City of Stirling
City of Choice

Local Biodiversity **Strategy**

LOCAL BIODIVERSITY STRATEGY

Establishing Biodiversity
as a Core Community Value

City of Stirling, Perth, Western Australia

JANUARY 2010

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EXECUTIVE SUMMARY

Council in May 2005 resolved, under its Sustainable City Agenda, to proceed with the development of a Local Biodiversity Strategy for the City of Stirling. In so doing, a framework was adopted for the development of the Strategy based on the Biodiversity Planning Guidelines released the previous year by the Perth Biodiversity Project (PBP) unit of the Western Australian Local Government Association.

In September 2005, the City was successful in securing a grant from PBP for site assessments of all its natural areas and landforms for biodiversity condition. Site assessments began in 2006 using standard assessment templates as per the Biodiversity Planning Guidelines. With the exception of vegetated wetlands, all bushland and coastal sites were surveyed. This was followed, in 2007, by entry of all gathered field data on to the City's Geospatial Information System (GIS) as site specific maps and on to an electronic version of the standard assessment templates for subsequent analysis under various ecological parameters.

The analysis of survey data has enabled a more accurate determination of the condition of the City's natural areas in terms of the diversity and richness of flora and fauna, the extent of remnant Vegetation Complexes, the absence or presence of Threatened Ecological Communities, Declared Rare Flora, Priority Species of flora and fauna considered Endangered or Vulnerable as well as various threats and disturbances that the City has to contend with in the conservation of its natural areas. The availability of this information has been crucial in the development of the Local Biodiversity Strategy now presented.

This Strategy is divided into four main sections as follows: Part 1- Background Information, Part 2 - Survey Methodology, Part 3 - Strategy Development and Part 4 - Implementation Plan. A total of 44 recommendations are presented. Relevant maps, figures and tables are appendixed or inserted throughout the document. A bibliography and glossary are also attached.

Terms of Reference

There are a number of Federal, State and Local laws and policies as well as international agreements that relate to biodiversity conservation in the Perth Metropolitan Region. These obligate the City of Stirling as well as other Local Governments, other government authorities, agencies and private land owners to be compliant in terms of planning and management of their lands and natural resources.

In the City of Stirling, it is envisaged that the Local Biodiversity Strategy will assume a strategic place under the Sustainable City Agenda and introduce a 'top to bottom' approach to natural area conservation especially with regard to policy development, site assessment and planning, establishment of conservation targets and implementation of management programmes. The Strategy will become a key reference document for Natural Resource Management and will provide the overarching structure and terms of reference to sub strategies and any attendant management plans and conservation plans e.g. Coastal Foreshore Action Plans 1 and 2, the Green Plan 2 (Urban Bushland Conservation Plan), the proposed Wetland Protection Plan and various other management plans specific to major conservation reserves.

Definitions

Biodiversity refers to the numerous plants, animals and other organisms that make up natural ecosystems (e.g. bushland, wetland or coastal dune) and the part these organisms have in the sustainability of ecosystems by their interdependence and survival links to each other; the greater the biodiversity of a given ecosystem (as measured by the number of separate species per unit area) the greater is the capacity of that ecosystem to sustain itself and to withstand various environmental and human induced threats and pressures.

It is vital that natural areas are protected and retained so that biodiversity and related values are not lost. These related values include: the creation of soils and maintenance of soil quality; maintenance of air quality; maintenance of water quality; the natural control of pest populations; assimilation, detoxification and decomposition of wastes; pollination for natural regeneration and economic crop production; stabilization of climate and moderation of extreme weather patterns; prevention and/ or mitigation of natural disasters; ensuring food security for human survival; provision of natural resources for human health care; ensuring income generation and economic growth; and retention of spiritual/ cultural values.

The Study Area

The intent of this strategy is to cover all natural areas within the City of Stirling regardless of land tenure or ownership so that an accurate accounting of the extent and condition of biodiversity areas is obtained. In the first instance, site surveys for biodiversity condition have focused primarily on natural areas in Local Government reserves with the remaining to be the subject of future negotiations with land owners/ managers. With regard to Local Government reserves, the City is endowed with natural areas and landforms comprising 616 hectares of bushland over 68 sites, 33 wetland sites and 6.5 kilometers of coastal dunes and beaches. These reserves range in size from 0.2 hectares to more than 100 hectares. A further 390 hectares exist under other authorities/ agencies or are privately held.

Vision Statement

The following is proposed as the City's broad vision for biodiversity conservation: 'to establish local biodiversity as a core community value.' This vision statement may be supported by the following principles:

- All ecological communities locally represented must be protected to ensure retention in perpetuity;
- The conservation of locally significant natural areas is just as important as those that are regionally significant;
- Natural ecosystems must be given the opportunity to naturally regenerate before resorting to revegetation;
- The highest biodiversity value natural areas should be given greater conservation priority over other areas;
- Threats to natural ecosystems are mostly human induced; conservation strategies should therefore be based on this assumption;
- The conservation of natural areas as a legitimate form of land use must be recognized to ensure protection of these areas;

- Community engagement is vital to perpetuating biodiversity into the future; and
- The conservation of natural areas must of necessity adopt a long-term perspective.

Field Surveys

All sites were surveyed for integrity of vegetation structure with respect to growth form and make-up of the above ground biomass as well as Vegetation Condition in accordance with a graduated qualitative scale ranging from pristine through to excellent, very good, good, degraded and completely degraded (as per the Keighery 1994 Vegetation Condition Scale).

Sites surveyed have included reserves already classed as Regionally Significant as well as all other natural area reserves (classed as Local Natural Areas). Local Natural Areas (LNAs) were further assessed in accordance with a range of ecological and viability criteria to determine local significance and where this was established, they were upgraded to Locally Significant Natural Areas (LSNAs). Ecological criteria employed in this assessment have included the following: the extent of Vegetation Complexes under the major land form elements, Floristic Community types and the presence of Threatened Ecological Communities. Viability criteria has involved consideration of attributes such as size, shape, condition, perimeter to area ratio and the potential for connectivity as part of regional and/ or local ecological links.

Interpretation of Survey Data

A total of eight (8) Regionally Significant natural areas have been identified, including Bush Forever sites. Of the remaining sites assessed, 21 were classed as LSNAs with the remaining being designated LNAs. Regionally Significant reserves, by virtue of their size, were found to be generally better conserved in terms of Vegetation Condition. Several smaller reserves (i.e. greater that 10 ha but less that 20 ha) showed relatively high diversity and were found to be in a 'Good' or better condition according the Keighery (1994) Vegetation Condition Scale. Although most of the LNAs were small (i.e. greater that 1 ha but less that 4 ha), most were classed as 'Good' or better according the Keighery (1994) Vegetation Condition Scale.

Five (5) Vegetation Complexes were discovered in the City of Stirling. These refer to the patterning of vegetation at the regional level based on determining factors such as landform, soil and climate. The Vegetation Complexes are Quindalup, Cottesloe Central and South, Herdsman, Karrakatta Central and South, and Bassendean Central and South. All Vegetation Complexes reveal extensive loss compared to their pre-European extent and are well below the 30% National threshold level for retention targets. With the exception of the Quindalup Complex, the Cottesloe Complex Central and South and the Herdsman Complex all others are also well under the10% State threshold level for retention targets. In view of the fact that these Vegetation Complexes are under represented within the City of Stirling it makes the protection and retention of all remnants of these Vegetation Complexes even more compelling.

At the Floristic Community level, 18 Priority Flora species were located during the field assessments of bushland reserves (refer Table 12). Two (2) Declared Rare Flora pursuant to Subsection 2 of Section 23F of the Wildlife Conservation Act (1950) and listed by the Department of Environment and Conservation Act were also located during

the assessments (refer Table 12). A further two (2) species have yet to be confirmed as Declared Rare Flora.

Regarding fauna, 46 species of native fauna including 41 bird, three reptile, one amphibian and one mammal species were located. Two (2) Specially Protected Fauna as listed under Schedule 1 of the State's Wildlife Conservation Act (1950) were discovered (refer Table 13). Also, as listed under the Wildlife Conservation Act (1950), two (2) Endangered Fauna, one (1) Threatened Fauna and two (2) Vulnerable Fauna were observed (refer Table 13). Of particular note is the Carnaby's Black Cockatoo (*Calytorhynchus latirostris*) and the Graceful Sun Moth (*Synemon gratiosa*), both listed as Endangered under the Commonwealth's Environmental Protection and Biodiversity Conservation Act (1999). Additionally, protected as an important migratory bird under the same Federal legislation, the Rainbow Bee Eater (*Merops ornatus*), was observed in twelve separate reserves (refer Table 13).

Implications for Biodiversity Management

The above findings point to the need for the establishment of Representational Targets for each of the Vegetation Complexes. Desirable Criteria stipulates that 30% minimum should exist of the pre-European extent. Where the Desirable Criteria of 30% can not be met, then the fallback position is to ensure that at least 10% of the pre-European extent (Essential Criteria) is fulfilled. Where neither Desirable nor Essential Criteria can be complied with, then there should be a moratorium on all native vegetation clearing within the Local Government area.

The matter of Representational Targets may similarly be applied to each of the City's land zonings under the Metropolitan Region Scheme to ensure equitable dispersion of biodiversity areas in both public and private lands and between Local Government reserves and lands under other authorities/ agencies.

Conservation embraces several elements including protection, restoration and on-going maintenance. A key aspect of conservation is to prevent natural areas classed as 'Good' or better from becoming further degraded. The findings strongly imply the need for prioritization of conservation sites in order of ecological significance and viability. It further implies that the preparation of site specific conservation plans and resource allocation should be prioritized on the basis of sites that are Regionally Significant followed by LSNAs and LNAs.

Biodiversity Protection

Inadequacies within current legislation and policy can constitute equally difficult constraints and impediments to biodiversity protection compared to other threats that are more directly site related. These require serious consideration to having them resolved in order to ensure greater certainty and a degree of protection to all natural areas that are the centers of biodiversity. A review of Local Planning Policy is advocated with the view to the formulation of specific provisions pertaining to biodiversity protection and to enable assessment of the merits of adopting the following mechanisms:

- Formalizing the protection status of LNAs by the dedication of distinct conservation zones within reserves;
- Following due process with regard to the Bushland Clearing Regulations under the Environmental Protection Act (1986);

- Declaration of Green Belts for the arbitrary amalgamation of natural areas in near proximity to provide best opportunities fro ecological linking;
- Reservation of natural areas through Structure Planning at the Local District level; and
- Establishment of Conservation Covenants and Voluntary Reservation for natural areas in the private domain.

Abatement of Threats and Disturbances

A key component of biodiversity protection must involve the identification and elimination all threatening processes and disturbance factors affecting natural areas. Threatening processes refer to occurrences, activities or continuing processes that could jeopardize the survival and sustainability of native species or ecosystems. Examples include weed invasion, disease and pest infestations, diffuse-source pollution, soil erosion and impacts from continued non-compatible public access. Disturbance factors are incidents that cause sudden detrimental changes to natural areas. Examples of disturbance factors include bushfires, point-source pollution, land clearing, hydrological changes, dune blowouts, cliff collapses etc. Threat Abatement Initiatives need to adopt a strategic approach to issues that confront the entire City e.g. the control of animal pests however several threats and disturbance are site-specific and require dedicated reserve based Conservation Plans to bring about an effective resolution or control.

Strengthening Local Biodiversity

Fragmentation and isolation of many natural areas in the urban environment is threatening the long-term viability of several of the larger natural areas in the urban environment and has rendered many smaller areas almost unsustainable. The effects of fragmentation are reduced connectivity between natural areas due to loss of habitat and the decline in the movement and survival of species. Where clearing for development has reduced natural areas to small unviable patches, plant and animal species may be deprived of sufficient resources and appropriate mechanisms to complete their life cycles.

This is crucial where key species or indicator species are involved to the extent that it impacts on various dependent species and even the entire ecological community. It is particularly acute with plants and animals that do not disperse easily therefore strategies aimed at preserving biodiversity must of necessity include measures to facilitate such dispersal. Valid and effective mechanisms to ensure this must include the following:

- Development of ecological linkages both at the Regional and local levels;
- Conservation of wetlands for their importance in providing secure habitats for wildlife, expression of species diversity and richness, preservation of cultural and ethnic history, preservation of groundwater resources and opportunities for public education and interest;
- Recognition of the validity and importance of wetland buffer zones and transitional vegetation; and
- Conservation of coastal landforms and associated vegetation as these provide an added dimension to biodiversity conservation in terms of the variety of habitat niches for wildlife and opportunities for ecological linking;
- Designation of Ecozones on selected parkland as part of the City's Groundwater Conservation Strategy (synonymous to ecological links as per Green Plan 2); and

- Comprehending the principles of species specificity and habitat preference in implementing local biodiversity conservation plans to encourage wildlife habitation in natural areas.

Community Focus on Biodiversity

In most cases, biodiversity conservation involves the management of human activity in the way that it impacts the natural environment rather than having to provide any direct requirement of ecosystems. By far the majority of threats and disturbances are human induced. Conservation measures must therefore seek to engage the community in ways to endear public sentiment towards protecting and enhancing biodiversity and not destroying it. Overcoming public apathy and soliciting community support is a huge challenge but nevertheless a worthwhile objective and perhaps the most effective way of resolving many of the human related conflicts in the conservation of natural areas. The key question is 'how do we change people's mind sets and bring about behavioral change so that biodiversity conservation becomes just as equally valued as all the other core values of society'. Key elements of what may be required include the following:

- Survey of Public Perceptions to capture current thinking on the environment and related matters and to able to refine strategies and effectively respond to public need or concern;
- Creating awareness through a variety of community education initiatives but particularly through activity based learning in place of the traditional knowledge based methods;
- Community engagement whereby a sense of ownership is instilled through the development of partnerships and alliances; and
- Environmental interpretation which in this context means to elaborate those aspects of the environment that we want the community to comprehend. Effective interpretation not only deals with the different facets of the environment with its complexities and related issues but also factors in past anthropogenic links and the consequences of those links to the current state of the environment.

Strategy Implementation

This will initially involve the re-formatting of all recommendations arising from this Strategy into an Implementation Matrix to enable prioritization and scheduling of implementation items as well as the allocation of resources.

Monitoring and Evaluation

Key Performance Indicators together with benchmarks and annual targets will be developed to assist annual performance measurement for various aspects of biodiversity management.

RECOMMENDATIONS

1. That the Local Biodiversity Strategy be incorporated into the Sustainable Policy of the City of Stirling to strengthen impetus and policy direction under the Natural Resource Management framework.

2. That the following definition of biodiversity be adopted - Biodiversity refers to the numerous plants, animals and other organisms that make up natural ecosystems (e.g. bushland, wetland or coastal dune) and the part these organisms have in the sustainability of ecosystems by their interdependence and survival links to each other; the greater the biodiversity of a given ecosystem (as measured by the number of separate species per unit area) the greater is the capacity of that ecosystem to sustain itself and to withstand various environmental and human induced threats and pressures (as per Section 3.1).

3. That the importance of conserving biodiversity for the following values be recognized - Creation of soils and maintenance of soil quality; maintenance of air quality; maintenance of water quality; natural control of pest populations; assimilation, detoxification and decomposition of wastes; pollination for natural regeneration and economic crop production; stabilization of climate and moderation of extreme weather patterns; prevention and/ or mitigation of natural disasters; ensuring food security for human survival; provision of natural resources for human health care; ensuring income generation and economic growth; and retention of spiritual/ cultural values (as per Section 3.2).

4. That the following statement be adopted as the City's broad vision for biodiversity conservation – 'to establish local biodiversity as a core community value'.

5. That the biodiversity vision statement be supported on the basis of the following principles (as per Section 5.1):
    - All ecological communities locally represented must be protected to ensure retention in perpetuity.
    - The conservation of locally significant natural areas is just as important as those that are regionally significant.
    - Natural ecosystems must be given the opportunity to naturally regenerate before resorting to revegetation.
    - The highest biodiversity value natural areas should be given greater conservation priority over other areas.
    - Threats to natural ecosystems are mostly human induced; conservation strategies should therefore be based on this assumption.
    - The conservation of natural areas as a legitimate form of land use must be recognized to ensure protection of these areas.
    - Community engagement is vital to perpetuating biodiversity into the future.
    - The conservation of natural areas must of necessity adopt a long-term perspective.

6. That the specific targets proposed under each of the above Principles be adopted with the view to the establishment of realistic goal measurement associated with each Principle.

7. That the City's adoption of standard assessment templates developed by the Perth Biodiversity Project of the Western Australian Local Government Association for assessment of the City's natural areas (Natural Area Initial Desktop and Field Assessments – as per Appendix IV) be endorsed.

8. That the standard assessment templates be adopted as the basis for all future updates on the condition of the City's natural areas surveyed thus far and for the condition assessment of sites yet to be surveyed.

9. That Natural Area Condition Targets based on ecological criteria as outlined under Section 6.5 of the Local Biodiversity Strategy be adopted as the future standard for the assessment of Local Natural Areas (LNAs) and to determine local significance and re-classification of such sites, where warranted, as Locally Significant Natural Areas (LSNAs).

10. That the City's Resourcing Targets and Management Action Targets for LNAs be based on further criteria for the estimation of Viability as outlined under Section 6.6 and as per the Natural Area Initial Summary Template under Appendix IV.

11. That the status of City managed Natural Areas (bushland reserves) with respect to Vegetation Complexes and Vegetation Condition as per Table 7 be received.

12. That the matter of outstanding assessments of City managed Natural Areas (vegetated wetlands and coastal dunes) as per Tables 8 and 9 be the subject of funding allocation over subsequent budget programmes with the view to the ecological significance of these sites being determined.

13. That the matter of outstanding assessments of Natural Areas managed by other authorities/ agencies or those privately held as per Table 10 be the subject of further negotiations with respective managers/ owners with the view to Ecological Significance of these sites being determined.

14. That the findings of field surveys on biodiversity condition be received with respect to the following as per Sections 8.1 and 8.2:
    - The regional and local significance of several of the City's natural areas (eight Regionally significant and 21 Locally Significant Natural Areas identified);
    - The number of Vegetation Complexes present (five identified) and their extent (all greatly under-represented in comparison to their pre-European extent).

15. That in reference to biodiversity condition, the site assessments at the Floristic Community level be received with respect to the following as per Sections 8.3 & 8.4:
    - No Threatened Ecological Communities (TECs) discovered on bushland reserves surveyed;
    - Two (2) Declared Rare Flora (DRFs) discovered at two separate reserves;
    - 18 Priority Species of flora (Priority 1, 2, 3 and 4) discovered at 15 separate reserves;
    - The discovery of one Specially Protected fauna, one Endangered fauna and one Vulnerable fauna.

16. That further to Recommendation 14, a listing of typical flora and fauna be formulated for each of the five Vegetation Complexes discovered to enable a more complete profiling of these Complexes.

17. That considering all Vegetation Complexes discovered within the City are under represented relative to their pre-European extent, the protection and retention of all Local Natural Areas (LNAs) be advocated in recognition of their values towards ecological linking and promotion of biodiversity in this part or the Region.

18. That prioritization and resource allocation for the conservation of natural areas is to be based in order of (1) Regionally Significant Natural Areas, including Bush Forever sites, (2) Locally Significant Natural Areas and lastly (3) Local Natural Areas.

19. That prioritization for the conservation of Locally Significant Natural Areas (LSNAs) is to be based on these sites meeting Essential and/ or Desirable Criteria as per Sections 6.6 and 9.1 and Table13.

20. That prioritization for the conservation of Local Natural Areas (LSNAs) is to be further based on these sites being assessed for Viability as per the Natural Area Initial Summary Template as per Appendix IV.

21. That further to Recommendations 20 and 21, site specific conservation plans be prepared for LSNAs thus prioritized.

22. That in consideration of the current representation of Vegetation Complexes within the City, the goal of 10% (Essential Criteria) and 30% (Desirable Criteria) retention targets of the pre-European extent be endorsed.

23. That with the regard to current representation of Vegetation Complexes within the City, representational targets be established (as per Table 18 and Figure 3) to ensure that no further loss of native vegetated areas are incurred and the all existing remnants are retained and protected.

24. That Council's previous resolution of the 20 April 1993 be reiterated to recognize urban bushland on reserves as defined by Green Plans 1 and 2 as 'Local Authority Reservations – Urban Bushland' on the City's Scheme maps and that this outstanding resolution be urgently incorporated as a scheme amendment within Local Planning Scheme 3, the draft of which is currently undergoing adoption and gazettal.

25. That due regard be given to regulations enacted in 1995 under the Environmental Protection Act (1986) that prohibit clearing of native vegetation for any purpose without a permit unless the clearing is for an exempt purpose and that this be incorporated as part of the City's internal processes and procedures pertaining to land use planning and reserves management.

26. That the opportunity for the dedication of 'Green Belts be investigated in the future District Planning Reviews of the City's to enable the establishment of regional and local ecological links (as per Section 10.2.3).

27. That the opportunity for reservation of natural areas under future land development subdivisions be investigated early in the planning stages through the formulation of precinct based Structure Plans (as per Section 10.2.4).

28. That Council's precious resolution of the 20 April 1993 be reiterated with respect to the acquisition of natural areas on private lands (as per Section 10.2.5) to recognize areas with biodiversity values wherever they occur within the City regardless of land tenure and to acquire for the purpose of reservation, where possible, with fair compensation to land owners or other equitable mechanisms (as per Sections 10.2.6 and 10.2.7).

29. That a review of Local Planning Policy be undertaken with the view to the strengthening of current provisions for the retention and protection of natural areas and associated biodiversity values (as per Section 10.3).

30. That due regard be given to the identification and elimination of all threatening processes and disturbance factors affecting natural areas so that biodiversity values may be preserved (as per Section 11) and that this be reflected in (1) site specific conservation plans and (2) annual resource allocation for conservation.

31. That the concept of regional and local ecological links as advocated in Section 12.1.1 be adopted and that opportunities be investigated and mapped for the inclusion of as many Local Natural Areas (LNAs) to provide connectivity and 'stepping stones' in the linking process.

32. That wetlands and their buffer zones/ transitional zones be recognized as integral to the protection and perpetuation of biodiversity and that these sites are afforded due conservation status as part of the City's management of its natural areas.

33. That further to Recommendation 33 above, the City undertakes the development of a Wetlands Protection Strategy as an extension of the current draft Wetlands Protection Policy.

34. That coastal landform and associated vegetation be recognized for their significance in providing an added dimension to biodiversity conservation in terms of the habitat opportunities and potential for ecological linking and that these sites be afforded due conservation status as part of the City's management of its natural areas.

35. That further to Recommendation 35 above, the City proceeds to review its Coastal Planning Strategy (Coastal Report of 1984 and Review of Coastal Report of 1996).

36. That further to Recommendation 35 above, the City proceeds to implement the recommendations of Coastal Foreshore Action Plans Parts 1 and 2.

37. That further to Recommendation 35 above, the City undertakes an assessment of coastal risks and vulnerability in expectation of impacts under various climate change scenarios with the view to the development of adaptation and remediation strategies to protect valuable coastal landforms.

38. That the implementation of Ecozones as part of the City's Groundwater Conservation Strategy be endorsed as this is synonymous to the establishment of local ecological links as advocated under Green Plan 2 (Strategy for the Conservation Urban

Bushland for the Promotion of Biodiversity) and that this be reflected in the planning and implementation of the City's Million Trees Imitative.

39. That the conservation of natural areas be recognized as integral to promoting wildlife diversity by the provision of habitat niches, feeding opportunities and movement corridors and that this be reflected in the development of site specific conservation plans for Bush Forever sites and LSNAs.

40. That further to Recommendation 37 above, particular focus be attached to the protection and retention of all remaining Vegetation Complexes critical for the survival of Specially Protected Fauna and those fauna listed as Endangered and Vulnerable.

41. That the importance of community engagement be recognized as integral to the successful implementation of recommendations of the Local Biodiversity Strategy and in establishing biodiversity as a core community value and that this be reflected in the development of an annual schedule of community engagement activities.

42. That further to Recommendation 40 above, a survey of community perceptions be undertaken to gauge people's understanding of biodiversity and the threats confronting natural areas (as per Section 13.1) and how these issues may be resolved.

43. That innovative ways be adopted to create community awareness about the plight of natural areas in the urban environment and that this involve some aspect of 'activity based learning' in addition to 'knowledge based learning' (as per Section 13.2).

44. That opportunities be explored to engage the community in ways that will engender acceptance and ownership of conservation initiatives (as per Section 13.3).

45. That further to Recommendations 42 and 43 above, an environmental interpretation programme be developed to support the City's conservation initiatives and that local community expertise be engaged in this process.

46. That further to Recommendations 40, 41, 42 and 43 above, renewed consideration be given to the provision of vital staffing resources at the Henderson Environmental Centre to enable the planning and implementation of community engagement and environmental interpretation programmes on a regular and continuous basis.

Part A:
Background Information

PART A:
BACKGROUND INFORMATION

1. PREAMBLE

1.1 Events Leading to Formulation of this Strategy

The vision of Local Governments caring for their natural areas with a biodiversity enhancement focus was conceived in 1999 jointly by the WA Local Government Association (WALGA), the Federal Bushcare Programme and a number of leading Perth Local Governments. This idea was soon reinforced in 2000 by the Western Australian Government by its release of the Bush Forever Plan which marked the culmination of extensive mapping of natural areas within the Perth Metropolitan Region and the identification all bushland considered regionally significant. Whilst the management of most of these bushland was considered the responsibility of State Government, some were recognised as being the responsibility of Local Government. Additionally, the Bush Forever Plan recognised the existence of numerous locally significant bushland which although considered the domain of Local Government were nevertheless important in association with regionally significant reserves in sustaining a comprehensive biodiversity base and in the provision of essential ecological networks.

It was on this premise that the Perth Biodiversity Project (PBP) was initiated as a collaborative project involving WALGA, the Natural Heritage Trust, the Department of Planning and Infrastructure, and some 30 Local Governments within the Perth Metropolitan Region. The other major project partners were Greening Australia WA, Birds Australia WA and the then Department of Conservation and Land Management (now the Regional Parks Unit of the Department of Environment and Conservation).

In recognition of the responsibility of Local Governments in the management of regionally significant and local natural areas, the PBP was clearly an initiative to (1) improve local conservation capacity and biodiversity protection and (2) to assist Local Governments adopt a more strategic approach to natural areas conservation. Indeed, with impending threats to our unique biodiversity due to the expansion of the Perth region, Local Government has a key role in the retention, protection and management of Perth's biodiversity because it represents the level of government closest to the community and is required to make land use planning decisions with the potential to impact on exclusive areas of native vegetation (Del Marco et al 2004). Accordingly, the broad objectives of PBP then outlined were as follows:

- To protect and manage all local biodiversity areas in the Perth Metropolitan Region within a secure conservation network; and
- To plan for the enhancement and establishment of ecological linkages between regional and local biodiversity areas (WALGA 2000a).

A Memorandum of Understanding (MOU) was subsequently secured (in 2002) with all 30 Local Governments to ensure the commitment of Local Government towards the biodiversity conservation process. In broad terms, all signatories agreed to protect natural areas under their management control from further threatening processes (including clearing) and to actively pursue conservation measures so that positive biodiversity outcomes could be realized.

The MOU was preceded in quick succession with the development by PBP of standard templates appropriate for the use by all Local Governments in the assessments of their natural areas (subsequently referred to as standard templates for Natural Area Initial Desktop and Field Assessments). A number of Local Governments including the City of

Stirling were involved in conjunction with PBP in 'field testing' the standard templates. Finalisation of these templates was then considered vital to enable (1) individual Local Governments to proceed with assessment of their natural areas using a convenient guide and (2) subsequent comparisons to be made across the Metropolitan Region of biodiversity condition.

Under WALGA's Local Biodiversity Planning Targeted Grants, several rounds of funding were made available from 2002 to 2006 for Local Governments to undertake assessments of their natural areas for biodiversity status. The City of Stirling was successful in Round 4 (September 2005)) in securing a grant of $15,000 which was supplemented by a Council allocation of $30,000 towards the City's own assessment of its natural areas.

As Local Governments were required to develop their own Local Biodiversity Strategies on completion of natural area assessments, WALGA in June 2004, released the Local Government Biodiversity Planning Guidelines for the Perth Metropolitan Region. Quite importantly, these Guidelines were to assist Local Governments to:

- Determine the protection status of all locally significant natural areas;
- Formalize policies and processes to ensure biodiversity considerations are integrated into Council assessment of development proposals and construction activities;
- Develop and provide incentives to encourage the conservation of natural areas on private lands; and
- Plan for the management of natural areas on Council reserves to conserve biodiversity (Del Marco *et al* 2004).

The Biodiversity Planning Guidelines were endorsed by the Council of the City of Stirling in August 2004. In reference to the model Planning Process offered by the Biodiversity Planning Guidelines, Council further resolved that a report be submitted outlining the framework for the initiation of site assessments of all natural areas and the development of a Local Biodiversity Strategy. Following consultation of the City's Natural Environment Advisory Committee and the collaboration of the City's Parks and Reserves Business Unit and the then existing Policy and Strategic Planning Business Unit a revised Planning Process was submitted for Council adoption in May 2005.

1.2 Biodiversity Planning Process

The revised Planning Process as adopted by Council consists of the following phases (Fig 2 provides a schematic view):

Phase 1 – Commitment to biodiversity protection and resource allocation;

- Vision statement to support biodiversity preservation
- Scope of biodiversity resources within the City
- General approach to strategy development
- Expected outcomes
- Implications in terms of new policies and procedures
- Generic protection mechanisms for various land tenures including statutory compliance procedures
- Links to other key strategies of the City of Stirling
- Commitment of relevant Business Units of the City

Phase 2 – Establishment of working group;

- Reference to the City's Natural Environment Working Group

Phase 3 – Desktop survey and site assessments of natural areas;

- Action Plan for the assessment of all natural areas in the City of Stirling
- Preliminary desk top survey
- Field assessments for biodiversity condition using standard assessment templates (Natural Area Assessment Templates)

Phase 4 – Compilation and analysis of survey data;

- Data entry (GIS based) of spatial information
- Data entry of qualitative information
- Data retrieval for development of site specific management plans

Phase 5 – Preparation of Strategy document;

- Formulate goals and targets for biodiversity retention and improvement
- Determine the policy approaches to adopt regarding biodiversity protection on City managed reserves and (if applicable) on private lands
    - Local Planning Schemes
    - Rezoning and Structure Plan/ Overall Development Plan approval procedures and processes
    - Sub-division or Development Application approval procedures and processes
    - Planning criteria for the provision of Public Open Space by which natural areas could be retained
    - Designation of Special Control Areas within reserves whereby natural areas could be recognised as a distinct land uses and protected
- Develop policy instruments and/ or review current Local Planning Policy to ensure that biodiversity considerations are incorporated into development proposals via the following mechanisms as they affect natural areas in reserves
- Where applicable pursue mechanisms for the retention, protection and management of natural areas in non-City managed lands e.g. incentive programmes for private owners
- Plan for the conservation of natural areas in City owned/ vested reserves viz.
    - Identification and resolution of threatening processes
    - Natural regeneration
    - Assisted regeneration/ revegetation
- Formalize the protection status of natural areas by
    - Assessing constraints and opportunities for protection
    - Assessing connectivity, habitat fragmentation, long term viability and buffer zones
    - Assessing the protection of species, ecosystems genetic variability
    - Recognition of Local Natural Areas as distinct conservation zones within reserves

Phase 6 – Stakeholder and general public comment;

- Seek comments to draft Strategy from Natural Environment Working Group
- Presentation of draft Strategy to Executives for endorsement
- Submission to Council for endorsement for stakeholder and general pubic comment (to involve Council briefing)

Phase 7 – Audit of submissions and Council adoption;

- Incorporation of amendments from audit of submissions
- Re-submission to Council for adoption of Strategy

Phase 8 – Strategy implementation and review process.

- Application of Local Planning Policy amendments as endorsed by Council

- Application of mechanisms for the retention, protection and management of natural areas in non- City managed lands as endorsed by Council
- Implementation of recommendations biodiversity outcomes of natural areas in City owned/ vested reserves
- Delegation to relevant Business Units of the City (as identified in Phase 1) for coordinating the on-going delivery of specific aspects of the implementation programme
- Implement a monitoring and review programme on a pre-established frequency (between 3 to 5 years)
- Develop and implement and a awareness programme to sustain (1) on-going organizational commitment and (2) general public support
- Engage the local community in the implementation of field based planning and management programmes

Plate 1 - Walter Hamer Eighth Ave Bushland typifying the flora diversity of many smaller bushland reserves (photo by Geoffrey & Margaret Owens 2009)

2. TERMS OF REFERENCE

2.1 Relevant Legislation and Policy

There are a number of Federal, State and Local laws and policies as well as international agreements that relate to biodiversity conservation in the Perth Metropolitan Region. These obligate Local Governments, other government authorities, agencies and private land owners to be compliant in terms of planning and management of their lands and natural resources.

2.1.1 Federal Government Legislation

The most important Federal Government legislation relevant to biodiversity conservation is the Environment Protection and Biodiversity Conservation Act 1999 (EBPC Act). The EPBC Act is invoked under situations of national environmental significance whereby proposed actions are assessed. Proposed actions may relate to clearing for development, for instance, or some aspect of land management that will have or is likely to cause environmental impact on air, water, soil, biodiversity and other natural resources. The EPBC Act lists seven situations of national significance where the requirement for assessment under the Act is triggered. These are impacts on the following (Department of Environment and Heritage 2003):

- World Heritage listed properties;
- National Heritage listed properties;
- Wetlands of international significance listed under the Ramsar convention;
- Nationally threatened species and communities listed under the EPBC Act;
- Migratory species listed under the EPBC Act as obligated under international agreements;
- Areas of proposed nuclear actions, including uranium mining; and
- Australian marine environment ie beyond the 3 nautical mile limit of State controlled waters.

2.1.2 Federal Government Policy

Policies at the Federal level related to biodiversity conservation include the following:

- The National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996) - developed as part of an intergovernmental agreement and signed by the Commonwealth and all States and Territories;
- Natural Heritage Trust Partnership Agreement (Commonwealth of Australia and State of Western Australia 1997);
- National Local Government Biodiversity Strategy (Berwick & Thorman 1999);
- National Framework for the Management of and Monitoring of Australia's Native Vegetation (ANZECC 2000b);
- National Objectives and Targets for Biodiversity Conservation 2001-2005 (Commonwealth of Australia 2001b) – developed as part of a review of The National Strategy for the Conservation of Australia's Biological Diversity (ANZECC 2000c) and signed by the Commonwealth and five States and Territories including Western Australia; these National Objectives and Targets advocate the retention of 30% or more of the pre- settlement clearing extent of each ecological

community to achieve a realistic level of protection of Australia's biodiversity (ANZECC 2000c);

- National Weeds Strategy: A Strategic Approach to Weed Problems of National Significance (ARMCANZ, ANZEC & Forestry Ministers 1997).

2.1.3 State Government Legislation

Whilst some State Government legislation mirror those at the Federal level, most are specific to issues here in Western Australia. The following are relevant to biodiversity conservation:

Wildlife Conservation Act 1950

This is the main legislation that currently offers protection of all native flora and fauna in Western Australia. Although it contains specific measures to protect rare or threatened species these measures do not cover the protection of elements specific to biodiversity conservation viz. rare or threatened species and ecological communities or to recognise threatening processes in natural areas. It is envisaged that this Act will be replaced by the proposed new Biodiversity Conservation Act which will address these current legislative deficiencies (Government of Western Australia 2002a).

Environmental Protection Act 1986

This is a key legislation providing various mechanisms through which biodiversity values may be protected. The primary mechanism is the assessment of all development proposals through the Environmental Impact Assessment (EIA) Process. This obligates all Local Governments, other land management authorities and agencies and private land owners to submit proposals that will or are likely to impact the environment to the Environmental Protection Authority for assessment (Section 38 of the Act). The Environmental Protection Authority is empowered to modify or disapprove proposals likely to significantly impact the environment. Environmental assessments are further extended to the strategic review of Local Planning Schemes (previously Town Planning or District Planning Schemes) of Local Government whereby significant environmental impacts are identified on lands affected by the Scheme amendments (Section 48 of the Act).

The Act also regulates the activities of commercial and industrial premises to ensure that pollution or degradation of the environment does not occur. Additionally, the Environmental Protection Act empowers the State Government to formulate Environmental Protection Policies (EPP) to prevent, control or abate pollution or to protect any portion of the environment (Del Marco *et al* 2004). Examples of EPP's pertaining to biodiversity conservation include the Environmental Protection (Swan Coastal Plain Lakes) Policy and the Western Swamp Tortoise EPP.

Under recent amendments to the Environmental Protection Act 1986, proponents intending to clear native vegetation must obtain a Clearing Permit from the Department of Environment and Conservation before any clearing can proceed, unless exempted under the Act e.g. maintenance operations. Local Governments, other government authorities, agencies and private land owners would therefore be required to submit Vegetation Management Plans for any area affected by the proposed clearing to demonstrate how the impacts can be minimized and/ or 'offsets' created. The

amendments specific to the native vegetation clearing have now replaced processes that existed previously under the Soil and Land Conservation Act 1945 Del Marco *et al* 2004).

The above amendments to the Environmental Protection Act 1986 and the proposed new Biodiversity Conservation Act significantly strengthen legislative powers at both State and Local Government levels to conserve biodiversity values. These changes will also ensure that biodiversity related legislation in Western Australia is brought into synchrony with the Federal Environmental Protection and Biodiversity Conservation Act and biodiversity conservation legislation in other States.

Planning and Development Act 2005

This legislation (as currently amended) is the primary mechanism regulating the subdivision, development and use of land in Western Australia. Provisions under the Act include the review of Local Planning Schemes (previously Town Planning Schemes) and the development of Statements of Planning Policies as applicable to Local Government.

Aboriginal Heritage Act 1972 and Native Title Act 1993

These Acts are relevant to biodiversity conservation mainly because Aboriginal sites are traditionally associated with many natural areas. In addition to biodiversity values such sites may constitute areas of historical, anthropological, archeological and ethnographic interest and should therefore be preserved. Under the Aboriginal Heritage Act 1972, it is an offence to disturb any Aboriginal site without the consent of the Minister for Aboriginal Affairs. Proposals for land clearing and development by Local Governments, other government authorities, agencies and private land owners would therefore be subject to Section 18 of the Aboriginal Heritage Act 1972 whereby formal processes are outlined for expert survey, assessment, consultation and resolution of issues with traditional land owners and submission of proposals to the Department of Indigenous Affairs.

2.1.4 State Government Policy

The following is a list (not by any means exhaustive) of State Government policies relevant to biodiversity conservation:

- Bush Forever and related bushland policies e.g. Urban Bushland Strategy (Govt. of WA 2000a);
- Environmental Protection Authority (EPA) Guidance Statement No 10: Guidance for the Assessment of Environmental Factors – Level of assessment for proposals affecting natural areas within the System 6 Region and Swan Coastal Plain of System 1 (EPA 2003a);
- EPA Guidance Statement No. 33: Environmental Guidance for Planning and Development – a key document that supports local biodiversity planning processes as outlined in the Perth Metropolitan Region Local Government Biodiversity Planning Guidelines which provide advise on identifying, protecting and managing locally significant natural areas in Perth metropolitan local government areas (EPA 2008);
- Wetland Conservation Policy for Western Australia (Govt. of WA 1997);
- EPA Position Statement No. 4: Environmental Protection of Wetlands (EPA 2001);
- EPA Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia (EPA 2000b);

- Draft Policy Statement No. 9: Conserving Threatened Species and Ecological Communities (DCLM 2003a);
- EPA Guidance Statement No. 51: Guidance for the Assessment of Environmental Factors – Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia (EPA 2003c);
- EPA Guidance Statement No. 56: Guidance for the Assessment of Environmental Factors – Terrestrial fauna surveys for environmental impact assessment in Western Australia (EPA 2003d);
- Draft Statement of Planning Policy: Bushland Policy for the Perth Metropolitan Region (WAPC draft);
- Environment and Natural Resources Statement of Planning Policy No. 2 (Govt. of WA 2003a);
- Development Control Policy No. 2.3:c Public Open Space in Residential Areas (WAPC 2002);
- Position Statement: Wetlands (WRC 2001);
- Wildlife Conservation (Rare Flora) Notice 2001 (Govt. of WA 2001b);
- Wildlife Conservation (Specially Protected Fauna) Notice 2001 (Govt. of WA 2001c);
- Statement of Planning Policy No. 2.6: State Coastal Planning Policy (Govt. of WA 2003c).

2.2 Bush Forever and Urban Bushland Strategy

The Bush Forever Policy (2000) is the primary mechanism governing the conservation of regionally significant bushland in the Perth Metropolitan Region. It supersedes the original 1983 System 6 report of recommendations of the then Department of Conservation and Environment for the Swan Coastal Plain portion of the Perth Metropolitan Region. The Urban Bushland Strategy (1995) precedes Bush Forever and together with the System 6 Report Update Programme (DEP unpublished 1996) provided the impetus for the formulation of the Bush Forever Policy (2000). Both the Urban Bushland Strategy and the Bush Forever Policy support the idea that conservation of regionally significant bushland should primarily be the domain of State Government whilst local bushlands remain the responsibility of Local Government. Both documents advocate the preparation of Local Bushland Strategies by individual Local Governments (e.g. the City of Stirling Green Plan 2). The Bush Forever Policy further advocates that Local Governments develop Local Biodiversity Strategies as over-aching documents to their bushland and other natural area strategies or site specific management plans.

Bush Forever is a long-term strategy to protect some of the 51,200 hectares of regionally significant bushland in 287 Bush Forever sites. These sites represent, where achievable, a target of at least 10% of the pre-European extent for each of the original 26 vegetation complexes indentified in the System 6 Report although 7 of the 26 vegetation complexes are under represented and fall below the 10% target (Del Marco *et al* 2004). Updated research, on the other hand, indicates that the retention target of 10% is insufficient and that, realistically, a target of 30% of the pre-European extent would be needed of each vegetation complex or ecological community to adequately protect biodiversity and sustain ecosystem processes. This revised target of 30% is now reflected in the National Objectives and Targets for Biodiversity Conservation 2001-2005 (Commonwealth of Australia 2001b).

2.3 Wetland Conservation Policy

The Wetland Conservation Policy for Western Australia (1997) was primarily developed to cover wetlands of international (ie Ramsar Convention listed wetlands), national and regional significance. Many of these are 'open water' wetlands and are now protected by the Environmental Protection (Swan Coastal Plain Lakes) Policy of 1992 whereby it is an offence to fill, excavate, mine, discharge affluent into, install drainage works or alter existing drainage works associated with any of these wetlands (Del Marco *et al* 2004). As many of these are linked to seasonally inundated wetlands (ie sumplands, damplands, floodplain, palusplain and other vegetated wetlands) of local significance with immense biodiversity values, Local Governments are obligated to also include these areas within their biodiversity strategy framework.

2.4 Swan Natural Resource Management Strategy

The Swan Natural Resource Management (NRM) Strategy of December 2004 is one of several Regionally Accredited NRM Strategies across Australia that has involved Local Governments, relevant non-government organisations, industries, landowners and other sections of the community in the identification and resolution of major conservation issues at a regional level. The Swan NRM Strategy covers most Local Government areas in the Perth Metropolitan Region. Regionally Accredited NRM Strategies have now become the recognised delivery mechanism for grant funding under the Commonwealth Government's National Heritage Trust through which Local Governments are able to undertake clearly defined, workable projects to invest in the future of their natural resources. Of note within the Swan NRM Strategy is a biodiversity component that to outlines the overarching regional objectives and targets to assist in consistent biodiversity planning and strategy implementation across the Swan region. This is indeed of value to all Local Governments not only from the regional perspective but in the formulation of their own Local Biodiversity Strategies.

2.5 Memorandum of Understanding

A Memorandum of Understanding (MOU) was established in 2002 with WALGA and all 30 Local Governments to ensure the commitment of Local Government towards the biodiversity conservation process. All signatories including the City of Stirling agreed to the following (WALGA 2000b):

- To protect and prohibit clearing in reserves vested for the purpose of conservation under its care, control and management (note: the term reserves subject to variation amongst Councils to variously denote conservation, conservation of flora and fauna, wildlife park, wildflower sanctuary, recreation and dune protection, landscape protection, protection of indigenous vegetation, natural flora, bushland preservation);
- To maximize protection of biodiversity areas in other reserves under their care, control and management viz. recreation, public purposes, foreshore management, parklands, drainage;
- To rehabilitate bushland under their care control and management; and
- To work with private land owners to maximize opportunities for the conservation of local biodiversity areas on private property.

2.6 City of Stirling Sustainability Agenda

It is envisaged that this Local Biodiversity Strategy will assume a strategic place under the City's of Stirling's Sustainable City Agenda. As illustrated in Fig 1, the Local

Biodiversity Strategy will introduce a 'top to bottom' approach to natural areas conservation especially with regard to policy development, site assessment and planning, establishment of conservation targets and implementation of management programmes. It will adopt strategic ideals and become the key reference document to sub strategies and their attendant management plans and conservation plans e.g. Coastal Foreshore Action Plans 1 and 2, the Green Plan 2, the proposed Wetland Protection Plan and various other management plans specific to major conservation reserves. Without the benefit of the Local Biodiversity Strategy, many of these plans in the past have undesirably followed a 'bottom to top' approach to policy setting and strategy development.

Under the proposed model it is also intended that all outcomes and recommendations from the Local Biodiversity Strategy will 'feed into' the Natural Resource Management process. However this is contingent on incorporation of the Local Biodiversity Strategy into the Sustainable City Agenda with clearly defined operational processes. It is nevertheless a vital step for cohesive policy direction and strategic impetus and for the development of subsequent resource specific management plans.

Adopting the Natural Resource Management approach will not only enhance current policy on the conservation of natural areas but also lead to the holistic inclusion of all other natural resources on the City's planning agenda. Quite importantly it will align the City's natural resources and biodiversity conservation agenda along Regional and even National goals and targets.

The following model further reveals those aspects of the Sustainable City Agenda that are still outstanding viz. cultural heritage, land, air, water, coastal and marine. In reference to water, Council early in 2008 endorsed the framework for the development of a Groundwater Conservation Strategy as part of an Integrated Water Cycle Management Programme (IWCMP). It is anticipated that submissions on the other components of the Integrated Water Cycle Management Programme viz. a Stormwater Management Strategy and a Strategies for Portable Water Use and Waste Water Reuse will follow in due course.

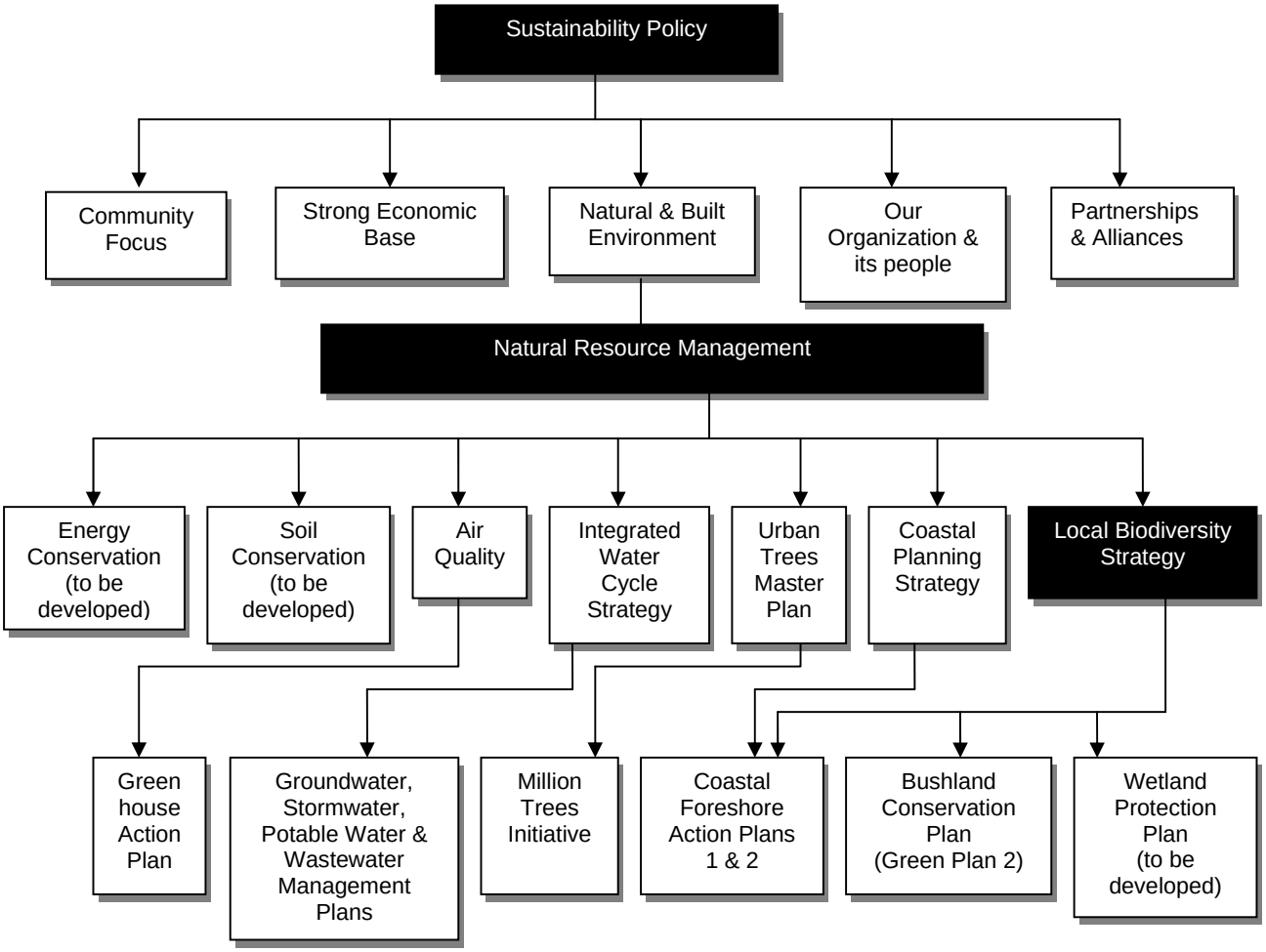

Fig 1 Incorporation of the Local Biodiversity Strategy within the Sustainability Policy of the City of Stirling under the Key Result Area (KRA) of 'Natural and Built Environment'.

Recommendation:

1. That the Local Biodiversity Strategy be incorporated into the Sustainable Policy of the City of Stirling to strengthen policy impetus and direction under the Natural Resource Management framework.

3. DEFINITIONS

3.1 Biodiversity - what is it?

Biodiversity refers to the numerous plants, animals and other organisms that make up natural ecosystems (e.g. bushland, wetland or coastal dune) and the part these organisms have in the sustainability of ecosystems by their interdependence and survival links to each other. The greater the biodiversity of a given ecosystem (as measured by the number of separate species per unit area) the greater is the capacity of that ecosystem to sustain itself and to withstand various environmental and human induced threats and pressures (City of Stirling 2003). In other words, the more complex an ecosystem, the more resilient its ability in restoring balance. Biodiversity has also been described as the 'variety of life forms comprising plants, animals and micro-organisms, the genes they contain and the ecosystems of which they form a part (DEC Naturebase). Biodiversity is not static but constantly changing. It is increased by genetic change and evolutionary processes but reduced by processes such as habitat degradation, population decline and extinction diversity (Commonwealth of Australia 1996). It is an appropriate measurement index of viability and the degree to which species are represented across all tiers of the ecosystem (City of Stirling 2003).

Biodiversity as concept may therefore be considered under three tiers: genetic diversity, species diversity and ecosystem diversity (Commonwealth of Australia 1996). These three levels of diversity, species, genetics and ecosystems are interrelated and interdependent. A population of a species is dependent on the genetic variation within it and upon its habitat (in the ecosystem) for survival; as a logical extension, an ecosystem is dependent on the full variety of the species that comprises it (Williams et al 2001). Diverse ecosystems are healthy and self sustaining. When there are many plant and animal species living together, there are built in checks and balances to keep the system operating smoothly; plants, insects, birds, predators, birth, death, decay, nutrient cycling, shelter, habitat – it is a delicate balance (Thomas 2005).

The goal of a Local Biodiversity Strategy therefore, should be to focus on the elements that govern the sustainability of natural ecosystems with the specific objective of improving biodiversity. Central to this is the conservation (ie retention, protection and management) of natural areas identified as being locally significant as well as those dedicated as regionally significant (viz. Bush Forever sites). As the expectation of a Local Biodiversity Strategy is to provide the general strategic direction for biodiversity conservation, it is quite appropriate that such a strategy be supported by sub-strategies dealing specifically with bushland, wetland, coastal dunes or other natural areas.

3.2 Significance of biodiversity (why important to protect and enhance)

Preservation of biodiversity, especially in the Southwest Australia Eco-region is critical not only because of its unique attributes by world-wide standards but also because it is threatened. Continued losses to biodiversity at the current rate simply can not be sustained and could even jeopardize human survival by any sustainable measure in the long-term. However, by far the most important, but the least recognized, reason for protecting biodiversity is simply because it exists.

In terms of global significance, the Southwest Australia Eco-region is one of 34 biodiversity hotspots of the world. It encompasses 10 Interim Bio-geographic Regions of the world including the Swan coastal plains and wetlands (Gole 2006). This Eco-region is

characterized by an exceptional concentration of endemism (ie found nowhere else in the world) at the species, genus and family levels but undergoing tremendous loss of habitat (Gole 2006). For instance, of more that 5,500 species of vascular plants, nearly 2,950 are endemic. Over 280 native bird species occur, 12 of which are endemic. This hotspot also has approximately 60 native mammal species of which are 12 are endemic. Additionally, nearly 30 of more than 175 species of reptiles and nearly 20 of the more than 30 amphibians are endemic (Conservation International 2008).

The diverse flora in this Eco-region may therefore be considered a storehouse of genetic information which could be valued for a variety of human uses including medicine. A diverse gene pool endows an ecosystem with the fundamental mechanism to withstand or respond to a range of environmental threats and pressures viz. tolerances to heat, drought, soil moisture stresses, lowering of the water table, changes in acidity, re-growth following fires and other changes in environmental parameters. Even ecosystems that appear very uniform and seemingly consisting of only a few species of plants and animals are actually complicated mosaics of various communities that depend on small variations in microclimate (ie differences in soil, topography, moisture and temperature).

Apart from immense aesthetic and recreational values, biodiversity at the ecosystem level provides the conditions that drive the processes governing global sustainability and the very survival of humans as a species (UNDP 2006).

Many native insects and small animals play a beneficial role towards human habitation especially where natural ecosystems in the near vicinity are kept intact. As an example, of all the pests that sometimes attack crop plants, many are kept under control by a complicated web of interactions involving several beneficial insects, small mammals, reptiles and amphibians. Adverse effects on the diversity of such natural ecosystem can lead to imbalances in species composition with subsequent outbreaks of pest populations in cropping systems.

It is not often appreciated that the diversity of local native fauna (insects, birds, small animals) is almost totally dependent on local native plants being as just as vibrant and diverse in providing the desired habitat opportunities. Many natural areas (bushland, wetland, coastal dunes), particularly those that are well structured, provide a diverse range of wildlife habitat as well as the potential for strong ecological links with other similar areas. An excellent example is the Banksia with different flowering times amongst its species, which if all present in any area, would ensure a year-round supply of nectar for many nectarivorous insects and birds. Considering that almost all our land-dwelling birds on the Coastal Plain are insectivorous, it becomes even more compelling why all areas of native vegetation should be retained and protected to prevent any decrease in current levels of biodiversity.

Every native plant species forms habitat for some living organism that has co-evolved with it often with mutually beneficial outcomes, such as the pollination of flowers or dispersal of seeds. Unlike exotic plants, nearly all parts of any locally native plant provide food and shelter for a myriad of insects. This principle of species specificity can not be more starkly displayed than in the spread of many introduced plants throughout bushland. As these plants do not have natural predators or are of little value to native insects, they are able to spread quickly and assume weed proportions.

Following are some of the benefits of ecosystem diversity:

- Creation of soils and maintenance of soil quality;

- Maintenance of air quality
- Maintenance of water quality;
- Natural control of pest populations;
- Assimilation, detoxification and decomposition of wastes;
- Pollination for natural regeneration and economic crop production;
- Stabilization of climate and moderation of extreme weather patterns;
- Prevention and/ or mitigation of natural disasters;
- Ensuring food security for human survival;
- Provision of natural resources for human health care;
- Ensuring income generation and economic growth; and
- Retention of spiritual/ cultural values (UNDP 2006).

Not withstanding the above values, the dilemma that we confront is that huge areas of native bushland are being cleared each year before time has been taken to document what is there. In fact, species are being eliminated faster than the discovery of new ones. Often concern is raised about the loss of a species only when it has become too late to economically or effectively implement any remedial strategy (UNDP 2006). It is becoming increasingly the norm in many cleared areas for naturally diverse vegetation to be replaced with artificial monocultures.

Apart from biodiversity loss through land clearing, elevated levels of soil, water and atmospheric pollution is beginning to impact on background environmental conditions at a rate faster than nature can respond or assimilate. Collectively, all these impacts could severely deplete the native gene pool to the extent that species diversity and ecosystem diversity may succumb to exceptional environmental pressures subsequently experienced.

Loss of native plant communities through weed invasion, clearing for development and other disturbances has placed the survival of many dependant fauna in jeopardy, examples being the Graceful Sun Moth and the Carnaby's Black Cockatoo. The Graceful Sun Moth is listed as a threatened species under the Western Australian Wildlife Conservation Act 1950 and as 'Endangered' under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. The plight of this moth species rests on sufficient habitat areas being protected – typically coastal heath and shrubland vegetation containing Lomandra maritima or Spearwood dune banksia woodland containing Lomandra hermaphrodita. In the case of the Carnaby's Black Cocaktoo, whilst several species of Banksia, Dryandra and Hakea offer convenient sources of food, there is insufficient dispersion of these plant communities within their preferred flight range across the region to provide all their habitat requirements.

3.3 Relevance to Climate Change

The Intergovernmental Panel on Climate Change (IPCC) reports that in recent decades, there have been significant changes to global climate, particularly in terms of temperature and rainfall. Observed temperature increases in recent decades are being attributed to greenhouse gas emissions largely as a result of anthropogenic (human induced) as well as other factors. Global temperatures have increased by an average of 0.5^{o}C between pre-industrial times (late 1800s) to 1900 and by an average of 1.5^{o}C since 1900 (Nicholls 2008).

In synchrony with global temperatures, mean average temperatures in WA have generally increased since 1910 by approximately 0.8^{o}C. A corresponding drying trend

has also occurred with declining late autumn and early winter rainfalls in WA most noticeably during the mid to late 1970s and more recently from the late 1990s to the present. In the south west of WA, there has been an average decrease of 10% rainfall in the mid-1970s (Nicholls 2008).

From various climate change modeling developed by the IPCC and others, projected annual warming for the IBRA (Interim Bio-geographic Regionalization of Australia) bioregions in Australia ranged from 0.8 to 6.2^{o}C by 2070 (relative to 1900 depending on the climate change model, emissions scenario and region). Even under the most conservative climate change model and lowest emissions scenario, warming trends are predicted in 83 of the 85 bioregions in Australia by 1.5^{o}C (Preston & Jones 2006). With regard to rainfall, there will be a 20% reduction in more than 60 of the IBRA regions, under a 'dry trending' climate model and high emissions scenario (Preston & Jones 2006).

There is growing evidence to show that species respond in different ways to climate change. Species responses in terms of changes in phenology, abundance and distribution will result in gradual changes in their co-occurrence and interactions with other species and thereby the relative abundance of different species. Such changes will flow on to affect ecosystem composition, structure and function (Hughes 2000; Walter *et al*. 2002). In other terms, species diversity (composition, richness and relative abundance) has a role in regulating ecosystem processes and affects how ecosystems respond to environmental change (Chaplin *et al* 2000; Hooper *et al* 2005).

Climate change may be considered as having both 'bottom up' and 'top-down' effects on ecosystems. Species-to-ecosystem changes, for instance, can influence hydrological and nutrient recycling, direct population regulation, or restricting food and habitat. At the other end of the scale, at the ecosystem level, effects could include wide-spread changes to ecosystem boundaries due to upheaval of the bioclimatic envelope (geographical distribution) of regionally endemic species and from human induced disturbances (Gates 1990). This decline in ecosystem structure is due to the extinction of key species and the introduction and dispersion of exotic species, relinquishment of traditional native ecosystems to more thicker and woodier tree and shrub assemblages mainly of exotic species due to increased CO_2 availability, increased water use efficiency and increased productivity (Chaplin *et al.* 2000; Hooper *et al.* 2005). Many exotic species display highly effective dispersal mechanisms, are less reliant on specific pollination mechanisms and therefore are able to out-compete local native species.

In reference to fauna effects, even small temperature increases (e.g. 0.5^{o}C) could lead to the decline of threatened or endangered mammals and amphibians (viz. some frog species). Those that are susceptible, typically have narrow geographic and climatic ranges with limited ability to migrate due to human induced constraints e.g. removal of connectivity and ecological linkages. (Brereton *et al.*1995). Although insects generally have wide tolerance range, several species of butterflies could be susceptible. Several migratory bird species could also be affected through habitat loss due to climate change related sea level rise (Brereton *et al.* 1995).

With regard to plants many Australian species are closely associated with local environmental conditions and have narrow distributions due to particular environmental preferences in soil type, temperature, rainfall, drainage, CO_2 availability and other growth/ survival factors. As most of these growth/ survival factors are almost invariably aligned to climatic variations it could restrict the ability of many plants to respond to shifts in bioclimatic habitat (Hughes *et al.* 1996). Many *Dryandra* species of the south west of WA,

for instance are very narrowly distributed so much so that with a 2^{o}C warming, the current bioclimatic envelopes of 91% of *Dryandra* species would decline to less than half their current area and 66% would disappear completely. Similarly, the current bioclimatic envelopes of 27 *Acacia* species endemic to Western Australia would be lost with a 2^{o}C warming (Pouliquen-Young & Newman 1999). Additionally, of all the eucalypyus species, 68% have a geographic distribution range covering less than 1% of the continent (Hughes *et al.* 1996). These case studies indicate clear evidence that there exist several more plant species that are governed by very narrow bioclimatic envelopes and growth/ survival constraints and as such very susceptible to the effects of climate change.

Taking into account all above scenarios, the implications for the management of natural areas become indeed challenging. Key questions are – how does the City prepare and adapt to climate change in natural areas? Are current policy and planning mechanisms compliant enough to bring about community change and acceptance under an increasingly warming climate, depleting water resources and rising ocean levels?

3.4 Definition and Classification of Natural Areas

The term natural area may be used to describe any physical area that contains native species or ecological communities in a relatively natural state hence displaying biodiversity (Del Marco *et al* 2004). Areas entirely revegetated or reconstructed landscapes of local native plants do not comprise natural areas and have not been included in this definition. However, areas of remnant native vegetation that offer values for sustaining biodiversity through ecological linking or buffering against threats have been included. In the context of this strategy, natural areas within the City of Stirling include:

- bushland – defined as native vegetation that may be classed as 'Good' or better condition based on the Keighery (1994) Vegetation Condition scale;
- bushland/ wetland transition zones;
- wetland – consisting of seasonally inundated wetlands (ie sumplands, damplands, floodplain, palusplain and other vegetated wetlands) as well as open lakes or basins;
- coastal dunes and beaches;
- biological links – consisting of remnant native vegetation; and
- natural landforms – viz. calcified cliffs, caves, crevices, overhangs and other features of coastal headlands.

For the purpose of management and determination of conservation priorities, natural areas may be classified under the following broad categories:

- Regionally Significant Natural Areas
    - Bush Forever Sites – listing of the Western Australian Government of regionally significant conservation sites within the Perth metropolitan region (including those vested in and managed by the City);
    - Regional Parks – vested in the Regional Parks Authority and managed by the Regional Parks Unit of the Department of Environment and Conservation;
- Locally Significant Natural Areas (LSNA) – local natural areas that have been professionally assessed to meet the need for one or more of the following broad local significance criteria (further detail under Section 6.5.7):

- Regional representation in terms of international, national, state or regional conservation category (other that those already protected under Bush Forever, DEC Managed Estate, or System 6 Reserves);
- Regional representation in terms of its status within the extent of ecological communities remaining in the region;
- Local representation in terms of its status within the current extent of ecological communities remaining in the Local Government area;
- Diversity in terms of the depth of species assemblages;
- Rarity in terms of the presence of threatened, endangered or rare ecological communities
- Viability in terms of various factors that determine its long-term survival;
- Capacity to sustain ecological processes and natural systems
- Associated with wetland, coastal dines and associated vegetation

- Local Natural Areas (LNA) – all natural areas in the City that exist outside of Bush Forever Sites (Swan Coastal Plain), the DEC managed Estate and Regional Parks.

3.5 Definition of Conservation

Conservation is an all embracive term that includes several elements aimed at the retention, protection and management of natural area. For the purpose of this strategy, the term conservation is meant to include all of the following:

- To ensure retention in perpetuity via appropriate legislative mechanisms;
- To protect inherent biodiversity values by affording legal conservation status;
- To identify and remove existing threats;
- To protect from further degradation;
- To restore, where possible, what has been lost;
- To rehabilitate what needs recovery;
- To facilitate natural regeneration;
- To assist with revegetation where needed or justified;
- To maintain so that regression does not occur of what has been achieved through conservation effort;
- To monitor and evaluate responses to conservation effort; and
- To review and refine conservation strategies, if required.

Recommendations:

2. That the following definition of biodiversity be adopted - Biodiversity refers to the numerous plants, animals and other organisms that make up natural ecosystems (e.g. bushland, wetland or coastal dune) and the part these organisms have in the sustainability of ecosystems by their interdependence and survival links to each other; the greater the biodiversity of a given ecosystem (as measured by the number of separate species per unit area) the greater is the capacity of that ecosystem to sustain itself and to withstand various environmental and human induced threats and pressures (as per Section 3.1).

3. That the importance of conserving biodiversity in terms of the following values be recognized - Generation of soils and maintenance of soil quality; maintenance of air quality; maintenance of water quality; natural control of pest populations; assimilation, detoxification and decomposition of wastes; pollination for natural regeneration and economic crop production; stabilization of climate and moderation of extreme weather patterns; prevention and/ or mitigation of natural disasters; ensuring food security for human survival; provision of natural resources for human health care; ensuring income generation and economic growth; and retention of spiritual/ cultural values (as per Section 3.2)

Plate 2 - Star Swamp Bushland Reserve: an example of bushland of the Cottesloe Central & South Vegetation Complex on Spearwood Dunes (photo by Daniel Rajah 2002)

4. THE STUDY AREA

4.1 Extent of Natural Areas within the City of Stirling

The City of Stirling is located 8 kilometers north of Perth and covers a total land area of just over 100 square kilometers. It is the largest Local Government authority in Western Australia in terms of population, consisting of approximately 180,000 residents spread out over 30 suburbs.

The City's municipal area falls within the Swan Coastal Plain sub-region of the Swan Coastal Plain Biogeographic Region (Environment Australia 2000) (Note: there are 85 Interim Biogeographic Regions throughout Australia, 53 of which are in Western Australia). In botanical terms, the City lies in the Drummond Botanical Sub-district or Darling Botanical District of the South-western Botanical Province as defined by Gardner (Gardner 1942) and later by Beard (Beard 1979, 1980). This area is typically characterized by Low Banksia Woodland with Melaleuca swamps and Woodlands of Tuart *(Eucalyptus gomphocephala)*, Jarrah *(Eucalyptus marginata)* and Marri *(Corymbia calophylla)* (Beard 1990).

As the geographical distribution of the City's natural areas traverses a wide range of terrain, a number of vegetation types can be expected (Mattiske & Procter 2007). The City is well endowed with natural areas which comprise 616 hectares of bushland dispersed over 68 Local Government vested reserves, 33 wetland sites and 6.5 kilometers of coastal dunes and beaches. The bushland reserves range in size from 0.2 to 100 hectares of which 8 are regionally significant. The wetlands are largely ephemeral and groundwater fed. Most occur along the line of depression between the Quindalup and Spearwood Dune systems. The coastal dunes may largely be classed as Quindalup Dunes (Safety Bay Sands) and Spearwood Dunes (sands derived from Tamala Limestone).

The purpose of this Local Biodiversity Strategy is to embrace all natural areas within the City of Stirling regardless of land ownership and the nature of tenure so as to enable comprehensive identification and conservation of biodiversity values in this part of the metropolitan region. Natural areas in the City mainly comprise of Local Government vested reserves and State Government lands although a few areas under private ownership also exist.

At this juncture in the development of this Local Biodiversity Strategy, not all of the above areas have been identified nor surveyed with respect to biodiversity condition. Nevertheless, the intent is to establish an evolving format in the strategy document to enable the inclusion of subsequent survey data as these become available.

Whilst the City will be responsible for all Local Government vested reserves with regard to the implementation of recommendations of this Local Biodiversity Strategy, the expectation is for authorities/ agencies/ owners of other lands to assume responsibility for management of their natural areas in accordance with the strategy principles and guidelines. Table 1 summarizes the possible extent of natural biodiversity areas within the City of Stirling.

In terms of the extent of native vegetation within the City of Stirling, only 42% remains of what existed prior European settlement. This however represents the total extent of remnant vegetation and not the extent remaining for each of the various Vegetation Complexes, some of which are well below the essential 10% of the pre-European extent or the desirable 30% of the pre-European extent. Table 11 and Figure 3 compares the pre-European extent of the vegetation complexes originally present in the City of Stirling the extent of vegetation loss that has occurred since settlement. These statistics make it even more compelling for all remaining natural areas to be retained and protected. Although new areas of naturally occurring biodiversity can not be created, the goal is to, where possible, extend buffer areas and ecological links to supplement the currently depleted extent so that least 10% of the pre-European coverage is achieved.

Table 1 Extent of Natural Areas in the City of Stirling

	COS Reserves (ha)	Regional Parks (ha)	State Govt. lands (ha)	School Grounds (ha)	Universities & Colleges (ha)	Golf Courses (ha)	Private Lands (ha)
Bushland	616	180	291	TBD	6	126	61
Wetland	84	162	TBD	TBD	0.4	14	TBD
Transition Zones	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Coastal Dunes	60	NA	NA	NA	NA	NA	NA
Biological Links	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Natural Landforms	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Total							

NA - Not Applicable TBD - To Be Determined

5. STRATEGY OBJECTIVES

5.1 Vision and Governing Principles

The City's broad vision for biodiversity conservation is reflected in the following statement: 'To establish local biodiversity as a core community value'. This vision may be supported by a number of principles as follows:

5.1.1 All ecological communities locally represented must be protected to ensure retention in perpetuity

It is essential that all ecological communities are adequately represented to provide true diversity of species in any part of the Perth Metropolitan Region. Sustaining biodiversity by any realistic measure requires that there be the retention of each ecological community (or vegetation complex) to at least 30% of its pre-European extent. Fragmentation or reduction in extent below 30% could seriously jeopardize ecological communities, especially those that are already threatened, to below sustainable levels (Commonwealth of Australia 2001b). Such a level of retention is equally compelling to the Local

Government area covered by the City of Stirling however where retention at the 30% (Desirable Level) is not achievable then retention at the 10% (Essential Level) must be adopted as the absolute minimum.

5.1.2 The conservation of locally significant natural areas is just as important as those that are regionally significant

Not withstanding the priority for conservation of regionally significant reserves, it is important that all local natural areas, particularly those deemed locally significant are given due prominence in terms of their management. Many local natural areas, although smaller in size, provide a degree of connectivity and ecological linking with the larger regionally significant reserves as well as buffering from biodiversity loss in the more significant reserves. The scope and intensity of conservation of the smaller areas should therefore be just as comprehensive to that of the larger regionally significant reserves because of the enormous peripheral pressures and other threats that the smaller areas are normally subject to.

Apart from their ecological significance, the conservation of locally significant natural areas forms an essential part of maintaining balance within suburbia between the natural and the developed environment. The value of local natural areas (bushland/ lake and wetland systems) within many parkland settings is not to be underestimated in terms of the aesthetic, recreational, educational and other community values that they provide and by this means, instilling a sense care/ concern for the welfare of such areas.

5.1.3 Natural ecosystems must be given the opportunity to naturally regenerate before resorting to revegetation

The regenerative capacity of many bushland areas is often underestimated. Even areas that have undergone prolonged stress (through frequent fires, weed competition etc) still retain latent mechanisms to produce new growth or recruit new offspring once the stress factors have been eliminated (City of Stirling 2003). Whist rehabilitation of severely degraded areas may require intervention in the form of direct seeding or planting with provanced seedling stock, these are not the preferred options until the capacity of the site for natural regeneration has been fully explored. Replacement plantings can never fully replace the original makeup of all under storey species nor is it fully attainable from a practical viewpoint (City of Stirling 2003). This makes it even more compelling why natural regeneration should be encouraged as much as possible before resorting to assisted methods.

5.1.4 The highest biodiversity value natural areas should be given conservation priority over other areas

It is more effective, from an ecological and resource allocation viewpoint, to protect biodiversity by conserving natural areas that are in a viable or good condition than those that are degraded. However, classifying natural areas for such a purpose must be based on expert evaluation of each site for biodiversity status and condition. It is only from such assessments that the presence of rare, endangered and threatened species and other ecological attributes can be determined and site prioritization assigned accordingly.

Notwithstanding the above, sites that are in a lesser or degraded condition have the potential for restoration through natural regeneration and other mechanisms pending the availability of resources and are therefore not to be undervalued.

5.1.5 Threats to natural ecosystems are of mostly of anthropogenic origins or human induced; conservation strategies should therefore be based on this assumption

When one considers all environmental threats currently manifest in natural areas they can be traced back almost indelibly to human related effects. These include clearing of native vegetation resulting in the destruction of vegetation structure and fragmentation of natural areas, irresponsible access through the needless duplication of walk trails, soil erosion, nutrient imbalance through fertilizer runoff and influx of pet animals, hydrological imbalance, altered fire regimes, invasion weeds, invasion of pests, infestation of disease, rubbish dumping, accumulation of various pollutants, vandalism, uncontrolled recreational impacts and illegal removal of plant material (City of Stirling 2003).

It is only through a focus on human induced threats (threatening processes and disturbance factors) to biodiversity that community awareness could be heightened to the plight of many natural areas in the urban environment.

5.1.6 The conservation of natural areas as a legitimate form of land use must be recognised

Natural areas have intrinsic values apart from biodiversity that must be recognised and should underpin all decisions related to land use (Del Marco *et al* 2004). Where non existent, appropriate policy and planning mechanisms must be enabled to validate the status of natural areas on Local Government reserves and to ensure that biodiversity is protected and strongly featured in all planning decisions affecting lands containing or adjacent to natural areas. Indeed the intent of this strategy is to integrate policy and planning mechanisms into key recommendations for Council adoption and implementation.

The above process however must be supplemented by site specific expert field surveys so that all biodiversity attributes and ecological values are recorded and fully acknowledged in on-going planning decisions.

5.1.7 Community engagement is vital in perpetuating biodiversity into the future

Engaging the local community in the planning and implementation of field-based conservation works is an important part of generating, interest, appreciation, fascination, empathy, a sense of care, a sense of belonging and a sense of place (City of Stirling 2003). An involved community becomes more informed about the plight of natural areas in the urban environment and is more likely to lend support to the City's biodiversity conservation objectives and take ownership of conservation outcomes.

A 'whole of community' approach is advocated involving local experts, the local neighbourhood, local primary and secondary schools, colleges, universities, industry, sporting and recreational clubs etc. Apart from field-based conservation work involving rubbish removal, weeding, planting etc. the local expertise could be engaged in critical tasks such as survey of weed infestations, identification of flora and fauna and monitoring responses of natural ecosystems to conservation effort. Recognition of community effort and promotion of community conservation activities is paramount in

engendering on-going interest and support and of biodiversity being truly adopted as a core community value.

5.1.8 The conservation of natural areas must adopt a long-term perspective

Whilst some responses to conservation effort become evident almost immediately, in the main, whole of ecosystem responses are often slow and protracted over several years. The scope and intensity of conservation programmes should therefore adopt a long-term perspective in keeping with expected with ecosystem changes. Monitoring programmes, of necessity need to be consistent and continuous over a number of years to derive meaningful data. This does have implications in terms of funding and resource allocation especially with a phased works programme spanning a number of years and also of community expectations of what can be realistically achieved each year.

5.2 Goals, Objectives and Targets

Application of the above principles is best undertaken by (1) their conversion into effective goals, (2) formulation of clear objectives and rationale for the goals adopted (3) setting of realistic targets to ensure successful goal achievement.

Principle 1: All ecological communities locally represented must be protected to ensure retention in perpetuity

Goal: To retain and protect all ecological communities represented within the City of Stirling.

Objective: Prevention of any further clearing from development or destruction through other means all ecological communities (or vegetation complexes) currently present so that these are not lost but retained in perpetuity.

Target: Aim for 10% of the pre-European extent of each ecological community (ESSENTIAL) and 30% if possible (DESIRABLE).

Principle 2: The conservation of locally significant natural areas is just as important as those that are regionally significant

Goal: To identify all locally significant natural areas and to develop and implement site-specific conservation programmes.

Objective: Inclusion of locally significant natural areas (LSNAs) within the City's conservation programme due to their ecological and community values.

Target: (A) Develop site-specific conservation programmes for all LSNAs by the end of the 2010/ 2011 financial year.
(B) Complete costing in time for budget submission for the 2011/ 2012 financial year.

Principle 3: Natural ecosystems must be given the opportunity to naturally regenerate before resorting to revegetation

Goal: To identify conservation sites where natural regeneration could be encouraged and to implement site-specific conservation programmes.

Objective: Conservation outcomes to reflect natural patterns of occurrence with regard to vegetation structure and floristic communities.

Target: (A) Complete identification of sites where natural regeneration could be encouraged by the end of the 2010/ 2011 financial year.

(B) Develop and cost site-specific conservation programmes for all identified sites in time for budget submission for the 2011/ 2012 financial year.

Principle 4: The highest biodiversity value natural areas should be given greater conservation priority over other areas

Goal: To identify all natural areas with the highest biodiversity values and to implement site-specific conservation programmes.

Objective: Site prioritization to reflect significant values viz. presence of rare, endangered and threatened species and other ecological attributes.

Target: (A) Complete identification of highest value natural areas by the end of the 2011/ 2012 financial year.
(B) Develop and cost site-specific conservation programmes for all identified sites in time for budget submission for the 2012/ 2013 financial year.

Principle 5: Threats to natural ecosystems are mostly of anthropogenic origin or human induced; conservation strategies should therefore be based on this assumption

Goal: To identify all environmental threats (threatening processes and disturbance factors) and to develop and implement a strategy to resolve human impacts.

Objective: Realistic conservation strategies to include measures that will encourage behaviourial changes with respect to community perception and treatment of natural areas.

Target: Complete review of Green Plan 2 by the end of the 2011/ 2012 financial year as all threats of anthropogenic origin have already been identified in this document.

Principle 6: The conservation of natural areas as a legitimate form of land use must be recognised to ensure protection of these areas

Goal: To adopt appropriate policy and planning mechanisms that will afford the protection of biodiversity conservation sites.

Objective: Realistic conservation strategies to include measures that will regulate land use with respect to areas containing or adjacent to natural areas.

Target: (A) Investigate, in conjunction with Statutory Planning, by the end of the 2010/ 2011 financial year, the feasibility of a Local Planning Policy review that would enable the incorporation of the above principle.
(B) Undertake and complete Local Planning Policy review (date to be determined in consultation with Statutory Planning).

Principle 7: Community engagement is vital to perpetuating biodiversity into the future

Goal: To develop a community engagement agenda that would engender greater involvement in biodiversity conservation.

Objective: Recognition of community effort and promotion of community conservation activities to engender on-going interest and support and of biodiversity conservation and of biodiversity being adopted as a core community value.

Target: Outline a community engagement agenda for Council endorsement by the end of the 2010/ 2011 financial year.

Principle 8: The conservation of natural areas must of necessity adopt a long-term perspective

Goal: To adopt a long-term perspective to the conservation of natural areas

Objective: Conservation strategies to be in synchrony with ecosystem responses to conservation effort and according to funding and resource availability.

Target: Adoption of a 10-20 year long-range budgetary programme for natural areas conservation by June 2010.

Recommendations:

4. That the following statement be adopted as the City's broad vision for biodiversity conservation - 'To establish local biodiversity as a core community value'

5. That the biodiversity vision statement be supported on the basis of the following principles:
   - All ecological communities locally represented must be protected to ensure retention in perpetuity.
   - The conservation of locally significant natural areas is just as important as those that are regionally significant.
   - Natural ecosystems must be given the opportunity to naturally regenerate before resorting to revegetation.
   - The highest biodiversity value natural areas should be given greater conservation priority over other areas.
   - Threats to natural ecosystems are mostly human induced; conservation strategies should therefore be based on this assumption.
   - The conservation of natural areas as a legitimate form of land use must be recognized to ensure protection of these areas.
   - Community engagement is vital to perpetuating biodiversity into the future.
   - The conservation of natural areas must of necessity adopt a long-term perspective.

6. That the specific targets proposed under each of the above Principles be adopted with the view to the establishment of realistic goal measurement associated with each Principle.

Part B:
Survey Methodology

PART B:
SURVEY METHODOLOGY

Section 6: Site Surveys for Biodiversity

Section 7: Organization of Survey Data

Section 8: Interpretation of Survey Data

6. SITE SURVEYS FOR BIODIVERSITY

6.1 Adoption of Standard Assessment Techniques

For the purpose of this strategy, site assessment templates developed by the Perth Biodiversity Project unit of the Western Australian Local Government Association were used. These templates (referred to as standard templates for Natural Area Initial Desktop and Field Assessments) have now been adopted as the standard across the Perth Metropolitan Region and are being utilized by all Local Governments involved in biodiversity conservation. The primary purpose in using these standard templates is to ensure that any local biodiversity assessment undertaken by the City can be validated in terms of regionally recognised and accepted criteria and to enable regional comparisons of biodiversity status and condition.

The standard templates nevertheless make provision for gathering specific information about each natural area site in terms of all ecological elements and their attributes, the extent and condition of flora and fauna including introduced species and any threatening process or disturbance factor identified that could jeopardize future conservation effort. A database of biodiversity information could thereby be structured to encompass all natural areas sites within the City to serve as a valuable management tool particularly in the following situations:

- Assessing local natural areas to identify those that are locally significant (in addition to those already known as regionally significant) so that formal legal protection status could be applied;
- Development of site specific management plans and conservation programmes;
- Identifying immediate management needs pertaining to each site;
- Prioritization of sites for protection and conservation;
- Allocation of resources for conservation effort;
- Assessment of development applications on land containing natural areas (as may be required under the City's Local Planning Policy for biodiversity conservation; and
- Clarifying gaps in knowledge where supplementary surveys would be required to obtaining more comprehensive biodiversity information for effective on-going management (hence referred to Initial Desktop and Field Assessments).

6.2 Nature and Extent of Surveys Undertaken

For each natural area site that was assessed, a Natural Area Initial Desktop Assessment and Field Assessment Templates were completed. The assessment templates consist of four parts as follows:

6.2.1 Natural Areas Initial Desktop Assessment

Remote collection of data was acquired prior to venturing into the field viz. of all regionally held information pertaining to each of the local natural area sites in terms of:

- Current administrative status e.g. ownership, vesting purpose etc;
- A list of potential reference sites in the region with similar environmental settings with recorded ecological information that can be used for comparison to the site being assessed;

- A bibliographic search of ecological data pertaining to the site being assessed and its reference sites, and
- Regional map of the site's location, any reference sites (based on a similar ecological community elsewhere in the Perth Metropolitan Region), regional map of ecological information and relevant aerial photographs.

6.2.2 Natural Area Initial Field Assessment A

The basic ecological attributes of each site being assessed, ground-verification of the desktop information, assessment of current vegetation condition, threatening processes and disturbance factors as well as site infrastructure viz. fences, access tracks etc. The field data gathered for this component has been formatted as:

- Overlay of the aerial photograph of each site showing mapped information of plant communities, vegetation condition (vegetation condition scales elaborated under Section 6.3), significant disturbances, site infrastructure and site boundaries;
- Detailed vegetation description for each plant community identified and mapped, comment on disturbance factors, observations of fauna, status of site infrastructure (fences, access tracks etc.) and recommendations for management;
- Photographs of described plant communities and significant disturbances,

6.2.3 Natural Area Initial Field Assessment B

This assessment determines the presence of significant species and communities such as Declared Rare or Priority Flora, Specially Protected or Priority Fauna and Threatened Ecological Communities and any other species or communities unique to the local area. The field data gathered for this component has been formatted as:

- Detailed description of significant native flora, fauna or communities, if any;
- Mapped information of significant native flora, fauna or communities; and
- Photographs of the above.

6.2.4 Natural Area Assessment Summary

General view of the biodiversity status and conditions of all natural area sites assessed status with particular emphasis of those sites deemed of local significance under the ecological criteria for Local Significance. The summary has been formatted as:

- List of assessed natural area sites with those deemed of Local Significance highlighted; and
- Prioritization of the assessed sites in order of ecological viability

6.3 Vegetation Structure Classification in Natural Area Assessment

Sites were additionally assessed for integrity of Vegetation Structure which refers to the growth form and make-up of any natural area and takes into account the various tiers or layers that comprises the above-ground biomass. Basic classification systems often refer to trees, shrubs and groundcover however the following offers a more comprehensive analysis of vegetation structure in relation to growth form and representational tiers:

Table 2 Classification System Employed for Assessment of Vegetation Structure

Growth Form/ Vegetative Tiers	Canopy Cover			
	100% to 70%	70% to 30%	30% to 10%	10% to 2%
Trees over 30m	Tall Closed Forest	Tall Open Forest	Tall Woodland	Tall Open Woodland
Trees 10 to 30 m	Closed Forest	Open Forest	Woodland	Open Woodland
Trees under 10m	Low Closed Forest	Low Open Forest	Low Woodland	Low Open Woodland
Mallee over 8m (Tree Mallee)	Closed Tree Mallee	Tree Mallee	Tall Tree Mallee	Very Open Tree Mallee
Mallee under 8m (Shrub Mallee)	Closed Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub
Shrubs over 2m	Closed Tall Shrub	Tall Open Scrub	Tall Shrubland	Tall Open Shrubland
Shrubs under 1 to 2m	Closed Heath	Open Heath	Shrubland	Open Shrubland
Shrubs under 1m	Closed Low Heath	Open Low Heath	Low Shrubland	Very Open Shrubland
Grasses	Closed Grassland	Grassland	Open Grassland	Very Open Grassland
Herbs	Closed Herbland	Herbland	Open Herbland	Very Open Herbland
Sedges	Closed Sedgeland	Sedgeland	Open Sedgeland	Very Open Sedgeland

Adapted after Keighery (1994), Muir (1977) & Aplin (979)

Definition of the above classification of Growth Form/ Vegetative Tiers may be defined as follows (Keighery 1994, McDonald et al 1990):

- Tree: woody plant with a single trunk and canopy; canopy less than or equal to 2/3 of the height of the trunk; no apparent lignotuber
- Mallee: woody plant with many woody stems; canopy well above the base; lignotuber usually apparent; commonly of the genus Eucalyptus
- Shrub: woody plant with one of many woody stems; foliage comprising all or part of the total height of the plant; includes grass trees (Zanthorrhoea spp.) and cycads (Macrozamia spp.)
- Herb: non woody plant with stems generally under 0.5 metres tall; not a grass, sedge or rush
- Grass: non-woody plant from the family Poaceae; all have inconspicuous individual flowers that are wind pollinated; leaf sheaths are always split; ligules present; leaf usually flat; stem cross-section circular; evenly spaced internodes
- Sedge: non-woody, tufted or spreading from the family Cyperaceae; most have inconspicuous flowers that are wind pollinated; leaf sheaths never split; leaf not always flat; extended internode below the inflorescence
- Rush: same as sedge but from the families Juncaceae, Restionaceae, Typhaceae or Xyridaceae; leaf sheath may be split as in Restionaceae

6.4 Vegetation Condition Scales for Natural Area Assessment

Vegetation condition is a measure of the biodiversity changes that may be evident in a natural area as a consequence of various threatening processes and disturbance factors when compared to what could be expected with similar vegetation in pristine condition. Particular focus is given to the degree of change in the structure and density of the vegetation being assessed and the species composition. For the assessment of the City's natural areas the Keighery (1994) and also the Kaesehagen (1994) Vegetation Condition Scales were employed.

Table 3 Comparative Analysis of Vegetation Condition Scales

Keighery Vegetation Condition Scale	Kaesehagen Vegetation Condition Scale
Pristine Pristine or nearly so, no obvious signs of disturbance	
Excellent Vegetations structure intact; disturbance affecting individual species; weeds are non-aggressive species	**Very Good to Excellent** • 80% to 100 % native flora composition • Vegetation intact or nearly so • Cover/ abundance of weeds < 5% • No or minimal signs of disturbance
Very Good Vegetation structure altered; obvious signs of disturbance (Examples of disturbance to vegetation structure include repeated fires, presence of some of the more aggressive weeds, logging, grazing).	**Fair to Good** • 50% to 80% native flora composition • Vegetation structure modified or nearly so • Cover/ abundance of weeds 5% to 20%, any number of individuals • Minor signs of disturbance
Good Vegetation significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate. (Examples of disturbance vegetation structure include very frequent fires, presence of some very aggressive weeds at high density' partial clearing, dieback, grazing).	
Degraded Basic vegetation structure severely impacted by disturbance; scope for regeneration; but not top a state approaching good condition; without intensive management. (Examples of disturbance to vegetation structure include very frequent fires, presence of very aggressive weeds, partial clearing, dieback, grazing).	**Poor** • 20% to 50% native flora composition • Vegetation structure completely modified or nearly so • Cover/ abundance of weeds 20% to 60%, any number of individuals • Disturbance incidence high
Completely Degraded Structure of vegetation no longer intact and the area completely devoid of native species. (Often referred to as 'parkland cleared' with flora predominantly non-local native and exotic species with only isolated local native trees or shrubs).	**Very Poor** • 0% to 20% native flora composition • Vegetation structure disappeared • Cover/ abundance of weeds 60% to 100%, any number of individuals • Disturbance incidence very high

Adapted after Keighery (1994) and Kaesehagen (1994)

6.5 Ecological Criteria to Determine Regional and Local Significance

The establishment of criteria to evaluate ecological attributes is an important part of planning for biodiversity management as it enables the classification of natural area sites (Local Natural Areas or LNAs) on a graduated scale of varying biodiversity values and on-site opportunities and constraints. Hence, sites of highest biodiversity values would receive greater priority in terms of resource allocation and conservation effort. The classification of natural areas in accordance with biodiversity values would further assist in (1) identifying natural areas of Regional significance as well local significance (i.e. Locally Significant Natural Areas or LSNAs) and (2) the establishment of site specific targets to improve biodiversity condition (Natural Area Condition Targets).

In most cases natural areas with vegetation communities considered Regionally significant have already been pre-established via listings under the Metropolitan Region Scheme and Bush Forever. Nevertheless, it is useful to know that the basis upon which such listings are made. These may include any or all of the following (WALGA 2004):

- Consist of vegetation communities limited in distribution to specific landform types;
- Vegetation communities that are uncommon or of restricted plant community types within the region; or
- Support populations of Declared Rare Flora.

Natural areas with vegetation communities may be declared Locally significant where they meet any or all of the following criteria (Del Marco *et al* 2004):

- Exhibit unusually high structural and species diversity;
- Extend the geographic range of particular taxa from previously recorded locations;
- Are restricted to only one of a few locations;
- Occur as small isolated communities; or
- Support populations of Priority Flora species.

In any event, general ecological criteria often used to characterize Local Natural Areas as being Locally significant consist of the following (del Marco et al 2004):

- Representation of ecological communities;
- Diversity;
- Rarity;
- Capacity to sustain ecological processes; and
- Significant as buffers to wetland and coastal dune systems (Del Marco *et al* 2004).

Criteria pertaining to the representation of ecological communities and rarity may be further designated a level of priority as either Essential criteria (where a 10% threshold target for retention and protection is attainable) or Desirable criteria (where a 30% threshold target is possible) consistent with existing legislation and policies (Del Marco *et al* 2004).

6.5.1 Representation of Ecological Communities

Under the Environmental Protection and Biodiversity Conservation Act 1999, ecological communities are defined as biological assemblages of native species that occur in a particular natural area or habitat type. The most common way to interpret ecological communities for quantitative targets for a given area is to utilize the system of Vegetation Complexes and their groupings in major land elements (Hedddle et al. 1980), (Mattiske and Havel 1998). As a further refinement, Vegetation Complexes may be further analyzed into Floristic Community Types contained within the same area.

Table 4 presents the key Vegetation Complexes under the major landform element currently employed in the assessment and classification of Local Natural Areas in the Metropolitan Region. These major landform elements point to useful attributes such as geological origin, topography, soil types and hydrological characteristics upon which the various Vegetation Complexes have been established. Table 5 demonstrates the site assessment matrix used for the evaluation of ecological criteria.

Table 4 Regional System of Vegetation Complexes under the Major Landform Elements

IBRA Region	Major Landform Element	Vegetation Complex
Jarrah Forest	DEC Managed Estate	Jarrah Forrest
Swan Coastal Plain	Dandaragan Palateau	Mogumber South
	Gingin Scarp	Reagan
	Foothills (Ridge Hill Shelf)	Forrestfield
	Pinjarra Plain	Guildford
		Swan
		Dardanup
		Serpentine River
		Beermullah
		Yanga
	Combinations of Bassendean Dunes & Pinjarra Plain	Cannington
		Southern River
	Bassendean Dunes	Bassendean Central & South
	Spearwood Dunes	Karrakata North
		Karrakatta Central & South
		Cottesloe Central & South
	Wetlands	Quindalup
		Herdsman
	Marine (Estuarine & Lagoonal) Deposits	Pinjar
		Vasse

Note: IBRA refers to Interim Bio regionalization of Australia

6.5.2 Diversity

This criterion relates to the diversity that exists within ecological communities in terms of the variety of species of plants, animals and other organisms that may inhabit a given natural area. Diversity may be more specifically manifest by differences at the genetic level, individual species level and species assemblage level. The presence of two or more ecosystems within a given area would further enhance biodiversity; for example having both wetland and upland communities would be expected to contribute to higher

diversity of living organisms not only within each ecosystem but also as part of the transitional habitats between these ecosystems.

Measurements for diversity may be undertaken by determining (1) what diversity attribute or characteristic to measure and (2) an appropriate measure of performance that could be applied over time to evaluate ecosystem responses to conservation effort. In the absence of any formal diversity criteria currently available, the following is advocated as interim criteria and process for diversity evaluation:

- Determination of Key Performance Indicators (KPIs) such as
    - Weed index – ratio of native plants to weeds within sample plots;
    - Diversity index – number of different families and species within sample plots;
    - Density index – total number of local native plants per sample plot;
- Adoption of recognised benchmarks for each KPI;
- Establishment of annual performance targets each KPI
- Undertake measurement of each KPI;
- Compare against established benchmarks;
- Refine annual performance targets for each KPI as required.

6.5.3 Rarity

This criterion refers to the scarcity or lack of abundance of ecological communities as measured at any or all the following levels: vegetation complex level, floristic community level and the individual species level (WALGA 2004). An attribute particularly significant at the floristic community level is Threatened Ecological Communities (TECs). Communities are deemed TECs if they are defined as per criteria of the Western Australian Threatened Ecological Communities Scientific Advisory Committee to be Presumed Totally Destroyed (PD), Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) (Mattiske & Procter 2007).

Attributes normally considered at the individual species level include Declared Rare Flora, Specially Protected Fauna or significant habitat for Specially Protected Fauna. Under Federal legislation, the Environment Protection and Biodiversity Conservation Act (1999) categorizes Threatened Species as Extinct (Ex), Extinct in the Wild (ExW), Critically Endangered (CE), Endangered (E),Vulnerable (V),Conservation Dependent (CD). Appendix I provides a definition of Threatened Species categories as per the above Act).

State legislation also protects flora and fauna species deemed threatened or significant. With regard to fauna, the Wildlife Conservation (Specially Protected Fauna) Notice 2005 issues as an adjunct to the Wildlife Conservation Act (1950) and covers fauna that are significant or in need of conservation at a State level. With regard to flora, the Wildlife Conservation Act (1950) again protects flora that have been defined as having Rare or Priority conservation status. Under the Act, it is an offence to 'take' Rare Flora ('take' being defined 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). Under the Act, Priority Flora are flora under consideration for declaration as Rare Flora but pending further survey (for Priority One to Three ratings) or flora that require monitoring every 5 to 10 years (for

Priority Four rating) (Mattiske & Procter 2007). Appendix II provides definitions of Declared Rare and the four Priority ratings under the Wildlife Conservation Act (1950).

6.5.4 Capacity to Sustain Ecological Processes

Apart from intrinsic values of biodiversity i.e. at the genetic level, individual species level and species assemblage level, various other criteria could be applied to measure the functional value of biodiversity at the ecosystem level. Measurement for such criteria should include the capacity to sustain ecological processes as a way of ensuring the viability of natural areas either within individual sites or as part of continuous linkages with other sites of similar dimension and status e.g. via a system of ecological linkages and 'stepping stones'. However, a number of studies have determined that linear corridors of native vegetation need to be at least 25 to 50 metres in width to serve as effective linkages for avian fauna (Freudenberger 1999, Barrett 2000). Where continuous corridors do not exist, a system of 'stepping stones' should assume the fallback position in facilitating the movement of migrating species. Effective 'stepping stones' of good condition native vegetation need to be at least 10 hectares in size and located no more than 500 to 1000 metres from each other (Freudenberger 1999).

Ecological linkages and 'stepping stones' may be evident both at regional and local scales. The value of ecological linkages via continuous corridors of native vegetation is not to be underestimated. By this mechanism various fauna (birds, insects, reptiles, amphibians, mammals) and flora (pollen, seeds and other propagules) to move between these areas to access resources and suitable habitat and growth conditions for survival and reproduction. It also means that the survival of connectivity-sensitive species is insured by allowing living organisms to conduit freely along environmental gradients or in response to various threats viz. bushfires, soil and hydrology differentials and climate change.

6.5.5 Significant as buffers to wetland systems and associated areas

The conservation of wetland systems is an integral part of protecting and perpetuating biodiversity. Many wetland systems play a pivotal role in the expression of sustainable hydrological cycles particularly in reference to groundwater aquifers and surface waterways. Seasonally inundated and vegetated wetlands viz. sumplands, damplands, floodplain, palusplain as well as upland vegetation or wetland transitional zones are some of the most biologically productive areas and are of immense value as surrogate areas for many native flora and fauna. These areas offer much needed buffering capacity for the stability of wetland associated landforms and the health of the wetlands in general. Failure to adequately protect such buffer areas has often been attributed to environmental impacts such as eutrophication of wetlands, decreased water quality, degradation of habitat, soil erosion, dryland salinity and soil acidity.

The use of the standard NAIA templates for the assessment of wetlands would only apply to the vegetated areas beyond the capillary zone of the wetland (or wetland transition zone) but not the wetland proper which includes the peripheral capillary zone, the seasonally inundated zone and the permanently inundated zone. Regionally accepted standard assessment criteria for wetlands have yet to be developed however the following could constitute the basic elements of site evaluation:

- Wetland type
- Conservation significance or classification

- Site information
    - Geology/ hydrology
    - Water chemistry
    - Aquatic invertebrates
    - Avian and other fauna
    - Aquatic and riparian vegetation
- Threats and disturbances
    - Land clearing/ development
    - Eutrophication
    - Salinity
    - Acidity
    - Vegetation decline
    - Habitat loss
- Seasonality factors

6.5.6 Significant as Buffers to Coastal Dune Systems

Coastal dunes act as overland repositories of sediment transport and in their vegetated form provide diverse habitat and refuge for a variety of wildlife. Aside from these biodiversity values, established coastal dune vegetation play a critical role in the stability of beaches, the dunes and associated coastal landform involving secondary, tertiary and quaternary dunes. Fore dunes and secondary in particular need to be retained and protected to prevent loss of coastal vegetation and wildlife habitat, erosion of dunes and the subsequent undermining of coastal infrastructure. These areas are hence significant buffers against coastal erosional processes, environmental gradients, tidal surges during abnormal storm events and associated effects of climate change.

6.5.7 Application of Essential and Desirable Criteria

Reference is made to the Local Government Biodiversity Planning Guidelines (WALGA 2004) that prescribes threshold targets (Natural Area Condition Targets) based on ecological and other criteria to determine local significance of natural areas. The preceding sections outline those criteria that govern local significance principally in terms of ecological attributes. Fundamental to these are (1) the degree of representation of remnant of vegetation complexes or the current extent of ecological communities and (2) the degree of rarity in terms of Threatened Ecological Communities. Criteria are designated Essential where a 10% threshold target for retention or protection exists and Desirable where a 30% threshold target exists (Del Marco *et al* 2004).

6.5.8 Classification of Significant Sites

Table 5 summarizes all criteria employed in the assessment of local natural areas to determine whether locally significant. Local Natural Areas deemed as locally significant by the application of Essential and Desirable criteria have been further prioritized in order of their degree of conformity into any one of the three Priority Classes shown in Table 5.

Table 5 Ecological Criteria for Identifying Locally Significant Natural Areas

Criteria	Representation & Rarity Ecological Criteria	Assessment Method	Primary Prioritization
Representation (Regional)			
Recognized international, national, state or regional conservation category (other than Bush Forever or DEC Managed Estate) not already protected (e.g. System 6 reserves	ESSENTIAL (also applicable to regional or higher conservation categories)	DESKTOP For Potentially Significant Natural Areas (PLSNA) plus FIELD CONFIRMATION	PRIORITY 1A
Ecological community with only 1500 ha or 30% or less (whichever is greater) remaining in the IBRA sub-region	ESSENTIAL Jarrah Forest only (also applicable to regional or higher conservation categories) DESIRABLE Bush Forever sites only	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 1A (Jarrah Forest only) PRIORITY 1B (Bush Forever Site only)
Large (greater than 20 ha) viable natural area in good or better condition of an ecological community with more than 30% remaining within the IBRA sub-region	DESIRABLE (also applicable to regional or higher value sites)	FIELD CONFIRMATION	PRIORITY 1C
Ecological community with only 1500 ha or 15% or less (whichever is greater) protected for conservation in the Jarrah Forest IBRA sub-region	DESIRABLE Jarrah Forest only (also applicable to regional or higher value sites)	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 1A (Jarrah Forest only)
Ecological community with only 400 ha or 10% or less (whichever is greater) protected for conservation in Bush Forever site	ESSENTIAL Bush Forever sites only (also applicable to regional or higher value sites)	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 1A (Bush Forever Site only)
Representation (Local)			
Ecological community with 10% or less remaining within the Local Government area (not applicable if 10% is already protected in DEC Managed Estate, Regional Parks or Bush Forever site)	ESSENTIAL		PRIORITY 2
Ecological community with 30% or less remaining within the Local Government area (not applicable if 30% is already protected in DEC Managed Estate, Regional Parks or Bush Forever site)	ESSENTIAL Jarrah Forest only DESIRABLE Bush Forever sites only	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 2 (Jarrah Forest only) PRIORITY 3 (Bush Forever Site only)

Large (greater than 10 ha) viable natural area in good or better condition of an ecological community with more than 30% remaining within the IBRA sub-region	DESIRABLE	FIELD CONFIRMATION	PRIORITY 3
Diversity			
Local Natural Area in good or better condition that contains upland and wetland structural plant communities	ESSENTIAL	FIELD CONFIRMATION	PRIORITY 2
Rarity			
Ecological community with only 1500 ha or 10% or less (whichever is the greater) remaining in the IBRA sub-region	ESSENTIAL (also applicable to regional or higher conservation categories)	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 1A
Ecological community with only 400 ha or 10% or less (whichever is the greater) remaining in Bush Forever sites	ESSENTIAL (also applicable to regional or higher conservation categories)	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 1A
Contains a Threatened Ecological Community (TEC)	ESSENTIAL (also applicable to regional or higher conservation categories)	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 1A
Contains Declared Rare Flora (DRF), Specially Protected Fauna (SPF) or significant habitat for these fauna	ESSENTIAL (also applicable to regional or higher conservation categories)	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 1A
Contains Priority Species or other significant flora or fauna or significant habitat for these fauna	ESSENTIAL (also applicable to regional or higher conservation categories)	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 1A
Maintaining Ecological Processes			
Local Natural Area providing connectivity as a 'stepping stone' within a Regionally Significant Ecological Linkage	ESSENTIAL (also applicable to regional or higher conservation categories)	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 1A
Local Natural Area providing connectivity as a 'stepping stone' within a Locally Significant Ecological Linkage	ESSENTIAL	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 2
Protection of Wetland, Coastal Dunes and their associated vegetation			
Local Natural Area (LNA) which is a Conservation category or Resource Enhancement category wetland and buffer vegetation	ESSENTIAL (also applicable to regional or higher conservation categories)	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 1A

LNA which is an EPP Lake and its buffer vegetation	ESSENTIAL (also applicable to regional or higher conservation categories)	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 1A
LNA serving as riparian vegetation and its buffer vegetation	ESSENTIAL (also applicable to regional or higher conservation categories)	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 1A
LNA encompassing a floodplain area and buffer vegetation	ESSENTIAL (also applicable to regional or higher conservation categories)	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 1A
LNA serving as estuarine fringing vegetation and its buffer	ESSENTIAL (also applicable to regional or higher conservation categories)	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 1A
LNA serving as coastal vegetation on foredunes and secondary dunes	ESSENTIAL (also applicable to regional or higher conservation categories)	DESKTOP (PLSNA) plus FIELD CONFIRMATION	PRIORITY 1A

Adapted after WALGA (2004)

6.6 Estimation of Viability

Viability is a measure of the ability of an ecological community to be self sustaining in supporting and maintaining the full range of living organisms. It depends considerably on the inherent resilience of an ecological community or its ability to resist or recover from threats and disturbances such as weed invasion, fire, pests, disease and others (Del Marco *et al* 2004). Hence there is a time element in evaluating whether a natural area has the inherent capacity to overcome threatening processes and disturbance factors and also the resources available from a management perspective to put in place the required remedial measures. Nevertheless, instantaneous assessments for viability are still possible if conducted in accordance with a number of obvious site-related criteria as outlined in the sections that follow. Guidelines associated with the Natural Areas Initial Assessment Templates (Appendix IV) elaborate on the methodology behind viability estimation based on a numerical scoring system.

6.6.1 Size

Size is an important factor in determining the long-term viability of a natural area; the larger the area, the greater will be its capacity to withstand threatening processes and disturbance factors and to retain its biodiversity values and maintain ecological function (WALGA 2004). Minimum sizes for viability consideration would however vary for different ecological communities because of inherent differences in vegetation structure and of site variations such as soil type.

Minimum size is also relative to the needs of particular flora or fauna species. For example, bushland remnants as small as 1 hectare can retain viable populations of reptile species if fire frequency and feral animal predation are controlled (How & Dell 2000). Studies of bird species have determined varying requirements, for example, many temperate woodland bird species in the ACT/ NSW region needing a roving range approximating 10 hectares (Barrett 2000, Freudenberger 1999) and shrubland and hearthland birds in the Wheatbelt of Western Australia requiring a minimum patch size of 15 hectares (Lambeck 1998).

Studies in the Perth Metropolitan Region suggest that for natural areas to be classed as locally significant (ie Locally Significant Natural Areas) they need to be at least 4 hectares in size (Government of WA 1995). There exist many bushland remnants in urban recreational parkland that are 1 hectare or even smaller. The sustainability of many of these smaller patches of bushland hinges on their amalgamation with each other to form larger more viable areas or their inclusion as ‘stepping stones’ in local and regional ecological links. Table 6 provides a general guide for determining the viability of natural areas.

6.6.2 Shape

The shape of a natural area influences the extent to which impacts are felt from threats originating around the edges. Referred to as ‘edge effects’ these can vary in different ecological communities depending on the resilience of the natural area to the threats posed. In terms of plant communities, edge effects include weed invasion, trampling, parkland mowing/ slashing, irrigation overspray, rubbish dumping, accumulation of pollutants (fertilizer, pesticides etc) and disease infestation from altered hydrology of surrounding land. With regard to fauna habitation, edge effects could include all the

above effects on plant communities as well as others viz. increased sun and wind exposure, increased noise levels and air pollution from traffic and industry and artificial light from area lighting in surrounding parkland. Although edge effects have been observed as far in as 50 metres into bushland proper (Del Marco *et al* 2004) areas even as narrow as 5 metres can be viable on some soils if edge effects are controlled (Safstrom & Craig unpub. 1997).

Compact shapes such as circles, squares and squat rectangles provide the greatest viability as their core areas are the largest possible for a given size. Linear, narrow shapes on the other hand have lower viability due to most of their areas being impacted by edge effects.

6.6.3 Perimeter to Area Ratio

Perimeter to area ratio is determined by the size and shape of a natural area. In assessing any natural area, the greater the perimeter to area ratio (ie distance round the perimeter in metres divided by the area in square metres) the greater would be the viability of that natural area.

6.6.4 Condition

Assessment of vegetation condition usually compares the present state of a natural area to what it would have appeared prior to European settlement. As there is little in the form of qualitative and quantitative data of original vegetation condition of the Perth Metropolitan Region to base such comparison today, arbitrary condition scales have been developed to serve that purpose. Reference is made to the Vegetation Condition Scales after Keighery (1994) and Kaesehagen (1994) both of which have been utilized in the biodiversity assessment of natural areas of the City of Stirling. Vegetation condition attributes considered as part of this assessment have included the following:

- Plant community structure and composition;
- Evidence of threatening processes viz. weed invasion; incidence of pests and disease etc;
- Presence of disturbance factors viz. clearing from BMX activity, removal of plant material, indiscriminate fires, soil erosion from stormwater drainage etc;
- Vegetation health in terms of decline in form and structure due to the effects of above threats and disturbances.

6.6.5 Connectivity

There is increasing evidence from various studies conducted elsewhere that selective management of mainly the larger sized or regionally significant natural area is flawed and provides no great advantage in terms of the continued survival if these areas. Several experts conclude that serious problems involving the loss of species diversity and long-term viability could occur in natural areas thus isolated in the urban environment and question the long long-term value of these areas as true examples of the kind of vegetation that once flourished on the Coastal Plain (City of Stirling 2003). Regardless of the fragmentation that has occurred of many natural areas in the urban environment, various studies confirm that remnant areas still continue to serve as habitat for diverse assemblages of wildlife (Del Marco *et al* 2004).

Connectivity is therefore an important factor governing the viability of any natural area in terms of its proximity to other natural areas as well as in the strength and vibrancy of that linkage as influenced by vegetation condition of these areas. These factors have a major influence on the flow of genetic material between natural areas and in turn the long-term survival of species, their genetic variation, their ability to adapt to the changes in the environment and the maintenance of ecosystem processes (Del Marco *et al* 2004).

Assessment of natural areas for the strength of connectivity should therefore seek to include sites on the following basis:

- Close proximity to other natural areas already protected and managed as a significant conservation site;
- Orientation and alignment to other natural areas through identifiable corridors or linkages;
- Intensity of dispersion of other natural areas in the near locality;
- Condition of vegetation in the above areas in terms of their capacity to effectively contribute to ecological linking; and
- Proximity to identified Regional and local ecological linkages.

Table 6 Natural Area Size Classes for Viability

Size	Viability	Maintenance Implications
Greater than 20 ha	Significantly high	Significantly low
Greater than 10 ha but less than 20 ha	High	Low
Greater than 4 ha but less than 10 ha	Moderate	Moderate
Greater than 1 ha but less than 4 ha	Low	High
Less than 1 ha	Very low	Very high

Adapted after WALGA 2004

6.7 Process Plan: Site Evaluation and Planning for Management

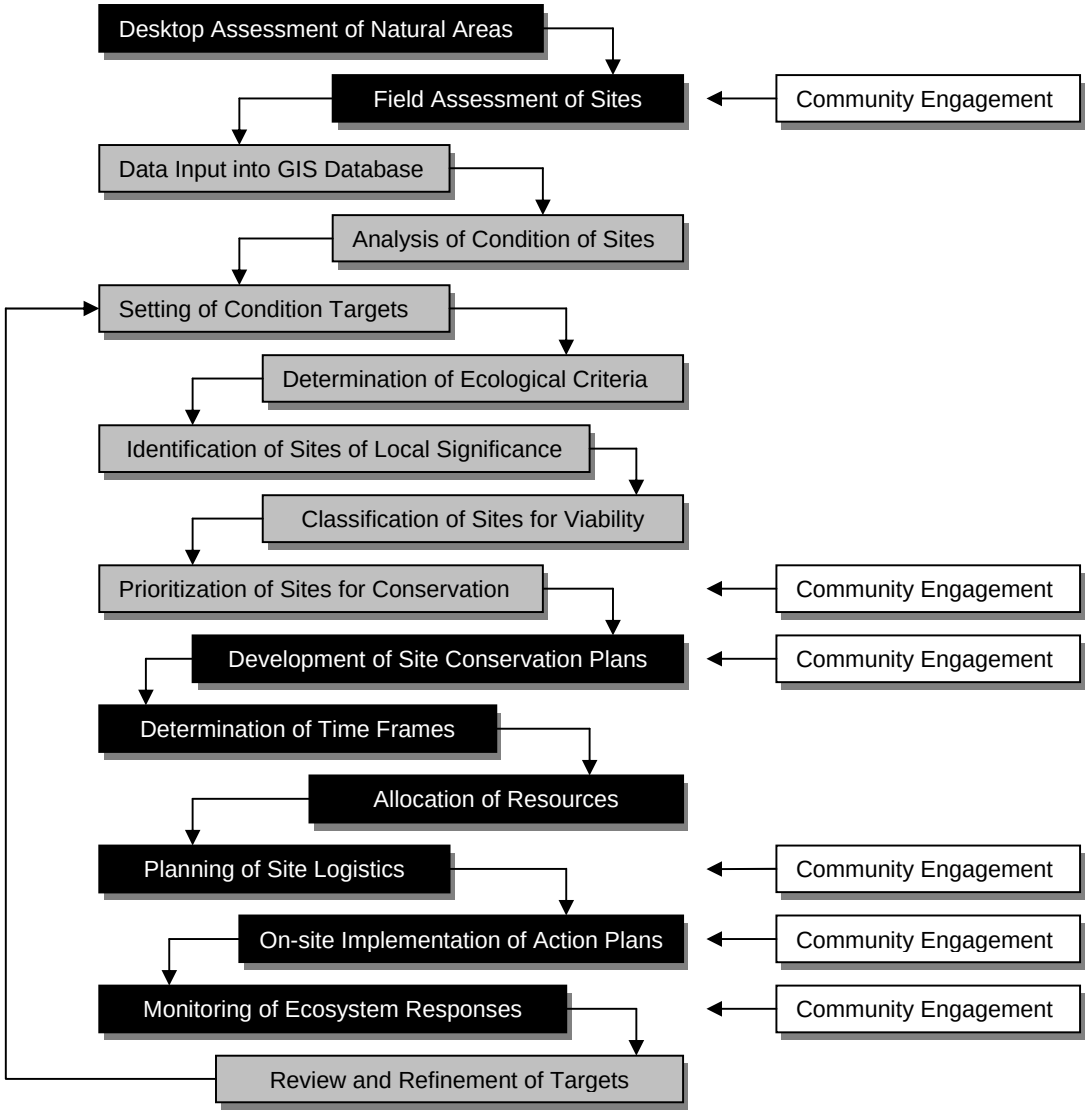

Fig 2 Process Plan – Natural Areas Condition Evaluation & Planning for Management

Recommendations:

7. That the City's adoption of standard assessment templates developed by the Perth Biodiversity Project of the Western Australian Local Government Association for assessment of the City's natural areas (Natural Area Initial Desktop and Field Assessments) be endorsed.

8. That the Natural Area Initial Desktop and Field Assessment templates be adopted as the basis for all future updates on the condition of the City's natural areas surveyed thus far and for the initial assessment of sites yet to be surveyed.

9. That Natural Area Condition targets based on ecological criteria as outlined under Section 6.5 of the Local Biodiversity Strategy be adopted as the future standard for the assessment of Local Natural Areas (LNAs) and to determine local significance and reclassification of such sites, where warranted, as Locally Significant Natural Areas (LSNAs).

10. That the City's Resourcing targets and Management Action targets for LNAs be based on further criteria for the estimation of Viability as outlined under Section 6.6 of the Local Biodiversity Strategy.

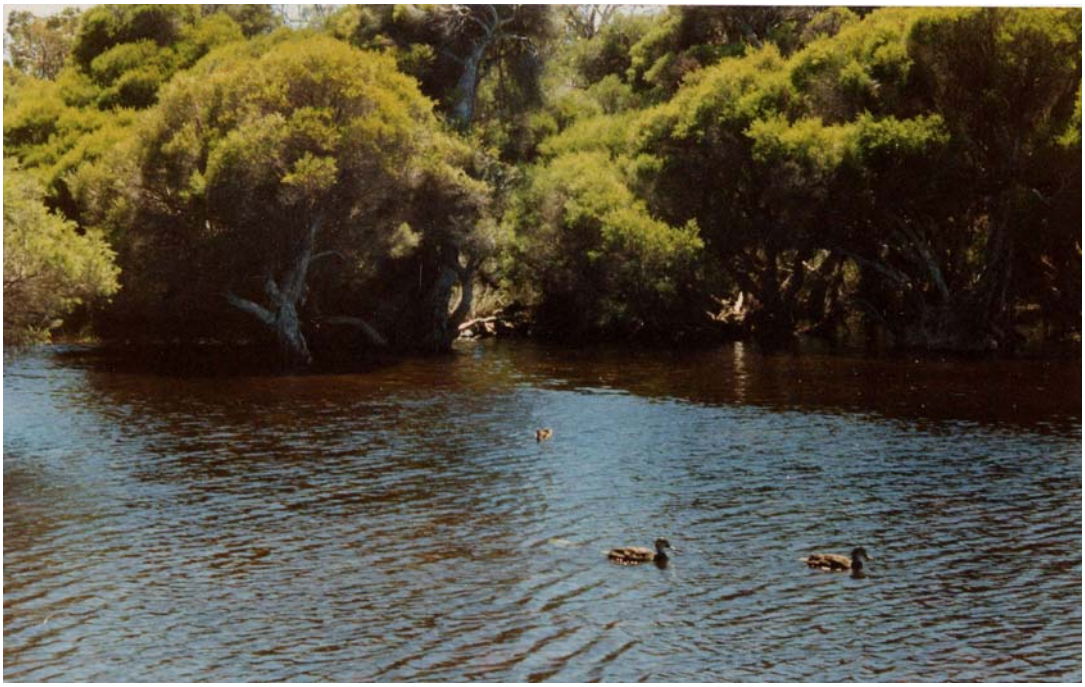

Plate 3 - Star Swamp and fringing Melaleuca rhaphiophylla: example of an ephemeral wetland of the Quindalup Vegetation Complex on Quindalup Dunes (photo by Daniel Rajah 1988)

7. ORGANISATION OF SURVEY DATA

7.1 Natural Area Sites Surveyed

Selected natural areas including all bushland reserves within the City of Stirling were assessed between January and March 2006 for Part A of the Natural Area Initial Field Assessment and during November 2006 for Part B of the same assessment. Plant specimens collected as part of these surveys were professionally handled and identified in accordance with procedures of the Western Australian Herbarium. Some native herbs and annual and geophytic weeds may not have been included in this assessment as it was undertaken in summer and autumn rather than in spring. Supplementary surveys for more comprehensive listing of plant species are therefore recommended.

Figures 8, 9 and 10 list all City managed natural area sites to indicate those that have been surveyed for biodiversity condition and those where this work is still pending. To date all bushland reserves have been assessed. Wetland reserves however have yet to be assessed mainly because there is no regionally recognised template currently available to enable the survey of biodiversity in wetlands and associated areas. The City understands that standard templates for wetland assessment are being prepared by the Department of Environment and Conservation. The City's wetlands will be assessed and relevant matrices in this strategy document updated as soon as the standard templates become available. With regard to coastal reserves, general assessments were conducted as part of a regional study of the coastal zone within the Metropolitan Region (initiated by Swan Catchment Council with funded from Greening Australia and completed in 2008) however site specific assessments using the standard NAIA templates are needed to get a clearer appreciation of biodiversity condition.

7.2 Data Collation under Individual Site Folios

A total of 68 bushland sites were assessed. Hardcopy folios have been created for each site to archive the completed Natural Area Initial Assessment (NAIA) templates (ie comprising Desktop Assessment, Forms A and B Field Assessments and Assessment Summary), location map, site map, grid overlay of site map with field recordings of biodiversity information and relevant site photographs of vegetation structure, evidence of threatening processes and disturbance factors. It is intended that this information be updated as biodiversity assessments are undertaken periodically.

7.3 Data Entry onto Computer Databases

7.3.1 Natural Area Initial Field Assessment Data

All field data from the NAIA assessments have now been entered into a computer database made available in 2008 by the Perth Biodiversity Project Unit of the Western Australian Local Government Association. Referred to as the Natural Areas Initial Assessment (NAIA) Database, it is Microsoft Access based and enables the electronic archival of the following components of the NAIA assessments:

- Natural Area Initial Desktop Assessment
- Natural Area Initial Field Assessment A (Vegetation Complexes and Ecological Condition

- Natural Area Initial Field Assessment B (Significant Species and Communities)
- Natural Area Initial Assessment Summary

The NAIA Database is now accessible via the City's network on O drive. A series of readily assessable templates with View and Edit functions permit data entry or amendments as needed. Apart from its archival function for periodic updates from subsequent field surveys, the NAIA Database has been designed to collate, analyze and interpret selected contents of the NAIA assessments thereby making it a valuable tool for the management of natural areas as well as for enquires related to property development of lands adjacent to or in the vicinity of natural areas.

7.3.2 Spatial and Attribute Data

A Geographical Information System based database was designed and developed to electronically record all field acquired data for the bushland, wetland and coastal dune sites. Referred to as the Natural Areas Geographical Information System (NAGIS) it represents the most efficient method currently available for storing, accessing and analyzing the vast amount of data collected through the biodiversity assessments of the City's natural areas. Additionally, it provides the means to incorporate future data collected through periodic re-surveys thereby ensuring that any on-going management modeling is based on updated biodiversity data.

NAGIS employs Intergraph Corporation's Geomedia 5.1 software as its operating medium. Geomedia 5.1 is currently used by the City to operate its web-based map viewer (or G-Map) which allows access to aerial photographs and to display property related cadastral attributes and statutory information.

Employing the Geomedia 5.1 functions, NAGIS has the capacity to store digitized spatial data (polygons) for each site assessed to show the location and orientation of all structural plant communities and respective vegetation condition. Linked to these polygons are relevant attribute data of all biophysical information observed during the site assessments (e.g. list of key species, presence of priority flora or fauna, weed invasion, threats and disturbances, perimeter fencing, access tracks and other management infrastructure). Under the Map Window format, NAGIS provides read/ write versions of reserve specific base maps upon which all spatial and attribute data may be entered. Depending on the types of spatial and attribute data available (e.g. structural plant communities or respective vegetation condition) these may be digitized as distinct layers and stored in separate 'warehouses'. Under the Layout Window format, NAGIS enables amendments to map layout such as caption text, scale bars, legends etc.

7.4 Data Retrieval for Management Purposes

In reference to the NAIA Database, a variety of enquiries are possible either as (1) single site searches for all attributes or (2) multiple site searches for selected attributes. The attributes that could be analyzed through these searches include Site Name and Identification Number, Vegetation Complex and Native Vegetation Unique Identification Number, Threatened Ecological Communities if present, Flora and Fauna most prevalent and any Weed Species present. Additionally, Criteria Rank and Viability Score are automatically assigned by the NAIA Database to each site however on condition that all data pertaining to the Assessment Summary pages of the NAIA template is completely entered. The NAIA Database is also able to generate a Prioritization List of all sites in

accordance with the Criteria Rank and Viability Score assigned to each site. Drop Lists enable the insertion of other attributes unique to a site that are not part of the standard attributes. Images and Map Views enable links to other data 'warehouses' for the inclusion of relevant data pertaining to a site or the production of site specific profiles.

In reference to NAGIS, all spatial and attribute data 'warehouses' are hyperlinked to access and display composite layers of information at the same instance. Site specific maps showing all spatial and attribute data could therefore be generated to show natural area condition at each reserve. By activation of the spatial data polygons thus generated, linked attribute data including coverage area (in hectares) of an ecological community or a particular weed species could be displayed. Hyperlinked attribute data 'warehouses' could also include other relevant information e.g. a photo library, species lists and regional biodiversity datasets (viz. PBP Mapping and Information Installment 2 of September 2003). All these features render NAGIS a valuable tool for the formulation of reserve specific management plans and conservation programmes for the development of management plans.

Apart from the generation of site specific maps for the display of layers of relevant spatial and attribute data, NAGIS also has a spatial analysis capacity to enable enquiry and retrieval of information on a Citywide basis. This is a particularly useful function for modeling future scenarios and trends e.g. the expected rate of spread of a particular weed in a particular reserve based on sequentially stored data from past survey or the rate of decline of bushland condition from one condition category to another or the rate of ecosystem recovery based on variously modeled management regimes.

7.5 Access to Regional Datasets

Electronic datasets provided by the Perth Biodiversity Project Unit of the Western Australian Local Government Association (Mapping and Information Installment 2) consists of a series of digital ortho-photos of the Perth Metropolitan Region at a scale of 1:20,000 which depict various attributes of native vegetation from a regional perspective. These datasets are GIS based and lend themselves for the City's administrative access in situations where Local Planning Policy has to be invoked for consideration of development proposals or for determining the status of natural areas for biodiversity conservation purposes. These datasets include the following:

- Native Vegetation Extent by Administrative Planning Category – spatial extent of Local Natural Areas under existing administrative, planning and protection categories;
- Native Vegetation Extent by Ownership Category – categorizes native vegetation extent according to ownership and management responsibility particularly with reference to Local Government;
- Native Vegetation Extent by Vegetation Complex – categorizes native vegetation extent according to vegetation complexes thereby indicating the likely ecological communities to be prevalent as determined by factors such s landform, soils and climate;
- Native Vegetation Extent by MRS Zoning – categorizes native vegetation extent according to MRS zoning in terms of urban or rural, regional or local thereby indicating the level of protection possible of biodiversity values present;

- Regional Ecological Linkages – indicating the location and alignment of 500 metre wide regional ecological linkages forming a network with Regionally Significant Reserves (viz. Bush Forever sites, Regional Parks);
- Potentially Locally Significant Natural Areas – identifies Local Natural Areas that potentially meet essential and/or desirable criteria to be considered locally significant;
- Potentially Significant Local Government Natural Areas – identifies Local Government Reserves containing natural areas that potentially meet essential and/or desirable criteria to be considered locally significant.

Recommendations:

11. That the status of City managed Natural Areas (bushland reserves) with respect to Vegetation Complexes and Vegetation Condition as per Table 7 be received.

12. That the matter of outstanding assessments of City managed Natural Areas (vegetated wetlands and coastal dunes) as per Tables 8 and 9 be the subject of funding allocation over subsequent budget programmes with the view to the Ecological Significance of these sites being determined

13. That the matter of outstanding assessments of Natural Areas managed by other authorities/ agencies or those privately held as per Table 10 becomes the subject of further negotiations with respective managers/ owners with the view to the Ecological Significance of these sites being determined.

Plate 4 - Carine Regional Open Space: an example of vegetated wetlands of the Herdsman Vegetation Complex over Spearwood Dunes (photo by Daniel Rajah 2009)

Table 7 Status of City Managed Natural Areas (Bushland Reserves)

Reserve Location	Size (ha)	NAIA Survey Complete	Ecological Significance	Vegetation Complex	Predominant Vegetation Condition
Aintree Eglington	1.8	Yes	LNA	Cottesloe Central & South	35%VG 15%G 25%D 25%CD
Allamanda Gardens	1.1	Yes	LNA	Karrakatta Central & South	60%VG 40%CD
Alvaston Ashover	1	Yes	LNA	Karrakatta Central & South	
Appleblossom Polyantha	1.1	Yes	LSNA	Karrakatta Central & South	35%VG 65%CD
Ardleigh Eccles	2.9	Yes	LNA	Karrakatta Central & South	25%G 75%CD
Arkana Walderton		Pending	LNA	Karrakatta Central & South	
Avocado Bangalay	1.8	Yes	LSNA	Bassendean Central & South	40%E 60%CD
Babakin Bolgart	0.8	Yes	LNA	Karrakatta Central & South	20%G 10%D 70%CD
Basalt Silver Topaz	1	Yes	LNA	Cottesloe Central & South	
Beach Alexander		Pending	LNA	Karrakatta Central & South	
Beach Marmion	3.3	Yes	LSNA	Cottesloe Central & South	50%VG 50%CD
Bellview Hellenic	2.2	Yes	LNA	Karrakatta Central & South	70%G 30%D
Bradford Glick	1	Yes	LNA	Karrakatta Central & South	100%D
Breckler Park	10.5	Yes	LSNA	Bassendean Central & South	
Carine ROS	5.6	Yes	Bushplan Site 203	Karrakatta Central & South Herdsman	90%G 10%D
Celebration Park	1.2	Yes	LNA	Karrakatta Central & South	
Charles Riley	1.8	Yes	LSNA	Cottesloe Central & South	70%D 30%CD
Chelleston Edlaston	0.9	Yes	LNA	Cottesloe Central & South	85%VG 15%CD
Coniston Beach	1.2	Yes	LNA	Karrakatta Central & South	20%VG 15%G 10%D 65%CD
Cloralberry Verbena	1.5	Yes	LNA	Karrakatta Central & South	20%G 80%CD
Corrington Circle	1	Yes	LNA	Karrakatta Central & South	25%D 75%CD
Cottonwood Crescent	9.5	Yes	Bushplan Site 43	Karrakatta Central & South	94%E 5%VG 1%D
Crowcombe Exford	1	Yes	LNA	Karrakatta Central & South	65%D 35%CD
Dianella ROS	7.5	Yes	Bushplan Site 280	Bassendean Central & South	20%VG 10%G 25%D 45%CD
Donnybrook Shadycroft	1.1	Yes	LNA	Karrakatta Central & South	80%E 20%G
Dryandra Pendula	1.8	Yes	LSNA	Karrakatta Central & South	10%VG 10%G 80%CD
Eastland Molloy	3.2	Yes	LSNA	Karrakatta Central & South	50%VG 50%CD
Emerald Marmion	1.1	Yes	LNA	Cottesloe Central & South	90%G 10% CD
Esperanto Harris Gibb	1	Yes	LNA	Karrakatta Central & South	55%VG 45%CD
Esperanto Martin	2.7	Yes	LSNA	Karrakatta Central & South	85%VG 15%D
Fletching Climping	1	Yes	LNA	Karrakatta Central & South	80%G 20%D
Florence Venice	1	Yes	LNA	Karrakatta Central & South	15%VG 85%D
Fragrant Gardens	0.9	Yes	LSNA	Karrakatta Central & South	25%E 75%CD
Hamer Eighth Walter	2.4	Yes	LSNA	Bassendean Central & South	32%VG 55%G 8%D 5%CD

Hartley Way	0.7	Yes	LNA	Karrakatta Central & South	10%VG 90%D
Herb Elliot	1	Yes	LSNA	Cottesloe Central & South	2%G 10%D 88%CD
Heritage Park	2.4	Yes	LSNA	Karrakatta Central & South	95%G 5%D
Honeywell Oakleaf	1.2	Yes	LSNA	Karrakatta Central & South	60%VG 5%G 15%D 20%CD
Jackson Duke Wheeler	8.5	Yes	LSNA	Cottesloe Central & South	5%VG 60%G 5%D 30%CD
Jeans Prisk	1.5	Yes	LNA	Cottesloe Central & South	20%VG 35%G 45%CD
Kitchener Hammersley	1.2	Yes	LNA	Quindalup	95%VG 5%CD
Lake Gwelup ROS	22.7	Yes	Bushplan Site 212	Karrakatta Central & South Cottesloe Central & South	
Laurie Strutt	1.4	Yes	LNA	Quindalup	40%VG 20%G 40%CD
Lucca Tuscany	0.7	Yes	LNA	Cottesloe Central & South	14%D 86%CD
Meadowbrook Montclaire		No	LNA	Karrakatta Central & South	50%G 40%D 10%CD
Memory Place	9.3	Yes	LSNA	Cottesloe Central & South	80%D 20%CD
Mt Lawley Golf North		Pending	LNA	Bassendean Central & South	
Newborough Rainer	0.8	Yes	LNA	Cottesloe Central & South	50%G 20%D 30%CD
Pagoda Gardens	0.7	Yes	LNA	Karrakatta Central & South	35%VG 65%CD
Peet Fyfe	0.7	Yes	LNA	Quindalup	20% 80%CD
Prevelly Elleker	0.8	Yes	LSNA	Karrakatta Central & South	
Prevelly Sattleberg	0.8	Yes	LSNA	Karrakatta Central & South	35%E 40%VG 5%G 20%CD
Princess Wallington	3.6	Yes	LSNA	Karrakatta Central & South	85%VG 5%G 5%D 5%CD
Rannoch Tay Earn	2.3	Yes	LSNA	Karrakatta Central & South	20%VG 45%G 35%CD
Redunca Coronata	1.5	Yes	LNA	Karrakatta Central & South	5%E 35%VG 5%G 55%CD
Richard Guelfi	4.4	Yes	LSNA	Karrakatta Central & South	10%VG 15%G 5%D 70%CD
Sandover Reserve	6.5	Yes	LSNA	Cottesloe Central & South	33%G 17%D 50%CD
Silica Almadine	1	Yes	LNA	Cottesloe Central & South	25% G 20%D 55%CD
Star Swamp	93	Yes	Bushplan Site 204	Cottesloe Central & South Quindalup	30%E 40%VG 25%G 5%D
Trigg ROS	112	Yes	Bushplan Site 308	Cottesloe Central & South Quindalup	30%E 40%VG 20%G 9%D 1%CD
Trusley Tone	0.8	Yes	LNA	Cottesloe Central & South	10%D 90%CD
Vickers Wanneroo	0.8	Yes	LNA	Karrakatta Central & South	20%D 80%CD
Wanneroo Beach	1	Yes	LNA	Karrakatta Central & South	2%G 33%D 65%CD
Wanneroo Blissett Cope	1.2	Yes	LSNA	Karrakatta Central & South	60%G 40%CD
Wanneroo Derrington	2.1	Yes	LSNA	Karrakatta Central & South	20%VG 15%G 5%D 60%CD
Willeton Kestrel	1	Yes	LNA	Cottesloe Central & South	100%G
Wythburn Redcliff	3.6	Yes	LSNA	Karrakatta Central & South	100%E
Yokine West	2.7	Yes	LNA	Karrakatta Central & South	

Legend to Vegetation Condition Scale

P Pristine
E Excellent
VG Very Good
G Good
D Degraded
CD Completely Degraded

Table 8 Status of City Managed Natural Areas (Wetland Reserves)

Reserve Location	Size (ha)	NAIA Survey Complete	Ecological Significance	Vegetation Complex	Vegetation Condition
Abbett Park					To be determined
Antonio Scarfo		N/A			To be determined
Babkin Bolgart		N/A			To be determined
Beach Marmion					To be determined
Brushfield Way					To be determined
Butlers Reserve					To be determined
Caley Street					To be determined
Careniup Balcatta		Pending	EPP Wetland		To be determined
Careniup Exmouth		Pending	EPP Wetland		To be determined
Careniup Sarus		Pending	EPP Wetland		To be determined
Careniup Willowbank		Pending	EPP Wetland		To be determined
Careniup Grassbird		Pending	EPP Wetland		To be determined
Carine ROS		Pending	EPP Wetland		To be determined
Cedric Grebe		Pending			To be determined
Colin Ventnor		N/A			To be determined
Deanmore Square					To be determined
Dianella ROS		Pending			To be determined
Dog Swamp		Pending	EPP Wetland		To be determined
Glendalough Res		Pending			To be determined
Hamer Valley					To be determined
Jackadder Lake		Pending	EPP Wetland		To be determined
Lake Gwelup		Pending	EPP Wetland	Herdsman	To be determined
Lake Karrinyup		Pending			To be determined
Lilac Shannon					To be determined
Maurie Hamer Park			EPP Wetland		To be determined
Normanby Dundas					To be determined
Porter Street					To be determined
Princeton Estate		Pending			To be determined
Roslea Estate		Pending			To be determined
Ron Stone Park		Pending			To be determined
Spoonbill Shearwater		Pending	LSNA		To be determined
Star Swamp		Pending	EPP Wetland		To be determined
Stirling Civic Gardens					To be determined
Talia Drive		Pending			To be determined
Waverley Pola					To be determined
Wrigley Seabrook					To be determined
Yokine West Res					To be determined

Table 9 Status of City Managed Natural Areas (Coastal Reserves)

Reserve Location	Size (ha)	NAIA Survey Complete	Ecological Significance	Vegetation Complex	Vegetation Condition
Peasholm St Dog Beach (Peasholm St to Brighton Bch carpark)		Pending	To be determined	Quindalup	To be determined
Brighton Beach (Brighton Bch carpark to Scarb SLSC)		Pending	To be determined	Quindalup	To be determined
Scarborough Beach (Scarb SLSC to Reserve St carpark)		Pending	To be determined	Quindalup	To be determined
South Trigg Beach (Reserve St carpark to Groper's Kiosk)		Yes	Bushplan Site 308	Quindalup	To be determined
Trigg Beach (Groper's Kiosk to Clarko Reserve)		Yes	To be determined	Quindalup	To be determined
Bennion Beach (Kathleen St to Bailey St)		Pending	To be determined	Quindalup	To be determined
Mettams Pool (Bailey St to Scholl Ave)		Pending	To be determined	Quindalup	To be determined
Hammersley Pool (Scholl Ave to North Bch Rd)		Pending	To be determined	Quindalup	To be determined
North Beach (North Bch Rd to Lawley St)		Pending	To be determined	Quindalup	To be determined
South of Marine Labs (Lawley St to Margaret St)		Pending	To be determined	Quindalup	To be determined
Watermans Bay (Margaret St to Beach Rd)		Pending	To be determined	Quindalup	To be determined

Legend to Vegetation Condition Scale

P Pristine
E Excellent
VG Very Good
G Good
D Degraded
CD Completely Degraded

Table 10 Status of Natural Areas Managed by Other Authorities/ Agencies or Privately Held

Reserve Location	Size (ha)	NAIA Survey Complete	Ecological Significance	Vegetation Complex	Predominant Vegetation Condition
Herdsman Lake Regional Park	68	Pending	Bushplan Site 281 EPP Wetland	Herdsman	To be determined
Reid Hwy/ Northwood Dve Bushland, Mirrabooka	130.9	Pending	Bushplan Site 385	Karrakatta Central & South Bassendean Central & South	To be determined
Karrinyup Country Club Golf Course	47.1	Pending	To be determined	Cottesloe Central & South	To be determined
Hamersley Golf Course	20.9	Pending	To be determined	Karrakatta Central & South	To be determined
Mt Lawley Golf Course	41.8	Pending	To be determined	Karrakatta Central & South	To be determined
Yokine Golf Course	15.9	Pending	To be determined	Karrakatta Central & South	To be determined
Channel 9 Bushland Dianella	13.3	Pending	LSNA	Karrakatta Central & South	To be determined
ABC Radio Tower (Wanneroo Rd/ Blissett Way	37.8	Pending	To be determined	Karrakatta Central & South	To be determined

Legend to Vegetation Condition Scale

P Pristine
E Excellent
VG Very Good
G Good
D Degraded
CD Completely Degraded

8. INTERPRETATION OF SURVEY DATA

8.1 Regional and Local Perspective

Taking into account both City managed natural areas and those under other authorities/ agencies or privately held there are a total of eight (8) Regionally significant natural areas. Of the remaining sites assessed twenty one (21) are locally significant based on assessment against a number of ecological criteria and may be classed as Locally Significant Natural Areas (LSNAs). All remaining sites (refer Figure 9) may be classed as Local Natural Areas (LNAs). Although most the LNAs are small (ie greater that 1 ha but less than 4 ha) the 'Vegetation Condition' of several bushland sites have been categorized as 'Good' or better under the Keighery (1994) Vegetation Condition scale.

LSNAs may be further prioritized for management purposes in terms of viability based on a various site attributes as previously described under Section 6.6. Although viability estimates have yet to complete for these sites it is recommended that these be retained, protected and afforded the necessary conservation measures in recognition of their potential for ecological linking with the 'Regionally' significant sites.

8.2 Vegetation Complex Level

The system Vegetation Complexes classify the patterning of vegetation at a regional level based on the determining factors, such as, landform, soil and climate. The major underlying Landform Elements governing the extent and dispersion of these Vegetation Complexes within the City of Stirling are principally the Bassendean Dune and Spearwood Dune systems as well as the chain of wetlands that marks the swale depression between these two dune systems. Table 11 shows the five (5) Vegetation Complexes that occur within the City of Stirling and their current extent compared to their pre-European extent. The pre-European and current extent in terms of total hectares indicates the extent of each Vegetation Complex within the City's administrative boundary or Local Government area. The pre-European % indicates the extent of each Vegetation Complex as a percentage of the same Local Government area. The Remaining Extent % (as of 2001) indicates areas remaining as a percentage of the pre-European extent of each Vegetation Complex.

With the exception of the Quindalup Complex, and possibly the Cottesloe Complex Central and South, there has been a marked decrease in the extent of Vegetation Complexes that did exist within the City of Stirling to levels below 'Essential' or even 'Desirable' representational targets. Regarding the Quindalup Complex, the Remaining Extent % figures reflect the losses that have occurred in other parts of the Perth Metropolitan Region thereby rendering all remaining areas of this Vegetation Complex within the City even more critical in terms of their retention and protection.

The system of Vegetation Complexes appears to be the most appropriate mechanism for describing and interpreting ecological communities and for establishing representational targets based on the extent of current areas. Representational targets, in this case, refer to increments to critically under-represented Vegetation Complexes within the City proposed for achievement over specified time periods. This system of Vegetation Complexes has been employed in the assessment of natural area sites within the City

and is shown in Tables 7, 8, 9 and 10. The System of Vegetation Complexes is also relevant in the preparation of site specific Threat Abatement Plans (refer Section 9).

Table 11 Existing Vegetation Complexes within the City of Stirling and their Extent in Regional and Locally Significant Reserves

Vegetation Complex	Structural Description	Pre-European Extent		Remaining Extent	
		Total (ha)	%	Total (ha)	%
Bassendean Complex - Central & South	Vegetation ranges from woodland of Eucalyptus marginata/ Allocasuarina fraseriana. Banksia spp. And sedgelands on the moister sites. This area includes the transition of Eucalyptus marginata and Eucalyptus toditiana in the vicinity of Perth.	1268	12	38	3
Cottesloe Complex - Central & South	Mosaic of woodland of Eucalyptus gomphocephala and open forest of E. gomphocephala/ Eucalyptus marginata/ Corymbia calophylla; closed heath on limestone outcrops.	1894	18	292	15
Herdsman Complex	Sedgelands and fringing woodland of Eucalyptus rudis and Melaleuca spp.	1486	14	179	12
Karrakatta Complex - Central & South	Predominantly open forest of Eucalyptus gomphocephala/ Eucalyptus marginata/ Corymbia calophylla and woodland of Eucalyptus marginata and Banksia spp.	5463	52	423	8
Quindalup Complex	Coastal dune complex consisting of mainly two alliances viz. (1) the strand and fore dune alliance and (2) the mobile and stable dune alliance. Local variations include the low closed forest of Melaleuca lanceolata/ Callitris preissii and the closed scrub of Acacia rostellifera.	407	4	74	18

Adapted after WALGA (2004)

8.3 Floristic Community Level

Floristic Community level assessment has thus far been confined to bushland sites. A total 65 reserves were assessed on site. Structural vegetation communities were largely confirmed as defined in earlier mapping (Heddle et al 1980) for the System 6 Report. Vegetation condition was found to be widely ranging from Excellent to Degraded in accordance with the Keighery (1994) Vegetation Condition scale. None of the reserves contained currently listed Threatened Ecological Communities (TECs). Nevertheless, in view of the fact that most of the Vegetation Complexes within the City are under

represented, all remnant native vegetation is to be retained and recognised as having biological values that contribute significantly to promoting biodiversity in this part of the Metropolitan Region. Bushland reserves of Regional significance listed under the Bush Forever programme were observed to be, by virtue of their size, generally to be better conserved in terms of Vegetation Condition. Several smaller reserves (ie greater than 10 hectares but less than 20 hectares and also greater than 4 hectares but less than 10 hectares00000000) also showed relatively high diversity and were found to be in a Good or better condition under the Keighery (1994) Vegetation Condition scale.

8.4 Individual Species Level

As expected the larger reserves (ie greater than 20 ha) expressed greater species diversity than those smaller in size although, surprisingly, a number of smaller reserves displayed relatively high diversity.

At the individual species level, 18 Priority Flora species (Including two Priority 1 and five Priority 2) were located during the field assessments of bushland reserves (refer Table 12). Two (2) Declared Rare Flora pursuant to Subsection 2 of Section 23F of the Wildlife Conservation Act (1950) and listed by the Department of Environment and Conservation Act (DEC 2007a) were located during the assessments (refer Table 12). A further two (2) species have yet to be confirmed as Declared Rare Flora.

Regarding fauna, 46 species of native fauna including 41 bird, three reptile, one amphibian and one mammal species were located. Two (2) Specially Protected Fauna as listed under Schedule 1 of the State's Wildlife Conservation Act (1950) were discovered (refer Table 13). Also as listed under the Wildlife Conservation Act (1950), two (2) Endangered Fauna, one (1) Threatened Fauna and two (2) Vulnerable Fauna were observed (refer Table 13). These include the Carnaby's Black Cockatoo (*Calytorhynchus latirostris*) listed as Endangered under the Commonwealth's Environmental Protection and Biodiversity Conservation Act (1999) and the Baudin's Black Cockatoo (*Calyptorhynchus baudinii*) listed as Threatened under the same legislation. Of particular note is the Graceful Sun Moth (*Synemon gratiosa*) protected by both Federal and State legislation – listed as Endangered under the Commonwealth's Environmental Protection and Biodiversity Conservation Act (1999) and as a threatened species under the Wildlife Conservation Act (1950). Additionally, the Rainbow Bee Eater (*Merops ornatus*) listed as an important migratory bird under the Environmental Protection and Biodiversity Conservation Act (1999), was observed in twelve separate reserves (refer Table 13).

A number of species of Pest Fauna were also observed in some reserves. These species include *Trichoglossus haematodus* (rainbow lorikeet), *Columbia livia* (domestic pigeon), *Streptopelia senegalensis* (laughing turtle dove), *Dacelo novaeguineae* (kookaburra), *Vulpes vulpes* (fox), *Oryctolagus cuniculus* (rabbit) and European honey bee.

The surveys further discovered three Declared Weed taxa, as defined by the Agriculture and Related Resources Protection Act (1976), at eight separate reserves. These were *Asparagus asparagoides* (Bridal Creeper), *Moraea flaccida* and *Zantedeschia aethiopica* (Arum Lily).

Table 12 Presence of Declared Rare Flora and/ or Priority Flora

Species	Conservation Status	Site Location
Hibbertia glomerata subsp. gingensis	Priority 1	• Dianella Regional Open Space #
Eremaea asterocarpa subsp. brachyclada	Priority 1	• Dianella Regional Open Space #
Eremaea acutifolia (Rusty Eremaea)	Priority 2	• Dianella Regional Open Space • Appleblossom Polyantha
Acacia benthamii (?)	Priority 2	• Princess Wallington Reserve • Star Swamp Reserve • Dianella Regional Open Space
Amocrinum gracillium (Lily)	Priority 2	• Appleblossom Polyantha • Richard Guelfi Reserve
Calectasia browneana (Blue-tinsel Lily)	Priority 2	• Dianella Regional Open Space #
Stylidium pseudocaespitosum	Priority 2	• Dianella Regional Open Space
Synaphea aephynsa	Priority 3	• Dianella Regional Open Space #
Tetratheca parvifoia	Priority 3	• Dianella Regional Open Space
Tetratheca pilifera	Priority 3	• Dianella Regional Open Space
Calothamnus rupestris	Priority 4	• Esperanto Martin Reserve
Jacksonia sericea	Priority 4	• Appleblossom Polyantha • Princess Wallington Res • Dryandra Pendula Reserve • Fragrant Gardens Reserve • Heritage Park • Honeywell Oakleaf Reserve • Rannoch Tay Earn Reserve • Sandover Reserve • Richard Guelfi Reserve • Star Swamp Reserve • Trigg Bushland Reserve • Wanneroo Blissett Cope Res • Dianella Regional Open Space
Grevillea thelemanniana subsp. preissii	Priority 4	• North Beach Coastal Reserve
Grevillea thelemanniana subsp. preissii	Priority 4	• Watermans Bay Coastal Reserve
Anigozanthus humilis subsp. chrysanthus (Golden Cats Paw)	Priority 4	• Dianella Regional Open Space
Caladenia longicauda subsp. civicola	Priority 4	• Dianella Regional Open Space
Stylidum striatum (Fan-leaved Trigger Plant)	Priority 4	• Dianella Regional Open Space #
Stylidium inversiflorum	Priority 4	• Dianella Regional Open Space

Caladenia hugellii (Grand Spider Orchid)	Declared Rare	• Dianella Regional Open Space
Banksia oligantha (Holly-leaved Banksia)	Declared Rare	• Dianella Regional Open Space • Richard Guelfi Reserve
Calectasia cyanea (Blue-tinsel Lily)	Declared Rare	• Dianella Regional Open Space # • Cottonwood Cres Bushland Res
Calytrix breviseta subsp. breviseta	Declared Rare	• Dianella Regional Open Space

Adapted after Mattiske & Procter (2007) Note: # Location to be confirmed

Plate 5 – Walter Hamer Eighth Ave Bushland typifying the flora diversity on many smaller bushland reserves (photo by Christine Richardson 2009)

Table 13 Presence of Declared Rare Fauna and/ or Priority Fauna

Species	Conservation Code	Site Location
Botaurus poiciloptilus (Australian Bittern)	Specially Protected (as per Schedule 1 of WC Act: fauna that is rare or is likely to become extinct)	• Herdsman Lake Regional Park
Falco peregrinus (Peregrine Falcon)	Specially Protected (as per Schedule 1 of WC Act: fauna that is rare or is likely to become extinct)	• Herdsman Lake Regional Park
Calyptorhynchus latirostris (Carnaby's Black Cockatoo)	Endangered (as per EPBC Act)	• Star Swamp Bushland Res • Cottonwood Cres Bushland Res • Dianella Regional Open Space • Richard Guelfi Reserve • Herb Elliot Reserve
Synemon gratiosa (Graceful Sun Moth)	Endangered (as per EPBC Act) Threatened Species (as per WC Act)	• Cottonwood Cres Bushland Res • Richard Guelfi Reserve • Herb Elliot Reserve
Leioproctus douglasiellus (Native Bee)	Endangered (as per EPBC Act)	• Breckler Park Bushland • Richard Guelfi Reserve
Calyptorhynchus baudinii (Baudin's Black Cockatoo)	Threatened (as per EPBC Act)	• Breckler Park Bushland • Cottonwood Cres Bushland Res
Rostratula benghalensis australis (Australian Painted Snipe)	Vulnerable (as per EPBC Act)	• Herdsman Lake Regional park
Merops ornatus (Rainbow Bee Eater)	Migratory Species (as per EPBC Act)	• Star Swamp Reserve • Dianella Regional Open Space • Cottonwood Crescent • Eastland Molloy Reserve • Lake Gwelup Reserve • Spoonbill Shearwater Reserve • Appleblossom Polyantha • Carine Regional Open Space • Careniup Swamp Wetlands • Trigg Bushland Reserve

Adapted after Mattiske & Procter (2007)

Note: Commonwealth's Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)
State's Wildlife Conservation Act 1950 (WC Act)

8.5 Determination of Ecological Significance

Standard ecological criteria were applied to determine which of the natural area sites met ecological significance. Criteria consisted of Representation of Ecological Communities, Diversity, Rarity, Maintaining Ecological Processes (including ecological links) and Significance as Wetland Buffers. Any Local Natural Area meeting one or more of the above criteria were classified as Locally Significant Natural Areas. All criteria were nevertheless employed in this assessmement.

The application of criteria pertaining to Representation of Ecological Communities will have relevance to the determination of Representational Targets in terms of (1) the various Vegetation Complexes represented or under represented and (2) over the City's land use zonings (Refer Section 10).

The application of criteria pertaining to Rarity revealed the presence of Threatened Ecological Communities in terms of Specially Protected Fauna and Priority Flora at a number of sites. Table 7 reflects all bushland sites assessed in this regard. Assessment of wetland and a number of coastal dune sites are still pending and these will be updated as information becomes available.

8.6 Determination of Viability

As discussed previously under Section 6.6, viability is defined as the capacity for long-term survival of a particular ecosystem or in other terms, its potential sustainability. Criteria governing viability include Size, Shape, Perimeter to Area Ratio, Vegetation Condition and Connectivity. These criteria have been applied to all natural area sites and viability scores are currently in the process of being developed based on guidelines under the Assessment Summary of the Natural Areas Initial Assessment template (refer Appendix IV).

The application of criteria pertaining to Size will be particularly significant as it is expected to determine the viability of several LNAs that have areas less that one hectare and areas more that one but less than four hectares (refer Figure 7). Figures 10, 11 and 12 will be updated as the viability scores for all sites become available.

8.7 Locally Typical Flora and Fauna

A listing of locally typical flora and fauna will be developed from data already gathered through the Natural Area Initial Assessment process for each of the Vegetation Complexes represented in the City as a guide for the conservation of individual sites.

8.7.1 Quindalup Complex
8.7.2 Cottesloe Complex – Central and South
8.7.3 Herdsman Complex
8.7.4 Karrakatta Complex – Central and South
8.7.5 Bassendean Complex – Central and South

Recommendations:

14. That the findings of field surveys on biodiversity condition be received with respect to the following as per Sections 8.1 and 8.2:
    - The regional and local significance of several of the City's natural areas (eight regionally significant and 25 locally significant identified);
    - The number of Vegetation Complexes present (five identified) and their extent (all greatly under-represented in comparison to their pre-European extent).

15. That in reference biodiversity condition, the site assessments at the Floristic Community level be received with respect to the following as per Sections 8.3 and 8.4:
    - No Threatened Ecological Communities (TECs) being discovered on bushland reserves surveyed;
    - Two (2) Declared Rare Flora (DRFs) being discovered at two separate reserves;
    - 18 Priority Species of flora (Priority 1, 2, 3 & 4) discovered at 15 separate reserves;
    - The discovery of one Specially Protected fauna, one Endangered fauna and one Vulnerable fauna.

16. That further to Recommendation 14, a listing of typical flora and fauna be formulated for each of the five Vegetation Complexes discovered.

17. That considering all Vegetation Complexes discovered within the City are under represented relative to their pre-European extent, the protection and retention of all other Local Natural Areas (LNAs) is advocated in recognition of their values towards ecological linking and promotion of biodiversity in this part or the Region.

Part C:
Strategy Development

PART C:
STRATEGY DEVELOPMENT

9. IMPLICATIONS FOR BIODIVERSITY MANAGEMENT

9.1 Selection of Areas to Conserve

9.1.1 Classification of Significant Sites and Assignment of Conservation Priorities

As previously discussed, the City's natural areas may be broadly classified into Regionally Significant Natural Areas, Locally Significant Natural Areas (LSNAs) and Local Natural Areas (LNAs). Regionally Significant Natural Areas include Bush Forever sites as well as other sites that are large (greater than 20 ha), viable and in a 'Good' or better condition under the Keighery (1994) Vegetation Condition Scale and of an ecological community with over 10% (Essential criteria) or 30% (Desirable criteria) of its pre-European extent remaining in the IBRA (Interim Biogeographical Regionalization of Australia) sub-region. Locally Significant Natural Areas are Local Natural Areas that have been professionally assessed on site and have met one or more 'Essential' and 'Desirable' criteria consistent with existing legislation and policies (refer Table 5). All other natural areas are designated Local Natural Areas.

Whist it is the City's policy to conserve all natural areas, a degree of prioritization must be attached to those sites assured of survival because of their sustainable condition. Apart from Regionally Significant Natural Areas, priority must be attached to all sites deemed as LSNAs in terms of future conservation effort. For the purpose of protection and resource allocation towards the conservation of LSNAs, these sites may be further grouped under priority classes based on ecological criteria (as per Table 5) and estimations for viability (as per Appendix IV of the Natural Area Initial Summary Template). The principal priority classes may be defined as follows:

- Priority 1 – high value LSNAs because they meet Regional representation criteria viz. those pertaining to viability, rarity of species and ecological linking;
- Priority 2 – LSNAs that fulfill Local Representation criteria that are Essential and Desirable and are important for the protection of biodiversity resources as a whole; and
- Priority 3 – LSNAs that meet only Desirable criteria but still important for the protection of biodiversity resources as a whole.

9.1.2 Prioritization – Threatened Species and Ecological Communities

In interpreting the data from the Natural Area Initial Assessment at the individual species level, Tables 12 and 13 list a number of LNAs which, by virtue of the discovery of Priority Flora and Fauna, have been upgraded to LSNAs. For instance, 18 Priority flora species (including two Priority 1 and five Priority 5 species) were located during the field assessments of bushland reserves. In terms of fauna, two (2) Specially Protected Fauna, two (2) Endangered Fauna, one (1) Threatened Fauna and two (2) Vulnerable Fauna were discovered. Table 14 takes into account the presence of Threatened Species and Ecological Communities in the classification of LSNAs.

9.1.3 Prioritization – Other Ecological Criteria

Apart from the presence of Threatened Ecological Communities, Declared Rare Flora and Priority Species, Table 14 also considers other ecological criteria in the classification of LSNAs such as sites that provide connectivity within Regionally significant ecological linkages, those with environmentally significant wetland and other wetland features present (viz. buffer vegetation, fringing vegetation, riparian vegetation, floodplain) and those that contain coastal vegetation on fore dunes and secondary dunes.

Table 14 Prioritization of Locally Significant Natural Areas

Reserve Location	Size (ha)	Priority Class	Viability Score
Appleblossom Polyantha	1.1	Priority 1A	To be determined
Avocado Bangalay	1.8	Priority 1A	To be determined
Beach Marmion	3.3	Priority 1A	To be determined
Breckler Park	10.5	Priority 1A	To be determined
Charles Riley	1.8	Priority 1A	To be determined
Dryandra Pendula	1.8	Priority 1A	To be determined
Eastland Molloy	3.2	Priority 1A	To be determined
Esperanto Martin	1	Priority 1A	To be determined
Fragrant Gardens	0.9	Priority 1A	To be determined
Hamer Eighth Walter	2.4	Priority 1A	To be determined
Herb Elliot	1	Priority 1A	To be determined
Heritage Park	2.4	Priority 1A	To be determined
Honeywell Oakleaf	1.2	Priority 1A	To be determined
Jackson Duke Wheeler	8.5	Priority 2	To be determined
Memory Place	9.3	Priority 2	To be determined
Prevelly Elleker	0.8	Priority 2	To be determined
Prevelly Sattleberg	0.8	Priority 2	To be determined
Princess Wallington	3.6	Priority 1A	To be determined
Rannoch Tay Earn	2.3	Priority 1A	To be determined
Richard Guelfi	4.4	Priority 1A	To be determined
Sandover Reserve	6.5	Priority 1A	To be determined
Wanneroo Blissett Cope	1.2	Priority 1A	To be determined
Wanneroo Derrington	2.1	Priority 2	To be determined
Wythburn Redcliff	3.6	Priority 2	To be determined
Spoonbill Shearwater		Priority 1A	To be determined

9.2 Formulation of Representational Targets

9.2.1 Applicable to areas under Vegetation Complexes

Representational Targets refer to areas to be protected under each of the six Vegetation Complexes occurring within the City. Establishment of these targets take into consideration two critical factors: (1) what has been mapped as remaining of the pre-European extent of each Vegetation Complex naturally occurring within the City of Stirling under protected status viz. Bush Forever, DEC Estate or Regional Parks and (2) the extent subsequently identified through the NAIA process for each Vegetation Complex in Local Natural Areas of the City. The combined totals for each Vegetation Complex have then been matched against guidelines supplied by the Perth Biodiversity Project Unit of WALGA to determine whether Essential and Desirable criteria have been met. Essential criteria stipulates that at least 10% of the pre-European extent should exist whilst Desirable criteria requires at least 30% of the pre-European extent.

Table 19 and Fig 3 indicate that of the five Vegetation Complexes discovered within the City, all are well below the 30% Desirable criteria and only two of the Vegetation Complexes, the Quindalup and the Cottesloe Central and South are significantly above the 10% Essential criteria. The Herdsman Complex could be considered to be only marginally above the 10% threshold. These figures strongly imply the retention and protection of not only those Vegetation Complexes that are under represented by all accounts viz. the Bassendean Complex Central and South and the Karrakatta Complex Central and South but also all other Vegetation Complexes so that there is no further reduction to their current extent within the City.

9.2.2 Applicable to areas under the City's Land Zonings

The matter of Representational Targets may similarly be applied to each of the City's land zonings (i.e. Local Planning Scheme Zonings) under the Metropolitan Region Scheme to ensure the following:

- Equitable dispersion of biodiversity areas in both public and private lands and between Local Government reserves and lands under other authorities/ agencies;
- Mandatory protection of all planning categories particularly of Bush Forever sites in Metropolitan Region Scheme Reserves and Local Authority Reservations; and
- Adequate level of protection of Locally Significant Natural Areas (LSNAs) in Local Authority Reservations.

Land zonings currently gazetted in the City of Stirling include Residential, Commercial, Industrial, Other Zones, Local Authority Reservations, Metropolitan Region Scheme Reserves and Public Use Reserves. Most of the natural areas within the City of Stirling occur within Local Authority Reservations and Metropolitan Region Scheme Reserves (sub-zone Parks and Recreation). However, as identified in Green Plan 2, significant areas of bushland do occur within Other Zones (sub-zones Special Use and Private Institutions), Metropolitan Region Scheme Reserves (sub-zone High Schools) and Public Use Reserves (sub-zone Primary Schools). The extent of this occurrence has yet to be fully determined, nevertheless, it is recommended that these areas be similarly surveyed under the NAIA process before realistic representational targets under land zonings are imposed. Preliminary representation is provided under Table 15. Pending the complete determination of the extent of natural areas under all Local Planning Scheme Zones, various Decision Support Tools may be employed (WALGA 2007) by the City to explore different protection and retention options/ scenarios for each Vegetation Complex.

9.3 Determination of Condition Targets

Reference is made to Table 3 (Comparative Analysis of Vegetation Condition Scales) that prescribe the criteria for vegetation condition assessment and Tables 7, 8, 9 & 10 (Status of City's Natural Areas) that outline the current condition of predominant vegetation in sites assessed - these form the basis for the establishment of Natural Area Condition Targets for each of the following Vegetation Complexes discovered in the City:

- Quindalup Complex
- Cottesloe Complex – Central & South
- Herdsman Complex

- Karrakatta Complex – Central & South
- Bassendean Complex – Central & South

However it would be impractical to attempt the establishment of general targets for each Vegetation Complex without reference to specific sites and their condition. Ultimately it would have to be the sum collection of the condition targets for all sites representative under each Vegetation Complex that would determine the true status of vegetation types represented in the City. Whilst the general vegetation condition target for all sites is for a 'Good' of better grading under the Keighery (1994) Vegetation Condition Scale, the goal for each site would be to improve its current condition by one increment upwards on the Vegetation Condition Scale over the ten (10) year life of this strategy.

9.4 Conservation Plans for Local Natural Areas

As previously defined (Section 3.5) the term conservation embraces several elements including retention, protection, restoration and ongoing management. It must be recognised that this Local Biodiversity Strategy and other supporting strategies e.g. Green Plan 2 provide mainly the overarching structure and terms of reference for more reserve specific conservation plans. Clearly, reserve specific conservation plans are meant to deal more comprehensively with on-site issues and to provide a schedule of actions that can be resourced. The basis for the formulation reserve specific conservation plans lie with the initial field assessment and associated notes generated as part of the NAIA process. It is from these original field assessment data that reserve specific maps may be generated displaying Vegetation Complexes and Vegetation Condition as well areas requiring special attention due the presence of Threatened Ecological Communities, the control of localized weeds based on their distribution, eradication of other threats and the restoration of degraded areas or areas reclaimed from the removal of these threats. For the purpose of this Local Biodiversity Strategy, the formulation of reserve specific conservation plans applies only to existing natural areas and not to created sites that may contain local native plantings.

The key aspect of conservation is preventing natural areas classed as good or higher from degrading as further elaborated under Sections 10 and 11. A subsidiary aspect of conservation is the restoration of degraded sites or sites that have been reclaimed after the removal of various threatening processes. Restoration encompasses both regeneration and revegetation. Regeneration refers purely to the self renewal or native ecosystems assisted, where required, with the removal of threats (e.g. weed, pest and disease control). Revegetation on the other hand involves planting of areas classed as 'Degraded' or 'Completely Degraded' after all attempts at natural regeneration have been explored. Generally, sites classed as 'Good' or better may not require revegetation. Although sites classed as 'Degraded and Completely Degraded' will require revegetation at some stage in the future, it is recommended that priority be assigned to such areas in Locally Significant Natural Areas.

A pre-condition of revegetation, however, is that all plantings be (1) locally provanced i.e. seeds sourced from reserves where plantings are to take place and (2) the planting plan reflect the correct plant communities and species pertaining to the area.

Re-vegetation plantings may consist of direct seeding or planting of nursery tube-stock, although the former is preferred as it lends itself to a more natural mix of species and dispersion pattern. Central to any revegetation programme is a nursery facility that can

house a 'Seed Bank' for provanced seeds and guarantee disease free propagation conditions of local native and indigenous stock. Note: this is already assured through the City's currently accredited nursery. Reserve specific conservation plans should therefore provide details of areas to be revegetated, the desired mix of species and an estimate of the plant numbers required of each species.

Additionally, reserve specific conservation plans should outline the nature and extent of all threatening processes and disturbance factors as identified in the initial site assessment as part of NAIA process and then proceed to detail what threat abatement programmes could be put in place at each site (Section 11 provides guidelines on the abatement of threats and disturbances).

Table 15 Native Vegetation Extent in the City of Stirling within relevant zones of the Metropolitan Region Scheme

Metropolitan Region Scheme (MRS) Zoning	All Natural Areas incl. Bush Forever (ha)	Local Natural Areas or LNAs (ha)
Residential	0	0
Commercial	0	0
Industrial	0	0
Other Zones – Private Institution	47	47
Other Zones – Civic	0	0
Other Zones – Special Use	14	14
Local Authority Reservations	616	284
MRS Reserves – Primary & Other Regional Road	0	0
MRS Reserves – Parks & Recreation	0	0
MRS Reserves – Special Use	0	0
MRS Reserves – Commonwealth Government	0	0
MRS Reserves – High School	0	0
MRS Reserves – University	0	0
MRS Reserves – Technical College	0	0
MRS Reserves – Hospital	0	0
Public Use Reserves – Fire Station	0	0
Public Use Reserves - Transport	0	0
Public Use Reserves – Water, Sewerage or Drainage	0	0
Public Use Reserves - Energy	0	0
Public Use Reserves – Primary School	0	0
Public Use Reserves – Telecommunication	0	0
Public Use Reserves – Other Commonwealth Govt.	38	38
Public Use Reserves – Police Station	0	0
Public Use Reserves - Hospital	0	0
Total (ha)	**1006**	**383**

Adapted after WALGA 2007

Table 16 Native Vegetation Extent in terms of Administrative Planning Category Adapted after WALGA 2007

Local Government	Bush Forever (ha)	Vegetated Local Natural Areas in Council reserves (ha)	Vegetated LNAs under other authorities & private holdings (ha)	Regional Parks (ha)	Total (ha)
City of Stirling	463	284	99	160	1006

Table 17 Native Vegetation Extent in terms of Ownership Category Adapted after WALGA 2007

Local Government	Local Gov't - Vested (ha)	Local Gov't - Freehold (ha)	Crown (unknown) (ha)	Private (ha)	Private - Commercial (ha)	State Gov't (ha)	Vacant Crown Land (ha)	Total (ha)
City of Stirling	616	0	38	0	61	291	0	1006

Table 18 Local Natural Areas (LNAs) in terms of Ownership Category Adapted after WALGA 2007

Local Government	Local Gov't - Vested (ha)	Local Gov't - Freehold (ha)	Crown (unknown) (ha)	Private (ha)	Private - Commercial (ha)	State Gov't (ha)	Vacant Crown Land (ha)	Total (ha)
City of Stirling	284	0	38	0	61	0	0	383

Table 19 Vegetation Complexes – Current Extent and Proposed Retention Targets for the City of Stirling

Vegetation Complex	Original	Remaining				Implications under Local Representation							
	Pre-European Extent	Current Extent		Bush Forever	Local Natural Areas (LNAs) discovered through NAIA surveys	10% target		Actions for 10% Target		30% Target		Actions for 30% Target	
	Total (ha)	Total (ha)	%	Currently Protected (ha)	Protection pending by COS (ha)	Area Required (ha)	Achieved	LNA Protection (ha)	Restoration	Area Required (ha)	Achieved	LNA Protection (ha)	Restoration
Bassendean Complex - Central and South	1268	38	3%	16	22	127	N	22	89	380	N	22	342
Cottesloe Complex - Central and South	1894	292	15%	205	87	189	Y	NA		568	N	87	276
Herdsman Complex	1486	179	12%	160	19	149	Y	NA		446	N	19	267
Karrakatta Complex - Central and South	5463	423	8%	169	254	546	N	254	123	1639	N	254	1216
Quindalup Complex	407	74	18%	73	1	41	Y	NA		122	N	1	48
TOTAL	**10518**	**1006**	**10%**	**623**	**383**	**1052**		**276**	**212**	**3155**		**383**	**2149**

Adapted after WALGA 2007

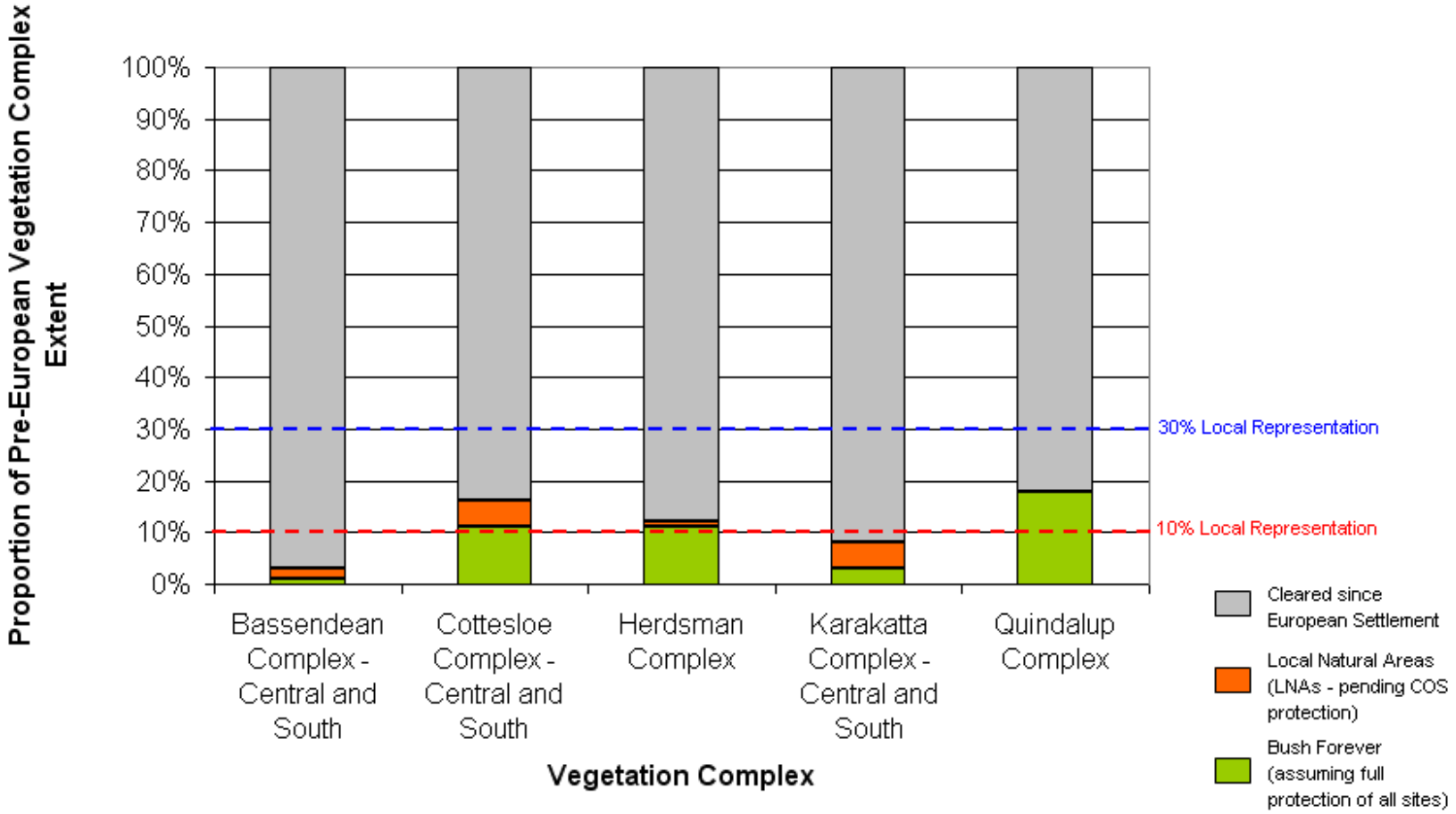

Figure 3 Level of Protection and Retention of Native Vegetation for each Vegetation Complex within the City of Stirling Adapted after WALGA 2007

Recommendations:

18. That prioritization and resource allocation for the conservation of natural areas is to be based in order of (1) Regionally Significant Natural Areas, including Bush Forever sites, (2) Locally Significant Natural Areas and lastly (3) Local Natural Areas.

19. That prioritization for the conservation of Locally Significant Natural Areas (LSNAs) is to be based on these sites meeting Essential and/ or Desirable Criteria as per Section 9.1 and Table 13.

20. That prioritization for the conservation of Local Natural Areas (LSNAs) is to be further based on these sites being assessed for Viability as per the Natural Area Initial Summary Template under Appendix IV.

21. That further to Recommendations 20 and 21, site specific conservation plans be prepared for LSNAs thus prioritized.

22. That with regard to the current representation of Vegetation Complexes within the City, the goal of 10% (Essential Criteria) and 30% (Desirable Criteria) retention of the pre-European extent be endorsed.

23. That with the regard to the current representation of Vegetation Complexes within the City, representational targets be established (as per Table 18 and Figure 3) to ensure that no further loss of native vegetated areas are incurred and the all existing remnants are retained and protected.

10. BIODIVERSITY PROTECTION: LEGISLATIVE & POLICY INSTRUMENTS

Inadequacies within current legislation and policy can constitute equally difficult constraints and impediments to biodiversity protection compared to other threats that are more directly site related. These require serious consideration to having them resolved in order to ensure greater certainty and a degree of protection to all natural areas that are the centers of biodiversity.

10.1 Current Constraints to Biodiversity Protection

The system of land use and planning based on current zonings under Metropolitan Region Scheme (MRS) tends to be biased, in most cases, towards a development centered paradigm. MRS zonings that pose a threat to biodiversity values include Urban, Urban Deferred, Commercial and Industrial and Regional Roads. There is no clear differentiation in this zoning scheme between natural areas and land cleared or available for development. This places undue expectations on land owners and property developers alike to value land more for economic gain rather than biodiversity potential. It further engenders a speculative environment whereby unimproved land values have become unrealistically overvalued mainly because of their close proximity to areas already zoned and developed as urban.

With the rapid expansion of the Perth Metropolitan Region and escalating land values there is concern that little thought is being given to the reservation and protection of all remnant natural areas. Some protection is afforded through mechanisms to officially recognize certain natural areas as being locally significant (Locally Significant Natural Areas or LSNAs) in legislation particularly those known to contain Declared Rare Flora (DRF), Threatened Ecological Communities (TEC) or Conservation Category Wetlands. With the exception of these, most other Local Natural Areas (LNAs) are unprotected although occurring within Public Open Space (POS) provisions of local subdivisions.

The constraint in more LNAs not being reserved is that traditionally the allocation of POS has been limited to no more that 10% of any sub-dividable area. This however is based purely on meeting community recreational needs rather than on a policy inclusive of environmental needs and values. The result has been that most POS created via subdivisions have been vested for purposes of Public Recreation or similar. The basic flaw in this mechanism is that it has often led to the clearing of most areas of natural vegetation for the development of active and passive recreation with only small areas of poor viability being retained for conservation. Even these could be subsequently cleared for expanding recreational demands and have a tenuous hold on being protected in the absence of any legal mechanism to recognize natural areas as dedicated conservation zones within reserves.

The root of the above constraints may be summed up simply as a lack of awareness and knowledge at all levels of the community including governments. As will be further discussed under Section 13, there is generally little understanding of the importance of biodiversity to human survival and community well being. There is lack of knowledge about what our natural areas actually do contain in terms of the diversity and richness of flora and fauna. Whilst there are now regulations under State legislation that prohibit the clearing of bushland on reserves there does not seem to be the same level of scrutiny

with regard to the clearing of bushland on privately held lands or lands earmarked for development.

10.2 Mechanisms to Overcome Constraints

10.2.1 Formalize the Protection Status of Local Natural Areas

Council on the 20 April 1993 endorsed a recommendation of its then existing Town Planning and Statutory Services Committee in reference to the recognition of bushland within the City's District Planning Scheme. The ensuing resolution of Council is as follows:

That District Planning Scheme 2 be amended as part of its next scheduled review to (1) include a definition of bushland (2) include in Clause 1.2 of the Scheme, Reserved Provisions relating to the protection of Urban Bushland and the preparation of Management Plans and (3) reserve those areas within existing reserves identified as bushland (or proposed as bushland) in the City of Stirling Green Plan as 'Local Authority Reservations – Urban Bushland' on the Scheme maps.

Council's decision to recognize bushlands as dedicated conservation zones within reserves adds the weight of law on the protection of these areas and gives certainty to their permanent tenure. Opportunity to incorporate the above resolution of Council was however missed in the review of District Planning Scheme 2. Nevertheless, renewed effort is being made in the current review of Local Planning Scheme 3 to ensure the incorporation of the above outstanding resolution of Council.

A possible way forward would be through a review of the City's Local Planning Policy (see Section 10.3) with the view to the formulation of specific provisions pertaining to biodiversity conservation. Such provisions could be enunciated within a new policy viz. Local Planning (Biodiversity) Policy with the basic provisions appended to the scheme text of the City's Local Planning Scheme viz. Local Planning Scheme 2.

10.2.2 Administration of Bushland Clearing Regulations

New regulations enacted in 2005 under provisions of the Environmental Protection Act (1986) ensure that clearing of native vegetation will now require a permit from the Department of Environment and Conservation unless the clearing for an exempt purpose. Clearing under the Act has been defined as the killing or removal of native vegetation, the severing or ring barking of trunks or stems, the draining or flooding of land, the burning of vegetation, the grazing of stock and any other cavity that kills or damages native vegetation.

Adherence to these regulations within the local government context is vital particularly within the framework of conservation policy and as part of internal processes and procedures.

10.2.3 Declaration of Green Belts

Green Belts may best be described as an arbitrary amalgamation (in Local Planning terms) of natural areas in near proximity that provide the best opportunity for ecological linking. The geographical orientation of Green Belts should logically include recognized

regional and local ecological links within the City of Stirling (as per Green Plan 2 and the Perth Biodiversity Project), the chain of wetlands, the coastal corridor, arterial road network and wetland buffers or transitional areas between wetland and upland.

Appropriately, the process of identifying Green Belts should be part of the City's current District Planning Reviews for all it's twelve local districts viz. North Beach, Carine, Karrinyup, Balcatta, Balga, Mirrabooka, Dianella, Mt Lawley, Tuart Hill, Wembley Downs, Doubleview and the Stirling Regional Centre. Such an initiative would serve to highlight early in the planning process the City's intent with regard to its biodiversity conservation objectives, the distinct Green Belts that are thus being proposed and the considerations that must be taken into account by the community in relation to all other precinct issues e.g. recreation, housing, transport, education, commerce, industry etc.

Quite importantly, it will provide opportunities to identify natural areas in good to pristine condition within each precinct, to examine the status of Vegetation Complexes within each natural area and to consider the setting of realistic and achievable representational targets.

10.2.4 Natural Area Reservation through Structure Planning

Structure Planning is akin to District Planning and adopts a similar approach except that it is more applicable at the precinct level rather than within any district of the City. Structure Plans are normally formulated when land is zoned or rezoned for subsequent subdivision and development. This process is crucial to ensuring a practical balance between the protection of biodiversity values and the other values of the community.

10.2.5 Acquisition of Natural Area on Private Lands

Further to the resolution of Council of the 20 April 1993 as detailed under Section 10.2.1 above, part 2 of the resolution address provisions for the acquisition of bushlands on lands not currently reserved or lands privately held. The resolution reads as follows:

Than any proposal for the inclusion of land which is not currently subject to local authority reservation in the District Planning Scheme in an 'Urban Bushland' reserve be the subject of report to Council, such report to include an estimate of compensation which might be applicable and a detailed assessment of the value of the bushland.

The intent of this resolution is to recognize areas with biodiversity values wherever they occur within the City regardless of land tenure and to acquire for the purpose of reservation, where possible, with fair compensation to land owners. In all instances, where acquisition is warranted, the City will investigate options for a collaborative approach with potential stakeholders viz. industry and other levels of government.

10.2.6 Provision of Tax Incentives

Investigation is warranted into alternative arrangements and incentives such as tax deductions for land owners that may choose to donate land for the retention of Local Natural Areas (LNAs). Potential for the application of such a mechanism within the City of Stirling is to be further investigated.

10.2.7 Establishment of Conservation Covenants

The aim of Voluntary Conservation Covenants (VCAs) is to foster partnerships between Local Government and landowners with the view to conserving natural areas on privately held lands (Brisbane City Council 2001) or they investigate lateral mechanisms to ensure the voluntary reservation and protection of natural areas on privately held lands.

Participation in the programme is completely voluntary and agreements are negotiated individually with landowners to suit their particular requirements and significant features of their properties. Under a VCA, relevant portions of the property are designated 'conservation areas' thereby enabling the Local Government and the landowner to cooperatively develop a plan for management. VCAs may be partially or fully binding on title depending on the nature and extent of the undertaking, however ownership of the land would remain with the landowner without any obligation to allow public access (Brisbane City Council 2001).

Such a scheme would normally be linked to an appropriate incentive scheme e.g. rate rebates, management grants (possibly secured from other government sources) and the provision of free technical advice being considered in return for the landowner implementing the management plan

10.3 Review of Local Planning Policy

A review of Local Planning Policy is needed to examine the feasibility of various planning attributes as advocated under Sections 10.1 and 10.2. Basically, it is important that the recommendations arising from this Local Biodiversity Strategy are incorporated with the statutory planning policies and processes of the City's Local Planning Scheme. In the revision of the Local Planning Policy (LPP) it is incumbent upon the City to ensure that processes subsequently adopted are rigorous enough to provide a consistent methodology to the identification, assessment and protection of natural areas that may be subject to proposals for land development where adverse impacts on biodiversity values are likely.

In more specific terms, the objective of the review of local Planning Policy would be to incorporate the following features:

- That the protection status of Local Natural Areas is formalized through a mechanism to recognize such areas as dedicated conservation zones within reserves;
- That the City is able to conform to all legislative and procedural requirements related to biodiversity conservation;
- That the City is able to meet the biodiversity objectives and targets as adopted by Council (as specified in this Local Biodiversity Strategy);
- That the City's Local Planning Policy encapsulates the comprehensive process involved in biodiversity planning and management at the local level (as outlined in this Local Biodiversity Strategy);
- That as part of that process, a mechanism is formulated to assess the impacts of proposed development on natural areas and its biodiversity values;

- That the assessment of impacts is particularly cognizant of regulations under the Environmental Protection Act (1986) with reference to permits for bushland clearing;
- That a clear policy stance is possible with individual development applications in instances where biodiversity values are at risk; and
- That all the above features are integrated as part of the existing planning and development assessment processes of the City.

A Model Local Planning Policy is attached under Appendix III. It is basically structured to provide (1) its purpose and objectives, (2) key definitions of terminology, (3) legislative context of the policy, (4) situations where the policy has application and (5) specific policy measures.

Recommendations:

24. That Council's previous resolution of the 20 April 1993 be reiterated to recognize urban bushland on reserves as defined by Green Plans 1 and 2 as 'Local Authority Reservations – Urban Bushland' on the City's Scheme maps and that this outstanding resolution be urgently incorporated as a scheme amendment within Local Planning Scheme 3, the draft of which is currently undergoing adoption and gazettal.

25. That due regard be given to regulations enacted in 1995 under the Environmental Protection Act (1986) that prohibit clearing of native vegetation for any purpose without a permit unless the clearing is for an exempt purpose and that this be incorporated as part of the City's internal processes and procedures pertaining to planning and management.

26. That the opportunity for the dedication of 'Green Belts be investigated in the future District Planning Reviews of the City's to enable the establishment of regional and local ecological links (as per Section 10.2.3).

27. That the opportunity for reservation of natural areas under future land development subdivisions be investigated early in the planning stages through the formulation of precinct based Structure Plans (as per Section 10.2.4).

28. That Council's precious resolution of the 20 April 1993 be reiterated with respect to the acquisition of natural areas on private lands (as per Section 10.2.5) to recognize areas with biodiversity values wherever they occur within the City regardless of land tenure and to acquire for the purpose of reservation, where possible, with fair compensation to land owners or other equitable mechanism (as per Sections 10.2.6 and 10.2.7).

29. That a review of Local Planning Policy be undertaken with the view to the strengthening current provisions for the protection and retention of natural areas and associated biodiversity values (as per Section 10.3).

11. ABATEMENT OF THREATS & DISTURBANCES

A key component of biodiversity protection must involve the identification and elimination all threatening processes and disturbance factors affecting natural areas. Threatening processes refer to occurrences, activities or continuing processes that could jeopardize the survival and sustainability of native species or ecosystems. Examples include weed invasion, disease and pest infestations, diffuse-source pollution, soil erosion and impacts from continued non-compatible public access. Disturbance factors are incidents that cause sudden detrimental changes to natural areas. Examples of disturbance factors include bushfires, point-source pollution, land clearing, hydrological changes, dune blowouts, cliff collapses etc. Threat Abatement Initiatives need to adopt a strategic approach to issues that confront the entire City e.g. the control of animal pests however several threats and disturbance are site-specific and require dedicated reserve based Conservation Plans to bring about an effective resolution or control. The following are management prescriptions for some of the major issues encountered in the City.

Plate 6 - Breckler Park Bushland: an example of a bushland of the Bassendean Central and South Vegetation Complex over Bassendean Dunes (photo by Jesse Bridge 2009)

11.1 Managing Public Access and Activity

The pressure to access bushland areas for a variety of recreational and leisure pursuits is constant. Excessive or inappropriate access is often responsible for the degradation of many urban bushland areas. The needless duplication of paths invariably leads to destruction of vegetation, soil erosion and destruction of valuable ground litter. Consequently this could create other problems commonly associated with uncontrolled

access or inappropriate use such as removal of plant material, (wildflowers, bark etc) and clearing of bushland for BMX activity.

11.1.1 Definition of Public Access

The public right to access and enjoy bushland cannot be denied, however there is the need to clearly define protocols regarding permissible ingress and egress to prevent the creation of a myriad of unnecessary tracks. The following need to be taken into account:

- The location and number of access points should be carefully determined in relation to the size of the reserve and commonly observed usage patterns;
- All trails through bushland deemed unnecessary should be barricaded and closed off and the re-claimed areas re-vegetated;
- All tracks considered necessary should be consolidated to provide a stable natural appearing surface (options for materials that can be used are crushed limestone, stabilised limestone or cemented earth); to prevent erosion and unnecessary widening beyond required widths;
- Unconsolidated sand trails almost invariably widen with regular use over time and present loose unstable conditions that become invasion corridors for weeds;
- All access points should, where possible, be adequately sign-posted and controlled via standard pedestrian/disabled access gates.

11.1.2 Protective Perimeter Fencing

Perimeter fencing of bushland sites is increasingly becoming a necessity in the urban environment because of the high level of surrounding impacts that reserve managers have to contend with. Perimeter fencing is to be installed in situations where indiscriminate pedestrian access is not desired as it could lead to the creation of numerous informal walk trails. The principal objective of perimeter fencing is to guide and direct public access and to prevent off-road vehicle access across broadly exposed fronts of bushland or coastal dunes. Boundary definition with fencing would also prevent regression of the bushland fringe from periodic mowing with parkland mowers. It could additionally provide a barrier against adverse land use impacts on adjoining lands.

Any perimeter fencing installed is not to however restrict the natural movement of small animals to other natural area reserves via movement corridors.

11.1.3 Reserve Signage

Generally, signage at bushland conservation sites is intended to convey essential messages that either inform or require compliance with some aspect relevant to the site. All signage should be worded courteously and invite positive action rather than overly emphasise the negative consequences of non-compliance. The following are the major types of signs that should be considered:

- Declaration Signs – to declare and designate bushland sites as important reserves for biodiversity conservation;
- Regulatory Signs – to request avoidance of any form of abuse or misuse in particular reference to issues such as rubbish dumping, litter disposal, lighting of fires, collecting of plant material, dog control, horse riding, off-road vehicle access, clearing for BMX activity, logging etc;

- Directional Signs – to guide and direct proper and safe public access, usage of facilities where provided and orientation of principal access tracks and walk trails;
- Interpretation Signs – to provide concise information, of an educational nature, regarding features and attributes of public interest such as wildlife habitats, the diversity of plants and animals, ecosystem relationships and other aspects of natural and cultural heritage.

11.2 Dealing with Adjoining and Catchment Related Land Use Impacts

Frequent impacts from adjoining land uses in residential areas include rubbish dumping (household and garden waste), discharge of drainage, discharge of toxic wastes, herbicide/pesticide spray drift and selective clearing along immediate fringes for substitution with exotic plantings. Impacts from adjoining industrial/commercial areas whilst not as prevalent in the City can be equally damaging to bush areas.

11.3 Control of Soil Erosion

This is encountered especially where there are differing land levels and where there has been a sudden change in the nature of adjoining land use, for example, from re-development of old residential allotments. Soil erosion in such cases is commonly as a result of uncontrolled or inadequately designed drainage. Erosion is also a problem when there has been sudden loss in natural vegetation cover following bushfires or gradual loss of vegetation from disease. In both cases water induced erosion can eventuate because of the loss of soil permeability. Soil erosion is therefore a critical issue to the survival of bushlands as it often involves the irreplaceable loss of valuable topsoil or the humic layer and with it, many years accumulation of latent seed store.

11.4 Avoiding Nutrient Imbalances

Most natural soils on the Coastal Plain are quite infertile, by world standards, and many native plants have become adapted to these conditions. Increased nutrient regimes usually permit the invasion and prevalence of weeds that subsequently outgrow native species. Sources of nutrient influxes include fertilizer run-off from surrounding grassed areas of parkland reserves and residential lawns and gardens. Additional sources may be from dumping of road-metal dust, stormwater run-off, sewerage surcharges and dumping of garden waste.

11.5 Avoiding Hydrological Imbalances

Sources that contribute to un-natural soil moisture conditions tend to be similar to those that contribute to nutrient influxes. Apart from promoting the growth of weeds, soil moisture changes usually favour a dominance of native mesomorphic species over original sclerophyll types. This can, in certain areas, result is a somewhat altered floristic composition with the suppression of many inherent species. Hydrological imbalance from sudden changes in drainage is also attributed to disease outbreaks in stands of native vegetation. Particularly susceptible areas are natural swales and depressions in bushland although disease susceptibility usually tends to be specific to certain species.

11.6 Preventing the Acidification of Soils

Acid sulphate soils (ASS) are naturally occurring soils, originally formed by bacterial conversion of iron in organically rich waterlogged sediments and marine deposited sulphate in these sediments. Hence they occur predominantly within coastal regions of the State particularly in organic sediments associated with wetlands although other areas are equally susceptible. As a result of the bacterial conversion ASS are characterized by the presence of iron sulfide (or iron pyrite). These soils are generally benign when undisturbed and retained under natural soil moisture conditions however any exposure of the pyrite to air by drainage, dewatering or excavation can cause the iron sulfide to oxidize and generate large amounts of sulfuric acid.

As the acid leaches into lower profiles it releases iron, aluminum and other metals as well as heavy metals and toxic elements viz. arsenic. These released substances subsequently contaminate groundwater systems and associated flows into wetlands (including lakes) and waterways (DEC 2004). Pyrite oxidization and soil acidification may also be attributed to the lowering of the groundwater table due to below average recharge of aquifers from winter rainfall and from increased groundwater abstraction within the catchment by private and public bores. Pyrite rich sediments often underlie groundwater dependent wetlands and these are susceptible to acidification if the groundwater table falls below the pyritic layer (DEC 2004).

The consequences of the acidification of ASS on the aquatic biodiversity of wetlands are several. Immediate impacts include mass mortality of macro invertebrates, mortality of larger acid sensitive organisms (viz. some crustaceans, amphibians and fish), reduced nutrients due to increased levels of toxic elements, fall in recruitment due to reduced breeding success and changes in food chain and web as acid tolerant species dominate e.g. mosquitoes. Long term impacts point to habitat loss through loss of wetland vegetation and alteration of water plant communities, occurrence of barriers to nutrient recycling, reduced food resources and decline wetland ecosystems (Department of Environment & Heritage 2000).

Owing to the impacts on biodiversity measures to prevent the acidification of soils are imperative. These include the following:

- Characterization of soils with respect to ASS or PASS (Potential Acid Sulfate Soils) in all wetlands and immediate catchments to determine the severity, extent and depth of pyritic materials ;
- Development and implementation of soil acidification prevention measures in high conservation category reserves;
- Development of realistic and workable remediation strategies in wetland areas where ASS expression has already been identified;
- Review of current planning and land management controls with the view to ensuring the avoidance of soil disturbance in areas of high risk with respect to ASS;
- Development and implementation of a groundwater conservation strategy for Council owned bores;
- Development and implementation in conjunction with relevant State authorities, guidelines for the use of domestic bores in critical areas (viz. wetland catchments with confirmed Class 1 soils (moderate to high risk of ASS or PASS occurring <3meters from the soil surface));

11.7 Dealing with the Effects of Past Land Clearing

Some bushlands within the City have been subject to selective clearing from past timber harvesting activity. A higher degree of restoration is required in these areas mainly because of the loss of original structure, composition and diversity and as a result, a predisposition for the entry of other threats such as weed invasion.

11.8 Bushfire Prevention and Contending with Altered Fire Regimes

This refers to the frequency, intensity and season of fire occurrence. Fire regimes of urban bushlands today are very different to that prior to European settlement and urban development. Current fire regimes comprise of more frequent fires, intentionally lit usually as a result of vandalism, and sometimes very quickly controlled. The absence of any natural fire regime can adversely affect the successful recruitment of many native plants and instead favour the establishment of mesic species (that is those generally featured in temporary succession e.g. Solanum symonii and various Acacias) as well as weeds. Many trees are killed by leaf scorch from frequent and particularly hot, intense fires and only re-sprout from lignotubers stimulated by the fire or from fire-damaged roots. However, as re-establishment of the over-storey usually takes the longest, bushland structure is altered in the meanwhile leading to the dominance of scrub vegetation.

Altered fire regimes are also thought to be affecting relict species such as the Tuart, which is now experiencing decline in some areas of the State. Under fire frequencies any more than 8-10 years, many trees and shrubs that normally mature and flower after approximately 8 years or those that flower and set seed infrequently, are killed without establishment of progeny. Such species are being lost irreversibly from our bushland systems at an alarming rate. (Ideally, the maximum fire frequency is thought to be 2.5 – 3.0 times the period to first flowering, ie if a species first flowers at 8 years, then the minimum fire frequency should be 20 – 24 years).

Occasional fires under natural conditions are beneficial by destroying pests and diseases, rejuvenating moribund vegetation and recycling nutrients. Conversely, too frequent fires are a threat to biodiversity, wildlife habitat (e.g. bird nests, hollow logs, dense understory etc) and food resources, all of which are incinerated and often unrecoverable at the same site.

Although it is unrealistic to expect an environment free of indiscriminate fires in the urban situation, a number of steps can be taken to ensure that effects of fire damage are minimised in the event of a fire. Firstly, it is important to know the conditions and circumstances under which bushfires can be a risk. This means timely assessment of individual sites to identify all possible on-site hazards and to have an annual programme to resolve these. It also means adopting attendant strategies that would seriously address the causes of indiscriminate fire lighting, which in most cases is due to a lack of community awareness of the damaging effects of frequent bushfires. The following is therefore recommended:

- Installation of appropriate fire breaks to safeguard adjoining property and to arrest progress or confine the fire to sections as close as possible to the flashpoint;

- Installation of adequate vehicle access tracks to enable unhindered and safe access by fire fighting vehicles;
- Reduction of potential fuel load (viz. dry flammable material) on the ground by the appropriate and timely control of broad-leaved non-native annuals, perennials and grassy weeds;
- Reduction of potential fuel load immediately around the bases of significant trees or stands of trees;
- Implementation of a system of cool burns, where appropriate, to reduce excess fuel loading on the ground – to be on a rotational cycle of no less that 20 years and on condition that there have not been intermittent fires in between cycles (supervision of the Fire and Emergency Services Authority or FESA is essential);
- Establish a community oriented Volunteer Fire Watch scheme to enable the prompt reporting of any fire;
- Declaration of annual fire risk periods to ensure extra vigilance by all concerned (the most damaging fires are those intentionally lit during hot dry summers);
- Cooperation of the media is to be sought to denounce common fallacies about the need for annual burning, to raise concern about the ecological damage sustained by frequent fires and to promote the importance of conserving remnant bushland within the urban environment rather than merely sensationalising the aspect of arson commonly associated with bushfires;
- Cooperation of education authorities should be sought to teach children about the enormous environmental damage/disadvantages of burning bushland at frequencies that cannot be sustained by the ecosystem.

In addition to the above fire prevention measures, it would be prudent to have in place a clear emergence response strategy to combat and contain bushfires, should one occur, so as to ensure no risk to life and private property and with minimum damage to bushland areas. The following is therefore recommended:

- Identify all essential emergency services relevant to bushfire situations within the City and devise a clear system of communication to ensure prompt reporting of bushfire incidents;
- Institute an annual check of all regionally significant reserves within the City with officers from FESA to ensure the following:
    - Identification of fire hazards and emergency access issues
    - Maps lodged with the local Fire Brigade showing location of all gates and vehicle access tracks for both water tankers and light tenders
    - Council standard keys to be issued to access gates
- Annually re-visit all emergency response procedures with FESA with respect to possible locations of command stations, aerial monitoring, issue of neighbourhood warnings, and traffic diversions in conjunction with Traffic Police and protocols governing commissioning of the water bomber.
- Ensure that FESA is clear of Council's requirement that the City be notified of all bushfires, no matter how small, and that have been attended to by local Fire Brigades before their leaving the site; this will ensure that post-fire vigilance can be maintained by Council staff to avoid further damage from any re-flaring of fires not completely extinguished;
- Clarify the role of other civil emergency authorities viz. State Emergency Services so that un-justified felling of significant trees is avoided either during or after a fire.

11.9 Resolving the Issue of Fragmented Bushland Areas

Intact areas of bushland have become fragmented in various ways. The loss of bushland structure from frequent fires is implicated in this process. Initially the over storey is thinned out followed by weed infestation of the understory from increased light penetration and much later, loss of even this understory from subsequent fires. Fragmentation also occurs through the creation of informal pedestrian trails. These invariably widen over time and become primary sources for weed dispersion and eventually regression of bush areas along either side of these trails. With a number of bushland sites in the City that occupy recreational parkland reserves, fragmentation has taken place because of poor planning in the past with regard to the location of recreational/sporting facilities. Intact areas have thus been bisected or 'carved out' leaving behind several smaller areas of bush. In some cases, such remnant small areas have been further reduced in size and segregated by being progressively mowed out along the fringes by parkland mowers and in some cases, eventually, completely mowed out.

11.10 Preventing Weed Invasion

Most successful invaders of the bush are either mesomorphic broad-leaved weeds or grasses. Broad-leaved species out-compete other plants as they cast heavy shade and produce conditions inappropriate for the germination and establishment of native species. Grasses compete in a similar manner however the greatest hazard that they present is when they dry out in summer and form dense masses of dry matter. In the event of deliberate or arson related fires, the fuel load thus consumed at ground level, renders the fires extremely intense and hot resulting in the loss of a vast amount of regenerative material of many native species.

The presence of weeds in bushland is often an indication of severe degradation brought about by too frequent a fire. In a more vibrant understory where frequent fires and grassy weeds have not been a problem, the understory is usually capable of withstanding fairly intense fires without severe loss of regenerative material. The gradual loss of the over storey through successive fires and environmental changes in the lower storey brought about by increased moisture and light conditions, further encourages the emergence of grassy weeds and the suppression of a normally shade tolerant native understory.

Weed occurrence may also be attributed to uncontrolled public access that has been allowed to occur over time via numerous tracks and trails through bushland. These provide avenues for further weed dispersion with vast areas eventually being infested. The influence of peripheral roads/streets particularly around small bushland reserves has the same effect. Because of the high 'edge to area ratios' associated with such reserves, weed growth, if left uncontrolled on road verges, very quickly proceeds to infest the entire reserve.

The presence of weeds in bushland may further lead to other long term environmental changes such as alteration to soil chemistry and structure, changes in microbial populations, reduction in nutrient recycling and the depletion or enrichment of soil minerals and trace elements.

Where practical, weed control should be based on the principle of minimum ground disturbance and in establishing a vibrant ground cover of local native species as quickly as possible. Most forms of ground disturbance promote weeds and can be caused by events such as clearing, bushfires, and soil erosion from stormwater drainage and uncontrolled pedestrian/vehicle access. The mechanism of invasion is commonly through so-called invasion corridors viz. paths, tracks, trails, firebreaks, drains and service roads. This is further augmented by the activities and movement of people, dogs, horses etc along these invasion corridors. Where weeds have been allowed to gain a foothold the following strategies for control and eventually eradication should apply:

- Infestations of perennial grasses (e.g. Veldt Grass) and annual grasses (e.g. Wild Oats) should not be pulled out as this would disturb the soil and cause further germination;
- All grassy weeds should either be slashed and/or sprayed with a selective herbicide (e.g. fluazifop-p which is grass specific and does not affect native plants except native grasses);
- Rhizomatous grasses e.g. Buffalo and Couch are to be cut and removed of extraneous biomass prior to all remaining green matter being sprayed with a selective herbicide;
- Rhizomatous gasses e.g. Kikuyu are to be cut and removed of extraneous biomass prior to all remaining green matter being spot-sprayed with a non-residual contact herbicide e.g. glyphosate;
- With geophytic weeds (bulbs and corms), mechanical cutting does not remove nor eradicate the reproductive structures. It is preferred that these species e.g. Gladiolus, Freesia and Sparaxis be hand pulled following the onset of flowering and/or spot-sprayed with a non-residual contact herbicide e.g. glyposate;
- Woody shrub species such as Castor Oil and non-local species of Wattle are best controlled by cutting and removing from the area all above ground biomass followed by herbicide sprays with glyphosate for any regrowth or emerging seedlings;
- Herbaceous groundcover species such as Wild Geranium are best controlled by cutting and removing from the area all above ground biomass followed by herbicide sprays with glyphosate of any regrowth;
- Herbaceous annuals such as Lupins and perennials such as Carnation Weed are best controlled by hand pulling;
- Control of geophytic creepers such as Bridal Creeper present options for an integration of chemical control (metsulphuron which is translocated down to the underground tubers) and biological control (using host specific species of a leafhopper, a beetle and a rust fungus);
- Bushlands that occupy part of recreational parklands suffer from grass encroachment (Couch and Kykuyu) around the fringes due mainly to the over-spray of irrigation sprinklers – these must be re-located to avoid over-spray into bush areas or converted to part-circles.

It is also important to pre-plan weed control/eradication programmes to the extent that all known areas are sampled and accurately mapped out to determine the varying densities of occurrence for any one weed species. Using principles espoused under the Bradley method, it may be more appropriate to affect controls commencing from areas of least resistance ie where bush density is the strongest and weed density is weakest. This should ensure that competition from weeds is progressively eliminated from areas of

least resistance towards principal source areas of weeds or areas where competition is most intense.

Prompt removal of competition from areas of least resistance will halt further dispersion of weeds deeper into bushland proper and facilitate quick restoration of native plant cover and vigour. Prompt restoration of full structure, cover and vigour are probably the best defenses against further weed invasion. It is expected that the Bradley method would be effective with most forms of weed control - physical (hand pulling), mechanical (cutting and removal) and chemical (herbicide sprays).

11.11 Controlling Animal and other Pests

The fragmentation of bushlands can cause marked reductions in the diversity of native animal habitation. With even greater access to domestic pets (particularly cats and dogs) under such conditions, further dramatic changes tend to occur. An obvious effect is that the natural balance of many small native animals and birds is adversely affected and over turned.

Cats make occasional forays into the bush and are known to be carnivorous. Other studies have found that cats hunt extensively even when adequately fed. Dogs are known to leave incompatible scents that discourage habitation of affected bush areas by small native animals. Persistent populations of foxes in some metropolitan reserves are also of concern as these are a threat to the survival of many small animals. Rabbit populations are also widespread and are a threat to any serious attempts to regenerate remnant bushland.

Another potential threat to the natural balance of birds and plants in bushland appears to be the feral bee or European Honey Bee. These not only displace many native insects that usually pollinate native plants but also compete for habitat space (usually tree hollows) with various native birds. Once a hive is built in a tree hollow, the nest is rendered almost permanently unusable for nesting birds.

Yet another pest of increasing proportions is the feral dove because of its potential for the dispersal of seeds of certain weeds, particularly Carnation Weed. They are also known to consume the seeds of numerous native obligate seeders that become exposed on the ground straight after a fire.

The control of feral animals and pets must feature strongly in any management programme for remnant bushland so as to maximize on rehabilitation efforts and to restore biodiversity.

- Free ranging dogs within bush areas should not be permitted. Dog owners must be encouraged to keep their pets under control on a leash and to use only paths or tracks designated for pedestrian access in bushland conservation reserves.
- Restriction on cat numbers per household and curfews during late evening and night hours for domestic cats are now in place under the City's new Cat By-law – and is applicable anywhere within a 200 metre zone around all major conservation reserves within the City.
- Trapping for foxes should be undertaken under advice from the Agricultural Protection Board (APB).

- Rabbit control, preferably using a combination of the myxomatosis virus and Calici (Rabbit Hemorrhage Disease) virus should be undertaken under the direction of the APB. (A previous introduction of the myxomatosis virus by the APB at Star Swamp Bushland Reserve late in the 80's still appears to be active and effective in rabbit kills each Summer).
- The problem with feral bees or the European Honey Bee (as discussed under Section 2.2.10) is mainly a matter of commercial hive management. Bees swarm from commercial hives usually when hives are full of honey or when the hives are infrequently harvested. Some awareness/education amongst apiarists in this regard could assist and may be necessary. However where hives are detected in bushland trees, it is recommended that fumigation be undertaken by licensed pest control operators.
- The problem of feral doves and pigeons is best resolved by trapping and humane disposal under methods prescribed by the Royal Society for the Prevention of Cruelty to Animals (RSPCA) and to be undertaken by appropriately licensed pest control operators.

11.12 Control of Disease Infestation

Plants in the natural environment are subject to numerous insects and microbes some of which are vectors for a variety of pathogens. Pathogenic activity, whilst unnoticed in a balanced ecosystem, becomes obvious when large-scale deaths occur usually as a result of some change to environmental conditions. Examples are dieback from Phytophthora cinnamomi and basal canker from Amillaria both due to unnatural changes in soil moisture conditions possibly from diversion of off-street drainage. Some studies attribute dieback to changes in the association of soil mycorrhiza with the root systems of dieback susceptible plants; the changes referred to in this case being brought about by frequent fires mainly as a result of cool burns. Another example of disease incidence is the phenomenon referred to as 'Tuart decline' that, from recent theories, points to long-term regressive changes to bushland understory as the possible cause.

11.13 Mitigation of Stormwater Bourne Pollution

With the ever-increasing proportion of impervious surfaces (roads, carparks, footpaths, driveways, roofs etc) discharge peaks from storm events develop quickly and with greater velocity that previously accustomed. Where there are no convenient wet or dry detention basins, stormwater seems to be always directed into the nearest bushland (or wetland in other areas).

Impervious run-off surfaces accumulate a wide range of pollutants viz. silica based sediments, nutrient adsorbed clay colloids, oxygen demanding organic matter, nutrients such as nitrogen and phosphorus, heavy metals, hydro-carbons, animal faeces, urine and various bacteria. In addition to the discharge of these pollutants into bushland, permanent changes to soil moisture and temperature tend to occur, and consequently, changes to the floristic composition of these areas. Perhaps the most serious impact from stormwater drainage is the dispersion of seeds of many weeds and exotic plants. These generally favour the raised nutrient levels and the altered soil moisture and temperature conditions.

All too often stormwater drainage from surrounding residential/ industrial/ commercial/ horticultural land use catchments are terminated into bushland reserves. Whilst the re-routing of such drainage to alternate discharge points is neither likely nor feasible in engineering terms, steps must be taken to mitigate direct discharge that already occurs into bush areas. Possible solutions include the installation of added capacity sediment detention traps on road verges just before the drainage outfall or purpose built detention-cum-infiltration soaks and swales in convenient off-road areas.

In conjunction with engineered devices and mechanisms a variety of nutrient stripping techniques may be employed. These include the planting of native rushes where the bushland is associated with a wetland. Another method is to terminate the discharge into suitably designed swales or fluidized beds filled with limestone spalls and soaks that have the capacity to absorb most of the nutrients. Problems associated with unmitigated stormwater drainage include, soil erosion (particularly valuable topsoil), increasing the level of nutrients and soil moisture to un-natural levels and the associated encouragement and spread of weed growth and soil-bourn pathogenic fungi such as Armillaria.

11.14 Preventing Dumping of Rubbish

The problem may be divided into compostable and non-compostable rubbish. The latter refers to discarded/ old household items (clothes, furniture, toys, white goods, car bodies etc) and industrial garbage (packaging material, glass, metals and building rubble) These are visibly distracting as well as smother all living and emerging native plants in the areas affected. Compostable rubbish refers to garden waste (e.g. grass clippings, pulled out weeds, tree/shrub prunings, surplus sand and soil). Those who dump such rubbish do it either out of ignorance and are not concerned about its effects or because they think it will 'do the bush some good'. Compostable rubbish will, in time, release large amounts of nutrients into the soil and provide ideal conditions for the establishment of dumped weeds. The greatest concern is the dumping of grass clippings most often by residents but also by unscrupulous lawn maintenance contractors. Grass clipping will almost invariably lead to the dispersion of seeds and invasion of grassy weeds for several metres into bushland. The following steps are recommended in instances of rubbish dumping in bushland areas (also refer Section 2.2.13):

- Non-compostable rubbish – remove all material from dumped site whilst avoiding any damage to living plants amongst or around the dumped area and ensure that the ground surface is cleaned of any contaminants;
- Exercise caution and involve special procedures with regard to the removal of sharp objects, discarded syringes, broken glass, toxic materials and asbestos;
- Compostable rubbish – remove all garden waste including grass clippings and ensure that any dumped sand/soil is also removed;
- The cleaned site is to monitored for weed emergence and any emergence promptly controlled;
- Install appropriate signage that will
    - Declare the site as a conservation area awaiting rehabilitation
    - Prohibit the dumping of further rubbish
    - Provide a City contact number for options on preferred disposal of green waste and non-compostable matter;

- Design a brochure that would explain the environmental harm sustained by natural areas from rubbish dumping and seeking public cooperation in preventing the problem; and
- Identify all similar 'hot spots' throughout the City and carry out a letter drop around affected neighbourhoods requesting cooperation in avoiding the dumping of green waste and to advise their contract gardeners of the need for the same compliance.

11.15 Overcoming Vandalism

This consists of a wide range of activities and may be divided into damage to physical infrastructure and damage to biotic elements of the bushland. Physical damage includes damage to gates, fences, signage, access tracks, etc. Damage to biotic elements involves, amongst others, tree felling for timber, excavation and removal of grass trees and intentionally setting the bush alight. The huge costs incurred each year in post vandalism remediation could impinge on funding resources that could otherwise be for much needed conservation works.

11.16 Preventing Illegal Removal of Plant Material

The removal of plant material can range from removal of entire plants (e.g. grass trees) to removal of parts of plants such as wildflowers, fruits and seeds, cut portions of living stems/ branches, bark and fallen wood. The removal of wildflowers, fruits and seeds, if allowed to continue uncontrolled, could eventually deplete the regenerative potential of a bushland site. The removal of other material can upset certain components of the bushland ecosystem for example, bark and fallen wood which form valuable habitat niches for numerous insects that are themselves the food source for various insectivorous birds.

Recommendations:

30. That due regard be given to the identification and elimination of all threatening processes and disturbance factors affecting natural areas so that biodiversity values may be preserved (as per Section 11) and that this be reflected in (1) site specific conservation plans and (2) annual resource allocation for conservation.

12. STRENGTHENING LOCAL BIODIVERSITY

12.1 Development of Regional and Local Ecological Linkages

Fragmentation and isolation of many natural areas in the urban environment is threatening the long-term viability of several of the larger natural areas in the urban environment and has rendered many smaller areas almost unsustainable (City of Stirling 2003). The effects of fragmentation are reduced connectivity between natural areas due to loss of habitat and the decline in the movement and survival of species. Where clearing for development has reduced natural areas to small unviable patches, plant and animal species may be deprived of sufficient resources and appropriate mechanisms to complete their life cycles.

This is crucial where key species or indicator species are involved to the extent that it impacts on various dependent species and even the entire ecological community (City of Stirling 2003). It is particularly acute with plants and animals that do not disperse easily therefore strategies aimed at preserving biodiversity must of necessity include measures to facilitate such dispersal (City of Stirling 2003). Valid and effective mechanisms to ensure this must include the creation of ecological linkages both at the Regional and local levels.

Plate 7 - Cottonwood Crescent Bushland: an example of a bushland of the Karrakatta Central and South Vegetation Complex over Spearwood Dunes (photo by Daniel Rajah 2002)

12.1.1 Regional Ecological Linkages

The concept of Regional ecological linkages is based on the identifying movement corridors linking Regionally Significant Natural Areas with each other via strategically located Local Natural Areas (LNAs). The LNAs thereby act as 'stepping stones' in these linkages. To be most effective it would be prudent to ensure that Regional ecological linkages contain LNAs in good condition and that they incorporate varied ecological

communities e.g. bushland, wetland and coastal dunes so that these links are utilized by the widest range of flora and fauna.

In assessing the City's natural areas, particular attention was given to those LNAs that are viable and that have the potential to serve as 'stepping stones' in Regional ecological linkages. Apart from viability criteria already discussed above, local knowledge of traditional fauna movements, known habitat preferences, fauna breeding patterns and potential avenues for species mobility and dispersal were also taken into account.

Reference is made to Maps 1 to 5 which show the Regional ecological linkages within the City of Stirling. These have been arbitrarily defined by the Perth Biodiversity Project (PBP) Unit of Western Australian Local Government Association (WALGA) as part of a total assessment of the Perth Metropolitan Region. (Note: Definition of the Regional ecological linkages has involved input from the Regional Parks Unit of the Department of Environment and Conservation and the Department of Planning and Infrastructure. It has also taken into consideration previous concepts of Regional ecological linkages viz. Bush Forever plan (Government of WA 2000b), Perth Greenways report (Tingay & Assoc 1983) and the Environmental Protection Authority's System 6 report (Department of Conservation & Environment).

The PBP data on Regional ecological Linkages has been the basis of the City's assessment of its own natural areas and has been particularly beneficial in identifying the location and alignment of these linkages within the City of Stirling. (Note: The data supplied by PBP is in the form a GIS dataset titled Perth Metropolitan Region - Regional Ecological Linkages. The data is spatially represented and defines intended primary linkage lines between Regionally Significant Natural Areas together with a 250 metre inclusion zone on either side of the primary linkage line thereby creating an effective corridor of 500 metres. This width of 500 metres is the minimum advocated to capture as many viable LNAs as possible within the intended ecological linkages).

12.1.2 Local Ecological Linkages

The function of local ecological linkages is to link Locally Significant Natural Areas (LSNAs) with each other either through directly identifiable linkages or via strategically located Local Natural Areas (LNAs). Similar to Regional ecological linkages, maximum benefit is derived from (1) inclusion of as many natural areas as possible within each linkage and (2) maximizing the number of connections to each natural area. By this process, local ecological linkages can be expected to play an important part in improving the viability of many natural areas that are currently too small or too degraded to survive on their own. In assessing the City's natural areas the following attributes were considered crucial to the success and effectiveness of local ecological linkages:

- Presence of continuous corridors of well structured local native vegetation as wide as possible (minimum 100 metres);
- Selection of appropriate LNAs as 'stepping stones' where continuous corridors do not exist and the inclusion of as many 'stepping stones' as possible;
- Natural area size to be no less than 1 hectare (where possible) and maximum distance between natural areas to be no greater than 1000 metres;

- Linkages to include of as many ecological communities and as much vegetation structural complexity within each linkage to maximize usage by diverse fauna and flora;
- Each natural area to have as many linkages (incoming and outgoing) as possible and in diverse direction across the landscape so as to improve connectivity within the local area;
- Inclusion of natural areas occupying high vantage points in the landscape and that offer direct line of sight to other natural areas;
- Inclusion of riparian vegetation along water ways or open canals, along median strips of the City's major road network and along coastal dunes;
- Inclusion of Bushland Reserves
- Inclusion of Wetlands and Associated Transitional Zones
- Inclusion of Coastal Dune Systems and Associated Vegetation

12.2 Conservation of Wetlands and Buffers

As previously discussed under Section 6.5.5 the conservation of wetlands is integral to the protection and perpetuation of biodiversity in the local region. Apart from definable wetland areas there is often a transition of vegetation communities from wetland to upland which can be just as diverse floristically and in terms of habitat opportunity. Additionally, the ephemeral nature of many wetlands attracts the migration of diverse assemblages of fauna with habitat preferences or feeding opportunities based on such seasonal changes. Wetlands are also biologically productive areas because of their role in nutrient recycling and as such may be recognized as local centers of biodiversity expression.

Reference is made to the City's Draft Wetlands Protection Policy that sets the terms of reference for further development in a number of strategy areas however within the context of biodiversity conservation the following measures are recommended to ensure that wetlands are recognized for their biodiversity values and afforded the appropriate levels of protection.

- The recognition of wetlands for their importance in providing secure habitats for wildlife, expression of species diversity and richness, preservation of cultural and ethnic history, preservation of groundwater reserves and as a resource for public interest and education;
- The incorporation of wetlands as conservation zones in their own right within reserves under the next scheduled amendment of Local Area Scheme 3 to fully reflect the intent of the Environmental Protection (Swan Coastal Plain Lakes) Policy of 1992;
- The demarcation of naturally occurring wetland buffer zones of transitional vegetation wherever these are identified around wetlands and to include these for particular attention under the City's natural areas conservation programme;
- Any intent to re-zone wetland catchments to be subject to scrutiny with regard to the retention of adequate buffer zones (desirable minimum 50 metres recommended), the compatibility of intended land around wetlands, the likelihood of polluting sources being introduced, the likelihood of vegetated floodplains being filled in and transitional vegetation being cleared;
- The adoption of principles governing Integrated Catchment Management in the management of wetland catchments to ensure that the various forms of land use

do not impact on wetlands in terms of the discharge of pollutants (nutrients, herbicides, pesticides, hydrocarbons, phenols, heavy metals), the depletion of groundwater reserves due to insufficient aquifer recharge to meet abstraction rates, the acidification of soils particularly in Class 1 Acid Sulphate Soils areas, the residual contamination of soils from previous landfill activity, the erosion of soils from clearing of buffer vegetation and the burning of areas of transitional vegetation;

- The development of site specific management plans to resolve the issues confronting wetlands themselves viz. major threats to diversity and ecological sustainability posed by buoyant, benthic, emergent and other aquatic weeds, nutrification, unfiltered stormwater runoff, acidification of wetland soils and the continued presence of feral/ pest animals and birds;
- The development of separate Citywide strategies to comprehensively deal with (1) stormwater management and (2) acid sulphate soils owing to the relevance of these issues to all natural areas;
- The adoption of Water Sensitive Urban Design in the management of stormwater drainage to ensure that bio-filtration and containment of gross pollutants and pollutant laden sediments and to enable bio-filtration and groundwater conservation;
- The establishment of clear emergency management protocols to deal with accidental events (viz. chemical spills, oil spills, sewerage discharge) to ensure that impacts on wetlands are contained or minimized;
- The development of an Industry Policy and its incorporation within the Local Area Scheme to ensure that clear guidelines and compliance mechanisms are in place to deal with point source pollution within industrial or commercial catchments.

12.3 Conservation of Coastal Landform

The coastal landform and associated vegetation provides an added dimension to biodiversity conservation as it provides a variety of habitat niches for wildlife. The linear orientation of the coastal strip lends itself conveniently as a movement corridor for a several species of migratory wildlife. For ecological linking to occur to its fullest extent an integration of all natural areas is vital. In this regard the linear orientation of coastal dunes offers possibly some of the best opportunities for linking of the City's north-south chain of wetland and bushland.

The City's coastline covers 6.5 kilometers and stretches from the Peasholm Street Dog Beach northwards to Watermans Bay. South of Trigg Island, the City's coastline consists of sandy beaches flanked by dunelands where parabolic dunes occur ranging from 6,000 years (mid to late Holocene period) to the most recent. These dunes have been deposited over several episodes over an older lithified dune field. North of Trigg Island, the lithified dune field outcrops as coastal limestone reefs, rock platforms and cliffs thereby resulting in a rocky coastline interspersed with small bay beaches (City of Stirling 1984).

The above variations in coastal landform largely determine the vegetation associations and habitat opportunities. Vegetation on coastal landforms are typically of xerophytic and halophytic species that are tolerant of strong prevailing winds, salt spray, shifting growth substrates and low soil moisture conditions. Vegetation associations in the sandy dunes south of Trigg Island consist of Open Succulent Grassland on the primary foredunes, Open Tussock Grassland behind the frontal dunes, Low Open Shrubland on

the ocean side of the secondary dunes and Closed Heath and Open Scrub on the extended dune field and blowouts leeward of the secondary dunes. Vegetation associations north of Trigg Island on the other hand are more diverse and may be divided into Spearwood Sand Heath and Quindalup Dune Scrub. The former is typical of the more fertile yellow sands on Tamala limestone whilst the latter being less fertile reflects similar vegetation patterns to that of the sandy dunes south of Trigg Island.

The value of vegetation on coastal soils is its ability to reduce erosion. Without the stabilizing influence of widespread root systems and dense ground cover afforded by several coastal plant species, mush of the exposed dune surfaces would rapidly erode.

Apart from the effects of localized erosion on the biodiversity of the coastal zone, realistic conservation strategies must appropriately deal with long term changes in the shoreline configuration due to fluctuations on sediment supply and transport. These fluctuations usually occur in response to periodic variations in atmospheric and oceanographic conditions. Atmospheric changes include those related to the number, intensity and duration of coastal storms and associated storm winds. Oceanographic changes are related to atmospheric conditions but specifically include variations in mean sea level, regional wave regimes and near shore current patterns (City of Stirling 1984).

Reference is made to the City's Coastal Planning Strategy (Coastal Report of 1984 and Review of the Coastal Report of 1996) and also to the City's Green Plan 2 (Strategy for the Conservation of Urban Bushland to Promote Biodiversity) that detail conservation measures for coastal dunes and beaches along the 6.5 kilometers of the City's coastline. For management purposes, the coastline has been defined into the following discrete management nodes:

- Peasholm Street Dog Beach
- Brighton Beach
- Scarborough Beach
- South Trigg Beach
- Trigg Beach
- Bennion Beach
- Mettams Pool
- Hamersley Pool
- Marine Laboratory Foreshore
- Watermans Bay Beach

Key strategy elements for each of the above beach locations should include the following:

- Assessment of risks and areas of vulnerability that may expected under various climate change scenarios and the development of remediation strategies to protect the integrity of coastal landforms;
- Containment of sand drift and dune consolidation by the adoption of mechanisms that would complement the natural and visual environment;
- Appropriate delineation of recreational nodes and public movement corridors and protection from edge effects;
- Eradication of invasive plants, non local species and other weeds and the control of pest animals;

- Restoration of coastal plant diversity in sympathy with the prevailing conditions of the diverse coastal landforms and the predominant vegetation associations;
- Diversification of wildlife habitation by the restoration of the original vegetation associations specific to the coastal landforms; and
- Public education and awareness of the importance of protecting and restoring the City's diverse coastal landforms.

12.4 Designation of Ecozones on Selected Parkland

The concept of Ecozones is a' bi-product' of the City's Groundwater Conservation Strategy. Through this strategy, a scheme was introduced for differential watering of irrigated parks and reserves in an effort to reduce the demand on groundwater abstraction. Differential watering means irrigating different parts of parkland reserves at varying rates appropriate to the type of recreation that takes place, the intensity of recreation usage and the expected wear and tear on the turf surface from such usage. Passive recreation areas, for instance, would require lower rates of watering in comparison to areas where competitive sports are played. Public movement corridors and building surrounds would require even less rates of watering (Note: the scheme also factors in seasonal variations in watering rates depending on climatic patterns of precipitation and evaporation and the resulting conditions of soil moisture).

In the formulation of a differential watering scheme for each irrigated reserve, areas not needed for any direct form of recreation are identified. Such areas normally occur around the periphery of reserves. These areas are then converted into ecozones or areas for the planting of local native trees, shrubs and groundcover. Ecozones may therefore be defined as areas relinquished off recreational parks and reserves for the establishment of fully structured local native plantings. Areas thus designated are excluded from any form of irrigation, eradicated of all turf, soils loosened to remove compaction, heavily mulched and conditioned in preparation for planting.

Whilst, adopted as part of the City's Groundwater Conservation Strategy, ecozones are actually synonymous to ecological inks advocated in the City's Green Plan 2 (Strategy for the Conservation of Urban Bushland to promote Biodiversity) and may be summarized as follows:

- Advocated as part of groundwater conservation strategy;
- Conversion of non-recreation areas on reserves for local native plantings;
- Considered a valuable part of local ecological links; and
- Could include amalgamation of small currently unviable bush blocks on recreational parkland.

12.5 Encouraging Wildlife Habitation

From earlier discussion under Section 3.2, it is already evident that the diversity of animal life is inter-dependent or linked to an equally diverse range of plant communities and species being present. Many local native insects, birds, reptiles, amphibians and other animals have co-evolved with local native plant species and thereby occupy established niches within their respective ecosystems. In addition to food preferences, numerous hollows of mature as well as dead and decaying trees could be inhabited by birds such as kingfishers, pardalotes and tree martins. Other examples include the

under-storey of Banksia woodland being inhabited by jewel beetles; honey eaters and honey possums amongst Banksia and Grevillea and the extensive use of Tuart woodland by parrots and galahs.

Particularly important is the preservation of habitat, foraging areas, movement corridors and 'stepping stones' specific to Specially Protected Fauna (rainbow bee-eater) and those already listed as Endangered (viz. Carnaby's black cockatoo) and Vulnerable (viz. Baudin's black cockatoo). Pertaining to the latter two species the conservation of all that is remaining of the Cottesloe Central and South and the Karrakatta Central and South Vegetation Complexes is critical.

It is therefore compelling, from the principles discussed earlier of species specificity and habitat preference, to incorporate habitat creation as part of measures to conserve natural areas and to ensure that conservation effort is realistically translated into usable habitat space and resources. In essence, the range and diversity of wildlife habitation could be used as convenient success indicators of any natural area conservation programme. Specific habitat enhancement measures should include the following:

- Population surveys of fauna to determine what already exists in our natural areas and to what extent (in other words, a measure of species diversity and richness);
- Surveys need to be class specific for mammals, reptiles, amphibians, avian fauna and others;
- Determine whether any fauna discovered are from isolated populations or from inbred populations as this could influence what protection measures are adopted;
- Determine rarity of any fauna discovered and the sustainability of the population;
- Determine habitat preferences (in particular reference to Carnaby's Black Cockatoos, determine native plant species/ communities preferred for feeding and as roosting sites);
- Identify threats to any fauna discovered and outline abatement programmes;
- Undertake the removal of threats and disturbances to habitat areas (bushland, wetland, coastal dunes);
- Undertake the control of feral animals that could otherwise usurp valuable habitat space and resources;
- Implement a realistic control programme for domestic animals (as per the City's Dog and Cat Control Local Laws);
- Consult the Fauna Rehabilitation Centre for added statistics on cases referred to them for an indication of susceptible fauna types and geographical locations;
- Consult local 'Friends of' and Coastcare groups for reserve specific knowledge of fauna sightings in terms population trends and movements;
- Capacity build the City's natural area conservation staff and interested members of community conservation groups to undertake fauna identification by the provision of appropriate training; and
- Plan and implement periodic public awareness programmes on the diversity of local fauna through activity based site excursions supplemented by other mechanisms such as interpretative signage, website information, brochures, factsheets, static and interactive displays at the Henderson Environmental Centre.

Recommendations:

31. That the concept of regional and local ecological links as advocated in Section 12.1.1 be adopted and that opportunities be investigated and mapped for the inclusion of as many Local Natural Areas (LNAs) to provide connectivity and 'stepping stones' in the linking process.

32. That wetlands and their buffer zones/ transitional zones be recognized as integral to the protection and perpetuation of biodiversity and that these sites are afforded due conservation status as part of the City's management of its natural areas.

33. That further to Recommendation 33 above, the City undertakes the development of a Wetlands Protection Strategy as an extension of the current draft Wetlands Protection Policy.

34. That coastal landform and associated vegetation be recognized for their significance in providing an added dimension to biodiversity conservation in term of the habitat opportunities and potential for ecological linking and that these sites are afforded due conservation status as part of the City's management of its natural areas.

35. That further to Recommendation 35 above, the City proceeds to review its Coastal Planning Strategy (Coastal Report of 1984 and Review of Coastal Report of 1996).

36. That further to Recommendation 35 above, the City proceeds to implement the recommendations of Coastal Foreshore Action Plans Parts 1 and 2.

37. That further to Recommendation 35 above, the City undertakes an assessment of risks and vulnerability in expectation of impacts under various climate change scenarios with the view to the development of adaptation and remediation strategies to protect valuable coastal landforms.

38. That the implementation of Ecozones as part of the City's Groundwater Conservation Strategy be endorsed as this is synonymous to the establishment of local ecological links as advocated in Green Plan 2 (Strategy for the Conservation Urban Bushland for the Promotion of Biodiversity) and that this be reflected in the City's Million Trees Programme.

39. That the conservation of natural areas be recognized as integral to promoting wildlife diversity by the habitat niches, feeding opportunities and movement corridors that these areas provide and that this be reflected in site specific conservation plans for Bush Forever sites and LSNAs.

40. That further to Recommendation 37 above, particular focus be attached to the protection and retention of all remaining Vegetation Complexes critical for the survival of Specially Protected Fauna and those listed as Endangered and Vulnerable.

13 COMMUNITY FOCUS ON BIODIVERSITY

In most cases, biodiversity conservation involves the management of human activity in the way that it impacts the natural environment rather than having to provide any direct requirement of ecosystems. By far the majority of threats and disturbances are human induced. Conservation measures must therefore seek to engage the community in ways to endear public sentiment towards protecting and enhancing biodiversity and not destroying it. Overcoming public apathy and soliciting community support is a huge challenge but nevertheless a worthwhile objective and perhaps the most effective way of resolving many of the human related conflicts in the conservation of natural areas. The key question is 'how do we change people's mind sets and bring about behavioral change so that biodiversity conservation becomes just as equally valued as all the other core values of society'.

At the other end of the spectrum there are many members of the community who recognize the plight of natural areas and the growing threats to biodiversity and who through various community based conservation groups continue to work tirelessly on a volunteer basis at various conservation sites of the City. Their efforts have to be recognized and promoted as positive examples of how the general community can become engaged in protecting and promoting biodiversity. However the challenge of instilling these values on the broader community needs a 'whole of community' focus involving all facets of the public and private sector. Additionally, any realistic strategy to sustain these values into the future must target all age groupings in order to perpetuate an ongoing inter-generational response. The ensuing chapters consider key elements of what is required to ensure that biodiversity values can assume a greater focus in the community into the future.

13.1 Survey of Public Perceptions

Community surveys serve to capture public perceptions and current thinking on the environment and related matters and to be able to refine strategies and effectively respond to public need or concern. Appropriately designed surveys conducted periodically could be useful in soliciting judgments on core community values, on whether prioritization of these values has changed over time and on whether protection of the natural environment is featured amongst these core values.

Surveys are also useful in determining the effectiveness of the City's interpretation initiatives, whether this has resulted in greater awareness and behavioral change and whether there are more effective ways of reaching out to the community to get essential messages across. Specific survey elements could include the following:

- People's understanding of what biodiversity is;
- The importance of biodiversity and why it is important to protect and preserve it;
- People's awareness of the plight of natural areas in the urban environment and threats to biodiversity;
- People's comprehension of the environmental consequences of biodiversity loss;
- Whether people are willing to do something about resolving threats to biodiversity and if so, what exactly;
- What changes have people made in their home environment or property surroundings that will benefit the environment generally; and

- What are people prepared to forego in terms of community facilities to ensure greater resource allocation towards biodiversity conservation.

Types of surveys could include the following:

- On line via the City's website;
- Return postal surveys sent out with annual rates notices;
- Oral surveys or polls at major community events; and
- On-site visitor surveys at key conservation sites.

13.2 Creating Awareness

Creating awareness means (1) promoting the essential environmental/ conservation messages that we want the community to receive together with the rationale and (2) providing the incentives for acceptance of the essential messages and the motivation for behavioral change. As people are better informed they become more accepting of the need to change and more supportive of conservation initiatives of the City.

Usual community education methods tend to rely on passive techniques such as brochures, factsheets, press articles and signage. Such techniques are however limited in their effectiveness and, at best, reach out only selected audiences. Such techniques do not truly appeal to the public in terms of the much needed conversion of values nor do they engage the community in ways to interest and encourage participation. What is needed has to be something beyond brochures and signage. What is needed is something more dynamic and inclusive with regard to engaging the community.

Traditional education models have for many years been based on 'knowledge centered learning' with reliance on providing as much knowledge as possible to create awareness and understanding in the hope that this will bring about desired behavioral change (Harris 2009). Revised models rapidly being adopted in several schools advocate an 'action centered learning process' that is very much values focused to achieve the same objective. 'Action centered learning' is all about providing values changing experiences through field observations and activities designed to motivate self-search for greater knowledge as a way towards conversion and behavioral change (Harris 2009). This does not in any way discount the uses of passive techniques but rather to suggest that these be integrated with 'action centered leaning' to develop a comprehensive approach to community education.

The following outlines the techniques that could possibly be integrated with 'action centered learning':

- Static and interactive displays at the Henderson Environmental Centre on biodiversity related themes;
- Conducted tours for the general public of some of the City's biodiversity conservation sites;
- Establishment of links to the City's website with respect to
    - General information on biodiversity – why important to conserve;
    - The status of biodiversity in the City of Stirling;
    - Common threats and disturbances encountered in biodiversity sites
    - Photo library of flora/ fauna
    - Photo library of weeds
    - Details of the City's regeneration/ re-vegetation programs

    - Opportunities for community involvement - how you can help hotline
- Compilation of a Biodiversity Information Pack for distribution to schools and the general community - the pack to contain ideas on what people can realistically do to assist with the City's biodiversity conservation effort;
- Entail the assistance of community conservation groups and also community/ ratepayer organizations in promoting essential environmental/ conservation messages;
- Development of brochures/ factsheets on specific biodiversity related issues and their effective dissemination;
- Development and installation of interpretative signage at appropriate conservation sites; and
- Feature articles on biodiversity in the local press via Stirling Scoop.

13.3 Community Engagement

Engaging the community means instilling a sense of ownership through the development of partnerships and alliances. It is the key to community acceptance of environmental initiatives and the long-term success of strategy implementation. Further, it represents investment into social capital on an inter-generational scale through which perpetuation of environmental values may be engendered. How do we engage the community? The following are some considerations for the City:

- Recognition of community based conservation groups for their
    - Possession of historical and intellectual resources;
    - Scientific knowledge of local sites;
    - Countless hours spent in on-ground conservation work;
    - Voice of the general community with respect to environmental issues;
    - Advocacy with the City for community acceptance of environmental initiatives;
- Resourcing of local conservation groups in terms of
    - Comprehensive insurance cover whist engaged on City managed sites;
    - Orientation in Occupational Health and Safety matters;
    - Provision of appropriate tools and equipment;
    - Capacity building as appropriate to enhance working relationship with the City;
- Involvement in conservation planning particularly with regard to
    - Determining local and regional conservation priorities;
    - Selection of conservation sites;
    - Gathering of base-line surveys;
- Involvement with work programmes with respect to
    - On-site discussion of annual work programmes;
    - Logistics for the implementation of specific programmes;
- Inviting feedback from local conservation groups regarding
    - Review of the effectiveness of past programmes/ projects;
    - Analysis of how 'things could be done better;
- Soliciting general community feedback with regard to;
    - Environmental issues and concerns;
    - What are initiatives that the City should implement that would most likely get community support;
    - Perceptions on what the City is doing well.

13.4 Environmental Interpretation

Interpretation in this context means to elaborate those aspects of the environment that we seek the community's understanding on. Effective interpretation not only deals with the different facets of the environment with its complexities and related processes but also factors in past anthropogenic links and the consequences of those links in the current state of the environment. It also considers the implications of those links into the future under various environmental, economic and social scenarios. Desirably, the first step in the process would be to identify what needs to interpreted and then to employ mechanisms as appropriate to communicate those aspects to the community. Possible aspects for interpretation could be identified partly through surveys of public perceptions and interests as discussed earlier. The following are important aspects that should be included in future interpretation programs with particular reference to biodiversity conservation:

- Vegetation complexes and their extent;
- Floristic communities including those that are threatened or endangered;
- Vegetation structure and condition;
- Ecosystem elements and processes; and
- Ecological links.

Recommendations:

41. That the importance of community engagement be recognized as integral to the successful implementation of recommendations of the Local Biodiversity Strategy and in establishing biodiversity as a core community value and that this be reflected in the development an annual schedule for community engagement activities.

42. That further to Recommendation 40 above, a survey of community perceptions be undertaken to gauge people's understanding of biodiversity and the threats confronting natural areas (as per Section 13.1).

43. That innovative ways be adopted to create community awareness about the plight of natural areas in the urban environment and that this involve some aspect of 'activity based learning' (as per Section 13.2).

44. That opportunities be explored to engage the community in ways that will engender acceptance and ownership of conservation initiatives (as per Section 13.3).

45. That further to Recommendations 42 and 43 above an environmental interpretation programme be developed to support the City's conservation initiatives.

46. That further to Recommendations 41, 42, 43 and 44 above, renewed consideration be given to the provision of vital staffing resources at the Henderson Environmental Centre to enable the planning and implementation of community engagement and environmental interpretation programmes.

Part D:
Implementation Plan

PART D:
IMPLEMENTATION PLAN

14. STRATEGY IMPLEMENTATION

14.1 Schedule for Implementation of Recommendations

Actions Required and Desired Outcome	Responsibility for Action	Targets or Success Indicators	Timeframes
1. That the Local Biodiversity Strategy be incorporated into the Sustainable Policy of the City of Stirling to strengthen impetus and policy direction under the Natural Resource Management framework.	Economic Development & Urban Regeneration	Incorporation into Sustainable Policy	Complete
2. That the following definition of biodiversity be adopted - Biodiversity refers to the numerous plants, animals and other organisms that make up natural ecosystems (e.g. bushland, wetland or coastal dune) and the part these organisms have in the sustainability of ecosystems by their interdependence and survival links to each other; the greater the biodiversity of a given ecosystem (as measured by the number of separate species per unit area) the greater is the capacity of that ecosystem to sustain itself and to withstand various environmental and human induced threats and pressures (as per Section 3.1).	Council	Adoption by Council	April 2010
3. That the importance of conserving biodiversity for the following values be recognized – 'the creation of soils and maintenance of soil quality; maintenance of air quality; maintenance of water quality; natural control of pest populations; assimilation, detoxification and decomposition of wastes; pollination for natural regeneration and economic crop production; stabilization of climate and moderation of extreme weather patterns; prevention and/ or mitigation of natural disasters; ensuring food security for human survival; provision of natural resources for human health care; ensuring income generation and economic growth; and retention of spiritual/ cultural values' (as per Section 3.2).	Council	Adoption by Council	April 2010
4. That the following be adopted as the City's broad vision for biodiversity conservation – 'to establish local biodiversity as a core community value'.	Economic Development & Urban Regeneration	Incorporation into Sustainable Policy	June 2011
5. That the biodiversity vision statement be supported on the basis of the following principles (as per Section 5.1): • All ecological communities locally represented must be protected to ensure retention in perpetuity. • The conservation of locally significant natural areas is just as important as those that	Parks & Reserves	Adoption by Council	April 2010

are regionally significant. • Natural ecosystems must be given the opportunity to naturally regenerate before resorting to revegetation. • The highest biodiversity value natural areas should be given greater conservation priority over other areas. • Threats to natural ecosystems are mostly human induced; conservation strategies should therefore be based on this assumption. • The conservation of natural areas as a legitimate form of land use must be recognized to ensure protection of these areas. • Community engagement is vital to perpetuating biodiversity into the future. • The conservation of natural areas must of necessity adopt a long-term perspective.			
6. That the adoption of the standard assessment templates developed by the Perth Biodiversity Project of the Western Australian Local Government Association for assessment of the City's natural areas (Natural Area Initial Desktop and Field Assessments – as per Appendix IV) be endorsed.	Parks & Reserves	Endorsement by Council	April 2010
7. That the standard assessment templates be adopted as the basis for all future updates on the condition of the City's natural areas surveyed thus far and for the condition assessment of sites yet to be surveyed.	Parks & Reserves	Adoption by Council	April 2010
8. That Natural Area Condition Targets based on ecological criteria as outlined under Section 6.5 of the Local Biodiversity Strategy be adopted for the assessment of Local Natural Areas (LNAs) to determine local significance and re-classification of such sites as Locally Significant Natural Areas (LSNAs).	Parks & Reserves	Adoption by Council	April 2010
9. That the City's Resourcing Targets and Management Action Targets for LNAs be based on further criteria for the estimation of Viability as outlined under Section 6.6 and as per the Natural Area Initial Summary Template under Appendix IV.	Parks & Reserves	Completion of Viability assessments for LNAs	June 2011
10. That the status of City managed Natural Areas (bushland reserves) with respect to Vegetation Complexes and Vegetation Condition as per Table 7 be received.	Parks & Reserves	Council to Receive status of Natural Areas	April 2010
11. That the matter of outstanding assessments of City managed Natural Areas (vegetated wetlands and coastal dunes) as per Tables 8 and 9 be the subject of funding allocation over subsequent budget programmes with the view to Ecological Significance of these sites being determined.	Parks & Reserves	Completion of outstanding NAIA assessments	June 2013

12. That the matter of outstanding assessments of Natural Areas managed by other authorities/ agencies or those privately held as per Table 10 be the subject of further negotiations with respective managers/ owners with the view to Ecological Significance of these sites being determined.	City Planning	Completion of outstanding NAIA assessments	June 2015
13. That the findings of field surveys on biodiversity condition be received with respect to the following as per Sections 8.1 and 8.2: • The regional and local significance of several of the City's natural areas (eight Regionally significant and 21 Locally Significant Natural Areas identified); • The number of Vegetation Complexes present (five identified) and their extent (all greatly under-represented in comparison to their pre-European extent).	Parks & Reserves	Council to receive	April 2010
14. That as part of the field surveys of biodiversity condition, the site assessments at the Floristic Community level be received with respect to the following as per Sections 8.3 & 8.4: • No Threatened Ecological Communities (TECs) discovered on bushland reserves surveyed; • Two (2) Declared Rare Flora (DRFs) discovered at two separate reserves; • 18 Priority Species of flora (Priority 1, 2, 3 & 4) discovered at 15 separate reserves; • The discovery of one Specially Protected fauna, one Endangered fauna and one Vulnerable fauna.	Parks & Reserves	Completion of update surveys when next due (5 years from initial surveys)	Dec 2012
15. That further to Recommendation 14, a listing of typical flora and fauna be formulated for each of the five Vegetation Complexes discovered to enable a more complete profiling of these Complexes.	Parks & Reserves	Completion of flora fauna listings for each vegetation complex	Dec 2010
16. That considering that all Vegetation Complexes discovered within the City are under represented relative to their pre-European extent, the retention and protection of all Local Natural Areas (LNAs) be advocated in recognition of their values towards ecological linking and promotion of biodiversity in this part or the Region.	City Planning	Incorporation into Local Planning Scheme to be completed	December 2012
17. That prioritization and resource allocation for the conservation of natural areas is to be based in order of (1) Regionally Significant Natural Areas, including Bush Forever sites, (2) Locally Significant Natural Areas and lastly (3) Local Natural Areas.	Parks & Reserves	To be reflected in annual operational and capital works budgets	June 2011
18. That prioritization for the conservation of Locally Significant Natural Areas (LSNAs) is to be based on these sites further meeting Essential and/ or Desirable Criteria as per Sections 6.6 and 9.1 and Table 13.	Parks & Reserves	To be reflected in annual operational and capital works budgets	June 2011

19. That prioritization for the conservation of Local Natural Areas (LSNAs) is to be further based on these sites being assessed for Viability assessments as per the Natural Area Initial Summary Template as per Appendix IV.	Parks & Reserves	To be reflected in annual operational and capital works budgets	June 2010
20. That further to Recommendations 20 and 21, site specific conservation plans be prepared for LSNAs thus prioritized.	Parks & Reserves	Conservation plans for LSNAs to be completed	February 2011
21. That with regard to the current representation of Vegetation Complexes within the City, the goal of 10% (Essential Criteria) and 30% (Desirable Criteria) retention of the pre-European extent be endorsed.	Council	Council to endorse	April 2010
22. That with the regard to current representation of Vegetation Complexes within the City, representational targets be established (as per Table 18 and Figure 3) to ensure that no further loss of native vegetated areas are incurred and the all existing remnants are protected and retained.	Council	Council to endorse	April 2010
23. That Council's previous resolution of the 20 April 1993 be reiterated to recognize urban bushland on reserves as defined by Green Plans 1 and 2 as 'Local Authority Reservations – Urban Bushland' on the City's Scheme maps and that this outstanding resolution be urgently incorporated as a scheme amendment within Local Planning Scheme 3, the draft of which is currently undergoing adoption and gazettal.	City Planning	Incorporation into Local Planning Scheme	December 2012
24. That due regard be given to regulations enacted in 1995 under the Environmental Protection Act (1986) that prohibit clearing of native vegetation for any purpose without a permit unless the clearing is for an exempt purpose and that this be incorporated as part of the City's internal processes and procedures pertaining to land use planning and reserves management.	Parks & Reserves	Incorporation into City's development approval procedures	Perpetual
25. That the opportunity for the dedication of 'Green Belts be investigated in the future District Planning Reviews of the City's to enable the establishment of regional and local ecological links (as per Section 10.2.3).	City Planning	Identification of 'Green Belts' in future District Planning Reviews	Perpetual
26. That the opportunity for reservation of natural areas under future land development subdivisions be investigated early in the planning stages through the formulation of precinct based Structure Plans (as per Section 10.2.4).	City Planning	Incorporation into City's planning procedures	Perpetual

27. That Council's precious resolution of the 20 April 1993 be reiterated with respect to the acquisition of natural areas on private lands (as per Section 10.2.5) to recognize areas with biodiversity values wherever they occur within the City regardless of land tenure and to acquire for the purpose of reservation, where possible, with fair compensation to land owners or other equitable mechanisms (as per Sections 10.2.6 and 10.2.7).	City Planning	Incorporation into Local Planning Scheme	Perpetual
28. That a review of relevant sections of the Local Planning Policy be undertaken with the view to the strengthening of current provisions for the retention and protection of natural areas and associated biodiversity values (as per Section 10.3).	City Planning	Completion of review of Local Planning Policy	December 2012
29. That due regard be given to the identification and elimination of all threatening processes and disturbance factors affecting natural areas so that biodiversity values may be preserved (as per Section 11) and that this be reflected in (1) site specific conservation plans and (2) annual resource allocation for conservation..	Parks & Reserves	Completion of site-specific conservation plans for LSNAs	August 2011
30. That the concept of regional and local ecological links as advocated in Section 12.1.1 be endorsed and that opportunities be investigated and mapped for the inclusion of as many Local Natural Areas (LNAs) to provide connectivity and 'stepping stones' in the linking process.	Parks & Reserves	Identification and mapping of local ecological links	December 2015
31. That wetlands and their buffer zones/ transitional zones be recognized as integral to the protection and perpetuation of biodiversity and that these sites are afforded due conservation status as part of the City's management of its natural areas.	Parks & Reserves	Council to adopt principle	April 2010
32. That further to Recommendation 33 above, the City undertakes the development of a Wetlands Protection Strategy as an extension of the current draft Wetlands Protection Policy.	Parks & Reserves	Completion of strategy	September 2011
33. That coastal landform and associated vegetation be recognized for their significance in providing an added dimension to biodiversity conservation in terms of the habitat opportunities and potential for ecological linking and that these sites be afforded due conservation status as part of the City's management of its natural areas.	Parks & Reserves	Council to adopt principle	April 2010
34. That further to Recommendation 35 above, the City proceeds to review its Coastal Planning Strategy (Coastal Report of 1984 and Review of Coastal Report of 1996).	City Planning	Completion of review	December 2015
35. That further to Recommendation 35 above, the City proceeds to implement the recommendations of Coastal Foreshore Action Plans Parts 1 and 2.	Parks & Reserves	Recommendations to be inserted in Forward Works programme	June 2011
36. That further to Recommendation 35 above, the City initiates in conjunction with State government departments, an assessment of coastal risks and vulnerability in expectation of impacts under various climate change scenarios with the view to the development of adaptation and remediation strategies to protect valuable coastal landforms.	Engineering Design	Completion of assessments	December 2013

37. That the implantation of Ecozones as part of the City's Groundwater Conservation Strategy be endorsed as this is synonymous to the establishment of local ecological links as advocated under Green Plan 2 (Strategy for the Conservation Urban Bushland for the Promotion of Biodiversity) and that this be reflected in the City's Million Trees Programme.	Parks & Reserves	Identification and listing of possible ecozones sites	June 2011
38. That the conservation of natural areas be recognized as integral to promoting wildlife diversity by the provision of habitat niches, feeding opportunities and movement corridors and that this be reflected in site specific conservation plans for Bush Forever sites and LSNAs.	Parks & Reserves	Completion of site-specific conservation plans	April 2012
39. That further to Recommendation 37 above, particular focus be attached to the retention and protection of all remaining Vegetation Complexes critical for the survival of Specially Protected Fauna and those fauna listed as Endangered and Vulnerable.	City Planning	Council adoption of Media Zones Redevelopment Statement	April 2010
40. That the importance of community engagement be recognized as integral to the successful implementation of recommendations of the Local Biodiversity Strategy and in establishing biodiversity as a core community value and that this be reflected in the development of an annual schedule for community engagement activities.	Parks & Reserves	Completion of annual community engagement schedule	February 2011
41. That further to Recommendation 40 above, a survey of community perceptions be undertaken to gauge people's understanding of biodiversity and the threats confronting natural areas (as per Section 13.1) and how these issues may be resolved.	Parks & Reserves	Completion of community perceptions survey	August 2011
42. That innovative ways be adopted to create community awareness about the plight of natural areas in the urban environment and that this involve some aspect of 'activity based learning' in addition to 'knowledge based learning' (as per Section 13.2).	Parks & Reserves	Identify potential activity based learning and community engagement initiatives	June 2011
43. That opportunities be explored to engage the community in ways that will engender acceptance and ownership of conservation initiatives (as per Section 13.3).	Parks & Reserves		
44. That further to Recommendations 42 and 43 above, an environmental interpretation programme be developed to support the City's conservation initiatives and that local community expertise be engaged in this process.	Parks & Reserves		
45. That further to Recommendations 40, 41, 42 and 43 above, renewed consideration be given to the provision of vital staffing resources at the Henderson Environmental Centre to enable the planning and implementation of community engagement and environmental interpretation programmes on a regular and continuous basis.	Council	Appointment of Environmental Education Officer	June 2011

15. MONITORING & EVALUATION

15.1 Key Performance Indices

It is essential that the total sum of all conservation effort is translated into measurable indices to determine whether progress is being made in real terms in overcoming site related environmental issues and in improving biodiversity. Conservation effort may be measured in a variety of ways however it is best to adopt simple but realistic indices that could be replicated annually and used over time for the prediction of long-term trends. The adoption of Key Performance Indices is part of the City's Global Reporting Framework for organization-wide sustainability assessment and public reporting on biodiversity conservation and other sustainability initiatives.

15.1.1 Diversity Index

This index is a measure of the number of different species discovered (i.e. flora/ fauna) within a given area. Annual counts should therefore determine the extent of regeneration of new species, or otherwise. On a finer scale, a richness index could be incorporated to determine the number of individuals represented of any species. With regard to flora, the establishment of permanent monitoring stations (desirably 10 x 10 metres) for each floristic community is advocated at representative conservation sites. The diversity index may be expressed as the number of species per unit area.

15.1.2 Weed Index

This index is a measure of the number of introduced plants or non-local native species manifested within as given area. Annual counts should indicate the degree of success or otherwise of weed control programmes. As per the diversity index, the establishment of permanent monitoring station is advocated. The diversity index may be expressed as the number of species per unit area.

15.1.3 Cost Index

The adoption of any cost related index should be on the premise that all cost elements are factored into the calculation of conservation costs incurred within a given area. This is essential to ensure that this index of measurement is truly reflective of total conservation effort. As per the other indices a cost index may be expressed on a unit area basis.

15.1.4 Customer Satisfaction Index

This index seeks to measure the value that the community places on natural areas, the degree of community awareness of the plight of these areas in the urban environment and the community preparedness to support conservation initiatives. It is also a measure of community perception of whether natural areas are being given due regard in terms of conservation effort and presented in way that would engender public support. Customer satisfaction surveys are best undertaken with a questionnaire issued to visitors. It is desirable that the questionnaire be designed to numerically grade responses to eliminate any subjectivity that may occur.

15.2 Benchmarks/ Best Practice Standards

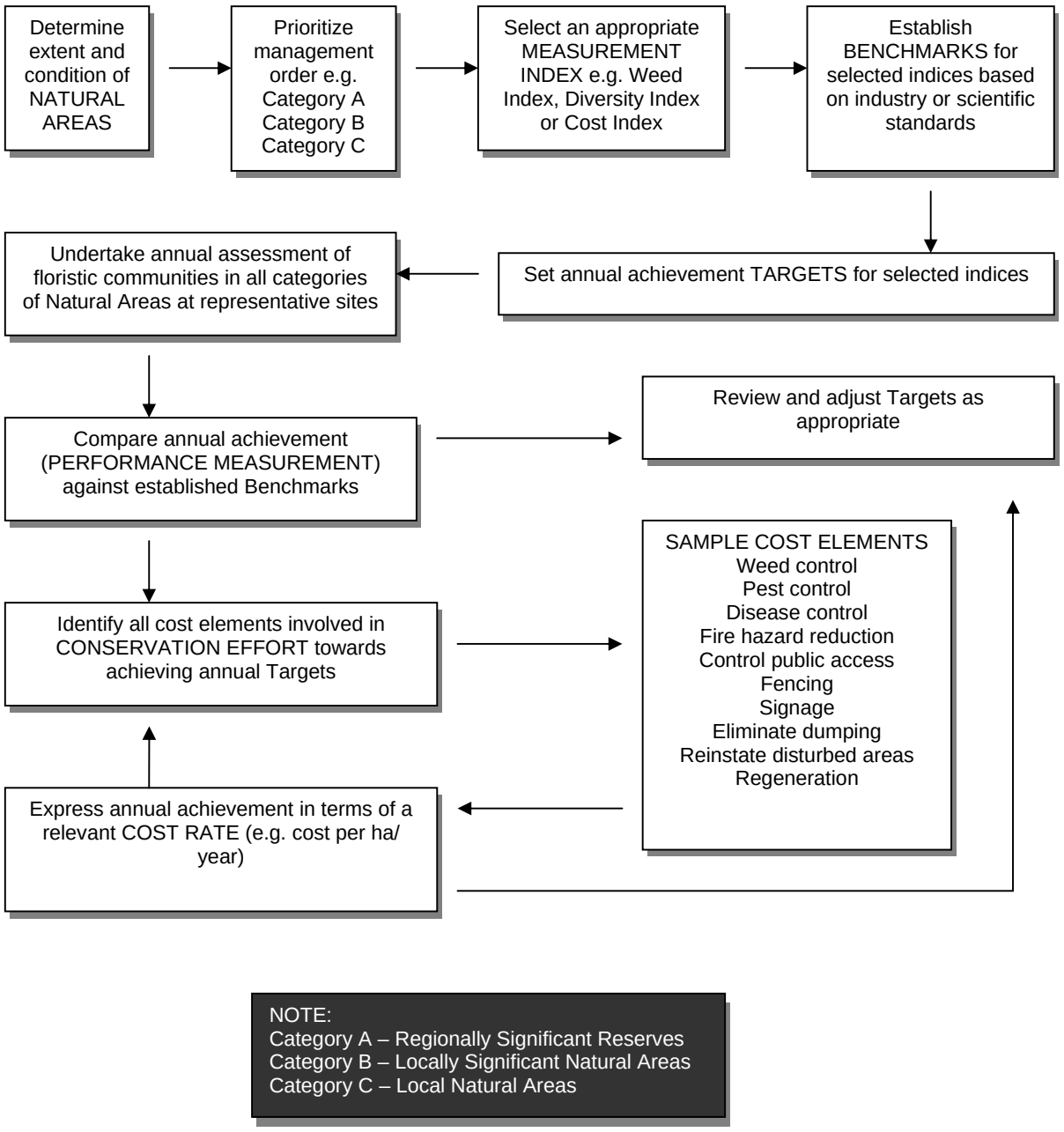

Fig 4 A Model for the Establishment of Benchmarks in the Conservation of Natural Areas

16. RESOURCE ALLOCATION

16.1 Staff and Material Resources

To be further determined.

16.2 Technical Resources

To be further determined.

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18. GLOSSARY

Biodiversity refers to the numerous plants, animals and other organisms that make up natural ecosystems (e.g. bushland, wetland or coastal dune) and the part these organisms have in the sustainability of ecosystems by their interdependence and survival links to each other. The greater the biodiversity of a given ecosystem (as measured by the number of separate species per unit area) the greater is the capacity of that ecosystem to sustain itself and to withstand various environmental and human induced threats and pressures

Bush Forever is a State wide strategy to protect some 51,200 hectares of regionally significant bushland in 287 sites, representing where achievable, a target of protecting at least 10% of each of the 26 vegetation complexes originally existent on the Swan Coastal Plain of the Perth Metropolitan Region.

Connectivity refers to the potential for connection between natural areas in terms of the mobility of plant propagules, insects, birds, animals and other organisms as part of how ecosystems function.

Corridors are contiguous natural areas or re-vegetated areas that directly connect larger natural areas allowing the movement over time of organisms between these larger areas.

Disturbance factors are activities that affect the condition of natural areas to the extent that self maintenance and sustainability of native plant communities are impaired. Such activities include partial clearing, fragmentation, plant removal, plant disease, feral animals, frequent fires, weed invasion, rubbish dumping, accumulation of pollutants, altered drainage patterns, indiscriminate pedestrian and vehicular access and others.

Ecosystem refers to the interaction and dependence of the physical and living elements of a given natural area in a way that sustains a stable relationship.

Ecological linkages are a series of non-contiguous natural areas that form 'stepping stones' to connect larger natural areas thereby enabling the movement over time of organisms between these larger areas.

Endemic species are those that have a natural distribution confined to particular geographic regions only. Whist there are many local native and indigenous species within the City, there are no species that are endemic to the City of Stirling.

Floristic communities refer to pre-defined assemblages of flora that comprise vegetation complexes.

Habitat is the natural environment of an organism or community including all biotic (living) and abiotic (non-living) elements that render the environment a suitable place for the organism or community to live.

Local Natural Areas (LNAs) are natural areas that are not listed as conservation sites under Bush Forever (Swan Coastal Plain), the CLAM Managed Estate or as Regional Parks.

Locally Significant Natural Areas (LSNAs) are Local Natural Areas that have been expertly field-assessed and determined that they meet one or more local significance criteria.

Natural Areas are areas that contain native species or ecological communities in a relatively natural state hence displaying biodiversity (WALGA 2004). Areas entirely re-vegetated or reconstructed landscapes of local native plants do not comprise natural areas and have not been included in this definition.

Priority Flora are plant taxa that are under consideration as threatened flora but need further survey to adequately determine their status or are adequately known but require monitoring to ensure that there is no further decline in their status or level of protection.

Protection refers to all processes that ensure the preservation of inherent biodiversity values by affording legally binding conservation status to the natural area both on public or private lands.

Regeneration refers to the restoration of native ecosystems through natural mechanisms viz. recruitment of progeny through self-seeding and germination and/ or vegetative re-sprouting.

Rehabilitation applies to native ecosystems that have been partially damaged or degraded through various disturbances where assisted restoration is undertaken.

Restoration is the return of a native vegetation community to its pre-disturbed or natural state in terms of its structure and composition.

Retention is the process of ensuring that a natural area is retained through statutory mechanisms; it does not necessarily infer that it will be protected to ensure its viability and long-term sustainability.

Revegetation refers to rehabilitation through assisted processes such as seed collecting and direct seeding or propagation and planting of local native and indigenous species.

Specially Protected Fauna are species protected under the Wildlife Conservation Act 1950 under Wildlife Conservation (Specially Protected Fauna) Notice 2001.

Stepping stones are non-contiguous pockets of natural areas that serve as temporary respite points along primary movement corridors for wildlife.

Threatened Ecological Community (TEC) is one that has been expertly assessed and determined as being under threat and classified according to the degree of the threat under any one of the following categories: 'Vulnerable', 'Endangered', 'Critically Endangered', or 'Presumed Totally Destroyed'.

Threatened Flora are plant species likely to become extinct or which are rare, and declared to be so under the Wildlife Conservation Act 1950.

Threatening processes refer to any activity or process that threatens or is likely to place a natural area under risk in terms of its continued survival and perpetuation of

ecological values; these could include environmental threats as well as uncertainty of tenure or land ownership under planning processes.

Vegetation condition is a rating assigned to vegetated natural areas to classify the state of their structure, density and species composition in comparison to undisturbed pristine native vegetation of the same type or as affected by various threats and disturbances.

Vegetation Complexes refers to a system of classification of vegetated natural areas based on the pattern of vegetation viewed at a regional scale based on underlying key determining factors of landforms, soils and climate.

Viability is one of the criteria used in the assessment of vegetated natural areas to determine their long-term sustainability as affected by various threats and disturbances.

19. APPENDICES

Appendix I

Definition of the Categories of Threatened Species as per the Environment Protection and Biodiversity Conservation Act (1999)

Category Code	Category Description
Ex (Extinct)	A native species is eligible to be included in the extinct category 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)	A native species is eligible to be included in the extinct in the wild category at a particular time, if at that time, (a) it is known only to survive in cultivation, in captivity or as a naturalized population well outside its past range or (b) 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 lifecycle and form.
CE (Critically Endangered)	A native species is eligible to be included in the critically endangered category at a particular time, if at that time, (a) it is not critically endangered and (b) it is facing an extremely high risk of extinction in the wild in the near future as determined in accordance with the prescribed criteria.
E (Endangered)	A native species is eligible to be included in the endangered category at a particular time if at that time, (a) it is not critically endangered and (b) it is facing a very high risk of extinction in the wild in the near future as determined in accordance with the prescribed criteria.
V (Vulnerable)	A native species is eligible to be included in the vulnerable category at a particular time, if at that time, (a) it is not critically endangered or endangered and (b) it 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)	A native species is eligible to be included in the conservation dependent category at a particular time, if at that time, the species is the focus of a specific conservation programme, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of five years.

Note: Adapted after Mattiske & Procter 2007

Appendix II

Definition of Rare and Priority Flora Species as defined by the Department of Environment and Conservation (DEC 2007b)

Conservation Code	Category Description
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)	Tax which are known from one of a few (generally <5) populations which are under threat either due to small population size or otherwise in need of special protection and have been gazetted as such.
P2 (Priority Two: Poorly Known Taxa)	Tax which are known from one of a few (generally <5) populations, at least some of which are not believed to be under immediate threat (ie 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 known to be under immediate threat (ie 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 factor.

Note: Adapted after Mattiske & Procter 2007

Appendix III

Sample Local Planning Policy

KEY DEFINITIONS

Biodiversity

Biodiversity is "the variety of all life forms – the different plants, animals and micro-organisms, the genes they contain, and the ecosystems of which they form a part. Biodiversity is not static, but constantly changing; it is increased by genetic change and evolutionary processes and reduced by processes such as habitat degradation, population decline and extinction (Commonwealth of Australia 1996). Biodiversity has two key aspects:

- its intrinsic value at the genetic level, individual species level, and species assemblages levels;
- its functional value at the ecosystem level.

Two species assemblages may have different intrinsic values but still have the same functional value in terms of the part they play in maintaining ecosystem processes." (Commonwealth of Australia, 1996)

Development

Development (according to the Town Planning and Development Act 1928) means the development or use of any land, including the demolition, erection, construction, alteration of or addition to any building or structure on the land and the carrying out on the land of any excavation or other works and, in the case of a place to which a Conservation Order made under section 59 of the Heritage of Western Australia Act 1990 applies, also includes any act or thing that:

- is likely to change the character of that place or the external appearance of any building, or
- would constitute an irreversible alteration of the fabric of any building.

depicted on a sub-divisional plan or diagram, whether so exhibited or deposited or not, but which is, either before or after the coming into operation of the Town Planning and Development Act Amendment Act 1956, approved by the Commission.

Local Natural Areas (LNAs) are natural areas that exist outside of Bush Forever Sites (Swan Coastal Plain), the Department of Conservation and Land Management (CALM) Managed Estate and Regional Parks.

Locally Significant Natural Areas (LSNAs) are Local Natural Areas that have been field assessed by a suitable expert and meet at least one Local Significance Criteria as determined by a Local Government.

Mitigation of impacts (or offsets, or compensation) – Mitigation includes any one or more of the following approaches with an emphasis on attempting measures in the sequence in which they are listed:

- avoiding the impact altogether by not taking a certain action or parts of an action;
- minimizing impacts by limiting the degree or magnitude of the action and its implementation;
- rectifying the impact by repairing, rehabilitating, or restoring the impacted environment;
- reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action;
- compensating for the impact by replacing or providing substitute resources or environments.

Mitigation measures are those that are added to a project to reduce, prevent, or correct its impact. This term is sometimes used interchangeably with "compensation" which accurately means "replacement".

Natural areas are any physical area that contains native species or communities in a relatively natural state and hence contains biodiversity. Natural areas can be areas of native vegetation, vegetated or open water bodies (lakes, swamps), or waterways (rivers, streams, creeks), estuaries, springs, rock outcrops, bare ground (generally sand or mud), caves, coastal dunes or cliffs (adapted from Environmental Protection Authority 2003a). Note that natural areas exclude parkland cleared areas, isolated trees in cleared settings, ovals and turfed areas.

BACKGROUND

The City of Stirling values biodiversity and recognises the importance of protecting natural areas for present and future generations. The protection of natural areas and biodiversity is a priority to deliver the following benefits:

- protection of native species of flora and fauna, including uncommon species;
- maintenance of evolutionary processes;
- maintenance of environmental services (e.g. clean air, water, biological pest control).
- stabilization of soil/prevention of erosion;
- prevention of siltation and eutrophication of wetlands, including rivers and estuaries;
- protection of local sense of place and character;
- sustainable uses, including commercial opportunities;
- landscape amenity;
- passive recreation;
- buffering land uses (e.g., residential from industrial); and
- cultural connection to land (European and Indigenous).

The policy recognises that natural areas within the City of Stirling can be broadly categorised according to their protection status, with those natural areas existing within the CALM estate, Regional Parks or Bush Forever Sites considered to have some level of protection. Natural areas that exist outside the Department of Conservation and Land Management (CALM) estate, Regional Parks and Bush Forever Sites, are considered to be Local Natural Areas (LNA).

LEGISLATIVE AND POLICY CONTEXT

The City of Stirling recognizes that it has a role in the identification, assessment and protection of biodiversity and natural areas as set out in this policy. It also acknowledges

the roles and responsibilities of the State and Federal Governments in this area, as set out in legislation and policy incorporated into this local policy. (refer related Federal and State legislation and policy).

PURPOSE AND OBJECTIVES OF POLICY

Purpose

The purpose of this Local Planning Policy (LPP) is to provide guidance to Council on the identification, assessment and protection of natural areas that may be subject to land development proposals, which may adversely impact biodiversity values.

The policy recognizes that the adequately assess the impact of proposed developments on natural areas, then new information will often be required to be collected on biodiversity and other natural area values through application of consistent methodologies.

Objective

The objective of this policy is to provide Council with guidance on the information required and the process to be undertaken by Council when assessing proposals that seek to rezone, subdivide and development lands that contain natural areas or are adjacent to lands identified as Bush Forever Sites or which form part of the CALM estate, in accordance with the biodiversity objectives and targets of the City of Stirling.

The City of Stirling has the following biodiversity objectives and targets: (Objectives and targets should be those presented in the 'City of Stirling local biodiversity planning Discussion Paper'.)

(Insert biodiversity objectives and targets)

APPLICATION OF THE POLICY

This policy applies to any proposals that may impact on a natural area or occur on land adjacent to Bush Forever Sites or CALM Estate within the City of Stirling including rezoning, structure plans, subdivisions and development applications. The policy shall also apply where the Local Government is the development proponent.

It is intended that this policy should be applied at the earliest stage in the planning process. Where sound and thorough ecological information is collected at the rezoning or district structure planning stages, then subsequent stages of development are less likely to find 'unexpected' natural features. It should also assist in the assessment of clearing permits where they may be required.

In assessing development proposals and determining whether or not to grant planning consent that would impact on natural areas, Council should have due regard to the objective and policy measures of this policy. This policy is to be used as a tool in the decision-making process by providing information on the ecological significance of natural areas and a process for considering the impacts of development proposal on natural areas.

This policy is applied in conjunction with all Council's policies, and all Federal, State, regional and local legislative and policy requirements. Application of the policy will not

obviate the need for proponents wishing to clear vegetation to obtain a permit for that clearing as required under the Environmental Protection Act 1986.

POLICY MEASURES

Identification of values of Natural Areas and Potential Impact

This policy recognises that any Local Natural Areas that are subject to proposals to rezone, subdivide or develop need to be assessed against Local Significance Criteria (outlined in Schedule 1) using information collected through desktop and field assessment. Council shall request proponents to collect and submit natural area information as part of their application according to the process outlined in Schedule 3 and the information standard contained in Schedule 4 for any development proposal occurring over part or all of a natural area.

Council shall ensure that the information is collected to a satisfactory standard to make determination of the natural area's values according to Local Significance Criteria and the level of potential impact on those values.

Where a development proposal occurs on land adjacent to Bush Forever Sites, CALM Estate or could otherwise impact on natural areas or biodiversity, a statement of the potential impacts of the proposal and how they will be mitigated should be prepared.

Presumption against Clearing

The City of Stirling supports a presumption against clearing of any Local Natural Area occurring on rural (insert other zonings with rural land use focus e.g., special rural etc, or other zonings as desired) zoned land that is confirmed through collection of field information to meet any of the Local Significance Criteria listed in schedule 1 as 'LG Resolution (High)'.

Mitigation of Impacts

The City of Stirling supports consideration of mitigation measures to limit or offset any loss of:

- any natural area occurring on residential or industrial (insert other intensive development zones) zoned land that is confirmed through collection of field information to meet any of the Local Significance Criteria listed in schedule 1 as 'LG Resolution (High)';
- any natural area that is confirmed through collection of field information to meet any of the Local Significance Criteria listed in schedule 1 as 'LG Resolution (Low)'.

Consideration of other Environmental Factors

Council recognises that natural areas may also have other environmental values other than those identified under the Local Significance Criteria (eg, importance for protecting surface or ground water resources) and that these benefits shall be identified as part of Council's consideration of proposals, along with all other considerations.

Relationship to Federal and State Government Decision Making Processes

Requirement to obtain a clearing permit under Environmental Protection Act 1986 (2003 amendments)

Council recognises that proponents wishing to clear native vegetation will require a permit under the proposed amendments to the Environmental Protection Act to undertake that clearing, unless the proposed clearing is specifically exempt under the Act.

Council shall use information collected under this policy to form its comment to other decision-making authorities on applications to clear vegetation. It is recognized that Council's development assessment process and the State Government's assessment of clearing permit applications must be complimentary.

Referral to Federal or State Government

Any Local Natural Area that is confirmed through collection of desktop and field information to meet any of the Local Significance Criteria should be referred to the relevant Agency as indicated in Schedule 1, if significant impacts on these Locally Significant Natural Areas (LSNAs) cannot be prevented.

The City of Stirling will endeavour to resolve the protection of Local Natural Areas meeting any of the criteria that are referrable (as indicated in Schedule 1), prior to actual referral of the development proposal to the relevant agency.

Any proposals to develop land within or adjacent to Conservation Estate (CALM managed land) and proposed conservation areas (includes System 6 recommendations that have not been superseded and Forest Conservation areas) should be referred to the EPA as indicated in Guidance Statement No 10 (Environmental Protection Authority 2003a). Additionally, any proposals to rezone, subdivide or develop land within or adjacent to Bush Forever Sites require approval from the Western Australia Planning Commission.

Protection of Locally Significant Natural Areas

Where a LSNA is to be retained (in part or full) by application of this policy, then Council may given consideration to formal protection of that area by one or more of the following mechanisms where this is supported by the Council's biodiversity targets and objectives:

- protective land zonings;
- Special Control Areas;
- reservation and purchase;
- management and conservation agreements;
- subdivision for conservation;
- provision of incentives.

In determining protection mechanisms, Council shall give considerations to the opportunities and constraints to protection and the incentives that may be applied to encourage protection.

Appendix IV

Natural Area Initial Desktop Assessment template
Natural Area Initial Field Assessment A
Natural Area Initial Field Assessment B (for significant species and communities)
Natural Area Initial Assessment Summary

Natural Area Initial Desktop Assessment

Date of assessment _____ Native Vegetation Unique ID No. _____

Name of area _____ Database Site No. _____

Other names used _____

Location (address/street name incl. suburb, nearest street corner, Local Government)

_____

_____

Street Directory: Year, Page and Grid Ref. (Street Smart/ Gregorys/ UBD) _____

Prepare the following maps and label with the name of the area.

Map 1: Location of _____

Photocopy of street directory showing location of site

Map 2: Reference Sites/Plots and Linkage for _____

A GIS print-out of general area showing vegetation complexes, potential reference sites and plots, mapped wetlands and their management category, areas of any previously recorded Declared Rare Flora, Specially Protected Fauna, Priority Flora or Fauna or Threatened Ecological Communities plus location of Draft Regional and, if available, Local Ecological Linkages. If no Local Ecological Linkages have been determined for the Local Government area, use this map to mark potential local ecological linkages to other natural areas.

Map 3: Aerial photograph of _____

Date of photography _____ Scale _____

GIS print-out of aerial photography (with topography, if available) at a scale that ensures site covers most of an A4 page. Easy-to-use scales are 1:2000 (1 cm = 20 m), 1:3000 (1 cm = 30 m), 1:4000 (1 cm = 40 m) or 1:5000 (1 cm = 50 m). For large sites, spread over several A4 pages at one of these scales if necessary.

Area (ha) _____ Perimeter (m) _____

Perimeter (m) to area (m^2) ratio _____ Priority for Further Investigation _____

Lot/Location/Reserve Number/s _____

Ownership (Local Government Reserve / Other Govt (Agency?) / Private) _____

_____

Land Manager _____

Vesting Purpose _____

_____

MRS Reservation or Zoning _____

TPS Reservation or Zoning _____

Protection Status (circle) none / conservation covenant / conservation zone / conservation vesting purpose / Bush Forever & Parks and Recreation in the MRS / protected CALM land

Current Status/Use of land _____

_____

Long term plans? _____

_____

Initial Desktop Assessment

Name of area _____

Recognised International/ National/ State/ Regional Conservation Value yes/no

Specify _____

Part of a Draft Regional Ecological Linkage yes/no

Specify (links which areas?): _____

Mapped Vegetation Complex/es _____

Mapped Soil Type/s (if mapping available) _____

Mapped wetland/s: yes/no Environmental Protection Policy (EPP) Lake: yes/no

Wetland Management Category: CC/RE/MU

Is it a mapped floodplain area? yes/no

Potential Reference Sites and Plots (e.g. Bush Forever Sites; CALM Reserves, see Map 2). For Bush Forever Sites note floristic community type/s (FCTs) and whether FCTs actual or inferred.

Existing biological information for area or for potential Reference Sites (reports/ surveys/ species lists)

Conservation Management Plan yes/no Current or Review needed? _____

Title/Author/Year _____

Part of a Local Ecological Linkage yes/no

(if these have not already been determined by Local Government mark potential linkages on Map 2)

Time since isolation from other natural areas <5 years/ 5 - 20 years/ >20 years

(consult local community, historical aerial photography)

Initial Desktop Assessment

Name of area _____

Does it contain any mapped Threatened Ecological Communities (see Map 2)? yes/no

Specify: _____

Does it contain any mapped Declared Rare Flora (see Map 2) or is it a known location for any Specially Protected Fauna or significant habitat for these fauna? yes/no

Specify: _____

Does it contain any mapped Priority (see Map 2) or other significant **flora** (e.g. see Table 13, Bush Forever, Vol. 2, p. 51) or is it a known location for any Priority or other significant **fauna** (e.g. see Tables 14 and 15, Bush Forever, Vol. 2, pp. 59-63) or significant habitat for these fauna?

yes/no

Specify _____

Riparian streamline vegetation expected yes/no

Estuarine fringing vegetation expected yes/no

Coastal vegetation expected (foredunes or secondary dunes) yes/no

Fire History (consult with FESA/Volunteer Fire Brigades, local community, historical aerial photography)

Known to be of particular value to the local community for conservation yes/no

Active Friends/Environmental Group yes/no

Name of group and contact details _____

Surrounding land uses with potential for community interest and possibly assistance with management

- educational facility yes/no
- residential development yes/no
- other (specify) yes/no

Indigenous or European Cultural or Historical Heritage Value yes/no

Notes _____

Natural Area Initial Field Assessment A

Date of assessment _____ Native Vegetation Unique ID No. _____

Name of area _____ Database Site No. _____

Location (address/street name) _____

_____

Assessor _____ *Skill Level _____

Recorder _____ Skill Level _____

Recorder _____ Skill Level _____

Recorder _____ Skill Level _____

**Important Note: Skill level 4 or above is required by the assessor to complete this template (see Appendix 1).*

Photographs

Indicate film roll no. and photograph no., location and direction of each photo on Map 4 during the field assessment. e.g. R1/P4 ⇗ (Roll 1/Photo 4 looking ⇗)

Photographer's Name _____

Latitude And Longitude (for various locations noted during assessment, optional)

GPS used: yes/no GPS datum:_____

Descriptor and Location No. (eg. BMX jump GPS 1)	Reading/calculation (mark location number on Map 4) Latitude (S) or Northing	Longitude (E) or Easting

Prepare the following map during the field assessment and label with the name of the area.

Map 4 (transparent overlay on aerial photograph, Map 3): Uplands/Wetlands, Structural Plant Communities, Vegetation Condition, Spot Weed Occurrences, Areas of Disturbance and Management Infrastructure of _____

_____

Uplands, Wetlands And Structural Plant Communities – Description And Mapping

On Map 4 divide the site into upland versus wetland areas and then into broad sections based on structural plant communities. Allocate a number to each community and describe each community using a representative sample point. Note the vegetation condition of each sample point as well as drawing a vegetation condition map for the whole site.

Describe each community using page 5 of these templates OR if preferred the templates of Keighery(1994) (see Appendix 3). If using the Keighery templates, describe each community on Recording Sheets 1 & 2 and list common native species present on Recording Sheet 3. Note that Appendix 3 contains minor modifications to the Keighery (1994) templates to include the additional information required on page 5.

Each structural plant community is described by noting the dominant species in each growth form layer of the community (see Appendix 2). Collect specimens for identification if necessary provided you have a licence from CALM and land owner permission. Carefully label all specimens. DO NOT collect species suspected of being DECLARED RARE FLORA instead take a good photo and accurately note location. Do not collect whole plants unless they are very small species and do not collect at all if only a few are present, take a good photo as an alternative

Photocopy page 5 or Appendix 3 and complete for **each** structural plant community identified.

Initial Field Assessment A

Name of area _____

Structural Plant Community No. _____ Indicate location of sample point described on Map 4.

Latitude and Longitude

GPS used: yes/no GPS datum: _____Lat.: _____ Long.: _____

Landform and Soils

SLOPE: flat/ gentle/ steep ASPECT: N/ NE/ E/ SE/ S/ SW/ W/ NW OR n/a

SURFACE SOIL: Colour: _____ Texture: sand/ loamy sand/ sandy loam/ loam/ clay/ gravel

EXPOSED ROCK (type and % of surface): _____

SUB-SURFACE SOIL: Colour: _____ Texture: sand/ loamy sand/ sandy loam/ loam/ clay/ gravel

UNDERLYING ROCK (type and depth if known): _____

DRAINAGE: well/ moderate/ poor WET: all year/ winter and spring only OR n/a

CURRENT WATER DEPTH: _____ cm

LITTER (% cover & depth):_____ _____ BARE GROUND (% cover) _____

Topographic Position Circle position of point described on a transect diagram of site below.

Upland or Wetland? (circle one)

Growth Form Layer	**Dominant species** for each growth form layer list all dominant species, in their order of dominance, up to a maximum of 3*. (* if more than 3 species are obviously dominant record as many as appropriate to describe the layer)	**Crown Cover (Keighery 1994)** 2-10% / 10-30% / 30-70% / over 70%	**Height & Crown Cover (NVIS)** Record max. height of layer & % crown cover to nearest 5%
Trees over 30 m			
Trees 10–30 m			
Trees under 10 m			
Mallees over 8 m			
Mallees under 8 m			
Shrubs over 2 m			
Shrubs 1-2 m			
Shrubs under 1 m			
Herbs			
Sedges/ Rushes			
Grasses			
Other (e.g. climbers)			

Common Native Species Note species observed.

Icon Flora Species (Note if present)

Vegetation Condition (Give reasoning and note scale used) (see Appendix 4) _____

Description Of Structural Plant Community No. __ (see Appendix 2) _____

Icon Community (tick if an icon community)

Initial Field Assessment A

Name of area _____

Weed Species Note species observed, especially the occurrence of species in better condition areas, even if they only occur in small numbers or in small patches at present. Note the distribution of each species across the site, e.g. throughout the site, spot occurrences or disturbed areas only (edges/tracks/cleared areas). Mark spot occurrences and easily mapped distributions on Map 4. If a species is widespread, note whether it is restricted to specific plant communities or wetland areas.

Weed Species	**Distribution** e.g. throughout the site, spot occurrences or disturbed areas only (edges/tracks/cleared areas)

Feral Fauna Note species observed or evidence for presence of species (scats, tracks or traces).

	✓	**Comments**
Evidence of Foxes (burrows, wildlife kills)		
Evidence of Rabbits (burrows, dung piles, grazing)		
Evidence of Dogs (droppings, scratchings)		
Evidence of Cats (wildlife kills)		
European Honey Bees (hives in tree hollows)		
Evidence of Horses/ Cattle/ Sheep (foot prints, droppings)		
Evidence of Pigs (soil disturbance)		
Rainbow Lorikeets		
Other		

Initial Field Assessment A

Name of area _____

Native Fauna and Fungi. Note species observed or evidence of presence for fauna species. Indicate icon species.

Species	**Comments:** Observed directly, evidence of presence (scats, tracks and traces) or likely habitat?

Native Fauna and Fungi Habitat

Habitat	✓	**Comments**
Areas of trees (with or without understorey)		
Areas of dense understorey vegetation		
Tree hollows in old mature trees		
Dead branches as perches for hunting/ look outs		
Dead vegetation for fungi/invertebrate habitat (leaf litter, branches/logs)		
Large fallen logs on the ground		
Granite or other natural rocky outcrops		
Moss beds for fungi habitat		
Wetlands or waterways		

Vegetation Health

Note dead or dying trees, shrubs, herbs and so on. Note the species concerned and the pattern of deaths/changes in the vegetation. *Phytophthora* Root Rot moves in fronts and along drainage lines therefore noting patterns helps to determine whether *Phytophthora* spp. are present. Appendix 5 defines and provides the website address for a list of common indicator species that are affected by *Phytophthora* spp. Do not automatically assume dead or dying plants means that *Phytophthora* is present.

	✓	**Comments**
Numerous tree stumps (not from logging)		
Dead or dying species		
Obvious reduction of tree canopies (e.g. staghorns)		
Heavy leaf/stem damage by insects (e.g. lerps, stem borers)		
Diseases/pests suspected		
Drought/lowering of groundwater table suspected		
Flooding/rise in groundwater table suspected		

Initial Field Assessment A

Name of area _____

Miscellaneous Disturbance Factors and Threatening Processes

Determine the range and extent of disturbance factors and threatening processes occurring at the site. If appropriate, mark on Map 4 and photograph as required. If site is large it may be beneficial to divide into sections and evaluate each separately.

Factor/Process	✓	Comments
Evidence of salinisation (e.g. scalding, seeps)		
Erosion (e.g. gullies, bank collapse)		
Wetland eutrophication (e.g. algal blooms)		
Stormwater drains/sumps		
Service corridors (e.g. Water Corp, Telstra, Western Power, Alinta Gas)		
Mining/extraction		
Evidence of past logging (e.g. selective removal of large trees)		
Previous clearing (may be partially cleared areas or evidence of previous clearing and regrowth over much of site)		
Overgrazing (e.g. rabbits, stock, goats; over-population by kangaroos)		
Firewood collection (e.g. recent chainsaw/axe cuts, sawdust piles)		
Dope plants/ production equipment		
Soil movement (dumping or removal)		
Rubbish dumping (note type, e.g. construction, garden waste, weed source?)		
Proliferation of tracks (fire breaks, walk trails)		
Off road vehicle use (4WD / trail bikes/ BMX/ mountain bikes)		
Cubby construction		
Vandalism (damage to plants)		
"Enrichment Planting" (revegetation with species not found in that local plant community, are these becoming weeds?)		
Impacts of High Fire Frequency and/or Intensity		
• Reduced range of tree ages		
• Fire scars high up (due to a hot burn)		
• Major trunk damage		
• Trees suckering from trunk and branches		
• Amount of leaf litter reduced		
• Large fallen logs nearly burnt away		
• Evidence of arson (burnt grass tree skirts, matches, cigarette lighters, exploded spray cans)		
Time since last fire (estimate)		<2 yrs/ < 5 yrs/ <10 yrs/ <20 yrs / >20 yrs (circle one)
Other disturbance factors or threatening processes		

Initial Field Assessment A

Name of area _____

Vegetation Condition Map

For initial assessment, the overall vegetation condition of the site can be determined after familiarising yourself with the site. On Map 4, divide the site into broad sections based on condition, draw the boundaries of each section and record their condition. Using the map, estimate the % area each section occupies of the total site and note in the relevant boxes below using either the Keighery (1994) or Kaesenhagen (1994) condition scale(see Appendix 4). For example, 'Very Good: Section 1, 75% of site.' 'Degraded: Section 2, 25% of site.' For most sites there will be very degraded areas along tracks, for example, where rubbish has been dumped. If not extensive, these can be referred to by adding a statement such as 'areas of severe localised disturbance' in the comments.

Vegetation Condition Scales Indicate % area each section occupies of the total site (ensure adds up to 100%).						
Keighery (1994)	Pristine	Excellent	Very Good	Good	Degraded	Completely Degraded
% area						
Kaesehagen (1994)		Very Good to Excellent	Fair to Good		Poor	Very Poor
% area						

Comments

Existing Management Infrastructure

Describe type in box below and mark location on Map 4, photograph if required.

	✓	**Comments**
Fencing		
Fence condition		
Gates		
Paths		Soil; concrete; limestone; mulch
Path condition		
Path fencing		
Path fence condition		
Fire access tracks		Slashed; sprayed; ploughed
Signs		Name of area; other (purpose?)
Previous works		

Social Significance Values

	✓	**Comments**
Evidence of Community/ Passive recreation/ Education interest		
Landscape amenity (e.g. area screens/ buffers conflicting land uses)		
Scenic features (e.g. high point in landscape)		
Indigenous/ European Heritage (Cultural or Historical)		
Other		

Initial Field Assessment A

Name of area _____

Surrounding Land Uses (mark on Map 4)

	Comments
Surrounding Land Uses (note type/s and indicate likely impacts/benefits e.g. source of rubbish; weed seeds blowing into site; potential for community interest and perhaps volunteers to assist management)	

Recommendations for Management List potential management actions (for example, assessment for the presence of *Phytophthora* species by an accredited assessor; fencing; signage to identify as a conservation area; rubbish removal; detailed weed survey and mapping; fire response and management planning; detailed flora/fauna/fungi surveys).

Initial Field Assessment A

Name of area _____

Confirmation of GIS Mapped Boundaries

Prepare the following map if recommending changes to native vegetation (A) or wetland (B) mapping and label with the name of the area.

Map 5: (overlay on aerial photo): Recommended GIS Boundary Changes for

When recommending changes, forward a completed copy of all 4 Initial Natural Area Assessment templates to the Perth Biodiversity Project, WALGA, 15 Altona St, West Perth 6005 for distribution to relevant custodian of database.

GIS dataset		**Changes recommended (yes/no)** Outline the rationale for each change against the relevant category (A, B or C). Prepare Map 5 if recommending changes to A or B only. Draw boundaries that correspond to your field assessment and assign accordingly to 'A' and/or 'B'.
A	**Mapped Native Vegetation** (DPI/Dept of Agriculture 2001)	Yes / No
	Rationale: _____	
B	**Mapped Wetland/s and Management Category** CC, RE or MU (DoE current update)	Yes / No / NA For changes to the mapping of wetlands on the Swan Coastal Plain complete and attach the current Department of the Environment guidelines for evaluating wetlands in this bioregion.
	Rationale: _____	
C	**Mapped Vegetation Complex/es** (Heddle, Loneragan and Havel 1980 or Mattiske & Havel 1998)	Yes / No More likely to be _____
	Rationale: (do not map) _____	

Natural Area Initial Field Assessment B

for Significant Species and Communities

General Information

Date of assessment _____ Native Vegetation Unique ID No. _____

Name of area _____ Database Site No. _____

Location (address/street name) _____

Assessor _____ *Skill Level _____

Recorder _____ Skill Level _____

Recorder _____ Skill Level _____

Recorder _____ Skill Level _____

**Important Note: Skill level 5 or above is required by the assessor to survey natural areas for significant species. Skill Level 6 is required to survey for threatened ecological communities (see Appendix 1).*

NO significant species or communities recorded through Field Assessment B If searches for significant flora, significant fauna and Threatened Ecological Communities by an appropriately skilled assessor have **NOT** recorded any significant species or communities on this site during this assessment, tick the box and continue no further.	✓

Partial Assessment ONLY In situations where significant species or communities have been recorded during Field Assessment A but a comprehensive Field Assessment B has **NOT** yet taken place, transfer the relevant information to these forms for databasing purposes and tick this box.	✓

Initial Field Assessment B

Name of area _____

Photographs

Indicate film roll no. and photograph no., location and direction of each photo on Map 4 during the field assessment. e.g. R1/P4 ⇗ (Roll 1/Photo 4 looking⇗)

Photographer's Name _____

Latitude And Longitude (for various locations noted during assessment, compulsory)

GPS used: yes/no GPS datum: _____

Descriptor and Location No.	Reading/calculation (mark location number on Map 6)	
(eg. Species A GPS 1)	Latitude (S) or Northing	Longitude (E) or Easting

Prepare the following map during the field assessment and label with the name of the area. Consult Map 4 prepared for Natural Area Initial Field Assessment A for the structural plant communities and vegetation condition mapping, update on Map 6 if necessary.

Map 6 (overlay on aerial photograph): Location of Threatened Ecological Communities, significant native flora or fauna or suitable habitat for these fauna of _____

Threatened Ecological Communities (TECs) (see Appendix 6)
List the Threatened Ecological Communities present or believed to be present on the site and the reasons why. For those TECs based on floristic community types, map the boundary of each TEC by cross referencing with the structural plant communities mapped during the Natural Area Initial Field Assessment A (Map 4). **During spring**, describe a standard 10 x 10 m quadrat and compile a species list for each structural plant community representing a TEC (see **page 15**, Threatened Ecological Communities – Description and Mapping).

Initial Field Assessment B

Name of area _____

Significant Native Flora (see Appendix 6)

Note presence of Declared Rare, Priority or other significant flora. Note location of species on Map 6. Indicate which structural plant communities they occur in (refer to Map 4 of the Natural Area Initial Field Assessment A).

Species and Significance	Comments eg. Structural Plant Community, Population Size

Significant Native Fauna (see Appendix 6)

Note presence or evidence for presence of Specially Protected, Priority or other significant fauna. Note location of species/evidence on Map 6. Indicate which structural plant communities they occur in or utilise.

Species and Significance	Comments: Observed Directly, Evidence of Presence or Likely Habitat?

Initial Field Assessment B

Name of area _____

Photocopy this page and complete for **each** Structural Plant Community identified as a TEC OR if preferred use Recording Sheets 1 & 2 of Keighery (1994) (see Appendix 3) to describe each community. Note that Appendix 3 contains minor modifications to the Keighery (1994) templates to include the additional information required below.

Threatened Ecological Communities – Description and Mapping

For TECs based on floristic community types, description and mapping needs to be undertaken during spring to provide the definitive floristic information needed to confirm the presence of a TEC. On Map 6, draw the boundary of each Threatened Ecological Community present and label with the TEC to which it belongs. These boundaries should be based on the structural plant communities identified on Map 4 of the Natural Area Initial Field Assessment A template. Allocate a number to each structural plant community representing a TEC and describe each below using a permanently located and representative 10 x 10 m quadrat. Note the vegetation condition of each quadrat. Compile a list of the plant species present within each quadrat.

Structural Plant Community No. _____ Indicate location of sample point described on Map 6.

Latitude and Longitude

GPS used: yes/no GPS datum: _____Lat.: _____ Long.: _____

Landform and Soils

SLOPE: flat/ gentle/ steep ASPECT: N/ NE/ E/ SE/ S/ SW/ W/ NW OR n/a

SURFACE SOIL: Colour: _____ Texture: sand/ loamy sand/ sandy loam/ loam/ clay/ gravel

EXPOSED ROCK (type and % of surface): _____

SUB-SURFACE SOIL: Colour: _____ Texture: sand/ loamy sand/ sandy loam/ loam/ clay/ gravel

UNDERLYING ROCK (type and depth if known): _____

DRAINAGE: well/ moderate/ poor WET: all year/ winter and spring only OR n/a

CURRENT WATER DEPTH: _____ cm

LITTER (% cover & depth):_____ BARE GROUND (% cover) _____

Topographic Position Circle position of point described on a transect diagram of site below.

Upland or Wetland? (circle one)

Growth Form Layer	**Dominant species** for each growth form layer list all dominant species, in their order of dominance, up to a maximum of 3*. (* if more than 3 species are obviously dominant record as many as appropriate to describe the layer)	**Crown Cover (Keighery 1994)** 2-10% / 10-30% / 30-70% / over 70%	**Height & Crown Cover (NVIS)** Record max. height of layer & % crown cover to nearest 5%
Trees over 30 m			
Trees 10–30 m			
Trees under 10 m			
Mallees over 8 m			
Mallees under 8 m			
Shrubs over 2 m			
Shrubs 1-2 m			
Shrubs under 1 m			
Herbs			
Sedges/ Rushes			
Grasses			
Other (e.g. climbers)			

Initial Field Assessment B

Name of area _____

Photocopy this page and complete for each Structural Plant Community identified as a TEC OR if preferred use Recording Sheet 3 of Keighery (1994) (see Appendix 3) to list species for each community. Note that Appendix 3 contains minor modifications to the Keighery (1994) templates to include the additional information required below.

Plant Species Note native and weed species observed within a standard 10 x 10 m quadrat.		
Trees / Mallees	**Herbs**	
Shrubs		
		Sedges / Rushes
		Grasses
Vegetation Condition (Give reasoning and note scale used) (see Appendix 4)		
Description Of Structural Plant Community No. _____ (see Appendix 2) _____		

Natural Area Initial Assessment Summary

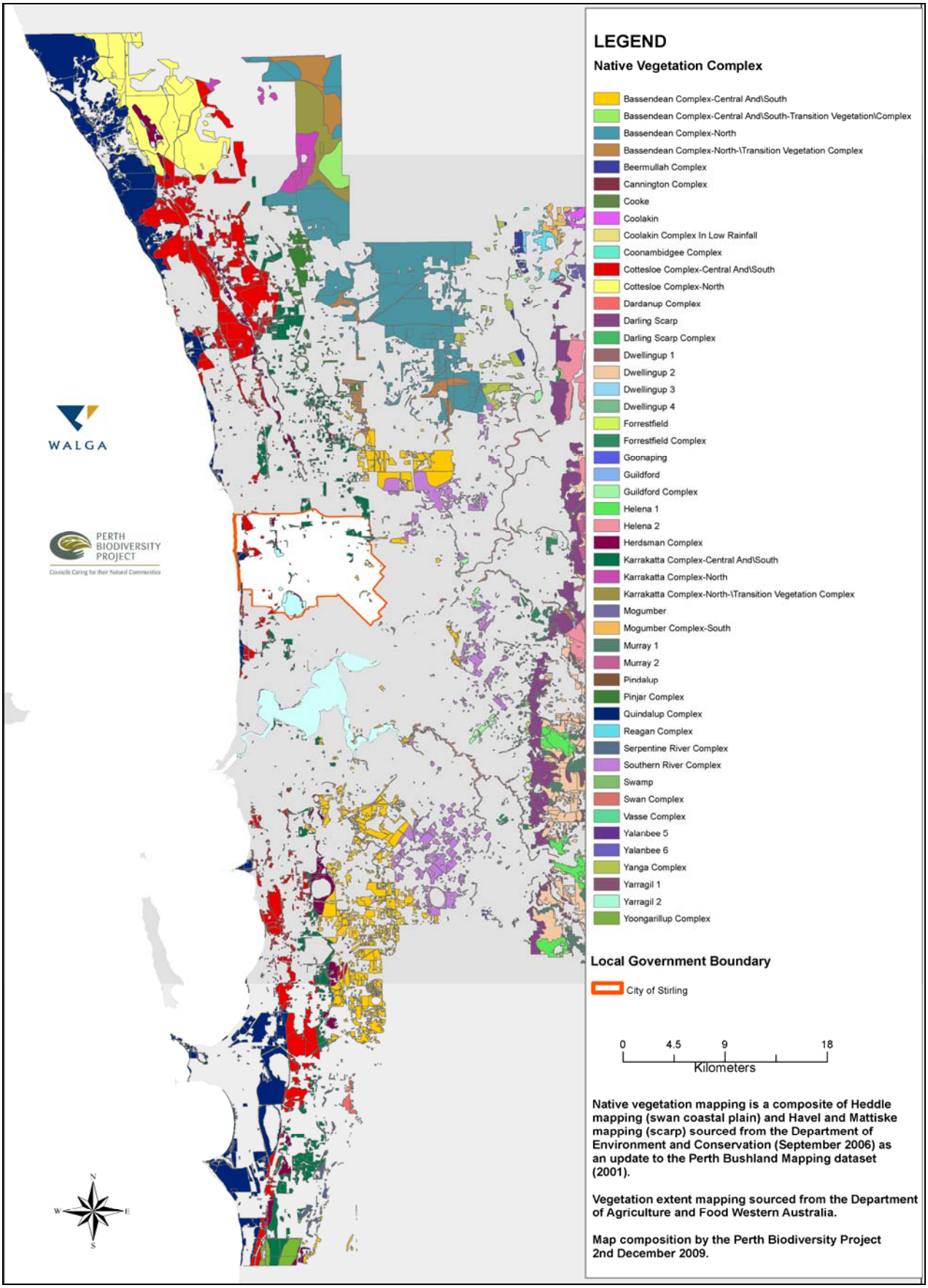
Database Site Number _____ Name of area _____

ECOLOGICAL CRITERIA	
1. Representation	
1a. Regional Representation	
i) recognised International, National, State or Regional conservation value but not already protected Specify:	yes/no
ii) of an ecological community with only 1500 ha or 30% or less (whichever is the greater) remaining in IBRA subregion Specify:	yes/no
iii) large (greater than 20 ha), viable natural areas in good or better condition of an ecological community with more than 30% remaining within the IBRA subregion	yes/no
iv) of an ecological community with only 1500 ha or 15% or less (whichever is the greater) protected for conservation in the Jarrah Forest IBRA subregion Specify:	yes/no
v) of an ecological community with only 400 ha or 10% or less (whichever is the greater) protected for conservation in the Bush Forever Study Area Specify:	yes/no
1b. Local Representation	
i) of an ecological community with 10% or less remaining of its pre-European extent within the Local Government Area Specify:	yes/no
ii) of an ecological community with 30% or less remaining of its pre-European extent within the Local Government Area Specify:	yes/no
iii) large (greater than 10 ha), viable natural areas in good or better condition of an ecological community with more than 30% remaining within the Local Government Area	yes/no
2. Diversity	
i) natural area in good or better condition that contains both upland and wetland structural plant communities	yes/no
3. Rarity	
i) of an ecological community with only 1500 ha or 10% or less (whichever is the greater) remaining in the IBRA subregion Specify:	yes/no
ii) of an ecological community with only 400 ha or 10% or less (whichever is the greater) remaining in the Bush Forever Study Area Specify:	yes/no
iii) contains a Threatened Ecological Community Specify:	yes/no
iv) contains Declared Rare Flora, Specially Protected Fauna or significant habitat for these fauna Specify:	yes/no
v) contains Priority or other significant flora or fauna or significant habitat for these fauna Specify:	yes/no
4. Maintaining Ecological Processes or Natural Systems - Connectivity	
i) natural areas acting as stepping stones in a Regionally Significant Ecological Linkage	yes/no
ii) natural areas acting as stepping stones in a locally significant ecological linkage	yes/no
5. Protection of Wetland, Streamline and Estuarine Fringing Vegetation and Coastal Vegetation	
i) Conservation or Resource Enhancement category wetland plus buffer	yes/no
ii) EPP Wetland plus buffer	yes/no
iii) riparian vegetation plus buffer	yes/no
iv) floodplain area plus buffer	yes/no
v) estuarine fringing vegetation plus buffer	yes/no
vi) coastal vegetation on foredunes and secondary dunes	yes/no

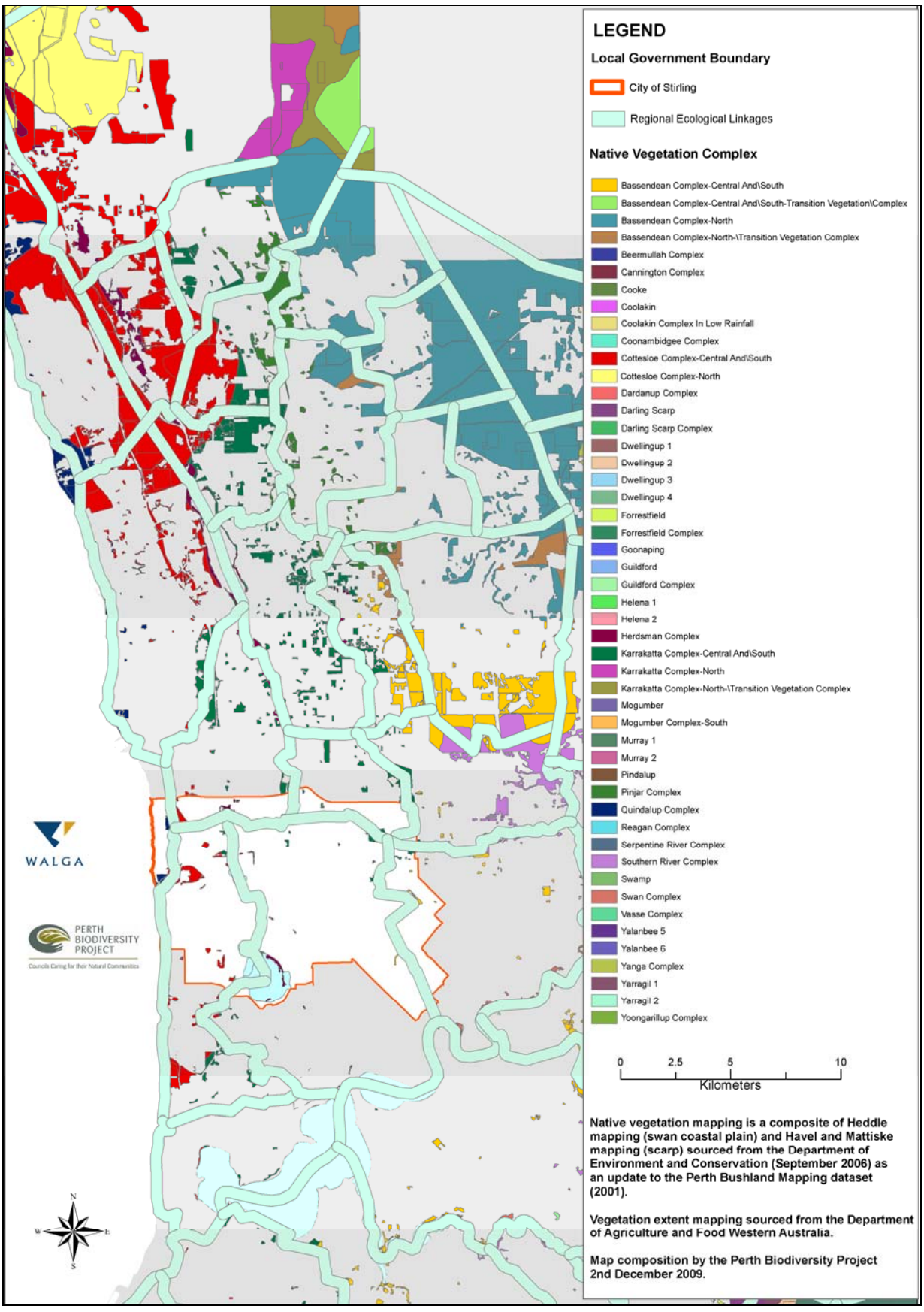
Initial Assessment Summary

Name of area _____

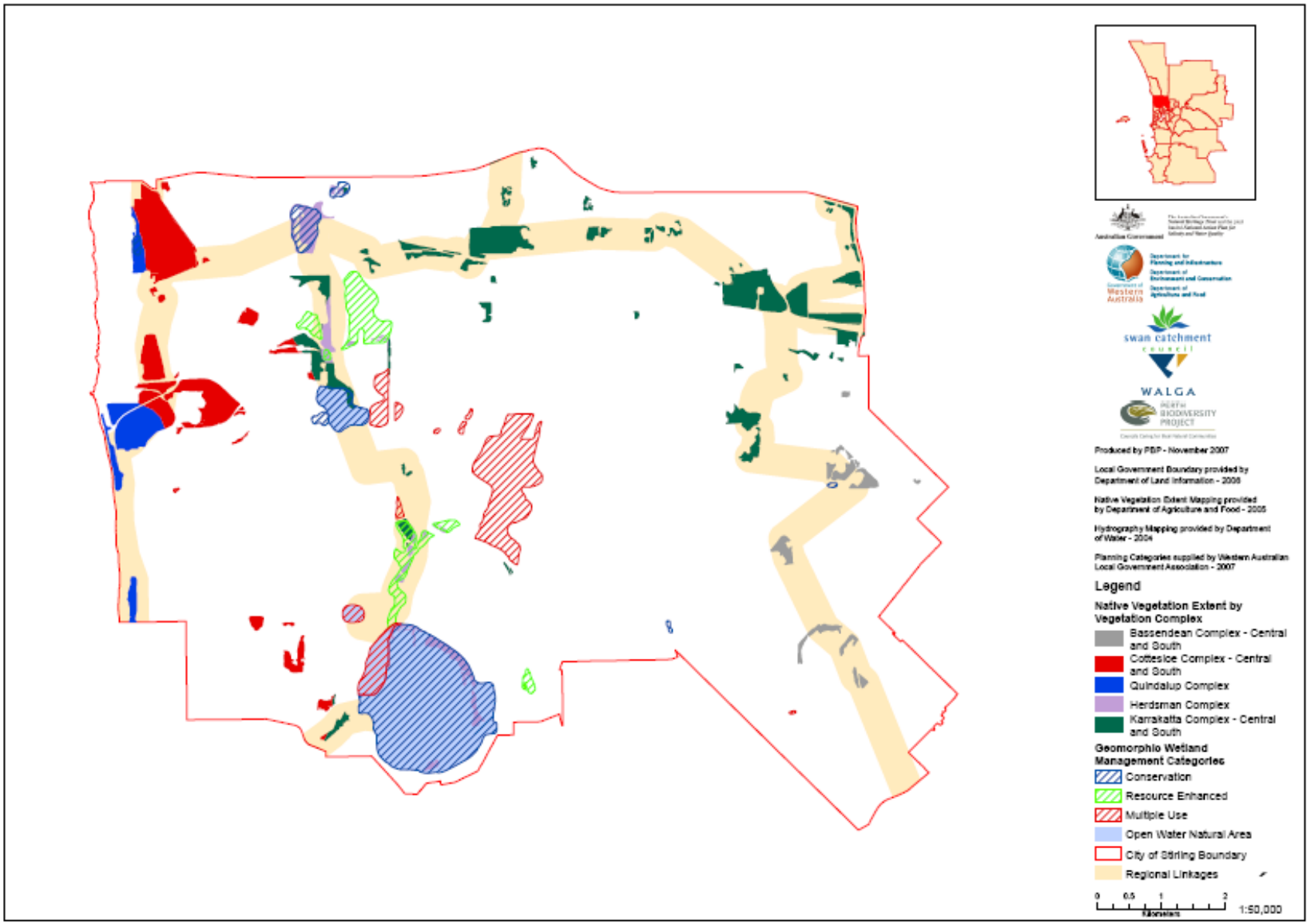
VIABILITY ESTIMATE				
Viability Factor	**Category**			**Score**
Size	Greater than 20 ha			5
	Greater than 10 ha less than 20 ha			4
	Greater than 4 ha less than 10 ha			3
	Greater than 1 ha less than 4 ha			2
	Less than 1 ha			1
Shape	Circle, square or squat rectangle			3.5
	Oval, rectangle or symmetrical triangle			3
	Irregular shape with few indentations			2.5
	Irregular shape with many indentations			2
	Long thin shape with large proportion of area greater than 50 m wide			1.5
	Long thin shape with large proportion of area less than 50 m wide			1
Perimeter to area ratio	Less than 0.01			4
	Greater than 0.01 less than 0.02			3
	Greater than 0.02 less than 0.04			2
	Greater than 0.04			1
Vegetation condition NB: based on Keighery (1994) condition scale	Pristine	10 x	% =	
	Excellent	8 x	% =	
	Very Good	6 x	% =	
	Good	4 x	% =	
	Degraded	2 x	% =	
	Completely Degraded	0 x	% =	
			Total calculated score =	
Connectivity	**A.** Forms part of a Regional Ecological Linkage and is contiguous with a protected natural area greater than 4ha			5
	B. Not part of a Regional Ecological Linkage but contiguous with a protected natural area greater than 4ha			4.5
	C. Forms part of a Regional Ecological Linkage and is within 500 m of more than 4 protected natural areas having an area greater than 4 ha			4
	D. Not part of a Regional Ecological Linkage but within 500 m of more than 4 protected natural areas having an area greater than 4 ha			3.5
	E. Forms part of a Regional Ecological Linkage and is within 500 m of 3 or 4 protected natural areas having an area greater than 4 ha			3
	F. Not part of a Regional Ecological Linkage but within 500 m of 3 or 4 protected natural areas having an area greater than 4 ha			2.5
	G. Forms part of a Regional Ecological Linkage and is within 500 m of 2 protected natural areas having an area greater than 4 ha			2
	H. Not part of a Regional Ecological Linkage but within 500 m of 2 protected natural areas having an area greater than 4 ha			1.5
	I. Forms part of a Regional Ecological Linkage and is within 500 m of 1 protected natural area having an area greater than 4 ha			1
	J. Not part of a Regional Ecological Linkage but within 500 m of 1 protected natural area having an area greater than 4 ha			0.5
	K. Forms part of a Regional Ecological Linkage but is not within 500 m of any protected natural areas having an area greater than 4 ha			0.25
TOTAL SCORE (Viability Estimate)				



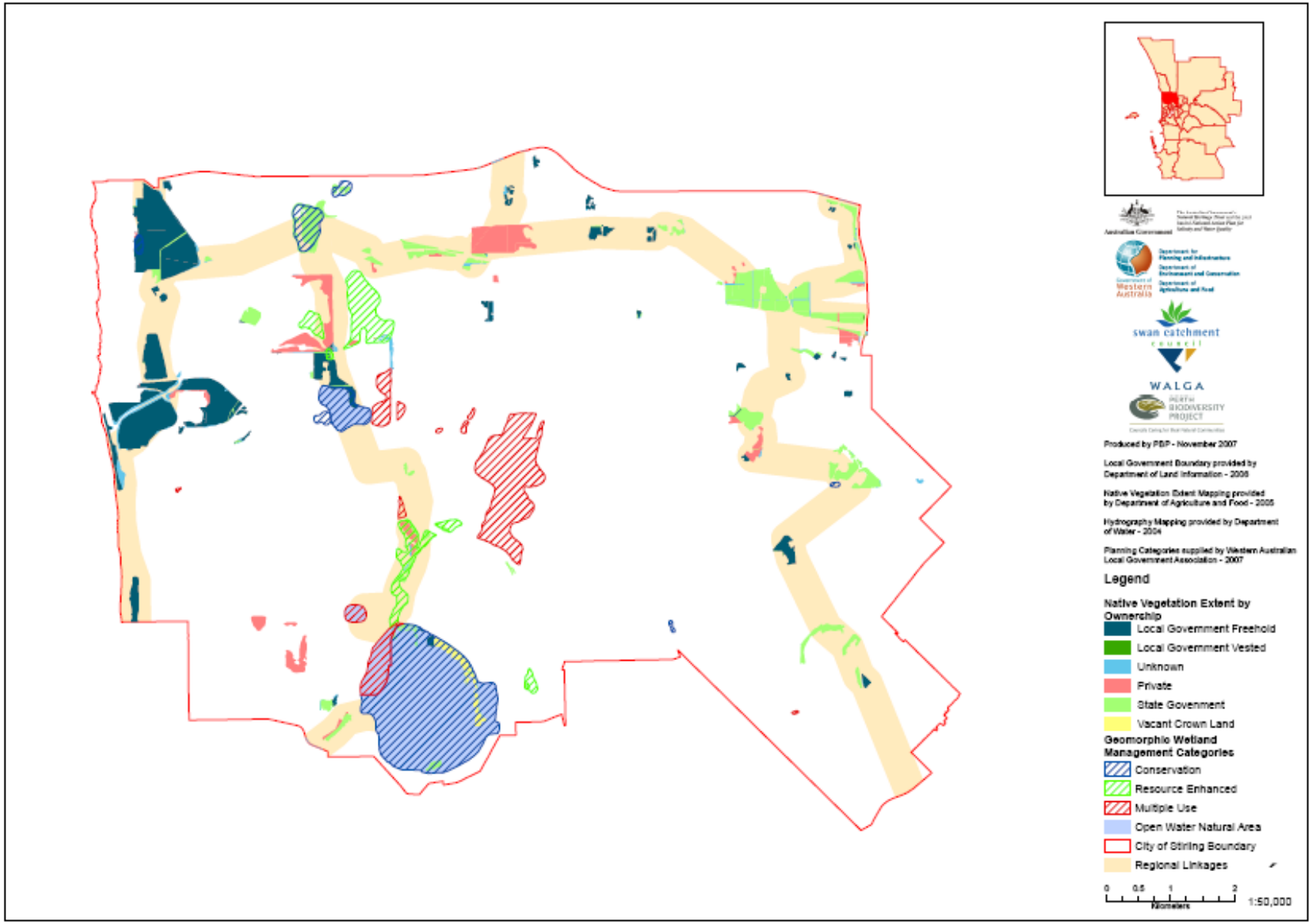
Map 1 – Regional Representation of Vegetation Complexes



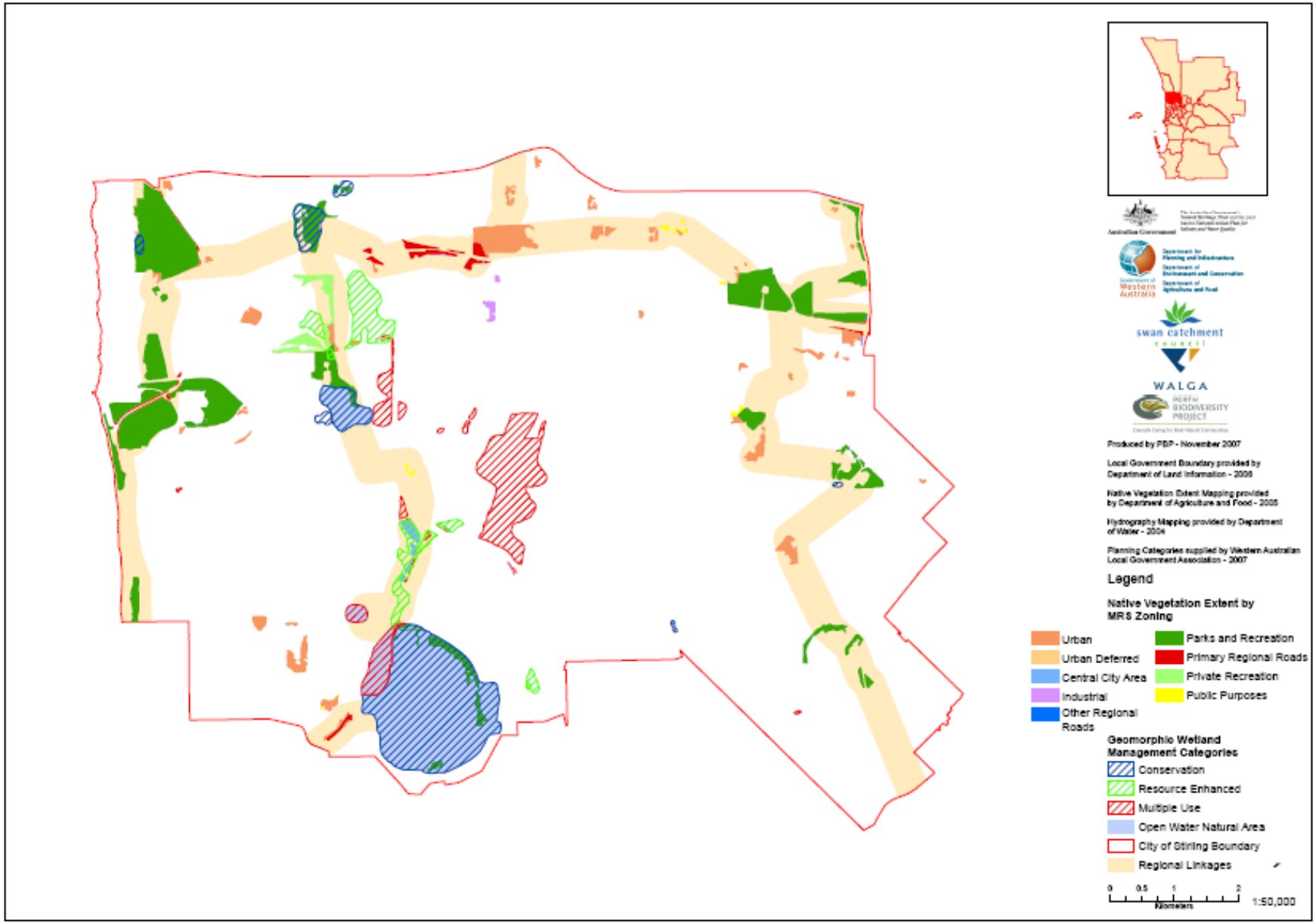
Map 2 - Regional Ecological Linkages



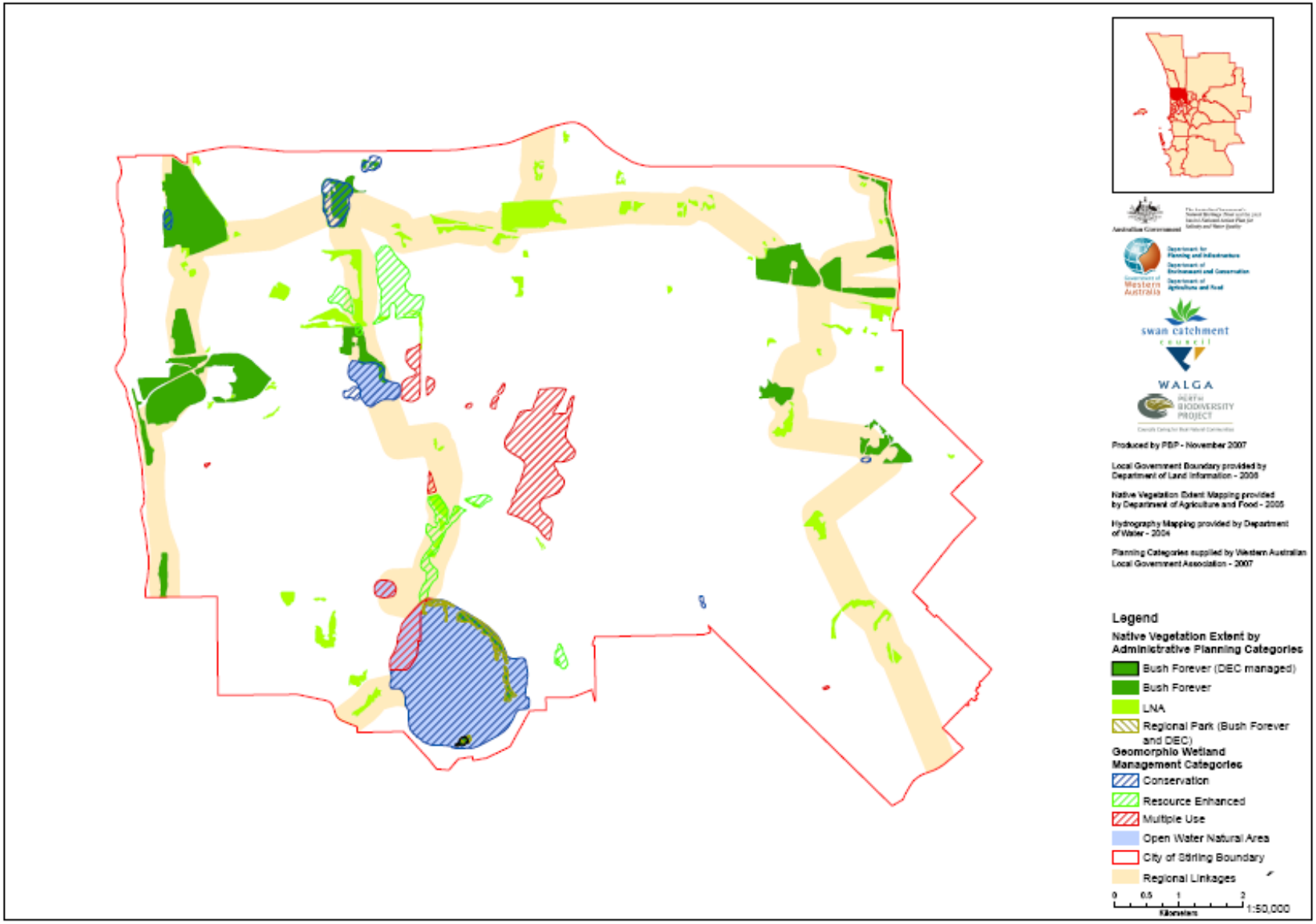
Map 3 – Native Vegetation Extent by Remnant Vegetation Complexes



Map 4 – Native Vegetation Extent by Ownership Categories



Map 5 – Native Vegetation Extent by MRS Zoning



Map 6 – Native Vegetation Extent by Administration Planning Categories

City of Stirling
City of Choice

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