Proposed Remediation of Contaminated Land

Lots 1–4 DP 818957 Addiscombe Road, Manly Vale

Project Application and Preliminary Environmental Assessment

August 2006

Manly Council

Parsons Brinckerhoff Australia Pty Limited ACN 078 004 798 and
Parsons Brinckerhoff International (Australia) Pty Limited ACN 006 475 056
trading as Parsons Brinckerhoff ABN 84 797 323 433

Ernst & Young Centre, Level 27
680 George Street
Sydney NSW 2000
GPO Box 5394
Sydney NSW 2000
Australia
Telephone +61 2 9272 5100
Facsimile +61 2 9272 5101
Email sydney@pb.com.au

ABN 84 797 323 433
NCSI Certified Quality System ISO 9001

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Author: E. Barnet, B. Young, G. Khosa .....

Reviewer: H Swinbourne, M Dale .....

Approved by: H Swinbourne .....

Signed:

Date: .....

On behalf of Parsons Brinckerhoff Australia

Endorsed by: .....

Title: .....

Date: .....

On behalf of AGL

Distribution:

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Introduction

The proposed remediation of contaminated land at Addiscombe Road, Manly Vale will be assessed under Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act) as a major project and following the project approval process.

This document:

- *Supports an application under Section 75E of the* Environmental Planning and Assessment Act 1979 *(EP&A Act) for Ministerial approval to carry out the proposed remediation of contaminated land at Lots 1–4 DP 818957 Addiscombe Road, Manly Vale (the Proposal) under Part 3A of the EP&A Act.*
- *Describes the Proposal, identifies its likely impacts and the mitigation measures proposed to be adopted in response.*
- *Seeks environmental assessment requirements under Section 75F(3) for the purposes of any additional environmental assessment which may be required under Sections 75F(5) and 75H(1).*

The proposed Addiscombe Road Remediation Project

The Proposal comprises:

- *clearing and off-site disposal of existing loose materials from the surface of the site*
- *removal/re-contouring contaminated topsoil and installation of warning layer and capping material to enclose the contaminated area*
- *reinstatement of topsoil and surface works to prepare the site for future land use as passive open-space recreation and nature conservation.*

Preliminary environmental assessment

The proposed remediation works at Addiscombe Road are likely to present a number of risks, which if unmitigated, may disturb or harm the surrounding biophysical and socioeconomic environment. However, provided the remediation follows appropriate safety and environmental management procedures, impacts would be mitigated.

It is proposed that environmental issues be assessed and managed through Manly Council's Statement of Commitments which would determine the requirements of the approval conditions and the Construction Environmental Management Plan.

Overall, the proposed remediation works would protect the environment from further degradation and provide a clean and safe site for future open-space use, benefiting the local community and current recreational users.

1. Introduction

1.1 Purpose and scope of this document

This document:

- Supports an application under Section 75E of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for Ministerial approval to carry out the proposed remediation of contaminated land at Addiscombe Road, Manly Vale (the Proposal) under Part 3A of the EP&A Act.
- Describes the Proposal, identifies its likely impacts and the mitigation measures proposed to be adopted in response.
- Seeks environmental assessment guidelines under Section 75F(3) for the purposes of any additional environmental assessment that may be required under Sections 75F(5) and 75H(1).

1.2 Background to the Proposal

The remediation of the Addiscombe Road site is part of a wider scheme by Manly Council to clean up contaminated sites and improve passive open-space/nature conservation areas within the Manly local government area.

The low-lying nature of the land and its historic use as an incinerator/building waste storage site prompted the NSW Department of Environment and Conservation (DEC) to declare the area as a remediation site under Division 3 of Part 3 of the *Contaminated Land Management Act 1997* (CLM Act).

Other interests in the land, including the Department of Housing, have previously sought approval to remediate and develop the Addiscombe Road site. However, the Department of Housing no longer required the land and approval was not pursued. Lot 2 is still owned by the Department of Housing. The proposed remediation of the site is being coordinated by Manly Council on behalf of all landowners.

Manly Council is committed to cleaning up the site, ensuring the safety of the local community and protecting the environment, particularly Manly Lagoon, from potential impacts.

Manly Council therefore seeks approval under Part 3A to undertake works to remediate contaminated land at the Addiscombe Road site in Manly Vale. This Proposal is known as the Addiscombe Road Remediation Project. A Remediation Action Plan is being prepared concurrently with this application.

1.3 Project need

Under the CLM Act, the NSW DEC regulates contaminated sites that pose a significant risk of harm to human health or the environment.

The Addiscombe Road site has been declared a remediation site under Division 3 of Part 3 of the CLM Act. Manly Council, as custodians of the site, has elected to remediate the site in accordance with a voluntary remediation agreement to reduce risks to human health and improve the visual quality and land use functionality of the site for public users.

Currently only a narrow strip on the shoreline is used, as an informal walking track. The end use of the site is likely to be a passive open-space/nature conservation land use, which would significantly increase the site's functionality and aesthetics.

1.4 The proponent

The proponent for the proposed remediation works is Manly Council.

1.5 Preliminary environmental assessment

Environmental impacts of the remediation works relate to the potential impacts of earthworks close to residential areas and Manly Lagoon. Human health risks associated with exposure to contaminated materials are considered minor due to the nature of materials found within the site.

An environmental assessment of potential environmental issues is presented in *Section 5.* The assessment demonstrates that, provided appropriate management measures are implemented, they would not have, or be likely to have, a significant effect on the environment due to the Proposal.

2. Project description

2.1 Site location and description

The proposed remediation site is located at the northern end of Addiscombe Road, Manly Vale, adjacent to Manly Lagoon. The site is on the northern border of the Manly local government area, adjoining the suburb of North Manly and the Warringah local government area. *Figure 2.1* shows the location of the site and surrounding land use features.

The proposed remediation site consists of four adjoining allotments with a total area of 1.73 hectares. The four allotments comprise:

- Lot 1 — DP818957, Manly Council (Community Land), 2,319 square metres
- Lot 2 — DP818957, Department of Housing, 1.066 hectares
- Lot 3 — DP818957, Crown Land, Council as trustee, 3,455 square metres (riparian zone)
- Lot 4 — DP818957, public road reserve, Manly Council, 325 square metres.

All allotments are Zone 6 – Open Space under the *Manly Local Environmental Plan 1988.*

2.1.1 Existing land use and characteristics

The proposed remediation site is currently vacant. A narrow gravel track runs parallel to the foreshore from Campbell Parade (Warringah local government area) to Addiscombe Road (Manly local government area). This track is used by local residents for recreation and as a means of access between Warringah and Manly local government areas. This track links Passmore Reserve to the north with Manly Golf Course to the south.

A temporary site shed has been erected on the site. No other buildings or structures are located on the site. The TS Condamine Naval Cadets building, which previously occupied a portion of the site, was recently demolished. All building materials and rubble were removed from the site as part of a separate remediation exercise. The remediation works were coordinated by the Department of Defence and HLA Environmental Sciences and will be reviewed by the auditor. Results of the demolition and remediation works are pending and will be used in future assessment.

The site is mostly covered by grasses and weeds, but also contains some large trees (see *Appendix B* for species names). The site is raised above normal levels due to the fill materials beneath its surface). While its topography varies, it generally slopes gently from west to east towards the Manly Lagoon. A portion of the site (Lot 2) is currently fenced (as part of the TS Condamine remediation). Public access to the rest of the site is possible from the walking track.

Proposed remediation site

2115107A_2007_Site_Location.mxd

Proposed remediation site

Site access

0 20 40 60 80 Metres

Scale 1:2,000

Figure 2.1 Proposed remediation site

2.1.2 Contaminated land

The site contains incinerator/building wastes in various locations and at different depths. The contaminated material is remnant ash disposed during municipal waste incineration which occurred between 1914 and the 1950s. The ash also contains materials which did not burn during the incineration process, such as metal objects, bricks, ceramics and glass. Asbestos bonded cement sheet fragments have also been identified within this fill material.

Some evidence indicates that sediments in Manly Lagoon contain contaminants from the Addiscombe Road site. The extraction and treatment of this sediment is currently being assessed by Manly and Warringah Council as part of a wider program to improve the hydraulics and water quality within Manly Lagoon. The remediation of sediments from Manly Lagoon under this program is subject to a separate approval process.

2.2 Site history

The site is thought to have been originally a low-lying and swampy area that over time has been reclaimed by adding clean and waste fill as described above.

The Addiscombe Road site was first granted to D'Arcy Wentworth in 1818. From this period until 1917 the land was owned by several owners after which it was purchased by Manly Council (Council). In 1989 the land was sold to the NSW Department of Housing.

In 1914 the site was subject to provisions of section 55 of the Public Health Act (1902). An interpretation of the notice indicates the order may have been issued due to the low lying and swampy nature of the site. The notice of revoked in April 1990.

Between 1914 and 1917, Council operated the site as a rubbish tip that may have included a garbage incinerator. Available information suggests that, since the tip also accepted waste that could not be incinerated, the incinerator might not have been located at the tip itself, and that instead, waste from the incinerator might have only been disposed of at the tip. It is reported that the Manly incinerator operated until 1939, after which rubbish was trucked to an incinerator in Mosman. Rubbish continued to be disposed of at the Addiscombe Road tip until the 1950s. A dog pound is also thought to have operated on site during this period.

Manly Council leased a portion of the land in 1953 for use as a joinery works. In 1969 the Naval Cadets leased a portion of the site for a training facility — TS Condamine — within Lot 3 (Crown Land) and Lot 1 (Council land). As previously stated, this facility was demolished in early 2006.

A large number of previous environmental studies, including an environmental impact statement and remedial action plan, have been undertaken at the site to determine the extent of contamination and remediation techniques. A list of all previous environmental studies on the site is provided in *Appendix A.*

2.3 Surrounding land use

The site is located at the northern end of Addiscombe Road, a cul-de-sac on the edge of a predominantly residential area. Three main roads — Condamine Street to the west, Pittwater Road to the east and Sydney Road to the south — provide nearby arterial road access to the site.

The site is bounded by industrial land to the west (Manly Grove Business Park), the Manly Lagoon/waterway to the north-east and east, and residential areas to the east and south. Mackellar Girls High School is located west of the large Manly Grove Business Park. There are several existing recreational land uses to the north of the site, including Manly Vale Bowling Club, Nolan Reserve and Passmore Reserve.

Figure 2.1 shows the proximity of surrounding land uses to the Addiscombe Road site.

2.4 Proposed remediation works

The proposed remediation works would primarily involve the containment of contaminated material that is located at various depths below the site. This process is called 'capping' and involves a number of safety measures to ensure the material being capped cannot be accessed.

The proposed remediation works would be undertaken in a series of staged events to minimise impact on the surrounding environment, in particular the lagoon. These staged events would generally involve setting up certain environmental controls. The events would include the removal of topsoil (where necessary), installation of a demarcation or protective geotextile fabric layer, installation of a capping/separating layer (with verified clean materials) and reinstatement of clean topsoil on the site. Final levels of cap thickness and materials will be agreed in discussions with a DEC Site Auditor during the Remediation Action Plan process.

It is proposed to convert the Addiscombe Road site to a passive recreation area with soft and hard landscaping and facilities for the local community to use.

2.4.1 Site preparation

Before works commence, signage would be erected at the site, detailing directions to key areas and relevant traffic restrictions. Signage at the main access points will include after-hours contact details.

Perimeter security fencing would be inspected and repaired as required. Work areas and exclusion zones would be fenced as required. The boundary of all exclusion zones would be defined by a tape fence comprising warning tape attached to pickets.

The following accommodation facilities would be established at the site:

- temporary site sheds and portable ablution blocks
- bins for domestic rubbish

- decontamination areas for plant and equipment (e.g. hardstand area).

Initially the vegetation on-site would be removed and disposed of off-site (except for the large trees that are identified to remain). Silt traps along foreshore, run-off drains, and sediment and stormwater collection basins would then be constructed to mitigate the effects of erosion and sedimentation. All other remnant loose materials would be stockpiled and reused or disposed as appropriate.

Large trees determined to be significant and requiring retention would be flagged and secured with barrier mesh or similar to ensure their protection during earthworks. When heavy machinery is scheduled to work near any large tree or tree roots, the Remediation Contractor would be required to have an arborist in attendance to ensure work methods maintain the health of the tree.

Protection of the foreshore area would also be required during the remediation works. Exposure of this region would need to be minimal. Green waste stripping and disturbance will be limited in areas near the lagoon to ensure bank stability.

2.4.2 Proposed plant for site works

Limited plant and machinery would be required to perform remediation works on-site. Generally, the type of plant and the works that it would undertake during the remediation phase are expected to be:

- Track or rubber-wheel excavators with extended reach booms — to remove vegetation and spread/distribute fill materials.
- Front-end loaders or dozers — to push, level and spread contaminated and clean fill materials to desired levels.
- Graders — to level out and contour areas of the site.
- Non-vibratory rollers/compactors — to stabilise fill materials and place/compact layers of the cap in place.
- Water trucks — to introduce moisture into construction/compaction works and suppress dust.
- Six or eight-wheel trucks — to import/export clean and contaminated fill materials.

2.4.3 Surface removal and containment works

Once the site is cleared of all non-essential vegetation, the topsoil would be removed and stockpiled separately for disposal. After it is tested for contaminants, the vegetation may be disposed as green waste. Removal of the vegetation and associated topsoil will be staged so that areas of exposure are minimised to prevent excessive erosion and sedimentation of the lagoon.

Once the surface areas of fill material are exposed, the required site levels would be contoured and levelled to accommodate placement of the demarcation layer and clean-fill cap. Site levels will be governed by existing features and elevation relevant to the lagoon and corresponding flood plain. Depending on the levels required to install the

cap, a small volume of fill may require off-site disposal. Off-site disposal materials and techniques will depend on waste classifications outlined in the *Environmental Guidelines: Assessment, Classification and Management of Liquid Wastes* (DEC, 2004). An estimate of the volumes potentially required for off-site disposal will be outlined in the Remediation Action Plan.

At the conclusion of fill contouring and distribution works, a demarcation layer would be placed over the exposed contaminated material. This layer would comprise a tough woven nylon netting (geofabric) or similar. The demarcation layer ensures that future workers at the site will be warned that they are entering the contaminated zone.

The contaminated area would then be capped with clean fill. The clean-fill cap would be Geotechnically suitable and imported from an external source either as Virgin Excavated Natural Material (VENM) or as clean fill which would be tested for contaminants prior to placement. The clean-fill layer would then be spread over the land surface and topsoil added to promote the growth of grasses, shrubs and trees.

The site would be turfed and landscaped in accordance with a Landscape and Urban Design Plan.

2.5 Project cost estimate

The capital cost of the proposal is estimated to be approximately $750,000 to 1,000,000.

Indicative average workforce numbers at any time during construction of the proposed Addiscombe Road Remediation Project is not anticipated to exceed 5 to 10 employees at any one time. Actual numbers would vary according to the contractor's work to be carried out on the day.

2.6 Key technical issues

Provided appropriate management measures are implemented for the project, the remediation works would be unlikely to impact the biophysical and socioeconomic environment. Since the works are temporary, construction impacts such as dust, noise and visual amenity would be acceptable, provided they are appropriately managed.

One of the key challenges for the remediation of the site is preventing sedimentation of Manly Lagoon and ensuring surface runoff and sedimentation is safely and permanently contained. This will primarily be achieved by the Remediation Contractor's use of various environmental controls and by staging works to ensure the lagoon and foreshore area receive minimal exposure.

2.7 Project timetable

The bulk of remediation works, that is capping, would be carried out over a six- to eight-week period. Pre-construction and post-construction activities would occur outside this timeframe.

A preliminary program of works associated with site preparation and anticipated landscaping is yet to be determined and will be provided within the Remediation Action Plan and proposed Warringah Landscape Masterplan.

3. Statutory and policy context

3.1 Commonwealth legislation

A search of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* Protected Matters (National Environmental Significance) database shows that no sites listed on the Register of the National Estate are close to the Proposal. The site is not a World Heritage property, neither contains nor is close to wetlands of International significance, and is not a marine environment.

An ecological assessment undertaken by Parsons Brinckerhoff shows that given the disturbed nature of the site and presence of exotic vegetation, it is unlikely that any endangered ecological communities or species of national significance are present or dependent on resources within the site.

The Proposal is therefore unlikely to result in any significant impact on the protected matters and therefore the Proposal does not need to be referred to the Commonwealth Minister for the Environment pursuant to the *Environment Protection and Biodiversity Conservation Act 1999*.

3.2 State legislation

3.2.1 Environmental Planning and Assessment Act 1979

Part 3A of the *EP&A Act* establishes an assessment and approval regime for major infrastructure projects. Part 3A applies to development that is declared to be a Part 3A project by either a state environmental planning policy or Ministerial order (Section 75B).

Clause 6 of *State Environmental Planning Policy (Major Projects) 2005* (Major Projects SEPP) provides that:

> …development that, in the opinion of the Minister, is development of a kind:
>
> (a) that is described in Schedule 1 or 2…
>
> is declared to be a project to which Part 3A of the Act applies.

In accordance with Clause 28 of Schedule 1 of the Major Projects SEPP, development for the purpose of remediation of land on:

(a) premises subject to a notice requiring prescribed remedial action to be taken under Section 35 or Section 36 of the *Environmentally Hazardous Chemicals Act 1985* (as continued in force by the *Contaminated Land Management Act 1997*), or

(b) land declared as a remediation site under Division 3 of Part 3 of the *Contaminated Land Management Act 1997*

is deemed to be development to which Part 3A applies.

Lots 1–4 DP 818957 Addiscombe Road, Manly, has been declared as a remediation site by the Department of Environment and Conservation (Environment Protection Authority) under Division 3 of Part 3 of the *Contaminated Land Management Act 1997*. In undertaking the remediation works it is envisaged that the notice to remediate the site will be removed

The proposal will therefore be assessed under Part 3A as a major project and following the project approval process.

3.2.2 Other legislation

Table 3.1 outlines approvals and licences required for the remediation of Lots 1–4 DP 818957 Addiscombe Road, Manly.

Table 3.1: Licences and approvals under NSW legislation

Legislation	Key requirements	Relevance to this Proposal
Protection of the Environment Operations Act 1997	Environment Protection Licences regulate water, air and noise pollution and waste. Under the Act the Department of Environment and Conservation requires licences for 'scheduled activities', 'scheduled development work' and for the purpose of regulating water pollution.	The Proposal is not a 'scheduled activity' or 'scheduled development work' under the Act and hence no licence would be required. However, the removal of waste from the remediation site, if it occurs, is listed as an activity needing a licence. The removal of waste would be carried out by a licensed contractor.

The *Rivers and Foreshores Improvement Act 1948* would normally apply to the site given the proposed works would be carried out within 40 metres of a waterway (Manly Lagoon). However, as Manly Council is the proponent for the works and as the project is deemed a major project for the purposes of Part 3A of the *EP&A Act*, this Act does not apply.

3.2.3 Other policy

State Environmental Planning Policy No. 55 — Remediation of Land

State Environmental Planning Policy No. 55 — Remediation of Land sets the regulatory framework for contaminated land and remediation works within New South Wales. *State Environmental Planning Policy No. 55* classifies the remediation of Addiscombe Road as *Category 1* remediation work.

This work requires the consent of the relevant planning authority, which in this case is Manly Council. The categorisation is a result of the site's location adjacent to Manly Lagoon, which is subject to coastal protection legislation.

As the project is considered a major project under the Major Projects SEPP (see *Section 3.2.1*), consent is not required through Council.

3.3 Local planning instruments

The *Manly Local Environment Plan 1988* applies to the subject site. Normally, consent is required for remediation works within the *6 — Open Space* zone, however as the project is considered a major project for the purposes of Part 3A of the *EP&A Act*, consent is not required through Council.

4. Consultation

4.1 Consultation activities

Consultation for the proposed remediation of Addiscombe Road began in 2002 with a public meeting held on 15 June 2002.

The meeting was attended by members of the public and representatives of Manly and Warringah Councils, including Councillors, to discuss the future use of the site. These discussions led to the engagement of a consultant to prepare a remediation action plan to remediate the site.

The Manly Lagoon Integrated Catchment Committee (formerly named the Manly Lagoon Joint Estuary/Floodplain Management Committee) has also been overseeing the project as part of its ongoing interest in activities and land issues within the Manly Lagoon catchment.

This committee has Councillor, community, stakeholder (including state government agencies) and Council staff representation, and meets bi-monthly. The Addiscombe Road site has been a standing item on the committee's agenda for some time.

Information on the remediation works at the Addiscombe Road site is made available at all public meetings. Regular updates on remediation works throughout the Manly Council area and on the Manly Lagoon remediation are provided on the Manly Council website (www.manly.nsw.gov.au).

4.2 Outcomes

The Manly Lagoon Integrated Catchment Committee has a direct interest in the remediation project and has particular concerns for Manly Lagoon and community impacts, particularly relating to amenity and safety.

Overall, it has been determined that community groups and stakeholders wish the Addiscombe Road site to remain open space and be developed as a passive recreation and nature conservation area.

The current project seeks to achieve remediation to a standard that allows future community use of the site.

5. Preliminary environmental assessment

5.1 Overview

A large number of environmental studies have been conducted for the Addiscombe Road site (see *Appendix A*). These studies have mostly examined the characteristics and dynamics of the contamination that exists below the Addiscombe Road site, particularly how the contaminated material interacts with the surrounding physical environment. An Environmental Impact Statement (Johnstone Environmental Technology, 1999) prepared for the Department of Housing assessed the impacts of a similar remediation scheme at Addiscombe Road. Where appropriate and relevant, this information has been used to support this preliminary environmental assessment.

The majority of contaminated materials are inert solid materials, such as asbestos cement fragments, bricks, metal objects, glass and ceramics. However, heavy metals in particular zinc have been detected and detected in groundwater that flows under the site and into Manly Lagoon. Other existing impacts relate to exposure of loose materials, where loose matter protrudes above the surface; however, these impacts are minor.

The proposed remediation works at Addiscombe Road are likely to present risks which, if unmitigated, may disturb or harm the surrounding biophysical and socioeconomic environment. However, provided the site is remediated in accordance with appropriate safety and environmental management procedures, impacts would be minor. A clean and safe site would provide immediate benefits to the community and the environment.

The proposed works would be carried out over an estimated period of six to eight weeks. Impacts associated with site works would therefore be temporary and solely related to the construction works involved in the remediation.

Environmental impacts of the remediation works relate to the impacts of earthworks close to residential areas and Manly Lagoon. Human health risks associated with exposure to contaminated materials are considered minor due to the nature of these materials and the management procedures proposed.

A preliminary assessment of environmental issues and proposed actions to mitigate potential impacts are outlined in *Table 5.1*.

Table 5.1: Assessment of environmental issues

Issue	Impacts	Proposed mitigation measures
Soil and water	***Soils*** Previous site investigations indicate the maximum depth of topsoils at the site to range between 0 and 0.5 metres, with less than 0.2 metres of topsoil over most of the site. The site is generally underlain by fill to an average depth of between 0.15 and 4.8 metres below ground surface. The fill consists of red to brown sandy clay with substantial fragments of metal, glass, ceramics, rock fragments, pipework, pieces of asbestos sheeting and other waste materials. Underlying the fill are discrete layers of sandy clay on top of sandstone (Hawkesbury). Based on the Acid Sulfate Soil risk map outlined in the Manly LEP (1988), the foreshore area of the site exhibits a high potential (Class 1) for acid sulfate soils to be present. The map indicates that the majority of the site contains a lower risk (Class 5) however this may be attributed to the presence of fill over most of the site. Although covered with fill this area of the site including underlying natural soils may exhibit acid sulfate soils characteristics and will need to be determined during site works. All areas of the site especially the foreshore will need to be assessed for Potential and Actual acid sulfate soils at the time of works to determine what kind of management procedures will need to be applied. There is the potential for soil erosion during excavation works where turf, vegetation and topsoil would be removed prior to laying the protective geotextile fabric layer. This may impact on surface water quality. ***Surface water*** As large areas of land would be exposed during excavation, careful management of surface flows and water quality is essential to restrict potential sedimentation and/or contamination of Manly Lagoon. Excess water usage for dust suppression and rainfall events may produce surface flows. Existing soil contaminants and pollutants from vehicles and machinery (fuel, lubricants, etc.) may contribute to contamination of surface water, which in turn would impact on water quality within Manly Lagoon. ***Groundwater*** The proposed remediation works would significantly improve groundwater. Groundwater flows at the site are influenced by a number of sources including, the lagoon, stormwater from up gradient residential areas and surface infiltration during high-rainfall events. Contaminated materials within the landfill pollute groundwater, which flows laterally into	A Soil and Water Management Plan would form part of the Construction Environmental Management Plan prepared by the contractor. The plan would outline best practice soil and water management techniques for contaminated site management. A key aspect of the plan will need to address the testing, stabilisation and management techniques for actual acid sulfate soils during site works. It is anticipated that acid sulfate soils will not be a major issue as disturbance caused by remediation works around the fore shore area will be minimal to preserve the sensitive areas. Other areas of the plan will include provisions to allow for soil and water management devices to be implemented prior to remediation works during site preparation. In particular the plan would outline provisions to reduce the flow of contaminated groundwater into the lagoon. The plan shall also outline contingency measures to mitigate against unexpected materials being encountered during remediation works. Mitigation measures would include: ▪ installation of a silt fence or RipWrap™ along the entire length of the site's border with Manly Lagoon ▪ hay bales or, geotextile filter fabric or silt traps with impermeable liners placed immediately downslope of current work areas, stockpiles, stripped or filled areas. These would act as a barrier, preventing sedimentation reaching the lagoon ▪ maintenance of all control devices beyond the completion of the remediation until the final cap layer has been fully stabilised

Issue	Impacts	Proposed mitigation measures
	Manly Lagoon. Previous studies by IT Environmental (2001) and WS Rooney & Associates (1997) on groundwater flows and heavy metal escape from the landfill site determined that zinc was the primary contaminant of groundwater. The installation of a layer of clean fill across the site will reduce vertical infiltration during rain events substantially reducing potential for leaching of contaminants to groundwater. Water will be more inclined to run off the capped area into designed drainage mechanisms to take water off-site in a safe manner (through stormwater receptors). A series of stormwater drains would be installed on the up gradient boundaries are proposed to prevent lateral groundwater flows from transporting water through the contaminated fill during high storm events.	▪ storage and handling of fuels and lubricants in appropriately bunded areas and in accordance with relevant standards and legislation. These measures, reinforced by regular inspection and maintenance, should ensure that potential water quality impacts and erosion and sedimentation are minimised
Air quality	During construction, potential sources of air pollutants may include: ▪ dust produced from site traffic movements and/or high winds and from the loading, transport and stockpiling of spoil. Dust from site soils may contain elevated copper, lead and zinc concentrations, and would need to be controlled for health and safety reasons ▪ vehicle emissions from remediation equipment and machinery, such as backhoes and dump trucks, used to transport clean fill to the site, and from general traffic associated with a construction site. Potential construction air quality impacts would be limited to particulate matter emissions. The impact of fugitive dust sources is related to the quantity and drift potential of the particles. Larger particles generally settle out near the source whereas fine particles can be dispersed over greater distances from the source. It is unlikely that organic vapours, combustible gases and odours would be generated during site remediation due to the results of gas surveys previously undertaken at the site, low concentration of organic contaminants within the fill and lack of putrescible wastes identified within in the fill.	An Air Quality Management Plan would be developed and implemented, as a part of the Construction Environmental Management Plan, to control dust emissions from the construction works. Mitigation measures would include: ▪ use of water sprays to suppress dust generation. All dust-generating activities will cease until the area has been sufficiently wetted for dust to be suppressed without causing run-off ▪ maintenance of vegetation, where possible ▪ If unexpected material are encountered works shall be undertaken in accordance with contingency measures outlined within the Construction Environmental Management Plan ▪ if stripped areas are left exposed for an extended period without being worked, covering the areas and/or stockpiles or spraying them with hydromulch or similar ▪ ensuring all vehicles and other powered equipment used on the site conform to current emission standards and are regularly maintained to ensure that emissions are minimised.
Noise and	This existing ambient noise environment is typical of a residential area, but is influenced	Noise management measures would be incorporated

Issue	Impacts	Proposed mitigation measures
vibration	by the small light-industrial park adjoining the site's western boundary. The nearest residential receivers are located close to the southern boundary of the site at the end of Addiscombe Road. Noise during the remediation works would be primarily generated from the operation of vehicles and machinery on the site and traffic movements along local roads to and from the site. Proposed plant and equipment include track or rubber-tyred excavators, front end loader, dozer and loader, and small grader. Other 4WD vehicles and vehicles used by site staff would be parked within the site compound adjacent to Addiscombe Road. General remediation works, spoil disposal, equipment and material deliveries at the construction sites would generate noise that may affect nearby residential and commercial receivers. Impacts of site activities are based on noise level objectives for construction noise set by the Department of Environment and Conservation in the *Environmental Noise Control Manual*. The nearby Mackellar Girls High School would be shielded to some extent by the light industrial complex to the west of the site. Residents on the southern boundary of the site would experience noise disturbance during site preparation works along this boundary. Predicted noise levels are unlikely to exceed specific noise criteria during proposed restricted work hours. Some residents may experience increased noise levels and disturbance; however, due to the temporary nature of works (6–8 weeks) and restricted working hours, noise impacts are considered minor. No blasting or use of vibratory compacting machinery is proposed. Therefore, vibration would not require assessment.	into the Construction Environmental Management Plan prepared by the contractor. Specific mitigation measures would include: ▪ restricting operating hours during remediation to 7:00 am – 5:00 pm weekdays and 8:00 am to 1.00 pm Saturdays, and no work on Sundays/public holidays (or as stipulated by Council) ▪ excavation works close to residents on the southern boundary would be carried out during week day working hours only ▪ where possible fitting stationary and mobile equipment with residential-type silencers ▪ Manly Council's notifying local residents of the proposed commencement and completion dates for the remediation work and providing a contact name and number for the site office ▪ forbidding the queuing of trucks in Addiscombe Road before 7:00 am weekdays or 8:00 am Saturdays.
Hazards and risks	The remediation works would require limited transport, storage, use, and disposal of various hazardous construction materials, such as grease, oils, and other petrochemical lubricants, and petrochemical fuels. Transportation off-site of contaminated fill may be required. Potential hazards associated with the Proposal are: ▪ physical hazards experienced on every construction site, possibly resulting in injury to personnel and damage to equipment	A Health and Safety Plan would be prepared by the contractor. Risk management measures would include: ▪ storage, handling and transportation of hazardous materials and liquids in accordance with relevant legislation, guidelines and standards ▪ erection of temporary barricades (fencing) at site remediation areas to prevent members of the public

Issue	Impacts	Proposed mitigation measures
	▪ inhalation of contaminant dusts ▪ release of contaminants into the receiving environment e.g. spills ▪ erosion of topsoil and sedimentation of local waterways ▪ contaminated soil potentially spilling from a truck in the event of an accident.	from entering these areas ▪ covering of loads and the implementation of emergency response procedures during transportation of contaminated soils ▪ transport of contaminated soil by a licensed waste contractor to a waste management facility licensed for the disposal of contaminated soil. All field personnel and subcontractors will conduct all site activities in compliance with the provisions of Worksafe Australia, Australian Standards and the NSW Work Cover, Construction Safety and Occupational Health and Safety Acts. Other mitigation measures to minimise potential hazards would be contained in the Soil and Water Management Plan and Air Quality Management Plan (see 'Air quality' and 'Soil and water' sections of this table)
Biodiversity	The remediation site is predominantly cleared of remnant native vegetation and dominated by exotic grasses and other weeds (73 percent of species recorded on the site were exotic). The structural complexity of the cleared areas is also low, hence the site provides poor fauna habitat. The remaining native species are restricted to scattered *Eucalyptus* spp. and *Glochidion ferdinandi* throughout the site and *Casuarina glauca* and other riparian species fringing Manly Lagoon. Searches of the Atlas of NSW Wildlife (Department of Environment and Conservation, 2006 #997) and the EPBC Protected Matters Search Tool (Department of the Environment and Heritage, 2006 #989) identified a diverse range of Threatened flora and fauna within the locality of the site (21 species of plant and 61 species of animal) listed under the *Threatened Species Conservation Act 1994* or the *Environment Protection and Biodiversity Act 1999*. No Threatened plants are likely to occur at the study site as a result of lack of suitable habitat and/or the high level of modification of the site. Fourteen species of bird were observed to frequent Manly Lagoon and hence it is unlikely Threatened and migratory species of animal occur at the site due to the unsuitable habitat and high degree of modification of fauna habitats. The study site does not form part of a significant regional corridor for fauna movement,	Measures to manage potential impacts on existing vegetation would be incorporated into the Construction Environmental Management Plan. Specific measures would include ▪ All trees to be retained will be clearly marked before any felling works begin. ▪ Before any earthworks begin, the trees to be retained will be fenced off to their drip line to prevent interference to the root zone under trees and accidental collision by machinery. ▪ The final capping design under the trees shall be different to open areas of the site and likely to incorporate a buried physical barrier such as a narrow gabion basket or geomesh (geosynthetic, plastic or steel) to contain the contaminated soil under the tree and provide a semi-impermeable barrier to the contaminated soil. The physical barrier will prevent compaction of the soil under the trees

Issue	Impacts	Proposed mitigation measures
	however Manly Lagoon may be considered as a fauna habitat corridor. Potential adverse impacts associated with the proposal area likely to include: ▪ removal of large Coral Trees that provide roosting and foraging habitat for native birds ▪ impacts to other large established *Eucalyptus* spp. trees within the study site resulting from disturbance to or compaction of the root zone, or accidental collision with plant and machinery ▪ exposure of contaminated soil with potential to leach or erode into Manly Lagoon ▪ other incidental or accidental trapping of fauna amongst the earthworks or erosion and sediment control fences. These impacts are likely to be contained within the site and not impact Manly Lagoon, hence they are unlikely to result in significant biodiversity (species, populations or ecological communities listed under the *Threatened Species Conservation Act 1994* or the *Environment Protection and Biodiversity Act 1999*). The rehabilitation of the site is likely to benefit flora and fauna in the long term by containing the contaminated soils and reducing weed densities. Post rehabilitation landscaping is also likely to incorporated native plantings and rehabilitation of the lagoon foreshore. A more detailed assessment of the impacts on biodiversity is provided in *Appendix B*.	and allow infiltration of air and water to the root zone. ▪ For measures to mitigate impacts on the lagoon, see the 'Soil and water' section. After the rehabilitation works are completed it is recommended that the site is landscaped using native species endemic to the lowland ecological communities of the Manly Council local government area and compatible to recreational land use (in accordance with the Warringah Landscape Masterplan).
Visual amenity	The site is bordered by a light industrial complex to the west, residential dwellings (and road) to the south and Manly Lagoon to the east. The topography of the site and density of trees on the boundary of the site currently limit views across the site. Houses across the lagoon, to the east, have direct views towards the site (Riverview Parade). However, to some extent the view is obscured by trees on the foreshore. Removal of some large trees may increase the site's visibility. Visual impacts of the remediation works are temporary. The overall visual amenity of the site would be significantly improved as a result of the works and once the site is landscaped.	Specific mitigation measures would include: ▪ work sites and the surrounding areas to be maintained in a clean and tidy condition ▪ perimeter fencing to be erected with hoarding to prevent views into the site.
Land use and socioeconomic impacts	The Proposal is generally consistent with the objectives of the land use zones in the Manly and Warringah areas. It is unlikely to significantly affect surrounding land uses or prevent any future development. Amenity-related impacts on surrounding land uses are discussed in relevant sections of this table.	No management measures are proposed.

Issue	Impacts	Proposed mitigation measures
	The Proposal would result in a positive net outcome for the local community, with the provision of a healthy and safe site prepared for a future passive recreational use.	
Traffic	Once the plant and equipment is delivered, there would be limited truck movements to and from the site. Periods of intense truck movements would occur during the filling operation and contaminated fill removal (if needed) when an anticipated 20 trips per day will be undertaken by trucks to and from the site. Employees' vehicles would park within the site compound off-road. It is expected that up to 10 vehicle trips per day would be undertaken by employees.	A Traffic Management Plan would be incorporated into the Construction Environmental Management Plan prepared by the contractor. This plan would focus on traffic management during the intense period when clean fill is being transported to the site. To reduce impacts on traffic, queuing of trucks in Addiscombe Road before 7:00 am weekdays or 8:00 am Saturdays would not be permitted.
Cumulative impacts	To reduce the duration of environmental and amenity-related impacts, the proposed remediation of Manly Lagoon sediments may be carried out in conjunction with the Addiscombe Road remediation works. Works, however, would be sequential rather than simultaneous, and would not exacerbate impacts; rather, the impacts would occur over a longer time. There are no other developments proposed near the site.	Should the Manly Lagoon project be carried out by a single contractor, a program of works would be communicated directly to local residents. Works would be appropriately programmed to avoid intense periods of activities that may impact on residential amenity.

Issue	Impacts	Proposed mitigation measures
Waste and resources	Potential impacts include the generation of various types of construction wastes, increased energy use and increased demand on local and regional resources. General domestic waste would be generated by construction staff. If not managed properly, this waste material could be discharged into the environment or local waterways as a result of the Proposal. It is unlikely that the Proposal would result in any resource becoming scarce or in short supply. Clean fill would be sourced to ensure it meets the requirements of suitable geotechnical and Virgin Excavated Natural Material (VENM) as required by the DEC Site Auditor.	Waste management measures would be incorporated into the Construction Environmental Management Plan prepared by the contractor. Management measures would include: ▪ recycling wastes, where feasible ▪ providing a sufficient number of suitable receptacles on-site for general waste, hazardous waste and recyclable materials ▪ providing on-site emergency spill kits and training all staff in their use ▪ ensuring any necessary machinery maintenance is conducted off-site in a suitable area ▪ ensuring the work site is left clean and free of debris and other rubbish at the completion of works ▪ ensuring the contractor follows a VENM Quality Control Plan for all materials entering the site.

5.2 Environmental management

Prior to the remediation phase of the works, management plans would be prepared to mitigate any issues associated with preparation, construction and finalisation works associated with the Remediation Action Plan. These would be incorporated in the Construction Environmental Management Plan and relevant Health and Safety Plans to be prepared by the contractor.

Environmental management measures are summarised in *Table 5.1*.

5.3 Further assessment

It is proposed that Manly Council conduct the following additional assessment of the traffic and noise impacts associated with the proposed remediation works.

5.3.1 Traffic

Manly Council would undertake the following traffic assessment:

- review site access and likely truck routes
- inspect site to observe traffic patterns during one critical peak period
- assess impact on road network and intersections

The assessment would make recommendations on measures to mitigate any identified adverse traffic impacts.

5.3.2 Noise

Manly Council would undertake the following noise assessment:

- identify sensitive receivers (e.g. nearby residences, Mackellar Girls H.S.)
- establish existing ambient noise levels at sensitive receivers
- establish noise criteria
- predict noise impacts during remediation works
- define measures to reduce noise impacts.

It is considered that no other additional detailed studies are needed to determine the environmental impacts of the proposed remediation works. Provided appropriate environmental management measures and site safety and management protocols are developed and adhered to, there would be a minimal impact on the environment.

Further, the proposed remediation works protect the environment from further degradation and provide a clean and safe site for the future open-space use, benefiting the local community and current recreational users.

References

Conaghan PJ (1980). The Hawkesbury Sandstone: Gross Characteristics and Depositional Environment. Article 12 in *A Guide to the Sydney Basin*. Bulletin 26, Geol Survey NSW.

IT Environmental (Australia) Pty Ltd (2001a) Manly Vale Groundwater Flow Assessment Prepared for DPWS, 10 July 2001.

Johnstone Environmental Technology (1999). *Environmental Impact Statement – Remediation of Lots 1-4 DP 818957, Addiscombe Road, Manly Vale.*

NSW EPA (1994) *Environmental Noise Control Manual*

NSW EPA (2000) *Industrial Noise Policy*

Soil Conservation Service of NSW (1995) *Sydney Basin Acid Sulfate Soils Risk Map*

WS Rooney & Associates (1997) *Impact of Heavy Metal Escape from the Addiscombe Road Incinerator Site, Manly Vale into Manly Lagoon.*

Appendix A

Previous environmental studies

Previous environmental assessments

A number of environmental assessments have previously been carried out on-site by various consultants. The principal reports in date order are:

- Groundwater Technology (1991) Environmental Assessment, Proposed Residential Development, Addiscombe Road, Manly Vale, NSW. Project number S5610.
- Groundwater Technology (1993) Additional Soil Sampling Proposed Residential Development, Addiscombe Road, Manly Vale, NSW. Project number S8227.
- Groundwater Technology (1994) Remedial Action Plan: Proposed Residential Development, Addiscombe Road, Manly Vale, NSW. Project number S8227.
- Groundwater Technology (1995) Revised Remedial Action Plan, Proposed public open space, Addiscombe Road, Manly Vale, NSW. Project Number S8227B.
- W.S Rooney & Associates (1997) Impact of Heavy Metal Escape from the Addiscombe Road Incinerator Site, Manly Vale into Manly Lagoon.
- Johnstone Environmental Technology (1999). Environmental Impact Statement – Remediation of Lots 1-4 DP 818957, Addiscombe Road, Manly Vale.
- HLA Envirosciences Pty. Ltd. (2000) Asbestos Audit Review, Department of Housing Property, Addiscombe Road, Manly Vale, NSW.
- Waste Service NSW (2000) Remediation Action Plan.
- IT Environmental (Australia) Pty Ltd (2001a) Manly Vale Groundwater Flow Assessment Prepared for DPWS, 10 July 2001.
- IT Environmental (Australia) Pty Ltd (2001b) Manly Lagoon - Literature and Data Review Prepared for DPWS 19 October 2001.
- IT Environmental (Australia) Pty Ltd (2002a) Risk Based Assessment of Groundwater
- Contamination Former Manly Council Tip, Lots 1-4, DP818957, Addiscombe Road, Manly Vale, Prepared for DPWS 14 August 2002.
- IT Environmental (Australia) Pty Ltd (2002b) Asbestos and Metals Investigation and Groundwater Assessment, Addiscombe Road, Manly Vale Prepared for DPWS, 29 November 2002.

Appendix B

Biodiversity assessment

Biodiversity assessment

This assessment was undertaken to identify and describe the flora and fauna habitats present and assess the likelihood of Threatened biodiversity to occur at the Addiscombe Road site. The assessment included a desk-based and site assessment. This section details the assessment methods, terminology, assumptions, limitations and results of the biodiversity assessment.

Methods

Definitions

For the purpose of this report the following definitions apply:

Study Area: the area of direct impact and any additional areas that could potentially be affected by the proposed activities either directly or indirectly.

Locality: the area within a ten kilometre radius of the study area.

Region: a bioregion defined in a national system of bioregionalisation. For this study this is the Sydney Bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway & Cresswell 1995).

Desk based assessment

Searches of the three databases were completed to identify Threatened species previously recorded or with predicted habitat within a ten kilometre radius of the study area (the locality).

This section details the types of data obtained from the NPWS Atlas of NSW Wildlife and the EPBC Protected Matters Search Tool and the accuracy of both datasets.

Atlas of NSW Wildlife

The Atlas of NSW Wildlife is based on records of specific sightings. Each point is entered on a one kilometre grid and hence location is only accurate to within one kilometre. The Atlas of NSW Wildlife is not based on systematic surveys across New South Wales and the number of records is generally biased towards coastal sites and areas where people commonly visit, such as National Parks. It is also biased towards particular species, reserves and roads.

EPBC Protected Matters Search Tool

The Department of the Environment and Heritage EPBC Protected Matters Search Tool is based on predicted distributions compiled from a number of sources at various resolutions. Generally, where distributions are well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and detailed habitat studies. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps. For species whose distributions are less well known, point locations

are collated from various sources and bioclimatic distribution models generated and then validated by experts. In some cases, distribution maps are based solely on expert knowledge.

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

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- cetaceans which are not listed as threatened
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers.

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

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

Field Assessment

A site inspection was completed by a ecologist on the 30 May 2006 to describe the species of plant and fauna habitats on the site.

Species of plant

Species of plants on site were assessed and recorded using the random meander technique (Cropper 1993),where the recorder walks in a random manner throughout the site, recording all species seen. The time spent in each vegetation community is generally proportional to the size of the community and its species richness.

Criteria used to assess quality of vegetation and fauna habitats

Condition of vegetation

The quality of vegetation was assessed using parameters such as intactness, diversity, history of disturbance, weed invasion and health.

Three categories were used to describe the condition of vegetation communities:

- **Good:** Vegetation still retains the species complement and structural characteristics of the pre-European equivalent. Such vegetation has usually changed very little over time and displays resilience to weed invasion due to intact ground cover, shrub and canopy layers.
- **Medium:** Vegetation generally still retains its structural integrity but has been disturbed and has lost some component of its original species complement. Weed invasion can be significant in such remnants.

- **Poor:** Vegetation that has lost most of its species and is significantly modified structurally. Often such areas now have a discontinuous canopy of the original tree cover, very few shrubs and exotic species, such as introduced pasture grasses or weeds, replacing much of the indigenous ground cover. Environmental weeds are often co dominant with the original indigenous species.

Condition of fauna habitats

Fauna habitats were assessed by examining characteristics such as the structure and floristics of the canopy, understorey and ground vegetation, the structure and composition of the litter layer and other habitat attributes important for feeding, roosting and breeding. Indirect evidence of faunal activity such as scats, diggings, scratch marks etc was also investigated. The following criteria were used to evaluate habitat values:

- **Good:** A full range of fauna habitat components are usually present (for example, old growth trees, fallen timber, feeding and roosting resources) and habitat linkages to other remnant ecosystems in the landscape are intact.
- **Moderate:** Some fauna habitat components are often missing (for example, old-growth trees, fallen timber), although linkages with other remnant habitats in the landscape are usually intact although sometimes degraded.
- **Poor:** Many fauna habitat elements in low quality remnants have been lost, including old growth trees (for example, due to past timber harvesting or land clearing) and fallen timber, and tree canopies are often highly fragmented. Habitat linkages with other remnant ecosystems in the landscape have usually been severely compromised by extensive past clearing.

Nomenclature

Names of plants used in this document follow *Flora of NSW* (Harden 1992, 1993, 2000, 2002) with updates from *PlantNet* (Royal Botanic Gardens 2006). Common names are used in this report for species of plant followed by the scientific name, where available, with the exception of those plants occurring in landscape settings. Scientific and common names of plants are listed in *Table C-1 and Table C-4.*

Names of vegetation communities used in this report are based on the dominant species and structure of the community. Where practical the names follow those used in the vegetation mapping of *Native vegetation of the Illawarra escarpment and coastal plain* (NSW National Parks and Wildlife Service 2003a).

Names of vertebrates follow the Census of Australian Vertebrates (CAVS) database maintained by the Department of the Environment and Heritage (2004). Common names are used in the report for species of animal. Scientific and common names are including in species lists found in *Table C-2* and *Table C-5*.

Limitations

The assessment was by design a habitat based assessment. Throughout a site, varying degrees of uniformity of flora and fauna habitats are encountered. Hence no sampling technique can totally eliminate the possibility that a species is present on site (e.g.

species of plant present in the seed bank). No targeted floral or faunal surveys were carried out.

As a result, the conclusions of this report are based upon available data and the field surveys and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of species. Also, it should be recognised that site conditions, including the presence of Threatened species, can change with time.

Results

The following tables detail the results of the biodiversity assessment. These are:

- Table C-1: species of plant recorded within the study area
- Table C-2: fauna habitats and microhabitat characteristics
- Table C-3: Endangered ecological communities identified within the Pittwater (Part B) CMA sub-region
- Table C-4: Threatened species of plant identified from the database searches, their preferred habitat and likelihood of occurrence within the study area
- Table C-5: Threatened species of animal identified from the database searches, their preferred habitat and likelihood of occurrence within the study area.

Table C-1 Species of plant recorded on site

Family	Botanical name	Common name	Native[1]	NW Act[2] class
Aceraceae	*Acer negundo*	Box Elder	N	
Amaranthaceae	*Alternanthera denticulata*	Lesser Joyweed	Y	
Apiaceae	*Foeniculum vulgare*	Fennel	N	
Asclepiadaceae	*Araujia sericifera*	Moth Vine	N	
Asteraceae	*Aster* sp.		N	
	Bidens pilosa	Cobbler's Pegs	N	
	Delairea odorata	Cape Ivy	N	4
Basellaceae	*Anredera cordifolia*	Madeira Vine	N	4
Casuarinaceae	*Casuarina glauca*	Swamp Oak	Y	
Commelinaceae	*Tradescantia fluminensis*	Wandering Jew	N	4
Euphorbiaceae	*Glochidion ferdinandi*	Cheese Tree	Y	
	Ricinus communis	Castor Oil Plant	N	4
Fabaceae (Faboideae)	*Erythrina X sykesii*	Coral tree	N	
Fabaceae (Mimosoideae)	*Acacia saligna*	Golden Wreath Wattle	N	
Malvaceae	*Lagunaria patersonia*	Norfolk Island Hibiscus	N	
	Sida rhombifolia	Paddy's Lucerne	N	
Moraceae	*Ficus rubiginosa*	"Port Jackson Fig, Rusty Fig"	Y	
Myrtaceae	*Eucalyptus botryoides*	Bangalay	Y	
	Lophostemon confertus	Brush Box	N	
Pinaceae	*Pinus radiata*	Radiata Pine	N	
Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum	Y	
Poaceae	*Cynodon dactylon*	Common Couch	Y	
	Ehrharta erecta	Panic Veldtgrass	N	
	Pennisetum clandestinum	Kikuyu Grass	N	
	Phragmites australis	Common Reed	Y	
	Stenotaphrum secundatum	Buffalo Grass	N	
Solanaceae	*Salpichroa origanifolia*	Pampas lily of the valley	N	
Urticaceae	*Parietaria judaica*	Pellitory	N	4
Verbenaceae	*Lantana camara*	Lantana	N	4

Notes: 1. Native refers to species endemic to the vegetation communities occurring within the study area

2. NW Act = *Noxious Weeds Act 1993* control classes are as follows: Class 1 - The plant must be eradicated from the land and the land must be kept free of the plant, Class 2 - The plant must be eradicated from the land and the land must be kept free of the plant, Class 3 - The plant must be fully and continuously suppressed and destroyed, Class 4 - The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority, Class 5 - The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with.

Table C-2 Fauna habitats and microhabitat characteristics

Microhabitat component	Habitats	
	Disturbed cleared areas	**Manly Lagoon Foreshore**
Upper canopy	Generally absent except for lone trees including natives and Coral Trees	Dominated by *Casuarina glauca*.
Shrub layer	Generally absent except for sparsely scattered weed thickets.	Generally absent except for sparsely scattered weed thickets.
Grasses, herbs and forbs	Dominated by exotic species of weeds and turf grasses.	Dominated by exotic species of weeds and turf grasses.
Leaf litter	Largely absent	Moderate
Fallen timber	Absent	Absent
Tree hollows and stages	Largely absent. Some hollows may be present within the scattered lone trees including natives and Coral Trees	Absent
Rocks and rock shelves	Absent	Absent
Water bodies	Absent with the exception of Manly Lagoon	Adjacent to Manly Lagoon
Connectivity	Poor except along Manly Lagoon	Poor except along Manly Lagoon
Overall fauna habitat Quality	Poor	Moderate

Table C-3 Endangered Ecological Communities identified within the Pittwater (Part B) CMA sub-region

Scientific Name	Comparable to vegetation communities observed on the study area
Blue Gum High Forest	No
Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions	No
Duffys Forest Ecological Community in the Sydney Basin Bioregion	Yes
Eastern Suburbs Banksia Scrub in the Sydney Basin Bioregion	No
Hygrocybeae Community of Lane Cove Bushland Park	No
Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions	No
River-Flat Eucalypt Forest on Coastal Floodplains	No
Swamp sclerophyll forest on coastal floodplains	No
Sydney Freshwater Wetlands in the Sydney Basin Bioregion	No
Sydney Turpentine-Ironbark Forest	No

Table C-4 Threatened species of plant previously recorded or predicted to occur within the locality

Family Name	Latin Name	Common Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Habitat	Potential habitat within the study area
Casuarinaceae	*Allocasuarina portuensis*		E1	E	2EiT	Known from only a single population within Sydney Harbour National Park. The single population has declined from only 10 individuals in 1986 to only a single female surviving in 2002, excluding re-introduced individuals (NSW National Parks and Wildlife Service 2004b).	No - population restricted to south side of Sydney Harbour.
Epacridaceae	*Epacris purpurascens* var. *purpurascens*		V		2K	Occurs in Gosford and Sydney districts where it grows in sclerophyll forest, scrub and swamps (Harden 1992). Usually found in sites with a strong shale influence (NSW National Parks and Wildlife Service 2002a).	No - restricted to one population within the locality at Artarmon.
Euphorbiaceae	*Chamaesyce psammogeton*	Sand Spurge	E1			Occurs in coastal regions of NSW where it grows on sand dunes near the sea (Harden 2000).	No - study area does not contain any sand dunes.
Fabaceae (Mimosoideae)	*Acacia bynoeana*	Bynoe's Wattle	E1	V	3V	Occurs south of Dora Creek-Morisset area to Berrima and the Illawarra region and west to the Blue Mountains. It grows mainly in heath and dry sclerophyll forest on sandy soils (Harden 2002). Seems to prefer open, sometimes disturbed sites such as trail margins and recently burnt areas. Typically occurs in association with *Corymbia gummifera, Eucalyptus haemastoma, E. gummifera, E. parramattensis, E. sclerophylla, Banksia serrata* and *Angophora bakeri* (NSW National Parks and Wildlife Service 1999e).	No – the species that it is known to occur with generally occur on valley slopes and ridges and do not occur on the floodplain within the study area.
Fabaceae (Mimosoideae)	*Acacia terminalis* ssp. *terminalis*		E1	E	2Ri	Grows in scrub and dry sclerophyll woodland between Botany Bay and the northern foreshore of Port Jackson. The locations from which several of the early collections were made no longer provide habitat, having been cleared for development of the eastern suburbs. Recent collections have been made only from Clifton Gardens, Dover Heights, Parsley Bay, Nielsen Park, Cooper Park, Chifley and Watsons Bay (NSW National Parks and Wildlife Service 2004a).	No – north of Middle Harbour the species is restricted to the Eastern Suburbs Banksia Scrub ecological community at North Head where is occurs in heath on aeolian sands.
Haloragaceae	*Haloragodendron lucasii*		E1	E	2Ea	Confined to the Sydney area where it grows in dry sclerophyll open forest on sheltered slopes near creeks on sandstone (Harden 2002).	No – the study site is too modified and the only areas possessing any remnant vegetation is along the lagoon edge which is not suitable habitat for this species.
Hygrophoraceae	*Hygrocybe collucera*		E1			Small, brightly-coloured red gilled fungus and is known only from its type locality in the Lane Cove Bushland Park in the Lane Cove local government area in Sydney (NSW National Parks and Wildlife Service 2002b).	No – study area is not within the only known locality. No fungus observed during site inspection.
Hygrophoraceae	*Hygrocybe griseoramosa*		E1			Small, buff to brown gilled fungus known only from its type locality in Lane Cove Bushland Park in the Lane Cove local government area in Sydney (NSW National Parks and Wildlife Service 2002c).	No – study area is not within the only known locality. No fungus observed during site inspection.

Family Name	Latin Name	Common Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Habitat	Potential habitat within the study area
Lamiaceae	*Prostanthera marifolia*		E4	X	2X	Thought to be extinct. Previously occurred in Mangrove Mountain and Sydney districts usually near the coast. Recorded within sclerophyll forest and woodland in sandy loamy soils on sandstone Occurs in the Springwood area where it grows in woodland on lateritic soils (Harden 1992). The taxonomic status of this name is uncertain (Royal Botanic Gardens 2004).	No – the study site is too modified and the only areas possessing any remnant vegetation is along the lagoon edge which is not suitable habitat for this species.
Myrtaceae	*Callistemon linearifolius*	Netted Bottle Brush	V		2Ri	Occurs chiefly from Georges to the Hawkesbury River where it grows in dry sclerophyll forest, open forest, scrubland or woodland on sandstone. Found in damp places, usually in gullies (Fairley & Moore 2002; Harden 2002; Robinson 1994). Within the Sydney region, recent records are limited to the Hornsby Plateau area near the Hawkesbury River (NSW Scientific Committee 1999).	No – the study site is too modified and the only areas possessing any remnant vegetation is along the lagoon edge which is not suitable habitat for this species. Record in locality from south side of Sydney Harbour.
Myrtaceae	*Eucalyptus camfieldii*	Heart-leaved Stringybark	V	V	2Vi	Occurs from Tomago to the Royal National Park where it grows in coastal shrub heath in sandy soils on sandstone (Harden 2002).	No – the coastal shrub heath in sandy soils on sandstone in the study locality is restricted to on sandstone ridges and plateaus such as North Head, Middle head and in Garigal National Park.
Myrtaceae	*Leptospermum deanei*		V	V	2V	Only occurs near the watershed of Lane Cove River where it grows on forested slopes (Harden 2002).	No – no forested slopes in the study area.
Myrtaceae	*Melaleuca deanei*		V	V	3R	Occurs in coastal districts, including western Sydney (e.g. Baulkham Hills, Liverpool shires) from Berowra to Nowra where it grows in wet heath on sandstone and shallow/skeletal soils near streams or perched swamps (Harden 2002; James 1997).	No – study area is on the floodplain of a coastal lagoon that would have originally possessed deep alluvial sediments.
Myrtaceae	*Syzygium paniculatum*	Magenta Lilly Pilly	V	V	3Ri	Occurs between Buladelah and St Georges Basin where it grows in subtropical and littoral rainforest on sandy soils or stabilized dunes near the sea (Harden 2002).	No – no littoral rainforest on sandy soils or stabilized dunes in the study area.
Orchidaceae	*Caladenia tessellata*	Thick Lip Spider Orchid	E1	V	3V	Occurs south of Swansea where it grows on clay loam or sandy soils (Harden 1993). Prefers low open forest with a heathy or sometimes grassy understorey (Bishop 2000). Within NSW, currently known from two disjunct areas; one population near Braidwood on the Southern Tablelands and three populations in the Wyong area on the Central Coast. Previously known also from Sydney and South Coast areas (NSW Scientific Committee 2002).	No – the study site is too modified and the only areas possessing any remnant vegetation is along the lagoon edge which is not suitable habitat for this species.
Orchidaceae	*Cryptostylis hunteriana*	Leafless Tongue Orchid	V	V	3V	Occurs south from the Gibraltar Range, chiefly in coastal districts but also extends on to tablelands. Grows in swamp-heath and drier forest on sandy soils on granite & sandstone. Occurs in small, localised colonies most often on the flat plains close to the coast but also known from some mountainous areas growing in moist depressions and swampy habitats (Harden 1993; NSW National Parks and Wildlife Service 1999c).	No – the study site is too modified and the only areas possessing any remnant vegetation is along the lagoon edge which is not suitable habitat for this species.

Family Name	Latin Name	Common Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Habitat	Potential habitat within the study area
Orchidaceae	*Microtis angusii*		E1	E		Known from few small populations at Sunny Corner near Bathurst, Ingleside and Warringah. Known to occur wihtin Duffy's Forest (Warringah Shire Council 2004).	No – in the study locality the species is restricted to Duffy's Forest which is not within the study area.
Poaceae	*Deyeuxia appressa*		E1	E	2E	Last collected from Was then collected in 1941 from Killara , near Hornsby area on wet ground. (Harden 1993; Sharp & Simon 2002). Given that D. appressa hasn't been seen in over 60 years, almost nothing is known of the species' habitat and ecology.	No - the study site is too modified.
Proteaceae	*Grevillea caleyi*	Caley's Grevillea	E1	E	2Ei	Occurs in the Terrey Hills-Belrose area north of Sydney where it grows in woodland on laterized sandstone ridgetops (Harden 2002).	No – restricted to areas of lateritic soil that does not occur within the study area.
Santalaceae	*Thesium australe*	Austral Toadflax	V	V	3Vi	Grows in grassland or woodland often in damp sites. It is a semi-parasitic herb and hosts are likely to be *Themeda australis* and *Poa* spp. (Harden 1992).	No - none of the likely host species occur in the study area.
Thymelaeaceae	*Pimelea curviflora* var. *curviflora*		V	V		Confined to coastal areas around Sydney where it grows on sandstone and laterite soils. It is found between South Maroota, Cowan, Narrabeen, Allambie Heights, Northmead and Kellyville, but its former range extended south to the Parramatta River and Port Jackson region including Five Dock, Bellevue Hill and Manly. Usually occurs in woodland in the transition between shale and sandstone, often on Lucas Heights soil landscape (Harden 2000; James 1997; James et al. 1999; NSW Scientific Committee 1998).	No – restricted to areas on sandstone and lateritic soil that do not occur within the study area.
Tremandraceae	*Tetratheca glandulosa*		V	V	2V	Occurs from Mangrove Mountain to the Blue Mountains where it grows in sandy or rocky heath or scrub (Harden 1992).	No – restricted to areas on sandstone that does not occur within the study area.

1:V= Vulnerable, E1 = Endangered (Threatened Species Conservation Act 1995),

2: V = Vulnerable, E = Endangered (Environment Protection and Biodiversity Conservation Act 1999),

3: ROTAP (Rare or Threatened Australian Plants, Briggs and Leigh 1996) is a conservation rating for Australian plants (Codes are:3 -Species with a geographic range of more than 100km in Australia, V -Vulnerable species at risk of long-term disappearance through continued depletion.

4)'Likely' means that it is not necessary for a significant impact to have a greater than 50 per cent chance of happening, however, the term is sufficient if a significant impact on a matter of national environmental significance is a real or not remote chance or possibility (Department of the Environment and Heritage 2005).

Table C-5 Threatened species of animal previously recorded or predicted to occur within the study area locality

Common Name	Latin Name	TSC Act[1]	EPBC Act[2]	Habitat	Potential habitat within the study area
Amphibians					
Giant Burrowing Frog	*Heleioporus australiacus*	V	V	Appears to exist as two distinct populations: a northern population largely confined to the sandstone geology of the Sydney Basin, from Wollemi National Park in the north and extending south to Jervis Bay; and a southern population occurring in disjunct pockets from about Narooma south into eastern Victoria. In the northern population there is a marked preference for sandstone ridgetop habitat and broader upland valleys. In these locations the frog is associated with small headwater creeklines and along slow flowing to intermittent creeklines. The vegetation is typically woodland, open woodland and heath and may be associated with 'hanging swamp' seepage lines and where small pools form from the collected water. They have also been observed occupying artificial ponded structures such as fire dams, gravel 'borrows', detention basins and box drains that have naturalised over time and are still surrounded by other undisturbed habitat. In the southern population, records from Narooma, Bega, Bombala and eastern Victoria appear to be associated with Devonian igneous and sedimentary formations and Ordovician metamorphics and are generally from more heavily timbered areas. However, again there appears to be an association with ridgetops, headwaters and slow flowing streams. Do not appear to inhabit areas that have been cleared for agriculture or for urban development. Breed in summer and autumn in burrows in the banks of small creeks. Often spends significant periods of time underground during unfavourable conditions and to avoid detection during the day. (Cogger 2000; NSW National Parks and Wildlife Service 2001a).	No – occurs on sandstone ridgetop habitat and broader upland valleys which do not occur in the study area.
Green and Golden Bell Frog	*Litoria aurea*	E1	V	Has a fragmented distribution of mainly near coastal locations from Lakes Entrance (Victoria) to south of the NSW-Queensland border; as far west as Bathurst in the more elevated southern tablelands and central slopes of NSW. Various types of habitat utilised has been documented. For breeding utilises a wide range of waterbodies, including both natural and man-made structures, such as marshes, dams and stream sides, and ephemeral locations that are more often dry than wet. Is found in various small pockets of habitat in otherwise developed areas and has the tendency of often turning up in highly disturbed sites. Lotic situations such as fast flowing streams appear to be one of the few water bodies not utilised, at least for breeding purposes. Habitat attributes associated with the various waterbodies occupied by the GGBF, and that appear to make such habitat more likely to be occupied, include that the water body is shallow, still or slow flowing, ephemeral and/or widely fluctuating, unpolluted and without heavy shading. Permanent waterbodies are also known to be used and there is historical evidence of occupation of large, often deep and permanent bodies of water. There is a clear preference shown by GGBF for sites with a complexity of vegetation structure and associated terrestrial habitat attributes that appear to favour the species include extensive grassy areas and an abundance of shelter sites such as rocks, logs, tussock forming vegetation and other cover, considered to be used for foraging and shelter. Over-wintering sites may be adjacent to or some distance away from breeding sites; such sites include the bases of dense vegetation tussocks, beneath rocks, timber, within logs or beneath ground debris, including human refuse such as sheet iron, but the full range of possible habitat used for this purpose is not yet well understood (Department of Environment and Conservation 2004, 2005) .	No – the main water body (Manly Lagoon) in the study area is brackish and not suitable habitat for this species.

Common Name	Latin Name	TSC Act[1]	EPBC Act[2]	Habitat	Potential habitat within the study area
Heath Frog	*Litoria littlejohni*	V	V	Distributed along the eastern slopes of the Great Dividing Range from Watagan State Forest near Wyong, south to Buchan in north-eastern Victoria. It appears to be restricted to sandstone woodland and heath communities at mid to high altitude. It forages both in the tree canopy and on the ground, and it has been observed sheltering under rocks on high exposed ridges during summer. It is not known from coastal habitats (NSW Scientific Committee 2000).	No – the main water body (Manly Lagoon) in the study area is brackish and not suitable habitat for this species.
Stuttering Frog	*Mixophyes balbus*	E1	V	Terrestrial species, found in rainforest, Antarctic beech forest or wet sclerophyll forest. The species depends on freshwater streams and riparian vegetation for breeding and habitation. No records are known from riparian habitat that has been disturbed (Cogger 2000; NSW Scientific Committee 2003).	No – the main water body (Manly Lagoon) in the study area is brackish and not suitable habitat for this species.
Red-crowned Toadlet	*Pseudophryne australis*	V		Occurs within 160 km of Sydney where it is restricted to Hawkesbury Sandstone. It breeds in deep grass and debris adjacent to ephemeral drainage lines. When not breeding individuals are found scattered on sandstone ridges under rocks and logs (Cogger 2000).	No – the main water body (Manly Lagoon) in the study area is brackish and not suitable habitat for this species.
Native Birds					
Australasian Bittern	*Botaurus poiciloptilus*	V		Occurs in shallow, vegetated freshwater or brackish swamps. Requires permanent wetlands with tall dense vegetation, particularly bulrushes and spikerushes. When breeding, pairs are found in areas with a mixture of tall and short sedges but will also feed in more open territory. (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 2002d).	Yes – potential to occur in Manly Lagoon and frequent the study site.
Bush Stone-curlew	*Burhinus grallarius*	E1		Require sparsely grassed, lightly timbered, open forest of woodland. In southern Australia they often occur where there is a well structured litter layer and fallen timber debris. Feed on a range of invertebrates and small vertebrates, as well as seeds and shoots (NSW National Parks and Wildlife Service 1999f, 2003b).	No – study site is too modified to provide adequately dense vegetation
Sanderling	*Calidris alba*	V	M	A coastal species found on low and open sand beaches exposed to open sea-swells. A migratory species, it has been recorded in NSW from September to May (Pizzey & Knight 1997).	No – prefers open beaches. Possible flyover species only.
Great Knot	*Calidris tenuirostris*	V	M	Generally a coastal species found on tidal mudflats and sandy ocean shores. A migratory species visiting Australian waters between September and March (Pizzey & Knight 1997).	Yes – potential to occur in Manly Lagoon and frequent the study site.
Gang-gang Cockatoo	*Callocephalon fimbriatum*	V		Occurs in wetter forests and woodland from sea level to an altitude over 2000 metres, timbered foothills and valleys, coastal scrubs, farmlands and suburban gardens (Pizzey & Knight 1997).	Yes – potential to frequent site for marginal foraging habitat.
Streaked Shearwater	*Calonectris leucomelas*		M		No – study site is too modified to provide adequately dense vegetation
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	V		Occurs in eucalypt woodland and forest with Casuarina/Allocasuarina spp. Characteristically inhabits forests on sites with low soil nutrient status, reflecting the distribution of key Allocasuarina species. The drier forest types with intact and less rugged landscapes are preferred by the species. Nests in tree hollows (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 1999g).	Yes – potential to frequent site for marginal foraging habitat.
Greater Sand Plover	*Charadrius leschenaultii*	V	M	Entirely coastal in NSW foraging on intertidal sand and mudflats in estuaries, and roosting during high tide on sand beaches or rocky shores. A migratory species it is found in New South Wales generally during the summer months (Pizzey & Knight 1997).	Yes – potential to occur in Manly Lagoon and frequent the study site.

Common Name	Latin Name	TSC Act[1]	EPBC Act[2]	Habitat	Potential habitat within the study area
Lesser Sand Plover	*Charadrius mongolus*	V	M	Migratory bird that migrates from the northern hemisphere to coastal areas of northern and east coast of Australia (Garnett & Crowley 2000).	Yes – potential to occur in Manly Lagoon and frequent the study site.
Amsterdam Albatross	*Diomedea amsterdamensis*		EM	Breeding on Amsterdam Island and foraging mainly in the surrounding Indian Ocean, but possibly occurring as far afield as Tasmania and New Zealan . Breed biennially in colonies among grass tussocks (Garnett & Crowley 2000).	No – marine flyover species only
Antipodean Albatross	*Diomedea antipedensis*	V	VM	A nomadic marine species that occasionally breeds off the coast of New South Wales (Garnett & Crowley 2000).	No – marine flyover species only
Shy Albatross	*Diomedea cauta*	V	VM	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	No – marine flyover species only
Tristan Albatross	*Diomedea dabbena*		EM	Breeding range now restricted to Inaccessible and Gough Island., having been eliminated from the main island of Tristan de Cunha by 1907. Current global population estimated to contain about 1,000 breeding pairs. There is only one record from Australian waters. Breed biennially in colonies among grass tussocks on isoltaed subantartic islands and feed pelagically on squid, fish and crustaceans (Garnett & Crowley 2000).	No – marine flyover species only
Wandering Albatross	*Diomedea exulans*	E1	VM	Nomadic marine species, that breeds in small losse colonies among grass tussocks, using a large mud nets, sometimes off the coast of NSW (Garnett & Crowley 2000).	No – marine flyover species only
Gibson's Albatross	*Diomedea gibsoni*	V	VM	A nomadic marine species that forages off the coast of New South Wales (Garnett & Crowley 2000).	No – marine flyover species only
Beach Stone-curlew	*Esacus neglectus*	E1		Found on beaches within species range, including short stretches of muddy sand among mangroves, coralline sands on atolls and prime surf beaches. Does not occupy long strectches of contnuous mangroves or cliffs though beaches associated with estuaries or near mangrones are favoured (Garnett & Crowley 2000).	No
Little Penguin	*Eudyptula minor*			Breeds on the Australian mainland and is found along the southern coasts of Australia, from near Perth in Western Australia to around Coffs Harbour in northern NSW.Usually nest in burrows and often sets up colonies in sand-dune vegetation, but can also be found among rocks, in sea caves, and on headlands usually nest in burrows. Can also be found among rocks, in sea caves, and on headlands. Colony at Manly on Sydney Harbour is protected as an endangered population under the Threatened Species Conservation Act 1995 (NSW National Parks and Wildlife Service 2004c).	No – restricted to one population in manly that is within the mouth of Sydney Harbour (within the heads).
Latham's Snipe	*Gallinago hardwickii*		M	Occurs in freshwater or brackish wetlands generally near protective vegetation cover. This species feeds on small invertebrates, seeds and vegetation. It migrates to the northern hemisphere to breed (Garnett & Crowley 2000).	Yes – potential to occur in Manly Lagoon and frequent the study site.
White Tern	*Gygis alba*	V		Occurs on oceanic islands, tropical and subtropical seas. Eggs are laid and incubated in depression on branch of forest tree or palm frond up to 10 metres above ground (Pizzey & Knight 1997).	No – marine flyover species only
Sooty Oystercatcher	*Haematopus fuliginosus*	V		Found on rocky shorelines where it forages on intertidal flats (Garnett & Crowley 2000).	Yes – potential to occur in Manly Lagoon and frequent the study site.

Common Name	Latin Name	TSC Act[1]	EPBC Act[2]	Habitat	Potential habitat within the study area
Pied Oystercatcher	*Haematopus longirostris*	V		Occurs in undisturbed beaches, sandpits, sandbars, tidal mudflats, estuaries and coastal islands. Occasionally found on rocky reefs, shores, rock stacks, brackish or saline wetlands and also in grassy paddocks, golf courses or parks near coast. Eggs are laid in shallow scrape in sand on open beach or among low growth behind beach (Pizzey & Knight 1997).	Yes – potential to occur in Manly Lagoon and frequent the study site.
White-bellied Sea-Eagle	*Haliaeetus leucogaster*		M	Occurs in coastal areas including islands, estuaries, inlets, large rivers, inland lakes and reservoirs. Builds a huge nest of sticks in tall trees near water, on the ground on islands or on remote coastal cliffs (Pizzey & Knight 1997).	Yes – potential to occur in Manly Lagoon and frequent the study site.
White-throated Needletail	*Hirundapus caudacutus*		M	Occurs in airspace over forests, woodlands, farmlands, plains, lakes, coasts and towns. Breeds in the northern hemisphere and migrates to Australia in October-April (Pizzey & Knight 1997).	No – possible flyover species only
Black Bittern	*Ixobrychus flavicollis*	V		Usually found in dense vegetation in and fringing streams, swamps, tidal creeks and mudflats, particularly amongst swamp she-oaks and mangroves. Feeds on aquatic fauna along streams, in estuaries and beside billabongs and pools. Breeding occurs in summer in secluded places in densely vegetated wetlands. It nests in trees that overhang the water (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 2002d).	Yes – potential to occur in Manly Lagoon and frequent the study site.
Swift Parrot	*Lathamus discolor*	E1	EM	Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern NSW, but also south-eastern Queensland as far north as Duaringa. Until recently it was believed that in New South Wales, swift parrots forage mostly in the western slopes region along the inland slopes of the Great Dividing Range but are patchily distributed along the north and south coasts including the Sydney region, but new evidence indicates that the forests on the coastal plains from southern to northern NSW are also extremely important. In mainland Australia is semi-nomadic, foraging in flowering eucalypts in eucalypt associations, particularly box-ironbark forests and woodlands. Preference for sites with highly fertile soils where large trees have high nectar production, including along drainage lines and isolated rural or urban remnants, and for sites with flowering Acacia pycnantha, is indicated. Sites used vary from year to year. (Garnett & Crowley 2000),(Swift Parrot Recovery Team 2001).	No – possible flyover species only
Southern Giant-Petrel	*Macronectes giganteus*	E1	EM	A partly nomadic marine species that forages off the coast of New South Wales (Garnett & Crowley 2000).	No – marine flyover species only
Northern Giant-Petrel	*Macronectes halli*	V	VM	Nomadic marine species, that nest as dispersed pairs, often admist tussocks in dense vegetation. Forages in inshores waters of southern Australia and occasionally visits the coast of NSW (Garnett & Crowley 2000).	No – marine flyover species only
Black-faced Monarch	*Monarcha melanopsis*		M	Occurs in rainforests, eucalypt woodlands, coastal scrubs, damp gullies in rainforest, eucalypt forest and in more open woodland when migrating (Pizzey & Knight 1997).	No – study site is too modified to provide adequately dense vegetation
Satin Flycatcher	*Myiagra cyanoleuca*		M	Occurs in heavily vegetated gullies, in forests and taller woodlands. During migration it is found in coastal forests, woodlands, mangroves, trees in open country and gardens (Pizzey & Knight 1997).	No – study site is too modified to provide adequately dense vegetation
Barking Owl	*Ninox connivens*	V		Occurs in dry sclerophyll woodland. In the south west it is often associated with riparian vegetation while in the south east it generally occurs on forest edges. It nests in large hollows in live eucalypts, often near open country. It feeds on insects in the non-breeding season and on birds and mammals in the breeding season (Garnett & Crowley 2000).	No – study site is too modified to provide adequately dense vegetation

Common Name	Latin Name	TSC Act[1]	EPBC Act[2]	Habitat	Potential habitat within the study area
Powerful Owl	*Ninox strenua*	V		A sedentary species with a home range of approximately 1000 hectares it occurs within open eucalypt, casuarina or callitris pine forest and woodland. It often roosts in denser vegetation including rainforest of exotic pine plantations. Generally feeds on medium-sized mammals such as possums and gliders but will also eat birds, flying-foxes, rats and insects. Prey are generally hollow dwelling and require a shrub layer and owls are more often found in areas with more old trees and hollows than average stands (Garnett & Crowley 2000).	No – study site is too modified to provide adequately dense vegetation
Osprey	*Pandion haliaetus*	V	M	Generally a coastal species, occurring in estuaries, bays, inlets, islands and surrounding waters, coral atolls, reefs, lagoons, rock cliffs and stacks. Sometimes ascends larger rivers to far inland. Builds nests high in tree, on pylon or on ground on islands. Feeds on fish (Pizzey & Knight 1997).	Yes – potential to occur in Manly Lagoon and frequent the study site.
Sooty Albatross	*Phoebetria fusca*	V	VM	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	No – marine flyover species only
Pacific Golden Plover	*Pluvialis fulva*		M	Prefers sandy, muddy or rocky shores, estauries and lagoons, reefs, saltmarsh, and or short grass in paddocks and crops. The species is usually coastal, icluding offshore islands; rarely far inland. Often observed on beaches and mudflats, sandflats and oocassionally rock shelves, or where these substrates intermingle; harbours, estauries and lagoons (Higgins & Marchant 1993).	Yes – potential to occur in Manly Lagoon and frequent the study site.
Gould's Petrel	*Pterodroma leucoptera*	E1	EM	A marine species, it nests on islands among rocks and debris of Cabbage Tree Palms. It feeds on fish, cephalapods and other marine animals (Garnett & Crowley 2000).	No – marine flyover species only
Kermadec Petrel	*Pterodroma neglecta*		V	An oceanic species that forages in the tropical and subtropical pacific ocean (Garnett & Crowley 2000).	No – marine flyover species only
Wompoo Fruit-Dove	*Ptilinopus magnificus*	V		Occurs in rainforests, monsoon forests, adjacent eucalypt forests, fruiting trees on scrubby creeks or in open country (Garnett & Crowley 2000).	No – study site is too modified to provide adequately dense vegetation
Superb Fruit-Dove	*Ptilinopus superbus*	V		Occurs in rainforests and fringes, scrubs, mangroves and wooded stream-margins, lantana thickets, isolated figs, pittosporums, lilly pillies and blackberries (Pizzey & Knight 1997).	No – study site is too modified to provide adequately dense vegetation
Little Shearwater	*Puffinus assimilis*	V		A marine species that occurs over the Tasman Sea and possibly the Coral Sea. The species breeds on island in burrows dug in soft soil among mats of succulents or among loose rocks and they forage far out to sea (Garnett & Crowley 2000).	No – marine flyover species only
Flesh-footed Shearwater	*Puffinus carneipes*	V	M	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	No – marine flyover species only
Rufous Fantail	*Rhipidura rufifrons*		M	Occurs in a range of habitats including the undergrowth of rainforests/wetter eucalypt forests/gullies, monsoon forests paperbarks, sub-inland and coastal scrubs, mangroves, watercourses, parks and gardens. When migrating they may also be recorded on farms, streets and buildings. Migrates to SE Australia in October-April to breed, mostly in or on the coastal side of the Great Dividing Range (Pizzey & Knight 1997).	No – study site is too modified to provide adequately dense vegetation
Painted Snipe	*Rostratula benghalensis*	E1	VM	Inhabits shallow, vegetated, temporary or infrequently filled wetlands, including where there are trees such as Eucalyptus camaldulensis (River Red Gum), E. populnea (Poplar Box) or shrubs such as Muehlenbeckia florulenta (Lignum) or Sarcocornia quinqueflora (Samphire). Feeds at the water's edge and on mudlflats on seeds and invertebrates, including insects, worms, molluscs and crustaceans. Males incubate eggs in a shallow scrape nest (Garnett & Crowley 2000).	Yes – potential to occur in Manly Lagoon and frequent the study site.

Common Name	Latin Name	TSC Act[1]	EPBC Act[2]	Habitat	Potential habitat within the study area
Diamond Firetail	*Stagonopleura guttata*	V		Occurs in a range of eucalypt dominated communities with a grassy understorey including woodland, forest and mallee. Most populations occur on the inland slopes of the dividing range. Feed on seeds, mostly of grasses (Garnett & Crowley 2000).	No – study site is too modified to provide adequately dense vegetation
Little Tern	*Sterna albifrons*	E1	M	A coastal species found along the coast of New South Wales. They nest between the high tide mark and shore vegetation on undisturbed and unvegetated sites near estuaries and adjacent freshwater lakes. They feed on fish taken from inshore waters (Garnett & Crowley 2000).	Yes – potential to occur in Manly Lagoon and frequent the study site.
Sooty Tern	*Sterna fuscata*	V		Occurs in tropical and subtropical seas, islands and cays. Nests in scrape in sand or coral debris, often in large colonies (Simpson & Day 1996).	No – marine flyover species only
Buller's Albatross	*Thalassarche bullei*		VM	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	No – marine flyover species only
Cambells Albatross	*Thalassarche impavida*		VM	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	No – marine flyover species only
Black-browed Albatross	*Thalassarche melanorphis*		M	Nomadic marine species that breeds on subantartic island oustide Australian waters, but moves northwards in non-breeding seasons. The waters off southern Australia between Brisbane and Perth are the principal feeding area of birds (Garnett & Crowley 2000).	No – marine flyover species only
Salvin's Albatross	*Thalassarche salvini*		VM	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	No – marine flyover species only
White-capped Albatross	*Thalassarche steadi*		VM	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	No – marine flyover species only
Masked Owl	*Tyto novaehollandiae*	V		Occurs within a diverse range of wooded habitats including forests, remnants and almost treeless inland plains. This species requires large-hollow bearing trees for roosting and nesting and nearby open areas for foraging. They typically prey on terrestrial mammals including rodents and marsupials but will also take other species opportunistically. Also known to occasionally roost and nest in caves (Garnett & Crowley 2000).	No – marine flyover species only
Regent Honeyeater	*Xanthomyza phrygia*	E1	EM	Occurs mostly in box-ironbark forests and woodland and prefers the wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with Casuarina cunninghamiana and Amyema cambagei are important for feeding and breeding. Important food trees include Eucalyptus sideroxylon (Mugga Ironbark), E. albens (White Box) , E. melliodora (Yellow Box) and E. leucoxylon (Yellow Gum) (Garnett & Crowley 2000).	No – study site is too modified to provide adequately dense vegetation
Native Mammals					
Rufous Bettong	*Aepyprymnus rufescens*	V		Distribution: From Cooktown in north Queensland, to north-east NSW, where it occurs east of the Dividing Range. In Queensland, it still occurs on both sides of the Great Divide. Macrohabitat: Found in a variety of forest types from wet sclerophyll to dry open woodland, where grass tussocks or fallen timber are present. Also known to occupy a mosaic of open forest and grasslands. Microhabitat: It appears to prefer a more open forest structure, with an sparse shrub layer and a diverse ground cover. Builds nests in grass tussocks and under logs. Strongly associated with dry sclerophyll forest particularly those dominated by Spotted Gum (NSW National Parks and Wildlife Service 1999c).	No – study site is too modified to provide adequately dense vegetation

Common Name	Latin Name	TSC Act[1]	EPBC Act[2]	Habitat	Potential habitat within the study area
Eastern Pygmy-possum	*Cercartetus nanus*	V		Found in a range of habitats from rainforest through sclerophyll forest to tree heath. It feeds largely on the nectar and pollen of banksias, eucalypts and bottlebrushes and sometimes soft fruits. It nests in very small tree holes, between the wood and bark of a tree, abandoned birds nests and shredded bark in the fork of trees (Turner & Ward 1995).	No – study site is too modified to provide adequately dense vegetation
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V	Occurs in moderately wooded habitats and roosts in caves, mine tunnels and the abandoned, bottle-shaped mud nests of Fairy Martins. Thought to forage below the forest canopy for small flying insects (Churchill 1998).	No – no known roosting sites in the study area. May frequent site for foraging over the lagoon however unlikely to roost within study area
Spotted-tailed Quoll	*Dasyurus maculatus*	V	E	Occurs from the Bundaberg area in south-east Queensland, south through NSW to western Victoria and Tasmania. In NSW, it occurs on both sides of the Great Dividing Range and north-east NSW represents a national stronghold (NSW National Parks and Wildlife Service 1999c). Occurs in wide range of forest types, although appears to prefer moist sclerophyll and rainforest forest types, and riparian habitat. Most common in large unfragmented patches of forest. It has also been recorded from dry sclerophyll forest, open woodland and coastal heathland, and despite its occurrence in riparian areas, it also ranges over dry ridges. Nests in rock caves and hollow logs or trees. Feeds on a variety of prey including birds, terrestrial and arboreal mammals, small macropods, reptiles and arthropods (NSW National Parks and Wildlife Service 1999a, 1999c).	No – study site is too modified to provide adequately dense vegetation
Eastern Quoll	*Dasyurus viverrinus*	E1		Found in a variety of habitats including dry sclerophyll forest, scrub, heathland and cultivated land. Lives in dens which consist of several chambers including underground burrows, hollow logs, rock piles and hay sheds (Strahan 1995).	No – study site is too modified to provide adequately dense vegetation
Southern Brown Bandicoot	*Isoodon obesulus*	E1	E	Occurs in a variety of habitats in south-eastern Australia, including heathland, shrubland, dry sclerophyll forest with heathy understorey, sedgeland and woodland. Many of the habitats are prone to fire (NSW National Parks and Wildlife Service 1999d).	No – study site is too modified to provide adequately dense vegetation
Eastern Bent-wing Bat	*Miniopterus schreibersii*	V	C	Usually found in well timbered valleys where it forages on small insects above the canopy. Roosts in caves, old mines, stormwater channels and sometimes buildings and often return to a particular nursery cave each year (Churchill 1998).	No – may frequent site for foraging over the lagoon however unlikely to roost within study area
Eastern Freetail-bat	*Mormopterus norfolkensis*	V		Thought to live in sclerophyll forest and woodland. Small colonies have been found in tree hollows or under loose bark. It feeds on insects above the forest canopy or in clearings at the forest edge (Churchill 1998).	No – may frequent site for foraging over the lagoon however unlikely to roost within study area
Long-nosed Bandicoot	*Perameles nasuta*			Occurs in a range of habitats from rainforest through wet and dry woodland areas with little ground cover. Nests in a shallow hollow on the surface of the ground (Strahan 1995).	No – population within locality restricted to the heath and woodland occurring on North Head.
Koala	*Phascolarctos cinereus*	V		Found in sclerophyll forest. Throughout New South Wales, Koalas have been observed to feed on the leaves of approximately 70 species of eucalypt and 30 non-eucalypt species. However, in any one area, Koalas will feed almost exclusively on a small number of preferred species. The preferred tree species vary widely on a regional and local basis. Some preferred species in NSW include Forest Red Gum Eucalyptus tereticornis, Grey Gum E. punctata, Monkey Gum E. cypellocarpa and Ribbon Gum E. viminalis. In coastal areas, Tallowwood E. microcorys and Swamp Mahogany E. robusta are important food species, while in inland areas White Box E. albens, Bimble Box E. populnea and River Red Gum E. camaldulensis are favoured (NSW National Parks and Wildlife Service 1999b, 2003c).	No – study site is too modified to provide adequate vegetation density or connectively and no suitable feed trees.

Common Name	Latin Name	TSC Act[1]	EPBC Act[2]	Habitat	Potential habitat within the study area
Long-nosed Potoroo	*Potorous tridactylus*	V	V	Disjunct distribution along coastal south-east Australia from near Gladstone in Queensland, to south-west Victoria and in Tasmania. Found from sea level up to 1500 metres in altitude generally in areas with rainfall greater than 760 millimetres. In NSW, it is found throughout coastal and subcoastal areas. Occurs in a range of habitats: coastal forest and woodland with a moderately dense heathy understorey, dense coastal scrubs or heath, wet and dry sclerophyll forest and sub-tropical, warm temperate and cool temperate rainforest of the eastern slopes and highlands. Often associated with gullies and forest ecotones. Open areas are used for foraging while areas of dense groundcover or understorey provide areas for shelter and protection from predators. Relatively thick ground cover is a major habitat requirement and it seems to prefer areas with light sandy soils. Feeds at dusk on roots, tubers, fungi, insects and their larvae and other soft bodied animals in the soil. Moves up and down slope as food resources become seasonally available (Johnston 1995; NSW National Parks and Wildlife Service 1999c).	No – study site is too modified to provide adequately dense vegetation
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps. Urban gardens and cultivated fruit crops also provide habitat for this species. Feeds on the flowers and nectar of eucalypts and native fruits including lilly pillies. It roosts in the branches of large trees in forests or mangroves (Churchill 1998; NSW National Parks and Wildlife Service 2001b).	No – may seasonally frequent site for foraging however the vegetation is too modified to provide adequate density for a roosting population
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V		The preferred hunting areas of this species include tree-lined creeks and the ecotone of woodlands and cleared paddocks but it may also forage in rainforest. Typically it forages at a height of 3-6 metres but may fly as low as one metre above the surface of a creek. It feeds on beetles, other large, slow-flying insects and small vertebrates. It generally roosts in tree hollows but has also been found in the roof spaces of old buildings (Churchill 1998).	No – may frequent site for foraging over the lagoon however unlikely to roost within study area
Reptiles					
Broad-headed Snake	*Hoplocephalus bungaroides*	E1	V	A nocturnal species that occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb, J.K. & Shine 1994; Webb, J.K & Shine 1998).	No – no sandstone outcrops or crevices in study area
Heath Monitor	*Varanus rosenbergi*	V		Found in coastal heaths, humid woodlands, wet and dry sclerophyll forests. Mostly a terrestrial species it shelters in burrows, hollow logs and rock crevices (Cogger 2000).	No – study site is too modified to provide adequately dense vegetation

1. V= Vulnerable, E1 = Endangered (*Threatened Species Conservation Act 1995*) 2. V = Vulnerable, E = Endangered, M = Migratory (*Environment Protection and Biodiversity Conservation Act 1999*) 3. 'Likely' means that it is not necessary for a significant impact to have a greater than 50 per cent chance of happening, however, the term is sufficient if a significant impact on a matter of national environmental significance is a real or not remote chance or possibility (Department of the Environment and Heritage 2005b). Note: Marine species including marine turtles, sharks, whales, seals dolphins, seals, ray finned fish and sea snake identified from the databases searches were not included in this table as no marine habitats occur within or are likely to be indirectly impacted by the proposal.

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