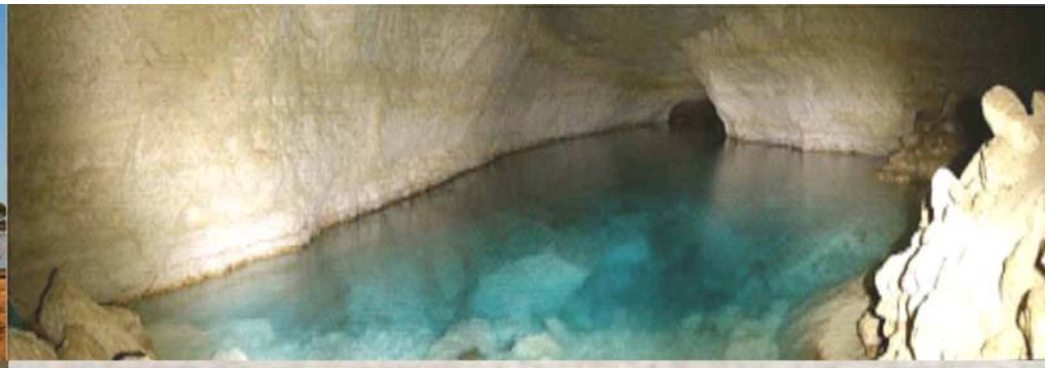

Field Managers' Abbreviated Version: Interim Management Guidelines for the Nullarbor Caves and Selected Karst Features

Prepared By

Geoscene International
Division of Scenic Spectrums Pty Ltd

Australian Government

Department of Environment and Conservation

RANGELANDS NRM Co-ordinating Group

Natural Heritage Trust
Helping Communities Helping Australia
An Australian Government Initiative

LANDCARE

Field Managers' Abbreviated Version: Interim Management Guidelines for the Nullarbor Caves and Selected Karst Features

A report funded through:
The Biodiversity Conservation Initiative - Save our Species Program
Rangelands NRM Co-ordinating Group
Department of Environment and Conservation (DEC), Western Australia

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- Paul Hosie (Cave diver; Representing Cave Exploration Group of South Australia –CEGSA -, who are the key custodians of Nullarbor Karst identification and location information);
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Organisations consulted and surveyed during 2007 by DEC:

- Australian Speleological Federation (ASF)
- Cave Divers Association of Australia (CDAA)
- Department of Environment and Conservation (DEC)
- Department of Indigenous Affairs (DIA)
- Department of Planning and Infrastructure (DPI)
- Fire & Emergency Services Authority (FESA)
- Goldfields and Esperance Development Commission (GEDC)
- Shaw Horizons (Tourism Operators)
- Shire of Dundas
- Speleological Research Group of Western Australia (SRGWA)
- Tourism Western Australia

Acronyms

ACKMA	Australian Cave and Karst Management Association
ARTC	Australian Rail Track Corporation Ltd
ASF	Australian Speleological Federation
CAC	Caves Access Committee
CALM	former Dept. of Conservation and Land Management
CDAA	Cave Divers Association of Australia
CEGSA	Cave Exploration Group (South Australia) Inc.
CLAP	Cave Leader Assessment Panel
CLMR	*Conservation and Land Management Regulations 2002*
CMAC	Caves Management Advisory Committee
DEC	Dept. of Environment and Conservation
DEWHA	Dept. of Environment, Water, Heritage and the Arts
DIA	Dept. of Indigenous Affairs
DIR	Dept of Industry and Resources
DOLA	former Dept. of Lands and Agriculture
DMPR	Dept. of Mineral and Petroleum Resources
DPI	Dept. of Planning and Infrastructure
DWR	Dept. of Water Resources
EPA	Environment Protection Authority
EPBA	*Environment Protection and Biodiversity Conservation Act 1999*
FESA	Fire and Emergency Services Authority
GEDC	Goldfields & Esperance Development Commission
GLSC	Goldfields Land and Sea Council
HREOC	Human Rights and Equal Opportunities Commission
IBRA	Interim Biogeographical Regionalisation for Australia
IMG	Interim Management Guideline(s)
IUCN	International Union for Conservation of Nature
KIDSA	Karst Index Database – South Australia
LAA	*Land Administration Act 1997*
LAC	Limits of Acceptable Change
LCDC	Land Conservation District Committees
MATs	Management Action Targets
NCKMAC	Nullarbor Caves and Karst Management Advisory Committee
NHT	Natural Heritage Trust
NLP	National Landcare Program
NRM	Natural Resource Management
NRS	National Reserve System
NUCC	National University Caving Club
PGA	Pastoralists and Graziers Association
PLB	Pastoral Lands Board
SEIG	Statutory Exploration Information Group
SRGWA	Speleological Research Group of Western Australia
SLS	State Land Services
TOMM	Tourism Optimisation Management Model
RAOU	Royal Australian Ornithologists Union UNESCO
RAS	Register of Aboriginal Sites
RATIS	Recreation and Tourism Information System
RCTs	Resource Condition Targets
ROS	Recreation Opportunity Spectrum
VAMP	Visitor Activity Management Process
VERP	Visitor Experience Resource Protection
VIM	Visitor Impact Management
WAFF	Western Australian Farmers Federation
WAHC	Western Australian Heritage Council
WAM	Western Australian Museum
WARMS	Western Australian Rangeland Monitoring System
WASG	Western Australian Speleological Group
WCPA	World Commission on Protected Areas
ZCA	Zone Control Authorities

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FIELD MANAGER'S ABBREVIATED VERSION: INTERIM MANAGEMENT GUIDELINES FOR THE NULLARBOR CAVES AND SELECTED KARST FEATURES

1. Executive Summary and Key Recommendations

This is the Field Managers' Abbreviated Version of the Interim Management Guidelines (IMGs) for caves and selected karst features of the Nullarbor Karst System in Western Australia [1]. The current focus area is primarily from the Trans Australian Railway south to the coastline and from the South Australian border west to Point Malcolm. A full, unabbreviated IMG report is also available from DEC and Rangelands NRM. The Nullarbor caves and associated features play a critical role in a much larger karst system that is without question of world and national significance for a range of natural and cultural resources (e.g. geologic, palaeontololgical, archeological, biological etc. and in terms of indigenous and non-indigenous cultural heritage).

Although the area receives relatively low visitor numbers due to remoteness, it is extremely fragile and vulnerable, even to the level of use currently received. Currently, the management co-ordination, presence, activity and control over the caves and karst features are inadequate given the high conservation values and vulnerability of the area. The current Cave Access Permit System is inconsistently applied and unenforceable, primarily due to a lack of public knowledge/co-operation and no field checks on usage. There are significant public safety and liability issues. There are also many untapped opportunities for presentation and interpretation of the outstanding features of the area to the public and for enhanced conservation measures and research. These issues are briefly presented in this report, but are fully explored and documented in the unabbreviated IMG report. Twenty-four IMGs are recommended for consideration (refer to Section 4). Priority guidelines include:

1. review and consideration of alternatives for field-based conservation officers;

2. apply the Cave Management Classification System and the Cave Access Permit System in a consistent and rigorous manner;

3. conduct assessments of cave risks to visitors for selected caves on a priority basis;

4. vestment of overall management of all caves and associated karst features to a single State Government department – DEC - with oversight from a new Nullarbor Cave and Karst Management Advisory Committee (NCKMAC);

5. fence, gate and lock critically significant and fragile caves, dolines and blowholes;

6. continue priority ecosystem, flora and fauna protection and recovery programs and weed and pest animal controls on a targeted basis;

7. survey and fence ground-surface footprints of significant cave passages on pastoral leasehold properties and Unallocated Crown Lands for safety and conservation purposes;

8. provide visitor information, safety and interpretive facilities and programs on a selected and priority basis as indicated by feasibility assessments and specified works plans;

9. conduct preliminary reviews of potential enhanced management frameworks.

Areas that may have the potential to receive funding under periodic Federal Government grant programs (e.g., Caring for Our Country) have been identified in the full IMG report, along with significant resource assessment, planning and research projects. Sharing the full IMG report with the community, key stakeholders and other government land managers, and partnering with them is strongly encouraged.

NOTE 1: Selected sections of the text have been highlighted in bold lettering to facilitate quicker reading of key points by the reader.

2. Project Background

2.1 Project Aims and Objectives

The Nullarbor Caves and Selected Karst Features IMG Project has as its principal aim the preparation of Interim Management Guidelines (IMGs) [2] for the caves, blowholes, dolines and key associated biological features of the Nullarbor Karst System[3] of Western Australia[4]. The focus area is located primarily south of the Trans Australian Railway.

It is anticipated that the primary audience for the IMGs will include the Department of Environment and Conservation (DEC), Rangelands Natural Resource Management (NRM) Co-ordinating Group, Pastoralists (particularly those who have caves and karst features on their properties), Tourism WA, Speleological and Cave Diving Groups, Local Government organisations and other State Government bodies.

WHAT IS KARST?

***"The term karst denotes a distinctive style of terrain which is characterised by individual landform types and landscapes that in large measure are the product of rock material having been dissolved by natural waters to a greater degree than is the norm in most landscapes. In a narrow sense, the word refers to any area which has been shaped by solution processes. More broadly, it is an integrated, yet dynamic system of landforms, life, energy, water, gases, soils and bedrock. Perturbation of any one of these will impact upon the rest of the system….Caves and other typical karst features may also result from other processes, and give rise to the phenomenon known as pseudokarst – land systems which contain karst-like features such as caves and surface collapses which are not formed by solution"*, (Watson et al., Eds., 1997. *Guidelines for Cave and Karst Protection,* IUCN).**

NOTE 2: IMGs are strategic planning documents usually used by DEC to describe management activities for a specific reserve or area, when a management plan for that area has not been completed. The IMGs provide context for operational activities in an area and provide the basis for the preparation of annual works programs. The IMGs are formatted as a package of operational strategies with basic supporting information. They are not prescriptive in nature, but constitute a comprehensive set of strategic guidelines for management of the asset by all stakeholders. IMGs are valid for a period of five years. In this case, the IMGs provide a useful framework for the interim management of lands that are vested in a number of government departments, and not solely DEC. The IMGs are aimed at informing the major stakeholders of the assets and values of the Nullarbor Caves and Karst Features and best practice management of the assets.

NOTE 3: The original brief for this project had as its aim and objectives the preparation of Interim Management Guidelines for the entire Nullarbor Karst System. Documentation covering this broader scope has been prepared by Geoscene International on behalf of the Clients and has been made available to them for reference. At the request of DEC, this report has been reduced in its scope to focus primarily on the caves, dolines and blowholes of the Nullarbor Karst System, primarily south of the Trans Australian Railway line. Geoscene International emphasises that the focus features should always be considered within the context of and their relationship to the broader Nullarbor Karst System in order to achieve a fully sustainable and holistic approach to resource management

NOTE 4: A Glossary is provided at the end of the main text for definitions of technical terms used.

2.2 Key Focus Attributes and Assets Addressed

The original brief for this project has been reduced in scope from the entire Nullarbor Karst System to focus on the key attributes of the southern portion of the Nullarbor Karst directly or closely associated with:

- caves and interior cave features;
- blowholes; collapse dolines, and;
- key subterranean ecosystems, flora and fauna associated with the above features.

Photos 1, 2 and 3 Cave, Collapse Doline and Blowhole Examples



(Source: Olaf Theden, 2007. Copyright – used with permission.)

Closely associated attributes and assets of the Nullarbor Karst addressed to varying extents include, but are not limited to:

- geology, landforms and soils;
- catchments and karst sub-catchments;
- karst aquifers and groundwater quality;
- native plants and plant communities;
- ecological communities;
- native fauna (terrestrial and subterranean);
- indigenous heritage;
- non-indigenous heritage; and
- other human values.

2.3 Potential Uses Considered

The uses of (and subsequent threats to) the Nullarbor Karst addressed include but are not limited to:

- tourism and visitor activities;
- indigenous and cultural activities;
- pastoral activities;
- mining activities;
- cave rescue and emergency services training;
- water extraction; and
- research.

2.4 Key Management Activities

Key management activities addressed in the Nullarbor Karst IMGs include, but are not limited to:

- tenure and control of associated uses;
- protection of native flora and fauna;
- control of environmental weeds;
- control of pest animals;
- fire;
- regulation of visitor access (including for the purpose of speleological expeditions and research, as well as tourism);
- visitor safety;

- public utilities and services;
- liability; and
- confidentiality.

This IMG report is to be available for comment by stakeholders. Specific mapping and locations of some features will not be provided in this report due to the highly vulnerable and valuable nature of many of the natural and cultural resources of the Nullarbor Karst Region.

2.5 Funding Agencies and Steering Committee

2.5.1 A Joint Initiative

This project has been prepared as a joint initiative between the Rangelands Natural Resource Management (NRM) Coordinating Group and the Department of Environment and Conservation (DEC)'s Biodiversity Conservation Initiative – Save our Species program. It has been prepared by Geoscene International on behalf of these funding organisations and in consultation with the Nullarbor Karst Steering Committee and key stakeholders.

2.5.2 Project Management and Consultations

Klaus Tiedemann, DEC Esperance District Manager, has been the Project Manager and a member of the Steering Committee. Dennis Williamson, a Geographer/Landscape Planner and Director of Geoscene International, has been the principal consultant and author of the report. The Steering Committee and persons/organisations consulted during the course of the project and the preparation of this report have been listed in the Acknowledgments.

2.6 Project Area and Overview Description

2.6.1 Geographic Area

The Nullarbor Karst System extends over an area of approximately 200,000 km^2 across Western Australia and South Australia (refer to Figure 1). Within Western Australia, the Nullarbor Karst System is located along the eastern coastline from the South Australian border at approximately 129.368° East longitude westward to approximately 123.484° East longitude and from the coastal shores and cliffs of the Great Australian Bight (Great Southern Ocean) inland to approximately 28.957° South latitude. For the focus features of this report, the project area has been limited to the areas south of the Trans Australian Railway, which generally runs slightly north or south of 31° South latitude (refer to area within red dashed line in Figure 1). However, it is emphasised that some caves, blowholes and other karst features do occur north of the railway. Future explorations may reveal more of these features, just as has been the case in the Mardabilla Plains in recent years.

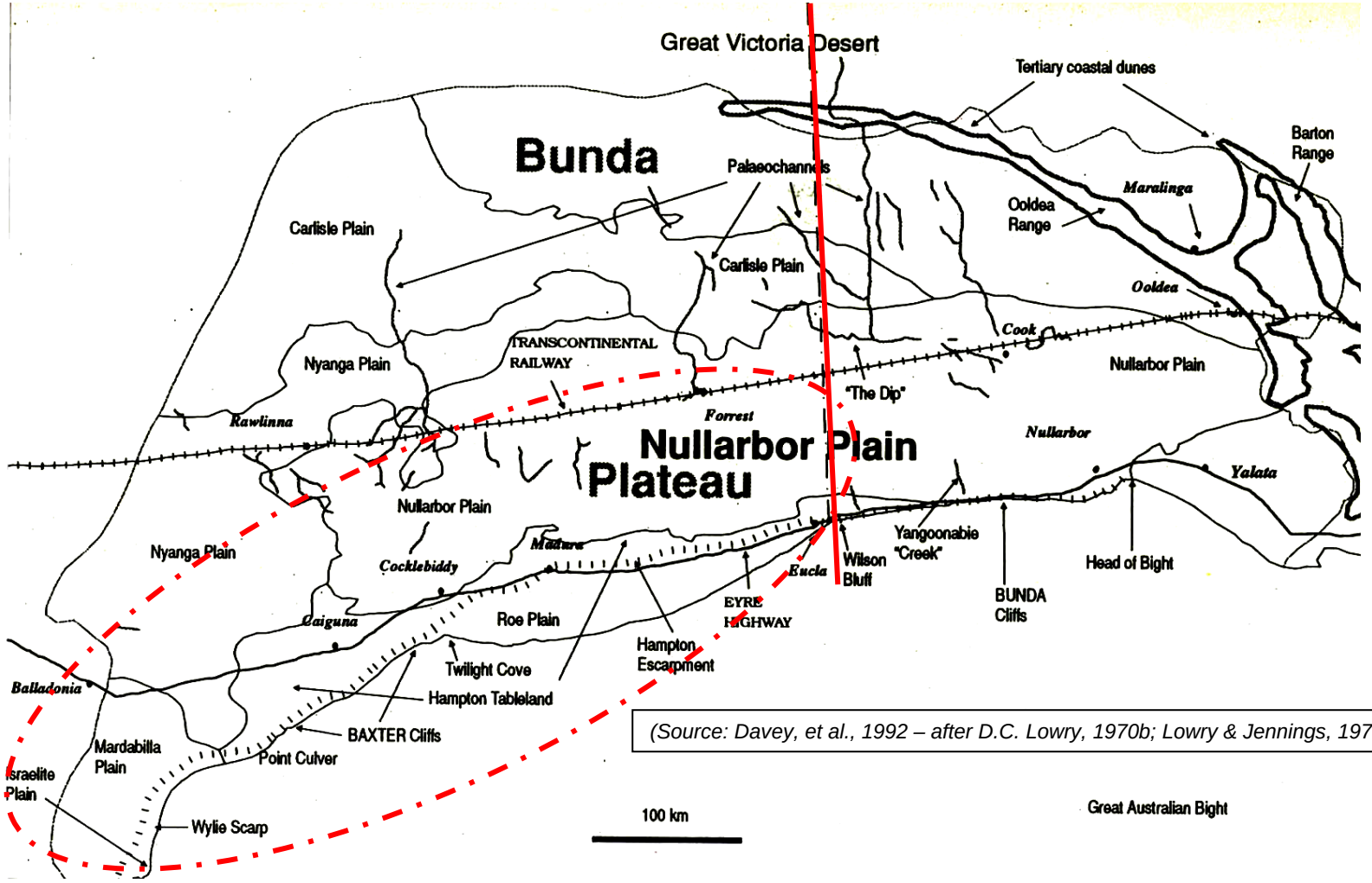
2.6.2 Physiographic Units, Biogeographic Subregions and Vegetation

Referring to Figure 1, the Nullarbor caves and selected associated features primarily occur within four of the eleven physiographic units of the Bunda Plateau referred to by Davey et al. (1992). The project area includes four of the seven subregions of the Interim Biogeographical Regionalisation for Australia (IBRA) subregions of the broader Nullarbor Karst System. Beard's (1975) Physiographic/Vegetation Units, shown in Figure 2, also provide reference to the areas of focus for this report.

The following is an overview description of the four key physiographic units and broad vegetation communities or associations of those units. The four physiographic units of our focus include (from north to south and east to west) the Nullarbor Plain, Hampton Tableland, Roe Plain and Mardabilla Plain.

Nullarbor Plain is a flat, treeless plain with significant small scale relief in the form of patterns of joint-controlled, clay-filled depressions (dongas) that alternate with ridge and corridor terrain in an area of thin stony soil or bare limestone. The southern end of several paleodrainage lines extend onto the Nullarbor Plain. The Nullarbor Plain also exhibits scattered caves and related karst features, including solution pans and rockholes, collapse dolines and blowholes.

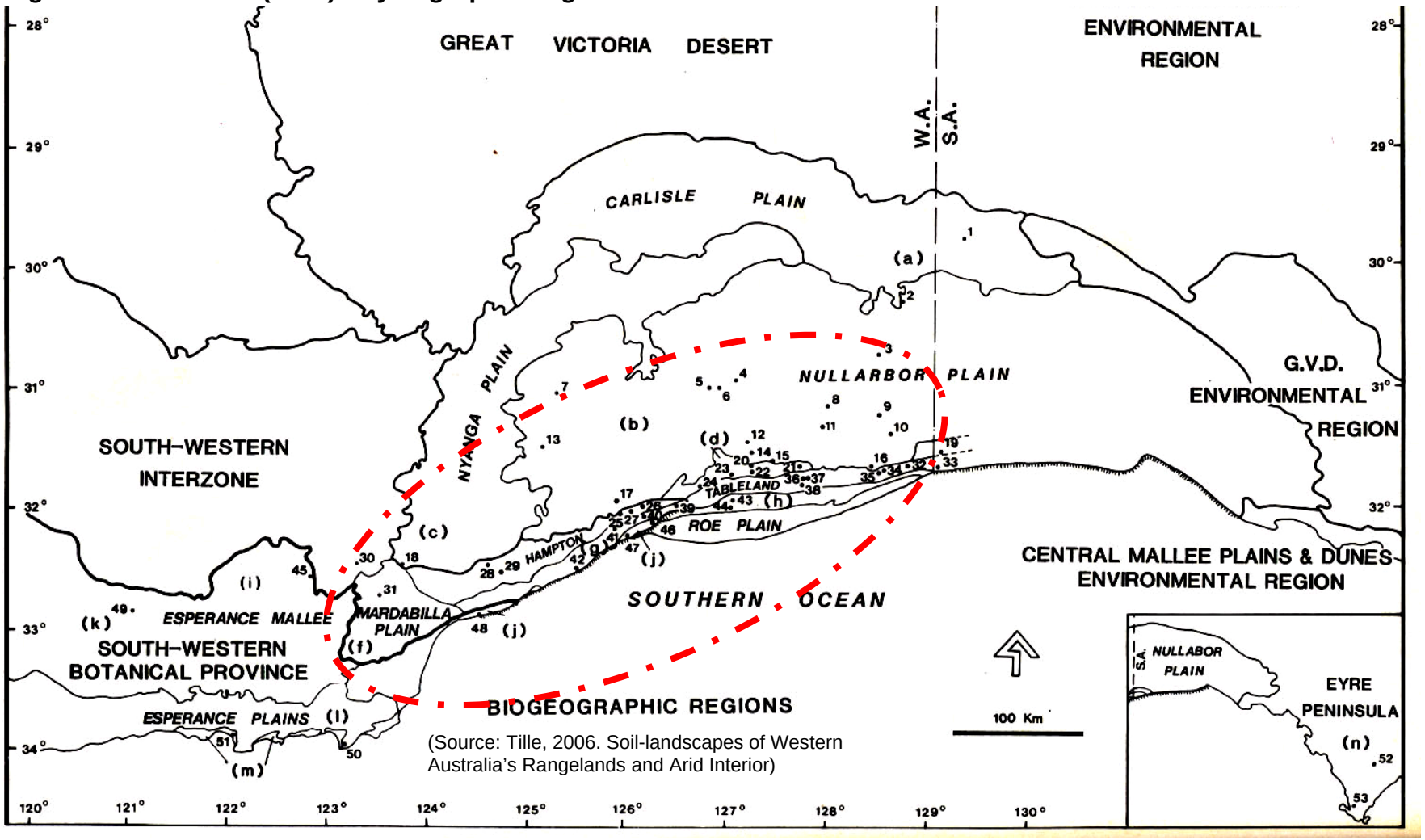
Figure 1 The W.A. Nullarbor Cave and Associated Features Project Area within the Broader Nullarbor Karst System



(Approximate Project area is within the red dashed line.)

(Source: Davey, et al., 1992 – after D.C. Lowry, 1970b; Lowry & Jennings, 1974; and Benbow, 1990b)

Figure 2 Beard's (1975) Physiographic/Vegetation Units



(Source: Tille, 2006. Soil-landscapes of Western Australia's Rangelands and Arid Interior)

The vegetation is Bluebush - Saltbush steppe in central areas; low woodlands of *Acacia papyrocarpa* (Western Myall) over *Maireana sedifolia* (Bluebush) are present in peripheral areas, including *Myoporum platycarpum* and *E. oleosa* in the east and west.

Hampton Tableland lies south of the Nullarbor Plain where the Nullarbor Limestone formation has undergone significant denudation, completely removed in parts, revealing the underlying Abrakurrie Limestone. This area has most of the known caves and collapse dolines of the region. The tableland surface is dominated by ridge and corridor terrain with local relief up to 10 m. The ridges tend to be rockier than those of the Nullarbor Plain and carry scattered *Acacia* and/or mallee *Eucalyptus* in the chenopod shrubland. A feature known as "karren" is restricted to the coastal cliffs and former coastal escarpment, adjacent to the collapse dolines and other cave entrances.

Rounded pocketing and perforation of the limestone, which occurs by solution beneath the soil, has been exposed in many places by subsequent deflation. The Hampton Tableland is considered to be the most important area of the region for the development of a range of surface and subsurface karst features. Various Mallee communities dominate the limestone scree slopes and pavements, as well as the sandy surfaces. Alluvial and calcareous plains below the scarp support Eucalypt woodlands and Myall open low woodlands.

Roe Plain is a depositional surface formed on the Pliocene to Pleistocene Roe Calcarenite. This comprises an emerging sea floor with beach ridges and coastal dunes that are separated from the higher parts of the Bunda Plain by the Hampton Escarpment. The dunes occur in several ages, including some modern active ridges. Some caves occur on the plain, showing a different style to those of the main Bunda Plateau (Lowry & Jennings, 1974). The alluvial and calcareous plains below the scarp support Eucalypt woodlands and Myall open low woodlands.

Mardabilla Plain is located in the south-western portion of the Bunda Plateau, south of the Nyanga Plain. This area is also flat and soil covered, with numerous inliers of basement rocks that distinguish this unit. The basement rocks are commonly ringed by shallow moats, 3-10 m deep and 50-150 m across, which probably formed from solution by aggressive runoff from the inliers. One of the largest basement rock inliers is Mount Ragged, which preserves a dramatic wave-cut bench of the Eocene age on the slopes of the mountain about 150 m above the plain (Lowry, 1970b). Mallees and shrublands on sandplains are associated with lateritised uplands, playas and granite outcrops. Diverse woodlands are rich in endemic eucalypts, on low greenstone hills, valley alluvials and broad plains of calcareous earths.

Immediately adjacent to the four focus physiographic units are the Nyanga Plain, Israelite Plain and Sea Cliffs physiographic units.

Nyanga Plain is a featureless plain located north and west of the Nullarbor Plain and flanks the northern edge of the western end of the Hampton Tableland. It is covered with a thick continuous layer of clay and calcrete with occasional closed depressions that may be the result of deflation, as well as solution of the substrate. Low erosion scarps mark the margins of the plain.

South of the Mardabilla Plain and the Wylie Scarp, the Israelite Plain is located adjacent to the coast. It is part of the Esperance 2 - Recherche IBRA subregion and vegetation comprises heath, coastal dune scrub, Mallee, Mallee-heath and granite heath. Vegetation types are diverse.

The Sea Cliffs physiographic unit (refer Photo 5) occurs in an unbroken line, with vertical sea cliffs 40 – 100 m above the ocean to the east and the west of Roe Plain. The eastern section in South Australia is called the Bunda Cliffs and is 200 km long. The western section is called the Baxter Cliffs, which extend for 160 km. These cliffs are unbroken due to the lack of streams in the region. The upper section commonly forms overhangs. The southern edge of the Hampton Escarpment constitutes a remnant sea cliff that was cut when the sea flooded the plain in the late Pliocene, tying in with the current Sea Cliffs at both ends. Mallee with Boree (*Melaleuca pauperiflora*) occurs on calcareous clay and loam.

2.6.3 Climate

Peter Tille's (2006) *Soil-landscapes of Western Australia's Rangelands and Arid Interior* follows Beard (1990) in describing the bioclimate of the Nullarbor soil-landscape province of the Central Southern soil-landscape region as "*mainly Eremaean. This is a desert climate, commonly with 12 dry months a year. Mean Rainfall is mostly 150-250 mm (dropping to 100 mm in the north) with no seasonal tendency. The south of the province extends into the Sub-Eremaen bioclimate zone, a Mediterranean semi-desert with 9-11 dry months and rainfall rising to 300 mm on the Great Australian Bight. In the southwest (near Israelite Bay) the bioclimate tends toward Thermoxeric, extra dry to dry Mediterranean with 6-8 dry months and up to 400 mm of winter-dominant rainfall.*"

2.6.4 Caves and Karst Features of the Nullarbor

The project area exhibits a high diversity and number of karst features, including numerous caves, blowholes, dolines, rock holes and rock shelters and other features (arches, fissures, sea caves and other holes). Until recently, most of these features were thought to be concentrated on the Nullarbor Plain, the Hampton Tableland and Roe Plain. (Refer to Section for further information on the cave and karst features and their ecology.

2.6.5 Coastal Features

Key coastal features from east to west include: Wilson Bluff (at Eucla), Low Point, Red Rocks Point (east end of Nuytsland Nature Reserve), Middini Beach, Widdingbillia Hill, Madura Beach, Scorpion Bight, Twilight Cove, Point Dover, Baxter Cliffs, Toolina Cove, Point Culver and Israelite Bay. These are relevant for features and reference points for coastal planning within the Nullarbor Karst System.

2.6.6 Transportation Routes, Settlements and Facilities

The Trans Australian Railway runs east-west through the northern portion of the Nullarbor Karst System. A number of railway stations and sidings were constructed along the railway, most of which are now abandoned. The Eyre Highway (referred to by some the Nullarbor Highway) runs east-west through the southern part of the planning area.

Key settlements or highway service centres located along the Eyre Highway from east to west include Border Village, Eucla, Mundrabilla Roadhouse, Madura Hotel, Cocklebiddy Motel, Caiguna, Old Telegraph Station (a ruin) and Balladonia Hotel. Many of these roadhouses and motel complexes obtain their water from underground sources via desalination processes.

Electricity transmission lines were previously established to settlements along the Trans Australian Railway, but not along the Eyre Highway. Formerly used microwave transmission towers exist in various locations. A number of optic fibre telecommunication lines extend along the main road and railway corridors and the microwave transmission towers (their technology now outdated) A relatively sparse network of minor roads, 4WD tracks and rough tracks exist throughout the region.

2.6.7 Land Use and Economic Sectors

The key land uses and economic sectors currently include pastoral grazing, mining, tourism, some commercial fishing and the conservation estate (Nature Reserves, National Parks, etc.). The land tenure, legislative and management framework for the land uses are discussed further in Section 3 and Appendix 1.

2.7 Overall Significance

The overall significance of the entire Nullarbor Karst System is of national and world importance and is fully documented in the unabbreviated IMG report. The caves and selected associated karst features documented in this report play a critical role in that overall significance.

2.7.1 Geologic and Geomorphic Values

The Nullarbor Karst is the largest karst area in Australia and the largest contiguous karst formation in the world. The arid nature of the Nullarbor Karst is highly significant in term of the type and variety of speleothems and other karst features within the caves. A high number of karst features, including dongas, blowholes, rockholes, dolines and caves of various types with dry and underwater sections exist (refer to Figures 3 and 4).

Many rare and beautiful internal cave features known as speleothems also occur throughout the caves. Devine (2003, as quoted by Subterranean Ecology, 2007) indicates that there are potentially 50,000 karst features on the Nullarbor. KIDSA currently have just over 3500 karst features recorded, including 684 caves, 1,169 blowholes, 926 dolines, 533 rockholes and rock shelters, and 255 other karst features (Subterranean Ecology, 2007 – Table 4-1, p. 14).

WHAT ARE SPELEOTHEMS?

Speleothems are cave features formed through calcium, solution, gypsum or salt crystalisation processes. They include halite, calcite and gypsum speleothems (mainly calcite in the Nullarbor Karst Region).

Halite speleothems are very delicate and beautiful in their form and may occur as fibres, crusts, stalactites, stalagmites, columns and calcite rafts.

Halite speleothems have been identified in at least seven caves and are most abundant and diverse in Mullamullang Cave (N37). They can be very large or of micro proportions.

Halite speleothems are considered to be very rare and fragile. Gypsum speleothems occur as needles, crusts and flowers on roofs and walls, as crusts near lakes and as coarse curving crystals in floor mud deposits, stalactites and as secondary deposits on calcite speleothems. Gypsum speleothems are relatively rare in Australia, but not on the Nullarbor, where significant deposits in caves are known. Refer to Davey, et al. (1992) and ASF (1978).

Recent discoveries on the Mardabilla Plain (Devine, 2007 and other unpublished data) have greatly increased the number of known karst features. Subterranean Ecology (2007, p. 19) estimate that only 7% of the total potential caves have been recorded to date. It is estimated that over 50,000 caves and karst features are likely to exist in the Nullarbor region.

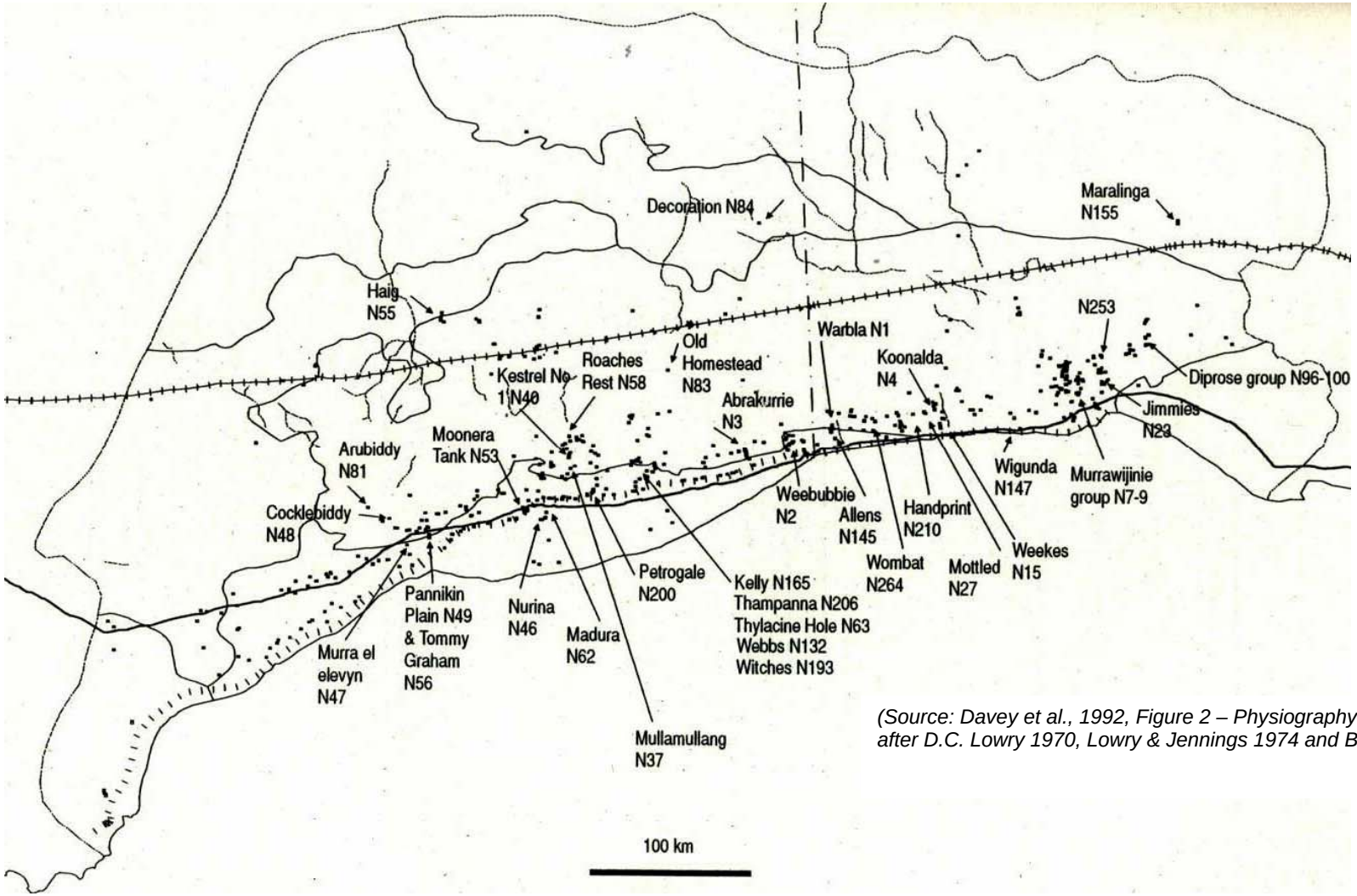
The plan length of caves and blowholes entails over 73 km of dry cave passages and over 11 km of wet passages in Western Australia.

2.7.2 Ecological, Flora and Fauna Values

The area supports a wide range of "at risk" rare, endangered, vulnerable and/or endemic flora and fauna species on the ground surface areas. Within the soils, regolith and cave passages, a wide range fauna exist, including troglofauna, stygofauna, guanofauna, edaphobites, bat species and bird species.

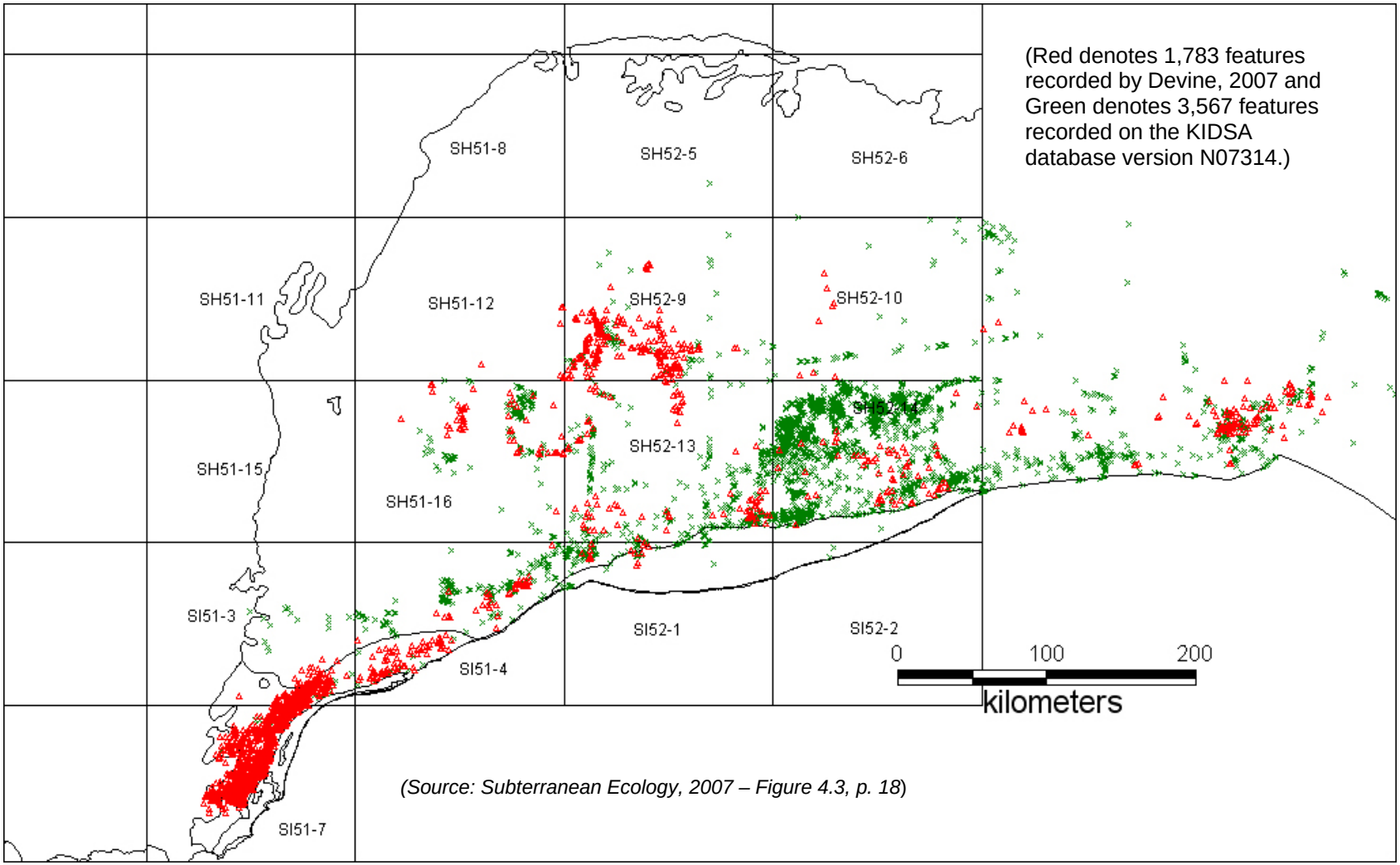
A high degree of endemism exists for many of these species. The caves and dolines play a refugia role for many of the species. Many of the species are distinctive and highly diverse and representative examples of relictual subterranean fauna are found in the caves of Roe Plain and the Hampton Tableland.

Figure 3 Cave and Karst Features Known during 1992



(Source: Davey et al., 1992, Figure 2 – Physiography of the Nullarbor region: after D.C. Lowry 1970, Lowry & Jennings 1974 and Benbow 1990)

Figure 4 Cave and Karst Features Known during 2007



(Source: Subterranean Ecology, 2007 – Figure 4.3, p. 18)

WHAT ARE TROGLOFAUNA, STYGOFAUNA, GUANOFAUNA AND EDAPHOBITES?

Troglofauna are subterranean fauna classified into three ecological-evolutionary categories:

- ***Trogloxenes*** – regularly found in subterranean (or hypogean) habitats, but must leave them to complete their life cycles (usually for food requirements). Includes bats and cave crickets, which shelter in caves during the day and forage for food outside caves at night.

- ***Troglophiles*** – facultative subterranean species that are able to complete their entire lifecycles in underground and epigean (surface environments) habitats, forming populations in both habitats. Individuals commute between them and maintain genetic flow between these populations.

- ***Troglobites*** – obligate subterranean species that are restricted to subterranean (or hypogean) environments (i.e. virtually always found in subterranean environments, not in epigean or surface environments). They typically have character traits related to subterranean existence (troglomorphisms) such as the reduction or loss of eyes and dark pigmentation, while displaying enhanced non-optic sensory capabilities.

Stygofauna are aquatic subterranean fauna that may be classified into three ecological-evolutionary categories that reflect similar habitat and physical characteristics as the troglofauna. The three categories of stygofauna include:

- ***Stygoxene***
- ***Stygophile***
- ***Stygobite***

Guanofauna are subterranean fauna that either require or use bat guano resources for feeding and/or reproduction. Similar to *Troglofauna and Stygofauna,* they are classified into three ecological – evolutionary categories:

- ***Guanobites*** – animals that require the presence of guano for survival.
- ***Guaonphiles*** – species that use guano resources opportunistically and are able to complete their entire life cycle using the guano substrate, but use other cave food resources when available.
- ***Guanoxenes*** – species that will exploit a guano resource for feeding or reproduction but require other substrates within a cave to complete their life cycle. They can be troglobites, troglophiles or trogloxines.

Edaphobites are obligate soil dwelling species that frequently display morphological traits similar to troglobites, such as loss of eyes and pigmentation. They are frequently found deeper underground in caves, but soil forms their primary habitat.

The presence of microbial mantles are considered to be rare and recommended for high priority protection. Specially protected fauna (Schedule 1 of the *Wildlife Conservation Notice 1998*) considered rare or likely to become extinct as a result of identified threatening processes include *Troglodiplura lowryi* and *Tartarus mullamullangensis* and the Pannikin Plains Cave Isopod (*Abebaioscia troglodytes* Vandel). Other localised troglobitic species include *Tartarus nurinensis* and *Speothalpius grayi, Speozuphium poulteri,* among others.

WHAT ARE MICROBIAL MANTLES?

Microbial mantles are made up of mucoid sheets or tongues comprised mainly of thin, densely packed, unbranched filaments 1-2 µm diameter, together with spherical, rod and spiral shaped cells and mycrocrystals of calcite in a mucoid matrix (Contos et al 2001; Holmes et al., 2001) within which small calcite crystals are embedded.

The mantles are associated with snowfields of biogenic microcrystalline calcite (Contos et al., 2001) and contain a great deal of biomass without there being much dissolved organic matter. This indicates that the community is chemoautrophic and they have been found to be dependent on nitrite oxidation, making them biochemically novel. Weebubbie Cave exhibits the most spectacular example of such microbial mantles, with a large number of genetically distinct phylotypes of bacteria. Holmes et al. (2001) has concluded that this makes the microbial communities significantly different in structure from other documented microbial communities.

The surface and subterranean ecology, flora and fauna of the Nullarbor has been previously documented in *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002* (Dept. of Conservation and Land Management, 2003 and McKenzie et al., 2003) and in *Subterranean Biodiversity of the Nullarbor Karst Desktop Study* (Subterranean Ecology, 2007).

It is emphasised that the both the number of caves that have been examined and the number and thoroughness of scientific expeditions of Nullarbor caves are very limited. It is estimated that the invertebrate fauna records examined represent only about 7% of the caves, blow-holes and dolines recorded in KIDSA (Karst Index Database – South Australia) and 27% of the caves currently recorded in KIDSA. As such, any analysis of records will be based on a highly restricted sampling of the full potential of the Nullarbor's subterranean fauna.

The subterranean ecosystems include evidence of 309 provisional fauna taxa belonging to 134 families based on surveys of only an estimated 7% of all caves, blowholes and dolines recorded to date on the Nullarbor in KIDSA (Karst Index Database – South Australia).

Subterranean Ecology (2007, pp 66 - 67) states that the Nullarbor caves overall are significant for biodiversity conservation due to their refugia role for many evolutionarily relict species; the high degree of regional endemism displayed by the Nullarbor cave fauna; and the presence of rare and distinctive species.

The Nullarbor provides a rare window to the relict subterranean fauna of the Nullarbor caves, with more ancient development and highly cave-adapted characteristics of the Nullarbor terrestrial troglobites compared to others recorded elsewhere in Australia. Several caves contain significant examples of root-driven ecosystems that are comparatively rare nationally and internationally (Jasinka et al 1996). Invertebrates (Arthroboda and Arachnids) have a high value and diversity in the project area.

Dolines in the Nullarbor have been found to have a high biodiversity and species richness value and caves with a large doline entrance are associated with high overall species richness.

Some of the key rare and/or vulnerable fauna examples include:

- biogeographic and ecological importance of the *speleohriid copepod*, a Tethyan anchialine faunal element, showing the extension of the Tethyan track to the southern continental margin of Australia and its penetration of the rift zone between Australia and Antarctica;

- the only known troglobitic species of mygalomorph spiders known in Australia;

- the only highly troglomorphic cave beetles outside Tasmania; and

- the only cave-adapted centipede and mygalomorph species in Australia that are and which are also quite rare on a world-wide basis;

- Specially Protected Fauna (Schedule 1 of the *Wildlife Conservation Notice 1998*) considered to be rare or likely to become extinct as a result of identified threatening processes, including:
    - *Troglodiplura lowryi* (a mygalomorph spider)
    - *Tartarus mullamullangensis*
    - *Abebaioscia troglodytes* Vandel (Pannikin Plains Cave Isopod) of Murra-El-Elevyn Cave.

- Likely qualification for listing on Schedule 1 by most other localised troglobitic species, such as:
    - *Tartarus nurinensis*
    - *Speothalpius grayi,*

Speozuphium poulteri, among others; Microbial mantles are special features of the lakes and water-filled passages of Cocklebiddy, Murra-El-Elevyn, Warbla, Weebubbie, Winbirra, Pannikin Plains, Olwolgin and other cave lakes on the Nullarbor (refer to box and photo on following page).

Other significant subterranean fauna and flora values of the Nullarbor include bird habitat (for the Australian Kestrel *Falco cenchroides*, Masked Owl *Tyto novaehollandiae*, Fairy Martin *Hirundo ariel* and Welcome Swallow *Hirundo neoxena*); bat habitat (for the Chocolate Wattled Bat *Chalinolobus morio* and the Lesser Long-eared Bat *Nyctophilus geoffroii*.

High biological significance rankings by Subterranean Ecology (2007) are based on the Graening method. The top 20 caves in order of their biological ranking include:

1. Old Homestead Cave (N83)
2. Mullamullang Cave (N37)
3. Cocklebiddy Cave (N48)
4. Thampanna Cave (N206)
5. Nurina Cave (N46)
6. Unnamed Cave (N1327)
7. Pannikin Plain Cave (N49)
8. Weebubbie Cave (N2)
9. Burnabbie Cave (N305)
10. Encompassing Cave (N327)
11. Olwolgin Cave (N920)
12. Murra-El-Elevyn Cave (N47)
13. Abrakurrie Cave (N470)
14. Koonalda Cave (N4)
15. Warbla Cave (N1)
16. Prostrate Cave (N1369)
17. Madura Cave (N62)
18. Fern Cave (N747)
19. Windy Hollow Cave (N645)
20. Dingo Donga Cave (N160)

The 2002 Biodiversity Audit (Dept. of Conservation and Land Management, 2003) and Devine (2007) note several species and ecosystems of significance in a number of IBRA Subregions relevant to the project area. These include:

- Subterranean wetlands of subregional significance in the Nullarbor Plain and Hampton Tablelands, including those at:
    - Cocklebiddy Cave (Nuytsland Nature Reserve)
    - Murra-El-Elevyn Cave (Nuytsland Nature Reserve)
    - Tommy Grahams Cave (Nuytsland Nature Reserve)
    - Mullamullang Cave;
    - Weebubbie Cave
    - Nurina Cave
    - Winbirra Cave
    - Pannikin Plains Cave (Nuytsland Nature Reserve)

- Centres of subterranean endemism for stygofauna associated with underground aquifers; the karst systems of the Hampton escarpment slopes and the Mardabilla Plain.

- Refugia caves and karst features in the Nullarbor Plain, Hampton Tableland and (likely) Mardabilla Plain are highly significant for many evolutionary relictual invertebrate species, including troglobites and troglophiles of the following groups: crustaceans, centipedes, cockroaches, ground (Carabid) beetles, Orthopterans, pseudoscorpions and spiders.

Davey et al. (1992) provides additional observations regarding the value and international significance of extant invertebrate fauna, stating that:

> *"The troglobitic fauna is both unique and rare. It includes one of the most diverse spider troglobitic faunas yet documented. Troglobitic cockroaches and mygalomorph spiders are rare world-wide. Both are represented here. The extreme troglomorphic modifications shown by the Nurina Cave N46 carabid beetle are comparable only with the remarkable northern hemisphere ice-age beetle troglobites." (p. 77).*

Davey et al. (1992) go on to state that the invertebrate fauna of the caves, including endemic troglobitic species and other notably restricted taxa meet the UNESCO (1991) World Heritage criteria 36(a) iv: *"Contain the most important and significant natural habitats where threatened species of animals or plants of outstanding universal value from the point of view of science and conservation still survive;"*.

Surface ecosystems, flora and fauna of the Nullarbor are of high value and include:

- all Declared Rare, Vulnerable and Special Priority flora and fauna species within five IBRA biogeographical subregions);

- Ecosystems at risk;

- Reserve Priority or Off-Reserve Conservation Species;

- Centres of Endemism Refugia in several areas.

Wetlands of subregional significance include:

- Lake Boonderoo,

- Hampton Scarp Rockholes,

- Duck Pond (Arubiddy Station);
- a Paleodrainage channel (on Gunnadorah Station); and
- Lake Daringdell.

All high value flora species and taxa within the project area are listed in Appendix 5 of the unabbreviated IMG report and include the Rare and Priority 1species shown in Table 1 and the example Schedule 1 and other Priority fauna species listed in Table 2.

Table 1 Rare and Priority 1 Flora Species in the Project Area

Adenanthos eyrei	R
Conospermum toddii	R
Dampiera eriantha	P1
Eremophila attenuata	P1
Eremophila oblonga	P1
Eremophila parvifolia subsp. *auricampa*	P1
Eremophila perglandulosa	P1
Eucalyptus merrickiae	R
Grevillea phillipsiana	P1
Lepidium fasciculatum	P1
Myoporum velutinum	P1
Thysanotus baueri	P1

(Source: DEC,2003. 2002 Biodiversity Audit Database. Western Australia)

Table 2 Examples of Schedule 1 and Other Priority Fauna Species in the Project Area

Schedule 1 – Fauna that is rare or likely to become extinct
Bettongia penicillata ogilbyi – Woylie*
Dasycercus cristicauda – Crest-tailed Mulgara, Minyiminyi*
Dasyurus geoffroii – Chuditch*
Lagostrophus fasciatus fasciatus – Banded Hare-wallaby, Mernine*
Macrotis lagotis – Bilby, Dalgyte, Ninu*
Notoryctes sp. – Marsupial Mole
Sminthopsis psammophila – Sandhill Dunnart
Leporillus conditor – Greater Stick-nest Rat, Wopilkara
Leipoa ocellata - Malleefowl
* species currently considered locally or regionally extinct
Schedule 4 – Other specially protected fauna
Cacatua leadbeateri – Major Mitchell's Cockatoo
Northiella haematogaster narethae – Naretha Blue Bonnet
Falco peregrinus – Peregrine Falcon

(Source: DEC, 2003. 2002 Biodiversity Audit Database. Western Australia)

Aside from the Schedule 1 fauna listed in Table 2, the Nullarbor is the western-most range of the Southern Hairy-nosed Wombat. Many of the caves also provide refuge and maternity shelters for the Chocolate Wattled Bat (McKenzie and Robinson, Eds., 1987).

2.7.3 Indigenous Heritage

The Nullarbor Karst System has been home to Aboriginal people groups for tens of thousands of years. The area is significant for its anthropological values and for its archaeological values with some evidence of Aboriginal cave paintings and rockhole modifications. The project area has considerable significance to the Aboriginal communities and the Traditional Owners of the region. The Aboriginal communities with potential interest include the Mirning People and the Ngadju People.

Up to four or more Native Title claims are currently being considered for the project area, including the Esperance – Nyungar Claim, the Mirning Claim, the Ngadju Claim, the Ngadjunngarra Claim, and the Nullarbor Claim. The Goldfields Land & Sea Council (GLSC) is the Native Title Representative Body for the project area.

Aboriginal heritage and heritage sites are recognised and protected through a number of legislative Acts, including the *Australian Heritage Council Act 2003* (Cth), the *Aboriginal Heritage Act 1972* (WA) and the *Heritage Act of Western Australia 1990*.

Indigenous cultural heritage places, sites and features are protected under the *Aboriginal Heritage Act 1972* (WA) and may potentially include: habitation sites, seed grinding sites, habitation structures, middens, stone artifact factory sites, marked trees, burial sites, stone structures, paintings, engravings, caches, ceremonial grounds, etc.

All information received regarding potential Aboriginal sites is placed on the Register of Aboriginal Sites by the DIA, including supporting evidence. In relation to caves, some example Registered Aboriginal Sites are located at Dingo Cave on Moonera Station; Wapet, Joe's, Mullamullang, Spider Sink and Kestrel No. 2 caves and Parritappa Doline on Madura Station; Madura Cave on Madura Station; Snake Pit and Webbs caves on Mundrabilla Station; Weebubbie Cave, Weebubbie Road Blowhole, Chowilla Landslip, Abrakurrie, Winbirra, and Kangaroo caves; and Cocklebiddy Cave in Nuytsland Nature Reserve.

GLSC have prepared draft Traditional Usage Guidelines on behalf of the Traditional Owners of the Goldfields and Esperance regions intended for use by DEC and other government departments in relation to the recognition of Aboriginal Cultural Heritage, traditional indigenous activities and the Traditional Owners extensive knowledge of the country and its cultural and ecological relationships.

2.7.4 Non-Indigenous Heritage

Non-Indigenous or European history in the project area dates back to the early explorations of Nuyts during 1627 and French and British explorers during the 1790s and early 1800s. Although European settlement of the Nullarbor has always involved relatively small populations, the Nullarbor has many important historic sites, places and structures as assessed in local and national terms. The Nullarbor karst supports some large pastoral leasehold properties that are iconic representations of life in the Australian Outback.

Non-indigenous heritage sites are protected under the Heritage of Western Australia Act 1990, the Historic Shipwrecks Act 1976 (Cth) or the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth). Non-Indigenous heritage sites and places may be listed under the former Commonwealth Register of National Estate, the National and Commonwealth Heritage Lists, the Western Australian Register of Heritage Places. Heritage Places may also be listed under Municipal Inventories or recorded/classified by the National Trust of Australia (WA Branch).

Site registers and listings include the former Commonwealth Register of National Estate, the National and Commonwealth Heritage Lists, the Western Australian Register of Heritage Places or the Western Australian Geoheritage Register. Natural heritage places may also be listed under Municipal Inventories or recorded/classified by the National Trust of Australia (WA Branch).

Examples of non-indigenous cultural heritage places, sites and features these within the project area include: National Heritage Register sites (e.g., the Eucla Area, Nuytsland Nature Reserve, Old Telegraph Station

at Balladonia) and State Heritage Register sites (e.g. Eucla Jetty, Old Eucla Telegraph Station, Eyre Telegraph Station, Mallee Tree, and Weebubbie Cave).

Heritage sites on the Register of the National Estate, on the Western Australian Register of Heritage Places, the National Trust of Australia (WA Branch) or by the Shires of Dundas or Esperance are provided in Appendix 2.

2.7.5 Tourism, Recreation and Wilderness Values, Facilities and Activities

Recreation, tourism and wilderness values are clearly highly important values of the Nullarbor given its unique landscape features, its isolation and the popularity and notoriety of "crossing the Nullarbor" by travelers from throughout Australia and overseas.

Tourism opportunities for the region noted by the (draft) Shire of Dundas Coastal Management Plan (South Coast Consulting, 2003) include:

- Landscape Features e.g. caves, cliffs, cave diving, underground lakes, fossils;
- Flora and Fauna Experiences e.g. Eyre Bird Observatory, whale watching, fishing;
- Nullarbor Experiences e.g. outback camping, star gazing, camel trekking;
- Historical Adventures e.g. visiting ruins, travelling the Telegraph Line, where Eyre travelled, where Baxter was buried;
- Festival Experiences e.g. Eucla Gold Day, Eucla Shoot;
- Nullarbor Products e.g. local seafood, artwork;
- Research Expeditions e.g. marine, caving, flora, fauna, geology.

The Eyre Bird Observatory (housed within the former Eyre Telegraph Station) annually runs environmental and educational courses, including bat banding in Murra El Elevyn Cave, Malleefowl surveys on the Roe Plain and other activities.

Annual visitor numbers to the Nullarbor's Conservation Estate were quite low during 2006-2007, ranging from 5,500 visitor days at Nuytsland Nature Reserve, to 1000 visitor days each for Eucla National Park and for Dundas Nature Reserve. Queen Victoria Spring Nature Reserve had an estimated 100 visitor days, while the Great Victoria Desert Nature Reserve had only 20 estimated visitor days. This data has been provided by DECs Recreation and Tourism Information System (RATIS) database.

Wilderness values of the Nullarbor are very high, as indicated by Davey et al. (1992, p. 79).

2.7.6 Scientific Research and Education Values

Davey et al. (1992) state that scientific research and education values are high for the project area and for the Nullarbor Karst System in general. Scientific values of the planning area include (among many others):

- Geologic and geomorphic values
- Speleological values
- Hydrologic values
- Botanical values (flora)
- Zoological values (fauna)
- Biodiversity values (flora and fauna)
- Archaeological values
- Anthropological values
- Paleontological values;

Davey et al. (1992) also state that "*the Nullarbor is regarded internationally as the classical area for the study of arid land karst processes";* "*The Nullarbor Plain is a vast educational resource at all levels in that it demonstrates all aspects of the formation of karst landforms in an arid climate*".

The Nullarbor is also a highly valuable exploration destination, with explorations since the 1950s leading to a range of very important scientific discoveries and research opportunities.

Most of these scientific and research values have been summarised above. Further brief summaries of the paleoenvironmental and archaeological values are provided here.

Paleoenvironmental Values

High paleoenvironmental values associated with fossils, subfossils, sediments, speleothems and other evidence of climate and forms of plants, animals and environmental conditions existing in prehistoric or geologic times are found on the Nullarbor.

An unusually high number of paleological sites are distributed over a vast area (800 km x 400 km). Nullarbor paleoenvironmental data is prominent in continental interpretations of Australian environmental change and prehistory (e.g., Bowler 1982; Bowler, 1976; Galloway & Kemp 1981; Wasson 1982; Prideaux et al. 2007) and paleoclimatic evidence up to 350,000 years old (Davey et al. 1992).

Well-preserved skeletons, tissue materials and mummified carcasses of Thylacine *Thylacinus cynocephalus* dated from 3300 – 4600 years BP have been found in Murra-El-Elevyn Cave N47 and Thylacine Hole N63 (Partrige 1967; Lowry & Lowry, 1967).

Extinct megafauna has been found in the Thylacoleo Caves, including the prehistoric marsupial lion, *Thylacoleo carnifex,* displaying a mixed diversity compared to other Pleistocene fossils found elsewhere in Australia (Prideaux, 2006; Prideaux et al., 2007)

The extinct Stick-nest Rat (*Leporillus spp.)* and associated pseudobitumen deposits have been found in many of the Nullarbor dolines and cave entrances.

Archaeological Values

High value archaeological materials and findings include:

- At least 60 archaeological sites have been identified on the Nullarbor Plains (unsure of how many of these are within Western Australia).
- Koonalda Cave (South Australia) exhibits Aboriginal rock art and is thought to have been used as a flint mine and migratory watering point. These prehistoric uses are estimated to date back to 15,000 to 22,000 years BP (Gallus, 1968a; 1968b; and 1971; Hirst, 2008);
- Cave art has been confirmed in five sites on the Nullarbor and further discoveries of cave art are thought to be likely;
- Allen's Cave contained potential evidence of one of the earliest human occupations in an arid zone (yet to be corroborated) up to 40,000 years BP.

2.7.7 Scenic Resources

Scenic resources include the visual landscape and the human appreciation of scenic beauty of the Nullarbor caves and associated karst features of focus. CALM's (1994) assessed the Nullarbor Plain Landscape Character Subtype as having moderate to high scenic quality (CALM, 1994).

Some of the notable features are the variety of landforms in the area including the steep cliffs (e.g. Baxter Cliffs), flat caves entrances (e.g. Cocklebiddy Cave), abrupt appearance of an escarpment (e.g. Hampton Scarp) and the formation and height of wind formed dunes (e.g., Delisser sand dunes and Eyre sand dunes). The vegetation also provides variety with pockets of taller vegetation in low lying areas that contrast with the surrounding adjacent low saltbush dominated plains.

Frame of reference assessment criteria for features of high or moderate scenic quality prepared by CALM (1994) are provided in Appendix 3.

2.7.8 Economic Values

Economically, the Nullarbor region has a very low population and is generally undeveloped except for pastoral uses, a relatively low level of commercial fishing and some mining and petroleum exploration (with relatively little current mineral extraction).

High value mineral sands and other mineral resources are thought to exist in the area and exploration continues with unknown, but potentially high economic value.

Tourism is important to the area, but is based on relatively low visitor numbers and expenditures compared with other regions of Australia due to the remoteness of the area and the lack of infrastructure, accommodation and activities. Tourism may have greater future potential if developed and managed appropriately.

3. Land Tenure, Legislative and Management Framework

3.1 Land Tenure

The major categories of tenure within the project area include:

- conservation estate (national parks, conservation parks, and nature reserves);
- Unallocated Crown (state) Land (UCL);
- reserved land;
- unmanaged reserves (e.g., Weebubbie Cave)
- pastoral leases;
- other leases (e.g., Eucla's recreational facilities; Roadhouse complexes).

Current land tenure is shown in Figure 5. (Crown Leases include pastoral leasehold properties.)

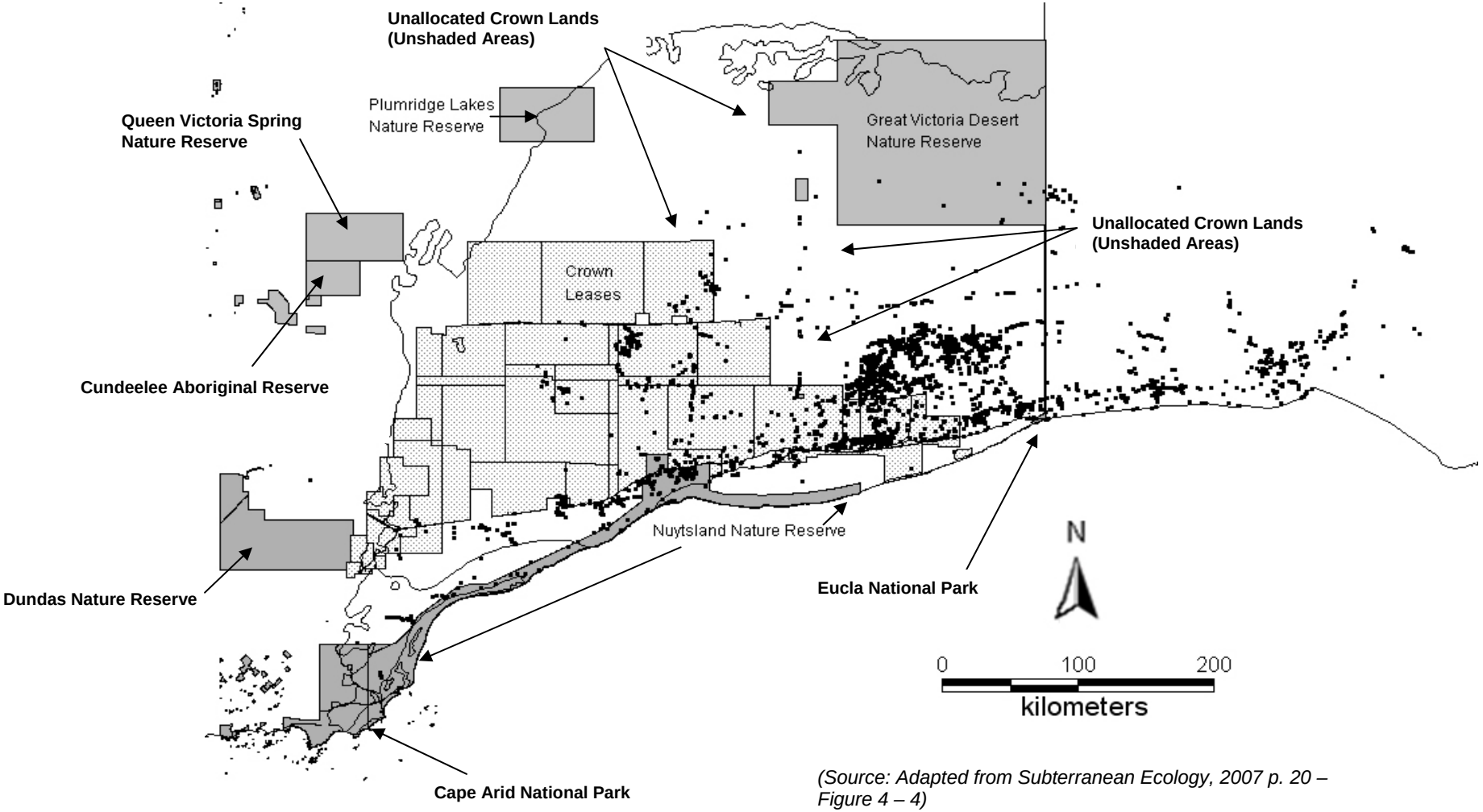
Nuytsland Nature Reserve and Eucla National Park form the bulk of the conservation estate vested with the DEC for management. Some recently negotiated small areas agreed to be fenced off within the current pastoral leases (as part of the 2015 Pastoral Review process, undertaken and resolved during 2004 – 05 - refer to *IMG 7 – Fencing Reserves within Pastoral Leaseholds* in Section 4.3.7).

State lands in Western Australia (all land, except alienated freehold land) are managed and disposed through the authority of the *Land Administration Act 1997* (LAA), which is administered by the Minister for Planning and Infrastructure in her statutory role as Minister for Lands and by the Department for Planning and Infrastructure (DPI). DPI is required to consult with local governments prior to exercising any powers under the LAA.

3.2 Conservation Estate

The Conservation Estate within the focus project area includes Nuytsland Nature Reserve, Eucla National Park. Dundas Nature Reserve and Cape Arid National Park are also situated just on the western edge of the focus area. Queen Victoria Spring Nature Reserve, Plumridge Lakes Nature Reserve and Great Victoria Desert Nature Reserve lie within the broader Nullarbor Karst System, but outside the current focus area.

Figure 5 Land Tenure of the Karst System with Caves



(Source: Adapted from Subterranean Ecology, 2007 p. 20 – Figure 4 – 4)

3.3 Legislative and Management Framework

A large number of legislative Acts apply to the Nullarbor at the Commonwealth and Stage Government levels. The legislation and key management vestings, government agencies, policies and strategies that apply to the project area are detailed in Appendix 1.

The most important aspect of this statutory framework is that DEC is responsible on behalf of the Conservation Commission of Western Australia (CCWA) for only those caves and associated karst features within the conservation estate. The Department of Planning and Infrastructure (DPI) is responsible for these features within Unallocated Crown Lands and within Pastoral Leasehold lands. This has some bearing on how caves, blowholes and dolines are managed and how cave access permits are administered. The Rangelands NRM Co-ordinating Council have their role in the region through the directives of the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA).

Many other State Government agencies have specific roles regarding the management or regulation of various other natural and cultural resources, as referred to further. The vestings, jurisdictions and policies of these various agencies tend to overlap with each other throughout the project area. These issues are raised through the full IMG report and outlined in Appendix 1.

4. Recommended Interim Management Guidelines

4.1 Introduction to the Guidelines and Management Context

The following Interim Management Guidelines are recommended to address key issues that may need to be addressed within the next five years.

The guidelines are not meant to replace existing legislation, regulations or policies relevant to the Nullarbor caves, blowholes and dolines within the project area, but should be complimentary. They guidelines are not meant to form a management plan at this time, but to provide guidance and direction for the management of key issues and the implementation of certain operational objectives and infrastructure that may arise in the interim.
Given the combination of high environmental and cultural values and the mix of land tenure and management vestings there are a very wide range of management issues. Figure 6 provides an overview of this range of issues.

In reviewing these issues, it is useful to recognise that the purpose of this report is to prepare Interim Management Guidelines for implementation over the next five years in order that essential field operations and management decisions can be carried out while a full management plan is in waiting. In addition, the focus is on the protection and management of the caves, dolines and blowholes and their immediate surrounds.

What we are basically trying to do is take the first significant step towards some type of agreed, united on-ground management by a number of key stakeholders around the cave and karst areas that we believe are currently under potential existing threat. Maintenance and protection of the caves, dolines and blowholes (and where necessary recovery or rehabilitation), along with the associated surface ecosystems, flora and fauna are the central focus of the guidelines. Minimisation and protection of the resources from either direct or indirect damage by cave visitation and usage (for recreational or research purposes) or by land use activities and other environmental factors should be the primary objective.

As Figure 6 indicates, all resource uses occurring within the broad legislative and management framework (as described in Section 3 and Appendix 1) may potentially result in various impacts to the caves and their associated karst features and ecosystems. The management framework should provide management and planning policies and programs designed to monitor and protect the resource condition and use.

Figure 6 Overview of Impact Management Issues and Relationships Regarding the Nullarbor Caves, Dolines, and Blowholes and Associated Karst Areas

(Source: Geoscene International, 2008)

The upper cells of Figure 6 show that the resources may potentially be damaged or degraded through:

- vegetation removal or damage;
- groundwater diversions or depletion;
- pollution or contamination;
- erosion and sedimentation;
- disease and infections, and
- predators and competitors (plants or animals).

These forms of damage may arise through the various land uses of the area (e.g. tourism and recreation, pastoralism, mining, or Indigenous uses) or through environmental factors or events (e.g. pest plants and animals or wildfire). Aside from reliance on statutory laws and regulations, managers may also modify or control the potential land uses and impacts through a combination of:

- establishment of Conservation Reserves;
- co-operative management and agreements (with freehold and leasehold landholders);
- lease and licensing conditions (as applied to pastoral leases);
- Native Title agreements, or
- other management actions and operations.

The lower cells of Figure 6 show that the resources may potentially be damaged or degraded through:

- soil or surface cover compaction (or trampling);
- breakage (primarily relating to speleothems or other internal cave features);
- removal of speleothems, fossils, fauna, flora, etc.; or
- contamination (e.g., chemical pollution, bacterial/fungal/virus invasions).

These impacts may potentially arise through recreational and tourism uses, cave rescue and safety training, research and exploration or various Indigenous uses. Such land uses and impacts may be modified or controlled through a combination of:

- controls/limitations on public knowledge of the location of the cave and karst features;
- controls/limitations on physical access to the cave and karst sites (e.g. by not providing or restricting vehicular and other forms of access);
- user permit and licensing procedures; and
- education and training (i.e., regarding cave and karst values, vulnerability and how to visit or use the resources in an environmentally sensitive and sustainable manner).

4.2 Key Issue Areas

Addressing all of the various issues raised by the flow chart in Figure 6 would certainly require a full management plan. For the purposes of the IMGs, it is suggested that the following are the key issue areas to be addressed for the interim period of management: (roughly in order of priority, but not absolutely so):

1. the use of caves and potential impacts on caves associated with:

    - recreation & tourism uses;
    - research & exploration uses; and
    - rescue & safety training uses;

2. ecosystem, flora and fauna issues

3. pastoral uses and potential impacts on caves;

4. mining uses and potential impacts on caves;

5. transport and communications infrastructure and associated impacts on caves;

6. issues related to indigenous cultural heritage and aboriginal recognition and co-operation;

7. safety and liability issues; and

8. consideration of enhanced management frameworks.

Each of these key issue areas involve a number of specific issues that may require IMGs, taking in several of the other considerations raised in Figure 6. These will be discussed further below. Several other uses with potential impacts are relatively well-addressed by existing regulations, guidelines and practices.

Indigenous use of the area is relatively low-profile. Protocols are in place for co-operative Aboriginal access and management under current land tenure arrangements. Until current Native Title claims are resolved, it is difficult to add to the guidelines and agreed arrangements already in place.

Wildfire or bushfire regulations and response guidelines are also in place. Apparently wildfires do not occur too often on the Nullarbor, but given the remoteness of the area and the low population, wildfires often go unchecked until they burn out naturally.

In a similar fashion to wildfires, pest plant and animal controls are generally in place, along with protective measures for flora and fauna species declared under the EPBC Act, the Conservation and Land Management Act 1984 or the Wildlife Conservation Act 1950.

New road and railway construction in the region is minimal, with most issues related to repairs and maintenance. Most of the issues are relatively site specific and would be handled through existing regulations and environmental management requirements of Main Roads, the railway authority and their contractors.

Many existing management guidelines and regulations are in place regarding pastoral and mining uses. However, specific aspects of these should be reviewed in light of the focus issues of this report and recent adjustments to tenure and reserve allocations. The issues addressed will consider options regarding the range of land use and impact modifiers noted in Figure 6, including the application where appropriate of: Conservation Reserves; co-operative management and agreements; lease and licensing conditions, and management actions and operations.

Each of these key issues and details regarding current management procedures and circumstances are fully reviewed in Section 5 of the unabbreviated IMG report, which should be read by all Nullarbor field managers.

4.3 Interim Management Guidelines for the General Management and Use of Caves

4.3.1 IMG 1: Vesting of Cave Management

A brief Discussion Paper should be prepared and considered regarding the vesting of primary responsibility for management of all caves, blowholes and dolines in the Nullarbor karst system with a single State Government authority for the purposes of rationalising and better managing g issues of visitor use, user permits, management classifications, facility provision, risk management, monitoring use and condition, safety and liability, and public relations and education regarding use.

Although DEC would seem to be the logical authority to take on the central responsibility for cave and related karst resources, the appropriate agency should be given consideration and recommendation by a joint committee with appropriate representation. This may require some minor adjustments to existing regulations and management guidelines.

Key Partnerships: DEC, DPI, PBL, SLS, DIA, GSLC and WAM.

4.3.2 IMG 2: Management Advisory Committee

The Caves Management Advisory Committee (CMAC) has been established to assist with the management of the caves in the Leeuwin-Naturaliste National Park and other areas of southwest Western Australia. CMAC may provide a model that can be considered for the establishment of a similar advisory committee for the Nullarbor caves and karst area, perhaps to be referred to as the Nullarbor Caves and Karst Management Advisory Committee (NCKMAC) [5]. Although there may be some cross-membership between CMAC and NCKMAC with one or two members initially, both areas require separate people with good knowledge of each region and the specific cave and karst resources of each. In addition, in consideration of time demands on committee members, it is best to have different people serving on the different committees. The committee should include representatives from the relevant Aboriginal communities, the local Nullarbor community, pastoralists, speleologists and other specialists.

Key Partnerships: DEC, DPI, ASF, ACKMA, WASG, SRGWA, CDAA, WAM, GLSC, and local community and pastoralist representatives.

4.3.3 IMG 3: Cave Access Permit System

Consideration should be given to standardising, rationalising, strengthening and promoting the Cave Access Permit System.

Extend and improve the application of the current DEC Cave Access Permit System as a central procedure and regulation implemented by DEC and DPI. Consider how the same procedure can be applied by both government agencies or whether only one of them (likely DEC) should be vested with the responsibility as per *IMG 1*.

Along with this, the regulations regarding the requirement for all cave visitors to have a permit prior to entering any cave in the Nullarbor region should be considered for any necessary improvement or strengthening. Some flexibility should be built into the permit process to consideration a higher level of security clearance for some cave explorers who have proven themselves to be more experienced, safe and trust-worthy. The permit requirements should be more widely advertised and promoted among all specialist dry caving groups, cave diving groups, outdoor education leaders, tour operators and the general community.

Consideration should be given to standardising all Caving Leader/Cave Diving Leader training courses, required qualification certificates and licenses. In addition, streamlining and automating as much of the permit system and its record-keeping functions should be examined, including the use of specialised cave permit software and karst management database such as TRIPMan (Webb, 2006). Annual records of the number of visitors, length of stay, purpose and activities in each destination should be maintained in as detailed a manner as possible to assist with the longer term management planning needs of the area.

Key Partnerships: DEC, DPI, ASF, ACKMA, WASG, SRGWA, CDAA, WAM, GLSC, and Tourism WA

NOTE 5: NCKMAC could potentially substitute for the listing of key partnerships with ASF, ACKMA, WASG, SRGWA, CDAA, WAM, GLSC, Tourism WA and Pastoralists as indicated for most IMGs.

4.3.4 IMG 4: Cave Management Classification System

A preliminary application of the DEC Cave Management Classification System should be applied to the caves, blowholes and dolines currently listed on the CEGSA Cave Prioritisation or Risk Assessment list and to any other caves that receive notable use. (An example of the DEC Cave Management Classification System is shown in Table 3).

This should incorporate and improve on the current Cave Risk Assessment, giving due consideration to classifying and prioritising caves, blowholes and dolines based on a full range of values as those can practically be assessed (including biodiversity ranking, speleological values and vulnerability, archaeological, palaeological, and Indigenous cultural values, etc.).

Key Partnerships: DEC, DPI, ASF, ACKMA, WASG, SRGWA, CDAA, WAM, GLSC, Tourism WA and Pastoral Leaseholders with caves being classified.

4.3.5 IMG 5: Assessment of Cave Risks to Visitors

What is currently referred to as the CEGSA Cave Prioritisation or Risk Assessment Table may be misconstrued by some as a comprehensive "risk assessment" rather than as a limited "cave vulnerability" table. It should be renamed and incorporated into the Cave Management Classification System (as per *IMG 4*).

As resources permit and based on cave classifications and prioritisation resulting from *IMG 4*, assessments of cave risks to visitors who may enter caves should be assessed using appropriate geophysical and Australian Standard risk assessment procedures. Other factors should be considered when assessing risks to visitors, such as the type of visitor group, their experience and qualifications, the type of equipment used for different areas and purposes.

The risk assessments should be maintained in a central database for referral and consideration in the application of the Cave Management Classification System and the Cave Access Permit System. The classification of caves as Tourist, Adventure or Restricted Access should be dependent on the assessment of cave risks to visitors.

The priorities for determining which caves should be assessed for their risks to visitors should be influenced by a preliminary assessment of which caves should be categorised into which cave classification (i.e., it is likely that caves considered for the Tourist Cave classification should be assessed for their risks to visitors first to determine whether the level of risk may be too great or cost too much to mitigate for certain caves to be considered for the Tourist Cave category). To this extent, this guideline raises a potential "chicken-or-egg-first" dilemma. However, for interim purposes, it is probably more practical to complete preliminary cave classifications first, followed by risk assessments of specific caves as time and budget permit.

Key Partnerships: DEC, DPI, PBL/SLS, ASF, ACKMA, WASG, SRGWA, CDAA, WAM, GLSC, Tourism WA and Pastoral Leaseholders.

4.3.6 IMG 6: Locked Access for Selected Caves

Based on the outcomes of *IMG 4* and *IMG 5*, selected caves should be considered by NCKMAC for fencing, gating and locking as time and budget permit. When locked gates or doors are involved, care should be taken that existing diurnal air flows into and out of caves is maintained unimpeded. The natural movement of fauna in and out of the caves should also not be impeded (i.e., for bats, owls and other fauna as appropriate.).

All fencing and locking of access gates should preferably be implemented as part of a site development plan and landscape design concept plan.

Key Partnerships: DEC, DPI, ASF, ACKMA, WASG, SRGWA, CDAA, WAM, GLSC, Tourism WA and Pastoral Leaseholders with caves being classified.

Table 3 DEC Cave Management Classification System (2006)

PUBLIC ACCESS	*TOURIST CAVE* (Guided or self-guided e.g. Crystal Cave, Yanchep National Park (YNP); Calgardup Cave, Leeuwin Naturaliste National Park (LNNP)	General public.	• Developed and managed for tourist use and/or as an educational resource • Clearly signposted with access restricted to specific times. • Payment of a fee required for entry. • Infrastructure installed to facilitate access, decrease visitor impacts and improve safety.
	ADVENTURE CAVE – Class 1 e.g. Tunnel Creek, Kimberley	General public.	• May be required to register at the cave entrance and/or pay a fee. • May be some infrastructure and signage to decrease visitor impacts and improve safety.
	ADVENTURE CAVE – CLASS 2 (horizontal) e.g. Golgotha Cave, Calgardup Window Extension (LNNP), Yonderup Cave, Mambibby Cave (YNP) - Class 3 (Vertical) e.g. Mill Cave (LNNP)	Novice groups (general public) led by an experienced leader, e.g. school groups and licensed commercial tour operators. Speleologists.	• General protection • Entry permit needed • DEC approved leader needed • May be limited infrastructure.
RESTRICTED ACCESS	*RESTRICTED ACCESS* Note: All caves are in this category unless designated otherwise. (Refer to section 2.4.2)	Experienced and responsible speleologists and scientists.	• Maximum protection • Entry permit needed • DEC approved leader needed • Speleological club visits • Research monitoring or management purposes.

(Source: Dept. of Environment and Conservation, Recreation Policy 18 Cave Policy Guidelines)

4.3.7 IMG 7: Fencing Cave Reserves within Pastoral Leaseholds

Caves and cave reserves located within pastoral leasehold areas should be fenced (if not gated and locked as per *IMG 6*). This would include, but not be limited to areas recently reserved as part of the 2015 Pastoral Review, including:

- Madura Station
  - Madura Cave (25 ha)
  - Mullamullang Cave (25 ha)
  - Kestrel Cavern No 1 (25 ha)
  - Kestrel Cavern No 2 (25 ha)
  - Roaches Rest (25 ha)

- Moonera Station
  - Moonera Tank Cave (100 ha)

- Mundrabilla Station
  - Webbs Cave / including the entrance to Snake Pit Cave (51 ha)
  - Thampanna Cave (37 ha)
  - Witches Cave (25 ha).

The objective of such fencing is to:

- keep sheep and other livestock well away from cave entrances, blowholes and dolines to prevent or minimise the potential effects of livestock manure and contaminants from being transferred into cave passages;

- keep domestic livestock from falling into caves, dolines and blowholes;

- keep land managers and mining exploration teams and their equipment from falling into cave openings or causing cave passages to collapse underneath them.

Such fencing should be designed and installed in a manner that ensures native fauna can move freely to and from the cave/passage entrances without being impeded or placed under stress or danger, while ensuring that sheep and other livestock remain out of the excluded reserve.

Key Partnerships: DEC, PBL, DPI, NRM Rangelands, ACKMA, ASF and Pastoral Leaseholders with caves being classified.

4.3.8 IMG 8: Visitor Impact Monitoring Methods

Visitor Impact Monitoring methods should be considered (as discussed in Section 5.3.8) and the most suitable methods selected for future implementation. The TOMM and LAC methodologies are particularly suggested for evaluation. (This review could be done by an outside consultant.)

Interim assessment of cave condition should take place for several caves as selected through the Cave Management Classification process (*IMG 3*), as time and budget permit.

Key Partnerships: DEC, DPI, ACKMA, WAM, GLSC, ASF and any Pastoral Leaseholders with caves being assessed.

4.3.9 IMG 9: Field Management Staffing Alternatives

Prepare a brief discussion paper regarding future field management staffing alternatives, including trained local volunteers, pastoral leaseholders and staff, Aboriginal people from the appropriate communities, DEC staff members or staff jointly funded by the Western Australian and South Australian Governments that can cover the whole of the Nullarbor karst system throughout both States. Depending on future cave classifications, interpretive programs and infrastructure, the staff may serve roles ranging from conservation management and monitoring to the provision of visitor information and interpretation to cave permit and land use regulation and enforcement. The number of staff and skill-set requirements should also be considered. The discussion paper should be discussed among appropriate State Government agencies and appropriate stakeholders.

Key Partnerships: DEC, DPI, NRM Rangelands, ACKMA, ASF, GLSC and SA Dept. of Environment and other stakeholders as appropriate.

4.3.10 IMG 10: Cave-Related Capital Works

Cave-related capital works should be considered and prioritised for future implementation as funding becomes available. This would take into consideration a combination of factors as addressed in several of the IMGs above, including cave management classifications, cave risks to visitors, relative visitor demand, locked access and fencing needs, etc. Identified Tourist Caves and Adventure – Class 1 caves may be identified that require safety and interpretive signage, directional signage along access routes, carparking and walking track improvements, etc. Once priorities for works are established, work plans, site development plans and cost estimates should be progressively prepared and implemented as approvals are granted and funding becomes available.

Key Partnerships: DEC, DPI, ACKMA/ASF, PBL/SLS and affected Pastoral Leaseholders.

4.3.11 IMG 11: Visitor Interpretation Feasibility Study

DEC and the proposed NCKMAC may find that the interim management period provides a good opportunity to conduct a feasibility study into the potential provision of various interpretive facilities (e.g. interpretive and directional signage systems, boardwalks, parking and other visitor facilities, information brochures/booklets, CDs, DVD videos or TV programs) and possibly even a feasibility study into a future visitor centre for the area. Such a feasibility investigation goes hand-in-hand with *IMG 4, IMG 5, IMG 8, IMG 9* and *IMG 10*. Conducting feasibility investigations of this nature during an interim management period without being rushed to respond to a political or economic directive is ideal and provides highly useful information for integration into a more permanent management plan for the area when that time comes.

Key Partnerships: DEC, DPI, Tourism WA, ACKMA, ASF and Local Governments (Shire of Dundas, Shire of Esperance and City of Kalgoorlie-Boulder).

4.3.12 IMG 12: Groundwater Protection

Extractions of and leakages or infusions into the Nullarbor groundwater system may occur through pastoral, mining exploration, road construction, and other land uses. These activities may have potential adverse effects on Nullarbor caves and karst features through the quantity and quality of groundwater recharge zones and confined or unconfined groundwater aquifers. Land use activities potentially affecting the groundwater should be considered through more integrated review and impact assessment procedures within the planning and land lease approval systems.

Such uses might be considered to trigger a referral to the suggested single authority over Nullarbor caves and karst (*IMG 1*) and/or the suggested Nullarbor Caves and Karst Management Advisory Committee (*IMG 2*) before lease and planning approvals are granted. (This would be somewhat similar to the referral process used by Local Government Councils when referring planning applications to other relevant Authorities for comment prior to approval or similar to the Native Title trigger for Mining Leases.). Uses that would potentially cause unacceptable impacts on recharge zones, groundwater quantities (or levels); groundwater quality, groundwater flow rates or groundwater-based fauna (stygofauna) should not be approved.

Key Partnerships: DEC, DPI, DWR, DIR, PBL, SLS, NRM Rangelands, ASF/ACKMA and Local Government within the region (Shire of Dundas, Shire of Esperance and City of Kalgoorlie-Boulder).

4.3.13 IMG 13: Ecosystems, Flora and Fauna Conservation

The biodiversity of indigenous flora and fauna should continue to be identified and protect with an emphasis on ecosystems, species and communities at risk.

Surface and subterranean flora and fauna species and taxa declared as protected under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth EPBC Act), the *Conservation and Land Management Act 1984* (WA) or the *Wildlife Conservation Act 1950* (WA) should be given management priority and conservation protection as required.

Other recommendations regarding subterranean flora and fauna in terms of conservation, protection, action programs, recovery programs and research as recommended by Subterranean Ecology (2007), the 2002 Biodiversity Audit and subsequent flora and fauna investigations should be considered and prioritised according to their urgency and available staffing and budgets.

In general, key actions should include:

1. Protect flora and fauna species listed under the EPBC Act 1999, the Wildlife Conservation Act 1950 and the CALM Act;

2. Apply recommendations of *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002* (Dept. of Conservation and Land Management, 2003)*;*

3. Apply recommendations of NRM Strategy for the Rangelands Region of Western Australia (Rangelands NRM, 2005);

4. Apply prescribed fire to conserve biodiversity according to DEC policy;

5. Prepare and implement approved recovery plans according to biodiversity priorities identified in the Biodiversity Audit (2002) or in further investigations;

6. Implement measures to mitigate impacts various threatening processes as identified, including that of visitor use to sensitive plant species or communities;

7. Prioritise and conduct specific research and monitoring activities;

8. Consider designation of new reserves in the Conservation Estate (as per Davey, et al. 1992 and according to priority species and taxa as identified in the 2002 Biodiversity Audit;

9. Capacity building of community groups, land and lease holders through projects such as the Macro Corridor project as referenced in *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002* (Dept. of Conservation and Land Management, 2003. Refer to the 2002 Biodiversity Audit (Dept. of Conservation and Land Management, 2003) and Subterranean Ecology (2007) for detailed recommendations.

Key Partnerships: DEC, NRM Rangelands, DPI, PBL, ASF, Pastoral Leaseholders and South Australia's Dept. of Environment and Heritage.

4.3.14 IMG 14: Threatening Pest Animal and Plant Control

Apply recommendations of *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002* (Dept. of Conservation and Land Management, 2003) and other more recent programs for the control of pest animals and plants that threaten indigenous flora and fauna species.

Implement specific targeted projects within a 5 year timeframe where possible and achievable. Carry out localised mapping, control or eradication of targeted species.

Continue monitoring programs and existing controls on feral animals (e.g. wild dogs, feral cats, fox, rabbits and starlings), adjusting and expanding eradication where necessary.

Priorities should focus on endemic vegetation communities and indigenous plant species in some Nullarbor dolines that are under immediate threat of displacement/smothering by introduced weeds (e.g. at Webbs Cave, Chapel Rock doline, Madura Cave and some more recently discovered caves on the Roe Plain).

Horehound, Deadly Nightshade, Wards Weed and Onion Grass are some of the pest weed species. Horehound seed, due to its sticking ability to clothes/ socks/ vehicles for instance can be easily, yet most of the time unknowingly, transported from one doline to another or to moisture-gaining areas.

Key Partnerships: DEC, NRM Rangelands, DPI, PBL, Pastoral Leaseholders and South Australia's Dept. of Environment and Heritage.

4.3.15 IMG 15: Fire Control

The objectives and strategies recommended by the Draft South Coast Regional Fire Management Plan 2008-2013 should guide responses to fire in the Nullarbor region. The recommendations of the report *Fire Management in the Rangelands* (Tropical Savannas and Desert Knowledge Cooperative Research Centres, 2004) should also be considered.

Key Partnerships: DEC, Shire of Dundas, the Fire and Emergency Service Authority (FESA), NRM Rangelands, and Pastoral Leaseholders.

4.3.16 IMG 16: Protection of Cultural Heritage Sites

Indigenous and non-indigenous cultural heritage sites and places should be conserved and protected as required by the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984, Aboriginal Heritage Act 1972* (WA), *Heritage of Western Australia Act 1990* and other relevant legislation and policies. Any planned development or excavations that may potentially affect archaeological or heritage features, fabric, sites or places should be referred to the appropriate government authorities, custodians and/or Traditional Owners for further assessment and approvals prior to any disturbance or alterations to the sites.

With the agreement of DIA and GLSC, data on cultural heritage sites may be considered for inclusion or linking to the Karst Management database(s) such as mentioned in IMG 3, however, culturally sensitive sites may not always be made publicly known. Hence, this would not eliminate the requirement for due planning processes to take place.

Key Partnerships: DEC, DPI, PBL, SLS, DIA, GLSC, HCWA, WAM (and DEHWA as appropriate).

4.3.17 IMG 17: Holistic and Best Management Practices

It should be recognised that the Nullarbor caves and associated karst system is highly complex, interconnected and vulnerable. A "whole-of-system", integrated and multi-disciplinary planning and management philosophy and approach should be encouraged. Best practice guidelines for caves and karst landscapes, such as those recommended in the box below, should be referred to and considered for all land use, conservation and visitor management decisions.

Key Partnerships: DEC, NRM Rangelands, ASF and all other involved agencies and stakeholders.

4.4 Interim Management Guidelines for Specific Pastoral Issues

4.4.1 IMG 18: Surveys and Fencing of Areas above Cave Passages

Existing surveys of the boundaries of areas directly above or close to known cave passages should be made available to pastoral leaseholders for conservation and safety purposes. Pastoralists should be encouraged to fence these areas off where practical from grazing sheep and livestock where such activity may adversely impact upon the indigenous vegetation important to meso-cavern and cave ecosystems and hydrology. These areas should also be clearly marked and/or fenced off where practical to prevent undesirable boring for water, excavations, leakage of human/animal wastes or chemical pollutants and to avoid the possible danger of heavy

vehicular or farming equipment causing cave collapses. To a certain degree, these fenced off areas may potentially serve a similar purpose as riparian vegetation corridors or biolinks. Any such fencing should be implemented in an environmentally sensitive manner to avoid possible adverse impacts and to minimise drawing attention to the karst feature.

Where existing surveys are not available from CEGSA, the ASF or other organisations, then priorities should be set for the surveying of known caves and the preparation of ground surface "footprint" maps for reference. [Note: to protect caves that are classified as Restricted Access or which have locations that are not to be available to the general public, the survey maps of cave passage locations should be kept in the strictest secrecy and confidentiality].

Key Partnerships: DEC, DPI, PBL, CEGSA/ASF, ACKMA and affected Pastoral Leaseholders.

Cave and Karst Management Best Practice References

- **Watson, John; Hamilton-Smith, Elery; Gillieson, David; Kiernan, Kevin, Eds., 1997. *Guidelines for Cave and Karst Protection.* Prepared for the World Commission on Protected Areas (WCPA) Working Group on Cave and Karst Protection, IUCN – The World Conservation Union.**
- **Elery Hamilton-Smith, 2006. *Spatial Planning and Protective Measures for Karst Areas* 2006, in ACTA Carsologica 35/2, 5-11, Ljubljana.**
- **British Columbia Ministry of Forests, 2003. *Karst Management Handbook for British Columbia.***
- **Karst Waters Institute, 2003. *Recommendations and Guidelines for Managing Caves on Protected Lands.* Jones, et al. contributors.**

4.4.2 IMG 19: Surface Drainage and Farm Dam Construction

Changes to surface drainage, siting and construction of farm dams may have potential adverse effects on caves, blowholes, dolines or the karst hydrologic system. Pastoral leaseholders should consult with DEC regarding significant proposed changes to surface drainage or the proposed construction of farm dams or reservoirs that could potentially affect the surface footprint of known cave passages (*IMG 18*) or the meso-catchment surrounding the entrances to caves, blowholes or dolines.

Key Partnerships: DEC, DPI, PBL, ACKMA, ASF and affected Pastoral Leaseholders

4.5 Interim Management Guidelines for Mining, Transport and Communications Infrastructure Uses

4.5.1 IMG 20: Excavations and Drilling Above Cave Passages

Excavations, exploratory or bore water drilling and other construction or extraction works directly above or close to known cave passages should be avoided where ever possible. Proposed works are subject to the normal planning approvals process and to planning, mining and environmental impact assessment regulations as required by the *Land Administration Act 1997* (LAA, WA), *Environmental Protection Act 1986*, *Conservation and Land*

Management Act 1984 (WA), *Mining Act 1978*, *Petroleum Act 1967*, *Industry and Technology Development Act 1998*, and other relevant legislation and policies.

The potential effects of exploratory drilling on groundwater resources should be minimised by applying the *Guidelines for the Protection of Surface and Groundwater Resources during Exploration Drilling* (WA Department of Mineral and Petroleum Resources, 2002).

Existing surveys of ground surface "footprint" maps for areas above cave passages available from DEC, CEGSA, or the ASF should be referred to during the process of planning any mining, drilling, road works or other excavations within the Nullarbor karst region. Cave passage footprint areas already fenced off (*IMG 18*) on pastoral leasehold properties or elsewhere should not be selected for such operations. Where such ground surface "footprint" surveys have not been completed for known caves, such surveys should be prepared prior to planning development, exploration and construction sites. (In order: to protect caves that are classified as Restricted Access or which have locations that are not to be available to the general public, the survey maps of cave passage locations should be kept in the strictest secrecy and confidentiality.)

Key Partnerships: DEC, DPI, DIR, PLB/SLS, Australian Rail Track Corporation Ltd (ARTC), EPA, ACKMA/ASF, Local Governments within the region (Shire of Dundas, Shire of Esperance and City of Kalgoorlie-Boulder), and all mining, telecommunications and railway companies operating in the area.

4.5.2 IMG 21: Surface Drainage Changes by Mining and Infrastructure

Changes to surface drainage, siting and construction of works related to mining, roads, railways, telecommunications or other infrastructure may have potential adverse effects on caves, blowholes, dolines or the karst hydrologic system. Agents and representatives of such mining and infrastructure organisations or companies should consult with DEC regarding any proposed changes to surface drainage or the proposed construction of dams or reservoirs that could potentially affect the surface footprint of known cave passages (*IMG 18*) or the meso-catchment surrounding the entrances to caves, blowholes or dolines.

Key Partnerships: DEC, DPI, DIR, PBL/SLS, EPA, ACKMA/ASF, Australian Rail Track Corporation Ltd (ARTC), Local Governments within the region (Shire of Dundas, Shire of Esperance and City of Kalgoorlie-Boulder), and all mining, telecommunications and railway companies operating in the area.

4.6 Interim Management Guidelines Related to Aboriginal Recognition and Co-operation

4.6.1 IMG 22: Aboriginal Rights, Knowledge and Co-operative Management

In all management decisions and activities regarding Nullarbor caves and associated karst areas, Aboriginal rights as per the United Nations Declaration on Rights of Indigenous Peoples (United Nations General Assembly, 2007) should be acknowledged and upheld. Management and development activities should adhere to all requirements of the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984,* the *Native Title Act 1993* (Cth), the *Aboriginal Heritage Act 1972* (WA) and any other relevant legislation and policies.

The Goldfields Land and Sea Council should be contacted regarding the involvement and co-operation of Indigenous communities and Traditional Owners. The concept of "free, prior and informed consent" should be implemented as per the United Nations Declaration on Rights of Indigenous Peoples (United Nations General Assembly, 2007).

In planning and managing any areas that may have Aboriginal connections, the Aboriginal knowledge of the country and culture be acknowledged and that Aboriginal management and ownership rights also be acknowledged and acted upon as appropriate.

Indigenous people's traditional use of the land for activities such as hunting, gathering native flowers, honey, etc. should be facilitated as appropriate.

Key Partnerships: DEC, DPI, PBL, SLS, DIA, GLSC, local Indigenous Communities, Traditional Owners, Pastoral Leaseholders and development proponents as appropriate.

4.7 Interim Management Guidelines Regarding Safety and Liability Issues

4.7.1 IMG 23: Risk Assessments and Management

Risk assessments for caves and associated karst features should be prepared as per *IMG 5* in relation to use by tourists, recreationists, researchers, pastoralists, government staff members and other visitors. Specialist risk assessment and management expertise should be sought wherever necessary.

Areas of potential liability should be reviewed in terms of the "duty of care" and responsibilities of DEC, DPI, PBL and SLS. Actions and safety measures to eliminate or minimise the risk should be taken on a priority basis. Any capital works required to implement such actions or safety measures should be carried out according to assessed priorities and available funding. In lieu of or in addition to such measures, hazard warnings, safety signage and notices or other information should be provided as appropriate to the general public, to leaseholders and to contractors who may be in the Nullarbor area.

Any legal provisos declaring that vested management authorities are not liable for potential damages to property or injury/death to persons should be clearly included in any lease agreements, permits or contracts as advised by independent legal advisors.

Consideration should be given to any accident liability and/or health/life insurance requirements for cave access permit-holders, pastoral leaseholders, researchers or other parties visiting or working in or near caves, blowholes or dolines

Key Partnerships: DEC, DPI, PBL/SLS, ASF, ACKMA, WASG, SRGWA, CDAA, WAM, GLSC, Tourism WA and Pastoral Leaseholders.

4.8 Enhanced Management Frameworks

4.8.1 IMG 24: Preliminary Review of Enhanced Management Frameworks

The highly dispersed and vulnerable nature of the caves and associated karst features of the project area, combined with the various land tenures and management vestings involved are an indication that at a preliminary level, it may be useful for the Nullarbor Cave and Karst Management Advisory Committee to investigate the appropriateness of forming some other regional management body that will provide for more of the key stakeholders and vested management authorities to be involved in joint decision-making and co-management regarding future land use and conservation management in the region, particularly regarding caves, blowholes and dolines.

This guideline follows on from the 2002 Biodiversity Audit recommendations and those made by Subterranean Ecology (2007) and previously by Davey et al. (1992), continuing examination of how caves and karst features might best be protected and conserved should be carried out over the next five years.

Further discussion of this issue and some of the alternative management frameworks that could be explored, each of which could allow continued use of Pastoral Leaseholds is provided in Appendix 10.

GLOSSARY[6]

Accidental – in the context of the classification of cavernicolous organisms, refers to species which occasionally occur in caves (e.g. humans, snakes) but which cannot survive there for long; compare with troglobite, troglophile & accidental

Aeolian – Windblown

Anastamosing tubes – mesh or network of tubes; where these follow a bedding plane or joint in this becomes exposed in the cave roof or walls they form half-tubes

Beachridge – a low linear ridge of beach and dune material formed at a coastline; generally found in groups of parallel ridges – compare with foredune

Biogenic – derived from biological sources, typically from accumulation of dung and/or discarded food material

Blind valley – a valley that is closed abruptly at its lower end by a cliff or slope facing up the valley; rare on the Nullarbor (e.g. Abrakurrie Cave N3)

Blowhole – a round hole in the ground ranging in diameter from a few tens of centimetres to one or two metres, connecting with a generally smooth-walled vertical tube of similar diameter, which may or may not descend into an accessible cave chamber

Cainozoic – the last of the geological eras, includes the Tertiary and Quaternary periods; extending from about 65 million years ago up to the present

Calcarenite – an indurated sand composed mainly of detrital calcium carbonate fragments

Calcite – the commonest calcium carbonate mineral and the main constituent of limestone

Calcrete – a deposit, often nodular, of calcium carbonate formed in the soil; kankar

Cave – a natural cavity in rock, large enough to be entered by a human

Cave coral – very small *speleothems* consisting of short stalks with bulbous ends, usually occurring in patches

Cavernicolous – found in caves; in relation to animals, the term cavernicole usually refers to a species which lives in caves for the whole or part of its life cycle

Chenopod – a plant species in the family Chenopodiaceae, many of which are commonly known as saltbushes or bluebushes

Chert – microcrystalline silica nodules; common in bands in the Wilson Bluff Limestone; exploited by Aboriginal people over many thousands of years (from caves, beach deposits and surface outcrops) for stone tools, with the material being very widely traded over a large part of Australia; also loosely called flint

Clastic – composed of loose fragments (e.g. an unconsolidated sediment; a heap of bones beneath an owl-roost; mounds of sand-sized or platy fragments spalled from a passage roof or walls by *crystal weathering*)

Coastal dunes – the combination of foredunes and backdunes over buried beachridges

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NOTE 6: This Glossary borrows primarily from that provided by Davey et al. (1992), with some minor adjustments and additions.

"Coffee and cream" – a characteristic soft powdery cave floor deposit of very low bulk density derived from breakdown of the roof and walls of cave passages

Cretaceous – the geological period that precedes the Tertiary; extending between about 135 and 65 million years ago

Crystal weathering – detachment of particles of various sizes from a rock surface by the growth of crystals (mainly gypsum, to a lesser extent *halite*) from percolating salt solutions; an important process within Nullarbor caves in modifying cave form and producing various *clastic* floor deposits; also known as salt weathering or exsudation.

Deflation – the removal of loose fine grained material from a surface by wind action

Denudation – the general lowering of the land surface

Detrital – material formed by mechanical breakage or abrasion

Diagenetic – processes that modify the nature of a sediment or rock after it has been deposited – particularly in relation to increases or decreases in porosity and coherence

Doline – crater – or well-like surface depressions or hollows (commonly but misleadingly known as sinkholes – especially on the Nullarbor where it is very rare for streams to sink into them), from a few to many hundreds of metres in dimensions

Donga – in long-established local usage (Gibson 1909b), this is a shallow, generally circular, closed depression several metres deep and hundreds of metres across, with a flat clay-loam floor and very gentle slopes; this local use of the term donga is quite different from the established international meaning in geomorphology, where donga refers to a type of wadi or intermittent stream channel in arid or semi-arid country

Duricrust – an *indurated* surface formed by weathering process involving cementation of the surficial soil and weathered rock by calcite (calcrete), iron oxides (ferricrete), silica (silcrete) or other cements

Endemic – refers to a species which is only known from the region, area or site in question (i.e. both described from and confined to that place)

Epeirogenic – pertaining to widespread, even (and usually gentle) uplift or subsidence of a land surface (with relatively little folding or faulting)

Eustatic – pertaining to worldwide changes of sea levels

Exsudation – see *crystal weathering*

Facies – a lateral subdivision o f a stratigraphic unit, varying from the main unit and /or other subdivisions in fossils, texture and /or environment of deposition

Ferricrete – a type of *duricrust* which is cemented by iron oxides

Fluvial – produced by the action of a stream or river

Foredune – a dune ridge build up behind a coastline; generally higher and more extensive than a *beachridge*

Guano – accumulation of dung, often partly mineralised; in caves, most commonly derived from bats; see also pseudobitumen

Gypsum – the most common mineral form of hydrated calcium sulphate

Half-tube – a semi-cylindrical, elongate, recess exposed on a cave surface, often meandering and /or *anastamosing*

Halite – the mineral form of sodium chloride

Halocline – a discontinuity in dissolved solids concentration of groundwater (i.e. a boundary between zones of a different concentration)

Hydrophilic – inhabiting moist places

Indurated limestone – rock at or near the surface which has been case hardened and made relatively impervious to water by weathering and precipitation of calcite within it

Kankar – *calcrete*

Karren – the minor forms of karst, due to solution sculpture of rock on the surface or underground

Karst – terrain with special landforms and drainage characteristics due to greater solubility of certain rocks (such as limestone) than is common on other lithologies; common examples include underground drainage differing markedly in configuration and connections from surface catchments, caves, rockholes, blowholes and various types of closed depression

Mallee – a multi-stemmed form of tree growth arising from a common root stock; a common growth habit in a substantial number of species in the genus Eucalyptus in semi-arid and arid parts of Australia; mallee woodland occurs in a narrow southern (i.e. slightly wetter) band across the region, on the coastal side of the treeless plain; the term is sometimes also applied (erroneously) to the open myall and mulga (*Acacia*) woodlands in the Nullarbor region

Megafauna – extinct marsupials of the Pleistocene which, although often closely related to modern species or genera, were relatively much larger and more heavily built

Meteoric (water) – derived from the atmosphere, i.e., in the Nullarbor case, percolation water derived from rainfall rather than lateral movement of phreatic water; broadly equivalent to *vadose*

Meteorite – stony or metallic extra-terrestrial objects which have fallen to earth; compare with *tektite*

Palaeochannel – a definable corridor formerly occupied by a river or stream but, as a result of increased aridity, no longer carrying any effective streamflow

Palaeodrainage – the network of *palaeochannels* and their watershed which, under less arid conditions, constituted the active surface catchment of the region; no longer active at present.
Paralic – a transitional environment, mainly occurring by the sea but mainly non-marine in character: includes littoral, lagoonal and swampy environments.

Phreatic – associated with that zone in the rock where voids are completely filled with water; compare with *vadose*.

Pseudobitumen [dung bitumen] – tarry biogenic deposits common on ledges and in hollows around the walls of cave entrances, dolines and on the escarpments, derived from dung and other organic matter which, in the Nullarbor region is most commonly associated with old nests of the Stick Nest Rat *Leporillus conditor* [now extinct on the mainland].

Regression – a withdrawal of the sea from the land, due to uplift or a *eustatic* drop in sea level; compare with *transgression.*

Ridge and corridor terrain – repetitive terrain of low relief with generally stony ridges a few meters above flat silt-floored corridors.

Rockhole (Gnamma) – a rounded basin which contains water after rain, ranging from 0.1m to several meters in diameter, up to a few meters deep.

Salt weathering [exsudation] – see crystal weathering

Silcrete – a type of duricrust cemented by amorphous or microcrystalline silica.

Solution pan – an irregular shallow flat hollow in *indurated* surface limestone, usually only a few centimeters deep, which contains water after rain; often surrounded by an extensive flat rock pavement which contributes runoff; see also *rockhole.*

Speleothem – a secondary mineral deposit formed in caves, most commonly of calcite; common forms include stalactites, stalagmites, helictites and cave coral.

Stillsand – stationary with respect to sea level.

Tektite – a usually glassy rounded object, derived from the earth by the impact of a large meteorite blasting rock up into the atmosphere at high velocity, which has fallen back to earth usually at a considerable distance from the impact; the impact site for Australian tektites is thought to have been in South-East Asia; all Australian examples date from a single event about 800,000 years ago; also know as Australites; in contrast with *meteorites* (which consist of extra-terrestrial material), tektites are made of terrestrial matter.

Tertiary – the geologic time period lying between the Cretaceous and the Quaternary; extending from 65 to 1.8 million years ago, it occupies the bulk of the Cainozoic era.

Tectonic – pertaining to large scale movements of the earth's crust: i.e. folding, faulting etc.

Terrigenous – shallow marine deposits consisting of sediments derived from the land surface.

Transgression – an advance of the sea across the land, due to subsidence of the land, or a *eutastic* rise in sea level; compare with *regression.*

Troglobite [& troglobitic] – an obligate *cavernicole*, unable to live outside the cave environment and exhibiting morphological adaptation to darkness and/or other characteristics of the cave environment; compare with *troglophile, tragloxene* and *accidental.*

Trogloxene – a *cavernicole* which spends only part of its life cycle in caves and returns periodically to surface habitats; compare with *troglophile, troglobite* and *accidental*.

Vadose – associated with that zone in the rock where voids are partly filled with air and through which water descends under gravity; compare with *phreatic*; see also *meteoric*

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APPENDICES

APPENDIX 1: Legislative and Management Framework

Table A1 Government Departments, Legislation, Ministries and Responsibilities

Government Departments/Branches	Enabling Legislation &/or Associated Ministry	Vested Management Responsibilities & Comments
Cth Dept. of Environment, Water, Heritage and the Arts (Natural Heritage Trust) Cth Dept. of Agriculture, Fisheries and Forestry CSIRO Sustainable Ecosystems	*Environment Protection and Biodiversity Conservation Act 1999* (Cth EPBC Act) Commonwealth Ministers responsible for these Departments Partnership with WA Dept. of Conservation and Land Management (now DEC).	• Australian Terrestrial Biodiversity Assessment (2002) of biodiversity values, condition, management requirements and investment opportunities for integration with the Australian Natural Resources Information and Atlas • Identify, protect manage and recover Australia's biodiversity values, including endangered, rare, and threatened flora and fauna ecosystems, communities and species as per The National Strategy for the Conservation of Biological Diversity (ANZECC 1996)
Australian Heritage Council Australian Government Department of the Environment, Water, Heritage and the Arts in co-operation with associated WA Govt. Departments (Dept. of Indigenous Affairs, WA Heritage Council, etc.)	*Environment Protection and Biodiversity Conservation Act 1999* (Cth EPBC Act) *Historic Shipwrecks Act 1976* *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* Cth Minister for the Environment, Heritage and the Arts	• Develop and implement national policy, programs and legislation to protect and conserve Australia's environment and heritage and to promote Australian arts and culture • Maintain the National and Commonwealth Heritage Lists of places of outstanding heritage significance to Australia on and off Commonwealth controlled lands. It includes natural, historic and Indigenous places • Protection of all shipwrecks more than 75 years (or less as declared by the relevant Cth Minister) together with their associated relics. • Blanket protection to Indigenous archaeological sites • Preservation and protection of areas and objects of particular significance to Aboriginals as per Aboriginal tradition.
Natural Resources Management (NRM) Co-ordinating Committees: • Rangelands Natural Resource Management Co-ordinating Council • The Australian Government Natural Resource Management Team (AGNRM Team)	Natural Heritage Trust Bilateral Agreement between the Commonwealth of Australia and the State of Western Australia (2002) AGNRM is a joint venture between the Australian Government Departments of the Environment, Water, Heritage and the Arts and Agriculture, Fisheries and Forestry and is composed of staff from both Departments.	• Integrated delivery of Natural Resource Management (NRM) priority issues • Restoring degraded arid shrublands in the Goldfields-Nullarbor sub-region • Biodiversity protection through the control of introduced weeds and feral animals and the re-establishment of appropriate fire regimes • Water quality and management • Applies to the Southern Range-lands and Arid Inland NRM Zones Originally developed from the National Action Plan for Salinity and Water Quality (NAP) and the Natural Heritage Trust (NHT) – now combined under the Caring for Our Country program.

Table A1 Government Departments, Legislation, Ministries and Responsibilities ...continued

Government Departments/Branches	Enabling Legislation &/or Associated Ministry	Vested Management Responsibilities & Comments
Native Title Representative Bodies[7] • Goldfields Land and Sea Council • Central Desert Native Title Services Limited	*Native Title Act 1993* (Cth) C'th Dept. of Families, Housing, Community Services and Indigenous Affairs Bilateral Agreement on Indigenous Affairs between the Commonwealth of Australia and the State of Western Australia 2006 – 2010.	• The GLSC and CDNTSL are the Federal Government-appointed Representative Bodies for Native Title in the Goldfields and Central Desert Regions of the Nullarbor • The peak Aboriginal land and heritage bodies in their respective regions with jurisdiction over the lands and sea • Consult with and represent Aboriginal people, particularly with regard to the achievement of meaningful native title outcomes as well as other land justice initiatives, while performing its functions under the Native Title Act 1993'
The Office of Native Title	*Native Title Act 1993* (C'tlh) Deputy Premier WA	• Implementation of the Common-wealth and State Government's native title policy • Policy is based on the principles of negotiation, not litigation • Where possible, to resolve all native title matters in Western Australia by agreement • Represents the State's interests in every native title determination application over land and water, and takes the lead in the negotiation and implementation of major projects on land under native title claim.
WA Dept. of Planning and Infrastructure (DPI): • State Lands Services (SLS); • Pastoral Lands Board (PLB - comprising DGs of DPI and Dept. of Agriculture & Food, 3 pastoral industry representatives, one conservation expert, and one Aboriginal member)	*Land Administration Act 1997* (LAA, WA) Minister for Planning & Infrastructure	Management and administration of: • State Lands • Freehold Lands (planning strategies and controls) • Pastoral Lands (Part 7 of the LAA) • PLB oversees administration of pastoral leases; ensures that pastoral leases are managed on an ecologically sustainable basis, and; prepares periodic Range Condition Assessment (RCA) on all pastoral leasehold properties. • The SLS administers the area on a risk management basis • Aboriginal persons have right to enter any unenclosed or unimproved parts of a pastoral lease for customary hunting and gathering for sustenance.

NOTE 7: This table does not include the Aboriginal Lands Trust, which is not a government agency or department, but which was established through the *Aboriginal Affairs Planning Authority Act 1972* (AAPA Act, WA) and is associated with the Commonwealth Minister for Indigenous Affairs. Key functions include, but not limited to:

- promote the economic, social and cultural advancement of persons of Aboriginal descent in Western Australia;
- apportion, apply or distribute the moneys available to it;
- granting, selling, alienating, mortgaging, charging or demising personal property and, with the prior approval of the Minister, of dealing in like manner with real property.

Table A1 Government Departments, Legislation, Ministries and Responsibilities ...continued

Government Departments/Branches	Enabling Legislation & Associated Ministry	Vested Management Responsibilities & Comments
Conservation Commission of WA (CCWA): • Department of Environment & Conservation (DEC) :	*Conservation and Land Management Act 1984* (WA) *Wildlife Conservation Act 1950* (WA) Minister for the Environment	DEC is vested with the following responsibilities on behalf of the Conservation Commission: • National Parks, Conservation Parks; • Nature Reserves • State Forests • Unallocated State Land, and • Unmanaged State Reserves • Fire and declared plants and animals (including weed and vermin control) on Unallocated State Land and Unmanaged Reserves
Department of Indigenous Affairs (DIA)	*Aboriginal Affairs Planning Authority Act 1972* (WA AAPA Act) Minister for Indigenous Affairs	• Advises Government, Aboriginal Cultural Material Committee and Aboriginal on the adequacy, implementation and coordination of services to Aboriginal people in WA and on matters related to the f Aboriginal Heritage Register • Provides policy development on key issues affecting Aboriginal Western Australians. • Ensures that Aboriginal people are fully engaged in policy development. • Promotes reconciliation and respect for Aboriginal history, heritage and culture. • Manages and protects places of significance to Aboriginal people • Maintains the Aboriginal Heritage Register. • Goldfields Region office serves as the 'front-line' liaison to Nullarbor Aboriginal communities in this collaboration process.
Aboriginal Cultural Material Committee (ACMA)	*Aboriginal Heritage Act 1972* (WA) Minister for Indigenous Affairs ACMA is comprised of Aboriginal and non-Aboriginal heritage experts	• provides advice to the Minister for Indigenous Affairs on the management of sites of significance in the development process. • ACMA is assisted and advised on such matters by DIA staff.
Heritage Council of Western Australia	*Heritage of Western Australia Act 1990* Minister for Heritage	• Non-indigenous heritage sites are protected under the *Heritage of Western Australia Act 1990* and may be listed under the Western Australian Register of Heritage Places, the Commonwealth Australian Heritage Council's National and Commonwealth Heritage List (previously the Register of National Estate) • The Heritage Council Register incorporates sites and places classified by the National Trust of Australia (WA) and shipwreck sites only within coastal estuaries or in the intertidal zone

Table A1 Government Departments, Legislation, Ministries and Responsibilities ...continued

Government Departments/Branches	Enabling Legislation & Associated Ministry	Vested Management Responsibilities & Comments
The Western Australian Museum	*Museum Act 1969* Minister for Culture and the Arts	• Maintains flora, fauna, historic, archaeological, palaeontological, and anthropological records and samples • Keeps records of other shipwrecks in the ocean beyond the intertidal zone • Conducts field research on the Nullarbor in relation to above
Department Industry and Resources • Resources Group • Office of State Development • Office of Science, Technology and Innovation • State Development Strategies • Corporate Support	*Mining Act 1978* *Petroleum Act 1967* *Industry and Technology Development Act 1998* Minister for Trade; Innovation; Science Minister for State Development Minister for Resources; Industry and Enterprise	Principal functions regarding Nullarbor Karst System include: • Regulates mineral and petroleum industries • Encourages new business development, investment in mineral/petroleum exploration • Supports and promotes science, research and technology • Mineral and exploration database • Minimises social and environmental impacts
Environmental Protection Authority of Western Australia	*Environmental Protection Act 1986* Minister for the Environment	• Environmental advice through environmental protection policies and assessment of development proposals and management plans • Public statements about matters of environmental importance
Department of Agriculture and Food (DAF) and some key branches: • Natural Response Management • Biosecurity Research • Industry and Rural Services Agriculture Protection Board (APB)	*Agriculture and Related Resources Protection Act 1976* *Soil and Land Conservation Act 1945* (SLC Act) *Agriculture Protection Board Act 1950* Minister for Agriculture and Food	• Research, technical advice and support for the management and facilitation of agricultural production and rangelands management (along with the Natural Resource Management (NRM) Region for the Nullarbor) • APB investigates and formulates schemes to control, prevent and eradicate noxious weeds and vermin • Soil inventories and mapping
Department of Water	*Rights in Water & Irrigation Act 1914* Minister for Water Resources	• Support the principles of the National Strategic Water Reform Framework Agreement • Monitor and manage surface and ground water, its quality quantity and supply; • Implement State Rural Water Plan • Implement Rural Water Planning Program • Support Integrated Catchment Management and water resource protection • Implement Salinity Management Program • License and regulate all groundwater bores and artesian wells

Table A1 Government Departments, Legislation, Ministries and Responsibilities ...continued

Government Departments/Branches	Enabling Legislation &/or Associated Ministry	Vested Management Responsibilities & Comments
Department of Local Government and Regional Development (DLGRD) Goldfields and Esperance Regional Development Commission Local Governments: • City of Kalgoorlie-Boulder • Shire of Dundas • Shire of Esperance	*Local Government Act 1995* *Regional Development Commissions Act 1993* *Control of Vehicles (Off-road Areas) Act 1978* Minister for Local Government Minister for Regional Development	• DLGRD provides support and advisory services to 142 local governments, • GEDC encourage, promote, facilitate and monitor the economic development in the Region • Local Governments provide: Land use planning controls through the Local Planning Scheme; Coastal Plans for areas outside Conservation Reserves, and Tourism/ Recreation Development Plans

A1.1 Key Legislative Acts

Commonwealth

- *Environment Protection and Biodiversity Conservation Act 1999* (Cth EPBC Act)
- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth)
- *Native Title Act 1993* (Cth)

Western Australia

- *Land Administration Act 1997* (LAA, WA)
- *Conservation and Land Management Act 1984* (WA)
- *Wildlife Conservation Act 1950* (WA)
- *Aboriginal Affairs Planning Authority Act 1972* (AAPA Act, WA)
- *Agriculture and Related Resources Protection Act 1976*
- *Soil and Land Conservation Act 1945* (SLC Act)
- *Agriculture Protection Board Act 1950*

As indicated above, a number of other Western Australian Acts bear on other aspects of land and resource management of the Nullarbor region.

A1.2 Key Government Departments

As with the legislative Acts, many Commonwealth and Western Australian government departments and agencies have areas of responsibility over the Nullarbor region. However, some of the key agencies include:

Commonwealth

- Dept. of Environment, Water, Heritage and the Arts (Natural Heritage Trust)
- Dept. of Agriculture, Fisheries and Forestry
- CSIRO Sustainable Ecosystems
- Australian Heritage Council
- Australian Government Natural Resource Management Team (AGNRM Team)
- Rangelands Natural Resource Management Co-ordinating Council
- Goldfields Land and Sea Council (Native Title Representative Bodies)

Western Australia

- WA Dept. of Planning and Infrastructure (DPI)
    - State Lands Services (SLS)
    - Pastoral Lands Board (PLB - comprising DGs of DPI and Dept. of Agriculture & Food, 3 pastoral industry representatives, one conservation expert, and one Aboriginal member)
- Conservation Commission of WA (CCWA)
    - Department of Environment & Conservation (DEC)
- Department of Indigenous Affairs (DIA)
- Aboriginal Cultural Material Committee (ACMA)
- Heritage Council of Western Australia
- The Western Australian Museum
- Department Industry and Resources
- Department of Agriculture and Food (DAF)
- Department of Water
- Department of Local Government and Regional Development (DLGRD)
    - Goldfields and Esperance Regional Development Commission

- Local Governments:
    - Shire of Dundas
    - Shire of Esperance

(In addressing the entire Nullarbor Karst System, the City of Kalgoorlie-Boulder is also included.)

A1.3 Key Commonwealth Policies and Strategies

Key Commonwealth Government policies and strategies include, but are not limited to:

- Australian Risk Management Standard (Australian Standards)
- National Strategy for Ecologically Sustainable Development (NSESD)
- National Strategy for the Conservation of Australia's Biological Diversity (NSCABD)
- National Principles and Guidelines for Rangeland Management (NPGRM)
- National Framework for Management and Monitoring Australia's Native Vegetation
- National Weeds Strategy (NWS)
- National Greenhouse Strategy (GHS)
- Operation Manual: Australian Rangelands Info System (Rangelands NRM Co-ordinating Committee)

A1.4 Key State Government Policies and Strategies

Key State Government land and resource management policies and strategies include, but are not limited to:

- Conservation and Land Management Regulations (2002);
- Destocking of Leases;
- DEC Policy No. 18 – particularly Sections 2.4 and 2.5 on Caves and Cave Diving;
- Draft Guidelines for the Preparation of Management Plans for Terrestrial Conservation Reserves (Department of Environment and Conservation, Management Planning Unit. Perth, 2006);
- Environmental Protection and Sustainability of the Rangelands of Western Australia (Environment Protection Authority, 2002);
- Guidance for the Assessment of Environmental Factors: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia (Guideline No. 54, 2003);
- Management Plan Guidelines (Pastoral Lands Board);
- Sub-leasing of Leases (State Land Services);
- Standard Conditions for the Transfer of a Pastoral Lease (Pastoral Lands Board);

- State Biodiversity Conservation Strategy (pending ratification and gazettal);
- State Sustainability Strategy (2002).

A1.5 Commonwealth and Interstate Management Agreements

Key agreements between Western Australia State Government and the Commonwealth or other State Governments include:

- The Bilateral Agreement on Indigenous Affairs between The Commonwealth of Australia and the State of Western Australia 2006 – 2010;
- Natural Heritage Trust Bilateral Agreement between the Commonwealth of Australia and the State of Western Australia (2002).

A1.6 International Treaties and Agreements

Key international treaties and agreements of relevance include:

- Local Agenda 21 – developed at Rio de Janeiro Earth Summit (1992): encourages local communities to act to address global problems in practical ways
- RAMSAR International Wetland Convention
- United Nations Convention for Combating Desertification (UNCCD: http://www.unccd.int/).

A1.7 Other Ex-Officio Policies and Guidelines

IUCN Guidelines for Karst and Cave Management (1996)

APPENDIX 2: Heritage Sites and Places Listed on Government and Community Registers and Lists

Table A2 Heritage Sites and Places Listed on Government and Community Registers and Lists

Place Number	Place Name	LGA	Listing Type
836	Israelite Bay Post and Telegraph Station	Esperance	Classified by the National Trust Municipal Inventory Register of the National Estate Statutory Data Base
4222	Eucla Jetty (Ruins), Abutment & Beach Landing (Remains)	Dundas	Register of the Natural Estate Statewide Lge Timber Str Survey Port-related Structures Survey
3558	Eucla Telegraph Station (Ruin)	Dundas	Classified by the National Trust Municipal Inventory
761	Balladonia Telegraph Station (fmr)	Dundas	Municipal Inventory
15722	Rawlinna Townsite	Kalgoorlie-Boulder	Classified by the National Trust
15746	Forrest Railway Station & Outbuildings	Kalgoorlie-Boulder	
760	Balladonia Station	Dundas	HCWA Assesst Program
2705	Nanambinia Station	Dundas	

APPENDIX 2: Heritage Sites and Places Listed on Government and Community Registers and Lists.....continued

Place Number	Place Name	LGA	Listing Type
4362	Mallee Tree	Dundas	Classified by the National Trust
9426	Weebubbie Cave	Dundas	
168 17	Telegraph Line Track		HCWA Assesst Program
5032	Deralinya Station	Esperance	Municipal Inventory
5040	Gabtoobitch (farmhouse & shed ruins)	Esperance	Municipal Inventory
5048	Hill Springs	Esperance	Municipal Inventory
5049	Kangawarrie Tank	Esperance	Municipal Inventory
5051	Middle Island	Esperance	Municipal Inventory
5053	Murtadina Dam and Rock	Esperance	Municipal Inventory
5064	Tooklejenna Rock	Esperance	Municipal Inventory

(Source: Heritage Council of Western Australia, 17 July, 2008. Provided by Penny O'Connor, Manager Assessments & Registration)

APPENDIX 3: Scenic Resource Frame of Reference Assessment Criteria

Table A3 Scenic Resource Frame of Reference Assessment Criteria

Nullarbor Plain Sub Type Visual Quality Classification – Frame of Reference			
SCENIC QUALITY	LANDFORM	VEGETATION	WATERFORM
HIGH	*Rounded clay filled depressions or dongas. *Distinctive low elongated parallel crests and corridor depressions. *Irregular coastline edges and steep vertical cliffs, e.g. Baxter Cliffs. *Irregular coastline edges and steep vertical cliffs, e.g. Baxter Cliffs. *Steeply sloping terrain of distinctive shape and abrupt appearance, e.g. Hampton Scarp. *Wind formed dunes of distinctive form which become focal points, e.g. Eucla National Park. *Coastal dunes which display areas of active weathering and abrupt edge transition to adjacent low-lying areas, e.g. Twilight Bay.	* Wind shaped, gnarled or dwarfed vegetation which create unique forms colours or textures, e.g. *Banksia epica*. *Stands of vegetation which display unusual form, colour or texture in comparison to surrounding vegetation and contrasting with the adjacent landscape, e.g. taller vegetation in dongas. *Ephemerals showing striking display of colours, shapes and textures, e.g. Sturt Desert Peas.	*Any evidence of lakes, clay pans or pooled water, filled or dry, e.g. Forrest Lakes.
MODERATE	*Dunal formation of uniform height and shape *Features which are not visually dominant and are surrounded by similar landforms. *Regular coastline edges with little contrast in form, texture and colour.	*Vegetation which displays the size, form, colour, texture and spacing found commonly in the surrounding landscape.	*Waterforms where present, rate no lower than high in this LCT.
The extensive, expansive and monotonous topographic and vegetative visual attributes of this Visual Landscape Character Sub Type is of special scenic interest and rate no lower than Moderate Scenic Quality.			

(Source: Dept. of Conservation and Land Management, 1994. Reading the Remote: Landscape Characters of Western Australia.)

APPENDIX 4: Visitor Access, Infrastructure Needs, Interpretation, Management Presence and Control Issues

A4.1 Two Schools of Thought on Public Access to Caves and Karst Features of the Nullarbor

Regarding the issue of visitor access to caves and karst features, there appear to be two schools of thought as to whether land managers should restrict information about cave locations, physically restrict access or provide public information and education, as follows:

1. That even though the majority of visitors may respond in a responsible and sensitive manner when educated about the fragility of the caves, there will always be a certain percentage of people who will not respond to signage provided to prevent destructive behaviours regarding caves. Cave protection needs to respond to the worst-case situation and the lowest-common denominators regarding cave visitors;

2. That environmental interpretation and educational programs can increase the public's knowledge of, appreciation for, and care for caves and their fragile contacts – influencing visitor behaviours to reflect management objectives.

There is a great deal of truth in both of these schools of thought. The question is - which approach is the best one for the Nullarbor caves given the current circumstances? And, is one method or the other best for the Nullarbor as a whole, or should some caves be treated with the more regulatory approach and should other caves be treated with the more enlightened, educative approach?

It is clear that the more restrictive secretive and regulatory approaches are simply un-enforceable and impractical for application to so many caves in such a remote area where there is no on-ground management presence. It is also clear that signage and self-administered educational tools (e.g., brochures, CDs, etc.) will also not be appropriate for all the caves in the region without providing some opportunities for people to visit and experience at least some of the caves.

Caves that display more spectacular or curious internal features are also more likely to have a high Overall Risk rating, but are the more desirable caves for tourist and adventure use (from the tourists perspective). A small number of these types of caves should possibly be considered for tourism and adventure uses. This would be particularly so if they do not contain the rarest and most sacred features.

Certainly the caves with the most rare and fragile features should be protected and most should not be opened to the public. Which of these caves should be available on a limited basis for research, exploration and survey by qualified professionals and certified organisa-tions is another point requiring further resolution. Whether certain caves should not ever be open to access or should be closed to access once their contents have been documented is another issue to be resolved, as even research activities can cause damage.

A4.2 Potential Infrastructure Needs at Caves Open to Access

For those caves that may be classified as Tourist Caves or Adventure Caves, additional infrastructure may be required or desirable to minimise visitor impacts. Currently, aside from the three caves that are gated and the few caves that may have small internal information and safety plaques, most caves have practically no infrastructure at all, other than a possible identification sign outside the cave entrance. The vehicular tracks and parking areas are generally informal and uncontrolled, with incremental damage being caused to the fringing vegetation areas (refer to Photos 47 and 48 as examples). Walking tracks to and from the cave are also usually informal and may often meander in multiple pathways, adding to the trampling of vegetation and the increase in erosion that may add to sedimentation within the caves.

One of the relatively consistent findings in recreation research is that the provision of well-defined parking areas and walkways (through paving, boardwalks or other forms of hardening the pathway surface and confining visitors

steps in the preferred direction) is very effective in preventing the random creation of adhoc pathways in various directions to and from recreational destinations. People will invariably choose the path of least resistance and the most obvious access way to reach the area of interest to them. This is also true within caves for the general public, even when the designated track may be relatively narrow.

In this sense, those caves that are most visited and that may become classified as Tourist Caves or Adventure Caves may require the addition of infrastructure that minimises the likely impact of visitors' vehicles and footsteps, as well as some aesthetic landscape design and interpretive signage.

The relatively sparse road system in the Nullarbor is probably one of the most useful management tools (or non-tool) available to land managers – many people may give up on looking for places they have found on internet satellite imagery when they cannot find or gain access to the right road to the locations. But, 4WD vehicles and those with more adventurous spirits can get to many places that would have been left alone in the past. Decisions about the provision of roads in the first place or the upgrading existing vehicular tracks leading to caves need to be carefully considered in the context of the eventual cave classification and management purpose. Where roads already exist, similar decisions must be made regarding the provision or non-provision of directional signage to the caves.

A4.3 Interpretive Facilities and Programs

Although most of the caves are likely to remain unpromoted and inaccessible to the general public due to their high significance and fragility levels, this does not necessarily mean that the general public should completely miss out on the educational value and sense of awe and wonder that these caves may offer.
As indicated above, some caves may be selected as Tourist Caves or Adventure Caves that are accessible to different segments of the public. Such caves may require better roads, improved directional, safety and interpretive signage, greater on-site infrastructure and possibly the implementation of guided tours with trained guides who can not only inform and interpret the caves for them, but also control and monitor visitors' actions.

Other alternatives include the provision of virtual cave tours (using sequential photography and videos), closed circuit television views into the caves (similar to the screening of bats in caves at Narracoorte World Heritage Area in South Australia), and educational DVDs and CDs that can be enjoyed in the car, at home or in schools. Lastly, the provision of a central museum on the Nullarbor Plain along the Eyre Highway or one or more visitor interpretation centres on the Nullarbor may be considered.

Obviously, each of these alternatives would require further feasibility assessment. However, it has been shown in the research that visitors' knowledge, appreciation and behaviours toward valuable and environmentally sensitive natural and cultural features make the greatest improvement when a combination of educational and interpretive techniques are utilised. These include personal contact and messages from rangers and tour guides, signage, brochures, videos, etc. Taken by themselves, especially in the case of signage and brochures, none of these methods is as effective by themselves as when combined with one or two of the other methods of educating visitors (refer to Roggenbuck, Chapter 7 in Manfredo, 1992). Usually, the more such public education and interpretive programs and facilities can be provided in locations away from the actual sites and prior to visitors going to the sites, the more effective the response.

Importantly, the provision of interpretive facilities and programs off-site may well satisfy much of the public curiosity about the caves and give them understanding as to why many of the caves should not be accessed, while at the same time, gaining personal knowledge and value from the existence of the caves, the karst system and their role. This, combined with the possibility of visiting selected caves (as discussed above) may be an important step in providing much greater community appreciation and sensitivity toward the Nullarbor caves and karst features.

A4.4 Provision of Management and Interpretive Presence

Most of the above considerations would require some form of management and interpretive presence of staff or volunteers based within the Nullarbor on a full-time or at least seasonal basis. Such staff would probably need offices and other facilities located at Cocklebiddy, Madura or Eucla along the Eyre Highway. So far, DEC has not been able to justify paid full-time or part-time rangers located on the Nullarbor. Whether this may change in the future or not is unknown at this time. Other possibilities include the training and/or payment of selected volunteers who live on the Nullarbor (or who are willing to move there) to play interpretive, monitoring and regulatory roles. Currently, two volunteer resident wardens are located at Eyre. They are the eyes and ears for DEC in that part of the Nuytsland Nature Reserve. Such volunteers might be selected from among the existing local community, from among the Pastoralists who run leasehold grazing properties, from among appropriate Aboriginal communities, or from among qualified applicants to advertised positions.

Another method of visitor control is to make selected caves accessible on a rotational basis during different years to allow rest periods without disruptions and impacts.

APPENDIX 5: Groundwater Issues

A5.1 Groundwater Values and Threats

Environmental values of groundwater include:

- stygofauna assemblages (in aquifer ecosystems);
- troglobitic faunal assemblages (in caves);
- groundwater dependent vegetation;
- maintaining baseflows or pools in waterways;
- maintaining open water or waterlogged soils in wetlands (Rangelands NRM Co-ordinating Group, 2005);
- bacterial colonies;
- maintaining or protecting habitats, including those in the soil, water, root systems and caves.

Major threats to the groundwater system include:

- potential over-extraction of groundwater;
- the uncontrolled flow of artesian bores;
- changes to flow patterns; and
- degradation of the water quality.

All of the above may pose a threat to the health and integrity of the groundwater ecosystems. (Threats also include human visitation and contamination within dolines, blowholes and caves through the spread of viruses and bacteria harmful to the indigenous flora and fauna.)

Aquifers are considered to be vulnerable to degradation by exploratory drilling in the following ways:

- aquifers may be contaminated by entry through open boreholes by run-off water from the surface, such as in saline and industrial areas;

- aquifers containing useable-quality water being connected by drill holes to aquifers with inferior-quality water or to leakage zones; cross flow may be induced by natural pressure differences or pressure differentials induced by pumping;

- uncontrolled flow of pressure aquifer water through drill holes between aquifers of different quality water or through uncontrolled flow to wastage at the surface.

The habitat and diversity of aquatic flora and fauna can be affected by contaminated groundwater aquifers.

A5.2 DMPR Guidelines Regarding Exploratory Drilling

Regarding the potential effects of exploratory drilling on groundwater resources, the WA Department of Mineral and Petroleum Resources have prepared *Guidelines for the Protection of Surface and Groundwater Resources During Exploration Drilling* (DMPR, 2002). These guidelines are in addition to regulations for exploration drilling and construction of water bores in designated groundwater areas. In Western Australia, the land occupier must have an appropriate groundwater license and the driller must hold an appropriate drillers' license (Classes 1, 2 or 3) issued by the Australian Drilling Association and applicable for the particular intended type of groundwater drilling and bore construction.

The *Guidelines for the Protection of Surface and Groundwater Resources during Exploration Drilling* (2002) identifies three types of aquifers:

- unconfined aquifers;
- multi-layered aquifers; and
- confined (artesian) aquifers.

The unconfined aquifers are also referred to as water table or phreatic aquifers, characterised by a groundwater body that has free exchange of pressure and moisture with the atmosphere. Rainfall on surface layers can percolate into the watertable and moisture from the watertable can also evaporate. Distinct layering of strata does not occur in these types of aquifers and little change in water level occurs when bore or exploration hills are drilled and completed. Little salinity mixing takes place naturally when the drilling penetrates these aquifers, although large increases in salinity may be found with increasing depth of bores.

Figure A5 shows a section drawn from the northwest to the southeast across the Eucla Basin. This illustrates the geological structure. Cretaceous Loongana Sandstone is located at the base, which forms the artesian aquifer on Roe Plains. This is overlain by shales of the Toondi and Madura Formation. The unconfined aquifer consists mainly of the Wilson Bluff Limestone and the Abrakurrie Limestone, with greensands of the Cretaceous Nurina Formation, and the Eocene Hampton Sandstone at the base.

Salinity levels and their geographic distribution vary considerably when comparing those of the upper level Wilson Bluff Limestone aquifer to those of the lower level Lagoona Sandstone aquifer.

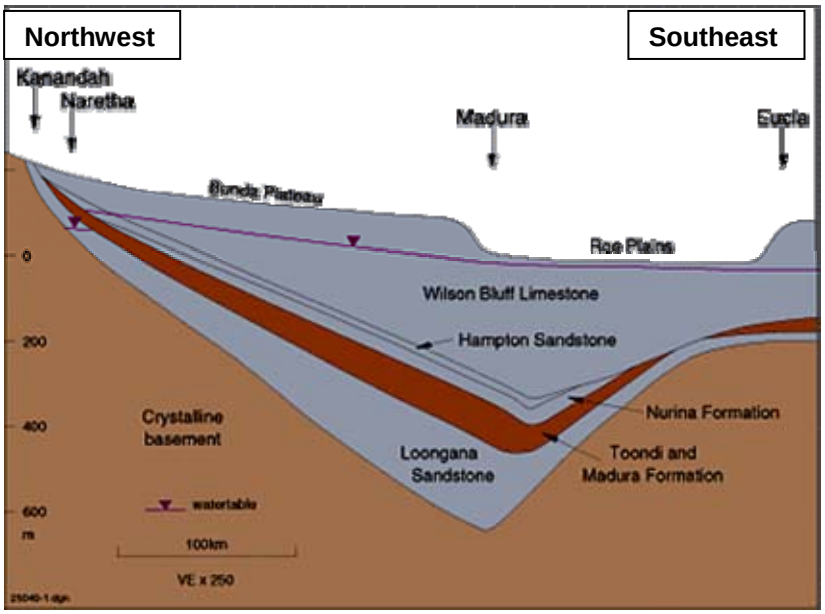
Unconfined aquifers are very susceptible to contamination from surface land uses, including the disposal of industrial waste, the use of agricultural fertilisers and sprays. Where the watertable is shallow, the salinity of these aquifers may increase.

Unconfined aquifers are usually found in the following areas:

- upper layers of the coastal plains;
- alluvial deposits of river valleys';
- in palaeoriver systems, such as those associated with the main salt lake chains;
- in the regolith, the soil and weathered hardrock layer that covers most of the inland part of the State, including the Goldfields, Ashburton, Pilbara and Kimberley regions.

The regolith layer extends downward into the broken, fractured and jointed hardrock zone. Multi-layered aquifers are primarily associated with layered or stratified sediments in the large sedimentary basins of the State, including the Eucla basin. Drill holes that penetrate each layer of such aquifers usually result in a change in water level, indicating that water exchange between layers may be induced by a drill hole as a result of differential pressures.

Figure A5 Northwest-Southeast Geological Section of the Eucla Basin



(Source: Aquaculture Groundwater Resource Atlas – Nullarbor (Eucla Basin), WA Dept. of Fisheries, 2008: http://www.fish.wa.gov.au/docs/pub/AquaGroundWater/nullarbor.php?00)

Confined or artesian aquifers are usually found in deeper layered or stratified sediments in the large sedimentary basins of Western Australia. Major changes in water level may occur due to penetration by a drill hole to the extent that significant water flow may exist at the surface. This is a significant characteristic of multi-layered aquifers. Large pressure differentials make multi-layered aquifers highly susceptible to cross-aquifer contamination, such as salt water invading a lower pressure, good-quality water aquifer. Such aquifers may be subjected to major losses of water by free flow to the surface. They can also be significantly affected by environmental impact at the surface.

Special cases may occur due to abnormal or unusual pressure situations in almost any part of Western Australia. This is particularly so in relation to hilly ground or where perched aquifers on elevated plains exist.

A5.3 EPA Guidance Statement No. 54

The EPA Guidance Statement No. 54 addresses the conservation of stygofauna in ground-water systems and troglofauna and stygofauna in subterranean caves. The primary focus of the guidance is to outline the technical information development proponents should collect for the assessment of the likely impacts on stygofauna. The objective of the EPA is to ensure adequate protection of important habitats for stygobitic species. In addition, on the advice of DEC, the EPA is to ensure that development proposals do not potentially threaten the viability of any subterranean species as per the *Wildlife Conservation Act 1950.*

A formal Environmental Impact Assessment under the *Environmental Protection Act* is required for development proposals that could have potentially significant impacts on stygofauna or troglofaunal habitat in one or more of the following ways:

- lowering of the water table sufficiently to dry out the zone in which some species live, or otherwise artificially changing water tables; or
- changing water quality (e.g. increasing salinity levels or altering haloclines, increasing nutrient levels or the availability of organic matter, or introducing other pollutants); or
- destroying or damaging caves (including changing their temperature and humidity).

The guidance provides advice regarding the survey sampling design, demonstrating the lack of threat and the development of a management plan for the conservation of stygofauna within the impact area.

A5.4 Regional Water Resource Assessments

Regional Water Resource Assessments (National Water Commission, 2005 http://www.water.gov.au/RegionalWaterResourcesAssessments/SpecificGeographicRegion/tabbedreports.aspx?PID=WA_GW_233b) suggest a number of high level performance indicators of water management for the Nullarbor groundwater management unit (GMU) based on information provided by the Western Australian Government. However, data and answers to a range of questions and key information of relevance to the National Water Initiative (NWI) do not appear to have been addressed to date, specifically in relation to:

- groundwater management framework;
- water resource caps;
- surface water / groundwater interaction;
- sustainable groundwater yield;
- environmental allowances / provisions;
- groundwater diversions; and
- groundwater entitlements.

Little monitoring of the above indicators appears to have taken place in the Nullarbor Karst region, nor is there strong evidence of a great deal of on-ground action in relation to management measures associated with these indicators.

A5.5 Draft NRM Strategy

The Draft NRM Strategy for the Rangelands Region (Rangelands NRM Co-ordinating Group, 2005) indicates that the implementation of groundwater monitoring and management actions in the Carnarvon Artesian Basin Rehabilitation Project has resulted in significant water savings due to the geophysical logging of bores, water management plans, decommissioning open flowing bores, and installation of reticulation to direct water to strategic locations. The economic and environmental benefits have included:

- improved management of total grazing pressure through better distribution of water to domestic animals and greater control of non-domestic species;
- more efficient and sustainable use of natural resources through better distribution of water; and
- increased access to water for other land uses such as tourism, aquaculture and horticulture.

In the Canning Basin, NLP funding has allowed the capping of artesian bores, resulting in the:

- removal of uncontrolled surface water to reduce the incidence of weed encroachment;
- feral animals will be easier to monitor and control as watering points will be turned on only when required;
- pumping water from re-drilled bores to areas deficient in water will increase pastoralists' capacity to manage grazing and reduce the pressure on single water points, where erosion risks are high; and
- using artificial watering points rather than natural water points (i.e., permanent pools and rivers) to lessen the impact of animals on fragile riparian areas.

Whether or not such management actions have been considered and tried in the Nullarbor is not known, however, if not, they could possibly be considered.

A5.6 Licensing and Monitoring Wells

All confined wells within Western Australia require a license via the Crown for the use, flow and control of groundwater under the *Rights in Water and Irrigation Act.* Unconfined wells within specific ally proclaimed Groundwater Areas also require licensing. Groundwater licenses have been allocated in a manner to achieve sustainable use of groundwater resources throughout the Rangelands Region. The Department of Environment and Conservation (DEC) have also incorporated an allocation strategy and regular benchmark monitoring in sensitive and heavily utilised areas to ensure groundwater resources remain at sustainable levels for industrial, public water and environmental requirements.

APPENDIX 6: Potential Impacts of Pastoral Uses on Caves, Karst Features and Associated Ecosystems

A6.1 Potential Adverse Effects

As caves, blowholes and dolines are linked to the surface; pastoral uses could potentially have adverse effects on the structure, physical and biological contents and hydrology of these karst features in the following ways:

- changes to the vegetative structure or removal of vegetation and the influence of tree/shrub root systems on the meso-cavernous system of the soils and regolith and on cave passages (which may also have adverse effects on surface ecosystems, flora and fauna);
- disruption) of surface water flows (diverting away from or into) in relation to the meso-cavernous system or into dolines, blowholes and cave entrances, affecting the hydrologic flows;
- removal of groundwater volume and interruption of aquifer flows through the installation of water bores and wells, potentially resulting in declines in water quality and saltwater intrusion into the karst aquifer;
- effects on the quality of surface and groundwater through the introduction of pesticides, chemicals, fertilizers, nutrients (e.g., nitrates, nitrites, phosphates, etc.), human sewage or animal wastes, or heavy metals (e.g. chromium, lead, mercury);
- development, construction, road building, and other infrastructure projects that may lead to drainage basin alterations, decreased water quality and siltation;
- construction of surface reservoirs and subsequent flooding of caves (with excavations potentially breaking through passages that are close to the surface); and
- solid waste dumping into blowholes and dolines.

It is thought that caves under the main, higher level Nullarbor Plain are approximately 100 m below the surface. However, many of the caves on the lower Row Plain are so shallow in depth that the tree roots grow through the cave ceilings. Pannikin Plains Cave, for instance, extends under the Eyre Highway and vehicular traffic can be heard overhead by cavers inside the passage. Although the caves known to be located closer to the surface are more vulnerable than the deeper caves, this is not to say that the deeper caves are not at all vulnerable to surface activities or that shallower caves may not exist on the main Nullarbor Plain.

The Western Australian Rangeland Monitoring System (WARMS) process indicates that improvements have been made in the Southern Rangelands since the 1990s and observations by Watson (unpublished) suggest there have been improvements in vegetation cover and erosion since the 1960s or 1970s. However, Pringle and Tinley (Pringle et al., submitted to Landscape Ecology, 2003) have identified insidious degradation in many areas of the Southern Rangelands that they predict will be felt gradually over very long timescales unless interventions are applied. In addition, Landsberg et al. (1997) of the CSIRO Division of Wildlife and Ecology identify the following

potential changes to vegetation in response to grazing where artificial water points (from water bores) are provided for sheep or cattle:

1. development of a zone of extreme degradation around the water (up to 0.5 km) where soil crust is broken, erosion is high, and forbs dominate after rain;

2. increase in the number of unpalatable perennial shrubs beyond the sacrifice zone, particularly in semi-arid woodland and arid shrubland habitats; and

3. decrease in abundance of palatable native perennial grasses due to selective grazing.

This is not to say that any of these problems actually exist within the project area, only that they may be potential problems to that require observation and monitoring.

A6.2 Monitoring Procedures

At present, there are two procedures in place for the assessment or monitoring of pastoral impacts:

- firstly, the Pastoral Lands Board inspects pastoral leases on a one to six year cycle. This approach varies the inspection frequency on the categorisation of each property from "Low Concern" (assessed every six years) to "High Concern" (assessed every year). It is assumed that such impacts are reasonably under control at present, however, it would be possible for management activities to occur on a property without being observed by the PLB for a number of years;

- secondly, the Western Australian Rangeland Monitoring System (WARMS) monitors approximately 1600 ground based sites selected to represent the pastoral Range-lands as a whole as well as areas where livestock grazing occurs. These include shrubland sites in the Southern Rangelands. The chenopod shrublands of the region receive proportionately more monitoring sites due to their relative productivity and fragility.

A6.3 Rangelands NRM Strategy and Best Practice Guidelines

The entire Nullarbor Karst System is within the Southern Rangelands and Arid Interior NRM Sub-Regions, while the project area for this report is restricted to the Southern Rangelands Subregion.

Pastoralism is the industry that affects the largest geographic areas of the Western Australian Rangelands. Pastoralists are key stakeholders and the Pastoralists and Graziers Association (PGA) and Western Australian Farmers Federation (WAFF) are peak industry bodies. Land Conservation District Committees (LCDCs), local zone meetings of the PGA and Zone Control Authorities (ZCAs), Landcare Groups and representatives to sub-regional NRM Groups are important participants in the NRM process.

The Strategy for Managing the Natural Resources of Western Australia's Rangelands (Rangelands NRM Co-ordinating Group, 2005) addresses rangelands management challenges through the identification and setting of performance standards and guidelines in relation to:

- priority natural resource assets;
- resource condition targets (RCTs); and
- management action targets (MATs).

Among the 14 key issues addressed by the RCTs and MATs are: declining soil condition, declining native vegetation integrity, declining inland aquatic water quality, altered water regimes, declining water quality/supply, declining terrestrial native species and community integrity, and decreasing primary productivity.

Key RCTS include the improvement of soil surface condition (RCT3), the eradication or reduction of invasive and pest species (RCT4) and the maintenance or improvement in the density and cover of perennial vegetation (RCT5).

The MATs are grouped under five major categories:

- benchmarking and monitoring
- on-ground actions
- institutional frameworks, planning and policy;
- education, awareness and further engagement ("capacity building"); and
- cultural heritage.

An example "on-ground" MAT is for 70% of land managers to be implementing ecologically sustainable management practices by 2010. However, only 20% of properties are expected to implement best practice management soil conservation by 2010.

A6.4 Field Actions on Pastoral Lands in Co-operation with Leaseholders

The PBL and NRM processes are producing positive outcomes on pastoral lands of the project area. However, additional awareness-raising, training and assistance to pastoralists regarding the cave and karst values of the Nullarbor and best practice management techniques should be encouraged.

More specifically, on-ground management actions, including potential fencing and revegetation may need to be considered for the recently negotiated exclusions around cave entries and dolines (refer to *IMG 7*).

Another specific issue that may require further attention is that of fencing-off areas surrounding other dolines and cave entries in order to prevent excessive nutrients and weed seed from being transported into the dolines and cave entries via sheep manure in surface run-off. Any such fencing would need to be done in a way that it does not prohibit access to the dolines and caves by indigenous fauna.

Lastly, it may be important for the pastoralists to understand which parts of their pastoral leases are located directly above/close to underground cave passages or where significant dolines and blowholes occur that may require care for either biodiversity or safety reasons. CEGSA and other speleological and cave diving groups hold survey information regarding the location of many caves, however, additional surveys and surface mapping may be required.

By knowing where the surface boundaries of underground cave passages are located, Pastoralists could better ensure that the indigenous vegetation over these passages are protected from over grazing, fire or other activities that may harm or diminish the vegetation in those areas.

In some ways, these areas located over cave passages may be treated in much the same way as riparian vegetation zones. In addition, such mapping would also assist the Pastoralists to avoid placing water bores, excavations, or heavy construction equipment within the boundaries of cave passages reflected on the ground surface.

APPENDIX 7: Potential Mining Uses and Infrastructure Impacts on Caves

A7.1 Potential Impacts of Mining

A thorough search would be required to identify all the existing mining operations and exploration leases within the Nullarbor region. This would also require an on-going process to keep track of new leases and licenses. Mineral explorers are required by Western Australian legislation to report periodically on their programs. After a period of confidentiality, exploration reports and data are made publicly available, so that past exploration work is not unnecessarily repeated. These are referred to as open-file data.

WAMEX is a searchable database of open-file reports on exploration for minerals (excluding oil and gas), and is managed by the Statutory Exploration Information Group (SEIG). Access to WAMEX is free of charge. Full digital copies of most reports are online (http://www.doir.wa.gov.au/5136.aspx). Where a digital copy is not yet available, a microfiche copy of the report can be accessed at the Mineral House Library and at the Geological Survey's Kalgoorlie Regional Office.

The total value of mining in the Nullarbor Karst region does not appear to be available. The economic value of mining is potentially significant, although not yet developed or fully verified. The Goldfields-Esperance Region produces gold, uranium and heavy mineral sands such as zircon. Mineral extraction predominantly occurs on the fringes of the Nullarbor (Kalgoorlie Terrane, Yilgarn Craton).

In some other portions of the project area, potential diamond producing lands are under exploration and assessment. Paleo-channels within the Nullarbor Karst could be particularly attractive to mining explorations and future extractive activities. Other off-shore mineral exploration for petroleum and natural gas is underway and/or could potentially be expanded.

The potential impacts of mining on caves, blowholes and dolines include many of the same impacts noted for pastoral land uses. Some of the key impacts of mining could include:

- oil and gas drilling on groundwater aquifers (in terms of interruption of flow, as well as potential pollution and contamination);
- removal of karst materials through quarrying activities;
- stockpile or landfill leachates contaminating surface and groundwater flows;
- physical impacts of heavy machinery or vehicles – potential collapse of cave passage rooftops, potential damage to doline vegetation and surfaces, potential destruction of cave entry overhangs, etc.

Pastoralists concerns noted by Pringle et al. (1990) regarding mining and mining exploration activities have included:

- excessive clearing of grid lines;
- failure to cap drill holes or fill costeans;
- alluvial mining not followed by rehabilitation; use of hyper saline water in sluice mining operations;
- damage to fixed station infrastructure; use of station access roads during wet weather;
- increased interference with normal station management;
- poorly sited and constructed access ways for pipelines and powerlines.

The IUCN Management Guidelines for Karst and Cave Management (1996) and members of the Steering Committee have noted the vulnerability of karst formation, ecology and ground-water quality to the percolation of contaminated water or to changes in surface water flows that percolate into the groundwater aquifers.

Protection of groundwater is a particularly significant issue where mining (as well as pastoralism and other infrastructure construction) is concerned.

As the Nullarbor groundwater system extends much further inland within the Eucla
Basin than the Nullarbor Karst System itself, the dangers of groundwater contamination or pollution caused by mining in areas far removed from the project area are significant.

A7.2 Mining Guideline Documents

A number of guideline documents have been prepared in order to prevent or minimise adverse environmental effects of mining and mining exploration or to guide Environmental Impact Assessment, including:

- *Guidelines for Mineral Exploration / Rehabilitation Activities* http://www.doir.wa.gov.au/documents/environment/Exploration_Rehab_Activities.pdf
- *Guidelines for the Protection of Surface and Groundwater Resources During Exploration Drilling* (Dept. of Mineral and Petroleum Resources, 2002);
- *Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986): Consideration of Subterranean Fauna in Groundwater and Caves during the Environmental Impact Assessment in Western Australia.* No. 54 (Environmental Protection Agency, 2003);
- *Guidelines for Mineral Exploration and Mining within Conservation Reserves and other Environmentally Sensitive Lands in WA* http://www.doir.wa.gov.au/documents/minealsandspetroleum/ED_Min_GL_ExpMininginConervReservesEnvSenstiveLandsWA_jan07.pdf
- *Interim Code of Conduct for Mineral Exploration in Western Australia* (Association of Mining and Exploration Companies, undated);
- *Guidelines for Management of Dieback Disease in Mineral Exploration* http://www.doir.wa.gove.au/documents/mineralsandpetroleum/ED_Min_GL_MgmtDiebackDisease_Dec06.pdf ;
- *Goldfields Land and Sea Council Mining Policy* (2008).

A7.3 GLSC Mining Policy

The GLSC Mining Policy requires observance of several UN conventions by mining companies. The policy outlines a number of principles for mining-related decisions (primarily to do with the protection of Aboriginal rights), the cooperative decision-making involving GLSC with the Western Australian Government, the Federal Government and the proponent where possible. Operational principles are also suggested, including the making of any traditional knowledge available to the process. This policy is primarily focused on ensuring Aboriginal rights, and although mention is made of environmental issues, there is no direct reference to potential impacts on caves and associated karst features.

A7.4 Transport and Communications Infrastructure Impacts

The potential impacts generated by transport and communications infrastructure impacts are not much different than those noted for pastoral and mining activities. Protection of surface drainage, flora and fauna habitats, and groundwater resources are key concerns. In addition, the avoidance of placing heavy equipment or excavating over cave passages or too closely to dolines and blowholes is critical.

APPENDIX 8: Aboriginal Cultural Heritage, Recognition and Co-operation

All Indigenous cultural sites are protected by law, whether they are listed by the Department of Indigenous Affairs on the Aboriginal Heritage Register or not. In addition, it is important to acknowledge and uphold Aboriginal rights as per the United Nations Declaration on Rights of Indigenous Peoples (United Nations General Assembly, 2007).

The Goldfields Land and Sea Council have adopted this standard for application when governments and others want to deal with indigenous peoples of the Goldfields-Esperance region or undertake development projects on their lands. The Declaration promotes the concept of "free, prior and informed consent", which is also endorsed by the Australian Human Rights and Equal Opportunities Commission (HREOC).

GLSC also request that in planning and managing any areas that may have Aboriginal connections, the Aboriginal knowledge of the country and culture be acknowledged and that Aboriginal management and ownership rights also be acknowledged and acted upon as appropriate. Indigenous people's traditional use of the land for activities such as hunting, gathering native flowers, honey, etc. also needs to be facilitated as appropriate.

Watson, et al. (2008), in their recent report on the Great Western Woodlands, provides a number of statements regarding Aboriginal Traditional Owners relationship and environmental knowledge of the landscape. These statements equally apply to Aboriginal relationships and knowledge of the Nullarbor landscape:

"*Traditional Aboriginal land use relies on intricate ecological and geographic knowledge. Over thousands of years, an intimate cultural understanding of the landscape and biota grew as successive generations watched seasons change and developed a 'cultural map' of their homelands. This knowledge is encoded in laws, stories, song, language, art and ritual, and has been passed through countless generations of custodians…..Historians and scientists have not yet paid enough attention to a range of customary Indigenous practices that are likely to be critical in successfully maintaining the full diversity of natural values found in the region. The long-accumulated ecological knowledge that underpins these practices is an important touchstone in understanding country…..Exercising and adapting these traditional practices to contemporary conservation and land management requires a direct management role for Traditional Owners. From the perspective of conservation science, traditional Indigenous management can be a vital part of responding to the environmental challenges. Moreover, the utilization of the latest conservation science, as well as contemporary techniques for recording and transmitting knowledge, can be a vital adaptive strategy for Indigenous custodians. Together, we can help respond to new and emerging threats"* (Watson, et. al, 2008, p. 50.)

APPENDIX 9: Safety and Liability Issues

Potential liability issues directly related to the Nullarbor caves, blowholes and dolines could include the following items:

1. potential injuries or death to cave visitors under the following circumstances:
    a. while on a guided tour in a Conservation Reserve/Nat. Park;
    b. while on a guided tour off-reserve on Unallocated Crown Land or an Unmanaged Reserve;
    c. while on a guided tour off-reserve on a Pastoral Leasehold property;
    d. while visiting independently with a DEC or DPI permit (either on or off-reserve)
    e. while visiting independently without a DEC or DPI permit (either on or off-reserve;

2. potential injuries or death to DEC, WA Museum or other government staff or researchers while on official business (with or without permits);

3. potential injuries or death to university researchers:
    a. with permits and not on pastoral leasehold or freehold lands
    b. with permits and on pastoral leasehold or freehold lands
    c. without permits and not on pastoral leasehold or freehold lands
    d. without permits and on pastoral leasehold or freehold lands.

4. potential injuries or death to pastoral leaseholders, staff or guests as a result of cave passage collapse on the leasehold property:
    a. with moderate to high risk areas identified and mapped for them prior to event;
    b. without moderate to high risk areas identified and mapped for them prior to event;

Obviously the degree of liability and the party who is liable would depend on each situation and the exact circumstances.

These situations raise the question of what "Duty of Care" and safety requirements the managing government agency or a leaseholder or freehold landholder may have in relation to:

- preparation of adequate visitor and leaseholder risk management assessments;
- adequate on-site posting and broader dissemination of appropriate safety, hazard and regulatory information to the general public and to specific special interest groups who may potentially visit the caves or work in and around them;
- fencing-off or gating caves to prevent non-permitted access;
- requirements for visitor/researcher safety training certificates, licenses, and proper equipment for circumstances;
- provision of adequate hazard and safety information within lease and permit conditions;
- provision of adequate safety, search and rescue plans in the event of an accident;
- requirements for liability insurances by the appropriate government agency, the leaseholder or freehold landowner, the tour operator, the research organisations or the clubs involved.

DEC provides cave leadership training under its "Cave Leadership Course" for which potential caving leaders are assessed by the Cave Leader Assessment Panel (CLAP). This provides approved leaders with the capability of being issued permits with which they are allowed to take 10 to 15 caving participants into approved Tourist or Adventure Caves. The participants apparently are not required to have taken any cave leadership or safety courses. DEC also appears to require cave divers to hold certificates in relation to the Australian National Competencies for Caving and Diving before cave access permits are issued.

The Australian Speleological Federation (via the Western Australian Speleological Group's website – www.wasg.iinet.net.au/asf_safe.html) provides relatively extensive Cave Safety Guidelines on its website, however, does not offer any training courses. Reference is made to the need for cave divers to be certified by the Cave Divers Association of Australia (CDAA). CDAA provides the following training courses:

- Penetration Diver Course;
- Cave Diver Course; and
- Deep Cavern Diver Course.

CDAA also recognise other certification and experience programs for their members. They also provide safety guidelines via the ASF, including "ASF Cave Diving – Code of Practice" (1988) and "ASF Free Diving – Code of Practice". These codes of practice, along with the ASFs Code of Ethics and Conservation 1992 and Minimal Impact Caving Code 1995 are referred to and form part of DECs own Caving Code of Practice (refer to box on page 46).

An article in *Quest* (Vol. 8, 2007) by Tania Yarra outlines some of the practical consideration regarding dives at Cocklebiddy and other caves of the Nullarbor.

APPENDIX 10 Enhanced Management Frameworks

The highly dispersed nature of the caves and associated karst features of the project area, combined with the various land tenures and management vestings involved are an indication that at a preliminary level, it may be useful for the Nullarbor Cave and Karst Management Advisory Committee to be formed with broader representation or to investigate the appropriateness of forming some other regional management body that will provide for more of the key stakeholders and vested management authorities to be involved in joint decision-making and co-management regarding future land use and conservation management in the region, particularly regarding caves, blowholes and dolines.

Following on from the 2002 Biodiversity Audit recommendations and those of Subterranean Ecology (2007) and previously by Davey et al. (1992), continuing examination of how caves and karst features might best be protected and conserved should be carried out over the next five years. Whether these resources are managed within a CAR Reserve System, the Conservation Estate or in other protective management agreements with Pastoral Leaseholders and Freehold land owners of the Nullarbor, it will be important to assess and prioritise the caves, blowholes and dolines for inclusion under various land tenure and management framework categories.

Along with this, consideration may also be given to the various levels or forms of protected area management, given the high significance and vulnerability of the Nullarbor karst. While assuming the retention of the current land tenure arrangements, these framework categories could possibly include:

- a regional management authority;
- a UNESCO Man and the Biosphere Programme "Biosphere Reserve";
- a World Conservation Union (IUCN) "Indigenous Protected Area";
- a UNESCO "Geopark" (Global Geoparks Network); or
- a UNESCO (World Heritage Commission) World Heritage Site.

All of these categories for protected areas could be established while maintaining and including the existing Pastoral leaseholds on the Nullarbor. However, within the IUCN Protected Area Management Categories, only Category VI - Managed Resource Protected Area, would seem to allow for pastoral uses. This category is also used, but not generally funded, under Australia's National Reserve System Program.

Further Websites and Links on Potential Protected Area Alternatives:

- Australia's National Reserve System (NRS) Program
  http://www.unep-wcmc.org/protected_areas/index.html
- UNESCO "Biosphere Reserves"
  http://www.unesco.org/mab/BRs.shtml
  http://www.environment.gov.au/parks/biosphere/index.html
  Video on Biosphere Reserves
- IUCN "Indigenous Protected Area" or "Indigenous Conservation Territory"
  http://www.environment.gov.au/indigenous/ipa/index.html
  http://cms.iucn.org/what/issues/issues/index.cfm?uNewsID=11
- UNESCO "Geopark"
  http://www.unesco.org/science/earth/geoparks.shtml
- UNESCO (World Heritage Commission) World Heritage Sites
  Australian National Commission for UNESCO
  UNESCO World Heritage
- IUCN, WCPA and Australia's NRS Protected Area Management Categories
  http://www.environment.gov.au/parks/iucn.html
  IUCN (World Conservation Union)
  http://www.unep-wcmc.org/protected_areas/index.html
  http://cms.iucn.org/about/union/commissions/wcpa/wcpa_overview/index.cfm

End Appendices and Report