Bush Forever Site Description (from *Bush Forever* Volume 2 Government of WA 2000), for the Maps see Volume 1 or attached copy of *Perth's Bushplan* Map

PERTH AIRPORT AND ADJACENT BUSHLAND

Boundary Definition: bushland (part taken to cadastre) boundary (Boundary adjusted in response to a submission to draft *Perth's Bushplan*.)

SECTION 1: LOCATION INFORMATION

Bush Forever Site no. 386
Area (ha): bushland 629.5 (Site also includes open water.)
Map no. 43, 48, 49
Map sheet series ref. no. 2034–II SE
Other Names: not known
Local Authorities (Suburb): Shire of Swan (Perth Airport, South Guildford), Shire of Kalamunda (High Wycombe), City of Belmont (Forrestfield, Perth Airport)
System 6 (1983): M52 Part System area bushland, only bushland described

SECTION 2: REGIONAL INFORMATION

LANDFORMS AND SOILS
Pinjarra Plain
Guildford Formation (Qpa: Mgs1)
Bassendean Dunes
Bassendean Sands (Qpb: S8)
Bassendean Dunes/Pinjarra Plain
Bassendean Sands over Guildford Formation (Qpb/Qpa: S10)
Wetlands (within the Bassendean Dunes and Pinjarra Plain)
Holocene Swamp Deposits (Qhw: Cps)

VEGETATION AND FLORA
Vegetation Complexes
Pinjarra Plain
Guildford Complex
Bassendean Dunes
Bassendean Complex — Central and South
Combinations of Bassendean Dunes/Pinjarra Plain
Southern River Complex
Floristic Community Types *not sampled, types inferred
Supergroup 2: Seasonal Wetlands
4 *Melaleuca preissiana* damplands
5 Mixed shrub damplands
7 Herb-rich saline shrublands in clay pans
*11 Wet forests and woodlands
12 *Melaleuca teretifolia* and/or *Astartea* aff. *fascicularis* shrublands
*15 Forests and woodlands of deep seasonal wetlands
Supergroup 3: Uplands centred on Bassendean Dunes and Dandaragan Plateau
20a *Banksia attenuata* woodlands over species-rich dense shrublands
20b Eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands (most northern occurrence)
23a Central *Banksia attenuata* — *B. menziesii* woodlands

WETLANDS
Wetland Types: lake, sumpland, dampland, palusplain, artificial channel, creek
Natural Wetland Groups
Bassendean—Pinjarra transition OR Bassendean with fluvial features
Mungala (B/P.2)
Wetland Management Objectives: Conservation (22ha), Resource Enhancement, Multiple Use
Swan Coastal Plain Lakes EPP: 30.4ha

THREATENED ECOLOGICAL COMMUNITIES
Not assessed, Endangered (floristic community types 20a, 20b), Vulnerable (floristic community types 7, 15)

SECTION 3: SPECIFIC SITE DETAIL

Landscape Features: open water, vegetated wetlands, vegetated uplands
Vegetation and Flora: limited survey (DEP 1996 (Perth 01–10), Keighery, BJ, 1995e, DEP 1998, DEP 1999); detailed survey (Tingay, Alan & Associates 1994c)

Structural Units: mapping (Tingay, Alan & Associates 1994c)
Uplands: *Eucalyptus calophylla* Woodland; *Eucalyptus marginata* Woodland; *Eucalyptus rudis* Woodland; *Banksia attenuata, B. menziesii* and *Allocasuarina fraseriana* Woodland; *Banksia attenuata, B. menziesii* and *B. ilicifolia* Woodland
Wetlands: *Banksia littoralis* Low Woodland to Forest; *Melaleuca preissiana* Low Woodland; *Melaleuca rhaphiophylla* Low Woodland; *Melaleuca rhaphiophylla* and *Eucalyptus rudis* Forest; *Jacksonia sternbergiana* Closed Tall Scrub to Tall Shrubland; *Jacksonia furcellata* Open Shrubland; *Adenanthos cygnorum* Shrubland; *Kunzea glabrescens* Tall Shrubland; *Hakea varia* Closed Heath; *Regelia ciliata* Shrubland; *Astartea* aff. *fascicularis* Closed Heath; *Pericalymma ellipticum* Shrubland; *Melaleuca teretifolia* Open to Closed tall Scrub; *Melaleuca viminea* Open Heath; Mixed Open Heath; *Acacia saligna* Shrubland to Open Tall Scrub; Sedgelands of *Leptocarpus* species, *Baumea articulata* and *Typha domingensis*
Scattered Native Plants: not assessed
Vegetation Condition: >60% Excellent to Very Good, <40% Good to Degraded (mapping Tingay, Alan & Associates 1994c)
Total Flora: 295 native taxa (Tingay, Alan & Associates 1994c, DEP 1996) (estimated >70% expected flora)
Significant Flora: *Conospermum undulatum* (R), *Macarthuria keigheryi* (R); *Eucalyptus marginata* subsp. *elegantella* (1), *Tripterococcus paniculatus* ms (1), *Myriophyllum echinatum* (3), *Stylidium longitubum* (3), *Haemodorum loratum* (3), *Conostephium minus* (4), *Villarsia submersa* (4), *Verticordia lindleyi* subsp. *lindleyi* (4); *Platysace juncea, Byblis lindleyana, Conospermum triplinervium* (hybrids with *C. undulatum*), *Levenhookia preissii* (rarely recorded on the Swan Coastal Plain), *Cheilanthes austrotenuifolia* (Tingay, Alan & Associates 1994; DEP 1996, uncommon on the Plain, associated with communities that are heavily cleared), *Verticordia nitens* (Tingay, Alan & Associates 1994; DEP 1996, only currently recorded population south of Gnangara in the Perth Metropolitan Region), *Villarsia violifolia* (uncommon on Plain); 34 taxa associated with eastern side of the Plain

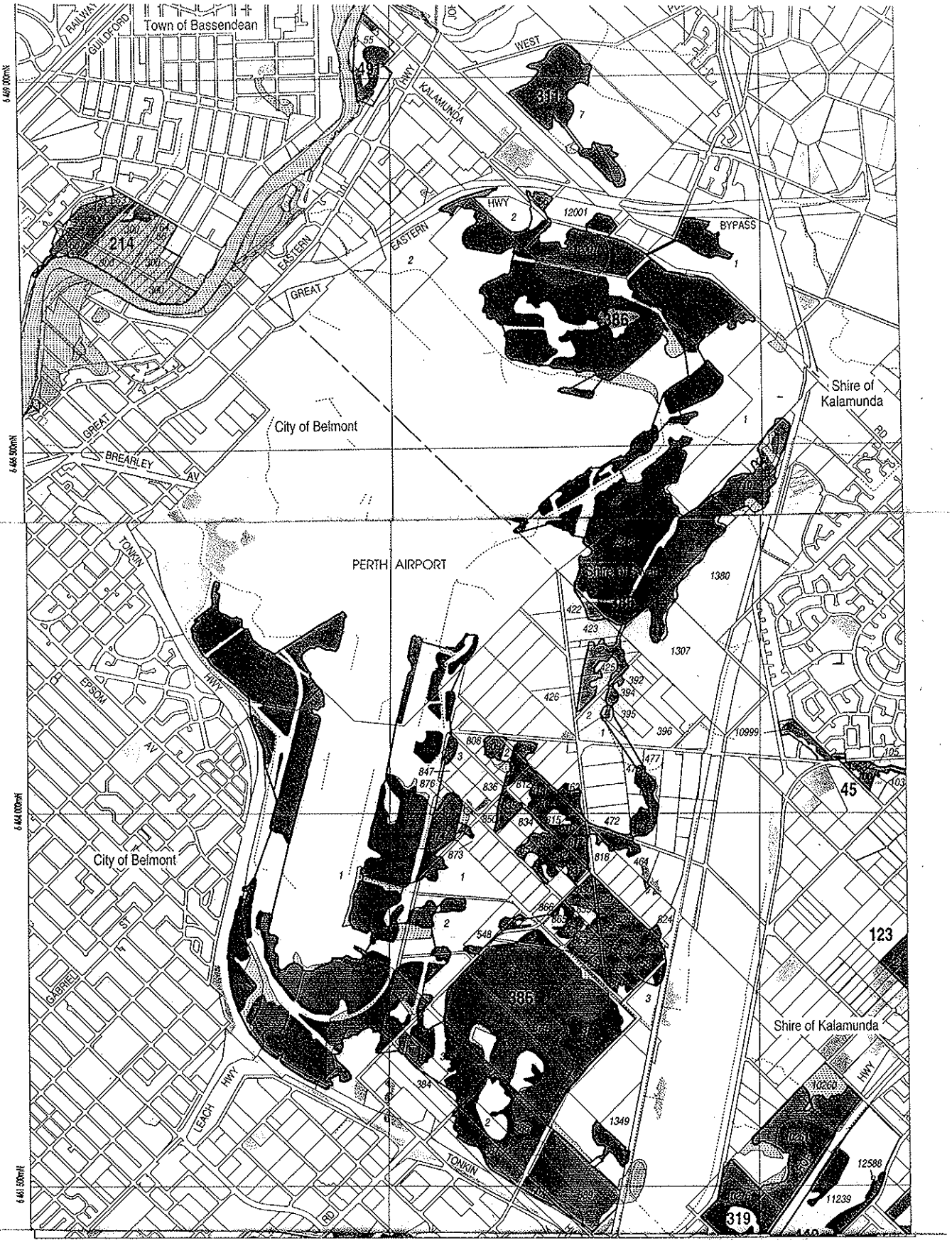
Fauna: structured survey for birds (87 species) (How and Dell 1994; RAOU 1996 D; Tingay, Alan & Associates 1994b), native mammals (2 species), reptiles (20 species) and amphibians (8 species) (How and Dell 1994; Tingay, Alan & Associates 1994b). Significant bird species: category 3 (2) and category 4 (7). Munday Swamp is in the top 6% of wetlands for breeding waterbirds (Jaensch *et al.* 1993). Significant mammal species: Quenda and Echidna. Significant reptile species: 1970 record of Western Swamp Tortoise. Rich frog assemblage typical of the eastern side of the Swan Coastal Plain. Only two other areas match the vertebrate species richness in the Perth Metropolitan Region. The only significant populations of two WA-endemic fish, the Western Pygmy Perch (*Edelia vittata*) and Western Minnow (*Galaxis occidentalis*) in the PMR (Robson and Charter 1989). Munday Swamp has an unusually rich and diverse invertebrate fauna (82 species), including several rare species
Linkage: no adjacent bushland; part of Greenways 26, 99, 109, 110 (Tingay, Alan & Associates 1998a); part of a regionally significant fragmented bushland/wetland linkage (Part A, Map 7)
Other Special Attributes: Munday Swamp and adjacent lands and lands to the north are considered to be of Aboriginal heritage value (Australian Archaeological Survey Consultants 1995); a number of uplands and wetlands are suitable for Western Swamp Tortoise release (Kuchling and Burbidge 1996); Munday Swamp, Runway Swamp, Link Road Swamp and sumplands east of the main runway are wetlands of national importance (ANCA 1996); National Trust of Australia (WA) Classification; contains a substantial sweep of soils and communities from eastern to central Plain (Bassendean Sands); contains plant communities representative of the eastern side of the Swan Coastal Plain

SECTION 4: INTERNATIONAL AND NATIONAL SIGNIFICANCE

Entered in the Register of the National Estate; Directory of Important Wetlands in Australia; subject to protection under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

SECTION 5: SELECTION CRITERIA AND RECOMMENDATIONS

Criteria: Representation of ecological communities, Diversity, Rarity, Scientific or evolutionary importance, General criteria for the protection of wetland, streamline and estuarine fringing vegetation and coastal vegetation
Recommendation: Part A: Cemetery Mechanism. Part B: Other Government Land Mechanism (see Table 3, Volume 1).



LEGEND

- 472 — Bushplan Sites With Regionally Significant Bushland
- Other Native Vegetation
- Conservation Category Wetlands
- Bushplan Sites With Some Existing Protection
- 696 — Lot Number, Location Number
- Channel Wetlands
- Local Government Boundary

2034 - II SE

IV | I
2034
III | NW | NE | SW | SE (33)

1 : 25 000 AMG Reference Grid showing Perth's Bushplan Map Sheet Breakdown

PERTH'S BUSHPLAN MAP INDEX

N

SCALE
0 500 1000
Metres

Produced by Project Mapping Section
Land Information Branch, Ministry for Planning, Perth W.A. November 1998

nwt-map11//environ/bushplan//bushv2_58.dgn

Cadastral Data supplied by Department of Land Administration, W.A.

Wetlands Data supplied by Water and Rivers Commission

Native Vegetation Extent for Study Area supplied by Agriculture Western Australia

EXTRACT of additional vegetation and flora information from: "Synopsis of Bush Forever Comment on Draft Major Development Plan for part Precinct 2C – Warehousing and Distribution Park in Bush Forever Site 386 (Perth Airport Bushland)
Departments of Environment and Planning and Infrastructure 15th August 2003"

Natural values of Precinct 2C Bushland
The area of Precinct 2C proposed for development contains areas of bushland identified in Bush Forever (Government of Western Australia 2000a&b) as depicted in Map 1 (hereafter referred to as the Precinct 2C bushland).

All known information on the natural values of the Precinct 2C bushland has been collated (Alan Tingay and Associates 1994, Keighery 1995, Robson and Charter 1989, Kuchling, and Burbidge 1996, DEP 1997-1998, DEP 1998, How and Dell 1994, How 1995, Harvey *et al.* 1997, Trudgen 1995, Ecologia 1998&1999, Biota 2002, Bennett 2002, ENV Australia 2003, WRC 2003 and DoE 2003 field observations). This information has been used to compare the Precinct 2C bushland with bushland in the broader area of Bush Forever Site Perth Airport bushland, Bush Forever Sites within the same landform unit and other areas of this landform unit on the Swan Coastal Plain. This comparison has confirmed the regional/national significance of the Precinct 2C bushland. These particular values are briefly listed below.

- Representative of the upland and wetland units of the Southern River Complex containing significant elements the interface between the Pinjarra Plain/Foothills and the Bassendean Dunes, forming part of a west-east transect of this interface;
- Contains significant areas of upland/wetland interface which are important fauna and flora habitat;
- Contains significant areas of Banksia woodland (approx. 15% of the bushland) that:
  - are habitat for the state and federally listed rare flora species *Macarthuria keigheryi;*
  - is most likely floristic community type 20a and contains one of five known populations of *Consopermum* aff. *undulatum* (BJK 2800) which is apparently as rare as *Consopermum undulatum* which is listed at the state and federal levels[1];
  - are habitat for significant vertebrate fauna including the state listed Priority fauna species Quenda and the Crowned Snake (*Notechis coronatus*);
  - are habitat for significant invertebrate fauna including species of *Laestrygones* in the family Toxopidae never previously recorded from the Swan Coastal Plain; and
  - contains areas of *Banksia* woodland intermediate between the *Banksia* woodland of the Pinjarra Plain/Foothills and the Bassendean Dunes.
- Contains areas of wetland, which are recognised nationally, predominantly mapped (approx. 85% of the bushland) by the state as conservation category and recognised as requiring retention.
- Contains vertebrate and invertebrate species that are considered regionally significant including several unnamed invertebrate species as well as the rare huntsman spider (*Zachria flavicoma*).

[1] Two floristic community types are most likely to occur in the area, types 20a and 23a as well as transitions between these two types. Floristic community type 20a is a threatened ecological community. The area of 20a coincides with the location of *Consopermum* aff. *undulatum* (BJK 2800). 15/09/03

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PERTH AIRPORT AND ADJACENT BUSHLAND

Boundary Definition: bushland (part taken to cadastre) boundary

SECTION 1: CADASTRAL INFORMATION

(Lots, locations and derived information to be updated in the public submission period)

Bushplan Site no. 386 **Map no.** 52, 58 **Map sheet series ref. no.** 2034–II SE

System 6 (1983): M52 Part System area bushland, only bushland described

Other Names: not known

Area (ha): total 771.4 (includes open water); bushland 632.3

Local Authorities (Suburb)

Shire of Swan (Perth Airport, South Guildford), Shire of Kalamunda (High Wycombe), City of Belmont (Forrestfield, Perth Airport)

Zoning

MRS: Public Purposes-Commonwealth Government, Railways, Controlled Access Highways, Important Regional Roads, Public Purposes-Special Uses

TPS: Landscape

Ownership Categories

Commonwealth Government, State Government

Lot/Location/Reserve numbers (Purpose), Street name

12001 Queens Rd; 1, 2, 54, 55, 56, 12001 Kalamunda Rd; 0, 1, 2, 3, 7, 382, 384, 385, 386, 387, 389, 392, 394, 395, 396, 422, 423, 425, 426, 462, 464, 471, 472, 500, 501, 548, 812, 813, 814, 815, 816, 817, 818, 824, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 847, 850, 852, 853, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 873, 874, 875, 876, 1349, 6246, 8794, 8795, 8898, 10570, 11872 Horrie Miller Dr; 0 Dundas Rd; 1 Waterhall Rd; 0, 164, 710, 1307, 1380 Wittenoom Rd; 1, 3, 476, 477, 808, 809 Grogan Rd; 0, 1, 2, 6, 8681, 10488 street not identified

Crown Reserve

SECTION 2: REGIONAL INFORMATION

LANDFORMS AND SOILS

Pinjarra Plain

Guildford Formation (Qpa: Mgs1)

Bassendean Dunes

Bassendean Sands (Qpb: S8)

Bassendean Dunes/Pinjarra Plain

Bassendean Sands over Guildford Formation (Qpb/Qpa:S10)

Wetlands (within the Bassendean Dunes and Pinjarra Plain)

Holocene Swamp Deposits (Qhw: Cps)

VEGETATION AND FLORA

Vegetation Complexes

Pinjarra Plain

Guildford Complex

Bassendean Dunes

Bassendean Complex — Central and South

Combinations of Bassendean Dunes/Pinjarra Plain

Southern River Complex

Floristic Community Types *not sampled, types inferred

Supergroup 2: Seasonal Wetlands

4 *Melaleuca preissiana* damplands
5 Mixed shrub damplands
7 Herb-rich saline shrublands in clay pans
*11 Wet forests and woodlands
12 *Melaleuca teretifolia* and/or *Astartea* aff. *fascicularis* shrublands
*15 Forests and woodlands of deep seasonal wetlands

Supergroup 3: Uplands centred on Bassendean Dunes and Dandaragan Plateau

20a *Banksia attenuata* woodlands over species-rich dense shrublands
20b Eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands (most northerly occurrence)
23a Central *Banksia attenuata* — *B. menziesii* woodlands

WETLANDS

Wetland Types: lake, sumpland, dampland, palusplain, artificial channel, creek

Natural Wetland Groups

Bassendean—Pinjarra transition OR Bassendean with fluvial features

Mungala (B/P.2)

Wetland Management Objectives: Conservation (229ha), Resource Enhancement, Multiple Use

Swan Coastal Plain Lakes EPP: 30.4ha

THREATENED ECOLOGICAL COMMUNITIES

Not assessed, Endangered (floristic community types 20a, 20b), Vulnerable (floristic community types 7, 15)

SECTION 3: SPECIFIC SITE DETAIL

Landscape Features: open water, vegetated wetlands, vegetated uplands

Vegetation and Flora: detailed survey (Tingay, Alan & Associates 1994c); limited survey (DEP 1996 (Perth 01–10), Keighery, BJ, 1995e, DEP 1998)

Structural Units: mapping (Tingay, Alan & Associates 1994c)

Uplands: *Eucalyptus calophylla* Woodland; *Eucalyptus marginata* Woodland; *Eucalyptus rudis* Woodland; *Banksia attenuata, B. menziesii* and *Allocasuarina fraseriana* Woodland; *Banksia attenuata, B. menziesii* and *B. ilicifolia* Woodland

Wetlands: *Banksia littoralis* Low Woodland to Forest; *Melaleuca preissiana* Low Woodland; *Melaleuca rhaphiophylla* Low Woodland; *Melaleuca rhaphiophylla* and *Eucalyptus rudis* Forest; *Jacksonia sternbergiana* Closed Tall Scrub to Tall Shrubland; *Jacksonia furcellata* Open Shrubland; *Adenanthos cygnorum* Shrubland; *Kunzea ericifolia* Tall Shrubland; *Hakea varia* Closed Heath; *Regelia ciliata* Shrubland; *Astartea* aff. *fascicularis* Closed Heath; *Pericalymma ellipticum* Shrubland; *Melaleuca teretifolia* Open to Closed tall Scrub; *Melaleuca viminea* Open Heath; Mixed Open Heath; *Acacia saligna* Shrubland to Open Tall Scrub; Sedgelands of *Leptocarpus* species, *Baumea articulata* and *Typha domingensis*

Scattered Native Plants: not assessed

Vegetation Condition: >60% Excellent to Very Good, <40% Good to Degraded (mapping Tingay, Alan & Associates 1994c)

Total Flora: 295 native taxa (Tingay, Alan & Associates 1994c, DEP 1996) (estimated >70% expected flora)

Significant Flora: *Conospermum undulatum* (R); *Eucalyptus marginata* subsp. *elegantella* (1), *Tripterococcus paniculatus* ms (1), *Myriophyllum echinatum* (3), *Stylidium longitubum* (3), *Haemodorum loratum* (3), *Conostephium minus* (4), *Villarsia submersa* (4), *Verticordia lindleyi* subsp. *lindleyi* (4); *Platysace juncea, Byblis gigantea, Conospermum triplinervium* (hybrids with *C. undulatum*), *Levenhookia preissii* (rarely recorded on the Swan Coastal Plain), *Cheilanthes austrotenuifolia* (Tingay, Alan & Associates 1994c, uncommon on the Plain, associated with communities that are heavily cleared), *Verticordia nitens* (Tingay, Alan & Associates 1994c, only currently recorded population south of Gnangara in the Perth Metropolitan Region), *Villarsia violifolia* (uncommon on Plain); 34 taxa associated with eastern side of the Plain, possible location for *Macarthuria keigheryi* (R)

Fauna: multiple and structured surveys by RAOU, Western Australian Museum of Natural Science and others for birds (87), native mammals (2), reptiles (20) and amphibians (8) (How and Dell 1994, RAOU (1996 D), Tingay, Alan & Associates 1994b). Significant bird species: category 3 (2) and category 4 (7). Munday Swamp is in the top 6% of wetlands for breeding waterbirds (Jaensch *et al.* 1993). Significant mammal species: Quenda and Echidna. Significant reptile species: 1970 record of Western Swamp Tortoise. Rich frog assemblage typical of the eastern side of the Swan Coastal Plain. Only two other areas match the vertebrate species richness in the Perth Metropolitan Region. The only significant populations of two WA endemic fish, the western Pygmy Perch (*Edelia vittata*) and Western Minnow (*Galaxis occidentalis*) in the PMR (Robson and Charter 1989). Munday Swamp has an unusually rich and diverse invertebrate fauna (82 species), including several rare species

Linkage: no adjacent bushland; part of proposed Greenways 111, 26, 123, 124 (Tingay, Alan & Associates 1997a); part of a regionally significant fragmented bushland/wetland linkage (Volume 2A, Map 8)

Other Special Attributes: Munday Swamp and adjacent lands and lands to the north are considered to be of Aboriginal heritage value (Australian Archaeological Survey Consultants 1995); a number of uplands and wetlands are suitable for Western Swamp Tortoise release (Kuchling and Burbidge 1996); Munday Swamp, Runway Swamp, Link Road Swamp and sumplands east of the main runway are wetlands of national significance (ANCA 1996); National Trust of Australia (WA) Classification; contains a substantial sweep of soils and communities from eastern to central Plain (Bassendean Sands); contains plant communities representative of the eastern side of the Swan Coastal Plain

SECTION 4: INTERNATIONAL AND NATIONAL SIGNIFICANCE

Interim list of the Register of the National Estate; Directory of Important Wetlands in Australia.

SECTION 5: SELECTION CRITERIA AND RECOMMENDATIONS

Criteria: Representation of ecological communities, Diversity, Rarity, Scientific or evolutionary importance, General criteria for the protection of wetland, streamline and estuarine fringing and coastal vegetation



LEGEND

- 472 — Bushplan Sites With Regionally Significant Bushland
- Other Native Vegetation
- Conservation Category Wetlands
- Bushplan Sites With Some Existing Protection
- 696 — Lot Number, Location Number
- Channel Wetlands
- Local Government Boundary

2034 - II SE

IV | I
2034
III | NW | NE
SW | SE | 58

1 : 25 000 AMG Reference Grid showing Perth's Bushplan Map Sheet Breakdown

PERTH'S BUSHPLAN MAP INDEX

N

SCALE
0 500 1000
Metres

Produced by Project Mapping Section
Land Information Branch, Ministry for Planning, Perth W.A. November 1998

nwt-map11//environ/bushplan//bushv2_58.dgn

Cadastral Data supplied by Department of Land Administration, W.A.

Wetlands Data supplied by Water and Rivers Commission

Native Vegetation Extent for Study Area supplied by Agriculture Western Australia

Bushplan Site Map

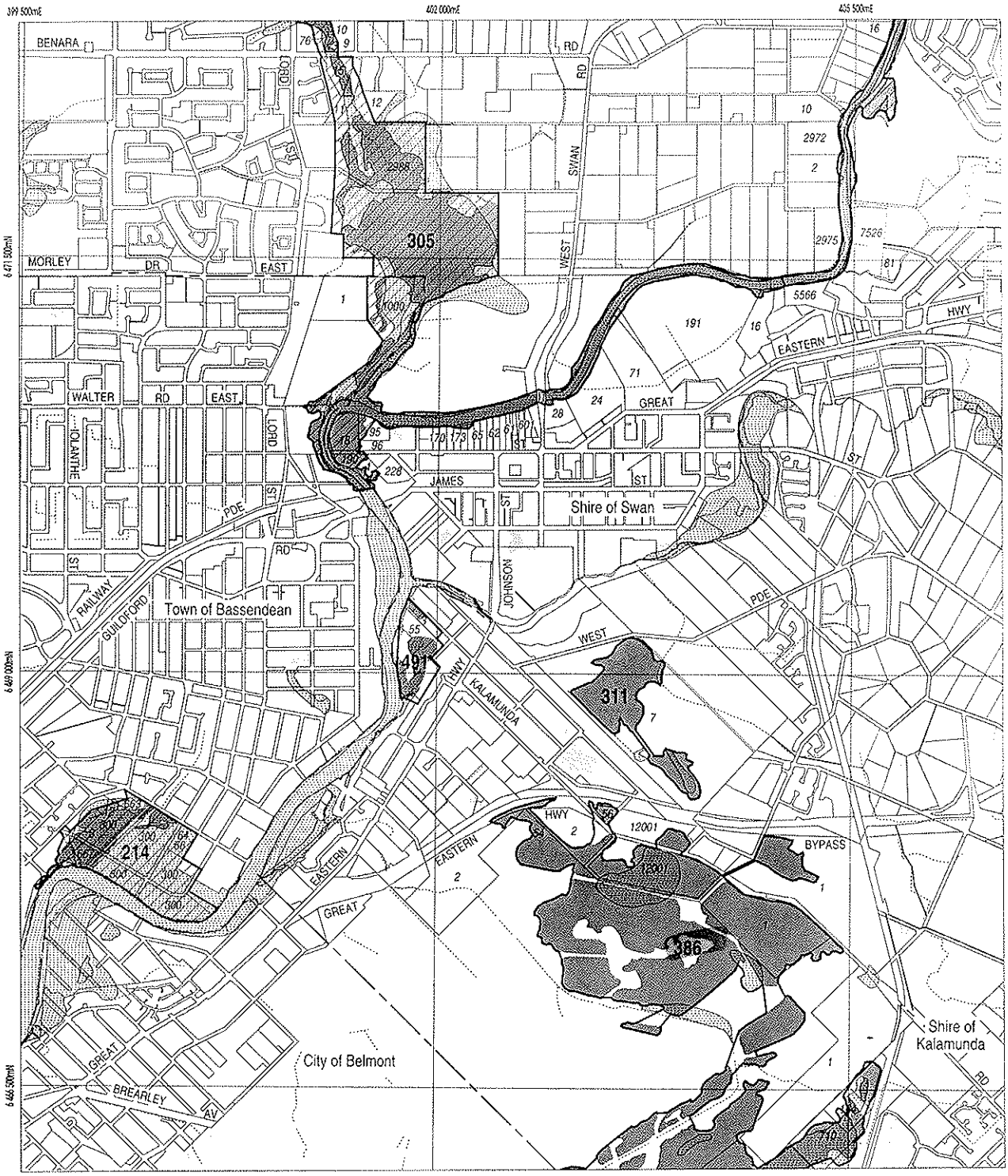
Map 58

Opportunities and/or Constraints

Opportunities: Bushplan Site/part Bushplan Site subject to Swan Coastal Plain Lakes EPP, Swan and Canning Rivers EPP; location of Declared Rare Flora and Scheduled Fauna, conservation category wetlands; under TPS Landscape Zoning, Crown Reserve

Constraints: under MRD regional road requirements, requirements for domestic and international airport

Recommendation: The most appropriate mechanism for the protection of this Bushplan Site be considered through the public comment period in consultation with the land owners. This may include parts for which: The conservation values of the Bushplan Site to be protected through one or more of a range of complementary mechanisms to encourage and secure conservation management on private lands; The specific approach to be determined in consultation/negotiation with the land owner(s), but will generally include conservation covenants/management agreements.



LEGEND

- **472** — Bushplan Sites With Regionally Significant Bushland
- Other Native Vegetation
- Conservation Category Wetlands
- Bushplan Sites With Some Existing Protection
- 696 — Lot Number, Location Number
- Channel Wetlands
- Local Government Boundary

2034 - II SE

IV | I
2034
III | II (NW, NE, SW, SE — 52)

1 : 25 000 AMG Reference Grid showing Perth's Bushplan Map Sheet Breakdown

PERTH'S BUSHPLAN MAP INDEX

N

SCALE

0 500 1000

Metres

Produced by Project Mapping Section
Land Information Branch, Ministry for Planning, Perth W.A. November 1998

ntw-map18//environ/bushplan//bushv2_52.dgn

Cadastral Data supplied by Department of Land Administration, W.A.

Wetlands Data supplied by Water and Rivers Commission

Native Vegetation Extent for Study Area supplied by Agriculture Western Australia

Bushplan Site Map

Map 52



LEGEND

- 472 — Bushplan Sites With Regionally Significant Bushland
- Other Native Vegetation
- Conservation Category Wetlands
- Bushplan Sites With Some Existing Protection
- 696 — Lot Number, Location Number
- Channel Wetlands
- Local Government Boundary

2034 - II SE

IV | I
2034
III | NW NE / SW SE 58

1 : 25 000 AMG Reference Grid showing Perth's Bushplan Map Sheet Breakdown

PERTH'S BUSHPLAN MAP INDEX

N

SCALE

0 500 1000
Metres

Produced by Project Mapping Section
Land Information Branch, Ministry for Planning, Perth W.A. November 1998

nwt-map11//environ/bushplan//bushv2_58.dgn

Cadastral Data supplied by Department of Land Administration, W.A.

Wetlands Data supplied by Water and Rivers Commission

Native Vegetation Extent for Study Area supplied by Agriculture Western Australia

Bushplan Site Map

Map 58

For more info on cemeteries

* BFS 303 Pinaroo
* BFS 306 Midland
* BFS 366 Guildford (part of Perth Airport)

See BFS 306 Midland

(partic. for FCT analysis)

Environmental Assessment Report

Perth Airport
Business and Recreational Park
Stage 2

Environment Assessment Branch
Environment Protection Agency

An Agency of the Department of Environment, Sport and Territories
September 1996

SUMMARY AND RECOMMENDATIONS i
1 INTRODUCTION 1
1.1 The Environmental Assessment Process 1
1.1.1 Development of the PER 1
1.1.2 Public Review 2
2 THE PROPOSAL 3
2.1 Need for the Proposal 3
2.2 Project Description 5
2.3 Project Alternatives 6
3 EXISTING ENVIRONMENT 8
3.1 Vegetation 8
3.1.1 Vegetation condition 9
3.1.2 Conservation significance 10
3.1.4 Fauna 12
3.1.5 Hydrology and Wetlands 13
4 MAJOR ISSUES AND SAFEGUARDS TO MINIMISE ENVIRONMENTAL IMPACTS 14
4.1 Remnant Vegetation 14
4.1.1 Systems 6 19
4.2 Fauna 20
4.2.1 Western Swamp Tortoise 21
4.2.2 The Southern Brown Bandicoot 22
4.2.4 Carnaby's Black Cockatoo 23
4.2.5 The echidna 23
4.2.6 Habitat Linkage 23
4.3 Hydrology and Wetlands 24
4.3.1 Wetlands and Groundwater 24
4.3.2 Drainage and Runoff 26
4.3.3 Nutrients 27
4.3.5 Pesticides 29
4.4 Heritage Issues 29
4.5 Noise 30
4.6 Traffic 31
4.7 Social Environment 31
5 CONCLUSION 31

PERTH AIRPORT
BUSINESS AND RECREATIONAL PARK STAGE 2

SUMMARY AND RECOMMENDATIONS

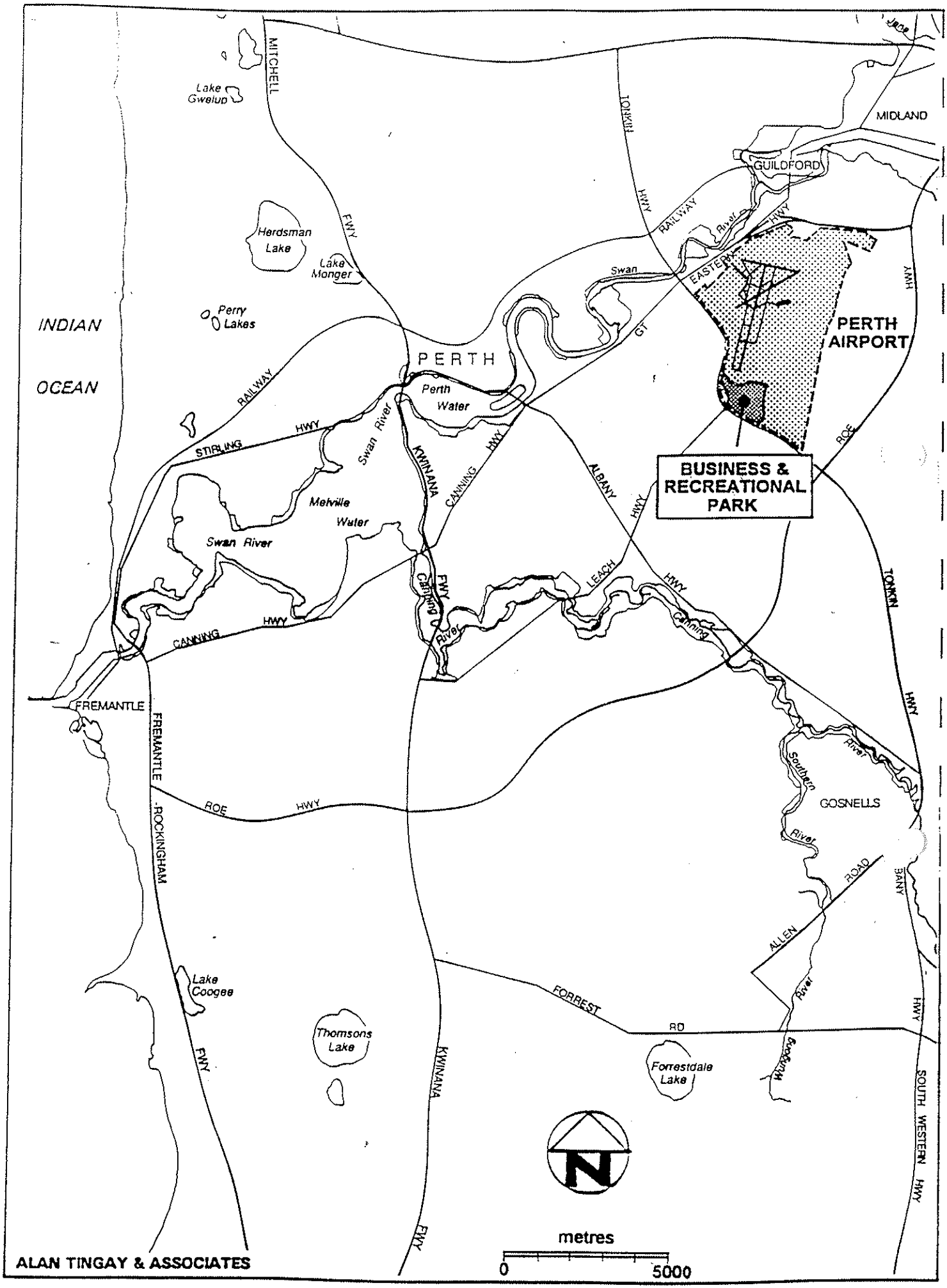
The Federal Airports Corporation (FAC) proposes to establish Stage 2 of a business and recreational park, on a 114 hectare site in the southern sector of Perth Airport adjacent to Tonkin Highway and Horrie Miller Drive in order to improve its revenues from non aeronautical sources. The proposal includes a business area, a resort style hotel complex, a golf course, a new entry road to the airport and new internal roads. It is anticipated that the business and recreational park will have a 10 year development horizon and that construction will be market driven. Land will be leased to private enterprise for development. All the land involved in the proposal is vested in the FAC on behalf of the Commonwealth of Australia. Consequently, the proposal is subject to the provisions of the *Environment Protection (Impact of Proposals) Act 1974.* The site is approximately 9 kms due east of the Perth Central Business District (**Figure 1**, locational map).

The environmental assessment of the project has been undertaken in accordance with the Administrative Procedures under the Act.

The key issues that have arisen during the assessment are:

Remnant Vegetation - The main environmental issue is the effects of the proposal on sizeable stands of natural vegetation remaining on the site, particularly in the western portion of the site. Perth Airport was identified as having significant conservation values by the Western Australian Environmental Protection Authority in its 1983 report on Conservation Through Reserves in the Darling System (also known as the System 6 Study Report). Areas designated for protection under the System 6 classification are well known to the public and proposals affecting them attract a high level of public attention. In respect of land at Perth Airport, the WAEPA recommended that the Commonwealth of Australia retain as much uncleared land as possible. Much of similar vegetation has been cleared in the development of metropolitan Perth.

The EPA believes that the proposed development will have unavoidable and irreversible impacts on areas of remnant vegetation of high regional importance. Should the development proceed, some 20.2 hectares of remnant vegetation will be directly cleared (15 hectares of which is within the golf course development). It is likely that a further 52 hectares of vegetation within or adjacent to the golf course will be adversely affected and suffer a gradual loss of condition and biodiversity by the fragmentation and practices associated with maintaining the golf course (irrigation, pesticides, fertilisers and introduced grasses).



REGIONAL LOCATION OF BUSINESS & RECREATIONAL PARK- PERTH AIRPORT

FIGURE 1

Western Swamp Tortoise - The effects on the nationally endangered Western Swamp Tortoise have been clarified by the survey undertaken of the entire Perth Airport by the Western Swamp Tortoise Recovery team. The report produced found that, with the exception of one swamp which is in good condition and provides suitable Western Swamp Tortoise habitat, the suitablity of swamps for the reintroduction of the tortiose on the business and recreational park is low, apart from one swamp located to the north of the business and recreational park. The EPA has recommended protection of this swamp.

Wetlands and Hydrology - The development proposes to utilise local shallow aquifers for irrigation of the golf course and for landscaping. The effects on wetlands and hydrology are not clearly assessed in the PER. The volume of water to be utilised for irrigation is not indicated and the adequacy of local groundwater supplies has not been investigated. The PER speculates on whether the water table would rise or fall. Should falls occur serious effects are likely in banksia woodlands. The EPA has recommended an assessment of the capability for sustainable use of the shallow aquifers proposed to be used for irrigation of the golf course.

Southern Brown Bandicoot - The effect on the Southern Brown Bandicoot listed as endangered under the WA Wildlife Conservation Act 1950-1979 is not adequately assessed in the PER. The EPA believes that the fragmentation and deterioration of vegetation associated with construction of the golf course and road network will unavoidably reduce fauna habitat values and that the developments are likely to have a negative effect on the local population of the site. The EPA has recommended consultation with the WA Department of Conservation and Land Management regarding the significance of the effects on the Southern Brown Bandicoot.

Alternatives - Specific alternatives developments were not described in the PER or the response document. The EPA is unable to environmentally assess the potential environmental impacts of the feasible and prudent alternatives to the proposed action because the proponent did not provide the information despite requests. The EPA has recommended that the FAC assure itself that the preferred proposal is environmentally the most acceptable, prior to making a decision to proceed with the proposal.

Recommendations

It is recommended that, in accordance with paragraph 9.3.1 of the Administrative Procedures under the *Environment Protection (Impact of Proposals) Act 1974*, the Managing Director and Chief Executive of the Federal Airports Corporation be advised that in addition to the commitments made by the proponent in the PER and the response document, the Perth Airport business and recreational park Stage 2 development be subject to the following recommendations:

- *That prior to the FAC making a decision to proceed with the proposal the potential environmental impacts of the prudent and feasible alternatives to the proposal be considered.*

- *That should the development proceed, any revegetation and landscaping to be carried out within the golf course and business park areas should utilise local endemic species.*

- *That the Environmental Management Plan to be prepared for the golf course include enhancement of native vegetation by ongoing weed eradication.*

- *That the swamp identified as Five Mile Swamp Centre 8 and an appropriate buffer area, as determined in consultation with the Western Swamp Tortoise Recovery Team, should be excluded from the development area. Consideration should be given to its inclusion with other swamps of the Five Mile Centre Group by construction of a fox-proof fence to provide suitable habitat for the translocation of the Western Swamp Tortoise.*

- *If the development is to proceed, that the FAC seek the advice of the Department of Conservation and Land Management with regard to the significance of effects on the Southern Brown Bandicoot populations on the site so that appropriate ameliorative or protective measures can be incorporated into the design of developments by including these matters in leases or agreements to develop the site with private developers.*

- *That wherever possible, large trees be retained in the development to conserve as much of the Carnaby's Black Cockatoo habitat as possible.*

- *If the development is to proceed, that the FAC seek the advice of the Department of Conservation and Land Management with regard to the significance of effects on the Short Beaked Echidna populations on the site so that appropriate ameliorative or protective measures can be incorporated into the design of developments by including these matters in leases or agreements to develop the site with private developers.*

- *That consultation take place with the WA Environment Protection Authority and Water and Rivers Commission regarding the size and nature of buffers to be maintained or provided for the significant wetland areas.*

- *Consultations should be undertaken with the Water and Rivers Commission and the Department of Environmental Protection with regard to minimising or avoiding any effects on the dampland to the east of the intersection of Tonkin and Leach Highway which has been classified in the conservation category.*

- *That an assessment of the capability for sustainable use of the shallow aquifers proposed to be used for irrigation of the golf course and for landscaping should be carried out in conjunction with the Water and Rivers Commission prior to the leasing of the area for an irrigated golf course. Should the resource prove to be unsustainable or insufficient for this use alternatives should be considered. If the resource proves sustainable the parameters of "significant decreases"in the average groundwater table need to be established in consultation with the Water and Rivers Commission prior to the development. Monitoring results of levels and quality should be provided to the Water and Rivers Commission.*

- *That before the development of the site a detailed nutrient management plan be compiled to the satisfaction of the Western Australian Department of Environmental Protection with the aim of minimising effects on groundwater and wetlands. That prior to development of plans for stormwater management to avoid nutrient contamination of groundwater be prepared to the satisfaction of the Water and Rivers Commission.*

- *That the use of herbicides, insecticides and fungicides on the golf course should be addressed within the management plan for the golf course to be formulated in consultation with the Department of Environmental Protection, the Department of Conservation and Land Management and the Water and Rivers Commission.*

- *That the FAC seek advice from the Department of Aboriginal Affairs on the significance of the 4 sites likely to be disturbed prior to the FAC entering into a lease or agreement with private developers so that any advice on site protection can be incorporated into specific development plan.*

- *That details of proposed traffic arrangements be submitted to the Department of Main Roads for approval before development commences.*

1 INTRODUCTION

This Assessment Report reviews the Public Environment Report (PER) submitted by the Federal Airports Corporation (FAC), on the proposed business and recreational park, Stage 2 at Perth Airport in Western Australia. The report has been prepared in accordance with paragraph 9.1.1 of the Administrative Procedures under the *Environment Protection (Impact of Proposals) Act 1974.*

The assessment of the proposal has been carried out in consultation with the Western Australian Department of Environmental Protection in accordance with the Ministerial agreement between the Commonwealth and Western Australian Governments for cooperation on environmental assessment of proposals.

Several site visits have been undertaken by staff of the Environment Protection Agency (EPA), the Australian Heritage Commission (AHC) and the Australian Nature Conservation Agency (ANCA).

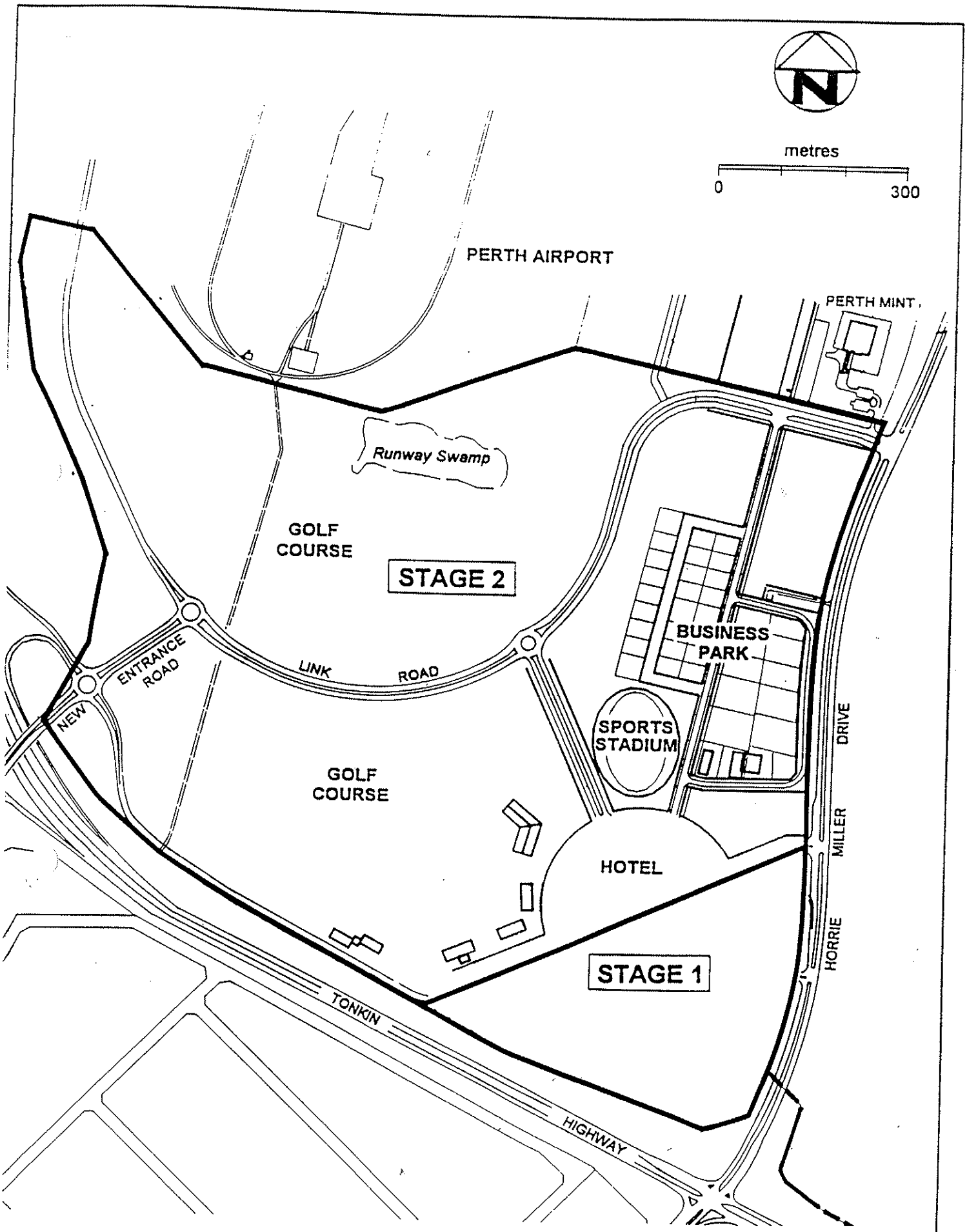
1.1 The Environmental Assessment Process

1.1.1 Development of the PER

On 25 June 1992 the Federal Airports Corporation, as proponent, submitted a Notice of Intention on the proposal to the EPA in accordance with the *Administrative Procedures* under the *Environment Protection (Impact of Proposals) Act 1974* (the Impact Act). Comments were then sought by the then Commonwealth Environment Protection Agency from various Commonwealth agencies and the Western Australian Environmental Protection Authority (WAEPA). The FAC provided supplementary information in September 1992.

A revised NOI which divided the business and recreational park into two stages was submitted on 25 November 1992. Stage 1 of the proposal, a retail/commercial development on 16 hectares in the corner of Horrie Miller Drive and the Tonkin Freeway (**Figure 2**), was found to have been extensively degraded. The EPA in consultation with the WAEPA agreed that this area had no significant conservation values. Mrs Kelly, the then Minister for the Arts, Sport, the Environment, Tourism and Territories determined that neither an Environmental Impact Statement nor a Public Environment Report (PER) was necessary to achieve the object of the Impact Act in relation to Stage 1, subject to a number of conditions. For the balance of the proposal (Stage 2), to be on land which retained some significant areas of remnant vegetation as well as several areas of wetlands, the Minister directed the preparation of a PER on 16 December 1992.

Guidelines for the content of the PER were prepared by the EPA in consultation with the WAEPA and the WA Department of Conservation and Land Management, the WA Department of Planning and Urban Development as well as the then Australian National Parks and Wildlife



SOURCE: FEDERAL AIRPORTS CORPORATION, MAY 1994

IAN TINGAY & ASSOCIATES

PERTH AIRPORT BUSINESS & RECREATIONAL PARK **FIGURE 2**

Service and the Australian Heritage Commission. The Guidelines were finalised on 29 March 1993.

On 18 May 1993 the FAC provided the EPA with a draft PER which was subsequently circulated to State and Commonwealth agencies for comment. On 23 August 1993 the EPA provided comments on the draft PER which requested significant revision of the document to include, among other issues, the provision of additional information on remnant vegetation and on alternatives to the project, as well as information on alternative road alignments.

On 25 May 1994, the proponent provided a revised draft PER which included a vertebrate fauna survey. The EPA responded with requests for further information, this included information on the alternatives and on the significance of the remnant vegetation. A series of letters from the consultant to the proponent provided information on the individual issues raised by the EPA

1.1.2 Public Review

The PER was initially made available for public review for a period of 8 weeks from 2 November 1994 to 28 December 1994. Following approaches to the EPA from the Western Australian (WA) Department of Environmental Protection and the WA Conservation Council for an extension to the period available for public comment, the EPA with the agreement of the FAC provided a further month for public comment, from 28 December to 25 January 1994.

Thirty one submissions were received by the EPA from a number of Commonwealth and State Government agencies, conservation groups and members of the general public. Copies of all submissions and comments received during the public review period were forwarded to the proponent. A submission from the Zoology Department of the University of Western Australia raised the possible presence of the Western Swamp Tortoise, a species listed under the *Endangered Species Protection Act, 1992* on the site of the proposed developments at Perth Airport. The submission from the Zoology Dept of the University of WA identified a need for further surveys of the Western Swamp Tortoise to establish if populations or suitable habitat remained for introduction of the species. No thorough survey for the tortoise had been undertaken in the area planned for development.

The EPA briefed the then Minister for Environment, Sport and Territories, Senator Faulkner, on the need for further information and on 13 February 1995 the Minister halted the assessment process and sought the provision of additional information under section 9.2 of the Administrative Procedures under the Impact Act. Senator Faulkner sought additional information about the status of the Western Swamp Tortoise in the area and the evaluation of areas suitable for re-introduction sites as well as further details concerning the prudent and feasible alternatives to the proposal and alternatives to the new access route proposed to the airport as this route

would traverse an area of relatively undisturbed remnant vegetation. Further clarification of the nature and significance in terms of regional importance of the remnant vegetation was also sought.

The FAC on 26 June 1995 provided part of the information, dealing with remnant vegetation and alternative road entry, requested by the Minister under Section 9.2. At this time a revised development plan was submitted indicating the layout of the golf course and a different route for part of the Link road.

The FAC advised the completion of the gathering of further information on the Western Swamp Tortoise and forwarded the report by the Western Swamp Tortoise Recovery Team and the Minister for the Environment then requested the EPA to recommence the environmental assessment.

The main issues raised in the submissions and comments received were the effects of the proposal on significant areas of remnant vegetation and on endangered or vulnerable animal species that occupy the site, the effects on wetlands and hydrology, the investigation of alternatives and the justification for the proposal. Other issues raised included the conceptual nature of the PER, the management of the area, water conservation, the increased risk of dieback, protection of aboriginal sites, need for a risk evaluation of the proposed uses and the interaction with State legislative controls. The issues raised in public submissions are summarised in tabular form.

2 THE PROPOSAL

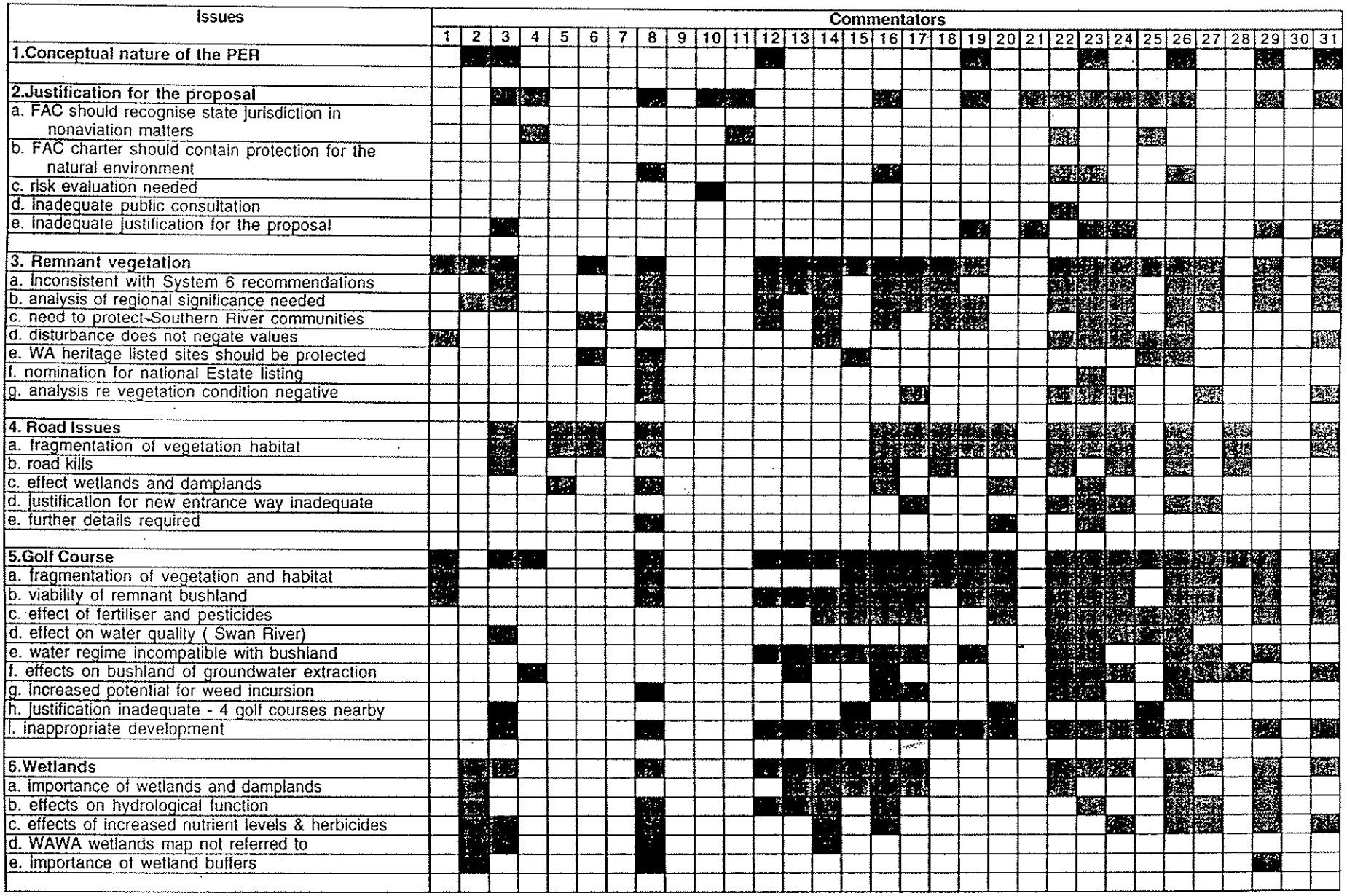
2.1 Need for the Proposal

In explaining the need for the proposal, the PER outlines the duties, responsibilities and powers of the FAC as they are specified in the *Federal Airports Corporation Act 1986* as follows. The FAC is required to perform its functions in a manner that enables it to make a reasonable return on assets. The functions of the FAC extend to the carrying on of commercial activities at, or in relation to Federal Airports. Such commercial activities are intended to improve revenues from non-aeronautical sources and are particularly important as the FAC is prevented from making a profit from aeronautical charges for services for which it is the monopoly provider. Commonwealth Government policy has been to encourage each major international airport to be self sufficient through increasing its revenue base from aeronautical and non-aeronautical activities.

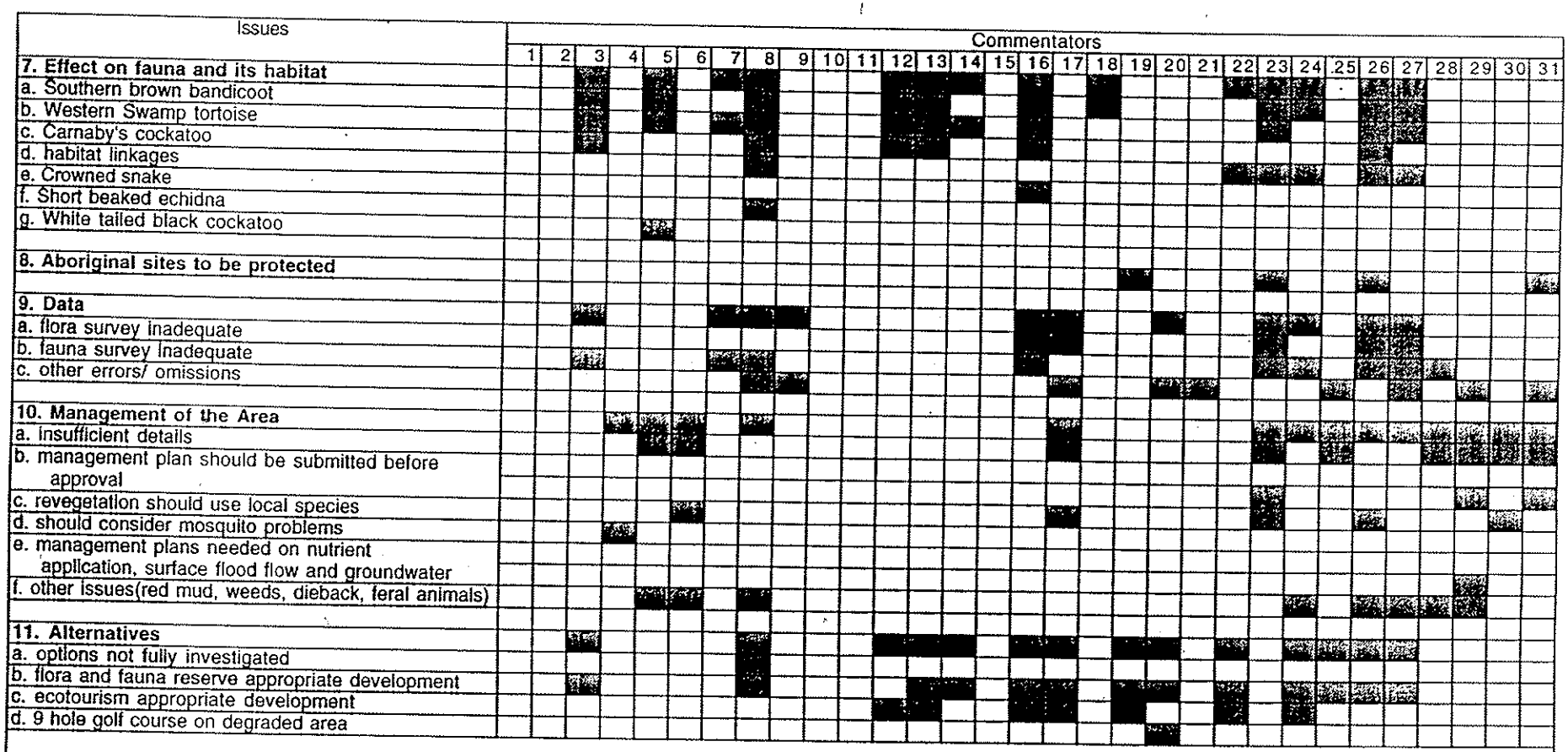
The PER states that the Business and Recreational Park proposal at Perth Airport is considered to be a critical component for the strategy to broaden the revenue base of the FAC through the development of non-aeronautical activities.

The need for the proposal has been identified by the FAC in terms of market demand for the facilities. The FAC reports that it has received numerous

Summary of Issues Raised



Summary of Issues Raised



1. Australian Heritage Commission
2. Waterbird Conservation Group
3. Member of the public
4. Health Department of Western Australia
5. Mr P. Coyle
6. Department of Conservation and Land Management(W.A
7. Dr G. Kuchling, University of Western Australia
8. Conservation Council of Western Australia
9. Western Australian Museum
10. A Government Agency
11. Retailers Against Government Enterprise
12. Ms A. Herlihy
13. Mrs E. Campbell
14. Wetlands Conservation Society
15. Mrs C. Hooper
16. Mr & Mrs S. Telford
17. Wildflower Society of Western Australia
18. D. F. James
19. Friends of Forrestdale
20. The Tree Society W.A.
21. W.A. Greens Economic Policy Working Group
22. Cathy Taylor
23. Friends of Signal Hill
24. Friends of Perth Airport Bushland
25. Mr. C. Robertson
26. Urban Bushland Council (W.A)
27. Mr K. McLean
28. W.A. Greens Environmental Working Group
29. Water Authority of Western Australia
30. City of Belmont
31. The Environmental Protection Authority

enquiries from business with interest in locating within the Park. The FAC also commissioned a market appraisal of the potential for the proposed hotel on the area. This appraisal concluded that the demand for accommodation in hotels in Perth has accelerated to around 11.5% each year and that occupancy rates in the near future are likely to be in excess of 80% with room shortages during peak months. The appraisal concluded that the hotel and recreational facilities would provide a much needed diversity to the existing and anticipated tourist accommodation inventory in Perth.

A number of submissions expressed the view that there is insufficient detail in the PER to demonstrate the need for, or the location of, the business and recreational park. Comments also drew attention to the fact that Perth Airport currently makes a profit on its operation and does not need to expand its activities in the non-aeronautical sphere to remain viable. One submission questioned the long term need for facilities designed for airport users by analysis of future passenger traffic forecasts. That submission indicated that present growth will be short lived with a decline forecast after the first decade next century.

The FAC in its response has indicated that the need stems from the development pressures exerted on it by the policy of the Commonwealth Government and by its legislative charter. Seven submissions believe that the FAC Charter should be modified so that commercial activity can not be used as a justification for destruction of natural areas. The FAC indicates that the specific site was chosen because of its optimal location for access within the airport and from major roads. The Corporation's Land Use Development Plan for Perth airport also points out the commercial advantage of the general area in terms of frontage to major roads. The PER states that the Stage 2 site satisfies all of the prime criteria contained in the relevant major State Government Planning documents such as the Metroplan and the Commercial Centres policy.

The EPA acknowledges that the business and recreational park is an element in broadening of the FAC's revenue base and that the Land Use Development Plan for Perth Airport has guided the choice of location.

2.2 Project Description

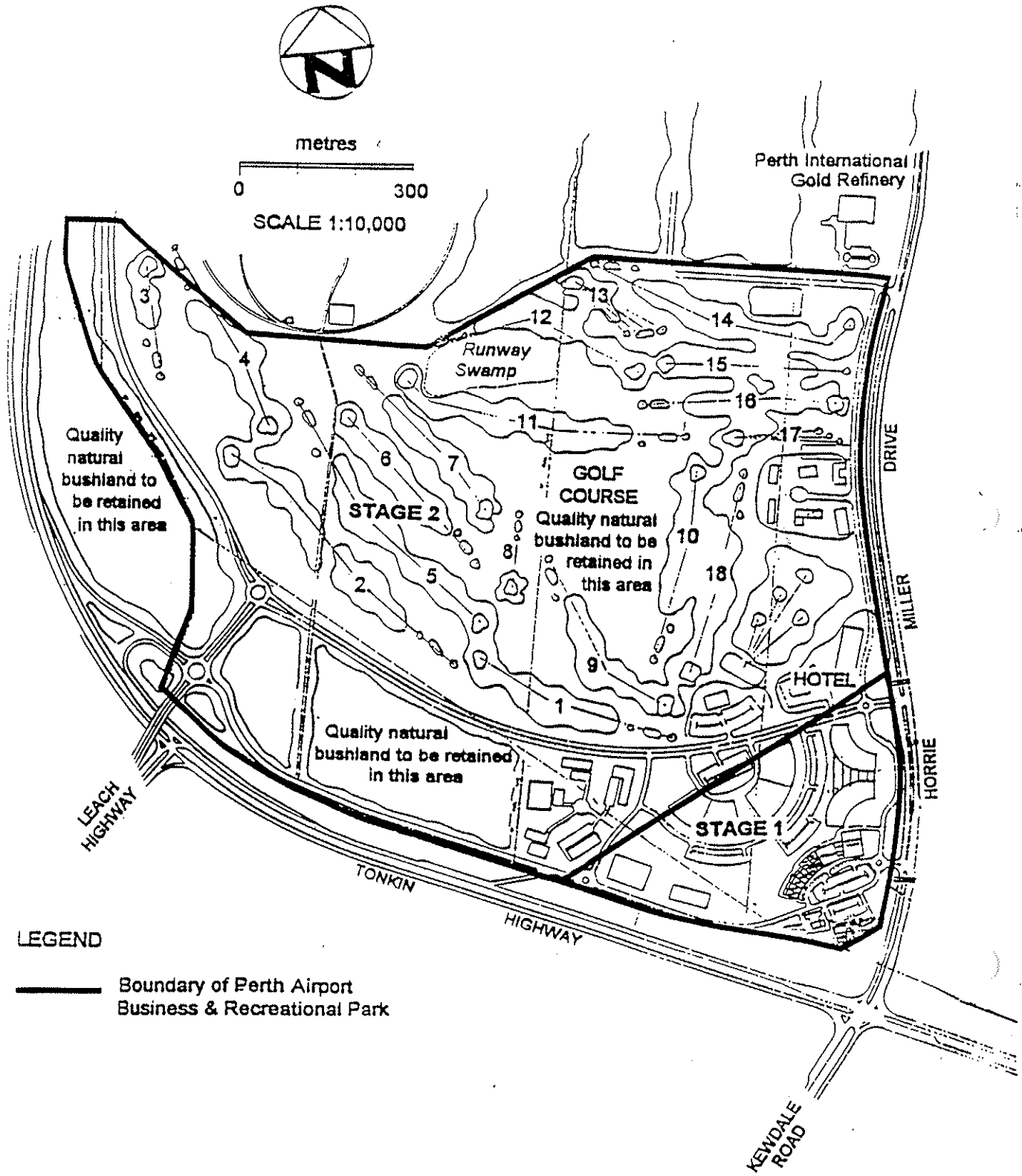
The components of the Business and Recreational Park Stage 2, as described in the PER comprise the following (see **Figure 2**):

- a business area located adjacent to Horrie Miller Drive, which will include freight storage, showrooms and warehouses, aerospace and aviation related industries, bond storage, customs control and related activities;
- a resort style low rise hotel complex which will include a convention centre and recreational facilities;
- a golf course of 18 holes which will also include a driving range, practice putting greens, mini golf, a club and associated facilities;
- a low rise sports stadium which will be open to the general public;
- a new entry road into the airport from the Leach Highway/Tonkin Highway intersection; and
- the alteration of an existing internal link road which joins the two existing terminals of the airport.

A significant number of submissions, including that from the WA Environmental Protection Authority was critical of the conceptual nature of the PER and the lack of detail presented and commented that it did not clarify the amount and nature of the vegetation likely to be affected. The conceptual nature of the proposal also affects the ability of the EPA to make conclusive judgements regarding the impacts. The FAC does not have specific plans as it intends to seek interest from the private sector for development of the business and recreational park.

To allow a clearer indication to be given of the nature of the impacts on remnant vegetation the FAC document responding to issues raised by public comments included a preliminary plan of the golf course and a modified development plan (**Figure 3**). **Tables 1** and **2** were also provided to clarify the total areas of native vegetation types affected by the business and recreational Park and the quality of the vegetation to be affected.

The revised development also incorporates an altered link road, a reduced business area north of Stage 1, a further business area to the west of Stage 1 and omits the sports stadium from the proposal. The eastern sector of the existing bitumenised link road is to be rehabilitated and become part of the golf course with a new bitumenised road to be built, along the route of the previous Hardey road where possible. This will join up with the western side of the existing Link road.



SOURCE: FEDERAL AIRPORTS CORPORATION MAY 1995.

ALAN TINGAY & ASSOCIATES

PERTH AIRPORT BUSINESS & RECREATIONAL PARK
DEVELOPMENT PLA
FIGURE

TABLE 1

Total areas of Native Vegetation Types at Perth Airport and Areas of Native Vegetation affected by the Business and Recreational Park Proposal (ha)

Dry *Eucalyptus* Woodlands						
	Slight	Disturbed	Obv Dist	Sev Dist	Degraded	**Total**
Total	0	7.8	57.4	25.5	4.2	**94.9**
Affected	0	0	1.8	0	0	**1.8**
% Affected	0	0	3	0	0	**1.8**
Dry *Banksia* Low Woodlands						
	Slight	Disturbed	Obv Dist	Sev Dist	Degraded	**Total**
Total	36.3	30.4	69.4	23.6	3.0	**162.7**
Affected	0	0.5	6.3	0.7	0	**7.5**
% Affected	0	2	9	3	0	**4.6**
Dry Shrublands						
	Slight	Disturbed	Obv Dist	Sev Dist	Degraded	**Total**
Total	0.2	0	3.4	7.6	0	**11.2**
Affected	0	0	0	3.9	0	**3.9**
% Affected	0	0	0	51	0	**34.8**
Seasonally Damp *Melaleuca* Low Woodlands						
	Slight	Disturbed	Obv Dist	Sev Dist	Degraded	**Total**
Total	30.1	46.9	59.4	2.7	3.8	**142.9**
Affected	0	0.5	0	0	0	**0.5**
% Affected	0	1	0	0	0	**0.3**
Transitional *Eucalyptus* Woodlands						
	Slight	Disturbed	Obv Dist	Sev Dist	Degraded	**Total**
Total	0	2.3	3.2	11.3	0	**16.8**
Affected	0	0	0.2	0.5	0	**0.7**
% Affected	0	0	6	4	0	**4.2**
Wet Low Woodlands						
	Slight	Disturbed	Obv Dist	Sev Dist	Degraded	**Total**
Total	9.0	29.4	8.9	10.7	1.0	**59.0**
Affected	0	0.7	3.0	0	0	**3.7**
% Affected	0	2	34	0	0	**6.3**
Transitional Shrublands						
	Slight	Disturbed	Obv Dist	Sev Dist	Degraded	**Total**
Total	0	0	15.1	12.3	0	**27.4**
Affected	0	0	0	0	0	**0**
% Affected	0	0	0	0	0	**0**
Seasonally Damp Heaths						
	Slight	Disturbed	Obv Dist	Sev Dist	Degraded	**Total**
Total	27.8	11.8	22.2	14.8	0.6	**77.2**
Affected	0	0	2.1	0	0	**2.1**
% Affected	0	0	9	0	0	**2.7**
Wet Sedgelands						
	Slight	Disturbed	Obv Dist	Sev Dist	Degraded	**Total**
Total	0.3	0	0	0	0	**0.3**
Affected	0	0	0	0	0	**0**
% Affected	0	0	0	0	0	**0**

(% affected represents whole airport area affected as proportion of vegetation on the whole of Perth Airport)

TABLE 2

Areas, Types and Quality of Vegetation Affected by Business Park, Golf Course and Entrance Road (ha)

Vegetation types and quality to be affected by the Golf Course						
	Slight	Disturbed	Obv Dist	Sev Dist		TOTAL
Ba	0	0	4.3	0.7		**5.0**
BaAf	0	0	0.6	0		**0.6**
Pe	0	0	1.2	0		**1.2**
MpPe	0	0.3	0	0		**0.3**
Ec	0	0	1.8	0		**1.8**
Er	0	0	0.2	0.5		**0.7**
Ac	0	0	0	3.0		**3.0**
Mr	0	0.7	1.7	0		**2.4**
TOTAL	**0**	**1.0**	**9.8**	**4.2**		**15.0**

Vegetation types and quality to be affected by the Business Park (including roads, buildings and carparks)						
	Slight	Disturbed	Obv Dist	Sev Dist		TOTAL
Ba	0	0	1.4	0		**1.4**
Mr	0	0	1.3	0		**1.3**
Pe	0	0	0.9	0		**0.9**
Ac	0	0	0	0.9		**0.9**
TOTAL	**0**	**0**	**3.6**	**0.9**		**4.5**

Vegetation types & quality to be affected by main roads from Tonkin/Leach Highway intersection						
	Slight	Disturbed	Obv Dist	Sev Dist		TOTAL
Ba	0	0.5	0	0		**0.5**
Mp	0	0.2	0	0		**0.2**
TOTAL	**0**	**0.7**	**0**	**0**		**0.7**

Proportion of vegetation quality affected by Golf Course						
	Slight	Disturbed	Obv Dist	Sev Dist	Degraded	Total
ha	0	1.0	9.8	4.2	14.3	**29.3**
%	0	3	33	14	49	**100**

Proportion of vegetation quality affected by Business Park						
	Slight	Disturbed	Obv Dist	Sev Dist	Degraded	Total
ha	0	0	3.6	0.9	23.9	**28.4**
%	0	0	13	3	84	**100**

2.3 Project Alternatives

The EPA formally sought further information on alternatives on two occasions (August 1993 and August 1994) during the assessment process when commenting on the draft PER. In addition, the former Minister for the Environment sought information under Section 9.2 of the Administrative Procedures in relation to alternative developments as well as in relation to alternative entrance ways to the site. However, specific alternative developments are not described in the PER nor in the responses to issues raised by public submissions. The FAC indicates that it assessed three development options on the basis of the broad potential identified in the Land Use Development Plan for Perth Airport. In this plan on a broad conceptual level, appropriate landuses were identified as hotel accommodation, recreational and commercial.

The PER states generally that three alternatives with more extensive commercial and retail areas than the proposed Business and Recreational Park were considered and that these more intensive development proposals were rejected because the FAC considered that they would require an unacceptable level of clearance of native vegetation. Some sectors of these proposals were also considered to be inappropriate as they were in relatively close proximity to the main runway. With respect to the non development of land, the Corporation sees it as being directly counter to their Charter from the Federal Government as discussed in section 3.1 of this report.

Over a third of the submissions were critical of the PER in that it did not present alternatives to the golf course style of development which might enable larger areas of remnant bushland to be retained. Four submissions commented that adequate golf courses already occur at the airport and in the general area. One commented that as there is already one course within the Airport boundary which is rarely used, the construction of a second seems quite contrary to the spirit of the System 6 recommendation. Thirteen submissions believed that a flora and fauna reserve with research and educational potential would be a more appropriate development, while seven submissions considered an ecotourism development would be a more appropriate use for the site. One submission suggests the re introduction of some of the animals that originally inhabited the area. A further submission raised the possibility of a tunnel under the runways to connect international and domestic terminals to avoid the use of the Link Road.

The proponent commented in its document, *Responses to Issues Raised by Public Submissions to the PER*, that other options recommended in submissions on the PER are now being considered and that these will be discussed in the context of a Land Use and Conservation Plan that will deal with the southern sector of Perth Airport. The proponent indicates that the existing West Aviat Golf Club which is located on airport land is not of a high enough standard to be used in conjunction with an International Resort Hotel. The Corporation comments further that the golf course resort

theme is designed to appeal to international visitors and that it is not a viable option to focus on golf courses which are not immediately adjacent to the hotel.

The PER does not provide information in relation to the options to the siting of the new entrance road which is proposed to enter from the Leach and Tonkin Highways intersection and which will impact on an area of remnant vegetation in a relatively undisturbed condition. The Western Australian Water Authority (WAWA) submission comments that the environmental aspects of the internal link road and airport access generally needs to be considered as a whole, rather than the portion within the Business Park in isolation. In its response to public comments in relation to alternatives to the entry road alignment, the proponent states that there is little flexibility in the location of the proposed road network as roadways have to connect with the existing external road network but that existing and old alignments will be used wherever possible.

Response 68 of the FAC's Response document comments that the design of the road is dictated by regional road requirements laid down in the Main Roads Strategy and administered by the Main Roads Department (MRD). It states that the original plan by the MRD for a three way grade separated intersection at the Leach and Tonkin Highway intersection would have necessitated a greater loss of native vegetation than the Corporation's proposal for a four way grade junction which will involve a modification of the existing intersection. Little evidence for this is presented in the PER as the previous proposal is not detailed.

The PER states that approaches have been made to the MRD including a referral of a design report for the Leach Highway/Tonkin Highway intersection. The EPA has not been provided with information in relation to the FAC's consultation with the Main Roads Department.

The FAC reports that studies support the need for an increase in capacity of the Leach Highway/ Tonkin Highway interchange in the near future and recommend the construction of a new entry into the airport to the Leach Highway/Tonkin Highway interchange. The PER contends that the four way intersection connecting with the proposed internal link road would reduce road traffic levels at this intersection and provide important regional benefits by diverting traffic from sections of Tonkin Highway and Horrie Miller Drive. The PER states that the location of the road is fixed as it must connect with the existing intersection of Leach Highway and Tonkin Highway in order to provide the most rational vehicle access from the major highway network. Further information regarding the need for the new entrance way has not been provided.

The EPA is unable to environmentally assess the potential environmental impacts of the feasible and prudent alternatives to the proposed action because the proponent did not provide the information despite requests. The EPA has recommended that the FAC assure itself that the preferred proposal is environmentally the most acceptable.

Recommendation: *That prior to the FAC making a decision to proceed with the proposal the potential environmental impacts of the prudent and feasible alternatives to the proposal be considered.*

3 EXISTING ENVIRONMENT

3.1 Vegetation

A number of public submissions indicated that the Business and Recreational Park site occupies a transitional area between the Bassendean Vegetation Complex: Central and South (to the west of the site) and the Southern Rivers Complex to the east of the site. This is illustrated in a Ministry of Planning Map of the area (Map reference 960513-1, prepared 13 May 1996). These complexes are correlated with soil and geomorphic characteristics. On the western side of the plain the soils are mostly sands blown in from the coast. The eastern side the soils are predominantly alluvial deposits washed down from the plateau and are mostly clayey although there are some areas of sands. These two major types meet in the Southern River Soil unit which has areas with low sand dunes and between these there are flat areas with sandy clay or clayey sand soils. To the west the Bassendean sands form larger dunes without clayey soils between them.

Alan Tingay and Associates mapped the vegetation of Perth Airport (Figure 9A PER) . The vegetation associations in the business park area are quite diverse (**Figure 4)** and range from dry upland types to seasonal and permanently wet types. The undisturbed dry uplands in the area support *Banksia attenuata* low woodlands with a species rich understorey. Down slope from the *Banksia attenuata* woodlands, the vegetation changes fairly abruptly into *Melaleuca preissiana* (Moonah Paperbark) low woodlands which occur in areas where the water table comes close to the surface in winter. *Banksia ilicifolium* characterises the interzone between dry and wet areas. The understorey in these areas is mainly a *Pericalymma ellipticum* closed heath.

In areas where surface water is present during winter, *Melaleuca rhaphiophylla* low woodlands occur either over a heath understorey or over a sedge or herbland understorey where inundation is of greater duration and depth.

Two areas of open water occur in the site. The largest, Runway Swamp is an open water body fringed by *Melaleuca rhaphiophylla, Eucalyptus rudis* (Flooded Gum) and *Typha domingensis.* Link Road Swamp contains a complete cover of tall *Melaleuca rhaphiophylla* and *Banksia littoralis* trees. There are dampland areas on the site, including one identified by Environment Protection Authority with the management objective "conservation".

3.1.1 *Vegetation condition*

The PER acknowledges that the site includes relatively large tracts of natural vegetation of varying quality. The Reponse document states that no dieback has been identified in the development area.

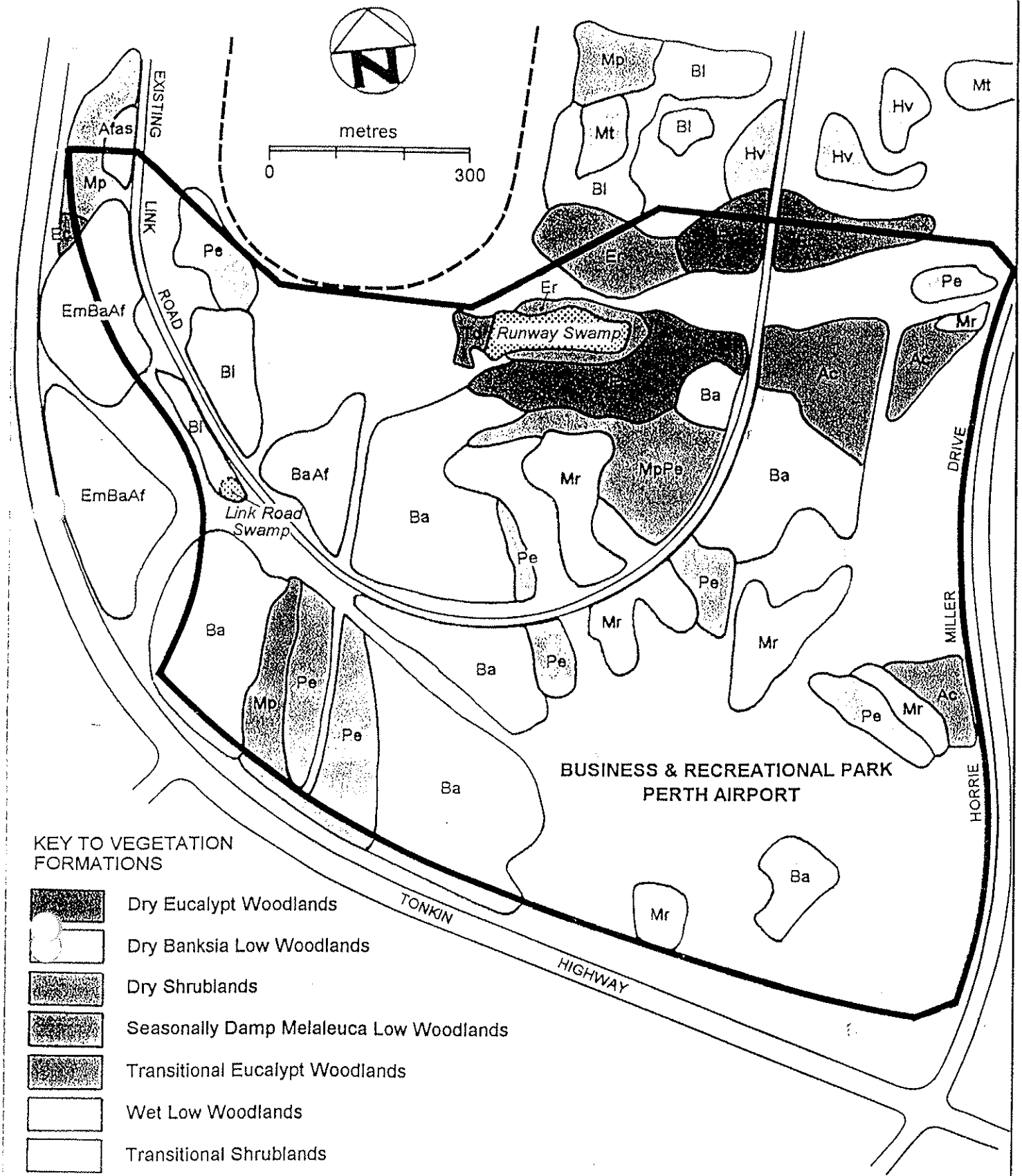
The vegetation quality of the site is described in the PER as ranging from degraded (areas that are completely or almost completely without native species in the structure of the vegetation) to slightly disturbed (showing some signs of damage caused by human activities, eg with the presence on non-aggressive weeds, vehicle tracks), see **Figure 5**. The PER states that the native vegetation of the study area has virtually all been disturbed to some degree. The PER refers to a considerable part of the area, particularly the eastern part as been having been cleared of most indigenous vegetation and now mainly supports grasslands of introduced species with occasional remnant trees. Evidence of roads, tracks and sand excavation are on the site. Other areas have some native species but have lost the original vegetation structure. The PER reports that weed invasion has resulted from the large network of roads and tracks and large areas of grass dominated cleared land.

The vegetation quality map and accompanying descriptions indicate that the majority of vegetation on the site (assessed as slightly disturbed, disturbed and obviously disturbed) is nonetheless capable of regeneration. Eight submissions comment that the condition rating of vegetation descriptions devalue the vegetation and question the accuracy of the vegetation quality assessments. One submission points to the significant differences in the assessment of vegetation quality between the vegetation quality maps in the Notice of Intention and the PER. The response document does not address this issue.

The response to public submissions comments that there is no standard method of describing vegetation quality in Western Australia and that the system used follows that of Trudgen (1991) but replaces the subjective terminology with more objective ratings of disturbance, such as Undisturbed, Slightly Disturbed and Obviously Disturbed which are defined.

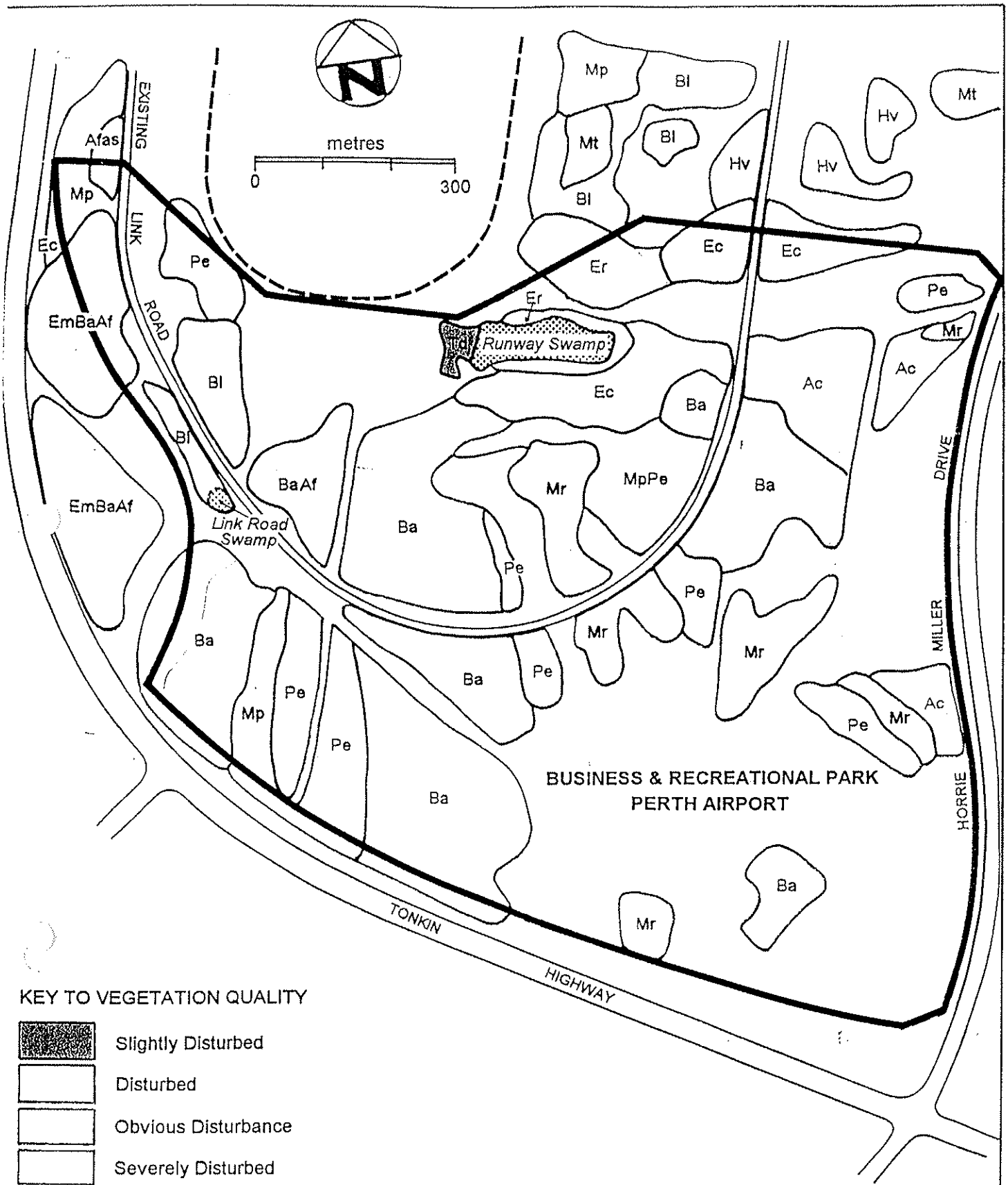
The Department of Environmental Protection comments that because vegetation is already fragmented and/or degraded, this does not justify further fragmentation and degradation. Several submissions comment that the environmental value of the development area is underestimated and that its value for habitat for some species, as a buffer and its potential for regeneration if actively managed, are not given sufficient consideration by the PER. They comment that there is little vegetation remaining in metropolitan Perth capable of meeting the criteria of disturbed or slightly disturbed and none likely in the undisturbed category.

Within the site, areas of better quality vegetation with a rating of disturbed (equivalent to good) include the *Banksia* woodlands and *Pericalymma* heath between Hardey Road and Tonkin Highway and the *Melaleuca raphiophylla* low open woodland and *Pericalymma* heath between Runway



ALAN TINGAY & ASSOCIATES

VEGETATION MAP **FIGURE 4**



KEY TO VEGETATION QUALITY

- Slightly Disturbed
- Disturbed
- Obvious Disturbance
- Severely Disturbed
- Degraded
- Open Water

BaBm — Refer to FIGURE 9A for details of Vegetation Associations

ALAN TINGAY & ASSOCIATES

VEGETATION QUALITY MAP

FIGURE 5

Swamp and the security fence. The Response document indicates that these areas will not be affected by the proposal (although the current development plan shows a road passing to the south of the former area).

The Ministry of Planning mapped the vegetation at Perth Airport (Ministry of Planning, 1996) and also assessed the general vegetation quality. The vegetation remnants within the business and recreational park were assessed as broadly being in good condition.

The EPA is of the view that the nomenclature as used by Trudgen should have been retained as this is in general usage and avoids misinterpretation. It is of the view, based on the recent Ministry of Planning mapping that much of the bushland on the site is in good condition in light of its inner metropolitan location.

3.1.2 Conservation significance

The PER indicates only 8.6% of the original 58 343ha of the Southern River Vegetation complex remains uncleared. A report by Bowman, Bishaw and Gorham (1994) indicates that less than 5% of the Bassendean Complex-Central and South remains on the Swan Coastal Plain and that the conservation status of this complex is very poor.

The Ministry for Planning of Western Australia has recently examined the status of the remnant vegetation within the Perth Metropolitan area in conjunction with work on an Urban Bushland Strategic Plan /System 6 Update (Ministry of Planning, 1996). It has also specifically mapped the vegetation, soils and wetlands within Perth Airport. The Ministry for Planning assessed the vegetation of the site of the business and recreational park as having an ecological rating among the top 6-10%.

In terms of conservation status, a table produced by the Ministry of Planning indicates that the Southern River Complex has 5 801ha remaining of an original range in the Perth metropolitan Area of 31 149 hectares. Only 1 788ha of remaining vegetation is included within the conservation estate and an additional 1 327 ha are required to achieve a target of 10% conservation of the complex. Ten percent is the minimum area recommended for protection of an ecosystem by the International Union for the Conservation of Nature.

The table also indicates that the Bassendean Complex; Central and South has only 11 350 ha remaining in the Perth metropolitan area of an original range of 46 279ha and requires the reservation of a further 1 779ha to achieve a target of conserving 10% of the original area.

An assessment of flora values at Perth Airport was undertaken in relation to an objection, in October 1995 by Malcolm Trudgen, expert consultant biologist in relation to an objection to the entering of four areas on the interim list of the Register of the National Estate by the Australian Heritage Commission. In making his assessment Trudgen found that some

significant heritage values at the airport, for example the vegetation of the Bassendean Vegetation Complex- Central and South, are not represented at all in the areas currently interim listed by the AHC and recommended that two areas on the west side of Horrie Miller Drive (including a large area within the proposed business and recreational park) should be listed in the Register of the National Estate.

The WA Department of Environmental Protection comments that the vegetation complexes at Perth Airport are now recognised as being seriously under threat. The Department comments further that it is highly likely that the Urban Bushland Strategic Plan/System 6 Update will recommend protection of almost all the remnant vegetation at Perth Airport. Poor condition will be balanced by the large total area of remnants. The Department states that Perth Airport supports one of the largest areas of contiguous remnant vegetation in the Perth region. Its location at the juncture of three complexes is probably unique. It contains a very diverse array of plant communities and structures. Habitat value is therefore considered very high.

The FAC in its response to public comments states that most of the vegetation types in the business and recreational park are well represented in other parts of the airport including areas which have been listed in the Register of the National Estate and that the vegetation in these other parts is more extensive and generally in better condition. The PER lists the vegetation types in the business and recreational park that are not well represented elsewhere on the airport as the *Banksia littoralis* and *Melaleuca rhapiophylla* low woodland in Link Road Swamp and the stand of *Typha domingensis* in Runway Swamp. It states that these two areas will not be subject to clearing. Stands of *Banksia attenuata* low woodland which include *Eucalyptus todtiana* as co dominant, such as near the Leach Highway/Tonkin Highway intersection, are also described as not being common elsewhere in the airport. These would be affected by the clearance of the proposed new entrance way.

The EPA is of the view that the vegetation of the Bassendean Vegetation Complex- Central and South within the business and recreational park is not well represented in other areas of the airport. Moreover, the representation of the Southern River Vegetation Complex in the areas of vegetation which are included on the Interim List of the Register of the National Estate does not necessarily mean that these areas are secure. The Perth International Airport Land Use Plan of 1991 indicates that a parallel runway and associated taxiways and hardstand areas is planned for a large part of the Airport where these other major remnant vegetation areas are sited.

3.1.4 *Fauna*

Fauna at Perth airport was surveyed by Alan Tingay and Associates and the PER estimeated that at least 85 species are likely to occur in the area of the proposed development.

Four submissions were critical of the fact that the fauna list does not distinguish between recorded species and potential species. The Response to Public Submissions clarifies this point by listing those species recorded in the business and recreational park and indicates that all other species listed in Appendix 4 of the PER are potential vertebrate fauna species. Three submissions were concerned that the two fauna survey sampling sites were carried out in locations which were either degraded or in close proximity to Tonkin Highway and hence not located in the areas most likely to yield the highest number of species. The Response document indicates that a only a relatively small proportion of the total fauna was specifically recorded in the Business and Recreational Park area but that it has provided an indicative list of those likely to be found there by listing potential species.

The PER indicates that none of the species are included in the *Endangered Species Protection Act 1992* but indicates that there is a record of an individual Western Swamp Tortoise (*Pseudemudura umbrina)* which was found in 1970 at Perth airport in a wetland adjacent to Hardey Road.

The Western Swamp Tortoise is possibly Australia's most threatened vertebrate with fewer than 40 animals in the wild. It is listed as an endangered species under the IUCN Amphibia-Reptilia red Data Book and in the Commonwealth's *Endangered Species Protection Act 1992* and is the subject of a Recovery Plan with assistance provided by the Australian Nature Conservation Agency. The occurrence of the juvenile about 20km south of the closest known Western Swamp Tortoise population at Ellen Brook Nature Reserve demonstrated the existence of a reproducing population of the species on airport land. It is currently found in two nature reserves in the Perth area but its survival in only two locations leaves it vulnerable so suitable additional re-introductory habitat is being sought. As the habitat of the tortoise was in an area which is now metropolitan Perth, very little remains.

The tortoise is difficult to monitor and survey as it is secretive, has cryptic colouration does not enter baited traps and spends six to eight months of the dry summer period aestivating in naturally occurring holes or under leaf litter.

The Southern Brown Bandicoot or Quenda (*Isoodon obeselus)* is described in the PER as being resident throughout the airport including the land involved in the present proposal. This marsupial is able to sustain a higher population density in dampland environments. The dense heathland vegetation of this wetland type allows the Quenda to avoid predation by cats and foxes more readily. It is listed in Schedule 1 of the Western Australian *Wildlife Conservation Act, 1950-79.* Species in this schedule are considered

to be rare and endangered. The PER comments that the species is relatively common in various locations in the Perth metropolitan region and that at Perth Airport it has been trapped in a wide range of vegetation types including grasslands dominated by introduced weeds. The PER comments that the wide distribution and abundance of Southern Brown Bandicoots at Perth Airport is attributed to a fox control program implemented by the FAC. A number of submissions comment that the bandicoot survives because of the extent and continuity of the bushland remnants and the amount of dense undergrowth that remains.

A second species, Carnaby's Black Cockatoo (*Calyptorhynchus funereus latirostris)* is listed in Schedule 2 of the Western Australian *Wildlife Conservation Act, 1950-79* and may occasionally occur in the Business and Recreational Park area. Species in the Schedule are considered to be in need of special protection. Submissions cite the use of banksia woodland for feeding, particularly in winter months and indicate that the reduction in woodland means less feeding areas and less birds visiting.

One submission points out that the listing of the Short beaked echidna (*Tachyglossus aculeatus*) if found on the site is of significance because the animal is now rare in the Perth metropolitan area.

3.1.5 Hydrology and Wetlands

The Water Authority of Western Australia (WAWA) commented that the Perth airport wetlands form a part of a major regional conservation corridor of seasonally waterlogged and inundated land which extends from Guildford in the north to the Jandakot water mound in the south.

The shallow aquifer under the site is part of a larger regional system which extends from almost the foot of the Darling escarpment in the east to the Swan River in the west. The base of the shallow aquifer under the Business and Recreational Park is generally at -10m AHD. The groundwater table in summer is about 6m below the ground surface. However, the water table may only be about 1.5m below the ground surface in summer in the lowest parts of the landscape.

Runway Swamp and Link Road Swamp are two wetlands on the site but seasonal damplands are also present. They are underlain by a mixture of sands and clays. This wetland was dewatered and mined for peat and is also connected to a drainage channel which runs from water logged parts of the Perth Airport. It has been modified from a seasonal dampland to a permanent lake. Link Road Swamp a dampland which is seasonally waterlogged situated at the end of the old Leach Highway- Hardey Road junction.

Runway Swamp is listed as a relevant wetland in terms of the WAEPA Environmental Protection Policy (EPP) which applies to specific lakes on the Swan Coastal Plain (EPA, 1992). The WA EPA has also produced a Guide to Wetland Management in Perth (EPA Bulletin 374) which provides a

classification system for wetlands on the Swan Coastal Plain and related management objectives. Runway Swamp is classified in the" resource enhancement" category of this system. Wetlands in this category have been modified and do not have clearly recognised human uses. The management objective for such wetlands is to maintain and enhance the existing ecological functions.

The PER indicates that Link Road Swamp was not included in the Environmental Protection Policy for wetlands on the Swan Coastal Plain possibly because the WAEPA was not aware of its existence at the time that the policy was developed. Link Road Swamp is in the "conservation" category of the WA EPA Guide. Such wetlands are considered to possess a high degree of naturalness and the management objective is to maintain and enhance the natural attributes and functions.

WA EPA Bulletin 374 also categorises the dampland area adjacent to Tonkin Hwy to the east of the intersection of Tonkin and Leach Highways in the conservation category, the management objective for which is "to maintain and enhance natural attributes and functions".

4 MAJOR ISSUES AND SAFEGUARDS TO MINIMISE ENVIRONMENTAL IMPACTS

4.1 Remnant Vegetation

This was clearly the issue of most concern to the public, with two thirds of submissions raising concerns with the impacts of the development on the relatively large tracts of remnant vegetation which forms part of "Systems 6" identified area.

The FAC argues that the broad design of the business and recreational park seeks to site the main built components of the site on the most disturbed parts of the site while retaining most of the better quality vegetation within the golf course development. The Corporation contends that vegetation is currently vulnerable to unauthorised access by the public and points to four fires having been lit in recent times which have resulted in the loss or damage of native vegetation. It indicates that with the development it will be possible for the FAC to commit more management resources to the area. The response document states that management will also include rehabilitation of some degraded areas.

Several submissions highlight the fact that the extent and impacts on vegetation are not made clear in the PER. To some extent the proponent has sought to clarify this matter by presenting a layout of the golf course in the response document. However, the EPA is of the view that the areas of vegetation to be cleared should be mapped and that the tables attached to the Responses document are inadequate to obtain a full understanding of the specific areal implications of the development on native vegetation. The differing map bases of the development plan and the vegetation map make overlaying and assessment difficult.

Tables 1 and 2 of the Response document document indicate that the development will remove a total of 20.2 hectares of native vegetation. The majority of this, 15 hectares, will be cleared to accommodate the golf course with 4.5 hectares to be cleared to accommodate the business park (including roads, buildings and car parks) and 0.7 ha to be affected by the Tonkin/Leach highway intersection.

Hotel and Business Complex

The hotel complex and business areas will clear 4.5ha of native vegetation comprised of comprised of *Banksia attenuata* low woodland, *Melaleuca rhaphiophylla* low open woodland, *Adenanthos cygnorum* shrubland and *Pericalymma ellipticum* closed heath. The smaller isolated stands of vegetation to the south and west, adjacent to Stage 1 are probably not viable in the long term. However, the western edge of the northern business zone will fragment an area of *Banksia attenuata* low woodland which is relatively large and part of a larger stand which extends beyond the limits of the business area. This area would be further dissected by holes 10, 18 and 16 of the golf course and is classified as obviously disturbed by the PER, but considered capable of regeneration.

The PER indicates that the east, where the hotel and other businesses will be located, is already serviced by water, sewerage, electricity, gas and Telecom which are either located in the road reserve of Horrie Miller Drive or actually traverse the area where buildings will be located. Distribution and reticulation lines from these underground services will be placed in road reserves within the Business Park.

The scale of earthworks has not been determined as specific design details have not been developed. However, the PER comments that the business area and hotel complex may require general levelling which would involve removal of sand from the northern ridgeline and placement on to the hotel site. The building area, adjacent to Tonkin Highway will presumably require levelling of the high point shown in Figure 6 of the PER. The PER in Section 5.5 indicates that all construction activities will be subject to a Construction Management Plan designed to limit environmental impact to the minimum necessary for development. The implementation of the Construction Management Plan will be a specific contractual requirement applying to all contractors and compliance with this requirement will be supervised by personnel of the FAC and/or by professional engineers engaged by the FAC. Issues to be covered by the Construction Management Plan include the control of dust, noise and conformity with the WA Environmental Protection Act, 1986 relating to noise levels, the disposal of wastes, and the marking of vegetation for protection, limiting the spread of dieback, Aboriginal sites, landscaping and design of buildings.

Golf Course

The PER indicates that as far as possible the FAC proposes to site fairways and greens on the grassland areas in order to retain as much natural vegetation as possible. It states that the natural vegetation and wetlands are landscape assets for the golf course design and will reduce the need for extensive landscaping.

The PER notes however, that the extent and location of the existing vegetation is not ideally placed for golf course design purposes and therefore it will be necessary to remove some vegetation to achieve a functional course. Some 15 hectares, will be cleared to accommodate the golf course. The more disturbed vegetation will be cleared in preference to less disturbed and the edges of vegetation stands will be cleared rather than whole stands. Reference is made in the PER to the planting of native vegetation in the golf course area partially compensating for any loss of vegetation in this area (P26, PER) but no details of the areas contemplated or nature of replanting is given. A number of submissions expressed the view that revegetation and landscaping should use only local native species to obviate the incursion of weedy species to remnant vegetation areas.

Recommendation: ***That should the development proceed, any revegetation and landscaping to be carried out within the golf course and business park areas should utilise local endemic species.***

Several submissions point out that there is no assessment of the effects on areas of vegetation which are less disturbed resulting from development of areas which are disturbed, by for example reducing the buffer to those areas, thus allowing for greater weed and feral animal incursion.

The PER states that there are many examples where golf courses have provided a means of protecting environmental features but provides no specific information to support this. Two submissions request further details be provided to support the claim in the PER. The Australian Heritage Commission comments that the development of the golf course would result in the removal of some vegetation and areas of retained native vegetation may not persist. The Response document lists Joondalup, the Vines, Secret Harbour and Meadow Springs golf courses in the Perth Metropolitan Area which have protected environmental features (wetlands, native vegetation, and landforms). The WA Department of Environmental Protection states that while no studies have been conducted on this issue, case observations indicate that success is likely to be superficial.

The WA Department of Environmental Protection comments further that loss of condition and bio diversity is expected within the remnant pockets near the golf course, with only the more robust species surviving over the longer term. It states that the development of fairways fragments the bushland and creates wide open corridors which will not be utilised by small fauna but will provide easy access for predators. Fragmentation creates large edge to area ratio which invariably leads to a loss of condition from adjacent land uses and activities. For example disturbance of the

understorey due to uncontrolled access, reduction in species diversity due to the impact of pesticides on plants and invertebrates and weed invasion facilitated by mowing, understorey disturbance and the drift of fairway irrigation and fertilisers. The Department and one other submission state that the only examples of adequate conservation of vegetation in golf courses are "dry", ie not irrigated. Irrigation leads to weed invasion, mowing and replacement by non local plants.

Several submissions indicate that fire is very damaging to isolated patches of bushland making it very difficult to re establish.

The FAC provides the commitment that it will provide a detailed design for the golf course and an environmental management plan to the satisfaction of the Environment Protection Agency prior to construction. The plan will be prepared in consultation with State Government agencies (including the Western Australian Department of Environmental Protection, the Water Authority of Western Australia (now the Water and Rivers Commission), and the Western Australian Department of Conservation and Land Management).

The Plan will propose management strategies for vegetation retention, groundwater extraction and fertiliser application. The Plan will include, but not necessarily be limited to, protection of remnant vegetation, revegetation measures, dieback hygiene, fire management, erosion control, groundwater extraction and watering regimes, stormwater management, nutrient budgets, the management of wetlands, and ongoing monitoring requirements. The PER indicates that the management of native vegetation will be developed in consultation with the WA Department of Conservation and Land Management and will include such matters as the use of local genetic stock in revegetation, the retention of mature trees which may provide nesting hollows for parrot species and ecological requirements for other vertebrate fauna, dieback hygiene, fire management.

It should also include enhancement of remaining native vegetation by ongoing weed eradication as suggested by City of Belmont.

Recommendation:
That the Environmental Management Plan to be prepared for the golf course include enhancement of native vegetation by ongoing weed eradication.

The WA Department of Environmental Protection comments that impacts of irrigation on native vegetation are not assessed in the PER. Other submissions cite the particular sensitivity of banksia woodland to watertable falls due to groundwater extraction and indicate that this vegetation is most susceptible to water table fluctuation in areas which have a depth to groundwater of around 3-5 m. These conditions are similar to those on the development site, where there is a relatively low depth to groundwater. Submissions argue that dry years could result in extensive tree deaths.

The response document acknowledges that excessive groundwater extraction may cause a local draw down in water table levels which might have a detrimental effect on native vegetation in that local area. It sees the solution in having several bores distributed over a larger area and situating bores distant from native vegetation.

One submission draws attention to the fact that Australian Proteaceae plants (which include Banksias, the predominant bushland trees on the site) are particularly affected by nutrients and points to the fact that the PER does not discuss this issue. The PER states that a specific nutrient management program will be developed in the detailed design phase. The EPA is of the view that the use of fertilisers on the golf course are likely to increase stress and degradation of native vegetation bordering the golf course.

The Environmental Protection Authority comments on the PER's statement,(p1) that the proposal "provides for the opportunity for more active management of remnant vegetation, wetlands, and fauna habitat within apart of the airport in the context of a public golf course in a parkland setting". The WA Environmental Protection Authority states that from the information available it appears more likely that the removal of remnant vegetation and the development of a golf course may be inimical to the protection of remnant vegetation.

The Entrance Road

Nine submissions expressed concern that the new entrance road to the airport from Leach Highway and Tonkin Highway will traverse an area of relatively undisturbed *Banksia attenuata* Low Woodland with Jarrah trees(*Eucalyptus marginata*) and clearing will be required. The vegetation in this locality is considered to be one of the better areas with native vegetation in the least disturbed condition. The PER (p25) indicates that some 2.25 ha will be affected by clearing of the road easement, while the Response document indicates only 0.7 ha will be removed. The Response document (response 68) indicates that the four way grade separated junction will affect 4ha. The area proposed for clearing in the region of the new entrance requires clarification.

The Response document indicates that the total areas required for roads will affect 5ha of *Banksia attenuata* Low woodland and 2ha of *Melaleuca preissiana* Low open woodland both of which are in the disturbed category (moderate to high conservation value).

The PER indicates that in this case there is a direct and unavoidable conflict between a planned use and an existing natural environmental feature. The PER states that the new entrance road is considered to be essential for future efficient traffic management within the airport and adjacent localities given the continuing increase in use of air transport and the new multiple functions of the two terminal areas at the airport.

The FAC's management approach is to minimise the amount of vegetation removed and to include environmental protection measures in the contracts of all companies involved in road survey and construction; and to ensure that the construction is supervised. These measures will be incorporated in a specific Construction Management Plan (commitment 2) to be applied to site works and construction of roads which will be prepared to the satisfaction of the Environment Protection Agency. The PER outlines that the Management Plan will cover such matters as clearing requirements, treatments for cleared vegetation and top soil, construction procedures for survey lines, roads, service corridors, equipment requirements, dieback control measures, stabilisation and rehabilitation procedures and ongoing management requirements and responsibilities. The Construction Management Plan will be incorporated into contract and other documentation and its implementation will be the subject of regular audits. The results of these audits will be provided to the EPA.

The new development plan attached to the Response document indicates that the eastern section of Link Road is altered from that shown in the PER so that it will largely follow the alignment of the old Hardey Road to intersect with Horrie Miller Drive. The eastern section which will no longer be required will be removed and rehabilitated. To the west it will follow the current internal road. The PER indicates that this road together with adjacent cleared land is of sufficient width to provide a dual carriageway if required and hence will not require vegetation removal.

4.1.1 Systems 6

About half of the submissions saw the proposal as inconsistent with System 6 recommendations that the Commonwealth retain as much uncleared land as possible. The WA EPA comments" ...it appears that what is proposed does not fit in with those recommendations". The Water Authority of Western Australia comments that "... the proposals being put forward in this PER conflict with both the letter and the spirit of the original System 6 recommendation".

The FAC considers that the plan is consistent with the WAEPA recommendation in that it believes that the main development areas are located where there are no significant stands of vegetation, the golf course will involve the retention of significant stands of vegetation, and where vegetation removal is required by critical features of development, (such as the entrance road from the Leach and Tonkin Highways) the clearing will be limited to the minimum necessary.

The WA Department of Environmental Protection commented that the System 6 recommendation in relation to Perth Airport aimed for the Commonwealth to retain as much remnant vegetation as possible, initially because it was in very good condition and contained uncommon flora and fauna. More recently however, so little remains of many vegetation complexes in the Perth metropolitan area due to clearing, that the proposed Urban Bushland Strategic Plan/Systems 6 Update, which is currently under

preparation, aims to ensure that at least 10% of each vegetation complex is protected regardless of condition.

The WA Department of Environmental Protection refers to recent analysis of remnant vegetation by the Ministry of Planning and indicates that the three vegetation complexes at Perth Airport are now recognised as being seriously under threat. It states that Perth Airport supports one of the largest areas of contiguous remnant vegetation in the Perth region and that its location at the juncture of three complexes is probably unique. It contains a very diverse array of plant communities and structures and habitat value is therefore very high. The Department also indicates that it is highly likely that the Urban Bushland Strategic Plan/Systems 6 Update will recommend the protection of almost all the remnant vegetation at Perth Airport. Poor condition will be balanced by the large total area of remnants.

The EPA believes that the proposed development will affect remnant vegetation complexes which are of high regional importance.

4.2 Fauna

The PER contends (piii) that "the retention of much of the remnant vegetation and the protection of wetlands will therefore provide for the retention of fauna in the area". The Environmental Protection Authority comments that this statement is not supported by the development outline.

Many submissions comment that the development by its clearance and fragmentation and consequent loss of continuity of vegetation will reduce the value of the areas as fauna habitat. Fragmentation will increase "edge effects" and deterioration of vegetation by weed invasion. The more extensive road system and greater traffic use will provide barriers to movement and increase the risk of road kills despite the assurance in the PER that new roads will utilise fauna link pipes. Submissions also indicate that disturbed sites also have value as habitat (pointing to the recording of the Southern Brown Bandicoot in degraded grasslands on the site) and that a mosaic of areas with varying condition ratings are likely to provide a better overall habitat than fragments retained in relatively good condition.

A number of public submissions expressed concerns that the development of the road network could lead to significant road kills of fauna. The proponent responded that the incidence of native fauna deaths on roads at the Perth Airport Business and Recreational Park are not likely to be significantly higher than those currently experienced on Tonkin Highway, Horrie Miller Drive and Link Road. No evidence was presented to support this statement.

The EPA believes that it is likely that further road kills would occur because the increased road network would open up new areas of habitat and by the increased levels of usage of Link Road. However, on the information presented the EPA is unable to comment on the significance of the impact on fauna.

The PER considers that the golf course will offer the best potential for fauna habitat conservation. Several submissions contend that the fragmentation of vegetation currently on the site will be very damaging to the site's fauna populations and that there will not necessarily be less fauna inhabiting vegetation of moderate condition than vegetation in very good condition.

The EPA believes that the development will unavoidably reduce the value of fauna habitat on the site by decreasing in the size of native vegetation areas and by increasing the fragmentation and vulnerability of habitat areas.

4.2.1 Western Swamp Tortoise

Many public submissions raised concerns about the possible impacts of the project on the Western Swamp Tortoise, *Pseudemydura umbrina*.

The PER commented that the record of the Western Swamp Tortoise is of special significance and stated that it had approved further surveys by the WA Department of Conservation and Land Management to determine if the species is still present. It did not assess the impacts of the proposed development on the Western Swamp Tortoise.

The previous Minister for the Environment halted the assessment and called for a survey to be undertaken of the Western Swamp Tortoise and its habitat. The FAC contracted the Western Swamp Tortoise Recovery Team to conduct the survey over the entire Airport land, including and particularly focusing on the area proposed for development as the Business and Recreational Park Stage 2. While no tortoises were found during the survey a number of areas were identified as habitat for the species.

As a result of the survey and analyses, recommendations are made which would allow the proposed business park development to proceed, with some modifications that conserve the swamps identified as potential Western Swamp Tortoise habitat. With the exception of one swamp, the surveyn report found that the suitability of swamps in the area proposed as a business and recreational park is at present low because most of the swamps in this area are too highly modified and /or drained. The report recommends that one swamp (identified as Five Mile Centre Swamp 8, directly south of the carpark of the Perth Mint and west of Horrie Miller Drive) which is in good condition and provides suitable Western Swamp Tortoise habitat, should be excluded from the Business Park and added to the proposed Five Mile Swamp Centre Group conservation area. ANCA comments that as there are possibly no other sites suitable for reintroduction in the historic range of the tortoise, the rehabilitation and protection of suitable swamps within the airport for future translocations of the tortoise may be vital to the survival of this critically endangered species.

The survey report also states that it may be possible to rehabilitate two swamp areas within swamps identified as Five Mile Swamp South 2 and Five Mile south 3 so they become suitable habitat for the Western Swamp

Tortoise but further investigations of the flooding regime and groundwater levels are required. The report recommends however, that the rehabilitation and conservation management of swamps elsewhere on Airport land has a higher priority.

Recommendation *That the swamp identified as Five Mile Swamp Centre 8 and an appropriate buffer area, as determined in consultation with the Western Swamp Tortoise Recovery Team, should be excluded from the development area. Consideration should be given to its inclusion with other swamps of the Five Mile Centre Group by construction of a fox-proof fence to provide suitable habitat for the translocation of the Western Swamp Tortoise.*

4.2.2 *The Southern Brown Bandicoot*

The PER comments that it is expected that populations of the Southern Brown Bandicoot will survive in the golf course area because it is continuous with the remainder of the undeveloped airport land and because fox control programs will continue.

Public submissions were concerned that the proposals will affect much of the habitat for the population on the site through clearing and fragmentation. They point out that the Quenda uses bushland and disturbed areas of grassland so developments on degraded sites also have the potential to adversely affect the species.

The EPA requested (in a letter of August 1993) that consultation be undertaken with the Wildlife Management section of the Department of Conservation regarding the effects of the development on the bandicoot and that this advice be incorporated in the PER so that this information could form part of the assessment of impacts. However, the PER incorporates as one of its commitments that prior to construction the FAC will consult with the WA Department of Conservation and Land Management regarding the protection of the Southern Brown Bandicoot.

From the information presented the EPA is not able to assess the significance of the impacts on the Southern Brown Bandicoot. However, it is of view that the development will reduce and fragment habitat which is likely to have a negative effect on local populations of the bandicoot.

Recommendation: *If the development is to proceed, that the FAC seek the advice of the Department of Conservation and Land Management with regard to the significance of effects on the Southern Brown Bandicoot populations on the site so that appropriate ameliorative or protective measures can be incorporated into the design of developments by including these matters in leases or agreements to develop the site with private developers.*

4.2.4 Carnaby's Black Cockatoo

The PER comments that as there are a limited number of large eucalypts within the development site it is most unlikely that any significant impact on populations of Carnaby's Black cockatoo will occur. However, the FAC will retain as many large trees as possible, to preserve fauna habitat and also for landscaping purposes. The FAC also indicates that the planting of local native Eucalyptus species may also provide further cockatoo habitat in the long term.

The EPA regards the effect on Carnaby's Black Cockatoo as unlikely to be significant but recommends the retention of the the majority of large trees in the development.

Recommendation: ***That wherever possible, large trees be retained in the development to conserve as much of the Carnaby's Black Cockatoo habitat as possible.***

4.2.5 The echidna

The Response document indicates that a short beaked echidna was recorded north of the International terminal in Dry Eucalyptus Woodlands. There is 94.9 ha of this vegetation type present 1.8ha of which will be removed for development of the Business and Recreational Park. This represents 2% of the woodland at Perth Airport and the FAC indicates that this is unlikely to affect the viability of remaining areas for Echidna populations.

Recommendation: ***If the development is to proceed, that the FAC seek the advice of the Department of Conservation and Land Management with regard to the significance of effects on the Short beaked echidna populations on the site so that appropriate ameliorative or protective measures can be incorporated into the design of developments by including these matters in leases or agreements to develop the site with private developers.***

4.2.6 Habitat Linkage

The PER states that the remnant vegetation on Perth Airport is probably only significant in terms of habitat linkages for nomadic bird species because the airport is effectively surrounded by developed land. The PER concludes that the main value of the vegetation on the airport to vertebrate fauna is as a remnant habitat within the Perth metropolitan Region, rather than as a fauna corridor. Linkage within the Airport and within the site should be examined. A number of submissions comment that the size and continuity of the vegetation, rather than condition maintains its value as fauna habitat. Areas of degraded vegetation provide cover for fauna movements between areas and hence protection from predators whereas roads, built up areas and fairways increase fauna vulnerability.

4.3 Hydrology and Wetlands

4.3.1 Wetlands and Groundwater

WA Water Authority considers it vital that the regional linkage of seasonally inundated land be maintained from an environmental viewpoint.

A number of public submissions were concerned that the ecological values of Runway and Link Road Swamps and damplands would be affected by the development.

The Response document states that the ecological values of Runway and Link Road Swamps will not be significantly affected by the Business and Recreational Park. It further states that these two swamps will not be filled, excavated or have drainage water directed to them during or after development and that ongoing management will ensure that presently degraded areas of the wetlands are actively rehabilitated and future disturbance of the wetlands is kept to a minimum. The document also provides that the area surrounding Link Road Swamp will not be changed by the proposed development. The Response document indicates that the current road design has relocated the current route of Link Road away from Runway Swamp and also that Runway Swamp will be included as part of the golf course, with fairways designed to skirt the boundaries of the wetland sump. The Response document indicates that some seasonally waterlogged areas will be affected and that a total of 3.7ha of Wet Low Woodlands will be modified within the golf course and business park, representing 6% of the total area of this vegetation type at the Perth Airport. It does not indicate the specific location of these areas.

The proponent does not specify the size of buffers contemplated for the significant wetlands. It should be noted that the Map sheet of the Wetlands (Map Sheet 203411 SE produced by WAEPA and WA WA, 1994) indicates the zone of critical influence as 50m.

Recommendation: ***That consultation take place with the WA Environment Protection Authority and Water and Rivers Commission regarding the size and nature of buffers to be maintained or provided for the significant wetland areas.***

The PER does not address any effects on the dampland lying to the east of the intersection of Tonkin and Leach Highways which is classified by the WA EPA in the "conservation" category. The EPA is of the view that the dampland may be affected by the new road to the south along the boundary of the airport land as well as the new route of the link road to the east along Hardey Road where the road corridor may need widening.

Recommendation: ***Consultations should be undertaken with the Water and Rivers Commission and the Department of Environmental Protection***

with regard to minimising or avoiding any effects on the dampland to the east of the intersection of Tonkin and Leach Highway which has been classified in the conservation category.

The PER sees the possibility of more significant impacts on the hydrology and health of wetlands by the proposal to use groundwater from the shallow aquifer on the site for watering the golf course and landscaped areas. If the average level of the water table was to fall then seasonal wetlands would dry out earlier in the year and would be drought stressed in more lower rainfall years than under present conditions. The PER states that the Runway Swamp, being a permanent wetland is not likely to be affected, except by a substantial fall in the water table.

Estimates of the drawdown effects of bores extracting from Bassendean Sands are presented in the PER and it is acknowledged that the siting of extraction bores is a very important factor in the protection of vegetation and wetland areas. However, the rate of extraction from the shallow aquifer for watering purposes is not known and is not estimated in the PER.

About a third of submissions expressed concerns with regard to the assessment of effects on hydrological function and to the fact that assessment was purely speculative. The WA Environment Protection Authority comments the the extraction of groundwater is likely to have an impact on the wetlands and on the vegetation, which is not adequately addressed. The Department of Environmental Protection comments that indicative modelling should be carried out prior to environmental approval to establish that sufficient water will be available for extraction without affecting water levels. The WA Water Authority comments that there needs to be a more in depth (quantitative and qualitative) analysis of water requirements and sources and surface water run-off (drainage) management. The Department of Environmental Protection indicates that the parameters of "significant decreases"to the groundwater table need to be established prior to the development.

The FAC proposes that the extraction of groundwater will be planned and regulated in order to ensure that a significant lowering of the average groundwater table does not occur over the site and particularly near Runway Swamp and Link Road Swamp.

The FAC provides the commitment (Commitment 1) that a management plan for the golf course will be prepared to the satisfaction of the Environmental Protection Agency in consultation with State Government agencies (including the WA Department of Environmental Protection, the Water Authority of WA and the WA Department of Conservation and Land Management). The plan will include the carrying out of specific hydrological monitoring as part of the development of a golf course design and ongoing monitoring of groundwater usage. Environmental Audits will be provided to the WA EPA. The PER indicates that the location and depth of the bores and the rates of groundwater extraction will be selected on the

basis of a detailed hydrological assessment and in consultation with the Water Authority of Western Australia.

The PER outlines that a groundwater monitoring program will be implemented for each bore which will include:

- weekly records of pumpage rates and water levels in bores and wetlands;
- the installation of piezometers alongside selected wetlands;
- weekly measurement of electrical conductivity (salinity), temperature and pH of borewater;
- Analysis of borewater and wetland water every 3 months for concentrations of major ions, total nitrogen and total phosphorus.
- Monitoring of the water levels and water quality in the wetlands will commence prior to construction to provide baseline information.

The Department of Environmental Protection comments that in this current dry climate interval with Greenhouse forecasts of drier times, bores should be into the Leederville (town supply) aquifer or fairways should not be watered.

The EPA is of the view that the groundwater resource and the likely requirements need to be assessed prior to earmarking or leasing the areas for a particular development. The Water and Rivers Commission should be consulted at an early stage and its advice forwarded to this agency and to the WA Department of Environmental Protection. Alternatives to irrigating the golf course using the shallow aquifer should be considered, if the resource proves insufficient or unsustainable for this use.

Recommendation: *That an assessment of the capability for sustainable use of the shallow aquifers proposed to be used for irrigation of the golf course and for landscaping should be carried out in conjunction with the Water and Rivers Commission prior to the leasing of the area for an irrigated golf course. Should the resource prove to be unsustainable or insufficient for this use alternatives should be considered. If the resource proves sustainable the parameters of "significant decreases"in the average groundwater table need to be established in consultation with the Water and Rivers Commission prior to the development. Monitoring results of levels and quality should be provided to the Waters and Rivers Commission.*

4.3.2 Drainage and Runoff

The PER acknowledges that the Business and Recreational Park will lead to a marginal rise in the average level of the groundwater table by increased recharge due to run-off from the roofs of buildings and paved surfaces. It comments that these variations would be within existing normal variations

in water levels caused by differences in rainfall from year to year and that changes to the wetland vegetation and fauna would be most unlikely. The PER states that the drainage of the development area will not be significantly altered by the development of the hotel and golf course. The PER indicates that the drainage and irrigation systems in the Business and Recreational Park will be based on the principles of water sensitive design (Water Authority of Western Australia, 1989). There are no plans to construct groundwater interception drains in the area and all storm waters will be allowed to infiltrate into the soil profile wherever possible. A number of water harvesting depressions, designed to limit the amount of water that leaves the site are likely to be incorporated into the golf course. The PER also indicates that artificial wetlands may be constructed to act as small compensating or infiltration basins for stormwater.

The WAWA comments that much more information needs to be presented on the drainage of the site in order to assess the proposal. For example, the area and proportion of the site rendered impermeable by roads, carparks, roofing etc, the area that will have increased or decreased run-off due to changes in vegetation and whether nutrient enriched run-off from fertilised grassed areas and contaminated run-off from roads and car parks will be able to be separated from the remaining wetland natural areas.

The response to issues raised in public submissions document states that drainage issues will be addressed as more detailed plans are created. Stormwater management will form part of the management plan for the golf course as outlined in Commitment 1 of the PER.

The preparation of a stormwater management plan in consultation with the Water and Rivers Commission is supported by the EPA.

4.3.3 Nutrients

Fertilisers containing phosphorus will be used to establish and maintain landscaped areas, lawns and golf course greens, tees and fairways. The PER estimates that about 30 ha may receive applications. In total the application rates are: 978 kg in year 1 and 864 kg in year 2 and following years. Indirect and direct run-off containing phosphorus may flow to wetlands where it can cause algae and eutrophication problems.

A number of public submissions commented that the sands of the site are porous, the watertable is high, thus leading to the nutrient fertilisers leaching down quickly and heightening the risk of contamination of groundwater. A large number of submissions raise the possibility of nutrients from golf course fertilisers entering the airport main drain just north of the site and thereafter entering the Swan River. The Response document indicates that all stormwater will be retained and disposed of on site in swales, infiltration basins and sediment traps. No stormwater will be directed to the main drain. In addition, leaf and soil testing of greens and fairways will be used to indicate when and how much fertiliser is required.

In an effort to address concerns with regard to contamination of the wetlands FAC undertakes to develop a specific nutrient management plan as part of the managment plan for the golf course to the satisfaction of the Environment Protection Agency in consultation with State Government agencies (including the WA Department of Environmental Protection, WA Water Authority and WA Department of Conservation and Land Management) in the detailed design phase of the Business and Recreational Park. The main aims of the plan will be to:

- minimise the overall phosphate requirements on the site
- prevent groundwater resources from experiencing significant increases in phosphate; and
- to prevent wetlands from experiencing significantly increased levels of nitrate and phosphate.

Possible methods are discussed, but not specified. These include:

- the use of red mud derived as a waste by product of the processing of bauxite to alumina to modify soils beneath grassed areas to prevent or minimise the potential for leaching. The red mud will also enhance the ability of the soil to retain water.
- the application of small quantities of fertiliser at frequent intervals
- the timing of application to avoid periods of high probability of significant rainfall
- the performance of periodic analyses on soils to adjust the fertiliser application rate to an optimal level
- the selection of appropriate grass species.

The Environment ProtectionAgency supports the use of the measures proposed and believes that they will go some way to mitigating possible impacts from the application of fertilisers. We note however that the WA EPA still has concerns. The WA EPA comments that the commitment to draw up a management plan is not sufficient for an adequate assessment of the likely impacts of the proposal.

Recommendation:
That before the development of the site a detailed nutrient management plan be compiled to the satisfaction of the Western Australian Department of Environmental Protection with the aim of minimising effects on groundwater and wetlands. That prior to development of plans for stormwater management to avoid nutrient contamination of groundwater be prepared to the satisfaction of the Water and Rivers Commission.

4.3.5 *Pesticides*

A number of submissions point to the fact that the PER does not discuss the use of herbicides, insecticides and fungicides on the golf course and landscape area and address the effects on native flora and fauna. The response document also does not address this issue.

The EPA believes this issue should form part of the matters to be included within the management plan for the golf course tol be developed in consultation with the WA Department of Conservation and Land Management and the WA Department of Environmental Protection and the Waters and Rivers Commission.

Recommendation:
That the use of herbicides, insecticides and fungicides on the golf course should be addressed within the management plan for the golf course to be formulated in consultation with the Department of Environmental Protection, the Department of Conservation and Land Management and the Waters and Rivers Commission.

Conclusion

The Environment Protection Agency believes that if the proposal proceeds there will be an unavoidable loss of some 20.2 hectares of remnant vegetation from the Southern River and Bassendean Complex- central and south. In addition it is likely that fragmentation of the remaining vegetation areas- by the construction of a new entrance way, internal roads, buildings and carparks and the development of fairways for the golf course will lead to a gradual decline in the condition and biodiversity of remaining remnant vegetation on the site.

This decline is likely to be exacerbated by the use of fertilizers and the irrigation regime associated with the golf course and landscaped areas.

4.4 Heritage Issues

The Australian Heritage Commission received a nomination for the whole of Perth airport and on the basis of evaluation against the criteria placed four areas of vegetation within the Airport on the Interim List of the Register of the National Estate. These all lie to the east of Horrie Miller Drive and are not affected by the proposed developments. The AHC has also received subsequent nominations for the whole of Perth Airport and for an area of remnant vegetation within the proposed business and recreational park but these have not yet been assessed and as nominations do not receive the protection of the *Australian Heritage Commission Act 1975*. The AHC commented on the PER and indicated that the Commission intends assessing the additional nominations at the same time as it investigates the FAC's objections to the interim listing of the airport, but to date this has not occurred.

The National Trust has classified all land vested in the FAC at Perth Airport together with a small adjacent parcel of land vested in the Main Roads Department as a place of natural heritage significance. The nomination excludes all built up areas, tarmac areas, and all land within 6m of the runway. The National Trust classification does not afford legal protection to sites.

Eleven archaeological and one ethnographic site have been recorded within the general area of the Business and Recreational park. Nine of the sites are archaeological sites, one is archaeological and ethnographic and one is ethnographic. Of these sites, two have already been disturbed by the construction of Horrie Miller Drive. Three archaeological sites are likely to be affected by the Business park, with part of the archaeological/ethnographic site affected by the extension of Link Road. The PER indicates that the Aboriginal Sites Department of the Western Australian Museum has been informed of the location an nature of these sites, but that details of the sites must not be made public. The PER indicates that an application will be made to disturb each of the sites if they are likely to be affected by the proposed development and that any such application will follow the procedures prescribed by the Western Australian *Aboriginal Heritage Act, 1972-1980.*

Recommendation:
That the FAC seek advice from the Department of Aboriginal Affairs on the significance of the 4 sites likely to be disturbed prior to the FAC entering into a lease or agreement with private developers so that any advice on site protection can be incorporated into specific development plan.

4.5 Noise

Several submissions expressed the view that hotel and golf course are situated in noise zones where levels are too high for these uses.

The ANEF map for Perth Airport in the region of the Business and Recreational park is shown in Figure 11 of the PER. The response document indicates that the golf course is the only part of the proposal located between the ANEF 25 and 40 contours. The business areas and hotel components are located between the ANEF 20 and 25 contours. These land uses are consistent with Australian Standards. Appropriate land uses in the vicinity of Australia Airports are presented in the Standards Association of Australia AS2021-1985, using the Australian Noise Exposure Forecast (ANEF) System. The PER states that it is recognised that noise attenuation measures will need to be included in the design of these buildings in accord ance with those described in Standards Association of Australia AS2021.

The EPA is of the view that the developments appear appropriate for the expected noise zones given the proposed inclusion of noise attenuation for commercial and motel buildings.

4.6 Traffic

The PER contends that the proposed road system will adequately service the Business Park and that the impact of the traffic created by the development would be confined to a large extent to the new link road. On the basis of a traffic study prepared for the proponent in 1992, the PER considers that the proposed road system will have a positive impact on regional traffic flow by diverting considerable numbers of vehicles that currently use other regional roads to gain access to the two airport terminals. The traffic study estimates that the internal link road would carry in excess of 8 000 vehicles per day.

The PER states that the FAC will liaise with the Department of Main Roads to ensure the best possible road design within the development and indicates that approaches have already been made to the Department of Main Roads including referral of a design report for the Leach Highway/Tonkin Highway intersection.

The EPA sought advice from the proponent on the results of consultation with the Department of Main Roads. This was not provided. Hence the EPA is unable to comment on the information presented. The EPA does not see traffic as a major issue for this proposal but recommends that details of proposed traffic arrangements be submitted to the Department of Main Roads for approval before development commences.

Recommendation:
That details of proposed traffic arrangements be submitted to the Department of Main Roads for approval before development commences

4.7 Social Environment

The PER states that the development is based on vacant land, is distant from urban areas, and will provide its own services infrastructure there is little potential for negative impacts on surrounding land uses.

The PER states that the current proposal will result in the opening up of much of the land in Stage 2 of the development for use by the general public, which is currently fenced to prevent access. The PER states that golf course will be accessible to the public and will have a positive impact on the availability of recreational facilities in the local region. The PER further predicts that the development may create up to 3 000 new jobs which would positively impact on regional employment opportunities.

5 CONCLUSION

The major issues in this development proposal are the effects on remnant native vegetation, on the nationally endangered Western Swamp Tortoise, on wetlands and hydrology and on the Southern Brown Bandicoot listed as endangered under the WA Wildlife Conservation Act.

The EPA believes that the proposed development will have unavoidable and irreversible impacts on an area of remnant native vegetation classified by the WA Environment Protection Authority in 1983 as an area valuable for conservation in the Darling Region (System 6).

Advice from the Department of Environmental Protection regarding the update of the status of System 6 areas currently being undertaken by the Department of Environmental Protection and the Ministry of Planning indicates that clearing which has taken place since the 1983 survey has heightened the value of remaining vegetation. The Department of Environmental Protection points out that the large size of remnants on Perth Airport, the diverse array of its plant communities and its location at the junction of 3 vegetation complexes make it particularly valuable. The DEP comments"it is highly likely that the the Urban Bushland Strategic Plan/ System 6 Update will recommend protection of almost all of the remaining vegetation at Perth Airport".

Should the development proceed some 20.2 hectares of remnant vegetation will be directly cleared (15 hectares of which is within the golf course). It is likely that a further 52 hectares of vegetation within or adjacent to the golf course will be adversely affected and suffer a gradual loss of condition and biodiversity by fragmentation, increasing the edge to area ratio, the use of local aquifers for irrigation, pesticides, fertilisers and introduced grasses. While the FAC claims that remaining native vegetation can be adequately protected within the golfcourse development, the Western Australian Department of Environmental Protection has commented that the only examples of adequate conservation of native vegetation in golf courses were in golf courses which were not irrigated.

The need to retain native vegetation is recognised by Australian Governments in a range of policies: the National Strategy for Ecologically Sustainable Development, the National Greenhouse Response Strategy, the draft National Strategy for for the Conservation of Australia's Biological Diversity and the National Landcare Program. It has also been affirmed by the Australian and New Zealand Environment and Conservation Council which agreed that accelerated action to encourage retention of native vegetation is a high priority in Australia.

The EPA believes that the fragmentation and decline in value of vegetation will unavoidably reduce fauna habitat values. The effect on the rare and endangered Southern Brown Bandicoot is not adequately assessed in the PER but the developments are likely to have a negative effect on the local population. The EPA recommends that if the development is to proceed, the FAC seek the advice of the Department of Conservation and Land Management with regard to the significance of the effect on Southern Brown Bandicoot populations on the site.

The effects on the nationally endangered Western Swamp Tortoise have been clarified by the survey undertaken of the entire Perth Airport by the Western Swamp Tortoise Recovery team. The report produced found that

with the exception of one swamp which is in good condition and provides suitable Western Swamp Tortoise habitat, the suitability of swamps in the Business and Recreational Park is low. The EPA recommends that the swamp identified as Five Mile Swamp Centre 8 and an appropriate buffer area as determined in consultation with the Western Swamp Tortoise Recovery Team should be excluded from the development area. Consideration should be given to its inclusion with other swamps of the Five Mile Centre Group by construction of a fox proof fence to provide suitable habitat for the translocation of the Western Swamp Tortoise.

The effects on wetlands and hydrology are not clearly assessed in the PER. The volume of water to be utilised for irrigation is not indicated and the adequacy of local groundwater supplies are not investigated. The PER speculates on whether the water table would rise or fall. Should falls occur serious effects are likely with tree deaths likely in banksia woodlands as these trees are quite susceptible to fluctuation in water table in areas of relatively low depth to groundwater table. Banksias are also very sensitive to fertilisers and may be affected by the entry of fertilisers to local groundwater. The EPA recommends that an assessment of the capability for sustainible use of the shallow aquifers proposed to be used for irrigation on the golf course and for landscaping should be carried out in conjunction with and on the advice of, the Water and Rivers Commission prior to leasing or entering into an agreement for the use of an area as an irrigated golfcourse. Should the resource prove to be unsustainable or insufficient for this use alternatives should be considered.

The evidence suggests that the environmental values of the remnant vegetation of Perth Airport are significant in the Perth region. If the development goes ahead the EPA believes it is likely that these values will be degraded. Management strategies proposed detail further assessment and monitoring once approval for general developments are given. However, the EPA believes that the alteration of the development based on adverse monitoring results once the development is in place is not a practicable result. After the development is in place, maintenance of the qualities of the golf course is likely to assume greater significance than protection of native vegetation.

The EPA is unable to say whether there are any feasible and prudent alternatives to the proposed action which may allow for the retention of larger areas of remnant vegetation or avoid impacting on the least disturbed areas.

Against these factors must be weighed the commercial pressures by the Commonwealth for development of the site and to maximise the return in the privatisation of the airport.

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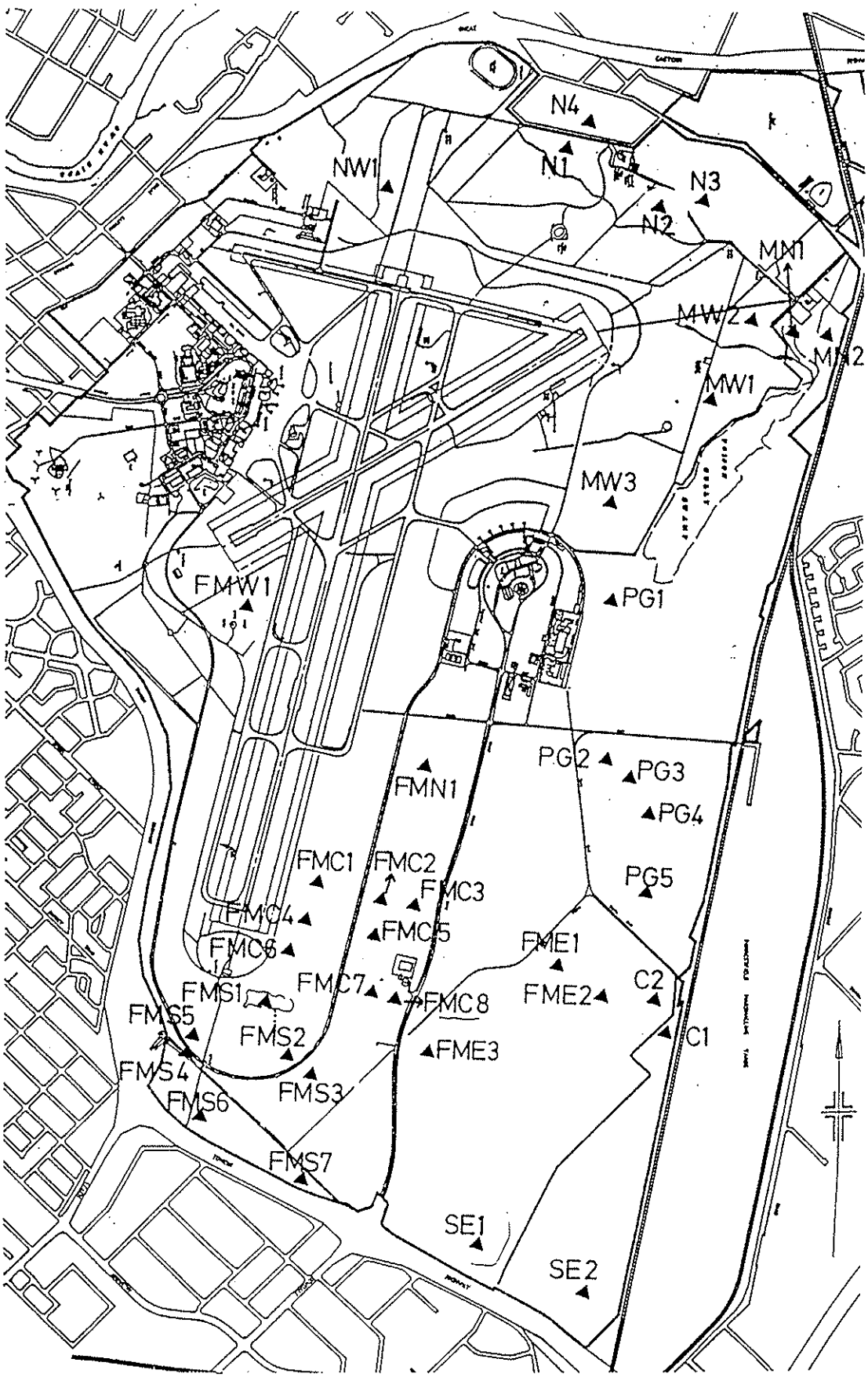


Figure 1 Map of Perth Airport land with location of the 39 swamp sites (triangles). Symbols as in Table 1.

8. CONCLUSIONS

1. The Western Swamp Tortoise has inhabited swamps and associated vegetation at Perth Airport within the past few decades, which equates to only one or two generations of this long-lived, slow-growing species.

2. No Western Swamp Tortoises were detected during the 1995 survey. However, the species is very difficult to detect when it is in low numbers. Based on the present level of information the species can not be considered to be locally extinct at the airport.

3. Some swamps within Perth Airport land provide suitable habitat for the Western Swamp Tortoise, a Critically Endangered Species specially protected under Commonwealth and Western Australian legislation. Western Swamp Tortoises could survive and breed in these swamps with minor changes to land management practices (mainly the exclusion of foxes) and constitute 'habitat', as defined in the ESP Act.

4. Additional swamps and adjacent areas could be made suitable as Western Swamp Tortoise habitat with modifications to the drainage system and current land management practices. These areas, also, are 'habitat' as defined in the ESP Act.

5. Areas within Perth Airport proposed as a Business Park do not contain swamps currently suitable as habitat for the Western Swamp Tortoise, with the exception of one swamp, FMC8, which should be excluded from the Business Park and added to the proposed Five Mile Swamp centre group conservation area. It may be possible to rehabilitate Swamps FMS2 and FMS3 so they become suitable habitat for the Western Swamp Tortoise (see Discussion), but further investigations of the flooding regime and groundwater levels are required.

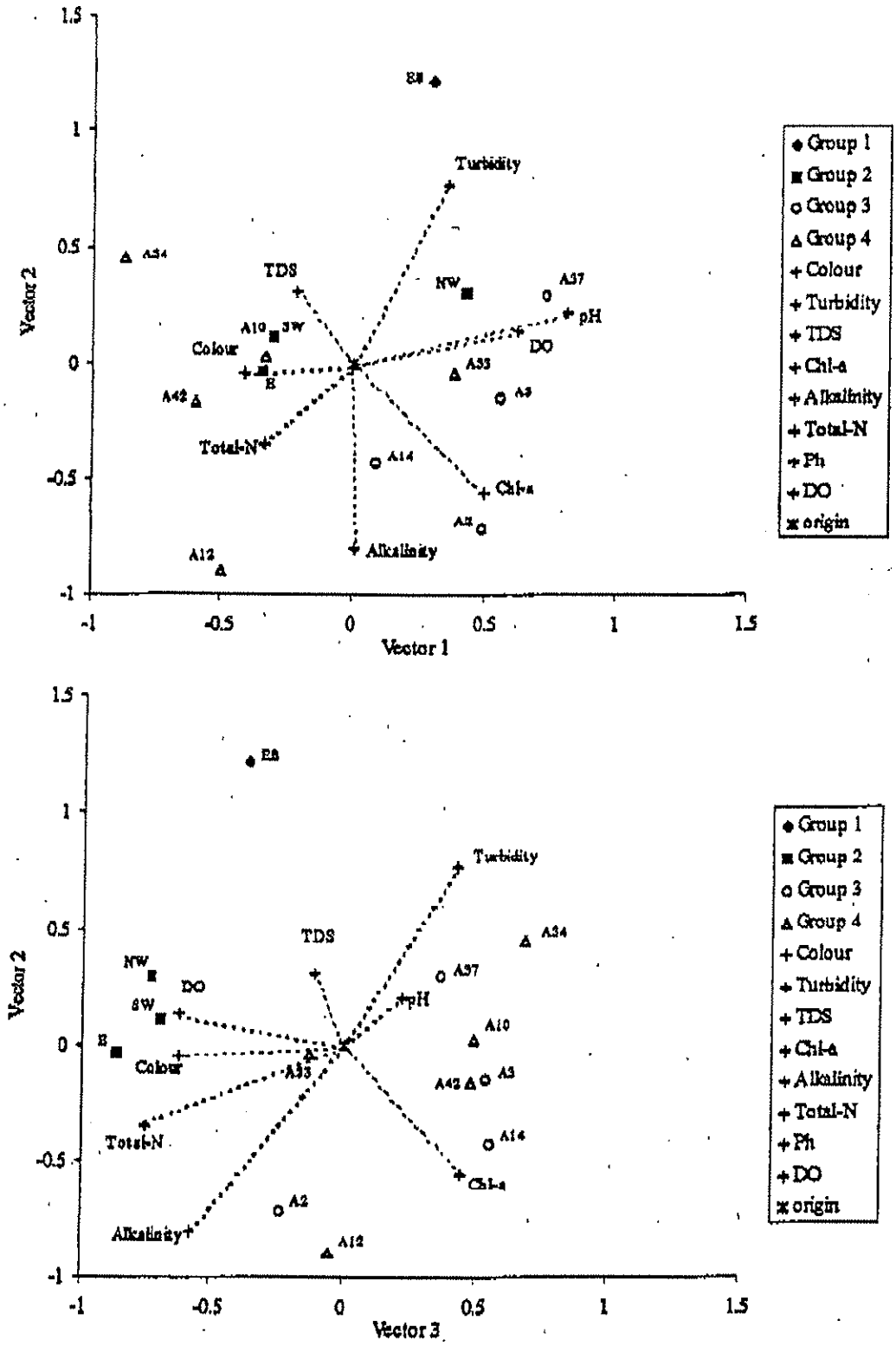


Figure 11. Ordination of Airport and Nature Reserve swamps based on species composition data.

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determined. From 29 June to 15 December 1995, Mr Philip Boglio was contracted as field assistant and constructed most drift fences during July and early August. Due to the fact that many areas were already flooded the construction took slightly more time than it would have earlier in the season. The first traps were set on 14 August 1995. The trapping and searching field work was carried out by Philip Boglio, Gerald & Gundi Kuchling (Chelonia Enterprises) and Andrew A. Burbidge (CALM).

The duration of trapping depended on the water levels in the swamps. The last traps were removed on 03 January 1996.

6. RESULTS

A. History of the swamps at the airport land

A Perth map from 1919 (Commonwealth Department of Defence, Sheet South H.50, correct to December 1915, at the scale of 1:63 360) shows most of the airport land as undeveloped timber, scrub and swamp land. Mundays Swamp, Poison Gully, and the smaller swamps in the northern part of the airport land south of Kalamunda Road are shown at about the same extent that they have today. The area south of the former Belmont-Kalamunda Road (now Grogan Road), which is the southern portion of the land vested in the FAC on behalf of the Commonwealth of Australia, has the name Five Mile Swamp in the western, central and southern parts, while the eastern part is marked "Liable to Floods", and in the south east Cummings Swamp extends on to airport land (Fig. 2).

A map from 1942 (No. 398 Zone 1. Sheet South H 50, 1:63 360) still shows vast swamp areas on the airport land, although some further development of roads and building blocks has taken place around them. The map does not show an airport, although an air photo of 1940 does (copies of air photos provided by Alan Tingay & Associates). Airport facilities then, as well as on an air photo from 1959, were confined to the northern half of the present airport land (north of the former Belmont-Kalamunda Road). The 1959 photo also does not show any drain in the southern part of the airport land.

The vast swamp area south the Belmont-Kalamunda Road, named Five Mile Swamp on the 1919 map, does not show major development impacts until the 1969 photo on which the runway is extended into its area and the main Water Authority drain is being built. The drain on this photo goes from the runway to the west and then turns north. Hardey Road and other roads in the area, although visible as tracks on the 1940 and the 1959 photos, are only major structures built since the 1969 photo. The drain extents to the east of the runway in a photo from 1972, when it had practically the same dimensions as today.

On a photo from 1982, the runway is being extended over the drain further to the south and reaches its present dimension. Swamp areas to the east and south of this

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Poison Gully Branch Drain Rehabilitation
Westralia Airports Corporation

Vegetation Monitoring Report

P121-01-Rev1

February 2006

Tranen Pty Ltd
1/110 Jersey Street
Jolimont, WA 6014
p (08) 9284 1399
f (08) 9284 1377
email@tranen.com.au
www.tranen.com.au

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Table of Contents

1 Introduction 1
1.1 Background 1
1.2 Site Maintenance 2
2 Monitoring Methodology 3
2.1 Assessment Methodology 3
3 Results 4
3.1 Section A 4
3.2 Section B 4
3.3 Sections C, D, E 5
3.4 Section F 5
3.5 Sections G and H 6
3.6 Areas Outside of the Security Fence 7
3.7 12m Strip 7
4 Discussion 9
4.1 Species Richness 9
4.2 Plant Density 9
4.3 Plant Development 10
4.4 Introduced Species 10
5 Conclusions 11
References 12
APPENDIX 1 SITE LOCATION 13
APPENDIX 2 SITE LAYOUT 15
APPENDIX 3 DETAILED MONITORING RECORDS 18

Table of Figures and Tables

Table 1 Initial Treatment Classifications 1
Table 2 Monitoring Plot Locations and Description 3
Figure 1 Monitoring Plot 3 February 2006 and May 2005 4
Figure 2 Monitoring Plot 4 February 2006 and May 2005 4
Table 3 Summary Plots 3 and 4 5
Figure 3 Monitoring Plot 2 February 2006 and May 2005 6
Table 4 Summary Plot 2 6
Figure 4 Monitoring Plot 1 February 2006 and May 2005 6
Table 5 Summary Plot 1 7
Figure 5 Monitoring Plot 5 February 2006 7
Figure 6 Monitoring Plot 6 February 2006 8
Table 6 Summary Plot 1 8

1 INTRODUCTION

Tranen Revegetation Systems have been commissioned to monitor the revegetation of the Poison Gully Branch Drain rehabilitation works. The aim of the assessment is to determine the level of success of the rehabilitation works and to provide information for future planning.

This assessment is a continuation of the methodology employed by Tranen in June 2005, which is based in part upon the monitoring program established by ENV Australia in spring 2004 (ENV Australia, 2004). Two new monitoring plots have also been added to assess the progress of the newly rehabilitated area between the access track and the area revegetated in 2004.

1.1 Background

In April 2003 works associated with the maintenance of the Poison Gully Drain resulted in an impact upon 0.8 hectares of bushland on the eastern side of the drain. The incident involved the storage of approximately 1,200 m^3 of soil on an area of vegetation outside of the designated drainage reserve.

A remediation plan was developed in consultation with officers from the Department of Transport and Regional Services (DOTARS) and the Department of Environment and Heritage. Remediation of the area was completed in April 2004 and involved:

- Removal of the excess soil using a bobcat until the natural soil or vegetation was exposed (August 2003);
- Spraying the entire area for weeds with Glyphosate (February 2004); and
- Dividing the affected area into sections that had similar vegetation communities and degree of regrowth. Methods of treatment were then established for each of these sections (see table below).

Table 1 Initial Treatment Classifications

Condition	Action	Applicable Section(s)
Successful native regrowth, no or low number of weeds.	No action, leave as is. Spraying for weeds not needed at this stage.	C, D, E
Successful native regrowth, large number of weeds.	Spot spraying.	A
No or low number of native regrowth, dominant number of weeds.	Spray all weeds, cover with mulch then deep rip. Direct seeding using seed stored in the provenance seed bank.	B, F, G, H

Sections that required direct seeding were classified according to the surrounding vegetation systems, of which three were identified. All were seeded with a selection of species and quantities suitable to the areas. These sections were prepared by spraying, mulching and ripping to ensure the best conditions for success of the direct seeding operation.

The airport security perimeter fence dissects the drain and on the eastern side there are two small sections that were also affected by the soil placement. As they are relatively small direct seeding was not considered necessary, however after the overburden was removed they were mulched and ripped.

Additional revegetation activities took place in June 2005 on a 12 m strip between the access road following the drain and the 2004 revegetation areas. This section was defined in the same way as sections B, F, G, and H as having 'No or low number of native regrowth, dominant number of weeds'. The site was ripped in May, allowed to settle for one month, sprayed with broad spectrum herbicide, lightly scarified, and then direct seeded. No mulch was used however as no suitable material was available at the time.

1.2 Site Maintenance

Weed management in the area has been ongoing with herbicide being applied in June 2005 and January 2006. This program will continue throughout 2006 and possibly further depending on native plant development and the effectiveness of the weed control measures.

Hand removal of weeds has also been conducted on two separate occasions since the 2004 installation works, by the Conservation Volunteers of Australia. The first targeted all species, and the second targeted only bulb species such as **Watsonia bulbillifera* and **Gladiolus caryophyllaceus*.

2 MONITORING METHODOLOGY

The Remediation Plan for Poison Gully requires that the following are monitored until spring 2009:

- Regrowth of native species;
- Numbers of weeds;
- Areas that have not responded to remediation.

2.1 Assessment Methodology

The protocol established for the assessments involves the monitoring of the following (established for the June 2005 assessment):

- Four randomly located permanent monitoring quadrats (measuring 5 m x 5 m) were established in the 2004 rehabilitation areas to represent the different conditions on site, with each quadrat broken down into 1 m x 1 m increments for assessment. Two new quadrats have been established in the area rehabilitated in 2005;
- Stem counts of each native species within quadrats;
- Determination of average native plant heights, and observations on plant health and development;
- Estimation of weed cover with identification of the most dominant and potentially threatening species; and
- Photographic representation of the site from a permanently established point for each plot.

In addition to the above protocol an assessment of the percentage native foliage cover has been introduced for this and all subsequent assessments. This information will provide a better representation of plant development than the measurement of plant heights alone.

Table 2 below provides details of the location of the sections in which the plots were located. The locations are also indicated on the maps in Appendix 2.

Table 2 Monitoring Plot Locations and Description

Plot	Location	Description	Sections Represented
1	H	Under canopy	G, H
2	F	Midway through section	E, F
3	B	Western end of section in middle	B
4	B	Centre of section close to existing vegetation	B, C, D
5	B	On new section between Plots 1 and 2	A, B, C, D
6	F	On new section between Plots 3 and 4	E, F

3 RESULTS

The information presented in this report is a summary of the recordings from the three monitoring assessments conducted to date. The primary focus however is on the differences between the quantitative data. Appendix 3 contains the details of the monitoring recordings.

3.1 Section A

This section was not originally direct seeded due to good natural regrowth. The only remediation involved chemical control of the weeds.

No quantitative assessments were carried out in this section as there is already considerable species representation and plant density. Weed levels are currently low and are not impacting upon the native vegetation.

3.2 Section B

Section B was sprayed for weeds, mulched, ripped, and direct seeded. Two monitoring plots were set up, in this the largest of the sections; one to determine what is occurring in the centre of the corridor (Plot 3), and the other located close to existing vegetation to determine if natural recruitment is occurring (Plot 4).



Figure 1 Monitoring Plot 3 February 2006 and May 2005



Figure 2 Monitoring Plot 4 February 2006 and May 2005

Table 3 Summary Plots 3 and 4

Plot	Number Native Plants		Number Native Species		Percentage Weed Cover	
	May 05	Feb 06	May 05	Feb 06	May 05	Feb 06
Plot 3	136	180	7	7	11%	2%
Plot 4	84	294	6	14	7%	2%

Table 3 shows the number of native plants within the plots has increased significantly since the last assessment. Plot 3 has increased by 44 plants and Plot 4 by 210. This has more than doubled the average plant density from 4.5 to 9.5 plants / m^2.

A total of 18 native species (10 new) and 7 weed species (4 new) were recorded in Section B within or adjacent to the monitoring plots during the most recent assessment.

Weed control in this area has been effective with only 2% of the area covered by weeds (previously 9% average). The dominant weeds in this section are **Erharta calycina* (Veldt grass), **Eragrostis curvula* (Lovegrass), and **Dittrichia graveolens* (Stinkwort). Also present in significant numbers were, **Leptospermum laevigatum* (Victorian Tea Tree), **Juncus microcephalus*, and **Watsonia bulbillifera*. The presence of other weeds was also noted, however as they were dead they were not taken into account during the monitoring assessment. A total of 14 introduced species have been observed in Section B during the two assessments.

3.3 Sections C, D, E

These sections did not need any remediation (including weed spraying) and were left to self-sustain.

Weeds levels are low in these sections and native regrowth is moderate, mostly arising by natural recruitment from the surrounding established vegetation. Plants in these sections are progressing well with signs of healthy plant development and natural recruitment.

3.4 Section F

Section F was sprayed for weeds, mulched, ripped, and direct seeded. Monitoring Plot 2 was established within this section.



Figure 3 Monitoring Plot 2 February 2006 and May 2005

Table 4 Summary Plot 2

Plot	Number Native Plants		Number Native Species		Percentage Weed Cover	
	May 05	Feb 06	May 05	Feb 06	May 05	Feb 06
Plot 2	22	29	6	7	8%	1%

As can be seen in Table 4 the native plant density in this section has increased from 0.9 to 1.2 plants / m^2 with an additional seven plants found within the quadrat since June 2005. Two new species were also recorded for this section. This raises the number of native species identified to date within the whole of Section F to 23.

Weed control has been very effective with cover in this section reduced to 1% of total ground cover. Lovegrass (**Eragrostis curvula*) is now found in small numbers, however the summer weed **Dittrichia graveolens* (Stinkwort) is now the dominant weed species. These weeds were recently sprayed and it is evident from the condition of the weeds that the poison has been absorbed and that the plants are dying. No other weed species were observed in Plot 2 during this assessment.

3.5 Sections G and H

Sections G and H were both sprayed for weeds, mulched, ripped, and direct seeded. Both sections are located next to each other and are presently in similar condition. Monitoring Plot 1 was positioned in section H.



Figure 4 Monitoring Plot 1 February 2006 and May 2005

Table 5 Summary Plot 1

Plot	Number Native Plants		Number Native Species		Percentage Weed Cover	
	May 05	Feb 06	May 05	Feb 06	May 05	Feb 06
Plot 1	89	74	10	10	0%	0%

A total of 74 natives (3.0 plants / m^2) from 12 species were identified in or around Plot 1 during the assessment (see Table 5). Whilst this represents a loss of 15 plants (the only plot to record a decrease in plant numbers), six new species were identified since the last assessment. A total of 19 native species have been observed to date in sections G and H. Approximately one quarter of the plants within the plot are established plants that were not originally affected by the drain maintenance activities.

Only one individual of **Eragrostis curvula* (Lovegrass) was found in Plot 1 and this was the only weed found within the quadrat.

3.6 Areas Outside of the Security Fence

This section has a Eucalyptus overstorey with little underneath except for a few introduced species. A few specimens of **Erharta calycina*, and **Eragrostis curvula* were noted, but they are only at early stages of development.

3.7 12m Strip

A 12 m strip adjacent to the existing remediation section was rehabilitated in 2005. This section was ripped, allowed to settle for one month, sprayed with broad spectrum herbicide, lightly scarified, and then direct seeded. Two new monitoring plots (Plots 5 and 6) have been established within this section. Plot 5 is located between Plots 1 and 2, and Plot 6 between Plots 3 and 4.



Figure 5 Monitoring Plot 5 February 2006



Figure 6 Monitoring Plot 6 February 2006

Table 6 Summary Plot 1

Plot	Number Native Plants		Number Native Species		Percentage Weed Cover	
	May 05	Feb 06	May 05	Feb 06	May 05	Feb 06
Plot 5	NA	8	NA	4	NA	22%
Plot 6	NA	18	NA	3	NA	22%

The results in Table 6 show that native germination in this section has been comparatively poor with an average native density of 0.5 plants / m^2 and six species found between the two plots. Development of the plants found has been slow with an average height of 50 mm.

In the northernmost section adjacent to Plot 1 a greater number of native species and individuals were observed. This section is slightly elevated, adjoins a different vegetation system, and weed numbers are much less.

Weed infestation levels are high in this section (22% weed cover) with **Dittrichia graveolens* (Stinkwort) being the most dominant species. None of the individual weeds in this area were observed to be flowering or setting seed at the time of monitoring, however they were well developed with an average height of 200 mm.

4 DISCUSSION

4.1 Species Richness

Species richness has progressively improved though each monitoring assessment. During the spring 2004 assessment 38 species were identified and by autumn 2005 46 species had been identified. After this current assessment the number of species identified to date is 52, of which 27 are currently found within the monitoring plots.

The most likely source of the increase in species richness is natural recruitment from the surrounding vegetation. The other possible sources include the topsoil that was buried and disturbed by the ripping, and secondary germination of direct seeded species. It is unlikely that the latter possible sources would have contributed to a similar extent as natural recruitment.

4.2 Plant Density

The plant density for the 2004 rehabilitation area is also increasing across the site with an average density across the four plots of just under six plants / m^2. This is a good result for this stage of any rehabilitation program. The only plot to record a loss of seedlings was Plot 1, however the density in this plot is still much greater than that of Plot 2.

Plots 3 and 4 were deliberately located so that a measure of natural recruitment could be obtained. Plot 3 was located approximately 20 m from the closest undisturbed vegetation, whilst Plot 4 was located adjacent to it. Initially Plot 3 had more stems than Plot 4, however Plot 4 now contains nearly double the number of plants of Plot 3. This clearly demonstrates the level of natural recruitment that is occurring along the fringes of the existing vegetation. This is expected to continue and extend further and further into the disturbed areas.

Plant density in the recently rehabilitated 12 m strip is relatively poor with an average density of 0.5 plants per m^2. In the northern section of the track, adjacent to Plot 1, a greater number of native plants of several species were observed, although this section was not formally monitored. Very few weeds were also found in this area. The lack of weed competition could be a possible reason for the better progress. It could also be due to the higher elevation of the ground, resulting in less seed being washed away or buried during the winter period. Weed control and further monitoring will help determine the most likely cause.

The **Dittrichia graveolens* (Stinkwort) that is dominating the strip was sprayed with herbicide in late January. The majority of the seed of this species germinates in the first year after seed set. As the spraying has taken place before this species has set further seed it is likely that the majority of the soil seed bank of this species has been exhausted. Therefore, competition from this species is likely to be significantly less in the short term future.

Secondary germination of native species is expected to occur in the strip once the weed levels have been reduced, provided the seed has not been too deeply buried.

The autumn 2006 assessment will provide further information to determine whether additional work is required in this area.

4.3 Plant Development

Native seedlings that have germinated from seed now range between 100 mm to 300 mm depending whereas previously the range was 50 mm to 200 mm). Previously established plants that have re-emerged (ie *Xanthorrhoea brunonis* in Plot 1) are more developed than those sourced from seed, due to existing root structures, and some are up to 0.8 m tall.

To compliment the plant height measurements, native foliage cover assessments were also conducted during this assessment. The average foliage cover across all plots is 3% with the greatest coverage of 10% measured in Plot 4. This plot was expected to have the greatest plant development rates and plant density due to the proximity to the adjacent undisturbed native vegetation.

The foliage cover assessments will become be integrated into all future monitoring assessments.

4.4 Introduced Species

12 introduced species were recorded in the monitoring plots during the autumn assessment. The main species that have the potential to cause problems at this point are **Eragrostis curvula*, **Dittrichia graveolens*, and **Erharta calycina*. All are currently at low levels due to the ongoing weed maintenance program.

Nine other species have been observed during previous assessments, the majority being annual species that are not normally present at the time of this assessment. None of these species are likely to be observed until the next monitoring, scheduled for autumn 2006.

5 CONCLUSIONS

Generally, all measurable aspects of the rehabilitation works are showing progress with the following changes since the last assessment:

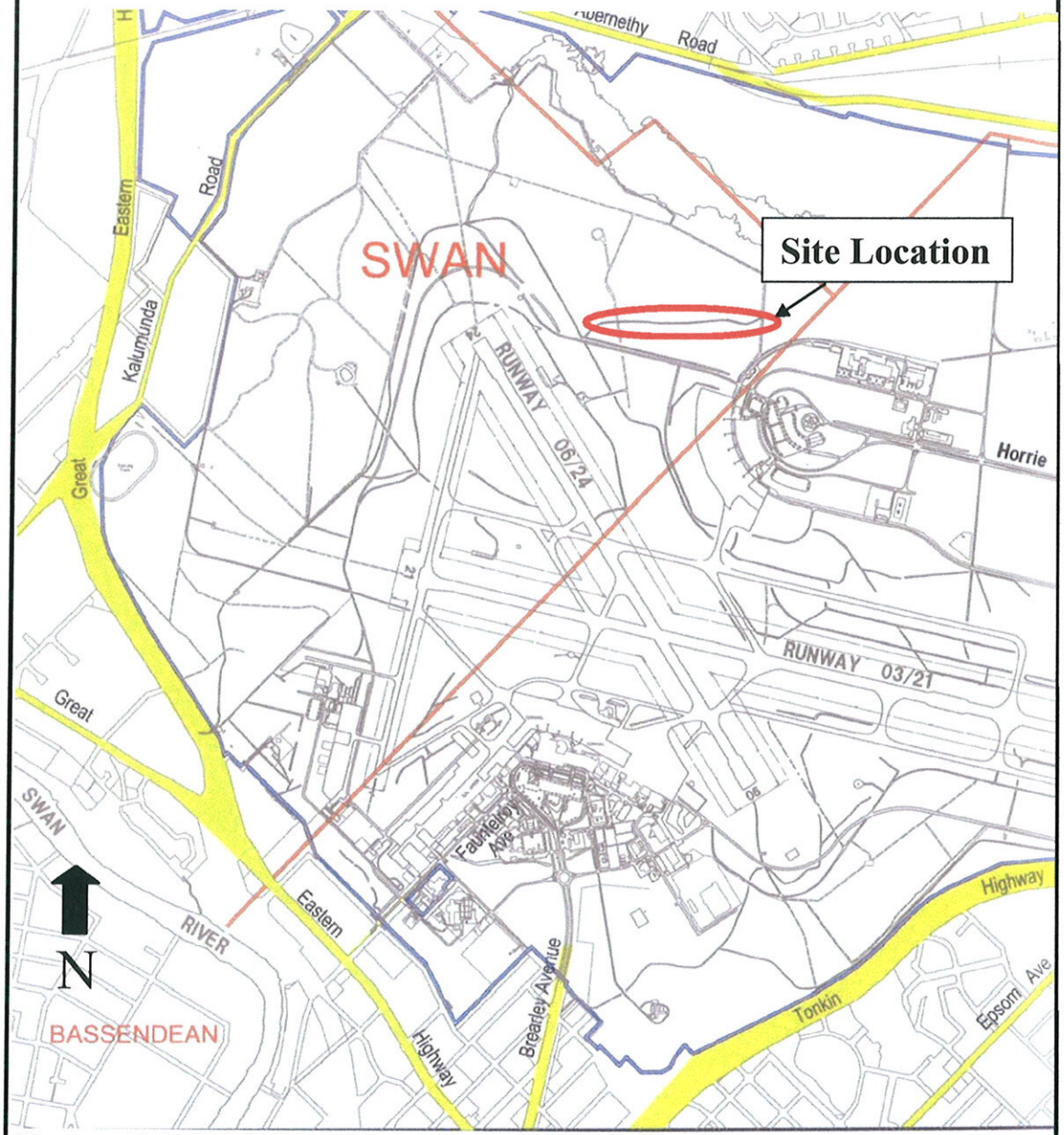
- Plant numbers (and hence plant density) have increased substantially;
- Species richness has increased;
- Plant growth rates and general development are normal; and
- Weed competition and infestation is minimal due to the ongoing weed maintenance program.

The exception is the 12 m strip, which has not provided the desired results on the ground for the current stage of development. The next two assessments will help determine the cause of the poor performance, and whether the recent weed control and / or secondary germination has improved the results on the ground.

REFERENCES

1. Remediation Plan for Poison Gully Drain, WAC, May 2004
2. Monitoring of Remediation Works of Poison Gully Drain, ENV Australia, 2004
3. Poison Gully Branch Drain Rehabilitation Vegetation Monitoring Report, Tranen Revegetation Systems, June 2005.

Appendix 1 Site Location

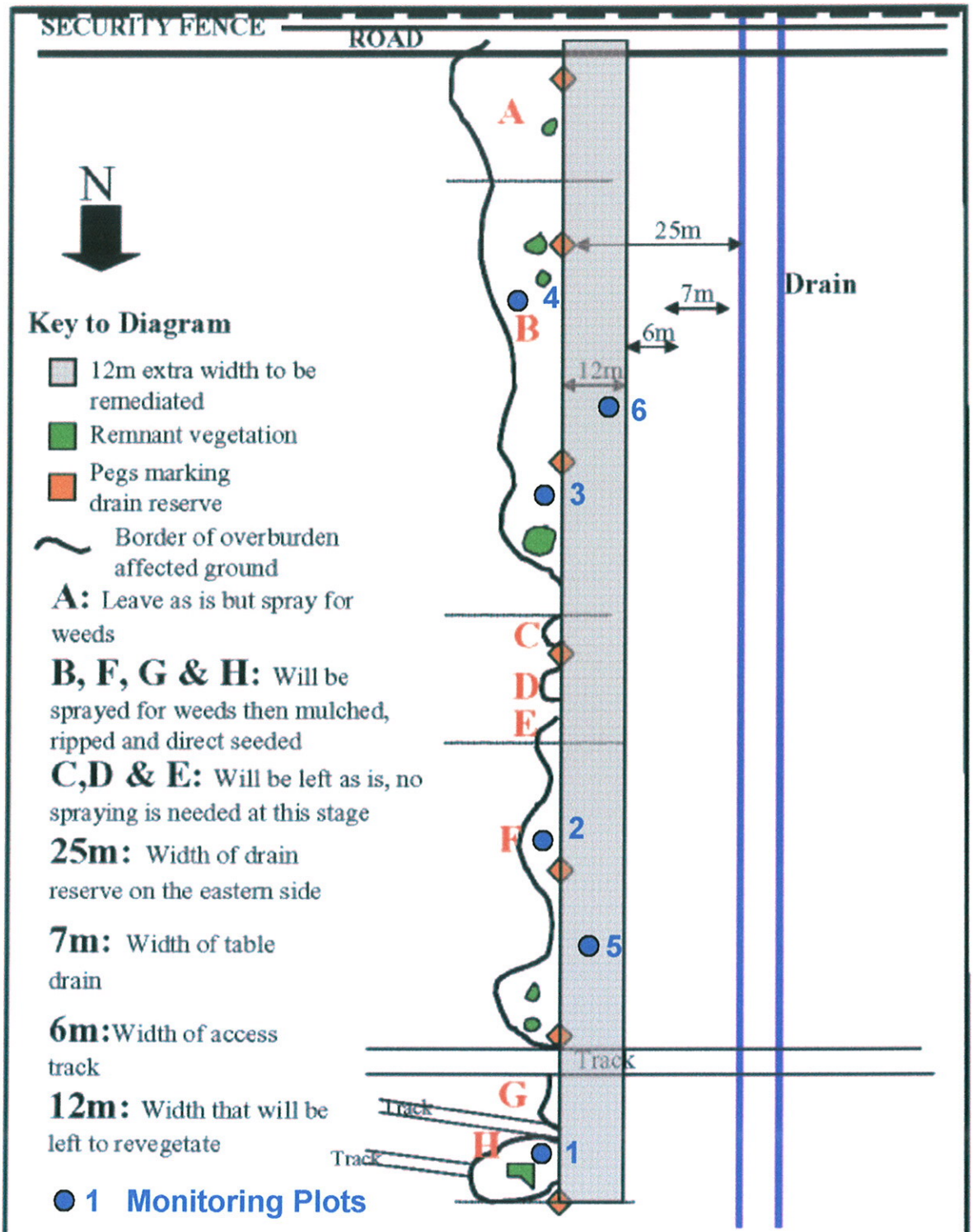


Map source: Environment Strategy, 2004

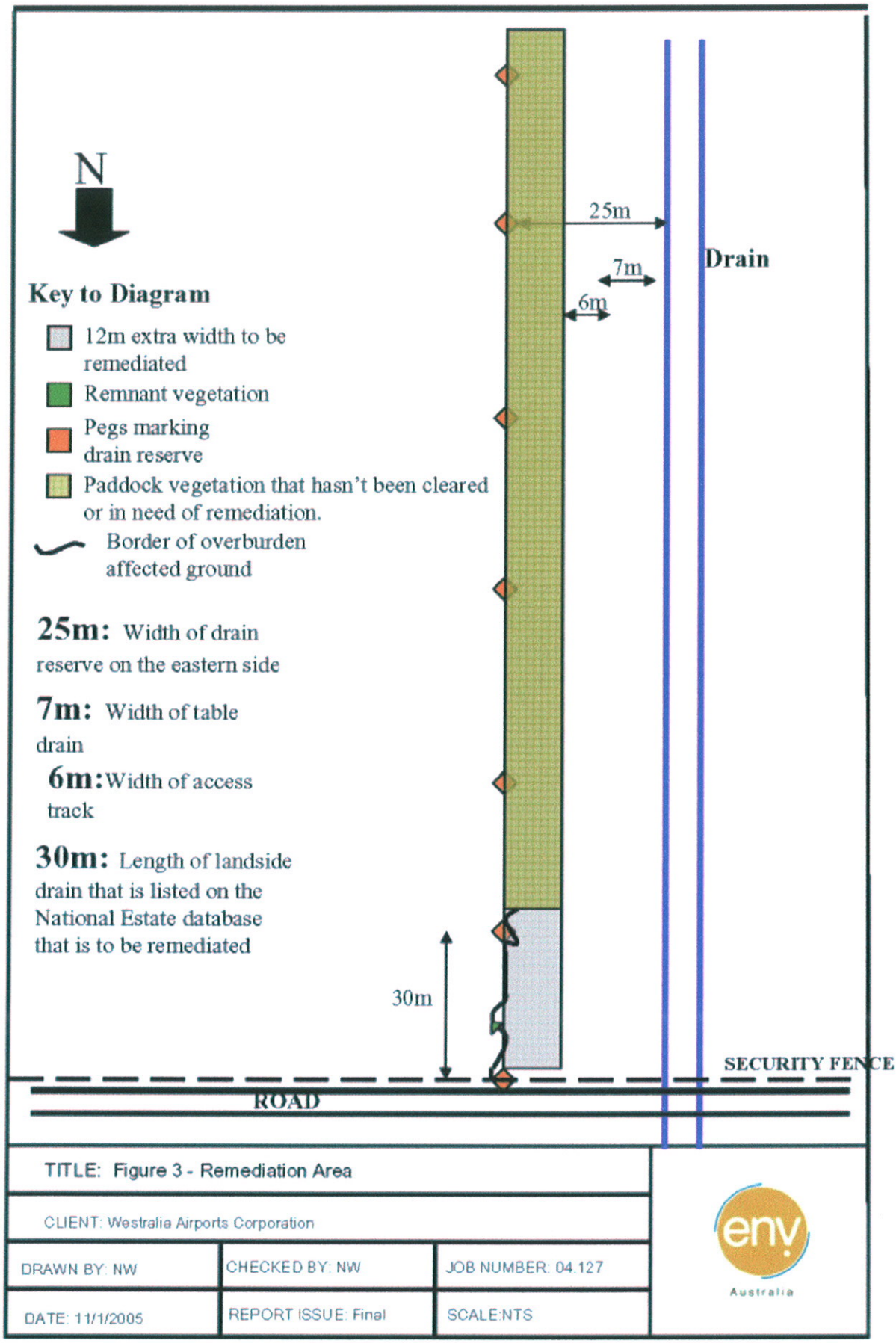
Figure 1 - Site Location		
CLIENT: Westralia Airports Corporation		
DRAWN BY: NW	CHECKED BY: NW	JOB NUMBER: 04.127
DATE:11/1/2005	REPORT ISSUE: Final	SCALE: NTS

env Australia

Appendix 2 Site Layout



TITLE: Figure 2 - Remediation Area		
CLIENT: Westralia Airports Corporation		
DRAWN BY: NW	CHECKED BY: NW	JOB NUMBER: 04.127
DATE: 11/1/2005	REPORT ISSUE: Final	SCALE:NTS


N
25m
7m
6m
Drain
Key to Diagram
12m extra width to be remediated
Remnant vegetation
Pegs marking drain reserve
Paddock vegetation that hasn't been cleared or in need of remediation.
Border of overburden affected ground
25m: Width of drain reserve on the eastern side
7m: Width of table drain
6m: Width of access track
30m: Length of landside drain that is listed on the National Estate database that is to be remediated
30m
SECURITY FENCE
ROAD
TITLE: Figure 3 - Remediation Area
CLIENT: Westralia Airports Corporation
DRAWN BY: NW
CHECKED BY: NW
JOB NUMBER: 04.127
DATE: 11/1/2005
REPORT ISSUE: Final
SCALE:NTS
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Appendix 3 Detailed Monitoring Records

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Poison Gully
Native Monitoring Summary

SPECIES	PLOT 1	PLOT 2	PLOT 3	PLOT 4	PLOT 5	PLOT 6	TOTAL FEB 06	TOTAL MAY 05
Acacia applanata	2						2	1
Acacia saligna		1		1			2	
Adenanthos cygnorum		2		2			4	3
Alexgeorgia nitens								
Allocasuarina humilis	36						36	45
Astartea scoparia				43	2		43	
Banksia attenuata								
Banksia telmatiaea		3	3	5	1		11	6
Bolboschoenus caldwellii								
Bossiaea eriocarpa								
Burchardia umbellata								
Conostylis aculeata			2	2			4	2
Conostylis juncea								
Conostylis sp.	4	4					8	6
Coymbia calophylla	1				1	4	1	
Cyathochaeta avenacea								
Cyperus sp.								2
Dampiera alata								
Dasypogon bromelifolius								
Desmocladus fasciculatus								3
Desmocladus flexuosus								
Drosera nitidula				8			8	
Dryandra lindleyana								
Dryandra nivea								
Gastrolobium sp				1			1	
Gompholobium marginatum								
Gompholobium tomentosum				1			1	
Haemodorum laxum	1						1	
Haemodorum sp.								
Hakea prostrata	2						2	1
Hakea varia								
Hardenbergia comptoniana								
Hypolaena exsulca				1			1	
Jacksonia furcellata	2			1			3	1
Jacksonia sternbergiana	4		1	3			8	6
Kennedia prostrata								
Lepidosperma pubisquameum		1	1	1			3	2
Lomandra sp.								
Lyginia barbata / imberbis	4	4	2			1	10	3
Mesomolaena tetragona								
Patersonia occidentalis				1			1	1
Pericalymma ellipticum var floridum		11	3	36	2	8	50	54
Petrophile linearis	1						1	
Schoenus curvifolius			1				1	
Siloxerus humifusus								8
Stirlingia latifolia								
Thysanotus sparteus	1						1	
Verticordia ? lindleyi subsp lindelyi			10				10	
Verticordia densiflora var densiflora		3	157	188	2	5	348	164
Waitzia suaveolens								
Xanthorrhoea brunonis	16						16	9
Xanthorrhoea preissii								15
TOTAL STEM COUNT:	74	29	180	294	8	18	577	
TOTAL STEM COUNT JUN 05:	89	22	136	84	0	0		331
NATIVE COVER PERCENTAGE	2%	1%	2%	10%	0%	0%	3%	
AVERAGE DENSITY (Plants/m2)	3.0	1.2	7.2	11.8	0.3	0.7	4.0	
AVERAGE DENSITY (Plants/m2) JUN 05	3.56	0.88	5.44	3.36	0	0		3.31
NUMBER OF NATIVE SPECIES IN PLOTS	10	7	7	14	4	3	27	
NUMBER OF NATIVE SPECIES IN PLOTS JUN 05	10	6	7	6	0	0		19
NUMBER OF SPECIES IN OR AROUND PLOT	13	8	12	16	5	5	31	
NUMBER OF SPECIES IN OR AROUND PLOT JUN 05	12	12	8	8	0	0		26
TOTAL NATIVE SPECIES TO FEB 06							52	
TOTAL NATIVE SPECIES TO JUN 05								46
TOTAL NATIVE SPECIES TO NOV 04								38

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Poison Gully
Weed Monitoring Summary

Taxa	PLOT 1	PLOT 2	PLOT 3	PLOT 4	PLOT 5	PLOT 6	OBSERVED FEB 06	OBSERVED MAY 05
* Aira caryophyllea								Y
* Anagallis arvensis				17			Y	Y
* Arctotheca calendula								Y
* Avena barbata								
* Briza maxima								
* Briza minor	1						Y	
* Conyza sp.					2		Y	Y
* Cynodon dactylon	2				4		Y	Y
* Dittrichia graveolens		57	41	25	75	75	Y	Y
* Eragrostis curvula		13	21	21		1	Y	Y
* Erharta calycina	2		57	47		46	Y	
* Gladiolus caryophyllaceus	4						Y	Y
* Hypochaeris glabra / Flatweeds								Y
* Juncus microcephalus			3				Y	
* Leptospermum laevigatum			2	6			Y	
* Lupinus consentinii								Y
* Poaceae sp.	3						Y	
* Trifolium sp.	4						Y	
* Ursinia anthemoides								
* Watsonia bulbillifera			4		2		Y	
* Weed A								Y
% WEED COVER IN PLOT	0%	1%	2%	2%	22%	22%	8%	
% WEED COVER IN PLOT JUN 05	0%	8%	10%	7%				6%
NUMBER OF WEED SPECIES FEB 06	6	2	5	5	3	3	12	
TOTAL WEED SPECIES TO FEB 06							21	
TOTAL WEED SPECIES TO JUN 05								18
TOTAL WEED SPECIES TO NOV 04								11

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P131-01-Rev2

May 2006

Tranen Pty Ltd
1/110 Jersey Street
Jolimont, WA 6014
p (08) 9284 1399
f (08) 9284 1377
email@tranen.com.au
www.tranen.com.au

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Table of Contents

1 Introduction 1
1.1 Background 1
1.2 Site Maintenance 2
2 Monitoring Methodology 3
2.1 Assessment Methodology 3
3 Results 4
3.1 Section A 4
3.2 Section B 4
3.3 Sections C, D, E 7
3.4 Section F 8
3.5 Sections G and H 10
3.6 Areas Outside of the Security Fence 12
3.7 12m Strip 12
4 Discussion 16
4.1 Species Richness 16
4.2 Plant Density 16
4.3 Plant Development 16
4.4 Introduced Species 17
5 Conclusions 18
6 References 19
APPENDIX 1 SITE LOCATION 20
APPENDIX 2 SITE LAYOUT 21
APPENDIX 3 DETAILED MONITORING RECORDS 24

Table of Figures

Figure 1 Monitoring Plot 3 - May 2006 5
Figure 2 Monitoring Plot 3 - May 2005 5
Figure 3 Monitoring Plot 4 - May 2006 6
Figure 4 Monitoring Plot 4 - May 2005 6
Figure 5 Monitoring Plot 2 - May 2006 9
Figure 6 Monitoring Plot 2 - May 2005 9
Figure 7 Monitoring Plot 1 - May 2006 11
Figure 8 Monitoring Plot 1 - May 2005 11
Figure 9 Monitoring Plot 5 - May 2006 13
Figure 10 Monitoring Plot 5 - February 2006 13
Figure 11 Monitoring Plot 6 - May 2006 14
Figure 12 Monitoring Plot 6 - February 2006 14

Table of Tables

Table 1 Initial Treatment Classifications 1
Table 2 Monitoring Plot Locations and Description 3
Table 3 Summary Plot 3 7
Table 4 Summary Plot 4 7
Table 5 Summary Plot 2 10
Table 6 Summary Plot 1 12
Table 7 Summary Plot 5 15
Table 8 Summary Plot 6 15

1 INTRODUCTION

Tranen Revegetation Systems have been commissioned to monitor the revegetation of the Poison Gully Branch Drain rehabilitation works. The aim of the assessment is to determine the level of success of the rehabilitation works and to provide information for future planning.

This assessment is a continuation of the methodology employed by Tranen in June 2005, which is based in part upon the monitoring program established by ENV Australia in spring 2004 (ENV Australia, 2004). Two new monitoring plots have also been added to assess the progress of the newly rehabilitated area (works conducted in 2005) between the access track and the area revegetated in 2004.

1.1 Background

In April 2003 works associated with the maintenance of the Poison Gully Drain resulted in an impact upon 0.8 hectares of bushland on the eastern side of the drain. The incident involved the storage of approximately 1,200 m^3 of soil on an area of vegetation outside of the designated drainage reserve.

A remediation plan was developed in consultation with officers from the Department of Transport and Regional Services (DOTARS) and the Department of Environment and Heritage. Remediation of the area was completed in April 2004 and involved:

- Removal of the excess soil using a bobcat until the natural soil or vegetation was exposed (August 2003);
- Spraying the entire area for weeds with Glyphosate (February 2004); and
- Dividing the affected area into sections that had similar vegetation communities and degree of regrowth. Methods of treatment were then established for each of these sections (see table below).

Table 1 Initial Treatment Classifications

Condition	Action	Applicable Section(s)
Successful native regrowth, no or low number of weeds.	No action, leave as is. Spraying for weeds not needed at this stage.	C, D, E
Successful native regrowth, large number of weeds.	Spot spraying.	A
No or low number of native regrowth, dominant number of weeds.	Spray all weeds, cover with mulch then deep rip. Direct seeding using seed stored in the provenance seed bank.	B, F, G, H

Sections that required direct seeding were classified according to the surrounding vegetation systems, of which three were identified. All were seeded with a selection of species and quantities suitable to the areas. These sections were prepared by spraying, mulching and ripping to ensure the best conditions for success of the direct seeding operation.

The airport security perimeter fence dissects the drain and on the eastern side there are two small sections that were also affected by the soil placement. As they are relatively small direct seeding was not considered necessary, however after the overburden was removed they were mulched and ripped.

Additional revegetation activities took place in June 2005 on a 12 m strip between the access road following the drain and the 2004 revegetation areas. This section was defined in the same way as sections B, F, G, and H as having 'No or low number of native regrowth, dominant number of weeds'. The site was ripped in May, allowed to settle for one month, sprayed with broad spectrum herbicide, lightly scarified, and then direct seeded. No mulch was used as no suitable material was available at the time.

1.2 Site Maintenance

Weed management in the area has been ongoing with herbicide being applied in June 2005 and January 2006. Annual grasses were targeted with grass specific herbicide, and this was followed with spot spraying of Glyphosate to control perennial herbs and bulbs. This program will continue throughout 2006 and possibly further depending on native plant development and the effectiveness of the weed control measures. The next herbicide applications are scheduled for June 2006 and again in spring 2006.

Hand removal of weeds has also been conducted on two separate occasions since the 2004 installation works, by the Conservation Volunteers of Australia. The first targeted all species, and the second targeted only bulb species such as **Watsonia meriana var. bulbillifera* and **Gladiolus caryophyllaceus*.

2 MONITORING METHODOLOGY

The Remediation Plan for Poison Gully requires that the following are monitored until spring 2009:

- Regrowth of native species;
- Numbers of weeds;
- Areas that have not responded to remediation.

2.1 Assessment Methodology

The protocol for the assessments involves the monitoring of the following (established for the June 2005 assessment):

- Four randomly located permanent monitoring quadrats (measuring 5 m x 5 m) were established in the 2004 rehabilitation areas to represent the different conditions on site, with each quadrat broken down into 1 m x 1 m increments for assessment. Two new quadrats have been established in the area rehabilitated in 2005;
- Stem counts of each native species within quadrats;
- Determination of average and tallest native plant heights, and observations on plant health and development;
- Estimation of weed cover with identification of the most dominant and potentially threatening species; and
- Photographic representation of the site from a permanently established point for each plot.

In addition to the above protocol an assessment of the percentage native foliage cover has been introduced for this and all subsequent assessments. This information will provide a better representation of plant development than the measurement of plant heights alone.

Table 2 below provides details of the location of the sections in which the plots were located. The locations are also indicated on the maps in Appendix 2.

Table 2 Monitoring Plot Locations and Description

Plot	Location	Description	Sections Represented
1	H	Under canopy	G, H
2	F	Midway through section	E, F
3	B	Western end of section in middle	B
4	B	Centre of section close to existing vegetation	B, C, D
5	B	On new section between Plots 1 and 2	A, B, C, D
6	F	On new section between Plots 3 and 4	E, F

3 RESULTS

The information presented in this report is a summary of the recordings from the four monitoring assessments conducted to date. The primary focus however is on the differences between the quantitative data. Appendix 3 contains the details of the monitoring recordings.

3.1 Section A

This section was not originally direct seeded due to good natural regrowth. The only remediation involved control of the weeds.

No quantitative assessments were carried out in this section as there is already considerable species representation and plant density. Weed levels are currently low and are not impacting upon the native vegetation.

3.2 Section B

Section B was sprayed for weeds, mulched, ripped, and direct seeded. Two monitoring plots were set up, in this the largest of the sections; one to determine what is occurring in the centre of the corridor (Plot 3), and the other located close to existing vegetation to determine if natural recruitment is occurring (Plot 4). Figures 1 to 4 below compare the current photographs of each site with those taken a year earlier to provide a visual comparison of progress.



Figure 1 Monitoring Plot 3 - May 2006



Figure 2 Monitoring Plot 3 - May 2005



Figure 3 Monitoring Plot 4 - May 2006



Figure 4 Monitoring Plot 4 - May 2005

Table 3 Summary Plot 3

Description	May 06	Feb 06	May 05
Number of Native Plants	162	180	136
Native Density (stems/m^2)	6.5	7.2	5.44
Native Cover %	5	2	-
Number of Native Species	12	9	7
Average Plant Height (m)	0.3	0.2	-
Maximum Plant Height (m)	1.0	0.5	-
Weed Cover %	1	2	11

Table 4 Summary Plot 4

Description	May 06	Feb 06	May 05
Number of Native Plants	199	294	84
Native Density (stems/m^2)	8.0	11.8	3.4
Native Cover %	13	10	-
Number of Native Species	16	15	6
Average Plant Height (m)	0.4	0.2	-
Maximum Plant Height (m)	1.2	0.5	-
Weed Cover %	1	2	7

Tables 3 and 4 show the number of native plants within the plots has decreased in both plots since the last assessment. Plot 3 has decreased by 18 plants to a density of 6.5 plants/m^2 and Plot 4 by 95 to 8.0 plants/m2. Compared to the same assessment one year previously however Plot 3 has 19% more plants, and Plot 4 has 137% more plants.

A total of 21 native species (3 new) and 11 weed species (4 new) were recorded in Section B within or adjacent to the monitoring plots during the most recent assessment.

The development of native plants has progressed with average plant heights increasing from 0.2 m to 0.35 m in the past 4 months. The maximum individual plant height in either monitoring plot is now 1.2 m.

Weed control in this area has been effective with only 1% of the area covered by weeds. In February the weed cover was 2% and at the same time in 2005 it was 9%. The dominant weeds in this section are flat weeds (at young stage making identification difficult), **Watsonia meriana var. bulbillifera*, and **Dittrichia graveolens* (Stinkwort). Also present in significant numbers were juvenile Poaceae sp., and **Leptospermum laevigatum* (Victorian Tea Tree). A combined total of 14 introduced species have been observed in Section B during the three assessments.

3.3 Sections C, D, E

These sections did not need any remediation (including weed spraying) and were originally left to self-sustain. This section is included in the overall weed management program and spraying is undertaken as necessary.

Weed levels remain low in these sections and native regrowth is moderate, mostly arising by natural recruitment from the surrounding established vegetation. Plants in these sections are progressing well with signs of healthy plant development and natural recruitment.

3.4 Section F

Section F was sprayed for weeds, mulched, ripped, and direct seeded. Monitoring Plot 2 was established within this section. Figures 5 and 6 below compare the current photographs of Plot 2 with those taken a year earlier.



Figure 5 Monitoring Plot 2 - May 2006



Figure 6 Monitoring Plot 2 - May 2005

Table 5 Summary Plot 2

Description	May 06	Feb 06	May 05
Number of Native Plants	22	29	22
Native Density (stems/m^2)	0.9	1.2	0.9
Native Cover %	4	1	-
Number of Native Species	7	8	6
Average Plant Height (m)	0.4	0.2	-
Maximum Plant Height (m)	0.8	0.3	-
Weed Cover %	1	1	8

As can be seen in Table 5 the native plant density in this section has reduced from 1.2 to 0.9 plants / m^2 with the loss of seven plants since February. One species no longer occurs within the monitoring plot; however it is still present nearby within Section F.

Although plants have been lost, the growth of the remaining plants has increased the native cover from 1% to 4%. The average plant height has increased from 0.2 m to 0.4 m and the maximum plant height is now 0.8 m.

Weed control has been very effective with weed cover remaining at 1% of total ground cover. Although low weed cover has been maintained there has been an increase in the number of weed species from 5 to 7. **Eragrostis curvula* (Lovegrass) has been eradicated from the monitoring plot, however the summer weed **Dittrichia graveolens* (Stinkwort) remains the dominant weed species. New **Watsonia meriana var. bulbillifera* seedlings are also present in significant numbers.

3.5 Sections G and H

Sections G and H were both sprayed for weeds, mulched, ripped, and direct seeded. Both sections are located next to each other and are presently in similar condition. Monitoring Plot 1 was positioned in section H. Figures 7 and 8 below compare the current photographs of Plot 1 with those taken a year earlier. See Appendix 4 for larger, more detailed photographs.



Figure 7 Monitoring Plot 1 - May 2006



Figure 8 Monitoring Plot 1 - May 2005

Table 6 Summary Plot 1

Description	May 06	Feb 06	May 05
Number of Native Plants	69	74	89
Native Density (stems/m^2)	2.8	3.0	3.6
Native Cover %	3	2	-
Number of Native Species	12	12	10
Average Plant Height (m)	0.1	0.1	-
Maximum Plant Height (m)	1.0	0.8	-
Weed Cover %	0	0	0

A total of 69 natives (2.8 plants / m^2) were recorded, a loss of 5 plants since February (see Table 6). This is the only plot that has seen a reduction in plant numbers since May 2005. Twelve species were identified in or around Plot 1 during the assessment, the same as in February 2006. However, five different species were recorded in the plot, which means that five species have perished. Approximately one quarter of the plants within the plot are established plants that were not originally affected by the drain maintenance activities.

Little plant development has occurred since the last assessment. Native cover has increased slightly, average heights remain the same and the maximum plant height has increased from 0.2 m to 1.0 m.

Only a few individual plants of **Erharta calycina* (Veldt Grass), **Eragrostis curvula* (Lovegrass), and various young flat weeds were found in Plot 1. Weed cover within and around the plot is negligible.

3.6 Areas Outside of the Security Fence

This section has a Eucalyptus overstorey with little underneath except for a few introduced species. A few specimens of **Erharta calycina*, and **Eragrostis curvula* were noted, but they are only at early stages of development.

3.7 12m Strip

A 12 m strip adjacent to the existing remediation section was rehabilitated in 2005. This section was ripped, allowed to settle for one month, sprayed with broad spectrum herbicide, lightly scarified, and then direct seeded. Two new monitoring plots (Plots 5 and 6) were established in February 2006. The locations of the two new plots are shown in Appendix 2. Figures 9 to 12 below compare the current photographs of each site with those taken in February to provide a visual comparison of progress.



Figure 9 Monitoring Plot 5 - May 2006



Figure 10 Monitoring Plot 5 - February 2006



Figure 11 Monitoring Plot 6 - May 2006



Figure 12 Monitoring Plot 6 - February 2006

Table 7 Summary Plot 5

Description	May 06	Feb 06	May 05
Number of Native Plants	11	8	-
Native Density (stems/m^2)	0.4	0.3	-
Native Cover %	0	0	-
Number of Native Species	6	5	-
Average Plant Height (m)	0.1	0.05	-
Maximum Plant Height (m)	0.2	-	-
Weed Cover %	15	22	-

Table 8 Summary Plot 6

Description	May 06	Feb 06	May 05
Number of Native Plants	8	18	-
Native Density (stems/m^2)	0.3	0.7	-
Native Cover %	0	0	-
Number of Native Species	4	4	-
Average Plant Height (m)	0.1	0.05	-
Maximum Plant Height (m)	0.2	-	-
Weed Cover %	6	22	-

The results in Tables 7 and 8 show poor native establishment rates. Plot 5 has seen an increase of three plants, however there has been a reduction of ten plants in Plot 6. One new species was recorded in Plot 5 since the last assessment and the same number was recorded in Plot 6.

Development of the plants found has been slow with an increase in the average plant height to 0.1 m. The maximum plant height is not much larger at 0.2 m and native cover is less than 1%.

Weed levels have been reduced from 22% in both plots in February to 15% in Plot 5 and 6% in Plot 6. **Dittrichia graveolens* (Stinkwort) remains the most dominant species however **Watsonia meriana var. bulbillifera* is starting to emerge in significant numbers.

4 DISCUSSION

4.1 Species Richness

Species richness has progressively improved though each monitoring assessment with 56 native species recorded to date. This is an increase of four species since the February 2006 assessment.

4.2 Plant Density

The plant density for the 2004 rehabilitation area has reduced from a site wide average of 5.8 plants / m^2 in February 2006 to 4.5 plants / m^2. When compared with the density of 3.3 plants / m^2 in June 2005 this equates to a net increase in plant density of 1.2 plants / m^2 or a 36% increase in plant numbers over the last 12 months. By comparing the results at the same time of year, seasonal fluctuations are removed and the figures show the revegetation is progressing.

Plot 1 was the only quadrat to record a decline since June 2005, Plot 2 recorded the same number of plants, and Plots 3 and 4 both increased. Plots 3 and 4 were deliberately located so that a measure of natural recruitment could be obtained. Plot 3 was located approximately 20 m from the closest undisturbed vegetation, whilst Plot 4 was located adjacent to it. Over the past year the plant numbers in Plot 3 have increased 20%, but in Plot 4 have increased 137%, clearly demonstrating the effect of natural recruitment along the fringes of the existing vegetation. This is expected to continue and will gradually extend further and further into the disturbed areas.

Plant density in the strip alongside the track that was rehabilitated in 2005 is relatively poor with an average density of 0.35 plants / m^2 in the monitoring plots, reduced from 0.5 plants / m^2 in February 2006. Weed competition appears to be the most likely reason for the poor response. Spraying was conducted in January and whilst this has reduced weed numbers, it has not eradicated them. In the northern section of the track, adjacent to Plot 1, a greater number of native plants of several species were observed, although this section was not formally monitored. Very few weeds were also found in this area.

Secondary germination of native species was expected to occur in this newer area once the weed levels were been reduced and whilst plant numbers increased by 37% in Plot 5, they reduced by 55% in Plot 6 resulting in a net loss of native plants.

4.3 Plant Development

In the 2004 rehabilitation area native seedlings that have germinated from seed now average 0.3 m in height and the maximum plant height is 1.2 m. In the 2005 rehabilitation area the average plant height is 0.1 m and the maximum plant height is 0.2 m.

To compliment the plant height measurements, native foliage cover assessments were also conducted during this assessment. Since February 2006 the average foliage cover across all plots has increased from 3% to 4% (6% average cover for

2004 rehabilitation area) with the greatest coverage of 13% (up from 10%) measured in Plot 4. This plot was expected to have the greatest plant development rates and plant density due to the proximity to the adjacent undisturbed native vegetation. No recordings were made of foliage cover in June 2005.

4.4 Introduced Species

A total of 26 introduced species have been observed in all assessments to date. 19 introduced species were recorded in the monitoring plots during the May 2006 assessment.

The main species of concern are **Watsonia meriana var. bulbillifera*, and **Dittrichia graveolens* (especially in the 2005 rehabilitation section). Previously problematic grass species **Eragrostis curvula* and **Erharta calycina* were specifically targeted during the last spraying operation and the plant numbers have been significantly reduced.

Weed cover is currently low at 1% due and consists mostly of new germinants of **Watsonia meriana var. bulbillifera* and **Dittrichia graveolens*. Both of these species will require specific targeting at a specific stage of growth and this will be incorporated into future spraying programs.

5 CONCLUSIONS

In the 2004 rehabilitation section all measurable aspects of the works are showing long term progress. Plant numbers and density may have reduced since the last assessment; however the following changes have been recorded since the same time last year:

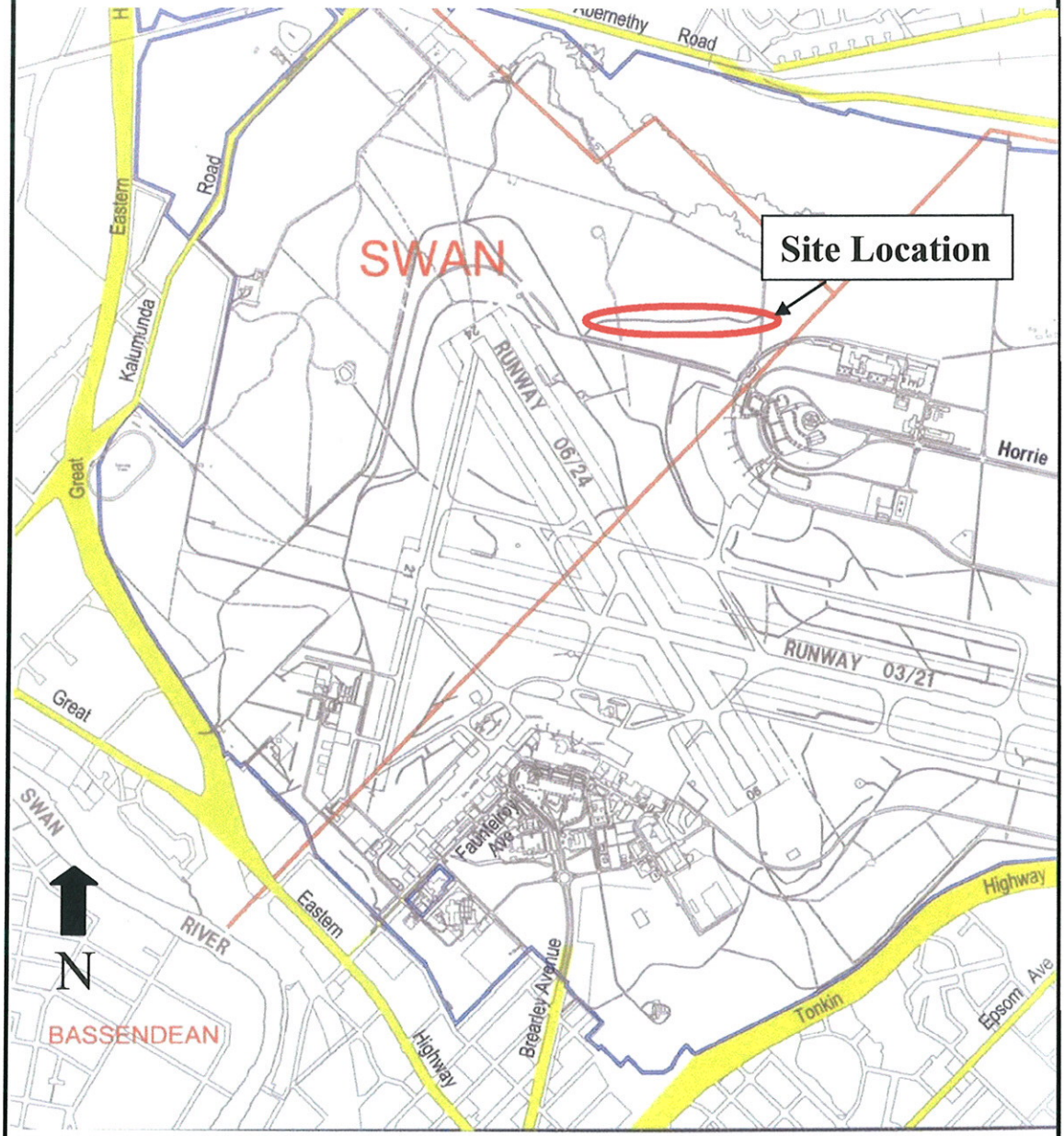
- Plant numbers (and hence plant density) have increased 36%;
- Species richness has increased by 11 species;
- Foliage cover, average plant height, and tallest plant height have all increased;
- Weed cover has reduced in all areas, although eight new species have been recorded.

The 12m strip alongside the track that was rehabilitated in 2005 has not achieved satisfactory progress to date. Native plant numbers and density are low and have reduced overall since the last assessment. However, four new species have been observed since February 2006. Average plant height and foliage cover have not changed since the last assessment The weed spraying operations have helped control the weeds, however weed cover is still relatively high and is still dominated by **Dittrichia graveolens*. Nine new introduced species have also been noted within the plots.

6 REFERENCES

1. Remediation Plan for Poison Gully Drain, WAC, May 2004
2. Monitoring of Remediation Works of Poison Gully Drain, ENV Australia, 2004
3. Poison Gully Branch Drain Rehabilitation Vegetation Monitoring Report, Tranen Revegetation Systems, June 2005.
4. Poison Gully Branch Drain Rehabilitation Vegetation Monitoring Report, Tranen Revegetation Systems, February 2006.

Appendix 1 Site Location

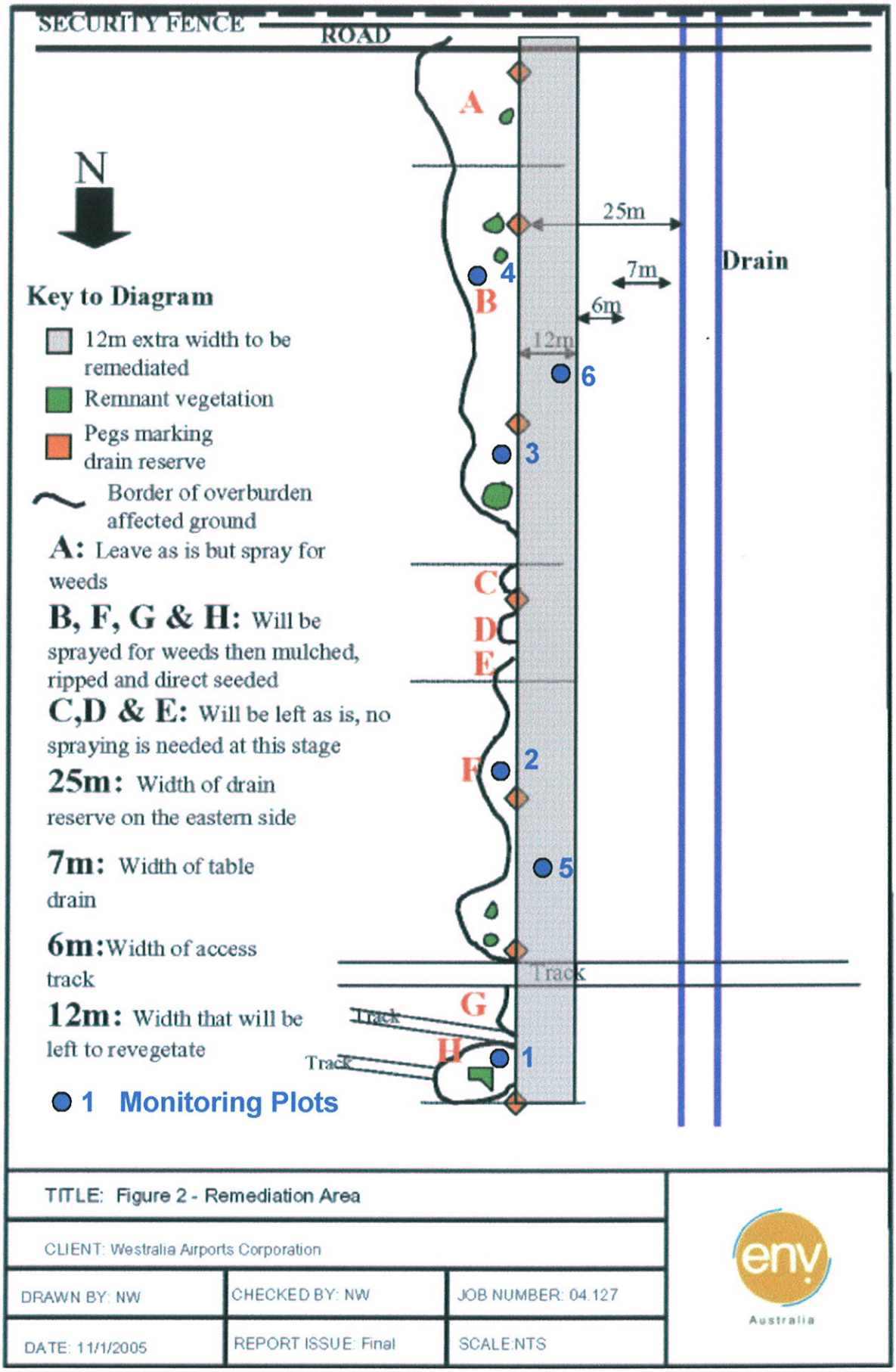


Map source: Environment Strategy, 2004

Figure 1 - Site Location		
CLIENT: Westralia Airports Corporation		
DRAWN BY: NW	CHECKED BY: NW	JOB NUMBER: 04.127
DATE:11/1/2005	REPORT ISSUE: Final	SCALE: NTS

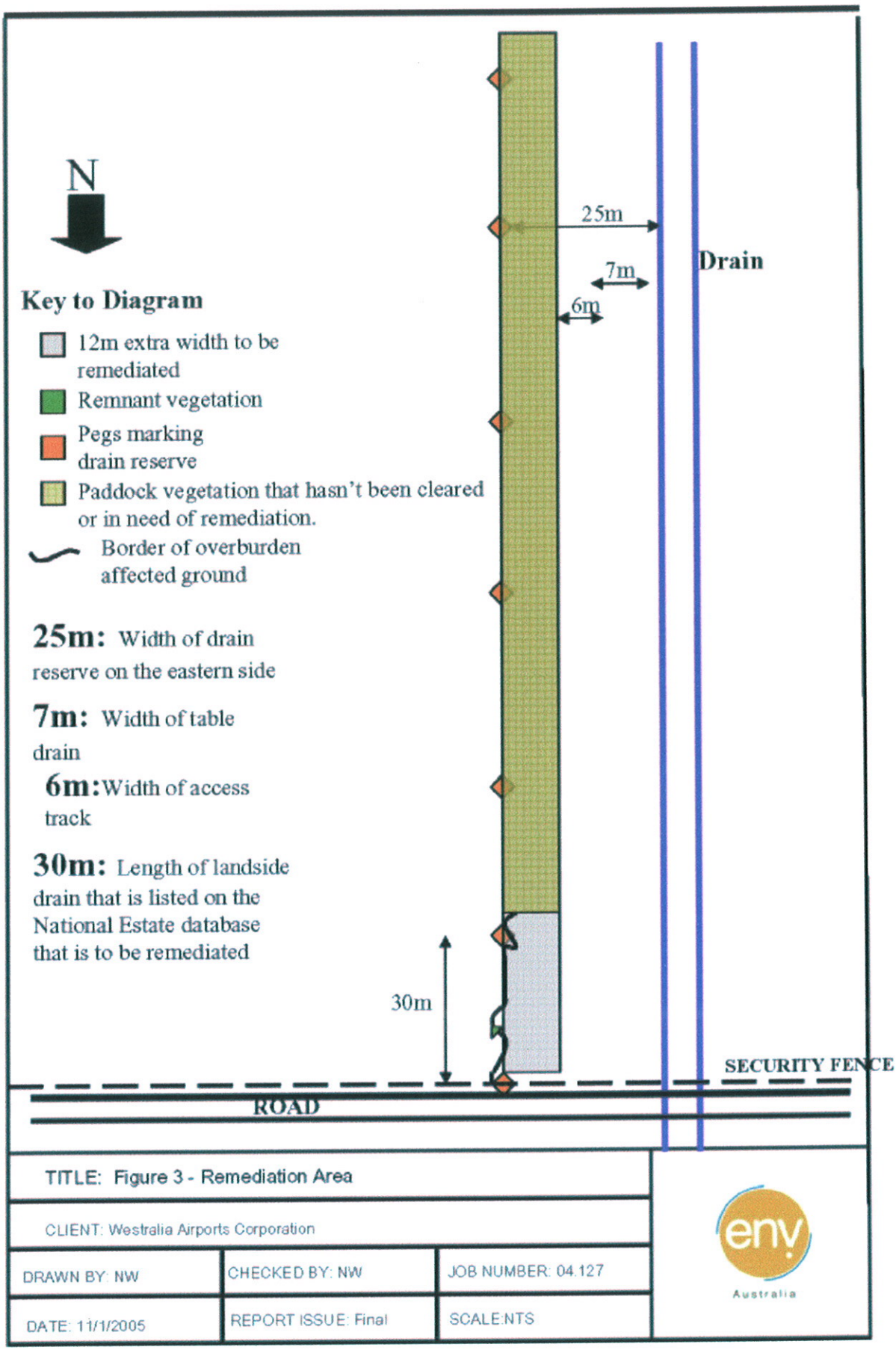
env Australia

Appendix 2 Site Layout



TITLE: Figure 2 - Remediation Area		
CLIENT: Westralia Airports Corporation		
DRAWN BY: NW	CHECKED BY: NW	JOB NUMBER: 04.127
DATE: 11/1/2005	REPORT ISSUE: Final	SCALE:NTS

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N
Key to Diagram
12m extra width to be remediated
Remnant vegetation
Pegs marking drain reserve
Paddock vegetation that hasn't been cleared or in need of remediation.
Border of overburden affected ground
25m: Width of drain reserve on the eastern side
7m: Width of table drain
6m: Width of access track
30m: Length of landside drain that is listed on the National Estate database that is to be remediated
25m
7m
6m
Drain
30m
SECURITY FENCE
ROAD
TITLE: Figure 3 - Remediation Area
CLIENT: Westralia Airports Corporation
DRAWN BY: NW
CHECKED BY: NW
JOB NUMBER: 04.127
DATE: 11/1/2005
REPORT ISSUE: Final
SCALE:NTS
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Appendix 3 Detailed Monitoring Records

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Poison Gully
Native Monitoring Summary

SPECIES	PLOT 1	PLOT 2	PLOT 3	PLOT 4	PLOT 5	PLOT 6	TOTAL MAY 06	TOTAL FEB 06	TOTAL MAY 05
Acacia applanata	1						1	2	1
Acacia saligna				1			1	2	
Adenanthos cygnorum		2		2			4	4	3
Alexgeorgia nitens									
Allocasuarina fraseriana					1		1		
Allocasuarina humilis	33						33	36	45
Astartea scoparia			2	32			34	45	
Banksia attenuata					1		1		
Banksia telmatiaea		3	2	2	4		11	12	6
Bolboschoenus caldwellii									
Bossiaea eriocarpa									
Burchardia umbellata									
Conostylis aculeata			1	2			3	4	2
Conostylis juncea	3	4	1				8		
Conostylis sp.								8	6
Coymbia calophylla	1		1		1	1	4	6	
Cyathochaeta avenacea	4						4		
Cyperus sp.									2
Dampiera alata									
Dasypogon bromelifolius									
Desmocladus fasciculatus									3
Desmocladus flexuosus									
Drosera nitidula				5			5	8	
Dryandra lindleyana									
Dryandra nivea									
Eutaxia virgata				1			1		
Gastrolobium sp				1			1	1	
Gompholobium marginatum									
Gompholobium tomentosum				1			1	1	
Haemodorum laxum								1	
Haemodorum sp.									
Hakea prostrata								2	1
Hakea varia									
Hardenbergia comptoniana									
Hypolaena exsulca	1		1	1			3	1	
Jacksonia furcellata								3	1
Jacksonia sternbergiana	4		1	3			8	8	6
Kennedia prostrata									
Lepidosperma pubisquameum	1	2		1			4	3	2
Lomandra sp.									
Lyginia barbata / imberbis		3	2				5	11	3
Melaleuca seriata			2			1	3		
Mesomolaena tetragona									
Patersonia occidentalis				1			1	1	1
Pericalymma ellipticum var floridum		7	2	23		3	35	60	54
Petrophile linearis								1	
Pterostylis sanguinea	3						3		
Schoenus curvifolius	2						2	1	
Siloxerus humifusus				4	1		5		8
Stirlingia latifolia									
Thysanotus sparteus	2						2	1	
Verticordia ? lindleyi subsp lindelyi			6				6	10	
Verticordia densiflora var densiflora		1	141	119	3	3	267	355	164
Waitzia suaveolens									
Xanthorrhoea brunonis	14						14	16	9
Xanthorrhoea preissii									15
TOTAL STEM COUNT MAY 06	**69**	**22**	**162**	**199**	**11**	**8**	**465**		
TOTAL STEM COUNT FEB 06:	74	29	180	294	8	18		603	
TOTAL STEM COUNT JUN 05:	89	22	136	84	-	-			331
AVERAGE DENSITY (Plants/m2) MAY 06	**2.8**	**0.9**	**6.5**	**8.0**	**0.4**	**0.3**	**3.1**		
AVERAGE DENSITY FEB 06	3.0	1.2	7.2	11.8	0.3	0.7		4.2	
AVERAGE DENSITY JUN 05	3.6	0.9	5.4	3.4	-	-			3.3
NATIVE COVER PERCENTAGE MAY 06	**3%**	**4%**	**5%**	**13%**	**0%**	**0%**	**4%**		
NATIVE COVER FEB 06	2%	1%	2%	10%	0%	0%		3%	
AVERAGE PLANT HEIGHT (m) MAY 06	**0.1**	**0.4**	**0.3**	**0.4**	**0.1**	**0.1**	**0.2**		
AVERAGE PLANT HEIGHT (m) FEB 06	-	-	-	-	-	-		0.2	
TALLEST PLANT (m) MAY 06	**1.0**	**0.8**	**0.5**	**1.2**	**0.2**	**0.2**	**1.2**		
TALLEST PLANT (m) FEB 06	-	-	-	-	-	-		0.8	
NUMBER OF NATIVE SPECIES IN PLOTS MAY 06	**12**	**7**	**12**	**16**	**6**	**4**	**30**		
NUMBER OF NATIVE SPECIES IN PLOTS FEB 06	12	8	9	15	5	4		27	
NUMBER OF NATIVE SPECIES IN PLOTS JUN 05	10	6	7	6	-	-			19
NUMBER OF SPECIES IN OR AROUND PLOT MAY 06	**13**	**8**	**12**	**16**	**5**	**5**	**34**		
NUMBER OF SPECIES IN OR AROUND PLOT FEB 06	13	8	12	16	5	5		4	
NUMBER OF SPECIES IN OR AROUND PLOT JUN 05	12	12	8	8	-	-			26
TOTAL NATIVE SPECIES TO MAY 06							**56**		
TOTAL NATIVE SPECIES TO FEB 06								52	
TOTAL NATIVE SPECIES TO JUN 05									46
TOTAL NATIVE SPECIES TO NOV 04									38

Note: Species in bold red are new species that have not been recorded during previous assessments

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Poison Gully
Introduced Species Monitoring Summary

Taxa	PLOT 1 *	PLOT 2 *	PLOT 3 *	PLOT 4 *	PLOT 5 *	PLOT 6 *	OBSERVED MAY 06	OBSERVED FEB 06	OBSERVED MAY 05
* Aira caryophyllea									Y
* Anagallis arvensis				5	2	1	Y	Y	Y
* Arctotheca calendula									Y
* Avena barbata			4			2	Y		
* Briza maxima									
* Briza minor								Y	
* Conyza sp.					2		Y	Y	Y
* Cynodon dactylon		2			14	2	Y	Y	Y
* Dittrichia graveolens		18	30	8	66	65	Y	Y	Y
*** Echium plantagineum**					7		Y		
* Eragrostis curvula	2			9		3	Y	Y	Y
* Erharta calycina	6					4	Y	Y	
*** Erodium botrys**		6		7			Y		
* Gladiolus caryophyllaceus		2			9		Y	Y	Y
* Hypochaeris glabra / Flatweeds									Y
*** Isolepis marginata**				3	1		Y		
* Juncus microcephalus			3				Y	Y	
* Leptospermum laevigatum			6	11			Y	Y	
* Lupinus consentinii									Y
*** Oxalis sp.**					9		Y		
*** Pelargonium capitatum**			2				Y		
* Poaceae sp.			16	3		2	Y	Y	
* Trifolium sp.								Y	
* Ursinia anthemoides	3	3					Y		
* Watsonia meriana var. bulbillifera		21	26	38	10	20	Y	Y	
* Weed A									Y
Flat weeds (unidentifiable at early stages)	6	59	32	33	10	27	Y		
% WEED COVER IN PLOT MAY 06	0%	1%	1%	1%	15%	6%			
% WEED COVER IN PLOT FEB 06	0%	1%	2%	2%	22%	22%	8%		
% WEED COVER IN PLOT JUN 05	0%	8%	10%	7%	-	-		6%	
NUMBER OF WEED SPECIES MAY 06	4	7	8	9	10	9	26		
NUMBER OF WEED SPECIES FEB 06	6	2	6	5	4	3		12	
TOTAL WEED SPECIES TO MAY 06							26		
TOTAL WEED SPECIES TO FEB 06								21	
TOTAL WEED SPECIES TO JUN 05									18
TOTAL WEED SPECIES TO NOV 04									11

Note: Species in bold red are new species that have not been recorded during previous assessments

* : Figures quoted are not actual numbers but a measure of species dominance. In each 1 m2 section of the plot the weeds are scored 3,2,1 with 3 being the most dominant. Max score per plot 75.

tranen
revegetation systems

Precinct 5 Rehabilitation
Westralia Airports Corporation

Vegetation Monitoring Report

February 2006

P113-01 Rev 1

Tranen Pty Ltd
1/110 Jersey Street
Jolimont, WA 6014
p (08) 9284 1399
f (08) 9284 1377
email@tranen.com.au
www.tranen.com.au

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Table of Contents

1 Introduction 1
2 Background 2
3 Monitoring Methodology 3
3.1 Transect Layout 3
3.2 Methodology 4
4 Results 5
4.1 Flora 5
4.1.1 Declared Rare and Priority Species 5
4.1.2 Introduced Species 5
4.2 Species Richness 6
4.3 Native Plant Density 6
4.4 Structural Layers and Surface Cover 7
4.5 Self-Regenerating Tracks 9
5 Discussion 11
5.1 General 11
5.2 *Corymbia calophylla* / *Banksia attenuata* 11
5.3 *Pericalymma ellipticum* 12
5.4 *Melaleuca preissiana* / *Pericalymma ellipticum* 13
5.5 *Banksia attenuata* / *Banksia menziesii* 13
5.6 Constructed Wetland 14
5.7 Self-Regenerating Tracks 15
6 Conclusions 16
7 References 17
APPENDIX 1 TRANSECT LOCATION MAPS 18
APPENDIX 2 TRANSECT LOCATION AND ORIENTATION DETAILS 24
APPENDIX 3 TRANSECT SUMMARIES 26
APPENDIX 4 LIST OF SPECIES IDENTIFIED BY TRANSECT 38

Table of Figures

Figure 1 Transect Layout 3
Figure 2 CcBa Control and Rehabilitation Transect Photos 12
Figure 3 Pe Control and Rehabilitation Transect Photos 12
Figure 4 MpPe Control and Rehabilitation Transect Photos 13
Figure 5 BaBm Control and Rehabilitation Transect Photos 13
Figure 6 Constructed Wetland Control and Rehabilitation Transect Photos 14

Table of Tables

Table 1 Total Number of Species Identified During Assessments 5
Table 2 Number of Species Identified By Transect 6
Table 3 Native Stem Counts and Density 7
Table 4 CcBa Structural Layer Composition 7
Table 5 Pe Structural Layer Composition 8
Table 6 MpPe Structural Layer Composition 8
Table 7 BaBm Structural Layer Composition 9
Table 8 BaBm Structural Layer Composition 9

1 INTRODUCTION

The Perth Airport is located approximately 10 km east of Perth and covers an area of 2,105 ha over 3 municipalities: City of Belmont, City of Swan, and the Shire of Kalamunda. The airport land is bounded by Tonkin Highway, Great Eastern Highway, Kalamunda Road, and Abernethy Road.

Figure 2 in Appendix 1 shows the airport is divided into 7 precincts, each with its own independent management objectives. The southern part of Precinct 2C was cleared for development in 2003 and the opportunity arose to utilise high quality topsoil and bush for the rehabilitation of unauthorised access tracks and the construction of a wetland in Precinct 5 (conservation zone).

Tranen Revegetation Systems were commissioned in May 2005 to continue the vegetation monitoring program in Precinct 5 for initial works that were undertaken in November 2003. This is the second assessment by Tranen, and the third since rehabilitation works were originally conducted. The monitoring of these works are to continue until November 2008 as committed to in the Precinct 5 Rehabilitation Plan (ENV Australia, 2003) approved by the Department of Transport and Regional Services, and the Department of Environment and Heritage.

The aim of the monitoring is to catalogue progress within the rehabilitation areas and to determine whether remedial actions are required. The program involves monitoring 11 permanently established transects in Precinct 5 by:

- Counting the total number of native seedlings;
- Identifying all species (both native and introduced) contained within;
- Determining the percentage cover of native and introduced species;
- Observing factors that may be impeding or promoting plant establishment; and
- Maintaining a photographic log for visual comparison.

The monitoring is to be conducted in spring and autumn each year for the five year period. This report details the findings from the three assessments conducted to February 2006.

2 BACKGROUND

The southern section of Precinct 2C has been developed as a business park. The development is outlined in the approved Master Plan and in the Major Development Plan (MDP), (The Planning Group, 2003). The MDP provides a detailed description of the environmental values of Precinct 2C South, the impacts associated with the development, and how these impacts are to be managed or mitigated.

As 8 of the 44 hectares within Precinct 2C South were classed as in 'good condition' (Mattiske, 2003) it was decided that this resource should not be wasted and that it would be used to rehabilitate sections of the conservation zone Precinct 5.

The general approach to the rehabilitation was to collect carefully selected soil and vegetation material from the cleared section of Precinct 2C South and use it to rehabilitate unauthorised access tracks and a constructed wetland in Precinct 5. The best quality vegetation and topsoil from Precinct 2C South was selected for use in the same vegetation community type in Precinct 5.

The activities undertaken during the clearing of Precinct 2C South and the rehabilitation of Precinct 5 involved:

- Bandicoot capture and relocation;
- Seed collection;
- Preparation and levelling of tracks;
- Relocation of soil surrounding a dead *Macarthuria keigheryi* plant (declared rare);
- Clearing and stockpiling of trees for use as brush and barricades;
- Clearing and stockpiling of other vegetative matter. A portion was mulched for later use and the remainder used for brushing;
- Windrowing of top 30 mm of topsoil (soil seed bank) from Precinct 2C South and relocation;
- Spreading of stockpiled mulch on remaining topsoil. Topsoil and mulch then windrowed to a depth of 150 mm to ensure thorough mixing. Mixture relocated to same vegetation system in Precinct 5;
- Spreading the soil seed bank over the topsoiled tracks and then deep ripping with a delta winged tine;
- Brushing and placement of large logs at the entry points to prevent further unauthorised access;
- Nomination to two tracks to self regenerate. The track in the Melaleuca vegetation community was also ripped and barricaded with logs, however the track in the Pericalymma community was not; and
- Conversion of a degraded open section to the north of the rehabilitation tracks into a constructed wetland.

Follow up weed control was undertaken in May 2005 in the constructed wetland. This involved the spraying of grass specific herbicide in the constructed wetland to prepare for additional rehabilitation works by the Conservation Volunteers of Australia (CVA). Tubestock were planted and tree-guarded around the wetland area in June 2005.

Since the last assessment the following activities have been undertaken in Precinct 5:

- Weed control in the constructed wetland (Feb 2006); and
- Provenance seed recovery in anticipation of remedial works (Oct 2005 to Feb 2006).

3 MONITORING METHODOLOGY

11 monitoring transects have been established in five different vegetation systems. There is one control transect for each location and one rehabilitation transect for each area except for the constructed wetland which has two transects and one control. The vegetation systems are:

1. Corymbia calophylla / Banksia attenuata (CcBa);
2. Pericalymma ellipticum (Pe);
3. Melaleuca preissiana / Pericalymma ellipticum (MpPe);
4. Banksia attenuata / Banksia menziesii (BaBm); and
5. Wetland.

Appendix 1 contains drawings showing the general position of the rehabilitation zones and the monitoring transects.

The monitoring began in December 2004 and was conducted by ENV Australia. Tranen Revegetation Systems were then commissioned to continue the monitoring program in June 2005, making a few modifications to the methodology.

3.1 Transect Layout

The transects were established in December 2003 shortly after the rehabilitation works were completed. The rehabilitation transects were established along the middle of the tracks, and the control plots nearby within a minimally disturbed section of the same type of existing bushland. Each transect is marked by six stakes spaced at 10m intervals (see Figure 1 below).

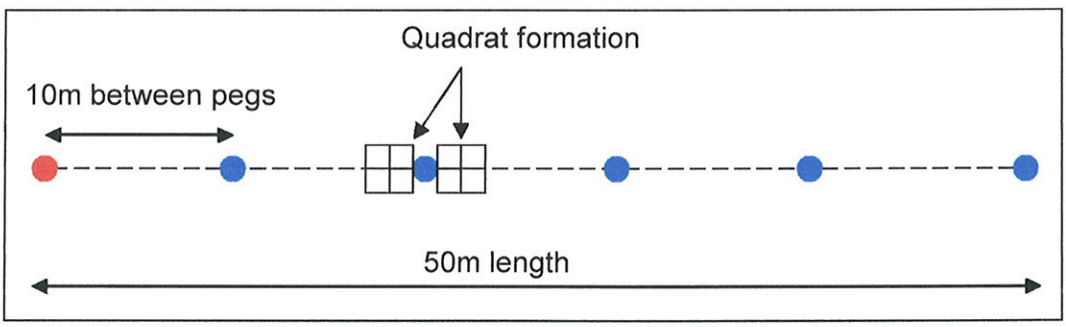


Figure 1 Transect Layout

The first marker is the location from which the photo is taken, and the remaining five stakes are where the two 2 m x 2 m quadrats are placed. The co-ordinates for the start and end point of each transect were determined using GPS and the details can be found in Appendix 2. For some tracks the transects may not be in a straight line as they have been placed on changes of direction in the track. The transects do however still span for 50m.

In the constructed wetland the transects are located so that they begin at the waters edge and proceeded up slope. The wetland control transect is located in Runway Swamp located some distance away near the end of Runway 21R.

3.2 Methodology

The monitoring program was established by ENV Australia for the first assessment in December 2004 and involves the recording of the following information for each quadrat:

- Transect and quadrat number;
- Species present;
- Number of alive and dead plants;
- Percentage cover of alive and dead plants;
- General observations of the site e.g. thick ground litter, rubbish, etc; and
- Photographic record.

The percentage cover is determined for each structural layer by assessing the amount of shade cast by each of the five main layers: grasses, herbs, sedges, shrubs, and trees. Native and introduced species are recorded separately.

For the tracks that were left to self-regenerate the state of each site is assessed and a photographic record maintained.

4 RESULTS

The information summarised in this section (further details and comparisons can be found in Appendix 3) is from the assessments conducted in:

- December 2004 (ENV Australia, 2004)
- June 2005 (Tranen Revegetation Systems, 2005); and
- February 2006 (Tranen Revegetation Systems).

4.1 Flora

Nine new native species and three new introduced species were recorded during this assessment. The total number of native species recorded to date is 147, and for introduced species is 40, giving a total of 187 species recorded to date. Table 1 below contains a summary. A complete list of species can be found in Appendix 5. The level of identification of 6 species has been refined since the last assessment.

Table 1 Total Number of Species Identified During Assessments

Species	Dec 04	Jun 05	Feb 06	Total To Date
Native	107	96	89	147
Introduced	26	24	16	40
Total	**133**	**120**	**105**	**187**

4.1.1 Declared Rare and Priority Species

No Endangered or Vulnerable species pursuant to s178 of the Environmental Protection and Biodiversity Act, 1999 have been located during the monitoring assessments.

Two taxa gazetted for the area as Declared Rare of Priority Flora pursuant to subsection 1 of Section 23F of the Wildlife Conservation Act, 1950 (Western Australian Herbarium, 2005) have been located during the monitoring assessments. They are:

- *Byblis gigantea* (Priority 2) – Pe (Control); and
- *Schoenus benthamii* (Priority 3) – Pe (Rehab).

4.1.2 Introduced Species

Three new introduced species have been discovered within the monitoring plots bringing the total observed to date to 40. Many of the annual species were not observed during the most recent assessment as the timing is outside of their normal growth cycle. Because of this however several new species were observed.

One of the species identified previously (* Moraea flaccida – One-Leaf Cape Tulip) is listed as a Declared Plant pursuant to Part IV, Section 37 of the Agriculture and Related Resources Protection Act, 1976 (Department of Agriculture, 2005). During the June 2005 assessment this declared species

was found in small populations in the control transects of two vegetation communities: *Corymbia calophylla / Banksia attenuata* and, *Banksia attenuata / Banksia menziesii*. It was not observed in February 2006 as this is a period in which the plant is dormant.

4.2 Species Richness

Table 2 below is a summary of the number of species found within each of the monitoring transects for the two assessments. The details of the species found in each transect can be found in Appendix 2.

Table 2 Number of Species Identified By Transect

Transect	Dec 04		Jun 05		Feb 06	
	N	I	N	I	N	I
CcBa (C)	34	11	38	7	32	11
CcBa (R)	30	6	25	9	22	6
Pe (C)	17	3	16	1	17	0
Pe (R)	20	13	18	4	20	5
MpPe (C)	11	2	15	1	12	0
MpPe (R)	17	8	15	10	16	5
BaBm (C)	35	4	36	5	35	1
BaBm (R)	21	6	20	7	17	2
Wetland (C)	11	9	16	5	16	5
Wetland A (R)	29	8	24	9	23	7
Wetland B (R)	14	10	7	10	8	9
Total	**107**	**26**	**96**	**24**	**89**	**16**

Note: Control transects are marked (C) and Rehabilitation transects (R)
N and I refer to Native and Introduced species respectively

4.3 Native Plant Density

A count of the number of individual native plants was made during both the February 2006 and June 2005 assessments and can be found in Table 3. No data is available from the December 2004 assessment for comparison.

Table 3 Native Stem Counts and Density

Transect Location	Jun 05		Feb 06	
	Stem Count	Density (Stems / m2)	Stem Count	Density (Stems / m2)
CcBa (C)	1,065	26.6	1,402	35.0
CcBa (R)	275	6.9	180	4.5
Pe (C)	1,332	33.3	1,301	32.5
Pe (R)	1,255	31.4	1,303	32.5
MpPe (C)	677	16.9	641	16.0
MpPe (R)	374	9.4	335	8.4
BaBm (C)	898	22.5	1,252	31.3
BaBm (R)	175	4.4	104	2.6
Wetland (C)	1,054	26.4	848	21.2
Wetland A (R)	591	14.8	395	9.9
Wetland B (R)	53	1.3	657	16.4

Note: Control transects are marked (C) and Rehabilitation transects (R)

4.4 Structural Layers and Surface Cover

Tables 4 to 8 below show the average composition of the five main structural layers (grasses, herbs, sedges, shrubs, and trees) by percentage ground cover for each of the five vegetation systems. In each table the control plot (marked with a C) is shown in red, followed by the December 2004 assessment and the June 2005 assessment for comparison.

The figures represent the amount of shade cast by the structural layers for each quadrat. The figures may therefore total more than 100%, as the layers overlap.

Table 4 CcBa Structural Layer Composition

Layer Type	Native / Weed	CcBa (C)	CcBa (R)	CcBa (R)	CcBa (R)
Date		Feb-06	Dec-04	Jun-05	Feb-06
% Grass	Native	0%	1%	0%	0%
% Grass	Weed	1%	5%	1%	1%
% Herb	Native	60%	1%	1%	0.25%
% Herb	Weed	0%	2%	2%	0%
% Sedge	Native	10%	0%	0%	0.25%
% Sedge	Weed	0%	0%	0%	0%
% Shrub	Native	30%	7%	0%	0.25%
% Shrub	Weed	0%	0%	0%	0%
% Tree	Native	20%	3%	0%	0.25%
% Tree	Weed	0%	0%	0%	0%
TOTAL	**Native**	**80%**	**12%**	**1%**	**1%**
TOTAL	**Weed**	**1%**	**7%**	**2%**	**1%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

Table 5 Pe Structural Layer Composition

Layer Type	Native / Weed	Pe (C)	Pe (R)	Pe (R)	Pe (R)
Date		Feb-06	Dec-04	Jun-05	Feb-06
% Grass	Native	0%	2%	0%	0%
% Grass	Weed	0%	3%	0%	0.3%
% Herb	Native	5%	1%	0%	1%
% Herb	Weed	0%	3%	1%	0.1%
% Sedge	Native	25%	1%	1%	2%
% Sedge	Weed	0%	0%	0%	0.5%
% Shrub	Native	60%	7%	2%	10%
% Shrub	Weed	0%	0%	0%	0%
% Tree	Native	0%	0%	0%	0%
% Tree	Weed	0%	0%	0%	0%
TOTAL	**Native**	**75%**	**10%**	**3%**	**13%**
TOTAL	**Weed**	**0%**	**5%**	**1%**	**1%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

Table 6 MpPe Structural Layer Composition

Layer Type	Native / Weed	MpPe (C)	MpPe (R)	MpPe (R)	MpPe (R)
Date		Feb-06	Dec-04	Jun-05	Feb-06
% Grass	Native	0%	1%	0%	0.1%
% Grass	Weed	0%	3%	4%	0.75%
% Herb	Native	1%	1%	1%	0.1%
% Herb	Weed	0%	1%	3%	0%
% Sedge	Native	25%	0%	0%	0.2%
% Sedge	Weed	0%	0%	0%	0.25%
% Shrub	Native	30%	2%	0%	0.5%
% Shrub	Weed	0%	0%	0%	0%
% Tree	Native	5%	0%	0%	0.1%
% Tree	Weed	0%	0%	0%	0%
TOTAL	**Native**	**55%**	**4%**	**1%**	**1%**
TOTAL	**Weed**	**0%**	**4%**	**7%**	**1%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

Table 7 BaBm Structural Layer Composition

Layer Type	Native / Weed	BaBm (C)	BaBm (R)	BaBm (R)	BaBm (R)
Date		Feb-06	Dec-04	Jun-05	Feb-06
% Grass	Native	4%	0%	0%	
% Grass	Weed	0%	2%	3%	1%
% Herb	Native	20%	1%	0%	0.4%
% Herb	Weed	0%	1%	5%	0%
% Sedge	Native	10%	0%	0%	0.1%
% Sedge	Weed	0%	0%	0%	0%
% Shrub	Native	20%	2%	0%	0.4%
% Shrub	Weed	0%	0%	0%	0%
% Tree	Native	5%	0%	0%	0.1%
% Tree	Weed	0%	0%	0%	0%
TOTAL	**Native**	**39%**	**3%**	**1%**	**1%**
TOTAL	**Weed**	**0%**	**3%**	**8%**	**1%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

Table 8 BaBm Structural Layer Composition

Layer Type	Native / Weed	Wet (C)	Wet A (R)	Wet A (R)	Wet A (R)	Wet B (R)	Wet B (R)	Wet B (R)
Date		Feb-06	Dec-04	Jun-05	Feb-06	Dec-04	Jun-05	Feb-06
% Grass	Native	0%	0%	0%	0%	0%	0%	0%
% Grass	Weed	3%	2%	1%	2%	5%	0%	1%
% Herb	Native	2%	1%	0%	0%	2%	0%	0%
% Herb	Weed	0%	1%	2%	0%	2%	1%	1%
% Sedge	Native	20%	1%	0%	1%	1%	0%	2%
% Sedge	Weed	1%	2%	0%	3%	8%	0%	9%
% Shrub	Native	7%	7%	4%	3%	2%	0%	0%
% Shrub	Weed	0%	0%	0%	0%	0%	0%	0%
% Tree	Native	4%	0%	0%	0%	0%	0%	2%
% Tree	Weed	0%	0%	0%	0%	0%	0%	0%
TOTAL	**Native**	**27%**	**9%**	**5%**	**4%**	**5%**	**0%**	**4%**
TOTAL	**Weed**	**4%**	**4%**	**3%**	**5%**	**15%**	**1%**	**11%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

The average plant height across all locations is 200 mm (not including ground cover or low growing plants). The exception is the rehabilitated track within the *Pericalymma ellipticum* vegetation system which has an average height of 300 mm. The tallest plant observed in any rehabilitation section was 500 mm (Wetland A, Wetland B, and Pe).

4.5 Self-Regenerating Tracks

The first track, located within a Banksia littoralis / Melaleuca rhaphiophylla vegetation community has shown little natural recruitment. Native seedlings were observed but only in small clusters within low lying depressions. The track was infested with annual weeds in June 2005, however, late rains resulted in the area

being flooded which has drowned many of the weeds and reduced the level of infestation. Significant infestations still exist along the edges of the adjoining bushland.

The track through the Pericalymma heath has good native recruitment with reasonable species richness and plant numbers, and the growth rates are greater than in some of the transects. Weed levels are minimal and do not appear to be having any negative effects.

5 DISCUSSION

5.1 General

The species richness has increased by ten native species and three introduced species. It is possible that the actual number of species may be higher than recorded due to the difficulty in the identification of young germinants, and different growth cycles amongst species. Several species could only be identified to genus or family level.

The use of topsoil at this stage has proven to be successful with respects to species richness. A direct seeding or seedling planting approach would not have provided the number of species that have been recorded to date, due to some of the species being difficult to harvest for seed, or to propagate.

Seedling development has progressed since June with plant heights averaging 200 mm in height (not including ground cover or low growing plants). The rehabilitation track in the *Pericalymma ellipticum* vegetation system has shown the most development with seedling heights averaging 300 mm. All sites have a similar total native ground cover percentage to the last assessment, except for increases in the *Pericalymma ellipticum* (from 3% to 13% cover) and Wetland B (from 0% to 4% cover) sections.

Weed levels across the site are low at present. Although the assessment has been conducted during summer, there have been frequent rainfall events and it has been a relatively wet summer. The main weeds present at this time are the grasses **Erharta calycina* (Veldt Grass) and **Eragrostis curvula* (Lovegrass). The former is generally easily controlled using Fusilade ® however the latter does not respond to this herbicide and requires a spot sprayed application of glyphosate.

The brush and log placement has worked well for all of the rehabilitation tracks within Precinct 5, as few vehicle impacts have been noted so far. The exception is for the constructed wetland, which in the past has been heavily impacted by unauthorised vehicle access. Vehicle access since the last assessment appears to have reduced in this area due to high water levels within the wetland, and the closure of access to areas previously used by recreational vehicles.

5.2 *Corymbia calophylla / Banksia attenuata*

This rehabilitation area has had a reduction in both plant density (from 7.0 to 4.5 plants / m^2) and native species representation (from 24 to 22). There is good representation of all species with trees representing 25%, shrubs 25%, and the remainder being herbs and grass like plants. A small number of sedges were found in the monitoring plots.

Native ground cover remains at 1%, however given the reduction in the number of plants this demonstrates that surviving plants are developing. At this stage there is little threat from weeds as they only cover 1% of the area. *Erharta calycina (Veldt Grass) is the dominant weed. This species is easily controlled with the specific herbicide Fusilade ®.



Figure 2 CcBa Control and Rehabilitation Transect Photos

**Moraea flaccida* (One-Leaf Cape Tulip) was recorded in the control transect in small numbers previously, but was not seen during this assessment. This was expected given that at this time of year the bulb is dormant.

5.3 *Pericalymma ellipticum*



Figure 3 Pe Control and Rehabilitation Transect Photos

The Pericalymma rehabilitation track has shown the greatest number of germinants with only 2 more plants than recorded in the control plot. This equates to an average of 32.5 plants / m^2. There were also three more native species in the rehabilitation transect than in the control. The majority of the seedlings are located within the riplines.

Plant development is excellent (see Figure 3) with an increase of 10% (total 13%) in the native ground cover in the last six months. Weed cover is very low at 1%, and the most abundant species are **Erharta calycina* (Veldt Grass) and **Isolepis marginata* (Coarse Club Rush). The **Erharta* is easily controlled using Fusilade ® in autumn. The **Isolepis* is at the end of its growth cycle and should be monitored next autumn and spring.

The two newly discovered Priority Flora *Byblis gigantea*, and *Schoenus benthamii* were discovered in the control plot and rehabilitation plot respectively.

5.4 *Melaleuca preissiana / Pericalymma ellipticum*

This rehabilitation track has high levels of brush material (average 42% ground cover) which is keeping the traffic off, but may be inhibiting plant growth as well. Notwithstanding this the number of seedlings is good with an average of 8 plants / m^2 which is down slightly from the last assessment (was 9.4 plants / m^2). The majority of these seedlings are found in the bare sections devoid of brush and in these patches the density is approaching that of the control.



Figure 4 MpPe Control and Rehabilitation Transect Photos

Native cover remains at 1% which shows little plant development since the last assessment. Weed cover has significantly reduced from 7% to 1%, however this is most likely due to the autumn assessment recording the annual introduced species which are not normally present at this time of year.

5.5 *Banksia attenuata / Banksia menziesii*



Figure 5 BaBm Control and Rehabilitation Transect Photos

The BaBm rehabilitation has the lowest plant density of the rehabilitation tracks with 2.6 seedlings / m^2 (previously 4.4 seedlings / m^2). Over half of the native plants recorded were *Podotheca angustifolia* which is an annual herb species. This results in the perennial plant density for the transect being half of the figure above.

The control plot is somewhat degraded with an open understorey and tree canopy. A recent dieback assessment has indicated that dieback is found in this area and is responsible for the loss of several trees along the control transect. It is likely to also be found along the rehabilitation track.

Weed coverage levels are currently low at 1%, however there is a significant number of dead **Erharta calycina* (Veldt Grass) present. This species should be targeted in the autumn spraying program. The declared weed, One-leaf Cape Tulip (**Moraea flaccida*) was observed in the control transect previously, however as with other locations was not seen during this assessment due to the timing.

5.6 Constructed Wetland



Top left: Control
Top right: Wetland A
Bottom: Wetland B

Figure 6 Constructed Wetland Control and Rehabilitation Transect Photos

Vehicle traffic to the constructed wetland has been reduced due to the high water levels within the basin. Wetland A has seen a reduction in the number of natives recorded in the 6 quadrats above the high water level. The density has dropped from 15 stems/m^2 to 9.4 stems/m^2. The ground cover has decreased from 5% to

4% but taking into consideration the reduction in stems this shows a small increase in the development of surviving natives.

Wetland B now has a native density of 16 stems/m^2 which is a substantial increase from the 1.3 stems/m^2 recorded 6 months ago. This is due to the germination of a large number (399) of Melaleuca rhaphiophylla seedlings. The most likely source is seed stored within in the brush material. This should be taken into consideration for any new brushing works (i.e. transport quickly) to take maximum advantage of the resources available.

Weed cover is relatively high in both Wetland A (5%) and Wetland B (11%) due to the high moisture content of the soil surrounding the wetland. The dominant species is **Isolepis marginata* and also found in significant numbers were **Juncus microcephalus*, and **Erharta calycina*. **Typha orientalis* was recently noted in this area. This species is one of the most invasive wetland plants, and early control is essential to prevent it from establishing in the constructed wetland.

Herbicide was applied in the constructed wetland and surrounding areas a week after the assessment was conducted.

5.7 Self-Regenerating Tracks

The Banksia littoralis / Melaleuca rhaphiophylla track was infested with annual weeds in June 2005, however, late rains resulted in the area being flooded which has drowned many of the weeds and reduced the level of infestation. Natural recruitment has been observed of both native and weed species. Provided the weeds are controlled there is a good chance this area will recover and self-regenerate.

The track through the Pericalymma heath has good native recruitment with reasonable species richness and plant numbers, and the growth rates are greater than in some of the transects. Weed levels are minimal and do not appear to be having any negative effects.

6 CONCLUSIONS

For this stage of development the rehabilitation of most sites is progressing towards a successful outcome. Plant densities have dropped in some areas, however plant development and ground cover have remained the same or increased.

Plant densities are relatively low and the species richness is low in the following areas:

- The Banksia attenuata / Banksia menziesii (BaBm) rehabilitation track;
- The Corymbia calophylla / Banksia attenuata (CcBa) rehabilitation track; and
- The self-regenerating Banksia littoralis / Melaleuca rhaphiophylla track.

If there is no improvement in these areas by the next assessment then remedial works may be required.

The constructed wetland has shown significant progress since the last assessment due to a reduction in the vehicular traffic. Notwithstanding this remedial works involving the planting of 1,000 tree and shrub and 10,000 rush and sedge seedlings are planned for the coming winter.

Autumn and spring herbicide applications are scheduled in the next 12 months for all tracks and adjacent areas. After this period weed control will be considered on an as needed basis as determined by the ongoing monitoring program.

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Appendix 1 Transect Location Maps

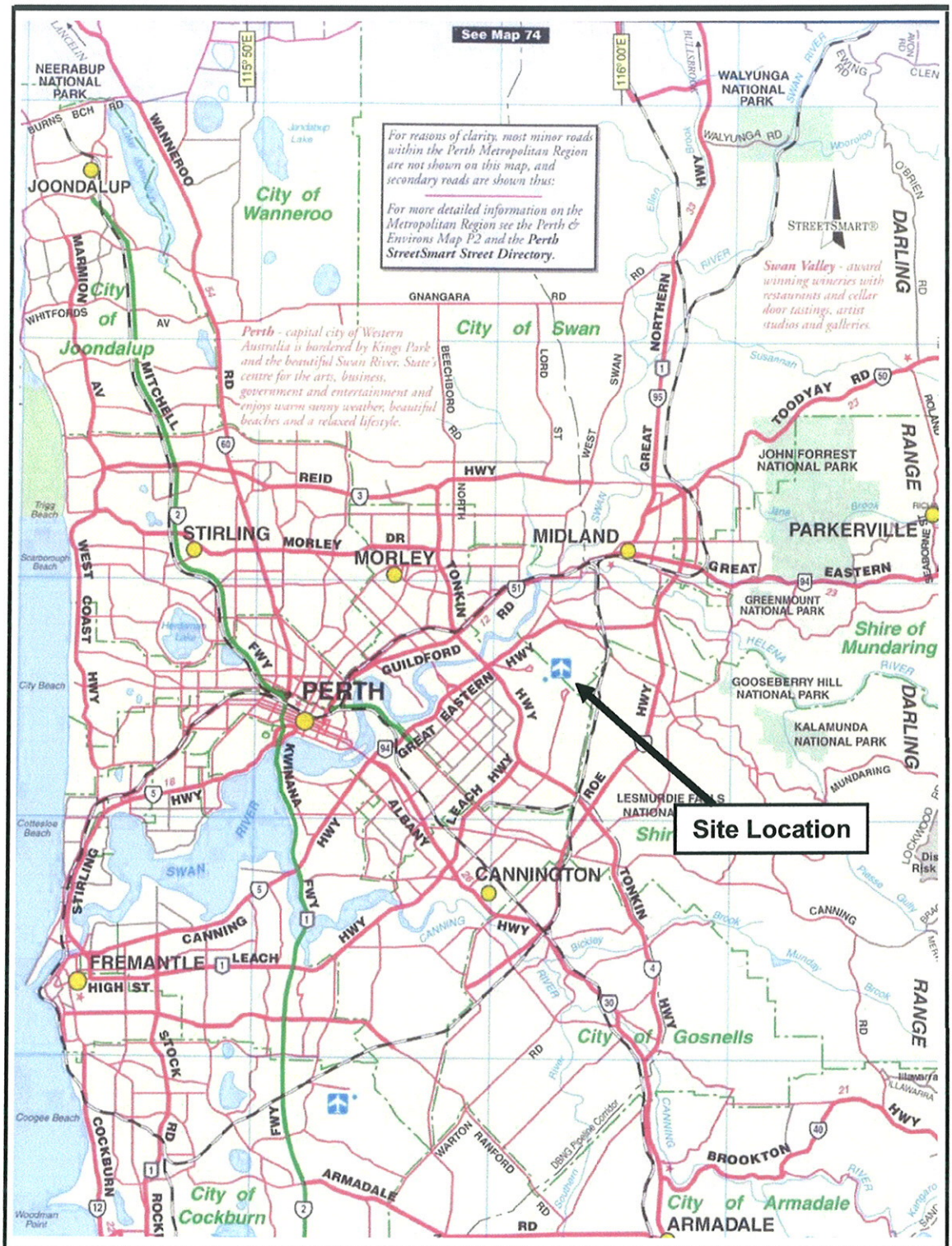


FIGURE 1 - Site Location		
CLIENT: Westralia Airports Corporation		
DRAWN BY: LS	CHECKED BY: NW	JOB NUMBER: 04.128
DATE: 19/1/2005	REPORT ISSUE: Final	SCALE: NTS

env Australia

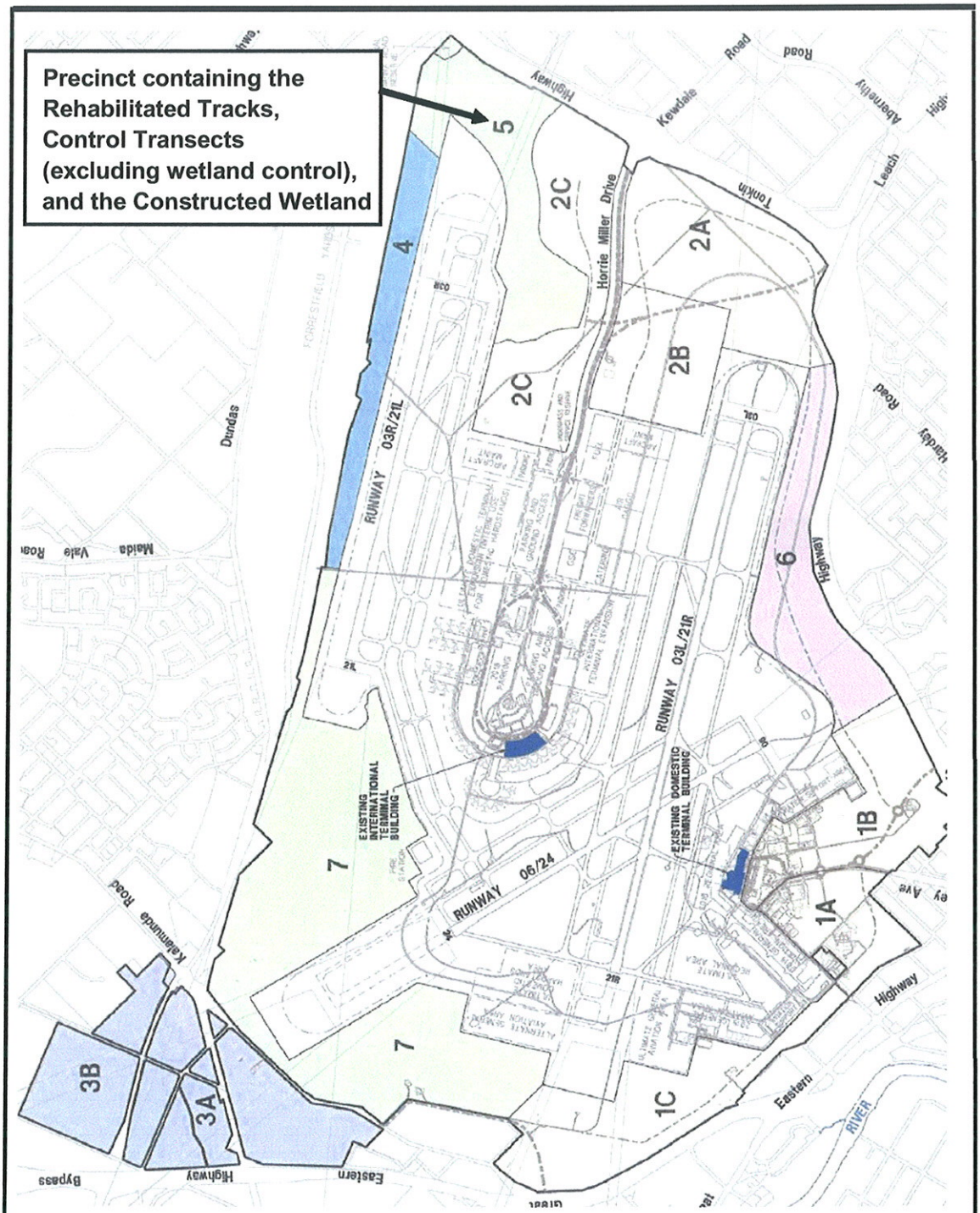


FIGURE 2 – Perth Airport Precincts		
CLIENT: Westralia Airports Corporation		
DRAWN BY: NW	CHECKED BY: KL	JOB NUMBER: 04.128
DATE:10/1/2005	REPORT ISSUE: FINAL	SCALE: NTS

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KEY

Rehabilitated tracks

Rehab and control transects

Rehabilitation monitoring transects for constructed wetland

FIGURE 3: Location of rehabilitation and control transects		
CLIENT: Westralia Airports Corporation		
DRAWN BY: NW	CHECKED BY: KL	JOB NUMBER: 04.128
DATE: 10/1/05	REPORT ISSUE: Final	Insert generated by GJC @ WAC

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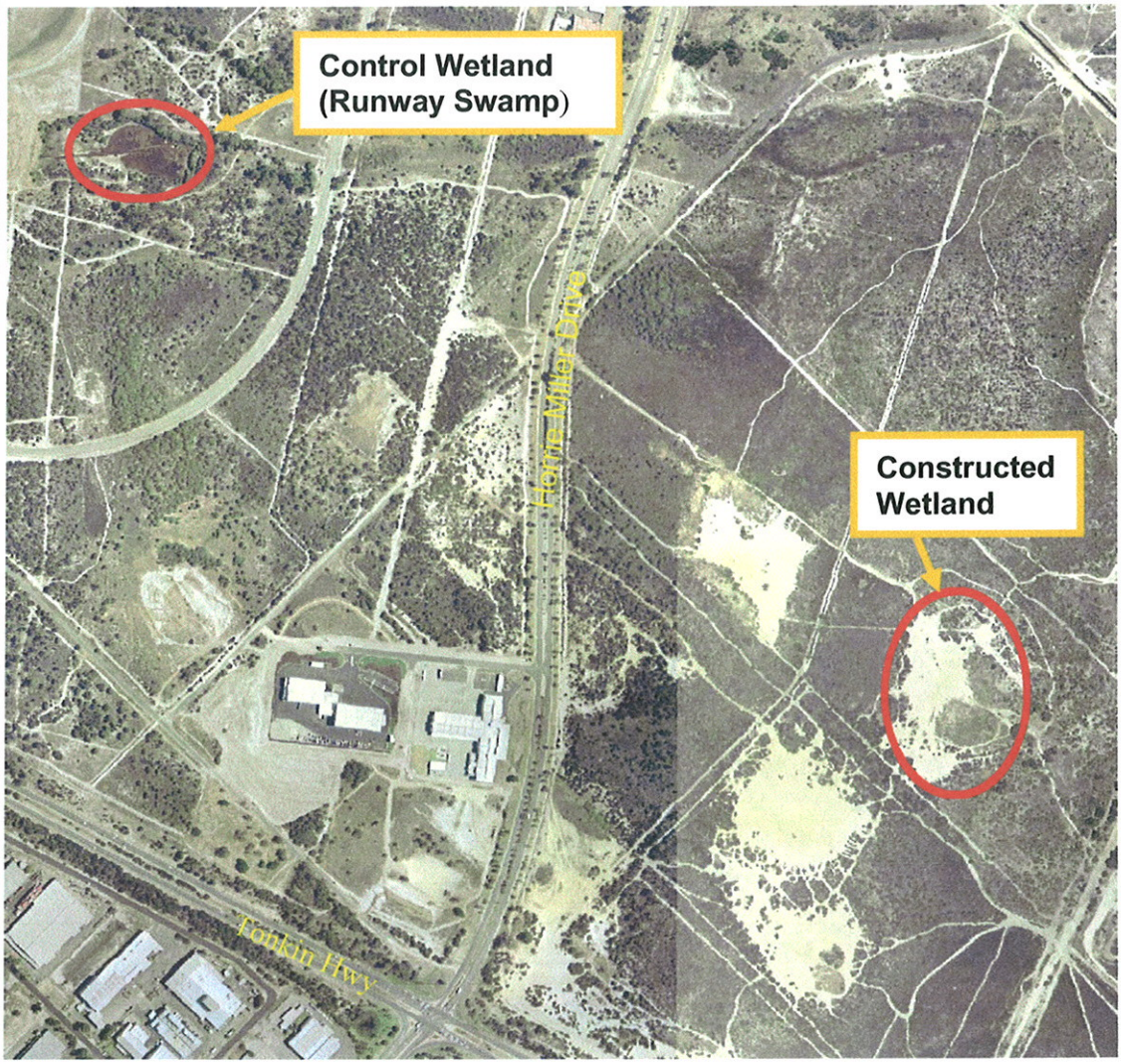


FIGURE 4 – Location of Control and Constructed Wetlands		
CLIENT: Westralia Airports Corporation		
DRAWN BY: NW	CHECKED BY: SB	JOB NUMBER: 04.128
DATE:10/1/05	REPORT ISSUE: Final	SCALE: NTS

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FIGURE 5: Location of tracks that were nominated to regenerate themselves		
CLIENT: Westralia Airports Corporation		
DRAWN BY: NW	CHECKED BY: KL	JOB NUMBER: 04.128
DATE: 10/1/05	REPORT ISSUE: Final	Insert generated by GJC @ WAC

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Appendix 2 Transect Location and Orientation Details

Transect Location and Orientation Details

Transect	Flagging Colour	Direction from Start	Start Easting *	Start Northing	Finish Easting *	Finish Northing
CcBa (R)	Orange / Yellow	NW	403354 E	6461471 N	403325 E	4641500 N
CcBa (C)	Orange / Yellow	S	403394 E	6461535 N	403387 E	6461573 N
MpPe (R)	Orange / Yellow	E	403443 E	6461576 N	403499 E	6461573 N
MpPe (C)	Orange / Yellow	SE	403470 E	6461566 N	403513 E	6461552 N
BaBm (R)	Orange / Yellow	NW	403508 E	6461734 N	403479 E	6461772 N
BaBm (C)	Orange / Yellow	NW	403446 E	6461749 N	403425 E	6461790 N
Pe (R)	Orange / Yellow	NE	403045 E	6461868 N	403071 E	6461913 N
Pe (C)	Orange / Pink	NE	403116 E	6462054 N	403094 E	6462017 N
Wetland (C)	Orange / Yellow	SE	401829 E	6463201 N	401785 E	6463185 N
Wetland A (R)	Orange / Yellow	SE	403056 E	6462477 N	403082 E	6462450 N
Wetland B (R)	Orange / Yellow	SE	403050 E	6462400 N	403079 E	6462383 N

- Note: All co-ordinates for Area 50 (GDA94)

Appendix 3 Transect Summaries

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Precinct 5 Monitoing
Transect Summary

Quadrat: CcBa (Control)

Species	Total
* Ehrharta calycina	12
Acacia applanata	1
Acacia huegeliii	1
Acacia pulchella	1
Alexgeorga nitens	512
Allocasuarina fraseriana	1
Astartea affinis (ms)	2
Banksia menziesii	1
Bossiaea eriocarpa	55
Burchardia umbellata	8
Calytrix flavescens	20
Corymbia calophylla	3
Dampiera linearis	57
Dasypogon bromelifolius	106
Desmocladus fasciculatus	37
Desmocladus flexuosus	21
Gompholobium tomentosum	1
Haemodorum spicatum	1
Hovea trisperma	9
Hypolaena exculsa	58
Jacksonia floribunda	20
Laxmannia ramosa	3
Lyginia barbata / imberbis	415
Melaleuca seriata	4
Myrtaceae sp.	1
Lomandra nicricans	1
Patersonia occidentalis	23
Phlebocarya ciliata	16
Scholtzia involucrata	7
Thysanotus manglesianus	1
Tricoryne elatior	8
Xanthorrhoea brunonis	1
Xanthorrhoea preissii	7
Total Natives	**1402**
Total Native Species	**32**
Native Cover %	**80%**
Weed Cover %	**12%**
Total Weed Species	**1**

Density 35 plants/m2

Dominant Native Species	1	*Alexgeorga nitens*
	2	*Lyginia barbata / imberbis*
	3	*Dasypogon bromelifolius*
Dominant Introduced Species	1	** Erharta calycina*
	2	
	3	
Site Description	Very good native cover with few weeds.	

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Precinct 5 Monitoing Transect Summary

Quadrat: CcBa (Rehab)

Species	Total
* Conyza sp.	7
* Ehrharta calycina	85
* Hypochaeris glabra	6
* Sonchus oleraceus	2
* Ursinsia anthemoides	6
* Yellow balls	2
Adenanthos cygnorum	12
Allocasuarina humilis	4
Banksia attenuata	3
Banksia menziesii	27
Bossiaea eriocarpa	2
Conostylis sp.	1
Corymbia calophylla	24
Dasypogon bromelifolius	7
?Daviesia triflora (formerly Photo sample 1)	1
Gompholobium tomentosum	29
Hibbertia racemosa	3
Hypolaena exculsa	2
Jacksonia floribunda	3
Kennedia prostrata	15
Laxmannia ramosa	3
Laxmannia squarrosa	13
Leucopogon conostephioides	2
Patersonia occidentalis	7
Podotheca angustifolia	14
Scholtzia involucrata	5
Stylidium dichotomum	1
Verticordia densiflora var densiflora	2
Total Natives	**180**
Total Native Species	**22**
Native Cover %	**1%**
Weed Cover %	**1%**
Total Weed Species	**6**

Density 4.5 plants/m2

Dominant Native Species	1	*Gompholobium tomentosum*
	2	*Corymbia calophylla*
	3	*Banksia menziesii*
Dominant Introduced Species	1	** Erharta calycina*
	2	** Conyza sp.*
	3	** Hypochaeris glabra*
Site Description	Loss of some plants, however all seedlings remaining appear healthy. Good development of trees (observed). Lots of dead matter within quadrats taking up space (approx 30%).	

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Precinct 5 Monitoing Transect Summary

Quadrat: Pe (Control)

Species	Total
Byblis gigantea	1
Calothamnus lateralis	1
Cassytha pomiformis	2
Cytogodinium leptocarpoides	405
Dampiera linearis	10
Dasypogon bromelifolius	6
Euchilopsis linearis	20
Hairy conostylis	1
Lyginia barbata / imberbis	6
Melaleuca seriata	109
Patersonia occidentalis	2
Pericalymma ellipticum	563
Phlebocarya ciliata	5
Stirlingia latifolia	16
Stylidium dichotomum	19
Thysanotus multiflorus	1
Verticordia densiflora var densiflora	134
Total Natives	**1301**
Total Native Species	**17**
Native Cover %	**75%**
Weed Cover %	**0%**
Total Weed Species	**0**

Density 32 plants/m2

Dominant Native Species	1	*Pericalymma ellipticum*
	2	*Cytogodinium leptocarpoides*
	3	*Melaleuca seriata*
Dominant Introduced Species	1	*None*
	2	
	3	
Site Description	Excellent condition seasonal wetland. No weeds recorded during latest assessment.	

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Precinct 5 Monitoing Transect Summary

Quadrat: MpPe (Control)

Species	Total
Astartea affinis (ms)	53
Calothamnus lateralis	9
Cassytha pomiformis	1
Eutaxia virgata	3
Lepidosperma longitudinale	42
Meeboldina cana	303
Melaleuca lateritia	85
Melaleuca preissiana	14
Melaleuca rhaphiophylla	8
Melaleuca seriata	4
Pericalymma ellipticum	54
Villarsia albiflora	65
Total Natives	**641**
Total Native Species	**12**
Native Cover %	**55%**
Weed Cover %	**0%**
Total Weed Species	**0**

Density 16 plants/m2

Dominant Native Species	1	*Meeboldina cana*
	2	*Melaleuca lateritia*
	3	*Astartea affinis (ms)*
Dominant Introduced Species	1	*None*
	2	
	3	
Site Description	No weeds recorded. Not as dense as Pe control.	

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Precinct 5 Monitoing
Transect Summary

Quadrat: MpPe (Rehab)

Species	Total
* Ehrharta calycina	44
* Eragrostis curvula	24
* Hypochaeris glabra	3
* Isolepis marginata	22
Adenanthos cygnorum	1
Amphipogon turbinatus	2
Conostylis setosa	1
Euchilopsis linearis	2
Hypocalymma angustifolium	1
Hypolaena exculsa	17
Jacksonia furcellata	2
Laxmannia squarrosa	5
Lyginia barbata / imberbis	10
Melaleuca lateritia	2
Melaleuca rhaphiophylla	1
Patersonia occidentalis	72
Pericalymma ellipticum	155
Siloxerus humifusus	13
Stylidium dichotomum	16
Verticordia densiflora var densiflora	35
Total Natives	**335**
Total Native Species	**16**
Native Cover %	**1%**
Weed Cover %	**1%**
Total Weed Species	**5**

Density 8 plants/m2

Dominant Native Species	1	*Pericalymma ellipticum*
	2	*Patersonia occidentalis*
	3	*Verticordia densiflora var densiflora*
Dominant Introduced Species	1	** Erharta calycina*
	2	** Eragrostis curvula*
	3	** Isolepis marginata*
Site Description	High levels of brush remain on track (cover approx 30 to 40% of quadrats). Taking this into account plant density is therefore close to the control plot in the barer sections. Weed cover is low and dominated by grasses.	

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Precinct 5 Monitoing
Transect Summary

Quadrat: BaBm (Control)

Species	Total
* Hypochaeris glabra	1
Acacia pulchella	9
Alexgeorga nitens	624
Amphipogon turbinatus	21
Banksia attenuata	3
Banksia menziesii	3
Bossiaea eriocarpa	11
Bossiaea ornata	3
Burchardia umbellata	5
Calytrix fraseri	5
Cassytha pomiformis	11
Conostephium pendulum	1
Conostylis juncea	9
Dampiera linearis	39
Dasypogon bromelifolius	11
Desmocladus fasciculatus	10
Desmocladus flexuosus	19
Eremaea pauciflora	13
Gompholobium tomentosum	9
Hibbertia aurea	1
Hibbertia racemosa	2
Hovea trisperma	2
Jacksonia floribunda	20
Laxmannia ramosa	103
Laxmannia squarrosa	9
Lepidosperma squamatum	2
Leucopogon conostephioides	19
Lomandra hermaphrodita	10
Lyginia barbata / imberbis	171
Melaleuca seriata	58
Patersonia occidentalis	6
Petrophile linearis	2
Podotheca angustifolia	22
Scholtzia involucrata	16
Stylidium repens	2
Xanthorrhoea brunonis	1
Total Natives	**1252**
Total Native Species	**35**
Native Cover %	**39%**
Weed Cover %	**0%**
Total Weed Species	**1**

Density 31 plants/m2

Dominant Native Species	1	*Alexgeorga nitens*
	2	*Lyginia barbata / imberbis*
	3	*Melaleuca seriata*
Dominant Introduced Species	1	** Hypochaeris glabra*
	2	
	3	
Site Description	Good diversity of species.	

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Precinct 5 Monitoing Transect Summary

Quadrat: BaBm (Rehab)

Species	Total
* Ehrharta calycina	54
* Ursinsia anthemoides	3
Adenanthos cygnorum	2
Banksia menziesii	3
Bossiaea eriocarpa	4
Conostylis setosa	2
Dampiera linearis	1
Desmocladus flexuosus	1
Eremaea pauciflora	3
Euchiliopsis linearis	2
Gompholobium tomentosum	20
Hypolaena exculsa	1
Jacksonia floribunda	4
Jacksonia furcellata	1
Lyginia barbata / imberbis	2
Patersonia occidentalis	1
Pericalymma ellipticum	1
Podotheca angustifolia	53
Scholtzia involucrata	3
Total Natives	**104**
Total Native Species	**17**
Native Cover %	**1%**
Weed Cover %	**1%**
Total Weed Species	**2**

Density 2.6 plants/m2

Dominant Native Species	1	*Podotheca angustifolium*
	2	*Gompholobium tomentosum*
	3	*Banksia menziesii*
Dominant Introduced Species	1	** Erharta calycina*
	2	** Ursinia anthemoides*
	3	
Site Description	Loss of 40% of seedlings since last assessment. All quadrats still covered with thick brush layer, hence smaller number of plants compared with other transects. Main species is annual so may not be present at next assessment.	

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Precinct 5 Monitoing Transect Summary

Quadrat: Wetland Control

Species	Total
* Cyndon dactylon	14
* Ehrharta calycina	12
* Eragrostis curvula	12
* Hypochaeris glabra	5
* Isolepis marginata	9
Astartea affinis (ms)	51
Baumea articulata	135
Centella asiatica	92
Crassula sp.	12
Dampiera linearis	3
Eutaxia virgata	2
Goodenia pulchella subsp Coastal Plain A	5
Jacksonia furcellata	3
Lepidosperma sp	1
Meeboldina cana	470
Melaleuca lateritia	19
Melaleuca preissiana	7
Melaleuca rhaphiophylla	3
Melaleuca teretifolia	2
Schoenus subfascicularis	42
Unidentified (no nearby sample)	1
Total Natives	**848**
Total Native Species	**16**
Native Cover %	**27%**
Weed Cover %	**4%**
Total Weed Species	**5**

Density 21 plants/m2

Dominant Native Species	1	*Meeboldina cana*
	2	*Baumea articulata*
	3	*Centella asiatica*
Dominant Introduced Species	1	** Cyndon dactylon*
	2	** Ehrharta calycina*
	3	** Eragrostis curvula*
Site Description	Area still very wet due to above average and summer rainfall. Green frog observed in monitoring plot during assessment. Weeds concentrated in waterside quadrats.	

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Precinct 5 Monitoing
Transect Summary

Quadrat: Wetland A

Species	Total
* Anagallis arvensis var arvensis	12
* Ehrharta calycina	8
* Eragrostis curvula	16
* Isolepis marginata	77
* Juncus microcephalus	3
* Solanum nigrum	2
* Typha orientalis	5
Acacia pulchella	3
Adenanthos cygnorum	1
Astartea affinis (ms)	2
Conostylis setosa	18
Cyperus polystachyos	3
Dampiera linearis	1
Dasypogon bromelifolius	17
Desmocladus flexuosus	1
Eucalyptus rudis	3
Euchilopsis linearis	12
Gompholobium tomentosum	31
Hypocalymma angustifolium	111
Hypolaena exculsa	96
Jacksonia furcellata	3
Juncus planifolius	7
Kennedia prostrata	1
Kunzea ericifolia	37
Lyginia barbata / imberbis	15
Patersonia occidentalis	4
Pericalymma ellipticum	8
Scholtzia involucrata	2
Siloxerus humifusus	12
Stylidium diuroides subsp diuroides	7
Total Natives	**395**
Total Native Species	**23**
Native Cover %	**4%**
Weed Cover %	**5%**
Total Weed Species	**7**

Density 9.4 plants/m2

Dominant Native Species	1	*Hypocalymma angustifolium*
	2	*Hypolaena exsulca*
	3	*Kunzea ericifolia*
Dominant Introduced Species	1	** Isolepis marginata*
	2	** Eragrostis curvula*
	3	** Anagallis arvensis var arvensis*
Site Description	First quadrat under water, second bare. High cover of dead weeds, predominantly * Isolepis marginata.	

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Precinct 5 Monitoing Transect Summary

Quadrat: Wetland B

Species	Total
* Anagallis arvensis var arvensis	22
* Avena barbata	4
* Conyza sp.	6
* Eragrostis curvula	6
* Hypochaeris glabra	3
* Isolepis marginata	77
* Juncus microcephalus	15
* Typha orientalis	9
* Vellereophyton dealbatum	4
Astartea affinis (ms)	1
Cyperus polystachyos	251
Eucalyptus rudis	1
Hypocalymma angustifolium	1
Hypolaena exculsa	1
Juncus pallidus	1
Melaleuca preissiana	2
Melaleuca rhaphiophylla	399
Total Natives	**657**
Total Native Species	**8**
Native Cover %	**4%**
Weed Cover %	**11%**
Total Weed Species	**9**

Density 16 plants/m2

Dominant Native Species	1	*Melaleuca rhapiophylla*
	2	*Cyperus polystachyos*
	3	*Melaleuca preissiana*
Dominant Introduced Species	1	** Isolepis marginata*
	2	** Anagallis arvensis var arvensis*
	3	** Juncus microcephalus*
Site Description	First plot under water. Melaleuca rhaphiophylla concentrated in two quadrats where it appears to have germinated from seed stored in brushing material. Doesn't represent entire site. High dead weed cover of *Isolepis marginata.	

Appendix 4 List of Species Identified By Transect

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Precinct 5 Monitoring
Species Diversity Summary

Taxa Identified Feb 06	CcBa C	CcBa R	Pe C	Pe R	MpPe C	MpPe R	BaBm C	BaBm R	Wetland C	Wetland A	Wetland B	Summary Feb 06	Summary Jun 05	Summary Dec 04	Summary to Date
Acacia applanata	Y											Y	Y	Y	Y
Acacia extensa													Y	Y	Y
Acacia huegeliii	Y											Y	Y	Y	Y
Acacia pulchella	Y						Y			Y		Y	Y	Y	Y
Acacia sp.														Y	Y
Adenanthos cygnorum		Y		Y		Y		Y		Y		Y	Y	Y	Y
* Aira caryophyllea														Y	Y
Alexgeorga nitens	Y						Y					Y	Y	Y	Y
Allocasuarina fraseriana	Y											Y		Y	Y
Allocasuarina humilis		Y										Y	Y		Y
Amphipogon turbinatus						Y	Y					Y	Y	Y	Y
* Anagallis arvensis var arvensis										Y	Y	Y		Y	Y
* Anagallis arvensis var caerulea														Y	Y
* Anagallis arvensis													Y		Y
* Arctotheca calendula													Y	Y	Y
Astartea affinis (ms)	Y				Y				Y	Y	Y	Y	Y	Y	Y
Astartea sp.													Y	Y	Y
* Avena barbata											Y	Y	Y	Y	Y
Banksia attenuata		Y					Y					Y	Y	Y	Y
Banksia menziesii	Y	Y					Y	Y				Y	Y	Y	Y
Baumea articulata									Y			Y	Y	Y	Y
Boronia ramosa subsp anethifolia													Y		Y
Boronia sp.														Y	Y
Bossiaea eriocarpa	Y	Y					Y	Y				Y	Y	Y	Y
Bossiaea ornata							Y					Y	Y	Y	Y
* Briza maxima				Y								Y	Y	Y	Y
* Briza minor														Y	Y
Burchardia umbellata	Y						Y					Y	Y	Y	Y
Byblis gigantea (Priority 2) - formerly Unidentifieable Native			Y									Y	Y		Y
Caladenia sp.													Y		Y
Calothamnus lateralis			Y	Y	Y							Y	Y	Y	Y
Calytrix flavescens	Y											Y			Y
Calytrix fraseri							Y					Y	Y	Y	Y
Cassytha pomiformis			Y		Y		Y					Y	Y	Y	Y
* Centaurium erythraea				Y								Y		Y	Y
Centella asiatica									Y			Y	Y		Y
Centrolepis aristata														Y	Y
* Cicendia filiformis														Y	Y
Conostephium minus														Y	Y
Conostephium pendulum							Y					Y	Y	Y	Y
Conostylis juncea							Y					Y	Y	Y	Y
Conostylis setosa			Y			Y		Y		Y		Y			Y
Conostylis sp.		Y										Y	Y	Y	Y
*** Conyza sp.**		Y									Y	Y			Y
Corymbia calophylla	Y	Y										Y	Y	Y	Y
Crassula sp									Y			Y		Y	Y
Cyperus polystachyos										Y	Y	Y			Y
* Cyndon dactylon									Y			Y	Y	Y	Y
Cytogodinium leptocarpoides			Y									Y	Y	Y	Y
Dampiera linearis	Y		Y				Y	Y	Y	Y		Y	Y	Y	Y
Dasypogon bromelifolius	Y	Y	Y	Y			Y			Y		Y	Y	Y	Y
Daviesia sp														Y	Y
? Daviesia triflora (formerly photo sample 1)		Y										Y	Y		Y
Desmocladus fasciculatus	Y						Y					Y	Y	Y	Y

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Precinct 5 Monitoring
Species Diversity Summary

Taxa Identified Feb 06	CcBa C	CcBa R	Pe C	Pe R	MpPe C	MpPe R	BaBm C	BaBm R	Wetland C	Wetland A	Wetland B	Summary Feb 06	Summary Jun 05	Summary Dec 04	Summary to Date
Desmocladus flexuosus	Y						Y	Y		Y		Y	Y	Y	Y
Desmocladus sp														Y	Y
Drosera sp													Y	Y	Y
* Ehrharta calycina	Y	Y		Y		Y		Y	Y	Y		Y	Y	Y	Y
* Eragrostis curvula						Y			Y	Y	Y	Y	Y		Y
Eremaea pauciflora							Y	Y				Y	Y	Y	Y
* Erodium botrys													Y		Y
Eucalyptus marginata														Y	Y
Eucalyptus rudis										Y	Y	Y	Y	Y	Y
Eucalyptus sp.														Y	Y
Euchilopis linearis		Y	Y	Y		Y		Y		Y		Y	Y	Y	Y
Eutaxia virgata					Y				Y			Y	Y	Y	Y
Gastrolobium capitatum													Y		Y
* Gladiolus caryophyllaceus													Y	Y	Y
Gompholobium sp.														Y	Y
Gompholobium tomentosum	Y	Y		Y			Y	Y		Y		Y	Y	Y	Y
Gonocarpus sp.?													Y		Y
Goodenia pulchella subsp Coastal Plain A				Y					Y			Y	Y		Y
Haemodorum spicatum	Y											Y			Y
Hibbertia aurea							Y					Y			Y
Hibbertia hypericoides													Y	Y	Y
Hibbertia racemosa		Y					Y					Y	Y	Y	Y
Hibbertia stellaris														Y	Y
Hovea trisperma	Y						Y					Y	Y	Y	Y
* Hydrocotyle bonariensis														Y	Y
Hypocalymma angustifolium				Y		Y				Y	Y	Y	Y	Y	Y
Hypocalymma sp.													Y	Y	Y
* Hypochaeris glabra / Flatweed		Y		Y		Y	Y		Y		Y	Y	Y	Y	Y
Hypolaena exculsa	Y	Y		Y		Y		Y		Y	Y	Y	Y	Y	Y
* Introduced Species 1														Y	Y
* Introduced Species 2														Y	Y
* Isolepis marginata				Y		Y			Y	Y	Y	Y	Y	Y	Y
Jacksonia floribunda	Y	Y					Y	Y				Y	Y	Y	Y
Jacksonia furcellata						Y		Y	Y	Y		Y	Y	Y	Y
Jacksonia sp														Y	Y
Jacksonia sternbergiana														Y	Y
* Juncus articulatus														Y	Y
*** Juncus microcephalus**										Y	Y	Y		Y	Y
Juncus pallidus											Y	Y			Y
Juncus planifolius										Y		Y			Y
Kennedia coccinea														Y	Y
Kennedia prostrata		Y								Y		Y	Y	Y	Y
Kunzea ericifolia										Y		Y	Y		Y
? Kunzea recurva													Y		Y
Lagenophora huegellii														Y	Y
Laxmannia ramosa	Y	Y					Y					Y	Y	Y	Y
Laxmannia sp.														Y	Y
Laxmannia squarrosa		Y				Y	Y					Y	Y	Y	Y
Lechenaultia biloba													Y	Y	Y
Lechenaultia ? biloba														Y	Y
Lechenaultia expansa														Y	Y
? Lechenaultia sp.														Y	Y
Lepidosperma longitudinale				Y	Y							Y	Y	Y	Y
Lepidosperma sp									Y			Y		Y	Y

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Precinct 5 Monitoring
Species Diversity Summary

Taxa Identified Feb 06	CcBa C	CcBa R	Pe C	Pe R	MpPe C	MpPe R	BaBm C	BaBm R	Wetland C	Wetland A	Wetland B	Summary Feb 06	Summary Jun 05	Summary Dec 04	Summary to Date
Lepidosperma squamatum							Y					Y	Y	Y	Y
Lepidosperma tenue														Y	Y
Leucopogon ? Sp. Murdoch (M. Hislop 1037)													Y		Y
Leucopogon conostephoides		Y					Y					Y	Y	Y	Y
Leucopogon sp														Y	Y
Levenhookia preissii														Y	Y
? Liliaceae sp.													Y		Y
Lobelia tenuior														Y	Y
Lomandra hermaphrodita							Y					Y	Y	Y	Y
Lomandra nigricans	Y												Y		Y
Lomandra sp														Y	Y
* Lotus subbiflorus														Y	Y
* Lupinus consentinii													Y		Y
Lyginia barbata / imberbis	Y		Y	Y		Y	Y	Y		Y		Y	Y	Y	Y
Meeboldina cana					Y				Y			Y	Y		Y
Meeboldina roycei													Y	Y	Y
Melaleuca lateritia					Y	Y			Y			Y	Y	Y	Y
Melaleuca preissiana					Y				Y		Y	Y	Y		Y
Melaleuca rhaphiophylla					Y	Y			Y		Y	Y	Y	Y	Y
Melaleuca seriata	Y		Y		Y		Y					Y	Y	Y	Y
Melaleuca sp														Y	Y
Melaleuca teretifolia									Y			Y	Y	Y	Y
* Moraea flaccida													Y		Y
MYRTACEAE sp.												Y	Y		Y
MYRTACEAE sp. 2	Y											Y	Y		Y
* Oxalis glabra													Y		Y
* Oxalis sp.													Y		Y
Patersonia occidentalis	Y	Y	Y	Y		Y	Y	Y		Y		Y	Y	Y	Y
? Patersonia sp														Y	Y
* Pelargonium sp													Y	Y	Y
Pericalymma ellipticum			Y	Y	Y	Y		Y		Y		Y	Y	Y	Y
Petrophile linearis							Y					Y	Y	Y	Y
Philotheca spicata													Y		Y
? Philotheca spicata												Y	Y	Y	Y
Phlebocarya ciliata	Y		Y											Y	Y
? Phyllanthus sp													Y	Y	Y
POACEAE sp												Y	Y		Y
Podotheca angustifolia		Y		Y			Y	Y						Y	Y
PROTEACEAE sp													Y		Y
Pterostylis sanguinea													Y		Y
Quinetia urvellii														Y	Y
RESTIONACEAE sp														Y	Y
* Romulea rosea													Y		Y
? Sample B (Unidentifiable)													Y		Y
? Sample G (Unidentifiable)												Y			Y
Schoenus benthamii (Priority 3)				Y								Y	Y		Y
Schoenus subfascicularis									Y			Y	Y	Y	Y
Scholtzia involucrata	Y	Y					Y	Y		Y		Y		Y	Y
Siloxerus humifusus		Y		Y		Y				Y		Y	Y		Y
* Solanum nigrum												Y	Y	Y	Y
* Sonchus oleraceus		Y										Y	Y	Y	Y
Stirlingia latifolia			Y											Y	Y
Stylidium brunonianum														Y	Y
Stylidium dichotomum															

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Precinct 5 Monitoring
Species Diversity Summary

Taxa Identified Feb 06	CcBa C	CcBa R	Pe C	Pe R	MpPe C	MpPe R	BaBm C	BaBm R	Wetland C	Wetland A	Wetland B	Summary Feb 06	Summary Jun 05	Summary Dec 04	Summary to Date
Stylidium diuroides subsp diuroides										Y		Y			Y
Stylidium piliferum														Y	Y
Stylidium repens				Y			Y					Y	Y	Y	Y
Stylidium sp.													Y		Y
? Tetratheca hirsuta														Y	Y
Thysanotus manglesianus	Y											Y	Y	Y	Y
Thysanotus multiflorus			Y	Y								Y	Y	Y	Y
Trachymene pilosa														Y	Y
Tricoryne elatior	Y											Y	Y	Y	Y
* Trifolium sp														Y	Y
*** Typha orientalis**										Y	Y	Y			Y
Unidentiable Native 2 (no sample avail)									Y			Y	Y		Y
Unidentified Native 3 (no sample avail)				Y								Y			Y
* Unidentified Dicotyledon													Y		Y
* Unidentified Monocotyledon													Y		Y
* Ursinsia anthemoides		Y						Y				Y	Y	Y	Y
* Vellereophyton dealbatum				Y							Y	Y		Y	Y
Verticordia densiflora var densiflora		Y	Y	Y		Y						Y	Y	Y	Y
Verticordia sp														Y	Y
Villarsia albiflora					Y							Y	Y		Y
* Vulpia sp.													Y		Y
Wahlenbergia preissii													Y		Y
* Watsonia meriana var bulbillifera													Y	Y	Y
Xanthorrhoea brunonis	Y						Y					Y			Y
Xanthorrhoea preissii	Y											Y	Y	Y	Y
Total Species	**33**	**28**	**16**	**25**	**12**	**19**	**36**	**19**	**21**	**30**	**17**	**105**	**121**	**134**	**187**
Native Species	**32**	**23**	**16**	**19**	**12**	**15**	**35**	**17**	**16**	**23**	**8**	**89**	**98**	**107**	**147**
Introduced Species	**1**	**5**	**0**	**6**	**0**	**4**	**1**	**2**	**5**	**7**	**9**	**16**	**23**	**27**	**40**

Note:
Bold = New species
Blue = refinement of identification of species

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Precinct 5 Rehabilitation
Westralia Airports Corporation

Vegetation Monitoring Report

May 2006

P130-01 Rev 1

Tranen Pty Ltd
1/110 Jersey Street
Jolimont, WA 6014
p (08) 9284 1399
f (08) 9284 1377
email@tranen.com.au
www.tranen.com.au

Disclaimer

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Table of Contents

1 Introduction 1
2 Background 2
3 Monitoring Methodology 4
3.1 Transect Layout 4
3.2 Methodology 5
3.3 New Measure – Transect Representation 5
4 Results 7
4.1 Flora 7
4.1.1 Declared Rare and Priority Species 7
4.1.2 Introduced Species 7
4.2 Species Richness 8
4.3 Native Plant Density 8
4.4 Structural Layers and Surface Cover 9
4.5 Average and Maximum Plant Heights 12
4.6 Transect Representation of Tracks 12
4.7 Self-Regenerating Tracks 13
5 Discussion 14
5.1 General 14
5.2 Corymbia calophylla / Banksia attenuata Tracks 15
5.3 Pericalymma ellipticum Tracks 15
5.4 *Melaleuca preissiana / Pericalymma ellipticum* Tracks 17
5.5 *Banksia attenuata / Banksia menziesii* Tracks 17
5.6 Constructed Wetland 18
5.7 Self-Regenerating Tracks 20
6 Conclusions 21
7 References 22
APPENDIX 1 TRANSECT LOCATION MAPS 23
APPENDIX 2 TRANSECT LOCATION AND ORIENTATION DETAILS 29
APPENDIX 3 TRANSECT SUMMARIES 31
APPENDIX 4 LIST OF SPECIES IDENTIFIED BY TRANSECT 43
APPENDIX 5 TRANSECT AND TRACK COMPARISON MAP 48

Table of Figures

Figure 1 Transect Layout 4
Figure 2 MpPe Track – Transect (Left) and 100 m Further Along (Right) 5
Figure 3 CcBa Control and Rehabilitation Transect Photos 15
Figure 4 Pe Control and Rehabilitation Transect Photos 16
Figure 5 MpPe Control and Rehabilitation Transect Photos 17
Figure 6 BaBm Control and Rehabilitation Transect Photos 18
Figure 7 Constructed Wetland Control and Rehabilitation Transect Photos 19

Table of Tables

Table 1 Track Comparison Ratings 6
Table 2 Total Number of Species Identified During Assessments 7
Table 3 Number of Species Identified By Transect 8
Table 4 Native Stem Counts and Density 9
Table 5 CcBa Structural Layer Composition 9
Table 6 Pe Structural Layer Composition 10
Table 7 MpPe Structural Layer Composition 10
Table 8 BaBm Structural Layer Composition 11
Table 9 Wetland A Structural Layer Composition 11
Table 10 Wetland B Structural Layer Composition 12
Table 11 Average and Maximum Plant Heights 12
Table 12 Transect Representation of Entire Track 13

1 INTRODUCTION

The Perth Airport is located approximately 10 km east of Perth and covers an area of 2,105 ha over 3 municipalities: City of Belmont, City of Swan, and the Shire of Kalamunda. The airport land is bounded by Tonkin Highway, Great Eastern Highway, Kalamunda Road, and Abernethy Road.

Figure 2 in Appendix 1 shows the airport is divided into 7 precincts, each with its own independent management objectives. The southern part of Precinct 2C was cleared for development in 2003 and the opportunity arose to utilise high quality topsoil and bush for the rehabilitation of unauthorised access tracks and the construction of a wetland in Precinct 5 (conservation zone).

Tranen Revegetation Systems were commissioned in May 2005 to continue the vegetation monitoring program in Precinct 5 for initial works that were undertaken in November 2003. This is the third assessment by Tranen, and the fourth since rehabilitation works were originally conducted. The monitoring of these works are to continue until November 2008 as committed to in the Precinct 5 Rehabilitation Plan (ENV Australia, 2003) approved by the Department of Transport and Regional Services, and the Department of Environment and Heritage.

The aim of the monitoring is to catalogue progress within the rehabilitation areas and to determine whether remedial actions are required. The program involves monitoring 11 permanently established transects in Precinct 5 by:

- Counting the total number of native seedlings;
- Identifying all species (both native and introduced) contained within;
- Determining the percentage cover of native and introduced species;
- Observing factors that may be impeding or promoting plant establishment; and
- Maintaining a photographic log for visual comparison.

The monitoring is to be conducted in spring and autumn each year for the five year period. This report details the findings from the four assessments conducted to May 2006.

2 BACKGROUND

The southern section of Precinct 2C has been developed as a business park. The development is outlined in the approved Master Plan and in the Major Development Plan (MDP), (The Planning Group, 2003). The MDP provides a detailed description of the environmental values of Precinct 2C South, the impacts associated with the development, and how these impacts are to be managed or mitigated.

As 8 of the 44 hectares within Precinct 2C South were classed as in 'good condition' (Mattiske, 2003) it was decided that this resource should not be wasted and that it would be used to rehabilitate sections of the conservation zone Precinct 5.

The general approach to the rehabilitation was to collect carefully selected soil and vegetation material from the cleared section of Precinct 2C South and use it to rehabilitate unauthorised access tracks and a constructed wetland in Precinct 5. The best quality vegetation and topsoil from Precinct 2C South was selected for use in the same vegetation community type in Precinct 5.

The activities undertaken during the clearing of Precinct 2C South and the rehabilitation of Precinct 5 involved:

- Bandicoot capture and relocation;
- Seed collection;
- Preparation and levelling of tracks;
- Relocation of soil surrounding a dead *Macarthuria keigheryi* plant (declared rare);
- Clearing and stockpiling of trees for use as brush and barricades;
- Clearing and stockpiling of other vegetative matter. A portion was mulched for later use and the remainder used for brushing;
- Windrowing of top 30 mm of topsoil (soil seed bank) from Precinct 2C South and relocation;
- Spreading of stockpiled mulch on remaining topsoil. Topsoil and mulch then windrowed to a depth of 150 mm to ensure thorough mixing. Mixture relocated to same vegetation system in Precinct 5;
- Spreading the soil seed bank over the topsoiled tracks and then deep ripping with a delta winged tine;
- Brushing and placement of large logs at the entry points to prevent further unauthorised access;
- Nomination to two tracks to self regenerate. The track in the Melaleuca vegetation community was also ripped and barricaded with logs, however the track in the Pericalymma community was not; and
- Conversion of a degraded open section to the north of the rehabilitation tracks into a constructed wetland.

The following maintenance activities have been undertaken in Precinct 5 since May 2005:

- May 2005 – weed control - constructed wetland;
- June 2005 – tubestock planting by Conservation Volunteers of Australia (CVA) – constructed wetland
- October 2005 – February 2006 – provenance seed recovery in anticipation of remedial works – all Precinct 5; and
- February 2006 – weed control – constructed wetland;
- June 2006 – weed control – rehabilitation tracks – grass specific and spot spraying.

The following activities are scheduled in Precinct 5 over winter / spring 2006:

- June 2006 – planting 1,800 trees and shrubs – constructed wetland;
- July 2006 – weed control all Precinct 5 rehabilitation tracks, and constructed wetland; and
- September 2006 – planting 10,000 rushes and sedges, plus translocation of difficult to propagate species – constructed wetland.

3 MONITORING METHODOLOGY

11 monitoring transects have been established in five different vegetation systems. There is one control transect for each location and one rehabilitation transect for each area except for the constructed wetland which has two transects and one control. The vegetation systems are:

1. Corymbia calophylla / Banksia attenuata (CcBa);
2. Pericalymma ellipticum (Pe);
3. Melaleuca preissiana / Pericalymma ellipticum (MpPe);
4. Banksia attenuata / Banksia menziesii (BaBm); and
5. Wetland.

Appendix 1 contains drawings showing the general position of the rehabilitation zones and the monitoring transects.

The monitoring began in December 2004 and was conducted by ENV Australia. Tranen Revegetation Systems were then commissioned to continue the monitoring program in June 2005, making a few modifications to the methodology.

3.1 Transect Layout

The transects were established in December 2003 shortly after the rehabilitation works were completed. The rehabilitation transects were established along the middle of the tracks, and the control plots nearby within a minimally disturbed section of the same type of existing bushland. Each transect is marked by six stakes spaced at 10m intervals (see Figure 1 below).

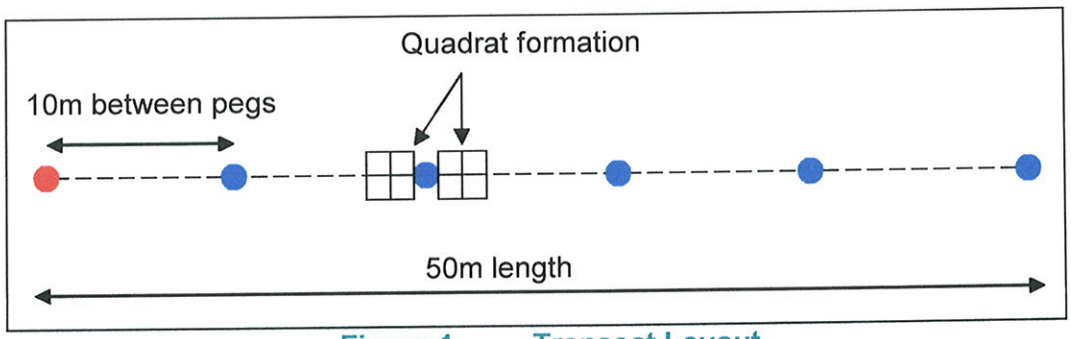


Figure 1 Transect Layout

The first marker is the location from which the photo is taken, and the remaining five stakes are where the two 2 m x 2 m quadrats are placed. The co-ordinates for the start and end point of each transect were determined using GPS and the details can be found in Appendix 2. For some tracks the transects may not be in a straight line as they have been placed on changes of direction in the track. The transects do however still span for 50 m.

In the constructed wetland the transects are located so that they begin at the waters edge and proceeded up slope. The wetland control transect is located in Runway Swamp located some distance away near the end of Runway 21R.

3.2 Methodology

The monitoring program was established by ENV Australia for the first assessment in December 2004 and involves the recording of the following information for each quadrat:

- Transect and quadrat number;
- Species present;
- Number of alive and dead plants;
- Percentage cover of alive and dead plants;
- General observations of the site e.g. thick ground litter, rubbish, etc; and
- Photographic record.

The percentage cover is determined for each structural layer by assessing the amount of shade cast by each of the five main layers: grasses, herbs, sedges, shrubs, and trees. Native and introduced species are recorded separately.

For the tracks that were left to self-regenerate the state of each site is assessed and a photographic record maintained.

3.3 New Measure – Transect Representation

The total area monitored for each transect is 40 m^2 which represents a small percentage (< 1%) of the actual area covered by the rehabilitation tracks. For the information collected during the monitoring to be relevant the transects must accurately represent the condition of the remainder of rehabilitation tracks and controls.



Figure 2 MpPe Track – Transect (Left) and 100 m Further Along (Right)

Figure 2 shows the condition of the MpPe rehabilitation transect on the left, and the same track 100 m further along on the right. The difference in plant density and species richness is large. It is clear that the rehabilitation transect does not accurately represent the entire track.

To determine how accurately the transects represent the remainder of the tracks, the entire length of each track was traversed and qualitative comparisons made. The condition of each section of track was compared with the condition of each transect and given a rating between 1 and 5. Table 1 below explains the rating system.

Table 1 Track Comparison Ratings

Rating	Estimated Native Density of Track As Percentage Of Transect Density
1	50% or less
2	50 – 75%
3	75 – 125%
4	125 – 150%
5	More than 150%

As an example if a transect has a density of 10 plants / m^2 then the track would have a rating of 3 if there were estimated to be between 7.5 and 12.5 plants / m^2. Less than 5.0 plants / m^2 would have a 1 rating, 5.0 – 7.5 plants / m^2 a 2 rating, 12.5 – 15.0 plants / m^2 a 4 rating and more than 15 plants / m^2 a 5 rating.

Appendix 5 contains a drawing which identifies each section of track and provides the ratings assigned to each section. Sections 4 and 5 provide further details on the findings.

4 RESULTS

The information summarised in this section (further details and comparisons can be found in Appendix 3) is from the assessments conducted in:

- December 2004 (ENV Australia, 2004)
- June 2005 (Tranen Revegetation Systems, 2005);
- February 2006 (Tranen Revegetation Systems, 2006-1);
- May 2006 (Tranen Revegetation Systems, 2006-2).

4.1 Flora

Five new native species and two new introduced species were recorded during this assessment. The total number of native species recorded to date is 152, and for introduced species is 42, giving a total of 194 species recorded to date. Table 2 below contains a summary. A complete list of species can be found in Appendix 4. The level of identification of one species has been refined since the last assessment.

Table 2 Total Number of Species Identified During Assessments

Species	May 06	Feb 06	Jun 05	Dec 04	Total To Date
Native	86	89	96	107	152
Introduced	18	16	24	26	42
Total	**104**	**105**	**120**	**133**	**194**

4.1.1 Declared Rare and Priority Species

No Endangered or Vulnerable species pursuant to s178 of the Environmental Protection and Biodiversity Act, 1999 have been located during the monitoring assessments.

Two taxa gazetted for the area as Declared Rare of Priority Flora pursuant to subsection 1 of Section 23F of the Wildlife Conservation Act, 1950 (Western Australian Herbarium, 2005) have been located to date during the monitoring assessments. They are:

- *Byblis gigantea* (Priority 2) – Pe (Control); and
- *Schoenus benthamii* (Priority 3) – Pe (Rehab).

During this most recent assessment *Byblis gigantea* was not recorded. Only one specimen was observed during the last assessment. *Schoenus benthamii* was observed in the same location as previously recorded however numbers have declined from 12 to 2 since the last assessment.

4.1.2 Introduced Species

Two new introduced species (**Dittrichia graveolens*, and **Phytolacca octandra*) have been discovered within the monitoring plots bringing the total observed to date to 42. Some of the annual species were not observed

during the most recent assessment as the timing is outside of their normal growth cycle, or they were at early stages of growth and could not be distinguished between.

One of the species identified previously (* Moraea flaccida – One-Leaf Cape Tulip) is listed as a Declared Plant pursuant to Part IV, Section 37 of the Agriculture and Related Resources Protection Act, 1976 (Department of Agriculture, 2005). This species was not observed in February 2006 as it is a period in which the plant is dormant, but it was recorded again during this assessment.

4.2 Species Richness

Table 3 below is a summary of the number of species found within each of the monitoring transects for the two assessments. The details of the species found in each transect are presented in Appendix 2.

Table 3 Number of Species Identified By Transect

Transect	May 06		Feb 06		Jun 05		Dec 04	
	N	I	N	I	N	I	N	I
CcBa (C)	26	6	32	11	38	7	34	11
CcBa (R)	24	6	22	6	25	9	30	6
Pe (C)	17	1	17	0	16	1	17	3
Pe (R)	18	3	20	5	18	4	20	13
MpPe (C)	11	0	12	0	15	1	11	2
MpPe (R)	13	5	16	5	15	10	17	8
BaBm (C)	35	7	35	1	36	5	35	4
BaBm (R)	17	6	17	2	20	7	21	6
Wetland (C)	18	6	16	5	16	5	11	9
Wetland A (R)	26	7	23	7	24	9	29	8
Wetland B (R)	8	11	8	9	7	10	14	10
Total	**86**	**18**	**89**	**16**	**96**	**24**	**107**	**26**

Note: Control transects are marked (C) and Rehabilitation transects (R)
N and I refer to Native and Introduced species respectively

4.3 Native Plant Density

A count of the number of individual native plants was made during both the February 2006 and June 2005 assessments and can be found in Table 4. No data is available from the December 2004 assessment for comparison.

Table 4 Native Stem Counts and Density

Transect Location	May 06		Feb 06		Jun 05	
	Stem Count	Density (Stems / m2)	Stem Count	Density (Stems / m2)	Stem Count	Density (Stems / m2)
CcBa (C)	1,732	43.3	1,402	35.0	1,065	26.6
CcBa (R)	131	3.3	180	4.5	275	6.9
Pe (C)	1,189	29.7	1,301	32.5	1,332	33.3
Pe (R)	1,142	28.6	1,303	32.5	1,255	31.4
MpPe (C)	738	18.5	641	16.0	677	16.9
MpPe (R)	284	7.1	335	8.4	374	9.4
BaBm (C)	1,114	27.9	1,252	31.3	898	22.5
BaBm (R)	60	1.5	104	2.6	175	4.4
Wetland (C)	675	16.9	848	21.2	1,054	26.4
Wetland A (R)	305	7.6	395	9.9	591	14.8
Wetland B (R)	415	10.4	657	16.4	53	1.3
Average (C)	**1,090**	**27.3**	**1,089**	**27.2**	**1,005**	**25.1**
Average (R)	**390**	**9.7**	**496**	**12.4**	**453**	**11.3**

Note: Control transects are marked (C) and Rehabilitation transects (R)

4.4 Structural Layers and Surface Cover

Tables 5 to 10 below show the average composition of the five main structural layers (grasses, herbs, sedges, shrubs, and trees) by percentage ground cover for each of the five vegetation systems. In each table the control plot (marked with a C) is shown in red, followed by the four assessments between December 2004 and May 2006 for comparison.

The figures represent the amount of shade cast by the structural layers for each quadrat. The figures may therefore total more than 100%, as the layers overlap.

Table 5 CcBa Structural Layer Composition

Layer Type	Native / Weed	CcBa (C)	CcBa (R)	CcBa (R)	CcBa (R)	CcBa (R)
Date		**May-06**	**May-06**	**Feb-06**	**Jun-05**	**Dec-04**
% Grass	Native	0%	0%	0%	0%	1%
% Grass	Weed	1%	2%	1%	1%	5%
% Herb	Native	50%	0.25%	0.25%	1%	1%
% Herb	Weed	0%	1%	0%	2%	2%
% Sedge	Native	20%	0.25%	0.25%	0%	0%
% Sedge	Weed	0%	0%	0%	0%	0%
% Shrub	Native	30%	0.5%	0.25%	0%	7%
% Shrub	Weed	0%	0%	0%	0%	0%
% Tree	Native	20%	1%	0.25%	0%	3%
% Tree	Weed	0%	0%	0%	0%	0%
TOTAL	**Native**	**75%**	**2%**	**1%**	**1%**	**12%**
TOTAL	**Weed**	**1%**	**3%**	**1%**	**2%**	**7%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

Table 6 Pe Structural Layer Composition

Layer Type	Native / Weed	Pe (C)	Pe (R)	Pe (R)	Pe (R)	Pe (R)
Date		May-06	May-06	Feb-06	Jun-05	Dec-04
% Grass	Native	0%	0%	0%	0%	2%
% Grass	Weed	0%	1%	0.3%	0%	3%
% Herb	Native	5%	1%	1%	0%	1%
% Herb	Weed	0%	0%	0.1%	1%	3%
% Sedge	Native	30%	3%	2%	1%	1%
% Sedge	Weed	0%	0%	0.5%	0%	0%
% Shrub	Native	60%	20%	10%	2%	7%
% Shrub	Weed	0%	0%	0%	0%	0%
% Tree	Native	0%	0%	0%	0%	0%
% Tree	Weed	0%	0%	0%	0%	0%
TOTAL	**Native**	**83%**	**24%**	**13%**	**3%**	**10%**
TOTAL	**Weed**	**0%**	**1%**	**1%**	**1%**	**5%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

Table 7 MpPe Structural Layer Composition

Layer Type	Native / Weed	MpPe (C)	MpPe (R)	MpPe (R)	MpPe (R)	MpPe (R)
Date		May-06	May-06	Feb-06	Jun-05	Dec-04
% Grass	Native	0%	0%	0.1%	0%	1%
% Grass	Weed	0%	0.5%	0.75%	4%	3%
% Herb	Native	2%	0.25%	0.1%	1%	1%
% Herb	Weed	0%	0.5%	0%	3%	1%
% Sedge	Native	35%	0.25%	0.2%	0%	0%
% Sedge	Weed	0%	0%	0.25%	0%	0%
% Shrub	Native	40%	1.5%	0.5%	0%	2%
% Shrub	Weed	0%	0%	0%	0%	0%
% Tree	Native	5%	0%	0.1%	0%	0%
% Tree	Weed	0%	0%	0%	0%	0%
TOTAL	**Native**	**72%**	**2%**	**1%**	**1%**	**4%**
TOTAL	**Weed**	**0%**	**1%**	**1%**	**7%**	**4%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

Table 8 BaBm Structural Layer Composition

Layer Type	Native / Weed	BaBm (C)	BaBm (R)	BaBm (R)	BaBm (R)	BaBm (R)
Date		May-06	May-06	Feb-06	Jun-05	Dec-04
% Grass	Native	4%	0%	0%	0%	0%
% Grass	Weed	0%	2%	1%	3%	2%
% Herb	Native	20%	0.2%	0.4%	0%	1%
% Herb	Weed	1%	2%	0%	5%	1%
% Sedge	Native	10%	0.4%	0.1%	0%	0%
% Sedge	Weed	0%	0%	0%	0%	0%
% Shrub	Native	20%	0.4%	0.4%	0%	2%
% Shrub	Weed	0%	0%	0%	0%	0%
% Tree	Native	5%	0%	0.1%	0%	0%
% Tree	Weed	0%	0%	0%	0%	0%
TOTAL	**Native**	**36%**	**1%**	**1%**	**1%**	**3%**
TOTAL	**Weed**	**1%**	**4%**	**1%**	**8%**	**3%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

Table 9 Wetland A Structural Layer Composition

Layer Type	Native / Weed	Wet (C)	Wet A (R)	Wet A (R)	Wet A (R)	Wet A (R)
Date		May-06	May-06	Feb-06	Jun-05	Dec-04
% Grass	Native	0%	0.1%	0%	0%	0%
% Grass	Weed	0.5%	0.25%	2%	1%	2%
% Herb	Native	2%	1%	0%	0%	1%
% Herb	Weed	0.5%	0.75%	0%	2%	1%
% Sedge	Native	40%	2%	1%	0%	1%
% Sedge	Weed	0%	0%	3%	0%	2%
% Shrub	Native	7%	4%	3%	4%	7%
% Shrub	Weed	0%	0%	0%	0%	0%
% Tree	Native	4%	0%	0%	0%	0%
% Tree	Weed	0%	0%	0%	0%	0%
TOTAL	**Native**	**45%**	**7%**	**4%**	**5%**	**9%**
TOTAL	**Weed**	**1%**	**1%**	**5%**	**3%**	**4%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

Table 10 Wetland B Structural Layer Composition

Layer Type	Native / Weed	Wet (C)	Wet B (R)	Wet B (R)	Wet B (R)	Wet B (R)
Date		May-06	May-06	Feb-06	Jun-05	Dec-04
% Grass	Native	0%	0%	0%	0%	0%
% Grass	Weed	0.5%	1%	1%	0%	5%
% Herb	Native	2%	0%	0%	0%	2%
% Herb	Weed	0.5%	2%	1%	1%	2%
% Sedge	Native	40%	0.25%	2%	0%	1%
% Sedge	Weed	0%	1%	9%	0%	8%
% Shrub	Native	7%	0%	0%	0%	2%
% Shrub	Weed	0%	0%	0%	0%	0%
% Tree	Native	4%	1.75%	2%	0%	0%
% Tree	Weed	0%	0%	0%	0%	0%
TOTAL	**Native**	**45%**	**2%**	**4%**	**0%**	**5%**
TOTAL	**Weed**	**1%**	**4%**	**11%**	**1%**	**15%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

4.5 Average and Maximum Plant Heights

The maximum and average plant heights recorded across each transect are shown in Table 11. A record was made of the average height for each quadrat and this figure has been averaged across the transect.

Table 11 Average and Maximum Plant Heights

Transect Location	May 06		Feb 06	
	Average (m)	Max. (m)	Average (m)	Max. (m)
CcBa (C)	0.2	10.0		
CcBa (R)	0.2	0.5	0.2	
Pe (C)	1.0	1.5		
Pe (R)	0.4	1.0	0.3	0.5
MpPe (C)	1.2	5.0		
MpPe (R)	0.2	0.4	0.2	
BaBm (C)	0.4	5.0		
BaBm (R)	0.1	0.2	0.2	
Wetland (C)	1.1	1.2		
Wetland A (R)	0.2	1.2	0.2	0.5
Wetland B (R)	0.1	0.8	0.2	0.5

4.6 Transect Representation of Tracks

As can be seen in Table 12 the actual length of track represented by the transects is 25%. Approximately 34% of the tracks are in better condition than the transects, and 41% are in poorer condition. As the number of plants in each transect varies, these figures must be compared on a track by track basis. For example 64% of the

Pe track is in poorer condition than the transect, however the transect is in excellent condition, and these sections of track are considered to be in good condition.

Table 12 Transect Representation of Entire Track

Track	Approx Length (m)	Track Length (m) by Rating					Percentage Of Track by Rating				
		1	2	3	4	5	1	2	3	4	5
CcBa	300		50	190	60		0%	17%	63%	20%	0%
Pe	1,030	130	660	240			13%	64%	23%	0%	0%
MpPe	930		180	130	100	520	0%	19%	14%	11%	56%
BaBm	330		50	80	150	50	0%	15%	24%	45%	15%
TOTAL	**2,590**	**160**	**910**	**640**	**310**	**570**	**6%**	**35%**	**25%**	**12%**	**22%**

4.7 Self-Regenerating Tracks

The first track, located within a Banksia littoralis / Melaleuca rhaphiophylla vegetation community has shown little natural recruitment. Native seedlings were observed but only in small clusters within low lying depressions. The track was infested with annual weeds in June 2005, however, late rains resulted in the area being flooded which has drowned many of the weeds and reduced the level of infestation. Natural recruitment is evident especially in the eastern part of the track with various sedges and Banksia littoralis seedlings observed.

The track through the Pericalymma heath has good native recruitment with reasonable species richness and plant numbers, and the growth rates are greater than in some of the transects. Weed levels are minimal and do not appear to be having any negative effects.

5 DISCUSSION

5.1 General

The species richness has increased by five native species and two introduced species. Also one species previously identified only to genus level has been identified to species level. Fewer native species were recorded during this assessment than in February 2006 in part due to some annual species not being present at this time of year.

The use of topsoil at this stage has proven to be successful with respect to species richness. A direct seeding or seedling planting approach would not have provided the number of species that have been recorded to date, due to some of the species being difficult to harvest for seed, or to propagate.

Site wide there has been a decreasing trend in stem counts and plant density in the rehabilitation transects since February 2006. This is not unexpected due to the dry period between assessments. There has also been a reduction in plant numbers in all rehabilitation transects compared with the same time last year, except Wetland B, which saw a large increase in plant numbers due to seed stored within stockpiled cleared vegetation. This reduction is most likely due to most individual plants having not yet reached reproduction maturity and the natural attrition rate being higher than the recruitment rate. Once plants within the quadrats reach seed production maturity the downward trend in plant density is expected to reverse.

Seedling development has progressed in some rehabilitation areas since February 2006 especially in the *Pericalymma ellipticum* transect which now has an average seedling height of 400 mm (up 100 mm). Most other areas remained the same except for the BaBm transect which reduced to 100 mm.

All sites have seen an increase in total native ground cover percentage since the last assessment, except for BaBm which remains the same and Wetland B which has decreased from 4% to 2%. Despite a drop in plant numbers across all transects, this demonstrates that the development of plants that have been established for a season or two is progressing. The *Pericalymma ellipticum* rehabilitation transect had the greatest increase (from 13% to 24% cover).

The biggest factor influencing plant height and foliage development (and probably also plant density) is predation by rabbits. In every transect (control as well as rehabilitation) there was evidence of rabbit damage including scratchings, droppings, and bite marks on plants. The most affected transect was Wetland B in which 80% of the established seedlings counted had been trimmed through predation to 100 mm above the ground.

Weed levels across the site remain low at present. In two sections there has been a slight increase in weed cover (CcBa up to 3%, BaBm up to 4%). Both the wetland transects have had a reduction in weed cover (Wetland A down from 5% to 1% and Wetland B down from 11% to 4%). The other two transects (Pe, MpPe) remained steady at 1% weed cover.

Vehicle access to the constructed wetland has increased since February due to the drying out of the basin. Fortunately the majority of the traffic has been confined to

the basin and plant damage has been minimal. Additional log placement will take place in the constructed wetland in June to hopefully further reduce traffic before the basin is planted.

5.2 *Corymbia calophylla* / *Banksia attenuata* Tracks



Figure 3 CcBa Control and Rehabilitation Transect Photos

This rehabilitation area has had a reduction in density (from 4.5 to 3.3 plants / m^2); however native species representation has increased (from 22 to 24). Trees represent half of the plants at present, shrubs 25%, and the remainder being equal quantities of herbs and sedges. The dominant native species are *Banksia menziesii*, *Corymbia calophylla*, and *Gompholobium tomentosum*.

Native ground cover has increased to 2%, however given the reduction in the number of plants this demonstrates that surviving plants are increasing their foliage development with trees being the greatest contributor. Rabbits are responsible for the loss of some plants, and a reduction in the foliage of others through the eating of leaves and scratchings around the roots.

Weed cover has increased slightly to 3% (up from 1%). *Ehrharta calycina (Veldt Grass) is still the most dominant weed; however the increase in ground cover is due more to the emergence of annual weeds. Veldt Grass is easily controlled with the specific herbicide Fusilade ® and will be specifically targeted in the June spraying program. The declared weed **Moraea flaccida* (One-Leaf Cape Tulip) was first recorded in the control transect in June 2005 and was observed again during this assessment. It should be specifically targeted during the spring spraying program.

The CcBa tracks are approximately 300 m long and represent 12% of all the tracks. Table 11 shows 63% of the track being represented by the quadrat, 20% being in better condition and 17% in poorer condition. The current condition of the transect is the recommended minimum acceptable standard for these sections of the track. Remedial action should be considered for the 17% of track that is in poorer condition.

5.3 *Pericalymma ellipticum* Tracks

The Pericalymma rehabilitation transect has shown the greatest progress of all the tracks. Plant numbers have reduced slightly but are nearly the same as for the control transect. The average density is now 28.6 plants / m^2. Two of the native species recorded in February 2006 were not observed during this assessment, and the rehabilitation transect contains one more native species than the control transect. The majority of the seedlings in the rehabilitation tracks are located within the riplines as can be seen in Figure 4.



Figure 4 Pe Control and Rehabilitation Transect Photos

The dominant native species are *Pericalymma ellipticum*, *Verticordia densiflora subsp densiflora*, and *Euchilopis linearis*. One new species (*Drosera nitidula*), not previously observed for any of the transects, was recorded during this assessment.

Plant development is excellent with an increase in foliage cover of 11% (total 24%) in the past four months. The average plant height is the greatest of all the rehabilitation transects at 400 mm, with the tallest plant reaching 600 mm.

Weed cover is very low at 1%, and the most abundant species is **Ehrharta calycina* (Veldt Grass) and small numbers of **Eragrostis curvula* (Lovegrass) were also recorded.

Two Priority Flora were noted in the February 2006 assessment. *Byblis gigantea* was originally found in the control transect but was not observed during this assessment. *Schoenus benthamii* is still present in the rehabilitation transect, although numbers have declined since February.

The Pe rehabilitation track has a length of 1,030 m which is the greatest representation of any of the vegetation systems. Approximately 23% of the track is in similar condition to the transect, just under two-thirds has 50-75% of the plant density, and 13% has less than 50% of the density. In this case 50% of the transect plant density still equates to 14 plants/m^2 which is very good for this stage of development. The one track that had less than 50% of the plant density had very few plants at all which is uncharacteristic for this vegetation system. It appears that this track may be maintained as a strategic firebreak as no brushing has been observed.

5.4 *Melaleuca preissiana / Pericalymma ellipticum* Tracks

This rehabilitation track has high levels of brush material covering approximately 40% of the transect area which has reduced the space in which plants can establish. Notwithstanding this the number of seedlings is good with an average of 7.1 plants / m^2 which is down slightly from the last assessment (was 8.0 plants / m^2). The majority of these seedlings are found in the bare sections devoid of brush and in these patches the density is approaching that of the control.



Figure 5 MpPe Control and Rehabilitation Transect Photos

Native cover remains at 1% which shows little plant development since the last assessment. This is partly due to rabbits with scratchings, droppings, and leaf damage evident within the quadrats. The dominant species are *Pericalymma ellipticum*, *Verticordia densiflora subsp densiflora*, and *Patersonia occidentalis*.

Weed cover has increased from 1% to 2% due to the emergence of annual weeds. **Ehrharta calycina* (Veldt Grass) remains the most abundant species.

The MpPe tracks have an approximate length of 930 m, representing 35% of the total track length. Of this length only 14% represents the conditions found in the monitoring transect. 11% of the tracks have an estimated 125% to 150% of the plant density of the transect but more than half of the track length (56%) has a plant density greater than 150% of the transect. 19% of the track is in poorer condition with 50% to 75% of the plant numbers. This section of the track may require some remedial action.

5.5 *Banksia attenuata / Banksia menziesii* Tracks



Figure 6 BaBm Control and Rehabilitation Transect Photos

There has been a 40% reduction in the number of native plants in the BaBm rehabilitation transect since February 2006. This track had the lowest plant density of all the tracks in February with 2.6 seedlings / m^2 and this has now reduced to 1.5 seedlings / m^2. Over half of the native plants recorded in February however were *Podotheca angustifolia* which is an annual herb species and this species was not recorded at this time. This means the perennial plant density in the transect has increased slightly since the last assessment.

The same number of native species was recorded as in February (17) however different species were observed. The dominant species at present are *Lyginia barbata / imberbis*, *Gompholobium tomentosum*, and *Melaleuca seriata*.

Native foliage cover has not changed since February (still 1%); however the average plant height has reduced slightly (from 200 mm to 100 mm). This change has been primarily caused by rabbit predation as there was evidence within the quadrats of droppings, scratchings, and foliage that had been eaten.

Weed coverage levels have increased from 1% to 4% due to the emergence of annual weeds such as **Erharta calycina* (Veldt Grass) and flat weeds *(*Hypochaeris glabra*, **Arctotheca calendula*, etc – indistinguishable at this early stage). The declared weed **Moraea flaccida (*One-leaf Cape Tulip) has re-emerged in the control transect and is the most abundant weed in this area. Its control is scheduled for when flowering occurs; the optimum time for herbicide uptake in this species.

The BaBm tracks have a total length of approximately 330 m. Of this 24% of the track is in similar condition to the transect, 45% has up to 150% of the plant density and 15% has more than 150%. Approximately 15% of the track is in poorer condition than the transect. Current conditions in the transect are below recommended levels and there has been a declining trend through the last three assessments. It is recommended that remedial action be undertaken in the parts of this track that are at or below the transect density.

5.6 Constructed Wetland

Vehicle traffic to the constructed wetland has increased again due to the seasonal drying out of the basin. The high water levels over spring and early summer

reduced traffic and provided the elevated vegetation a chance to establish with significant development of planted *Juncus pallidus* and *Eucalytpus rudis*. Logs have now been placed in the main unauthorised access route to further restrict vehicle activity in the area.

Wetland A has seen a 25% reduction in the number of natives. The average density has dropped from 9.4 to 7.6 stems/m^2 over all ten quadrats. Four of the ten quadrats are located within the basin and have no native plant or weed cover due to vehicle disturbance and seasonal inundation. By averaging the results over the six vegetated quadrats located outside of the basin the plant density becomes 12.7 stems/m^2. This figure provides a better representation of the vegetation condition surrounding the basin.

The number of native species recorded has increased by three to 26. One new species (*Amphipogon amphipogonoides*) was recorded in the transect, the first time it has been observed in any of the transects. The transect is currently dominated by *Hypocalymma angustifolium*, *Hypolaena exsulca*, and *Kunzea ericifolia*.

Native foliage cover in Wetland A has increased from 4% to 7% across all ten quadrats (11% over the upper six quadrats). This demonstrates healthy plant development with an increase in foliage cover of remaining plants of over 100%. The average plant height has not changed since February (remains at 200 mm) but the tallest plant is now 600 mm tall.



Top left: Control
Top right: Wetland A
Bottom: Wetland B

Figure 7 Constructed Wetland Control and Rehabilitation Transect Photos

Wetland B now has a native density of 10.4 stems/m^2 which is a decrease from the 16 stems/m^2 recorded in February. This is due to the loss of a number of *Melaleuca*

rhaphiophylla seedlings as a result of rabbit predation. In addition, the height of most of the *Melaleuca rhaphiophylla* seedlings has decreased by half as a result of the predation. However, most of these predated individuals appear to be alive and recovering.

Native species diversity is low with 85% of the plants being Melaleuca rhaphiophylla, and most are these are contained within four of the ten quadrats. The next most abundant native species are *Juncus pallidus* and *Cyperus polystachyos*. A total of eight species were recorded in Wetland B, one of them (*Schoenus curvifolius*) not previously recorded in any of the transects.

Weed cover has reduced significantly in both Wetland A (from 5% to 1%) and Wetland B (from 11% to 4%) due to the weed control measures undertaken over the past four months. The dominant species at present is **Erharta calycina* (Veldt Grass), but also found in significant numbers were **Annagallis arvensis var arvensis*, **Juncus microcephalus*, and annual flat weeds.

The transects represent the conditions of the site when considered on a quadrat by quadrat basis. Some sections are devoid of vegetation and others are progressing well as has also been observed within the quadrats. Remedial action was scheduled for this area after the February assessment to increase plant density in the barer sections, especially within the basin itself. A total of 1,800 trees and shrubs, and 10,000 rushes and sedges will be installed between June and September.

5.7 Self-Regenerating Tracks

The Banksia littoralis / Melaleuca rhaphiophylla track is recovering from the flooding that drowned both native species and weeds over the past spring. Substantial natural recruitment has been observed along the start and edges of the track with good numbers of Banksia littoralis seedlings found within close proximity to an established tree. Weed recruitment has been low and the area is scheduled for control in June once annual weeds emerge.

The track through the Pericalymma heath has good native recruitment with reasonable species richness and plant numbers, and the growth rates are greater than in some of the transects. Weed levels are minimal and do not appear to be having any negative effects.

6 CONCLUSIONS

For this stage of development the rehabilitation of the majority of the tracks is progressing towards a successful outcome. Changes to the monitoring methodology now provide more accurate representation of conditions outside of the transects.

Native plant densities have dropped in all areas (some more than others), however plant development and foliage cover have remained the same or increased. Average plant heights have increased in most areas. Rabbits appear to be responsible for a significant proportion of plant deaths, as well as reductions in plant heights. Evidence of rabbit damage was collected from every transect including both rehabilitation and control.

Plant densities and species richness are at relatively low levels in the following rehabilitation tracks:

- Corymbia calophylla / Banksia attenuata (CcBa) - 17% of total length;
- Melaleuca preissiana / Pericalymma ellipticum (MpPe) – 19% of total length;
- Banksia attenuata / Banksia menziesii (BaBm) rehabilitation track - 39% of total length; and

Overall this represents 14% of the total rehabilitation track length.

Additional works have been scheduled for the constructed wetland in June and September to increase plant density. The June planting involves the planting of 1,800 tree and shrub species between the basin and established bushland around the perimeter, and the September planting involves the planting (and translocation) of 10,000 rushes and sedges in the basin area. The basin planting has been scheduled for later in the year once water levels have peaked, as this is the ideal time for rush and sedge establishment and development.

The weed management program has had a significant impact on weed levels since the last assessment. Autumn and spring herbicide applications are scheduled for the next 12 months for the constructed wetland as well as all tracks and adjacent weed infested areas. After this period weed control will be considered on an as needed basis as determined by the ongoing monitoring program.

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Appendix 1 Transect Location Maps

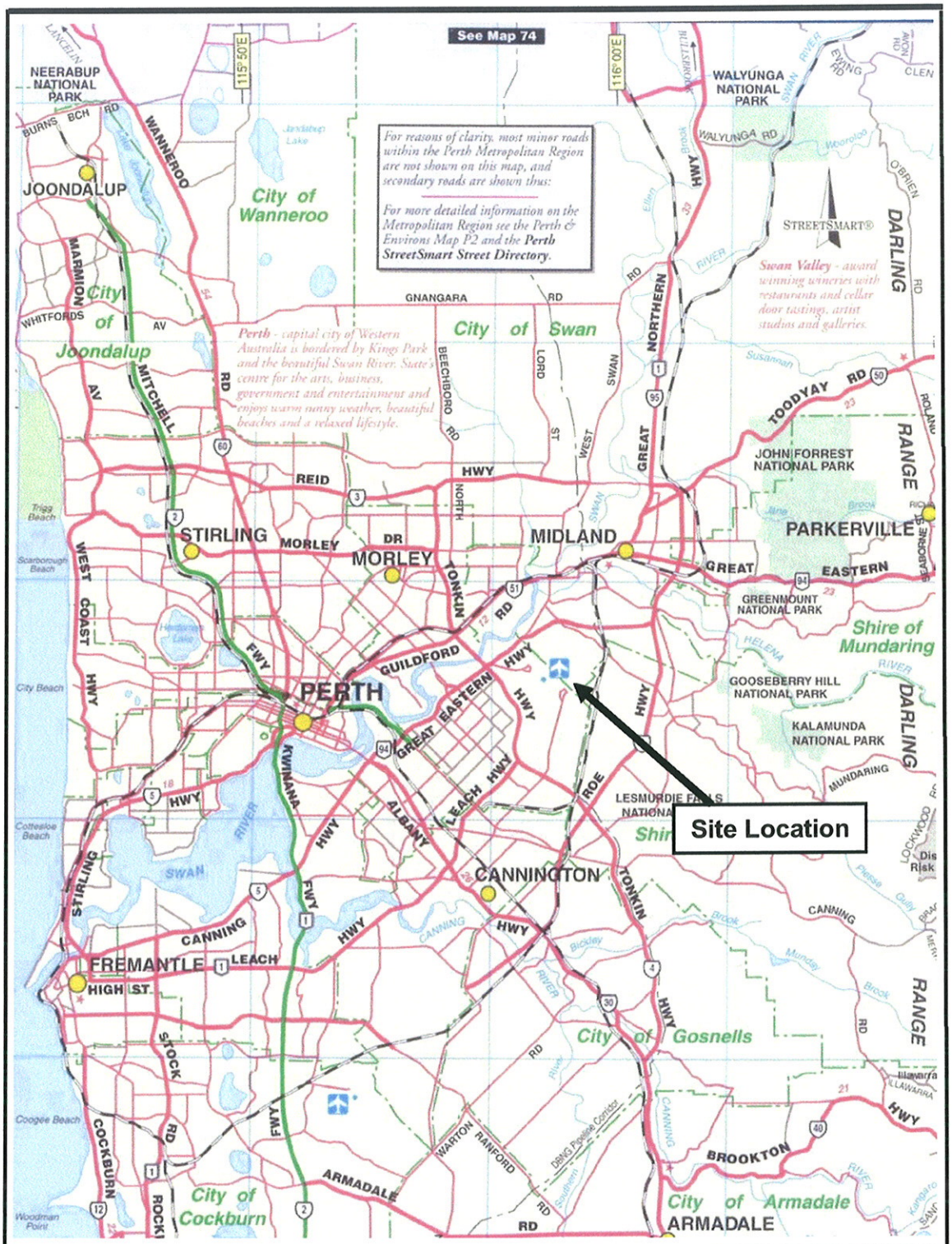


FIGURE 1 - Site Location		
CLIENT: Westralia Airports Corporation		
DRAWN BY: LS	CHECKED BY: NW	JOB NUMBER: 04.128
DATE: 19/1/2005	REPORT ISSUE: Final	SCALE: NTS

env Australia

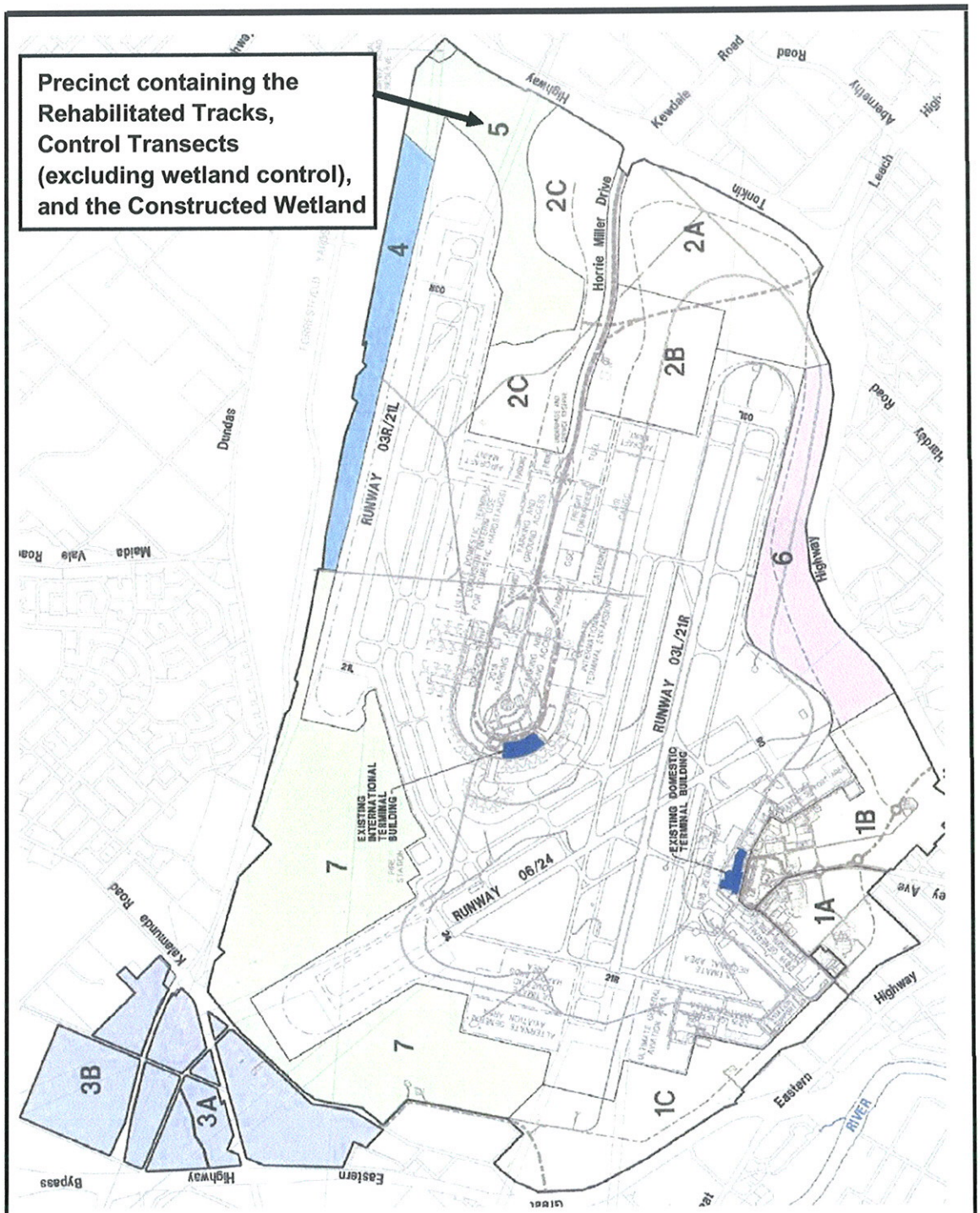


FIGURE 2 – Perth Airport Precincts		
CLIENT: Westralia Airports Corporation		
DRAWN BY: NW	CHECKED BY: KL	JOB NUMBER: 04.128
DATE:10/1/2005	REPORT ISSUE: FINAL	SCALE: NTS

env Australia

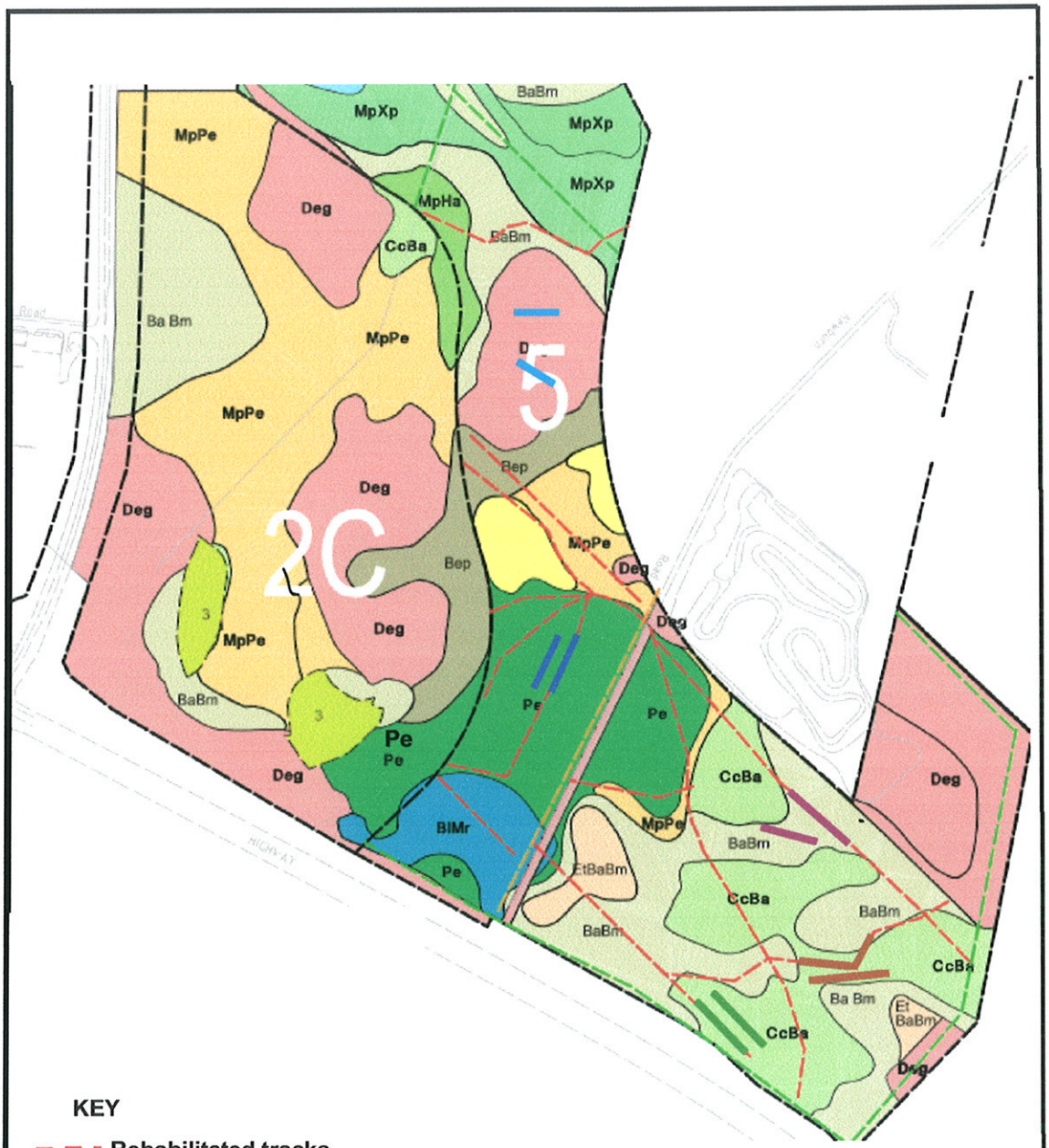


FIGURE 3: Location of rehabilitation and control transects		
CLIENT: Westralia Airports Corporation		
DRAWN BY: NW	CHECKED BY: KL	JOB NUMBER: 04.128
DATE: 10/1/05	REPORT ISSUE: Final	Insert generated by GJC @ WAC

env Australia

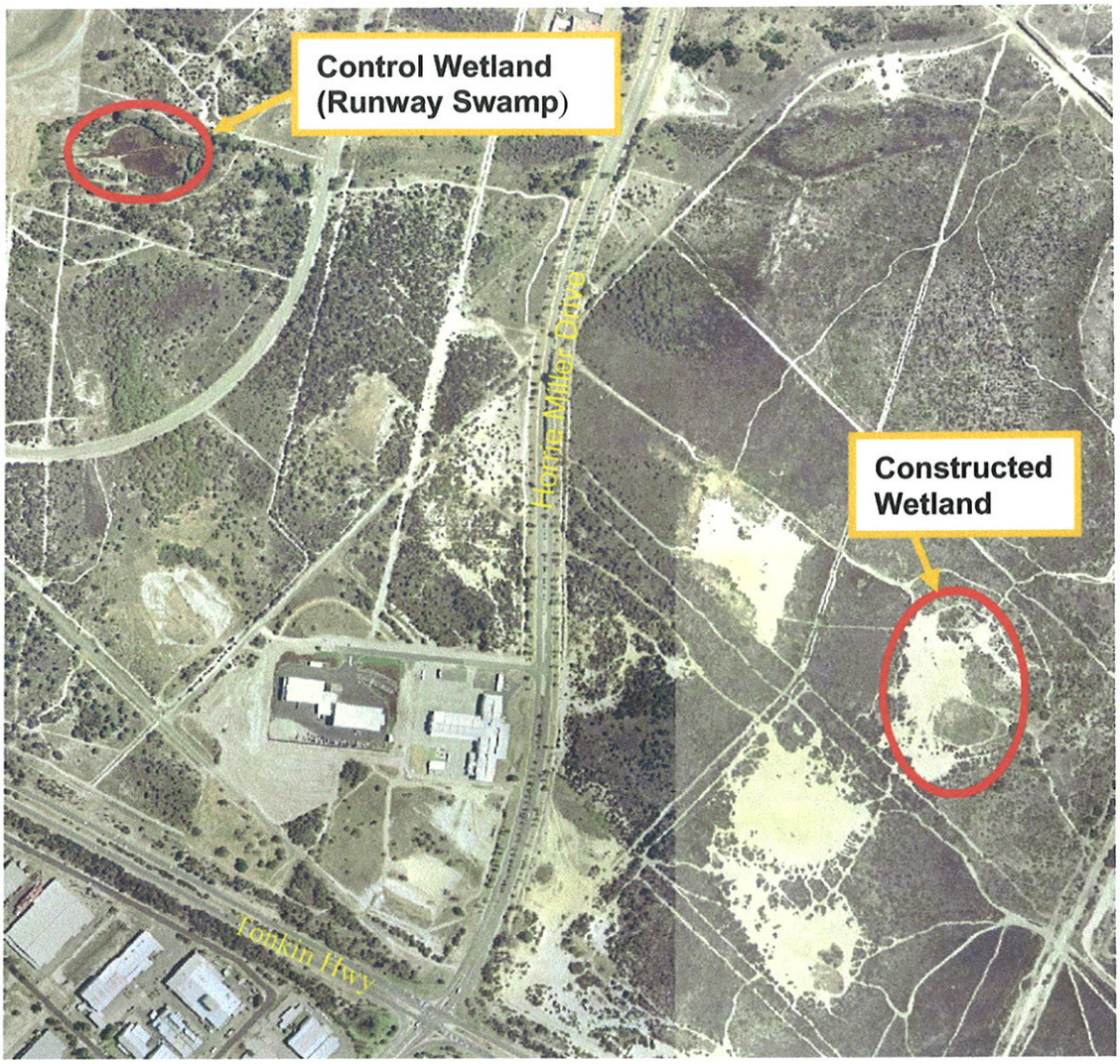
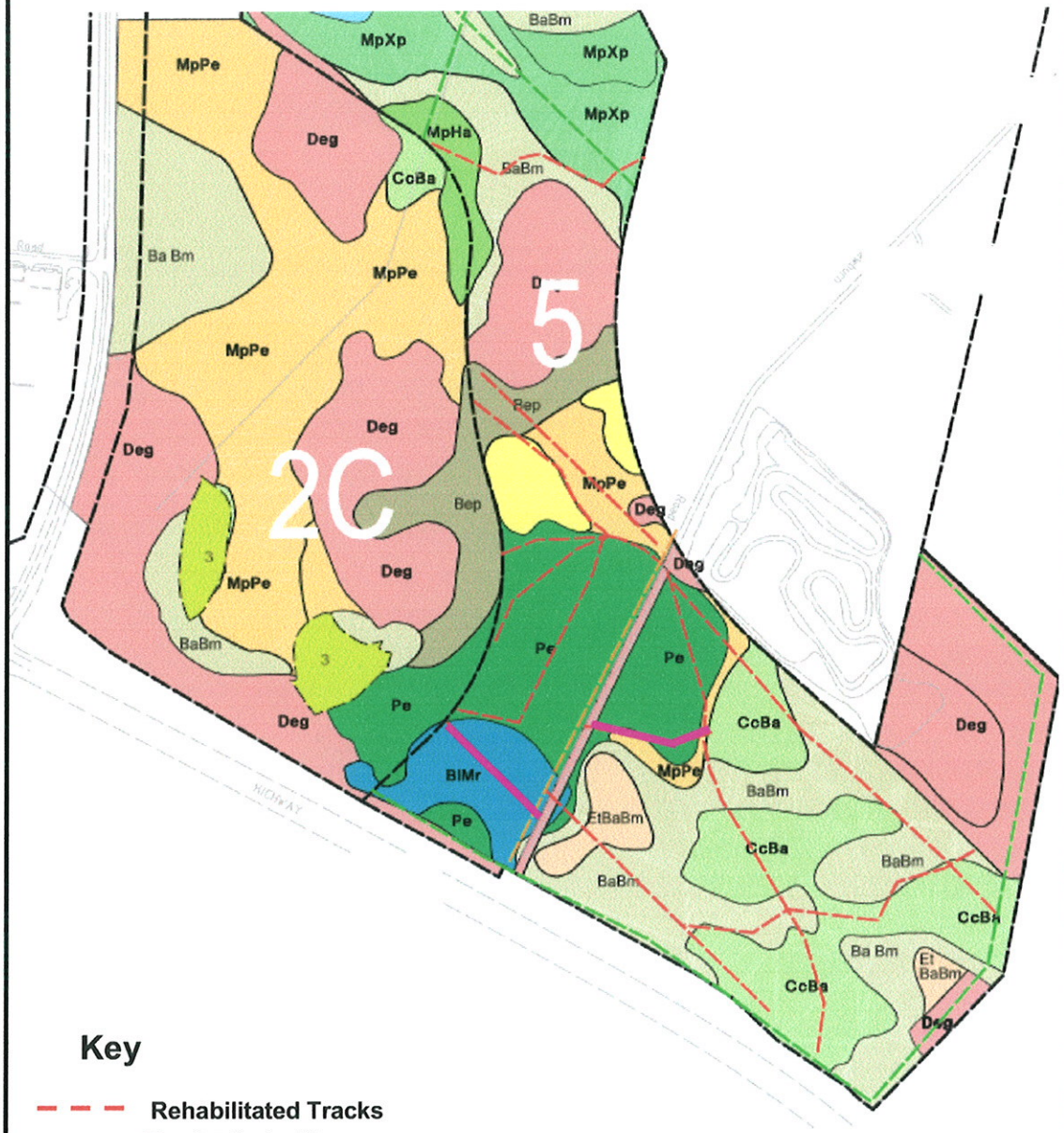


FIGURE 4 – Location of Control and Constructed Wetlands		
CLIENT: Westralia Airports Corporation		
DRAWN BY: NW	CHECKED BY: SB	JOB NUMBER: 04.128
DATE:10/1/05	REPORT ISSUE: Final	SCALE: NTS

env Australia



Key

Rehabilitated Tracks

Tracks that will regenerate themselves

FIGURE 5: Location of tracks that were nominated to regenerate themselves

CLIENT: Westralia Airports Corporation

DRAWN BY: NW	CHECKED BY: KL	JOB NUMBER: 04.128
DATE: 10/1/05	REPORT ISSUE: Final	Insert generated by GJC @ WAC

env Australia

Appendix 2 Transect Location and Orientation Details

Transect Location and Orientation Details (ENV Australia, 2004)

Transect	Flagging Colour	Direction from Start	Start Easting *	Start Northing	Finish Easting *	Finish Northing
CcBa (R)	Orange / Yellow	NW	403354 E	6461471 N	403325 E	4641500 N
CcBa (C)	Orange / Yellow	S	403394 E	6461535 N	403387 E	6461573 N
MpPe (R)	Orange / Yellow	E	403443 E	6461576 N	403499 E	6461573 N
MpPe (C)	Orange / Yellow	SE	403470 E	6461566 N	403513 E	6461552 N
BaBm (R)	Orange / Yellow	NW	403508 E	6461734 N	403479 E	6461772 N
BaBm (C)	Orange / Yellow	NW	403446 E	6461749 N	403425 E	6461790 N
Pe (R)	Orange / Yellow	NE	403045 E	6461868 N	403071 E	6461913 N
Pe (C)	Orange / Pink	NE	403116 E	6462054 N	403094 E	6462017 N
Wetland (C)	Orange / Yellow	SE	401829 E	6463201 N	401785 E	6463185 N
Wetland A (R)	Orange / Yellow	SE	403056 E	6462477 N	403082 E	6462450 N
Wetland B (R)	Orange / Yellow	SE	403050 E	6462400 N	403079 E	6462383 N

- Note: All co-ordinates for Area 50 (GDA94)

Appendix 3 Transect Summaries

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Precinct 5 Monitoring
Transect Summary

Quadrat: CcBa (Control)

Introduced Species	**Score**
* Ehrharta calycina	24
* Eragrostis curvula	3
* Gladiolus caryophyllaceus	28
* Moraea flaccida	7
* Unidentified Dicotyledon	39
* Ursinsia anthemoides	11
Native Species	**Total**
Acacia applanata	6
Acacia huegeliii	2
Acacia pulchella	2
Alexgeorga nitens	804
Allocasuarina fraseriana	1
Bossiaea eriocarpa	28
Burchardia umbellata	1
Calytrix flavescens	17
Corymbia calophylla	4
Dampiera linearis	50
Dasypogon bromelifolius	87
Desmocladus fasciculatus	25
Gompholobium tomentosum	2
Hovea trisperma	4
Hypolaena exculsa	18
Jacksonia floribunda	23
Lyginia barbata / imberbis	572
Melaleuca seriata	6
Patersonia occidentalis	22
Phlebocarya ciliata	13
Pterostylis sanguinea	1
Scholtzia involucrata	13
Stylidium repens	22
Thysanotus manglesianus	4
Xanthorrhoea brunonis	1
Xanthorrhoea preissii	4
Total Natives	**1732**
Density (plants/m2)	**43.3**
Total Native Species	**26**
Native Cover %	**75%**
Average Plant Height (m)	**0.2**
Tallest Plant Height (m)	**10.0**
Weed Cover %	**1%**
Total Weed Species	**6**

Dominant Native Species	1	*Alexgeorga nitens*
	2	*Lyginia barbata / imberbis*
	3	*Dasypogon bromelifolius*
Dominant Introduced Species	1	* Unidentified Dicotyledon
	2	* Gladiolus caryophyllaceus
	3	* Ehrharta calycina
Comments	Very good native cover with few weeds. Evidence of rabbit scratchings and mature plant predation (Patersonia).	

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Precinct 5 Monitoring
Transect Summary

Quadrat: CcBa (Rehab) 25/05/2006

Introduced Species	**Score**
* Conyza sp.	2
* Ehrharta calycina	112
* Erodium botrys	2
* Gladiolus caryophyllaceus	6
* Unidentified Dicotyledon	60
* Ursinsia anthemoides	16
Native Species	**Total**
Adenanthos cygnorum	11
Allocasuarina humilis	1
Banksia attenuata	1
Banksia menziesii	25
Bossiaea eriocarpa	1
Conostylis setosa	5
Corymbia calophylla	19
? Daviesia triflora (formerly photo sample 1)	1
Dasypogon bromelifolius	3
Gompholobium tomentosum	19
Hibbertia racemosa	1
Hypolaena exculsa	2
Jacksonia floribunda	2
Kennedia prostrata	5
Laxmannia ramosa	2
Laxmannia squarrosa	15
Leucopogon conostephoides	1
Lyginia barbata / imberbis	1
Melaleuca seriata	1
Pericalymma ellipticum	1
Scholtzia involucrata	7
Stirlingia latifolia	1
Thysanotus manglesianus	3
Verticordia densiflora var densiflora	3
Total Natives	**131**
Density (plants/m2)	**3.3**
Total Native Species	**24**
Native Cover %	**2%**
Average Plant Height (m)	**0.2**
Tallest Plant Height (m)	**0.5**
Weed Cover %	**3%**
Total Weed Species	**6**

Dominant Native Species	1	*Banksia menziesii*
	2	*Corymbia calophylla*
	3	*Gompholobium tomentosum*
Dominant Introduced Species	1	* Ehrharta calycina
	2	* Unidentified Dicotyledon
	3	* Ursinsia anthemoides

Comments	Loss of plants since last assessment but increase in species richness. Evidence of rabbit scratchings and plant predation.

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Precinct 5 Monitoring Transect Summary

Quadrat: Pe (Control) 26/05/2006

Introduced Species	**Score**
* Gladiolus caryophyllaceus	3
Native Species	**Total**
Baumea juncea	2
Calothamnus lateralis	1
Conostylis setosa	1
Cytogonidium leptocarpoides	452
Dampiera linearis	3
Dasypogon bromelifolius	8
Euchilopis linearis	12
Laxmannia ramosa	9
Lyginia barbata / imberbis	7
Meeboldina cana	1
Melaleuca seriata	105
Patersonia occidentalis	1
Pericalymma ellipticum	531
Petrophile linearis	5
Stirlingia latifolia	11
Stylidium dichotomum	12
Verticordia densiflora var densiflora	28
Total Natives	**1189**
Density (plants/m2)	**29.7**
Total Native Species	**17**
Native Cover %	**83%**
Average Plant Height (m)	**1.0**
Tallest Plant Height (m)	**1.5**
Weed Cover %	**0%**
Total Weed Species	**1**

Dominant Native Species	1	*Pericalymma ellipticum*
	2	*Cytogonidium leptocarpoides*
	3	*Melaleuca seriata*
Dominant Introduced Species	1	* Gladiolus caryophyllaceus
	2	
	3	
Comments	Very good native cover with only one weed. Evidence of rabbit scratchings. Byblis gigantea (P2) not observed during assessment.	

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Precinct 5 Monitoring Transect Summary

Quadrat: Pe (Rehab) 26/05/2006

Introduced Species	**Score**	
* Ehrharta calycina	39	
* Eragrostis curvula	3	
* Unidentified Dicotyledon	4	
Native Species	**Total**	
Adenanthos cygnorum	12	
Calothamnus lateralis	2	
Dasypogon bromelifolius	24	
Drosera nitidula	10	
Euchilopis linearis	76	
Gompholobium tomentosum	3	
Hypocalymma angustifolium	1	
Hypolaena exculsa	79	
Lechenaultia expansa	2	
Lepidosperma longitudinale	16	
Meeboldina cana	31	
Patersonia occidentalis	2	
Pericalymma ellipticum	722	
Podotheca angustifolia	1	
Schoenus benthamii (Priority 3)	2	
Stylidium diuroides subsp diuroides	11	
Stylidium repens	2	
Verticordia densiflora var densiflora	146	
Total Natives	**1142**	
Density (plants/m2)	**28.6**	
Total Native Species	**18**	
Native Cover %	**24%**	
Average Plant Height (m)	**0.4**	
Tallest Plant Height (m)	**1.0**	
Weed Cover %	**1%**	
Total Weed Species	**3**	
Dominant Native Species	1	*Pericalymma ellipticum*
	2	*Verticordia densiflora var densiflora*
	3	*Euchilopis linearis*
Dominant Introduced Species	1	*Ehrharta calycina
	2	*Unidentified dicotyledon (flatweeds)
	3	*Eragrostis curvula
Comments	Small loss in plant numbers, however 11% increase in native ground cover.	

tranen revegetation systems

Precinct 5 Monitoring Transect Summary

Quadrat: MpPe (Control)

Native Species	**Total**	
Astartea affinis (ms)	34	
Calothamnus lateralis	14	
Eutaxia virgata	4	
Lepidosperma longitudinale	45	
Meeboldina cana	384	
Melaleuca lateritia	96	
Melaleuca rhaphiophylla	3	
Melaleuca seriata	6	
Pericalymma ellipticum	99	
Villarsia albiflora	53	
Total Natives	**738**	
Density (plants/m2)	**18.5**	
Total Native Species	**10**	
Native Cover %	**72%**	
Average Plant Height (m)	**1.2**	
Tallest Plant Height (m)	**5.0**	
Weed Cover %	**0%**	
Total Weed Species	**0**	
Dominant Native Species	1	*Meeboldina cana*
	2	*Melaleuca lateritia*
	3	*Astartea affinis*
Dominant Introduced Species	1	None
	2	
	3	
Comments	Little change from last assessment other than an increase in native cover, and the loss of all weeds. Some rabbit scratchings within quadrats.	

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Precinct 5 Monitoring Transect Summary

Quadrat: MpPe (Rehab)

Introduced Species	**Score**	
* Ehrharta calycina	77	
* Eragrostis curvula	20	
* Isolepis marginata	4	
* Unidentified Dicotyledon	38	
* Ursinsia anthemoides	1	
Native Species	**Total**	
Adenanthos cygnorum	1	
Cassytha pomiformis	3	
Conostylis setosa	1	
Euchilopis linearis	2	
Hypocalymma angustifolium	2	
Hypolaena exculsa	10	
Jacksonia furcellata	2	
Laxmannia squarrosa	23	
Lyginia barbata / imberbis	4	
Melaleuca lateritia	1	
Patersonia occidentalis	30	
Pericalymma ellipticum	171	
Verticordia densiflora var densiflora	34	
Total Natives	**284**	
Density (plants/m2)	**7.1**	
Total Native Species	**13**	
Native Cover %	**2%**	
Average Plant Height (m)	**0.2**	
Tallest Plant Height (m)	**0.4**	
Weed Cover %	**1%**	
Total Weed Species	**5**	
Dominant Native Species	1	*Pericalymma ellipticum*
	2	*Verticordia densiflora var densiflora*
	3	*Patersonia occidentalis*
Dominant Introduced Species	1	* Ehrharta calycina
	2	* Unidentified dicotyledon (flatweed)
	3	* Eragrostis curvula
Comments	Small decline in plant numbers. Rabbits partly responsible as scratchings, droppings, and predation evident. High levels of brush within quadrats has reduced space available for natives to colonise.	

tranen revegetation systems

Precinct 5 Monitoring
Transect Summary

Quadrat: BaBm (Control)

Introduced Species	**Score**
* Gladiolus caryophyllaceus	11
* Moraea flaccida	81
* Oxalis glabra	21
* Unidentified Dicotyledon	2
* Ursinsia anthemoides	2
* Vulpia sp.	3
Native Species	**Total**
Acacia pulchella	6
Alexgeorga nitens	500
Amphipogon turbinatus	16
Banksia attenuata	1
Banksia menziesii	4
Bossiaea eriocarpa	8
Bossiaea ornata	4
Calytrix fraseri	3
Cassytha pomiformis	7
Conostephium pendulum	1
Conostylis setosa	6
Dampiera linearis	31
Dasypogon bromelifolius	31
Desmocladus fasciculatus	1
Desmocladus flexuosus	15
Eremaea pauciflora	7
Gompholobium tomentosum	5
Gonocarpus cordiger	1
Hibbertia aurea	1
Hibbertia racemosa	4
Hovea trisperma	1
Jacksonia floribunda	18
Laxmannia ramosa	25
Laxmannia squarrosa	4
Lepidosperma squamatum	4
Leucopogon conostephoides	17
Lomandra hermaphrodita	1
Lyginia barbata / imberbis	188
Melaleuca seriata	78
Patersonia occidentalis	7
Petrophile linearis	3
Scholtzia involucrata	29
Stylidium repens	86
Xanthorrhoea preissii	1
Total Natives	**1114**
Density (plants/m2)	**27.9**
Total Native Species	**34**
Native Cover %	**36%**
Average Plant Height (m)	**0.4**
Tallest Plant Height (m)	**5.0**
Weed Cover %	**1%**
Total Weed Species	**6**

Dominant Native Species	1	*Alexgeorga nitens*
	2	*Lyginia barbata / imberbis*
	3	*Melaleuca seriata*
Dominant Introduced Species	1	** Moraea flaccida*
	2	** Oxalis glabra*
	3	** Gladiolus caryophyllaceus*
Comments	Little change since last assessment other than emergence of annual weeds.	

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Precinct 5 Monitoring Transect Summary

Quadrat: BaBm (Rehab)

Introduced Species	Score
* Ehrharta calycina	92
* Gladiolus caryophyllaceus	20
* Unidentified Dicotyledon	89
* Ursinsia anthemoides	10
* Vulpia sp.	4
Native Species	**Total**
Adenanthos cygnorum	1
Alexgeorga nitens	1
Banksia menziesii	4
Bossiaea eriocarpa	4
Conostylis setosa	1
Dasypogon bromelifolius	2
Desmocladus flexuosus	2
Euchilopis linearis	3
Gompholobium tomentosum	10
Gonocarpus cordiger	2
Hypolaena exculsa	2
Jacksonia floribunda	4
Jacksonia furcellata	1
Laxmannia ramosa	1
Lyginia barbata / imberbis	11
Melaleuca seriata	6
Scholtzia involucrata	5
Total Natives	**60**
Density (plants/m2)	**1.5**
Total Native Species	**17**
Native Cover %	**1%**
Average Plant Height (m)	**0.1**
Tallest Plant Height (m)	**0.2**
Weed Cover %	**4%**
Total Weed Species	**5**

Dominant Native Species	1	*Lyginia barbata / imberbis*
	2	*Gomhpolobium tomentosum*
	3	*Melaleuca seriata*
Dominant Introduced Species	1	** Ehrharta calycina*
	2	** Unidentified dicotyledon (flatweed)*
	3	** Gladiolus caryophyllaceus*
Comments	Rabbit droppings, scratchings and the foliage of many natives have been eaten. Weed levels up and native numbers down. Also high brush levels within quadrats blocking space for establishment.	

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Precinct 5 Monitoring Transect Summary

Quadrat: Wetland (Control)

Introduced Species	**Score**
* Cyndon dactylon	18
*** Dittrichia graveolens**	3
* Ehrharta calycina	5
* Eragrostis curvula	3
* Gladiolus caryophyllaceus	17
* Unidentified Dicotyledon	8
Native Species	**Total**
Astartea affinis (ms)	34
Baumea articulata	109
Baumea juncea	74
Centella asiatica	5
Crassula sp	3
Eutaxia virgata	1
Goodenia pulchella subsp Coastal Plain A	5
Jacksonia furcellata	1
Lepidosperma squamatum	1
Lobelia tenuior	10
Meeboldina cana	380
Melaleuca lateritia	14
Melaleuca preissiana	1
Melaleuca rhaphiophylla	1
Pterostylis sanguinea	4
Schoenus subfascicularis	15
Thysanotus manglesianus	4
Villarsia albiflora	13
Total Natives	**675**
Density (plants/m2)	**16.9**
Total Native Species	**18**
Native Cover %	**45%**
Average Plant Height (m)	**1.1**
Tallest Plant Height (m)	**1.2**
Weed Cover %	**1%**
Total Weed Species	**6**

Dominant Native Species	1	*Meeboldina cana*
	2	*Baumea articulata*
	3	*Astartea affinis (ms)*
Dominant Introduced Species	1	** Cynodon dactylon*
	2	** Gladiolus caryophyllaceus*
	3	** Unidentified dicotyledon (flatweed)*
Comments	Rabbit burrow within one of the quadrats. Weeds low.	

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Precinct 5 Monitoring
Transect Summary

Quadrat: Wetland A (Rehab)

Introduced Species	**Score**
* Anagallis arvensis var arvensis	6
* Conyza sp.	9
* Ehrharta calycina	14
* Lupinus consentinii	3
* Unidentified Dicotyledon	22
* Ursinsia anthemoides	8
* Vellereophyton dealbatum	9
Native Species	**Total**
Acacia pulchella	3
Adenanthos cygnorum	1
Amphipogon amphipogonoides	1
Astartea affinis (ms)	5
Conostylis setosa	11
Cyperus polystachyos	4
Dasypogon bromelifolius	11
Desmocladus flexuosus	27
Eucalyptus rudis	3
Euchilopis linearis	12
Gompholobium tomentosum	17
Hypocalymma angustifolium	94
Hypolaena exculsa	50
Jacksonia floribunda	1
Jacksonia furcellata	5
Juncus pallidus	5
Kennedia prostrata	1
Kunzea ericifolia	33
Kunzea recurva	2
Melaleuca preissiana	1
Melaleuca seriata	1
Patersonia occidentalis	7
Pericalymma ellipticum	1
Stylidium diuroides subsp diuroides	8
Verticordia densiflora var densiflora	1
Total Natives	**305**
Density (plants/m2)	**7.6**
Total Native Species	**25**
Native Cover %	**7%**
Average Plant Height (m)	**0.2**
Tallest Plant Height (m)	**1.2**
Weed Cover %	**1%**
Total Weed Species	**7**

Dominant Native Species	1	*Hypocalymma angustifolium*
	2	*Hypolaena exsulca*
	3	*Kunzea ericifolia*
Dominant Introduced Species	1	** Unidentified dicotyledon (flatweed)*
	2	**Ehrharta calycina*
	3	** Vellereophyton dealbatum*
Comments	Reduction in plant numbers however ground cover has increased. 6 out of 10 transects were undisturbed the actual cover in these plots averages 11%. Weed cover has reduced.	

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Precinct 5 Monitoring
Transect Summary

Quadrat: Wetland B (Rehab)

Introduced Species	**Score**
* Anagallis arvensis var arvensis	31
* Cyndon dactylon	3
* Ehrharta calycina	26
* Eragrostis curvula	2
* Gladiolus caryophyllaceus	4
* Juncus microcephalus	19
* Lupinus consentinii	6
*** Phytolacca octandra**	3
* Unidentified Dicotyledon	22
* Vulpia sp.	12
Native Species	**Total**
Astartea affinis (ms)	2
Cyperus polystachyos	21
Eucalyptus rudis	2
Juncus pallidus	19
Melaleuca preissiana	16
Melaleuca rhaphiophylla	351
Patersonia occidentalis	1
Schoenus curvifolius	3
Total Natives	**415**
Density (plants/m2)	**10.4**
Total Native Species	**8**
Native Cover %	**2%**
Average Plant Height (m)	**0.2**
Tallest Plant Height (m)	**0.8**
Weed Cover %	**4%**
Total Weed Species	**10**

Dominant Native Species	1	*Melaleuca rhaphiophylla*
	2	*Juncus pallidus*
	3	*Cyperus polystachyos*
Dominant Introduced Species	1	** Annagallis arvensis var arvensis*
	2	** Ehrharta calycina*
	3	** Juncus microcephalus*
Comments	Reduction in overall plant numbers. 99% of Melaleuca rhaphiophylla seedlings have been eaten but are still actively growing. Weed cover reduced due to spraying operations.	

Appendix 4 List of Species Identified By Transect

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Precinct 5 Monitoring
Species Diversity Summary

Taxa Identified May 06	CcBa C	CcBa R	Pe C	Pe R	MpPe C	MpPe R	BaBm C	BaBm R	Wetland C	Wetland A	Wetland B	Summary May 06	Summary Feb 06	Summary Jun 05	Summary Dec 04	Summary to Date
Acacia applanata	Y											Y	Y	Y	Y	Y
Acacia extensa														Y	Y	Y
Acacia huegeliii	Y											Y	Y	Y	Y	Y
Acacia pulchella	Y						Y			Y		Y	Y	Y	Y	Y
Acacia sp.															Y	Y
Adenanthos cygnorum		Y		Y		Y		Y		Y		Y	Y	Y	Y	Y
*Aira caryophyllea															Y	Y
Alexgeorga nitens	Y						Y	Y				Y	Y	Y	Y	Y
Allocasuarina fraseriana	Y											Y	Y		Y	Y
Allocasuarina humilis		Y										Y	Y	Y		Y
Amphipogon amphipogonoides										Y		Y				Y
Amphipogon turbinatus							Y					Y	Y	Y	Y	Y
*Anagallis arvensis														Y		Y
*Anagallis arvensis var arvensis										Y	Y	Y	Y		Y	Y
*Anagallis arvensis var caerulea															Y	Y
*Arctotheca calendula														Y	Y	Y
Astartea affinis (ms)					Y				Y	Y	Y	Y	Y	Y	Y	Y
Astartea sp.														Y	Y	Y
*Avena barbata													Y	Y	Y	Y
Banksia attenuata		Y					Y					Y	Y	Y	Y	Y
Banksia menziesii		Y					Y	Y				Y	Y	Y	Y	Y
Baumea articulata									Y			Y	Y	Y	Y	Y
Baumea juncea			Y						Y			Y				Y
Boronia ramosa subsp anethifolia														Y		Y
Boronia sp.															Y	Y
Bossiaea eriocarpa	Y	Y					Y	Y				Y	Y	Y	Y	Y
Bossiaea ornata							Y					Y	Y	Y	Y	Y
*Briza maxima													Y	Y	Y	Y
*Briza minor															Y	Y
Burchardia umbellata	Y											Y	Y	Y	Y	Y
Byblis gigantea (P2)													Y	Y		Y
Caladenia sp.														Y		Y
Calothamnus lateralis			Y	Y	Y							Y	Y	Y	Y	Y
Calytrix flavescens	Y											Y	Y			Y
Calytrix fraseri							Y					Y	Y	Y	Y	Y
Cassytha pomiformis						Y	Y					Y	Y	Y	Y	Y
*Centaurium erythraea													Y		Y	Y
Centella asiatica									Y			Y	Y	Y		Y
Centrolepis aristata															Y	Y
*Cicendia filiformis															Y	Y
Conostephium minus															Y	Y
Conostephium pendulum							Y					Y	Y	Y	Y	Y
Conostylis juncea													Y	Y	Y	Y
Conostylis setosa		Y	Y			Y	Y	Y		Y		Y	Y			Y
Conostylis sp.													Y	Y	Y	Y
*Conyza sp.		Y								Y		Y	Y			Y
Corymbia calophylla	Y	Y										Y	Y	Y	Y	Y
Crassula sp									Y			Y	Y		Y	Y
*Cyndon dactylon									Y		Y	Y	Y	Y	Y	Y
Cyperus polystachyos										Y	Y	Y	Y			Y
Cytogodinium leptocarpoides			Y									Y	Y	Y	Y	Y
Dampiera linearis	Y		Y				Y					Y	Y	Y	Y	Y
Dasypogon bromelifolius	Y	Y	Y	Y			Y	Y		Y		Y	Y	Y	Y	Y
Daviesia sp															Y	Y
?Daviesia triflora		Y										Y	Y	Y		Y

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Precinct 5 Monitoring
Species Diversity Summary

Taxa Identified May 06	CcBa C	CcBa R	Pe C	Pe R	MpPe C	MpPe R	BaBm C	BaBm R	Wetland C	Wetland A	Wetland B	Summary May 06	Summary Feb 06	Summary Jun 05	Summary Dec 04	Summary to Date
Desmocladus fasciculatus	Y						Y					Y	Y	Y	Y	Y
Desmocladus flexuosus							Y	Y		Y		Y	Y	Y	Y	Y
Desmocladus sp															Y	Y
***Dittrichia graveolens**									Y			Y				Y
Drosera erythryhiza																Y
Drosera nitidula				Y								Y				Y
Drosera sp														Y	Y	Y
*Ehrharta calycina	Y	Y		Y		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
*Eragrostis curvula	Y			Y		Y			Y		Y	Y	Y	Y		Y
Eremaea pauciflora							Y					Y	Y	Y	Y	Y
*Erodium botrys		Y										Y		Y		Y
Eucalyptus marginata															Y	Y
Eucalyptus rudis										Y	Y	Y	Y	Y	Y	Y
Eucalyptus sp.															Y	Y
Euchilopis linearis			Y	Y		Y		Y		Y		Y	Y	Y	Y	Y
Eutaxia virgata					Y				Y			Y	Y	Y	Y	Y
Gastrolobium capitatum														Y		Y
*Gladiolus caryophyllaceus	Y	Y	Y				Y	Y	Y		Y	Y		Y	Y	Y
Gompholobium sp.															Y	Y
Gompholobium tomentosum	Y	Y		Y			Y	Y		Y		Y	Y	Y	Y	Y
Gonocarpus cordiger							Y	Y				Y		Y		Y
Goodenia pulchella subsp Coastal Plain A									Y			Y	Y	Y		Y
Haemodorum spicatum													Y			Y
Hibbertia aurea							Y					Y	Y			Y
Hibbertia hypericoides														Y	Y	Y
Hibbertia racemosa		Y					Y					Y	Y	Y	Y	Y
Hibbertia stellaris															Y	Y
Hovea trisperma	Y						Y					Y	Y	Y	Y	Y
*Hydrocotyle bonariensis															Y	Y
Hypocalymma angustifolium				Y		Y				Y		Y	Y	Y	Y	Y
Hypocalymma sp.														Y	Y	Y
*Hypochaeris glabra													Y	Y	Y	Y
Hypolaena exculsa	Y	Y		Y		Y		Y		Y		Y	Y	Y	Y	Y
*Introduced Species 1															Y	Y
*Introduced Species 2															Y	Y
*Isolepis marginata						Y						Y	Y	Y	Y	Y
Jacksonia floribunda	Y	Y					Y	Y		Y		Y	Y	Y	Y	Y
Jacksonia furcellata						Y		Y	Y	Y		Y	Y	Y	Y	Y
Jacksonia sp															Y	Y
Jacksonia sternbergiana															Y	Y
*Juncus articulatus															Y	Y
*Juncus microcephalus											Y	Y	Y		Y	Y
Juncus pallidus										Y	Y	Y	Y			Y
Juncus planifolius												Y	Y			Y
Kennedia coccinea															Y	Y
Kennedia prostrata		Y								Y		Y	Y	Y	Y	Y
Kunzea ericifolia										Y		Y	Y	Y		Y
Kunzea recurva										Y		Y		Y		Y
Lagenophora huegellii															Y	Y
Laxmannia ramosa		Y	Y				Y	Y				Y	Y	Y	Y	Y
Laxmannia sp.															Y	Y
Laxmannia squarrosa		Y				Y	Y					Y	Y	Y	Y	Y
Lechenaultia ? biloba												Y		Y	Y	Y
Lechenaultia biloba															Y	Y

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Precinct 5 Monitoring
Species Diversity Summary

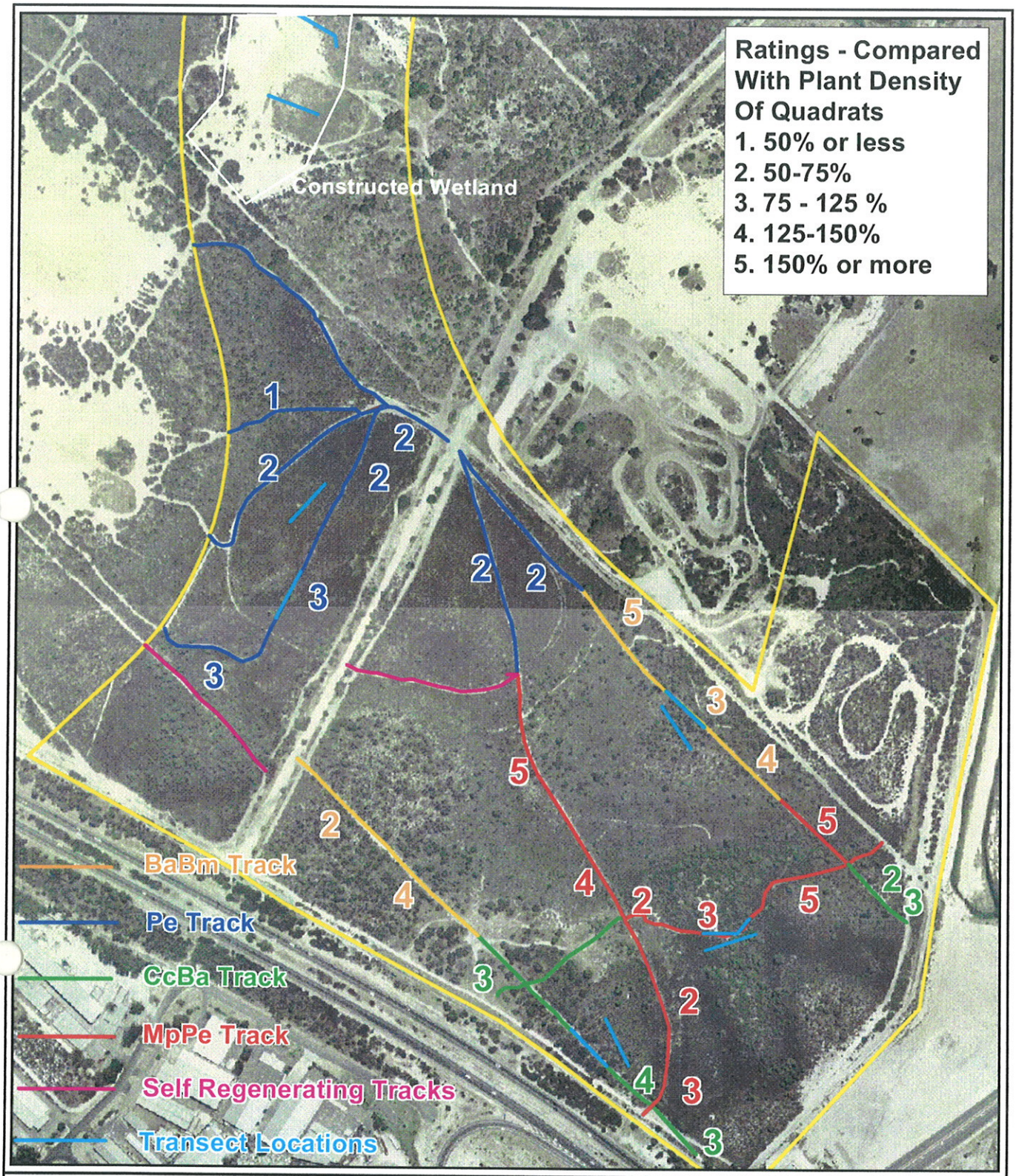
Taxa Identified May 06	CcBa C	CcBa R	Pe C	Pe R	MpPe C	MpPe R	BaBm C	BaBm R	Wetland C	Wetland A	Wetland B	Summary May 06	Summary Feb 06	Summary Jun 05	Summary Dec 04	Summary to Date
Lechenaultia expansa				Y											Y	Y
?Lechenaultia sp.															Y	Y
Lepidosperma longitudinale				Y	Y							Y	Y	Y	Y	Y
Lepidosperma sp													Y		Y	Y
Lepidosperma squamatum							Y		Y			Y	Y	Y	Y	Y
Lepidosperma tenue															Y	Y
Leucopogon conostephoides		Y					Y					Y	Y	Y	Y	Y
Leucopogon ? Sp. Murdoch (M. Hislop 1037)														Y		Y
Leucopogon sp															Y	Y
Levenhookia preissii															Y	Y
?Liliaceae sp.														Y		Y
Lobelia tenuior									Y			Y			Y	Y
Lomandra hermaphrodita							Y						Y	Y	Y	Y
Lomandra nigricans														Y		Y
Lomandra sp															Y	Y
*Lotus subbiflorus															Y	Y
*Lupinus consentinii										Y	Y	Y		Y		Y
Lyginia barbata / imberbis	Y	Y	Y			Y	Y	Y				Y	Y	Y	Y	Y
Meeboldina cana			Y	Y	Y				Y			Y	Y	Y		Y
Meeboldina roycei					Y							Y		Y	Y	Y
Melaleuca lateritia					Y	Y			Y			Y	Y	Y	Y	Y
Melaleuca preissiana									Y	Y	Y	Y	Y	Y		Y
Melaleuca rhaphiophylla					Y				Y		Y	Y	Y	Y	Y	Y
Melaleuca seriata	Y	Y	Y		Y		Y	Y		Y		Y	Y	Y	Y	Y
Melaleuca sp															Y	Y
Melaleuca teretifolia													Y	Y	Y	Y
*Moraea flaccida	Y						Y					Y		Y		Y
MYRTACEAE sp.													Y	Y		Y
MYRTACEAE sp. 2													Y	Y		Y
*Oxalis glabra							Y					Y		Y		Y
*Oxalis sp.														Y		Y
Patersonia occidentalis	Y		Y	Y		Y	Y			Y	Y	Y	Y	Y	Y	Y
?Patersonia sp															Y	Y
*Pelargonium sp														Y	Y	Y
Pericalymma ellipticum		Y	Y	Y	Y	Y				Y		Y	Y	Y	Y	Y
Petrophile linearis			Y				Y					Y	Y	Y	Y	Y
Philotheca spicata														Y	Y	Y
?Philotheca spicata														Y		Y
Phlebocarya ciliata	Y											Y	Y	Y	Y	Y
?Phyllanthus sp															Y	Y
***Phytolacca octandra**											Y	Y				Y
POACEAE sp														Y	Y	Y
Podotheca angustifolia				Y								Y	Y	Y		Y
PROTEACEAE sp															Y	Y
Pterostylis sanguinea	Y								Y			Y		Y		Y
Quinetia urvellii														Y		Y
RESTIONACEAE sp															Y	Y
*Romulea rosea															Y	Y
?Sample B (Unidentifiable)														Y		Y
?Sample G (Unidentifiable)														Y		Y
Schoenus benthamii (Priority 3)				Y								Y	Y			Y
Schoenus curvifolius											Y	Y				Y
Schoenus subfascicularis									Y			Y	Y	Y		Y
Scholtzia involucrata	Y	Y					Y	Y				Y	Y	Y	Y	Y
Siloxerus humifusus													Y		Y	Y

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Precinct 5 Monitoring
Species Diversity Summary

Taxa Identified May 06	CcBa C	CcBa R	Pe C	Pe R	MpPe C	MpPe R	BaBm C	BaBm R	Wetland C	Wetland A	Wetland B	Summary May 06	Summary Feb 06	Summary Jun 05	Summary Dec 04	Summary to Date
*Solanum nigrum													Y	Y		Y
*Sonchus oleraceus													Y	Y	Y	Y
Stirlingia latifolia		Y	Y									Y	Y	Y	Y	Y
Stylidium brunonianum															Y	Y
Stylidium dichotomum			Y									Y			Y	Y
Stylidium diuroides subsp diuroides				Y						Y		Y	Y			Y
Stylidium piliferum															Y	Y
Stylidium repens	Y			Y			Y					Y	Y	Y	Y	Y
Stylidium sp.														Y		Y
?Tetratheca hirsuta															Y	Y
Thysanotus manglesianus	Y	Y							Y			Y	Y	Y	Y	Y
Thysanotus multiflorus													Y	Y	Y	Y
Trachymene pilosa															Y	Y
Tricoryne elatior													Y	Y	Y	Y
*Trifolium sp															Y	Y
*Typha orientalis													Y			Y
Unidentiable Native 2 (no sample avail)													Y	Y		Y
*Unidentified Dicotyledon	Y	Y		Y		Y	Y	Y	Y	Y	Y	Y		Y		Y
*Unidentified Monocotyledon														Y		Y
Unidentified Native 3 (no sample avail)													Y			Y
*Ursinsia anthemoides	Y	Y				Y	Y	Y		Y		Y	Y	Y	Y	Y
*Vellereophyton dealbatum										Y		Y	Y		Y	Y
Verticordia densiflora var densiflora		Y	Y	Y		Y				Y		Y	Y	Y	Y	Y
Verticordia sp															Y	Y
Villarsia albiflora					Y				Y			Y	Y	Y		Y
*Vulpia sp.							Y	Y			Y	Y		Y		Y
Wahlenbergia preissii														Y		Y
*Watsonia meriana var bulbillifera														Y	Y	Y
Xanthorrhoea brunonis	Y											Y	Y			Y
Xanthorrhoea preissii	Y						Y					Y	Y	Y	Y	Y
Total Species	**32**	**30**	**18**	**21**	**11**	**18**	**42**	**23**	**24**	**33**	**19**	**104**	**105**	**121**	**134**	**194**
Total Native Species	**26**	**24**	**17**	**18**	**11**	**13**	**35**	**17**	**18**	**26**	**8**	**86**	**89**	**98**	**107**	**152**
Total Introduced Species	**6**	**6**	**1**	**3**	**0**	**5**	**7**	**6**	**6**	**7**	**11**	**18**	**16**	**23**	**27**	**42**

Note:
Bold = New species
Blue = refinement of identification of species



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Drawing	Scale
P130-01-1	1:5000
Drawn By	Size
DG	A4

Precinct 5 Rehabilitation Tracks Vegetation System and Ratings

Perth Airport

FLORA, VEGETATION AND VERTEBRATE FAUNA

ON

PROPOSED BGC DEVELOPMENT AREA

Prepared for:

BGC (Australia) Pty Ltd

Prepared by:

Mattiske Consulting Pty Ltd

September 2006



Mattiske Consulting Pty Ltd

TABLE OF CONTENTS

1. SUMMARY 1

2. INTRODUCTION 3

2.1. Background Information 3
2.2. Climate 3
2.3. Landforms and Soils 3
2.4. Vegetation 3
2.5. Rare and Priority Flora 4
2.6. Fauna - Nomenclature, Taxonomy and Distribution Patterns 6
2.7. Fauna - Protected Species - Commonwealth 6
2.8. Fauna - Protected and Priority Species - Western Australia 7
2.9. Review of Significance 8

3. METHODS 9

4. OBJECTIVES 9

5. RESULTS 10

5.1. Flora 10
5.2. Introduced Flora 10
5.3. Rare, Priority and Threatened Flora Species 10
5.4. Vegetation 11
5.5. Condition of Vegetation 12
5.6. Vertebrate Fauna 12
5.7. Fauna Habitats 14

6. DISCUSSION 14

7. REFERENCES 17

TABLES

1: Definition of Rare and Priority Flora Species (Department of Environment and Conservation 2006a)
2: Categories of Threatened Flora Species (Environment Protection and Biodiversity Conservation Act 1999)
3. Condition Rating Scale from Bush Forever (Keighery 1994 as summarized in Government of Western Australia 2000)
4. Fauna Habitats – Proposed Development Site
5: Comparison of Floristics with Plant Communities as defined by Gibson *et al.* (1994)

FIGURES

1: Vegetation
2: Condition of Vegetation

APPENDICES

A: Summary of Vascular Plant Species Recorded on the BGC site, 2006
B: List of Vertebrate Fauna Species recorded in the proposed BGC Site

1. SUMMARY

Mattiske Consulting Pty Ltd was commissioned by BGC (Australia) Pty Ltd to assess the botanical values in the proposed development area north of Kalamunda Road. The field studies were undertaken by experienced biologists from Mattiske Consulting Pty Ltd in September 2006. This team has been involved with similar studies to the west and south on the Westralia Airports lands and consequently are well-placed to place the findings into a local context. The survey effort on the proposed site included detailed recordings on the flora and fauna at a range of sites both on and near the proposed site development and also foot traverses along the less disturbed fringes of the fairways.

The proposed development occurs in part of the strip of land between the Great Eastern Highway Bypass and Kalamunda Road. The proposed development area has been disturbed by a range of previous activities including office facilities, a developed golf course and several artificial wetlands that were established for supplying water to the golf-course.

A total of 132 vascular plant taxa from 40 plant families and 99 genera were recorded within the proposed development area. No plant taxa gazetted as Declared Rare Flora pursuant to subsection (2) of section 23F of the Wildlife Conservation Act (1950) were located in the survey area. No Priority taxa as listed by the Department of Environment and Conservation (2006a) were located during the survey.

A total of 39 introduced species were recorded in the proposed development area and these contribute to 30% of the vascular plant species recorded. This proportion reflects the past disturbance levels on the site.

The vegetation of the study area was divided into 9 mapping units (including 6 plant communities and 3 disturbed areas - open water, fairways and cleared areas).

The Perth International Airport occurs near the interface of the Bassendean – Central and South, the Guildford complex and the Southern River vegetation complex as defined by Heddle *et al.* (1980). The woodlands of Jarrah, Marri and Banksia's on the aeolian sands are more typical of the Bassendean dune system and the woodlands and shrublands on the intervening swamps reflect the influence of seasonally inundated soils (irons, humus podsols, peats and clays – Churchward and McArthur 1980).

The proposed development area occurs on the Southern River vegetation complex, near the interface with the Bassendean Central and South and the Guildford as defined by Heddle et all. (1980).The plant communities on the sandier soils of the Bassendean are well reserved on the Bassendean dune systems (24% Bassendean Central and South, Government of Western Australia – Bush Forever 2002). The communities on the Southern River vegetation complex on the loamier soils are less well-represented (17% Southern River - Government of Western Australia – Bush Forever 2002). The key question in relation to the development area relates to the condition of the vegetation on the site. As indicated, the majority of the site is either degraded or completely degraded.

The Perth Airport has been divided into different areas based on its variety of vegetation and the condition of this vegetation. In view of the degree of disturbance in the vegetation on the proposed development site north of Kalamunda Road has been modified substantially as reflected in the proportion of introduced species in the respective communities. As indicated in the Environmental Review document by BGC (2006), the vegetation on the perimeter of the development area and the non-development areas will remain.

An additional comparison was made with the floristic communities as defined by Gibson *et al.* (1994). Several of the Gibson *et al.* (1994) communities underpin the delineation of threatened ecological communities on the Swan Coastal Plain as listed under the Environment Protection Biodiversity Conservation Act (EPBC Act 1999). The comparison of the floristic composition of the communities as defined in the survey area and the types defined by Gibson *et al.* (1994) highlighted some similarities.

In view of the proportion of introduced species, the justification that the J1 and J2 communities are equivalent to the EPBC Act listed threatened ecological communities appears difficult to justify at this juncture. If one takes a conservative approach in this matter, it would be advisable to protect the Marri communities (J1 and J2) on the perimeters of the proposed development, including in the south-east and north-west corners of the survey area. The latter approach also would assist in providing a visual buffer to the development. The value of the perimeters and the vegetation outside the proposed development areas was acknowledged in the BGC documents (2006).

In designing the development, consideration of drainage off the site should be considered. As indicated in other publications on the Perth Airport, one of the critical sites is the conservation areas to the south of Kalamunda Road and Munday Swamp. These areas have been recognised in planning the conservation areas on the Airport and also through the listings of the heritage sites at the national level (Department of Environment and Heritage, 2006b).

The combined surveys of the Perth Airport have recorded a range of vertebrate species (Government of Western Australia 2000) – namely:

- 87 bird species (How and Dell 1994; RAOU 1996, Tingay and Associates 1994b),
- 2 native mammal species (How and Dell 1994, Tingay and Associates 1994b),
- 20 reptile species (How and Dell 1994, Tingay and Associates 1994b),
- 8 amphibian species (How and Dell 1994, Tingay and Associates 1994b).

In the recent Evironment Review for the proposed development, the report noted the potential for "129 species of vertebrates to date including 3 fish, 8 frogs, 22 reptiles, 81 birds and 5 mammals". As it was recognized that the Chuditch (Western Quoll) and Quenda (Southern Brown Bandicoot) could be present on site, it was acknowledged in the BGC documents (2006) that the native fauna would be located on site and then trapping would be undertaken in conjunction and consultation with DEC and methods consistent with the Perth Airport Environment Strategy.

A range of species and habitats have been highlighted for the Perth Airport – namely several bird species, Munday Swamp as a breeding site for waterbirds (Jaensch *et al.* 1993) and the swamps on the clay soils appeared to have once supported the critically endangered Western Swamp Tortoise - *Pseudomydura umbrina* (WA Museum record from 1970) as listed under the Environment Protection Biodiversity Conservation Act (1999) (Kuchling and Burbidge 1996). Further, the Forrestfield Bushland and Munday Swamp Bushland contain the only known populations of the crowned snake (*Notechis coronatus*) in the Perth metropolitan area and one of the front-fanged snakes near Munday Swamp (*Rhinocephalus gouldii*), (Department of Environment and Heritage 2006b). The goanna (*Varanus gouldii*) is known from the shrubland areas dominated by *Adenanthos cygnorum* (woolly bush).

Munday Swamp supports lake populations of the Western Pygmy Perch (*Edelia vittata*) and the Western Minnow (*Galaxias occidentalis*).

In the recent survey, 28 species of bird, 3 species of mammal, one reptile and one amphibian were recorded. The birds utlilised both the completely degraded as well as the less disturbed woodlands. Several of the trees had small hollows that were utilised for nesting by a range of birds. This was particularly apparent in several larger Jarrah (*Eucalyptus marginata*) trees in the survey area.

The completely degraded swamps dominated by *Eragrostis curvula* (South African Love Grass) and the Marri woodlands with dense Watsonia (*Watsonia meriana*) understoreys supported Bandicoots (Quenda – *Isoodon obesulus*) populations. The Southern Brown Bandicoot (*Isoodon obesulus obesulus*) is listed as Endangered under the EPBC Act 1999, but is a different subspecies to the Quenda and is confined to eastern states.

The fauna management plan needs to include the management of the Southern Brown Bandicoot and introduced animals.

2. INTRODUCTION

2.1. Background Information

Perth International Airport comprises of 2,105ha of land and is located approximately 10km to the east of the city of Perth. Substantial amounts of the natural vegetation have been cleared for runways, hangars, warehouses, passenger terminals, offices, car parks and access roads. The proposed development occurs in part of the strip of land between the Great Eastern Highway Bypass and Kalamunda Road in the northern section of the airport land. The proposed development area has been disturbed by a range of previous activities including office facilities, a developed golf course and several artificial wetlands that were established for supplying water to the golf-course. There have been several botanical surveys undertaken within the airport that have covered various areas of vegetation, including Alan Tingay and Associates (1994), Trudgen (1995), Bennett Environmental Consulting Pty Ltd (2001; 2002), Lawn (2002) and Mattiske Consulting Pty Ltd (2001, 2003, 2005).

The purpose of this survey is to identify ecological values likely to be affected by the proposed development by BGC. The study area falls on the fringes of an area of remnant vegetation to the north of Kalamunda Road (Bush Forever site 386), (Government of Western Australia 2000). The vast majority of the proposed site occurs outside this Bush Forever site.

2.2. Climate

The Perth Airport has a warm dry Mediterranean climate with a defined seasonal pattern of cool, wet winters and hot, dry summers. The mean annual rainfall is 786mm, most of which falls from May to September. The average monthly minima and maxima range from 8.1-17.8˚C in July to 17.4-31.8˚C in February (Bureau of Meteorology 2006).

2.3. Landforms and Soils

The Swan Coastal Plain can be divided into a series of physiographic sub-units running roughly parallel to the coastline (Churchward and McArthur 1980). They are the Pinjarra Plain, an alluvial formation abutting the Darling Scarp, and three dune systems of different ages, whose soils reflect different degrees of weathering and leaching.

Perth Airport is situated on the eastern fringes of the Bassendean Dune system and in some eastern sections of the Airport interfaces with the Pinjarra Plain. The Bassendean System lies inland from the more fertile Spearwood System and is approximately 15km wide. It consists of low, gently undulating dunes interspersed with swamps and damplands. The soils are mostly leached, siliceous sands that are very poor in nutrients (Beard 1990). The Pinjarra Plain consists of fluviatile soils, which originate from the Darling Ranges to the east.

2.4. Vegetation

Perth International Airport is situated in the Swan Coastal Plain Subregion and is classified into the Drummond Botanical subdistrict (Beard 1990). The natural vegetation of the Perth Airport area is dominated by the communities on the Bassendean System (Beard 1979). A typical Bassendean catena features *Banksia* low woodland on elevated, drier sites and *Eucalyptus marginata - Corymbia calophylla* woodland with *Banksia* and *Allocasuarina* on moister sites, with various swamp communities in the wettest areas (Beard 1981).

The Perth International Airport occurs near the interface of the Bassendean – Central and South, the Guildford complex and the Southern River vegetation complex as defined by Heddle *et al.* (1980). The woodlands of Jarrah, Marri and Banksia's on the aeolian sands are more typical of the Bassendean dune system and the woodlands and shrublands on the intervening swamps reflect the influence of seasonally inundated soils (irons, humus podsols, peats and clays – Churchward and McArthur 1980).

2.5. Rare and Priority Flora

Species of flora are defined as rare or priority conservation status where their populations are restricted geographically or threatened by local processes. The Department of Environment and Conservation recognises these threats of extinction and consequently applies regulations towards population and species protection. Rare Flora species are gazetted under subsection 2 of section 23F of the Wildlife Conservation Act (1950) and therefore it is an offence to "take" or damage rare flora without Ministerial approval. Section 23F of the Wildlife Conservation Act (1950-1980) defines "to take" as "... to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means.

Priority Flora are under consideration for declaration as 'rare flora', either as there is an urgent need of further survey (Priority One to Three) or a need for monitoring every 5-10 years (Priority Four). Table 1 presents the definitions of Declared Rare and the four Priority ratings under the Wildlife Conservation Act (1950) as extracted from Department of Environment and Conservation (2006a). Table 2 presents the definitions of the categories of threatened species under the Environment Protection and Biodiversity Conservation Act, 1999.

Table 1: Definition of Rare and Priority Flora Species (Department of Environment and Conservation, 2006a)

Note: In other sections of the report these codes are referred to as the SCC – State Conservation Code

Conservation Code	Category
R	Declared Rare Flora – Extant Taxa "Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such."
P1	Priority One – Poorly Known Taxa "Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey."
P2	Priority Two – Poorly Known Taxa "Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey."
P3	Priority Three – Poorly Known Taxa "Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but need further survey."
P4	Priority Four – Rare Taxa "Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years."

Table 2: Categories of Threatened Flora Species (Environment Protection and Biodiversity Conservation Act, 1999)
Note: In other sections of the report these codes are referred to as the FCC – Federal Conservation Code

Category Code	Category
Ex	Extinct Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	Extinct in the Wild Taxa which is known only to survive in cultivation, in captivity or as a naturalized population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	Critically Endangered Taxa which at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	Endangered Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	Vulnerable Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	Conservation Dependent Taxa which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

2.6. Fauna - Nomenclature, Taxonomy and Distribution Patterns

The following literature sources have been used to discuss nomenclature, taxonomy and fauna distribution patterns in this report:

- **Birds:** Blakers *et al.* (1984); Collins (1995); Garnett (1992); Johnstone & Storr (1998); Storr, G.M. (1980), Simpson & Day (2004).
- **Mammals**: Strahan (1998).
- **Bats**: Churchill (1998)
- **Amphibians**: Tyler *et al.* (2000).
- **Reptiles:** Cogger (2000); Storr *et al.* (1983); Storr *et al.* (1990); Storr *et al.* (1999); Wilson & Knowles (1988); Storr *et al.* (2002) and Wilson and Swan (2003).

Other, more recent, taxonomic revisions have been used when applicable. These are noted in text and are listed in References.

2.7. Fauna - Protected Species - Commonwealth

In 1974, Australia signed the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). As a result, an official list of Endangered, Vulnerable or Extinct species was established and regularly updated (Endangered Species Protection Act 1992).

The Act was replaced by the Environment Protection and Biodiversity Conservation Act 1999 on 16 July 2000. It replaced the following Commonwealth statutes:

- *Environment Protection (Impact of Proposals) Act 1974*;
- *Endangered Species Protection Act 1992*;
- *National Parks and Wildlife Conservation Act 1975*;
- *World Heritage Properties Conservation Act 1983*; and
- *Whale Protection Act 1980.*

Of particular relevance is the assessment and approval mechanism included in this Act.

"*The Act provides that certain actions – in particular, actions which are likely to have a significant impact on a matter of national environmental significance – are subject to a rigorous assessment and approval process.*" (Environment Australia 1999).

Matters of national environmental significance that act as triggers for the referral process under Chapter 4 of the EPBC Act 1999 are:

- World Heritage properties;
- RAMSAR wetlands;
- nationally threatened species and ecological communities;
- migratory species;
- Commonwealth marine areas; and
- nuclear actions (including uranium mining).

The Act uses six levels of status classification for fauna species:

- Extinct;
- Extinct in the Wild;
- Critically Endangered;
- Endangered;
- Vulnerable;
- Conservation Dependent.

The Act also concerns itself with Key Threatening Processes and Threatened Ecological Communities. Whereas the latter does not in itself trigger the referral process, disturbance of listed ecological communities does.

The EPBC Act also covers all its international obligations under the one category of Migratory Species. This section covers fauna listed under the:

- Japan-Australia Migratory Bird Agreement (JAMBA);
- China-Australia (CAMBA) Migratory Bird Agreement, and
- Conventions on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

A range of shorebirds are listed under the Japan-Australia (JAMBA) and China-Australia (CAMBA) Migratory Bird Agreements. Most of the species listed on the JAMBA and/or CAMBA agreements are associated with coastal shores or inland saline wetlands and are not relevant to the current study area. However, some land birds are also listed in these international treaties and are discussed in this report.

2.8. Fauna - Protected and Priority Species - Western Australia

Currently in Western Australia, rare or endangered species are protected by the *Wildlife Conservation Act WA 1950*. The various schedules defined under this notice are:

- Schedule 1 – fauna that is rare or likely to become extinct and is in need of special protection;
- Schedule 2 – fauna that is presumed to be extinct;
- Schedule 3 – birds protected under international agreement;
- Schedule 4 – other specially protected fauna.

This Act is periodically reviewed and the current list of protected fauna was published in the Government Gazette, WA as the *Wildlife Conservation (Specially Protected Fauna) Notice 2003*.

A 1997 review of the International Union for Conservation of Nature and Natural Resources (IUCN) criteria for threatened species resulted in the deletion of several species from Western Australia's *Wildlife Conservation (Specially Protected Fauna) Notice 2003*. Some of these species have been placed on the CALM Priority Fauna List and require further monitoring.

Priority Fauna List classifies species as:

- Priority 1 - taxa with few, poorly known populations on threatened lands;
- Priority 2 - taxa with few, poorly known populations on conservation lands;
- Priority 3 - taxa with several, poorly known populations, some on conservation lands;
- Priority 4 - taxa in need of monitoring.

The Priority Fauna List does not confer any additional legal protection to the species listed apart from the normal protection afforded to most native animals. It does, however, indicate the need for vigilance during the construction and commissioning of development projects to manage native vegetation and rehabilitation so that Priority species, should they occur, do not meet the IUCN Criteria for listing on the Threatened Species List.

2.9. Review of Significance

All recorded flora species, vertebrate fauna species and plant communities were compared with State and Federal listings and an assessment was made of their current conservation status at the State and Federal levels. In undertaking this assessment, the condition of the vegetation was taken into consideration. The condition of each plant community was rated according to the scale used for assessing Bush Forever sites. The scale is summarised in Table 3.

Table 3: Condition Rating Scale from Bush Forever (Keighery 1994 as summarized in Government of Western Australia 2000)

Rating	Description	Explanation
1	Pristine	Pristine or nearly so, no obvious signs of disturbance.
2	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
3	Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure covers repeated fire, aggressive weeds, dieback, logging, grazing.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure covers frequent fires, aggressive weeds at high density, partial clearing, dieback and grazing.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure includes frequent fires, presence of very aggressive weeds, partial clearing, dieback and grazing.
6	Completely degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas often described as "parkland cleared" with the flora comprising weed or crop species with isolated native trees or shrubs.

As summarised in the BushForever document (The Government of Western Australia 2000) a range of biological attributes occur on the Perth International Airport and include:

- Munday Swamp (located south of the current survey area).
- a number of uplands and wetlands are suitable for Western Swamp Tortoise release (Kuchling and Burbidge 1996);
- Munday Swamp, Runway Swamp, Link Road Swamp and sumplands east of the main runway are wetlands of national importance (ANCA 1996);
- National Trust of Australia (WA) Classification – contains a substantial sweep of soils and communities from the eastern to the central Swan Coastal Plain (Bassendean Sands); contains plant communities representative of the eastern side of the Swan Coastal Plain;
- Sections of the Perth International Airport (including sections of the survey area in the southeastern corner of the Perth International Airport) are entered in the Register of the National Estate and in the Directory of Important Wetlands in Australia; and
- Floristic Community Types as delineated by Gibson *et al.* (1994) which were summarised in BushForever (The Government of Western Australia 2000).
- Designated remnant vegetation areas as highlighted in Bush Forever (The Government of Western Australia 2000).

3. METHODS

The survey was carried out on foot using aerial photographs to assist in the selection of sampling sites. Sites were selected in each vegetation type. At each sampling site, the cover and height of each stratum of vegetation was estimated and used to describe the local vegetation structure according to the terminology of Beard (1990). The height and percent cover of all vascular plant taxa were then recorded. For each survey site, the flora was systematically recorded. Plant specimens were collected wherever further identification was required.

All plant specimens collected during the field survey were handled and identified in accordance with the requirements of the Western Australian Herbarium. Where necessary, specimens were compared with pressed specimens housed at the Western Australian Herbarium, and plant taxonomists with specialist skills were consulted. Nomenclature of all taxa was checked against listings in the "MAX" database, and were compared to those distributions recorded in the "Florabase" database. Both databases are managed by the Department of Environment and Conservation (2006a and 2006d). Mattiske Consulting Pty Ltd has electronic access to both databases through licensing and an annual fee payment.

Because the survey was carried out in September 2006, many annual and geophytic herbs were present and were recorded

The fauna observations were based on vertebrate fauna sightings, faecal material and habitat utilisation of different areas within the proposed BGC site. All sightings were compared with State and Federal listings.

4. OBJECTIVES

In 2006, BGC (Australia) Pty Ltd commissioned Mattiske Consulting Pty Ltd to assess the biological values in the proposed development on the site north of Kalamunda Riad on the Perth Airport land.

The specific tasks include the following

- review the proposed methodology with the Westralia Airports Corporation and Department of Environment and Heritage (undertaken in the early part of September 2006)
- review the literature for the area
- search current databases for the area
- desktop review of potential issues
- search the targeted areas for rare and priority flora and rare and endangered fauna
- define and map the location of any rare and endangered species located within the survey area
- define the vegetation values in the survey area at the site-vegetation type, floristic communities and vegetation complex levels
- define and map the condition of the vegetation
- define the fauna habitats for the area
- review the significance of the values as defined on the survey area against the WA State Government Bush Forever Policy and in the local and regional context
- if any endangered species are located the assist in the development of a Flora and Fauna Management Plan for the site. Assist in the negotiation of the contents of the Flora and Fauna Management Plan with the AEO and DEP. The Flora and Fauna Management plan to be approved by the AEO in consultation with DEH prior to the commencement of building activities. The plan will include the following:
    - a plans showing vegetation communities; important flora and fauna habitat areas; locations where threatened species, populations or ecological communities were recorded; and areas to be cleared. The plans must also identify vegetation adjoining the proposed works where this contains important habitat areas and/or threatened species, populations or ecological communities;
    - b. methods to manage impacts on flora and fauna species and their habitat which may be directly or indirectly affected by the proposed works;

c. rehabilitation details;
d. a Weed Management Strategy;
e. a program for reporting on the effectiveness of flora and fauna management measures against the identified performance criteria.

- define any management issues related to flora, vegetation and vertebrate fauna values
- assist in the integration of the findings into the CEMP for the site

5. RESULTS

5.1. Flora

A total of 132 vascular plant taxa from 40 plant families and 99 genera were recorded within the proposed development area. No plant taxa gazetted as Declared Rare Flora pursuant to subsection (2) of section 23F of the Wildlife Conservation Act (1950) were located in the survey area. No plant taxa pursuant to section 179 of the Environment Protection Biodiversity Conservation Act (1999) were located in the survey area. A total of 39 introduced species were recorded in the proposed development area.

The combined surveys of the Perth Airport have recorded 677 taxa from 93 families and 311 genera, and including 201 introduced plant species (Alan Tingay and Associates 1994, Trudgen 1995, Bennett Environmental Consulting Pty Ltd 2001; 2002, Lawn 2002 and Mattiske Consulting Pty Ltd 2001, 2003, 2005). The apparent high proportion of introduced species reflects the degree of disturbance over large sections of the Perth Airport land. The range of native species occurs largely within the remnant areas of native bushland as highlighted by Bush Forever (Government of Western Australia, 2000) and the Australian Heritage Council (Department of Environment and Heritage 2006b).

5.2. Introduced Flora

The 39 introduced species recorded in the proposed development area north of Kalamunda Road, contribute to 30% of the vascular plant species recorded. This proportion reflects the past disturbance levels on the site.

Two of these introduced species, *Zantedeschia aethiopica* (P1, P4) and *Moraea flaccida* (P1) are listed as Declared Plants under the Agriculture and Related Resources Protection Act (1976) (http://www.agric.wa.gov.au/programs/app/dec_pl/declaredplants.htm) (Department of Agriculture and Food 2006). The Arum Lily (*Zantedeschia aethiopica)* only occurred in low numbers in local areas and therefore control measures should be effective. The Cape Tulip *(Moraea flaccida)* was more widespread and will require greater intervention. The declared weed species will require specific management during the operational activities. The weed management program will require control of these species on the site and also the strict hygiene of vehicles leaving the site.

5.3. Rare, Priority and Threatened Flora Species

Previous surveys and assessments of the Perth Airport land has highlighted several Rare, Priority and Theratened species as listed at the State and Federal levels. These included – *Conospermum undulatum* (on the eastern part of the Airport), *Macarthuria keigheryi* (on the southern and eastern part of the Airport) which are listed as Vuilnerable and Endangered respectively under the Environment Protection Biodiversity Conservation Act (1999).

No plant taxa gazetted as Declared Rare Flora pursuant to subsection (2) of section 23F of the Wildlife Conservation Act (1950) were located in the survey area.

No plant taxa pursuant to section 179 of the Environment Protection Biodiversity Conservation Act (1999) were located in the survey area.

Seven priority flora species, as listed by the Department of Environment and Conservation have been recorded previously in the wider Perth Airport, namely – *Schoenus benthamii* – P3 (Tingay 1994), *Haemodorum loratum* – P3 (Trudgen 1995), *Verticordia lindleyi* subsp. *lindleyi* – P4 (Tingay 1994, Trudgen 1995 and Mattiske 2002), *Myriophyllum echinatum* – P3 (Trudgen 1995 and Bennett 2002), *Villarsia submerse* – P4 (Mattiske 2002), *Goodenia filiformis* – P3 (Bennett 2002) and *Stylidium longitubum* (Trudgen 1995 and Bennett 2002).

No Priority flora taxa as listed by the Department of Evironment and Conservation (2006a) were located during the survey.

5.4. Vegetation

The vegetation of the study area was divided into 13 mapping units (including 8 plant communities and 5 disturbed areas - open water, fairways, planted areas, the oval and cleared areas), Figure 1.

H1 - Low Forest to Low Woodland of *Banksia attenuata, Banksia menziesii* and *Eucalyptus todtiana* over *Hibbertia hypericoides, Alexgeorgea nitens* and *Mesomelaena pseudostygia.*

This community is found on the sandier dune systems which have been disturbed to varying degrees on the proposed development sites. In the north-west corner this community is less disturbed, although the majority of this less disturbed area occurs to the west of the proposed development site. The community consists of a mixed *Banksia attenuata, Banksia menziesii* and *Eucalyptus todtiana* dominated canopy over a diverse sclerophyllous understorey. In parts, *Allocasuarina fraseriana* and *Eucalyptus marginata* also contribute to the canopy. Within the proposed development area the majoritry of the sites have been disturbed and are dominated by a range of introduced species (including Veldt grass). A total of 53 taxa were recorded in the sites, of which 19% were introduced.

I1 – Low Forest to Low Woodland of *Eucalyptus marginata, Banksia attenuata* and *Banksia menziesii* with occasional *Allocasuarina fraseriana* over *Acacia pulchella, Patersonia occidentalis* and *Dasypogon bromeliifolius.*

Community I1 occurs on the dune slopes between the Banksia dominated community (H1) to the west on the Airport land and the woodlands of Jarrah and Marri on the lower slopes. This community is largely degraded and dominated by introduced species on the fringes of the fairways. Within the proposed development area the majoritry of the sites have been disturbed and are dominated by a range of introduced species (including Veld grass). A total of 65 taxa were recorded, of which 20% were introduced. This higher range of taxain part reflected the dominance of this community and therefore the number of recording sites (6 in all).

I2 – Low Woodland of *Banksia attenuata* and *Allocasuarina fraseriana* over *Jacksonia sternbergiana, Bossiaea eriocarpa* and *Adenanthos cygnorum* over low herbs.

Community I2 occurs on the low dune slopes in the southeast corner of the survey area. This community is not part of the proposedm clearing area. A total of 22 taxa were recorded, of which 18% were introduced.

J1 - Woodland of *Corymbia calophylla, Melaleuca preissiana* and *Banksia* spp. over *Xanthorrhoea preissii, Hypocalymma angustifolium* and *Jacksonia sternbergiana* over low herbs and shrubs.

This community is variable and occurs in localised pockets around the fairway, the oval and the previously disturbed dampland in the northeast of the survey area. This community is largely degraded and dominated by introduced species on the fringes of the fairways. A total of 33 taxa were recorded in the sites, of which 45% were introduced.

J2 - Woodland of *Corymbia calophylla* over *Kingia australis, Xanthorrhoea preissii* over low shrubs and herbs.

This community was very similar to the J1 community as defined above, however it supported one Kingia australis on the fringes of its occurrence. This community, although restricted to a very small area, was less degraded. A total of 36 taxa were recorded, of which 25% were introduced.

J3 - Woodland of *Melaleuca preissiana – Banksia littoralis* with occasional *Corymbia calophylla* over *Hakea varia, Hypocalymma angustifolium* and low shrubs and sedges (variant of J1).

This community was very similar to the J1 community as defined above, however it occurred on the seasonally moister fringes of the J1 community. This community was restricted to a very small area within the survey area. A total of 38 taxa were recorded, of which 16% were introduced.

K2 - Closed Heath of *Hakea varia, Hypocalymma angustifolium* and *Melaleuca lateritia* over *Meeboldina cana* and *Hypolaena exsulca* with occasional *Melaleuca rhaphiophylla.*

This community is a variant of other dampland communities in the Perth Airport and is less disturbed than the other swamps in the area. This community was restricted to a very small area within the suvery area. A total of 11 taxa were recorded, of which 46% were introduced.

K6 - Tall Shrubland of *Viminaria juncea* over low herbs and invasive *Eragrostis curvula*

This community is a variant of other dampland communities, however in view of the degree of degradation has been split off from others. The condition ranges from degraded to completely (or very) degraded. This community dominated the north-eastern section of the survey area and a total of 18 taxa were recorded, of which 72% were introduced.

OW - Open water with aquatic herbs and emergent sedges and rushes.

CL - Cleared Areas

F1 - Fairways

The latter three codes supported a range of plant species, but were considered to be completely degraded or artificial.

5.5. Condition of Vegetation

The vegetation varies from completely degraded to very good (Figure 2). The remnant bushland to the west of the north-west corner of the proposed development site is in excellent condition. The proportion of the area that has been already cleared extensively and modified by previous human activities is obvious from the range of introduced species and the lack of intact overstoreys in the upper layers.

5.6. Vertebrate Fauna

The combined surveys of the Perth Airport have recorded a range of vertebrate species (Government of Western Australia 2000) – namely:

- 87 bird species (How and Dell 1994; RAOU 1996, Tingay and Associates 1994b),
- 2 native mammal species (How and Dell 1994, Tingay and Associates 1994b),
- 20 reptile species (How and Dell 1994, Tingay and Associates 1994b),
- 8 amphibian species (How and Dell 1994, Tingay and Associates 1994b).

In the recent Evironment Review for the proposed development, the report noted the potential for "129 species of vertebrates to date including 3 fish, 8 frogs, 22 reptiles, 81 birds and 5 mammals". As it was recognized that the Chuditch (Western Quoll) and Quenda (Southern Brown Bandicoot) could be present on site, it was acknowledged in the BGC documents (2006) that the native fauna would be located on site and then trapping would be undertaken in conjunction and consultation with DEC and methods consistent with the Perth Airport Environment Strategy.

A range of species and habitats have been highlighted for the Perth Airport – namely several bird species, Munday Swamp as a breeding site for waterbirds (Jaensch *et al.* 1993) and the swamps on the clay soils appeared to have once supported the critically endangered Western Swamp Tortoise - *Pseudomydura umbrina* (WA Museum record from 1970) as listed under the Environment Protection Biodiversity Conservation Act (1999) (Kuchling and Burbidge 1996). Further, the Forrestfield Bushland and Munday Swamp Bushland contain the only known populations of the crowned snake (*Notechis coronatus*) in the Perth metropolitan area and one of the front-fanged snakes near Munday Swamp (*Rhinocephalus gouldii*), (Department of Environment and Heritage 2006b). The goanna (*Varanus gouldii*) is known from the shrubland areas dominated by *Adenanthos cygnorum* (woolly bush).

Munday Swamp supports lake populations of the Western Pygmy Perch (*Edelia vittata*) and the Western Minnow (*Galaxias occidentalis*).

In the recent survey, 28 birds, 3 mammals, one reptile and one amphibian species were recorded. The birds utlilised both the completely degraded as well as the less disturbed woodlands. Several of the trees had small hollows that were utilised for nesting by a range of birds, particularly the Tree Martin *Petrochelidon nigricans* and the Twenty-Eight Parrot *Barnardius zonarius semitorquatus*. This was particularly apparent in several larger Jarrah (*Eucalyptus marginata*) trees in the survey area.

The completely degraded swamps dominated by *Eragrostis curvula* (South African Love Grass) and the Marri woodlands with dense Watsonia (*Watsonia meriana*) understoreys supported Bandicoots (Quenda – *Isoodon obesulus*) populations. Although the Southern Brown Bandicoot is listed as Endangered under the EPBC Act 1999, that listing is actually for a different subspecies to the Western Australian one: *Isoodon obesulus obesulus*, confined to South Australia, Victoria and New South Wales as opposed to the Quenda *Isoodon obesulus fusciventer*.

The Chuditch or Western Quoll *Dasyurus geoffroii*, a nocturnal carnivore, is listed as Vulnerable under the EPBC Act 1999. This marsupial occupies scattered areas of forest, shrubland and desert across the south-western corner of Western Australia (Strahan ed. 1995).

The Western Swamp Tortoise *Pseudemydura umbrina* is listed as Critically Endangered under the EPBC Act 1999. This species is confined to wetlands associated with clay soils on the Swan Coastal Plain, and is highly susceptible to hydrological changes, fox predation and habitat loss.

Of these highlighted species, the Southern Brown Bandicoot was recorded in the degraded swamps and woodlands. Neither the Chuditch or Western Quoll *Dasyurus geoffroii*, or Western Swamp Tortoise *Pseudemydura umbrina,* were sighted, or evidence of these two species located, during this survey.

5.7. Fauna Habitats

The following fauna habitats were defined as a result of the survey work, Table 4.

Table 4: Fauna Habitats – Proposed Development Site (see Appendix B)

Community Code	Fauna Habitats	Comments
H1	1	Sandy soils supporting range of Low Forests and Woodlands of *Banksia attenuata, Banksia menziesii, Eucalyptus todtiana and Eucalyptus marginata.* Some hollows in older trees.
I1		
J1	2	Sandy loams supporting range of Woodlands of *Corymbia calophylla* with patches of *Melaleuca preissiana, Banksia littoralis.* Some hollows in older trees. In weed infested areas, also dense understorey (*Watsonia* patches).
J2		
J3		
K6	3	Clay-loams supporting *Viminaria juncea* and dense thickets of introduced grasses, including *Eragrostis curvula.*
OW	4	Open water with fringing sedges and small shrubs.
Fairway	5	Parkland Cleared Woodlands of Tall Trees with some hollows.
Cleared		

6. DISCUSSION

Flora

A total of 132 vascular plant taxa from 40 plant families and 99 genera were recorded within the proposed development area. No plant taxa gazetted as Declared Rare Flora pursuant to subsection (2) of section 23F of the Wildlife Conservation Act (1950) were located in the survey area. No plant taxa pursuant to section 179 of the Environment Protection Biodiversity Conservation Act (1999) were located in the survey area. A total of 39 introduced species were recorded in the proposed development area. Two of these introduced species, *Zantedeschia aethiopica* (P1, P4) and *Moraea flaccida* (P1) are listed as Declared Plants under the Agriculture and Related Resources Protection Act (1976) (http://www.agric.wa.gov.au/programs/app/dec_pl/declaredplants.htm) (Department of Agriculture and Food 2006). The Arum Lily (*Zantedeschia aethiopica)* only occurred in low numbers in local areas and therefore control measures should be effective. The Cape Tulip *(Moraea flaccida)* was more widespread and will require greater intervention. The declared weed species will require specific management during the operational activities. The weed management program will require control of these species on the site and also the strict hygiene of vehicles leaving the site.

As indicated in the Environmental Review document by BGC (2006), the vegetation on the perimeter of the development area and the non-development areas will remain. Additional sites to the north-west, west and the south-east of the proposed clearing areas supported a further 28 species that were not recorded within the project area, including 21 native species and 7 introduced species. None of these species are listed as rare or endangered under the State and Federal listings.

The combined surveys of the Perth Airport have recorded 677 taxa from 93 families and 311 genera, and including 201 introduced plant species (Alan Tingay and Associates 1994, Trudgen 1995, Bennett Environmental Consulting Pty Ltd 2001; 2002, Lawn 2002 and Mattiske Consulting Pty Ltd 2001, 2003, 2005). The apparent high proportion of introduced species reflects the degree of disturbance over large sections of the Perth Airport land. The range of native species occurs largely within the remnant areas of native bushland as highlighted by Bush Forever (Government of Western Australia, 2000) and the Australian Heritage Council (Department of Environment and Heritage 2006b).

No plant taxa gazetted as Declared Rare Flora pursuant to subsection (2) of section 23F of the Wildlife Conservation Act (1950) were located in the survey area to the north of Kalamunda Road. No plant taxa pursuant to section 179 of the Environment Protection Biodiversity Conservation Act (1999) were located in the survey area to the north of Kalamunda Road.

Vegetation

Perth International Airport is situated in the Swan Coastal Plain Subregion and is classified into the Drummond Botanical subdistrict (Beard 1990). The natural vegetation of the Perth Airport area is dominated by the communities on the Bassendean System (Beard 1979). A typical Bassendean catena features *Banksia* low woodland on elevated, drier sites and *Eucalyptus marginata - Corymbia calophylla* woodland with *Banksia* and *Allocasuarina* on moister sites, with various swamp communities in the wettest areas (Beard 1981).

The survey area within the Perth International Airport is included in the Bassendean and Southern River vegetation complexes as defined by Heddle *et al.* (1980). The woodlands of Jarrah, Marri and Banksia's on the aeolian sands are more typical of the Bassendean dune system and the woodlands and shrublands on the intervening swamps reflect the influence of seasonally inundated soils (irons, humus podsols, peats and clays – Churchward and McArthur 1980).

The Perth Airport has been divided into different areas based on its variety of vegetation and the condition of this vegetation. In view of the degree of disturbance in the vegetation on the proposed development site north of Kalamunda Road has been modified substantially as reflected in the proportion of introduced species in the respective communities. As indicated in the Environmental Review document by BGC (2006), the vegetation on the perimeter of the development area and the non-development areas will remain.

The proposed development area occurs on the Southern River vegetation complex, near the interface with the Bassendean Central and South and the Guildford as defined by Heddle et al. (1980). The plant communities on the sandier soils of the Bassendean are well reserved on the Bassendean dune systems (24% Bassendean Central and South, Government of Western Australia – Bush Forever 2002). The communities on the Southern River vegetation complex on the loamier soils are less well-represented (17% Southern River - Government of Western Australia – Bush Forever 2002). The key question in relation to the development area relates to the condition of the vegetation on the site. As indicated in Figure 2, the majority of the site is either degraded or completely degraded.

An additional comparison can be made with the floristic communities as defined by Gibson *et al.* (1994), Table 5. Several of the Gibson *et al.* (1994) communities underpin the delineation of threatened ecological communities on the Swan Coastal Plain as listed under the Environment Protection Biodiversity Conservation Act (EPBC Act 1999).

Table 5: Comparison of Floristics with Plant Communities as defined by Gibson *et al.* (1994)
Note - * denotes number of introduced taxa within total of taxa.

Community Code	Potential Gibson *et al.* 1994 Community	TEC as listed by EPBC Act 1999	Number of Taxa recorded in Survey on BGC site	Percentage Overlap with Taxa as defined by Gibson *et al.* 1994
H1	SCP20a	-	19 (7*)	9%
I1	SCP20a	-	62 (13*)	32%
J1	SCP3c	SCP3c	32 (12*)	9%
J2	SCP3a	SCP3a	35 (9*)	13%
J3	SCP4	-	37 (6*)	18%
K6	SCP8	-	17 (14*)	5%

In view of the lack of overlap of taxa within these plant communities as defined by Gibson *et al.* (1994), and the proportion of introduced species, the justification that the J1 and J2 communities are equivalent to the EPBC Act listed threatened ecological communities appears difficult to justify at this juncture. If one takes a conservative approach in this matter, it would be advisable to protect the Marri communities (J1 and J2) on the perimeters of the proposed development, including those in the south-east and north-west corners of the survey area. The latter approach also would assist in providing a visual buffer to the development. The value of the perimeters and the vegetation outside the proposed development areas was acknowledged in the BGC documents (2006).

In designing the development, consideration of drainage off the site should be considered. As indicated in other publications on the Perth Airport, one of the critical sites is the conservation area to the south of Kalamunda Road and Munday Swamp. These areas have been recognised in planning the conservation areas on the Airport and also through the listings of the heritage sites at the national level (Department of Environment and Heritage, 2006b).

Vertebrate Fauna

In the recent survey, 28 birds, three mammals, one reptile and one amphibian were recorded. The birds utlilised both the completely degraded as well as the less disturbed woodlands. Several of the trees had small hollows that were utilised for nesting by a range of birds. This was particularly apparent in several larger Jarrah (*Eucalyptus marginata*) trees in the survey area.

The completely degraded swamps dominated by *Eragrostis curvula* (South African Love Grass) and the Marri woodlands with dense Watsonia (*Watsonia meriana*) understoreys supported Bandicoots (Quenda – *Isoodon obesulus*) populations. Although the Southern Brown Bandicoot (*Isoodon obesulus obesulus*) is listed as Endangered under the EPBC Act 1999, that subspecies is confined to eastern states and is a different subspecies to the Western Australian one. These animals will need to be trapped and translocated just prior to clearing activities on the proposed development area.

Of these highlighted species, the Bandicoot as recorded in the degraded swamps and woodlands will require trapping and translocation to other areas on the Swan Coastal Plain in consultation with appropriate authorities.

In view of the lack of listed endangered species under the EPBC Act 1999, there is no need to prepare a specific management plan for rare or endangered flora and fauna species.

To assist in the ongoing management of the flora and fauna values on the site the following recommendations are made for the BGC site:

a. Maintain buffers on the fringes of the development site.
b. Where feasible, maintain habitat trees for nesting bird species.

c. Avoid disturbing the Marri communities in the northwest section of the lease area and in the southeast corner of the lease area.
d. In designing any stormwater sumps in the facilities, the sump should be constructed prior to the removal of the established sumps, thereby assisting some of the local waterbirds.
e. As indicated in the environmental review documents, the Bandicoots should be trapped and translocated to other sites in consultation with the Department of Conservation and Environment.
f. The declared weeds on site should be managed in line with current practices as outlined in the Department of Agriculture and Food.
g. Feral animals should be controlled (eg. rabbit and domestic animals) as these introduced animals can influence the presence and numbers of native animals.
h. Rehabilitation activities should be undertaken with local native plant species.

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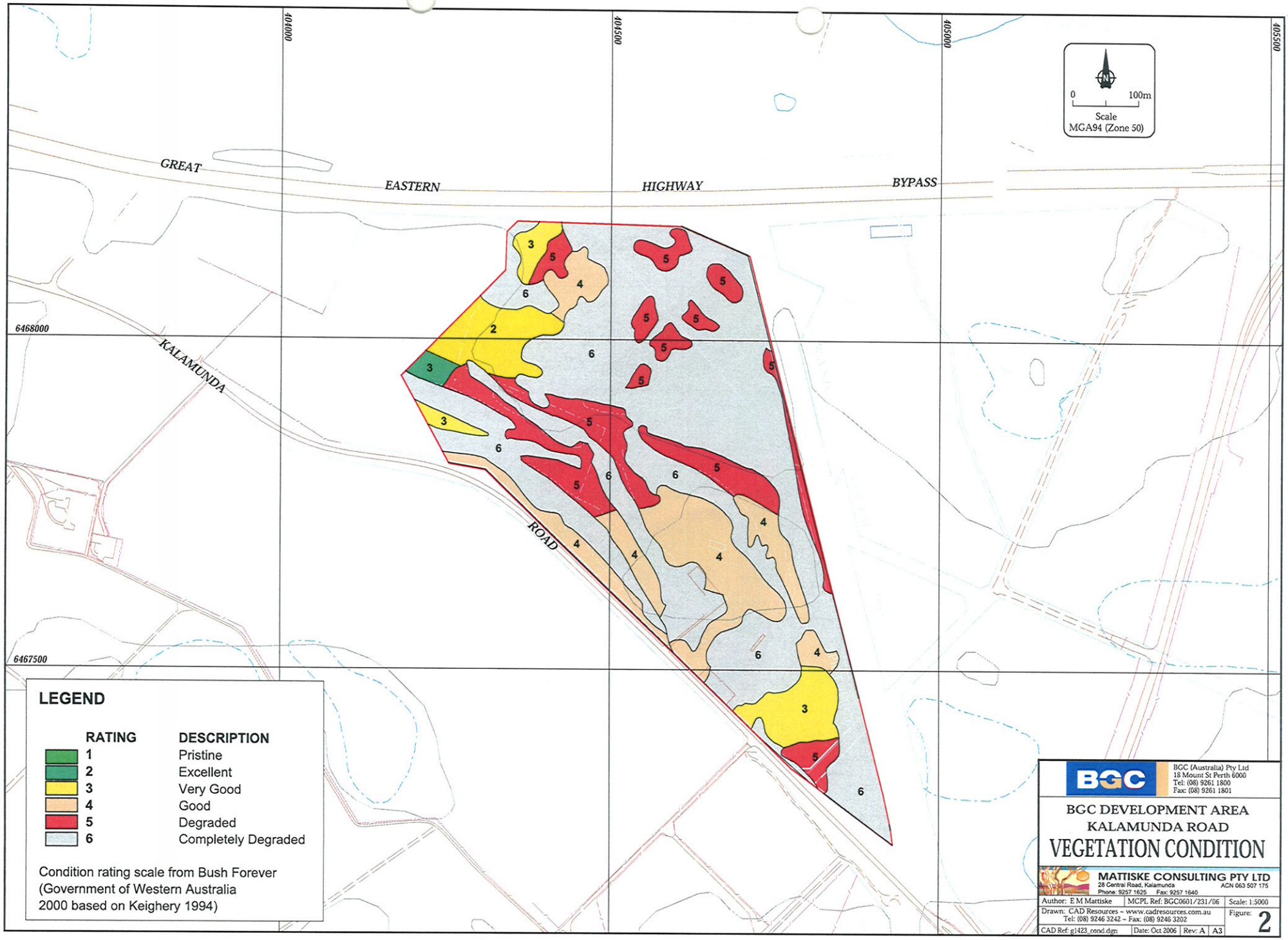
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1 Pristine
2 Excellent
3 Very Good
4 Good
5 Degraded
6 Completely Degraded
Condition rating scale from Bush Forever (Government of Western Australia 2000 based on Keighery 1994)
BGC
BGC (Australia) Pty Ltd
18 Mount St Perth 6000
Tel: (08) 9261 1800
Fax: (08) 9261 1801
BGC DEVELOPMENT AREA
KALAMUNDA ROAD
VEGETATION CONDITION
MATTISKE CONSULTING PTY LTD
28 Central Road, Kalamunda
Phone: 9257 1625 Fax: 9257 1640
ACN 063 507 175
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BGC (Australia) Pty Ltd
18 Mount St Perth 6000
Tel: (08) 9261 1800
Fax: (08) 9261 1801

BGC DEVELOPMENT AREA KALAMUNDA ROAD
VEGETATION

MATTISKE CONSULTING PTY LTD
28 Central Road, Kalamunda ACN 063 507 175
Phone: 9257 1625 Fax: 9257 1640

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APPENDIX A: SUMMARY OF VASCULAR PLANT SPECIES RECORDED ON THE BGC SITE, 2006

Note: * - Introduction species

Family	Taxa
ZAMIACEAE	*Macrozamia riedlei*
TYPHACEAE	* *Typha orientalis*
POACEAE	* *Briza maxima*
	* *Bromus diandrus*
	* *Cynodon dactylon*
	* *Ehrharta calycina*
	* *Eragrostis curvula*
	* *Poa annua*
	* *Vulpia myuros*
CYPERACEAE	*Cyathochaeta avenacea*
	Cyperus polystachyos
	Lepidosperma effusum
	Lepidosperma squamatum
	Mesomelaena pseudostygia
ARACEAE	* *Zantedeschia aethiopica*
RESTIONACEAE	*Desmocladus fasciculatus*
	Desmocladus flexuosus
	Hypolaena exsulca
	Lyginia barbata
JUNCACEAE	* *Juncus capitatus*
	Juncus pallidus
DASYPOGONACEAE	*Dasypogon bromeliifolius*
	Kingia australis
	Lomandra preissii
XANTHORRHOEACE	*Xanthorrhoea preissii*
ANTHERICACEAE	*Chamaescilla corymbosa* var. *corymbosa*
	Johnsonia pubescens subsp. *pubescens*
	Laxmannia ramosa subsp. *ramosa*
	Sowerbaea laxiflora
	Thysanotus patersonii
COLCHICACEAE	*Burchardia multiflora*
	Burchardia umbellata

APPENDIX A: SUMMARY OF VASCULAR PLANT SPECIES RECORDED ON THE BGC SITE, 2006

Note: * - Introduction species

Family	Taxa
HAEMODORACEAE	*Anigozanthos humilis* subsp. *humilis*
	Anigozanthos manglesii subsp. *manglesii*
	Conostylis aculeata subsp. *aculeata*
	Conostylis aurea
	Haemodorum spicatum
IRIDACEAE	* *Freesia alba* x *leichtlinii*
	* *Gladiolus caryophyllaceus*
	* *Moraea flaccida*
	Patersonia occidentalis
	* *Romulea rosea* var. *communis*
	* *Sparaxis bulbifera*
	* *Watsonia meriana*
	* *Watsonia meriana* var. *bulbillifera*
	* *Watsonia meriana* var. *meriana*
ORCHIDACEAE	*Caladenia flava* subsp. *flava*
	Caladenia longicauda subsp. *longicauda*
	* *Disa bracteata*
	Diuris corymbosa
	Pterostylis recurva
	Thelymitra pauciflora
CASUARINACEAE	*Allocasuarina fraseriana*
	Allocasuarina humilis
PROTEACEAE	*Adenanthos cygnorum* subsp. *cygnorum*
	Banksia attenuata
	Banksia grandis
	Banksia littoralis
	Banksia menziesii
	Conospermum stoechadis subsp. sclerophyllum
	Dryandra lindleyana var. *lindleyana*
	Hakea prostrata
	Hakea varia
	Petrophile linearis
	Stirlingia latifolia
LORANTHACEAE	*Nuytsia floribunda*
LAURACEAE	*Cassytha glabella*
FUMARIACEAE	* *Fumaria capreolata*
BRASSICACEAE	* *Brassica tournefortii*

APPENDIX A: SUMMARY OF VASCULAR PLANT SPECIES RECORDED ON THE BGC SITE, 2006

Note: * - Introduction species

Family	Taxa
DROSERACEAE	*Drosera erythrorhiza* subsp. *erythrorhiza*
	Drosera pallida
	Drosera stolonifera subsp. *stolonifera*
CRASSULACEAE	*Crassula colorata*
PITTOSPORACEAE	*Billardiera fusifomis*
MIMOSACEAE	*Acacia huegelii*
	Acacia pulchella
	Acacia saligna
	Acacia sessilis
	Acacia willdenowniana
PAPILIONACEAE	*Bossiaea eriocarpa*
	Daviesia physodes
	Gompholobium capitatum
	Gompholobium tomentosum
	Hardenbergia comptoniana
	Hovea trisperma
	Jacksonia floribunda
	Jacksonia furcellata
	Jacksonia sternbergiana
	Kennedia prostrata
	* *Lupinus cosentinii*
	* *Medicago* sp.
	* *Vicia sativa*
	Viminaria juncea
GERANIACEAE	* *Erodium botrys*
OXALIDACEAE	* *Oxalis pes-caprae*
	* *Oxalis purpurea*
RUTACEAE	*Philotheca spicata*
EUPHORBIACEAE	*Phyllanthus calycinus*
DILLENIACEAE	*Hibbertia huegelii*
	Hibbertia hypericoides
	Hibbertia racemosa
VIOLACEAE	*Hybanthus calycinus*

APPENDIX A: SUMMARY OF VASCULAR PLANT SPECIES RECORDED ON THE BGC SITE, 2006

Note: * - Introduction species

Family	Taxa
MYRTACEAE	*Astartea scoparia*
	Corymbia calophylla
	Eremaea pauciflora
	* *Eucalyptus maculata* var. *citriodora*
	Eucalyptus marginata
	* *Eucalyptus platypus*
	Eucalyptus rudis subsp. *rudis*
	* *Eucalyptus sideroxylon*
	* *Eucalyptus wandoo*
	Hypocalymma angustifolium
	* *Leptospermum laevigatum*
	Melaleuca preissiana
	Melaleuca rhaphiophylla
	Scholtzia involucrata
	Verticordia densiflora var. *densiflora*
HALORAGACEAE	*Gonocarpus cordiger*
APIACEAE	*Trachymene pilosa*
EPACRIDACEAE	*Conostephium pendulum*
	Leucopogon conostephioides
LAMIACEAE	*Hemiandra pungens*
SOLANACEAE	* *Solanum nigrum*
PLANTAGINACE/	* *Plantago lanceolata*
GOODENIACEAE	*Dampiera linearis*
ASTERACEAE	* *Arctotheca calendula*
	* *Cotula turbinata*
	* *Dittrichia graveolens*
	* *Hypochaeris glabra*
	* *Sonchus oleraceus*
	* *Ursinia anthemoides*
	Waitzia suaveolens

APPENDIX B: LIST OF VERTEBRATE FAUNA SPECIES RECORDED IN THE PROPOSED BGC SITE

* = feral or introduced species

§ = species identified from dead animal

BIRDS		**Habitat 1 – H1, I1**	**Habitat 2 – J1, J2, J3**	**Habitat 3 – K6**	**Habitat 4 – Open Water**	**Habitat 5 – Cleared and Fairways**
PODICIPEDIDAE						
Tachybaptus novaehollandiae	Australasian Grebe				X	
ARDEIDAE						
Ardea novaehollandiae	White-faced Heron				X	X
ANATIDAE						
Tadorna tadornoides	Australian Shelduck				X	
Anas superciliosa	Pacific Black Duck				X	X
Aythya australis	Hardhead				X	
Chenonetta jubata	Australian Wood Duck					
RALLIDAE						
Fulica atra	Eurasian Coot				X	
COLUMBIDAE						
Streptopelia senegalensis	Laughing Turtle-Dove	X	X			
PSITTACIDAE						
Barnardius zonarius semitorquatus	Twenty-eight Parrot	X	X			X
TYTONIDAE						
Tyto alba	Barn Owl§		X			
HALCYONIDAE						
Dacelo novaeguineae	Laughing Kookaburra	X				
Todiramphus sanctus	Sacred Kingfisher	X				
ACANTHIZIDAE						
Gerygone fusca	Western Gerygone					X
MELIPHAGIDAE						
Lichmera indistincta	Brown Honeyeater	X	X	X		X
Anthochaera carunculata	Red Wattlebird		X	X		
Phylidonyris novaehollandiae	New Holland Honeyeater				X	
NEOSITTIDAE						
Daphoenositta chrysoptera	Varied Sittella	X				
PACHYCEPHALIDAE						
Pachycephala rufiventris	Rufous Whistler					X
DICRURIDAE						
Rhipidura albiscapa preissi	Grey Fantail				X	
Rhipidura leucophrys	Willie Wagtail		X		X	X
Grallina cyanoleuca	Magpie-lark	X	X	X		X
CAMPEPHAGIDAE						
Coracina novaehollandiae	Black-faced Cuckoo-shrike		X			X
CRACTICIDAE						
Cracticus torquatus	Grey Butcherbird		X			
Cracticus tibicen	Australian Magpie		X	X		X

APPENDIX B: LIST OF VERTEBRATE FAUNA SPECIES RECORDED IN THE PROPOSED BGC SITE

* = feral or introduced species

§ = species identified from dead animal

BIRDS		**Habitat 1 – H1, I1**	**Habitat 2 – J1, J2, J3**	**Habitat 3 – K6**	**Habitat 4 – Open Water**	**Habitat 5 – Cleared and Fairways**
CORVIDAE						
Corvus coronoides	Australian Raven					X
HIRUNDINIDAE						
Petrochelidon nigricans	Tree Martin	X			X	X
DICAEIDAE						
Pardalotus striatus	Striated Pardalote	X				
ZOSTEROPIDAE						
Zosterops lateralis	Silvereye	X	X		X	

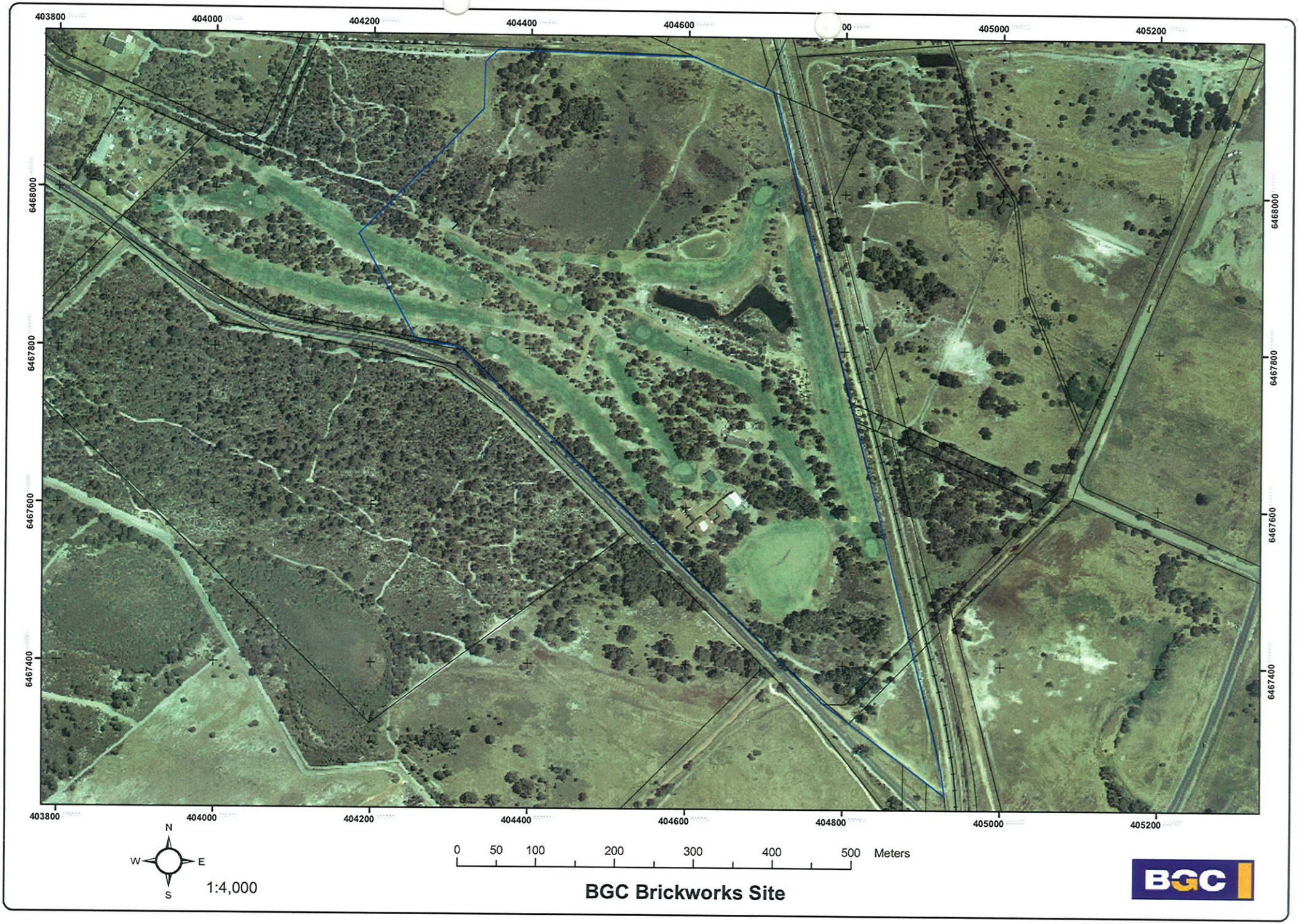
MAMMALS		**Habitat 1 – H1, I1**	**Habitat 2 – J1, J2, J3**	**Habitat 3 – K6**	**Habitat 4 – Open Water**	**Habitat 5 – Cleared and Fairways**
LEPORIDAE						
**Oryctolagus cuniculus*	Rabbit	X	X	X	X	X
CANIDAE						
**Canis lupus*	Dog	X				
PARAMELIDAE						
Isoodon obesulus (fusciventer)	Quenda	X	X	X		

REPTILES and AMPHIBIANS		**Habitat 1 – H1, I1**	**Habitat 2 – J1, J2, J3**	**Habitat 3 – K6**	**Habitat 4 – Open Water**	**Habitat 5 – Cleared and Fairways**
CHELIDAE						
Chelodina oblonga	Oblong Turtle §		X			
HYLIDAE						
Litoria sp.	Tree frog (sp. unconfirmed))				X	

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FLORA AND VEGETATION OF REMNANT BUSHLAND ON THE CORNER OF GROGAN ROAD AND HORRIE MILLER DRIVE PERTH INTERNATIONAL AIRPORT

Prepared for: Westralia Airports Corporation Pty Ltd
Baker Road
Perth International Airport

Prepared by: Bennett Environmental Consulting Pty Ltd
21 Currawong Drive
GOOSEBERRY HILL 6076

19th September 2000

CONTENTS

		Page
1.	INTRODUCTION	1
2.	BACKGROUND	1
2.1	Geology	1
2.2	Flora and Vegetation	2
2.3	Fauna	3
2.4	Wetlands	3
2.5	Selection of Bushplan Sites	4
3.	OBJECTIVES	5
4.	METHOD	5
5.	RESULTS	6
5.1	Flora Recorded	6
5.2	Vegetation Communities	6
	5.2.1 Wetlands	6
	5.2.2 Banksia Woodland	8
	5.2.3 Disturbed Land	8
5.3	Condition	9
6.	DISCUSSION	10
7.	CONCLUSION	14
8.	REFERENCES	15

APPENDICES

A. Species List of Vascular Plant Species Recorded in the Survey
B. Vascular Plant Species Recorded in Each of the Different Vegetation Communities
C. Vegetation Communities and Condition
D. Photographic Record of Vegetation Communities

SUMMARY

The Perth Bushplan sites on Horrie Miller Drive and Grogan Road consist of the following vegetation communities:

- Wetland 1, a Dense Low Shrubland of *Pericalymma ellipticum* and *Astartea fascicularis* over sedges and rushes with scattered low trees of *Melaleuca preissiana.*
- Wetland 2 a Low Shrubland of *Calytrix fraseri, Hypocalymma angustifolia* and *Pericalymma ellipticum* over mixed sedges with scattered trees of *Eucalyptus rudis* and *Melaleuca preissiana.* are both classified as Community Type 4, *Melaleuca preissiana* damplands (Gibson *et .al*, 1994).
- Wetland 3, a Woodland of *Banksia littoralis, Melaleuca preissiana* and *M. rhaphiophylla* with occasional *Eucalyptus rudis* over introduced species. A degraded condition (5) indicates it has the potential for restoration but not to a state approaching good condition without intensive management. All the tree species occur in other locations throughout the bushland of Perth International Airport (Alan Tingay and Associates, 1994).
- The Open to Dense Woodland of *Banksia attenuata* with scattered *Eucalyptus todtiana, B. menziesii and B. ilicifolia* over a dense shrubland and herbland.
- Three disturbed areas:

  1. Dense herb and grassland of introduced species with scattered *Melaleuca preissiana* and *Corymbia calophylla.*

     The community occurred on the south eastern corner of Horrie Miller Drive and Grogan Road. The herbs and grasses were dominated by the introduced species *Homeria flaccida, Eragrostis curvula* and *Ehrharta calycina* but there were no native species present in the understorey. The south eastern edge of this paddock had a remnant of Banksia Woodland but this was highly degraded due to the presence of dense infestation of introduced species.

  2. Scattered *Adenanthos cygnorum* over weeds, dominated by *Ehrharta calycina* and *Eragrostis curvula.*

     This is a cleared area between Wetland 2 and the Banksia Woodland. It would appear this community should be the interzone between the other two communities. This community was totally degraded.

3. An abandoned orchard consisting of lemon and olive trees over weeds, dominated by *Ehrharta calycina* and *Eragrostis curvula*.

The first two communities are classified as Community Type 4, *Melaleuca preissiana* damplands (Gibson *et .al*, 1994). This community is not under threat being classified as well reserved and of low conservation risk (Gibson *et. al*, 1994). This is the *Pericalymma ellipticum* Closed Heath of Alan Tingay and Associates (1994). The vegetation mapping undertaken by Alan Tingay and Associates (1994) indicates this community is widespread in the south and southeast of Perth International Airport's remnant bushland plus there is an additional community in the north. Wetland 1 was mapped during the 1994 survey but wetland 2 was not included, presumably as it was considered too degraded for inclusion as a section of remnant bushland.

Wetland 3 is classified as Community Type 15, Forests and woodlands of deep seasonal wetlands by Gibson *et.al.* (1994) and is considered to be well reserved but with a vulnerable conservation status. It is listed as a vulnerable ecological community on the Swan Coastal Plain by English and Blythe (1997). This community occupied a small area, the remainder possibly being removed with the construction of Horrie Miller Drive.

The Banksia Woodland is classified as Type 23a Central *Banksia attenuata – B. menziesii* Woodlands (Gibson *et. al*, 1994) and is well reserved and of low conservation risk. This community is common throughout the bushland of Perth International Airport land.

A small portion of the Banksia Woodland was in excellent to good condition. The southern end was recorded as condition 5 as all the understorey (except for a very few plants) had been replaced with *Ehrharta calycina*. There was only a very small area of the Banksia woodland which could be considered as Condition 2 the majority being Condition 5.

Wetland 1 was also in good condition, which means the community has been significantly altered, as indicated by the numerous deaths of *Pericalymma ellipticum* recorded during the survey. There were also several aggressive weeds recorded from the area, including the wetter areas, so if the area was opened up these aggressive weeds within the area could possibly dominate. If the community is left with no management this is also a possible outcome. Wetlands 2 and 3 are degraded with most of the understorey species replaced by weeds.

Considering the condition of these areas, the selection procedures for a Bushplan Site and their representation in the Perth International Airport conservation areas, it would appear

these areas are sufficiently represented elsewhere within the conservation areas of Perth International Airport or are too degraded to consider for conservation as outlined in Perth's Bushplan (Environmental protection Authority, 1998). In addition the areas of native vegetation where the structure and the floristics have been altered to the extent that the vegetation cannot practically be restored to be 'representative of the structure and floristics of the natural vegetation' indicates that the majority of the areas surveyed are too degraded to be considered as representative of the structure and floristics of the natural vegetation.

Westralia Airports Corporation has given a commitment to maintain and enhance the two designated conservation areas within Perth International Airport. It would be appropriate for these areas to be enhanced by weed removal and enhancement planting with species native to the particular vegetation communities rather than attempting to maintain all the areas designated in Perth's Bushplan.

1. INTRODUCTION

In July 1997, the Commonwealth Government of Australia sold a 50 year lease, plus a 49 year option, to manage and develop Perth International Airport to the Westralia Airports Corporation (WAC). Two areas within Perth International Airport are registered by the Australian Heritage Commission (2000) on the Register of the National Estate database as from 26th October 1999. These are:

- Forrestfield Bushland in the south east corner and
- Munday Swamp Bushland in the north east section.

State legislation may not be applicable to Perth International Airport as it is on Commonwealth land. The Conservation Through Reserves (1983) study by the Western Australian Environmental Protection Authority included Perth International Airport in the System 6 Region. The recommendation for Perth International Airport (Area M52) states "that the Commonwealth of Australia retain as much uncleared land as possible".

Some of the bushland of Perth International Airport is included in Perth's Bushplan (Environmental Protection Authority, 1998) as Bushplan Site No. 386. This Bushplan Site also includes railway land, controlled access highways, important regional roads and land for public purposes - special uses, within the Shires of Swan and Kalalmunda and City of Belmont. The total area is 771.4ha (including open water) of which 632.3ha is bushland. Munday Swamp is one of these open water areas, an area of Aboriginal heritage value that also has an unusually rich and diverse invertebrate fauna.

WAC has taken into account all the environmental factors impacting on the future development of the area and has set aside 312 hectares including Munday Swamp for conservation. An attempt was made when deciding on the areas to be left for conservation to ensure that large areas of varied and good quality vegetation are included. It is proposed Westralia Airports Corporation will maintain and improve these conservation areas.

2. BACKGROUND

2.1 Geology

The superficial Quaternary deposits are poorly sorted quartz sand, mainly fine to medium grained, off-white to pale grey at the surface and cream to yellow at depth. Perth International Airport is included in the Bassendean Dunes Major Landform Element (Heddle et.al, 1980). The south western section is included in the Bassendean Complex – Central and South and the remainder in the Southern River Complex comprising sandy

plains with low dunes and intervening swamps. The sandy soils are well drained and leached, ranging from peaty podzols in the Bassendean swamps through iron and humus podzols to clays underlying some swamps in the Southern River Units.

2.2 Flora and Vegetation

A considerable portion of the Perth International Airport site has been modified and cleared substantially of natural vegetation due to agricultural, horticultural and recreational activities. Flora surveys have been undertaken by Dixon (1983), an extensive survey by Alan Tingay and Associates (1997) and a survey by the Department of Environmental Protection (Environmental Protection Authority, 1998). These surveys have recorded over 300 native plant species. Alan Tingay and Associates (1997) produced vegetation and vegetation condition maps. They recognised 8 major vegetation groupings based on vegetation formations that were further subdivided into 42 vegetation communities.

Conospermum undulatum a Declared Rare Flora under the provisions of the Western Australian Wildlife Conservation Act (1950) has been located on the northeast boundary. In addition the Department of Conservation and Land Management maintain priority flora lists. Priority 1 flora are "Taxa with few, poorly known populations on threatened lands (ie not managed for conservation)": Priority 2 flora are "Taxa with few, poorly known populations on conservation lands": Priority 3 flora are "Taxa with several, poorly known populations, some on conservation lands": and Priority 4 are "Taxa in need of monitoring". In addition to the above rare and Priority plant taxa six rarely recorded species from the Swan Coastal Plain were recorded. Table 2.1 lists the Rare and Priority Flora recorded from Bushplan site 386 (Environmental Protection Authority, 1998).

Table 2.1 Rare and Priority Flora recorded from Bushplan Site 386.

Rare or Priority	Taxon
Rare	*Conospermum undulatum*
1	*Eucalyptus marginata* subsp. *elegantella*
1	*Tripterococcus paniculatus*
3	*Myriophyllum echinatum*
3	*Stylidium longitubum*
3	*Haemodorum loratum*
3	*Schoenus banthamii*
4	*Conostephium minus*
4	*Verticordia lindleyi* subsp. *lindleyi*
4	*Villarsia submersa*

The Ministry for Planning has collated information on the environmental attributes and significance of areas within the Perth Metropolitan Region. Vegetation was classified on the basis of vegetation complexes and assigned an ecological rating based on size, condition, presence of rare flora, the extent of the vegetation complex remaining and representativeness. The vegetation in the northern section and south-eastern section of Perth International Airport is rated in the top 5%; Munday Swamp and the adjoining vegetation to the west and most of the vegetation in the southwest and western side of Perth International Airport are rated in the 6-10% group and the remaining vegetation in the 21-50% group.

2.3 Fauna

Perth International Airport is considered to support a diverse vertebrate fauna in comparison with many other urban areas. Several surveys have been undertaken (Alan Tingay and Associates, 1994) recording 87 birds, 2 native mammals, 20 reptiles and 8 amphibians (Environmental Protection Authority, 1998). Three fish species, Pygmy Perch (*Edelia vittata*), Western Minnow (*Galaxis occidentalis*) and one introduced species have been recorded. Munday Swamp is particularly diverse and rich in invertebrate species.

Two fauna species listed on Schedule 1 are recorded from the Perth International Airport. These are Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) and the Quenda (*Isoodon obesulus*). In 1970 there was a record of the Western Swamp Tortoise (*Pseudemydura umbrina*) but surveys in 1995-1996 failed to locate the species. The Western Sawmp Tortoise is listed in Schedule 1 of the Commonwealth Endangered Species Act, 1992, as an Endangered Species and in Schedule 1 of the Western Australian Conservation Act, 1950 as rare or likely to become extinct.

Two species protected under the Japan – Australia Migratory Bird Agreement (JAMBA) of 1981 and the China – Australia Migratory Bird Agreement (CAMBA) of 1988 have been recorded from Perth International Airport. These are the Great Egret (*Ardea alba*) and the Rainbow Bee-eater (*Merops ornatus*).

2.4 Wetlands

Seasonal wetlands due to inundation caused by rising water table or surface water inflows are relatively common within the Perth International Airport. Munday Swamp in the

north-east is fed by ground water, including Poison Creek Gully which originates on the Darling Scarp in Kalamunda.

Wetland areas to the west of Munday Swamp are classified as sumplands. These are well vegetated and are where the Quenda (*Isoodon obesulus*) is found. Wetlands to the east and south of Munday Swamp are palusplains being seasonally waterlogged. These have been substantially modified for agriculture purposes and no longer support functioning wetland systems.

Runway Swamp lies within a large seasonally wet area in the south-west portion of Perth International Airport. This swamp has been deepened by peat extraction and now contains open water permanently. Link Road Swamp is located near the south-west corner which includes a large seasonally wet area modified by Link Road. *Banksia littoralis* low woodland occurs adjacent to the swamp and occupies adjoining areas subject to frequent inundation.

Munday Swamp, Runway Swamp. Link Road Swamp and the sumplands east of the main runway are wetlands classified by both ANCA (1996) and the National Trust of Australia (WA) as being of national significance.

2.5 Selection of Bushplan Sites

In Perth's Bushplan, Volume 2, Part A, page 1 (Environmental Protection Authority, 1998) it is stated that " The Bushplan Site boundaries circumscribe areas of bushland, with bushland being defined as: 'land on which there is vegetation which is either a remainder of the natural vegetation of the land; or if altered, is still representative of the structure and floristics of the natural vegetation, and provides the necessary habitat for fauna'.

Areas of native vegetation where the structure and the floristics have been altered to the extent that the vegetation cannot practically be restored to be 'representative of the structure and floristics of the natural vegetation' are not considered bushland. While these areas have conservation value, as they provide habitat for some fauna, they are not generally considered the prime conservation areas."

The Bushplan Site boundaries were determined by comparing:

- Agriculture Western Australia vegetation mapping,
- ground truthing undertaken in 1995 by Ministry for Planning,
- 1997 Metropolitan Street Directory aerial photography and 1997 Perth Metropolitan Region digital colour orthophotography,

- Department of Environmental Protection survey records,
- boundaries of Conservation Category Wetlands (Hill et al., 1996) and verified Conservation Category Wetlands.

It is stated that while the boundaries are as accurate as possible and that the mapped vegetation is a good guide, detailed determination of the bushland boundaries will depend on individual ground truthing of each bushland boundary. The final boundaries of the areas to be managed for conservation will involve consideration of:

- individual area ground-truthing of bushland boundaries,
- management design criteria such as;
  - reducing the bushland edge to edge ration,
  - establishing a foreshore reserve or management buffer area,
  - connectivity with other sites and natural areas,
- cadastral boundaries,
- existing planning constraints.

Wetlands are recognised as an important feature of the Swan Coastal Plain. Conservation category wetlands are often core areas in Bushplan Sites

3. OBJECTIVES

Perth International Airport intends to develop some of the land along Horrie Miller Drive for commercial concerns. The objectives of this study were within the designated areas (Appendix C) to:

- record the vegetation communities present
- record the condition of the vegetation communities
- determine the extent of these communities within Perth International Airport as a whole.

4. METHOD

The areas were surveyed by foot on 22nd and 23rd August 2000. Transects were walked through the larger areas and where the bushland areas were small these were thoroughly walked to record the vegetation community and its condition and to list the vascular plant taxa present.

All plants observed were identified and collections made of those species whose identification was unknown. These plants were then checked against specimens housed at the Western Australian Herbarium. Information on Rare or Priority plant species will be

sent to the Rare Flora Section of CALM and the pressed plants submitted to the Western Australian Herbarium for incorporation in their collection.

5. RESULTS

5.1 Flora Recorded

A total of 140 vascular taxa (97 native taxa, 43 introduced taxa) in 39 plant families were recorded from the sites sampled. The dominant plant families recorded are listed in Table 5.1.

Table 5.1 Dominant vascular plant families recorded during the survey

FAMILY	NO. NATIVE TAXA	NO INTRODUCED TAXA	TOTAL NO. TAXA
Myrtaceae (eucalypt family)	16	6	22
Papilionaceae (pea family)	9	4	13
Poaceae (grass family)	2	9	11
Proteaceae (banksia family)	9	0	9
Asteraceae (daisy family)	1	8	9

Alan Tingay and Associates (1994) recorded Myrtaceae (eucalypt family), Papilionaceae (pea family), Cyperaceae (sedge family), Proteaceae (Banksia family), Haemodoraceae (kangaroo paw family) and Asteraceae (daisy family) as the dominant families. However their survey was of the whole of the bushland within Perth International Airport and therefore covered a much larger and varied area.

Conostephium minus a Priority 4 species was recorded during the August 2000 survey. This was the only Rare or priority species recorded from the areas surveyed.

5.2 Vegetation Communities

The vegetation present was divided into three major communities, wetlands, Banksia Woodland and disturbed land. Gibson *et al* (1994) described the vegetation communities of the Swan Coastal Plain. In addition they provided the Reservation Status and Conservation Status of each community.

5.2.1 Wetlands

Wetland 1. Dense Shrubland of *Pericalymma ellipticum* and *Astartea fascicularis* over sedges and rushes with scattered low trees of *Melaleuca preissiana*.

Community Type 4, *Melaleuca preissiana* damplands (Gibson *et.al*, 1994). Well reserved and of low conservation risk.

This wetland occurred on the west side of Horrie Miller Drive. When the field work was undertaken there was water 10-30cm deep covering the low lying areas. The condition varied from highly degraded consisting predominantly of *Eragrostis curvula* to small patches in very good condition.

An old track and all the lower areas were inundated at the time of the survey and consisted of *Cynodon dactylon* with *Lepidosperma longitudinale* and *Juncus pallidus*. It was only in the lower, wetter areas that *Lepidosperma longitudinale* was recorded.

Where the vegetation was in better condition there were large number of dead shrubs of *Pericalymma ellipticum* and scattered *Astartea fascicularis* with many having fallen over to form a dense mass, making the area nearly impenetrable. However underneath several *Hypochoeris radicata* were growing. The large number of deaths should be of a concern for the maintenance of the wetland, although young *Pericalymma ellipticum* seedlings were observed.

The wetland was surrounded by a higher sandy ridge, but this was very limited in size and was not surveyed in detail. The western and north western edge of this Bushplan site consisted of dense *Ehrharta calycina* with scattered *Pennisetum curvula*, with no native species present.

Wetland 2 Shrubland of *Calytrix fraseri, Hypocalymma angustifolia* and *Pericalymma ellipticum* over mixed sedges with scattered trees of *Eucalyptus rudis* and *Melaleuca preissiana.*

Community Type 4, *Melaleuca preissiana* damplands (Gibson *et.al*, 1994). Well reserved and of low conservation risk.

This wetland occurred on the east side of Horrie Miller Drive was drier than Wetland 1, and very disturbed with only a very small patch of good vegetation. It was surrounded by the old orchard to the east, a degraded paddock to the north and the road to the west.

Most of the shrubland was underlain with weed species predominantly *Ehrharta calycina* and *Eragrostis curvula* and was therefore degraded.

Wetland 3. Woodland of *Banksia littoralis, Melaleuca preissiana* and *M. rhaphiophylla* with occasional *Eucalyptus rudis* over introduced species.
Community Type 15, Forests and woodlands of deep seasonal wetlands (Gibson *et.al*, 1994). Well reserved with a vulnerable conservation status.

This community occurred on the east side of Horrie Miller Drive. It was very small and highly degraded. There were occasional patches of better condition bushland, especially where the canopy was dense. Several of the wetland species common to Wetland 1 and 2 were recorded from these better condition areas but these plants were scattered and often appeared stressed.

5.2.2 Banksia Woodland

Open to dense Woodland of *B. attenuata* with scattered *Eucalyptus todtiana, Banksia menziesi* and *B. ilicifolia* over a dense shrubland and herbland.
Community Type 23a. Central *Banksia attenuata – B. menziesii* woodland (Gibson *et. al*, 1994). Well reserved and of low conservation risk.

This was the most extensive of the communities surveyed and occurred on the higher ground. The condition varied considerably. The southern triangle was highly degraded consisting of an understorey of weeds with scattered shrubs but with an open tree canopy. Towards the northern end the community was in excellent condition except for along tracks or where it adjoined the cleared land to the east. In between these two areas it varied considerably in condition. It was in this community that one plant only of *Conostephium minus* was located.

5.2.3 Disturbed Land

These communities were highly disturbed with negligible or no vegetation present. There were only scattered native trees or shrubs remaining making the restoration of the area to its natural condition extremely difficult.

Community 1 – Disturbed 1. Dense herb and grassland of introduced species with scattered *Melaleuca preissiana* and *Corymbia calophylla.*

The community occurred on the south eastern corner of Horrie Miller Drive and Grogan Road. The herbs and grasses were dominated by the introduced species *Homeria flaccida, Eragrostis curvula* and *Ehrharta calycina* but there were no native species present in the understorey. *Drosera zonaria* was located on the northern perimeter of the area in a very moist area.

The south eastern edge of this paddock had a remnant of Banksia Woodland but this was highly degraded due to the presence of dense infestation of introduced species.

Community 2 – Disturbed 2. Scattered *Adenanthos cygnorum* over weeds, dominated by *Ehrharta calycina* and *Eragrostis curvula*

As indicated on the map this was a cleared area between Wetland 2 and the Banksia Woodland. It would appear this community should be the interzone between the other two communities. This community was totally degraded.

Community 3 - Orchard. Abandoned orchard consisting of lemon and olive trees over weeds, dominated by *Ehrharta calycina* and *Eragrostis curvula.*

5.3 Condition

Vegetation condition is discussed in Perth's Bushplan (Environmental Protection Authority, 1998). There are six condition scales listed:

- Pristine (1) – no obvious signs of disturbance,
- Excellent (2) – vegetation structure still intact, weeds non-aggressive,
- Very good (3) – vegetation structure altered due to presence of aggressive weeds, grazing,
- Good (4) – Vegetation structure significantly altered by obvious multiple disturbance,
- Degraded (5) – Basic vegetation structure severely impacted by disturbance,
- Completely degraded (6) - vegetation structure no longer intact.

Using this condition scale Table 5.2 lists the condition for each of the vegetation communities described above.

Table 5.2 Condition of Vegetation Communities identified in the 2000 survey

VEGETATION COMMUNITY	CONDITION
Wetland 1	4 (Good)
Wetland 2	5 (Degraded)
Wetland 3	5 (Degraded)
Banksia Woodland	2-5 (Excellent to degraded)
Disturbed 1	6 (Completely degraded)
Disturbed 2	6 (Completely degraded)
Orchard	6 (Completely degraded)

A small portion of the Banksia Woodland was in excellent to good condition. The southern end was recorded as condition 5 as all the understorey (except for a very few plants) had been replaced with *Ehrharta calycina*. There was only a very small area of the Banksia woodland which could be considered as Condition 2 the majority being Condition 5 (See Appendix C).

Wetland 1 was also in good condition, which means the community has been significantly altered, as indicated by the numerous deaths of *Pericalymma ellipticum* recorded during the survey. There were also several aggressive weeds recorded from the area, including the wetter areas, so if the area was opened up these aggressive weeds within the area could possibly dominate. If the community is left with no management this is also a possible outcome. Wetlands 2 and 3 are degraded with most of the understorey species replaced by weeds.

6. DISCUSSION

Over 300 native vascular plant taxa have been recorded from the remnant bushland of Perth International Airport during previous surveys (Alan Tingay and Associates (1994). In this current survey 97 native taxa and 43 introduced taxa were recorded from the three areas. One Priority 4 flora species, *Conostephium minus,* was recorded from the Banksia Woodland, however only one plant was observed.

Wetland 1, a Dense Low Shrubland of *Pericalymma ellipticum* and *Astartea fascicularis* over sedges and rushes with scattered low trees of *Melaleuca preissiana* and Wetland 2 a Low Shrubland of *Calytrix fraseri, Hypocalymma angustifolia* and *Pericalymma ellipticum* over mixed sedges with scattered trees of *Eucalyptus rudis* and *Melaleuca preissiana* are both classified as Community Type 4, *Melaleuca preissiana* damplands (Gibson *et .al*, 1994). This community is not under threat being classified as well reserved and of low conservation risk (Gibson *et. al*, 1994). This is the *Pericalymma*

ellipticum Closed Heath of Alan Tingay and Associates (1994). The vegetation mapping undertaken by Alan Tingay and Associates (1994) indicates this community is widespread in the south and southeast of Perth International Airport's remnant bushland plus there is an additional community in the north. Wetland 1 was mapped during the 1994 survey but wetland 2 was not included, presumably as it was considered too degraded for inclusion as a section of remnant bushland.

Wetland 3, a Woodland of *Banksia littoralis, Melaleuca preissiana* and *M. rhaphiophylla* with occasional *Eucalyptus rudis* over introduced species. This community was classified as Community Type 15, Forests and woodlands of deep seasonal wetlands by Gibson *et.al.* (1994) and is considered to be well reserved but with a vulnerable conservation status. It is listed as a vulnerable ecological community on the Swan Coastal Plain by English and Blythe (1997). This community occupied a small area, the remainder possibly being removed with the construction of Horrie Miller Drive. A degraded condition (5) indicates it has the potential for restoration but not to a state approaching good condition without intensive management. All the tree species occur in other locations throughout the bushland of Perth International Airport (Alan Tingay and Associates, 1994).

The Open to Dense Woodland of *Banksia attenuata* with scattered *Eucalyptus todtiana, B. menziesii and B. ilicifolia* over a dense shrubland and herbland is classified as Type 23a Central *Banksia attenuata – B. menziesii* Woodlands (Gibson *et. al*, 1994) and is well reserved and of low conservation risk. This community is common throughout the bushland of Perth International Airport land.

In Section 2.6 it is stated "Areas of native vegetation where the structure and the floristics have been altered to the extent that the vegetation cannot practically be restored to be 'representative of the structure and floristics of the natural vegetation' are not considered bushland". Using this definition as it appeared in Perth's Bushplan then Wetlands 2 and 3 and all the disturbed areas fall into this category and therefore should not be considered for conservation. Wetland 1 may be possible with a lot of effort to restore to a reasonable condition. The area is completely surrounded by degraded land and without constant attention is likely to continue to degrade. Examples are provided in Perth's Bushplan where vegetation on the eastern side of the Coastal Plain are able to survive in a reasonably good condition due to the heavier soils of the area. This may be the case with Wetland 1 however the vegetation community present is recorded as well reserved and of low conservation risk.

The disturbed areas discussed in the report are so highly disturbed that time and effort would be better spent on improving the proposed conservation areas. The conservation areas set aside during the development of the Master Plan will form bushland buffers to the major roads, Great Eastern Highway bypass, Kalamunda Road and Tonkin Highway. They include the areas to the north and north east and south east of Perth International Airport a total of 312ha. An attempt was made when deciding upon the conservation areas to include areas of Aboriginal significance, fauna importance and many of the vegetation communities identified by Alan Tingay and Associates (1994). Munday Swamp and the surrounding vegetation is included in the northern conservation area (registered with the Australian Heritage Commission on 26/10/1999).

Twenty one or twenty two of the total of 42 vegetation communities recorded for Perth International Airport will be included in the conservation areas (Table 6.1). Several of the vegetation communities are very similar varying in the combination of the tree species recorded.

The Banksia Woodland recorded in the current survey was listed as *Banksia attenuata* Low Woodland and Wetland 1 as *Pericalymma ellipticum* Closed Heath by Alan Tingay and Associates (1994). Both communities are included in the Conservation Area. Wetland 3 is listed as *Banksia littoralis, Melaleuca preissiana* Low Woodland to Low Closed Forest by Alan Tingay and Associates (1994), which is not included in the conservation areas. However in the map by Alan Tingay and Associates (1994) it is shown as occupying a reasonable area, however when the survey was undertaken in August 2000 the area of this community was much smaller than mapped and surrounded on the higher ground by the *Banksia attenuata* Low Woodland (see Appendix C).

Alan Tingay and Associates (1994) used six conditions to describe vegetation condition; undisturbed, slightly disturbed, disturbed, obvious disturbance, severely disturbed and degraded. All the areas mapped by Alan Tingay and Associates (1994) as slightly disturbed (equivalent to excellent, Section 5.3) in the northern conservation area and most in the southern conservation area are included in the conservation areas. The remainder of the area in the northern conservation area is classified as disturbed (equivalent to very good), a larger area as having obvious disturbance (equivalent to good), a small area as severely disturbed (equivalent to degraded) and the remainder as degraded (equivalent to completely degraded). In the southern conservation area the bushland is mapped as disturbed (very good) or with obvious disturbance (good) but with only small areas recorded as severely disturbed (degraded) to degraded (completely degraded).

Table 6.1 Vegetation communities (Alan Tingay and Associates, 1994) and presence in Conservation Areas

VEGETATION COMMUNITIES	CONS. AREA
Eucalyptus marginata Open Woodland over *Banksia attenuata, Allocasuarina fraseriana* Low Woodland	✓
Eucalyptus marginata Woodland over *Banksia attenuata,* Low Woodland	✓
Eucalyptus marginata Woodland	✓
Eucalyptus marginata Woodland over *Allocasuarina fraseriana* Low Woodland	
Eucalyptus marginata over *E. todtiana, Banksia attenuata, Allocasuarina fraseriana* Low Woodland	✓
Corymbia calophylla Woodland	✓
Eucalyptus marginata, Corymbia calophylla Woodland over *Allocasuarina fraseriana* Low Woodland	
Banksia attenuata, Low Woodland	✓
Banksia attenuata, B. menziesii, Eucalyptus todtiana Low Woodland	
Banksia attenuata, B. menziesii, Eucalyptus todtiana Allocasuarina fraseriana Low Woodland	✓
Banksia attenuata, B. menziesii Low Woodland	✓
Banksia attenuata, B. menziesii, Banksia ilicifolia Low Woodland	
Banksia attenuata, B. menziesii, Allocasuarina fraseriana Low Woodland	✓
Banksia attenuata, B. menziesii, Allocasuarina fraseriana, Eucalyptus marginata Low Woodland	
Banksia menziesii, Eucalyptus todtiana Low Woodland	x
Adenanthos cygnorum Shrubland	
Jacksonia sternbergiana Shrubland to Open Scrub	✓
Leptospermum laevigatum Shrubland	
Melaleuca preissiana Low Open Woodland to Low Woodland over mixed heath	✓
Melaleuca preissiana Low Open Woodland over *Pericalymma ellipticum* Closed Heath	✓
Eucalyptus rudis Woodland over *Melaleuca preissiana* Low Woodland	x
Corymbia calophylla Woodland over *Melaleuca preissiana* Low Woodland	✓
Corymbia calophylla Open Woodland to Woodland (wet)	✓
Eucalyptus rudis Woodland	✓
Eucalyptus rudis Woodland over *Banksia littoralis* Low Woodland	
Banksia littoralis, Melaleuca preissiana Low Woodland to Low Closed Forest	
Banksia littoralis Low Woodland to Low Closed Forest	?
Melaleuca rhaphiophylla Low OpenWoodland to Low Closed Forest	✓
Kunzea ericifolia High Open *Shrubland*	
Jacksonia furcellata Open Shrubland	
Acacia saligna Shrubland to Open Scrub	✓
Acacia saligna Shrubland over *Regelia ciliata* Low Open Heath	✓
Regelia ciliata Low Open Heath	✓
Pericalymma ellipticum Closed Heath	✓
Pericalymma ellipticum, Hakea varia Closed Heath	✓
Hakea varia Heath to Closed Heath	
Melaleuca teretifolia, Hakea varia Closed Heath	
Melaleuca teretifolia Closed Heath to Closed Scrub	
Melaleuca viminea Open Heath	
Astartea fascicularis Closed Heath	
Typha domingensis Sedgeland	

✓ = included in conservation area: ? maybe included in conservation area: x not indicated on the map

The areas surveyed in August 2000 were listed as disturbed (very good) for Wetland 1 and severely disturbed (degraded) for Wetland 3 and the Banksia Woodland (Alan Tingay and Associates, 1994).

The only vegetation community mapped during the current survey that is listed as a vulnerable ecological community on the Swan Coastal Plain (English and Blythe, 1997) was the degraded Wetland 3. None of the other communities are listed as endangered or vulnerable. However Wetland 3 has so very little of the original understorey vegetation remaining that it was classified in the current survey as condition 5 (degraded) in Table 5.2.

Perth's Bushplan does state that wetland sites were generally added to Perth's Bushplan due to their importance for reasons other than flora and vegetation. This would account for the areas designated as Wetland 1, 2 and 3 being included as Bushplan sites. However the wetland areas identified in the August 2000 survey also occurred elsewhere on Perth International Airport land and are included in the conservation areas.

7. CONCLUSION

The following conclusions can be reached from the above information:

- All the vegetation communities surveyed during the August 2000 survey are included within the conservation areas proposed for Perth International Airport land.
- Of the areas surveyed in August 2000 one vegetation community is listed as a vulnerable ecological community on the Swan Coastal Plain (English and Blythe, 1997). This is the disturbed Woodland of *Banksia littoralis, Melaleuca preissiana* and *M. rhaphiophylla* with occasional *Eucalyptus rudis* over introduced species designated Wetland 3 in this report.
- Most of the communities recorded a condition of 5-6 ie degraded to highly degraded (Environmental Protection Authority, 1998) with Wetland 1 recording a condition rating of 4 ie good, and the Banksia Woodland a condition rating of 2-5 ie excellent through to degraded. However the excellent section in this community was only a small part of the total.
- Considering the condition of the areas surveyed during August 2000, the selection procedures for a Bushplan Site and their representation in the Perth International Airport conservation areas, it would appear these areas are

sufficiently represented elsewhere within the conservation areas or are too degraded to consider for conservation as outlined in Perth's Bushplan.

- Areas of native vegetation where the structure and the floristics have been altered to the extent that the vegetation cannot practically be restored to be 'representative of the structure and floristics of the natural vegetation' are not considered bushland". Again this indicates that the majority of the areas surveyed are too degraded to be considered as representative of the structure and floristics of the natural vegetation.
- Westralia Airports Corporation has given a commitment to maintain and enhance the two designated conservation areas within Perth International Airport. It would be appropriate for these areas to be enhanced by weed removal and enhancement planting with species native to the particular vegetation communities rather than attempting to maintain all the areas designated in Perth's Bushplan.

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APPENDIX A

Species List of Vascular Plants Species Recorded in the Survey

FAMILY	TAXON
AMARYLLIDACEAE	**Amaryllis belladonna*
	**Narcissus tazetta*
ANACARDIACEAE	**Schinus terbinthifolia*
ANTHERICACEAE	*Arthropodium* sp.
	Johnsonia pubescens
	Laxmannia ramosa
	Thysanotus arenarius
	Thysanotus manglesii
	Thysanotus multiflorus
	Thysanotus sparteus
ASPARAGACEAE	**Asparagus asparagoides*
ASTERACEAE	**Arctotheca calendula*
	**Aster subulatus*
	**Conyza bonariensis*
	**Conyza parva*
	**Cotula coronopifolia*
	**Hypochoeris radicata*
	Quinetia urvillei
	**Sonchus oleraceus*
	**Ursinia anthemoides*
CARYOPHYLLACEAE	**Sagina apetala*
CASUARINACEAE	*Allocasuarina humilis*
COLCHICACEAE	*Burchardia umbellata*
CRASSULACEAE	*Crassula colorata*
CYPERACEAE	*Cyathochaeta avenacea*
	Cyperus congestus
	Lepidosperma longitudinale
	Schoenus curvifolius
	Schoenus efoliatus
DASYPOGONACEAE	*Dasypogon bromeliifolius*
DILLENIACEAE	*Lomandra caespitosa*
	Hibbertia huegelii
	Hibbertia hypericoides
DROSERACEAE	*Hibbertia subvaginata*
	Drosera menziesii
	Drosera platystigma
EPACRIDACEAE	*Drosera zonaria*
	Conostephium minus (P4)
	Conostephium pendulum
GERANIACEAE	*Leucopogon conostephioides*
GOODENIACEAE	**Pelargonium capitatum*
	Dampiera linearis
	Dampiera trigona
HAEMODORACEAE	*Lechenaultia floribunda*
	Anigozanthos humilis
	Conostylis aurea
	Conostylis serrulata

FAMILY	TAXON
HAEMODORACEAE	*Haemodorum sparsiflorum*
	Haemodorum spicatum
	Phlebocarya ciliata
	Tribonanthes longipetala
HALORAGACEAE	*Glischrocaryon flavescens*
IRIDACEAE	**Gladiolus caryophyllaceus*
	**Homeria flaccida*
	Patersonia occidentalis
	**Romulea rosea*
	**Sparaxis bulbifera*
	**Watsonia bulbillifera*
JUNCACEAE	**Juncus microcephalus*
	Juncus pallidus
JUNCAGINACEAE	*Triglochin procera*
LAMIACEAE	*Hemiandra pungens*
LAURACEAE	*Cassytha racemosa*
LORANTHACEAE	*Nuytsia floribunda*
MIMOSACEAE	*Acacia applanata*
	Acacia huegelii
	Acacia pulchella var. *pulchella*
	Acacia saligna
MYRTACEAE	*Astartea fascicularis*
	Calytrix flavescens
	Calytrix fraseri
	**Chamelaucium uncinatum*
	Corymbia calophylla
	Eremaea pauciflora
	**Eucalyptus citriodora*
	**Eucalyptus macrandra*
	**Eucalyptus robusta*
	Eucalyptus rudis
	Eucalyptus todtiana
	Hypocalymma angustifolia
	Kunzea vestita
	**Leptospermum laevigatum*
	**Melaleuca nesophylla*
	Melaleuca preissiana
	Melaleuca rhaphiophylla
	Melaleuca seriata
	Melaleuca teretifolia
	Pericalymma ellipticum
	Scholtzia involucrata
	Verticordia densiflora
ORCHIDACEAE	*Caladenia flava*
	Pterostylis vittata
OXALIDACEAE	**Oxalis pes-caprae*
PAPILIONACEAE	*Aotus procumbens*
	Burtonia eriocarpa
	Daviesia hakeoides

FAMILY	TAXON
PAPILIONACEAE	*Daviesia triflora*
	Euchilops linearis
	Gompholobium tomentosum
	Hovea trisperma
	Jacksonia densiflora
	Jacksonia furcellata
	**Lupinus angustifolia*
	**Lupinus consentinii*
	**Medicago sp.*
	**Ornithopus compressus*
PLANTAGINACEAE	**Plantago lanceolata*
POACEAE	*Amphipogon turbinatus*
	**Avena barbata*
	**Briza maxima*
	**Cortaderia selloana*
	**Cynodon dactylon*
	**Ehrharta calycina*
	**Ehrharta longiflora*
	**Eragrostis curvula*
	Eragrostis elongata
	**Paspalum dilatatum*
	**Pennisetum clandestimun*
POLYGONACEAE	**Rumex crispus*
PROTEACEAE	*Adenanthos cygnorum*
	Banksia ilicifolia
	Banksia littoralis
	Banksia menziesii
	Dryandra lindleyana
	Hakea varia
	Petrophile linearis
	Stirlingia latifolia
	Synaphaea spinulosa
RESTIONACEAE	*Alexgeorgia nitens*
	Chordifex sinuosus
	Cytogonideum leptocarpoides
	Hypolaena exsulca
	Lyginia barbata
	Meeboldina cana
RUTACEAE	*Boronia ramosa* subsp. *anethifolia*
	Philotheca spicata
SOLANACEAE	**Solanum nigrum*
STYLIDIACEAE	*Stylidium repens*
XANTHORRHOEACEAE	*Xanthorrhoea preissii*
ZAMIACEAE	*Macrozamia riedlei*

APPENDIX B

Vascular Plants Species
Recorded in Each of the
Different Vegetation Communities

Count of PRESENCE	AREA							
SPECIES	Banksia	Disturbed 1	Disturbed 2	Orchard	Wetland 1	Wetland 2	Wetland 3	Total
Acacia applanata						1		1
Acacia huegelii	1							1
Acacia pulchella var. *pulchella*	1					1		2
Acacia saligna					1			1
Adenanthos cygnorum	1		1			1		3
Alexgeorgia nitens	1				1			2
Allocasuarina humilis	1							1
**Amaryllis belladonna*							1	1
Amphipogon turbinatus	1							1
Anigozanthos humilis	1							1
Aotus procumbens	1						1	2
**Arctotheca calendula*		1						1
Arthropodium sp.					1			1
**Asparagus asparagoides*					1			1
Astartea fascicularis					1		1	2
**Aster subulatus*					1			1
**Avena barbata*						1		1
Banksia ilicifolia	1			1				2
Banksia littoralis							1	1
Banksia menziesii				1				1
Boronia ramosa subsp. *anethifolia*	1				1	1		3
**Briza maxima*					1	1	1	3
Burchardia umbellata	1							1
Burtonia eriocarpa	1							1
Caladenia flava	1							1
Calytrix flavescens	1							1
Calytrix fraseri	1				1	1		3
Cassytha racemosa					1			1

Count of PRESENCE	AREA							
SPECIES	Banksia	Disturbed 1	Disturbed 2	Orchard	Wetland 1	Wetland 2	Wetland 3	Total
**Chamelaucium uncinatum*	1							1
Chordifex sinuosus	1							1
Conostephium minus (P4)	1							1
Conostephium pendulum	1							1
Conostylis aurea	1							1
Conostylis serrulata	1							1
**Conyza bonariensis*					1			2
**Conyza parva*					1			1
**Cortaderia sellooana*							1	1
Corymbia calophylla					1			1
**Cotula coronopifolia*		1			1			2
Crassula colorata	1	1						1
Cyathochaeta avenacea								1
**Cynodon dactylon*							1	1
**Cyperus congestus*		1	1		1	1	1	5
Cytogonideum leptocarpoides	1				1			1
Dampiera linearis	1				1	1		3
Dampiera trigona					1	1		3
Dasypogon bromeliifolius	1				1			1
Daviesia hakeoides	1				1	1		3
Daviesia triflora	1							1
Drosera menziesii	1							1
Drosera platystigma								1
Drosera zonaria	1						1	1
Dryandra lindleyana			1					2
**Ehrharta calycina*						1		1
**Ehrharta longiflora*	1	1	1	1	1	1	1	6
**Pennisetum clandestimun*			1			1	1	4
**Eragrostis curvula*	1	1	1	1	1			1
Eragrostis elongata						1	1	6
					1		1	2

Count of PRESENCE	AREA							
SPECIES	Banksia	Disturbed 1	Disturbed 2	Orchard	Wetland 1	Wetland 2	Wetland 3	Total
Eremaea pauciflora	1					1		2
**Eucalyptus citriodora*						1		1
**Eucalyptus grandis*						1		1
**Eucalyptus macrandra*						1		1
Eucalyptus rudis						1		1
Eucalyptus todtiana	1						1	2
Euchilops linearis	1				1	1		3
**Gladiolus caryophyllaceus*	1		1		1	1	2	6
Glischrocaryon flavescens							1	1
Gompholobium tomentosum	1		1		1	1		4
Haemodorum sparsiflorum					1			1
Haemodorum spicatum					1	1		2
Hakea varia					1			1
Hemiandra pungens	1							1
Hibbertia huegelii	1							1
Hibbertia hypericoides	1							1
Hibbertia subvaginata	1							1
**Homeria flaccida*		1						1
Hovea trisperma	1				1	1		3
Hypocalymma angustifolia	1				1	1		3
**Hypochoeris radicata*	1	1	1		1	1	1	6
Hypolaena exsulca	1				1	1	1	4
Jacksonia densiflora	1							1
Jacksonia furcellata	1				1	1		3
Johnsonia pubescens	1				1			2
**Juncus microcephalus*					1		1	2
Juncus pallidus		1			1			2
Kunzea vestita	1							1
Laxmannia ramosa	1				1	1		3
Lechenaultia floribunda						1		1
Lepidosperma longitudinale					1			1

Count of PRESENCE	AREA							
SPECIES	Banksia	Disturbed 1	Disturbed 2	Orchard	Wetland 1	Wetland 2	Wetland 3	Total
**Leptospermum laevigatum*					1			1
Leucopogon conostephioides	1							1
Lomandra caespitosa	1							1
**Lupinus angustifolia*			1			1	1	3
**Lupinus consentinii*							1	1
Lyginia barbata	1					1	1	3
Macrozamia riedlei	1							1
**Medicago sp.*		1						1
Meeboldina cana					1			1
**Melaleuca nesophylla*					1			1
Melaleuca preissiana		1			1	1	1	4
Melaleuca rhaphiophylla							1	1
Melaleuca seriata	1				1			2
Melaleuca teretifolia							1	1
**Narcissus tazetta*							1	1
Nuytsia floribunda	1					1		2
**Ornithopus compressus*		1						1
**Oxalis pes-caprae*	1						1	2
**Paspalum dilatatum*					1			1
Patersonia occidentalis	1				1	1	1	4
**Pelargonium capitatum*					1			1
**Pennisetum curvula*					1			1
Pericalymma ellipticum					1	1	1	3
Petrophile linearis	1							1
Philotheca spicata	1					1		2
Phlebocarya ciliata					1	1		2
**Plantago lanceolata*					1			1
Pterostylis vittata	1							1
Quinetia urvillei	1				1			2
**Romulea rosea*	1		1			1	1	4
**Rumex crispus*		1			1			2
**Sagina apetala*							1	1

Count of PRESENCE	AREA							
SPECIES	Banksia	Disturbed 1	Disturbed 2	Orchard	Wetland 1	Wetland 2	Wetland 3	Total
Scheonus efoliatus					1			1
**Schinus terbinthifolia*	1				1			2
Schoenus curvifolius	1							1
Schoenus efoliatus							1	1
Scholtzia involucrata	1					1	1	3
Sochus oleraceus					1			1
Solanum nigrum	1				1			2
Sparaxis bulbifera					1			1
Stirlingia latifolia	1					1		2
Stylidium repens	1							1
Synaphaea spinulosa	1							1
Thysanotus arenarius					1			1
Thysanotus manglesii	1							1
Thysanotus multiflorus					1	1		2
Thysanotus sparteus	1							1
Tribonanthes longipetala					1			1
Triglochin procera					1			1
Ursinia anthemoides	1		1		1	1		4
Verticordia densiflora					1	1	1	3
Watsonia bulbillifera	1	1			1			3
Xanthorrhoea preissii	1				1	1		3
Grand Total	74	14	12	4	66	46	35	251

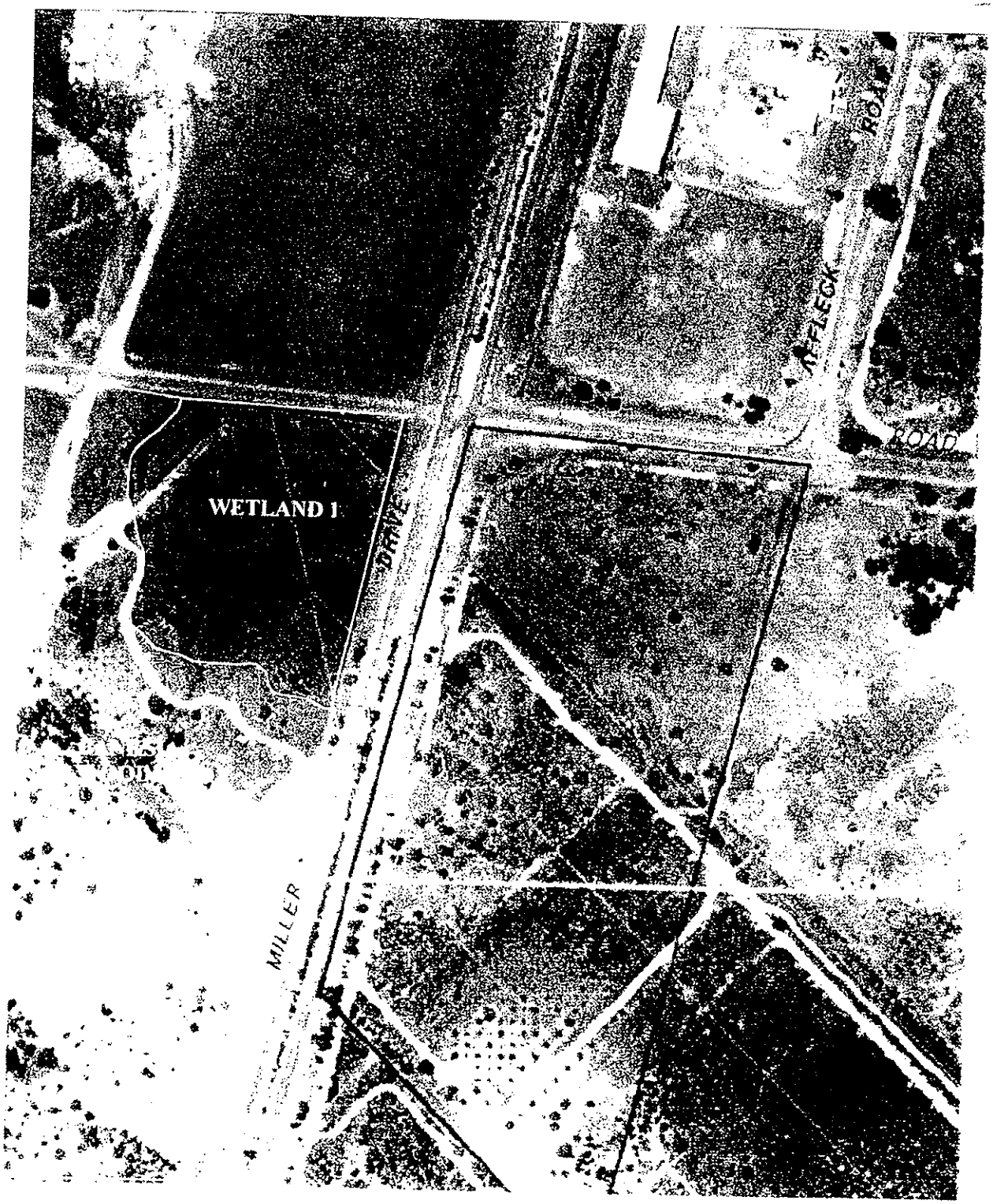


Diagram 1: Vegetation of Wetland 1

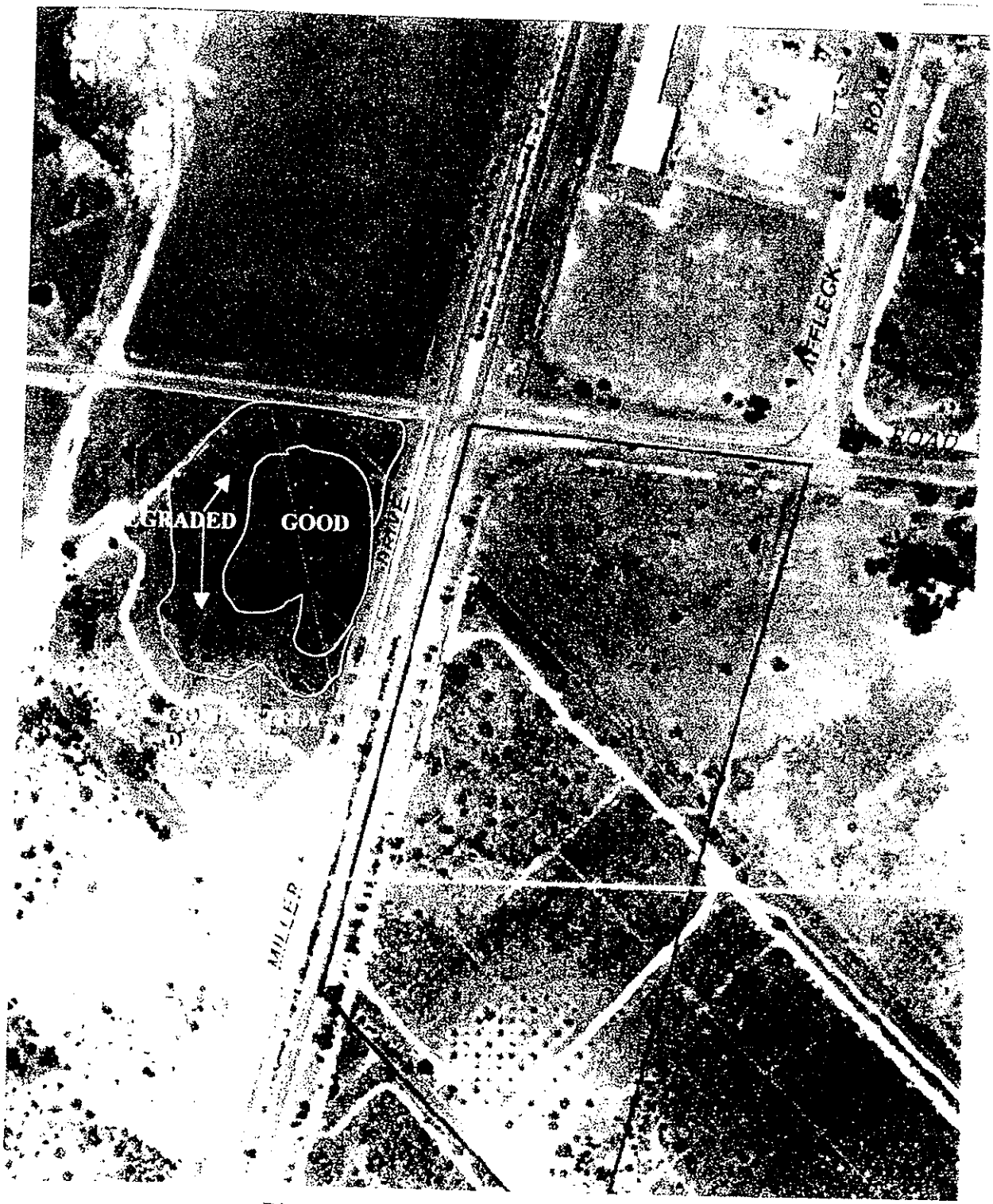


Diagram 2: Vegetation Condition of Wetland 1

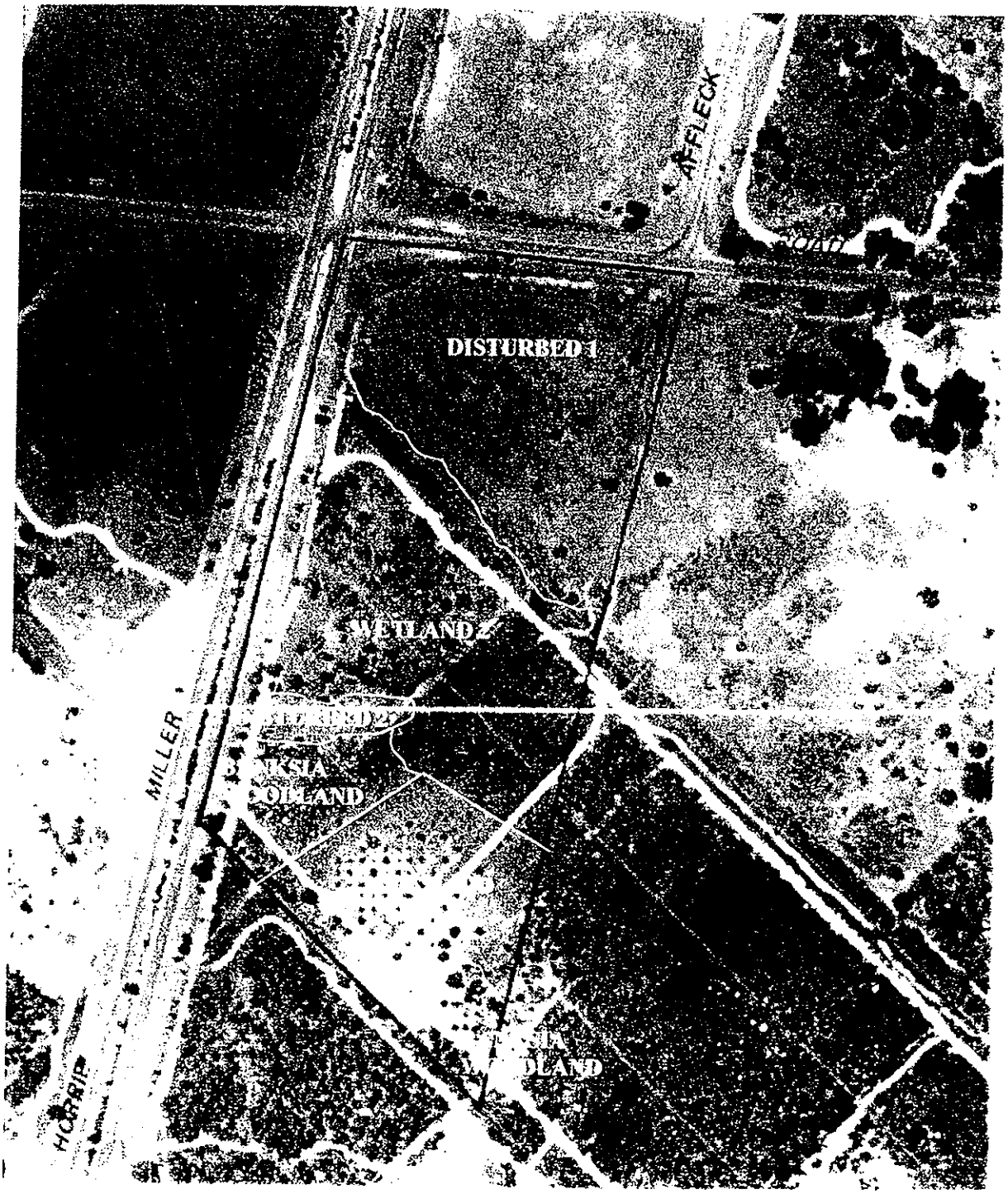


Diagram 3: Vegetation of area proposed for development

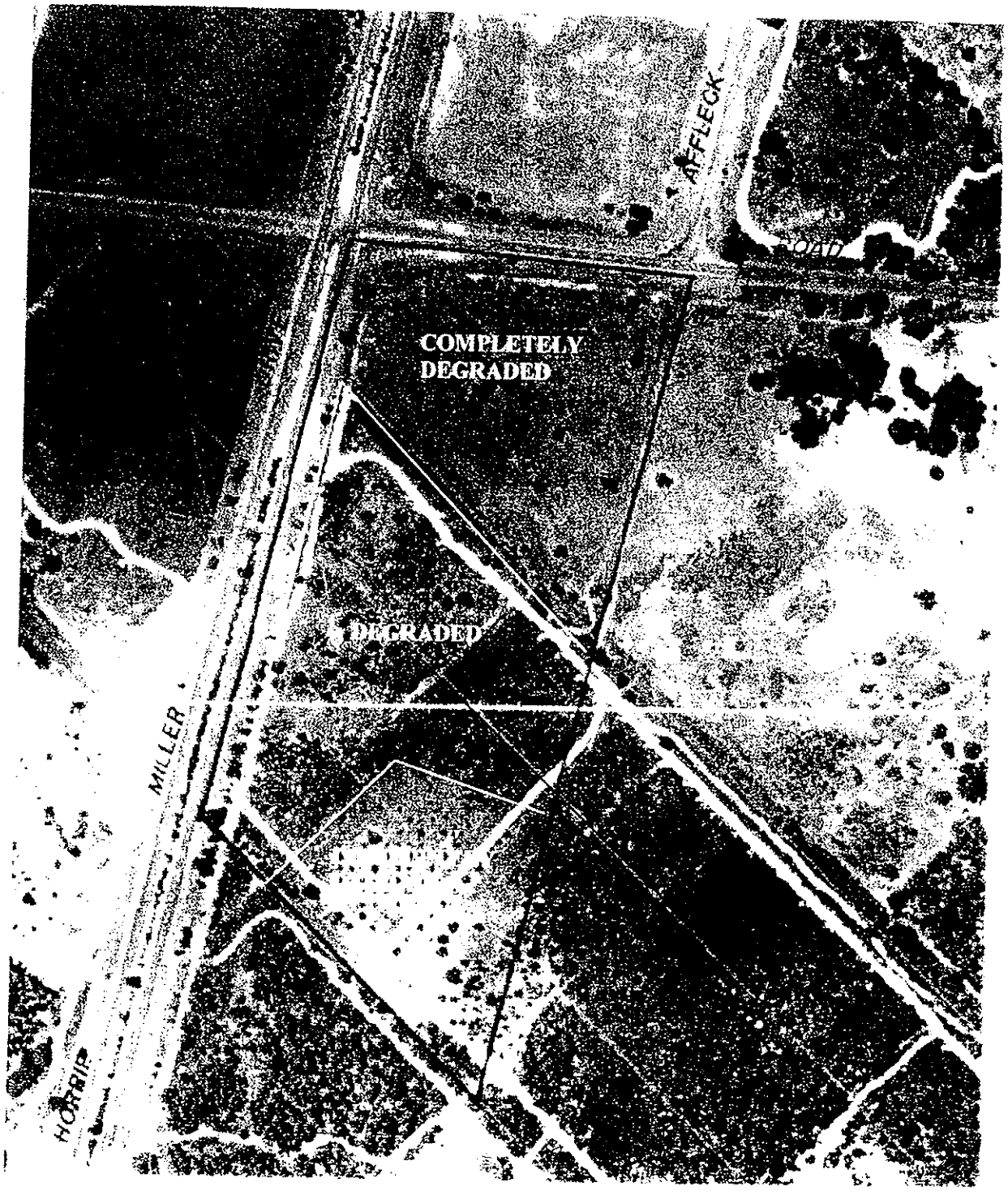


Diagram 4: Condition of area considered for development



Diagram 5: Vegetation communities in the southern triangle



Diagram 6: Condition of southern triangle.

APPENDIX D

Photographic Record

of

Vegetation Communities



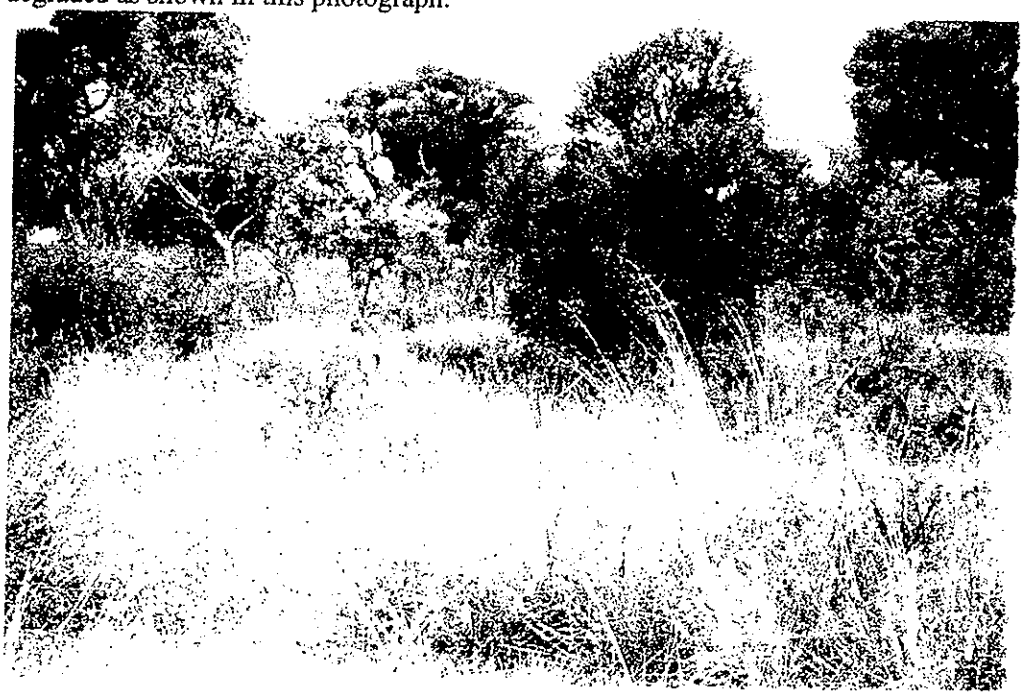
Photograph 1 Dense Shrubland of *Pericalymma ellipticum* and *Astartea fascicularis* over sedges and rushes with scattered low trees of *Melaleuca preissiana*. On the south west corner of Grogan Road and Horrie Miller Drive. This shows an old track now covered with water and the area surrounded by introduced species in particular *Leptospermum laevigatum*.



Photograph 2. Shrubland of *Calytrix fraseri, Hypocalymma angustifolia* and *Pericalymma ellipticum* over mixed sedges with scattered trees of *Eucalyptus rudis* and *Melaleuca preissiana*. Numerous introduced species have replaced the native vegetation, several of the shrubs are dead and the canopy has completely opened up.



Photograph 3. Woodland of *Banksia littoralis, Melaleuca preissiana* and *M. rhaphiophylla* with occasional *Eucalyptus rudis* over introduced species. Most of this vegetation community was degraded as shown in this photograph.



Photograph 4. Woodland of *Banksia littoralis, Melaleuca preissiana* and *M. rhaphiophylla* with occasional *Eucalyptus rudis* over introduced species. One of the very small areas in better condition.



Photograph 5a. Condition 2. Very few weeds in amongst dense, varied native species.



Photograph 5b. Condition 4. Numerous weeds in the understorey, tree canopy in good condition.



Photograph 5c. Condition 5. The understorey nearly completely replaced with introduced species and the tree canopy opened.

Photographs 5a, 5b, and 5c. Open to dense Woodland of *B. attenuata* with scattered *Eucalyptus todtiana, Banksia menziesi* and *B. ilicifolia* over a dense shrubland and herbland.



Photograph 6. Dense herb and grassland of introduced species with scattered *Melaleuca preissiana* and *Corymbia calophylla*. The herbs and grasses were dominated by the introduced species *Homeria flaccida, Eragrostis curvula* and *Ehrharta calycina* with no understorey native species. Condition 6.



Photograph 7. Scattered *Adenanthos cygnorum* over weeds, dominated by *Ehrharta calycina* and *Eragrostis curvula*. There is an old track running through the area. Condition 6.

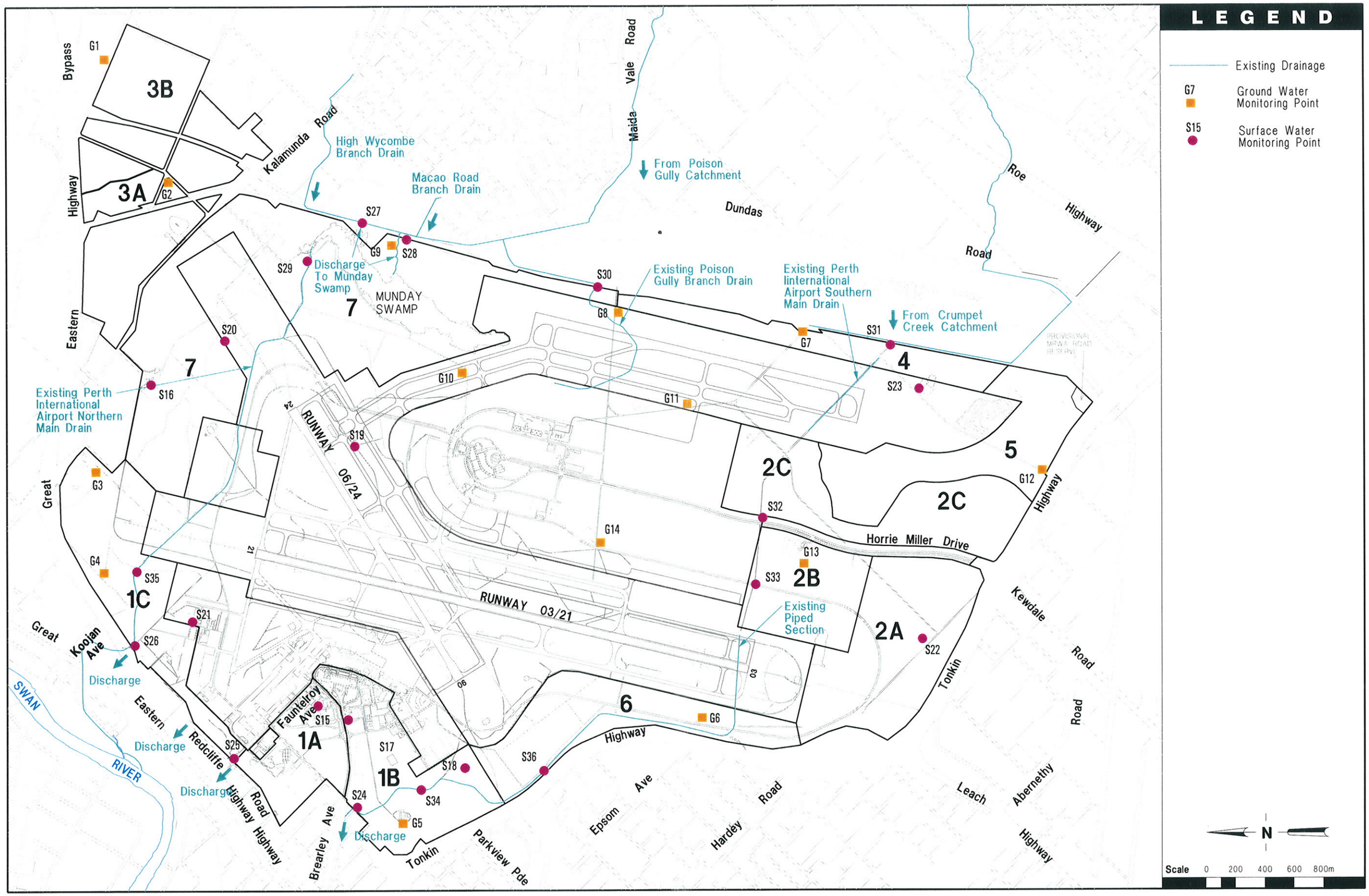


Figure 4-1: Current Drainage System and Monitoring Locations

185/01/3.

tranen
revegetation systems

Poison Gully Branch Drain Rehabilitation
Westralia Airports Corporation

Vegetation Monitoring Report

P153-01-Rev0

October 2006

Tranen Pty Ltd
1/110 Jersey Street
Jolimont, WA 6014
p (08) 9284 1399
f (08) 9284 1377
email@tranen.com.au
www.tranen.com.au

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Table of Contents

1 Introduction 1
1.1 Background 1
1.2 Site Maintenance 2
2 Monitoring Methodology 3
2.1 Assessment Methodology 3
3 Results 4
3.1 Section A 4
3.2 Section B 4
3.3 Sections C, D, E 8
3.4 Section F 8
3.5 Sections G and H 10
3.6 Areas Outside of the Security Fence 12
3.7 12m Strip 12
4 Discussion 16
4.1 Species Richness 16
4.2 Plant Density 16
4.3 Plant Development 16
4.4 Introduced Species 16
5 Conclusions 18
6 References 19
APPENDIX 1 SITE LOCATION 20
APPENDIX 2 SITE LAYOUT 22
APPENDIX 3 MONITORING RESULTS 25

Table of Figures

Figure 1 Monitoring Plot 3 - October 2006 5
Figure 2 Monitoring Plot 3 - May 2006 5
Figure 3 Monitoring Plot 4 - October 2006 6
Figure 4 Monitoring Plot 4 - May 2006 6
Figure 5 **Watsonia* Sprayed in September 2006 8
Figure 6 Monitoring Plot 2 - October 2006 9
Figure 7 Monitoring Plot 2 - May 2006 9
Figure 8 Monitoring Plot 1 - October 2006 11
Figure 9 Monitoring Plot 1 - May 2006 11
Figure 10 Monitoring Plot 5 - October 2006 13
Figure 11 Monitoring Plot 5 - May 2006 13
Figure 12 Monitoring Plot 6 - October 2006 14
Figure 13 Monitoring Plot 6 - May 2006 14

Table of Tables

Table 1 Initial Treatment Classifications 1
Table 2 Monitoring Plot Locations and Description 3
Table 3 Summary Plot 3 7
Table 4 Summary Plot 4 7
Table 5 Summary Plot 2 10
Table 6 Summary Plot 1 12
Table 7 Summary Plot 5 15
Table 8 Summary Plot 6 15

1 INTRODUCTION

Tranen Revegetation Systems have been commissioned to monitor the revegetation of the Poison Gully Branch Drain rehabilitation works. The aim of the assessment is to determine the level of success of the rehabilitation works and to provide information for future planning.

This assessment uses the same methodology employed by Tranen in June 2005, which is based in part upon the monitoring program established by ENV Australia in spring 2004 (ENV Australia, 2004). Two new monitoring plots have also been added to assess the progress of the newly rehabilitated area (works conducted in 2005) between the access track and the area revegetated in 2004.

1.1 Background

In April 2003 works associated with the maintenance of the Poison Gully Drain resulted in an impact upon 0.8 hectares of bushland on the eastern side of the drain. The incident involved the storage of approximately 1,200 m^3 of soil on an area of vegetation outside of the designated drainage reserve.

A remediation plan was developed in consultation with officers from the Department of Transport and Regional Services (DOTARS) and the Department of Environment and Heritage. Remediation of the area was completed in April 2004 and involved:

- Removal of the excess soil using a bobcat until the natural soil or vegetation was exposed (August 2003);
- Spraying the entire area for weeds with Glyphosate (February 2004); and
- Dividing the affected area into sections that had similar vegetation communities and degrees of regrowth. Methods of treatment were then established for each of these sections (see table below).

Table 1 Initial Treatment Classifications

Condition	Action	Applicable Section(s)
Successful native regrowth, no or low number of weeds.	No action, leave as is. Spraying for weeds not needed at this stage.	C, D, E
Successful native regrowth, large number of weeds.	Spot spraying.	A
No or low numbers of native regrowth, dominant number of weeds.	Spray all weeds, cover with mulch then deep rip. Direct seeding using seed stored in the provenance seed bank.	B, F, G, H

Sections that required direct seeding were classified according to the surrounding vegetation systems, of which three were identified. All were seeded with a selection of species and quantities suitable to the areas. These sections were prepared by spraying, mulching and ripping to ensure the best conditions for success of the direct seeding operation.

The airport security perimeter fence dissects the drain, and on the eastern side there are two small sections that were also affected by the soil placement. As they are

relatively small, direct seeding was not considered necessary. However, after the overburden was removed they were mulched and ripped.

Additional revegetation activities took place in June 2005 on a 12 m strip between the access road following the drain and the 2004 revegetation areas. This section was defined in the same way as sections B, F, G, and H as having 'No or low numbers of native regrowth, dominant number of weeds'. The site was ripped in May, allowed to settle for one month, sprayed with broad spectrum herbicide, lightly scarified, and then direct seeded. No mulch was used as no suitable material was available at the time.

1.2 Site Maintenance

Weed management in the area has been ongoing with herbicide being applied in June 2005, January 2006, and September 2006. Annual grasses were targeted with grass specific herbicide, followed with spot spraying of Glyphosate to control perennial herbs and bulbs. This program will continue throughout 2006 and 2007 and possibly further, depending on native plant development and the effectiveness of the weed control measures. The next herbicide applications are scheduled for summer 2006/07 and again in autumn 2007.

Hand removal of weeds has also been conducted on two separate occasions since the 2004 installation works, by Conservation Volunteers of Australia. The first targeted all species, and the second targeted only bulb species such as **Watsonia meriana var. bulbillifera* and **Gladiolus caryophyllaceus*.

2 MONITORING METHODOLOGY

The Remediation Plan for Poison Gully requires that the following are monitored until spring 2009:

- Regrowth of native species;
- Numbers of weeds;
- Areas that have not responded to remediation.

2.1 Assessment Methodology

The protocol for the assessments involves the following (as per the June 2005 assessment):

- Monitoring of four randomly located permanent quadrats (measuring 5 m x 5 m) established in the 2004 rehabilitation areas to represent the different conditions on site, with each quadrat broken down into 1 m x 1 m increments for assessment. Two new quadrats were established in the area rehabilitated in 2005;
- Stem counts of each native species within quadrats;
- Determination of average and tallest native plant heights, and observations on plant health and development;
- Estimation of weed cover with identification of the most dominant and potentially threatening species; and
- Photographic representation of the site from a permanently established point for each plot.

In addition to the above protocol an assessment of the percentage native foliage cover has been introduced for this and all subsequent assessments. This information will provide a better representation of plant development than the measurement of plant heights alone.

Table 2 below provides details of the location of the sections in which the plots were located. The locations are also indicated on the maps in Appendix 2.

Table 2 Monitoring Plot Locations and Description

Plot	Location	Description	Sections Represented
1	H	Under canopy	G, H
2	F	Midway through section	E, F
3	B	Western end of section in middle	B
4	B	Centre of section close to existing vegetation	B, C, D
5	B	On new section between Plots 1 and 2	A, B, C, D
6	F	On new section between Plots 3 and 4	E, F

3 RESULTS

The information presented in this report is a summary of the recordings from the four monitoring assessments conducted to date. The primary focus, however, is on the differences between the quantitative data. Appendix 3 contains the details of the monitoring recordings.

3.1 Section A

This section was not originally direct seeded due to good natural regrowth. The only remediation involved control of the weeds.

No quantitative assessments were carried out in this section, as there is already considerable species representation and plant density. Weed levels are currently low, and are not impacting upon the native vegetation.

3.2 Section B

Section B was sprayed for weeds, mulched, ripped, and direct seeded. Two monitoring plots were set up, in this, the largest of the sections; one to determine what is occurring in the centre of the corridor (Plot 3), and the other located close to existing vegetation, to determine if natural recruitment is occurring (Plot 4). Figures 1 to 4 below show the current photographs of each site and those taken during the last assessment, to provide a visual comparison of progress.



Figure 1 Monitoring Plot 3 - October 2006



Figure 2 Monitoring Plot 3 - May 2006



Figure 3 Monitoring Plot 4 - October 2006



Figure 4 Monitoring Plot 4 - May 2006

Table 3 Summary Plot 3

Description	Oct 06	May 06	Feb 06	May 05
Number of Native Plants	125	162	180	136
Native Density (stems/m^2)	5.0	6.5	7.2	5.44
Native Cover %	6	5	2	-
Number of Native Species	13	12	9	7
Average Plant Height (m)	0.3	0.3	0.2	-
Maximum Plant Height (m)	0.6	0.5	0.5	-
Weed Cover %	1	1	2	11

Table 4 Summary Plot 4

Description	Oct 06	May 06	Feb 06	May 05
Number of Native Plants	149	199	294	84
Native Density (stems/m^2)	6.0	8.0	11.8	3.4
Native Cover %	13	13	10	-
Number of Native Species	15	16	15	6
Average Plant Height (m)	0.4	0.4	0.2	-
Maximum Plant Height (m)	1.5	1.2	0.5	-
Weed Cover %	<1	1	2	7

Tables 3 and 4 show the number of native plants within the plots has decreased in both plots since the last assessment. Plot 3 has decreased by 37 plants, to a density of 5.0 plants/m^2, and Plot 4 by 50, to 6.0 plants/m^2. Some of the losses could be attributed to off-target herbicide damage during an extensive spot spraying operation in September 2006.

A total of 22 native species and 9 weed species were recorded in Section B within or adjacent to the monitoring plots during this assessment. Three newly observed species (*Drosera sp.*, *Meeboldina cana*, and *Stylidium sp.*) were found in this section.

Average plant heights have not changed since the May 2006 assessment. The maximum plant height for the two plots has increased to 1.5 m. The native ground cover percentage has increased by 1% in Plot 3 and remained stable in Plot 4. Given that plant numbers actually decreased by 25%, this indicates that there has been progress in plant development for numbers to have reduced, and cover to have increased.

Weed control in this area has been effective with less than 1% of the area covered by weeds. The main weeds remaining are **Hypochaeris glabra* (and other flat weeds), **Ehrharta calycina*, and **Eragrostis curvula*. A large infestation of new **Watsonia meriana var. bulbillifera* seedlings was spot sprayed with Glyphosate in September 2006 and this appears to have been very successful (see Figure 5 below).



Figure 5 **Watsonia* Sprayed in September 2006

3.3 Sections C, D, E

These sections did not need any remediation (including weed spraying) and were originally left to self-sustain. This section is included in the overall weed management program, and spraying is undertaken as necessary.

Weed levels remain low in these sections, and native regrowth is moderate, mostly arising by natural recruitment from the surrounding established vegetation. Plants in these sections are progressing well, with signs of healthy plant development and natural recruitment.

3.4 Section F

Section F was sprayed for weeds, mulched, ripped, and direct seeded. Monitoring Plot 2 was established within this section. Figures 6 and 7 below compare the current photographs of Plot 2 with those taken during the last assessment in May.



Figure 6 Monitoring Plot 2 - October 2006



Figure 7 Monitoring Plot 2 - May 2006

Table 5 Summary Plot 2

Description	Oct 06	May 06	Feb 06	May 05
Number of Native Plants	19	22	29	22
Native Density (stems/m^2)	0.8	0.9	1.2	0.9
Native Cover %	7	4	1	-
Number of Native Species	6	7	8	6
Average Plant Height (m)	0.4	0.4	0.2	-
Maximum Plant Height (m)	0.8	0.8	0.3	-
Weed Cover %	<1	1	1	8

As can be seen in Table 5, the native plant density in this section has reduced from 0.9 to 0.8 plants / m^2, with the loss of three plants since May. One species no longer occurs within the monitoring plot.

Although plants have been lost, the growth of the remaining plants has increased the native cover from 1% to 7%. The average and maximum plant heights have remained static at 0.4 m and 0.8 m respectively.

Weed control has been very effective, with weed cover now less than 1% of total ground cover. **Dittrichia graveolens* (Stinkwort) was the dominant weed species at the last assessment, and whilst this is a summer weed the control measures appear to have been effective given that there has been no sign of new germination yet. The annual species **Hypochaeris glabra* is currently the most abundant species, however a small number of **Ehrharta calycina* and **Eragrostis curvula* have the greatest threat potential. New **Watsonia meriana var. bulbillifera* seedlings were also present in significant numbers, but appear to have been eradicated through effective herbicide applications.

3.5 Sections G and H

Sections G and H were both sprayed for weeds, mulched, ripped, and direct seeded. Both sections are located next to each other, and are presently in similar condition. Monitoring Plot 1 was positioned in section H. Figures 8 and 9 below compare the current photographs of Plot 1 with those taken during the last assessment.



Figure 8 Monitoring Plot 1 - October 2006



Figure 9 Monitoring Plot 1 - May 2006

Table 6 Summary Plot 1

Description	Oct 06	May 06	Feb 06	May 05
Number of Native Plants	108	69	74	89
Native Density (stems/m^2)	4.3	2.8	3.0	3.6
Native Cover %	5	3	2	-
Number of Native Species	13	12	12	10
Average Plant Height (m)	0.2	0.1	0.1	-
Maximum Plant Height (m)	1.0	1.0	0.8	-
Weed Cover %	0	0	0	0

A total of 108 natives (4.3 plants / m^2) were recorded, an increase of 39 plants (mostly *Allocasuarina humilis*) since May (see Table 6). This is the only plot that has seen an increase in plant numbers since May 2006. Thirteen species were identified in or around Plot 1 during the assessment, an increase of one since May. Approximately one quarter of the plants within the plot are established plants that have recovered from the original drain maintenance activities.

Native cover has increased 2% across the plot, average heights have increased from 100 mm to 200 mm, and the maximum plant height remains at 1.0 m.

Only three individual weeds were recorded, two being **Ehrharta calycina* (Veldt Grass), and the other **Gladiolus caryophyllaceus*. Weed cover within and around the plot is negligible.

3.6 Areas Outside of the Security Fence

This section has a *Eucalyptus* overstorey with little underneath except for a few introduced species. A few specimens of **Ehrharta calycina*, and **Eragrostis curvula* were noted, but they are only at early stages of development. No weed control has been undertaken in this area to date.

3.7 12m Strip

A 12 m strip adjacent to the existing remediation section was rehabilitated in 2005. This section was ripped, allowed to settle for one month, sprayed with broad spectrum herbicide, lightly scarified, and then direct seeded. Two new monitoring plots (Plots 5 and 6) were established in February 2006. The locations of the two new plots are shown in Appendix 2.

Figures 9 to 12 below compare the current photographs of each site with those taken in May 2006. It is apparent that there has been little new weed germination and that the weeds sprayed previously were effectively controlled.

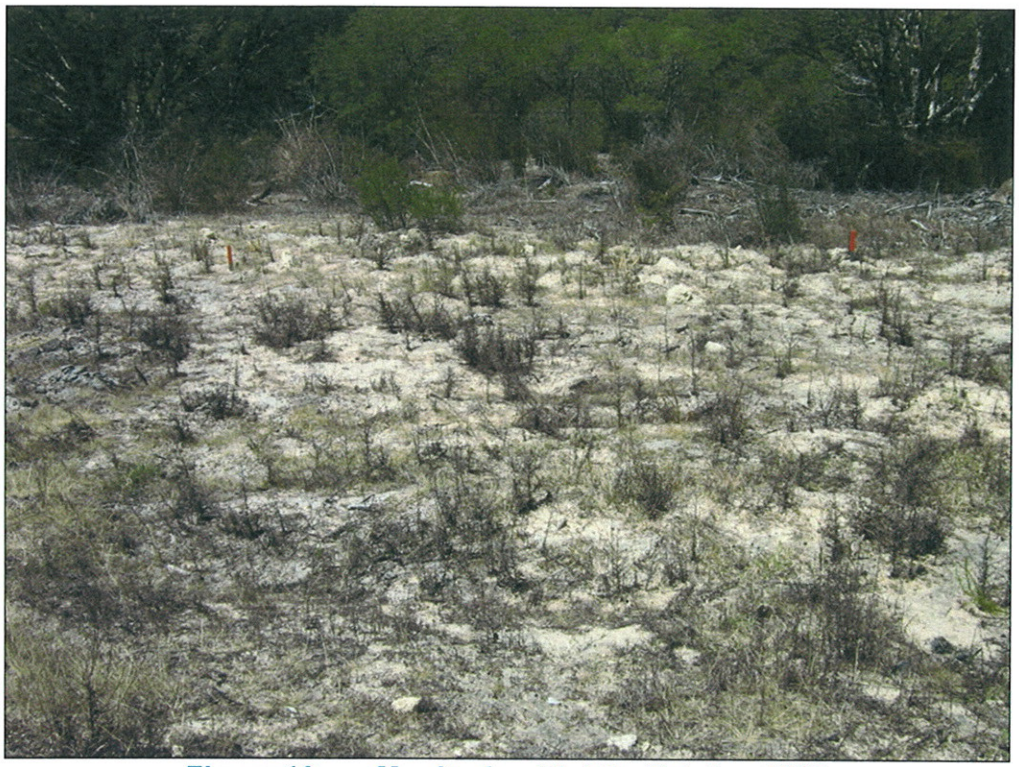


Figure 10 Monitoring Plot 5 - October 2006



Figure 11 Monitoring Plot 5 - May 2006



Figure 12 Monitoring Plot 6 - October 2006

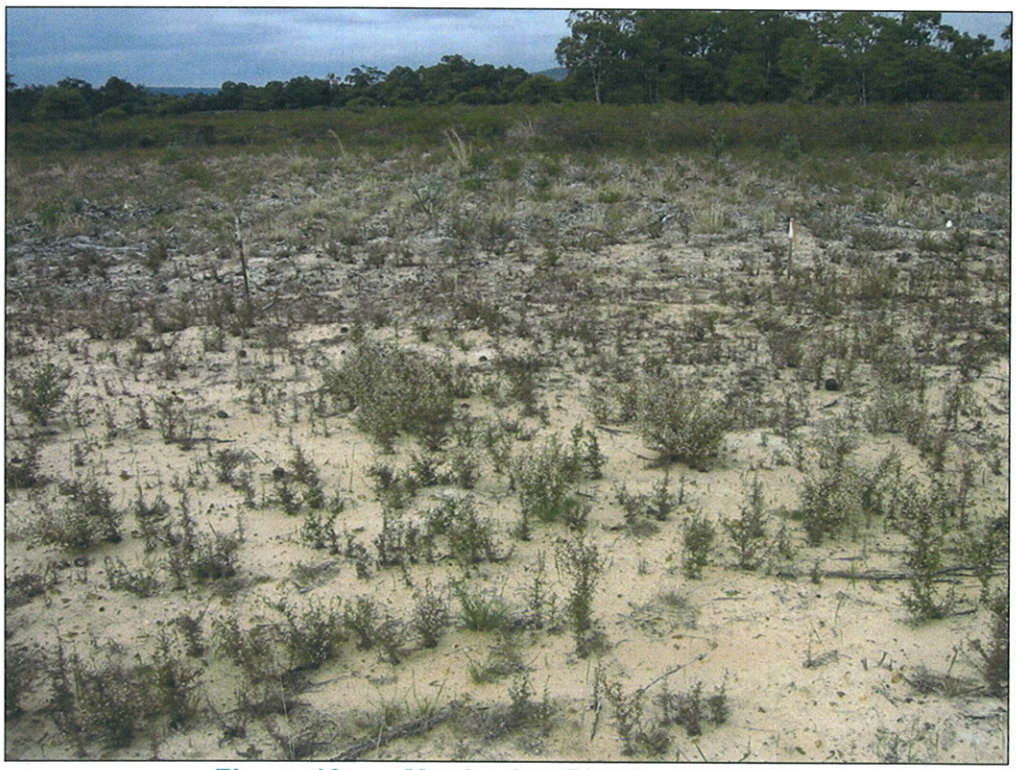


Figure 13 Monitoring Plot 6 - May 2006

Table 7 Summary Plot 5

Description	Oct 06	May 06	Feb 06	May 05
Number of Native Plants	11	11	8	-
Native Density (stems/m^2)	0.4	0.4	0.3	-
Native Cover %	0	0	0	-
Number of Native Species	4	6	5	-
Average Plant Height (m)	0.1	0.1	0.05	-
Maximum Plant Height (m)	0.1	0.2	-	-
Weed Cover %	1	15	22	-

Table 8 Summary Plot 6

Description	Oct 06	May 06	Feb 06	May 05
Number of Native Plants	3	8	18	-
Native Density (stems/m^2)	0.1	0.3	0.7	-
Native Cover %	0	0	0	-
Number of Native Species	3	4	4	-
Average Plant Height (m)	0.1	0.1	0.05	-
Maximum Plant Height (m)	0.1	0.2	-	-
Weed Cover %	0	6	22	-

The results in Tables 7 and 8 show poor native establishment rates. Plot 5 has remained stable, but another five plants have perished from Plot 6. One new native species was recorded in Plot 5 (*Melaleuca lateritia*)

Development of the native plants has been slow with no increase in the average plant height of 0.1 m. The maximum plant height in both plots has reduced to 0.1 m, and the native cover is effectively 0%.

Weed levels have been from 15% in Plot 5 and 6% in Plot 6 to less than 1%. **Dittrichia graveolens* (Stinkwort) and **Watsonia meriana var. bulbillifera* were the most dominant species, but both were targeted in an intensive herbicide application program and both have been eradicated from the monitoring transects. The summer active weeds **Cynodon dactylon* (Couch Grass), and **Conyza sp.* (Fleabane) are now the most abundant species in this area.

4 DISCUSSION

4.1 Species Richness

Species richness has progressively improved though each monitoring assessment, with 60 native species recorded to date. This is an increase of four species since the May 2006 assessment. Some of the new species are still very small and were difficult to identify to species level.

4.2 Plant Density

The plant density for the 2004 rehabilitation area has reduced from a site-wide average of 4.5 plants / m^2 in May 2006 to 4.0 plants / m^2. Plot 1 was the only quadrat to record an increase in native plant numbers, possibly as it was not part of the spraying program due to its low weed cover. Plot 2 recorded a slight decrease in plant numbers but a significant increase in percentage ground cover. The decline in plant numbers in both plots 3 and 4 can be directly attributed to the herbicide spraying program, as this was the most infested area.

Although the off target damage was unfortunate the slight overspray has ensured that every individual in the entire population of **Watsonia meriana var. bulbillifera* in the rehabilitation area was treated. Without total knockdown, this species will continue to cause problems at this location.

Plant density in the strip alongside the track that was rehabilitated in 2005 is relatively poor, with a reduction in average native average density to 0.3 plants / m^2. Secondary seed germination and natural recruitment were anticipated, but have not occurred. Plant numbers in this area are below acceptable standards.

4.3 Plant Development

In the 2004 rehabilitation area native seedlings derived from seed now average 0.3 m in height and the maximum plant height is 1.5 m. In the 2005 rehabilitation area the average plant height is 0.1 m and the maximum plant height is 0.1 m.

To complement the plant height measurements, native foliage cover assessments were also conducted during this assessment. The average foliage cover across all plots has increased from 6% to 8% in the 2004 rehabilitation area, with the greatest coverage of 13% measured in Plot 4. The native ground cover percentage in the 2005 rehabilitation area is effectively 0%.

4.4 Introduced Species

A total of 29 introduced species were identified in all of the assessments to date, but only 13 of these were found in this assessment. Weed cover is less than 1%, and most individual weeds are new plants, showing that recent weed control activities have been effective. Continuation of the eradication program will maintain this low weed status.

The main species of concern were **Watsonia meriana var. bulbillifera*, and **Dittrichia graveolens*, but numbers have declined significantly since they were specifically targeted for eradication. **Eragrostis curvula* and **Ehrharta calycina* have been targeted in the past and are currently the most abundant of the introduced species in the 2004 rehabilitation section, with a small number of new plants are scattered across the site.

Ongoing weed control appears to have dramatically reduced the number of established individuals of **Dittrichia graveolens* (Stinkwort) in the 2005 rehabilitation section. **Cynodon dactylon* and **Conyza sp* are now the dominant introduced species in this section and are starting to become active now that the hotter weather has arrived.

5 CONCLUSIONS

In the 2004 rehabilitation section all measurable aspects of the works are progressing towards a self-sustaining long term outcome. Plant numbers and density have reduced since the last assessment, but plant development is progressing as the average ground cover has increased to nearly 8%.

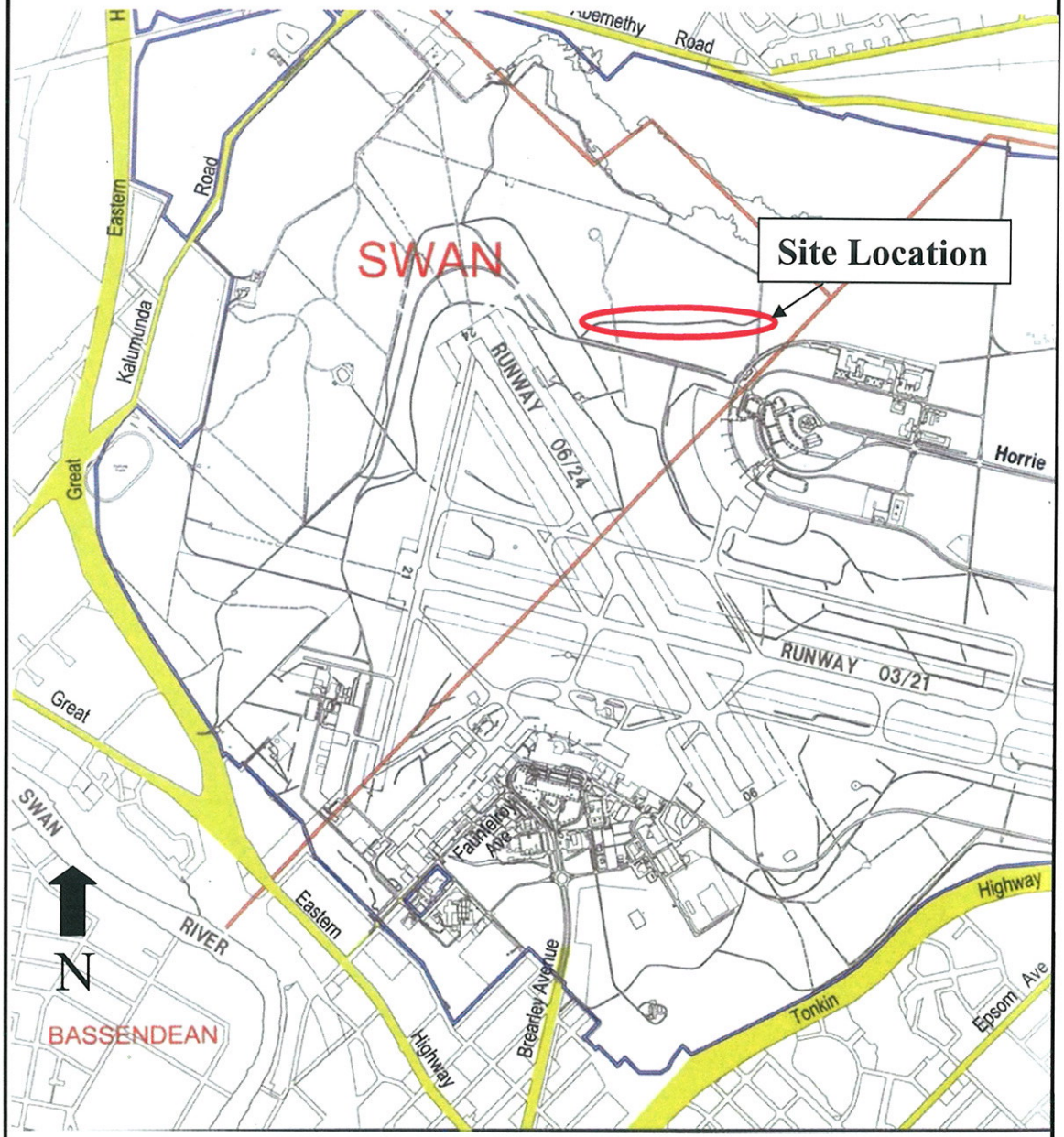
Off-target damage during herbicide spraying operations has reduced the number of plants in some areas. However, this is offset by the fact that the previously problematic introduced species have been effectively eradicated and the total weed cover is now less than 1% in all areas.

The 12 m strip alongside the track that was rehabilitated in 2005 has not achieved satisfactory progress to date. Native plant numbers, plant heights, and species representation are all low, and have reduced since the May 2006 assessment. Remedial action may be required in this area, but shouldn't be attempted until the weeds are well under control. The herbicide spraying operations have helped control the **Dittrichia graveolens*, reducing the weed cover from an average 10% in May to less than 1%. Notwithstanding this, two new introduced species were noted in this section.

6 REFERENCES

1. Remediation Plan for Poison Gully Drain, WAC, May 2004
2. Monitoring of Remediation Works of Poison Gully Drain, ENV Australia, 2004
3. Poison Gully Branch Drain Rehabilitation Vegetation Monitoring Report, Tranen Revegetation Systems, June 2005.
4. Poison Gully Branch Drain Rehabilitation Vegetation Monitoring Report, Tranen Revegetation Systems, February 2006.

Appendix 1 Site Location



Map source: Environment Strategy, 2004

Figure 1 - Site Location		
CLIENT: Westralia Airports Corporation		
DRAWN BY: NW	CHECKED BY: NW	JOB NUMBER: 04.127
DATE:11/1/2005	REPORT ISSUE: Final	SCALE: NTS

env Australia

Appendix 2 Site Layout

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Precinct 5 Monitoing
Native Monitoring

Quadrat: CcBa Rehab

Native Species	Total
Adenanthos cygnorum	10
Allocasuarina humilis	2
Austrostipa macalpinei	4
Banksia attenuata	3
Banksia menziesii	31
Bossiaea eriocarpa	2
Conostylis setosa	1
Corymbia calophylla	18
Dasypogon bromelifolius	3
Gompholobium tomentosum	17
Hibbertia racemosa	1
Jacksonia floribunda	3
Kennedia prostrata	8
Laxmannia ramosa	1
Laxmannia squarrosa	17
Macarthuria australis	2
Melaleuca seriata	1
Patersonia occidentalis	3
Pericalymma ellipticum	1
Podotheca angustifolia	28
Sample 13	11
Scholtzia involucrata	8
Siloxerus humifusus	1
Stirlingia latifolia	2
Stylidium brunonianum	1
Stylidium dichotomum	43
Stylidium piliferum	1
Trachymene pilosa	395
Tricoryne elatior	3
Unidentiable Native 2 (no sample avail)	2
Verticordia densiflora var densiflora	4
Wahlenbergia preissii	8

Weed Species	Score
*Arctotheca calendula	3
*Briza maxima	2
*Ehrharta calycina	25
*Erodium botrys	3
*Gladiolus caryophyllaceus	6
*Hypochaeris glabra / flatweeds	75
*Pelargonium sp	2
*Romulea rosea	4
*Ursinsia anthemoides	56
***Wahlenbergia capensis**	9

Native Species		**Introduced Species**
Total Natives	635	
Total Species	32	10
Native Cover %	3%	1%
Maximum Plant Height	0.4	
Average Plant Height	0.3	
Dominant Native Species		**Dominant Introduced Species**
Trachymene pilosa	1	**Hypochaeris glabra / flatweeds*
Stylidium dichotomum	2	**Ursinia anthemoides*
Banksia menziesii	3	**Ehrharta calycina*
Structural Layer Composition		
Native		**Introduced**
0%	Sedge	0%
0%	Grass	0.5%
0.5%	GC / Herb	0.5%
1.5%	Shrub	0%
1.5%	Tree	0%

Site Description	High number of native annuals present. Increase in perennial species as well. Monitored ransect area reduced to 38 m2 from 40% due to external impact.

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Precinct 5 Monitoing
Native Monitoring

Quadrat: Pe Control

Native Species	Total	Weed Species	Score
Calothamnus lateralis	2		
Cytogonidium leptocarpoides	442		
Dampiera linearis	7		
Dasypogon bromelifolius	5		
Euchilopis linearis	7		
Hibbertia stellaris	1		
Lagenophora huegellii	1		
Laxmannia ramosa	3		
Lyginia barbata / imberbis	36		
Meeboldina cana	18		
Melaleuca seriata	81		
Pericalymma ellipticum	452		
Phlebocarya ciliata	9		
Schoenus efoliatus	10		
Stirlingia latifolia	12		
Stylidium brunonianum	1		
Stylidium dichotomum	11		
Thysanotus multiflorus	2		
Verticordia densiflora var densiflora	66		

Native Species		**Introduced Species**
Total Natives	1166	
Total Species	19	0
Ground Cover %	77%	0%
Maximum Plant Height	1.2	
Average Plant Height	0.8	

Dominant Native Species		**Dominant Introduced Species**
Pericalymma ellipticum	1	*None*
Cytogonidium leptocarpoides	2	
Verticordia densiflora var densiflora	3	

Structural Layer Composition		
Native		**Introduced**
60%	Sedge	0%
0%	Grass	0%
5%	GC / Herb	0%
60%	Shrub	0%
0%	Tree	0%

Site Description	Very good native cover with weeds. Evidence of rabbit scratchings. Byblis gigantea (P2) not observed during assessment.

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Precinct 5 Monitoing
Native Monitoring

Quadrat: Pe Rehab

Native Species	Total
Adenanthos cygnorum	5
Alexgeorga nitens	6
Austrodanthonia ? setacea	2
Austrostipa macalpinei	5
Cytogonidium leptocarpoides	13
Dasypogon bromelifolius	4
Euchilopis linearis	64
Gompholobium tomentosum	2
Goodenia pulchella subsp Coastal Plair	4
Hypolaena exculsa	69
Lechenaultia expansa	11
Lepidosperma longitudinale	17
Lyginia barbata / imberbis	1
Meeboldina cana	26
Patersonia occidentalis	2
Pericalymma ellipticum	557
Schoenus benthamii (Priority 3)	18
Schoenus efoliatus	4
Stylidium brunonianum	5
Stylidium dichotomum	9
Thysanotus manglesianus	14
Verticordia densiflora var densiflora	159

Weed Species	Score
*Briza maxima	3
*Ehrharta calycina	9
*Hypochaeris glabra	5
*Ursinsia anthemoides	8

Native Species		**Introduced Species**
Total Natives	997	
Total Species	22	4
Ground Cover %	30%	1%
Maximum Plant Height	1.0	
Average Plant Height	0.4	
Dominant Native Species		**Dominant Introduced Species**
Pericalymma ellipticum	1	**Ehrharta calycina*
Verticordia densiflora var densiflora	2	**Ursinsia anthemoides*
Euchilopis linearis	3	**Hypochaeris glabra*
Structural Layer Composition		
Native		**Introduced**
4%	Sedge	0%
0.5%	Grass	0.5%
4%	GC / Herb	0.5%
27%	Shrub	0%
0%	Tree	0%

Site Description	Excellent progress with 30% total ground cover, up 6%. Increase in native species richness too with 3 new species.

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Precinct 5 Monitoing
Native Monitoring

Quadrat: MpPe Control

Native Species	Total	Weed Species	Score
Astartea affinis (ms)	38		
Calothamnus lateralis	12		
Cassytha pomiformis	2		
Centella asiatica	92		
Eutaxia virgata	4		
Lepidosperma longitudinale	12		
Lepyrodia muirii	10		
Lomandra hermaphrodita	1		
Meeboldina cana	382		
Melaleuca lateritia	85		
Melaleuca rhaphiophylla	4		
Melaleuca seriata	3		
Patersonia occidentalis	1		
Pericalymma ellipticum	62		
Native Species		**Introduced Species**	
Total Natives	708		
Total Species	14		0
Ground Cover %	72%		0%
Maximum Plant Height	5.0		
Average Plant Height	1.2		
Dominant Native Species		**Dominant Introduced Species**	
Meeboldina cana	1		
Melaleuca lateritia	2		
Pericalymma ellipticum	3		
Structural Layer Composition			
Native		**Introduced**	
45%	Sedge		0%
0%	Grass		0%
0%	GC / Herb		0%
50%	Shrub		0%
5.0%	Tree		0%
Site Description	Little change to last assessment. No weeds found.		

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Precinct 5 Monitoing
Native Monitoring

Quadrat: MpPe Rehab

Native Species	Total
Adenanthos cygnorum	1
Austrostipa macalpinei	8
Conostylis setosa	2
Dasypogon bromelifolius	1
Euchilopis linearis	2
Hypolaena exculsa	9
Jacksonia furcellata	1
Laxmannia squarrosa	3
Lechenaultia expansa	1
Patersonia occidentalis	38
Pericalymma ellipticum	72
Schoenus benthamii (Priority 3)	2
Siloxerus humifusus	37
Stylidium dichotomum	20
Thysanotus multiflorus	1
Trachymene pilosa	1
Verticordia densiflora var densiflora	41

Weed Species	Score
*Briza maxima	8
*Ehrharta calycina	27
*Eragrostis curvula	8
*Gladiolus caryophyllaceus	3
*Hypochaeris glabra	25
*Pelargonium sp	2
*Romulea rosea	2
*Ursinsia anthemoides	3

Native Species		**Introduced Species**
Total Natives	240	
Total Species	17	8
Ground Cover %	2%	1%
Maximum Plant Height	0.4	
Average Plant Height	0.2	
Dominant Native Species		**Dominant Introduced Species**
Pericalymma ellipticum	1	**Ehrharta calycina*
Verticordia densiflora var densiflora	2	**Hypochaeris glabra*
Patersonia occidentalis	3	**Eragrostis curvula*
Structural Layer Composition		
Native		**Introduced**
0.1%	Sedge	0%
0.2%	Grass	0.5%
0.2%	GC / Herb	0.5%
1.5%	Shrub	0%
0.0%	Tree	0%
Site Description	Small reduction in plant numbers. High levels of brush cover have reduced the amount of space available to support vegetation. Brush is gradually breaking down.	

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Precinct 5 Monitoing
Native Monitoring

Quadrat: BaBm Control

Native Species	Total
Acacia pulchella	6
Alexgeorga nitens	197
Amphipogon turbinatus	17
Banksia menziesii	5
Bossiaea eriocarpa	11
Bossiaea ornata	4
Burchardia umbellata	51
Calytrix fraseri	1
Conostephium pendulum	4
Conostylis juncea	4
Conostylis setosa	7
Dampiera linearis	15
Dasypogon bromelifolius	34
Desmocladus fasciculatus	306
Drosera sp (?menziesii subsp penicillaris)	3
Eremaea pauciflora	11
Gompholobium tomentosum	2
Hibbertia aurea	3
Hibbertia racemosa	1
Hovea trisperma	3
Jacksonia floribunda	13
Lagenophora huegellii	2
Laxmannia ramosa	33
Leucopogon conostephoides	14
Levenhookia stipitata	1
Lomandra hermaphrodita	10
Lyginia barbata / imberbis	166
Melaleuca seriata	54
Patersonia occidentalis	7
Petrophile linearis	1
Podotheca angustifolia	4
Scholtzia involucrata	14
Stylidium brunonianum	7
Stylidium piliferum	90
Stylidium repens	125
Trachymene pilosa	53
Xanthorrhoea brunonis	1

Weed Species	Score
*Gladiolus caryophyllaceus	3

Native Species		**Introduced Species**
Total Natives	1280	
Total Species	37	1
Ground Cover %	38%	0%
Maximum Plant Height	5.0	
Average Plant Height	1.2	
Dominant Native Species		**Dominant Introduced Species**
Desmocladus fasciculatus	1	**Gladiolus caryophyllaceus*
Alexgeorga nitens	2	
Lyginia barbata / imberbis	3	
Structural Layer Composition		
Native		**Introduced**
17%	Sedge	0%
3%	Grass	0%
6%	GC / Herb	0.1%
27%	Shrub	0%
12%	Tree	0%

Site Description	Suspect quadrat is dieback infected as large Banksia (5m) has snapped at base. Understorey also quite bare and degraded. Only area immediately around the quadrat appears to be affected.

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Precinct 5 Monitoing
Native Monitoring

Quadrat: BaBm Rehab

Native Species	Total	Weed Species	Score
Adenanthos cygnorum	2	*Aira caryophyllea	14
Alexgeorga nitens	1	*Anagallis arvensis var caerulea	2
Austrostipa macalpinei	337	***Euphorbia terracina**	3
Banksia menziesii	3	*Gladiolus caryophyllaceus	2
Bossiaea eriocarpa	3	*Hypochaeris glabra	91
Conostylis setosa	8	*Moraea flaccida	2
Dampiera linearis	7		
Euchilopis linearis	2		
Gompholobium tomentosum	9		
Gonocarpus cordiger	3		
Jacksonia floribunda	2		
Jacksonia furcellata	1		
Laxmannia squarrosa	3		
Levenhookia stipitata	69		
Lyginia barbata / imberbis	3		
Melaleuca seriata	5		
Patersonia occidentalis	2		
Podotheca angustifolia	136		
Scholtzia involucrata	8		
Siloxerus humifusus	266		
Stylidium dichotomum	1		
Stylidium repens	2		
Trachymene pilosa	386		
Wahlenbergia gracilienta	1		

Native Species		**Introduced Species**
Total Natives	1260	
Total Species	24	6
Ground Cover %	1%	1%
Maximum Plant Height	0.4	
Average Plant Height	0.2	
Dominant Native Species		**Dominant Introduced Species**
Trachymene pilosa	1	**Hypochaeris glabra*
Austrostipa macalpinei	2	**Aira caryophyllea*
Siloxerus humifusus	3	**Euphorbia terracina*
Structural Layer Composition		
Native		**Introduced**
0.1%	Sedge	0%
0.2%	Grass	0.1%
0.2%	GC / Herb	0.8%
0.8%	Shrub	0.1%
0.0%	Tree	0%
Site Description	Large native density (30+ plants/m2) but most small annuals so actual ground cover low. Perennial density (1.5 plants/m2). Weed density also low - predominantly flat weeds, however Euphorbia observed - potentially very invasive.	

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Precinct 5 Monitoing
Native Monitoring

Quadrat: Wetland Control

Native Species	Total	Weed Species	Score
Astartea affinis (ms)	28	*Cyndon dactylon	23
Baumea articulata	104	*Ehrharta calycina	8
Crassula colorata var acuminata	9	*Gladiolus caryophyllaceus	18
Eutaxia virgata	4	*Phytolacca octandra	3
Goodenia pulchella subsp Coastal Plain A	36	*Ursinsia anthemoides	2
Jacksonia furcellata	1	*Watsonia meriana var bulbillifera	6
Lagenophora huegellii	1		
Meeboldina cana	309		
Melaleuca lateritia	10		
Melaleuca rhaphiophylla	3		
Schoenus subfascicularis	81		
Thysanotus manglesianus	2		
Villarsia albiflora	26		

Native Species		Introduced Species
Total Natives	614	
Total Species	13	6
Ground Cover %	43%	1%
Maximum Plant Height	1.2	
Average Plant Height	1.1	
Dominant Native Species		**Dominant Introduced Species**
Meeboldina cana	1	**Cyndon dactylon*
Baumea articulata	2	**Gladiolus caryophyllaceus*
Schoenus subfascicularis	3	**Ehrharta calycina*
Structural Layer Composition		
Native		**Introduced**
37%	Sedge	0%
0%	Grass	0.5%
1%	GC / Herb	0.5%
6%	Shrub	0%
8%	Tree	0%
Site Description	Nest with eggs (presumed to be tortoise) found within monitoring quadrat close to waters edge.	

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Precinct 5 Monitoing
Native Monitoring

Quadrat: Wetland A

Native Species	Total	Weed Species	Score
Acacia pulchella	3	*Anagallis arvensis	17
Adenanthos cygnorum	1	*Anagallis arvensis var arvensis	3
Astartea affinis (ms)	3	*Arctotheca calendula	2
Austrostipa macalpinei	4	*Avena barbata	8
Calandrinia granulifera	5	*Briza maxima	3
Calothamnus lateralis	2	?*Chamaecytisus palmensis	3
Centrolepis polygyna	13	*Conyza sp.	2
Conostylis setosa	17	*Ehrharta calycina	13
Cyperus polystachyos	8	*Eragrostis curvula	4
Dasypogon bromelifolius	9	*Gladiolus caryophyllaceus	2
Eucalyptus rudis	3	*Hypochaeris glabra	19
Euchilopis linearis	19	*Isolepis marginata	24
Gompholobium tomentosum	36	***Lupinus angustifolius**	3
Gonocarpus cordiger	3	*Ursinsia anthemoides	21
Hypocalymma angustifolium	77	*Vellereophyton dealbatum	18
Hypocalymma sp.	8		
Hypolaena exculsa	77		
Jacksonia floribunda	12		
Jacksonia furcellata	1		
Jacksonia sp	2		
Juncus pallidus	425		
Kennedia prostrata	1		
Kunzea ericifolia	7		
Laxmannia squarrosa	17		
Melaleuca preissiana	1		
Melaleuca seriata	2		
Patersonia occidentalis	7		
Persicaria decipiens	5		
Phlebocarya ciliata	1		
Schoenus benthamii (Priority 3)	17		
Schoenus curvifolius	23		
Scholtzia involucrata	1		
Siloxerus humifusus	1		
Stylidium diuroides subsp diuroides	4		
Thysanotus multiflorus	2		
Verticordia densiflora var densiflora	1		

Native Species		**Introduced Species**
Total Natives	818	
Total Species	36	15
Ground Cover %	11%	1%
Maximum Plant Height	2.0	
Average Plant Height	0.3	
Dominant Native Species		**Dominant Introduced Species**
Juncus pallidus	1	**Isolepis marginata*
Hypocalymma angustifolium	2	**Ursinsia anthemoides*
Hypolaena exculsa	3	**Hypochaeris glabra*
Structural Layer Composition		
Native		**Introduced**
4%	Sedge	0.3%
0.25%	Grass	0.3%
0.75%	GC / Herb	0.4%
7%	Shrub	0%
1%	Tree	0%
Site Description	New seedlings planted in constructed wetland area, and also germination of new species from topsoil have lead to increase in plant numbers and species richness. Weed levels very low due to intensive herbicide application.	

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Precinct 5 Monitoing
Native Monitoring

Quadrat: Wetland B

Native Species	Total	Weed Species	Score
Astartea affinis (ms)	2	*Anagallis arvensis var arvensis	43
Austrostipa macalpinei	40	*Arctotheca calendula	2
Bolboschoenus caldwellii	5	*Avena barbata	27
Calothamnus lateralis	1	*Eragrostis curvula	13
Centrolepis aristata	118	*Hypochaeris glabra	9
Cyperus polystachyos	10	*Isolepis marginata	13
Dampiera linearis	2	*Juncus microcephalus	16
Euchilopis linearis	1	***Lythrum hyssopifolia**	9
Hypocalymma angustifolium	7	***Phalaris angustata**	2
Jacksonia sternbergiana	47	*Sonchus oleraceus	2
Juncus pallidus	117	*Vellereophyton dealbatum	12
Kunzea ericifolia	1	*Vulpia sp.	14
Melaleuca preissiana	3	*Watsonia meriana var bulbillifera	2
Melaleuca rhaphiophylla	220		
Podotheca angustifolia	2		
Schoenus curvifolius	51		
Siloxerus humifusus	16		

Native Species		**Introduced Species**
Total Natives	643	
Total Species	17	13
Ground Cover %	4%	1%
Maximum Plant Height	1.0	
Average Plant Height	0.3	
Dominant Native Species		**Dominant Introduced Species**
Melaleuca rhaphiophylla	1	**Anagallis arvensis var arvensis*
Juncus pallidus	2	**Avena barbata*
Schoenus curvifolius	3	**Juncus microcephalus*
Structural Layer Composition		
Native		**Introduced**
1.75%	Sedge	0.4%
0.25%	Grass	0.2%
0.1%	GC / Herb	0.4%
0.1%	Shrub	0%
2.5%	Tree	0%
Site Description	High dead weed cover around one of the quadrats. Good plant development with a doubling of ground cover. Some new seedlings planted in 2006.	

Appendix 4 List of Species Identified By Transect

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Precinct 5 Monitoing
Native Monitoring

Taxa Identified Oct 06	CcBa C	CcBa R	Pe C	Pe R	MpPe C	MpPe R	BaBm C	BaBm R	Wetland C	Wetland A	Wetland B	Summary Oct 06	Summary May 06	Summary Feb 06	Summary Jun 05	Summary Dec 04	Summary to Date
Acacia applanata	Y											Y	Y	Y	Y	Y	Y
Acacia extensa															Y	Y	Y
Acacia huegeliii	Y											Y	Y	Y	Y	Y	Y
Acacia pulchella	Y						Y			Y		Y	Y	Y	Y	Y	Y
Acacia sp.																Y	Y
Adenanthos cygnorum		Y		Y		Y		Y		Y		Y	Y	Y	Y	Y	Y
* Aira caryophyllea								Y				Y				Y	Y
Alexgeorga nitens	Y			Y			Y	Y				Y	Y	Y	Y	Y	Y
Allocasuarina fraseriana	Y											Y	Y	Y		Y	Y
Allocasuarina humilis		Y										Y	Y	Y	Y		Y
Amphipogon amphipogonoides													Y				Y
Amphipogon turbinatus							Y					Y	Y	Y	Y	Y	Y
* Anagallis arvensis	Y	Y										Y			Y		Y
* Anagallis arvensis var arvensis	Y	Y								Y	Y	Y	Y	Y		Y	Y
* Anagallis arvensis var caerulea								Y		Y		Y				Y	Y
* Arctotheca calendula											Y	Y				Y	Y
Astartea affinis (ms)					Y				Y	Y	Y	Y	Y	Y	Y	Y	Y
Astartea sp.															Y	Y	Y
Austrodanthonia ? setacea				Y								Y					Y
Austrostipa macalpinei		Y		Y		Y		Y		Y	Y	Y					Y
* Avena barbata										Y	Y	Y		Y	Y	Y	Y
Banksia attenuata		Y										Y	Y	Y	Y	Y	Y
Banksia menziesii		Y					Y	Y				Y	Y	Y	Y	Y	Y
Baumea articulata									Y			Y	Y	Y	Y	Y	Y
Baumea juncea													Y				Y
Bolboschoenus caldwellii											Y	Y					Y
Boronia ramosa subsp anethifolia															Y		Y
Boronia sp.																Y	Y
Bossiaea eriocarpa	Y	Y					Y	Y				Y	Y	Y	Y	Y	Y
Bossiaea ornata							Y					Y	Y	Y	Y	Y	Y
* Briza maxima	Y	Y		Y		Y				Y		Y		Y	Y	Y	Y
* Briza minor																Y	Y
Burchardia umbellata	Y						Y					Y	Y	Y	Y	Y	Y
Byblis gigantea (P2)														Y	Y		Y
Caladenia sp.															Y		Y
Calandrinia granulifera										Y		Y	Y	Y	Y	Y	Y
Calothamnus lateralis			Y		Y					Y	Y	Y	Y	Y	Y	Y	Y
Calytrix flavescens	Y											Y	Y	Y			Y
Calytrix fraseri							Y					Y	Y	Y	Y	Y	Y
Cassytha pomiformis					Y							Y	Y	Y	Y	Y	Y
* Centaurium erythraea														Y		Y	Y
Centella asiatica					Y							Y	Y	Y	Y		Y
Centrolepis aristata											Y	Y				Y	Y
Centrolepis polygyna										Y		Y					Y
?* **Chamaecytisus palmensis**										Y		Y					Y
* Cicendia filiformis																Y	Y
Conostephium minus																Y	Y
Conostephium pendulum							Y					Y	Y	Y	Y	Y	Y
Conostylis juncea	Y						Y					Y		Y	Y	Y	Y
Conostylis setosa		Y				Y	Y	Y		Y		Y	Y	Y			Y
Conostylis sp.														Y	Y	Y	Y
* Conyza sp.										Y		Y	Y	Y			Y
Corymbia calophylla	Y	Y										Y	Y	Y	Y	Y	Y
Crassula colorata var acuminata (formerly Crassula sp)									Y				Y	Y		Y	Y
* Cyndon dactylon									Y			Y	Y	Y	Y	Y	Y
Cyperus polystachyos										Y	Y	Y	Y	Y			Y
Cytogonidium leptocarpoides			Y	Y								Y	Y	Y	Y	Y	Y
Dampiera linearis	Y		Y				Y	Y			Y	Y	Y	Y	Y	Y	Y
Dasypogon bromelifolius	Y	Y	Y	Y		Y	Y			Y		Y	Y	Y	Y	Y	Y
Daviesia sp																Y	Y
Desmocladus fasciculatus	Y						Y					Y	Y	Y	Y	Y	Y
Desmocladus flexuosus	Y											Y	Y	Y	Y	Y	Y
Desmocladus sp																Y	Y
* Dittrichia graveolens													Y				Y
Drosera ? menziesii subsp penicillaris							Y					Y					Y
Drosera ? stolonifera	Y											Y					Y
Drosera erythryhiza													Y				Y
Drosera nitidula													Y				Y
Drosera sp															Y	Y	Y
* Ehrharta calycina	Y	Y		Y		Y			Y	Y		Y	Y	Y	Y	Y	Y
* Eragrostis curvula	Y	Y				Y				Y	Y	Y	Y	Y	Y	Y	Y
Eremaea pauciflora							Y					Y	Y	Y	Y	Y	Y
* Erodium botrys													Y		Y		Y
Eucalyptus marginata																Y	Y
Eucalyptus rudis										Y		Y	Y	Y	Y	Y	Y
Eucalyptus sp.																Y	Y
Euchilopis linearis			Y	Y		Y		Y		Y	Y	Y	Y	Y	Y	Y	Y
* **Euphorbia terracina**								Y				Y					Y

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revegetation systems

Precinct 5 Monitoing
Native Monitoring

Taxa Identified Oct 06	CcBa C	CcBa R	Pe C	Pe R	MpPe C	MpPe R	BaBm C	BaBm R	Wetland C	Wetland A	Wetland B	Summary Oct 06	Summary May 06	Summary Feb 06	Summary Jun 05	Summary Dec 04	Summary to Date
Eutaxia virgata					Y				Y			Y	Y	Y	Y	Y	Y
Gastrolobium capitatum															Y		Y
* Gladiolus caryophyllaceus						Y		Y	Y	Y		Y	Y		Y	Y	Y
Gompholobium sp.																Y	Y
Gompholobium tomentosum	Y	Y		Y			Y	Y		Y		Y	Y	Y	Y	Y	Y
Gonocarpus cordiger								Y		Y		Y	Y		Y		Y
Goodenia pulchella subsp Coastal Plain A				Y					Y			Y	Y	Y	Y		Y
Haemodorum spicatum														Y			Y
Hibbertia aurea							Y					Y	Y	Y			Y
Hibbertia hypericoides															Y	Y	Y
Hibbertia racemosa		Y					Y					Y	Y	Y	Y	Y	Y
Hibbertia stellaris			Y									Y				Y	Y
Hovea trisperma	Y						Y					Y	Y	Y	Y	Y	Y
* Hydrocotyle bonariensis																Y	Y
Hypocalymma angustifolium	Y									Y	Y	Y	Y	Y	Y	Y	Y
Hypocalymma sp.										Y		Y			Y	Y	Y
* Hypochaeris glabra	Y	Y		Y		Y		Y		Y	Y	Y		Y	Y	Y	Y
Hypolaena exculsa	Y			Y		Y				Y		Y	Y	Y	Y	Y	Y
* Introduced Species 1																Y	Y
* Introduced Species 2																Y	Y
* Isolepis marginata										Y	Y	Y	Y	Y	Y	Y	Y
Jacksonia floribunda	Y	Y					Y	Y		Y		Y	Y	Y	Y	Y	Y
Jacksonia furcellata						Y		Y	Y	Y		Y	Y	Y	Y	Y	Y
Jacksonia sp										Y		Y				Y	Y
Jacksonia sternbergiana											Y	Y				Y	Y
* Juncus articulatus																Y	Y
* Juncus microcephalus											Y	Y	Y	Y		Y	Y
Juncus pallidus										Y	Y	Y	Y	Y			Y
Juncus planifolius													Y	Y			Y
Kennedia coccinea																Y	Y
Kennedia prostrata		Y								Y		Y	Y	Y	Y	Y	Y
Kunzea ericifolia										Y	Y	Y	Y	Y	Y		Y
Kunzea recurva													Y		Y		Y
Lagenophora huegellii			Y				Y		Y			Y				Y	Y
Laxmannia ramosa	Y	Y	Y				Y					Y	Y	Y	Y	Y	Y
Laxmannia sp.																Y	Y
Laxmannia squarrosa		Y				Y		Y		Y		Y	Y	Y	Y	Y	Y
Lechenaultia ? biloba													Y		Y	Y	Y
Lechenaultia biloba																Y	Y
Lechenaultia expansa				Y		Y						Y				Y	Y
? Lechenaultia sp.																Y	Y
Lepidosperma longitudinale				Y	Y							Y	Y	Y	Y	Y	Y
Lepidosperma sp														Y		Y	Y
Lepidosperma squamatum													Y	Y	Y	Y	Y
Lepidosperma tenue																Y	Y
Lepyrodia muirii					Y							Y					Y
Leucopogon ? Sp. Murdoch (M. Hislop 1037)															Y		Y
Leucopogon conostephoides							Y					Y	Y	Y	Y	Y	Y
Leucopogon sp																Y	Y
Levenhookia preissii																Y	Y
Levenhookia stipitata							Y	Y				Y					Y
? Liliaceae sp.															Y		Y
Lobelia tenuior													Y			Y	Y
Lomandra hermaphrodita	Y				Y		Y					Y		Y	Y	Y	Y
Lomandra nigricans	Y											Y			Y		Y
Lomandra sp																Y	Y
* Lotus subbiflorus																Y	Y
* **Lupinus angustifolius**										Y		Y					Y
* Lupinus consentinii													Y		Y		Y
Lyginia barbata / imberbis	Y		Y	Y			Y	Y				Y	Y	Y	Y	Y	Y
* **Lythrum hyssopifolia**											Y	Y					Y
Macarthuria australis (formerly ?Daviesia triflora)		Y										Y	Y	Y	Y		Y
Meeboldina cana			Y	Y	Y				Y			Y	Y	Y	Y		Y
Meeboldina roycei													Y		Y	Y	Y
Melaleuca lateritia					Y				Y			Y	Y	Y	Y	Y	Y
Melaleuca preissiana										Y	Y	Y	Y	Y	Y		Y
Melaleuca rhaphiophylla					Y				Y		Y	Y	Y	Y	Y	Y	Y
Melaleuca seriata	Y	Y	Y		Y		Y	Y		Y		Y	Y	Y	Y	Y	Y
Melaleuca sp																Y	Y
Melaleuca teretifolia														Y	Y	Y	Y
* Moraea flaccida								Y				Y	Y		Y		Y
MYRTACEAE sp.														Y	Y		Y
MYRTACEAE sp. 2														Y	Y		Y
* Oxalis glabra													Y		Y		Y
* Oxalis sp.															Y		Y
Patersonia occidentalis	Y	Y		Y		Y	Y	Y		Y		Y	Y	Y	Y	Y	Y
? Patersonia sp																Y	Y
* Pelargonium sp						Y						Y			Y	Y	Y

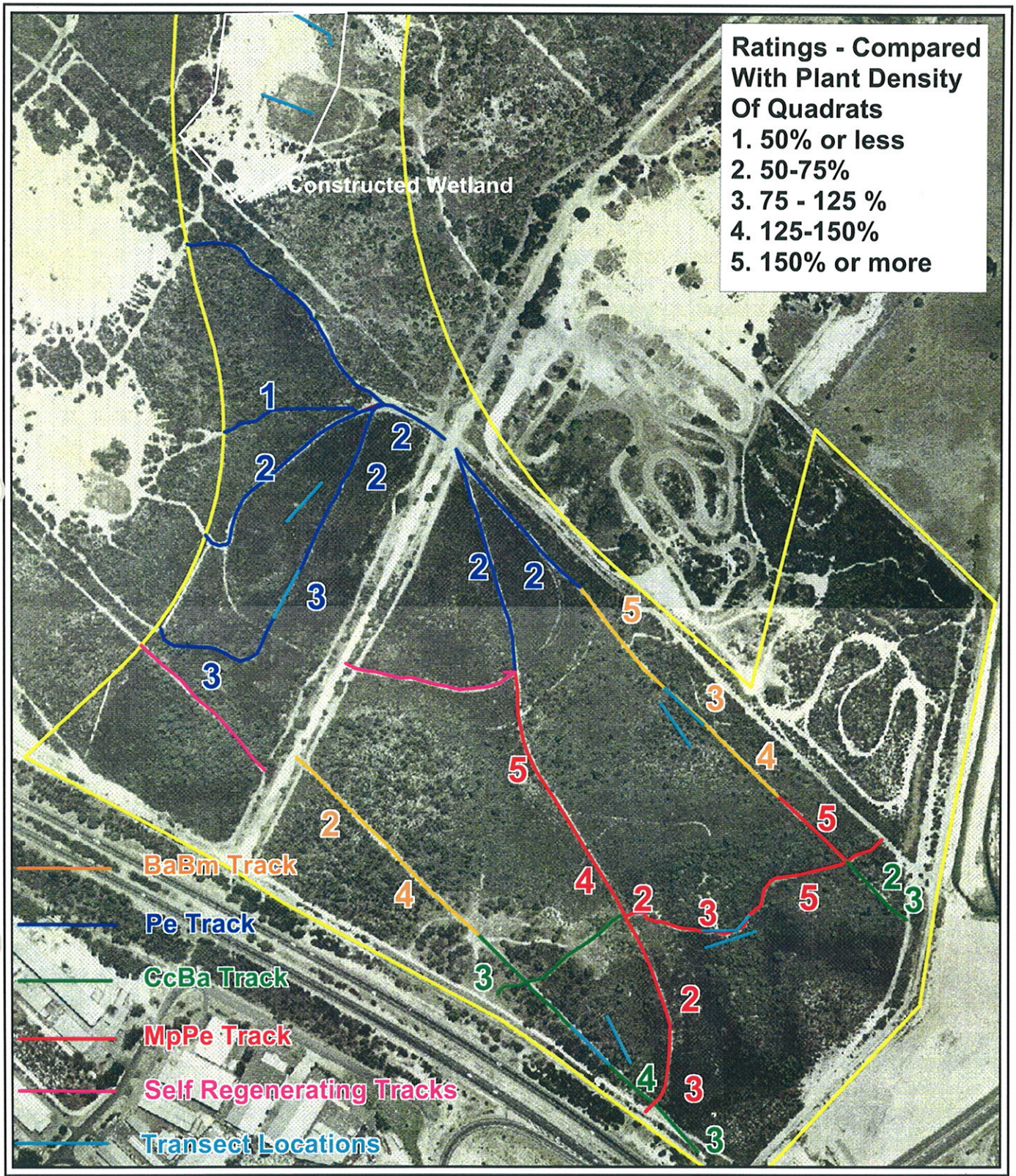
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revegetation systems

Precinct 5 Monitoing
Native Monitoring

Taxa Identified Oct 06	CcBa C	CcBa R	Pe C	Pe R	MpPe C	MpPe R	BaBm C	BaBm R	Wetland C	Wetland A	Wetland B	Summary Oct 06	Summary May 06	Summary Feb 06	Summary Jun 05	Summary Dec 04	Summary to Date
Pericalymma ellipticum		Y	Y	Y	Y	Y						Y	Y	Y	Y	Y	Y
Persicaria decipiens										Y		Y					Y
Petrophile linearis							Y					Y	Y	Y	Y	Y	Y
* **Phalaris angustata**											Y	Y					Y
Phelbocarya ciliata	Y											Y			Y	Y	Y
Philotheca spicata	Y											Y			Y		Y
Phlebocarya ciliata	Y		Y							Y		Y	Y	Y	Y	Y	Y
? Phyllanthus sp																Y	Y
* Phytolacca octandra									Y			Y	Y				Y
POACEAE sp															Y	Y	Y
Podotheca angustifolia		Y					Y	Y			Y	Y	Y	Y	Y		Y
PROTEACEAE sp																Y	Y
Pterostylis sanguinea													Y		Y		Y
Quinetia urvellii															Y		Y
RESTIONACEAE sp																Y	Y
* Romulea rosea						Y						Y				Y	Y
Sample 13		Y										Y					Y
? Sample B (Unidentifiable)															Y		Y
? Sample G (Unidentifiable)															Y		Y
Schoenus benthamii (Priority 3)				Y		Y				Y		Y	Y	Y			Y
Schoenus curvifolius										Y	Y	Y	Y				Y
Schoenus efoliatus			Y	Y								Y	Y				Y
Schoenus subfascicularis									Y			Y	Y	Y	Y		Y
Scholtzia involucrata	Y	Y					Y	Y		Y		Y	Y	Y	Y	Y	Y
Siloxerus humifusus	Y	Y				Y		Y		Y	Y	Y		Y		Y	Y
* Solanum nigrum														Y	Y		Y
* Sonchus oleraceus											Y	Y		Y	Y	Y	Y
Stirlingia latifolia		Y	Y									Y	Y	Y	Y	Y	Y
Stylidium brunonianum		Y	Y	Y			Y					Y				Y	Y
Stylidium dichotomum		Y	Y	Y		Y		Y				Y	Y			Y	Y
Stylidium diuroides subsp diuroides										Y		Y	Y	Y			Y
Stylidium piliferum		Y					Y					Y				Y	Y
Stylidium repens	Y						Y	Y				Y	Y	Y	Y	Y	Y
Stylidium sp.															Y		Y
? Tetratheca hirsuta																Y	Y
Thysanotus manglesianus				Y					Y			Y	Y	Y	Y	Y	Y
Thysanotus multiflorus			Y			Y				Y		Y		Y	Y	Y	Y
Trachymene pilosa	Y	Y				Y	Y	Y				Y				Y	Y
Tricoryne elatior	Y	Y										Y		Y	Y	Y	Y
* Trifolium sp																Y	Y
* Typha orientalis														Y			Y
* Unidentified Dicotyledon													Y		Y		Y
* Unidentified Monocotyledon															Y		Y
Unidentified Native 2 (no sample avail)		Y										Y		Y	Y		Y
Unidentified Native 3 (no sample avail)														Y			Y
* Ursinsia anthemoides	Y	Y		Y		Y			Y	Y		Y	Y	Y	Y	Y	Y
* Vellereophyton dealbatum										Y	Y	Y	Y	Y		Y	Y
Verticordia densiflora var densiflora		Y	Y	Y		Y				Y		Y	Y	Y	Y	Y	Y
Verticordia sp																Y	Y
Villarsia albiflora									Y			Y	Y	Y	Y		Y
* Vulpia sp.											Y	Y	Y		Y		Y
* **Wahlenbergia capensis**																	Y
Wahlenbergia gracilienta								Y				Y					Y
Wahlenbergia preissii	Y	Y										Y			Y		Y
* Watsonia meriana var bulbillifera									Y		Y	Y			Y	Y	Y
Xanthorrhoea brunonis	Y						Y					Y	Y	Y			Y
Xanthorrhoea preissii	Y											Y	Y	Y	Y	Y	Y
Total Native Species	37	32	19	22	13	17	37	24	13	36	17	108	89	90	99	108	165
Total Introduced Species	7	7	0	4	0	8	0	6	6	14	13	29	18	16	23	28	48
Total Species	44	39	19	26	13	25	37	30	19	50	30	137	107	106	122	136	213

Note:
Bold = New species
Blue = refinement of identification of species

Appendix 5 Transect and Track Comparison Map



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revegetation systems

Drawing	Scale
P130-01-1	1:5000
Drawn By	Size
DG	A4

Precinct 5 Rehabilitation Tracks Vegetation System and Ratings

Perth Airport

WESTRALIA AIRPORTS CORPORATION

PERTH AIRPORT

01 May 2007

FILE → PB185-06
PB185/1-03
R RYAN

Ms Rebecca Ryan
Botanist
Department of Environment and Conservation
Level 4 168 St Georges Tce
PERTH 6000

DEPARTMENT OF ENVIRONMENT & CONSERVATION
0 3 MAY 2007
Corporate Information Section
ATRIUM

SCANNED

DOC 21318

Dear Rebecca,

RE: CONSERVATION PRECINCTS VEGETATION MONITORING REPORTS OCT 06 PERTH AIRPORT

Please find enclosed a copy of Perth Airport's Vegetation Monitoring Reports for our two Conservation Precincts as required:

- Precinct 5;
- Poison Gully Branch Drain.

These reports are for the quarter up until October 2006.

If you have any questions please feel free to contact me.

Regards,

Arnica Di Lollo
ENVIRONMENTAL SCIENTIST
Tel: 9478 8457
E-mail: arnica.dilollo@wac.com.au

BFS 386

PB 185 BT01

185/01/3

tranen
revegetation systems

Precinct 5 Rehabilitation
Westralia Airports Corporation

Vegetation Monitoring Report

October 2006

P154-01 Rev 0

Tranen Pty Ltd
1/110 Jersey Street
Jolimont, WA 6014
p (08) 9284 1399
f (08) 9284 1377
email@tranen.com.au
www.tranen.com.au

Disclaimer

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Table of Contents

1 Introduction 1
2 Background 2
3 Monitoring Methodology 4
3.1 Transect Layout 4
3.2 Methodology 5
3.3 New Measure – Transect Representation 5
4 Results 7
4.1 Flora 7
4.1.1 Declared Rare and Priority Species 7
4.1.2 Introduced Species 7
4.2 Species Richness 8
4.3 Native Plant Density 8
4.4 Structural Layers and Surface Cover 9
4.5 Average and Maximum Plant Heights 12
4.6 Transect Representation of Tracks 12
4.7 Self-Regenerating Tracks 13
5 Discussion 14
5.1 General 14
5.2 *Corymbia calophylla* / *Banksia attenuata* Tracks 15
5.3 *Pericalymma ellipticum* Tracks 16
5.4 *Melaleuca preissiana* / *Pericalymma ellipticum* Tracks 17
5.5 *Banksia attenuata* / *Banksia menziesii* Tracks 18
5.6 Constructed Wetland 19
5.7 Self-Regenerating Tracks 20
6 Conclusions 22
7 References 23
APPENDIX 1 TRANSECT LOCATION MAPS 24
APPENDIX 2 TRANSECT LOCATION AND ORIENTATION DETAILS 30
APPENDIX 3 TRANSECT SUMMARIES 32
APPENDIX 4 LIST OF SPECIES IDENTIFIED BY TRANSECT 44
APPENDIX 5 TRANSECT AND TRACK COMPARISON MAP 48

Table of Figures

Figure 1 Transect Layout 4
Figure 2 MpPe Track – Transect (Left) and 100 m Further Along (Right) 5
Figure 3 CcBa Rehabilitation Transect Photos October and May 2006 15
Figure 4 Pe Rehabilitation Transect Photos October and May 2006 16
Figure 5 MpPe Control and Rehabilitation Transect Photos 17
Figure 6 BaBm Rehabilitation Transect Photos October and May 2006 18
Figure 7 Wetland A Rehabilitation Transect Photos October and May 2006 19
Figure 8 Wetland A Rehabilitation Transect Photos October and May 2006 19
Figure 9 Eggs Found in Wetland Control Transect 20

Table of Tables

Table 1 Track Comparison Ratings 6
Table 2 Total Number of Species Identified During Assessments 7
Table 3 Number of Species Identified By Transect 8
Table 4 Native Stem Counts and Density 9
Table 5 CcBa Structural Layer Composition 9
Table 6 Pe Structural Layer Composition 10
Table 7 MpPe Structural Layer Composition 10
Table 8 BaBm Structural Layer Composition 11
Table 9 Wetland A Structural Layer Composition 11
Table 10 Wetland B Structural Layer Composition 12
Table 11 Average and Maximum Plant Heights 12
Table 12 Transect Representation of Entire Track 13

1 INTRODUCTION

The Perth Airport is located approximately 10 km east of Perth and covers an area of 2,105 ha over 3 municipalities: City of Belmont, City of Swan, and the Shire of Kalamunda. The airport land is bounded by Tonkin Highway, Great Eastern Highway, Kalamunda Road, and Abernethy Road.

Figure 2 in Appendix 1 shows the airport is divided into 7 precincts, each with its own independent management objectives. The southern part of Precinct 2C was cleared for development in 2003 and the opportunity arose to utilise high quality topsoil and bush for the rehabilitation of unauthorised access tracks and the construction of a wetland in Precinct 5 (conservation zone).

Tranen Revegetation Systems were commissioned in May 2005 to continue the vegetation monitoring program in Precinct 5 for initial works that were undertaken in November 2003. This is the third assessment by Tranen, and the fourth since rehabilitation works were originally conducted. The monitoring of these works are to continue until November 2008 as committed to in the Precinct 5 Rehabilitation Plan (ENV Australia, 2003) approved by the Department of Transport and Regional Services, and the Department of Environment and Heritage.

The aim of the monitoring is to catalogue progress within the rehabilitation areas and to determine whether remedial actions are required. The program involves monitoring 11 permanently established transects in Precinct 5 by:

- Counting the total number of native seedlings;
- Identifying all species (both native and introduced) contained within;
- Determining the percentage cover of native and introduced species;
- Observing factors that may be impeding or promoting plant establishment; and
- Maintaining a photographic log for visual comparison.

The monitoring is to be conducted in spring and autumn each year for the five year period. This report details the findings from the four assessments conducted to May 2006.

2 BACKGROUND

The southern section of Precinct 2C has been developed as a business park. The development is outlined in the approved Master Plan and in the Major Development Plan (MDP), (The Planning Group, 2003). The MDP provides a detailed description of the environmental values of Precinct 2C South, the impacts associated with the development, and how these impacts are to be managed or mitigated.

As 8 of the 44 hectares within Precinct 2C South were classed as in 'good condition' (Mattiske, 2003) it was decided that this resource should not be wasted and that it would be used to rehabilitate sections of the conservation zone Precinct 5.

The general approach to the rehabilitation was to collect carefully selected soil and vegetation material from the cleared section of Precinct 2C South and use it to rehabilitate unauthorised access tracks and a constructed wetland in Precinct 5. The best quality vegetation and topsoil from Precinct 2C South was selected for use in the same vegetation community type in Precinct 5.

The activities undertaken during the clearing of Precinct 2C South and the rehabilitation of Precinct 5 involved:

- Bandicoot capture and relocation;
- Seed collection;
- Preparation and levelling of tracks;
- Relocation of soil surrounding a dead *Macarthuria keigheryi* plant (declared rare);
- Clearing and stockpiling of trees for use as brush and barricades;
- Clearing and stockpiling of other vegetative matter. A portion was mulched for later use and the remainder used for brushing;
- Windrowing of top 30 mm of topsoil (soil seed bank) from Precinct 2C South and relocation;
- Spreading of stockpiled mulch on remaining topsoil. Topsoil and mulch then windrowed to a depth of 150 mm to ensure thorough mixing. Mixture relocated to same vegetation system in Precinct 5;
- Spreading the soil seed bank over the topsoiled tracks and then deep ripping with a delta winged tine;
- Brushing and placement of large logs at the entry points to prevent further unauthorised access;
- Nomination of two tracks to self regenerate. The track in the *Melaleuca* vegetation community was also ripped and barricaded with logs, however the track in the Pericalymma community was not; and
- Conversion of a degraded open section to the north of the rehabilitation tracks into a constructed wetland.

The following maintenance activities have been undertaken in Precinct 5 since May 2005:

- May 2005 – weed control - constructed wetland;
- June 2005 – tubestock planting by Conservation Volunteers of Australia (CVA) – constructed wetland
- October 2005 – February 2006 – provenance seed recovery in anticipation of remedial works – all Precinct 5; and
- February 2006 – weed control – constructed wetland;
- June 2006 – weed control – rehabilitation tracks – grass specific and spot spraying;
- August 2006 – weed control – rehabilitation tracks – grass specific and spot spraying;
- September and October 2006 – weed control – constructed wetland;

- June 2006 – planting of 1,917 seedlings – constructed wetland;
- August 2006 – placement of large logs along constructed wetland entry;
- September 2006 – planting of 10,525 rush and sedge seedlings, and translocation of difficult to propagate species – constructed wetland;
- September 2006 – installation of motorbike deterrent fencing - constructed wetland;
- September 2006 – specific weed control - **Moraea flaccida* – BaBm (Rehab).

The following activities are scheduled in Precinct 5 between October 2006 and May 2007:

- Weed control as necessary - all Precinct 5 rehabilitation tracks, and constructed wetland; and
- April 2007 - removal of tree guards in constructed wetland.

3 MONITORING METHODOLOGY

11 monitoring transects have been established in five different vegetation systems. There is one control transect for each location and one rehabilitation transect for each area except for the constructed wetland which has two transects and one control. The vegetation systems are:

1. *Corymbia calophylla / Banksia attenuata* (CcBa);
2. *Pericalymma ellipticum* (Pe);
3. *Melaleuca preissiana / Pericalymma ellipticum* (MpPe);
4. *Banksia attenuata / Banksia menziesii* (BaBm); and
5. Wetland.

Appendix 1 contains drawings showing the general position of the rehabilitation zones and the monitoring transects.

The monitoring began in December 2004 and was conducted by ENV Australia. Tranen Revegetation Systems were then commissioned to continue the monitoring program in June 2005, and made a few modifications to the methodology.

3.1 Transect Layout

The transects were established in December 2003 shortly after the rehabilitation works were completed. The rehabilitation transects were established along the middle of the tracks, and the control plots nearby within a minimally disturbed section of the same type of existing bushland. Each transect is marked by six stakes spaced at 10m intervals (see Figure 1 below).

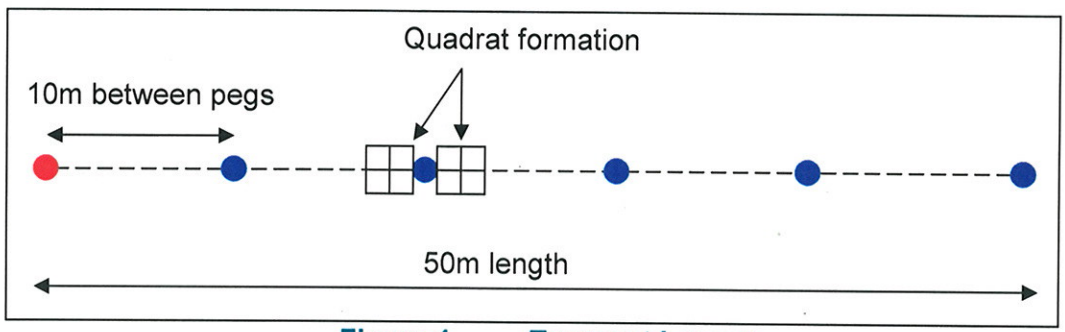


Figure 1 Transect Layout

The first marker is the location from which the photo is taken, and the remaining five stakes are where the two 2 m x 2 m quadrats are placed. The co-ordinates for the start and end point of each transect were determined using GPS and the details can be found in Appendix 2. For some tracks the transects may not be in a straight line as they have been placed on changes of direction in the track. The transects do, however, still span 50 m.

In the constructed wetland the transects are located so that they begin at the water's edge and proceeded up slope. The wetland control transect is located in Runway Swamp, located some distance away, near the end of Runway 21R.

3.2 Methodology

The monitoring program was established by ENV Australia for the first assessment in December 2004 and involves the recording of the following information for each quadrat:

- Transect and quadrat number;
- Species present;
- Number of alive and dead plants;
- Percentage cover of alive and dead plants;
- General observations of the site e.g. thick ground litter, rubbish, etc; and
- Photographic record.

The percentage cover is determined for each structural layer by assessing the amount of shade cast by each of the five main layers: grasses, herbs, sedges, shrubs, and trees. Native and introduced species are recorded separately.

For the tracks that were left to self-regenerate the state of each site is assessed and a photographic record maintained.

3.3 New Measure – Transect Representation

The total area monitored for each transect is 40 m^2 which represents a small percentage (< 1%) of the actual area covered by the rehabilitation tracks. For the information collected during the monitoring to be relevant the transects must accurately represent the condition of the remainder of rehabilitation tracks and controls.



Figure 2 MpPe Track – Transect (Left) and 100 m Further Along (Right)

Figure 2 shows the condition of the MpPe rehabilitation transect on the left, and the same track 100 m further along on the right. The difference in plant density and species richness is large. It is clear that the rehabilitation transect does not accurately represent the entire track.

To determine how accurately the transects represent the remainder of the tracks, the entire length of each track was traversed and qualitative comparisons made. The condition of each section of track was compared with the condition of each transect and given a rating between 1 and 5. Table 1 below explains the rating system.

Table 1 Track Comparison Ratings

Rating	Estimated Native Density of Track As Percentage Of Transect Density
1	50% or less
2	50 – 75%
3	75 – 125%
4	125 – 150%
5	More than 150%

As an example if a transect has a density of 10 plants / m^2 then the track would have a rating of 3 if there were estimated to be between 7.5 and 12.5 plants / m^2. Less than 5.0 plants / m^2 would have a 1 rating, 5.0 – 7.5 plants / m^2 a 2 rating, 12.5 – 15.0 plants / m^2 a 4 rating and more than 15 plants / m^2 a 5 rating.

Appendix 5 contains a drawing which identifies each section of track and provides the ratings assigned to each section. Sections 4 and 5 provide further details on the findings.

4 RESULTS

The information summarised in this section (further details and comparisons can be found in Appendix 3) is from the assessments conducted in:

- December 2004 (ENV Australia, 2004)
- June 2005 (Tranen Revegetation Systems, 2005);
- February 2006 (Tranen Revegetation Systems, 2006-1);
- May 2006 (Tranen Revegetation Systems, 2006-2)
- October 2006 (Tranen Revegetation Systems, 2006-3).

4.1 Flora

Twelve new native species and six new introduced species were recorded during this assessment. The total number of native species recorded to date is 165, and for introduced species is 48, giving a total of 213 species recorded to date. Table 2 below contains a summary. A complete list of species can be found in Appendix 4. The levels of identification of two species have also been refined since the last assessment.

Table 2 Total Number of Species Identified During Assessments

Species	Oct 06	May 06	Feb 06	Jun 05	Dec 04	Total To Date
Native	108	89	90	99	108	165
Introduced	29	18	16	23	28	48
Total	**137**	**107**	**106**	**122**	**136**	**213**

4.1.1 Declared Rare and Priority Species

No Endangered or Vulnerable species pursuant to s178 of the Environmental Protection and Biodiversity Act, 1999 have been located during the monitoring assessments.

Two taxa gazetted for the area as Declared Rare of Priority Flora pursuant to subsection 1 of Section 23F of the Wildlife Conservation Act, 1950 (Western Australian Herbarium, 2005) have been located to date during the monitoring assessments. They are:

- *Byblis gigantea* (Priority 2) – Pe (Control); and
- *Schoenus benthamii* (Priority 3) – Pe (Rehab).

During this most recent assessment *Byblis gigantea* was not recorded. Only one specimen was observed, and this was in the February 2006 assessment. *Schoenus benthamii* was previously recorded only in the Pe (Rehab) transect, however it has now also been recorded in the MpPe (Rehab) and Wetland A transects. Plant numbers in the Pe (Rehab) transect had declined from 12 to 2 by May 2006 however numbers have since increased to 18.

4.1.2 Introduced Species

Six new introduced species (?*Chamaecytisus palmensis*, **Euphorbia terracina*, **Lupinus angustifolius*, **Lythrum hyssopifolia*, **Phalaris angustata*, and **Wahlenbergia capensis*) have been discovered within the monitoring plots bringing the total observed to date to 48.

One of the species identified previously (**Moraea flaccida* – One-Leaf Cape Tulip) is listed as a Declared Plant pursuant to Part IV, Section 37 of the Agriculture and Related Resources Protection Act, 1976 (Department of Agriculture, 2005). This species was observed in the BaBm (Rehab) transect.

4.2 Species Richness

Table 3 below is a summary of the number of species found within each of the monitoring transects for the two assessments. The details of the species found in each transect are presented in Appendix 2.

Table 3 Number of Species Identified By Transect

Transect	Oct 06		May 06		Feb 06		Jun 05		Dec 04	
	N	I	N	I	N	I	N	I	N	I
CcBa (C)	37	7	26	6	32	11	38	7	34	11
CcBa (R)	32	7	24	6	22	6	25	9	30	6
Pe (C)	19	0	17	1	17	0	16	1	17	3
Pe (R)	22	4	18	3	20	5	18	4	20	13
MpPe (C)	13	0	11	0	12	0	15	1	11	2
MpPe (R)	17	8	13	5	16	5	15	10	17	8
BaBm (C)	37	0	35	7	35	1	36	5	35	4
BaBm (R)	24	6	17	6	17	2	20	7	21	6
Wetland (C)	13	6	18	6	16	5	16	5	11	9
Wetland A (R)	36	14	26	7	23	7	24	9	29	8
Wetland B (R)	17	13	8	11	8	9	7	10	14	10
Total	**108**	**29**	**86**	**18**	**89**	**16**	**96**	**24**	**107**	**26**

Note: Control transects are marked (C) and Rehabilitation transects (R)
N and I refer to Native and Introduced species respectively

4.3 Native Plant Density

A count of the number of individual native has been made during all assessments, except for the December 2004 assessment. This data is summarised in Table 4 below for comparison.

Table 4 Native Stem Counts and Density

Transect Location	Oct 06	May 06	Feb 06	Jun 05
CcBa (C)	1,653	1,732	1,402	1,065
CcBa (R)	635	131	180	275
Pe (C)	1,166	1,189	1,301	1,332
Pe (R)	997	1,142	1,303	1,255
MpPe (C)	708	738	641	677
MpPe (R)	240	284	335	374
BaBm (C)	1,280	1,114	1,252	898
BaBm (R)	1,260	60	104	175
Wetland (C)	614	675	848	1,054
Wetland A (R)	818	305	395	591
Wetland B (R)	643	415	657	53
Average (C)	**1,084**	**1,090**	**1,089**	**1,005**
Average (R)	**765**	**390**	**496**	**453**

Note: Control transects are marked (C) and Rehabilitation transects (R)

4.4 Structural Layers and Surface Cover

Tables 5 to 10 below show the average composition of the five main structural layers (grasses, herbs, sedges, shrubs, and trees) by percentage ground cover for each of the five vegetation systems. In each table the control plot (marked with a C) is shown in red, followed by the five assessments between December 2004 and October 2006 for comparison.

The figures represent the amount of shade cast by the structural layers for each quadrat. The figures may therefore total more than 100%, as the layers overlap.

Table 5 CcBa Structural Layer Composition

Layer Type	Native / Weed	CcBa (C)	CcBa (R)	CcBa (R)	CcBa (R)	CcBa (R)	CcBa (R)
Date		**Oct-06**	**Oct-06**	**May-06**	**Feb-06**	**Jun-05**	**Dec-04**
% Grass	Native	0%	0%	0%	0%	0%	1%
% Grass	Weed	0.5%	0.5%	2%	1%	1%	5%
% Herb	Native	21%	0.5%	0.25%	0.25%	1%	1%
% Herb	Weed	0.5%	0.5%	1%	0%	2%	2%
% Sedge	Native	31%	0%	0.25%	0.25%	0%	0%
% Sedge	Weed	0%	0%	0%	0%	0%	0%
% Shrub	Native	7%	1.5%	0.5%	0.25%	0%	7%
% Shrub	Weed	0%	0%	0%	0%	0%	0%
% Tree	Native	37%	1.5%	1%	0.25%	0%	3%
% Tree	Weed	0%	0%	0%	0%	0%	0%
TOTAL	**Native**	**74%**	**3%**	**2%**	**1%**	**1%**	**12%**
TOTAL	**Weed**	**1%**	**1%**	**3%**	**1%**	**2%**	**7%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

Table 6 Pe Structural Layer Composition

Layer Type	Native / Weed	Pe (C)	Pe (R)	Pe (R)	Pe (R)	Pe (R)	Pe (R)
Date		Oct-06	Oct-06	May-06	Feb-06	Jun-05	Dec-04
% Grass	Native	0%	0.5%	0%	0%	0%	2%
% Grass	Weed	0%	0.5%	1%	0.3%	0%	3%
% Herb	Native	5%	4%	1%	1%	0%	1%
% Herb	Weed	0%	0.5%	0%	0.1%	1%	3%
% Sedge	Native	60%	4%	3%	2%	1%	1%
% Sedge	Weed	0%	0%	0%	0.5%	0%	0%
% Shrub	Native	60%	27%	20%	10%	2%	7%
% Shrub	Weed	0%	0%	0%	0%	0%	0%
% Tree	Native	0%	0%	0%	0%	0%	0%
% Tree	Weed	0%	0%	0%	0%	0%	0%
TOTAL	**Native**	**77%**	**30%**	**24%**	**13%**	**3%**	**10%**
TOTAL	**Weed**	**0%**	**1%**	**1%**	**1%**	**1%**	**5%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

Table 7 MpPe Structural Layer Composition

Layer Type	Native / Weed	MpPe (C)	MpPe (R)	MpPe (R)	MpPe (R)	MpPe (R)	MpPe (R)
Date		Oct-06	Oct-06	May-06	Feb-06	Jun-05	Dec-04
% Grass	Native	0%	0.2%	0%	0.1%	0%	1%
% Grass	Weed	0%	0.5%	0.5%	0.75%	4%	3%
% Herb	Native	0%	0.2%	0.25%	0.1%	1%	1%
% Herb	Weed	0%	0.5%	0.5%	0%	3%	1%
% Sedge	Native	45%	0.1%	0.25%	0.2%	0%	0%
% Sedge	Weed	0%	0%	0%	0.25%	0%	0%
% Shrub	Native	50%	1.5%	1.5%	0.5%	0%	2%
% Shrub	Weed	0%	0%	0%	0%	0%	0%
% Tree	Native	5%	0%	0%	0.1%	0%	0%
% Tree	Weed	0%	0%	0%	0%	0%	0%
TOTAL	**Native**	**72%**	**2%**	**2%**	**1%**	**1%**	**4%**
TOTAL	**Weed**	**0%**	**1%**	**1%**	**1%**	**7%**	**4%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

Table 8 BaBm Structural Layer Composition

Layer Type	Native / Weed	BaBm (C)	BaBm (R)	BaBm (R)	BaBm (R)	BaBm (R)	BaBm (R)
Date		Oct-06	Oct-06	May-06	Feb-06	Jun-05	Dec-04
% Grass	Native	3%	0.2%	0%	0%	0%	0%
% Grass	Weed	0%	0.1%	2%	1%	3%	2%
% Herb	Native	6%	0.2%	0.2%	0.4%	0%	1%
% Herb	Weed	0.1%	0.8%	2%	0%	5%	1%
% Sedge	Native	17%	0.1%	0.4%	0.1%	0%	0%
% Sedge	Weed	0%	0%	0%	0%	0%	0%
% Shrub	Native	27%	0.8%	0.4%	0.4%	0%	2%
% Shrub	Weed	0%	0.1%	0%	0%	0%	0%
% Tree	Native	12%	0%	0%	0.1%	0%	0%
% Tree	Weed	0%	0%	0%	0%	0%	0%
TOTAL	**Native**	**38%**	**1%**	**1%**	**1%**	**1%**	**3%**
TOTAL	**Weed**	**0%**	**1%**	**4%**	**1%**	**8%**	**3%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

Table 9 Wetland A Structural Layer Composition

Layer Type	Native / Weed	Wet (C)	Wet A (R)	Wet A (R)	Wet A (R)	Wet A (R)	Wet A (R)
Date		Oct-06	Oct-06	May-06	Feb-06	Jun-05	Dec-04
% Grass	Native	0%	0.25%	0.1%	0%	0%	0%
% Grass	Weed	0.5%	0.3%	0.25%	2%	1%	2%
% Herb	Native	1%	0.75%	1%	0%	0%	1%
% Herb	Weed	0.5%	0.4%	0.75%	0%	2%	1%
% Sedge	Native	37%	4%	2%	1%	0%	1%
% Sedge	Weed	0%	0.3%	0%	3%	0%	2%
% Shrub	Native	6%	7%	4%	3%	4%	7%
% Shrub	Weed	0%	0%	0%	0%	0%	0%
% Tree	Native	8%	1%	0%	0%	0%	0%
% Tree	Weed	0%	0%	0%	0%	0%	0%
TOTAL	**Native**	**43%**	**11%**	**7%**	**4%**	**5%**	**9%**
TOTAL	**Weed**	**1%**	**1%**	**1%**	**5%**	**3%**	**4%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

Table 10 Wetland B Structural Layer Composition

Layer Type	Native / Weed	Wet (C)	Wet B (R)	Wet B (R)	Wet B (R)	Wet B (R)	Wet B (R)
Date		Oct-06	Oct-06	May-06	Feb-06	Jun-05	Dec-04
% Grass	Native	0%	0.25%	0%	0%	0%	0%
% Grass	Weed	0.5%	0.2%	1%	1%	0%	5%
% Herb	Native	1%	0.1%	0%	0%	0%	2%
% Herb	Weed	0.5%	0.4%	2%	1%	1%	2%
% Sedge	Native	37%	1.75%	0.25%	2%	0%	1%
% Sedge	Weed	0%	0.4%	1%	9%	0%	8%
% Shrub	Native	6%	0.1%	0%	0%	0%	2%
% Shrub	Weed	0%	0%	0%	0%	0%	0%
% Tree	Native	8%	2.5%	1.75%	2%	0%	0%
% Tree	Weed	0%	0%	0%	0%	0%	0%
TOTAL	**Native**	**43%**	**4%**	**2%**	**4%**	**0%**	**5%**
TOTAL	**Weed**	**1%**	**1%**	**4%**	**11%**	**1%**	**15%**

Note: Control transects are marked (C) and Rehabilitation transects (R)

4.5 Average and Maximum Plant Heights

The maximum and average plant heights recorded across each transect are shown in Table 11. A record was made of the average height for each quadrat and this figure has been averaged across the transect.

Table 11 Average and Maximum Plant Heights

Transect Location	Oct 06		May 06		Feb 06	
	Ave. (m)	Max. (m)	Ave. (m)	Max. (m)	Ave. (m)	Max. (m)
CcBa (C)	0.5	10	0.2	10.0		
CcBa (R)	0.3	0.4	0.2	0.5	0.2	
Pe (C)	0.8	1.2	1.0	1.5		
Pe (R)	0.4	1.0	0.4	1.0	0.3	0.5
MpPe (C)	1.2	5.0	1.2	5.0		
MpPe (R)	0.2	0.4	0.2	0.4	0.2	
BaBm (C)	1.2	5.0	0.4	5.0		
BaBm (R)	0.2	0.4	0.1	0.2	0.2	
Wetland (C)	1.1	1.2	1.1	1.2		
Wetland A (R)	0.3	2.0	0.2	1.2	0.2	0.5
Wetland B (R)	0.3	1.0	0.1	0.8	0.2	0.5

4.6 Transect Representation of Tracks

As can be seen in Table 12 the actual length of track represented by the transects is 25%. Approximately 34% of the tracks are in better condition than the transects, and 41% are in poorer condition. As the number of plants in each transect varies, these figures must be compared on a track by track basis. For example 64% of the Pe track is in poorer condition than the transect, however the transect is in excellent condition, and these sections of track are considered to be in good condition.

Table 12 Transect Representation of Entire Track

Track	Approx Length (m)	Track Length (m) by Rating					Percentage Of Track by Rating				
		1	2	3	4	5	1	2	3	4	5
CcBa	300		50	190	60		0%	17%	63%	20%	0%
Pe	1,030	130	660	240			13%	64%	23%	0%	0%
MpPe	930		180	130	100	520	0%	19%	14%	11%	56%
BaBm	330		50	80	150	50	0%	15%	24%	45%	15%
TOTAL	**2,590**	**160**	**910**	**640**	**310**	**570**	**6%**	**35%**	**25%**	**12%**	**22%**

4.7 Self-Regenerating Tracks

The first track, located within a *Banksia littoralis / Melaleuca rhaphiophylla* vegetation community has shown little natural recruitment. Native seedlings were observed but only in small clusters within low lying depressions. The track was infested with annual weeds in June 2005, but late rains resulted in the area being flooded which has drowned many of the weeds and reduced the level of infestation. Natural recruitment is evident especially in the eastern part of the track with various sedges and *Banksia littoralis* seedlings observed.

The track through the *Pericalymma* heath has good native recruitment with reasonable species richness and plant numbers, and the growth rates are greater than in some of the transects. Weed levels are minimal and do not appear to be having any negative effects.

5 DISCUSSION

5.1 General

The species richness has increased by twelve native species and six introduced species. Also, two species previously identified only to genus level have now been identified to species level. More native species were recorded during this assessment than in May 2006, mostly due to the presence of annual species, and the recording of the new species.

The use of topsoil at this stage has proven to be successful with respect to species richness. A direct seeding or seedling planting approach would not have provided the number of species that have been recorded to date, due to some of the species being difficult to harvest for seed, or to propagate.

Site-wide there has been an increasing trend in stem counts and plant density in the rehabilitation transects, mostly due to the presence of large numbers of annual species. There has been a slight drop in plant numbers in two of the rehabilitation transects (Pe and MpPe). In the Pe transect the plant numbers are high and plant development is good. The numbers in the MpPe transect are relatively low, but remedial works are planned for this area in winter 2007.

Seedling development has progressed in most rehabilitation areas since May 2006. All of the rehabilitation transects have shown an increase in average plant height or percentage ground cover since May 2006. Although the MpPe transect did not show any average improvement, as there was a drop in plant numbers between assessments, the only way the percentage ground cover could have remained static is through increases in development of surviving plants.

The biggest factor influencing plant height and foliage development (and probably also plant density) is predation by rabbits. In every transect (control as well as rehabilitation) there was evidence of rabbit damage including scratchings, droppings, and bite marks on plants. Previously the most affected transect was Wetland B, however a rabbit proof fence was installed around the most affected section and this has allowed the recovery of the predated seedlings.

Another factor believed to be influencing plant numbers is Dieback. Whilst it has had no apparent effect in the rehabilitation transects, it appears to have had an effect around the BaBm control transect. A mature *Banksia* tree located along the transect (but not within the monitoring quadrats) has recently fallen over due to basal rot, and the understorey is also quite degraded. Both of these observations are typical of Dieback infection. Fortunately at this stage the affected area does not extend very far past the transect.

Weed cover percentage across all transects is less than 1% due to the autumn and spring weed control programs. Weed control will continue as necessary to ensure weed levels are maintained at this minimal level. Six new weed species were identified since the last assessment. **Euphorbia terracina* was recorded in the BaBm rehabilitation transect. This species is the most potentially invasive of the new species. This species has been targeted in weed control operations in specific sections of Precinct 5, and this should now extend throughout the remainder of the Precinct to prevent further spread.

There has been no evidence of vehicle access to the constructed wetland since the last assessment due to the installation of logs and fences within the wetland, and a crackdown on motorcycle activity within airport lands. This has prevented disturbance of the newly planted seedling and has allowed for excellent survival and development rates.

5.2 *Corymbia calophylla* / *Banksia attenuata* Tracks



Figure 3 CcBa Rehabilitation Transect Photos October and May 2006

The CcBa rehabilitation transect has been unintentionally impacted upon by a revegetation trial conducted by Kings Park. The last metre of the transect now has rabbit proof fence laid over it. Whilst the plants there are still alive, it was decided that this section would be omitted from this and future assessments as the fence would impact upon the plant growth and development, and would therefore influence the outcome. The actual area monitored has reduced 5% from 40 m^2 to 38 m^2.

This rehabilitation area has had a large increase in plant density (from 3.3 to 16.7 plants / m^2). This is mostly due to the presence of annual species. The perennial plant density is actually 5.6 plants / m^2 which is an increase of 60%. The dominant annual species is *Trachymene pilosa* representing 395 (62%) of the total 635 stems counted.

Native species representation has increased from 24 to 32 species. Two new species were recorded; *Drosera ? stolonifera* in the control transect and *Austrostipa macalpinei* in the rehabilitation transect. Another species previously observed but not identified (*Macarthuria australis*) has now identified to species level due to the presence of flowers. The dominant perennial native species are *Stylidium dichotomum*, *Banksia menziesii*, *Corymbia calophylla*, and *Gompholobium tomentosum*.

Native ground cover has increased to 3%, due to significant growth of the *Banksias* and *Eucalypts*. Even though there is a high number of annual species this has not had a significant effect on the total ground cover.

Weed cover has reduced back to 1% due to the weed control effeort. **Ehrharta calycina* (Veldt Grass) is no longer the most dominant weed due to effective herbicide control. The annual weeds **Hypochaeris glabra*, and **Ursinia anthemoides* are now the most abundant weeds, but these are not considered to be as great a threat as the Veldt Grass. The declared weed **Moraea flaccida* (One-Leaf Cape

Tulip) was recorded in the control transect in June 2005 and May 2006, but was not observed during this assessment. It was specifically targeted during the spring spraying program, and this appears to have been effective.

The CcBa tracks are approximately 300 m long and represent 12% of all the tracks. Table 11 shows 63% of the track being represented by the quadrat, 20% being in better condition and 17% in poorer condition. The current condition of the transect is the recommended minimum acceptable standard for these sections of the track. Remedial action should be considered for the 17% of track that is in poorer condition.

5.3 *Pericalymma ellipticum* Tracks

The *Pericalymma* rehabilitation transect has shown the greatest progress of all the tracks. Plant numbers have again reduced slightly but are still very good with an average density of 24.9 plants / m^2. The majority of the seedlings in the rehabilitation tracks are located within the riplines as can be seen in Figure 4.

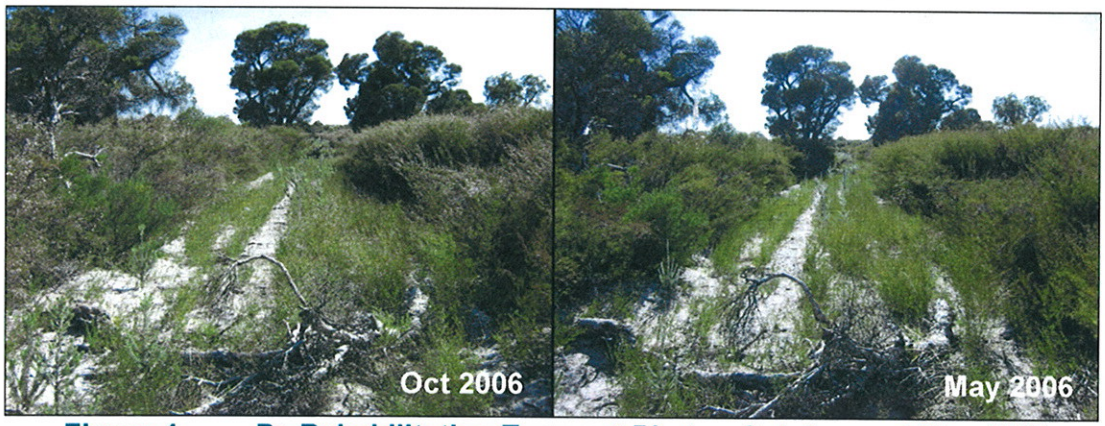


Figure 4 Pe Rehabilitation Transect Photos October and May 2006

A total of 22 species were recorded within the quadrats, which is four more than in May. The dominant native species are *Pericalymma ellipticum*, *Verticordia densiflora subsp densiflora*, and *Euchilopis linearis*. Three new native species (*Austrodanthonia ? setacea, Austrostipa macalpinei, and Schoenus efoliatus*) not previously observed for any of the transects, were recorded during this assessment.

Plant development is excellent with an increase in foliage cover of 6% to 30% in the past five months. The average plant height is the greatest of all the rehabilitation transects at 400 mm, with the tallest plant reaching 1 m.

Weed cover is very low at less than 1%. **Eragrostis curvula* (Lovegrass) has been eradicated from within the transects, and only small numbers of **Ehrharta calycina* remain. The natives should soon outcompete the remaining weeds.

Two Priority Flora have been noted in the transects previously. *Byblis gigantea* was originally found in the control transect but was not observed during this assessment. *Schoenus benthamii* is still present in the rehabilitation transect. Numbers declined between the February 2006 and May 2006 assessments, but they have now recovered, and there are 16 more plants within the quadrats than in May 2006. The population continues along most of the surrounding track too.

The Pe rehabilitation track has a length of 1,030 m which is the greatest representation of any of the vegetation systems. Approximately 23% of the track is in similar condition to the transect, just under two-thirds has 50-75% of the plant density, and 13% has less than 50% of the density. In this case 50% of the transect plant density still equates to 14 plants/m^2 which is very good for this stage of development. The one track that had less than 50% of the plant density had very few plants at all, which is uncharacteristic for this vegetation system. It appears that this track may be maintained as a strategic firebreak, as no brushing has been observed.

5.4 *Melaleuca preissiana / Pericalymma ellipticum* Tracks

This rehabilitation track has high levels of brush material covering approximately 40% of the transect area which has reduced the space in which plants can establish. This brush is slowly decomposing but it will still be several years until the majority has broken down. The average of 6.0 plants / m^2 is down slightly from the last assessment (was 7.1 plants / m^2). The majority of these seedlings are found in the bare sections devoid of brush and in these patches the density is approaching that of the control.



Figure 5 MpPe Control and Rehabilitation Transect Photos

Native cover has increased to 2%, which shows little plant development since the last assessment, although this is not evident in Figure 5. The number of native species represented has increased from 13 to 17 since May and one of these (*Austrostipa macalpinei*) has not previously been recorded in any of the transects. The dominant native species are *Pericalymma ellipticum*, *Verticordia densiflora subsp densiflora*, and *Patersonia occidentalis*.

Weed cover reduced back to 1% due to the weed control program. **Ehrharta calycina* (Veldt Grass) remains the most abundant species, but it is easy to control with selective herbicides.

The MpPe tracks have an approximate length of 930 m, representing 35% of the total track length. Of this length only 14% represents the conditions found in the monitoring transect. 11% of the tracks have an estimated 125% to 150% of the plant density of the transect but more than half of the track length (56%) has a plant density greater than 150% of the transect. 19% of the track is in poorer condition

with 50% to 75% of the plant numbers. This section of the track may require some remedial action.

5.5 *Banksia attenuata / Banksia menziesii* Tracks



Figure 6 BaBm Rehabilitation Transect Photos October and May 2006

There has been a 2000% increase in the number of native plants in the BaBm rehabilitation transect since May 2006. This track had the lowest plant density of all the tracks in May, with 1.5 seedlings / m^2, but this has now increased to 31.3 plants / m^2. The majority of these are annual species. The perennial plant density in the transect has increased over 500% with the germination of 337 *Austrostipa macalpinei* seedlings.

Of the 24 species recorded, three have not been recorded in any of the previous assessments in any transect. They are *Austrostipa macalpinei*, *Levenhookia spitata*, and *Wahlenbergia gracilienta*. The dominant annual species are *Trachymene pilosa*, *Siloxerus humifusus*, and *Podotheca angustifolia*. The dominant perennial species are *Austrostipa macalpinei*, *Gompholobium tomentosum*, and *Conostylis setosa*.

Native foliage cover has not changed since May (still 1%), however, the average plant height has increased from 100 mm to 200 mm. The majority of the annual seedlings are small and have little effect on the total ground cover.

Weed coverage levels have reduced from 4% to 1% due to the weed control program. The declared weed **Moraea flaccida* (One-leaf Cape Tulip) located in the control transect was specifically targeted in a spot-spraying operation in early spring, and only one specimen was recorded. This species will be specifically targeted again in spring 2007.

The BaBm tracks have a total length of approximately 330 m. Of this 24% of the track is in similar condition to the transect, 45% has up to 150% of the plant density and 15% has more than 150%. Approximately 15% of the track is in poorer condition than the transect. Current conditions in the transect are below recommended levels and there has been a declining trend through the last three assessments. It is recommended that remedial action be undertaken in the parts of this track that are at or below the transect density.

5.6 Constructed Wetland

Vehicle access to the constructed wetland has been made more difficult since the last assessment and as a result there has been no visible access to the area. Logs have now been placed in the main unauthorised access route and random fences have been installed throughout the wetland basin. There have also been regular sweeps of the area by police and WAC to further deter unauthorised access.

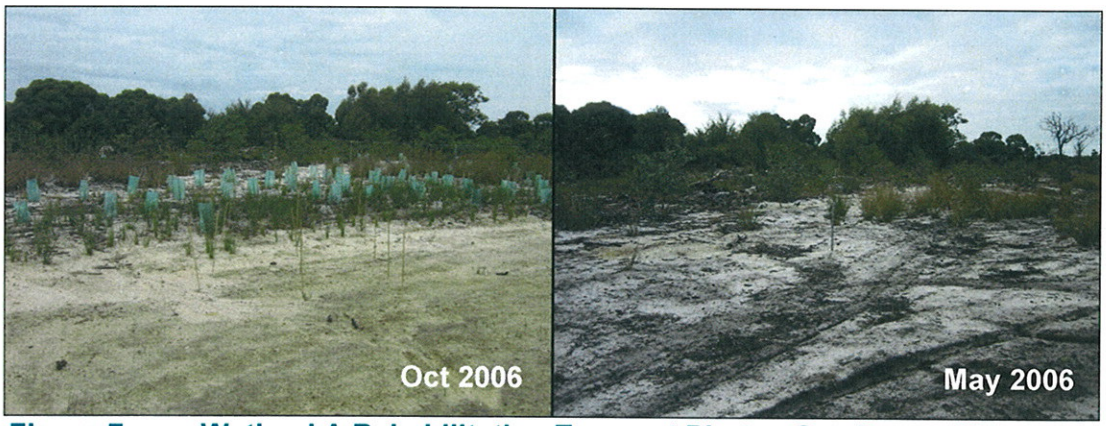


Figure 7 Wetland A Rehabilitation Transect Photos October and May 2006

Wetland A has seen a 170% increase in the number of native plants through seedling planting and natural recruitment. The average density has increased from 7.6 stems/m^2 to 20.4 stems/m^2 over all ten quadrats. The four quadrats located within the basin now have native representation due to planting, natural germination and a reduction in vehicle activity.

The number of native species recorded has increased by ten to 36. Four species (*Austrostipa macalpinei, Calandrinia granulifera, Centrolepis polygygna,* and *Persicaria decipiens*) not previously recorded in any transect were observed in the transect. The drier sections of the transect are currently dominated by *Hypocalymma angustifolium*, *Hypolaena exsulca*, and *Gompholobium tomentosum*. The wetter sections are dominated by *Juncus pallidus* as this was the main sedge planted in 2006.

Plant development is progressing well, with total native foliage cover in Wetland A increasing from 7% to 11%. The average plant height is now 300 mm, and the tallest plant is now over 2 m tall.



Figure 8 Wetland A Rehabilitation Transect Photos October and May 2006

Wetland B now has a native density of 16.1 stems/m^2, an increase of 55% since May. The increase is due equally to the seedling planting, and the presence of annual species. Vermin proof fencing was installed around the *Melaleuca rhaphiophylla* seedlings that appeared to have been predated prior to the last assessment. The affected seedlings appear to have quickly recovered, and have shown excellent growth rates since May with some plants now 600 mm tall.

With the added protection *Melaleuca rhaphiophylla* still dominates the species representation. The next most abundant perennial native species are *Juncus pallidus* and *Schoenus curvifolius*. A total of 17 species were recorded in Wetland B, an increase of nine. Two of these (*Austrostipa macalpinei*, and *Bolboschoenus caldwellii*) were not previously recorded in any transect. The *Bolboschoenus* was planted in 2006, but the *Austrostipa* has naturally recruited.

Weed cover has again reduced through spraying, and the average weed cover in both Wetland A and Wetland B is less than 1%. One new weed species was recorded in Wetland A (**Lupinus angustifolia*), and two in Wetland B (**Lythrum hyssopifolia*, and **Phalaris angustata*). The dominant species are **Annagallis arvensis var arvensis*, **Isolepis marginata*, and **Avena barbata*.

Overall the constructed wetland is progressing well due to the weed control, additional planting, and the control measures for unauthorised vehicles.

One observation of interest in the monitoring of the Wetland Control transect was the presence of eggs within one of the monitoring quadrats (see Figure 9 below). Due to the burrow, it is believed that these may be tortoise eggs (not confirmed by a zoologist). All appear to have hatched or been predated as the shells are no longer intact.



Figure 9 Eggs Found in Wetland Control Transect

5.7 Self-Regenerating Tracks

The *Banksia littoralis* / *Melaleuca rhaphiophylla* track is recovering from the flooding that drowned both native species and weeds over the past spring. Substantial natural recruitment has been observed along the start and edges of the track with good numbers of *Banksia littoralis* seedlings found within close proximity to an

established tree. Weed recruitment has been low, and the area is scheduled for ongoing weed control.

The track through the *Pericalymma* heath has good native recruitment with reasonable species richness and plant numbers, and the growth rates are greater than in some of the transects. Weed levels are minimal and do not appear to be having any negative effects.

6 CONCLUSIONS

For this stage of development the rehabilitation of the majority of the tracks is progressing towards a successful outcome:

- Native plant densities have increased in some transects (especially those that were previously low), but have decreased slightly in some;
- Plant development and foliage cover has remained the same or increased in all locations;
- Average plant heights have increased in most areas;
- Twenty two more native species were recorded than in May 2006;
- Twelve new native species were recorded, bringing the total to date to 165; and
- Weed cover was 1% or less across all transects.

The weed management program has had a significant impact on weed levels since the last assessment. Autumn and spring herbicide applications are scheduled for the next 12 months throughout Precinct 5 on an as needed basis.

Plant densities and species richness are at relatively low levels in the following rehabilitation tracks:

- *Corymbia calophylla* / *Banksia attenuata* (CcBa) - 17% of total length;
- *Melaleuca preissiana* / *Pericalymma ellipticum* (MpPe) – 19% of total length;
- *Banksia attenuata* / *Banksia menziesii* (BaBm) rehabilitation track - 39% of total length; and

Overall this represents 14% of the total rehabilitation track length. Remedial works (seedling planting and direct seeding) are scheduled in 2007 for these areas that have not progressed at a satisfactory level.

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Western Australian Herbarium, 2005 - 06 – Florabase – http://florabase.calm.wa.gov.au/.

Appendix 1 Transect Location Maps



FIGURE 1 - Site Location		
CLIENT: Westralia Airports Corporation		
DRAWN BY: LS	CHECKED BY: NW	JOB NUMBER: 04.128
DATE: 19/1/2005	REPORT ISSUE: Final	SCALE: NTS

env Australia

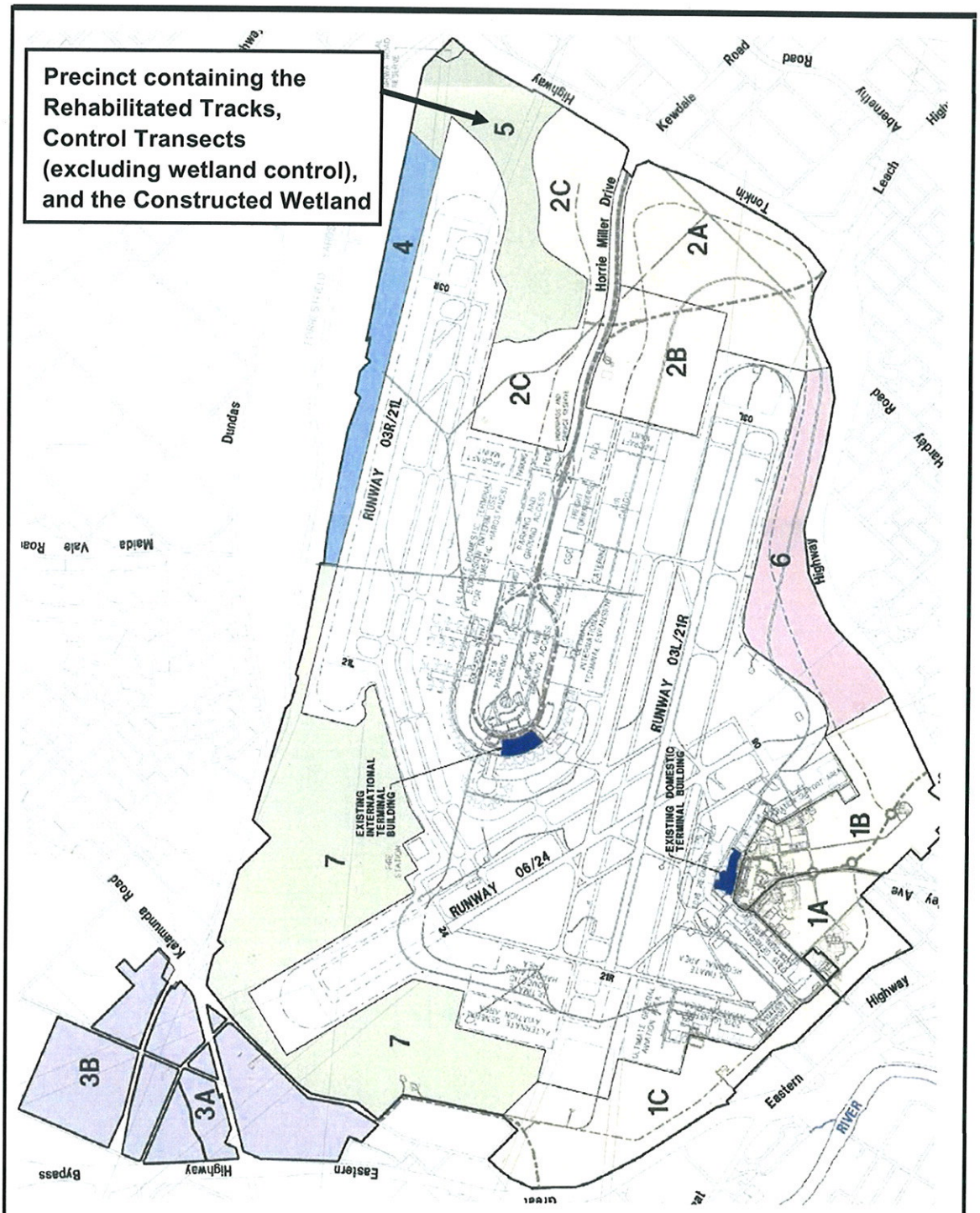
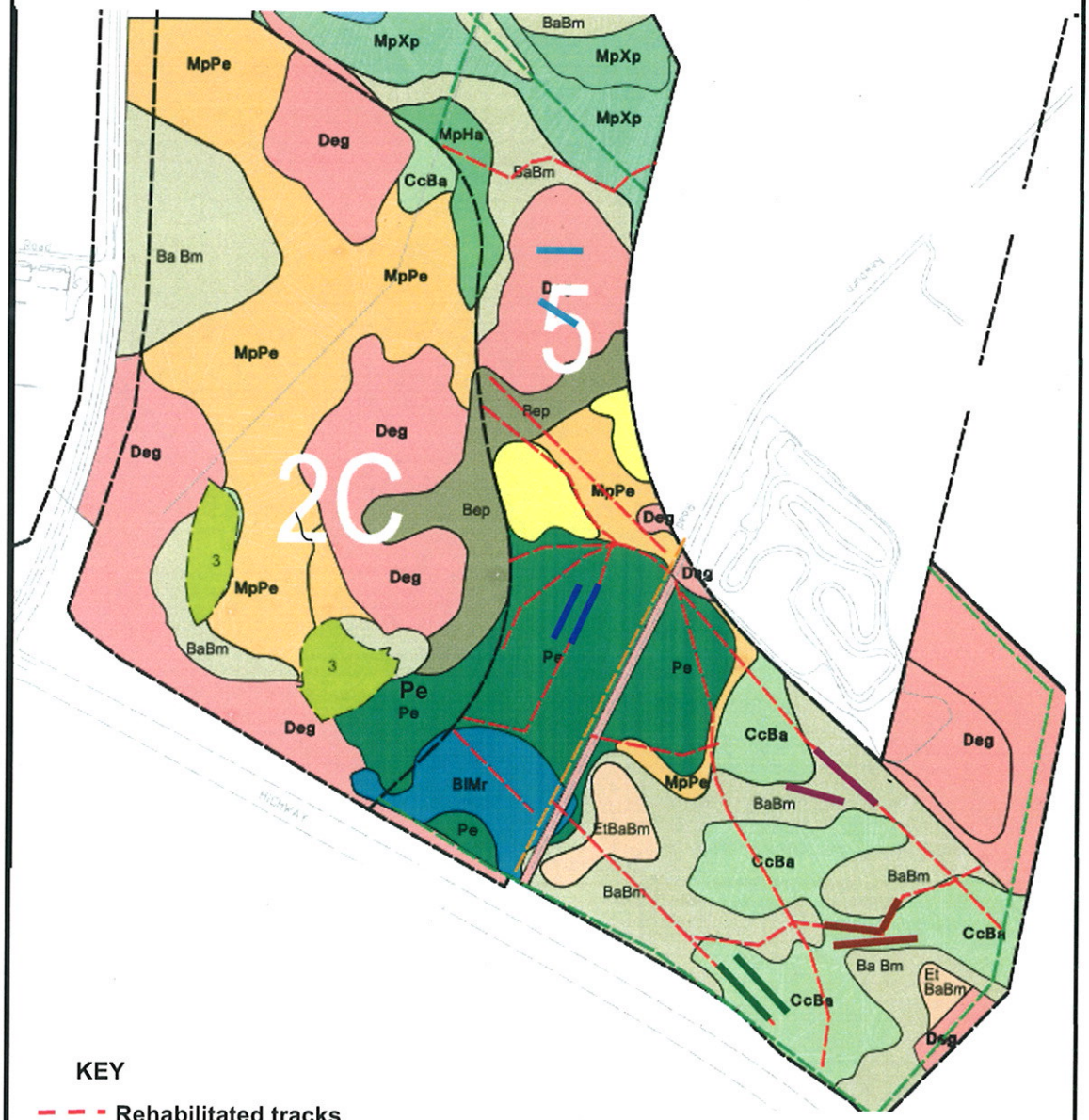


FIGURE 2 – Perth Airport Precincts		
CLIENT: Westralia Airports Corporation		
DRAWN BY: NW	CHECKED BY: KL	JOB NUMBER: 04.128
DATE:10/1/2005	REPORT ISSUE: FINAL	SCALE: NTS

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KEY

Rehabilitated tracks

Rehab and control transects

Rehabilitation monitoring transects for constructed wetland

FIGURE 3: Location of rehabilitation and control transects

CLIENT: Westralia Airports Corporation

DRAWN BY: NW	CHECKED BY: KL	JOB NUMBER: 04.128
DATE: 10/1/05	REPORT ISSUE: Final	Insert generated by GJC @ WAC

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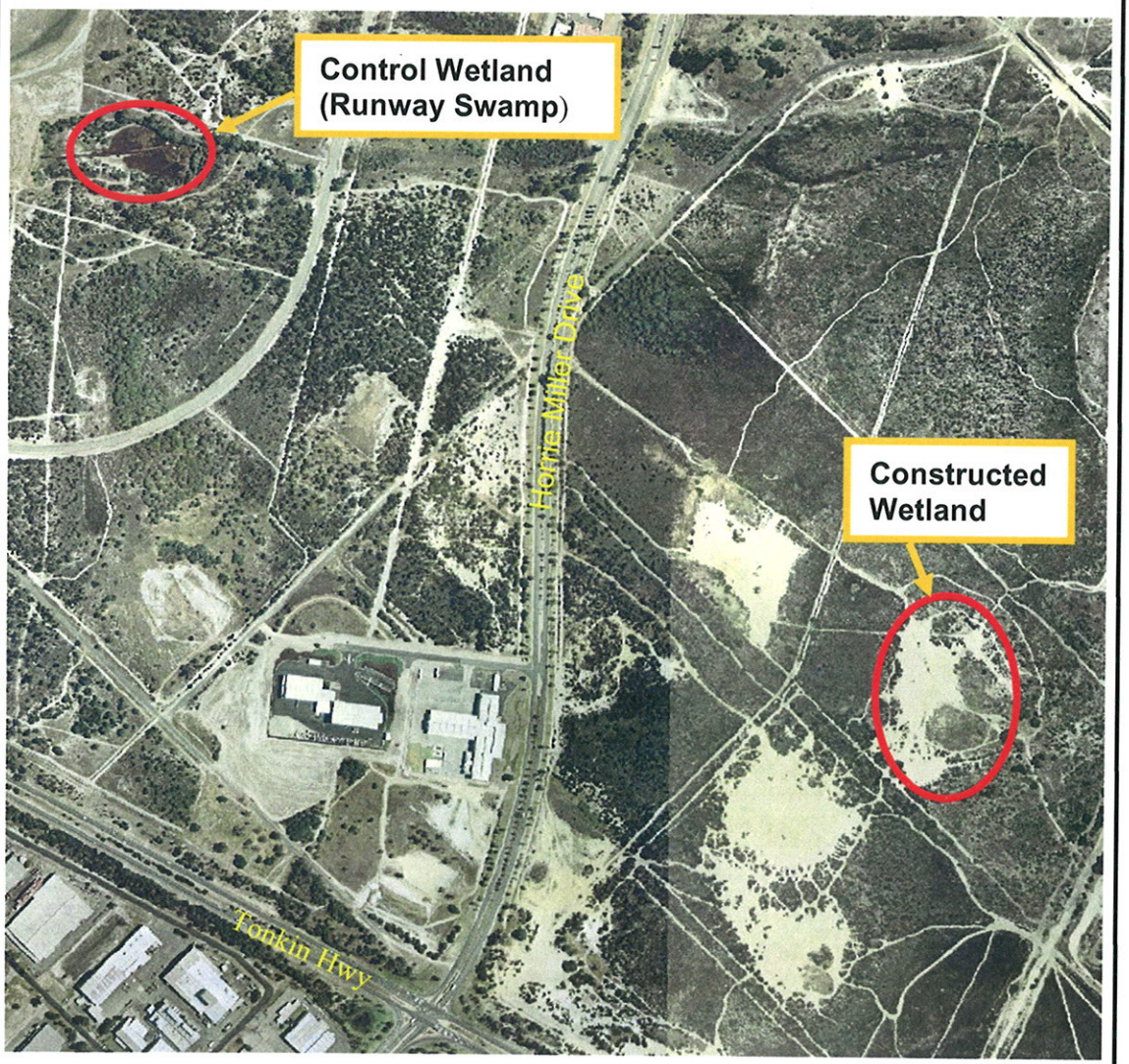


FIGURE 4 – Location of Control and Constructed Wetlands		
CLIENT: Westralia Airports Corporation		
DRAWN BY: NW	CHECKED BY: SB	JOB NUMBER: 04.128
DATE:10/1/05	REPORT ISSUE: Final	SCALE: NTS

env Australia



Key

Rehabilitated Tracks

Tracks that will regenerate themselves

FIGURE 5: Location of tracks that were nominated to regenerate themselves

CLIENT: Westralia Airports Corporation

DRAWN BY: NW	CHECKED BY: KL	JOB NUMBER: 04.128
DATE: 10/1/05	REPORT ISSUE: Final	Insert generated by GJC @ WAC

env Australia

Appendix 2 Transect Location and Orientation Details

Transect Location and Orientation Details (ENV Australia, 2004)

Transect	Flagging Colour	Direction from Start	Start Easting *	Start Northing	Finish Easting *	Finish Northing
CcBa (R)	Orange / Yellow	NW	403354 E	6461471 N	403325 E	4641500 N
CcBa (C)	Orange / Yellow	S	403394 E	6461535 N	403387 E	6461573 N
MpPe (R)	Orange / Yellow	E	403443 E	6461576 N	403499 E	6461573 N
MpPe (C)	Orange / Yellow	SE	403470 E	6461566 N	403513 E	6461552 N
BaBm (R)	Orange / Yellow	NW	403508 E	6461734 N	403479 E	6461772 N
BaBm (C)	Orange / Yellow	NW	403446 E	6461749 N	403425 E	6461790 N
Pe (R)	Orange / Yellow	NE	403045 E	6461868 N	403071 E	6461913 N
Pe (C)	Orange / Pink	NE	403116 E	6462054 N	403094 E	6462017 N
Wetland (C)	Orange / Yellow	SE	401829 E	6463201 N	401785 E	6463185 N
Wetland A (R)	Orange / Yellow	SE	403056 E	6462477 N	403082 E	6462450 N
Wetland B (R)	Orange / Yellow	SE	403050 E	6462400 N	403079 E	6462383 N

- Note: All co-ordinates for Area 50 (GDA94)

Appendix 3 Transect Summaries

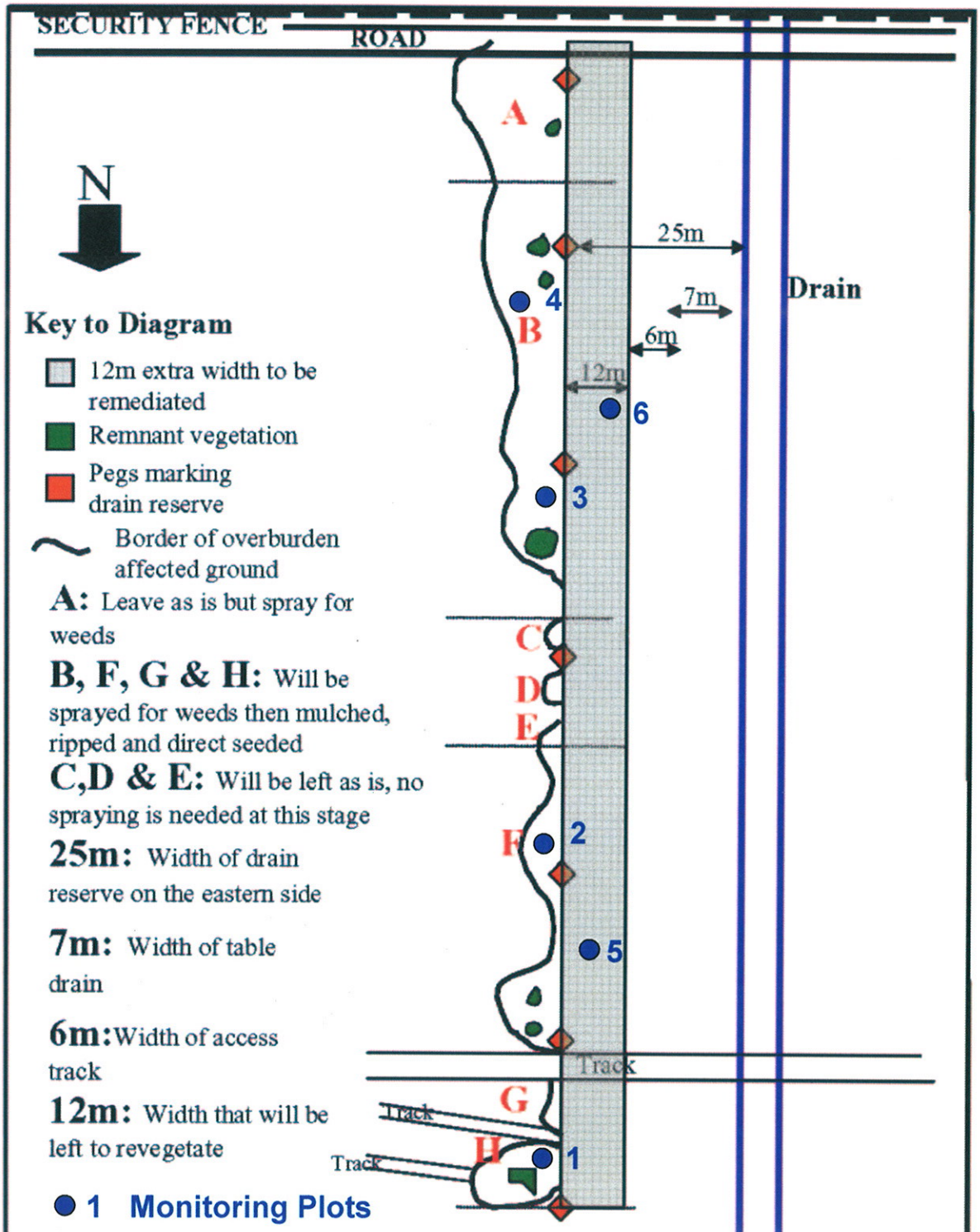
tranen
revegetation systems

Precinct 5 Monitoing
Native Monitoring

Quadrat: CcBa Control

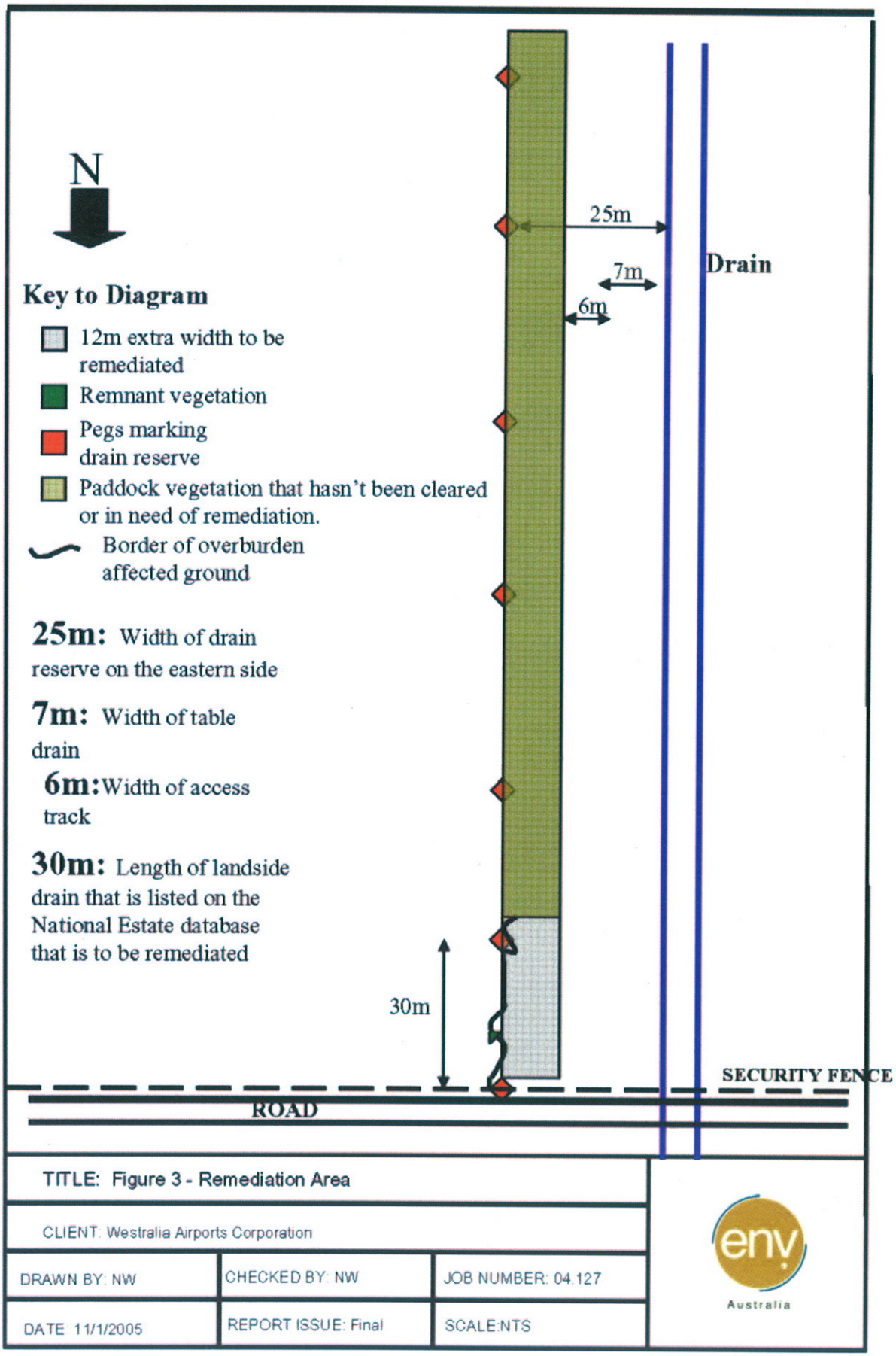
Native Species	Total	Weed Species	Score
Acacia applanata	5	*Anagallis arvensis	3
Acacia huegeliii	1	*Anagallis arvensis var arvensis	2
Acacia pulchella	2	*Briza maxima	3
Alexgeorga nitens	421	*Ehrharta calycina	44
Allocasuarina fraseriana	1	*Eragrostis curvula	3
Bossiaea eriocarpa	23	*Hypochaeris glabra	9
Burchardia umbellata	4	*Ursinsia anthemoides	30
Calytrix flavescens	7		
Conostylis juncea	8		
Corymbia calophylla	3		
Dampiera linearis	61		
Dasypogon bromelifolius	64		
Desmocladus fasciculatus	22		
Desmocladus flexuosus	424		
Drosera ? stolonifera	26		
Gompholobium tomentosum	3		
Hovea trisperma	8		
Hypocalymma angustifolium	1		
Hypolaena exculsa	13		
Jacksonia floribunda	18		
Laxmannia ramosa	22		
Lomandra hermaphrodita	1		
Lomandra nigricans	7		
Lyginia barbata / imberbis	333		
Melaleuca seriata	1		
Patersonia occidentalis	15		
Phelbocarya ciliata	1		
Philotheca spicata	16		
Phlebocarya ciliata	30		
Scholtzia involucrata	6		
Siloxerus humifusus	2		
Stylidium repens	26		
Trachymene pilosa	44		
Tricoryne elatior	25		
Wahlenbergia preissii	1		
Xanthorrhoea brunonis	2		
Xanthorrhoea preissii	6		

Native Species		**Introduced Species**
Total Natives	1653	
Total Species	37	7
Native Cover %	74%	1%
Maximum Plant Height	10.0	
Average Plant Height	0.5	
Dominant Native Species		**Dominant Introduced Species**
Desmocladus flexuosus	1	**Erharta calycina*
Alexgeorga nitens	2	**Ursinsia anthemoides*
Lyginia barbata / imberbis	3	**Hypochaeris glabra*
Structural Layer Composition		
Native		**Introduced**
31%	Sedge	0%
0%	Grass	0.5%
21%	GC / Herb	0.5%
7%	Shrub	0%
37%	Tree	0%
Site Description	Very good native cover with few weeds. Evidence of rabbit scratchings.	



TITLE: Figure 2 - Remediation Area		
CLIENT: Westralia Airports Corporation		
DRAWN BY: NW	CHECKED BY: NW	JOB NUMBER: 04.127
DATE: 11/1/2005	REPORT ISSUE: Final	SCALE:NTS

env Australia


N
25m
7m
6m
Drain
Key to Diagram
12m extra width to be remediated
Remnant vegetation
Pegs marking drain reserve
Paddock vegetation that hasn't been cleared or in need of remediation.
Border of overburden affected ground
25m: Width of drain reserve on the eastern side
7m: Width of table drain
6m: Width of access track
30m: Length of landside drain that is listed on the National Estate database that is to be remediated
30m
SECURITY FENCE
ROAD
TITLE: Figure 3 - Remediation Area
CLIENT: Westralia Airports Corporation
DRAWN BY: NW
CHECKED BY: NW
JOB NUMBER: 04.127
DATE: 11/1/2005
REPORT ISSUE: Final
SCALE:NTS
env Australia

Appendix 3 Monitoring Results

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Poison Gully
Native Monitoring Summary

SPECIES	PLOT 1	PLOT 2	PLOT 3	PLOT 4	PLOT 5	PLOT 6	TOTAL	TOTAL MAY 06	TOTAL FEB 06	TOTAL MAY 05
Acacia applanata	2						2	1	2	1
Acacia saligna				1			1	1	2	
Adenanthos cygnorum		2		2			4	4	4	3
Alexgeorgia nitens							0			
Allocasuarina fraseriana							0	1		
Allocasuarina humilis	49						49	33	36	45
Astartea scoparia				40			40	34	45	
Banksia attenuata							0	1		
Banksia telmatiaea		3	2		5		10	11	12	6
Bolboschoenus caldwellii							0			
Bossiaea eriocarpa							0			
Burchardia umbellata							0			
Conostylis aculeata		3	3	2			8	3	4	2
Conostylis juncea	2						2	8		
Conostylis sp.							0		8	6
Coymbia calophylla	4					1	5	4	6	
Cyathochaeta avenacea	7		1	2			10	4		
Cyperus sp.							0			2
Dampiera alata							0			
Dasypogon bromelifolius							0			
Desmocladus fasciculatus	1						1			3
Desmocladus flexuosus							0			
Drosera nitidula							0	5	8	
Drosera sp.			4				4			
Dryandra lindleyana							0			
Dryandra nivea							0			
Eutaxia virgata				2			2	1		
Gastrolobium sp				1			1	1	1	
Gompholobium marginatum	3						3			
Gompholobium tomentosum				1			1	1	1	
Haemodorum laxum							0		1	
Haemodorum sp.	2						2			
Hakea prostrata							0		2	1
Hakea varia							0			
Hardenbergia comptoniana							0			
Hypolaena exsulca			3	2			5	3	1	
Jacksonia furcellata							0		3	1
Jacksonia sternbergiana	5		1	3			9	8	8	6
Kennedia prostrata							0			
Lepidosperma pubisquameum	2			2			4	4	3	2
Lomandra sp.			1				1			
Lyginia barbata / imberbis							0	5	11	3
Meeboldina cana			2				2			
Melaleuca laterita					3		3			
Melaleuca seriata							0	3		
Mesomolaena tetragona							0			
Patersonia occidentalis				2			2	1	1	1
Pericalymma ellipticum var floridum	4	6	4	23		2	39	35	60	54
Petrophile linearis							0		1	
Pterostylis sanguinea							0	3		
Schoenus curvifolius	10	4			1		15	2	1	
Siloxerus humifusus			3				3	5		8
Stirlingia latifolia							0			
Stylidium sp.			1				1			
Thysanotus sparteus							0	2	1	
Verticordia ? lindleyi subsp lindelyi			96				96	6	10	
Verticordia densiflora var densiflora		1	4	64	2		71	267	355	164
Waitzia suaveolens				2			2			
Xanthorrhoea brunonis	17						17	14	16	9
Xanthorrhoea preissii							0			15
TOTAL STEM COUNT OCT 06	**108**	**19**	**125**	**149**	**11**	**3**	**415**			
TOTAL STEM COUNT MAY 06	69	22	162	199	11	8		471		
TOTAL STEM COUNT FEB 06:	74	29	180	294	8	18			603	
TOTAL STEM COUNT JUN 05:	89	22	136	84	-	-				331
AVERAGE DENSITY (Plants/m2) OCT 06	**4.3**	**0.8**	**5.0**	**6.0**	**0.4**	**0.1**	**2.8**			
AVERAGE DENSITY (Plants/m2) MAY 06	2.8	0.9	6.5	8.0	0.4	0.3		3.2		
AVERAGE DENSITY FEB 06	3.0	1.2	7.2	11.8	0.3	0.7	24.1		7.5	
AVERAGE DENSITY JUN 05	3.6	0.9	5.4	3.4	-	-				3.3
NATIVE COVER PERCENTAGE OCT 06	**5%**	**7%**	**6%**	**13%**	**0%**	**0%**	**5%**			
NATIVE COVER PERCENTAGE MAY 06	3%	4%	5%	13%	0%	0%		4%		
NATIVE COVER FEB 06	2%	1%	2%	10%	0%	0%			3%	
AVERAGE PLANT HEIGHT (m) OCT 06	**0.2**	**0.4**	**0.3**	**0.4**	**0.1**	**0.1**	**0.2**			
AVERAGE PLANT HEIGHT (m) MAY 06	0.1	0.4	0.3	0.4	0.1	0.1		0.2		
AVERAGE PLANT HEIGHT (m) FEB 06	-	-	-	-	-	-			0.2	
TALLEST PLANT (m) OCT 06	**1**	**0.8**	**0.6**	**1.5**	**0.1**	**0.1**	**1.5**			
TALLEST PLANT (m) MAY 06	1.0	0.8	0.5	1.2	0.2	0.2		1.2		
TALLEST PLANT (m) FEB 06	-	-	-	-	-	-			0.8	
NUMBER OF NATIVE SPECIES IN PLOTS OCT 06	**13**	**6**	**13**	**15**	**4**	**2**	**30**			
NUMBER OF NATIVE SPECIES IN PLOTS MAY 06	12	7	12	16	6	4		30		
NUMBER OF NATIVE SPECIES IN PLOTS FEB 06	12	8	9	15	5	4			27	
NUMBER OF NATIVE SPECIES IN PLOTS JUN 05	10	6	7	6	-	-				19
TOTAL NATIVE SPECIES							**60**	56	52	46

Note: Species in bold red are new species that have not been recorded during previous assessments

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Poison Gully
Introduced Species Monitoring Summary

Taxa	PLOT 1 *	PLOT 2 *	PLOT 3 *	PLOT 4 *	PLOT 5 *	PLOT 6 *	OBSERVED OCT 06	OBSERVED MAY 06	OBSERVED FEB 06	OBSERVED MAY 05
* Aira caryophyllea										Y
* Anagallis arvensis								Y	Y	Y
* Arctotheca calendula										Y
* Avena barbata			12				Y	Y		
* Briza maxima										
* Briza minor									Y	
* Conyza sp.		4			21		Y	Y	Y	Y
* Cynodon dactylon		3			24		Y	Y	Y	Y
* Dittrichia graveolens								Y	Y	Y
* Echium plantagineum								Y		
* Eragrostis curvula		6	6	6	2		Y	Y	Y	Y
* Erharta calycina	6	8	13	9		3	Y	Y	Y	
* Erodium botrys								Y		
* Gladiolus caryophyllaceus	3		9				Y	Y	Y	Y
* Hypochaeris glabra / Flatweeds		14	25	2			Y			Y
* Isolepis marginata								Y		
* Juncus microcephalus			3				Y	Y	Y	
* Leptospermum laevigatum				3			Y	Y	Y	
* Lupinus consentinii										Y
* Oxalis sp.								Y		
* Pelargonium capitatum								Y		
* Poaceae sp.					1		Y	Y	Y	
*** Romulea rosea**					3		Y		Y	
* Trifolium sp.			9							
* Ursinia anthemoides								Y		
*** Vulpia sp.**					6		Y			
* Watsonia meriana var. bulbillifera				8			Y	Y	Y	
* Weed A										Y
Flat weeds (unidentifiable at early stages)								Y		
% WEED COVER IN PLOT OCT 06	**0%**	**0%**	**1%**	**0%**	**1%**	**0%**	**1%**			
% WEED COVER IN PLOT MAY 06	0%	1%	1%	1%	15%	6%		4%		
% WEED COVER IN PLOT FEB 06	0%	1%	2%	2%	22%	22%			8%	
% WEED COVER IN PLOT JUN 05	0%	8%	10%	7%	-	-				6%
NUMBER OF WEED SPECIES OCT 06	**2**	**5**	**7**	**5**	**6**	**1**	**13**			
NUMBER OF WEED SPECIES MAY 06	4	7	8	9	10	9		26		
NUMBER OF WEED SPECIES FEB 06	6	2	6	5	4	3			12	
TOTAL WEED SPECIES							29	27	21	18

Note: Species in bold red are new species that have not been recorded during previous assessments

* : Figures quoted are not actual numbers but a measure of species dominance. In each 1 m2 section of the plot the weeds are scored 3,2,1 with 3 being the most dominant. Max score per plot 75.

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Poison Gully
Native Monitoring Records

SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL	Nearby
Acacia applanata																			1						1	2	
Acacia saligna																										0	
Adenanthos cygnorum																										0	
Alexgeorgia nitens																										0	
Allocasuarina fraseriana																										0	
Allocasuarina humilis	5	1	1	2	4	2	1			1	4	3		2	6	4		1	1	1	1	2	2	3	2	49	
Astartea scoparia																										0	
Banksia attenuata																										0	
Banksia telmatiaea																										0	
Bolboschoenus caldwellii																										0	
Bossiaea eriocarpa																										0	
Burchardia umbellata																										0	
Conostylis aculeata																										0	
Conostylis juncea																1	1									2	
Conostylis sp.																										0	
Coymbia calophylla						1	1		1													1				4	
Cyathochaeta avenacea																	3						3	1		7	
Cyperus sp.																										0	
Dampiera alata																										0	
Dasypogon bromelifolius																										0	
Desmocladus fasciculatus																	1									1	
Desmocladus flexuosus																										0	
Drosera nitidula																										0	
Drosera sp.																										0	
Dryandra lindleyana																										0	
Dryandra nivea																										0	
Eutaxia virgata																										0	
Gastrolobium sp																										0	
Gompholobium marginatum																						3				3	
Gompholobium tomentosum																										0	
Haemodorum laxum																										0	
Haemodorum sp.					1	1																				2	
Hakea prostrata																										0	
Hakea varia																										0	
Hardenbergia comptoniana																										0	
Hypolaena exsulca																										0	
Jacksonia furcellata																										0	
Jacksonia sternbergiana											1				1					2	1					5	
Kennedia prostrata																										0	
Lepidosperma pubisquameum																2										2	
Lomandra sp.																										0	
Lyginia barbata / imberbis																										0	
Meeboldin a cana																										0	
Melaleuca laterita																										0	
Melaleuca seriata																										0	
Mesomolaena tetragona																										0	
Patersonia occidentalis																										0	
Pericalymma ellipticum var floridum														2	1											4	
Petrophile linearis																								1		0	
Pterostylis sanguinea																										0	
Schoenus curvifolius			1	1				1	1	2				1				1				1	1			10	
Siloxerus humifusus																										0	
Stirlingia latifolia																										0	
Styldium sp.																										0	
Thysanotus sparteus																										0	
Verticordia ? lindleyi subsp lindelyi																										0	
Verticordia densiflora var densiflora																										0	
Waitzia suaveolens																										0	
Xanthorrhoea brunonis						1					4					1				4	6		1			17	
Xanthorrhoea preissii																										0	
TOTAL NATIVES																										108	
NATIVE COVER PERCENTAGE	1%	1%	1%	1%	1%	3%	1%	1%	1%	1%	10%	1%	0%	1%	2%	1%	1%	1%	1%	15%	80%	1%	2%	1%	1%	5%	

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Poison Gully
Introduced Species Monitoring Records

Taxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Score
* Aira caryophyllea																										0
* Anagallis arvensis																										0
* Arctotheca calendula																										0
* Avena barbata																										0
* Briza maxima																										0
* Briza minor																										0
* Conyza sp.																										0
* Cynodon dactylon																										0
* Dittrichia graveolens																										0
* Echium plantagineum																										0
* Eragrostis curvula																										0
* Erharta calycina													3									3				6
* Erodium botrys																										0
* Gladiolus caryophyllaceus	3																									3
* Hypochaeris glabra / Flatweeds																										0
* Isolepis marginata																										0
* Juncus microcephalus																										0
* Leptospermum laevigatum																										0
* Lupinus consentinii																										0
* Oxalis sp.																										0
* Pelargonium capitatum																										0
* Poaceae sp.																										0
* Romulea rosea																										0
* Trifolium sp.																										0
* Ursinia anthemoides																										0
* Vulpia sp.																										0
* Watsonia meriana var. bulbillifera																										0
* Weed A																										0
Flat weeds (unidentifiable at early stages)																										0
% WEED COVER IN PLOT	**1%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**1%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**1%**	**0%**	**0%**	**0%**	**0.1%**

Note: Species in red have not been observed in the monitoring plots to date

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Poison Gully
Native Monitoring Records

SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL	Nearby
Acacia applanata																										0	
Acacia saligna																										0	
Adenanthos cygnorum												1					1									2	
Alexgeorgia nitens																										0	
Allocasuarina fraseriana																										0	
Allocasuarina humilis																										0	
Astartea scoparia																										0	
Banksia attenuata																										0	
Banksia telmatiaea	1								1									1								3	
Bolboschoenus caldwellii																										0	
Bossiaea eriocarpa																										0	
Burchardia umbellata																										0	
Conostylis aculeata				1			1												1							3	
Conostylis juncea																										0	
Conostylis sp.																										0	
Coymbia calophylla																										0	
Cyathochaeta avenacea																										0	
Cyperus sp.																										0	
Dampiera alata																										0	
Dasypogon bromelifolius																										0	
Desmocladus fasciculatus																										0	
Desmocladus flexuosus																										0	
Drosera nitidula																										0	
Drosera sp.																										0	
Dryandra lindleyana																										0	
Dryandra nivea																										0	
Eutaxia virgata																										0	
Gastrolobium sp																										0	
Gompholobium marginatum																										0	
Gompholobium tomentosum																										0	
Haemodorum laxum																										0	
Haemodorum sp.																										0	
Hakea prostrata																										0	
Hakea varia																										0	
Hardenbergia comptoniana																										0	
Hypolaena exsulca																										0	
Jacksonia furcellata																										0	
Jacksonia sternbergiana																										0	
Kennedia prostrata																										0	
Lepidosperma pubisquameum																										0	
Lomandra sp.																										0	
Lyginia barbata / imberbis																										0	
Meeboldin a cana																										0	
Melaleuca laterita																										0	
Melaleuca seriata																										0	
Mesomolaena tetragona																										0	
Patersonia occidentalis																										0	
Pericalymma ellipticum var floridum		1	2								1		1											1		6	
Petrophile linearis																										0	
Pterostylis sanguinea																										0	
Schoenus curvifolius							3					1														4	
Siloxerus humifusus																										0	
Stirlingia latifolia																										0	
Styldium sp.																										0	
Thysanotus sparteus																										0	
Verticordia ? lindleyi subsp lindelyi																										0	
Verticordia densiflora var densiflora																1										1	
Waitzia suaveolens																										0	
Xanthorrhoea brunonis																										0	
Xanthorrhoea preissii																										0	

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revegetation systems

Poison Gully
Introduced Species Monitoring Records

Taxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Score
* Aira caryophyllea																										0
* Anagallis arvensis																										0
* Arctotheca calendula																										0
* Avena barbata																										0
* Briza maxima																										0
* Briza minor																										0
* Conyza sp.							3																	1		4
* Cynodon dactylon											3															3
* Dittrichia graveolens																										0
* Echium plantagineum																										0
* Eragrostis curvula									3															3		6
* Erharta calycina					3																	3		2		8
* Erodium botrys																										0
* Gladiolus caryophyllaceus																										0
* Hypochaeris glabra / Flatweeds							2					3					3	3							3	14
* Isolepis marginata																										0
* Juncus microcephalus																										0
* Leptospermum laevigatum																										0
* Lupinus consentinii																										0
* Oxalis sp.																										0
* Pelargonium capitatum																										0
* Poaceae sp.																										0
* Romulea rosea																										0
* Trifolium sp.																										0
* Ursinia anthemoides																										0
* Vulpia sp.						3																				0
* Watsonia meriana var. bulbillifera																										0
* Weed A																										0
Flat weeds (unidentifiable at early stages)																										0
% WEED COVER IN PLOT	**0%**	**0%**	**0%**	**0%**	**1%**	**1%**	**1%**	**0%**	**1%**	**0%**	**1%**	**1%**	**0%**	**0%**	**0%**	**0%**	**1%**	**1%**	**0%**	**0%**	**0%**	**1%**	**0%**	**1%**	**1%**	**0%**

Note: Species in red have not been observed in the monitoring plots to date

tranen
revegetation systems

Poison Gully
Native Monitoring Records

SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL	Nearby
Acacia applanata																										0	
Acacia saligna																										0	
Adenanthos cygnorum																										0	
Alexgeorgia nitens																										0	
Allocasuarina fraseriana																										0	
Allocasuarina humilis																										0	
Astartea scoparia																										0	
Banksia attenuata																										0	
Banksia telmatiaea										2																2	
Bolboschoenus caldwellii																										0	
Bossiaea eriocarpa																										0	
Burchardia umbellata																										0	
Conostylis aculeata									1											1		1				3	
Conostylis juncea																										0	
Conostylis sp.																										0	
Coymbia calophylla																										0	
Cyathochaeta avenacea																				1						1	
Cyperus sp.																										0	
Dampiera alata																										0	
Dasypogon bromelifolius																										0	
Desmocladus fasciculatus																										0	
Desmocladus flexuosus																										0	
Drosera nitidula																										0	
Drosera sp.	1	1																	2							4	
Dryandra lindleyana																										0	
Dryandra nivea																										0	
Eutaxia virgata																										0	
Gastrolobium sp																										0	
Gompholobium marginatum																										0	
Gompholobium tomentosum																										0	
Haemodorum laxum																										0	
Haemodorum sp.																										0	
Hakea prostrata																										0	
Hakea varia																										0	
Hardenbergia comptoniana																										0	
Hypolaena exsulca															1							2				3	
Jacksonia furcellata																										0	
Jacksonia sternbergiana																									1	1	
Kennedia prostrata																										0	
Lepidosperma pubisquameum																										0	
Lomandra sp.											1															1	
Lyginia barbata / imberbis																										0	
Meeboldina cana										1		1														2	
Melaleuca laterita																										0	
Melaleuca seriata																										0	
Mesomolaena tetragona																										0	
Patersonia occidentalis																										0	
Pericalymma ellipticum var floridum														2	1									1		4	
Petrophile linearis																										0	
Pterostylis sanguinea																										0	
Schoenus curvifolius																										0	
Siloxerus humifusus								1			1			1												3	
Stirlingia latifolia																										0	
Styldium sp.											1															1	
Thysanotus sparteus																										0	
Verticordia densiflora var densiflora	8	4	5	5	4	4	2	3	1	5	4	2	2		3	3		3	3	6	3	10	13	3		96	
Verticordia lindleyi subsp lindelyi			1																	1				1	1	4	
Waitzia suaveolens																										0	
Xanthorrhoea brunonis																										0	
Xanthorrhoea preissii																										0	

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revegetation systems

Poison Gully
Introduced Species Monitoring Records

Taxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Score
* Aira caryophyllea																										0
* Anagallis arvensis																										0
* Arctotheca calendula																										0
* Avena barbata	3		3			3	3																			12
* Briza maxima																										0
* Briza minor																										0
* Conyza sp.																										0
* Cynodon dactylon																										0
* Dittrichia graveolens																										0
* Echium plantagineum																										0
* Eragrostis curvula																							3	3		6
* Erharta calycina											3			3			2				2	3				13
* Erodium botrys																										0
* Gladiolus caryophyllaceus												3			3	3										9
* Hypochaeris glabra / Flatweeds				2		2		3	3	3			3						3	3				3		25
* Isolepis marginata																										0
* Juncus microcephalus																					3					3
* Leptospermum laevigatum																										0
* Lupinus consentinii																										0
* Oxalis sp.																										0
* Pelargonium capitatum																										0
* Poaceae sp.																										0
* Romulea rosea																										0
* Trifolium sp.				3	3												3									9
* Ursinia anthemoides																										0
* Vulpia sp.																										0
* Watsonia meriana var. bulbillifera																										0
* Weed A																										0
Flat weeds (unidentifiable at early stages)																										0
% WEED COVER IN PLOT	**1%**	**0%**	**1%**	**1%**	**1%**	**1%**	**1%**	**1%**	**1%**	**1%**	**11%**	**1%**	**1%**	**0%**	**1%**	**1%**	**1%**	**0%**	**1%**	**1%**	**1%**	**1%**	**2%**	**1%**	**1%**	**1%**

Note: Species in red have not been observed in the monitoring plots to date

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Poison Gully
Native Monitoring Records

SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL	Nearby
Acacia applanata																										0	
Acacia saligna																					1					1	
Adenanthos cygnorum																					1		1			2	
Alexgeorgia nitens																										0	
Allocasuarina fraseriana																										0	
Allocasuarina humilis																										0	
Astartea scoparia				1	1	1			1			1	1	2	2	1	1	23	3	2						40	
Banksia attenuata																										0	
Banksia telmatiaea																										0	
Bolboschoenus caldwellii																										0	
Bossiaea eriocarpa																											
Burchardia umbellata																										0	
Conostylis aculeata															2											2	
Conostylis juncea																										0	
Conostylis sp.																										0	
Coymbia calophylla																										0	
Cyathochaeta avenacea					1								1													2	
Cyperus sp.																										0	
Dampiera alata																										0	
Dasypogon bromelifolius																										0	
Desmocladus fasciculatus																										0	
Desmocladus flexuosus																										0	
Drosera nitidula																										0	
Drosera sp.													1														
Dryandra lindleyana																										0	
Dryandra nivea																										0	
Eutaxia virgata											2															2	
Gastrolobium sp																							1			1	
Gompholobium marginatum																										0	
Gompholobium tomentosum									1																	1	
Haemodorum laxum																										0	
Haemodorum sp.																										0	
Hakea prostrata																										0	
Hakea varia																										0	
Hardenbergia comptoniana																										0	
Hypolaena exsulca			1																			1				2	
Jacksonia furcellata																										0	
Jacksonia sternbergiana		1															1	1								3	
Kennedia prostrata																										0	
Lepidosperma pubisquameum																									2	2	
Lomandra sp.																										0	
Lyginia barbata / imberbis																										0	
Meeboldin a cana																										0	
Melaleuca laterita																										0	
Melaleuca seriata																										0	
Mesomolaena tetragona																										0	
Patersonia occidentalis		1																					1			2	
Pericalymma ellipticum var floridum					2	2	1				1	2	1	1	2	4	4		2			1				23	
Petrophile linearis																										0	
Pterostylis sanguinea																										0	
Schoenus curvifolius																										0	
Siloxerus humifusus																										0	
Stirlingia latifolia																										0	
Styldium sp.																										0	
Thysanotus sparteus																										0	
Verticordia ? lindleyi subsp lindelyi																										0	
Verticordia densiflora var densiflora					1		2			2			2	5	10	8	11	4	2				1	6	10	64	
Waitzia suaveolens																									2	2	
Xanthorrhoea brunonis																										0	
Xanthorrhoea preissii																										0	

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Poison Gully
Introduced Species Monitoring Records

Taxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Score
* Aira caryophyllea																										0
* Anagallis arvensis																										0
* Arctotheca calendula																										0
* Avena barbata																										0
* Briza maxima																										0
* Briza minor																										0
* Conyza sp.																										0
* Cynodon dactylon																										0
* Dittrichia graveolens																										0
* Echium plantagineum																										0
* Eragrostis curvula												3												3		6
* Erharta calycina			3	3															3							9
* Erodium botrys																										0
* Gladiolus caryophyllaceus																										0
* Hypochaeris glabra / Flatweeds													2													2
* Isolepis marginata																										0
* Juncus microcephalus																										0
* Leptospermum laevigatum																							3			3
* Lupinus consentinii																										0
* Oxalis sp.																										0
* Pelargonium capitatum																										0
* Poaceae sp.																										0
* Romulea rosea																										0
* Trifolium sp.																										0
* Ursinia anthemoides																										0
* Vulpia sp.																										0
* Watsonia meriana var. bulbillifera													3					3						2		8
* Weed A																										0
Flat weeds (unidentifiable at early stages)																										0
% WEED COVER IN PLOT	**0%**	**0%**	**1%**	**1%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**1%**	**1%**	**0%**	**0%**	**0%**	**0%**	**1%**	**1%**	**0%**	**0%**	**0%**	**1%**	**1%**	**0%**	**0%**

Note: Species in red have not been observed in the monitoring plots to date

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Poison Gully
Native Monitoring Records

SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL	Nearby
Acacia applanata																										0	
Acacia saligna																										0	
Adenanthos cygnorum																										0	
Alexgeorgia nitens																										0	
Allocasuarina fraseriana																										0	
Allocasuarina humilis																										0	
Astartea scoparia																										0	
Banksia attenuata																										0	
Banksia telmatiaea	1					1				1	1							1								5	
Bolboschoenus caldwellii																										0	
Bossiaea eriocarpa																										0	
Burchardia umbellata																										0	
Conostylis aculeata																										0	
Conostylis juncea																										0	
Conostylis sp.																										0	
Coymbia calophylla																										0	
Cyathochaeta avenacea																										0	
Cyperus sp.																										0	
Dampiera alata																										0	
Dasypogon bromelifolius																										0	
Desmocladus fasciculatus																										0	
Desmocladus flexuosus																										0	
Drosera nitidula																										0	
Drosera sp.																										0	
Dryandra lindleyana																										0	
Dryandra nivea																										0	
Eutaxia virgata																										0	
Gastrolobium sp																										0	
Gompholobium marginatum																										0	
Gompholobium tomentosum																										0	
Haemodorum laxum																										0	
Haemodorum sp.																										0	
Hakea prostrata																										0	
Hakea varia																										0	
Hardenbergia comptoniana																										0	
Hypolaena exsulca																										0	
Jacksonia furcellata																										0	
Jacksonia sternbergiana																										0	
Kennedia prostrata																										0	
Lepidosperma pubisquameum																										0	
Lomandra sp.																										0	
Lyginia barbata / imberbis																										0	
Meeboldin a cana																										0	
Melaleuca laterita	3																									3	
Melaleuca seriata																										0	
Mesomolaena tetragona																										0	
Patersonia occidentalis																										0	
Pericalymma ellipticum var floridum																										0	
Petrophile linearis																										0	
Pterostylis sanguinea																										0	
Schoenus curvifolius															1											1	
Siloxerus humifusus																										0	
Stirlingia latifolia																										0	
Styldium sp.																										0	
Thysanotus sparteus																										0	
Verticordia ? lindleyi subsp lindelyi																										0	
Verticordia densiflora var densiflora								1					1													2	
Waitzia suaveolens																										0	
Xanthorrhoea brunonis																										0	
Xanthorrhoea preissii																										0	

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revegetation systems

Poison Gully
Introduced Species Monitoring Records

Taxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Score
* Aira caryophyllea																										0
* Anagallis arvensis																										0
* Arctotheca calendula																										0
* Avena barbata																										0
* Briza maxima																										0
* Briza minor																										0
* Conyza sp.		3					3		3				3		3									3	3	21
* Cynodon dactylon	3					3				3	3									3	3	3	3			24
* Dittrichia graveolens																										0
* Echium plantagineum																										0
* Eragrostis curvula																								2		2
* Erharta calycina																										0
* Erodium botrys																										0
* Gladiolus caryophyllaceus																										0
* Hypochaeris glabra / Flatweeds																										0
* Isolepis marginata																										0
* Juncus microcephalus																										0
* Leptospermum laevigatum																										0
* Lupinus consentinii																										0
* Oxalis sp.																										0
* Pelargonium capitatum																										0
* Poaceae sp.																										0
* Romulea rosea					3																			1		1
* Trifolium sp.																										3
* Ursinia anthemoides																										0
* Vulpia sp.																										0
* Watsonia meriana var. bulbillifera																	3	3								6
* Weed A																										0
Flat weeds (unidentifiable at early stages)																										0
% WEED COVER IN PLOT	**2%**	**1%**	**0%**	**0%**	**1%**	**2%**	**1%**	**0%**	**1%**	**1%**	**2%**	**0%**	**1%**	**0%**	**0%**	**1%**	**1%**	**1%**	**0%**	**2%**	**10%**	**5%**	**1%**	**1%**	**1%**	**1%**

Note: Species in red have not been observed in the monitoring plots to date

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Poison Gully
Native Monitoring Records

SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL	Nearby
Acacia applanata																										0	
Acacia saligna																										0	
Adenanthos cygnorum																										0	
Alexgeorgia nitens																										0	
Allocasuarina fraseriana																										0	
Allocasuarina humilis																										0	
Astartea scoparia																										0	
Banksia attenuata																										0	
Banksia telmatiaea																										0	
Bolboschoenus caldwellii																										0	
Bossiaea eriocarpa																										0	
Burchardia umbellata																										0	
Conostylis aculeata																										0	
Conostylis juncea																										0	
Conostylis sp.																										0	
Coymbia calophylla																								1		1	
Cyathochaeta avenacea																										0	
Cyperus sp.																										0	
Dampiera alata																										0	
Dasypogon bromelifolius																										0	
Desmocladus fasciculatus																										0	
Desmocladus flexuosus																										0	
Drosera nitidula																										0	
Drosera sp.																										0	
Dryandra lindleyana																										0	
Dryandra nivea																										0	
Eutaxia virgata																										0	
Gastrolobium sp																										0	
Gompholobium marginatum																										0	
Gompholobium tomentosum																										0	
Haemodorum laxum																										0	
Haemodorum sp.																										0	
Hakea prostrata																										0	
Hakea varia																										0	
Hardenbergia comptoniana																										0	
Hypolaena exsulca																										0	
Jacksonia furcellata																										0	
Jacksonia sternbergiana																										0	
Kennedia prostrata																										0	
Lepidosperma pubisquameum																										0	
Lomandra sp.																										0	
Lyginia barbata / imberbis																										0	
Meeboldin a cana																										0	
Melaleuca laterita																										0	
Melaleuca seriata																										0	
Mesomolaena tetragona																										0	
Patersonia occidentalis																										0	
Pericalymma ellipticum var floridum																								1	1	2	
Petrophile linearis																										0	
Pterostylis sanguinea																										0	
Schoenus curvifolius																										0	
Siloxerus humifusus																										0	
Stirlingia latifolia																										0	
Styldium sp.																										0	
Thysanotus sparteus																										0	
Verticordia ? lindleyi subsp lindelyi																										0	
Verticordia densiflora var densiflora																										0	
Waitzia suaveolens																										0	
Xanthorrhoea brunonis																										0	
Xanthorrhoea preissii																										0	

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Poison Gully
Introduced Species Monitoring Records

Taxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Score
* Aira caryophyllea																										0
* Anagallis arvensis																										0
* Arctotheca calendula																										0
* Avena barbata																										0
* Briza maxima																										0
* Briza minor																										0
* Conyza sp.																										0
* Cynodon dactylon																										0
* Dittrichia graveolens																										0
* Echium plantagineum																										0
* Eragrostis curvula																										0
* Erharta calycina															3											3
* Erodium botrys																										0
* Gladiolus caryophyllaceus																										0
* Hypochaeris glabra / Flatweeds																										0
* Isolepis marginata																										0
* Juncus microcephalus																										0
* Leptospermum laevigatum																										0
* Lupinus consentinii																										0
* Oxalis sp.																										0
* Pelargonium capitatum																										0
* Poaceae sp.																										0
* Romulea rosea																										0
* Trifolium sp.																										0
* Ursinia anthemoides																										0
* Vulpia sp.																										0
* Watsonia meriana var. bulbillifera																										0
* Weed A																										0
Flat weeds (unidentifiable at early stages)																										0
% WEED COVER IN PLOT	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**1%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**

Note: Species in red have not been observed in the monitoring plots to date

Objection Assessment for Perth Airport, flora values and advice on the flora values of bushland not currently listed

Prepared for the Australian Heritage Commission

by

Malcolm Trudgen

Consultant Botanist

October 1995

TABLE OF CONTENTS

1.0 INTRODUCTION 3
1.1 Purpose of this assessment 3
1.2 Objection assessment process 3
1.3 Potentially relevant criteria for listing the Perth Airport bushland 4
1.4 Major points raised by the FAC's consultants during briefings and discussions 6
1.5 Objections raised by the Federal Airport Corporation in the report "Australian Heritage Commission Listing Perth Airport" (Tingay and Associates 1993) 6
1.6 Limited scope of objections raised by the FAC 7
1.7 Major points raised by the conservation lobby 7
1.8 Definitions of rare and unusual flora, of rare flora communities (vegetation) and of rare ecosystems 7

2.0 GEOMORPHOLOGY AND SOILS 10

3.0 FLORA OF THE REGION INCLUDING PERTH AIRPORT 11

4.0 VEGETATION OF THE REGION INCLUDING PERTH AIRPORT 12
4.1 Introduction 12
4.2 Vegetation complexes 12
4.2.1 Concept of vegetation complexes 12
4.2.2 Distribution of vegetation complexes 13
4.2.3 Vegetation complexes present in Perth Airport 13
4.3 Floristic Community Types 14
4.3.1 Concept of Floristic Community Types 14
4.3.2 Results of floristic community type approach 14
4.4 Comparison of vegetation complexes and floristic community types 16

5.0 AMOUNT REMAINING AND IMPLICATIONS FOR HERITAGE STATUS, OF THE NATIVE VEGETATION TYPES FOUND AT PERTH AIRPORT 17
5.1 Introduction 17
5.2 Amount remaining of the original vegetation of the Swan Coastal Plain south of the Swan River 17
5.3 Amount remaining of the Southern River Vegetation Complex 19
5.4 Amount remaining of the Guildford Vegetation Complex 19
5.5 Amount remaining of the Bassendean Complex Central and South 19

6.0 NATIONAL ESTATE VALUES OF THE FLORA AND VEGETATION AT PERTH AIRPORT 21
6.1 Introduction 21
6.2 Flora and vegetation national estate values present at Perth Airport 21
6.2.1 Criterion A: Its importance in the course, or pattern, of Australia's natural or cultural history 21
6.2.2 Criterion B: Its possession of uncommon, rare or endangered aspects of Australia's natural or cultural history 24

7.0 DETAILED OBJECTION ASSESSMENT FOR FLORA VALUES OF THE BUSHLAND AREAS AT PERTH AIRPORT CURRENTLY ON THE INTERIM LIST OF THE NATIONAL ESTATE 30
7.1 Introduction 30

7.2 Adequacy of Commission database 30
7.3 Objection assessment of area A 30
7.3.1 Grounds for objection which relate to the national estate significance of area A 30
7.3.2 Appropriateness of the boundaries given the significance of area A 31
7.3.3 Significance of area A in relation to the definition of the national estate 31
7.3.4 Comments on the integrity of area A, or other comments of a technical nature 31
7.4 Objection assessment of area B 32
7.4.1 Grounds for objection which relate to the national estate significance of area B 32
7.4.2 Appropriateness of the boundaries given the significance of area B 34
7.4.3 Significance of area B in relation to the definition of the national estate 34
7.4.4 Comments on the integrity of area B, or other comments of a technical nature 35
7.5 Objection assessment of area C 35
7.5.1 Grounds for objection which relate to the national estate significance of area C 35
7.5.2 Appropriateness of the boundaries given the significance of area C 37
7.5.3 Significance of area C in relation to the definition of the national estate 37
7.5.4 Comments on the integrity of area C or other comments of a technical nature 38
7.6 Objection assessment of area D 38
7.6.1 Grounds for objection which relate to the national estate significance of area D 38
7.6.2 Appropriateness of the boundaries given the significance of area D 39
7.6.3 Significance of area D in relation to the definition of the national estate 39
7.6.4 Comments on the integrity of area D or other comments of a technical nature 40

8.0 OVERALL RECOMMENDATIONS FOR LISTING BUSHLAND AREAS AT PERTH AIRPORT ON THE REGISTER OF THE NATIONAL ESTATE 41

9.0 ACKNOWLEDGMENTS 43

10.0 REFERENCES 44

APPENDIX ONE: Letters received from voluntary conservation groups

APPENDIX TWO: Condition scale

APPENDIX THREE: Information relevant to the flora and floristic community types present at Perth Airport made available by the Department of Environmental Protection

APPENDIX FOUR: A list of priority and rare taxa that are potentially in the bushland at Perth Airport, or are already known there (from Goff and Associates 1994).

MAPS ONE TO FOUR at end

1.0 INTRODUCTION

1.1 Purpose of this assessment

The purpose of this assessment is to assist and advise the Australian Heritage Commission in the assessment of the national estate significance of the bushland areas of Perth Airport (for areas already listed) and to advise the Commission of the national estate significance of bushland areas within the Perth Airport which have not as yet been listed (after Australian Heritage Commission 1995, Schedule 1 paragraph A). Thus, there are two parts to this report. Firstly, relating to those areas currently on the interim list and secondly relating to bushland areas on the airport land which have not been currently listed.

1.2 Objection assessment process

The relevant part of the objection assessment process for this report is as follows:

"Assessors are asked to address the following five points in their reports:

(i) is the database information produced by the Commission accurate and comphrehensive?;

(ii) comment on those grounds for objection which relate to the national estate significance of the place. These grounds are identified in the 'Terms of Reference' for the contract for the assessment;

(iii) are the boundaries of the proposed area appropriate, given the significance of the place? What adjustments to the boundary, if any, are needed to define the significant area accurately and closely?

(NB. The answer to this question may involve deletion or addition of areas, however substantial proposed additions will be dealt with separately by the Commission and must not be dealt with in the assessment report. Any such proposed additions must be the subject of a separate report);

(iv) Given the definition of the "National Estate" contained in the *Australian Heritage Commission Act* and the criteria illuminating that definition,

does the place, in your opinion, warrant entry in the Register?;

(v) do you have any comments on the integrity of the place, or other views of a technical nature, which may assist the Commission in deciding whether the place should be entered in the Register of the National Estate." (Australian Heritage Commission 1995, attachment 1, paragraph 2).

In relation to section (ii), it should be noted that there is no section entitled 'Terms of Reference' in the contract for this assessment. Discussions with the Project Officer" for this assessment have confirmed that the objections made by the Federal Airport Corporation are those in the Federal Airport Corporation document "Australian Heritage Commission Listing Perth Airport" (Tingay and Associates, 1993) and those made during the briefing at Perth Airport, the actual letter of objection only being written to forshadow the preparation of these objections.

1.3 Potentially relevant criteria for listing the Perth Airport bushland

Not all the criteria (Australian Heritage Commission 1995, attachment 2) for listing on the Register of the National Estate, are potentially relevant to the bushland at Perth Airport for the values of the flora (flora is interpreted here as being used by the Australian Heritage Commission in the broad sense of individual species and of vegetation) found in and making up that bushland.

The criteria that seem potentially relevant (for those parts of them relating to flora and including in this vegetation) are:

Criterion A: Its importance in the course, or pattern, of Australia's natural or cultural history. (Particularly, A.2 Importance in maintaining existing processes or natural systems at the regional or national scale. Possibly also criterion A.1 Importance in the evolution of Australian flora, fauna landscapes or climate.)

Criterion B: Its possession of uncommon, rare or endangered aspects of Australia's natural or cultural history. (Particularly, B.1 Importance for rare, endangered or uncommon flora, fauna, communities, ecosystems, natural landscapes or

phenomena, or as a wilderness.)

Criterion C: Its potential to yield information that will contribute to an understanding of Australia's natural or cultural history. (Particularly, C.1 Importance for information contributing to a wider understanding of Australian natural history, by virtue of its use as a research site, teaching site, type locality, reference or benchmark site.)

Criterion D: Its importance in demonstrating the principal characteristics of : (I) A class of Australia's natural or cultural places; or (II) A class of Australia's natural or cultural environmentst. (Particularly, D.1 Importance in demonstrating the principal characteristics of the range of landscapes, environments or ecosystems, the attributes of which identify them as characteristic of their class.)

1.4 Major points raised by the FAC's consultants during briefings and discussions

During the course of a briefing session and a tour of the bushland areas of Perth Airport, Dr. Tingay (the Federal Airport Corporation's environmental consultant) placed emphasis on areas proposed to be listed having real value for the national estate in terms of being significantly different or having suites of values. He also strongly argued that the vegetation on areas listed should be in very good condition, or the standing of listing in the eyes of the community would be diminished.

In later discussions (22/9/95), he raised the issue of the process of heritage listing. He expressed a view that the process should be carried out in an orderly fashion, he was particularly concerned that if the review process resulted in larger areas of the Perth Airport being recommended for listing then the FAC would see the direction of the process as having changed and the process as being unpredictable. (I have paraphrased this, as I did not make notes but, believe I have the intent correctly expressed.) I responded that I could see the point he was making but, that I was involved purely to make assessment of the worth of areas and could not take the processes of listing, or possible reactions of affected landholders/managers to the implications of listing of areas into account. Further, I pointed out that I was contracted to answer particular questions and that defined what I could do.

1.5 Objections raised by the Federal Airport Corporation in the report "Australian Heritage Commission Listing Perth Airport" (Tingay and Associates 1993)

In the report "Australian Heritage Commission Listing Perth Airport" (Tingay and Associates 1993) prepared for the Federal Airport Corporation, the Corporation makes objections relevant to some of the boundaries of the four areas interim listed by suggesting changes to the boundaries. The basis for the changes (and thence objection) is given as vegetation quality (see first paragraph of section 2.6 quoted below and the second sentence of the first paragraph of section 3, page 11). The suggested changes are detailed in section 2.6 and figure five (of Tingay and Associates 1993). Section 2.6 "Changes to AHC Boundaries", is quoted here in full:

"This study has assessed the quality of vegetation within the four areas of bushland currently on the interim list of the Register of the National Estate. Minor variations to the boundaries of Areas A, C and D are proposed since those given do not fully encompass areas of vegetation that are of good quality. These minor alterations are shown in Figure 5.

Minor alterations to the boundaries of Area B are also recommended especially in relation to land immediately adjacent to wetland areas. Some land should be included as buffer to the wetlands and thus should be included in the listed areas. However, a significant portion of Area B is considered to be significantly disturbed and its inclusion is not warranted on the basis of vegetation. This assessment is consistent with the information given in the AHC documentation as the presence of Gould's Snake is the rationale for its inclusion within the interim listed areas.

As discussed in section 2.4 Gould's Snake is not considered to be uncommon as stated in the Statement of Significance provided by the AHC. Rather it has been described as common and is well collected in the Metropolitan Area (Western Australian Museum, 1978). It is therefore concluded that the inclusion of the degraded portion of Area B should be amended as shown in Figure 5." (Tingay and Associates 1993).

The changes suggested (i.e. objections) are minor, except, for the larger of the changes to Area B (which includes Munday Swamp).

1.6 Limited scope of objections raised by the FAC

The objections raised by the FAC (with the exception of the larger change to Area B) are limited to suggesting minor changes to the boundaries of the four areas (A,B,C, D) interim listed. This in effect agrees, that the majority of the areas interim listed are worthy of such listing.

1.7 Major points raised by the conservation lobby

Several points were made by representatives of the conservation movement (by letter (see Appendix one), in telephone conversations (with C. Taylor and J.P. Orsini) and during a field visit (with Kevin McLean). They expressed a view that all the bushland at Perth Airport should be placed on the Register of the National Estate, in line with the listing by the National Trust. A major point they made was that the small amount of remaining vegetation on the eastern side of the Swan Coastal Plain and in the inner Metropolitan area meant that the vegetation at Perth Airport has high conservation value (and hence in their view high national estate value). Reasons advanced by them for the retention of all the bushland included the greater resilience of a larger area to perterbations such as fire and the greater likelihood of the maintenance of more of the existing national estate values in the better condition areas if they are linked and have buffers of the vegetation in poorer condition, as this would allow migration of species between areas and avoid an increase in edge effects that would occur if the poorer vegetation was removed. They stressed that the fact that all the bushland areas at Perth Airport were not in the best possible condition should not mean that they not be considered for listing as other areas with significant value (they cited King's Park and Bold Park) are not pristine, or uniformly in very good condition.

1.8 Definitions of rare and unusual flora, of rare flora communities (vegetation) and of rare ecosystems

Some of the criteria by which national estate value is to be judged (particularly Criterion B1) involve the presence of "rare, endangered or unusual flora, fauna,

communities, natural landscapes or phenomena". This immediately raises the question of the definition of rarity.

In Western Australia, there is an accepted definition of rare flora under the Wildlife Act and a defacto definition of uncommon species can be inferred for those that are on the Department of Conservation and Land Management (CALM) priority flora list (some of these are considered rare by that Department as well) although, the lists of rare and priority species are far from complete.

However, there are no accepted definitions of rare flora communities (vegetation) and ecosystems and no simple definition is practical. For the purposes of this analysis, the following definition is advanced: an ecosystems or vegetation type (whether plant community, association, vegetation complex or floristic community type) should be considered rare when:

- its original extent was less than 2,000 hectares, irrespective of what proportion of its original extent survives; or

- its original extent was 2,000 to 20,000 hectares and less than 2,000 hectares or less than 30% of its original extent survives; or

- its original extent was 20,000 to 100,000 hectares or more and the portion of the original extent remaining is less than 30% for an original extent of 20,000 ha declining to less than 20% for an original extent of 50,000 ha declining to less than 10% for an original extent of 100,000 ha or more.

The thrust of this definition is to define vegetation as rare when its original extent was very small (2,000 ha or less) and as having become rare compared to an original extent when the original distribution has been reduced by clearing or other activities below the areas suggested above. The end of this sliding scale has been take as ten percent for areas of 100,000 hectares or more, as ten percent is the <u>minimum</u> area recommended for protection of an ecosystem by the International Union for the Conservation of Nature (IUCN). However, this would obviously not be appropriate

for vegetation types (or ecosystems) with very small original extents. Therefore, a sliding scale was chosen to link small areas through intermediate sized areas to the general standard. Obviously, this is somewhat arbitrary but, a vegetation type with an original extent of only 2,000 hectares is rare or at least unusual on a national scale and a vegetation type that originally had an extent of more than 100,000 hectareas and has been reduced to 10,000 hectares or less is certainly uncommon (or rare) compared to its original extent. The scale attempts to provide a resolution of a problem that is partly absolute (for small original extents) and partly relative (for large original extents) and should be taken as a guide.

2.0 GEOMORPHOLOGY AND SOILS

Perth Airport lies on the Swan Coastal Plain, the plain between the Darling Scarp and the coastline. It is a fairly narrow but, quite long, plain that has been developed by the deposition of material washed down from the plateau above the scarp and in more recent times from material that has blown in from the coastline.

On the eastern side of the Swan Coastal Plain the soils are predominantly alluvial deposits washed down from the plateau and are mostly clayey although, there are areas of sands. On the western side of the plain the soils are mostly sands blown in from the coast. These two major types meet in the the Southern River Soil unit. Which has areas with low sand dunes, or low sand drifts where they are too small (say about 1 to 3 metres thick) to justify being called dunes, and between these there are flat areas with sandy clay or clayey sand soils. The dunes and sand drifts of the Southern River Soil unit are the eastern most extension of the Bassendean Sands. To the west of the Southern River Soil unit, these sands form larger dunes without clayey soils between them. This soil/geomorphological unit is the Bassendean Dunes (Churchward et al. 1980).

The soil/geomorphological units of Churchward et al. (1980) are the ecological basis for the vegetation complexes discussed below (which have names derived from the names of the soil/geomophological unit they are on) and generally have the same distribution. However, there may be more than one vegetation complex on a soil/geomorphological unit due to climate changes along the plain. The Southern River soil unit has the same distribution as the Southern River Vegetation Complex, and the soil, geomorphology and water relations factors unique to the the Southern River soil unit are what cause the Southern River Vegetation Complex to be different from the other vegetation complexes on the Swan Coastal Plain. The Bassendean Vegetation Complex - central and south occurs on the areas of bassendean dunes south from the Lake Gnangara area.

3.0 FLORA OF THE REGION INCLUDING PERTH AIRPORT

The flora of the region including Perth Airport is now moderately well known. There is a flora (Marchant et al 1987) that includes the region (it also covers part of the adjacent Darling Plateau) and records 1510 native plant species (flowering plants, ferns, fern allies and gymnosperms). This is a reasonably diverse flora for the size of the region covered (10,500 square kilometres) but, is not particularly diverse when compared to other parts of the South West Botanical Province. The later study by Gibson et al (1994) of the southern Swan Coastal Plain (mostly in the area covered by the flora) recorded 1313 taxa (species, subspecies, varieties) of native flowering plants.

Gibson et al (1994) also give information on undescribed species, which made up 8.7% of there records, indicating that there is still a significant deficit in our knowledge. They also give a figure of 61 species recorded by them as being endemic to their study area, with a significant proportion of these (28 species) restricted to the eastern side of the Swan Coastal Plain, where Perth Airport lies. They consider that a further 13 taxa not encountered by them are also endemic to the southern Swan Coastal Plain.

4.0 VEGETATION OF THE REGION INCLUDING PERTH AIRPORT

4.1 Introduction

There are many levels at which, and ways in which, vegetation can be described and analysed. There are two broadscale descriptions of the vegetation of the region including the Perth Airport that it is most useful to discuss here as tools for assessing the heritage value of the vegetation of Perth Airport. These are the "vegetation complexes" of Heddle et al (1980) and the "floristic community types" of Gibson et al (1994). These are both broad scale interpretations of vegetation but, differ very significantly in their approaches.

4.2 Vegetation complexes

4.2.1 Concept of vegetation complexes

It was noted in the section above dealing with geomorphology that on the Swan Coastal a number of units have been described, each with a range of soil and geomorphic characteristics. Each of these units also has a particular range of vegetation types developed on them, in response to the particular soil and geomorphic characteristics of the unit. The range of vegetation types on each of the units is referred to as a "vegetation complex", to reflect the fact that they contain a variety of vegetation types. One of the geomorphic units of the Swan Coastal Plain is called the Southern River soil unit (Churchward and McArthur 1980) and the vegetation on it is called the "Southern River Vegetation Complex" (Heddle et al 1980).

A vegetation complex is a grouping of vegetation types. However, it is not a hierarchical grouping, that is, the different vegetation types (vegetation communities or vegetation associations) found in a vegetation complex are grouped by where they occur rather than than by having some characteristic such as the same dominant species in common. An extension of this is that a plant community (the lower level of vegetation classification) may occur in more than one vegetation complex but, the overall grouping of plant communities and the relative amounts of different plant communities in a vegetation complex will be different. For example, a close comparison of the vegetation of the Southern River Vegetation Complex and of the Bassendean Vegetation Complex - Central and South (the latter lying to the west of

the former on the Swan Coastal Plain) would show that while both have a plant community with Banksia woodland over Stirlingia latifolia, Allocasuarina humilis shrubland there is much more of this community in the latter vegetation complex. The reason for this is that this community occurs on dune crests in these complexes and the Southern River soil unit has much lower dunes than the Bassendean unit and so has fewer and smaller crests. To look at the other side of this example, the Southern River Vegetation Complex has more extensive areas of lower slope vegetation types due to having low, gently sloping dunes, that often are not thick enough to have vegetation types characteristic of crests. The differences go beyond this however, as the Southern River unit has the dunes separated by clayey flats or sandy-clayey flats and these can have quite different vegetation to that found in the Bassendean Vegetation Complex - Central and South. Also, where the sand is very thin vegetation types not found in the Bassendean Vegetation Complex - Central and South can be developed.

Vegetation complexes can be viewed as broad ecosystems or sub-systems, that contain a range of habitats for both flora and fauna species, each particular vegetation complex being unique in the mix and relative abundance of the plant communities found in it. This means that they can be a useful guide to assessment of conservation value or heritage value.

4.2.2 Distribution of vegetation complexes

The development of the geomorphology/soil units on the Swan Coastal Plain has tended to be parallel to the coast (although those associated with the rivers cut across this). Therefore, it is not surprising that the predominant distribution pattern of the vegetation complexes is also north-south. However, they generally occur in discrete blocks rather than as continuous strips.

4.2.3 Vegetation complexes present in Perth Airport

The vegetation complexes present in Perth Airport are:

- the Southern River Vegetation Complex (on aeolian and alluvial deposits)

- the Guildford Vegetation Complex (on alluvial deposits)

- the Basssendean Central and South Vegetation Comlplex (on aeolian deposits)

4.3 Floristic Community Types

4.3.1 Concept of Floristic Community Types

Recently (Gibson et al 1994), a different approach (to vegetation complexes) has been used to study the vegetation of the Swan Coastal Plain although, similar approaches have been used for parts of the Plain in the past (e.g. Weston, Griffin and Trudgen 1992; Griffin and Trudgen 1994). This second approach is based on an underlying concept that flora species occur in groups as a response to environmental factors and that defining such groups of species over the Swan Coastal Plain would then enable individual stands of vegetation to be assigned to a group of sites with similar flora composition. These groups of sites with similar flora composition are referred to as "floristic community types"; in other words, they have groups of species that consistently occur together. Such groups are not absolutely consistent, since some species have environmental tolerances that are broader than the groups and others will occur too infrequently to be useful.

The methodology used in this approach was to sample a large number of plots (five hundred and nine, each ten by ten metre squares) on publicly owned land in different vegetation types, to determine what species were present and then to compare the species present using computer programmes. More than thirteen hundred species were recorded in the plots and used in the analysis.

4.3.2 Results of floristic community type approach

Using the methodology described (briefly) above, Gibson et al (1994) looked at two levels of analysis, a four group level (supergroups) and a thirty group level. At the four group level the groups reflected "major geomorphological elements" and seasonal wetlands, the later occurring "across all geomorphological groups". The thirty group level "best reflected the scale of pattern seen in the field.

The four supergroups are:

1. Sites "almost entirely restricted to the Pinjarra Plain and the Ridge Hill Shelf" (i.e. the eastern part of the Swan Coastal Plain);

2. Sites "the almost entirely seasonal wetlands group"; the largest and most diverse group occurring across all geomorphic units. That is within the major geomorphological groups, the seasonal wetland habitat occurs in appropriate places and the water relations determine the flora and vegetation;

3. Sites "centred on but not exclusive to the Bassendean Dunes. There are also significant occurrences on the Pinjarra Plain and Spearwood Dune Systems." (and also some on the Whicher Scarp);

4. "Group 4 is almost exclusively a Spearwood and Quindalup Dunes group."

Within the four supergroups, thirty floristic community types were recognised (the thirty group level referred to above), some with distinct subunits, giving a total of forty-three floristic community types and subtypes. These were grouped under the four group headings in the following way:

- Floristic community types of heavy soils: types 1a, 1b, 2, 3a, 3b, 3c;

- Floristic community types of the seasonal wetlands: types 4 to 19;

- Floristic community types centred on the Bassendean System: types 20 to 23;

- Floristic community types centred on the Spearwood and Quindalup Systems: types 24 to 30c.

The individual floristic community types are discussed in Gibson et al (1994) on pages 29 to 46, where maps of the distribution of sites recorded in each floristic community type are also given. The delineation of the floristic community types provides a regional framework for the assessment of floristic variation on the Swan

Coastal Plain and thus an can enable assessment of the value for flora, at a broad level, of a specific area. However, for some of the floristic community types with more restricted distribution a more specific assessment of value for flora can be made if the floristic community type is known. However, it should be realised that this is a different approach to describing plant communities and that these are broad units of a scale similar to plant associations or formations, i.e., they are mostly quite broad units. (All quotations in this section are from Gibson et al 1994.)

4.4 Comparison of vegetation complexes and floristic community types

Floristic community types can be though of as equivalent to somewhere between the more traditional vegetation association and vegetation formation. They are mostly quite broad units and, are fairly variable in the diversity found in them. Unlike vegetation complexes, the individual plant communities found in them are fairly closely related in terms of species composition although, struture can still vary considerably. As a result, their distribution is somewhat different to that of the vegetation complexes. For example, wetland floristic community types tend to occur across several vegetation complexes. In some cases, there is good correspondence between floristic communitiy type and vegetation complex. In others, such as the Soutern River Vegetation Complex, the complex is made up of a mosaic of different floristic community types.

5.0 AMOUNT REMAINING AND IMPLICATIONS FOR HERITAGE STATUS, OF THE NATIVE VEGETATION TYPES FOUND AT PERTH AIRPORT

5.1 Introduction

The amount remaining overall of the different native vegetation types found at Perth Airport obvously has important implications for the assessment of the national estate value of the remnants of native vegetation found there. The amount of these vegetation types remaining can be assessed in different ways: as a proportion of the original cover of the Swan Coastal Plain, or parts of it (specifically the eastern part where the Perth Airport lies); as a proportion of the original extent of the vegetation complexes represented; or as a proportion of the floristic community types represented. The latter is difficult to do as these units have not been mapped and there are not areas available for them. It would also be possible to look in detail at other mapping of the vegetation of the Swan Coastal Plain by Beard (1979) but, this is unlikely to add much to the analysis.

The conservation status of the individual vegetation complexes are discussed below but, it is currently very difficult to obtain accurate figures on the remaining extent of the vegetation complexes throughout their ranges (figures are available for the Metropolitan Area, but in isolation these are nearly meaningless).

5.2 Amount remaining of the original vegetation of the Swan Coastal Plain south of the Swan River

This area is reviewed because it is the part of the Swan Coastal Plain the Perth Airport lies on and, there are significant changes in the vegetation of the Swan Coastal Plain at or near the Swan River. While there is variation in the extent remaining of the different vegetation complexes and floristic community types found at Perth Airport, the following generalisations can be made about the status of the native vegetation there:

- firstly, the Swan Coastal Plain south of the Swan River is more than ninety percent cleared for agriculture, industrial and urban development. Consequently, most of the vegetation complexes and floristic community types in this area are also more than ninety percent cleared. It is worth while examining

this in the broader perspective of the south-west of Western Australia. Beard and Sprenger (1984) have computed figures on the clearing of different vegetation types and areas of the south-west of the state, based on vegetation mapping (by Beard) and overlays of alienation of land provided by the Lands Department. In arriving at their figures Beard and Sprenger have made the assumption for land alienated from the Crown "that alienated means cleared as it does for practical purposes." However, they note that "By no means all alienated land has been cleared, though the proportion remaining untouched diminishes annually." They give the following figures, that are of particular interest to the present study: Southwest Botanical Province (309,840 km2), 65% cleared; Drummond subdistrict (approximately the same as the Swan Coastal Plain, 14,637 km2) 78% cleared, "but south of Perth, virtually 100%" cleared; Beards unit 30 (Banksia low woodland with scattered Jarrah on the Swan Coastal Plain south of Perth, before clearing 680 km2) virtually "100%" cleared. While Beard and Sprenger's approach has some problems (and thus overstates the situation slightly), it underscores the fact that clearing on the Swan Coastal Plain south of the swan River has been very extensive and that the remnants of vegetation in the Perth Metropolitan Area are very significant not just in the context of urban conservation but, in a regional and natinoal estate context. It should also be noted that their work is now more than ten years old and that there has been substantial clearing in that time.

- secondly the eastern part of the Swan Coastal Plain south of the Swan River is very highly cleared with only very small amounts remaining of the vegetation complexes found in that area (Keighery and Trudgen 1992, Keighery and Keighery 1992, Gibson et al. 1994). That is, the eastern strip of the Swan Coastal Plain south of Perth is more highly cleared than the average for the Plain south of Perth.

The extent of clearing on the Swan Coastal Plain means that the national estate value of the remaining areas of vegetation in the Perth Airport are likely to be high or very high. Factors such as the condition of the vegetation and the diversity of types found would alter a final determination.

5.3 Amount remaining of the Southern River Vegetation Complex

More than 90% of the original extent of the Southern River Vegetation Complex has been cleared and, with at the most five to seven percent of it's total original area remaining, it should be considered to be a rare and endangered ecosystem.

If it is accepted that it is desirable to reserve in secure conservation reserves at least ten percent of an ecosystem, it is obvious that any significant sized remnant of the Southern River Vegetation Complex in good or better condition (see Appendix two for definitions of condition terms) has very significant national estate and conservation value, with the degree of this value depending on its size, its condition and the particular flora, vegetation and fauna present.

5.4 Amount remaining of the Guildford Vegetation Complex

Gibson et al 1994 (quoting unpublished data of A.H. Burbidge and J.K. Rolfe) state that the Guildford Vegetation Complex is 99.4% cleared. That is, only 0.6% of the Guildford Vegetation Complex remains uncleared. Therefore, any area of this complex that remains in a size that is maintainable, even if the condition rating is only poor, has very significant national estate and conservation value.

5.5 Amount remaining of the Bassendean Complex Central and South

The original extent of the Bassendean Complex - Central and South (which extended between Lake Gnangara and the Bunbury area) on the area covered by the vegetation maps in the Atlas of the Darling System (Heddle 1980) was in the order of 87,329 hectares and of this some 3,567 hectares (or 4.1%) may be in reserves in the CALM Central Forest and Swan Regions with possibly a similar area in State Forest (P. Hanley pers comm.). However, much of the area in State Forest appears to have been cleared for pine plantations. (Note, that the Atlas of the Darling District covers most of the original extent of the complexes concerned.)

In contrast to Hanley's figures, Burbidge and Hopper (1989) have stated that 1.6% of the original extent of the Bassendean Complex - Central and South is protected in reserves and the general opinion among botanists familiar with the complex is that somewhat less than 5% of the complex remains with a significant amount of this in

the Jandakot area. The Lowlands block, which is on this complex is "very valuable since it is the only large area of its type between Perth and Bunbury" (D.C.E 1981)

Whichever figures are more accurate, it is obvious that the the Bassendean Complex - Central and South has been extensively cleared and remaining areas of it have very significant heritage and conservation value, with the degree of this value depending on its size, its condition and the particular flora, vegetation and fauna present.

6.0 NATIONAL ESTATE VALUES OF THE FLORA AND VEGETATION AT PERTH AIRPORT

6.1 Introduction

It would be extremely repetitive to discuss the national estate values for flora and vegetation of each of areas A,B, C, and D at Perth Airport individually. The approach that will be taken is to discuss these values for the Airport area as a whole, and then to refer to the values present in each area as necessary when the individual areas are discussed. It should be noted that although the criteria include aspects other than flora (including vegetation as a broad sense of flora) that this report is centred on flora values and the fact that other values are not discussed does not mean they are not present (they are the subject of separate reports).

6.2 Flora and vegetation national estate values present at Perth Airport

6.2.1 Criterion A: Its importance in the course, or pattern, of Australia's natural or cultural history.

Criterion A.1: Importance in the evolution of Australian flora, fauna, landscapes or climate.

The physical environment of the Swan Coastal Plain on which Perth Airport is situated is relatively young compared to that on the adjoining plateau and is quite different in the soils and landforms developed.

This different physical environment has allowed the development of vegetation assemblages (vegetation complexes) which are unique to the Swan Coastal Plain (Heddle et al 1980) and floristic community types which are either unique to the Swan Coastal Plain or are found only on it and adjacent areas with most of their occurrence on the Swan Coastal Plain (Gibson et al 1994). Thus in the broader sense of the term "flora", of including the development of flora as vegetation, the remnants of vegetation at Perth Airport are important examples that demonstrate the evolution of flora in response to a new environment. Thus, the national estate value of the flora remnants at Perth Airport for Criterion A.1 is very high because:

- three vegetation complexes are represented, all of which have been reduced to less than ten percent of their original extent (and thus can be classified as rare

vegetation);

- the remnants are relatively large compared to many other remnants;

- there is some linkage of the remnants which have heritage values;

- a significant proportion of the remnants is of the rarer eastern side of the Swan Coastal Plain floristic community types; and

- a significant proportion of the remnants is in good, very good or excellent condition, with other parts maintaining some national estate value and by providing buffers maintaining national estate values in adjoining areas at a higher level.

In the bushland at Perth Airport there are a number of flora species (B.J. Kieghery pers. comm., see Appendix three) that are either:

- associated with heavy inundated soils on the eastern side of the Swan Coastal Plain;

- associated with the eastern side of the Swan Coastal Plain, generally on sands;

- or, are uncommon taxa in the region.

These are species that have distributions that are indications of the pattern of the natural history of evolution and plant distribution that has occurred on the part of the Swan Coastal that Perth Airport lies on (i.e., the eastern part). The bushland at Perth Airport therefore also has significant heritage value for flora (in the restricted sense of particular species) in the populations of these species

As an example of the landscape developed on the Swan Coastal Plain, that is the landform (geomorphological component) with the vegetation naturally developed on them then the bushland remnants Perth Airport also have high national estate

value under Criterion A.1 for landscape. In the course of Australia's natural history these landscapes have only developed on the Swan Coastal Plain and, the examples at Perth Airport are rare remainders of these landscapes in having both the geomorphological component and the biological component relatively intact.

Criterion A.2: Importance in maintaining existing processes or natural systems at the regional or national scale.

The bushland at Perth Airport maintains a variety of ecological processes or natural systems, including those found in wetlands and damplands of several types and on sandunes and sand drifts of varying shape and height. While from one point of view these processes may be found in all such environments, the particular natural systems developed in the bushland at Perth Airport are either restricted to the Swan Coastal Plain or are found there and also found in other parts of the South West Botanical Province adjacent to the Swan Coastal Plain.

The maintenance of these processes at Perth Airport has high to very high national estate significance because, the extent of clearing on the eastern side of the Swan Coastal Plain is so high that loss of these processes at Perth Airport would have a major impact on the extent of the continued existence of these processes. This is particularly so for the damplands types that are unique to the eastern side of the Plain but, also applies to the wetland types and the types found on the dunes and low sand drifts. In the latter case some of the natural systems found on the lower slopes of low sand drifts (for example with vegetation dominated by Eucalyptus calophylla or Jacksonia stembergiana) are as highly cleared as the damplands restricted to the eastern side of the Swan Coastal Plain and are also restricted to the eastern side of the Swan Coastal Plain.

A very important aspect of the National Estate value of the bushland at Perth Airport relevant to criterion A.2, is that this bushland is virtually the last remaining large example of bushland in the inner Perth Metropolitan area where the particular processes (particularly the dampland/wetland processes) can be maintained.

Criterion A3: Importance in exhibiting unusual richness or diversity of flora, fauna, landscapes or cultural features.

In the sense that there are very few areas of the original vegetation of the eastern side of the Swan Coastal Plain remaining, particularly where there are seasonal damplands in conjunction with Banksia woodlands and wetlands, the vegetation of the Perth Airport is unusual in the diversity of the vegetation present. In one sense, this is largely a product (artifact) of the fact that clearing of the eastern part of the Swan Coastal Plain has been so extensive that most other remnants are much smaller than the total of the bushland areas at Perth Airport and thus most other remnants on the eastern part of the Swan Coastal Plain do not have the diversity of vegetation and flora species found at Perth Airport. However, because the Southern River Complex is a mosaic of the vegetation of damplands typical of the eastern side of the Swan Coastal Plain and of dunes (with Banksia woodland) more typical of the centre of the Swan Coastal Plain this vegetation complex does have an unusual richness or diversity of vegetation and flora compared to some other vegetation complexes on the Swan Coastal Plain (although possibly fewer flora species than some areas of the eastern part of the Swan Coastal Plain such as those at Brixton Street in the City of Gosnells). The result of these two factors is that the bushland at Perth Airport has significant national estate value for "unusual richness or diversity of flora..." (noting, that flora is used here in the wide sense of including vegetation).

6.2.2 Criterion B: Its possession of uncommon, rare or endangered aspects of Australia's natural or cultural history.

Criterion B.1: Importance for rare, endangered or uncommon flora, fauna, communities, ecosystems, natural landscapes or phenomena, or as a wilderness.

The flora of Perth Airport has not been thoroughly studied but, B.J. Kieghery (pers comm, see Appendix three) has recorded species that are uncommon in the region:

- Byblis gigantea
- Levenhookia preissii;

or are on the CALM Priority Flora List:

- Villarsia submersa (P4)
- Stylidium longitubum (P3)
- Verticordia lindleyii ssp. lindleyii (P4)
- Haemodorum loratum (P3)

Priority three (P3), or poorly known taxa are defined as "Taxa which are known from several populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered)." They are "under consideration for declaration as 'rare flora' but are in need of further survey." (Atkins 1992).

Priority four (P4) are rare taxa which are "Taxa which are considered to have been adequately surveyed and which whilst being rare (in Australia), are not currently threatened by any identifiable factors." (Atkins 1992).

Consequently, Perth Airport has a significant national estate value for rare and uncommon flora although (on current knowledge), this value would be less than for some other areas on the east side of the Swan Coastal Plain (e.g. Ellenbrook or Brixton Street). On the available data, this value would reasonably be assessed as moderate although there is no information available on the size of the populations of these taxa at Perth Airport. However, Kieghery has estimated that her work has only recorded 60% of the flora species present at Perth Airport. Goff and Associates (1994) have assembled a list (see Appendix four) of priority and rare taxa that are potentially in the bushland at Perth Airport (i.e. there is appropriate habitat there). While it is unlikely that all the species listed by Goff and Associates are actually at the Perth Airport it is quite likely that a proportion of them are. This leaves open the realistic potential for Perth Airport to have a national estate value for rare and uncommon flora that is higher than moderate, based on the probable presence of a number of such species.

The national estate value of the bushland at Perth Airport for "Importance for rare, endangered or uncommon .... communities, ecosystems..." is much more clearcut.

The three vegetation complexes present have each had more than 90% of their

original extent cleared. The Bassendean Central and South Vegetation Complex had an original area within the area covered by the Atlas of the Darling System of about 87,329 ha, the Southern River Vegetation Complex had about 57,983 ha and the Guildford Vegetation Complex about 92,399 ha (Hanley pers com.). The Bassendean Central and South Vegetation Complex has been reduced to about 5% of its original extent, the Southern River Vegetation Complex to about 8.5% and the Guildford Vegetation Complex to about 0.6%. It is clear from this, that at the vegetation complex/ecosystem level the bushland at Perth Airport has high national estate value. If the total area of bushland at Perth Airport was larger, or less fragmented, this value would have to be assessed as very high.

At a similar level of assessment to the vegetation complexes, there are five or six floristic community types present at Perth Airport (B.J. Kieghery pers comm.). These are floristic community types 12, 5, 20 (subtype 20a), 7, 23 (presumably 23a) and a stand that was intermediate between types 28 and 23. The conservation and reservation status of these is given by Gibson et al (1994) as:

- fct 12. Low risk/well reserved (Melaleuca teretifolia and/or Astartea aff. fascicularis shrublands);

- fct 5. Low risk/well reserved (mixed shrub damplands);

- 20a. Endangered/unreserved (Banksia attenuata woodlands over species rich dense shrublands);

- fct 7. Vunerable/well reserved (Herb rich saline shrublands in clay pans);

- fct 23(a?). Low risk/well reserved. (Central Banksia attenuata - B. menziesii woodlands).

- fct. 28-23. Both 23 and 28 were rated as low risk/well reserved. But, the intermediate may be less widespread and have a different status.

There is an apparent contradiction between the assessment of heritage value based on the vegetation complexes and the heritage value that might be deduced from the conservation/reservation status levels ascribed to most of the floristic community types listed above for Perth Airport. However, Gibson et al (1994) define the term "well reserved" in the following way "known from two or more A class National Parks or Nature Reserves". That is, their use of the term is a very relative one and does not imply that a floristic community type is well reserved in the sense of having an adequate proportion of its original extent in National Parks or Nature Reserves or that the areas reserved are strategically placed. In fact their use of "well reserved" is quite misleading, as many of the floristic community types they describe in this way are certainly not well reserved when criteria such as meeting the IUCN minimum standard of 10% of original extent in secure reserves or other biologically desirable criteria such as large size of reserves and reservation occurring at various parts of the original range are applied (it should be noted that they recognise some of these problems on page 59 of their report). Putting these problems with the terminology of Gibson et al aside, there are some other problems assessing the heritage value of Perth Airport using the floristic community type concept. One of these is the relatively small number of sample sites at the Airport, meaning that not necessarily all types there have been recorded yet. Another is that there are no areas available for the floristic community types (either original extent or portion remaining) meaning that assessing heritage status on the remaining area as a proportion of the original cannot currently be carried out. However, Gibson et al have made guestimates of which floristic community types have "range contractions likely to be > 90%" (their table 23). Of those recorded at Perth Airport (12, 5, 20 (subtype 20a), 7, 23 (presumably 23a) and a stand that was intermediate between types 28 and 23), they rate only floristic community type 7 as being in this category. Their guestimates for at least some of the others may be somewhat generous. For example:

- floristic community type 12 is known from the Perth area to north of Busselton, with most locations being on the eastern half of the Swan Coastal Plain. This whole region is more than 90% cleared, and it is hard to conceive that this floritic community type has faired much better than average.

- floristic community type 20a is only known from the Perth Metropolitan area and may have always been very localised but, it seems unlikely that much more than 10% of its original distribution could survive, if that much does.

- floristic community type 5 is known from Gingin to Harvey, with most records (and two thirds of its range) south of Perth. Again, the area south of Perth is more than 90% cleared and even if there are substantial areas north of Perth it seems unlikely that much more than 10% of the original extent of this type could be extant, if that much.

At a more detailed level, there are plant communities present in the bushland at Perth Airport that are uncommon or very rare. For example, there are:

- the Melaeuca rhaphiophylla woodland/forest on Munday swamp
- the Melaleuca rhaphiophylla tall shrublands on seasonally damp/wet flats (in both area A and area B). A few similar stands are known from the Gosnells area but, the stands there are very heavily weed invaded.

- Stands of Marri (Eucalyptus calophylla) with various understories. Marri stands with good quality understorey are rare on the eastern side of the Swan Coastal Plain. They have a large range of understorey types, even within Perth Airport bushland.

- Stands of Jacksonia sterngergiana tall open shrubland. These are quite rare, occurring where there are thin layers of sand at the edges of low sand drifts over damp areas. There are some in the City of Gosnells (one or two stands). At Perth Airport they are in the bushland adjacent to area A (as interim listed).

- Stands of Banksia littoralis woodland over various understories. Due to the very large loss of wetlands on the Swan Coastal Plain Banksia littoralis woodlands are becoming quite uncommon on the Plain.

So, at the more detailed level of assessment of vegetation there is also demonstrably

significant heritage value for flora at Perth Airport because, there are rare and uncommon plant communities present.

6.0 DETAILED OBJECTION ASSESSMENT FOR FLORA VALUES OF THE BUSHLAND AREAS AT PERTH AIRPORT CURRENTLY ON THE INTERIM LIST OF THE NATIONAL ESTATE

7.1 Introduction

As is evident from the titles of this and the next section, it is proposed (as is required under the contract for this report) to deal with the bushland areas at Perth Airport currently on the Interim Register of the national estate in this section and areas not on the register in the next section. It is proposed to deal with item (i) of the five points defined in Attachment 1 of Australian Heritage Commission 1995 first (see section 1.2 above) and then deal with the other items (ii, iii, iv and v) separately for areas A, B, C and D.

7.2 Adequacy of Commission database

The Commission database in relation to the flora and vegetation at Perth Airport is limited both in scope and quality. It is limited in scope in that the descriptions given of the vegetation are very general and for the flora in that only a very small proportion of native flora of the four areas interim listed is given. It is limited in quality in that the standard of the vegetation descriptions is poor and that the selection of flora species cited is only those used in the description of the vegetation.

7.3 Objection assessment of area A

7.3.1 Grounds for objection which relate to the national estate significance of area A

The FAC has made one objection to the boundaries of area A, through suggesting a slight change to the original boundary (figure five, Tingay and Associates 1993). The change has apparently been suggested so that the boundary would follow a track rather than go through bushland. This is not in fact an objection that relates to the national estate significance of the areas affected by the two alternatives to the boundary but rather based on having a more easily identifiable boundary. While this change might be sensible from the point of view of identifying the area (if the original boundary was appropriate on heritage grounds), it is not based on an assessment of heritage values and would be superseded by recommendations made below.

7.3.2 Appropriateness of the boundaries given the significance of area A

Given the national estate significance of area A (and adjoining areas) for flora and vegetation, the original boundaries are not appropriate. In fact, they are quite inappropriate, as they do not include adjoining areas of vegetation with high national estate value for vegetation and flora. Map one shows the original boundary, the change suggested by the FAC and the recommended boundary for area A.

7.3.3 Significance of area A in relation to the definition of the national estate

Area A has significance for flora communities (vegetation), processes found in damplands and low dunes, and a moderate diversity of flora species. The flora communities of particular significance are representative of those found in the Southern River Vegetation Complex. Flora communities of particular significance are stands of Marri (Eucalyptus calophylla) tall woodland to open forest on low dunes (sand drifts) and stands of Melaleuca rhaphiophylla high shrubland on seasonal damplands (some areas have open water but, it is quite shallow). Both these vegetation types are quite rare due to extensive clearing. Processes of particular importance are those found in the damplands, which have been extensively cleared and, the processes resulting in the development of flora communities related to the interaction between the low sand drifts and the damplands which underlie them (for example, the Marri stands on the lower edges of sand drifts). From this discussion, it is apparent that area A has national estate value in own right however, it also contributes to the national estate value of the whole area of bushland at Perth Airport. Consequently, in my opinion, area A deserves inclusion on the Register of the National Estate.

7.3.4 Comments on the integrity of area A, or other comments of a technical nature

Considering its fairly small size (as interim listed, or as the bushland block of which it is part), area A has retained significant integrity of its national estate values. For example, the condition of the vegetation is quite good, weed invasion is relatively low, processes such as regeneration after fire are still effective and the water relations of the site appear to have not been badly afffected by drains (as indicated by the health of the vegetation.

7.4 Objection assessment of area B

7.4.1 Grounds for objection which relate to the national estate significance of area B

The FAC has made objections to the boundaries of area B through suggesting three changes to the boundaries of the interim listed area in Tingay and Associates (1993, figure five). One of the changes would put the boundary along a track, including some small areas of bushland in the process and excluding a small cleared area. This change is sensible and should be accepted. A smaller change at the other end of area B is also sensible and should be accepted.

The third suggested change is of a different nature, and proposes to exclude a large portion of area B as circumscribed in the interim listing from being permanently listed. The vegetation of this portion of area B is mapped as "obviously disturbed" by Tingay and Associates (1993, figure four). This is the third level on the scale used by Tingay and Associates, which is not generally accepted, although, it parallels in divisions the more generally accepted scale of Trudgen (1988, see Appendix 2),using different names for them.

I recorded condition and plant community descriptions at a number of sites in this disputed area, condition assessments made were: VG-E; VG-E; G-VG (closer to VG); VG; G-VG (if not burnt would be VG-E); G-VG (if not burnt would be VG-E). Where areas have been burnt they are rated a level lower than they would be if unburnt but, the sites are recognised as having the potential to return to the level above if not burnt excessively frequently in the future. Undoubtedly, there were areas where there has been disturbance within this portion of area B (including substantial disturbance such as drains and tracks. However, this is not uncommon in urban bushland areas and much of the vegetation in this disputed portion of area B is in remarkably good condition considering the short distance from the centre of Perth. Consequently, the condition of the vegetation in this disputed portion of area B is such that it retains a large part of any national estate value that the vegetation originally had, it is also in generally better condition than the condition it is mapped as by Tingay and Associates.

The plant (flora) communities present in the disputed area are a subset of the plant communities of the Southern River Vegetation Complex, and as such have high

national estate value. The particular communities present range from more common types in the part of the Southern River Vegetation Complex still extant (in this case Banksia woodland types and Pericalymma ellipticum heath types), to ones that are quite uncommon or rare. The latter included:

- a stand of Banksia telmatiaea low heath. This stand was in a slight depression, weed invasion was low;

- a stand of Eucalyptus calophylla (Marri) low woodland over Xanthorrhoea preissii shrubland over Stirlingia latifolia low open shrubland over a mixed herb/sedge layer. This stand was rated as "good to very good", although it had been burnt (it was only a small part of the Marri woodland present). Weed invasion was low;

- a stand of Melaleuca rhaphiophylla high shrubland over Melaleuca lateritia shrubland over Lepidosperma longitudinale open sedgeland. This stand was on a seasonally damp area, with shallow pools having aquatic flora species. Although it had been burnt, it was rated as "very good", and had very few weeds. Other stands of this vegetation type that I have seen have been heavily invaded by weeds.

Tingay and Associates (1993, page 10, paragraph two) justified the suggested exclusion of the dispute portion of area B in the following way: "However, a significant portion of Area B is considered to be significantly disturbed and its inclusion is not warranted on the basis of vegetation." As the discussion of the area above illustrates, there are two serious flaws in the reasoning of Tingay and Associates. The first, is that they have misinterpreted the condition of the area by having allowed the disturbance of the area to be over-rated. Secondly, they have not adressed the true significance of the national estate value of the vegetation of the area. This is partly because they have not fully identified the vegetation present at the plant community level (their map does not show the first two stands described above, or the variation in the Marri stands) and partly because they simply have not properly identified the true significance of the vegetation at the broader level than plant community type. If they

had properly assessed the national estate value of the vegetation present, they would have found that even if it was as disturbed as they mapped it, then it would still have sufficient national estate value to deserve listing on the Register of the national estate. At the risk of being repetetive, the stands of vegetation concerned are part of a vegetation complex that is cleared below the IUCN recommended minimum reservation level, as such this vegetation complex can be considered rare relative to its former extent. Further, the disputed area contains particular plant communities (see above) that are at least uncommon and almost certainly rare, not only relative to their (presumed) former extent, but, also in an absolute sense. Some of these plant communities would have total areas (of all known stands) of less than tens of hectares, that is, they are rare in an absolute sense.

7.4.2 Appropriateness of the boundaries given the significance of area B

Given the significance of area B and adjoining areas for plant communities (and probably flora, but insufficient detail is available), the interim listed boundaries are not entirely appropriate. This is because they do not include adjoining areas with with national estate value. However, where the boundaries are along the edges of cleared areas they are appropriate given current land use (see 7.4.4 below). Map two shows the original boundary, the changes suggested by the FAC and the recommended boundary for area B.

7.4.3 Significance of area B in relation to the definition of the national estate

Area B has significance for flora communities (vegetation), processes found in damplands and low dunes, and for a moderate diversity of flora species.

The flora communities present are part of the variation found in the Southern River Vegetation Complex, all areas of which have heritage value due to the extensive clearing of this vegetation complex. Flora communities of particular significance are stands of Marri (Eucalpyptus calophylla) woodland on low dunes or shallow sand drifts, stands of Melaleuca rhaphiophylla high shrubland on seasonal damplands (some areas have open water but, it is quite shallow), a stand of Banksia telmataea low heath and the stand of Melaleuca rhaphiophylla on Munday Swamp. These plant communities are quite rare due to extensive clearing.

Processes of particular importance are those found in the damplands, which have been extensively cleared and, the processes resulting in the development of flora communities related to the interaction between the low sand drifts and the damplands which underlie them (for example, the Marri stands on the lower edges of sand drifts).

From this discussion, it is apparent that area B has national estate value. Consequently, in my opinion, area B deserves inclusion on the Register of the National Estate. In addition, the bushland in area B also contributes to the national estate value of the whole area of bushland at Perth Airport.

7.4.4 Comments on the integrity of area B, or other comments of a technical nature

The vegetation in area B is in general in quite good (Good, Very Good or Very Good to Excellent, see Appendix 2 for definitions) condition although there are areas that are more highly disturbed. However, weed invasion is progressing, particularly along more recent disturbances such as drains. Fire has also caused some damage to the vegetation.

7.5 Objection assessment of area C

7.5.1 Grounds for objection which relate to the national estate significance of area C

The FAC has made two objections to the boundaries of area C, through suggesting slight change to the boundaries of the interim listed area (figure five, Tingay and Associates 1993).

The small change to the western boundary takes it out to the edge of the bushland, is sensible and should be accepted.

The change to the eastern boundary is also fairly small but, rather than taking the boundary to an edge of the bushland, takes it to a line dividing areas of different condition in the bushland block in which area C lies. The rationale behind this sugested change is based in Dr Tingay's assertion during the briefing at Perth Airport that bushland areas listed on the Register of the National Estate should only contain areas in the best or near best condition, or the public perception of national estate

listing would be diminished. Notwithstanding the fact that there is a seductive quality to Dr Tingay's argument, it should not prevail because:

- there is a greater danger that if bushland that does not meet his condition criteria for listing has national estate values then, those values may be lost if such areas are not listed and, those values may not be adequately represented in other places.

- the situation with regard to protecting adequate representations of the National Estate values of bushland in many areas of the south-west of Western Australia, particularly on the Swan Coastal Plain, is such that there simply are not always areas that meet Dr Tingay's condition criteria remaining (or not enough to adequately protect the range of heritage values. In such situations areas that still retain heritage value should be listed even if their original value has been lessened.

- it is simplistic, as there is no reason why listed areas should not contain some portions which are in poorer condition than others but still have national Estate values. Or, no reason why a boundary should not be drawn to list areas of national estate value but, which also includes a minor proportion of areas which are either in poor condition or entirely degraded and whose exclusion would result in contorted boundaries or reduction in the values listed if a smaller area was listed.

- areas with vegetation in poor condition, or even physically disturbed, can still maintain heritage values, such as the presence of populations of uncommon or rare species or the continuation of biological processes.

While the area proposed to be excluded by the change to the eastern boundary of area C is related to condition, it has not been demonstrated that the change in condition has extinguished all national estate values and the change should be rejected. In any case, the change would be superseded by recommendations made below.

7.5.2 Appropriateness of the boundaries given the significance of area C

Given the significance of area C and adjoining areas for plant communities (and probably flora but, insufficient detail is available) and processes, the interim listed boundaries are not entirely appropriate. This is because they do not include adjoining areas with national estate value. Taking into account the discussion in the section above and in the introduction (Section 1.0), it would be desirable to extend the area to the east and to include the area to the north. Map three shows the original boundary, the change suggested by the FAC and the recommended boundary for area C. The heritage values of the adjoining areas are discussed in the section immediately below this section.

7.5.3 Significance of area C in relation to the definition of the national estate

As defined for the interim list, area C has national estate values for plant communities of the Southern River Vegetation Complex and the processes found in them. It has national estate value for flora at the species level also, but the information available is not adequate to fully define this.

The area to the north-east of area C includes a linear dampland/wetland complex that appears to be an old (natural) drainage line, which continues westwards towards Runway Swamp. It also has a substantial variety of plant communities, including Marri (Eucalyptus calophylla) woodland; Banksia woodland; Melaleuca preissiana open woodland over Melaleuca rhaphiophylla high scrub; Banksia telmatiaea, Hakea varia, Pericalymma ellipticum, Melaeuca lateritia mixed heath, as well as a wetland. Some of these plant communities are uncommon or rare and the area has heritage value for them as well as for the Southern River Vegetation Complex as a whole. The condition of the vegetation in this block is quite variable but, there are significant parts of it that are in somewhat better condition than figure 3E of Tingay 1994 would suggest, with the retention of heritage values being significant in these as well as in some of the areas that are in poorer condition. The wetland in this area has a population of Villarsia sumersa, a priority four species (rare but not declared rare) and so has national estate value for this species. There has not been an intensive fora survey of the area, so there is the potential that the area has greater value for rare or uncommon species than is currently known.

The interim listed boundaries, the changes suggested by the FAC and the boundaries recommended in this report are shown on map three. As a consequence of the values found in area C, I believe that it and the adjoining areas recommended for inclusion have national estate values that warrant their being placed on the Register of the National Estate.

7.5.4 Comments on the integrity of area C or other comments of a technical nature

Area C as interim listed has a good boundary to area ratio and (except for the small area on the east side which is the subject of the FAC suggested boundary change) has vegetation that is in very good condition. While the inclusion of the areas suggested above would mean that areas of poorer condition vegetation would be included and that the boundary to area ratio would be worsened, this would be offset by an increase in the total area and the inclusion of a wider range of heritage values for plant communities, for flora species and for biological processes. The increase in area would help to assist in the maintenance of the biological processes of national estate value through giving more resilience to perterbations such as fire.

7.6 Objection assessment of area D

7.6.1 Grounds for objection which relate to the national estate significance of area D

The FAC has made two objections to the boundaries of area D through suggesting slight change to the boundaries of the interim listed area (figure five, Tingay and Associates 1993). These changes have apparently been made on assessments of condition (Tingay and Associates 1993, page 10, paragraph one). However, one change (to the western boundary) is small and would substitute a curved boundary for a straight one next to an old sandpit. This change is trivial, and while it would be of little consequence either way on heritage criteria, it would be overtaken by recommendations made below. The other change, which extends along the Tonkin Highway side and adjacent to the railway line is sensible in its general approach, of taking an intrusion into the body of area D out even though this area is in fact significantly degraded. However, I cannot see any point in moving the boundary in a few yards from the interim listed boundary. The practicality is that the margins of such areas in an urban environment are going to be disturbed and more heavily weed invaded than the interior.

7.6.2 Appropriateness of the boundaries given the significance of area D

Given the significance of area D and adjoining areas for plant communities and processes (and probably flora but, insufficient detail is available to properly quantify this), the interim listed boundaries are not entirely appropriate. This is because they do not include adjoining areas with national estate value. Taking into account the discussion in section 7.5.1 above and in the introduction (Section 1.0), it would be desirable to extend the area towards Horrie Miller Drive to include the bushland areas between the interim listed boundary and Horrie Miller Drive. This would efectively link areas D and C. The combined area (i.e. the present reality in the field) has greater heritage value for flora than the two smaller areas (C and D as interim listed) would have if they became isolated. This is because there would currently be movement of animal and insect species within the existing bushland area which would carry pollen and the heritage value of these processes would be lost or reduced by fragmentation of the area. Other processes such as regeneration after fire would also be more effective in a larger area and thus the presently existing larger area has higher heritage value for such processes. The fact that this area includes some small areas that have been sandpits is not of great significance, what is important is the overall suite of values present and the maintenance of processes in the area as a whole. The fact that some areas included would be of poorer condition than others, or even have suffered physical disturbance, is also not of great significance, as they would not be the greater part of the area and would contribute some values themselves. It should be noted, that in the disturbed area next to Horrie Miller Drive that there is a population of Conospermum densiflorum, this species was not recorded at the Perth Airport until the field inspection of the area carried out for this report. This population has national estate significance because it is the most southerly known for the species and demonstrates that disturbed reas can still have national estate values. Map three shows the original boundary, the change suggested by the FAC and the recommended boundary for area C.

7.6.3 Significance of area D in relation to the definition of the national estate

As defined for the interim list, area D has national estate values for plant (flora) communities of the Southern River Vegetation Complex and the processes found in them. It has national estate value for flora at the species level also, but the

information available is not adequate to fully define this.

Area D and and the areas between the interim listed boundary of area D and Horrie Miller Drive differ from area C, B and A in having larger, taller sand dunes. This reflects its position closer to the boundary between the Bassendean Central and South Vegetation Complex and the Southern River Vegetation Complex (in which it lies, on the mapping of Heddle et al 1980). Thus, area D and the areas between the interim listed boundary of area D and Horrie Miller Drive have significant national estate value because they have values that represent part of the transition between the Bassendean Central And South Vegetation Complex and the Southern River Vegetation Complex.

As a consequence of the values found in area D, I believe that it and the adjoining areas recommended for inclusion have national estate values that warrant their being placed on the Register of the National Estate.

7.6.4 Comments on the integrity of area D or other comments of a technical nature

Area D as interim listed has a good boundary to area ratio (except for the intrusion which the FAC objection/recommendations made above on Figure 7.6.2 would remove) and mostly has vegetation that is in very good condition. While the inclusion of the areas suggested above would mean that areas of poorer condition vegetation would be included, the boundary to area ratio would be improved (both for area D and an amalgamated area C/D). The inclusion of areas of poorer condition would by itself have no deleterious impacts that would not occur anyway and their inclusion would increase the total area and the range of heritage values for plant communities, for flora species and for biological processes.

8.0 BUSHLAND AREAS OF PERTH AIRPORT NOT INTERIM LISTED THAT HAVE NATIONAL ESTATE VALUE

In section 6.0 of this report ("National estate values of the flora and vegetation at Perth Airport", see above), the overall national estate values of the vegetation and flora of Perth Airport are discussed. Examination of the areas of vegetation remaining at Perth Airport in the context of that assessment readily show that the four areas (A, B, C and D) at Perth Airport on the interim list of the Register of the National Estate do not contain all the areas of bushland with national estate value at the airport. This was recognised by the FAC's consultants, who in the conclusion of the document that contains the FAC's objections (Tingay and Associates 1993, page 11) stated: "It is the conclusion of this study that the boundaries used to define the area of bushland entered on the interim list of the Register of the National Estate do not contain the full extent of vegetation worthy of listing."

In the discussion of the individual interim listed areas (A, B, C and D) above, additions were recommended that would partially overcome the obvious ommissions from the interim list of the Register of the National Estate for Perth Airport. However, this process was constrained by the necessity not to go outside the required process by proposing "substantial additions"in the first part of the brief for this report (see section 1.0 Introduction). So, the question remains, what should be the overall areas at Perth Airport listed on the permanent Register of the National Estate? To answer this question fully it is necessary to deal with the problem in a way that maturely deals with national estate values at Perth Airport. This requires:

- boundaries that include minor proportions that are significantly disturbed or which include some degraded areas whose exclusion would require convoluted boundaries (e.g. the sand pits near areas C and D);

- the recognition that maintaining the highest level of national estate values at Perth Airport would necessitate including areas of lower national estate value in listed areas becuase of their role in maintaining natural processes auch as the movement of biological material from one high value area to another.

- recognition that some significant heritage values at the airport (for example the vegetation of the Bassendean Vegetation Complex - Central and South) are not represented at all in the areas interim listed, or the proposed additions to those areas made above (maps one to three);

- recognition that a significant heritage value of the bushland at Perth Airport is the overall diversity of the vegetation there; and

- recognition that the combined size of the individual blocks and their near proximity to each other allows the continuation of processes with heritage value and that a reduction of this area would result in loss of national estate values.

Consideration of these factors, and the full extent of national estate values for flora (in the widest sense, including related processes) present at Perth Airport has led me to recommend that the areas A, B, C and D should be retained and the listing should be substantially larger, in effect including most areas of native vegetation at Perth Airport with National Estate value (to be practical, some small areas distant from the main areas of vegetation have been ommitted).

The areas of vegetation on the west side of Horrie Miller Drive should be listed because areas of the Bassendean Vegetation Complex - Central and South there have significant national heritage value and the bushland in this part of the airport contributes to the overall diversity and size of the vegetation at the airport thus adding further to the national estate value of bushland at the airport.

The areas recommended are shown on map four, there are five larger areas, one each based on areas A and B of the interim listing, one combining and expanding areas C and D of the interim listing and two new areas on the west side of Horrie Miller Drive. In addition, there are two smaller areas.

9.0 ACKNOWLEDGMENTS

Dr. Tingay kindly lent a large aerial photograph of Perth Airport with the interim listed areas marked on an overlay, as well as a copy of a report prepared by his firm.

Paul van der Mozel (from Tingay and Associates) kindly allowed me to accompany him during a field trip to the Airport.

The Department of Environmental Protection kindly made available information collected by B.J. Kieghery, including records of flora species and information on the floritic community types present at the Airport.

Mr K. McLean (of the Friends of Perth Airport Bushland) kindly made time available to show me some of the interesting facets of the bushland at Perth Airport.

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APPENDIX ONE: Letters received from voluntary conservation groups

Two letters were received from voluntary conservatin groups, the groups being the "Friends of Perth Airport Bushland" and the "Conservation Council of Western Australia Inc."

CONSERVATION COUNCIL
OF WESTERN AUSTRALIA INC.
79 Stirling Street, Perth 6000
Phone (09) 220 0652 Fax (09) 220 0653

23rd September, 1995

Mr Malcolm Trudgen
90 Arkwell Street
WILLAGEE WA 6156

Dear Mr Trudgen,

PERTH AIRPORT BUSHLAND -

The Conservation Council of Western Australia wish to reiterate its strong support for the nomination of the Perth Airport bushland to the Register of the National Estate. Our nomination includes the bushland to the west and east of Horrie Miller Drive. The Perth Airport bushland is the only significant area of natural bushland left in the region and listing presents an opportunity to recognise this bushland, and its plant and animal communities.

The area was identified in the System 6 study because of its important conservation values. Also recent wetland mapping of the Perth region show that the Perth airport land comprises different wetland types including seasonally inundated and waterlogged areas which support a rich floristic community.

If you require any further information not included in our nomination of the area, please contact Joan Payne at this office on 220 0652.

Yours faithfully,

Joan Payne
Urban Bushland Coordinator

Friends of
Perth Airport Bushland

402 Berwick Street,
St James, W.A. 6102
telephone 361 0373
23 September, 1995

Malcolm Trudgen
Consulting Botanist
90 Arkwell Street
Willagee

Dear Malcolm

re: Objections to Heritage nominations at Perth Airport

As you are aware four small portions of the Perth Airport have been placed on the interim list of the Register of the National Estate. The Friends of Perth Airport Bushland would object strongly to any diminution of the nominated areas A, B, C, and D. Indeed, we believe that all remnant bushland at Perth Airport should be listed, just as the National Trust has already done.

We have a number of reasons for proposing that all the bushland should be listed.

We believe that the ecological and other values of areas A, B, C, and D will decline if they are left as isolated pockets in a large development. Fragmentation in these circumstances leads to damaging edge effects and other problems related to human pressure.

The relatively large size of the airport bushland is very important to its ecological value because it provides a range of habitats which can interact with one another so that, for example, in a fire mobile species can use natural corridors to find safety, alternative food sources and so on. Another example is the aestivation of the western swamp tortoise in Banksia woodland near the type of wetland where the animal is normally found. Unlike some other possible re-introduction sites for the tortoise, the airport has a selection of these habitats in safe proximity to one another.

The size of the Airport Bushland is also important because of the scarcity of natural vegetation on the east side of the Swan Coastal Plain. Genetic diversity is better protected in a large area than in isolated pockets where in-breeding can occur,and fire and other devastating events can cause local extinction because there is no recolonization.

We do not believe that the conditions of particular pieces of the bushland should determine whether one piece should be listed. Other large bushland areas in Perth such as King's Park and Bold Perk are not entirely pristine either. However, they are recognised as having great ecological and social values.....

There is also a need to plan for the future when with continuing improvement in bush management tools and ever greater community interest, degraded areas will be rehabilitated. These options must not be cut off by short-sightedness and lack of vision in the 1990's.

Thank you

Cathy Taylor

Cathy Taylor

for Friends of Perth Airport Bushland.

APPENDIX TWO: Condition scale

From Trudgen 1988.

E = Excellent. Pristine or nearly so, no obvious signs of damage caused by the activities of Europaean man.

VG = Very good. Some relatively slight signs of damage caused by the activities of Europaen man. E.g. some signs of damage to tree trunks caused by repeated fire and the presence of some relatively non-agressive weeds such as Ursinia anthemoides or Briza spp., or occasional vehicle tracks.

G = Good. More obvious signs of damage caused by the activities of Europaen man, including some obvious impact on the vegetation structure such as caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones.

P = Poor. Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of Europaen man such as grazing or partial clearing (chaining) or very frequent fires. Weeds as above, probably plus some more aggressive ones such as *Ehrharta* spp.

VP = Very poor. Severely impacted by grazing, fire, clearing or a combination of these activities. Scope for some regeneration but, not to a state approaching good condition without intensive management. Usually with a number of weed species including aggressive species.

D = Completely degraded. Areas that are completely or amost completely without native species in the structure of their vegetation. I.e. areas that are cleared or "parkland cleared" with their flora comprising weed or crop species with isolated native trees or shrubs.

APPENDIX THREE: Information relevant to the flora and floristic community types present at Perth Airport made available by the Department of Environmental Protection

This material consisted of the following eleven pages (no page three) and a list of floristic community types as follows:

Site	Floristic community type
Perth 01	12
Perth 02	5
Perth 03	20 (20a)
Perth 04	28/23 (closest to Bull.11 fct 28)
Perth 05	7
Perth 06	23 (23a?)
Perth 07	20 (20a)

Department of Environmental Protection System 6 Update : Flora List and Vegetation Notes for M52, Perth Airport (B.J. Keighery 21/2/1995)

Method and Limitations

Approximately two days were spent in the area (20/11/94 and 7/12/94). Work involved the location of floristic sites (Sites 1 - 6 based on units mapped by Tingay 1994), site recording on two occasions and general survey. The floristic sites are established according to the procedures established in Gibson, Keighery, Keighery, Burbidge and Lyons 1994. Time constraints did not allow for the location of floristic sites outside the security area. Some descriptive information (Sites A - L) was collected for the entire area and collections were made of taxa considered of interest. A flora list has been compiled from the floristic site records and records from the general survey.

The year (1994) was unusually dry, there being little rain after the end of October which placed some limitations on sampling in the entire area. There was no free water observed in the seasonally inundated areas surveyed. The area to the south of Site 1 had been inundated but this was dry and much of the annually renewed flora was dead and unable to be sampled.

Flora

All taxa collected in the seven florstic sites, the descriptive sites and limited opportunistic collections are listed in Appendix 1. This list is far from complete as all vegetation units were not sampled (see Vegetation) and no attempt was made to conduct a comprehensive flora survey. It is estimated that this list represents approximately 60% of the taxa expected to be found in the area.

The presence of taxa listed associated with the eastern side of the Plain indicates the presence of alluvial soils in the area. Four taxa are Priority Taxa (Appendix 1), and two of these taxa are considered to be endemic to the eastern side of the Plain (Gibson et. al. 1994).

More detail on individual taxa is given in the vegetation descriptions.

Vegetation

The vegetation of the area has been mapped by Tingay (1994). This mapping is based on dominant species and a diversity of vegetation associations are mapped. This map was used as a guide in locating the floristic sites. The floristic site information is yet to be analysed but at this stage it indicates that there is variation on a floristic level within some of the units mapped by Tingay.

Also, the floristic information indicates that the area is floristically allied to the communities of the Bassendean Sands, the Pinjarra Plain and the eastern sands as is indicated by the geomorphological mapping (Gozzard 1986). This is in keeping with the current regional mapping based on structural units which places the area in the Bassendean Central and South Complex and the Southern River Complex (Heddle et al 1983).

Vegetation Condition

Tingay (1994) maps the condition of the vegetation using a condition scale (Table 2) based on that developed by Trudgen (1991). A modified version of Trudgen's scale is used in this study (Keighery 1994), to record the condition of individual sites (See Vegetation Descriptions).

While the general condition of the vegetation is given in the map prepared by Tingay it should also be noted that within the areas mapped in a single condition category the condition may range through several categories. This is illustrated by the condition ratings given to to Sites 5 ad 6, Excellent and Very Good to Excellent while the whole area is mapped as Very Good (Obvious Disturbance). It is probable that the overall condition rating of the area mapped is

related to a pattern of severe localised disturbance such as the sand mine beside Site 6 and the track alongside Site 5. This disturbance illustrates a general pattern of apparently random disturbance in the area associated with clearing for roads, tracks, drains, sand mines and pasture. Many of the roads and tracks serve no apparent use at this time. Within the security area the disturbance is associated with airport activities. Outside the security area the numerous tracks appear to be the site of regular off-road vehicle use (cars and trail bikes) and associated rubbish dumping (particularly abandoned cars and tyres). This usage has had a significant impact on the vegetation. The disturbed area associated with the tracks provides opportunities for weeds to invade from the previously cleared areas where weeds are well established. The continued activities of the vehicles in the areas cleared for sand mining and the heavy flats in the area of Sites A, G and H effectively prevent regeneration by the native vegetation.

Another significant source of disturbance is the high level of rabbit grazing evident in the area. Sites 1 - 3, 4 and 5 were significantly impacted by rabbit grazing and in many cases by their diggings. This was particularly evident on the second sampling in December.

There was no indication that the area is managed for the values of remnant vegetation in the area. Off road vehicle use, weed and rabbit control in this bushland areas is urgently required.

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Appendix 1: Department of Environmental Protection System 6 Update : Site based Flora List for M52, Perth Airport (B.J. Keighery 21/2/1995)

Native vascular plants are listed alphabetically in families and genera, as are weeds but these are listed alphabetically in genera at the end of the family list.

Key
Column 1 H taxa associated with heavy inundated soils on the eastern side of the Plain
E taxa associated with the eastern side of the Plain, generally on sands
U Uncommon taxa in the region

Column 2 Conservation Code (Atkins 14/9/1994)

Anthericaceae
- Arnocrinum preissii
- Borya scirpoidea
- Johnsonia pubescens
- Laxmannia ramosa
- Sowerbaea laxiflora
- Thysanotus multiflorus
- Thysanotus patersonii
- Thysanotus sparteus
- Tricoryne elatior
- Tricoryne tenella

Apiaceae
- Homalosciadium homalocarpum

H Hydrocotyle alata
E Platysace juncea
- Trachymene pilosa
- Xanthosia huegelii

Asteraceae
- Brachyscome iberidifolia
- Cotula coronopifolia
- Hyalosperma cotula
- Lagenifera huegelii
- Olearia elaeophila

H Podolepis gracilis swamp (GJK 13126)
- Podotheca angustifolia
- Pogonolepis stricta
- Quinetia urvillei
- Siloxerus humifusus
- Waitzia suaveolens

* Hypochaeris glabra
* Ursinia anthemoides
* Vellereophyton "candisimum"

Byblidaceae
U Byblis gigantea

Campanulaceae
- Wahlenbergia preissii

Caryophyllaceae
* Spergula arvensis

Casuarinaceae
Allocasuarina fraseriana
Allocasuarina humilis

Centrolepidaceae
Aphelia cyperoides
H Centrolepis alepyroides
Centrolepis aristata
Centrolepis drummondiana
H Centrolepis glabra
H Centrolepis mutica

Colchicaceae
Burchardia umbellata

Crassulaceae
Crassula colorata
Crassula pedicellosa

Cyperaceae
Baumea articulata
Baumea juncea
Bolboschoenus caldwellii
H Cyathochaeta avenacea
E Cyathochaeta clandestina
Isolepis marginata
Isolepis oldfieldiana
Lepidosperma angustatum
Lepidosperma longitudinale
Lepidosperma scabrum
Mesomelaena pseudostygia
E Mesomelaena tetragona
Schoenus brevisetis
Schoenus clandestinus
Schoenus curvifolius
Schoenus sp. 2 (GJK 5739)
Schoenus tenellus
Tetraria octandra
* Cyperus tenellus

Dasypogonaceae
Calectasia cyanea
Dasypogon bromeliifolius
H Kingia australis
Lomandra hermaphrodita
Lomandra preissii

Dilleniaceae
E Hibbertia aurea
Hibbertia huegelii
Hibbertia hypericoides

Droseraceae
Drosera erythrorhiza
Drosera gigantea
Drosera glanduligera
Drosera macrantha
Drosera paleacea

Drosera pulchella
Drosera stolonifera

Epacridaceae
Astroloma pallidum
E Astroloma stomarrhena
Conostephium pendulum
Conostephium preissii
Leucopogon conostephioides
Lysinema ciliatum
E Styphelia tenuiflora

Euphorbiaceae
Monotaxis grandiflora
Poranthera microphylla

Gentianaceae
* Cicendia filiformis

Goodeniaceae
Dampiera linearis
H Goodenia micrantha

Haemodoraceae
Anigozanthos humilis
E Conostylis aurea
H Conostylis festucacea
Conostylis juncea
Conostylis setigera
E 3 Haemodorum loratum
Phlebocarya ciliata
Phlebocarya filifolia
H Tribonanthes australis

Haloragaceae
H 1 Myriophyllum echinatum

Iridaceae
Patersonia occidentalis
* Gladiolus caryophyllaceus

Isoetaceae
H Isoetes drummondii

Juncaceae
* Juncus capitatus

Juncaginaceae
Triglochin centrocarpum
Triglochin procerum

Lamiaceae
Hemiandra pungens

Lauraceae
Cassytha racemosa

Lentibulariaceae
H Polypompholyx tenella
H Utricularia violacea

Lobeliaceae
Lobelia tenuior
Monopsis simplex

Loranthaceae
Nuytsia floribunda

Menyanthaceae
Villarsia capitata

Mimosaceae
Acacia pulchella
Acacia sessilis •
Acacia willdenowiana

Myrtaceae
Astartea aff. fascicularis
Baeckea camphorosmae
E Calytrix aurea
Eremaea pauciflora
Eucalyptus calophylla
Eucalyptus marginata
Eucalyptus todtiana
Melaleuca lateritia
H Melaleuca pauciflora
Melaleuca rhaphiophylla
Melaleuca sp. B FPR (BJK&NG 054)
Melaleuca teretifolia
H Melaleuca viminea
Pericalymma ellipticum
Scholtzia involucrata
Verticordia densiflora
H 4 Verticordia lindleyi subsp. lindleyi
* Lepidospermum laevigatum

Orchidaceae
Caladenia flava
Caladenia ?georgii ms
Caladenia paludosa ms
Caladenia spp
Diuris carinata
Microtis media
Pterostylis vittata
Thelymitra sp.
* Monadenia bracteata

Papilionaceae
Aotus gracillima
Bossiaea eriocarpa
Daviesia decurrens
Daviesia triflora
Euchilopsis linearis
Eutaxia virgata
Gompholobium tomentosum

Hovea trisperma
Jacksonia densiflora
Jacksonia sternbergiana
Kennedia prostrata
* Lotus angustissimus

Pittosporaceae
Pronaya fraseri

Poaceae
Agrostis plebeia
Amphipogon turbinatus
Cynodon dactylon
Eragrostis elongata
Neurachne alopecuroidea
Stipa compressa
* Aira caryophyllea
* Briza maxima
* Briza minor
* Ehrharta calycina
* Eragrostis curvula
* Vulpia myuros

Portulacaceae
H Calandrinia sp. swamp

Primulaceae
* Anagallis minor

Proteaceae
Adenanthos cygnorum
Banksia attenuata
Banksia ilicifolia
Banksia menziesii
E Banksia telmatiaea
Conospermum ?triplinervium
Dryandra nivea
Hakea sulcata
Hakea varia
Petrophile linearis
Stirlingia latifolia
Synaphea spinulosa

Restionaceae
Alexgeorgea nitens
Hypolaena exsulca
Leptocarpus aristatus
Leptocarpus canus
Leptocarpus roycei ms
Lepyrodia muirii
Loxocarya fasciculata
Loxocarya flexuosa
Lyginia barbata
Restio leptocarpoides
Restio stenostachyus

Rubiaceae
Opercularia vaginata

Rutaceae
Eriostemon spicatus

Santalaceae
Leptomeria cunninghamii

Scrophulariaceae
Gratiola peruviana

Stylidiaceae
U Levenhookia preissii
Levenhookia stipitata
Stylidium calcaratum
H Stylidium dichotomum
H 3 Stylidium longitubum
Stylidium obtusatum
Stylidium repens
Stylidium schoenoides

Xanthorrhoeaceae
Xanthorrhoea preissii

Zamiaceae
Macrozamia riedlei

fidd Villarsia submersa

Appendix 2: Department of Environmental Protection System 6 Update : vegetation Descriptions for M52, Perth Airport

See Map (Figure 9B Tingay 1994) for site locations.

Floristic Sites (1- 7)

Site 1: *Melalueca rhaphiophylla* Thicket over Very Open Low Grass, *Villarsia capitata* and mixed natives and exotic Open Herbs and *Lepidosperma longitudinale* and annual Sedges.
Condition: Very Good to Good

Adjacent area: Site was located on the edge of a well defined ephemeral wetland or sumpland (Semeniuk 1983). The central area of the wetland is dominated by *Melaleuca lateritia* and had contained free water. When sampled in November *Gratiola peruviana* was the dominant herb but the area could contain native aquatic herbs, some of which are Declared Rare Flora (Atkins 1994). Survey would need to be done in early spring to find these. The ground flora contains a significant percentage of weed taxa.and a more accuate assessment of condition wolud need to be made in early spring when the proportion of annually renewed native and weed taxa could be assessed.

There is another sumpland to the north east and this appears to contain similar vegetation.

Site 2: *Melalueca rhaphiophylla* Thicket over *Verticordia densiflora* and.*Eichilopsis linearis* Heath B over *Leptocarpus roycei* Tall Sedges.
Condition: Excellant to Very Good.

Adjacent Area: The *Banksia* Woodland to the south of this wetland obviously impacted by dieback see photo 17 and 18. To the south east there is an area that is Completely Degraded and was reported to be (Security Guard pers comm) the site where fire training is performed.

Site 3: *Eucalyptus calophylla* Forest over *Xanthorrhoea preissii, Jacksonia sternbergiana* and *Stirlingia latifolia* LowScrub B and *Hibbertia hypericoides, Bossiaea eriocarpa* and*Conostylis pendulum* Dwarf Scrub C over *Droser stolonifera* and *Lagenifera huegelii* Very Open Herbs and *Mesomelaena tetragona, Cyathochaeta clandestina* and *Tetraria octandra* Tall Sedges and *Loxocarya flexuosa* and *Loxocarya fasciculata* Very Open Low Sedges.
Condition: Excellent.

Site 4: *Banksia menziesii* and *Banksia attenuata* Low Forest A over *Jacksonia densiflora* and *Allocasuarina humilis* Open Low Scrub A and *Petrophile linearis, Stirlingia latifolia, Baeckea camphorosmae* and *Bossiaea eriocarpa* Low Heath C over *Conostylis aurea, Drosera stolonifera, Drosera erythrorhiza* and *Drosera macrantha* Very Open Herbsand *Loxocarya flexuosa* Very Open Low Sedges.
Condition: Very Good to Excellent.

Adjacent area: Between sites 3 &4 was an area dominated by *Jacksonia sternbergiana* low trees, vegetation structural unit observed when areas are not burnt for many years and which was apparently more widespread on the Swan Coastal Plain in the past (keighery and Trudgen 1992). There is evidence of Jarrah being removed from the area , the Jarrah in the area being coppice growth from felled trees.

Site 5: *Pericalymma ellipticum, Banksia telmatiaea* and *Hakea varia* Heath B and *Verticordia densiflora* and *Dryandra nivea* Dwarf Scrub D over *Drosera gigantea, Conostylis festucacea* and *Tribonanthes australis* Herbs and Low Sedges.
Condition: Excellent.

Adjacent area: Site 5 is charcteristic of the depressed area of the sumpland in which it falls the edges are charcterised by scattered Marri over *Melaleuca preissii* Low Open Woodland A. Of interest in the understorey are: *Stylidiun dichotomun, Borya scirpoidea , Helipterum cotula* and

Restio leptocarpoides. A clump of *Kingias* were observed in this sumpland. The adjacent upland is characterised by Site 6. To the north is another sumpland (not mapped by Tingay) with a similar fringing vegetation but *Melaleuca rhaphiophylla* was also present and the depressed area of the sumpland was *Astartea* aff. *fascicularis* and *Pericalymma ellipticum* Heath A over scattered Herbs and Sedges like those found in Site 5. *Melaleuca rhaphiophylla* and *Banksia littoralis* are scattered through the Heath.

Site 6: *Banksia menziesii, Banksia attenuata* and *Nuytsia floribunda* Low Woodland A over *Acacia pulchella* and *Jacksonia floribunda Open Low Scrub B and Gompholobium tomentosum, Eremaea pauciflora* and *Stirlingia latifolia* Low Heath C and *Hemiandra pungens* Open Dwarf Scrub D over *Amphipogon turbinaus* and *Ehrharta calycina* Very Open Grass and *Patersonia occidentalis, Conostylis juncea* and *Johnsonia pubescens* Open Herbs and *Loxocarya flexuosa* Very Open Low Sedges.
Condition: Very Good to Excellent.

Site 7: *Eucalyptus marginata* Open Woodland and *Banksia menziesii* Low Woodland A over *Allocasuarina humilis* and *Jacksonia densiflora* Low Scrub B and *Stirlingia latifolia* , *Gompholobium tomentosum* and *Leucopogon ? squarrosus* Low Heath C and *Petrophile linearis* and *Hibbertia hypericoides* Low Heath D over *Amphipogon turbinatus* Very Open Grass and *Waitzia suaveolens, Conostylis aurea* and *Patersonia occidentalis* Open Herbs and *Mesomelaena pseudostygia* and *Lyginia barbata*. *Loxocarya fasiculata* , *Loxocarya flexuosa* and *Alexgeorgia nitens* Open Sedges.
Condition: Excellent.

General Sites (A - L)

Munday Swamp: fringed with *Melaleuca rhaphiophylla* and *Eucalyptus rudis* Forest over *Baumea articulata* Tall Sedges.

Site A: *Melaleuca rhaphiophylla* Low Forest over scattered *Melaleuca lateritia* over *Baumea articulatea* Tall Sedgeland and *Lepidosperma longitidinale* Low Sedges.

Site B: Mixed Thicket. Dominant species in Thicket include *Hakea varia, Melaleuca rhaphiophylla* and *Astartea* aff. *fascicularis*. *Melaleuca rhaphiophylla* occurs as a tree in the centre of the wetter areas.

Site C: Heath A.and Low Scrub A. *Pericalyma ellipticaum* is the dominant in much of the Heath and Low Scrub. This area of Heath and Low Scrub are similar to Sites 2 and 5 being more complex in general than 2 but less than 5.

Site D: *Kunzea recurva, Jacksonia* aff. *sericea, Xanthorrhoea preissii, Verticordia lindleyi* subsp. *lindleyi, V. densiflora* and *Dryandra nivea* Low Heath C over *Stylidium dichotomum* Herbs and *Restio leptocarpoides* Low Sedges.
Condition: Excellent.

Site E: *Banksia* Low Woodland, equivilant to Site 6.

Site F: This area was recently burnt (?summer 1993/94) and there were several herbs in the area which occur more conspicuously after fire; *Byblis gigantea* and *Levenhookia preissii* . Both taxa are uncommon in the Perth Metropolitan Region, known from very few collections on the Swan Coastal Plain and were not encountered by Gibson et. al. (1994). These are significant populations of both of these taxa.

Site G: *Melaleuca viminea* Low Scrub A over *Baumea juncea* Tall Closed Sedges This general area was very disturbed and in someplaces completely cleared. Scatterred occurrences of late flowering (*Podolepis gracilis* 'swamp') or perennial taxa associated with the heavy soils

of the Pinjarra Plain (*Leptocarpus aristatus*, *Melaleuca pauciflora*, *Bolboschoenus caldwellii*). Areas of vegetation similar to Site 5 occur on the sandier soils alongside these clay flats.

Site H: This sandy ridge was *Banksia* Low Woodland but the area appears to have been cleared in the past. Regrowth has occurred. An unusual form of *Conospermum triplinervium* occurred in a small population on this ridge. The presence of undulate leaves on some of the individulas in the population indicate that the population may be hybridising with *Conospermum undulatum* (E. Bennet pers. comm). *Conospermum undulatum* is a rare taxa confined to the Forrestfield area that has been recommended for Declared Rare Flora (Gibson et al 1994).

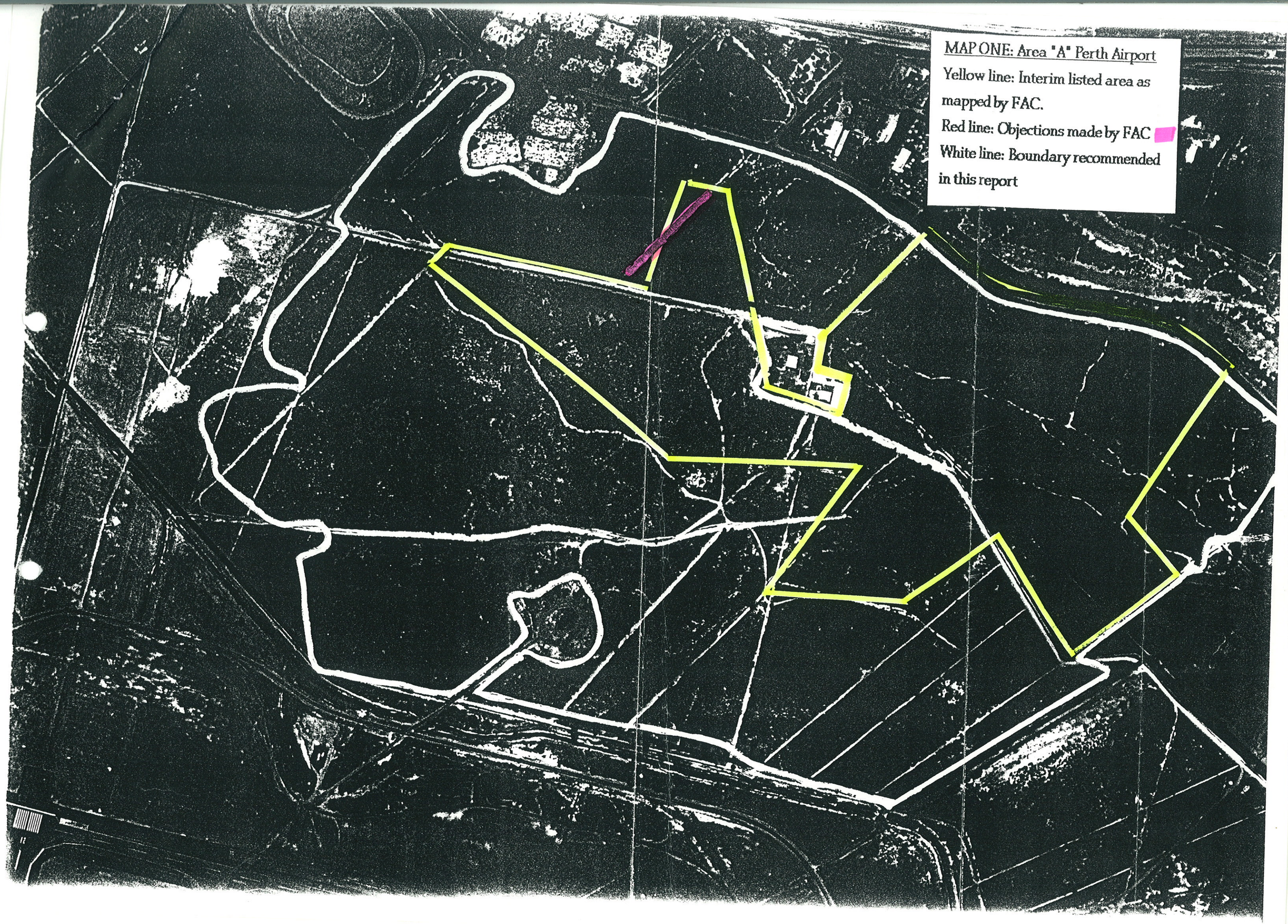
Site I: Scattered *Eucalyptus calophylla*, *Melaleuca presissiana* and *Eucalyptus rudis* over *Hakea varia*, *Aotus gracilima*, *Melaleuca teretifolia*, *Eutaxia virgata* and *Astartea* aff. *fasciculatis* Dense Heath B over *Lepyrodia muirii* and *Lepidosperma longnitudinale* Sedges. The most significant weeds in the ara are **Lepidosperma laevigatium* and **Eragrostis curvula*.
Condition: Excellent with areas of severe localised disturbance.

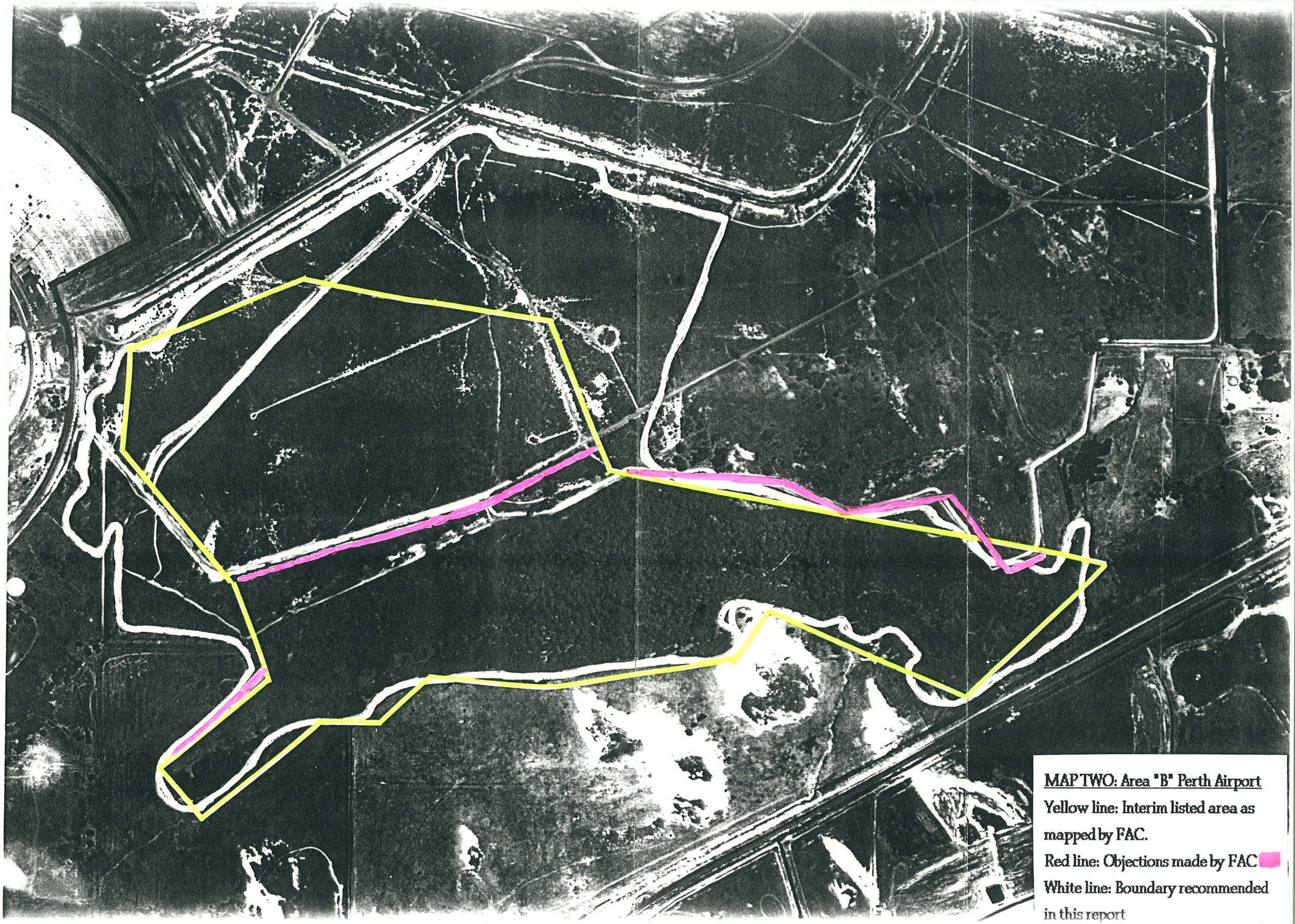
Site J: *Banksia menziesii*, *Banksia attenuata* and *Banksia ilicifolia* Low Forest A over scattered shrubs over **Ehrharta calycina* and **Briza maxima* Open Grass and *Phlebocarya ciliata* Herbs and *Lyginia barbata* Very Open Low Sedges.
Condition: Good

Site K: *Pericalymma ellipticm* and *Astartea* aff. *fascicularis* Heath B over Sedges. The area of the site is fringed with a Low Woodland of *Melaleuca preissiana*., scattered individuals also occur in the community.
Condition: excellanr to Very Good.

Site L: *Eucalyptus marginata* Very Open Woodland over *Banksia attenuata* and *Banksia menziesii* Low Woodland A over Low Heath C. The community appears closely related to the site located in Dianella Open Space. *Conostylis aurea* .is present which is often associated with Floristic Community Type 20a.
Condition: Excellent.

APPENDIX FOUR: A list of priority and rare taxa that are potentially in the bushland at Perth Airport, or are already known there (from Goff and Associates 1994).


MAP ONE: Area "A" Perth Airport
Yellow line: Interim listed area as mapped by FAC.
Red line: Objections made by FAC
White line: Boundary recommended in this report

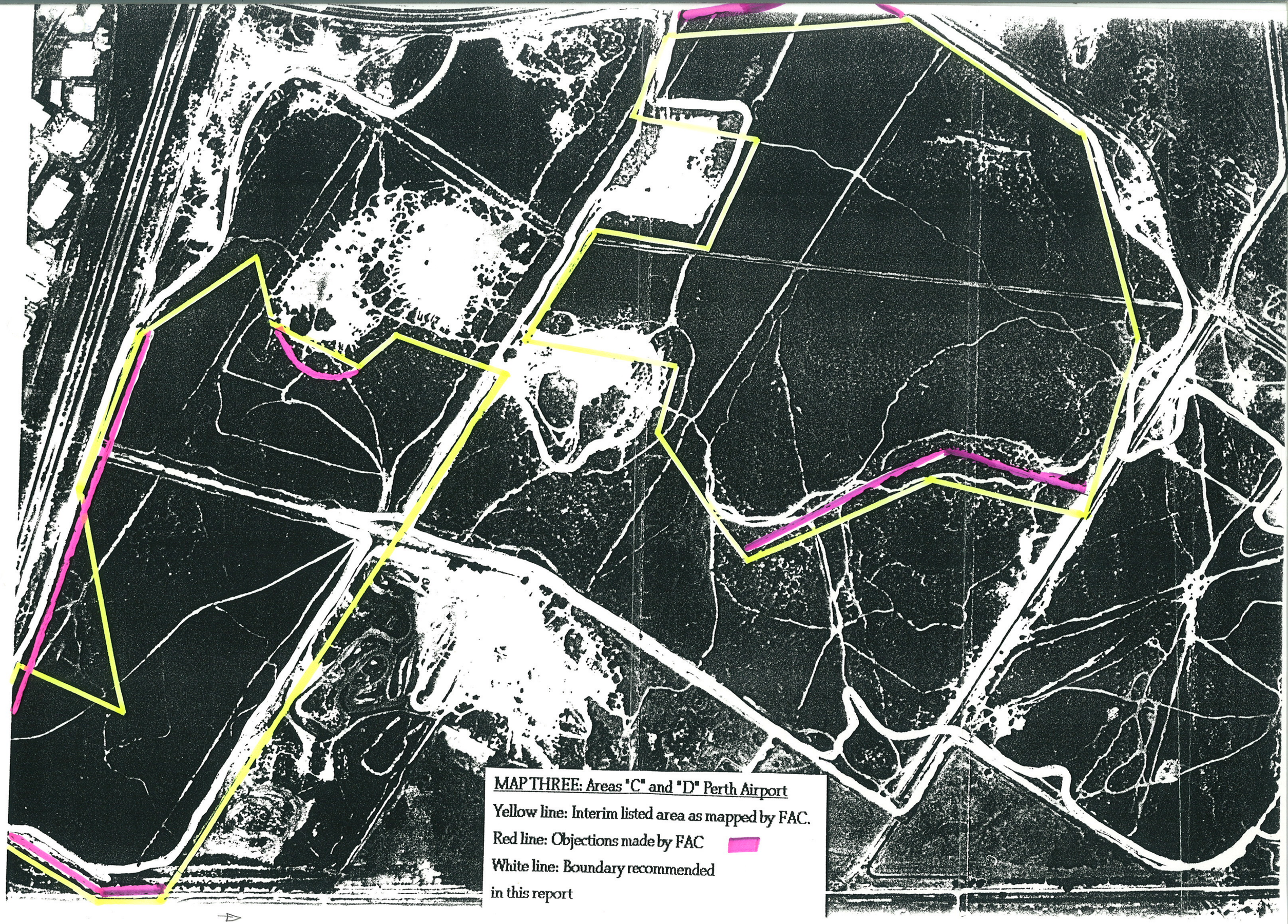


MAP TWO: Area "B" Perth Airport

Yellow line: Interim listed area as mapped by FAC.

Red line: Objections made by FAC

White line: Boundary recommended in this report



MAP THREE: Areas "C" and "D" Perth Airport

Yellow line: Interim listed area as mapped by FAC.

Red line: Objections made by FAC

White line: Boundary recommended in this report

Department of Environmental Protection
- Technical Report

The natural values of bushland and wetland areas of the Perth Airport with particular reference to the Perth Airport Preliminary Draft Masterplan and the Preliminary Draft Environmental Strategy prepared for the Westralia Airport Corporation.

CONFIDENTIAL

May 1998

INDEX

1 Introduction 1

2 Identification and Description of the Values of Natural Areas in the Perth Airport 1

2.1 Introduction 1
2.2 Determination of Conservation Value of Natural Areas on the Swan Coastal Plain with special reference to natural areas in the Perth Airport 1
2.2.1 Regional and area specific natural value datasets 1
2.2.2 Datasets available for describing the bushland/wetland areas at Perth Airport 2
2.2.3 Use of the natural value datasets in the PDMP and PDES 2
2.3 Identification of the values of the Perth Airport bushland/wetland areas at the national, state and local level 5
2.4 Identification of the values of individual natural areas at Perth Airport 6
2.4.1 Prioritisation of natural areas in the PDMP and PDES 6
2.4.2 Information sets used for describing individual bushland areas in Perth Airport 6
2.5 Prioritisation individual natural areas at Perth Airport and determination of protection 7
2.5.1 Prioritisation individual natural areas at Perth Airport according to described natural values and previous determinations of significance 7
2.5.2 Location of Developments in relation to prioritisation of natural areas 8
2.6 Recommendations - Identification of Areas for Conservation 8

3 Management 9

3.1 Management and recognition of conservation areas 9
3.2 Recommendations - Management of Conservation Areas 10

4 Public consultation 10

4.1 The public consultation process 10
4.2 Recommendation - Public Consultation 10

5 Perth Airport as a gateway to Western Australia and role in presenting values of world famous flora 10

5.1 Western Australia's unique flora and the Perth Airport 10
5.2 Recommendations - Landscaping 10

6 References 10

Appendix 1: Summary of Regional Conservation Values of Perth Airport Bushland 13
Appendix 2: Guide to Draft Perth's Bushplan 18
Appendix 3: Values of bushland/wetland areas at Perth Airport. 20

Map 1: Location of individual area described in Appendix 3
Map 2: Regionally significant remnant vegetation at Perth Airport
Map 3: Location of Zones 1-7 proposed in the PDMP and PDES

1 Introduction

The description of the Perth Airport's natural values is considered an essential step in identifying the constraints framework for the Preliminary Draft Masterplan (PDMP) and the scope of the Environmental Strategy (PDES). The principles identified to manage on site impacts (PDES pES-4), as quoted below, are supported and commended

- "Identifying areas within the airport precinct which have natural and indigenous value.
- Optimal siting of development to minimise disturbance to areas identified as having high conservation value.
- Developing and implementing Environmental Management Plans for various areas categorised according to past and future use."

These principles are addressed in this report under three broad headings
- identification of natural areas and description of their values
- comparison of the areas on the basis of their natural values and impact of proposed developments on these areas
- management of natural areas.

This report also comments on the public consultation process and the overall landscaping of the Perth Airport in relation to the state and the local area's natural values.

2 Identification and Description of the Values of Natural Areas in the Perth Airport

2.1 Introduction

The first principle identified in the PDMP and PDES to manage on site impact (PDES pES-4), "Identifying areas within the airport precinct which have natural and indigenous value.", addresses the identifcation of the natural areas on the Perth Airport lands.

2.2 Determination of Conservation Value of Natural Areas on the Swan Coastal Plain with special reference to natural areas in the Perth Airport

2.2.1 Regional and area specific natural value datasets

The Perth Airport lies on the Swan Coastal Plain in the Swan Coastal Plain Biogeographic region (Thackaway and Cresswell 1995). The identification of values of an area at the national and state level should refer to the region as this gives the context for a comparison.

The natural values of the Swan Coastal Plain are relatively well documented. Any consideration of regional significance of a natural area on the Plain should consider the standard, and generally widely available, sets of biological information on the Swan Coastal Plain outlined in Table 1. These are not 'new' information sets and should be used in the initial determination of a bushland/wetland area's regional conservation values.

The individual natural attributes of each area, according to the categories outlined in Table 2, should be compared with and compliment the regional information sets in the final determination of regional conservation value.

Table 1: National and Regional Information Sets for the Swan Coastal Plain used in Perth's Bushplan and other studies

Key

*	datasets used in Alan Tingay and Assoc. 1998
#	datasets given partial consideration in Alan Tingay and Assoc. 1998
•	datasets not used by Alan Tingay and Assoc. 1998

*LANDFORM AND SOIL (various sources)

VEGETATION AND FLORA
*Vegetation Complex (Heddle *et al.* 1980)
•Floristic Community Types (Gibson *et al.* 1994, DEP 1996)

WETLANDS
*Wetland Types (Hill *et al.* 1996a, Hill *et al.* 1996b)
Consanguineous suite (Hill *et al.* 1996a, Hill *et al.* 1996b)
*Wetland Management Objective (Hill *et al.* 1996a, Hill *et al.* 1996b)
*Lake EPP

•THREATENED ECOLOGICAL COMMUNITIES (English and Blyth 1997)

*THREATENED SPECIES (*CALM current Declared Rare and Prioity Flora and Fauna Lists, #reports, *own survey)

*INTERNATIONAL AND NATIONAL SIGNIFICANCE
•Reference to international treaties, *listing on the register of the National Estate etc.

Table 2: Specific Area Information (the limitations of any survey work should be clearly stated)

Key

*	datasets used in Alan Tingay and Assoc. 1998
#	datasets given partial consideration in AlanTingay 1998
•	datasets not used by AlanTingay and Associates 1998

*Landscape features

Vegetation and Flora (#any existing information and *own survey)
*Structural units (should be mapped and related to on the ground descriptions)
*Vegetation Condition (should be mapped)
Total Flora, #including total flora (level of survey should be indicated), #significant flora (DRF, priority taxa, range extensions, species at geographic limits etc.)

Fauna (#any existing information and *own survey)

Linkage (adjacent bushland areas)

2.2.2 Datasets available for describing the bushland/wetland areas at Perth Airport

A series of studies have included the area of the Perth Airport (see Section 6). All of the studies are available in a published format or from the relevant agency/individual. The Department of Environmental Protection (DEP) supplied Sinclair Mertz Knight with Keighery (1994) and Department of Environmental Protection (1996, information relevant to Perth Airport given in Keighery 1997) in December 1997.

2.2.3 Use of the natural value datasets in the PDMP and PDES

The PDMP (12-8 to 12-9) and PDES consider the natural values of the Perth Airport in a national, state and local context and then prioritise individual areas according to these values. While many of the information sets outlined in Section 2.1 are used in the assessment for the PDMP and PDES there are some significant omissions in the datasets used (see Table 1 and 2).

The most recent floristic study of the Swan Coastal Plain (Gibson *et al.* 1994, which was used as the basis for the determination of the floristic based threatened ecological communities) and threatened ecological communities (English and Blyth 1997) are not referred to. Information on the floristic community types and threatened ecological communities is considered by the Department of Conservation and Land Management, DEP and MfP as critical in determining regional significance.

TABLE 4: Vegetation Condition Scales commonly used in the Perth Metropolitan Area

Condition scale used in BUSHPLAN DIRECTORY from Keighery (1994)	Condition scale from Trudgen (1993)used to derive Keighery (1994), Connell (1995) and Alan Tingay and Associates 1994b	Condition scale used in PEP MAPPING after Connell (1995)
Pristine (1) Pristine or nearly so, no obvious signs of disturbance	**Excellent (E) Undisturbed** Pristine or nearly so, no obvious signs of damage caused by the activities of European man	No equivalent unit
Excellent (2) Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species	**Very Good (VG) Slightly Disturbed** Some relatively slight signs of damage caused by the activities of European man. For example, some signs of damage to tree trunks caused by repeated fires and the presence of some relatively non-aggressive weeds such as *Ursinia anthemoides* or *Briza* spp., or occasional vehicle tracks	**Very Good (vg)** Evidence of localised low level damage to otherwise healthy bush. Seedling recruitment and generally healthy population size (age/stage) structure apparent. Weed and grazing damage is confined (<20% of area). Some modification to vegetation structure due to changes in fire regimes may be apparent. Evidence of logging or fire wood collection may be found. High likelihood that vegetation structure and species richness can be maintained.
Very Good (3) Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing	**Good (G) Disturbed** More obvious signs of damage caused by the activities of European man, including some obvious impact on the vegetation structure such as caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones.	**Good (g)** Evidence of localised high level damage to otherwise low level damaged bush. Recruitment is localised and the populations of some species may be senescent. Weed and grazing damage is apparent in 20-50% of the area. Modification to vegetation structure due to changes in fire regimes may be apparent. Localised gall and parasitic plant damage may be apparent. Evidence of logging or fire wood collection. Moderate likelihood that vegetation structure and species richness can be maintained.
Good (4) Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing	**Poor (P) Obvious Disturbance** Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of European man such as grazing or partial clearing (chaining) or very frequent fires. Weeds as above, probably plus some more aggressive ones such as *Ehrharta* spp.	**Poor (p)** Widespread high level damage. Recruitment is disrupted and most woody species appear senescent. Weed and grazing damage may be apparent throughout >50% of the area. Modification to vegetation structure due to changes in fire regimes may be apparent. Locally some vertical strata are absent. Gall and mistletoe damage apparent. Evidence of logging or fire wood collection. Low likelihood that vegetation structure and species richness can be maintained or re-established.
Degraded (5) Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing	**Very Poor (VP) Severely Disturbed** Severely impacted by grazing, fire, clearing, or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species including aggressive species.	**Very Poor (vp)** Widespread high level damage. Recruitment is disrupted and most species appear senescent. Weed and grazing damage apparent throughout the area. Modification to vegetation structure due to changes in fire regimes apparent. Widespread loss of vertical strata. Gall and mistletoe damage apparent. Evidence of logging or fire wood collection. Little to no likelihood that vegetation structure and species richness can be re-established.
Completely Degraded (6) The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora composing weed or crop species with isolated native trees or shrubs.	**Completely Degraded (D) Degraded** Areas that are completely or almost completely without native species in the structure of their vegetation. ie. areas that are cleared or "parkland cleared" with their flora comprising weed or crop species with isolated native trees or shrubs.	Not used - does not apply to bushland.

All datasets listed above were used in the description of the Perth Airport bushland/wetlands given in Appendix 1. All known/available information was used to prepare this description. This description differs from that given in the PDMP and PDES (p3-1 to 5) on the following points.

- The area contains areas of Guildford, Southern River and Bassendean units not only the latter two (PDES p3-1).
- The vegetation condition is consistently downgraded in the PDMP and PDES by
  - use of subjective terminology that names the standard categories (see Table 3) according to a level of disturbance (PDES p3-1, 3) (Note: Environment Protection Agency 1996 considers the use of different condition ratings at Perth Airport) .
  - allocation of general condition ratings to blocks in variable condition, especially frequent tracks, when much of the area may be in a less disturbed condition (PDES p3-1, 3).
- Flora surveys have recorded 295 native taxa (Dixon 1983, Alan Tingay and Associates 1994b, DEP 1996) which is estimated to be around 70% of the expected flora not 227 native taxa (PDES p3-1, after Dixon 1983, Alan Tingay and Associates 1994b).
- No reference is made to the 3 wetland floristic community types and 3 upland floristic community types (after Gibson *et al.* 1994, DEP 1996) Note: as a result of further survey and consideration of the floristic data on Perth Airport bushland/wetland areas for this report it is considered that two other floristic groups, types 11 and 15 are also present.
- Three of the floristic community types are threatened ecological communities.
- Incomplete reference to priority flora (see Table 4).
- Incomplete reference to significant flora (see Table 4).
- Inaccurate reference to priority flora as *Scaevola repens* was incorrectly called *Scaevola paludosa* in the Flora of the Perth Region, *Scaevola repens* which is the taxon present in the PMA is not a priority taxon.
- Other studies list at least 121 native vertebrate taxa for the Perth Airport (Alan Tingay and Associates 1994a, How 1995, How and Dell 1993): 8 frogs, 87 birds, 2 freshwater fish, 22 reptiles, 2 mammals not 118 as quoted in the PDES (p3-4).

Table 4: DRF and Priority Flora and significant flora listed for Perth Airport

Key

*	listed in PDES p3-4
()	DRF (R) and priority codes (1, 2,3,4)

**Conospermum undulatum* (R)
**Myriophyllum echinatum* (3)
**Stylidium longitubum* (3)
**Haemodorum loratum* (3)
**Schoenus benthamii* (3)
Conostephium minus (4)
Villarsia submersa (4)
**Verticordia lindleyi* subsp. *lindleyi* (4)

possibly, should be searched for
Macarthuria keigheryi (R)
Eucalyptus marginata subsp. *elegantella* (1)

Significant flora
Banksia telmataea
Platysace juncea (uncommonly recorded on the Swan Coastal Plain in the PMA)
Byblis gigantea (rarely recorded on the Swan Coastal Plain in the PMA)
Conospermum triplinervium (hybrids with *C. undulatum*)
Levenhookia preissii (rarely recorded on the Swan Coastal Plain)
Cheilanthes austrotenuifolia (uncommon on the Plain, associated comminutes that are heavily cleared)
Verticordia nitens (only currently recorded population south of Gnangara in the Perth Metropolitan Area)
Villarsia violifolia (uncommon on Plain)

34 taxa associated with eastern side of the Plain

In addition the significance of the diversity of vegetation associations is not recognised in the PDMP and PDES. Forty different vegetation associations are mapped (Alan Tingay and Assoc. 1994b) and many of these units contain a series of different structural and/or floristic units. For example:

- *Melaleuca rhaphiophylla* dominates a series of areas where it occurs as a tree or tall shrub and grows with a different assemblage of wetland species; in the northern bushland area swamps (Map 1, Area 2B) where it is a shrub there is *Melaleuca rhaphiophylla* Tall Scrub over *Villarsia capitata* Open Herbland and *Lepidosperma longitudinale* Sedgeland and at Munday Swamp (Map 1, Area 1C) where it is a tree there is *Melaleuca rhaphiophylla* and *Eucalyptus rudis* Low Forest over *Baumea articulata* Sedgeland, two very different associations, both mapped (PDES Fig 3.1) as *Melaleuca rhaphiophylla* Low Forest to Woodland. There are many other different associations dominated by *Melaleuca rhaphiophylla* in Areas 1A (not mapped in PDES Fig 3.1), 1D, 1E etc; and
- *Banksia attenuata* Low Woodland in areas 1B and 3C are different floristic community types, floristic community type 20a in Area 1B is generally associated with sands from the eastern side of the Swan Coastal Plain (Forrestfield and Guildford units) and floristic community type 23a in Area 3C with central sands (Bassendean units).

These examples further highlight the range of wetland and upland units present in the Perth Airport bushland/wetland areas and the occurrence of units representative of the eastern side of the Plain and the central Plain.

2.3 Identification of the values of the Perth Airport bushland/wetland areas at the national, state and local level

The bushland/wetland areas within the boundaries of the Airport have been recognised as having regional conservation value (that is having national and state significance) for many years. In 1983 the System 6 Report (Department of Conservation and Environment 1983) recognised the values of the bushland within the Airport's boundaries. Work for the System 6 Update (for Perth Airport contained in Keighery 1994 and 1997), other more recent studies (Kuchling and Burbidge 1996) and national comparisons (ANCA 1996, Trudgen 1995) have further recognised the values and significance of the bushland/wetland areas at Perth Airport. The DEP has brought the values of the Airport's bushland to the attention of the past managers, the Federal Airports Corporation (FAC), and the present managers Westralia Airports Corporation (WAC) on many occasions.

The datasets described in Section 2.2.1 (applied to Perth Airport bushland/wetland areas in Appendix 1) have been used in the preparation of the update of the conservation area recommendations for the Swan Coastal Plain (Perth Metropolitan section to be released as Perth's Bushplan, Appendix 2). This set of information was used to determine regional significance in Perth's Bushplan. The regional significance of much of the bushland/wetland areas at Perth Airport was upheld (see Map 2).

While the PDMP and PDES recognise the national and state significance of much of the bushland/wetland areas at Perth Airport, these values are often understated. The following examples illustrate this.

- The information from MfP (quoted as Perth Environmental Project, from Connell 1995, MfP 1996) is incorrectly considered under 'local' significance. The information from MfP on ecological significance primarily relates to the recognition of at least 10% of each vegetation complex (after Heddle *et al.* 1980) in the PMA in accordance with the State Government's Urban Bushland Strategy (Government of WA 1994). That is bushland with a rating of 5% and 6-10% indicates that the bushland is regionally significant. Bushland with these ratings was of high consideration for inclusion in Perth's Bushplan.
- In independently assessing the National Estate Significance of bushland/wetland areas at Perth Airport, Trudgen (1995) recommended that there were two parcels of bushland to the west of the airport that contained vegetation worthy of being listed on the National Estate. This is not referred to in the PDMP or PDES. The boundaries of the eastern bushland/wetland National Heritage Listed Areas (PDES Fig 3.4) are very close to those recommended by Trudgen (1995).

In addition to its national and state significance the bushland in Perth Airport has substantial local significance as Perth Airport is located in a series of highly cleared local government areas. The bushland/wetland areas in the Airport constituting the largest area of bushland on the Swan Coastal Plain in these local areas. The most highly cleared of these, and that in which the majority of the

Airport is found, is the City of Belmont. The only other significant area of non-estuarine bushland in the City of Belmont, is the three hectare Signal Hill Reserve.

2.4 Identification of the values of individual natural areas at Perth Airport

2.4.1 Prioritisation of natural areas in the PDMP and PDES

Individual areas of bushland/wetland within the boundaries of the Perth Airport were prioritised for conservation purposes in the PDMP and PDES primarily with reference to vegetation condition (quality) and wetlands as well as fauna and available habitat and visual amenity (outlined in Alan Tingay and Assoc. 1998). As discussed previously (Sections 2.2.3) this consideration has not included all known current information and has incorrectly interpreted other information.

2.4.2 Information sets used for describing individual bushland areas in Perth Airport

In keeping with the approach in the PDMP and PDES each bushland/wetland area (as delineated in PDES Fig 3.5, p3-12, this report Map 1) has been described according to its natural attributes and previous determinations of national/regional significance. Descriptions of each of the areas are found in Appendix 3. Except in a few cases where land outside the Perth Airport is also included each of area is comparable with those in the PDMP and PDES. The areas have been placed in three groups , 1, 2&3 as in the PDMP and PDES but the subgroups are named alphabetically rather than numbered to indicate that this is not a prioirty ranking. The notation used for each area in the PDMP and PDES is indicated in each description. Each of the information sets and how these were applied in describing the areas is outlined below.

(i) Natural Attributes

Bushland/Vegetation Condition

- Bushland: bushland is defined as

"Bushland is land on which there is vegetation which is either a remainder of the natural vegetation of the land, or, if altered, is still representative of the structure and floristics of the natural vegetation, and provides the necessary habitat for fauna." (Keighery and Gray 1993, Connell 1995, adapted from the Government of New South Wales State Environmental Planning Policy No 19 - Bushland in Urban Areas).

- estimated percentage of each bushland/wetland area present as being determined from Ministry for Planning (1996), Trudgen (1995) and aerial photography interpretation, that is tracks and discernible areas of cleared and degraded land (that is condition ratings 5&6 excluded, see Vegetation Condition below and Table 4) were excluded to estimate the percentage;
- vegetation condition: estimated range of areas of each condition rating from most common to least common after Alan Tingay and Associates 1994b, DEP 1996, Keighery 1994 & 1997, Trudgen 1995 and aerial photography interpretation;
- condition ratings are numbered from 1(best condition) to 6 (cleared). Table 4 gives the relationship between the four condition ratings used in the background documents to this report. When names are used they are after Keighery 1994 (these names are used in Perth's Bushplan).

Vegetation Complex

- from GIS dataset after Heddle, Loneragan and Havel 1980.

Mapped Vegetation Units

- presence of wetland and/or upland units, estimated percentage of wetland given;
- number of vegetation associations as mapped in Alan Tingay and Associates 1994b with additional units from DEP 1996, Keighery 1994 & 1997 and Trudgen 1995 (as discussed in Section 2.2.3 units with the same notation are not necessarily equivalent).

Floristic Community Types/Threatened Ecological Communities

- plot based floristic community types after Gibson *et al.* 1994, from DEP 1996 and Keighery 1997, this plot based work was used to infer groupings elsewhere;
- additional proposed based floristic community types after Gibson *et al* 1994, from DEP 1996 and Keighery 1997 and field visit by Keighery in April 1998, these are indicated with an asterisk (wetland floristic community types 11 and 15 are considered to be present in the area);
- threatened ecological communities after English and Blyth 1997 from analysis of plot records (DEP 1996) or inferred from floristic observations (see above).

Flora

- presence of Declared Rare Flora, Priority Flora and other significant species from Alan Tingay and Associates 1994b, DEP 1996, Keighery 1994 & 1997;
- diversity from number of taxa per 10m X 10m plot (as used for floristic work Keighery 1997).

Fauna (in general the diversity of vegetation associations indicates a diversity of habitat)

- Birds recorded in area (as quoted in How 1995);
- suitable habitat for Western Swamp Tortoise (after Kuchling and Burbidge 1996);
- Quenda habitat.

Wetland Classification

- estimated percentage of conservation and resource enhancement category wetlands (after Hill *et al.* 1996a and 1996b);
- area conservation and resource enhancement after field/aerial photography check (after Semeniuk 1997) (Note: resource enhancement are considered to have significant conservation values but are in need of management to maintain/restore these values A. Hill pers. comm.).

(ii) National/Regional Significance

Area considered to be of regional (state) and/or national significance by previous studies

- on Interim List of the Register of the National Estate (AHC 1997)
- considered worthy of placing on the Interim List of the Register of the National Estate (after Trudgen 1995)
- includes nationally significant wetlands after Australian Nature Conservation Authority 1996
- System 6 1983
- Masterplan: refers to level of recognition in PDMP and PDES
  - estimated percentage areas found in the Conservation Zones (Zones 5 and 7) are designated as category 1 (dark green) and category 2 - buffer (light green)
  - estimated percentage areas for conservation in other zones could not be given as while there is reference to protection the area to be protected is not identified
- rank by MfP, classes top 5%, 6-10% and 11-20%
- proposed for inclusion in Perth's Bushplan

2.5 Prioritisation individual natural areas at Perth Airport and determination of protection

2.5.1 Prioritisation individual natural areas at Perth Airport according to described natural values and previous determinations of significance

Comparison of the descriptions in Appendix 3 with reference to - vegetation condition (average and range), vegetation associations and floristic community types (diversity, rarity), flora (diversity, rarity), habitat (diversity, rarity), fauna (diversity, rarity) and regional(state) and national studies; indicates that there are four categories of significant areas. That is

Category 1: 1A, 1B, 1C, 1D and 1E (core areas with highest values, consistent recognition and least disturbance)
Category 2: 3C, 2B, 2I, 2J, 3I and 2G (equivalent to above but greater areas of localised disturbance)
Category 3: 2D, 2E, 2F, 3K, 3I, 3J (increasing level of disturbance in relation to total area)
Category 4: 2A, 2C, 3A, 3D, 3E, 3G, 3F, 3H and 2H (as above).

While this is consistent with the priorities set by the PDMP and PDES at the highest priority there is less consistency at the Priority 2 and 3 levels (PDES Table 3.1, p 3-10 to 3-11). That is the recognition in the PDMP and PDES of undoubted high priority areas of natural value, such as Munday Swamp and core natural areas in the north eastern corner (Northern Conservation Area, Zone 7 - part Area 1A, 1B) and south eastern corner (South-eastern Conservation Area, Zone 5 - part Areas 1D and 1E) is strongly supported by comparison of the descriptions in Appendix 3. The most significant differences between the two prioritisations is the considerably higher ranking of areas 3C and 3I in this reports ranking. Both areas are considered, in this report's analysis, to contain regionally significant communities (also threatened ecological communities) which have high habitat value. As a consequence using maps in the PDMP (base map PDMP Fig 12.8) that only shows Priority 1 and 2 areas as being constrained by natural values is effectively undervaluing the natural values and significance of the bushland/wetland areas at Perth Airport.

Also, the prioritisation of individual areas in isolation is an inadequate representation of an area's value. Most of the areas considered are part of larger blocks of bushland/wetland. As part of this larger area the smaller areas have greater value. As a consequence the areas as grouped in Map 2 are considered to be of highest regional significance. It is difficult to compare the consolidated areas (and the individual areas) as each has significantly different values associated with their position on the Plain and the group of communities they contain.

This grouping does not include some areas identified in the process of determining regional significance in Perth's Bushplan however it does represent the consolidated areas of highest priority for protection. Bushland/wetland areas outside the boundaries given in Map 2 have significance but at a lesser level.

2.5.2 Location of Developments in relation to prioritisation of natural areas

The second principle identified in the PDMP and PDES to manage on site impact (PDES pES-4) calls for the "optimal siting of development to minimise disturbance to areas identified as having high conservation value."

Siting of the develpoments is considered under two headings relating to the nature of the proposed developments.

(i) Proposed airfield/terminal uses (essential airport functions)

While the majority of the areas given highest priority in the PDMP and PDES are given recognition in the Conservation Areas (Zones 5 and 7) substantial areas of high priority bushland/wetland are proposed for development (see Appendix 3 under Masterplan for each area).

It is appreciated that the third runway has been located to reduce impact on the highest priority areas identified in the PDMP and PDES it is impacting significantly on areas of considerable significance - Areas 3C, 2D and 2E. In addition further development of the existing N/S runway proposes to impact on Area 2I (Category 2 this study).

(ii) Proposed non - airfield/terminal uses (non-essential airport functions)

In the areas of non-airfield/terminal uses where there are substantial areas of natural value identified there is no current delineation of conservation areas. This is not satisfactory. As discussed above these areas have considerable natural value, complimentary to the above values that should be recognised and protected. The determination of significance in this report is consistent with that for Zone 2 in environmental assessment (EAR 1996). The prioritisation in this study and the PDMP and PDES give sufficient scope to identify clearly areas for conservation in Zones 6 and 2. While environmental assessment is planned for future the broad directions in this plan should and can be clearer as regards conservation lands.

All areas recognised with conservation as there primary purpose should be given statutory recognition, through covenanting or another equivalent level of protection. At this stage this could be applied to Zones 5 and 7 for conservation. There is some confusion in the PDMP and PDES as to the future for these areas (Table 5.3 makes reference to "development works" within this area) which is inconsistent with conservation. Covenanting of all conservation areas would make the future intentions clear.

In addition the actual designation of areas for protection of natural values should be clearly indicated. The areas in Zone 7 that are not naturally vegetated and have apparently been included in the conservation area as buffers to Munday Swamp and for their Indigenous Values should be described as such.

2.6 Recommendations - Identification of Areas for Conservation

- Protection of the Northern Conservation Area (Zone 7) and the South-eastern Conservation Area (Zone 5) be supported by statutory recognition of the conservation areas, through covenanting or another equivalent level of protection.

- If two categories of conservation area are to be used they should be clearly identified and the potential uses highlighted.

• That the claims to retention of 15% of the airport as conservation areas be modified to reflect the proportion of the airport retained as conservation in the long term.

• That the Bushplan agencies (DEP, CALM, MfP and WRC) liaise with WAC during the current public comment period to determine an agreed prioritisation of bushland/wetland areas using all available information. The community conservation groups should be invited to participate.

• At the present time all bushland /wetland areas designated on Map 2 should be protected and managed for conservation. Other bushland/wetland areas should be retained and managed for conservation wherever possible.

• The general management directions described for the bushland/wetland areas in the designated conservation areas (Zones 5 and 7) should be applied to all bushland/wetland areas identified in Map 2.

• Such management should continue until bushland/wetland areas are deemed required to be essential airfield and terminal related uses after environmental assessment as proposed in the PDMP and PDES. When clearing does occur this should be minimised. In some cases vegetation can be periodically mown rather than cleared.

• Bushland/wetland areas shown on Map 1 should not be available for development in the commercial zones (Zones 2A, 2B, 2C and 6) for non airfield or terminal support uses. Any commercial development in these areas should be outside the bushland/wetland areas and be designed to avoid impact on the values of the bushland/wetland areas. These areas should also have statutory recognition, through covenanting or another equivalent level of protection.

3 Management

3.1 Management and recognition of conservation areas

The third principle identified in the PDMP and PDES to manage on site impact (PDES pES-4), "Developing and implementing Environmental Management Plans for various areas categorised according to past and future use.", addresses the issue of managing the natural areas. This statement and the direction and actions summarised in Tables 5.2 and Table 5.3 (PDES p5-8, p5-9) indicate the management direction and some actions in the conservation zones and areas of bushland outside these areas.

The "accommodation of natural heritage on the airport through sensitive planning, integration and presentation of natural values"(PDMP 11-1) is endorsed . The activities outlined in Table 5.3 (PDES, p5-9) are generally supported with the following qualifications/comments:

• All areas designated as having high priority for conservation (Map 2) should be managed to maintain "species diversity and remnant bushland".

• Any bushland/wetland areas determined, after environmental impact assessment, to be needed for airfield and terminal uses OR other developments should be subject to minimal "clearing/disturbance".

• As discussed areas of conservation priority in the non airfield/terminal development zones (see Section 2.5.2) should be identified and given some level of protection and management as well as encouraging grouping of development to minimise impacts on the areas and reduce infrastructure costs (PDMP 11-4)

• Given the considerable value placed on the bushland/wetland areas by the state and community the WAC should be supported in its management by CALM, DEP, WRC, MfP and the interested community. Groups such as the Friends of Signal Hill Bushland, the newly formed Belmont Catchment Group and the Kalamunda Reserves group have the interest and the expertise to aid in the management of the conservation areas.

• The height and fauna usage of trees around Munday Swamp should be carefully monitored to obtain information on the impacts of potential tree pruning (PDES p5-5) with the possible runway construction. Any plantings in the non-vegetated buffer areas should be designed to avoid potential tree pruning.

• Preference be given to retention of areas rather than regeneration/restoration of degraded areas.

• Regeneration/restoration efforts should focus on the localised disturbance within high priority conservation areas, buffer areas and linkage.

3.2 Recommendations - Management of Conservation Areas

• WAC work with CALM, DEP, WRC, MfP and the interested community to manage all designated conservation areas.

• The general management directions described for the bushland/wetland areas in the Northern Conservation Area and the South-eastern Conservation Area are supported. These protection measures should be supported by statutory recognition of the conservation areas, through covenanting or another equivalent level of protection.

4 Public consultation

4.1 The public consultation process

The issues associated with the identification and protection of bushland/wetland areas at the Airport were to be considered prior to the release of the PDMP and PDES through a Conservation Special Interest Group (state conservation agencies and community conservation groups). The Public Consultation Strategy leading to the PDMP and PDES was not adequate to allow for effective input from state government and community groups. Some government agencies involved in conservation issues and key conservation groups were invited to attend preliminary workshops and two Environment /Conservation Special Interest Group meetings (PDES Table 7.2). However key government agencies, the Department of Conservation and Land Management the Water and Rivers Commission are not listed for the Environment /Conservation Special Interest Group. The Water and Rivers Commission attended the last Special Interest Group meeting when a DEP officer drew the meeting to the attention of a WRC officer involved in Perth's Bushplan.

In addition, while it is stated that there was 'extensive input of diverse range of Commonwealth, State and Local Government Authorities, community, environmental groups and interested individuals.' (PDMP 12-1) there is uncertainty as to the use of this information (see Section 2.2.2, 2.2.3)

A series of concerns about the process and outcomes have been raised by DEP with the primarily related to the very limited time frame for members of the Conservation Special Interest Group to comment on any specific conservation issues to be raised in the PDMP and PDES.

As a consequence the Public Consultation Strategy leading to the PDMP and PDES was not adequate to allow for effective input from state government and community groups. In particular there has been no significant discussion concerning the determination of priority areas. These boundaries were finalised in the PDMP and PDES in the final week before release. This is noted in the PDES (p7-2) and is clearly acknowledged in the PDMP and PDES through the following comments:
- "The need to justify the designated priority areas - the technical background reports should be made available during the comment process" and
- "Further discussions would be important during the 90-day comment period to clarify and identify areas considered to be of significance within the proposed development areas."

4.2 Recommendation - Public Consultation

• Discussion and comment by the Environment /Conservation Special Interest Group on the prioritisation of conservation areas and the rationale on which this was based and the final determination of lands in the conservation zones (Zones 5 and 7) needs to be addressed in the current public consultation period.

5 Perth Airport as a gateway to Western Australia and role in presenting values of world famous flora

5.1 Western Australia's unique flora and the Perth Airport

Western Australia has a diverse and unique flora of world heritage value. Many people specifically visit WA to observe and enjoy this flora. The Airport has a unsurpassed opportunity to introduce travellers and Western Australian residents to this flora as:

- there are significant bushland/wetland areas within walking distance of the international terminal which are seen from the air on arrival

- arrivals from the east pass over contrasting heavily cleared areas (Wheatbelt) and vegetated areas (Goldfields, Darling Plateau).

These two features could be the basis of an innovative and dynamic introduction to the flora. A focus of the programme should be the retention of significant conservation areas complemented by appropriate landscaping of the Airport itself and the proposed bushland sensitive design of new development areas.

5.2 Recommendations - Landscaping

• Landscaping within the Perth Airport, outside conservation areas, should be designed to complement the natural landscape values and use local plants as a fitting introduction to the unique and wonderful flora of Western Australia.

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Appendix 1: Summary of Regional Conservation Values of Perth Airport Bushland

(updated for this report to include additional inferred floristic community types)

The naturally vegetated areas (bushland) of Perth Airport Bushland as shown on the Map 1, are of regional conservation value and represent plant communities and habitat that are poorly reserved. The clearing and destruction of habitat in this area is considered to have unacceptable environmental impacts.

Containing both vegetated wetlands and uplands in excellent to good condition the bushland in the area is typical of the interface of the Bassendean Dunes and the Pinjarra Plain. The area is mapped as the Guildford Complex, Southern River Vegetation Complex and the Bassendean Complex Central and South (Heddle *et al* 1980).

The Guildford and the Southern River Vegetation Complexes have been heavily cleared and it is estimated that over the entire area the range of the complexes less than 0.6% of the former (Burbidge and Rolfe 1986) and less than 8% of the later complex (8.6% Burbidge and Rolfe 1986 and 7% Trudgen and Keighery 1995) remains uncleared. Within the Perth Metropolitan Area 5% of the former and 18% of the later complex was considered to be uncleared in 1994 (Dixon *et al* . 1994). Therefore in the context of Government's policy, outlined in the Urban Bushland Strategy (Anon 1995), which aims to protect 10% of each vegetation complex the area is considered to be regionally significance and poorly conserved.

The Perth Airport Bushland is an excellent example, both structurally and floristically, of the Bassendean Central and South and Southern River Vegetation Complex. This is one of the few areas representing the intergrade of these two complexes in the Perth Metropolitan Area. The area also contains the intergrade of the Southern River and Guildford Complexes. Generally the areas of the mapped Guildford Complex in the Perth Airport are degraded to completely degraded but there are intact communities (good and better condition) floristically typical of wetlands and uplands of the eastern side of the Swan Coastal Plain (Guildford and Forrestfield Complexes) in the areas mapped as Southern River. These floristic community types (after Gibson *et al.* 1994) are 'threatened ecological communities' (English and Blyth 1997). Floristic community types typical of the eastern side of the Plain would be expected to occur in the Southern River Complex as it contains elements of the complexes of the eastern side of the Plain and the central Plain (Bassendean Central and South). That is the plant communities of the area have particular value as they contain both communities of the eastern side of the Swan Coastal Plain and the central Plain (Bassendean Sands).

Much of the area of the Perth Airport is wetland. Within the area of regionally significant bushland in the Perth Airport are over 500ha of 'Conservation Category' wetlands which have been identified by Hill *et al.* (1996b and Map 1) and verified in 1997 (V&C Semeniuk 1997). Recognition of the wetlands is also consistent with the Government's policy, outlined in the Wetland Conservation Policy for Western Australia (1997) which has the primary objective of preventing "..the further loss or degradation of valuable wetlands and wetland types..".

The western areas of bushland on the Airport land are contiguous with areas identified within the Draft Greenways (Alan Tingay and Assocs 1998).

In addition the bushland areas identified in the area of Perth Airport have the following specific conservation attributes:

- one species of Declared Rare Flora and seven Priority taxa

- three 'threatened ecological communities' (after English and Blyth 1997) have been identified in the area (Endangered (floristic community type 20a, 20b), Vulnerable (floristic community type 7);

- the area has a rich fauna including 8 frog species (typical assemblage of the eastern side of the Plain); 87 bird species (7 of which are uncommon on the Plain, only 2 other areas match the species richness in the Perth Metropolitan Area, in top 6% of wetlands for breeding species); 2 species of native freshwater fish; 22 reptiles and a 1970 record of the critically endangered Western

Swamp Tortoise (*Pseudemydura umbrina*); Echidna (*Tachyglossus aculeatus*), large populations of Quenda (*Isoodon obesulus*);

- Munday Swamp has an unusually rich and diverse invertebrate fauna (82 species), including several rare species, and the only significant populations of two WA endemic fish, the western Pygmy Perch (*Edelia vittata*) and Western Minow (*Galaxis occidentalis*) in the Perth Metropolitan Area (Robson and Charter 1989);

- Munday Swamp and adjacent lands to the north are considered to be of Aboriginal heritage value (Australian Archaeological Survey Consultants 1995);

- a series of uplands and wetlands are considered suitable habitat for Western Swamp Tortoise release (Kuchling and Burbidge 1996); and

- Munday Swamp, Runway Swamp, Link Road Swamp and sumplands east of the main runway are wetlands of national significance (ANCA 1996).

Description of Perth Airport Bushland

REGIONAL INFORMATION

LANDFORM AND SOILS (Jordan 1986)

Pinjarra Plain

Guildford Formation (Qpa: Mgs1)

Bassendean Dunes

Bassendean Sands (Qpb: S8)

Bassendean Dunes/Pinjarra Plain

Bassendean Sands over Guildford Formation (Qpb/Qpa: S10)

Wetlands (within the Bassendean Dunes and Pinjarra Plain)

Holocene Swamp Deposits (Qhw: Cps)

VEGETATION AND FLORA

Vegetation Complex (Heddle *et al.* 1980)

Pinjarra Plain

Guildford Complex

Bassendean Dunes

Bassendean Complex - Central and South

Combinations of Bassendean Dunes/Pinjarra Plain

Southern River Complex

Floristic Community Types (Gibson *et al.* 1994 and DEP 1996) * not sampled types inferred

Supergroup 2 - Seasonal Wetlands

4 *Melaleuca preissiana* damplands
5 Mixed shrub damplands
7 Herb rich saline shrublands in clay pans
*11 Wet forests and woodlands
12 *Melaleuca teretifolia* and/or *Astartea* aff. *fascicularis* shrublands
*15 Forests and woodlands of deep seasonal wetlands

Supergroup 3 - Uplands, centred on Bassendean Dunes and the Dandaragan Plateau

20a *Banksia attenuata* woodlands over species rich dense shrublands
20b Eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands (most northerly occurrence)
23a Central *Banksia attenuata - B. menziesii* woodlands

WETLANDS (Hill *et al.* 1996a & b)

Wetland Types: lake, sumpland, dampland, palusplain, artificial channel, creek

Consanguineous suite

Bassendean - Pinjarra transition OR Bassendean with fluvial features

Mungala (B/P.2)

Wetland Management Objective: Conservation (539.775ha), Resource Enhancement

Lake EPP: 38ha

THREATENED ECOLOGICAL COMMUNITIES (English and Blyth 1997)
Not assessed, Endangered (floristic community type 20a, 20b), Vulnerable (floristic community type 7, 15)

AREA DETAIL

Landscape Features: lake, vegetated wetlands, vegetated uplands

Vegetation and Flora: detailed survey (Alan Tingay and Associates 1994b); limited survey (DEP 1996 (Perth 01-10))

Structural Units: mapping (Alan Tingay and Associates 1994b)
Uplands: *Eucalyptus calophylla* Woodland; *Eucalyptus marginata* Woodland; *Eucalyptus rudis* Woodland; *Banksia attenuata*, *B. menziesii* and *Allocasuarina fraseriana* Woodland; *Banksia attenuata*, *B. menziesii* and *B. ilicifolia* Woodland
Wetlands: *Banksia littoralis* Low Woodland to Forest; *Melaleuca preissiana* Low Woodland; *Melaleuca rhaphiophylla* Low Woodland; *Melaleuca rhaphiophylla* and *Eucalyptus rudis* Forest; *Jacksonia sternbergiana* Closed Tall Scrub to Tall Shrubland; *Jacksonia furcellata* Open Shrubland; *Adenanthos cygnorum* Shrubland; *Kunzea ericifolia* Tall Shrubland; *Hakea varia* Closed Heath; *Regelia ciliata* Shrubland; *Astartea* aff. *fascicularis* Closed Heath; *Pericalymma ellipticum* Shrubland; *Melaleuca teretifolia* Open to Closed tall Scrub; *Melaleuca viminea* Open Heath; Mixed Open Heath; *Acacia saligna* Shrubland to Open Tall Scrub; Sedgelands of *Leptocarpus* species, *Baumea articulata* or *Typha domingensis*

Remnant vegetation: not applicable

Vegetation Condition: >60% Excellent to Very Good with <40% Good to Degraded (units from Keighery 1994 from mapping by Alan Tingay and Associates 1994b)

Total Flora: 295 native taxa (Alan Tingay and Associates 1994b, DEP 1996; estimated >70% expected flora)

DRF/Priority and significant flora: *Conospermum undulatum* (R), *Myriophyllum echinatum* (3), *Stylidium longitubum* (3), *Haemodorum loratum* (3), *Schoenus benthamii* (3, Alan Tingay and Associates 1994b)*Conostephium minus* (4), *Villarsia submersa* (4), *Verticordia lindleyi* subsp. *lindleyi* (4), possibly *Macarthuria keigheryi* (R) and *Eucalyptus marginata* subsp. *elegantella* (1); *Platysace juncea*; *Byblis gigantea*, *Conospermum triplinervium* (hybrids with *C. undulatum*), *Levenhookia preissii* (rarely recorded on the Swan Coastal Plain), *Cheilanthes austrotenuifolia* (Alan Tingay and Associates 1994b, uncommon on the Plain, associated comminutes that are heavily cleared), *Verticordia nitens* (Alan Tingay and Associates 1994b, only currently recorded population in south of Gnangara in the Perth Metropolitan Area), *Villarsia violifolia* (uncommon on Plain); 34 taxa associated with eastern side of the Plain

Fauna: survey by Tingay and Associates (1994a), How (1995), (How and Dell 1993): for frogs (8) (typical assemblage of the eastern side of the Plain); 87 bird species (7 of which are uncommon on the Plain, only two 2 other areas match the species richness in the PMA, in top 6% of wetlands for breeding species); 2 species of native freshwater fish; 22 reptiles and a 1970 record of Western Swamp Tortoise (*Pseudemydura umbrina*); Echidna (*Tachyglossus aculeatus*) sighted, large populations of Quenda (*Isoodon obesulus*). Munday Swamp has an unusually rich and diverse invertebrate fauna (82 species), including several rare species, and the only significant populations of two WA endemic fish, the western Pygmy Perch (*Edelia vittata*) and Western Minow (*Galaxis occidentalis*) in the PMA (Robson and Chester 1989)

Linkage: fragmented bushland linkage north west to Swan and to 'Greenways corridor' to south west

Other Attributes: Munday Swamp and adjacent lands and lands to the to the north are considered to be of Aboriginal heritage value (Australian Archaeological Survey Consultants 1995), a series of uplands and wetlands are suitable for Western Swamp Tortoise release (Kuchling and Burbidge 1996). Munday Swamp, Runway Swamp, Link Road Swamp and sumplands east of the main runway are wetlands of national significance (ANCA 1996). The National Trust of Australia (WA) Classification; substantial sweep of soils and communities from eastern to central Plain (Bassendean Sands)

INTERNATIONAL AND NATIONAL SIGNIFICANCE
part Bushplan Site on Register of the National Estate Interim List; ANCA directory of important Wetlands in Australia.

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V. &C. Semeniuk Research Group, 1997 Verification of the Conservation Category Wetlands in the Perth Metropolitan Area. Unpublished report to the Waters and River Commission.

APPENDIX 2:

Introducing the *DRAFT PERTH'S BUSHPLAN*

The *Draft Perth's Bushplan* identifies natural areas of regional conservation value on the Swan Coastal Plain (SCP) portion of the Perth Metropolitan Area (PMA) (see Map overleaf). These natural areas have been identified by a coordinated programme between the Ministry for Planning (MfP), Department of Environmental Protection (DEP), Department of Conservation and Land Management (CALM) and Water and Rivers Commission (WRC). The respective authorities - Western Australian Planning Commission, Environmental Protection Authority, National Parks and Nature Conservation Authority and Waters and Rivers Commission will review and sign off on the *Draft Perth's Bushplan* and refer the report to the appropriate Ministers for their consideration.

The *Draft Perth's Bushplan* is planned to be released for a three month public comment period in early-mid 1998.

The release of the *Draft Perth's Bushplan* contributes to addressing the Government's commitment to the identification of regionally significant areas in the Urban Bushland Strategy, the Wetlands Conservation Policy, the update of the System 6 report and the National Strategy for the Conservation of Biodiversity within the Swan Coastal Plain portion of the Perth Metropolitan Area. A similar coordinated programme will continue for the remainder of the System 6 area and the Swan Coastal Plain portion of System 1.

The natural areas recognised in the *Draft Perth's Bushplan* are identified as Bushplan Sites. The areas within the Sites were selected on the basis of information collected and collated for the Perth Environmental Project (MfP), the System 6 Update (DEP), CALM regional survey and wetland mapping and evaluation work (WRC). A series of criteria, as defined in the report, were used to select the areas.

The *Draft Perth's Bushplan* is in two volumes, each in three parts:

VOLUME 1: THE REPORT TEXT

1. Introduction: outlining the scope of the *Draft Perth's Bushplan*, the background to its preparation, accounts of the regional planning context and ecological setting of the PMA.
2. Development of the *Draft Perth's Bushplan* covering contributory studies, methodologies of assessment and area selection.
3. Recommendations: general recommendations covering the implementation of the *Draft Perth's Bushplan* with maps showing areas recommended for protection.

VOLUME 2: DIRECTORY OF *BUSHPLAN* SITES

1. Guide to information in the Directory: a brief description of each of the categories of information used to describe the *Bushplan* Sites. This part complements Volume 1 giving greater detail of the contributory sources.
2. *Bushplan* Site Descriptions: descriptions of each of the *Bushplan* Sites.
3. *Bushplan* Site Maps: maps at 1:25 000 showing each of the *Bushplan* Sites.

Example of Information Sources

Australian and New Zealand Conservation Council (1994) The National Strategy for Conservation of Australia's Biodiversity

Department of Conservation and Environment (1976) *Conservation reserves for WA as recommended by the Environmental Protection Authority - 1976* The South West System - System 1

Department of Conservation and Environment (1983) *Conservation reserves for WA as recommended by the Environmental Protection Authority - 1983* The Darling System - System 6: Parts 1 and 2

English, V. and Blyth, J. (1997) *Identifying and Conserving Threatened Ecological Communities in the South West Botanical Province* Unpublished report for the Department of Conservation and Land Management to Environment Australia

Gibson, N., Keighery, B.J., Keighery, G.J., Burbidge, A.H., and Lyons, M.N. (1994) *A Floristic Survey of the Southern Swan Coastal Plain* Unpublished report for the Australian Heritage Commission, prepared by the Department of Conservation and Land Management and the Conservation Council of WA (Inc.)

Government of Western Australia (1995) *Urban Bushland Strategy*

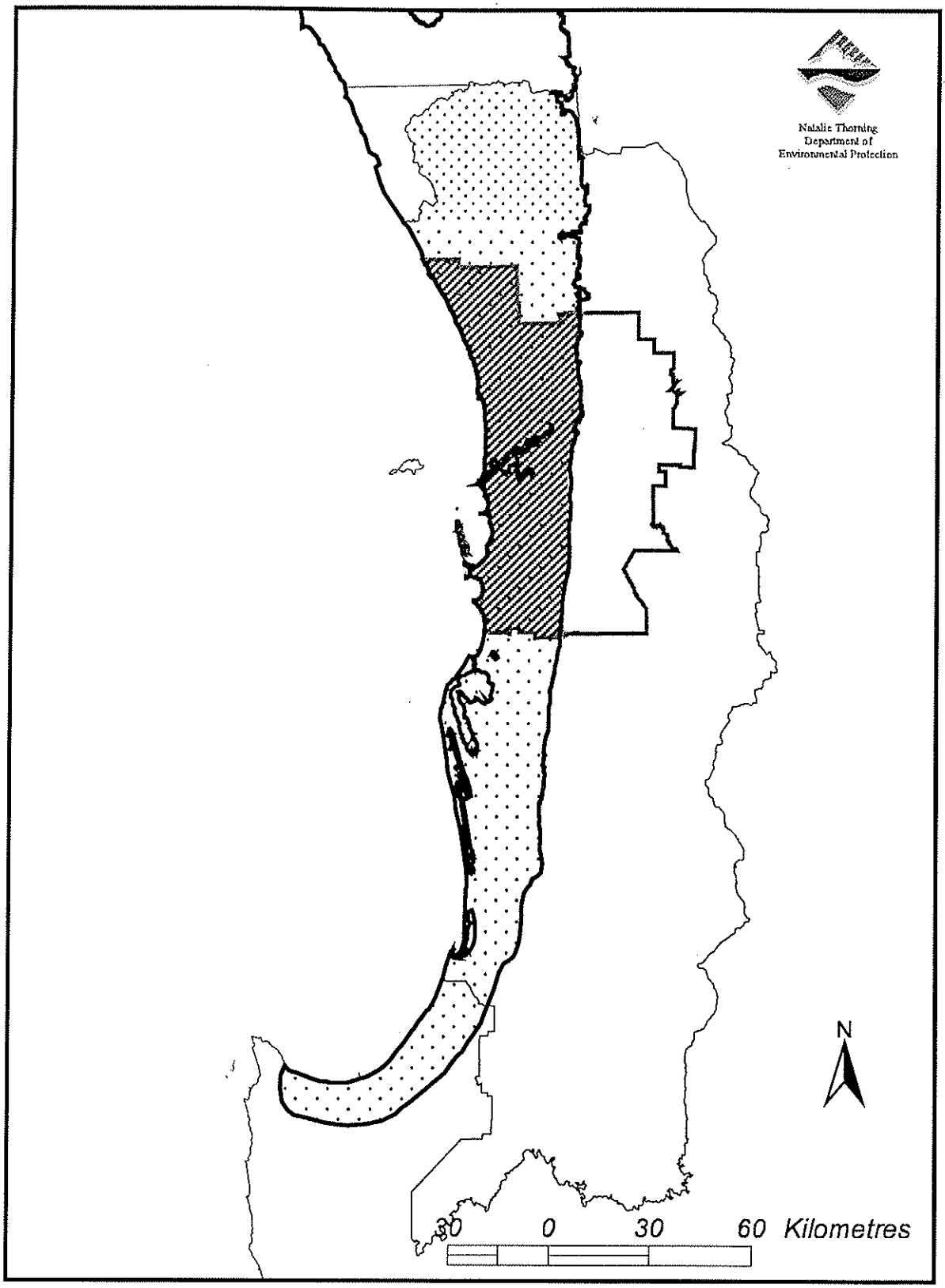
Government of Western Australia (1997) *Wetlands Conservation Policy*

Heddle, E.M., Loneragan, O.W. and Havel, J.J. (1980) *Vegetation of the Darling System in Atlas of Natural Resources, Darling System, Western Australia* Department of Conservation and Environment, Western Australia

Hill, A.L., Semeniuk, C.A., Semeniuk, V., and Del Marco, A. (1996) *Wetlands of the Swan Coastal Plain Vol. 2A and 2B* Water and Rivers Commission and Department of Environmental Protection

For more information: Bronwen Keighery, Department of Environmental Protection (08) 9222 7028

Map: Showing area covered in the *Draft Perth's Bushplan*
- in relation to the System 6 area and the regional vegetation studies.



Area covered in *Draft Perth's Bushplan*

Perth Metropolitan Area (PMA)

System 6 Area boundary* and boundary of the vegetation complex mapping (Heddle *et al*1980)
(*except where north-western boundary follows the Moore River on the Swan Coastal Plain)

Swan Coastal Plain (SCP) boundary

Area of floristic survey - Gibson *et al*.1994, System 6 Update

Additional area of floristic survey - System 6 Update

APPENDIX 3: Values of bushland/wetland areas at Perth Airport.

Note:
Bushland/wetland areas 1A to 3L are as indicated on Map 1.
Explanations of value determination and source are given in Section 2.4.2.
All percentages are estimates.
When no information is recorded alongside a 'value' specific information for the area was not known.

AREA 1A (1.1 plus area in Guildford Cemetery as Map 1)

CONFIDENTIAL

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	90%	
range vegetation condition	2/3	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland	100% area
number of vegetation assoc.	1(4)	Mp with patches Pe, Rg, Mr
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	2	
types	5, 12	plot 2 (fct 5)
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity	15	plot 2
Fauna		
Birds	diverse	area of 33/25 records
Western Swamp Tortoise habitat	yes	in most suitable group
Quenda habitat	yes	
other		possible Echidna habitat
Wetland Classification		
diversity types		dampland
% conservation category	100%	
% verified resource enhancement category	50%	of original conservation category
% verified conservation category	50%	of original conservation category
National/Regional Significance		
Interim List National Estate	50%	
Suitable for National Estate		
Nationally significant wetland		
System 6	yes	
Masterplan - conservation - conservation	40%	NE Conservation Area (7), 60% Category 1 outside airport
Bushland Patch Rank %	top 5%	
Perth's Bushplan	100%	

AREA 1B (1.2 plus area in Guildford Cemetery as Map 1)

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	90%	
range vegetation condition	2-3-4	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	upland	100% area
number of vegetation assoc.	1 (2)	Ba and Bm Ba
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	1	
types	20a	plot 7
Flora		
Declared Rare Flora		
Priority Flora	1	*Haemodorum loratum*
significant taxa	>10	taxa associated with the eastern side of the SCP
diversity	52	plot 7
Fauna ?Echidna		
Birds	diverse	plot records 33/25
Western Swamp Tortoise habitat		upland adjacent to suitable wetlands
Quenda habitat		upland adjacent to suitable wetlands
Wetland Classification		
diversity types	no	
% conservation category		
% verified resource enhancement category		
% verified conservation category		
National/Regional Significance		
Interim List National Estate	100%	
Suitable for National Estate		
Nationally significant wetland		
System 6	yes	
Masterplan - conservation - conservation	100%	NE Conservation Area (7), Category 1
Bushland Patch Rank	top 5%	
Perth's Bushplan	yes	

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AREA 1C - Munday Swamp (1.3)

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	80%	fringing wetland vegetation
range vegetation condition	3/2 - 4	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland	100% area, some open water
number of vegetation assoc.	2 (4)	Ec, Mr also ErMp, Baumea Sedgelands
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	1	
types	11	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Significant Fauna		
Birds	diverse	plot records 30, significant water bird breeding site
Western Swamp Tortoise habitat	yes	6th most suitable group
Quenda habitat		
other	fish/ invertebrates	two native fish, diverse invertebrate fauna
Wetland Classification		
diversity types	1	lake (EPP lake)
% conservation category	100%	
% verified resource enhancement category		
% verified conservation category	100%	of original conservation category
National/Regional Significance		
Interim List National Estate	100%	
Suitable for National Estate		
Nationally significant wetland	yes	
System 6	yes	
Masterplan - conservation	100%	NE Conservation Area, Category 2
Bushland Patch Rank %	top 6 -10%	
Perth's Bushplan	yes	

AREA 1D (1.4)

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	100%	
range vegetation condition	2-3	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland/ upland	100% wetland (Hill *et al.* 1996b) but mosaic of wetland and upland units
number of vegetation associations	6 (9)	Bm, Bl, Ba, Mr, MpPe, Pe and Mp, Sedgelands, mixed shrublands (mosaic of units in wetland)
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	3 (4)	
types	4, 5, ?7, 23a	complex of wetland units needs more survey and sampling
Flora		
Declared Rare Flora		
Priority Flora	2	*Schoenus benthamii, Verticordia lindleyi*
significant taxa	>2	*Levenhookia preissii, Byblis gigantea*
diversity		
Significant Fauna		
Birds	diverse	plot records 37/24
Western Swamp Tortoise habitat	yes	fourth priority
Quenda habitat	yes	
Wetland Classification		
diversity types	2	sumpland, dampland
% conservation category	100%	
% verified resource enhancement category	50%	of original conservation category
% verified conservation category	50%	of original conservation category
National/Regional Significance		
Interim List National Estate	100%	
Suitable for National Estate		
Nationally significant wetland	yes	
System 6	yes	
Masterplan - conservation	60%	60% SE Conservation Area, Category 2 (5); 30% 2C - development; 10% aviation
Bushland Patch Rank %	top 5%	
Perth's Bushplan	yes	

AREA 1E (1.5/1.6)

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	90%	
range vegetation condition	2-3	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland/ upland	70% wetland
number of vegetation associations	5 (8)	Ba, EcMp, Mr, Pe, Mp and Ac, Sedgelands, mixed shrublands
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	5	
types	4, 5, 7, 11, **20a**	complex of wetland units needs more survey and sampling
Flora		
Declared Rare Flora	1	*Conospermum undulatum*
Priority Flora	2	*Schoenus benthamii, Verticordia lindleyi*
significant taxa	3	*Levenhookia preissii, Byblis gigantea, Dasypogon obliquifolius*
diversity	>10	taxa associated with the eastern side of the SCP
Fauna		
Birds, reptiles		bird plot records 20/11; reptile plot records 13/7
Western Swamp Tortoise habitat	yes	fifth priority
Quenda habitat	yes	
Wetland Classification		
diversity types	2	sumplands, damplands
% conservation category (cc)	80%	
% verified resource enhancement category	20%	of original conservation category
% verified conservation category	80%	of original conservation category
National/Regional Significance		
Interim List National Estate	90%	
Suitable for National Estate		
Nationally significant wetland	yes	
System 6	yes	
Masterplan - conservation	80%	SE Conservation Area (5), 20% 2C - development
Bushland Patch Rank %	top 5%	
Perth's Bushplan	yes	

AREA 2A (2.1)

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	80%	
range vegetation condition	3-4	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	upland	100% upland
number of vegetation assoc.	3	Ba, BaBm
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	1	
types	23a	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles	diverse	bird plot records 33/25, reptile plot records 13/13
Western Swamp Tortoise habitat	adj	
Quenda habitat	yes	
Wetland Classification		
diversity types		
% conservation category		
% verified resource enhancement category		
% verified conservation category		
National/Regional Significance		
Interim List National Estate	100%	
Suitable for National Estate		
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	20%	NE Conservation Area (7), Category 2 Buffer; 80% 1C development
Bushland Patch Rank %	top 5%	
Perth's Bushplan	yes	

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AREA 2B (2.2)

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	90%	
range vegetation condition	3-2	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland/ upland	50% wetland
number of vegetation assoc.	4 (6)	EmEcAf, BaBm, Mr, Ec and wet sedgelands and herblands
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	3	
types	12, **20b**, 23a	Plot 1, 3 and 4
Flora		
Declared Rare Flora		
Priority Flora	3	*Conostephium minus*, *Myriophyllum echinatum*
significant taxa	>5	*Cyathochaeta clandestina*, taxa associated eastern side SCP
diversity	28, 29, 56	plot 1, plot 3, plot 4
Fauna		
Birds, reptiles	diverse	bird plot records 33/25, reptile plot records 13/13
Western Swamp Tortoise habitat	yes	in most suitable group
Quenda habitat	yes	
Wetland Classification		
diversity types	2	sumpland, dampland (EPP Lake)
% conservation category		
% resource enhancement category	100%	
% verified conservation category	30%	of above reclassified
National/Regional Significance		
Interim List National Estate	100%	
Suitable for National Estate		
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	100%	NE Conservation Area, Category 1
Bushland Patch Rank %	top 5%	
Perth's Bushplan	yes	

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AREA 2C (2.3)

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	70%	
range vegetation condition	3(2)-4	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	upland/ wetland	no wetland apparently mapped Hill *et al.* 1996b
number of vegetation assoc.	7	Ec, BaBmAf, Er, Js, Rc, Mr, Pe
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	3	
types	5, 12 23a	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat		
Quenda habitat		
Wetland Classification		
diversity types		
% conservation category		
% verified resource enhancement category		
% verified conservation category		
National/Regional Significance		
Interim List National Estate	100%	
Suitable for National Estate		
Nationally significant wetland		
System 6	100%	NE Conservation Area (7), Category 2 - Buffer
Masterplan - conservation	yes (cat 2)	
Bushland Patch Rank %	top 5%	
Perth's Bushplan	yes	

AREA 2D (2.4, includes link area)

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	80%	
range vegetation condition	3(2) -4(5)	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland/ upland	70% wetland
number of vegetation assoc.	8 (10)	Ec, BmEt, Bm, ErMr, Mp, MpPe, PeHv, Pe and Mv, sedgelands
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	5	
types	4, 5, 7, 12, 23a	
Flora		
Declared Rare Flora		
Priority Flora	3	*Villarsia submersa, Schoenus benthamii, Verticordia lindleyi*
significant taxa		*Conospermum triplinervium* (hybrids with *C. undulatum*
diversity		
Fauna		
Birds, reptiles	diverse	
Western Swamp Tortoise habitat	yes	fourth priority
Quenda habitat	yes	
Wetland Classification		
diversity types	3	sumpland, dampland, palusplain
% conservation category	100%	
% verified resource enhancement category	50%	of original conservation category
% verified conservation category	20%	or original conservation category (other 30% cleared)
National/Regional Significance		
Interim List National Estate	100%	
Suitable for National Estate		
Nationally significant wetland	yes	
System 6	yes	
Masterplan - conservation	?	80% Aviation uses; 20% 4 - development
Bushland Patch Rank %	top 5%	
Perth's Bushplan	yes	

AREA 2E (2.5)

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	70%	
range vegetation condition	4/3 - 5	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland/ upland	80% wetland
number of vegetation assoc.	5	Mp, EmBaAf, EcMp, Ec, MpPe
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	4	
types	5, 4, 23, 23a	
Flora		
Declared Rare Flora		
Priority Flora	1	*Verticordia lindleyi*
significant taxa		
diversity		
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat		
Quenda habitat		
Wetland Classification		
diversity types	2	sumpland, dampland
% conservation category	100%	
% verified resource enhancement category	30%	of original conservation category
% verified conservation category	40%	of original conservation category (other 30% cleared)
National/Regional Significance		
Interim List National Estate		
Suitable for National Estate		
Nationally significant wetland		
System 6		
Masterplan - conservation	?	90% aviation; 10% development (4)
Bushland Patch Rank %	top 5%	
Perth's Bushplan		

AREA 2F (2.6)

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	80%	
range vegetation condition	2-3	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland	
number of vegetation assoc.	3	MpPe, Pe, Ac
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	3	
types	4, 5, 12	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		bird plot records 20/11
Western Swamp Tortoise habitat		
Quenda habitat		
Wetland Classification		
diversity types	2	sumpland, dampland
% conservation category	100%	
% verified resource enhancement category		
% verified conservation category	60%	of original (other 40% cleared, but difficult to match to aerial photography)
National/Regional Significance		
Interim List National Estate	100%	
Suitable for National Estate		
Nationally significant wetland	yes	
System 6	yes	
Masterplan - conservation	?	100% 2C - development
Bushland Patch Rank %	top 5%	
Perth's Bushplan	yes	

AREA 2G (2.7) (includes adjacent bushland outside Airport and Link swamp)

Value	**Score**	**Comment**
Natural Attributes		
Bushland/Vegetation Condition		
bushland	70%	
range vegetation condition	3(2)-4	
Vegetation Complex	BCS/SR	
Mapped Vegetation Units		
wetland and/or upland units	Wetland/ upland	100% wetland (Hill *et al.* 1996b) but mosaic of wetland and upland units
number of vegetation assoc.	7	Ec, EmBaAf, Ba, Bl, Mp, Afas, Pe
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	2	
types	4, 23a	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat		
Quenda habitat		
Wetland Classification		
diversity types	2	sumpland, dampland
% conservation category	100%	
% verified resource enhancement category	50%	of original conservation category
% verified conservation category	50%	of original conservation category
National/Regional Significance		
Interim List National Estate		
Suitable for National Estate	yes	
Nationally significant wetland	yes	link swamp
System 6	yes	
Masterplan - conservation	?	50% outside airport; 40% development (2A)
Bushland Patch Rank %	top 6-10%	
Perth's Bushplan	yes	

AREA 2H (2.8) Runway Swamp

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	60%	
range vegetation condition	3(2)-4	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	Wetland	100% open water, EPP Lake
number of vegetation assoc.	3	Er, Td, Ec
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	1	
types	12	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat	yes	third priority
Quenda habitat	yes	
Wetland Classification		
diversity types	1	sumpland (EPP Lake)
% conservation category	100%	
% verified resource enhancement category		
% verified conservation category	100%	
National/Regional Significance		
Interim List National Estate		
Suitable for National Estate	yes	
Nationally significant wetland	yes	
System 6	yes	
Masterplan - conservation	?	25% aviation; 75% 2A/2B - development
Bushland Patch Rank %	top 6-10%	
Perth's Bushplan	yes	

AREA 2I (2.9) Five Mile Swamp

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	90%	
range vegetation condition	2-3-4	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland/upland	90% wetland, EPP Lake
number of vegetation assoc.	10	Er, Ec, Bl, Mt, Mp, Hv, ErMp, Jf, BaBmAf, BaBmAfEm
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	2	
types	11, 12	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat	yes	second priority, area of last siting
Quenda habitat	yes	
Wetland Classification		
diversity types	2	sumpland, dampland
% conservation category	100%	
% verified resource enhancement category		
% verified conservation category	70%	or original (other 30% cleared)
National/Regional Significance		
Interim List National Estate		
Suitable for National Estate	100%	
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	?	50% aviation; 50% 2B - development
Bushland Patch Rank %	top 6-10%	
Perth's Bushplan	yes	

AREA 2J (2.10)

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	80%	
range vegetation condition	3(2)	
Vegetation Complex	BCS/SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland/upland	70% wetland
number of vegetation assoc.	2(4)	BaBm, Mp and BaBmBilicifolia, Pe
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	2	
types	4, 23a	plot 10 (fct 4), plot 9 (fct 23a)
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa	>1	*Platysace juncea*
diversity	47, 29	plot 9, plot 10
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat		
Quenda habitat		
Wetland Classification		
diversity types	1	dampland
% conservation category	100%	
% verified resource enhancement category	100%	of original conservation category
% verified conservation category		
National/Regional Significance		
Interim List National Estate		
Suitable for National Estate	100%	
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	?	40% aviation; 60% 6 - development
Bushland Patch Rank %	top 6-10%	
Perth's Bushplan	yes	

AREA 2K (2.11)

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	90%	
range vegetation condition	2-3	
Vegetation Complex	BCS	
Mapped Vegetation Units		
wetland and/or upland units	wetland	
number of vegetation assoc.	2	Ec, Mp
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	1	
types	5	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat		
Quenda habitat		
Wetland Classification		
diversity types	1	palusplain
% conservation category	100%	
% verified resource enhancement category	100%	of original conservation category
% verified conservation category		
National/Regional Significance		
Interim List National Estate		
Suitable for National Estate	100%	
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	?	100% development (6)
Bushland Patch Rank %	top 6-10%	
Perth's Bushplan	yes	

AREA 2L (2.12)

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	80%	
range vegetation condition	3 (2) - 4	
Vegetation Complex	BCS	
Mapped Vegetation Units		
wetland and/or upland units	upland	
number of vegetation assoc.	1	EmAf
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	1	
types	23a	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat		
Quenda habitat		
Wetland Classification		
diversity types		
% conservation category		
% resource enhancement category		
% verified conservation category		
National/Regional Significance		
Interim List National Estate		
Suitable for National Estate	100%	
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	?	100% 1B- development
Bushland Patch Rank %	21-50%	
Perth's Bushplan	50%	

AREA 3A

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	60%	
range vegetation condition	4(3)-5	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland/ upland	60% wetland
number of vegetation assoc.	4	Ec, As, AsRc, Js
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	2	
types	5, **20b**	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat		
Quenda habitat		
Wetland Classification		
diversity types	1	dampland (EPP Lake)
% conservation category	100%	
% verified resource enhancement category	20%	of original conservation category, 80% mapped as cleared
% verified conservation category		
National/Regional Significance		
Interim List National Estate	100%	
Suitable for National Estate		
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	60%	NE Conservation Area, Category 2 - Buffer; 40% aviation
Bushland Patch Rank %	top 5%	
Perth's Bushplan	yes	

AREA 3B (picks up piece of 2.2, 1.2)

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	50%	
range vegetation condition	4(3)-5	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland/ upland	40% wetland
number of vegetation assoc.	5	Ba, Ec, Em, Pe, Mr
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	3	
types	5, 12, **20a**	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat	yes	first priority but small portion
Quenda habitat		
Wetland Classification		
diversity types	1	sumpland, ?
% conservation category		
% resource enhancement category	100%	60% after verification
% verified conservation category	40%	of above
National/Regional Significance		
Interim List National Estate	100%	
Suitable for National Estate		
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	none	100% aviation
Bushland Patch Rank %	top 5%	
Perth's Bushplan	yes	

AREA 3C

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	80%	
range vegetation condition	2-3-4	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland/ upland	50% wetland
number of vegetation assoc.	5(8)	Ba, EmBa, Ec, Pe, MpPe and mixed shrublands, Mr, *Verticordia densiflora* Heath)
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	3	
types	~~5, 6~~, 23a	plot 5 (fct 7), plot 6 (fct 23a)
Flora		
Declared Rare Flora		
Priority Flora	2	*Verticordia lindleyi*, *Myriophyllum echinatum*
significant taxa	>5	*Banksia telmatiaea* and taxa associated with the eastern side of the SCP
diversity	43, 57	plot 5, plot 6
Fauna		
Birds, reptiles	diverse	bird plot records 30
Western Swamp Tortoise habitat	yes	sixth most suitable group
Quenda habitat	yes	
other		only area both tree frogs recorded, How 1995
Wetland Classification		
diversity types	1	sumpland
% conservation category		
% resource enhancement category	100%	90% after verification
% verified conservation category	10%	of original resource enhancement
National/Regional Significance		
Interim List National Estate	100%	
Suitable for National Estate		
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	40%	NE Conservation Area, Category 2 - Buffer; 60% aviation
Bushland Patch Rank %	top 6-10%	
Perth's Bushplan	yes	

AREA 3D

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	80%	
range vegetation condition	4(3)-5	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland/upland	60% wetland
number of vegetation assoc.	3	Em, EmBaAf, Er
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	2	
types	12, 23a	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat		
Quenda habitat	yes	
Wetland Classification		
diversity types	1	sumpland
% conservation category	20%	
% resource enhancement category	80%	
% verified conservation category	20%	as above
National/Regional Significance		
Interim List National Estate		
Suitable for National Estate		
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	none	100% aviation
Bushland Patch Rank %	top 21-50%	
Perth's Bushplan	yes	

AREA 3E

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	80%	
range vegetation condition	4(3)-5	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland/upland	70% wetland
number of vegetation assoc.	4	EmBmAf, Bm, BeMp, Pa
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	2	
types	5, 23a	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat	yes	marginal
Quenda habitat	yes	
Wetland Classification		
diversity types	2	sumpland, palusplain
% conservation category	50%	considered degraded on verification
% resource enhancement category	50%	
% verified conservation category	0%	
National/Regional Significance		
Interim List National Estate	90%	
Suitable for National Estate		
Nationally significant wetland	yes	
System 6	yes	
Masterplan - conservation	none	100% aviation
Bushland Patch Rank %	top 5%	
Perth's Bushplan	yes	

AREA 3F

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	70%	
range vegetation condition	4(3)-5	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland	100% (Hill *et al.* 1996b, inconsistency between this mapping and below)
number of vegetation assoc.	2	Em, Jf
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	1	
types	23a	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat		
Quenda habitat		
Wetland Classification		
diversity types	1	dampland
% conservation category	100%	
% verified resource enhancement category	100%	of original conservation category
% verified conservation category		
National/Regional Significance		
Interim List National Estate		
Suitable for National Estate		
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	none	100% aviation
Bushland Patch Rank %	top 21-50%	
Perth's Bushplan	yes	

AREA 3G

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	60%	
range vegetation condition	4(3)-5	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland	100%
number of vegetation assoc.	7	Ec, Mp, Mr, Jf, Hv, As, Pe
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	3	
types	4, 11, 12	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat		
Quenda habitat	yes	
Wetland Classification		
diversity types	1	dampland
% conservation category	100%	
% resource enhancement category		
% verified conservation category	90%	of original conservation category, 10% considered cleared
National/Regional Significance		
Interim List National Estate		
Suitable for National Estate	100%	
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	none	100% aviation
Bushland Patch Rank %	top 6-10%	
Perth's Bushplan	yes	

AREA 3H

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	60%	
range vegetation condition	4(2/3)-5	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland	100%
number of vegetation assoc.	2	Ec, Hv
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	1	
types	4	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat	yes	second priority
Quenda habitat	yes	
Wetland Classification		
diversity types	2	sumpland, dampland (EPP Lake)
% conservation category	100%	
% resource enhancement category		
% verified conservation category	50%	of original conservation category, 50% considered degraded
National/Regional Significance		
Interim List National Estate		
Suitable for National Estate	100%	
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	?	100% development (2B)
Bushland Patch Rank %	top 6-15%	
Perth's Bushplan	yes	

AREA 3I

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	60%	
range vegetation condition	3(2)-4(5)	
Vegetation Complex	BCS/SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland/ upland	60% wetland, additional area mapped on verification
number of vegetation assoc.	6 (7)	Ec, BaAf, MpPe, Mr, Bl, Pe and BaBm
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	3	
types	4, 11, 23a	plot 8 (fct 23a)
Flora		
Declared Rare Flora	(1)	possible location *Macarthuria keigheryi* (R)
Priority Flora		
significant taxa		
diversity	53	plot 8
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat	yes	third priority
Quenda habitat	yes	
Wetland Classification		
diversity types	2	sumpland, dampland
% conservation category	100%	
% resource enhancement category		
% verified conservation category	90%	of original conservation category, 10% degraded but additional conservation category mapped
National/Regional Significance		
Interim List National Estate		
Suitable for National Estate		
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	?	100% 2B/2A - development
Bushland Patch Rank %	top 6-10%	
Perth's Bushplan	yes	

AREA 3J

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	60%	
range vegetation condition	3(2)-4	
Vegetation Complex	BCS	
Mapped Vegetation Units		
wetland and/or upland units	wetland /upland	60% wetland
number of vegetation assoc.	2	Mp, Ke
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	1	
types	4	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat		
Quenda habitat	yes	
Wetland Classification		
diversity types	1	dampland
% conservation category	100%	
% verified resource enhancement category	80%	of original conservation category, other 20% degraded
% verified conservation category		
National/Regional Significance		
Interim List National Estate		
Suitable for National Estate	100%	
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	?	100% 1B/6 - development
Bushland Patch Rank %	top 6 - 10 %	
Perth's Bushplan	yes	

AREA 3K

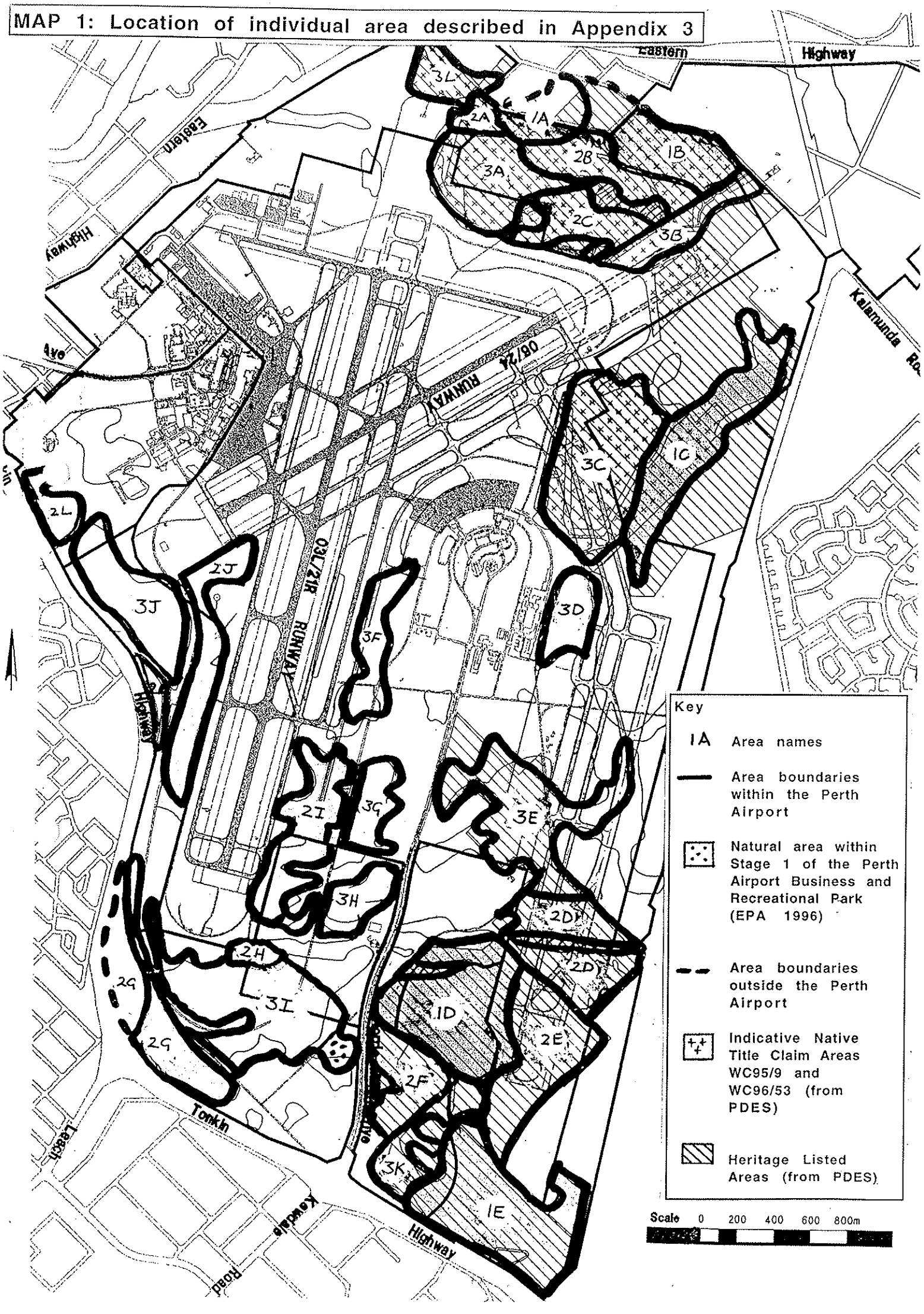
Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	90%	
range vegetation condition	3-4	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland/ upland	80% wetland
number of vegetation assoc.	2	MpPe, Ba
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	2	
types	5, 23a	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		bird plot records 20/11
Western Swamp Tortoise habitat		
Quenda habitat	yes	
Wetland Classification		
diversity types	2	sumpland, dampland
% conservation category	100%	
% resource enhancement category		
% verified conservation category		mapped as degraded
National/Regional Significance		
Interim List National Estate	90%	
Suitable for National Estate		
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	20%	SE Conservation Area Category 1; 80% 2C - development
Bushland Patch Rank %	top 5%	
Perth's Bushplan	yes	

AREA 3L

Value	Score	Comment
Natural Attributes		
Bushland/Vegetation Condition		
bushland	90%	
range vegetation condition	3-4	
Vegetation Complex	SR	
Mapped Vegetation Units		
wetland and/or upland units	wetland/ upland	20% wetland
number of vegetation assoc.	1 (3)	Ba and Pe, Re (inferred from aerial photo)
Floristic Community Types with Threatened Ecological Communities in BOLD		
expected no	2	
types	5, ?23a or ?**20a**	
Flora		
Declared Rare Flora		
Priority Flora		
significant taxa		
diversity		
Fauna		
Birds, reptiles		
Western Swamp Tortoise habitat		
Quenda habitat		
Wetland Classification		
diversity types	1	dampland
% conservation category	100%	
% verified resource enhancement category	100%	
% verified conservation category		
National/Regional Significance		
Interim List National Estate	100%	
Suitable for National Estate		
Nationally significant wetland		
System 6	yes	
Masterplan - conservation	?	100% 1C - development
Bushland Patch Rank %	top 5%	
Perth's Bushplan	yes	

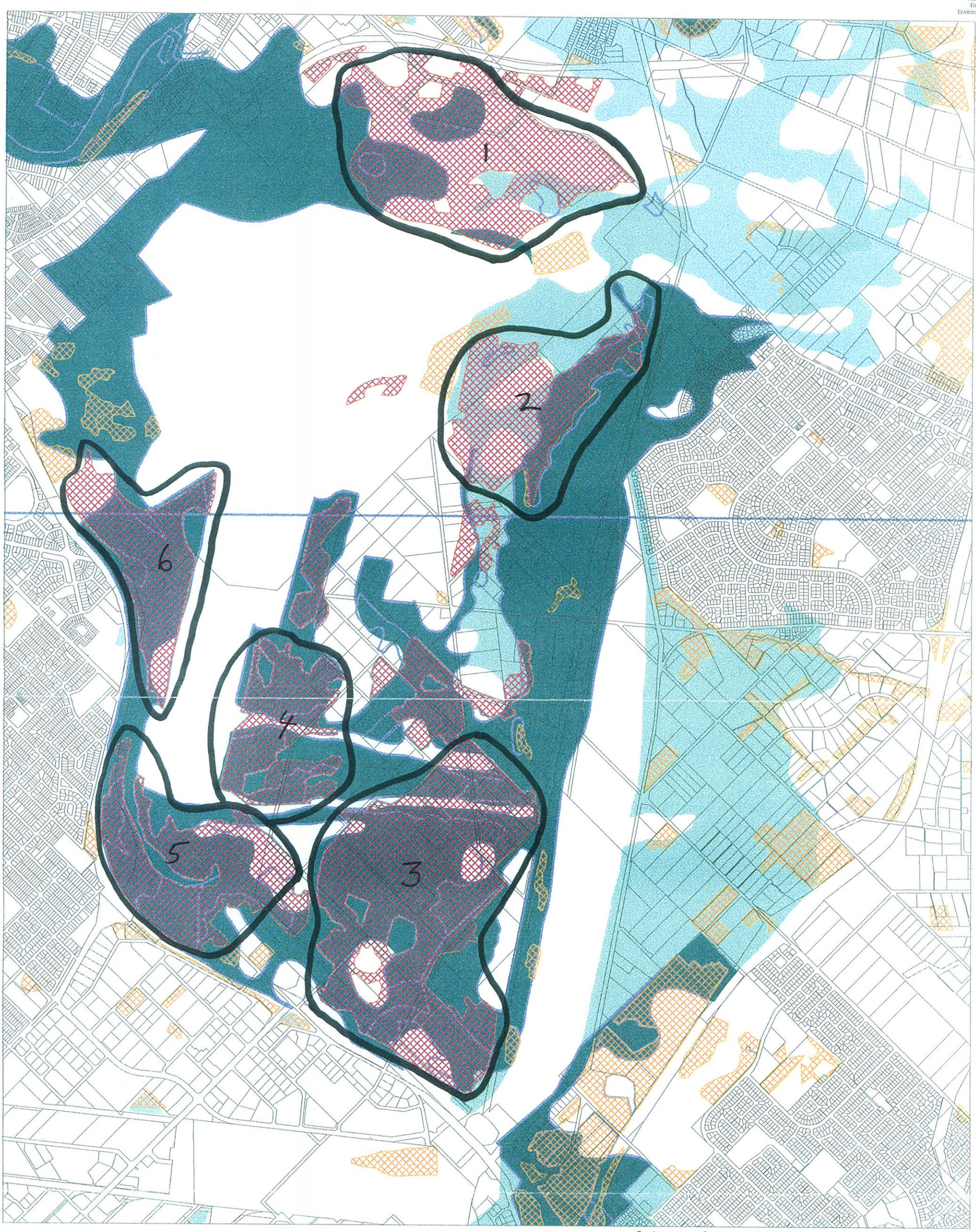
CONFIDENTIAL

MAP 1: Location of individual area described in Appendix 3



MAP 2 : Regionally Significant Remnant Vegetation at Perth Airport

prepared by
Natalie Thorning
Department of
Environmental Protection



0.4 0 0.4 0.8 Kilometres

1:25000

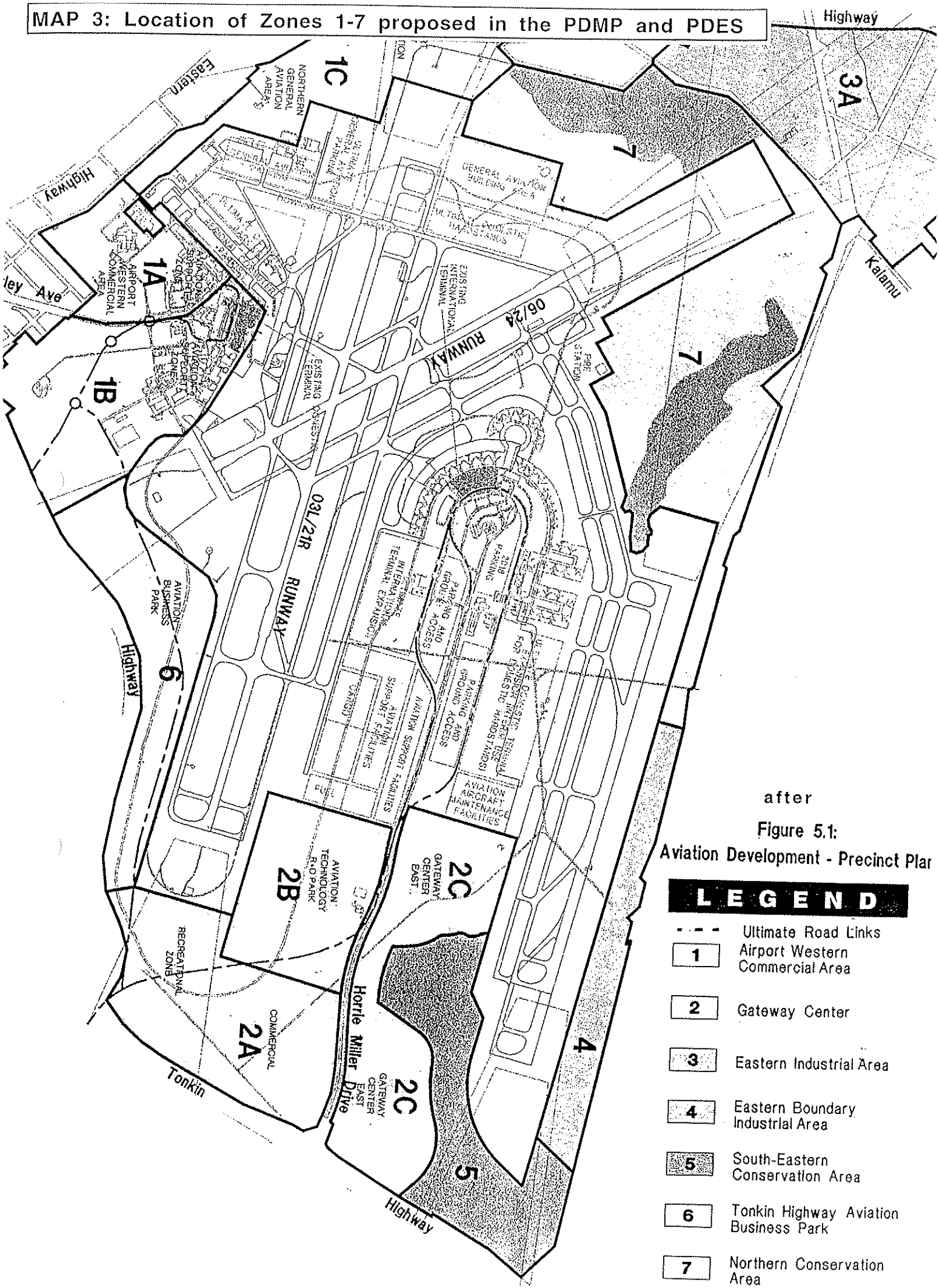
Cadastral Boundaries
remnant vegetation proposed for Perth's Bushplan in Perth Airport
Remnant Vegetation

Wetland Management Catagories
Conservation
Multiple Use
Resource Enhancement
Not Assessed
Verified conservation wetlands 1997

N

boundary encompassing bushland/wetland priority areas identified by DEP for protection and management for conservation values (DEP May 1998)

MAP 3: Location of Zones 1-7 proposed in the PDMP and PDES

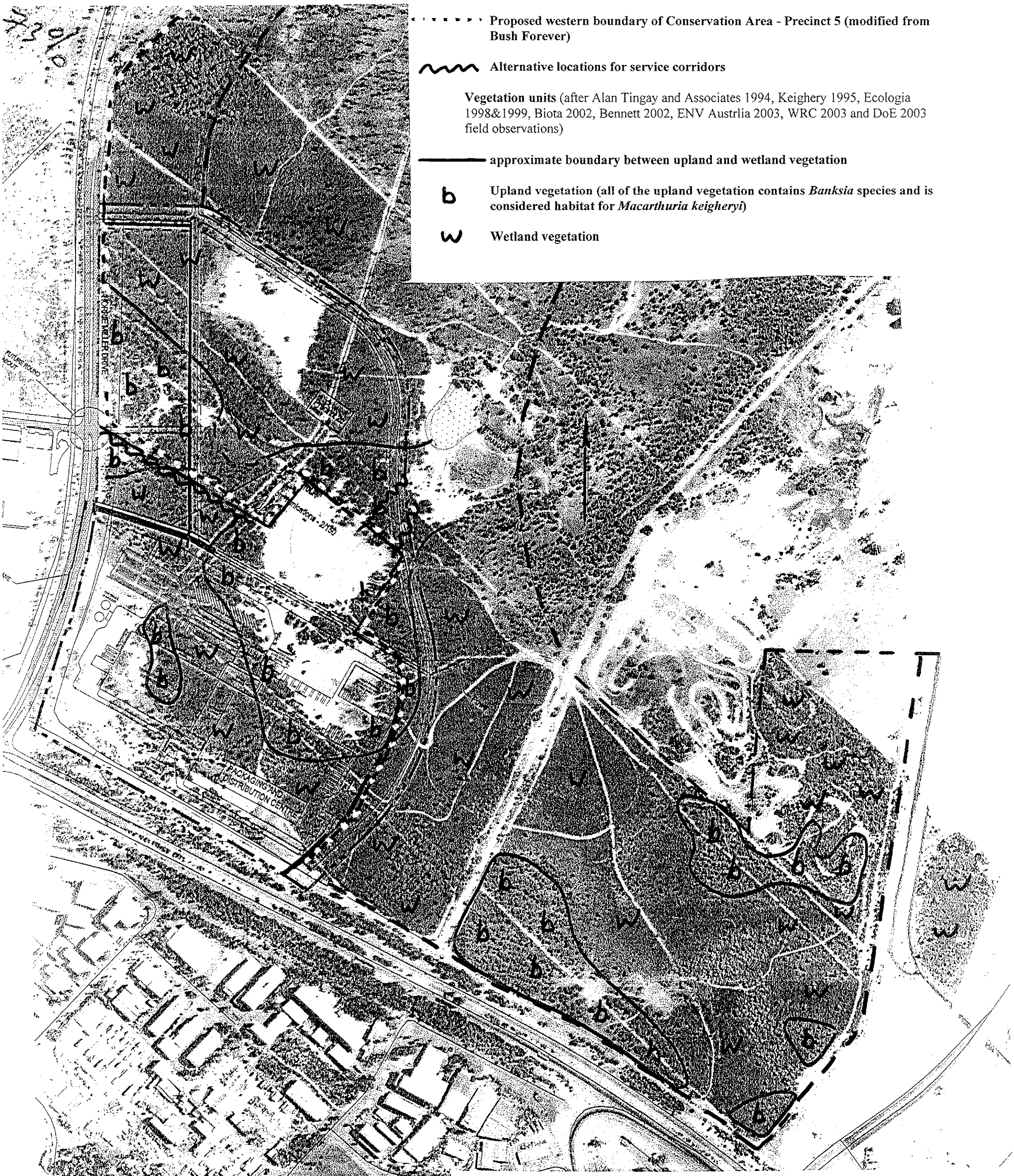


after

Figure 5.1:
Aviation Development - Precinct Plan

LEGEND

- Ultimate Road Links
- 1 Airport Western Commercial Area
- 2 Gateway Center
- 3 Eastern Industrial Area
- 4 Eastern Boundary Industrial Area
- 5 South-Eastern Conservation Area
- 6 Tonkin Highway Aviation Business Park
- 7 Northern Conservation Area



MAP 2: **Precinct 2C and adjacent Bush Forever Site 386**
Map 2 has been developed for a series of overlays and all boundaries should be considered approximate. The background aerial photography is DOLA 2002 at 1 : 6000 and the development overlay a 73% reduction from WAC 2003. The remaining line work is derived from reports and field observations.

1:6000

220'9 : 1

