Department of Environment and Conservation

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DEC Nature Conservation Service

Biodiversity

Monitoring Protocol

Monitoring of the extent of Dampier Peninsula Vine Thickets Threatened Ecological Community

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Prepared for:

Significant Native Species and Ecological Communities – Resource Condition Monitoring Project

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Version #	**Revision Date**	**Author**	**Changes**

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Advice when commencing this project was provided by Alan Byrne and Sharon Ferguson, West Kimberley District, Department of Environment and Conservation. The Bardi Jawi Rangers provided local knowledge of the vine thickets in the northern areas of the Dampier Peninsula and participated in the field work undertaken as part of this protocol.

Suggested Citation

This monitoring protocol may be cited as:

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APPENDICES

1 Introduction

This monitoring protocol provides information and procedures for monitoring the extent of occurrences of the Dampier Peninsula Vine Thicket ('vine thickets on coastal sand dunes of Dampier Peninsula') threatened ecological community (TEC). Condition of the community varies across its distribution and may be affected by various threats including weed infestation, clearing, inappropriate fire regimes and impacts of feral animals.

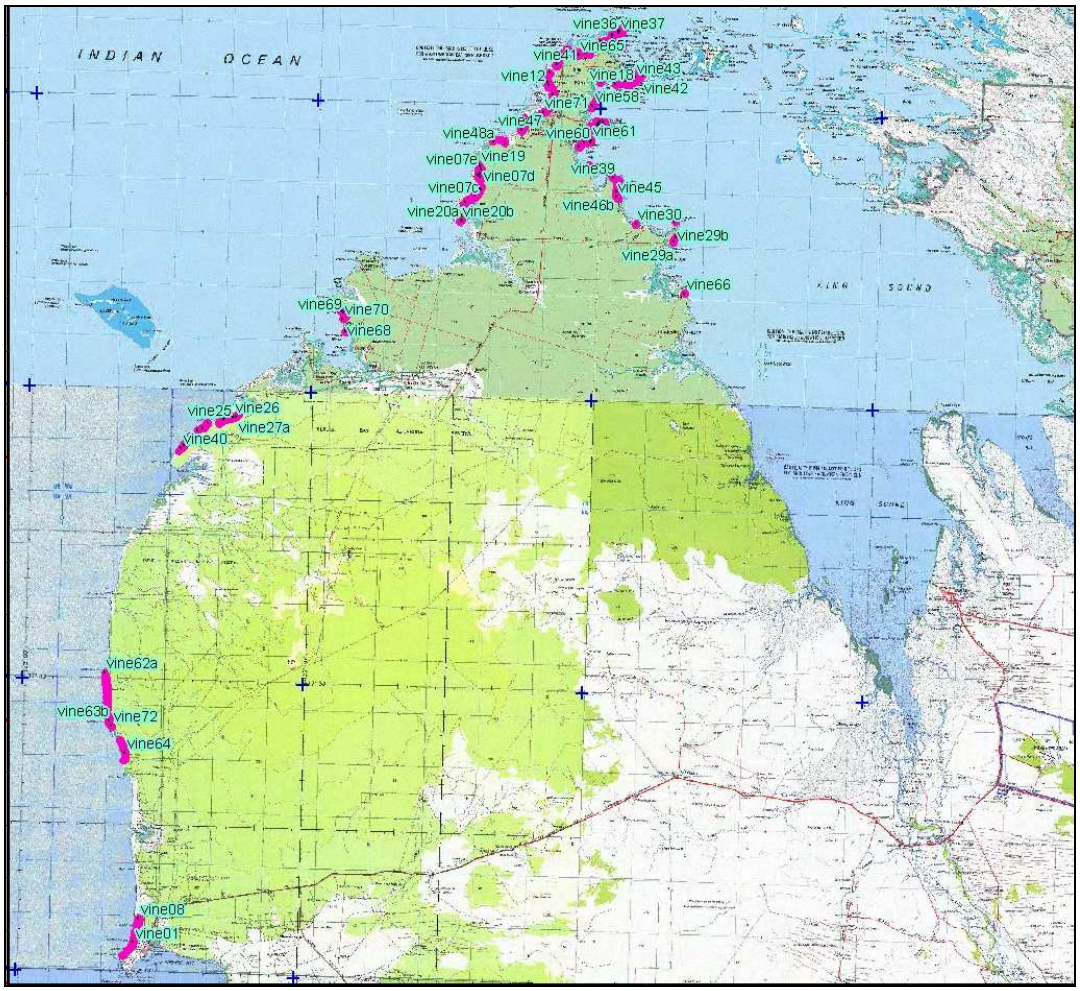

Figure 1: Dampier Peninsula Vine Thickets Threatened Ecological Community occurrences

2 Protocol Constituents

This protocol consists of this protocol narrative and the following standard operating procedure (SOP):

SOP 4.1: Setup of the SokkiaTM Axis3 Differential GPS

3 Background and Objectives

3.1 Background and history

The Dampier Peninsula Vine Thickets TEC is currently ranked as vulnerable (endorsed by the Minister in 2001) and is recommended for re-ranking as endangered. The community is located on the Dampier Peninsula and is based on the mapping of Black *et al*. (in press) (Appendix A), which further progressed the work under undertaken by Beard and Keneally, (1993) and McKenzie *et al*. (1991).

The TEC is described as:

Semi-deciduous vine thicket communities on leeward slopes of coastal sand dunes on Dampier Peninsula. Occur as discontinuous but discrete pockets of dense vegetation, ranging from a few trees to around 60 ha in size. Patches tend to be larger with increasing dune system size, and are generally better developed in structure and higher in species diversity at the northern end of the peninsula. The principal upper-storey tree species include: Cassine melanocarpa, Celtis philippinensis, Diospyros ferrea var. humilis, Ficus virens, Melaleuca cajuputi, M. dealbata, M. viridiflora, Mimusops elengi, Pouteria sericea, and Terminalia petiolaris. The understorey comprises shrub species such as: Croton tomentellus, Dodonaea platyptera, Exocarpos latifolius, Pandanus spiralis, Plumbago zeylanica, Santalum lanceolatum, and Securinega melanthesoides. Vine species include: Abrus precatorius, Adenia heterophylla, Caesalpinia globulorum, Gymnanthera nitida, Jacquemontia paniculata, Marsdenia cinerascens, Passiflora foetida and Tinospora smilacina. Soils are deep dune sands, white except for a superficial dark grey organic layer, and covered by leaf litter up to 6 cm in depth (Beard and Kenneally 1993).

McKenzie *et al*. (1991) differentiated the community from other rainforest communities in the Kimberley. Of the twenty-four rainforest patch groups derived by using species composition, three (groups V, W and X) are patches associated with Quaternary coastal sand dunes. Two of these (V and W) are known as the 'vine thickets on the coastal sand dunes of Dampier Peninsula'. The third Group, Group X, is located within tidal flats and is readily distinguishable from Groups V and W, and is situated over 600km away to the north east.

Threats listed for this TEC include:

- climate change and rising sea levels;
- clearing;
- groundwater drawdown;
- impacts of feral animals;
- inappropriate fire regimes, (too frequent, too hot);
- disturbance due to recreational activities;
- altered surface drainage pattern due to road construction;
- impacts of stock;
- storm water runoff;
- trampling by recreational users; and
- weed invasion.

The total area of the Dampier Peninsula Vine Thickets TEC is thought to have been reduced by around 40% since European settlement. It was also observed on a reconnaissance trip in 2008 that shifting sand dunes are covering some areas of Vine Thicket (Occurrence 32) near Hunter Creek and possibly the occurrence south west of Swan Point, Karrakatta Bay (Occurrence 38).

3.2 Rationale for selecting this resource to monitor

The Dampier Peninsula Vine Thickets TEC was considered to be the highest priority for monitoring in the Kimberley Region due to the threat of clearing for development, and to the immediacy of threats from inappropriate fire regimes and weed invasion. Selection of this TEC also provided the opportunity to work with district and regional DEC and NRM staff and local rangers to undertake monitoring. Some weed control and fire prevention work has been undertaken on occurrences of this community prior to development of this protocol.

The monitoring proposed for the Dampier Peninsula Vine Thickets TEC seeks to answer the following question:

- is disturbance (through direct clearing or degradation) reducing the total area of occurrences of this TEC?

3.3 Measurable objectives

The main objective of this proposal is to monitor the extent of occurrences of the Dampier Peninsula Vine Thickets to determine whether they are being reduced in extent.

4 Sampling Design

4.1 Rationale for selecting this sampling design over others

A report from surveys undertaken by Black *et al.* (in press) indicated that this TEC was under threat from several factors including clearing from urban development and weed invasion. The report provided recommendations that accurate mapping be undertaken for a number of occurrences of the TEC near One Arm Point (Bardi) and Broome town site as a priority.

4.2 Site Selection

4.2.1 Criteria for selection

The original Dampier Peninsula Vine Thickets TEC boundaries were mapped using aerial photography, topographical maps and site specific surveys. When overlaid on current large scale aerial photography it appeared that some of the original boundaries were not accurate, and in some instances included areas that were clearly not vegetated. The following recommendations were made (Black *et al.*, in press);

- establish a program to monitor the condition and extent of vine thicket patches on Dampier Peninsula in response to current and new management regimes. As a bare minimum, this should include the refinement of boundaries mapped under this project, and the investigation of possible patch boundary retreat (or expansion) over time, through further 'ground-truthing' survey work and the use of spatially rectified digital aerial photographs;
- refinement of our vine thicket patch boundary maps through: (i) the use of spatially rectified digital aerial photographs at a scale finer than 1:20 000; and (ii) a much greater investment in the ground-truthing of boundaries mapped from aerial photographs. As a basis for planning and environmental impact assessment, particular urgency applies to thickets and transitional vegetation in and adjacent to the towns of Broome, One Arm Point and Lombadina-Djarindjin (including and possibly adding to Patches 01, 02, 65, 71).

4.2.2 Procedures for selecting sampling locations

As noted above, sites were selected for accurate mapping using recommendations from Black *et al*. (in press). Important preparation for selecting sampling locations included discussions between the Department of Environment and Conservation (DEC), the Kimberley Land Council (KLC) and local land managers such as the Bardi Jawi Rangers. Discussions were required well in advance of field work. This ensured that landowners were consulted prior to planned field work and identified whether any proposed mapping sites had restricted access.

4.3 Sampling frequency and replication

Limited sampling of vegetation occurred as part of the monitoring of this TEC, via collection of samples of plants for herbarium field books. Quantitative data in the form of accurate boundary mapping of several occurrences of the TEC was undertaken. The mapping is recommended to occur every five years after the initial monitoring event in August 2008 (see Figure 1).

Recommendations for further accurate mapping of occurrences of this TEC can be found in Black *et al.* (in press) (Appendix A).

4.4 Recommended number and location of sampling sites

Seventy-two occurrences of the Dampier Peninsula Vine Thickets TEC are currently known. The boundaries of occurrences shown in Table 1 below have recently been accurately mapped. Further occurrences of the TEC will be accurately mapped as resources become available. Ideally, accurate boundary mapping of all occurrences is recommended.

Table 1: Vine Thickets occurrences addressed in this monitoring protocol

Vine Thicket	Location	Threat	Monitoring	Note
Vine 65	near Kooljaman	Good condition	Mapping	Access is restricted to part of this occurrence
Vine 10	near Chile Creek	Weeds	Mapping	
Vine 47	near Chile Creek	Sand dune encroachment	Mapping	
Vine 36	near Swan point	Sand dune encroachment	Mapping	
Vine 37	near Swan point	Sand dune encroachment	Mapping	

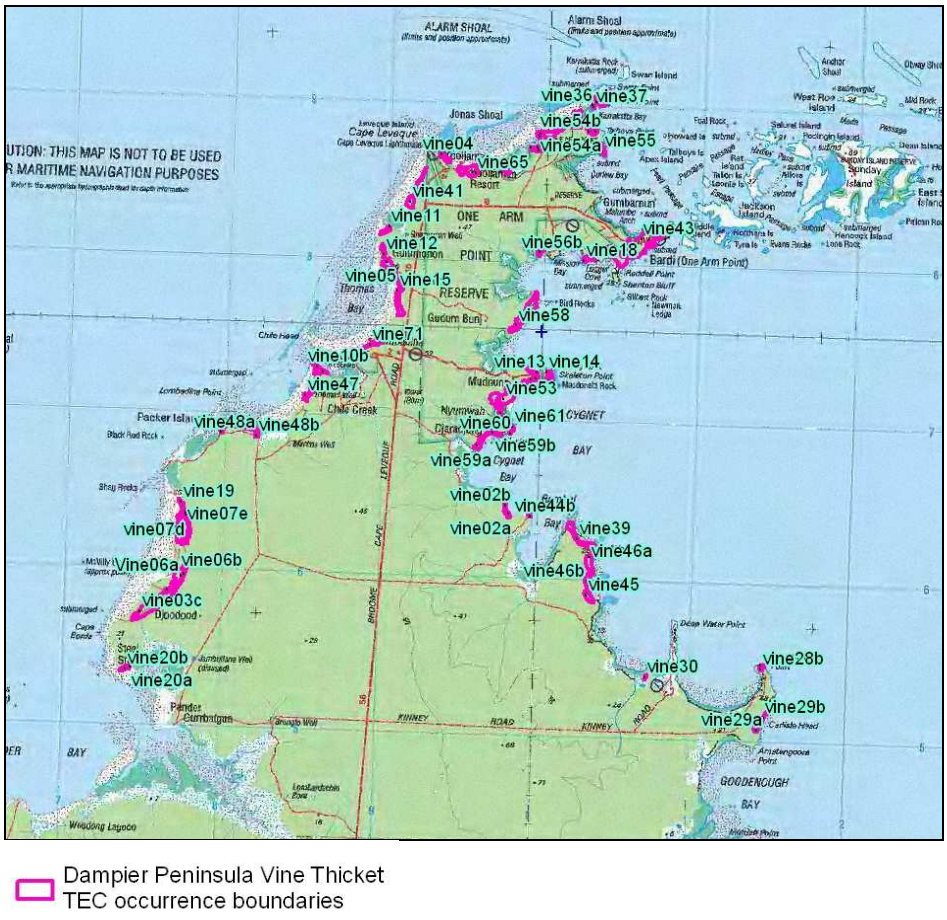

Figure 2: Vine Thicket TEC occurrences at the northern end of Dampier Peninsula

4.5 Recommended frequency and timing of sampling

The recommended frequency and timing of monitoring is five years after the initial sampling date in August 2008, and every five years thereafter.

Monitoring should also occur before and after any major management action is initiated, such as weed

pulling and spraying.

4.6 Level of change that can be detected for the amount/type of sampling being instituted

The level of change that can be detected for the occurrences where accurate boundary mapping is undertaken will be limited in occurrences that appear to be undisturbed. Rapid changes in the boundary of occurrences subject to disturbance are expected to be apparent at each monitoring event.

No quantitative data are currently available to predict the percentage of change that will be able to be detected. It is expected to be difficult to detect natural change of extent in undisturbed patches, but easy to detect large changes in extent in disturbed patches. It is envisaged that data collected from the project will allow determination of the detectable level of change in the future.

5 Field Methods

5.1 Field season preparations and equipment setup

Field work needs to be scheduled and organised prior to the start of each monitoring survey. Contact needs to be made between DEC Regional and District staff, regional NRM staff, the KLC and local land managers such as the Bardi Jawi Rangers to schedule survey dates and access arrangements. Prior to working in the field, staff must complete a field advice form and review safety protocols, and this protocol. A job safety analysis (JSA) should be prepared prior to field work, and read by all participants of the field work.

5.2 Sequence of events during field season

Desktop study
The following equipment was required to undertake the desktop study prior to field reconnaissance:

- digital data including aerial photography;
- cadastral information;
- TEC boundary mapping;
- weed/disturbance mapping.

The same equipment will be required for all subsequent monitoring surveys.

Field reconnaissance
A field reconnaissance was undertaken to meet with local DEC staff and the Bardi Jawi rangers and to visit several occurrences of the Dampier Peninsula Vine Thickets TEC. The field reconnaissance gave an indication of how many occurrences may be able to be mapped in the given field time, and to provide insight into the best monitoring methods.

The following equipment was required to undertake the field component of the monitoring:

- Plant collection permits (refer SOP Collecting Herbarium Specimens (in draft));
- Secateurs
- Plant tags
- Newspaper
- Plants presses
- Pens, pencils, permanent thick black marker pens
- Recording sheets (or PDA for direct data entry)
- Digital camera, memory card, batteries
- DGPS, Nomad PDA and GPS
- TEC Occurrence Report Forms
- Field herbarium book
- Plant specimen books, sticky tape, scissors
- Munsell soil colour chart
- Laptop.

The same equipment will be required for all subsequent monitoring surveys.

Preliminary preparations
Plant collection licences (including Permits to Take Declared Rare Flora (DRF)) should be organised at least one month prior to monitoring surveys. Accommodation preferably close to the monitoring sites should be organised as soon as field dates are determined and a full list of groceries and meal planning will be prepared prior to field work. Shared vehicles and equipment should be booked in advance. If mobilising from Perth, some equipment may need to be freighted to Broome in advance.

5.3 Details of taking measurements, with example field forms

Accurate boundary mapping of several occurrences of the vine thickets was undertaken using a Differential GPS (see SOP 4.1) within submetre accuracy. 1:100,000 scale aerial photography was consulted prior to on-ground mapping, and loaded on to Nomad PDA (Personal Data Assistant) to assist in on ground mapping.

Decisions were made about vegetation that was considered to be part of vine thicket TEC occurrences, by examining species lists and habitat descriptions for the community (see Section 3.1) and by making assessments of vegetation on the ground. Descriptions for occurrences as recorded in the WA TEC database were also consulted. As with all vegetation, patterns and continuums occur, and the delineation of a boundary can be subjective. Decisions were made about the condition and density of vegetation that would be mapped as part of each vine thicket occurrence, to provide consistency for mapping boundaries of occurrences, as outlined below.

For vine thicket occurrences mapped for this protocol, the vegetation boundary was often distinct, with Vine Thickets containing dense vegetation, with a closed tree canopy or 'Low Closed Forest' (70-100% canopy cover) approximately 4-6 metres high. The Vine Thicket occurrences mapped for this protocol occurred on the landward side of frontal dune areas, on sandy soils ranging from grey/white to pink sands.

Vegetation surrounding many of the vine thicket occurrences consisted of grassland, so delineation of the vegetation boundary was clear. Where small pockets of vine thickets appeared to be isolated from the main occurrence (for example several tree species and shrubs listed for the community clumped approximately 5-10 metres away from the main occurrence), these were considered to be part of the occurrence, but were mapped as separate polygons. Where single trees or shrubs that were listed as part of the community occurred in isolation (approximately five or more metres) away from the dense thicket vegetation, they were not mapped as part of the community.

In disturbed occurrences where rubbish or weeds made the vegetation boundary appear unclear, the boundary was mapped including only the dense vine thicket vegetation with little or no weeds or rubbish. The vegetation in the mapped Vine Thickets was in Good to Excellent condition, according to the Keighery condition scale used in Bush Forever (Government of Western Australia, 2000).

For Vine Thicket occurrences that were subject to disturbance as a result of shifting sand dunes, the vegetation boundary was mapped at the points where the sand met the vine thicket vegetation.

Disturbed areas that were considered to be part of the vine thickets included burnt areas. Where burnt areas encompassed areas of expected TEC occurrence boundary, recording of new boundary mapping was ceased and the former mapped boundary was maintained for shapefiles of mapping in burnt areas. Using the maps and aerial photos on the Nomad PDA, burnt vegetation was traversed along the lines of former boundary mapping, and the new boundary mapping was resumed when the unburnt vegetation was reached.

In many instances it was possible to walk to the edge of the apparent vegetation community boundary and to see that that point correlated with the dense vegetation that appeared on the aerial photos on the Nomad PDA.

For each vine thicket TEC occurrence that is mapped, any deviations from the above decisions need to be recorded for that occurrence.

TEC Occurrence Report forms were also filled out at each occurrence visited (Appendix B), and specimens collected for a field herbarium book. Unusual specimens were also collected for

submission to the WA Herbarium.

Photographs were taken at each occurrence and photo numbers recorded.

Soil information including pH, colour (Munsell) and depth to rock and landform aspect were noted.

Mapping information was downloaded nightly to the laptop, to help ensure data was not lost.

In occurrences where sand dunes were encroaching, photo monitoring points could be established. The position of the photo should be taken using DGPS and the angle the photograph is taken measured using a compass and recorded.

5.4 Post-collection processing of samples

The procedure for post-collection of plant specimens includes:

- newspaper to be changed after two to three days;
- plants are taken to WA Herbarium and stored in freezers or microwaved;
- preliminary plant identifications to be undertaken using reference collection and keys;
- additional identification assistance to be sought from WA Herbarium staff;
- RFRFs to be completed for DRF and priority taxa;
- plant collection labels produced and sorted with specimens;
- plant specimens and photographs lodged with the herbarium; and
- plant identifications transferred to TEC report forms, field herbarium books, databases.

5.5 End-of-season procedures

- data storage;
- clean/repair/replace & store field equipment;
- plant specimens lodged; and
- report preparation.

6 Data Handling, Analysis and Reporting

6.1 Metadata procedures

Metadata is “data about data”. That is, a statement about a dataset which describes the content, quality, currency and location and custodianship of the data.

The Australia New Zealand Land Information Council has developed guidelines for the collection of metadata (ANZLIC 2001). Metadata collection under this protocol will be compliant with these guidelines.

The data custodian should develop the original metadata record. Metadata records can be created in a Word document or text file and should be saved in the same directory as the dataset. See Appendix C for a template for metadata collection.

Metadata for this project will be for the data collected from both the survey and monitoring components of this protocol. The DEC TEC Database is the repository for the TEC metadata statements, and partner groups for the project will also save metadata statements.

6.2 Overview of database design

DeBacker *et al*. (2004) recognise that biodiversity monitoring creates large numbers of files and folders to store various databases; reports; GIS data; etc. and the organisation and linkages increase in complexity as data accumulates through time. The authors also note that foresight in database design is integral to ensuring data quality.

The DEC Threatened Ecological Communities Database (Microsoft Access) is the primary software environment for threatened ecological community data. ESRI ArcGIS 9 serves as a tool for validation of spatial data residing in this Microsoft Access database. Data collected in TEC Occurrence Report forms can be stored in the DEC Threatened Ecological Communities Database, and TEC spatial data

can be stored in the ArcGIS 9, with monitoring partner groups and DEC regional/district offices also storing collected data within their databases.

6.3 Data entry, verification and editing

Data entry involves transporting raw data from field sheets/notebooks into an electronic form such as a database. Quality assurance and control are important during the data entry process. DeBacker *et al*. (2004) suggest that where electronic data forms and databases are used for data entry, features such as drop-down lists and value limits may ensure minimal errors. Where plant specimens are collected, only valid names or measures should be allowed to be entered and spelling mistakes must be eliminated. Databases should be capable of receiving updates from the WA Herbarium to ensure name changes are addressed.

Data collected according to this protocol should be entered as soon as possible after collection into databases (for example TEC database and monitoring partner group databases) by people familiar with the data. This will help to minimise errors as familiarity with the data allows errors to be detected and easily corrected, and edits documented.

Mapping data collected using the DGPS should be backed up on computer upon return to the office and the data saved into the databases as a GIS layer for use (for example in ArcMap9).

6.4 Recommendations for routine data summaries and statistical analyses to detect change

A critical component of any long-term monitoring protocol is a consistent and systematic way of analyzing (sic) and reporting on information (data) collected (DeBacker *et al*., 2004, p. 33). DeBacker *et al*. (2004) also note that data summaries and statistical analyses need to describe the current condition, or status, of the subject being monitored and be robust enough to detect community changes through time. The information provided in data summaries must be complete, descriptive and easily interpretable.

Data summaries and analyses need to detail information about the subject of the data collection, for example factors noted in the field while undertaking mapping, such as visible disturbance (rubbish/fire scars/shifting sand dunes).

Any management interventions (for example fencing) that may influence these indicators need to be noted in the data summaries.

Data summaries should be undertaken at the end of each monitoring occasion. Given that monitoring is recommended at lengthy (five year) intervals on a long term basis, data summaries at such intervals should not be too laborious. Analyses will focus on changes as stated in the objectives of the monitoring protocol, so will therefore involve assessments in the change or otherwise of the mapped extent of the TEC occurrence. As additional data are collected, appropriate analyses as discussed will be undertaken to detect temporal trends in the monitoring data.

6.5 Recommended reporting schedule

Reports should be prepared and distributed within the same year as data collection and include maps, graphs, figures and other relevant visuals to facilitate comprehension of findings. DeBacker *et al*. (2004) suggest that more extensive summary reports, including trend analysis, should be completed every five to ten years depending on the rate of change in the monitoring data and the need for summary information to guide resource management. Summary reports may be used in place of annual reports for that year.

6.6 Recommended methods for long-term trend analysis

Methods for long term trend analysis will involve analysis of the change in extent of the TEC occurrences where accurate mapping has taken place. Mapping data will be analysed by someone competent in the use of GIS, to calculate aerial extents of occurrences and determine where changes in the boundary of occurrences have taken place. This will allow the perceived cause of the change to be assessed, and appropriate management initiated.

6.7 Data archival procedures

The *Natural Resource Management - Regional Spatial Information Management Toolkit* (2008) states that data must be copied and stored separately from the original dataset to ensure availability for other uses such as on-going monitoring, natural resource assessments or as agreed by the data custodian. The NRM toolkit also emphasises the importance of appropriate security and continuing recoverability of archived data as well as the inclusion of metadata and/or other relevant supporting documentation to enable use of those data and other information.

Long-term archives of TEC monitoring data (both electronic and hardcopy materials) are currently stored at the DEC Species and Communities Branch headquarters in Kensington. Data are stored on the DEC server and the TEC/PEC database. Data for this project should be stored with the TEC group, with monitoring partner groups and with DEC region/district headquarters. Hard copy materials may also be stored.

7 Personnel Requirements and Training

For safety considerations it is recommended that a minimum of two people undertake the monitoring for each TEC occurrence. Undertaking mapping, taking photographs and recording information is made easier with at least two people.

7.1 Roles and responsibilities

A mapping team leader is required to:

- liaise with managers and other stakeholders;
- co-ordinate field visits;
- team logistics (delegation);
- oversee data collection and data entry;
- analyse and interpret findings in liaison with a statistician; and
- participate in finalising/updating monitoring protocols.

A project/field officer is required to:

- use a DGPS and GIS applications such as ArcMap 9;
- enter data into the relevant database applications;
- organise and participate in field visits (accommodation, equipment etc);
- undertake field work; and
- write up reports in liaison with botanist/ecologist and statistician.

A person competent in the use of GIS is required to:

- assist in interpretation of findings.

7.2 Qualifications

It is important to note that where monitoring programs include vegetation surveys; the following EPA *Guidance for the Assessment of Environmental Factors Western Australia* (2004) recommendation is relevant;

> Flora and vegetation surveys should be coordinated and led by botanists who have had training, mentoring and experience in flora and vegetation survey. It is expected that they will have specific training and/or experience in ecology and taxonomy of the Australian flora and would normally have had a wide exposure to WA's flora and vegetation, preferably with knowledge and experience in the region being surveyed.
>
> It is recognised that some surveys may be done by survey teams that include members with less experience. These members should be supervised and mentored by the specialists mentioned above. This is seen as useful in training new practitioners. (p. 12).

7.3 Training procedures

Training is essential for developing competent observers. Refreshment of skills including species identification, GPS navigation, compass use, and estimation of foliage cover may be necessary for observers. Observers should be trained in the use of SOPs relevant to this protocol and discussions in the field regarding techniques are recommended.

8 Operational Requirements

8.1 Annual workload and field schedule

Monitoring of Dampier Peninsula Vine Thicket occurrence boundaries will likely require two teams of at least two people for each site visit. The time required to complete site visits may take in excess of a week. The time required may vary depending on logistics and weather.

Field schedules need to be prepared in consultation with district DEC staff, the KLC, local land managers and landholders.

8.2 Facility and equipment needs

Aside from general office facilities and equipment requirements, a range of computer hardware and software for data capture and storage are required. A differential GPS is necessary to accurately map Dampier Peninsula Vine Thicket occurrence boundaries. Other considerations include:

- Meals and accommodation in close proximity to the field sites need to be organised.
- Equipment listed in this document under "Field season preparations and equipment setup" needs to be purchased.
- Storage space for equipment needs to be organised.

8.3 Startup costs and budget considerations

Field equipment, accommodation and vehicle hire are the three major budgetary considerations for this project. Staff undertaking accurate boundary mapping are employed by the DEC and local land managers such as the Bardi Jawi Rangers, and no contractors were employed to undertake the mapping.

9 References

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10 Appendix

Appendix A: Draft recommendations extracted from 'Black S.J., Willing T., and Dureau D.M. (In press). The coastal vine thickets of Dampier Peninsula, West Kimberley 2000 - 2002. Broome Botanical Society.

Draft Recommendations

Community-based stakeholders and appropriate government agencies to:

1. (a) Change the category of threat assigned to the threatened ecological community (listed by CALM) - 'Vine thickets of coastal sand dunes on Dampier Peninsula'- from Vulnerable to Endangered as assessed and recommended by the WA Threatened Ecological Communities Scientific Committee in June 2005;
   (b) Nominate the 'Vine thickets of coastal sand dunes on Dampier Peninsula' for listing under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999*;

   (c) Establish a recovery team to develop and oversee the implementation of a Threatened Ecological Community recovery plan for the 'Vine thickets of coastal sand dunes on Dampier Peninsula'; and

   (d) In 2010, re-nominate the 'Vine thickets of coastal sand dunes on Dampier Peninsula' to the WA Threatened Ecological Communities Scientific Committee for review of the level of threat assigned to it as a Threatened Ecological Community.

2. Implement environmental impact assessment and planning processes for all developments on Dampier Peninsula. Particular urgency applies to the expansion of the major settlements/towns of One Arm Point and Lombadina-Djarindjin, and the establishment and expansion of outstation settlements and ecotourism ventures, where clearing and the construction of buildings, campsites and access tracks are having major impacts on vine thickets and surrounding country.

   Urgently required as a basis for urban planning, are fine-scaled surveys and detailed mapping of the extent and boundaries of vine thickets in and adjacent to Broome, One Arm Point and Lombadina-Djarindjin (including and possibly adding to Patches 01, 02, 65, 71). This should include the extent of any transitional vegetation at vine thicket margins and areas of vegetation containing significant vine thicket elements. True vine thicket patches should be retained for conservation along with a 500 m buffer zone extending into adjacent vegetation. Where possible, transitional vegetation containing vine thicket elements in the understorey should also be retained for conservation, as these also represent rare vegetation communities.

3. Establish a program to implement on-ground management of vine thickets and adjacent vegetation (refer recommendations 9 to 15). This would include the creation of a position of employment for a person to coordinate the writing and implementation of a recovery plan in cooperation with a recovery team, and the appointment and training of local Aboriginal 'Rangers' or 'Natural and Cultural Heritage Officers' to implement recovery actions.

4. Initiate a program of community liaison and education to increase awareness of the significance and conservation management requirements of Dampier Peninsula's coastal vine thickets, as well as any potential legal implications for activities impacting on vine thickets. This would involve the proposed recovery team, its coordinator, and Aboriginal 'Rangers' or 'Natural and Cultural Heritage Officers'.

5. Act to declare previously proposed conservation reserves and implement appropriate conservation management. The Proposed Borda Nature Reserve (12302 ha) is a particularly high priority and has been proposed since 1983. It contains six vine thicket patches, two of which are unusually large in area. Other proposed reserves are the Proposed Cygnet Bay Nature Reserve (15805 ha), the Proposed Reserve for Conservation and Aboriginal Heritage (Waterbank) (92234 ha), the Proposed Minyirr Coastal Park Stage 2 (approximately 50 ha), and the Proposed Leveque Nature Reserve (1010 ha).

6. Add to the proposed conservation reserve system and/or manage vine thickets for conservation based on the following, (1) Principles:

   (a) All vine thicket patches should be protected and preferably reserved. Research in the Northern Territory has shown that vine thickets function as a network of patches and that the loss of any single vine thicket patch can affect all of the others in the network. In addition, each patch should be protected by a 500 m buffer zone extending into adjacent vegetation;
   (b) Because of the need to maintain connectivity, critical clusters of vine thicket patches must be reserved;
   (c) Considerable areas of all habitats adjacent to vine thickets should be reserved and managed for conservation. These act as buffers and provide resources for animals like birds and bats that maintain the ecological function of vine thickets. Reserve boundaries should extend to the low tide line so as to include mangroves and tidal mudflats, as much of Dampier Peninsula's species richness comes from species dependent on these littoral areas. Ideally, the various adjacent habitats should be retained in their original proportion; and
   (d) Because most thickets occur in small or narrow linear patches and are highly vulnerable to disturbance, the majority of vine thicket patches should be protected from high rates of public access and usage. In particular, vehicular access other than on existing tracks should be prevented. However, the public should have the opportunity to walk in some patches of vine thickets and ecologically sensitive ecotourism ventures could cater to this. Nature reserves should remain open to Aboriginal usage for traditional purposes such as ceremonial use of sacred sites.

   And (2) priority areas for vine thicket conservation:

   (a) The cluster of ten vine thicket patches on coastal dune formations between Cape Baskerville and Baldwin Creek (Patches 06 to 14, and 62), on Aboriginal Reserve 22615 (Beagle Bay lands). The protected area should encompass all of Baldwin Creek including its mangroves and tidal mudflats to the low tide line, Bundabunda Spring and the intertidal mudflats of Carnot Bay, the rock outcrops King Peaks (Patch CC) and Carnot Peaks (Patch GG), and interspersed woodlands. This could be accomplished by drawing a circle of 15 km in radius around Patch 08;
   (b) The cluster of four vine thicket patches from East Sandy Point to Cliff Point (Patches 15, 16, 17 and 18) on Aboriginal Reserve 1834 (Beagle Bay lands). A circle with a radius of about 7 km from the southern end of Patch 16, would include Tappers Inlet in the conservation reserve;
   (c) As much of the northern Peninsula as possible should be protected with the aim of including those vine thickets not currently proposed for reservation. These are:
      (i) vine thickets on Lombadina Grazing Lease from just south of Chile Creek then north through Lombadina-Djarindjin to Kooljaman (Patches 24 to 68); and
      (ii) vine thickets on Aboriginal Reserve 20927 (One Arm Point lands) from Kooljaman (Patch69) northeast to Swan Point (Patch33), and south through One Arm Point (Patch71) to Gallen (Patch47) and Miligoon (Patch 51). This includes three patches on freehold land.
   (d) As the availability of resources for biodiversity conservation management are very limited, it is necessary to further prioritise individual patches.
      (i) All six unusually large vine thicket patches are a high priority. By chance, each of the four coastal vine thicket patch groups (classified according to similarities in perennial plant species) is represented in these patches (Patches 05, 20, 22, 39, 47, and 71).
      (ii) Vine thicket Patch 21 (60 ha) is a high priority for its structure.
      (iii) All four patches containing the Priority 4 listed tree *Pittosporum moluccanum.* Patches 05 and 14 are of the highest priority, but also of importance are Patch FF (transitional vegetation) and Patch 11, along with the *Melaleuca dealbata* woodland adjacent to Patch 11.
      (iv) Patch 06 and Patch 10 as further good examples of Patch Group D.
      (v) All the well-structured, species-rich Group C patches are a high priority for conservation. Along with those listed above, particular emphasis could be placed on Patches 25, 28, 26, 42, 30, 43, 55, 37, 36 and 52 because of their relatively high species richness.

Patches 39, 40 and 41 and significant buffer areas around them should be protected in order to conserve the only two occurrences we found of the shrub *Helicteres rhynchocarpa,* a Kimberley endemic restricted to woodland or open areas adjacent to

(vi) vine thickets, and one disjunct occurrence of *Trophis scandens,* normally found in the North Kimberley, which was also on the edge of a vine thicket.

7. Liaise with leaseholders regarding conservation management for vine thickets on Aboriginal leasehold land lots.

8. Liaise with owners and managers regarding conservation management for vine thickets on freehold land (oyster and pearl license areas).

9. (a) Implement fire management to protect individual vine thicket patches from intense late dry-season fires; and

   (b) Develop an integrated community-based fire management program for Dampier Peninsula.

10. Implement washdown hygiene to minimize the transport of weeds on heavy earth-moving equipment around Broome, between Broome and Dampier Peninsula, and between locations on the Peninsula. This should be strictly applied to the movement of equipment from Broome to the Peninsula.

11. Survey and map weed infestations, and as a matter of urgency, implement control of very high and high priority weeds in vine thickets and in settlements/town sites (particularly those adjacent to vine thickets, One Arm Point, Lombadina-Djarindjin and Broome, but also at Beagle Bay as people travel between there and vine thickets). Monitor weed infestations (species present, species abundance, and extent of area of infestation) and their response to management regimes. While the seeds of many weed species are wind and bird dispersed, they can also be transported by water so catchment areas draining into vine thickets should be surveyed for weeds.

    The highest priority weed to target for vine thicket conservation is Siratro or Black Pea *Macroptilium atropurpureum* (vine), which currently occurs at Broome, James Price Point, and in two patches near One Arm Point. New infestations are a higher priority than those in the already severely degraded Gubinge Road vine thicket (Patch 01).

    High priority weeds are: Darwin Pea *Clitoria ternatea* (vine) at Broome and One Arm Point; Hairy Morning Glory *Merremia dissecta* (vine) at Broome and Quondong Point; Coffee bush *Leucaena leucocephala* (tree) in two localized stands at James Price Point and north of Quondong Point; Neem trees *Azadirachta indica*; Rubber vine *Cryptostegia madagascariensis* (declared) recorded in Lombadina-Djarindjin; Horehound *Hyptis suaveolens* (herb) at Broome and in one patch near One Arm Point; and Yellow Poinciana *Peltophorum pterocarpum* (tree) at Broome only. Note that Neem trees have so far only been recorded in one vine thicket at Broome. However, the species has been planted in gardens at some Peninsula outstations from where it has the potential to spread into vine thickets.

    Medium priority weeds include Buffel Grass *Cenchrus ciliaris* and Birdwood Grass *Cenchrus setigerus* at numerous locations.

12. Apply restrictions to the cultivation and selling of potential weeds among horticultural species in Kimberley nurseries such as Rubber Vine *Cryptostegia madagascariensis,* Neem Trees *Azadirachta indica,* Lantana *Lantana camara*, and Yellow Poinciana *Peltophorum pterocarpum,* and raise public awareness as to the potential for these species to become weeds so as to discourage the planting of them. In addition, discourage the public from dumping garden prunings (or other rubbish) in the vicinity of vine thickets or elsewhere in the bush.

13. Manage domestic and feral or exotic animals on Dampier Peninsula. A priority is to exclude domestic cattle herds from vine thickets. Currently the number of domestic and feral cattle on the Peninsula is low but as more people take up residential leasehold blocks on Aboriginal land, the number of small domestic herds will potentially increase.

14. Implement management for ecologically sustainable forest product harvesting in vine thickets (e.g. craft wood timbers), including monitoring, regulation, and development of guidelines for sustainable use and practices.

15. Implement and plan for ecologically sustainable management of tourism and recreational impacts on vine thickets and surrounding vegetation.

16. Protect all *Ficus virens* trees (Banyan, Albay or Strangler Fig), *Canarium australianum* (Jalgir), *Terminalia petiolaris* (Marool or Blackberry), and hybrids of *T. petiolaris* and *Terminalia latipes* subsp. *psilocarpa* (Red Gubinge, Barragool or Gariling) on Dampier Peninsula, and where possible buffer each within a protected radius of 250 m. Plant or encourage the growth of these trees in towns. Studies in the Northern Territory have shown that several vine thicket trees (particularly *Ficus virens*) produce abundant fruit for fruit-eating birds and bats (flying foxes) that are the agents of dispersal for the seeds of most vine thicket plants. As well as occurring in vine thickets these four species may be found in woodland and are scattered (albeit thinly) throughout the landscape, thereby providing alternative food resources and acting as stepping-stones for birds and bats travelling between vine thicket patches.

17. Identify and protect all known flying fox roost sites on Dampier Peninsula. Studies in the Northern Territory recommend including roosts within reserves and buffering them by 500 m.

18. Protect and manage Bunda Bunda Mound Spring (Carnot Bay Spring) to conserve the only occurrence of 'wet rainforest' on Dampier Peninsula. Bach and Price (in press) found that among rainforest patches in the Northern Territory, each of 16 study patches had different patterns of fruit availability and this difference was most marked between 'wet' rainforest and 'dry' rainforest types such as semi-deciduous vine thickets. Given the individuality of each patch, any one, small or large, can become an important food resource and habitat for frugivores at some time of the year. Therefore, it is essential to conserve the existing diversity of rainforest types on Dampier Peninsula.

19. Establish and promote a standard and guidelines for access track construction on Dampier Peninsula in order to prevent excessive land degradation. In particular, unformed access tracks should not be graded or bulldozed, rather their construction should include driving over or removal and slashing of vegetation where necessary, such that soil surfaces remain intact (on the Peninsula, blade-down clearing for track construction is not necessary or ecologically sustainable, and unlike discrete bush tracks detracts from the wilderness experience).

20. Establish a program to monitor the condition and extent of vine thicket patches on Dampier Peninsula in response to current and new management regimes. As a bare minimum, this should include the refinement of boundaries mapped under this project, and the investigation of possible patch boundary retreat (or expansion) over time, through further 'ground-truthing' survey work and the use of spatially rectified digital aerial photographs.

21. Conduct further survey, mapping and ecological research, including:

    a) Refinement of our vine thicket patch boundary maps through: (i) the use of spatially rectified digital aerial photographs at a scale finer than 1:20 000; and (ii) a much greater investment in the ground-truthing of boundaries mapped from aerial photographs. As a basis for planning and environmental impact assessment, particular urgency applies to thickets and transitional vegetation in and adjacent to the towns of Broome, One Arm Point and Lombadina-Djarindjin (including and possibly adding to Patches 01, 02, 65, 71). Refer to Recommendations 2 and 20;
    b) Completion of botanical and condition survey for the few remaining unsurveyed patches on Dampier Peninsula;
    c) Identification of vine thicket patches most at risk from fire damage (using aerial photographs and the results of this survey);
    d) Survey for flying fox roost sites on Dampier Peninsula;
    e) Survey of frugivorous (fruit-eating) bird species on Dampier Peninsula (we have recorded the presence of two in numerous patches: the Rose-crowned fruit-dove and the Great Bowerbird);

f) Research on the ecology of frugivorous birds and bats on Dampier Peninsula, their role in vine thicket seed dispersal, and the implications of these relationships for local conservation management (including the complementary roles of other habitats in the provision of resources for mobile frugivore species);
g) Document the remaining knowledge of older Aboriginal people in relation to vine thickets on Dampier Peninsula, such as their values, uses, ecology, and traditional management; and

h) Taxonomic studies of *Capparis jacobsii* on Dampier Peninsula in order to determine its conservation status.

22. Consider and plan for the impacts of climate change by reserving, protecting and managing for conservation, as many vine thicket patches and as much of the intervening habitat on Dampier Peninsula as possible. The larger reserves are, the better the chances of maintaining a diversity of species, ecological communities (ecosystems) and ecological processes under fluctuating climatic conditions. As the thickets are coastal, many patches will be at risk from cyclone damage and inundation by rising sea levels, as well as changes in ecology and species composition.

Appendix B: Threatened Ecological Community Occurrence Report Form

Department of Environment and Conservation
Our environment, our future

Threatened Ecological Community (TEC) Occurrence Report Form

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Version 5.2 June 2009

Community: _____ **OBSERVATION DATE:** ___/___/___

New occurrence ☐ **Site ID:** _____ **CONS CODE:** _____

OBSERVERS: _____ **ORGANISATION:** _____

ROLE: _____ **DISTRICT:** _____ **SHIRE:** _____

DESCRIPTION OF LOCATION: _____

_____

_____

DATUM:
GDA94 ☐
AGD84 ☐
WGS84 ☐
Unknown ☐

COORDINATES:
LAT/Northing: _____
LONG/Easting: _____
MGA ZONE: __

METHOD USED:
GPS/ Differential GPS/ MAP
No. Sats: _____
Map Used: _____
Map Scale:

SURVEY EFFORT:
Edge survey ☐
Partial survey ☐
Full survey ☐
Area surveyed (ha):

LAND TENURE:

Nature Reserve ☐ | Timber Reserve ☐ | Private Property ☐ | Rail Reserve ☐ | Shire Rd Res ☐
National Park ☐ | State Forest ☐ | Pastoral Lease ☐ | MRWA Rd Res ☐ | Shire Reserve ☐
Cons. Park ☐ | Water Reserve ☐ | UCL ☐ | SLK/Pole ____ to ____ | Other (Specify) _____

Landowners permission sought: ☐ Landowner present: ☐ Reserve: _____

Threat type and supporting information: Eg clearing, recreation, too frequent fire, grazing, weeds, disease, fragmentation, hydrological change. • Rate current and potential threat impact: 1=LOW, 2=MEDIUM, 3=HIGH, 4=EXTREME.	Current impact (1-4)	Area affected	Potential Impact (1-4)	Onset: Imminent	Onset: Long Term
•	____	____%	____	☐	☐
•	____	____%	____	☐	☐
•	____	____%	____	☐	☐
•	____	____%	____	☐	☐
•	____	____%	____	☐	☐
•	____	____%	____	☐	☐

CONDITION OF SOIL: Moist ☐ Waterlogged ☐ Inundated ☐ Mud ☐
Dry ☐ Cracked ☐ Saline ☐ Other: _____

CONDITION OF OCCURRENCE (Bush Forever Scale)
(estimate % of area in each):

Pristine ☐ ____%
Excellent ☐ ____%
Very Good ☐ ____%
Good ☐ ____%
Degraded ☐ ____%
Completely Degraded ☐ ____%

RECOMMENDED MANAGEMENT ACTIONS: eg. roadside markers required, weed control, etc.

_____

_____

_____

_____

ACTIONS IMPLEMENTED (include date):

_____

_____

_____

Submitter of Record:_____ Role: _____ Signed:_____ Date:____/____/____

Please return completed form to, DEC, Locked Bag 104, BENTLEY DELIVERY CENTRE WA 6983

RECORDS: Please forward to **TEC Database Administrator**, SCB. **Record Entered in Database** ☐ Date:____/____/____

Department of Environment and Conservation
Our environment, our future

Threatened Ecological Community (TEC) Occurrence Report Form

Page 2

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HABITAT INFORMATION:

LANDFORM:	ROCK FORM:	ROCK TYPE:	SOIL TYPE:	SOIL COLOUR:	DRAINAGE:
Crest ☐	Bedrock ☐	Granite ☐	Sand ☐	Red ☐	Well drained ☐
Hillock ☐	Boulder ☐	Dolerite ☐	Sandy loam ☐	Brown ☐	Mod. drained ☐
Ridge ☐	Cobble ☐	Laterite ☐	Clay loam ☐	Yellow ☐	Seasonally inundated ☐
Slope ☐	Coarse gravel ☐	Ironstone ☐	Light clay ☐	White ☐	
Flat ☐	Medium gravel ☐	Limestone ☐	>20% Gravel ☐	Grey ☐	Permanently inundated ☐
Outcrop ☐	Fine gravel ☐		Peat ☐	Black ☐	Tidal ☐
Closed depression ☐		Specify other:	Specify other:	Specify other	
Open depression ☐					
Wetland ☐					
Drainage line ☐					

Specific Landform Element:

VEGETATION CLASSIFICATION:

1.
2.
3.
4.

FIRE HISTORY: **Last Fire:** Season/Month:_____ Year: _____ **Fire Intensity:** High/Medium/Low Long unburnt ☐

LANDUSES: **SITE:**

ADJACENT:

OTHER COMMENTS (include recommended management actions and/or implemented actions (include date):	**Associated Species:**

ATTACHED: Map ☐ Mudmap ☐ GIS data ☐ Photo ☐ Field notes ☐ Other: _____

Submitter of Record:_____ Role: _____ Signed:_____ Date:____/____/____

Please return completed form to, DEC, Locked Bag 104, BENTLEY DELIVERY CENTRE WA 6983

RECORDS: Please forward to **TEC Database Administrator**, SCB. **Record Entered in Database** ❑ Date:____/____/____

Appendix C: Metadata Statement Template

Category	Element	Comments
Dataset	**Title**	The ordinary name of the dataset.
	Custodian	The organisation responsible for the dataset.
Description	**Abstract**	A short description of the contents of the dataset.
	Search Word(s)	Words likely to be used by a non expert to look for the dataset.
	Geographic Extent Name(s) **OR**	A list of geographic extents such as • map sheets; • local government areas; • catchments; • IBRA regions; and • latitude/longitude co-ordinates for the top left and bottom right corners of the area covered, that reasonably indicate the spatial coverage of the dataset.
	Geographic Extent Polygon(s)	An alternate way of describing geographic extent if no pre-defined area is satisfactory. Provide polygon title and location/directory address.
Date Currency	**Commencement date**	Commencement date (of field work/data collection)
	Completion date	Last date of information in the dataset.
Dataset Status	**Status**	What is the current status of the database? Ongoing/Completed/Under development/Planned.
	Maintenance and Update Frequency Daily Weekly Fortnightly Monthly Annually Irregular	Frequency of changes or additions made to the dataset

Access	**Stored Data Format**	The format or formats in which the dataset is stored by the custodian. Eg. Microsoft Access database, Microsoft Excel Spreadsheets, ESRI shapefiles etc.
	Location/Directory address	Where can the data be found
	Available Format Types	The formats in which the dataset is available, showing at least, whether the dataset is available in digital or non digital form.
	Reports/Publications	What reports and publications have been produced using the dataset?
	Access Constraint	Any restrictions or legal prerequisites applying to the use of the dataset, eg. Licence required. Access and reliability.
Data Quality	**Lineage**	A brief history of the source and processing steps used to produce the dataset.
	Positional Accuracy	A brief assessment of the closeness of the location of spatial objects in the dataset in relation to their true position on the Earth.
	Attribute Accuracy	How accurate are the values in the Attribute Table of this spatial data in respect to the real world values? Eg. 'complete' = all tables are correctly labelled in the dataset.
	Logical Consistency	A brief assessment of the logical relationships between attributes and spatial objects in the dataset. Eg. 'consistent' = attribute values have been checked and validated for consistency; logic checked in relation to attribute names; and all attributes that require values have values assigned.
	Completeness	A brief assessment of the completeness of coverage, classification and verification.

Contact Information	**Contact Organisation**	Ordinary name of the organisation from which the dataset may be obtained.
	Contact Position	The relevant position in the Contact Organisation.
	Postal Address	Postal address of the Contact Position.
	Telephone Number	Telephone of the Contact Position.
	Facsimile	Facsimile of the Contact Position.
	Electronic Mail Address	Electronic Mail Address of the Contact Position.
Metadata Date		Date that the metadata record for the dataset was created.
Additional Metadata		Reference to other directories or systems containing further information about the dataset.