ANNE CLEMENTS & ASSOCIATES PTY. LIMITED
(ABN 41 077 242 365, ACN 077 160 939)
Environmental and Botanical Consultants
PO Box 1623, North Sydney 2059
Phone: (02) 9955 9733, Facsimile: (02) 9957 4343
Email: mail@acabotanic.com

21 March 2006

Flora assessment:
Lands north of 20 m AHD on Hall Street Pitt Town

Prepared by:

Dr AnneMarie Clements
Tony Rodd
Jane Rodd
Emma Laxton
Stephanie Chew

Prepared for:

Johnson Property Group
Suite 3205, Level 32 The Chifley Tower
2 Chifley Square
Sydney 2000
Phone: 9222 9900
Fax: 9232 5699

Contents

1.0 Introduction

The vegetation of the lands below 20 m AHD on Hall Street, Pitt Town (the Study Area) (Figure 1) was assessed.

The Study Area is approximately 59.5 ha in area and adjoins the Hawkesbury River to the north-west and north-east. The Study Area is in Hawkesbury Local Government Area (LGA).

2.0 Environmental setting

The Study Area is located on land below 20 m AHD adjoining the Hawkesbury River in the north of Pitt Town. The Study Area is bounded by the 20 m AHD contour in the south, and slopes down steeply towards the river in the west, with a gentler slope in the central and eastern parts of the Study Area. At the base of the slope, there is gently undulating pasture land extending to the steep, eroded riverbanks.

The Site has a long history of disturbance from agricultural activities, as well as extensive erosion and weed invasion along the river banks.

2.1 Climate

The closest meteorological station to the Study Area is located approximately 8 km south-west of the Study Area at the Richmond RAAF Base (Station Number 067033). The data from the station has been collected over 66 years from 1928 to 1994.

For the two stations, the recorded mean annual daily maximum temperature was 24°C and the recorded mean annual daily minimum temperature was 11°C.The highest mean daily maximum monthly temperature was recorded for January (30°C) and the lowest mean daily minimum monthly temperature for July (4°C) (Bureau of Meteorology website: www.bom.gov.au, searched 24 February 2006).

The recorded mean annual rainfall was 810 mm. The major portion of the rainfall occurs in late summer and early autumn, with the wettest month being February (106 mm mean monthly rainfall) and the driest month July (36 mm mean monthly rainfall) (Bureau of Meteorology website: www.bom.gov.au, searched 24 February 2006).

2.2 Geology and soil landscapes

2.2.1 Geology

The geology of the Study Area was mapped at a scale of 1:100 000 by Clark and Jones (1991) (Figure 2).

Four geological units were mapped on the Study Area:

- Quaternary Sands of the Lowlands Formation (map unit Qpl), described as "Gravel, sand, silt, clay" are mapped on the majority of the land west of Hall Street and in the northern approximately half of the land east of Hall Street;
- Londonderry Clay (map unit Tl), described as "Clay, patches of ferruginized, consolidated sand" is mapped on and adjoining the south of the land west of Hall Street and in the south of the land east of Hall Street;

- Ashfield Shale (map unit Rwa), described as "Dark-grey to black claystone-siltstone and fine sandstone-siltstone laminite" is mapped in two patches: one in the south-west and another in the north-east of the land west of Hall Street.
- Pitt Town Sand (map unit Qpp), described as "Quartz sand (reddish brown iron oxide coated), clay, minor pebbles" is mapped in the south of the land east of Hall Street and adjoins the entire Study Area to the south.

2.2.2 Soil landscapes

The soil landscapes of the Study Area were mapped at a scale of 1:100 000 by Hazelton *et al.* (1989) (Figure 3). Three soil landscapes were mapped on the Study Area, as described below.

Freemans Reach (map unit fr) was mapped across the northern parts of the Study Area:

Landscape - *present active floodplain of the Nepean River. Level with minor (<10 m) relief to meander scrolls, levees and back swamps.*
Soils - *Deep brown sands and loams, apedal to moderately structured, usually friable.*
Limitations - *high streambank erosion hazard, frequent flooding.*

Berkshire Park (map unit bp) was mapped in a strip along most of the south of the Study Area:

Landscape – *dissected, gently undulating low rises on Tertiary terraces of the Hawkesbury/Nepean river system.*
Soils – *weakly pedal orange heavy clays and clayey sands, often mottled. Ironstone nodules common. Large (up to 20 cm) boulders occur in sand/clay matrix.*
Limitations – *very high wind erosion hazard if cleared. Gully, sheet and rill erosion on dissected areas. Waterlogging, impermeable subsoils, low fertility hazard.*

Agnes Banks (map unit ab) was mapped in the south-west of the land east of Hall Street and adjoining the entire Study Area to the south:

Landscape – *low parallel sand dunes deposited on the flat Tertiary terrace. Local relief to 7 m, slopes generally <5%.*
Soils – *deep acid sandy soils, strongly leached overlying yellow sandy clays with coffee-coloured iron and organic rich layer podzols.*
Limitations – *low fertility, high wind and water erosion hazard. High permeability, seasonal high water tables, seasonal waterlogging.*

2.3 Land use

The Study Area (Figures 1 and 4) is bounded by:

- Hawkesbury River to the north-east and north-west, rural land and caravan park to the north,and Halls Point further north;
- Existing rural land adjoining Hall Street to the south and suburban abd rural residential land further south;
- Hawkesbury River and existing rural land to the east; and
- Punt Road to the west with existing rural land further west

The Study Area (Figures 1 and 4) supports:

- On the lands to the west of Halls Road, mostly cleared pasture with a few scattered eucalypts and two planted rows of tall pine trees in the north-west.

The riverbank is fringed with treed vegetation ranging from approximately 0 to 80 m in width.

- On the lands to the east of Halls Road, some uneven ground at the site of two former dams. To the north of this area, cleared grasslands dominated by *Eragrostis curvula* (African Lovegrass) with dense thickets of *Gleditsia triacanthos* (Honey Locust) with cleared pasture and a house in the south. The riverbank is fringed with trees.

The Study Area has a long history of agricultural use.

According to Benson and Howell (1990 p78):

> *The five Hawkesbury towns of Windsor, Richmond, Wilberforce, Pitt Town and Castlereagh were established in 1810 by Governor Macquarie, to promote the agricultural development of the floodplain. By 1826 James Atkinson could write: 'The greater part of the alluvial lands upon the Hawkesbury have been cleared, and are under cultivation'*

According to Hall (cited in Rosen 1995), in a study of the Hawkesbury River between Windsor and Wiseman's Ferry in the 1920s, the lowland region of river silts was completely cleared for agriculture "except for a strip of land 100 feet wide on either side of the river, which has been preserved... to minimise the risk of landslides". Rosen (1995 p102) adds:

> *The first rows of trees on the banks were willows and behind these were she-oaks with blackberries and other creepers growing around their base. The third line of trees, black wattles grew on the grassy flat.*

Rosen (1995) states that by the 1940s, Casuarinas and water-gums replaced willows along the banks of the river around Canning Reach, which adjoins the north-east of the Study Area.

The 1947 aerial photograph of the Study Area held by the NSW Lands Department (Figure 5) shows that the Study Area was almost completely cleared of trees, with the exception of a few scattered trees in the south-west and fringing the river. There appear to be orchards in the central south and north-east of the Study Area, with the remainder of the land possibly used for grazing.

3.0 Flora

3.1 Previous flora studies

Benson (1992) mapped the vegetation of the Study Area at 1:100 000 scale as cleared (map unit 'C') (Figure 6). It is stated in the description of this map unit that (Benson 1992 p551):

> *These areas are generally the better agricultural soils along the river alluvial flats or on the Wianamatta Shale country. Small remnants of native vegetation too small to show on the map may occur here.*

The nearest remnant was mapped approximately 0.9 km to the north-east of the Study Area across the river as map unit 10d – Grey Box-Ironbark Woodland. This unit is described as "Woodland dominated by *Eucalyptus moluccana, E. tereticornis* and *E. crebra.*"

NPWS (2002) mapped the vegetation communities of the Cumberland Plain at a scale of 1:25 000 using aerial photograph interpretation and limited ground survey. Three vegetation communities were mapped on the Study Area (Figure 7), namely:

Vegetation map unit	Polygon ID	Polygon code	Species code	Area of polygon	Approximate area of polygon within Study Area boundary
11 - Alluvial Woodland	1826	TX	4	2.92 ha	2.75 ha
	1846	TX	–	4.64 ha	3.5 ha
	1960	TX	4	1.86 ha	1.62 ha
12 - Riparian Forest	1916	TX	–	0.18 ha	0.18 ha
	1950	TX	4	0.11 ha	0.11 ha
10 - Shale Plains Woodland	1959	TX	–	0.33 ha	0.33 ha

Polygon code	TX	Area >0.5 ha, Crown Cover Projection Density <10%. Areas of native trees with very discontinuous canopy cover. Boundaries difficult to define from API due to low densities. Surrounding land use predominantly agricultural. Most have dominant canopy species assessed.
Species codes:	4	*Angophora subvelutina, Eucalyptus amplifolia, E. tereticornis.*

The conservation significance of the vegetation on the Study Area was mapped by NPWS (2002) as 'Other Remnant Vegetation' (Figure 8).

3.2 Current study

The vegetation of the Study Area was surveyed by Tony Rodd, Jane Rodd, Emma Laxton and Stephanie Chew on 10 February 2006. A total of 111 species were recorded (32 natives and 79 exotics) in seven 400 m^2 Quadrats (Q1–Q7) and 21 Spot locations (A–U) (Table 1 and Figure 9).

3.2.1 Methods

In order to be consistent with sampling size and methods used for the 400 m^2 sampling sites on the Cumberland Plain (NPWS 2002 and Tozer 2003), the quadrats (Q1–Q7) consisted of four 10 m x 10 m subquadrats within a 20 m x 20 m quadrat. The 20 m x 20 m quadrats were located in relatively homogeneous vegetation. The homogeneity was visually assessed.

The relative frequency of plant species was assessed by recording the presence/absence of each species in each of the four 10 m x 10 m subquadrats with presence/absence of herb and shrub species recorded in 5 m x 5 m subquadrats of each 10 m x 10 m quadrat (Table 1). In order to be consistent with the sampling method used by Tozer (2003), the whole 10 m x 10 m subquadrat outside the 5 m x 5 m subquadrat was also searched and any additional species recorded. In each 10 m x 10 m subquadrat, the numbers of individuals and heights of all tree species were recorded (Table 2).

Data was recorded from 21 Spot locations. Spot locations were used as the vegetation tended to be fragmented, and sampling with quadrats was not practicable along the riverbanks. The sampling at Spot locations consisted of recording species present within an approximately 10 m radius (Spot locations A–K) (Table 1).

The sampling locations were photographed at the time of inspection (Appendix 1).

Nomenclature is consistent with Harden (1990-1993, 2002) and Harden and Murray (2000) and subsequent taxonomic changes as published in *Telopea*, the Sydney Royal Botanic Gardens' journal of systematic botany, and in other Australian taxonomic literature. The Gardens' PlantNet web pages (plantnet.rbgsyd.nsw.gov.au) incorporating Flora Online is the major source for updated taxonomy.

3.2.2 Observations

The vegetation of the Study Area was generally dominated by exotic species, with between 55% and 100% of all species in each sampling location exotic. The land on the slopes and relatively flat areas apart from the riverbanks on the area west of Halls Road (sampled in Quadrats 1 to 5 and Spot locations A, E, F, G, I, L, M and N) was mostly cleared pasture dominated by exotic grass species such as *Eragrostis curvula* (African Lovegrass), *Paspalum dilatatum* (Paspalum), *Pennisetum clandestinum* (Kikuyu) and *Setaria gracilis* (Slender Pigeon Grass). Some paddocks had 100% cover of *Eragrostis curvula* with few other species occurring.

There were some native grass species interspersed with the exotics and in localised patches, including *Microlaena stipoides* (Meadow Rice-grass), *Bothriochloa macra* (Red-leg Grass) and the cosmopolitan species *Cynodon dactylon* (Couch). Tall saplings of *Acacia parramattensis* (Parramatta Wattle) were growing sparsely to a maximum height of 10 m on the slopes and a few trees of *Eucalyptus crebra* and *E. tereticornis* were observed on the hill and near the riverbank to a maximum height of 30 m.

Two parallel rows of tall trees of *Pinus elliottii* (Slash Pine) and *P. radiata* (Monterey Pine) were planted in the north-west of the Study Area, perpendicular to the riverbank (Spot locations I and J). The rows were 150 to 200 m long and between them was a large field of cleared soil, which appeared to be fallow cropland.

The far north-west of the Site, on the slope adjoining the riverbank, was dominated by *Eragrostis curvula* but some areas had been cleared and contained recently planted tubestock of Casuarinas.

The northern half of the land east of Halls Road (sampled in Quadrats 6 and 7 and Spot locations O, P, R and U) supported dense thickets of *Gleditsia triacanthos* (Honey Locust) with an understorey dominated by *Eragrostis curvula,* sometimes to the exclusion of almost all other species.

The vegetation on the steep banks of the Hawkesbury River was sampled in Spot locations B, C, D, H, J, K, Q and T. The main canopy species occurring along the riverbanks was *Casuarina cunninghamia* (River Oak), recorded at up to approximately 15 m in height. The tall shrub layer, when present, was often dominated by invasive exotic species such as *Cestrum parqui* (Green Cestrum), *Ligustrum sinense* (Small-leaved Privet), *Lantana camara* (Lantana) and *Ricinus communis* (Castor Oil Plant) with the native small tree species *Acacia parramattensis* (Parramatta Wattle), *Leptospermum polygalifolium* (Yellow Tea-tree) and *Melaleuca styphelioides* (Prickly Paperbark) infrequently occurring.

Understorey species frequently recorded along the riverbank included the exotic herbs *Cardiospermum grandiflorum* (Balloon Vine), *Tradescantia albiflora* (Wandering Jew), *Acetosa saggitata* (Turkey Rhubarb) and *Sida rhombifolia* (Paddy's Lucerne) and grasses *Pennisetum clandestinum* and *Eragrostis curvula.* Some native species were present in the understorey, the most common being the herbs

Commelina cyanea (Blue Spiderwort) and *Oxalis perennans* and the grasses *Microlaena stipoides* and *Cynodon dactylon.*

4.0 Conservation significance

The conservation significance of the communities and species recorded on the Study Area were assessed at a:

- National level against the schedules of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EP&BC Act);
- State level against the schedules of the Threatened Species Conservation Act 1995 (TSC Act);
- Regional level (species only) against James *et al.* (1999).

4.1 Communities

4.1.1 National

The *Environment Protection and Biodiversity Conservation Act 1999* lists threatened ecological communities and species and is a Commonwealth assessment and approval system for:

- actions that have a significant impact on matters of National Environmental Significance (NES);
- actions that have a significant impact on the environment of Commonwealth land and;
- actions carried out by the Commonwealth Government.

A search of the Commonwealth Department of Environment and Heritage Protected Matters Search Tool (www.deh.gov.au/erin/ert/epbc searched 14 March 2006) produced records of two ecological communities listed under the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 (EP&BC Act) occurring within a 10 km radius of the centre of the Study Area, namely:

Communities	Habitat
Cumberland Plain Woodland	Occurs on soils derived from shale on the Cumberland Plain (Commonwealth Listing Advice on Cumberland Plain Woodlands 16 July 2000)
Shale/Sandstone Transition Forest	Restricted to transitional areas between the clay soils derived from the Wianamatta shale and the sandy soils derived from Hawkesbury sandstone within the Sydney Basin Bioregion. (Commonwealth Listing Advice on Shale/Sandstone Transition Forest 4 April 2001)
Turpentine-Ironbark Forest in the Sydney Basin Bioregion	Occurs primarily on clay soils derived from Wianamatta shale, including clay lenses of Wianamatta shale within Hawkesbury sandstone. (Commonwealth Listing Advice on Turpentine-Ironbark Forest of the Sydney Basin Bioregion 26 August 2005).

None of these communities are considered likely to occur in the Study Area. Although a small area of Wianamatta Shale was mapped in the north of the Study Area by Clark and Jones (1991) (Figure 2), this area has been cleared of forest/woodland vegetation

since at least 1947 and currently supports grassland dominated by *Eragrostis curvula* and other exotic pasture species.

4.1.2 State

Eleven endangered ecological communities listed under the NSW TSC Act have previously been recorded as occurring in the Hawkesbury LGA namely:

Communities	Habitat	Likely to occur on the Study Area?
Blue Mountains shale cap forest in the Sydney Basin Bioregion	Found on deep fertile Wianamatta Shale soils on moist sheltered sites at lower and middle altitudes in the Blue Mountains and Wollemi areas (Final Determination 6 October 2000).	No. The Study Area is outside of the Blue Mountains and Wollemi areas.
Castlereagh Swamp Woodland Community	Associated with poorly-drained depressions and creeklines on clay soils associated with Tertiary alluvium (Final Determination 24 December 1999).	No. Although some clay soils associated with Tertiary alluvium occur in the south-east of the Study Area, these areas have been cleared of woodland vegetation since at least 1947.
Cooks River/Castlereagh Ironbark forest in the Sydney Basin Bioregion	Usually occurs on clay soils on Tertiary alluvium, or on shale soils on Wianamatta Shale including the Birrong Soil Landscape and associated shale lowlands (Final Determination 10 May 2001).	No. Although some clay soils associated with Tertiary alluvium occur in the south-east of the Study Area, these areas have been cleared of woodland vegetation since at least 1947, as has the small area of shale geology in the north of the Study Area.
Cumberland Plain Woodland	Soils derived from shale on the Cumberland Plain (Final Determination 13 June 1997).	No. The small area mapped as shale geology in the north of the Study Area is cleared and does not support woodland vegetation.

Communities	Habitat	Likely to occur on the Study Area?
Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	Associated with periodic or semi-permanent inundation by freshwater, although there may be minor saline influence in some wetlands. They typically occur on silts, muds or humic loams in depressions, flats, drainage lines, backswamps, lagoons and lakes associated with coastal floodplains (Final Determination 17 December 2004).	No. The Study Area is not periodically or semi-permanently inundated by freshwater.
Montane peatlands and swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions	Associated with accumulated peaty or organic-mineral sediments on poorly drained flats in the headwaters of streams. It occurs on undulating tablelands and plateaus, above 400-500 m elevation, generally in catchments with basic volcanic or fine-grained sedimentary substrates or, occasionally, granite (Final Determination 17 December 2004)	No. The Study Area is not on peatlands and is at a low elevation (0 to 20 m).
River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	Associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains (Final Determination 17 December 2004).	Possibly.
Shale gravel transition forest in the Sydney Basin Bioregion	Occurs primarily in areas where shallow deposits of Tertiary alluvium overlie shale soils but may also occur in association with localised concentrations of iron-indurated gravel (Final Determination 19 April 2002).	No. Although there is a geological transition between shale and gravel in the north of the Study Area, this area has been cleared of forest vegetation since at least 1947.

Communities	Habitat	Likely to occur on the Study Area?
Shale/Sandstone Transition Forest	Areas transitional between the clay soils derived from Wianamatta Shale and the sandy soils derived from Hawkesbury Sandstone on the margins of the Cumberland Plain (Final Determination 11 September 1998).	No. The Study Area does not occur on a shale/sandstone transition.
Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions	Associated with grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains (17 December 2004).	No. Groundwater not saline or sub-saline, dominant species River Oak, not Swamp Oak.
Western Sydney Dry Rainforest in the Sydney Basin Bioregion	Associated with gullies and sheltered slopes of hilly, relatively steep sections of the generally elevated Cumberland Plain in the Razorback Range from Cobbitty to Picton, and sporadically elsewhere in Western Sydney including Fairfield City Farm, Grose Vale and Cattai. Soils are clay soils on Wianamatta Shale (Final Determination 24 March 2000).	No. The Study Area is not associated with gullies and sheltered slopes of hilly, relatively steep sections of the generally elevated Cumberland Plain, nor are the soils clay soils on Wianamatta Shale.

The vegetation on the Study Area adjoining the Hawkesbury River meets the listed habitat criteria for one Ecologically Endangered Community, namely:

- River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (Final Determination in Appendix 2).

The vegetation adjoining the river is very degraded, with sampling locations containing from 64% to 84% exotic species. Native groundcover in these areas was severely reduced or absent, and invasive exotic species such as *Cestrum parqui, Tradescantia albiflora* and *Cardiospermum grandiflorum* dominated the understorey. The only abundant native species was *Casuarina cunninghamiana.*

When compared with the 88 listed characteristic species for River-flat Eucalypt Forest on Coastal Floodplains (RFEF), the vegetation within 40 m of the river (sampled in Quadrats 1, 3, and 4 and Spot locations A, B, C, D, H, I, J, K, Q and T), the percentage of characteristic species was very low:

Sampling location	No. of species recorded	No. native species recorded	No. RFEF characteristic species	% of RFEF char. spp. (Total = 88)
Q1	29	7	3	3%
Q3	32	15	8	9%
Q4	23	3	2	2%
A	20	4	3	3%
B	24	6	2	2%
C	16	5	3	3%
D	14	5	3	3%
H	21	6	5	6%
I	14	5	4	5%
J	19	3	3	3%
K	12	3	2	2%
Q	14	4	3	3%
T	21	5	3	3%
Total	85	25	12	14%

The riparian vegetation was dominated by *Casuarina cunninghamiana.* This was the only native canopy species recorded on the riverbank; *Eucalyptus tereticornis* was recorded in Quadrat 3, about 30 m from the river.

According to paragraph 4 of the Final Determination for River-flat Eucalypt Forest on Coastal Floodplains (Appendix 2), this community 'has a tall open tree layer of eucalypts'. *Eucalyptus tereticornis* is listed as one of the most widespread and abundant dominant tree species for RFEF; this species was only recorded in one sampling location near the river. *Casuarina cunninghamiana* is listed as part of 'a layer of small trees' that may be present in this community.

It is stated in paragraph 6 of the Final Determination for River-flat Eucalypt Forest on Coastal Floodplains (Appendix 2:

> *The combination of features that distinguish River-flat Eucalypt Forest on Coastal Floodplains from other endangered communities on the coastal floodplain include: its dominance by either a mixed eucalypt canopy or by a single species of eucalypt...*[and] *the relatively low abundance or sub-dominance of Casuarina and Melaleuca species...*

It is concluded that the vegetation in the Study Area within 40 m of the Hawkesbury River does not meet the criteria for River-flat Eucalypt Forest on Coastal Floodplains as specified in the Final Determination because:

- the vegetation is dominated by *Casuarina cunninghamiana* and not eucalypt species; and
- the percentage of characteristic species recorded was very low, at between 2% and 9% for any individual sampling location, and 14% in total.

4.2 Species

4.2.1 National

A search of the Commonwealth Department of Environment and Heritage Protected Matters Search Tool (www.deh.gov.au/erin/ert/epbc searched 14 March 2006) produced records of 19 threatened plant species listed under the Commonwealth

Environmental Protection and Biodiversity Conservation Act 1999 (EP&BC Act) occurring within a 10 km radius of the centre of the Study Area, namely:

Species	Status	Habitat (Harden 1990-1993, 2002)	Likely to occur on the Study Area?
Acacia bynoeana	V	Mainly in heath and dry sclerophyll forest on sandy soils; south of the Dora Creek-Morisset area to Berrima and the Illawarra Region, west to the Blue Mtns.	Possibly, however no heath or dry sclerophyll forest on Study Area.
Acacia gordonii	E	Grows in dry sclerophyll forest and heath on sandstone outcrops, chiefly recorded in the lower Blue Mountains from Bilpin to Faulconbridge, also in the Glenorie district.	No. No dry sclerophyll forest or heath on sandstone outcrops on Study Area.
Acacia pubescens	V	Usually grows in open sclerophyll forest and woodland on clay soils; Bilpin to Georges River area, also recorded at Woodford.	Possibly, however no open sclerophyll forest or woodland on Study Area.
Cryptostylis hunteriana	V	Grows on swamp heath on sandy soils, chiefly in coastal districts, south from the Gibraltar Range.	No. No swamp heath on Study Area.
Darwinia biflora	V	Grows in heath on sandstone or in the understorey of woodland on shale-capped ridges; Cheltenham to Hawkesbury R.	No. Study Area not on sandstone, no heath or woodland on Study Area.
Dillwynia tenuifolia	V	Grows in dry sclerophyll woodland on sandstone, shale or laterite; from Cumberland Plain, Blue Mtns to Howes Valley area.	Possibly, however no sclerophyll woodland on Study Area.
Kunzea rupestris	V	Grows in heath on rock platforms; known only from between Maroota and Ku-ring-gai Chase N.P.	No. No rock platforms on Study Area.
Melaleuca deanei	V	Grows in wet heath on sandstone, coastal districts from Berowra to Nowra.	No. Study Area not on sandstone, no wet heath on Study Area.
Micromyrtus blakelyi	V	Grows in heath in depressions on sandstone rock platforms; restricted to areas near the Hawkesbury River.	No. No sandstone rock platforms on Study Area.

Micromyrtus minutiflora	V	Grows in dry sclerophyll forest in the western part of the Cumberland Plain.	Possibly, however no dry sclerophyll forest on Study Area.
Olearia cordata	V	Grows in dry sclerophyll forest and open shrubland, on sandstone.	No. Study Area not on sandstone.
Persoonia hirsuta	E	Grows in woodland to dry sclerophyll forest on sandstone.	No. Study Area not on sandstone.
Pimelea curviflora var. *curviflora*	V	Confined to coastal areas around Sydney on sandstone. (Harden 1990). Coastal area of northern Sydney to Maroota in the north-west. It is found between South Maroota, Cowan, Narrabeen, Allambie Heights, Northmead and Kellyville (Final Determination 31 July 1998).	No. Study Area not on sandstone.
Pimelea spicata	E	Grows on the coast from Lansdowne to Shellharbour and inland to Penrith; rare.	?Possibly
Pomaderris brunnea	V	In open forest, confined to the Colo River and upper Nepean River.	No. Study Area adjoins Hawkesbury River.
Pterostylis saxicola	E	Grows in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. Vegetation above the shelves in either shale/sandstone transition or shale communities. From Picnic Point to Picton area (Final Determination dated 31 October 1997).	No. Study Area does not contain sandstone rock shelves above cliff lines.
Pultenaea parviflora	V	Grows in dry sclerophyll forest on Wianamatta shale, laterite or alluvium, Cumberland Plain.	Possibly; no dry sclerophyll forest on Study Area.
Tetratheca glandulosa	V	Grows in sandy or rocky heath or scrub from Mangrove Mtn to the Blue Mtns and Sydney.	No. Study Area does not contain sandy or rocky heath or scrub.
Zieria involucrata	V	Grows in wet sclerophyll forest, chiefly in the lower Blue Mtns, west to Katoomba district; rare.	No. No wet sclerophyll forest on Study Area.

E: Endangered V: Vulnerable

None of these species were recorded on the Study Area. In view of the long history of clearing and modification of the vegetation in the Study Area and the level of exotic invasion, it is unlikely that any of these species would occur on the Study Area.

4.2.2 State

The NPWS Atlas of NSW Wildlife (extracted 14 March 2006) contained records of 31 threatened species listed in the TSC Act that have been recorded in the Hawkesbury LGA, namely:

Species	Status	Habitat (Harden 1990-1993, 2002)	Likely to occur on the Study Area?
Acacia bynoeana	E1	See above in National listing.	See above.
Acacia gordonii	E1	See above in National listing.	See above.
Acacia pubescens	V	See above in National listing.	See above.
Acrophyllum australe	V	Grows in damp crevices in sandstone, usually near waterfalls. Restricted to Blue Mountains, near Springwood, Linden, Woodford and Lawson.	No. Study Area is not on sandstone, not in Blue Mountains.
Ancistrachne maidenii	V	Grows on sandstone-derived soils; north of Sydney.	No. Study Area is not on sandstone.
Asterolasia elegans	E1	Grows in wet sclerophyll forest on moist hillsides, known from only one locality, north of Maroota.	No. Study Area does not contain wet sclerophyll forest on moist hillsides, not near Maroota.
Cynanchum elegans	E1	Recorded from rainforest gullies scrub and scree slopes; from the Gloucester district to the Wollongong area and inland to Mt Dangar.	No. Study Area does not contain rainforest gullies scrub and scree slopes.
Dillwynia tenuifolia	V	See above in National listing.	See above.
Epacris sparsa	V	Grows in sandy soil among rocks beside Grose R.	No. Study Area is on Hawkesbury River.
Eucalyptus benthamii	V	Restricted but locally abundant, in wet forest on sandy alluvial soils along valley floors; confined to the lower Nepean R. and Kedumba Valley.	No. Study Area is on Hawkesbury River.
Grevillea juniperina subsp. *juniperina*	V	Restricted range occurring on red sandy to clay soils – often lateritic on Wianamatta Shale and Tertiary alluvium in Cumberland Plain Woodland and Castlereagh Woodland (Final Determination 28 April 2000)	No.
Kennedia retrorsa	V	Rare, chiefly on Mt Dangar and	No. Not in

		Goulburn River Valley to near Putty.	geographical range.
Keraudrenia corrolata var. *denticulata*	E2	An isolated population... occurs in Hawkesbury Local Government Area, disjunct from other populations and at the southern limit of its geographic range. There are collections from Colo River area between Lower Portland and Morans Rock and near Gees Lagoon (Final Determination 6 October 2000)	Possibly, however not in known geographic range.
Lasiopetalum joyceae	V	Grows in heath on sandstone; Hornsby plateau.	No. Study Area not on sandstone.
Leucopogon fletcheri subsp. *fletcheri*	E1	Grows in woodland on clayey and lateritic soils, south from Springwood.	No. Study Area not south of Springwood
Melaleuca deanei	V	See above in National listing.	See above.
Micromyrtus minutiflora	E1	See above in National listing.	See above.
Olearia cordata	V	See above in National listing.	See above.
Persoonia acerosa	V	Grows in heath or dry sclerophyll forest on sandstone; central Blue Mtns south to Hill Top.	No. Study Area not on sandstone.
Persoonia hirsuta	E1	See above in National listing.	See above.
Persoonia hirsuta subsp. nov.? Yengo National Park	E1	–	–
Persoonia nutans	E1	See above in National listing.	See above.
Pimelea curviflora var. *curviflora*	V	See above in National listing.	See above.
Pimelea spicata	E1	See above in National listing.	See above.
Pomaderris brunnea	V	See above in National listing.	See above.
Prostanthera cineolifera	V	Apparently grows in sclerophyll forest. The distribution of this taxon is uncertain.	? Study Area does not contain sclerophyll forest.
Pterostylis saxicola	E1	See above in National listing.	See above.
Pultenaea parviflora	E1	See above in National listing.	See above.
Tetratheca glandulosa	V	See above in National listing.	See above.
Tetratheca juncea	V	Grows in sandy, occasionally swampy heath and in dry sclerophyll forest; chiefly in coastal districts from Bulahdelah to Lake Macquarie, also recorded from Port Jackson to Botany Bay from which it is possibly extinct.	No. No heath or sclerophyll forest on Study Area, not near main population.
Velleia perfoliata	V	Grows in heath on shallow sandy soil over sandstone; the Hawkesbury district to the upper Hunter Valley.	No. Study Area not on sandstone.
Zieria involucrata	E1	See above in National listing.	See above.

E1: Endangered; E2: Endangered population; V: Vulnerable

None of these species were recorded on the Study Area. In view of the long history of clearing and modification of the vegetation in the Study Area and the level of exotic invasion, it is unlikely that any of these species would occur on the Study Area.

4.2.3 Regional

James *et al.* (1999) state that over 650 native species have been recorded in Hawkesbury LGA including "70 species of regional significance and 40% of species considered vulnerable and inadequately conserved in Western Sydney".

The regional (Western Sydney) conservation status of each species (James *et al.* 1999) was assessed as follows:

- **Regionally vulnerable** – not known to be conserved within three or more dedicated conservation reserves in Western Sydney or in the adjacent sandstone areas. At the time of publication of James *et al.* (1999), 60% of plants recorded for Western Sydney were considered to be regionally vulnerable and inadequately conserved.
- **Regionally significant** – includes those endemic to the Western Sydney area, those regarded as rare and endangered at National and State levels, species that are rare in the region or with disjunct populations, species restricted to endangered habitats, species at or close to geographic limits and species believed to be extinct. At the time of publication of James *et al.* (1999), 30% of plants recorded for Western Sydney were considered to be of particular regional significance

Ten regionally vulnerable species, including one species of particular conservation significance in Western Sydney, were recorded on the Study Area, namely:

Species	Regional status	Sampling locations
Amyema cambagei	V	Spot locations C and D
Bothriochloa macra	V	Quadrat 3, Spot location U
Convolulus erubescens	V	Quadrat 5
Einadia trigonos subsp. trigonos	V	Quadrat 3, Spot locations F and H
Eragrostis elongata	V	Quadrat 2
Oxalis perennans	V	Quadrats 1 to 5 and 7, Spot locations A, C, D and H
Portulaca oleracea	V	Spot location F
Rumex brownii	V	Quadrats 1 and 3, Spot location T
Schoenoplectus validus	V	Spot location B
Teucrium argutum	**V - regionally significant**	Quadrat 3

The Study Area is close to the southern geographical limit for *Teucrium argutum*. There are only two records of this species in the Sydney region, at Casula and Nortons Basin; these are disjunct populations, as the species occurs mostly north of Dubbo and in the northern botanical subdivisions of NSW (James 1999, Harden 1992).

5.0 Noxious weeds

The NSW Department of Primary Industries' *Noxious Weeds Declarations* (www.dpi.nsw.gov.au/noxweed, accessed 14 March 2006) identifies 91 noxious weed species for the Hawkesbury River County Council control area (which includes Hawkesbury LGA) (Appendix 3). Twelve of the 79 exotic species recorded in the current survey are declared noxious weeds in the Hawkesbury River County Council, namely:

Botanical name	Common name	Control Category	Sampling locations
Alternanthera philoxeroides	Alligator Weed	3	Spot location B
Asparagus asparagoides	Bridal Creeper	5	Quadrats 1, 3 and 4, Spot locations C, H, I, J, M, N and R
Cestrum parqui	Green Cestrum	3	Quadrats 3, 4, 5 and 7, Spot locations A to D, H, J, K, N, Q and T
Cortaderia selloana	Pampas Grass	4	Spot location Q
Echium plantagineum	Paterson's Curse	4	Spot location L
Lantana camara	Lantana	5	Spot locations B, C, D, H and T
Ligustrum lucidum	Small-leaved Privet	4	Quadrat 6, Spot location R
Ligustrum sinense	Broad-leaved Privet	4	Quadrats 3 and 6, Spot locations B, C, D, J, N, Q, R and T
Lycium ferocissimum	African Boxthorn	4	Spot location H
Rubus discolor (part of *Rubus fruticosus* aggregate species)	Blackberry	4	Spot location U
Salix alba	White Willow	5	Spot locations B, J, N and O
Xanthium occidentale	Noogoora Burr	4	Spot location B

Control categories:

3 The plant must be fully and continuously suppressed and destroyed

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.

5 The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with.

6.0 NSW Rivers and Foreshores Improvement Act 1948

The Study Area adjoins the Hawkesbury River to the north-west and north-east. The Department of Land and Water Conservation guidelines (Appendix 4) for the Rivers and Foreshores Improvement Act 1948 (R&FI Act) state that the Act:

"applies to natural and artificial water bodies, which are known as protected waters, and which include:

- *all clearly defined drainage lines;*
- *perennial (flowing) or intermittent (often dry) streams;*

- *modified stream channels;*
- *artificial channels diverting natural stream channels;*
- *estuaries, coastal lakes or lagoons;*
- *any perennial or intermittent lakes having a stream running into or from them and coastal lakes".*

Part 3A of the R&FI Act also applies to ***protected land****, which includes the bank, shore or bed of these water bodies, adjacent land within 40 metres of the top of their banks or shores, .. , and associated deposits of material. However, Part 3A may also apply to land further than 40 metres from a water body, if an activity poses a threat to protected waters or protected land.*

The Department of Land and Water Conservation guidelines (Appendix 4) for the Rivers and Foreshores Improvement Act 1948 (R&FI Act) also states that::

A riparian area of local native vegetation (comprising tree, shrub and groundcover species) should be maintained and enhanced wherever possible adjacent to rivers, estuaries and lakes. This riparian area will provide a natural filter for runoff, will stabilise stream banks and will provide habitat and corridor functions for flora and fauna. Generally, a minimum riparian area of 40 metres wide measured from the top of each bank is recommended for major watercourses and 20 metres for minor watercourses.

7.0 Conclusions

From the flora assessment of the Study Area, it was found that:

- The Site has a long history of disturbance from agricultural activities, with settlement of the Pitt Town Area in the early 1800s and the earliest aerial photograph of the Study Area (1947) showing it almost completely cleared of tree vegetation;
- A total of 111 species (32 native and 79 exotic) were recorded in the Study Area from seven quadrats (Quadrats 1 to 7) and 21 Spot locations (A to U);
- No Endangered Ecological Communities listed on the schedules of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EP&BC Act) or the NSW Threatened Species Conservation Act 1995 (TSC Act) were recorded;
- No threatened species listed on the EP&BC Act or the TSC Act were recorded;
- Ten species considered regionally vulnerable, including one species considered to be of particular significance in Western Sydney (James *et al.* 1999) were recorded;
- Twelve noxious weeds were recorded.

References

Benson D.H. and Howell J. (1990)
Taken for Granted: The bushland of s\Sydney and its suburbs. Kangaroo Press: Sydney.

Benson (1992)
Natural vegetation of the Penrith area. *Cunninghamia* 2(4).

Clark and Jones (1991)
Penrith 1:100 000 Geological Series Sheet 9030. Geological Survey of NSW., Department of Mineral Resources, Sydney.

Harden G. J. (1990-1993, 2002)
Flora of New South Wales. University of New South Wales Press, Kensington.

Harden G.J. and Murray L. J. (2000)
Supplement to Flora of New South Wales – Volume 1. University of New South Wales Press, Kensington.

Hazelton, Bannerman and Tille (1989)
Penrith 1:100 000 Soil Landscape Series Sheet 9030. Soil Conservation Service of NSW, Sydney.

James T., McDougall L. and Benson D.H. (1999)
Rare Bushland Plants of Western Sydney. Royal Botanic Gardens, Sydney.

NPWS (2002)
Native Vegetation of the Cumberland Plain, Western Sydney. Final Edition on CD Rom. National Parks and Wildlife Service, Hurstville.

Rosen S. (1995)
Losing Ground: An Environmental History of the Hawkesbury-Nepean Catchment. Hale & Ironmonger, Sydney.

Tozer M. (2003)
The native vegetation of the Cumberland Plain, western Sydney: systematic classification and field identification of communities. *Cunninghamia* 8(1), 1-76.