Herdsman Lake Regional Park

WEED CONTROL & REVEGETATION PLAN

Prepared for

DEPARTMENT OF
Conservation
AND LAND MANAGEMENT

June 2002

Prepared by

Regeneration Technology Pty Ltd

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1. INTRODUCTION

1.1 BACKGROUND

This plan has been requested to guide immediate and long-term management of weeds and revegetation in Herdsman Lake Regional Park. A draft management plan has been prepared for the park, which provides broad direction for planning, management and development of the park (CALM In Preparation). The draft management plan highlights the important values of the park and briefly describes some of the main impacts, including weed impacts. It includes a number of strategies that provide broad direction for the Weed and Revegetation Plan.

It is envisaged that the Weed Control and Revegetation Plan will provide the planning link between the broad strategies of the Management Plan and the detail required for annual works programs. It provides an appropriate vegetation and weeds knowledge base, and provides priorities, area definition, and guidelines for weed control and revegetation.

1.2 STUDY AREA DESCRIPTION

Herdsman Lake Regional Park is a circular shaped reserve approximately 2 km long (north to south) and 2 km wide, with a total area of 400 ha (see Map 1). It is located approximately 7 km from the CBD of Perth.

Herdsman Lake is one of the largest of lakes in a chain wetlands that extend along the length of the Spearwood dune system on the Swan Coastal Plain. It is a shallow wetland characteristed by an extensive *Typha orientalis* sedgeland that extends across the centre of the Lake. The *Typha orientalis* sedgeland is surrounded by a deeper open water moat that has been created to protect the sedgeland habitat for resident fauna.

The lake has two major stormwater drainage channels through it that are separated from the main water body of the lake by earthen bunds. There are also several minor stormwater drains that flow directly into the lake.

The ecosystems within the park are predominantly wetlands. The dryer areas of the park have been extensively cleared leaving no dryland vegetation remnants. The wetland ecosystems have also been extensively altered by past land uses and management resulting in small and isolated remnants. Revegetation has been undertaken on the north-eastern side of the park between the lake's edge and Jon Sanders Drive resulting in the remnant vegetation in this area being virtually indistinguishable from revegetation works.

The park is easily accessed for a range of uses. The park is now seen as a major sanctuary for wildlife. Recreation within the park is appropriately passive with the major activities being, bird watching, picnicking and walking. The Perth Horse and Pony Club situated in the north of the park completely contains its activities within its boundaries. The park is in a very urbanised setting with housing abutting approximately ¾ of the park's boundary. This pressure from

urbanisation has resulted in the need for consideration of adjacent landuses when undertaking weed control and revegetation works within the park.

The park is an important regional open space and includes important aesthetic values.

Significant features of the park include:

- the water body;
- habitat value, particularly for trans-equatorial migratory birds;
- Aboriginal significance;
- early European settlement history;
- recreational value; and
- aesthetic values, particularly the visual characteristics of the lake and views to the city skyline.

Map 1

1.3 STUDY OBJECTIVES

This purpose of the plan is to guide immediate and long-term management of weeds and revegetation in Herdsman Lake Regional Park. Key objectives included the:

- assessment and mapping of vegetation types, vegetation condition and weeds;
- preparation of a Weed Control Priority Plan and a Revegetation Priority Plan, including principles for prioritising; and
- preparation of frameworks for monitoring and community involvement.

1.4 SCOPE

The plan provides a knowledge base and priorities for weed control and revegetation that will allow the preparation of detailed works plans for specific sites. The main components of the study are described above as objectives. The system defined in this plan for setting priorities allows for adjustment on an ongoing basis. The plan is not intended to be a fixed, prescriptive program of works for the park.

All bushland and potential bushland has been assessed in the preparation of the plan. Non-bushland areas, such as any recreation, or developed areas, were generally treated as exclusion areas and are shown as such on the maps that accompany this report. All of these exclusion areas were visited for the purpose of identifying weed species.

There were some limitations in the coverage of the assessment work within bushland and potential bushland areas including:

- Some species, particularly bulbs, were not readily identified due to the timing of the field survey (undertaken in early summer). These could be more readily identified during winter.
- There is also very little remnant vegetation within the park, which further limited the survey especially to determine the species composition of the various communities for revegetation purposes.
- Further aspects of scope are discussed under the Methodology (Chapter 2).

1.5 REPORT STRUCTURE

This report is divided into six chapters and appendices as follows:

- Chapter 1 is introductory and describes the context and nature of the study and report.
- Chapter 2 briefly explains the study methodology.
- Chapter 3 summarises key planning inputs into the plan preparation.
- Chapter 4 presents the assessment results.
- Chapter 5 defines a system for setting priorities and presents weed control and revegetation based on these.
- Chapter 6 covers two important management aspects: community involvement, and monitoring.

A revegetation species list, weed list, weed distribution maps, and guidelines for weed control and revegetation are included in the appendices.

2. METHODOLOGY

A project process was defined which combined all the necessary steps outlined in the project brief. The steps in the process are outlined as follows:

1. Initial consultation was undertaken to clarify details of the project scope, outcomes and communication mechanisms. Information and data (including relevant reports) were collected, imported into GIS, summarised, and analysed.
2. Consultation was undertaken with key stakeholders.
3. Preliminary vegetation structure was mapped using aerial photography at a scale of 1:5000.
4. Field survey work was undertaken to:
   - ground-truth the vegetation structure type boundaries;
   - identify species by strata, including weed species;
   - identify vegetation communities based on dominant species in each strata (where the latter existed);
   - assess vegetation condition (assigned a rating of 1 to 6);

   Sampling (undertaken in early Summer 2001) was based on the following principles:
   - all structural units (preliminary mapping) were sampled in at least one location;
   - where areas were not able to be traversed (eg. wetland areas), observations were made from the nearest accessible point;
   - areas with a condition rating of 1-5 (ie. not cleared areas) were sampled according to their size using an irregular grid system. This consisted of east-west transects with three quadrats, one near each edge and the third in the middle. The number of transects was adjusted to suite size of the structural unit;
   - opportunistic observations (ie. outside the quadrats) were made along the transects and when moving around the reserve, particularly for identifying species. Most spot weeds (single specimens or small localized occurrences) were identified this way.

   The locations of all quadrats and spot weeds were recorded using a hand held GPS. Additional information, such as soil, slope and aspect, was also recorded for all quadrats.
5. Field data was assessed and mapped to identify community types, species lists, weed distribution, priority weeds, and extent of condition classes.
6. Checks were made for Rare and Priority Flora, Threatened Ecological Communities and Declared Weeds.
7. A system was developed that links assessment and mapping with bushland rehabilitation priorities, weed control priorities and revegetation priorities.
8. Frameworks were devised to cover the opportunities and methods for community involvement and monitoring.
9. Relevant guidelines for weed control and revegetation were prepared.

3. GENERAL PLANNING CONSIDERATIONS

3.1 CONSULTATION

Community consultation was an important part of the process, providing local knowledge and insight helpful to the preparation of the plan. Consultation with key stakeholders was undertaken either onsite or via telephone interview. A list of topics covered in discussion with participants, together with a summary of the outcomes, are listed in Appendix 1.

3.2 HERDSMAN LAKE REGIONAL PARK DRAFT MANAGEMENT PLAN 2001-2011

The Herdsman Lake Regional Park Draft Management Plan 2001-2011 provides broad direction for planning, management and development of the park (CALM, 2001). The management plan contains a number of sections that are particularly relevant to the Weed Control and Revegetation Plan including:

- Vision;
- Park Management Zones;
- Key Performance Indicators;
- Flora and Vegetation;
- Weeds; and
- Fire.

This Weed Control and Revegetation Plan is subsidiary to, and should be used in conjunction with the management plan.

4. ASSESSMENT RESULTS

4.1 VEGETATION SPECIES

Plant species were recorded for each quadrat visited and additional species were recorded opportunistically during the field survey for the purpose of collating indicative lists, suitable for defining communities and species for revegetation (Appendix 2). As there are no true dryland vegetation communities at Herdsman Lake all species identified and the list of indicative species for revegetation fall only into one wetland community. There are dryland sections of the park that are currently grassed areas that may have originally been covered by Banksia woodland.

There is no rare or priority listed flora in Herdsman Lake Regional Park.

4.2 VEGETATION COMMUNITIES

The vegetation communities (Map 2) of the park are primarily wetland communities that are either sedgelands dominated by *Typha orientalis* or woodlands with an overstorey of either *Melaleuca rhaphiophylla, Eucalyptus rudis,* or *Eucalyptus camaldulensis.* The wetland communities are influenced by, and are dependent on, the hydrological zones within the lake system. Sedgeland communities dominate the fringing open-water areas, the wet-forest and woodland communities are in the seasonally inundated margins between the open water and the dryer recreation areas. The native sedgeland communities throughout the park extend into the understorey of the forest and woodland. By contrast the *Typha orientalis* communities only occur where there is no shading overstorey.

Seven wetland communities were identified:

- *Baumea articulata/Typha orientalis* sedgeland;
- *Schoenoplectus validus/Typha orientalis* sedgeland;
- *Typha orientalis* sedgeland;
- *Melaleuca rhaphiophylla* woodland;
- *Melaleuca rhaphiophylla/Eucalyptus rudis* open forest;
- *Eucalyptus rudis/Eucalyptus camaldulensis* open forest; and
- *Eucalyptus rudis* open forest.

No remnant vegetation is represented in the dryland communities. The dryland sections have been extensively cleared and are now predominantly grassed areas.

There is very little of the original remnant vegetation within Herdsman Lake Regional Park. The original *Baumea articulata* and *Schoenoplectus validus* sedgeland communities that fringe the main lake are now dominated by the introduced *Typha orientalis*. The dominant and most extensive community within the Park is the *Typha orientalis* community that extends across the middle of the shallow lake forming a monoculture. There are small pockets of the

original woodland communities on the western side of the Park near Floreat Waters, the southern end of the lake near the wildlife centre and on the eastern side along Jon Sanders Drive.

The remnant woodland along Jon Sanders Drive is difficult to distinguish from the revegetation that was undertaken during the 1980s. Eucalypts of unknown origin were planted and it appears as though a mixture of *Eucalyptus rudis* and *Eucalyptus camalulensis* now exist with very little native understorey. The Eucalypts planted as part of a revegetation program in the 1980's are thought to be either *Eucalyptus rudis* or *E. camelulensus.* These two species readily hybridise making it difficult to determine where one species begins and the other ends. This highlights the importance of using local provenance for revegetation. Seed or vegetative propagules should only be collected from natural stands for revegetation programs, in the case of Herdsman Lake where the natural environment (especially the *Eucalyptus rudis* community) has been severely altered it would be safer to collect seed from known natural populations elsewhere in the Perth area.

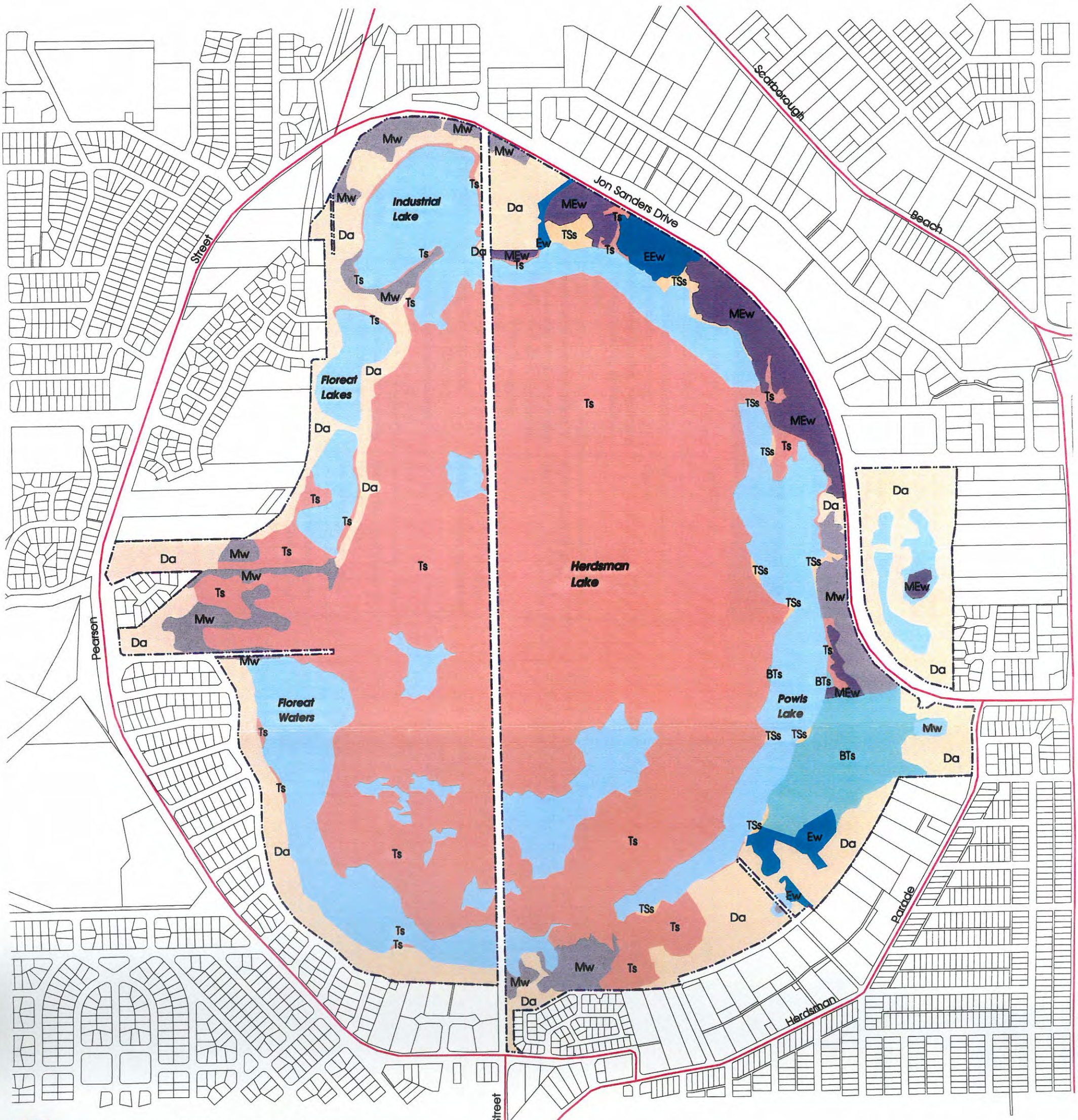
The management considerations for this area are:

- Don't use these trees as a seed source for revegetation around other parts of the Lake
- Any areas cleared for revegetation around the perimeter of this community should be planted with *E.rudis* of a known provenance rather than allowing natural regeneration from seed from these existing stands of trees.

The *Melaleuca rhaphiophylla* community at the southern end of the lake is the most intact remnant within the Park. This community is typical of the type of vegetation that would have originally existed across the wetland.

There are no Threatened Ecological Communities identified in the park.

Veg Comm



Vegetation Communities

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Map 2
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4.3 VEGETATION CONDITION

Bushland condition was assessed in the field and assigned a bushland condition rating based on the classifications used in Bush Forever (Keighery, 2000). The least disturbed sites were rated '1' and the most disturbed sites were rated '6'. The ratings are listed in Table 1 below together with an indication of the general management response for each rating (Regeneration Technology, 2000).

Table 1 - Vegetation condition ratings and management responses.

Condition Rating	Description	General Management Response
1 = Pristine	No obvious signs of disturbance.	Monitoring
2 = Excellent	Vegetation structure intact, disturbance affecting individual species, weeds are non-aggressive, occasional tracks.	Weed control plus above
3 = Very Good	Vegetation structure altered. Obvious signs of disturbance. Presence of more aggressive weeds, dieback, logging, repeated fires, and grazing.	Infill planting plus above
4 = Good	Vegetation structure significantly altered by obvious signs of multiple disturbance.	Rehabilitation, including above.
5 = Degraded	Vegetation structure severely impacted by disturbance.	Scope for rehabilitation but will require intensive management.
6 = Completely degraded/cleared	Structure of vegetation no longer intact. May be described as parkland or cleared.	Complete rehabilitation or rezoning (change use to non-bushland) required.

Bushland condition is shown on Map 3. The historical use of Herdsman Lake for grazing, market gardens and storm water run-off has resulted is an extremely altered environment with very little remnant vegetation. The existing remnant vegetation occurs in small isolated pockets and has suffered from the long-term pressures of urbanisation, resulting in a loss of the structural integrity of the original communities and extensive weed invasion.

With the exception of a small pocket of remnant vegetation near the wild life centre which has a condition rating of 2 the condition of the remaining vegetation within the park has a condition rating 4, 5 or 6.

There is no remnant vegetation with a condition rating of 3. This is not unusual in wetland communities that become very heavily weed infested when the structural integrity of the shading overstorey layer is lost.

Sections of the park along Jon Sanders Drive that have been revegetated in the 1980's now have a condition rating of 4 indicating vegetation condition can improve over time with appropriate planting and management. (Assessment for condition in this area did not take into account the possibility that some of the *Eucalypti* may not be endemic to this area).

The vast majority of the park has been assessed to have a condition rating of 5, indicating a high degree of management is required for improvement.

Veg cond

Industrial Lake
Floreat Lakes
Herdsman Lake
Floreat Waters
Powis Lake
Jon Sanders Drive
Scarborough Beach
Street
Pearson
Parade
Herdsman
Selby Street

Condition 2 - Excellent
Condition 4 - Good
Condition 5 - Degraded
Developed/Cleared Area
Open Water
Park Boundary
Road
Cadastre

Vegetation Condition

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100 0 100 200 300 400 500 m
1:10,000

NORTH

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4.4 WEED SPECIES

A total of 45 weed species were identified in Herdsman Lake Regional Park. These are listed in Appendix 3. These weeds species were rated according to their ecological and visual prominence and if they were not high priority, whether they were usually associated with high priority weeds (called Associated Species). Three of the listed priority weeds are associated species, they are all grasses.

Priority weed species for Herdsman Lake Regional Park have been listed (see Table 2 below) and include 12 species that were rated as High or Moderate Ecological Priority.

Another 6 species were rated as High Visual Prominence, of which none were classed as Associated Species.

Further discussion of the basis for these ratings is as follows:

PRIORITY WEED SPECIES

Ecological Priority

- Invasiveness. This is based on the ability to invade communities in good condition. The Environmental Weed Strategy for Western Australia (EWSWA) ratings were considered to be appropriate for this variable - rated as invasive or not invasive.
- Environmental Impact. This is based on the ability of the weed to change the structure, composition and function of ecosystems, particularly the ability to form a monoculture. EWSWA ratings were considered to be appropriate for this variable - rated as having a high environmental impact or not.
- Distribution. The EWSWA ratings were not generally considered to represent the distribution in Herdsman Lake Regional Park. The EWSWA is a generalised rating for all Western Australia and does not net necessarily account for specific local distribution. For example, some weeds species that rated moderate for in the EWSWA had a high distribution in Herdsman Lake Regional Park. An alternative rating system was devised, based on:
    - The nature of the distribution - rated as evenly distributed across a community (sub-ratings of dense or sparse) or localised (sub-ratings of patchy or singular (the latter usually trees)).
    - The number of communities affected. A high number of communities affected also indicates the weed's invasiveness (ie. an ability to invade a range of bushland types).
    - The proportion of the park affected for evenly distributed weeds (rated as a high or low proportion) or the number of occurrences (either patchy or singular) of localised weeds recorded during the field survey (rated as a high or low number).

Ratings for the three main variables were added together and overall ratings were assigned as follows:

- three High ratings were assigned a High Ecological Priority rating;
- two High ratings were assigned a Moderate Ecological Priority rating;
- one High ratings were assigned a Mild Ecological Priority rating;
- no High ratings were assigned a Low Ecological Priority rating.

This is the same approach as the EWSWA. Both High and Moderate Ecological Priority species have been included in the list of Priority Weeds for Herdsman Lake Regional Park (see Table 2).

Declared Weeds

There were no weeds officially declared under the *Agriculture and Related Resources Protection Act (1976)* recorded within the park. None of the weeds recorded in the park are declared in the Perth metropolitan area.

VISUALLY PROMINENT AND ASSOCIATED SPECIES

Visual Prominence of Species

- This was based on the visibility of the weed from key views in main use areas (rated as high or low visual prominence).

Associated Species

- These are weeds that do not have a high ecological rating but are usually associated with weeds species that do have a high ecological rating.

Table 2 - Priority Weeds of Herdsman Regional Park

Species	*Common Name*	*Ecological Priority*	*Visual Prominence of Species*	*EWSWA Rating*
Typha orientalis	Bulrush	High	High	High
Stenotaphrum secundatum	Buffalo Grass	High	Low	Moderate
Cortaderia selloana	Pampas Grass	Moderate	High	High
Bromus diandrus	Great Brome	Moderate	Low	High
Cynodon dactylon	Couch	Moderate	Low	Moderate
Ehrharta calycina	Perennial Veldt Grass	Moderate	Low	High
Euphorbia terracina	Geraldton Carnation Weed	Moderate	Low	High
Lagurus ovatus	Hares Tail Grass	Moderate	Low	High
Pelargonium capitatum	Rose Pelargonium	Moderate	Low	High
Pennisetum clandestinum	Kikuyu Grass	Moderate	Low	Moderate
Solanum nigrum	Black Berry Nightshade	Moderate	Low	Moderate
Zantedeschia aethiopica	Arum Lily	Moderate	Low	High

Visually Prominent species (in addition to those listed in Table 2) were:

- *Arundo donax* Giant Reed
- *Erythrina sykesii* Flame Tree
- *Melia azedarach* Cape Lilac
- *Populus alba* Poplars
- *Salix babylonica* Willow Tree
- *Schinus terebinthifolia* Japanese Pepper

The Visually Prominent species may be targeted as a weed control priority or they may form part of more general aesthetic priority (see Section 5.1). *Avena barbarta* (Bearded Oat), *Briza maxima* (Blowfly Grass) and *Bromus catharticus* (Prairie Grass) were classed as Associated Species.

4.5 WEED DISTRIBUTION

The distributions of most of the Priority Weed species and Visually Prominent weeds have been mapped based on an assessment of field data (see Maps 4 to 9, Appendix 4). These distributions are discussed briefly below.

Map 4 shows the distribution of the suite of grassy weeds that occur primarily in the 'dryer' wetland areas (ie *Eucalyptus rudis* and *Eucalyptus camaldulensis* woodland areas). The dominant and most widespread is *Ehrharta calycina* (Perennial Veldt Grass), which is rated as Moderate Ecological Priority. It often occurs in association with one or all of the following:

- *Avena barbata* (Bearded Oat) (Mild Ecological Priority);
- *Briza maxima* (Blowfly Grass) (Mild Ecological Priority);
- *Bromus diandrus* (Great Brome) (Moderate Ecological Priority);
- *Lagurus ovatus* (Harestail Grass) (Moderate Ecological Priority); and
- *Bromus catharticus* (Prairie Grass) (Low Ecological Priority).

The entire suite of weeds has a similar reproductive mode making it possible to target them for control as group . The species in this group of weeds have Moderate to Low Ecological Priority ratings indicating they are a threat to the ecology of woodland areas within the park.

Map 5 show the distribution of three lawn grass weeds:

- *Cynodon dactylon* (Couch) (Moderate Ecological Priority);
- *Pennisetum clandestinum* (Kikuyu) (Moderate Ecological Priority); and
- *Stenotaphrum secundatum* (Buffalo Grass) (High Ecological Priority).

These species are all rated as either High or Moderate Ecological Priority in the park and have and have typically invaded wetland areas and bushland that has irrigation runoff from recreation areas. All three species spread primarily from stolons (vegetatively) and occur in similar habitat making it possible to target them as a group for control.

Map 6 shows the distribution of *Typha orientalis* (Bulrush). This is the most dominant and widespread weed at Herdsman Lake. It stretches across the middle of the lake and shallow fringes around its perimeter. There are areas within the park where the *Typha orientalis* co-habits with some of the larger growing native species (ie. *Schoenoplectus validus* and *Baumea articulata*).

Typha orientalis is a High Ecological Priority weed and is the most visually dominant weed in the park. It poses a high fire risk, particularly to adjacent native species (eg. paperbarks). It has the potential to spread to large areas that it currently has not invaded. It also blocks views to the water in many places.

Typha orientalis does provide habitat for fauna species and also performs a nutrient stripping function, although its nutrient stripping capability is generally inferior to native species that grow in the same environment and are less seasonal in their growth cycle.

Controlling *Typha orientalis* can be taxing on management resources, particularly where it has spread over substantial areas. The control of *Typha orientalis* should target areas that will maximise effect of removal, will demand realistic use of management resources, and will consider the need to allow management resources for controlling other weeds.

There are a number of native species, such as *Schoenoplectus validus* and *Baumea articulata* that can successfully replace *Typha orientalis* if the *Typha orientalis* is controlled. Its removal needs to be coordinated with the planting or regeneration of native species, and staged to provide realistic control areas and to help maintain fauna habitat. An emphasis should be placed on defining practical areas for removal such as discrete wetland areas (areas separated by dryland areas or other barriers). Given that the *Typha orientalis* appears to cohabit and be present in fairly narrow bands of fringing vegetation around the perimeter of the lake, control should target these areas and the lakes isolated from the main lake (ie. the less aggressive edge of its occurrences).

The general priorities for the control of *Typha orientalis* are shown on Map 11 and is described in Part 5 of this report. Specific locations that include the considerations outlined above are:

- the edge of Floreat Waters (small and isolated area, less aggressive edge)
- the perimeter of Floreat Lakes (small and isolated area, less aggressive edge);
- the small lake between Moondine Dr and Jon Sanders Dr (relatively small and isolated area);
- the perimeter of industrial lake (less aggressive edge).

Map 7 shows the distribution of *Euphorbia terracina* (Geraldton Carnation Weed), which is rated as Moderate Ecological Priority and is considered to be one of the most serious threats to bushland on the Swan Coastal Plain. *Euphorbia terracina* has a limited distribution at Herdsman Lake Regional Park as it primarily occurs in dryland vegetation. At Herdsman Lake it occurs in the dryer fringes of the wetland vegetation.

It is a hardy, fleshy plant with an extremely irritating milky sap that can cause skin rashes and blindness. It reproduces by seed, which are often spread throughout the bushland by Turtle Doves.

Map 8: shows the distribution of *Pelargonium capitatum* (Rose Geranium), which is rated as Moderate Ecological Priority. Its distribution is similar to the *Euphorbia terracina* invading the dryer fringes of the wetland vegetation. However unlike the *Euphorbia terracina* it does not have an animal vector and usually only invades disturbed vegetation.

Map 9: shows the distribution of *Solanum nigrum* (Blackberry Nightshade), which is rated as Moderate Ecological Priority. It is widely distributed throughout the park occurring with the *Typha orientalis* in areas where there is no free surface water.

Map 10 shows the localised distribution of:

- *Cortaderia selloana* (Pampas Grass) (Moderate Ecological Priority);
- *Erythrina skyesii* (Flame Tree) (Low Ecological Priority);
- *Salix babylonica* (Weeping Willow) (Low Ecological Priority)
- *Schinus terebinthifolia* (Japanese pepper) (Mild Ecological Priority);
- *Zantedeschia aethiopica* (Arum Lily) (High Ecological Priority).

Of these only one species (*Zantedeschia aethiopica)* has a High Ecological Priority rating. It is a declared weed in other parts of the state. One of the species (*Cortaderia selloana*) has a Moderate Ecological Priority rating. The remainder of the species on this map have either a Low or Mild Ecological Priority rating but are rated as High Visual Prominence.

All of these species should be monitored and managed to ensure populations do not spread. It should be possible to eradicate all of these species from the park as there are effective control methods especially for small contained populations.

5. WEED CONTROL AND REVEGETATION PLANS

5.1 PRIORITIES

For the purpose of this plan, weed control and revegetation are discussed under the heading of bushland rehabilitation. Rehabilitation also covers control of other bushland impacts, such as fire, drainage and erosion, which are not the focus of this plan.

There are many considerations and variables that can be included in setting priorities for bushland rehabilitation (see Department of Conservation and Land Management 1999). It is often difficult for bushland managers to define overall priorities due to the many considerations involved and the competing nature of these considerations. While there may not be a simple, universal formula for setting priorities, a framework has been developed for Herdsman Lake Regional Park that will allow priorities to be defined on an ongoing basis. This framework is based on a hierarchy of four levels of priorities, as illustrated in Figure 1 below.

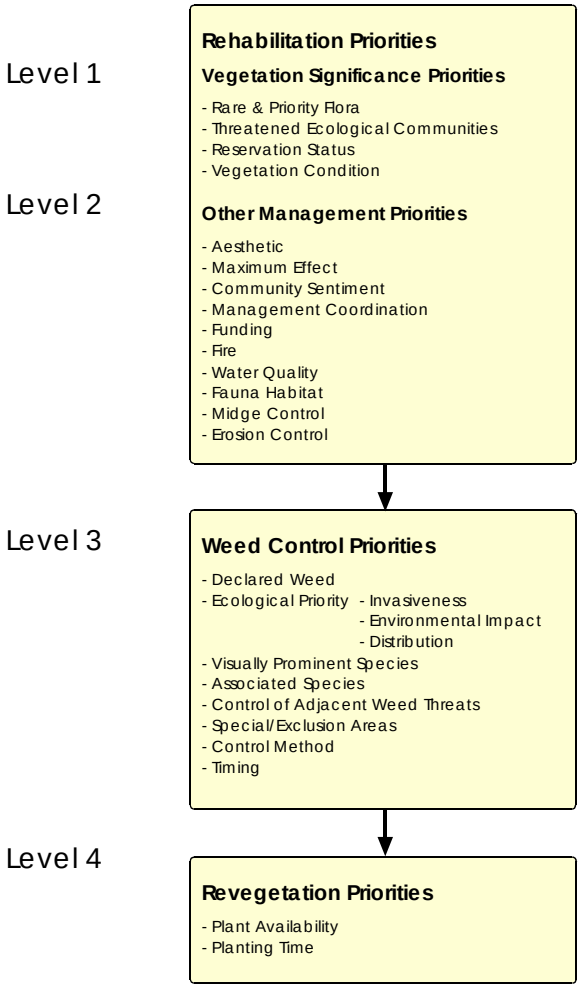


Figure 1 - Hierarchy of Priorities for Bushland Rehabilitation

The **Level 1** priorities relate to vegetation significance and are used to set priorities for all rehabilitation works. These priorities are relatively fixed (until any later assessment) once the assessment work has been completed for an area.

The **Level 2** priorities include a number of other management priorities that tend to be *ad hoc* in nature. These priorities may need to be re-assessed on a regular basis (eg. annually). Again, they are used to set priorities for all rehabilitation works.

The **Level 3** priorities include specific weed control related priorities. These priorities are relatively fixed (until any later assessment) once the assessment work has been completed for an area.

The **Level 4** priorities cover specific revegetation priorities. These priorities are generally quite predictable once the priorities of the first three levels have been defined. Revegetation priorities are also used to define weed control priorities.

These levels are discussed further below.

LEVEL ONE - VEGETATION SIGNIFICANCE PRIORITIES

Initial priorities for rehabilitation should be based on the importance of the bushland. This is based on:

- whether Rare or Priority Flora or Threatened Ecological Communities are present;
- the reservation status of the communities represented (a community is considered poorly reserved if it known from only one national park or nature reserve); and
- bushland condition.

In Herdsman Lake Regional Park, there are no threatened ecological communities, rare or priority flora that need to be considered for setting priorities.

LEVEL TWO - OTHER MANAGEMENT PRIORITIES

These priorities are difficult to predict but should be addressed as they arise. They can be applied as an additional and distinct layer over the priorities set in Level One. Examples of these priorities include:

- ***Aesthetic***. An area may be rehabilitated because it *looks* degraded or a group of weeds may be blocking views or it may be close to a recreation area (where aesthetic expectations may be higher).

- ***Maximum Effect.*** An area may be rehabilitated because it is located where it is highly visible, changes will be noticed, or the rehabilitation is easily achieved. Similarly, weeds that are easy to remove or have small populations may be targeted and trees may be planted first.

- ***Community Sentiment.*** There may be pressure from the community to rehabilitate specific areas (eg. areas close to where they reside). These areas may be covered by other priorities.

- ***Management Coordination.*** Shared management responsibilities may alter the priorities. In particular, different agency resources may be reflected in the extent of works undertaken.

- ***Funding***. Funding will also affect the degree and timing of works.

- ***Fire.*** Fire events may create new priorities, with opportunities for rehabilitation in some cases.

- ***Water Quality.*** Water quality may be an issue when nutrient loading increases as a result of vegetation changes.

- ***Fauna Habitat***. Some weed species may offer important habitat and their removal may need to be staged to allow replacement with native species or relocation of fauna species.

- ***Midge Control.*** Rehabilitation (particularly revegetation) may be needed to create a buffer to midge populations.

LEVEL THREE - WEED CONTROL PRIORITIES

Weed control priorities are based on bushland rehabilitation priorities together with a number of additional management considerations relating directly to weed species and their control, as briefly outlined below.

- ***Declared Weeds.*** There is statutory obligation to control Declared Weeds that may take priority over normal vegetation significance based priorities. There are no Declared Weeds in the park. Particular species may also be targeted under agency or government-wide programs.

- ***Invasive Weeds.*** Weed species that have a high ability to invade communities in good condition will need to be controlled and will take priority over less invasive species.

- ***Environmental Impact of Weeds.*** Species that have a high ability to change the structure, composition and function of ecosystems, particularly the ability to form a monoculture will also need to be controlled and will take priority over lower impact species.

- ***Distribution of Species.*** Widely distributed species may have a higher ecological impact than species that are localised.

- ***Visually Prominent Species.*** Some weed species may be highly visible, affecting the aesthetic value of the area and usually being prominent in the minds of those who use or manage the area.
- ***Associated Species.*** Some weed species may not be rated high for ecological reasons but are normally associated with other weed that are rated high and as a result will be included in control programs.
- ***Control of Adjacent Weed Threats.*** Weeds adjacent to priority areas may need to be controlled at the same time as those priority areas to maximize efficiency (eg. paddock weeds may need to be controlled adjacent to priority areas).

- ***Special/Exclusion Areas.*** There are areas (ie. sport, recreation or heritage areas) within the park that may need to be excluded from normal weed control priorities. This may also include areas of natural rehabilitation.

- ***Control Method.*** Control methods can be prioritised according to the selectiveness of the method and the degree of disturbance associated with it. Areas with different vegetation-based priorities may be grouped where one control method applies across them all (eg. blanket spraying of a selective herbicide).

- ***Timing.*** Weed control priorities may need to be adjusted to suit appropriate timing for the control method or the availability of resources. Weed control priorities will also be affected by the timing of ensuing revegetation.

LEVEL FOUR - REVEGETATION PRIORITIES

Revegetation priorities are based on weed control priorities together with a number of additional considerations relating directly to revegetation, as briefly outlined below.

- **Plant availability.** Plant availability will affect the timing or the ability to undertake revegetation. Plant composition should be based on the floristics of the relevant vegetation community.
- **Planting Time.** Appropriate planting season should be determined and revegetation projects adjusted accordingly.

The constraints that stem from revegetation priorities should be fed back into the process for establishing weed control priorities, as these two components of work need to be planned in an integrated manner.

5.2 WEED CONTROL PRIORITY PLAN

The **Weed Control Priority Plan** consists of:

1. **A map**, which defines areas based on vegetation significance and priority weeds. This map can be used as a basic Weed Control Priority Plan but will benefit from the planning steps outlined below.
2. **A series of planning steps**, which can be used to refine the Weed Control Priority Plan. These steps define other management priorities (for rehabilitation) and some of the weed control priorities. In some cases other management priorities may not exist and this step may be bypassed.
3. **A works program**, which defines appropriate weed control operations/projects based on practical implementation of the adjusted Weed Control Priority Plan.

This approach allows a works program to be developed that is responsive to vegetation significance related priorities, other management priorities, and specific weed control related priorities. These two components are discussed further below.

1 - THE MAP (WEED CONTROL PRIORITY AREAS - SEE MAP 11)

As a general rule, weed control should focus on the most important areas of bushland - the areas of vegetation significance. Once these areas have been established then attention can be turned to weed control within them. This map shows weed control priorities based on vegetation significance priorities (Level 1 Priority) and areas of high ecological priority weeds (Level 3 Priority). The vegetation significance priority areas are based on Condition. There were no Rare or Priority Flora sites or Threatened Ecological Communities.

The Weed Control Priority Areas map for the park includes the above priorities as follows:

- vegetation Condition shown coloured and coded;
- areas of high Ecological Priority Weeds that are known to exist, shown vertically hatched.

The principles to be employed when using this map include:

- The highest priority for rehabilitation, based on this map, is the Condition 2 areas that have High Ecological Priority Weeds.
- High Ecological Priority Weeds in one condition class should be addressed before moving onto High Ecological Priority Weeds in the next lower condition (eg. all Condition 2 areas should be rehabilitated before moving to Condition 3 or 4). The weeds remaining after this program can then be controlled.

The map also shows the control method and the weed group targeted by the control method. For example, '**b2'** refers to control method '**b'** (see Table 3) and weed group '**2'** (see Table 4). The weed groups have been defined by the distribution of the weeds (similar distribution for each group) and are listed in Table 4, along with an appropriate control method for each of two Condition categories. Once a target weed group and its control method are identified, the weed distribution maps (see Appendix 4) can then be used to locate localised

weeds ('community wide' species are assumed to be distributed across the community).

This approach, using the Weed Control Priority Areas Map, can be used to delineate weed control areas appropriate for developing weed control projects and annual works programs. An example has been provided that shows the first stage outcomes (see Maps 12-15). This type of maps can be produced very simply using the GIS dataset for the park or by hand-overlay techniques based on Map 11.

The Weed Control Priority Areas Map and subsidiary maps may be all that is required for much of the weed control planning for the park. The planning steps outlined below will generally assist with refinement of these maps.

2 - THE PLANNING STEPS

The planning steps cover two main groups of priorities not covered by the map(s). The steps are used to refine the areas generated from the Weed Control Priority Areas Map. The two groups of priorities are Other Management Priorities and Weed Control Priorities and are discussed further below.

2a - Other Management Priorities

These priorities (Level 2 Priority) have been discussed in Section 5.1. They tend to be *ad hoc* in nature and need to be assessed on an ongoing basis (for example annually). As highlighted above, there may not always be Other Management Priorities and this step can be bypassed. If they do exist, and have been assessed, they can be used to adjust the current Weed Control Priority Plan. Care should be taken in the planning to ensure that Other Management Priorities do not generally dominate the priorities set by Vegetation Significance and Priority Weeds. This is an important consideration and will help ensure that the ecological rehabilitation of the park remains on track.

2b - Weed Control Priorities

This part of the planning considers the weed control priorities (Level 3 Priority) other than those with ecological priority that have already been considered in the areas on Map 11. The remaining priorities are:

- Visually Prominent Species;
- Associated Species;
- Control of Adjacent Weed Threats;
- Special/Exclusion Areas;
- Control Method;
- Timing.

Visually Prominent Species and Associated Species have been assessed and listed (see Tables 2 and 9). This list may change with time as the size or area of weeds expands or diminishes. The maps of Visually Prominent Species can be used to adjust the Weed Control Priority Areas, depending on the emphasis that is placed on these weeds. Associated Species will generally be controlled by the control operations on Ecological Priority Weeds.

Control of Adjacent Weed Threats, Special/Exclusion Areas, and Timing will respectively add control areas, exclude some areas from control, and program works according to appropriate timing. The control of adjacent weed threats may, for example, require slashing in grass/paddock areas adjacent to the targeted bushland. These slashing areas will need to be:

- wide enough to be effective;
- avoid areas where natural regeneration is likely; and
- be undertaken before seed sets on the grasses.

Special/Exclusion Areas (ie. sport, recreation or heritage areas) will need to be delineated on the working Weed Control Priority Plan and these will normally be treated as exclusion areas.

Weed control method priorities have been provided in Table 3. These priorities can be used to determine priorities for weed control where there is more than one type of weed and control method in the one area (notwithstanding other priorities).

Weed control priorities may need to be adjusted to suit appropriate timing for the control method or the availability of resources. Weed control priorities will also be affected by the timing of ensuing revegetation. These factors will affect the areas that can be programmed for weed control.

All these additional weed control priority areas should be used to adjust the priority areas developed from the map and Other Management Priorities.

3 - DEFINE THE WORKS PROGRAM

In addition to prioritised areas as defined above, there a number of steps that can be undertaken to define a works program.

1. Produce working maps of the park with areas that have the same priority and control method grouped (ie. appropriate for one control operation). Examples of these have been provided (see Maps 12 - 15).
2. If necessary, add lesser priority areas if they contribute to more practical work areas.
3. For species that are identified in Table 4 as being localised species, check the weed distribution maps (Map 9) to determine the location of spot weeds.
4. Check species availability and timing for revegetation (Level 4 Priority)(see Table 8 and Revegetation Plan, Section 5.3) and adjust the weed control program accordingly.
5. Undertake general planning for the weed control project, including identifying the budget, appropriate works for volunteers, and required timing.
6. Undertake implementation, ‘as completed’ records, and monitoring.

Table 3 - Weed Control Methods and their Priorities.

Weed Control Method	Priority*
Biological	**a**
Selective Herbicide (blanket spray)	**b**
Manual control (see Table 5 for types)	**c**
Cut and Paint	**d**
Semi selective blanket or spot spray	**e**
Non-selective spot spray	**f**
Slash and wipe	**g**
Slash and spray	**h**
Non-selective Blanket spray	**i**
Bulldoze, scalping	**j**

*- Weed control methods generally apply to different species of weeds regardless of the priority of the method. These priorities can be used to determine priorities for weed control where there is more than one type of weed and control method in the one area (notwithstanding other priorities).

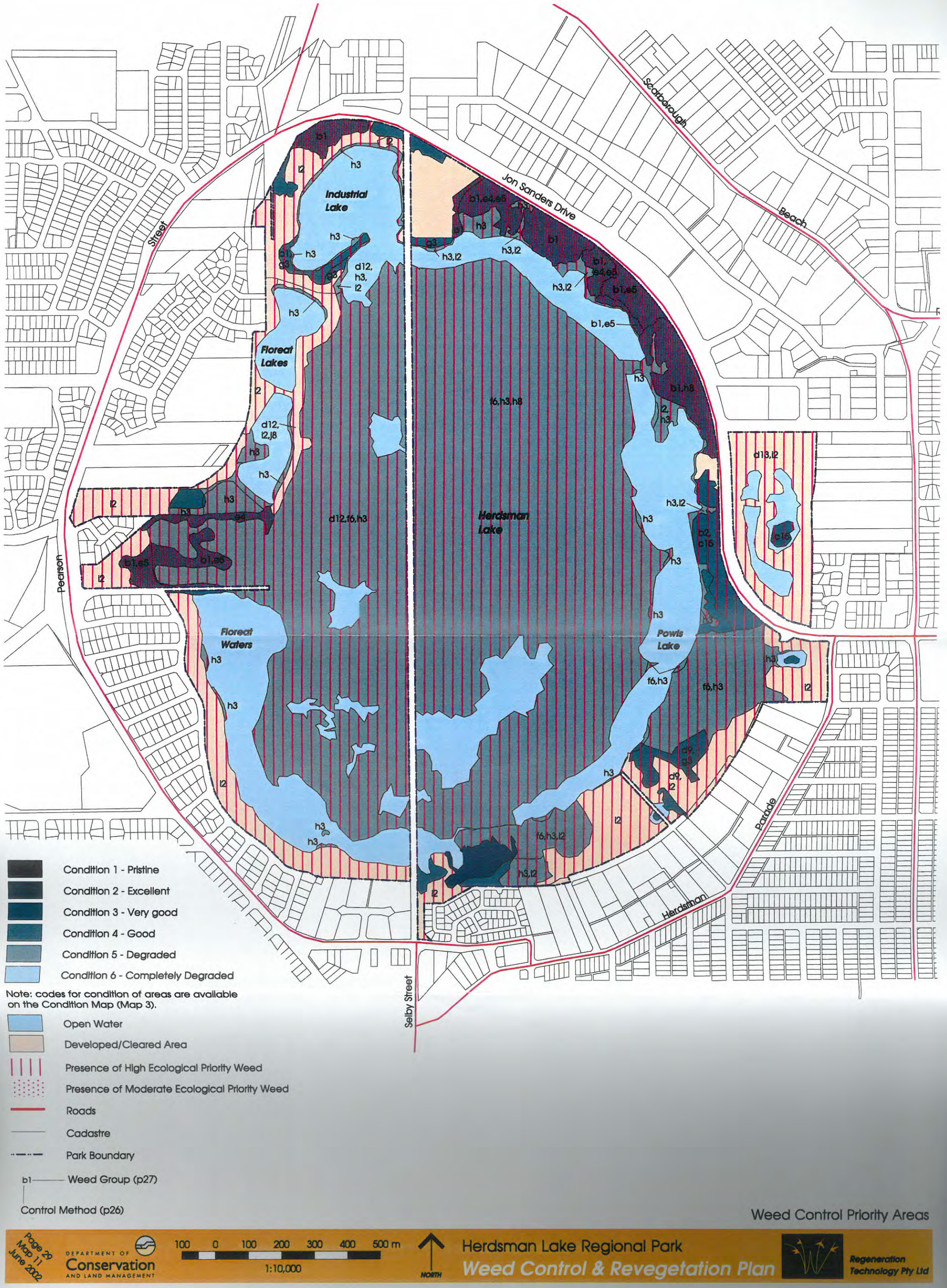
Table 4 - Weed group and associated control method code according to vegetation condition classes.

Weed Group Code	Species	Common Name	Distribution Type	Code for Weed Control Method:	
				where it occurs in Vegetation Condition 2, 3 or-4	where it occurs in Vegetation Condition 5 or 6
1	*Avena barbarta*	Bearded Oat	Community wide	**b**	**i**
	Briza maxima	Blowfly Grass	Community wide	**b**	**i**
	Bromus diandrus	Great Brome	Community wide	**b**	**i**
	Bromus catharticus	Prairie Grass	Community wide	**b**	**i**
	Ehrharta calycina	Perennial Veldt Grass	Community wide	**b**	**i**
	Lagurus ovatus	Harestail Grass	Community wide	**b**	**i**
2	*Cynodon dactylon*	Couch	Community wide	**b**	**i**
	Pennisetum clandestinum	Kikuyu	Community wide	**b**	**i**
	Stenotaphrum secundatum	Buffalo Grass	Community wide	**b**	**i**
3	*Typha orientalis*	Bulrush	Community wide	**g**	**h**
4	*Euphorbia terracina*	Geraldton Carnation Weed	Community wide	**e**	**e**
5	*Pelargonium capitatum*	Rose Geranium	Community wide	**e**	**e**
6	*Solanum nigrum*	Black Berry Nightshade	Localised	**f**	**f**
7	*Arundo donax*	Giant Reed	Localised	**d**	**j**
8	*Cortaderia selloana*	Pampas Grass	Localised	**h**	**h**
9	*Erythrina sykesii*	Flame Tree	Localised	**d**	**d**
11	*Melia azedarach*	Cape Lilac	Localised	**d**	**d**
12	*Populus alba*	Poplar	Localised	**d**	**d**
13	*Salix babylonica*	Weeping Willow	Localised	**d**	**d**
14	*Schinus terebinthifolia*	Japanese Pepper	Localised	**d**	**d**
15	*Zantedeschia aethiopica*	Arum Lily	Localised	**c**	**c**

Table 5 - Summary of weed control techniques for different plant types, and suggested timing (adapted from Nielssen in prep.). (Check growth and flowering times of individual species to ensure weeds are targeted at the optimum time).

WEED CONTROL METHOD		PLANT TYPE *(see Table 9 for species)*			
		Woody weeds *	***Herbaceous plants***	***Grasses***	***Bulbs, tubers and rhizomes***
Biologcial					all year
Selective herbicide blanket spray				winter and spring	
Manual control	***Mulch/smother***		all year	all year	all year
	Solarisation		spring and summer	spring and summer	spring and summer
	Topping	all year			
	Ring Bark	all year			
	Pull	all year	all year	all year	all year
	Slash		when flowering (prior to seed set)	all year (before flowering an seed set)	when flowering (prior to seed set)
Cut and Paint (or drill and inject)		spring			
Semi-selective blanket or spot spray			spring		winter and spring
Non Selective spot spray			spring	spring	spring
Slash and wipe			winter and spring	winter and spring	winter and spring
Slash and spray			winter and spring	winter and spring	winter and spring
Non-selective blanket spray			spring	winter and spring	winter and spring
Bulldoze/scalping		all year	all year	all year	all year

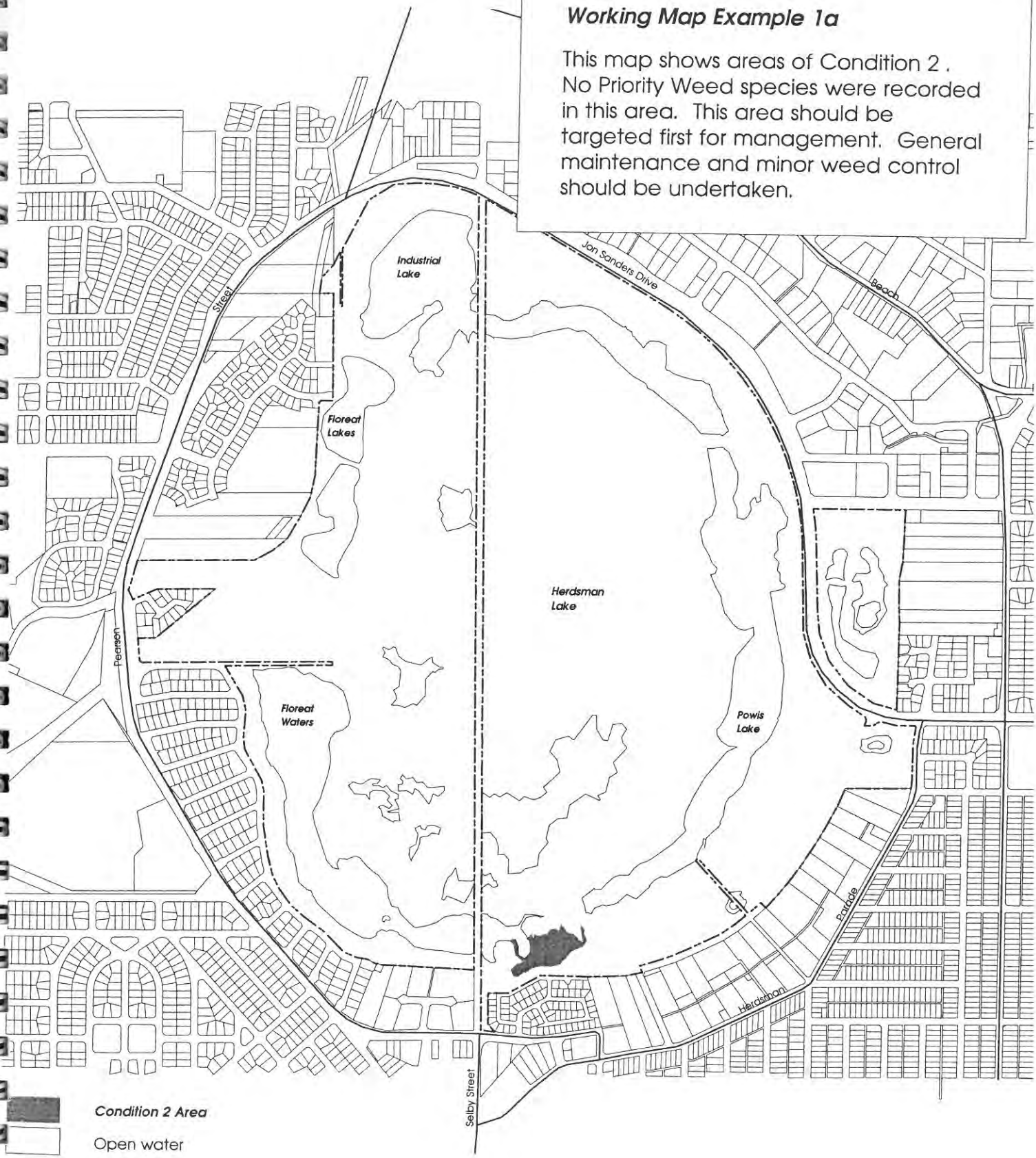
Weed Control Priority Areas


Scarborough Beach
Jon Sanders Drive
Street
Pearson
Selby Street
Parade
Herdsman
Industrial Lake
Floreat Lakes
Herdsman Lake
Floreat Waters
Powis Lake
b1
i2
h3
b1,e4,e5
h3,i2
b1,e5
b1,h8
f6,h3,i2
d12,f6,h3
d12,h3,i2
d12,i2,j8
d13,i2
f6,h3
b1,e5
b2,e15
d9,i2
Condition 1 - Pristine
Condition 2 - Excellent
Condition 3 - Very good
Condition 4 - Good
Condition 5 - Degraded
Condition 6 - Completely Degraded
Note: codes for condition of areas are available on the Condition Map (Map 3).
Open Water
Developed/Cleared Area
Presence of High Ecological Priority Weed
Presence of Moderate Ecological Priority Weed
Roads
Cadastre
Park Boundary
b1 Weed Group (p27)
Control Method (p26)
Weed Control Priority Areas
Page 29
Map 11
June 2002
DEPARTMENT OF Conservation AND LAND MANAGEMENT
100 0 100 200 300 400 500 m
1:10,000
NORTH
Herdsman Lake Regional Park
Weed Control & Revegetation Plan
Regeneration Technology Pty Ltd

Working Map Eg 1a

Working Map Example 1a

This map shows areas of Condition 2 . No Priority Weed species were recorded in this area. This area should be targeted first for management. General maintenance and minor weed control should be undertaken.



Condition 2 Area

Open water

Road

Cadastre

Park boundary

Working Map Example 1a

DEPARTMENT OF Conservation AND LAND MANAGEMENT

100 0 100 200 300 400 500 m

1:15,000

NORTH

Herdsman Lake Regional Park

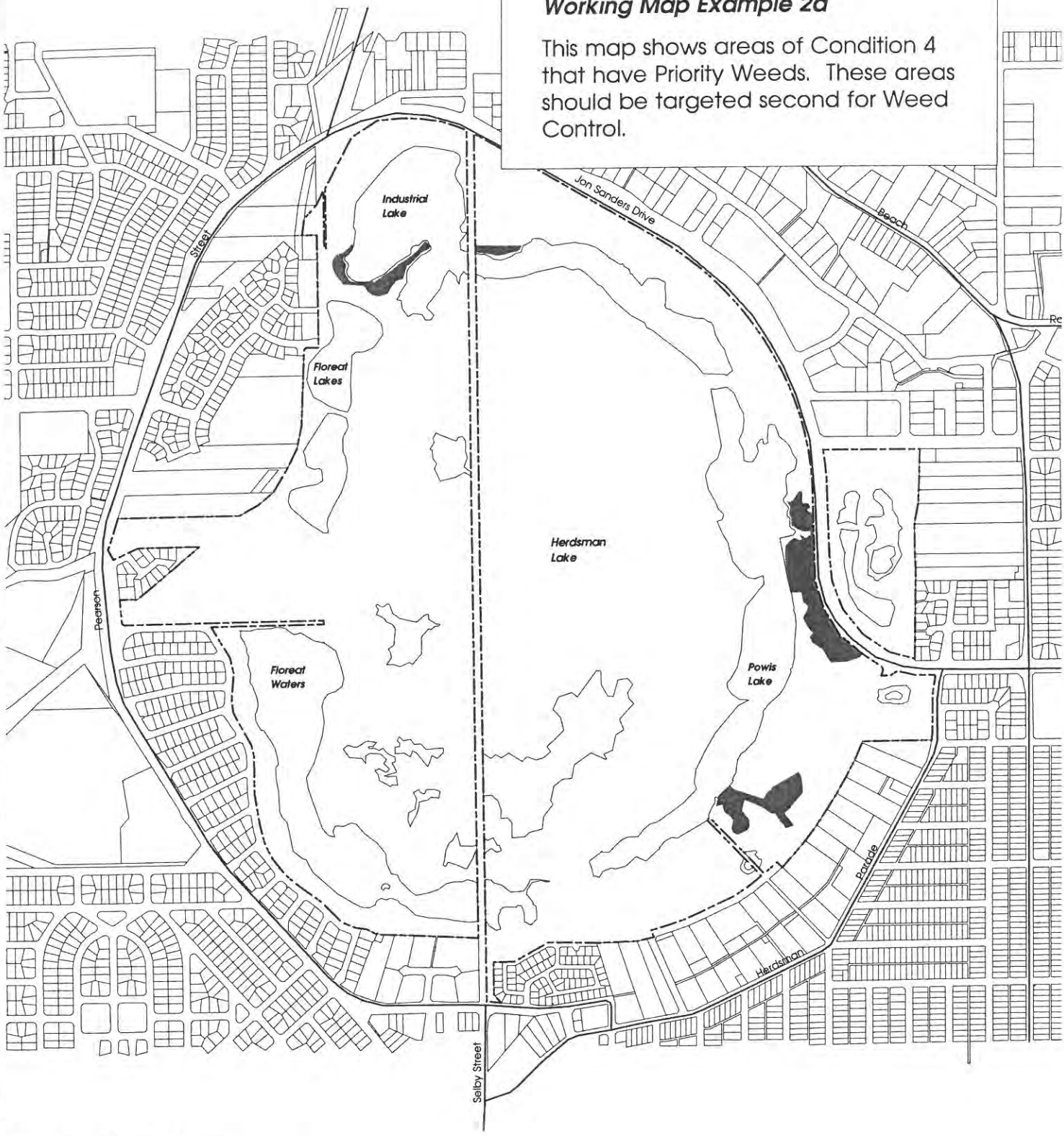
Regeneration Technology Pty Ltd

Page 30 Map 12 June 2002

Working Map Eg 2a

Working Map Example 2a

This map shows areas of Condition 4 that have Priority Weeds. These areas should be targeted second for Weed Control.



Condition 4 Area
High Ecological Priority Weeds

Open water

Road

Cadastre

Park boundary

Working Map Example 2

DEPARTMENT OF Conservation AND LAND MANAGEMENT

100 0 100 200 300 400 500 m

1:15,000

NORTH

Herdsman Lake Regional Park
Weed Control & Revegetation Plan

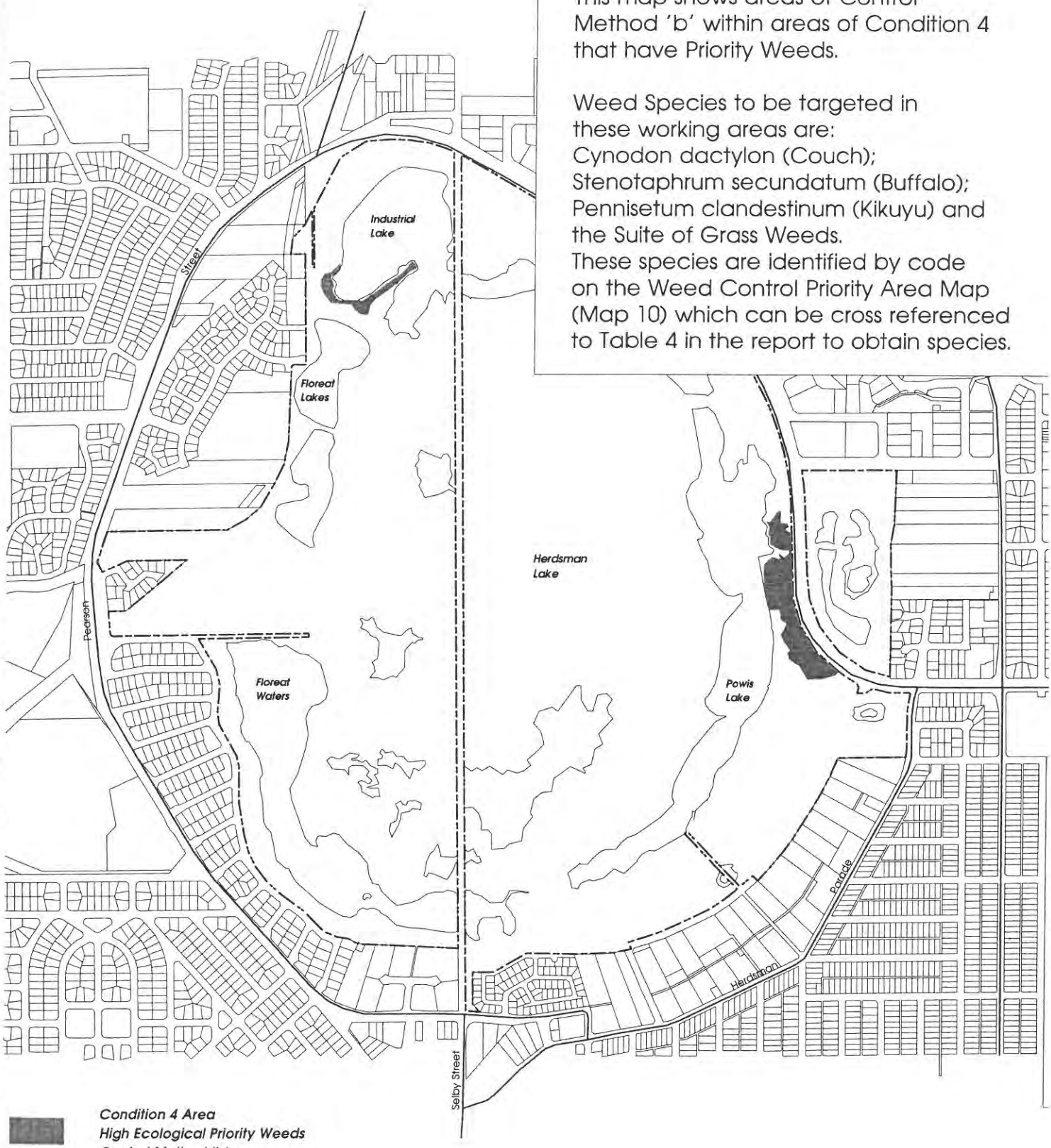
Regeneration Technology Pty Ltd

Working Map Eg 2b

Working Map Example 2b

This map shows areas of Control Method 'b' within areas of Condition 4 that have Priority Weeds.

Weed Species to be targeted in these working areas are:
Cynodon dactylon (Couch);
Stenotaphrum secundatum (Buffalo);
Pennisetum clandestinum (Kikuyu) and the Suite of Grass Weeds.
These species are identified by code on the Weed Control Priority Area Map (Map 10) which can be cross referenced to Table 4 in the report to obtain species.



Condition 4 Area
High Ecological Priority Weeds
Control Method 'b'

Open water

Road

Cadastre

Park boundary

Working Map Example 2b

DEPARTMENT OF Conservation AND LAND MANAGEMENT

100 0 100 200 300 400 500 m

1:15,000

NORTH

Herdsman Lake Regional Park

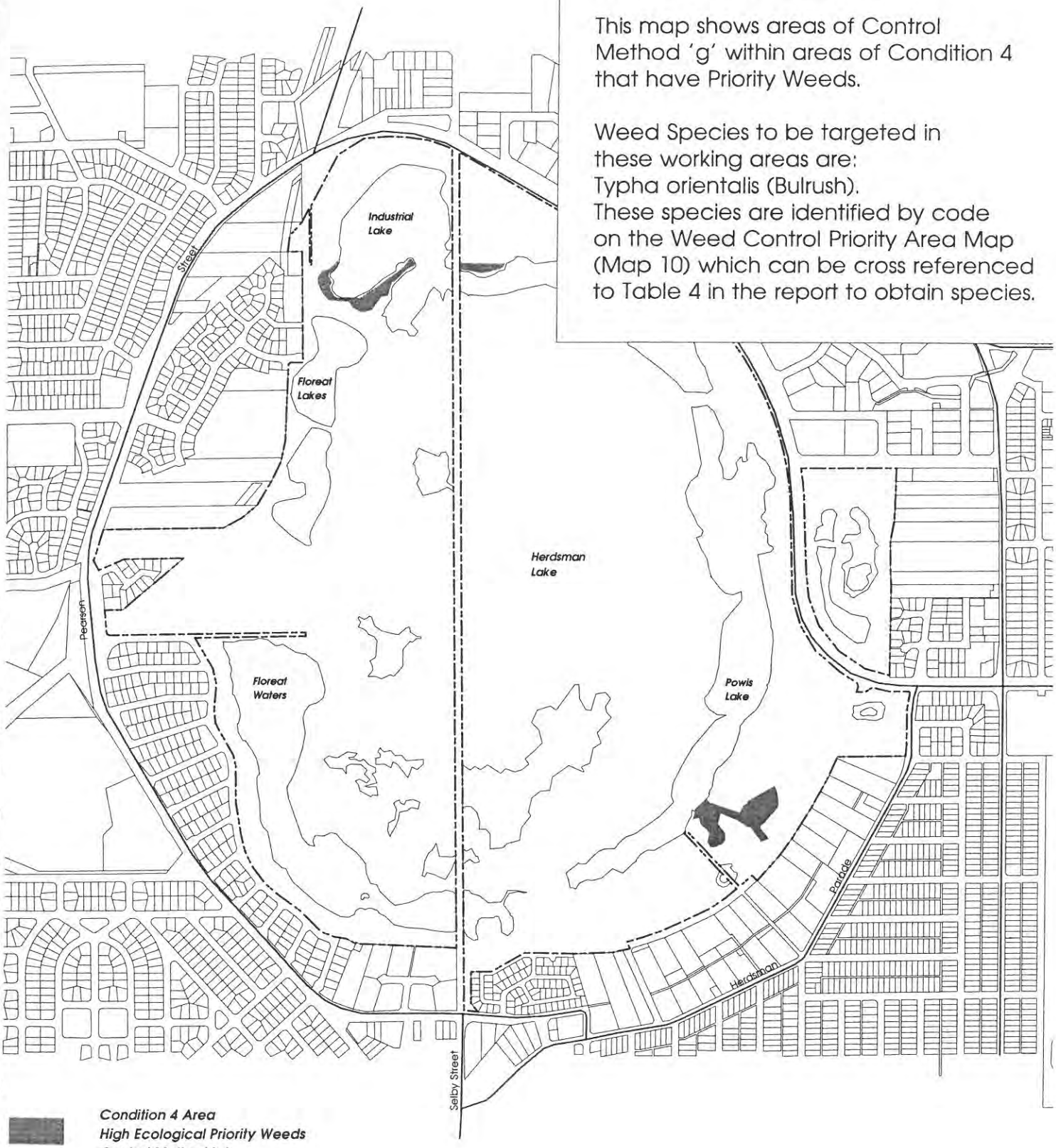
Regeneration Technology Pty Ltd

Working Map Eg 2c

Working Map Example 2c

This map shows areas of Control Method 'g' within areas of Condition 4 that have Priority Weeds.

Weed Species to be targeted in these working areas are:
Typha orientalis (Bulrush).
These species are identified by code on the Weed Control Priority Area Map (Map 10) which can be cross referenced to Table 4 in the report to obtain species.



Condition 4 Area
High Ecological Priority Weeds
Control Method 'g'

Open water

Road

Cadastre

Park boundary

Working Map Example 2c

DEPARTMENT OF Conservation AND LAND MANAGEMENT

100 0 100 200 300 400 500 m

1:15,000

NORTH

Herdsman Lake Regional Park

Regeneration Technology Pty Ltd

5.3 REVEGETATION PRIORITY PLAN

Revegetation priorities are based on the same priorities as Weed Control with the addition of some considerations that relate specifically to revegetation. The Revegetation Priority Plan consists of:

- working maps developed from the Weed Control Priority Plan; and
- a series of planning steps that will define revegetation areas appropriate for developing revegetation projects and annual works programs.

This approach allows a works program to be developed that is responsive to vegetation significance related priorities, other management priorities, and specific weed control related priorities.

The planning steps that define revegetation works are summarised below.

1. Check the working maps developed from the Weed Control Plan.
2. Determine the type and extent (ie: infill planting), from the vegetation condition and management response table (Table 1).
3. Determine the species composition appropriate for the area to be revegetated. Use the community mapping, the species database, and any relevant floristic studies.
4. Investigate plant or seed availability and appropriate planting times (Level 4 Priority).
5. Prepare a preliminary revegetation plan.
6. Note the timeframe of the revegetation program and adjust the timeframe of the Weed Control Plan accordingly.
7. Undertake general planning for the revegetation project, including identifying the budget, appropriate works for volunteers, and required timing.
8. Undertake implementation and monitoring.

6. COMMUNITY INVOLVEMENT & MONITORING

6.1 COMMUNITY INVOLVEMENT

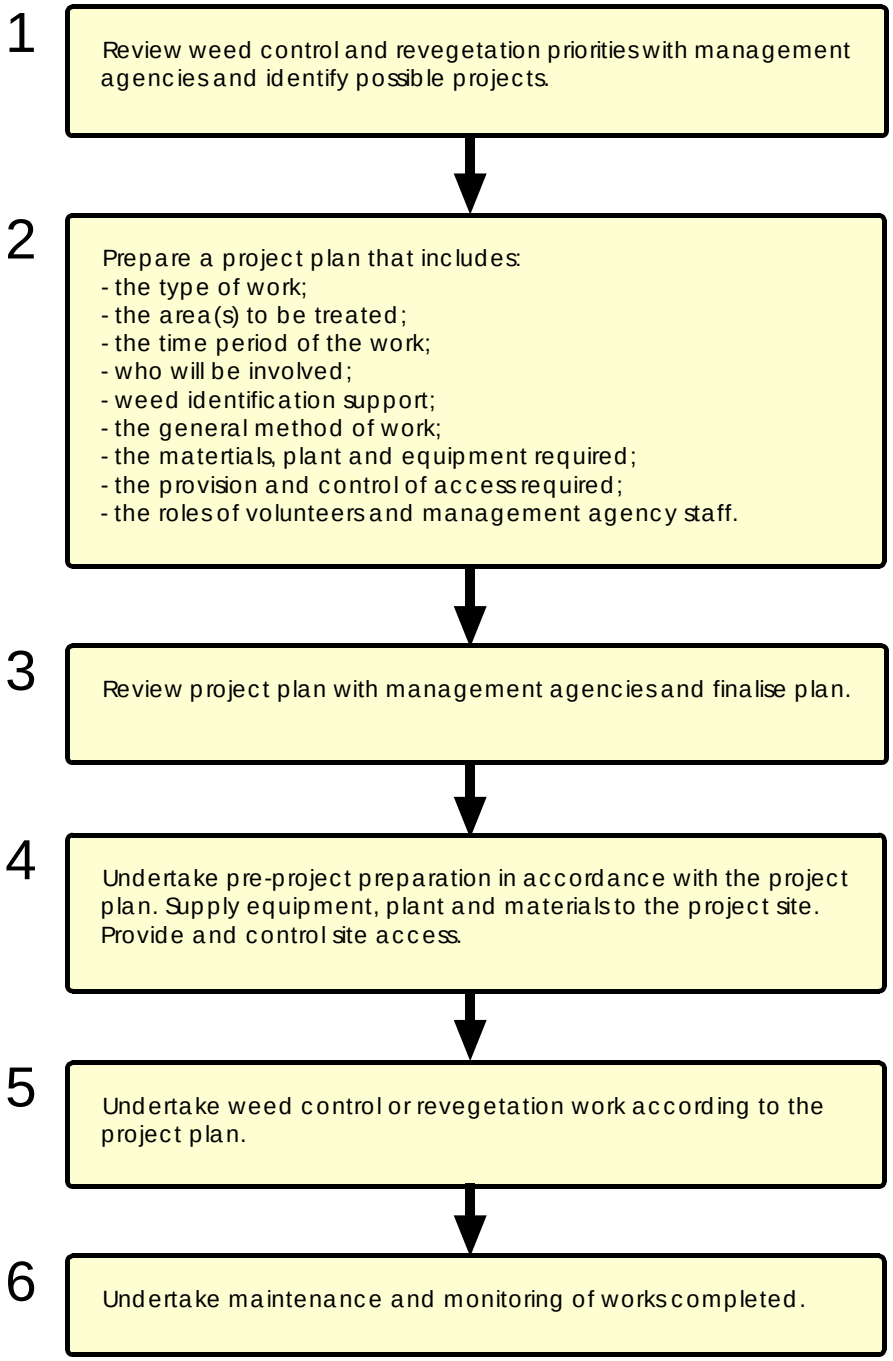
Volunteer groups can provide valuable contributions to the management of the park. Weed control and revegetation is relatively labour intensive and often stretches the resources of management agencies. Volunteers can undertake many tasks involved in this work and their effort is acknowledged as a valuable part of park management. In addition to accelerating the implementation of the plans, volunteer effort can foster a sense of ownership of the work (and the park), increase understanding of the park's ecosystems and values and facilitate communication and rapport between the community and management agencies.

There is currently only one active community group working at Herdsman Lake. They have concentrated their efforts around the wildlife centre and the management of the adjacent paperback woodland.

All work in the park should be carefully planned. This weed control and revegetation plan is intended to facilitate the planning of specific aspects of the park. Any work undertaken should generally be consistent with the weed control and revegetation priorities, and with the planning and operations undertaken as part of the management of the park. Planning should also match any project or tasks undertaken by volunteer groups with the capacity of the group.

The planning of work involves the coordination of effort by volunteers and management agencies. Generally it is the responsibility of management agencies to undertake park planning and consequently the coordination of weed control and revegetation works will be undertaken by these agencies. This coordination requires effective communication between volunteers and management agencies and protocols for initiating and undertaking work in the park. A coordination process for this purpose is illustrated below in Figure 2. It highlights that steps that are generally required to complete a project. Each step should be completed before proceeding to the next. In some cases, the management agencies may complete these steps and call for volunteers, either individuals or members of a group. Alternatively, this process may be initiated and driven by a volunteer group. Individual volunteers can work either directly for the management agency or a volunteer group when either of these initiates a project. The coordination process is not meant to prevent people casually removing known weeds.

Figure 2 - Coordination process for volunteers and management agencies. These steps are written as tasks for volunteers but some of this work may be undertaken by the management agencies. The tasks generally remain the same regardless of who completes them.



The following table is a summary of possible community involvement activities in weed control and revegetation works within the park.

Table 6 - Weed control, revegetation, ongoing maintenance and monitoring tasks and community involvement opportunities.

Weed Control	Community Involvement
Biological	Volunteers, community and school groups can greatly assist in the spread of biological control agents including rust fungus and leaf hopper.
Selective Herbicide (blanket spray)	This work should only be undertaken by a licensed herbicide contractor.
Manual control eg mulch/smother, solarisation, topping, pulling, ringbarking	Manual weed control can be undertaken by community groups after a training session that demonstrates species and how a particular weed should be removed. Very important to minimise disturbance.
Cut and Paint	Stems and trunks of cut plants should be painted immediately (within minutes). This is an ideal job for teams to work on.
Semi selective blanket or spot spray	This work should only be undertaken by a licensed herbicide contractor.
Non-selective spot spray	This work should only be undertaken by a licensed herbicide contractor.
Slash and wipe	Slashing can be undertaken using either a brush cutter or pruning saws. The follow-up wiping (usually 3-4 weeks later) should only be undertaken by a licensed herbicide contractor.
Slash and spray	Slashing can be undertaken using either a brush cutter or pruning saws. The follow-up spray (usually 3-4 weeks later) should only be undertaken by a licensed herbicide contractor.
Non-selective Blanket spray	This work should only be undertaken by a licensed herbicide contractor.
Bulldoze, scalping	This work should only be undertaken by a licensed machinery operator.

Table 6 (Continued) - Weed control, revegetation, ongoing maintenance and monitoring tasks and community involvement opportunities.

Revegetation	**Community Involvement**
Seed collecting	A license (from CALM wildlife branch) is required for all native seed collection. Most important to know the species being collected and the readiness of the seed. Suggest all volunteers undertake a seed collecting course with APACE.
Propagation	Plant propagation can be undertaken by any group that has the facilities. Nursery hygiene and labelling are the two most important considerations.
Planting	This is an excellent activity for community group involvement. Best to work on no more than 100 plants per person per day. (Professional planters 1000 plants per day.)
Mulching	Mulching can undertaken by community groups with the aid of moving equipment (ie. bobcat, trailer, wheelbarrows, mulch forks).
Brushing	Provided there is an adequate supply of endemic mulch this can be successfully undertaken by any size community group.
Ongoing Maintenance and Monitoring	**Community Involvement**
Ongoing maintenance	The success of weed control and revegetation can depend to large extent on ongoing maintenance. Maintenance can provide a number of activities for community involvement, including follow-up weed control, replenishment planting (where original plantings have failed), pest control, watering, and control of access.
Monitoring	A clear monitoring and reporting protocol is required for community groups to successfully undertake meaningful monitoring.

6.2 MONITORING

Monitoring is an essential part of the bushland management process. It can be directed at measuring the state of the environment or at evaluating management strategies/actions that affect the environment.

The aim of bushland monitoring has been expressed in the Key Performance Indicator section of the draft management plan. The two main bushland indicators suitable for monitoring are:

- maintain the range of vegetation communities;
- reduce the abundance and distribution of priority weed species.

There are other indicators allied to the range of vegetation communities (such as Bushland Condition) that may be appropriate to monitor, particularly where there are Rare and Priority Flora or Threatened or Vulnerable Ecological Communities.

The distribution of a number of weed species that are classed as invasive but are not priority weeds species in Herdsman Lake Regional Park is also an appropriate monitoring target.

The results from monitoring priority weed species will be significantly more effective if causes of weed impacts are also monitored. This may provide a correlation between variations in bushland condition or the distribution/density of priority weeds and the causes of weed infestation. Controllable causes can then be targeted by management.

The above indicators can be monitored for trends or absolute values using a variety of different measures. The sampling area may be a monitoring plot (or quadrat) or complete structural unit. Both of these may represent a rehabilitation works site. Possible Indicators, Measures and Standards are provided in the Table 7 below. High priority measures are indicated with tone and a hash symbol. An asterisk indicates bushland and weed indicators that have been surveyed.

Table 7 - Possible Indicators, Measures and Standards for monitoring performance.

Indicator	Possible Measures	Possible Standards
Bushland Condition	• Bushland Condition rating at established monitoring plots or across each structural unit.#*	• There should be an increasing trend in Bushland Condition ratings until Condition Rating 1 is achieved in a plot, structural unit, or an average of all units (ie. the park).
Weeds	• Number of different species at a plot or across the park.*	• There should be a decreasing trend in the number of different species at a plot or across the park until a state of no weeds is achieved.
	• Area of weeds.*	• There should be a decreasing trend in the area of weeds across the park until a state of no weeds is achieved.
	• Number of different priority weed species at a plot or across the park.#*	• There should be a decreasing trend in the number of different priority weed species at a plot or across the park until a state of no priority weeds is achieved.
	• Area of priority weeds.#*	• There should be a decreasing trend in the area of priority weeds across the park until a state of no priority weeds is achieved.
Bushland Composition/Area	• Number of species within a stratum within a given area.	• There should be an increasing trend in the number of species within a stratum within a given area until a climax state is achieved.
	• Number of plants within a stratum within a given area.	• There should be an increasing trend in the number of plants within a stratum within a given area until a climax state is achieved.

Table 7 (Continued) - Possible Indicators, Measures and Standards for monitoring performance.

Indicator	Possible Measures	Possible Standards
	• The number of strata.	• There should be a stable or increasing trend in the number of strata within a community until a climax state is achieved.
	• The number of community types.#*	• There should be stable or increasing trend in the number of community types.
	• The area of community type.*	• There should be stable or increasing trend in the area of the community type.
Bushland Impacts	• Frequency of wildfire.	• There should be a decreasing frequency of fires until no fires occur.
	• Area of wildfire.	• There should be a decreasing area of fires until no fires occur.
	• Number of incidents of weed rubbish dumping.	• There should be a decreasing number of incidents of weed rubbish dumping until no rubbish dumping occurs.
	• Population of seed-transmitting animals.	• There should be a decreasing population of seed-transmitting feral animals until zero population is achieved.
	• Quality of water from drains discharging into the park.	• There should be an increase in the quality of water from drains discharging into the park until appropriate water quality standards are attained.
	• Quantity of water overflowing from drains into the lake	• There should be a decrease in the quantity of water breaching the levee banks of the open drains through the lake.

The nature of many of these measures means that these tasks may need to be undertaken by specialist staff, depending on the expertise of any volunteers. It is suggested that general bushland monitoring be undertaken at 5 year intervals.

Bushland and weed indicators marked with an asterisk in Table 7 have been surveyed for the preparation of this plan and provide an ideal base for further monitoring. GIS databases have been prepared that will allow easy analysis and mapping of new data, and comparison with current data. The focus of monitoring should be on the priorities established though the preparation of the Weed Control and Revegetation Priority Plans, and should particularly address vegetation significance.

Monitoring can also be undertaken to directly measure the performance of weed and revegetation programs and projects. This monitoring may include visual checks of weed death or resprouting, and for revegetation may include plant survival or attrition or causes of attrition.

As highlighted in the section above on community involvement, some of this monitoring work may be undertaken by or with the help of the community, provided appropriate protocols are established. The focus of monitoring undertaken by the community is likely to be on weed control and revegetation works and the priorities will generally be linked to these activities.

APPENDICES

APPENDIX 1 - CONSULTATION

Community consultation was an important part of the process, providing local knowledge and insight helpful to the preparation of the plan. Consultation with key stakeholders was undertaken either onsite or via telephone interview. The topics covered in discussion with participants, together with a summary of the outcomes, are listed below.

Their connection to the park:

The respondents were connected to the park as: local residents, member of the Community Advisory Committee, Academics who had undertaken research in the park, and operations personnel from the Department of Conservation and Land Management.

Their field of expertise:

Expertise ranged from Environmental scientists, wetlands/geography, zoology and on-ground technical expertise.

Their knowledge of other studies on weeds or vegetation in the park:

There was no knowledge of additional studies relating to weeds or vegetation in the park.

Their knowledge of weeds and vegetation, history and general management issues:

Key concerns regarding the weeds at Herdsman Lake related to views across the water and snakes. The control of *Typha orientalis* in the park is considered by most of the respondents to be an onerous task due to the expanse across the main wetland. It is also considered to be excellent habitat for a variety of fauna found at the lake.

There was doubt as to the species (ie *Eucalyptus rudis* or *Eucalytpus camaldulensis*) of trees used for revegetation along Jon Sanders Drive.

Water levels and quality were considered to be key management issues. Breeches of the levee banks of Water Corporation's drains through the wetland have resulted in contaminants from the adjacent industrial area entering the lake. Higher water levels have also been noted in recent time.

Current works in the park:

Current works within the park include general maintenance of the recreation areas weed control and revegetation. Volunteers from the Herdsman Wildlife centre have been active in extending the *Melaleuca rhaphiophylla* community using brushing techniques.

Issues and future management suggestions (eg. weed control, revegetation priorities, threats to the ecology/vegetation):

All respondents were looking for some direction for establishing weed control and rehabilitation priorities.

Their interest in being involved in the weed control or revegetation and whether they have particular skills to contribute:

All respondents were keen to comment on a draft of the plan.

APPENDIX 2 - INDICATIVE REVEGETATION SPECIES

Table 8 - Indicative Species for Revegetation in Herdsman Lake Regional Park (non-weeds).

Species	Common Name	Family	Community Type					Max Height
			Baumea articulata Sedgeland	*Schoenoplectus validus* Sedgeland	*Melaleuca rhaphiophylla* Woodland	*Melaleuca rhaphiophylla/E.rudis*	*Eucalyptus rudis* Woodland	
Agonis linearifolia		Myrtaceae					■	4
Astartea fascicularis		Myrtaceae					■	3
Baeckea tenuiflora		Myrtaceae					■	0.7
Baumea articulata	Jointed Twig Rush	Cyperaceae	■					3.5
Baumea juncea	Bare Twig Rush	Cyperaceae			■	■	■	1.2
Baumea preissii	Broad Twig Rush	Cyperaceae		■	■			1
Baumea vaginalis	Sheath Twig Rush	Cyperaceae			■			2.5
Bolboschoenus caldwellii	Marsh Club Sedge	Cyperaceae			■	■		0.6
Carex appressa	Tall Sedge	Cyperaceae			■	■		1
Carex fasicularis	Tassel Sedge	Cyperaceae			■	■		1
Carex inversa	Knob Sedge	Cyperaceae			■	■	■	0.75
Casuarina obesa	Swamp Sheoak	Casuarina				■	■	10
Eleocharis acuta	Common Spike Rush	Cyperaceae			■			0.7
Eleocharis sphacelata	Tall Spike Sedge	Cyperaceae			■			2
Eucalyptus rudis	Flooded Gum	Myrtaceae				■	■	15
Hypocalymma angustifolia	White Myrtle	Myrtaceae					■	1.5
Hypocalymma	Swan River	Myrtaceae					■	0.8

Species	Common Name	Family	Community Type					Max Height
robustum	Myrtle							

Table 8 - Indicative Species for Revegetation in Herdsman Lake Regional Park (non-weeds) continued

Species	Common Name	Family	Community Type					Max Height
			Baumea articulata Sedgeland	*Schoenoplectus validus* Sedgeland	*Melaleuca rhaphiophylla* Woodland	*Melaleuca rhaphiophylla/E.rudis*	*Eucalyptus rudis* Woodland	
Isolepis nodosa	Club Sedge	Cyperaceae						1
Juncus pallidus	Pale Rush	Juncaceae						1
Kunzea ericifolia	Spearwood	Myrtaceae						3
Melaleuca incana	Grey Honey Myrtle	Myrtaceae						5
Melaleuca preissiana	Moonah	Myrtaceae						10
Melaleuca rhaphiophylla	Swamp Paperbark	Myrtaceae			c			10
Melaleuca teretifolia		Myrtaceae						5
Melaleuca teretifolia		Myrtaceae						5
Melaleuca thymoides		Myrtaceae						2
Pericalymma ellipticum	Ti-tree	Myrtaceae						1
Rhagodia baccata		Chenopodiaceae						1
Schoenoplectus validus	Lake Club Sedge	Cyperaceae						2
Viminaria juncea	Swishbush	Fabaceae						2

APPENDIX 3 - WEED SPECIES' CHARACTERISTICS

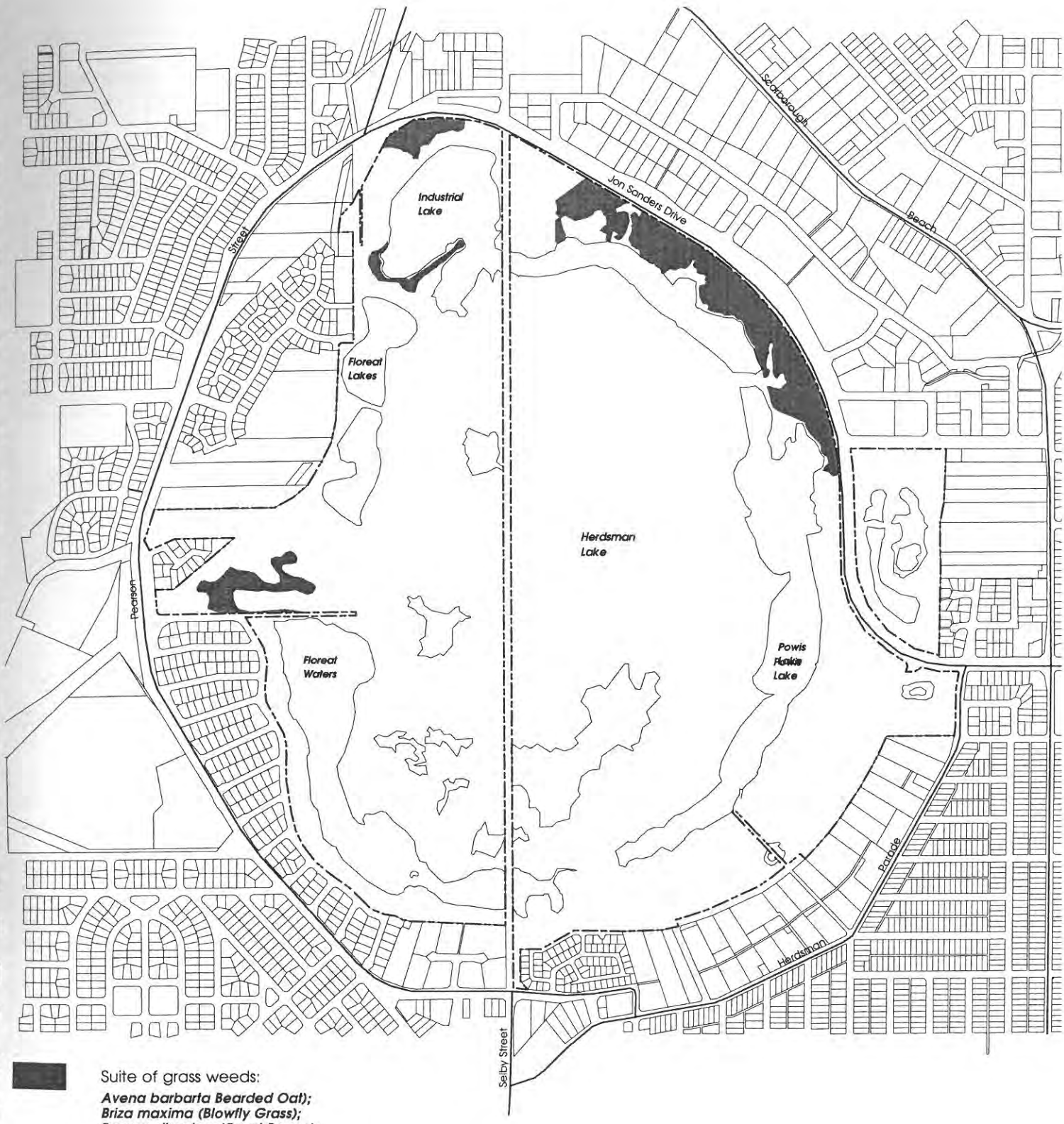
Table 9 - Weed Species Characteristics of Herdsman Lake Regional Park

Record Number	Species	Common Name	Declared Weed	Ecological Priority						Overall Ecological Priority Rating	Visual Prominence Rating	Associated Species	Overall EWSWA Rating
				Invasiveness Rating	Environmental Impacts Rating	Distribution							
						Nature of Distribution*	Number of Communities	Proportion of Park (% or No of occur.)	Overall Distribution Rating				
1	*Typha orientalis	Bulrush	-	High	High	DE	3	70%	High	High	High		High
2	*Stenotaphrum secundatum	Buffalo Grass	-	High	High	DE	7	20%	High	High	Low		Moderate
3	*Cortaderia selloana	Pampas Grass	-	High	High	S	2	3		Moderate	High		High
4	*Bromus diandrus	Great Brome	-	High	High	SE	3	5%		Moderate	Low		High
5	*Cynodon dactylon	Couch	-	High		DE	4	20%	High	Moderate	Low		Moderate
6	*Ehrharta calycina	Perennial Veldt Grass	-	High	High	SE	3	5%		Moderate	Low		High
7	*Euphorbia terracina	Geraldton Carnation weed	-	High	High	SE	3	<5%		Moderate	Low		High
8	*Lagurus ovatus	Hares Tail Grass	-	High	High	SE	2	5%		Moderate	Low		High
9	*Pelagonium capitatum	Rose Pelargonium	-	High	High	SE	3	<5%		Moderate	Low		High
10	*Pennisetum clandestinum	Kikuyu Grass	-	High		DE	8	20%	High	Moderate	Low		Moderate
11	*Solanum nigrum	Black Berry Nightshade	-	High		P	7	18	High	Moderate	Low		Moderate
12	*Zantedeschia aethiopica	Arum Lily	-	High	High	P	1	2		Moderate	Low		High
13	*Schinus terebinthifolia	Japanese Pepper	-	High		S	4	1		Mild	High		Moderate
14	*Glaiolus undulatus	Wavy Galdioli	-	High		S	1	1		Mild	Low		Moderate
15	*Arctotheca calendula	Cape Weed	-	High		P	3	1		Mild	Low		Moderate
16	*Aster subulatus	Bushy Starwort	-	High		P	2	1		Mild	Low		Moderate
17	*Avena barbarta	Bearded Oat	-	High		SE	3	5%		Mild	Low	Yes	Moderate
18	*Briza maxima	Blowfly Grass	-		High	SE	3	5%		Mild	Low	Yes	Moderate
19	*Cirsium vulgare	Spear Thistle	-	High		P	1	1		Mild	Low		Low
20	*Euphorbia peplus	Petty Spurge	-	High		P	3	<5%		Mild	Low		Moderate
21	*Fumeria capreolata	Climbing Fumaria	-		High	P	2	1		Mild	Low		Mild
22	*Gomphocarpus fruticosus	Cotton Bush	-	High		S	1	1		Mild	Low		Moderate
23	*Juncus acutus	Sharp Rush	-	High		S	1	1		Mild	Low		Moderate
24	*Paspalum dilatatum	Paspalum	-	High		SE	3	<5%		Mild	Low		Moderate
25	*Persicaria maculosa	Redshank	-			SE	4	70%	High	Mild	Low		Low
26	*Sonchus oleraceus	Sowthistle	-	High		P	7	1		Mild	Low		Moderate
27	*Vicia sativa	Common Vetch	-	High		P	3	1		Mild	Low		Moderate
28	*Arundo donax	Giant Reed	-			S	3	2		Low	High		Low
29	*Erythrina sykesii	Flame Tree	-			S	1	4		Low	High		Low
30	*Melia azedarach	Cape Lilac	-			S	1	1		Low	High		Not listed
31	*Populus alba	Poplars	-			S	4	1		Low	High		Low
32	*Salix babylonica	Willow Tree	-			S	3	2		Low	High		Low
33	*Apium graveolens	Celery	-			S	1	1		Low	Low		Not listed
34	*Bromus catharticus	Prairie Grass	-			SE	3	5%		Low	Low	Yes	Low
35	*Cotula australis	Common Cotula	-			P	1	2		Low	Low		Not listed
36	*Foeniculum vulgare	Fennel	-			P	1	1		Low	Low		TBA
37	*Lathyrus tingitanus	Tangier Pea	-			P	2	1		Low	Low		Low
38	*Nicotiana glauca	Tree Tobacco	-			S	4	2		Low	Low		Mild
39	*Phragmites australis	Reed	-			P	3	1		Low	Low		Low
40	*Ricinus communis	Castor Oil Tree	-			S	1	1		Low	Low		Low
41	*Rumex cripus	Curled Dock	-			S	4	1		Low	Low		Mild
42	*Thistle sp	Flat Leaf Thistle	-			P	1	4		Low	Low		
43	*Trachyandra divaricarta	Dune Onion Weed	-			P	3	1		Low	Low		Mild
44	*Vallisneria gigantea	Ribbon Weed	-			P	1	1		Low	Low		Not listed
45	*Verbena sp		-			S	1	1		Low	Low		

* DE = Dense Even Distribution
SE = Sparse Even
P = Patchy Distribution
S = Singular

APPENDIX 4 - WEED DISTRIBUTION MAPS

Map 4



Suite of grass weeds:
Avena barbarta Bearded Oat);
Briza maxima (Blowfly Grass);
Bromus diandrus (Great Brome);
Bromus catharicus (Prairie Grass);
Ehrharta calycina (Veldt Grass);
Lagurus ovatus (Harestail grass)

Open water

Road

Cadastre

Park boundary

Weed Distribution
Suite of Grass Weeds

DEPARTMENT OF Conservation AND LAND MANAGEMENT

100 0 100 200 300 400 500 m
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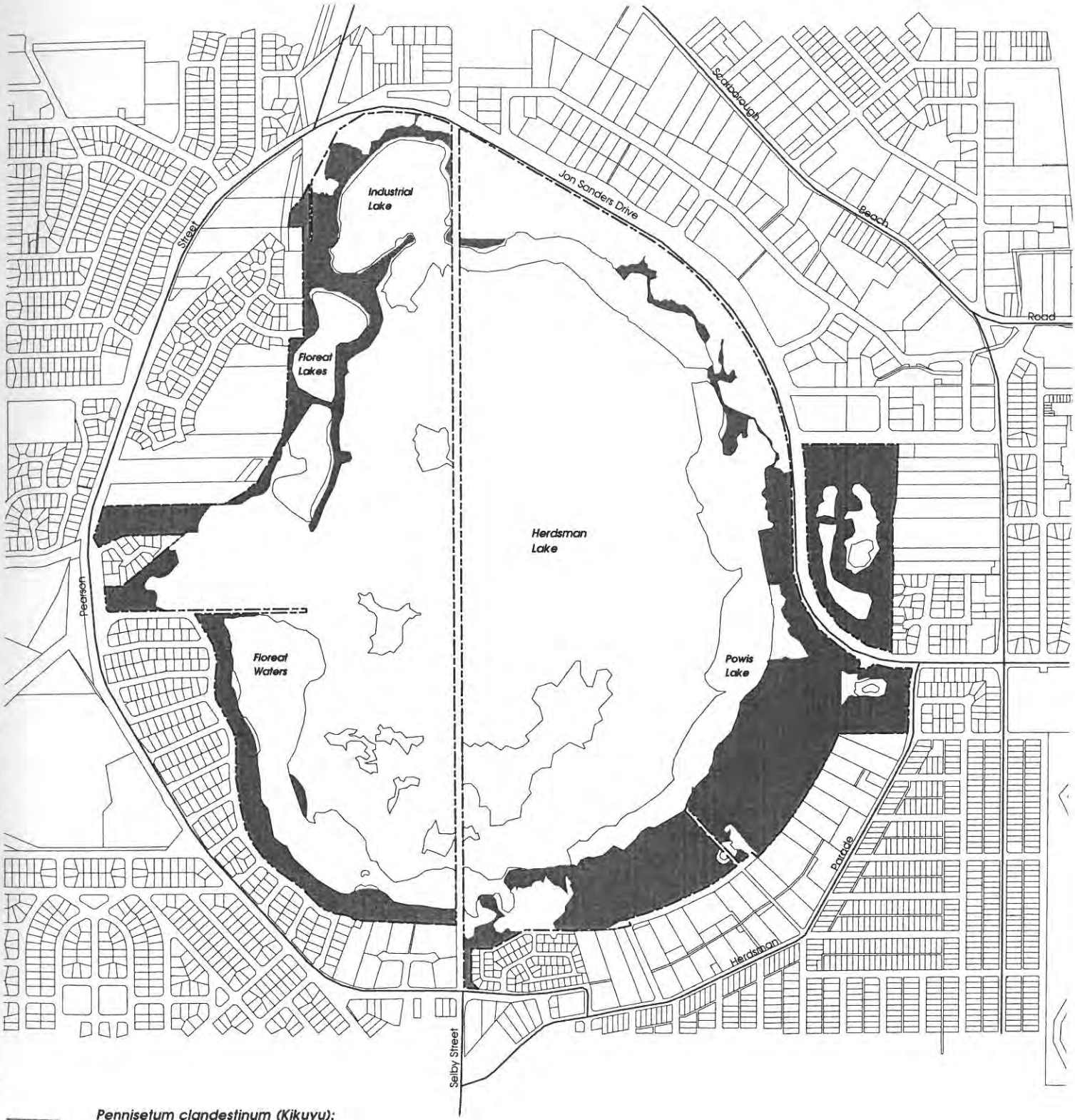
NORTH

Herdsman Lake Regional Park
Weed Control & Revegetation Plan

Regeneration Technology Pty Ltd

Map 5



Pennisetum clandestinum (Kikuyu); Cynodon dactylon (Couch) and Stenotaphrum secundatum (Buffalo)

Open water

Road

Cadastre

Park boundary

Weed Distribution

Pennisetum clandestinum, Cynodon dactylon and Stenotaphrum secundatum

DEPARTMENT OF Conservation AND LAND MANAGEMENT

100 0 100 200 300 400 500 m

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NORTH

Herdsman Lake Regional Park

Weed Control & Revegetation Plan

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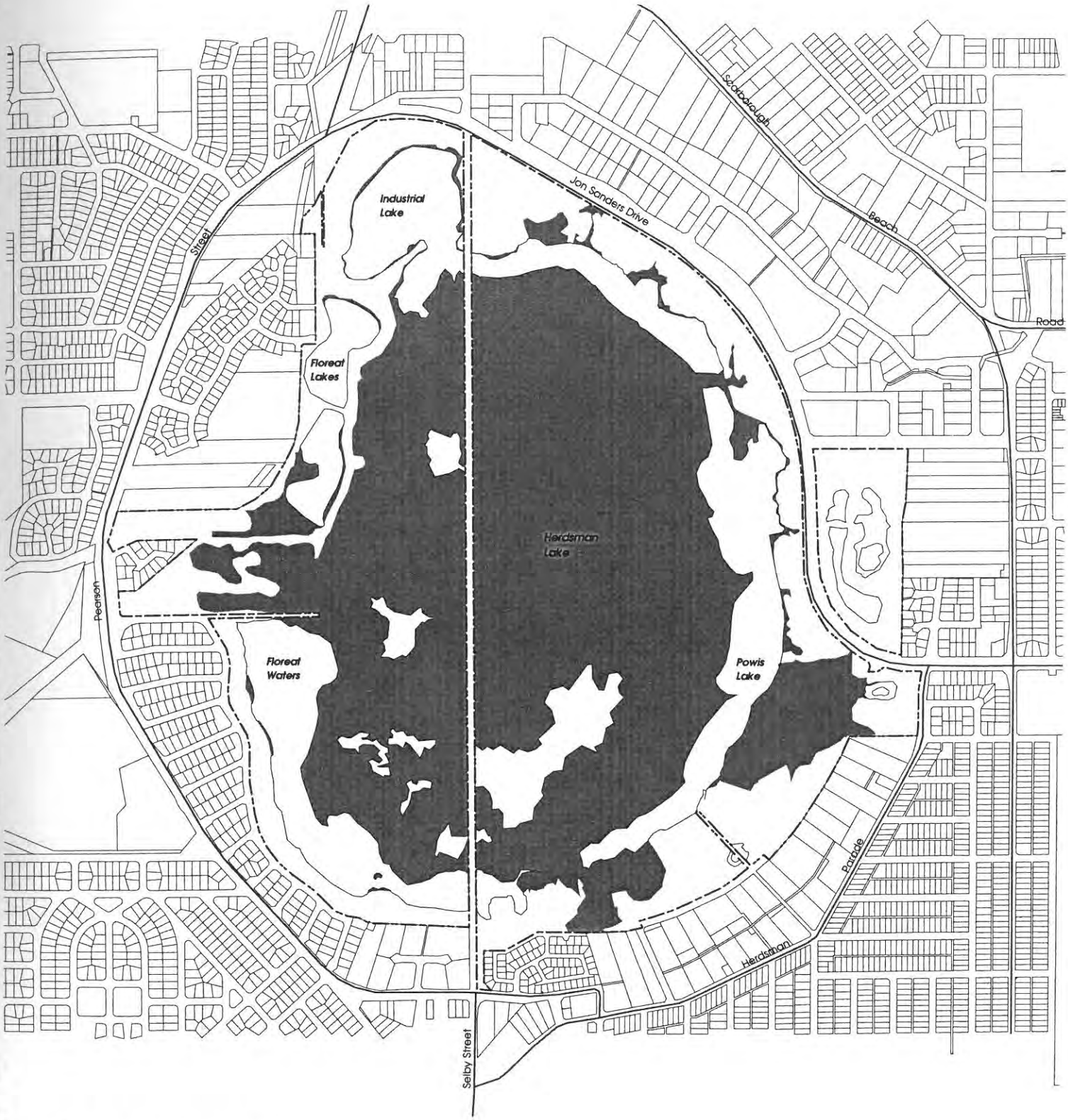
Page 30
Map 5
June 2002

Map 6



Typha orientalis (Bulrush)

Open water

Road

Cadastre

Park boundary

Weed Distribution
Typha orientalis

DEPARTMENT OF Conservation AND LAND MANAGEMENT

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NORTH

Herdsman Lake Regional Park
Weed Control & Revegetation Plan

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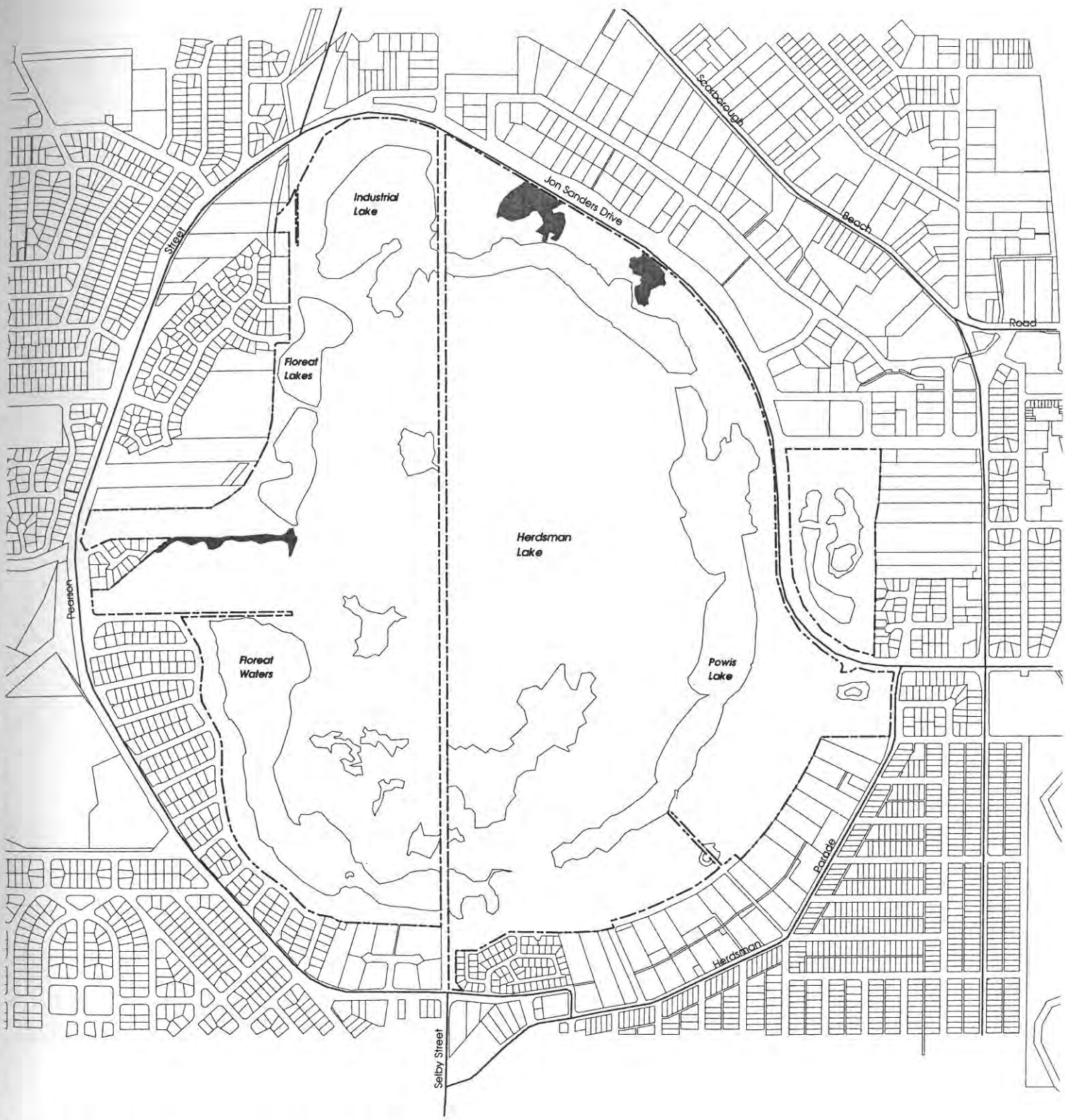
Map 6
June 2002

Map 7



Euphorbia terracina (Geraldton Carnation Weed)

Open water

Road

Cadastre

Park boundary

Weed Distribution
Euphorbia terracina

DEPARTMENT OF Conservation AND LAND MANAGEMENT

100 0 100 200 300 400 500 m

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NORTH

Herdsman Lake Regional Park
Weed Control & Revegetation Plan

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Map 7
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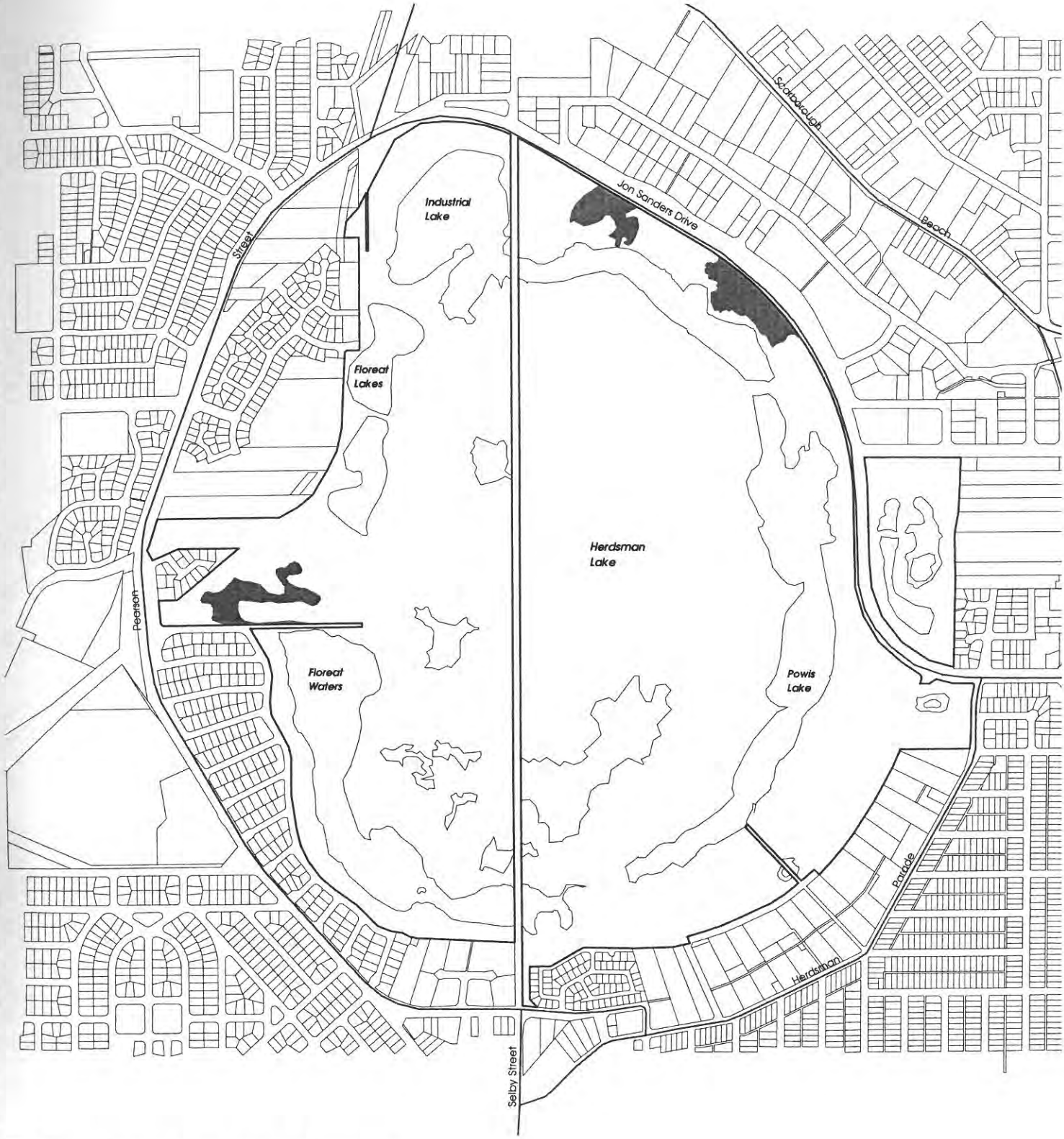
Map 8



Pelargonium capitatum (Rose Pelargonium)

Open water

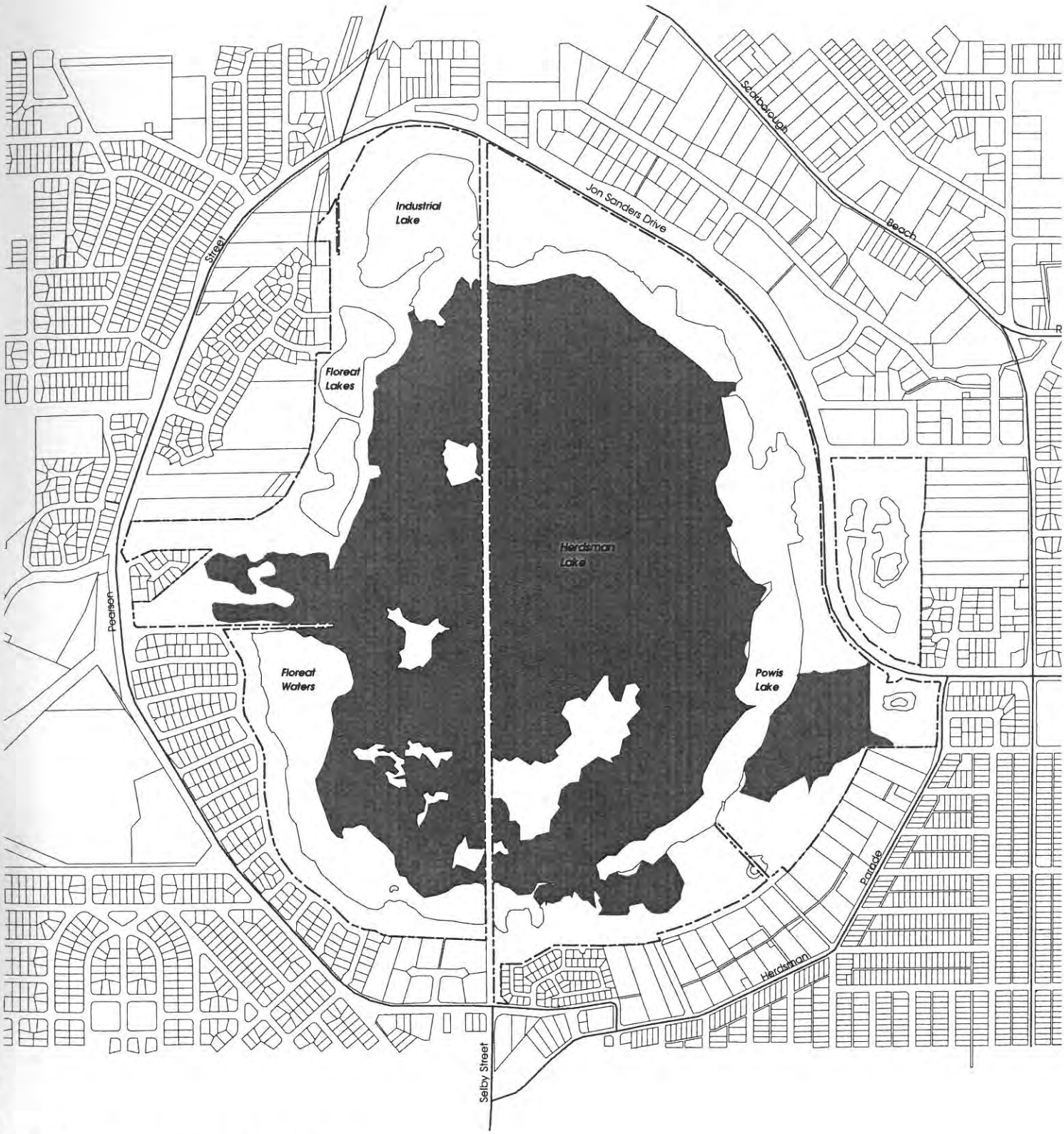
Road

Cadastre

Park boundary

Weed Distributio
Pelargonium capitatu

Map 9



Solanum nigrum (Black Berry Nightshade)

Open water

Road

Cadastre

Park boundary

Weed Distribution
Solanum nigrum

DEPARTMENT OF Conservation AND LAND MANAGEMENT

100 0 100 200 300 400 500 m

1:15,000

NORTH

Herdsman Lake Regional Park
Weed Control & Revegetation Plan

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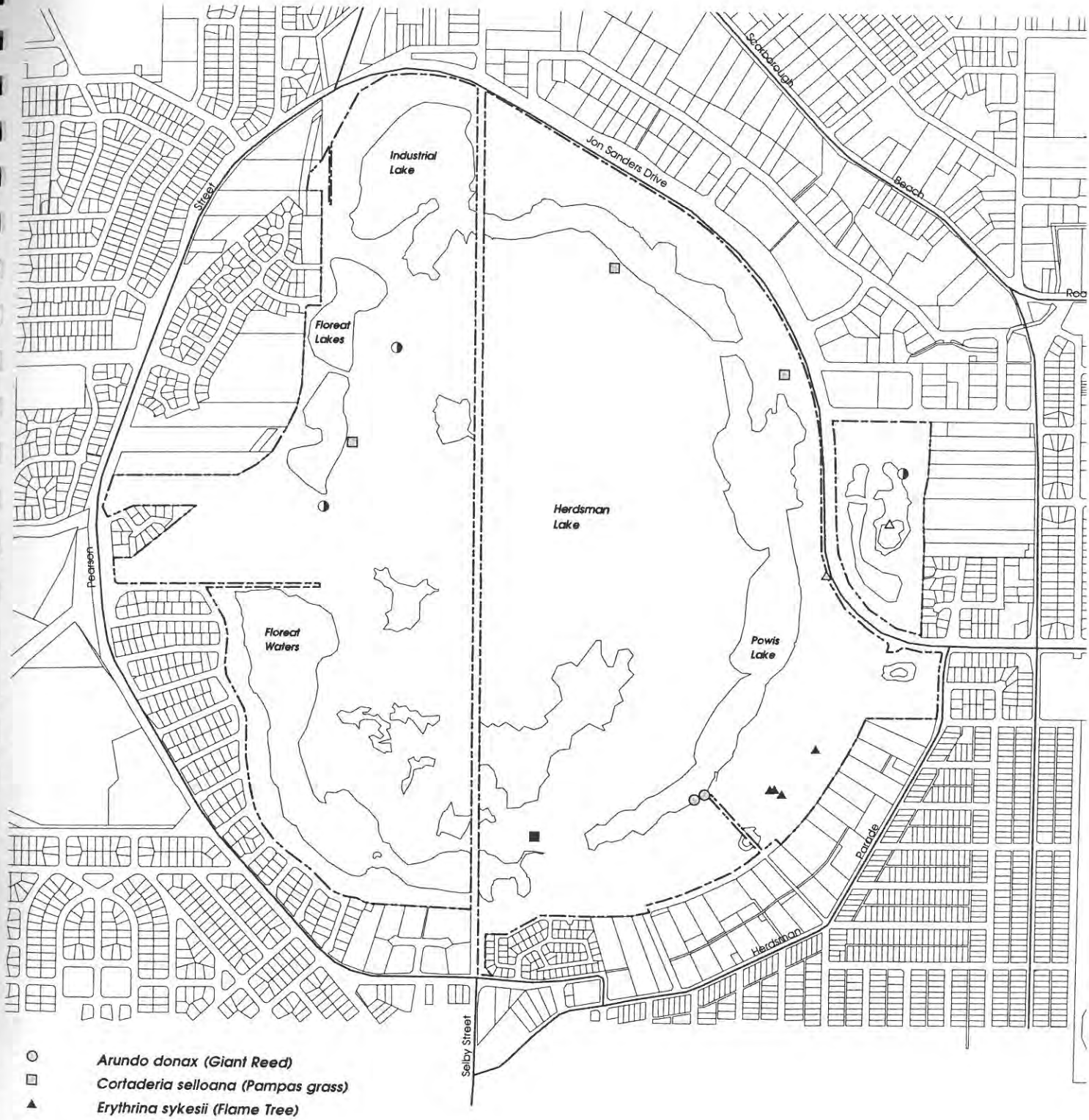
Map 9
June 2002

Map 10



- *Arundo donax (Giant Reed)*
- *Cortaderia selloana (Pampas grass)*
- *Erythrina sykesii (Flame Tree)*
- *Salix babylonica (Willow)*
- *Schinus terebinthifolia (Japanese Pepper)*
- *Zantedeschia aethiopica (Arum Lily)*
- Open water
- Road
- Cadastre
- Park boundary

Weed Distributior
Localised Weed Species

DEPARTMENT OF Conservation AND LAND MANAGEMENT

100 0 100 200 300 400 500 m

1:15,000

NORTH

Herdsman Lake Regional Park

Regeneration Technology Pty Ltd

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Map 10
June 2002

APPENDIX 5 - GUIDELINES

WEED CONTROL

Woody weeds are very tenacious and pose a serious threat to the bushland by displacing native species. Sometimes these trees form dense thickets under which no understorey can survive and produce an enormous viable seed bank each year. The seeds are held on capsules on the branches, which act like salt shakers dispersing the seed when it is ripe. It is important not to use the branches from these species for chipped mulch or brush mulch.

Other tenacious species, which displace the understorey component of the bushland, are the grasses. Some of the grass weeds are perennial such as couch or veldt grass while others are annuals. Regardless of their life cycle grasses have the capacity of filling niches in disturbed sites and preventing the germination and growth of slower growing native species.

The various weed species can be controlled by a variety of methods, depending on their growth cycle, regenerative strategies and soil seed bank. Generally weeding should minimise soil disturbance and work should be conducted from good (ie. low weed infestation) areas to bad. Removal of weeds should be undertaken in conjunction with revegetation.

Physical Removal

Physical removal is the most environmental friendly method of weed control. This method however is very labour intensive and can only be applied to relatively small areas where volunteer groups or other bodies are available. This method, combined with herbicides, is most useful for eliminating woody weeds.

Herbicides

Key herbicides for the control of environmental weeds in WA include; Brush off® or Ally® for treating bridal creeper and some woody weeds such as blackberry, Roundup® (glyphosate) for treating broadleaf weeds such as Watsonia and Fusilade®, which is a selective herbicide, for grasses. Fusilade® can be sprayed over areas of vegetation that are specifically infested with grass weeds without damaging the native vegetation. As precautionary measure, when using non-selective herbicides the native plants should be tagged first and if possible weeds pulled away from the plants prior to spraying. Spraying should only take place during still weather to ensure accidental overspray does not occur.

Solarisation

Solarisation, to kill weeds and sterilise soil, can be achieved by laying good quality, UV resistant black plastic sheeting over areas of low weeds or newly turned soil and leaving undisturbed for 2 - 3 weeks. For best results the black plastic should be in the direct sunlight and the soil should be damp. This encourages the weed seeds to germinate, after which they die due to the high temperatures under the plastic. The best success is achieved during summer and early autumn. Solarisation may be used where there is a need to kill weed seeds (either in or on the soil), where there is a need to avoid herbicides, where

contiguous blocks of area need treatment and the long term benefit of this technique justifies the extra initial cost.

MULCH AND MAT

There are three mulch and mat types that could be used for rehabilitation works in the park: chipped mulch made from tree prunings, brush matting made from endemic tree prunings, and a number of roll out commercially available products (stabilising mats).

Chipped mulch retains soil moisture and provides microclimates to promote seed germination rates and can enhance rehabilitation success. The areas that will most benefit from a mulch layer are the edge areas surrounding remnant vegetation as well as denuded areas.

The advantages of laying chipped mulch are:

- it is a natural product and therefore appears more natural in a rehabilitation area;
- it can be cheap to produce and lay if it is made on site using endemic vegetation;
- it may contain additional seed for revegetation; and
- it can be placed in thick or thin layers as desired.

Brush mat provides most of the functions of chipped mulch as well as stabilising soils. It is more appropriate than chipped mulch for steep slopes and areas of high wind and water erosion. Some species used for mat may also provide additional seed resource (season of use is important).

Stabilising mats provide functions similar to brush mat but are more resistant to surface water erosion. They are made of a variety of materials but it is recommended that only biodegradable products be considered. While some of these mats may have a higher initial cost, they save on spreading costs and are more appropriate in some situations. For example, some of the roll out products (such as jutemat®) are much more useful for control and bank stabilisation than a top dressing of chipped mulch.

Advantages of laying a rollout commercially available product are:

- The cost of laying it is greatly reduced compared to the cost of spreading chipped mulch (ie. up to one-eighth of the cost);
- There are no problems associated with the introduction of non-endemic species; and
- Roll out biodegradable mats can be used for erosion control.

FERTILISER USE

The practice of applying fertiliser to lawn areas within the reserves and private lawns should be actively discouraged. Much of the fertiliser added to lawn areas will end up elsewhere, encouraging the growth of exotics rather then indigenous species and creating nutrification problems within waters bodies. There should be no need to include fertilisers when revegetating natural areas.

REVEGETATION AND PLANTING

- The size of the area to be revegetated should be determined by the number of plants available for revegetation and the capacity to maintain the area (weed control etc) until plants are well established.
- Access to the planting area needs to be planned to cause the least harm to existing vegetation and planted areas.
- Ensure that plants are pre-ordered at least six months before planting is intended.
- Where possible replant locally collected seeds or plants propagated from local seed. Seed collection should be undertaken by licensed collectors (a service provided by several local revegetation nurseries).
- Plant at appropriate densities. For trees/shrubs an average loss is 50-70%, therefore plant at 0.5m spacing.

Size of stock

For most species 7 to 8 month old seedlings are ideal for establishment under natural rainfall conditions. Under these conditions the seedlings benefit by developing extensive root systems. Larger stock may suffer moisture stress due to the large foliage area.

Species Selection

Species selected for replanting should reflect as many of the species as are or were originally present in the community to be rehabilitated. Suitable species for each vegetation type are found in Table 8.

Planting Times

In dryland areas planting is normally undertaken in autumn to maximise root growth before the onset of warm weather and dry soil surface conditions.

All plants regardless of ongoing watering regime should be watered in when planted. In dryland areas, seedlings should not be planted until the season has broken especially where no artificial watering is planned.

Direct Seeding

Direct seeding is often unsuccessful due to the superior competition of weed species. Seeds of exotics, which are often persistent in the seed bank even after the above ground biomass has been removed, will often germinate more rapidly, grow more quickly, and out-compete native species within several weeks. In addition, weed seeds transported from nearby sites are quick to germinate and establish. These factors must be addressed to achieve success. Techniques include:

- Undertake seeding in autumn
- Prepare site by removing above ground weeds and spraying regrowth. Site should be levelled to avoid puddling.
- Spread seed by mixing with clean sand, using dense sowing rates (minimum of 100 viable seeds per m^2)
- Monitor germination and undertake weed control where necessary.

Smoke

Smoke and smoked water can enhance germination of both the residual seedbank and broadcast seed. Many species such as *Conostylis* and *Stirlingia* that have been difficult to propagate from seed have excellent germination when either imbibed in smoked water or treated with aerosol smoke.

Smoked water does not inhibit the germination of any of the species used for rehabilitation in the park and can therefore be used as a pre-treatment for all seed to be used for broadcasting. Smoked water can be applied directly to soil in areas that have been cleared of weeds and either direct seeded or revegetated to enhance the germination of the residual native seedbank.

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