.98 ha (88%) of potential habitat for this species will be retained within the Conservation Lands at Nords Wharf. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

4.1.7 Targeted Threatened Flora Species Results

This section lists the results of the threatened flora surveys. One threatened flora species was located within the site, being *Tetratheca juncea.* One threatened flora species was previously recorded in the vicinity of the site by DECCW Database Atlas in 2003 being *Diuris praecox.* No other species were detected within the site.

Diuris praecox

This species has been recorded by DECCW Database Atlas in 2003 within the Coastal Sheltered Apple – Peppermint Forest to the north of the Development Estate. Potential habitat exists for this species within both the Coastal Plains Smooth-barked Apple Woodland and the Coastal Sheltered Apple – Peppermint Forest vegetation communities; and Targeted searches for *Diuris praecox* were conducted throughout the entire Development Estate and within the Coastal Sheltered Peppermint Apple Forest and

Narrabeen Wallarah Sheltered Grassy Forest in the Conservation Lands to the north of the Development Estate. These surveys were undertaken during the flowering period for this species (Table 3-3). No individuals of this species were located during any of the targeted searches. However due to the cryptic nature of this species (i.e. does not flower every year) it cannot be discounted as occurring within the Nords Wharf Site. Whilst, potential habitat for this species will be removed as part of the proposal it is considered that the impact upon this species will be minimal due to the large areas (104 ha) of potential habitat which will be retained within the Conservation Lands.

Caladenia porphyrea

Targeted surveys were undertaken within the Development Estate during the September flowering season for this species, with no individuals being located. During surveys, the similar species *Caladenia carnea* was checked when it was encountered to ensure it was not *C. porphyrea*.

Cryptostylis hunteriana

This species was surveyed for within the 2007 flowering period using parallel searches in the Development Estate and no specimens were located. RPS found a small population of this species on the edge of Narrabeen Doyalson Coastal Woodland (Coastal Plains Scribbly Gum Woodland) on adjacent lands to the south of the Coal & Allied lands within the Catherine Hill Bay locality in November 2007. Thus, this species was known to be flowering in 2007 and targeted surveys were undertaken within the Gwandalan Development Estate in late November 2007, with no specimens located.

Tetratheca juncea

A total of 6,798 *Tetratheca juncea* plants were located during the targeted surveys within the Nords Wharf site (Figure 4-2 shows the distribution). Of these 5,933 (88%) will be retained within the Conservation Lands to the south and north of the Development Estate. The remaining 865 (12%) individuals will be removed as part of the proposal. Thus, it is considered that this population is significant due to the large size of the population and likely high content of genetic diversity. Other similar sized populations of 25,000 have been located within the Wallarah Peninsula by Conacher Travers (2007). Of these, over 9,900 have been conserved within Wallarah National Park, with more individuals to be retained within the bush parks within the Development Estates.

The work of Payne (2000) states that all sub-populations of 100 plants or more are of very high conservation significance within the South-East quadrant in which this site occurs. However, at the time the whole population of *Tetratheca juncea* was estimated to be only 10,000 (Payne, 2000). This figure is an underestimation of the entire population throughout its range, but due to the cryptic nature of this species and the lack of extensive surveys a conservative approach was taken. Further surveys since that time has increased the known numbers of this species and this is supported by the large numbers located on the Wallarah Peninsula alone.

Some of the elements of the life-cycle of *Tetratheca juncea* have recently been discovered although much of the ecology is still unknown. However, as this species is an outcrosser (i.e. cannot self pollinate) and utilises buzz pollination (Gross *et al.,* 2003; Driscoll 2003)

this type of reproduction leads to low fruit set. Buzz pollinators are highly specialized and require specific habitat requirements and this has been hypothised as one of the reasons for the species decline and fragmentation (Gross *et al.,* 2003). As the population at Nords Wharf is large and contains other species, which utilise buzz pollination (e.g. *Hibbertia sp. and Dianella sp.*), it is considered that the habitat within the both the Development Estate and Offset Lands provides good quality habitat for the buzz pollinator of *Tetratheca juncea*. Thus, it is vital that conservation of good quality habitat for the pollinator is conserved to ensure sufficient seed is set to ensure the survival of this species. The populations located within the Offset Lands are densely spaced and may be more successful in attracting a pollinator than the population within the Development Estate.

In conclusion, it is estimated that the population within the Wallarah Peninsula is at least 49,000 to date (RPSHSO (2010a, 2010b) and Conacher Travers (2007) data combined). Table 4-1 shows a breakdown of the numbers of *Tetratheca juncea* currently within conservation lands that has been surveyed to date. This number is expected to be an underestimation as less than half of the habitat for this species has been surveyed at Catherine Hill Bay, and there are still some areas to be surveyed in the Conservation Lands at Gwandalan and Nords Wharf. In addition to these populations, Wildthing (2003) located further populations of *Tetratheca juncea* within Catherine Hill Bay and the land to the south of Nords Wharf. Thus whilst the population within the Development Estate is of a moderate size, over 88% (5,933) of the population within the Nords Wharf site will be conserved within the Conservation Lands. Within the Wallarah Peninsula this will increase the current known conservation of *Tetratheca juncea* numbers from 10,225 (Conacher Travers 2007, Payne (2000)) to over 29,000. Thus the removal of 1.7% of the Wallarah Peninsula population from the Nords Wharf site is unlikely to have a significant effect upon the population within the locality. Such a large number of known plants protected in several disjunct but proximate conservation areas bodes well for the long term security of the species in this locality.

Table 4-1: Known Distribution of *Tetratheca juncea* within the Wallarah Peninsula within Conservation Reserves

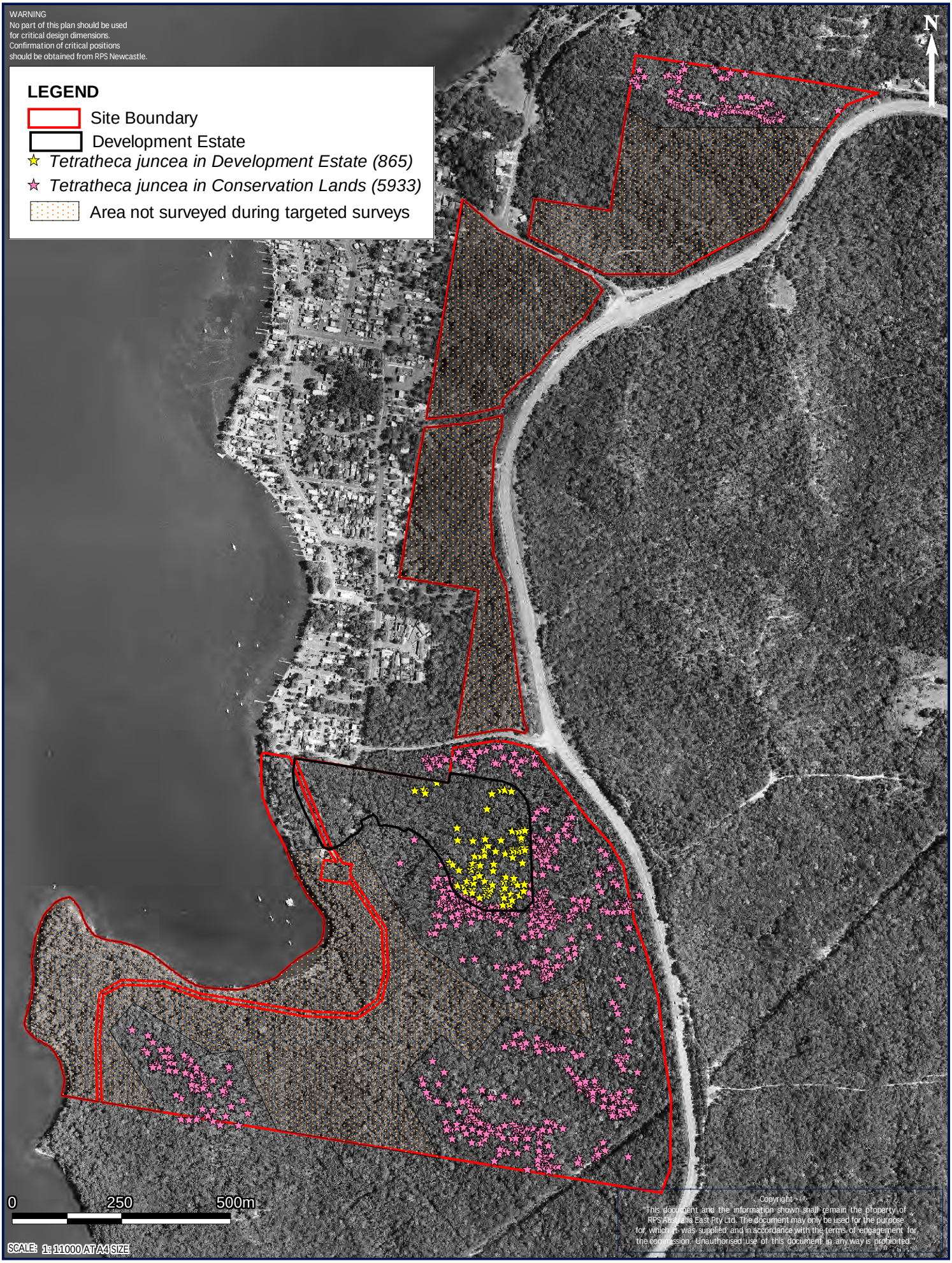
Site at Wallarah Peninsula	Numbers of *Tetratheca juncea*
Wallarah National Park and Habitat Corridor at Murrays Beach*	9900
Munmorah State Conservation Area**	296
Lake Macquarie State Conservation Area**	29
Catherine Hill Bay Proposed Conservation Lands	7,596
Gwandalan Proposed Conservation Lands	8,222
Nords Wharf Proposed Conservation Lands	5,933
Total in Conservation Reserves at Wallarah Peninsula	**31,976**

* Data from Conacher Travers (2007)

** Data from Payne (2000)

Other Cryptic orchids

No other cryptic orchids were located during the targeted surveys. However habitat is present for a number of the undescribed and threatened orchids. As several of these species are undescribed they cannot be discounted as not occurring within the Development Estate, however approx 124 ha of habitat is present within the Offset Lands which will be set aside for conservation.



TITLE: FIGURE 4-2 DISTRIBUTION OF *Tetratheca juncea*

LOCATION: NORD WHARF

DATUM: DATUM
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 31/3/2010
PURPOSE: EAR

24530\DRAFT\ECO\SOUTH\ALL WORKSPACES\2010 \NORDS WHARF\FIG 4-3 DISTRIBTJ2010 A4
LAYOUT REF:
VERSION (PLAN BY): A (A.P-M.D)

CLIENT: COAL & ALLIED INDUSTRIES LTD
JOB REF: 24530-1

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4940 4200 F: 02 4961 6794 www.rpsgroup.com.au

RPS

4.1.8 Regionally Significant Orchid Species

The following orchids which are listed in this section have not been listed under either state (TSC Act) or federal (EPBC Act) legislation as threatened. However, these species have been addressed here further to clarify their significance within the Nords Wharf site.

Acianthus exertus

Jones (2006) describes this orchid as occurring in QLD, NSW ACT and Victoria. This species is widespread and locally common occurring in coastal areas in forest and woodlands on well drained soils. Jones (2006) also notes that this species rarely occurs with *Acianthus fornicatus,* which was found to be common in the forest and woodland communities within Nords Wharf. Bell (2008) notes that there is a lack of records for this species along the coastal strip between Newcastle and the Hawkesbury River; however, Gunninah (2003) notes a record for this species at the Colongra Wetland near Doyalson. A submission to list an endangered population of this species has been submitted to the Scientific Committee (Bell 2008), but at the time of writing, this endangered population has not been listed as either a preliminary or a final determination on the DECCW web site. The location of this endangered population in the locality is also unknown in relation to published or informal literature at the time of writing. Potential habitats within the Nords Wharf site include, Narrabeen Wallarah Sheltered Grassy Woodland, Coastal Sheltered Apple – Peppermint Forest, Coastal Plains Smooth-barked Apple Woodland, Narrabeen Snappy Gum Forest and Narrabeen Foreshore Redgum Ironbark Forest. Whether this species occurs within the Development Estate is unknown, however, the proposed development will remove approximately 10.1ha (9%) of potential habitat for this species. However, over 102.51 ha (91%) ha of potential habitat to be retained within the Conservation Lands the impact of this proposal will be insignificant.

Genoplesium ruppii

One public submission reports that this species has been located within the Wallarah Peninsula, however no location information was provided with this submission. This species has been recorded at Wyee Road in Wyong and several other records exist from Paterson in the lower Hunter Valley. No targeted surveys for this species in particular have been undertaken within the Development Estate. However the habitat within which this species has been previously recorded varies from open grassland, heathlands (Gunninah 2003) to moist swampy forests (Jones 2006). Potential habitats within the Nords Wharf site include, Narrabeen Wallarah Sheltered Grassy Woodland, Coastal Sheltered Apple – Peppermint Forest, Coastal Plains Smooth-barked Apple Woodland, Narrabeen Snappy Gum Forest and Narrabeen Foreshore Redgum Ironbark Forest. Approximately 10.1 ha (9%) of habitat will be removed within the Nords Wharf Development Estate with over 102.51 ha (91%) to be retained within the Conservation Lands. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Pterostylis alveata* syn. *Diplodium alveata

There may be potential for this species to occur within the Development Estate at Catherine Hill Bay. It is generally found within teatree heathland on sand dunes (Bishop 2000). Bell (2008) suggests that an endangered population nomination has been submitted for this species. At the time of writing this report no preliminary to final determination for this species or population has been listed on either the TSC Act or the EPBC Act. Sub-optimal habitat occurs within the Narrabeen Snappy Gum Forest as this community occurs on sandy soils. However, it appears unlikely as this species is generally found on sand dunes. Whilst the proposal will remove 2.35 ha (12%) of sub-optimal habitat, over 17.98 ha (88%) of sub-optimal habitat will be retained within the Conservation Lands. Whilst it is a possibility that this species could occur within the Development Estate, it is unlikely due to lack of preferred optimal habitat. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Pterostylis daintreana* syn. *Pharochilum daintreanum

This species has been found along the edges of sandstone outcrops growing under heathy vegetation or in moss and lichen fringing this vegetation (Bishop 2000). Habitats such as these are common within the Hawkesbury sandstone vegetation communities in the vicinity of the Hawkesbury River. The Nords Wharf site may contain some habitat for this species on the edges of vegetation that adjoins the conglomerate headlands. The majority of this type of habitat occurs within the Narrabeen Foreshore Redgum Ironbark Forest vegetation community. These habitats do not occur within the Development Estate and therefore this species will not be impacted upon by the development and all potential habitat will be retained within the Nords Wharf Conservation Lands.

4.1.9 Regionally Significant Undescribed Cryptic Orchids

Bell (2008) identified several undescribed orchids which may have habitat within the Nords Wharf site. These orchids have been discussed below.

Caladenia* sp. aff. *fuscata

This species has been reported from three locations on the Central Coast with records also from the Wallarah Peninsula (Bell 2008). This species has wider petals than the common species, *Caladenia fuscata. Caladenia fuscata* was not detected by RPS during the vegetation surveys; however, as it is similar to *Caladenia carnea* it is possible that it occurs within the habitats within the Wallarah Peninsula and may have been overlooked during surveys due to similarities. Limited information is available on the habitat of this species to enable a full assessment of the suitable habitats for this species correctly. Further taxonomic investigations are required to determine if this is indeed a new species. Thus a precautionary approach has been taken in this instance to assume that *Caladenia* sp. aff *fuscata* occurs within similar habitats to *Caladenia fuscata.* Potential habitats within the Nords Wharf site are considered most likely to be Coastal Plains Smooth-barked Apple Woodland, Narrabeen Snappy Gum Forest, Narrabeen Foreshore Redgum Ironbark Forest and Narrabeen Wallarah Sheltered Grassy Woodland. Approximately 10.1 ha (9%) of habitat will be removed within the Nords Wharf Development Estate with over 102.51 ha (91%) to be retained within the conservation lands. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Caladenia catenata* var. *'warnervalensis'

Records for this species occur on the Central Coast and have been reported from the Wallarah Peninsula (Bell, 2008). A nomination has been made for this species to be listed as endangered; however, at the time of writing a preliminary or final determination for this species had not yet been listed on either the TSC Act or the EPBC Act. Further taxonomic investigations are required to determine if this is indeed a new species. Thus a precautionary approach has been taken in this instance to assume that *Caladenia catenata* var *'warnervalensis'* occurs within similar habitats to *Caladenia catenata.* Potential habitats within the Nords Wharf site are most likely to be Narrabeen Wallarah Sheltered Grassy Woodland, Coastal Sheltered Apple – Peppermint Forest, Coastal Plains Smooth-barked Apple Woodland, Narrabeen Snappy Gum Forest and Narrabeen Foreshore Redgum Ironbark Forest. Approximately 10.1 ha (9%) of habitat will be removed within the Nords Wharf Development Estate with over 102.51 ha (91%) to be retained within the Conservation Lands. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Calochilus* sp. aff. *paludosus

This species has been identified as occurring on the Wallarah Peninsula, however no information on the exact location is known (Bell 2008). The similar species *Calochilus paludosus* is common and occurs in open forest, woodland and heathland (Bishop 2001). *Calochilus paludosus* has not been recorded within the Nords Wharf site and surveys were conducted during the flowering period for this species. Thus a precautionary approach has been taken in this instance to assume that *Calochilus* sp. aff. *paludosus* occurs within similar habitats to *Calochilus paludosus.* Potential habitats within the Nords Wharf site are most likely to be Narrabeen Wallarah Sheltered Grassy Woodland, Coastal Sheltered Apple – Peppermint Forest, Coastal Plains Smooth-barked Apple Woodland, Narrabeen Snappy Gum Forest and Narrabeen Foreshore Redgum Ironbark Forest. Approximately 10.1 ha (9%) of habitat will be removed within the Nords Wharf Development Estate with over 102.51 ha (91%) to be retained within the Conservation Lands. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Diuris* sp. aff. *alba

Bell (2008) reports that this species has been recorded at several locations on the Central Coast and at Chain Valley Bay and Gwandalan. Little information is available on the description of this taxon and thus it is difficult to determine if this species is present. Thus a precautionary approach has been taken in this instance to assume that *Diuris* sp. aff *alba* occurs within similar habitats to *Diuris alba.* Potential habitat for this species within the Nords Wharf site are most likely to be Narrabeen Snappy Gum Forest and Coastal Sheltered Apple – Peppermint Forest. Approximately 7.95 ha (16%) of habitat will be removed within the Nords Wharf Development Estate with over 42.36 ha (84%) to be retained within the Conservation Lands. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Diuris* sp. aff. *aurea/Diuris* sp. aff. *chrysantha

The taxonomy of this species is currently under investigation as it is unknown if the affinities of this species is closer to *Diuris aurea* or *Diuris chrysantha* (Bell 2008). This species has been recorded in the local area including Gwandalan, Chain Valley Bay, Charmhaven, Warnervale, Munmorah and Norah Head (Gunninah 2003). As taxonomy of this species has not yet been determined for this species habitat has been assumed to be as for *Diuris aurea.* Potential habitats for *Diuris aurea* within the Nords Wharf site include Narrabeen Wallarah Sheltered Grassy Woodland, Coastal Sheltered Apple – Peppermint Forest, Coastal Plains Smooth-barked Apple Woodland, Narrabeen Snappy Gum Forest and Narrabeen Foreshore Redgum Ironbark Forest. Approximately 10.1 ha (9%) of habitat will be removed within the Nords Wharf Development Estate with over 102.51 ha (91%) to be retained within the Conservation Lands at Nords Wharf. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species.

Thelymitra* sp. aff. *purpurata

This species shows affinities to both *Thelymitra purpurata* and *Thelymitra ixioides.* Neither of these two species has been located within the Nords Wharf site. However, potential habitat and records exists for *Thelymitra ixioides* in the locality. Thus it has been assumed that this species may be present within the Nords Wharf site. Potential habitats include Narrabeen Wallarah Sheltered Grassy Woodland, Coastal Sheltered Apple – Peppermint Forest, Coastal Plains Smooth-barked Apple Woodland, Narrabeen Snappy Gum Forest and Narrabeen Foreshore Redgum Ironbark Forest. Approximately 10.1 ha (9%) of potential habitat will be removed within the Nords Wharf Development Estate with over 102.51 ha (91%) to be retained within the Conservation Lands. Therefore, it is considered unlikely that the proposal will have a significant impact upon this species

4.1.10 Groundwater Dependent Ecosystems

The potential presence of Groundwater Dependent Ecosystems (GDE's) within the Southern Lands was raised by DEWHA during the consultation stage of the project and is addressed in the following discussion.

GDE's is a broad definition covering all ecosystems which are dependent upon groundwater either permanently or occasionally to survive (DLWC, 2002). Several of the vegetation communities on the Nords Wharf site have been identified as GDE's (Refer to Table 4-2 and Figure 4-3). Identification GDE's depends upon the location of the vegetation communities in relation to groundwater. GDE's are typically the communities which are located in drainage depression, swamps and creeklines, where groundwater comes up to the surface.

Douglas Partners (2008) have undertaken groundwater and soil studies within the Nords Wharf site (Douglas Partners 2008). This report indicates that both the Swamp Oak Rushland Forest and the Redgum Roughbarked Apple Forest is situated on areas in which the groundwater is controlled by the water level within Lake Macquarie and not by recharge from rainfall within the vicinity of the Development Estate. Therefore these two GDE's will not be affected by the development. The alluvial soils which have been mapped by Douglas Partners (2008) to the south of the proposed Development Estate are

expected to contain unconfined aquifers perched above the less permeable underling residual soils and rock. This low lying area's source of recharge to the aquifers is from surface runoff and direct rainfall. The upslope area which will contribute to the recharge of these aquifers will include the Development Estate. The EEC of Swamp Mahogany Paperbark Forest is likely to be dependent upon this aquifer for a water source. Thus, it is important that surface runoff flows are maintained at the current level to ensure that adequate recharge to the aquifers will occur post-development.

Whilst the Riparian Melaleuca Swamp Woodland is generally dependent upon surface water runoff, some portions of this vegetation community may be dependent upon groundwater in the lower lying areas which adjoin the Swamp Mahogany Paperbark Forest. Therefore, the lower portions of Riparian Melaleuca Swamp Woodland maybe dependent upon groundwater and constitute a GDE. The remaining GDE vegetation community of Mangrove – Estuarine Complex can occasionally be dependent upon groundwater; however, due to the close proximity to Lake Macquarie in this case it is most likely to be dependent on water levels within Lake Macquarie rather than groundwater.

GDE's have been classified into several different types according to DLWC (2006). These classes take into consideration aquifer, ecological and geomorphic types. The GDE's that have been identified on Nords Wharf site include Swamp Mahogany- Paperbark Forest, Riparian Melaleuca Swamp Woodland, Swamp Oak- Rushland Forest and Mangrove – Estuarine Complex.

Table 4-2 below outlines the GDE types, classes and sub-classes as per DLWC (2006) which occur within the Nords Wharf Site.

Table 4-2: GDE's Types and Classes for Nords Wharf

Vegetation Community at Nords Wharf	GDE TYPE	Class	Description of Class	Habitat
Swamp Mahogany – Paperbark Forest	Riparian & Terrestrial Vegetation (T)	T1	Riparian Vegetation Community	Terrestrial
Riparian Melaleuca Swamp Woodland	Riparian & Terrestrial Vegetation (T)	T1	Riparian Vegetation Community	Terrestrial
Redgum Roughbarked Apple Forest	Riparian & Terrestrial Vegetation (T)	T1	Riparian Vegetation Community	Terrestrial
Mangrove – Estuarine Complex	Marine Estuarine Habitats (M)	T4	Mangrove Swamp	Epigean
Swamp Oak Rushland Forest	Marine Estuarine Habitats (M)	M4	Tidal Freshwater swamp forests	Epigean

If existing surface water flow rates are maintained there will be minimal impact upon the GDE's present within the Nords Wharf. As recommended by Douglas Partners (2008) this can be achieved by appropriate water sensitive design via the provision of surface water

detention basins or swales to limit peak flows.

In conclusion, several of the vegetation communities within the Nords Wharf Development Estate have been classed as GDE's. However, it must be noted that whilst some communities are generally reliant on surface water runoff, when groundwater is available these communities would utilise this water source for their water requirements.