

# 10 Biological environment—impacts and management

This chapter assesses the potential impacts that the proposed development may have on the biological environment of the Project Area, and the proposed mitigation of any impacts through environmental management and conservation of biodiversity within the Victoria–Bonaparte Biogeographic Region. Potential impacts and their management are considered in light of the current Western Australian, Northern Territory and Commonwealth conservation legislation and policies.

## 10.1 LEGISLATION AND POLICY FRAMEWORK FOR ENVIRONMENTAL MANAGEMENT

This section details the policy framework used to review the environmental impacts of, and proposed conservation management actions for, the Project. The legislation relevant to conservation management is identified in Table 10.1.

**Table 10.1 Conservation management legislation**

Western Australia	Northern Territory	Commonwealth
<i>Conservation and Land Management Act 1984</i>	<i>Environmental Assessment Act 1994</i>	<i>Environment Protection (Impact of Proposals) Act 1974</i>
<i>Environmental Protection Act 1986</i>	<i>Heritage Conservation Act 1996</i>	<i>National Parks and Wildlife Conservation Act 1975</i>
<i>Wildlife Conservation Act 1950</i>	<i>Parks and Wildlife Commission Act 1995</i>	<i>National Environment Protection Council Act 1994</i>
	<i>Territory Parks &amp; Wildlife Conservation Act 1996</i>	<i>National Environment Protection Measures (Implementation) Act 1998</i>
		<i>Environment Protection and Biodiversity Conservation Act 1999</i>
		<i>Endangered Species Protection Act 1992</i>
		<i>Fisheries Resources Management Act 1994</i>

There are a number of national strategies that relate to environmental management. Those of most relevance to the proposed development are described in Section 10.1.1. In addition, the EPA Assessment guidelines specify biodiversity parameters to be addressed in relation to the proposed development (Appendix A), and those parameters are reproduced in Section 10.1.2. Processes that are currently threatening biodiversity in Australia are described in Section 10.1.3.

Wesfarmers–Marubeni and the Water Corporation are committed to effective management of environmental issues associated with the Project, consistent with the principles of sustainable development as outlined in the national strategies.

### **10.1.1 National strategies for environmental management and their implications for the Project**

#### **The National Strategy for Ecologically Sustainable Development**

The National Strategy for Ecologically Sustainable Development (ESD) was endorsed by the Council of Australian Governments in December 1992. The principal objectives of ESD are to:

- enhance individual and community wellbeing and welfare by following a path of economic development that safeguards the welfare of future generations;
- provide for equity within and among generations;
- conserve biological diversity and maintain essential ecological processes and life-support systems.

These principles, which are being incorporated in various Government and private sector programmes, are the foundation for improved environmental management. They also address issues such as environmental liability and due diligence.

Environmental due diligence requires the application of best-practice environmental management, and includes the preparation, implementation and monitoring of a variety of documented controls, such as Environmental Management Plans (EMPs).

Environmental Management of the Project Area would be based on ESD principles. An EMP would be prepared for the Project, incorporating all the commitments made in this ERMP/draft EIS as well as any Ministerial Conditions. The EMP would also include elements of environmental management systems that have been specifically designed to improve environmental performance and achieve ESD. This would involve implementation of an environmental management system consistent with the principles of the International Standards Organisation ISO 14000 series.

#### **The National Strategy for Conservation of Biological Diversity**

Conservation of biodiversity is one of the three principal elements of ESD. The International Convention on Biological Diversity, adopted by Australia in June 1993, provides a global mechanism for the conservation of biodiversity for the benefit of present and future generations. Within Australia, the National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996) aims to bridge the gap between current activities and the effective identification, conservation and management of Australia's indigenous biological diversity.

The National Strategy for the Conservation of Australia's Biological Diversity (NSCABD) considers biological diversity at three levels: genetic diversity, species diversity and ecosystem diversity. The strategy contains six target areas:

- conservation of biological diversity across Australia
- integration of biological diversity, conservation and natural resources management

- management of threatening processes
- improvement of the knowledge and understanding of biodiversity
- involvement of the community
- Australia's international role regarding the conservation of biodiversity.

NSCABD notes the following key principles:

- Biological diversity is best conserved *in situ*.
- Although all levels of Government have clear responsibility, the cooperation of conservation groups, resource users, indigenous peoples, and the community in general is critical to the conservation of biological diversity.
- It is vital to anticipate, prevent, and attack at source the causes of significant reduction or loss of biological diversity.
- Processes for, and decisions about, the allocation and use of Australia's resources should be efficient, equitable and transparent.
- Lack of full knowledge should not be an excuse for postponing action to conserve biological diversity.
- The conservation of Australia's biological diversity is affected by international activities and requires actions extending beyond Australia's national jurisdiction.
- Australians operating beyond national jurisdiction should respect the principles of conservation and ecologically sustainable use of biological diversity, and act in accordance with any relevant national or international laws.
- Central to the conservation of Australia's biological diversity is the establishment of a comprehensive, representative and adequate system of ecologically viable protected areas integrated with the sympathetic management of all other areas, including agricultural and other resource production systems.
- The close, traditional association of Australia's indigenous peoples with components of biological diversity should be recognised, as should the desirability of sharing equitably benefits arising from the innovative use of traditional knowledge of biological diversity.

### **National Wilderness Inventory**

The Commonwealth Government initiated the National Wilderness Inventory in 1986. The World Heritage Branch of Environment Australia administers the National Wilderness Inventory, and it defines wilderness as:

*'...land that, together with its plant and animal communities, is in a state that has not been substantially modified, and is remote from, the influences of European settlement or is capable of being restored to such a state, is of sufficient size to make its maintenance in such a state feasible, and is capable of providing opportunities for solitude and self-reliant recreation.'*

Four criteria are used to estimate the quality of wilderness. These are:

- remoteness from settlement;
- remoteness from access;

- apparent naturalness (lack of permanent structures);
- biophysical naturalness (degree of biophysical disturbance such as grazing, logging, and mining).

The above criteria are used to define Wilderness Quality ratings. The Wilderness Quality rating for the Project Area, and the impact of development, are discussed in Section 10.4.9.

### **10.1.2 Requirements of the EPA**

The guidelines for this ERMP/draft EIS (Appendix A) were developed by the EPA and DLPE following the assessment of comments from the public on a set of draft guidelines. In the guidelines, the EPA has stated that its consideration of the Project's impact on biological diversity is to focus on the principles, and the related objectives and actions, of the NSCABD. It follows that the EPA's consideration of biological diversity would include:

- comparing a number of development scenarios to evaluate protection of biodiversity at the species and ecosystem levels;
- ensuring that no known species of plant or animal would become extinct as a consequence of the development and that any risk posed to threatened species is considered acceptable;
- ensuring that no association or community of indigenous plants ceases to exist as a result of the proposed development;
- ensuring there is comprehensive, adequate and secure representation of scarce or endangered habitats within the Project Area and/or in areas that are biologically comparable to the Project Area within Western Australia and the Northern Territory, protected in secure reserves;
- ensuring that the Project Area includes a comprehensive and adequate network of conservation areas and linking corridors whose integrity and biodiversity are secure and protected;
- identifying the on-site and off-site impacts of the proposed development and verifying that the co-proponents could manage those impacts.

Because of the size of the Project, the EPA considers that the co-proponents alone may not be able to protect biological diversity. The EPA has indicated that participation of the Western Australia and Northern Territory Governments in regional land use initiatives may be necessary to address biodiversity issues, and that further conservation reserves may be required outside the Project Area and, presumably, within the Victoria–Bonaparte Biogeographic Region. This issue is discussed further in Section 10.2.2.

### **10.1.3 Native title implications**

In 1998, the Federal Court determined that Miriuwung and Gajerrong people have certain native title rights over a portion of the Project Area (Chapter 12 refers). Furthermore, native title claims exist over the remainder of the Project Area, and over much of the land surrounding the Project Area.

The native title determination includes the right to possess, occupy, use and enjoy the land and resources subject to the determination area.

Wesfarmers–Marubeni and the Water Corporation have recognised the need to involve Miriuwung and Gajerrong people in the consideration of biodiversity issues in relation to the proposed development. Some resources, including the vegetation that would need to be cleared to enable the development of the farmland, would be adversely affected by the proposed development. Such impact is unavoidable. Any loss of, or impairment to, the use of flora or fauna and other resources by Miriuwung and Gajerrong people would be addressed in an Indigenous Land Use Agreement (ILUA) to be negotiated between the Co-proponents and the Miriuwung Gajerrong people (Chapter 12 refers). The potential involvement of Miriuwung and Gajerrong people in the management of the biodiversity resource in the conservation areas within and abutting the Project Area is discussed in Section 10.5.1.

#### 10.1.4 Management of biodiversity in the Australian context

Effective management of natural systems for the conservation of biodiversity requires an understanding of the systems being managed and processes likely to impact those systems. An understanding of the biological environment of the Project Area has been gained through biological surveys (see Chapters 7 to 9). Issues relevant to the *Endangered Species Protection Act 1992* include:

- a marked decrease in geographic distribution of species. This could be a decrease in the total area of the community without a species range contraction, a decrease in a species range within a given area, or fragmentation of the species range;
- a marked alteration of community structure. This includes the identity and number of species making up an ecological community, abundance of those species and the number, type and strength of processes operating within the community;
- a loss or decline of native species that are believed to play a major role in the community. This refers to important structural components of a community or those species that are important in the processes of a community;
- restricted geographic distribution such that the community could be lost within ten years by the action of a threatening process. This is determined at a national level and is dependent on particular species communities;
- community processes being altered to the extent that a marked alteration of community structure will occur. Ecological processes are important to maintain an ecological community (e.g. fire regimes, flooding, cyclone damage) and disruption to these processes can lead to significant alteration of an ecological community.

Threatening processes, as identified in NSCABD, are listed below. Also listed are brief references to the processes relevant to the proposed development. The processes include:

- *land clearing*—Clearance of native vegetation is an inevitable consequence of the proposed development. Land clearing would be minimised, but consistent with the objective of establishment of an economically viable industry. Representative samples of ecologically viable vegetation associations would be conserved *in situ*;
- *land degradation*—Degradation usually occurs as a consequence of inappropriate agricultural activities, and may include overstocking, rising groundwater levels and salinisation. The proposed groundwater management strategy is described in Chapter 6;

- *inappropriate fire regimes*—Formalised fire management practices do not currently occur in the Project Area. Such practices would be introduced as part of the EMP;
- *spread of alien species*—This may include the spread of exotic (introduced) species and native species outside of their normal range. Monitoring and management of weeds would be an element of the EMP;
- *global climate change*—It is not envisaged that global climate change would affect land use in the Project Area in the short or long term. The potential contribution made by the proposed development to national commitments made under the Kyoto Protocol are discussed in Chapter 13.

## 10.2 EXISTING AND PROPOSED RESERVES IN THE VICTORIA- BONAPARTE BIOGEOGRAPHIC REGION

Three classes of conservation reserves are recognised in Western Australia under the *Land Act 1984* in addition to National Parks. National Parks offer the highest level of environmental protection, while Class A reserves offer the highest level of environmental protection under *the Land Act 1984*, and parliamentary consent is necessary to downgrade this form of land classification. For land designated Class B or Class C, the Minister for Lands is able to unilaterally make changes to the designated purpose; however, in the case of Class B land, Parliament must be advised of the change within two weeks.

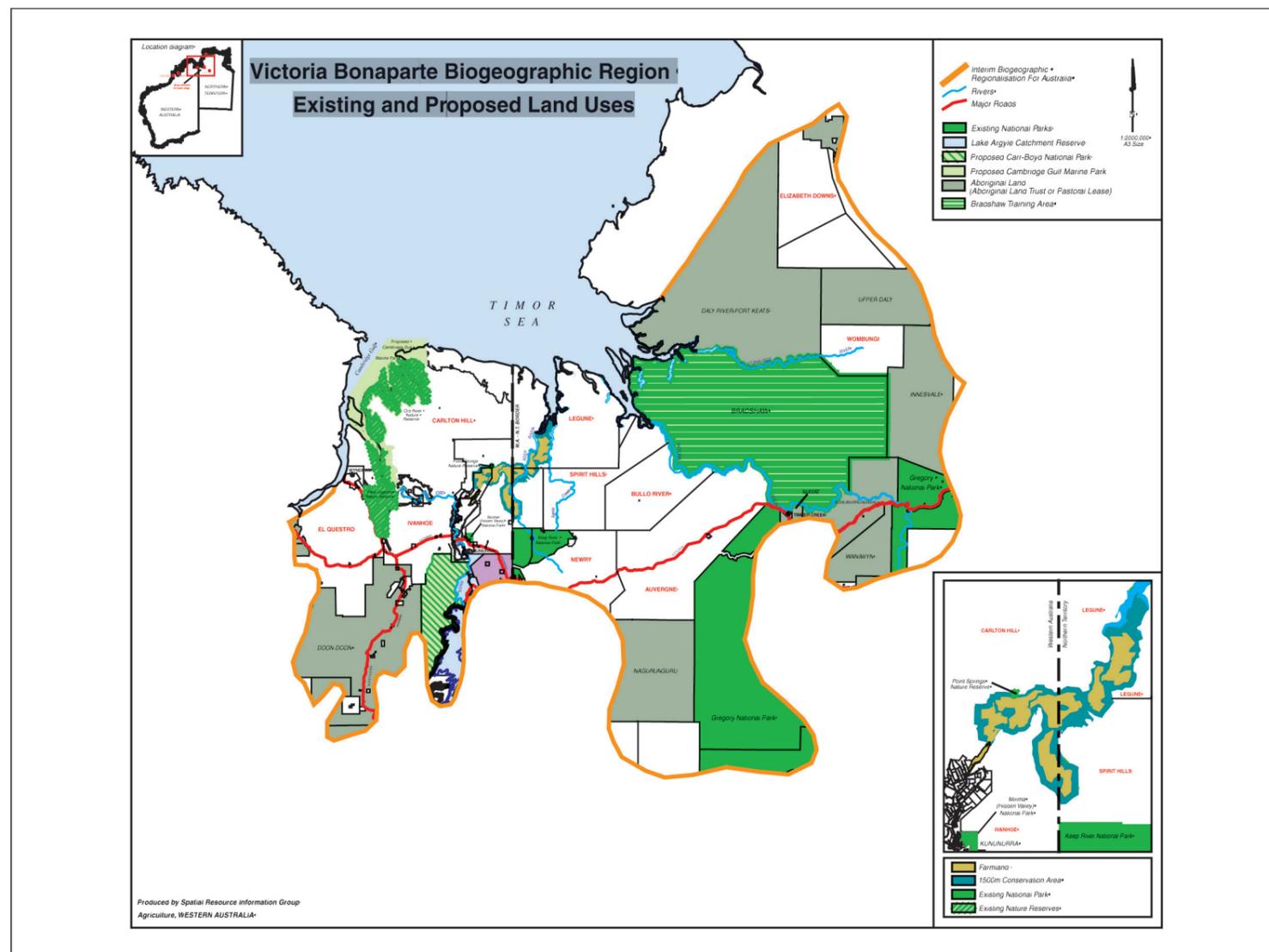
Northern Territory parks and reserves are declared as parks under Section 12 of the *Territory Parks & Wildlife Conservation Act 1996*. The Parks and Wildlife Commission of the Northern Territory classifies the parks according to purpose and function, namely, national parks, nature parks, conservation reserves, historical reserves and marine parks.

### 10.2.1 Current reserve system

The Victoria–Bonaparte Biogeographic Region has a total area of 72,970 km<sup>2</sup>, with approximately 73% of this area in the Northern Territory and 27% in Western Australia. Within the Victoria–Bonaparte Biogeographic Region, the area in conservation reserves in the Northern Territory is 6,846 km<sup>2</sup> or approximately 13%; in Western Australia, the area in conservation reserves is also approximately 13% (2,443 km<sup>2</sup>).

Connors et al. (1996) reviewed each biogeographic region within the Northern Territory including the indigenous vegetation types, plants and animals restricted to each biogeographic region, and also introduced plants and feral animals. This level of information is not available for Western Australia and, therefore, only information about that part of the Victoria–Bonaparte Biogeographic Region in the Northern Territory is provided in Table 10.2.

A summary of the existing conservation reserves within the Victoria–Bonaparte Biogeographic Region in Western Australia and the Northern Territory is presented in Table 10.3. The locations of the reserves are shown in Figure 10.1.



**Figure 10.1** Victoria–Bonaparte Biogeographic Region - existing and proposed land uses

**Table 10.2 Vegetation types in the Northern Territory portion of the Victoria–Bonaparte Biogeographic Region and their representation within reserves**

Vegetation type	Area (km <sup>2</sup> )	Area in reserves (km <sup>2</sup> )	Proportion in reserves (%)
Closed forest	49	0	0
Eucalypt forest and woodland with tussock grass understorey	17,765	1,729	10
Eucalypt low woodland with tussock grass understorey	2,381	6	0
Eucalypt woodland with hummock grass understorey	23,176	4,947	21
Mixed species low open woodland	387	150	39
Melaleuca forest/woodland	4,117	1	0
Floodplain	47	0	0
Hummock grassland	29	0	0
Tussock grassland	2,442	13	0
Littoral complex	2,845	0	0
<b>Total</b>	<b>53,238</b>	<b>6,846</b>	<b>13*</b>

Source: Connors et al. (1996)

\* Proportion of the total area of the Victoria–Bonaparte Biogeographical Region in reserves.

Lake Argyle and Lake Kununurra were formed as a result of the ORIA development and are listed under the Ramsar Convention as valuable habitat for aquatic birds, including migratory birds. The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are presently 116 Contracting Parties to the Convention, with 1005 wetland sites, totalling 71.3 million ha, designated for inclusion in the Ramsar List of Wetlands of International Importance.

The dominant species which make up the fringing grasslands of Lake Argyle and Lake Kununurra are *Eriachne sulcata*, *Echinochloa kimberleyensis* and *Oryza australiensis*, and a large number of ephemeral herbs (Burbidge et al. 1991). *Echinochloa kimberleyensis*, a Priority 1 species endemic to the Ord River area, was also recorded from the Project Area.

The cracking-clay black-soil plains within the Project Area would be the predominant soil type subjected to development. Within the current reserve system, in Western Australian and the Northern Territory, there are limited areas of cracking-clay black-soil plain. Table 10.4 lists the major features and soils for each of the reserves within the Victoria–Bonaparte Biogeographic Region.

**Table 10.3 Existing conservation reserves and wetlands included on the Ramsar List of Wetlands of International Importance within the Victoria- Bonaparte Biogeographic Region and adjoining areas**

Name of reserve	Area	Class; vesting	Comments
<b>Western Australia</b>			
Mirima National Park	2,068 ha	National Park; National Parks and Conservation Authority	Alongside Kununurra township. Striking scenery. Formerly named Hidden Valley National Park.
Ord River Nature Reserve*	79,842 ha	Class C; National Parks and Conservation Authority	Tidal portion of the Ord River, 25 km north-east of Wyndham, and includes the false mouths of the Ord River. Important bird, crocodile and mangrove habitat. Some boundaries classified as 40 m above high-water mark and some areas require fencing to control cattle access.
Parry Lagoons Nature Reserve*	36,111 ha	Class C; National Parks and Conservation Authority	25 km south-east of Wyndham. An easily accessible recreation site with outstanding birdlife.
Point Spring Nature Reserve	303 ha	Class A; National Parks and Conservation Authority	40 km north-east of Kununurra. A permanent wetland with remnant rainforest.
Eastern shore of Lake Argyle and Lake Kununurra	149,140 ha	Ramsar-listed wetland; National Parks and Conservation Authority	Spectacular scenery and wetlands.
Packsaddle Swamps	860 ha	Ramsar listed wetland; National Parks and Conservation Authority	5 km west of Kununurra. Spectacular scenery, wetlands and wildlife.
<b>Northern Territory</b>			
Keep River National Park	> 67,481 ha	Conservation of natural and cultural heritage; PWCNT	East of Kununurra and south of the Project Area. A significant planned expansion is to include Spirit Hills Station pastoral lease.
Gregory National Park	>1,278,304 ha	Conservation of natural and cultural heritage; PWCNT	Approximately 50% is within the Victoria-Bonaparte Biogeographic Region. Primarily rocky upland country, with minor areas of cracking-clay soils. Extensions are under consideration, and a draft management plan is being prepared.

\* Now combined into the Lower Ord Ramsar Site (Department of Conservation and Land Management 1998).

Notes: National Parks and Nature Conservation Authority Information was supplied by the CALM Information Management Branch. The Ord River Nature Reserve, Parry Lagoons Nature Reserve, Proposed Parry Lagoons National Park and Proposed Cambridge Gulf Marine Park are now included in the Lower Ord Ramsar Site.

Information on the Keep River National Park and Gregory National Park was supplied by the Parks and Wildlife Commission of the Northern Territory (PWCNT).

Information on Lake Argyle, Lake Kununurra and Packsaddle Swamps is from Department of Conservation and Land Management (1990).

**Table 10.4 Environmental features of Conservation Reserves and Ramsar Convention listed wetlands within the Victoria–Bonaparte Biogeographic Region**

Name of site or area	Environmental features	Soils present
<b>Western Australia</b>		
Mirima National Park	Sandstone hills, Ord River sandplains.	Alluvial red and yellow sandplains of the Ord River.
Ord River Nature Reserve	Coastal and estuarine deltaic plains, incised deltaic creeks, deep sandy soils and mudflats.	Coastal silt, minor limestone, conglomerates; black soils and alluvium.
Parry Lagoons Nature Reserve	Wetlands; water table at or near surface in dry season, flooded during wet season.	Extensive areas of black soil.
Point Spring Nature Reserve	Permanent spring; rainforest.	Sandstone and black soil.
Lake Argyle and Carr Boyd Ranges*	Flood plains, deep alluvial drainage valleys of river system.	Black soil with heavy texture, red and yellow earths with coarse texture, small areas of basalt, granite and dolerite.
Packsaddle Swamps	Inundated and exposed fluvial plains.	Black and red soils.
<b>Northern Territory</b>		
Keep River National Park	Dissected plateau, alluvial plains and river systems, and fluvial plains.	Sandstone tablelands, red and yellow earths and black soil.
Gregory National Park	Wetlands, alluvial plains and river systems, limestone hills, sandstone escarpments, climatic transition between tropical and semi-arid regions.	Sandstone and limestone hills, ferricrete, black soils.

\* The Carr Boyd Ranges are proposed under System 7 for national park status.

The Keep River National Park is the only reserve in the Victoria–Bonaparte Biogeographic Region with black-soil plains of the Ivanhoe Land System. However, there are black-soil plains outside the Victoria–Bonaparte Biographic Region to the west and the north of the Bungle Bungle massif in Purnululu National Park. These plains support significant areas of grasslands dominated by *Astrelba* species (Mitchell grasses). *Astrelba squarrosa* grassland was one of the vegetation associations in the Project Area recommended for conservation by Ecologia (1997).

### 10.2.2 Proposed reserve system

As signatories to the National Strategy for the Conservation of Australia’s Biological Diversity (Section 10.1.1), the Western Australian, Northern Territory and Commonwealth Governments are committed to the establishment of a comprehensive and representative system of ecologically viable protected areas. Following development, the Project Area would include undeveloped areas that would be managed for conservation. These conservation areas would not be formal conservation reserves; however, they would still provide an important contribution to the conservation estate.

The Governments of Western Australia and the Northern Territory continually review their systems of conservation reserves. As a consequence of these reviews, a number of proposals for the expansion of the conservation reserve system within the Victoria–Bonaparte Biogeographic Region are under consideration. The proposed development would provide significant opportunities for the State and Territory Governments to increase conservation

areas, particularly as these initiatives could be completed in parallel with the excisement of the Project Area from existing pastoral leases.

### **Western Australia**

The Parry Lagoons Nature Reserve is a Class C reserve for the conservation of flora and fauna. A proposal exists for an expansion of this conservation reserve by approximately 3,400 ha, and a reclassification of the reserve to National Park status.

A National Park is also proposed for Lake Argyle and the Carr Boyd Ranges (Item 7.10 of the red book for conservation, and System 7 and Item 3.3 of the CALM publication 'Nature Conservation Reserves in the Kimberley'). This crown land, and Lake Argyle, is listed as a Ramsar wetland of international importance. The area of the proposed national park is 125,000 ha.

### **Northern Territory**

The Northern Territory Government is considering a significant conservation initiative immediately adjacent to the Project Area. The initiative is the proposed extension of the Keep River National Park. The proposed extension of the Keep River National Park would result in an expansion of the conserved area in the Victoria–Bonaparte Biogeographic Region of approximately 220,000 ha.

## **10.3 CONSERVATION WITHIN THE PROJECT AREA**

### **10.3.1 The need for conservation areas within the Project Area**

The Project Area is predominantly located on black-soil plains (cracking clays) of the Ivanhoe Land System. Although there is some representation of this land system in other parts of Western Australia and the Northern Territory, these other areas:

- are generally poorly represented in conservation reserves;
- are predominantly subjected to pastoral activities and are consequently degraded;
- have different topography to that in the Project Area;
- are separated geographically from the Project Area and are therefore likely to differ biologically due to broad-scale climatic and geological differences.

As discussed in Section 10.2.2, the Northern Territory Government is considering a significant extension of the Keep River National Park, which would encompass most of the Spirit Hills Station pastoral lease (Parks and Wildlife Commission of the Northern Territory 1998b). If successful, this would extend the Keep River National Park up to the western side of the mouth of the Victoria River.

The Bradshaw Field Training Area north of Timber Creek in the Northern Territory has eleven land systems, including the Ivanhoe Land System (Connell Wagner 1997). The cracking-clay soils of this area consist of 'deep to very deep grey and brown cracking clays on the floodplains and drainage depressions', and 'grey and brown cracking clays along the Angalarri River and meander plain'. These soils support a low open woodland or grassland, similar to sections of the Project Area. However, the Bradshaw Field Training Area does not include the cracking clays of the Cununurra normal phase, which characterise the soils

proposed for development within the Project Area. Furthermore, the areas of the Ivanhoe Land System within the Bradshaw Field Training Area would be primarily utilised as fire and manoeuvre areas for armoured vehicles, and only small pockets would remain undisturbed.

Since the Project Area has a wider range of flora and fauna of conservation significance (see Sections 7.3 and 8.5) than other areas of the Ivanhoe Land System currently conserved, it is considered appropriate that conservation of certain habitats is planned within the Project Area.

### **10.3.2 Conservation strategy for the Project Area**

The key environmental and conservation management objective in relation to the proposed development is the management of a world-class broad-scale agricultural development, with integral conservation areas, in accordance with Australia's ESD and biodiversity policies. The conservation management would involve many issues, such as indigenous habitats and species, traditional land uses, community involvement, water and land pollution, construction and operational activities, and pest species.

The objectives of the conservation management would be to:

- minimise environmental disturbance consistent with development requirements;
- maintain and not degrade the biological integrity and diversity in the Project Area and adjacent regions/areas;
- manage areas to the satisfaction of the community and Governments.

The priorities for environmental management of the Project Area are to:

- protect scheduled and other significant species, including those protected under international agreements;
- preserve site or habitat-specific areas;
- sustain biological diversity in terms of species richness criteria;
- conserve genetic resources;
- control erosion.

These priorities have been considered in the context of representation of scheduled species and suitable habitats in conservation reserves in the East Kimberley and the adjacent Northern Territory.

In designing a conservation strategy for the Project Area, an assessment was made of the best spatial arrangement that would efficiently represent the conservation values within the Project Area and satisfy the conservation and environmental management objectives. The conservation system proposed for the Project Area is outlined in Figure 10.2.

A key element of the conservation strategy is the retention of representative associations and habitats of the Project Area within distinct conservation areas. It is envisaged that native title rights would prevail over all conservation areas within the Project Area. The following sections provide a brief description of the rationale underlying selection of the conservation areas.

Conservation areas were selected using the following criteria:

- representation of soil types
- representation of vegetation units and fauna habitats
- presence of rare and endangered and vulnerable flora and fauna
- area of Aboriginal significance.

#### **Northern sector of the Weaber Plain (Conservation Weaber North, CWN)**

Area CWN would include levee banks together with additional land that has been incorporated into the project design to insulate Point Spring Nature Reserve (a place of cultural significance to Miriuwung and Gajerrong people) from the anticipated higher flood water levels and flow velocities in Border Creek. It also includes the lower slopes of the Weaber Range, and would provide protection for fauna and flora in this locality.

Wild rice (*Oryza australiensis*), *Echinochloa kimberleyensis*, *Fimbristylis phaeoleuca*, *Goodenia malvina* and *Enteropogon minutus* would all be conserved in this area.

Soil Units conserved are 2c, 4c, 4d, 5a, 5b, 5c, 8a, and 8b

#### **Western sector of the Weaber Plain (CWW)**

The dolomite outcrop that would be contained in Area CWW is an upland area that supports substrate-specific fauna, including reptiles (e.g. *Varanus acanthurus* and *Gehyra nana*) and mammals such as rock rat (*Zygomys argurus*).

The two ephemeral billabongs adjacent to the dolomite outcrop (Figure 9.1) and created by irrigation water discharges from ORIA Stage 1 are waterbird and wader habitat, while the fringing vegetation supports additional bird species. The scheduled species radjah shelduck (*Tadorna radjah*) inhabits wetlands in this area.

Area CWW would also include Folly Rock (a place of cultural significance to Miriuwung and Gajerrong people) and an area around its periphery, including corridors linking Folly Rock to the north and south extremities of farmland on the Weaber Plain. Folly Rock supports upland site-specific flora and fauna, including *Brachyachne tenella*.

Soil Units conserved are 1, 2c, 4a, 4b, 4c, 4d, 5a, 5at, 5b, 5c, 6d, 8, 8a, 9a, 9b, 9c, and the Cockatoo Land System.

#### **Eastern and Southern sector of the Weaber Plain (CWE)**

Area CWE would include a seasonally inundated depression, including several small rock outcrops and an area of grassland and variable soils. The area would also include a large area of degraded Cockatoo Land System and a corridor to link that rock outcrop (a place of cultural significance to Miriuwung and Gajerrong people) with riparian vegetation of the Keep River.

The grassland areas that would be included in Area CWE also support black-soil endemics and the Western Australia threatened species yellow-rumped mannikin (*Lonchura flaviprymna*). Peripheral zones would include Soil Unit 8a and habitat likely to be important for burrowing species. It may also support the Northern Territory threatened species, the zitting cisticola (*Cisticola juncidis*).

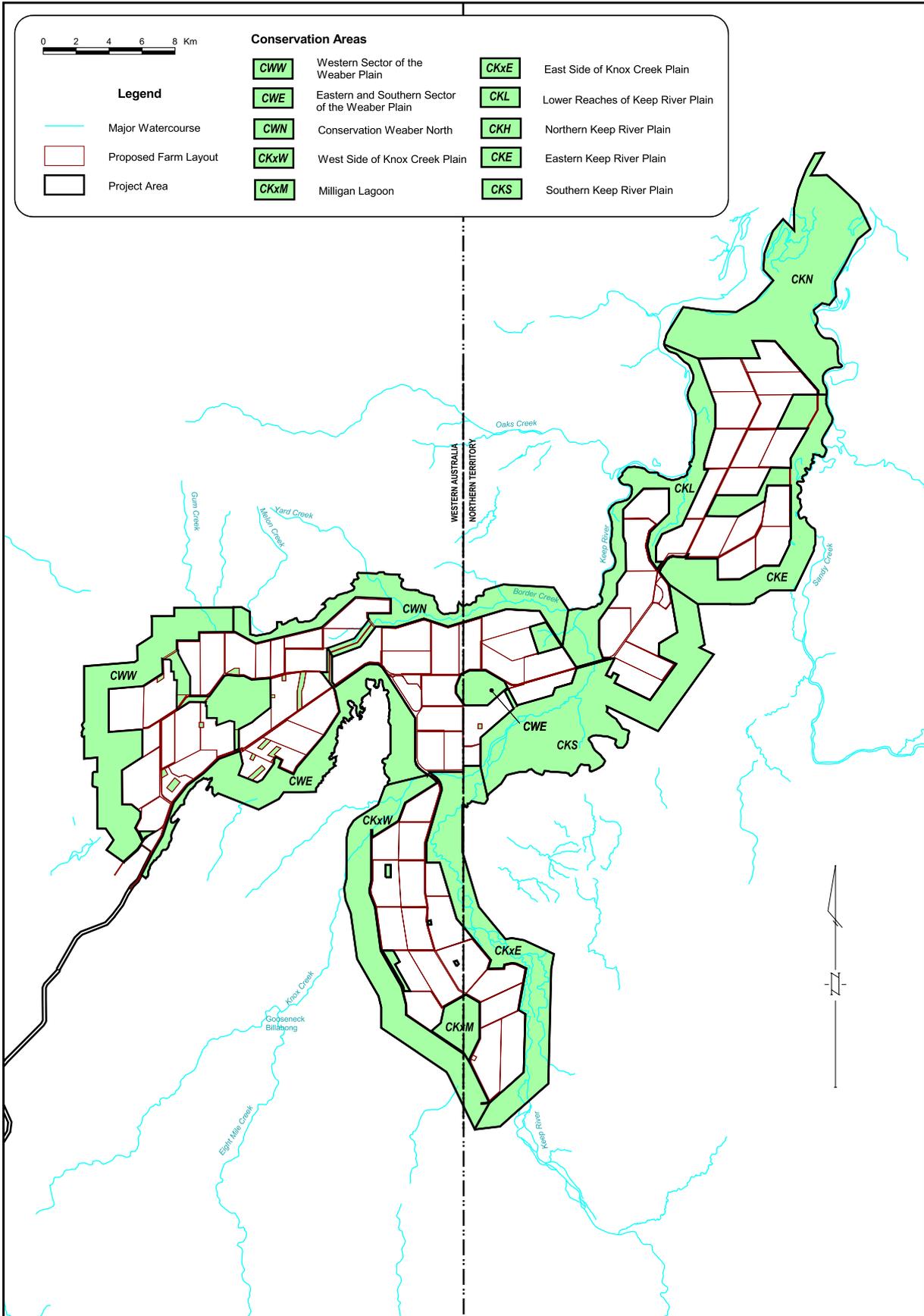


Figure 10.2 Conservation areas in the Project Area

Area CWE would include stands of wild rice (*Oryza australiensis*), which is a species restricted to the black-soil plains. The stands at this area are of exceptional size for Western Australia and, possibly, for the Northern Territory. Fantail grass (*Chrysopogon fallax*) occurs in association with *Oryza australiensis* in this area. *Echinochloa kimberleyensis*, a Priority 1 species in Western Australia, although sporadic in its distribution, also occurs in association with *Oryza australiensis* and *Chrysopogon fallax*.

This conservation area would include *Typhonium liliifolium* (3r flora species, Northern Territory) and *Lindernia tectanthera* (3r flora species, Northern Territory).

Soil Units conserved are 4a, 4c, 5a, 5b, 5bt, 5c, 6, 6a, 7b, 8a, and 8b.

#### **Lower reaches of the Keep River (CKL)**

Area CKL would include the dense riparian vegetation of the lower reaches of the Keep River, which is an important habitat for waterbirds and the threatened species white-browed robin (*Poecilodryas superciliosa cerviniventris*) and Gouldian finch (*Erythrura gouldiae*). The riparian vegetation in this area also supports a high diversity of reptiles, frogs and mammals, and is a habitat for freshwater crocodiles (*Crocodylus johnstoni*).

Purple-crowned fairy-wren (*Malurus coronatus coronatus*) (Schedule 1, Western Australia; Schedule 7, Northern Territory) has been found to occur in canegrass (*Sorghum* sp.) (Parks and Wildlife Commission of the Northern Territory 1998), a dominant grass species of Soil Unit 1, which is in this conservation area.

Area CKL is also considered to be an important feeding habitat for bats, with the dense vegetation providing protection. A number of plants would also be conserved here, including *Vittadinia spechti* var. *kimberleyensis*, *Hygrophila angustifolia*, *Alysicarpus vaginalis* and *Fimbristylis macrantha*.

Soil Units conserved are 1, 2a, 2b, 2d, 3a, 4a, 4b, 4d, 5a, 7a, 7b, and 8.

#### **Southern Keep River Plain (CKS)**

Area CKS would include the largest section of Soil Unit 1 (black soil) to be conserved within the Project Area with vegetation representative of that of the Knox Creek and Weaber plains. It would include *Typhonium liliifolium* (3r flora species, Northern Territory), *Ipomoea* aff. *agrillicole* (3r flora species, Northern Territory) and *Fimbristylis laxiglumis* (Priority 3 flora species, Western Australia) as well as *Fimbristylis phaeoleuca*.

Purple-crowned fairy-wren (*Malurus coronatus coronatus*) (Schedule 1, Western Australia; Schedule 7, Northern Territory) has been found to occur in canegrass (*Sorghum* spp.). (Parks and Wildlife Commission of the Northern Territory 1998), a dominant grass species in Soil Unit 1, which is in this conservation area.

Area CKS would also include two areas of varied Soil Units 2a, 3a, 3c, 4b and 4c and combinations of these. Soil Unit 2a supports *Melaleuca minutifolia* woodland, which is considered by Connors et al. (1996) to be a poorly conserved fine scale vegetation type.

Soil Units conserved are 1, 4c, 4d, 5a, 5b, 5c, 6, and 7b.

### **Northern Keep River Plain (CKN)**

Area CKN would include areas of the grasslands that are restricted within the Project Area to the northern area of the Keep River Plain, including areas of *Xerochloa* grasslands, a vegetation association regarded by Connors et al. (1996) as poorly reserved fine scale vegetation type.

The area would also include areas of *Halosarcia* mudflats, which do not occur elsewhere within the Project Area, *Cleome uncifera* (3r flora species, Northern Territory), *Tacca maculata* (3r flora species, Northern Territory) and *Triodia plectrachnoides*.

Soil Units conserved are 4a, 4d, 5a, 5b, 7a, and 7b.

### **Eastern Keep River Plain (CKE)**

Area CKE would include *Schoenus punctatus* and poorly conserved vegetation community *Melaleuca minutifolia* woodland. It also conserves an area of mixed Soil Unit types, 1, 2a, 3a, 3c, 2c, and 4a.

Soil Units conserved are 1, 2a, 2b, 2c, 3a, 3a/3c, 3c, 3d, 4a, 4b, 4c, 4d, 5a, 5b, 5c, and 7a.

### **Milligan Lagoon (CKxM)**

Area CKxM would include a large sandstone outcrop to the west of the lagoon. This entire area, including the sandstone outcrops and Milligan Lagoon, is of cultural significance to Miriwung and Gajerrong people.

The different soils within this area support a varied plant life, from water plants (including waterlilies) and the sedgeland swamps on the edge of Milligan Lagoon to the *Terminalia canescens* woodland on the lower to middle slopes of the sandstone outcrop and *Eucalyptus miniata* woodland on the upper slope.

This conservation area would include *Brachychiton tuberculatus* (Priority 3 flora species, Western Australia; 3r species Northern Territory), *Echinochloa kimberleyensis* (Priority 1 flora species, Western Australia), and a newly recorded *Ficus* sp.

*Grewia oxyphylla* also occurs on a sandstone hill within Area CKxM.

Vegetation fringing the lagoon is recognised as an important habitat for waterbirds, reptiles and mammals. This vegetation supports waterbirds, migratory waders, and aquatic fauna (including an undescribed tortoise of the genus *Chelodina*), and it is a possible refuge for some terrestrial fauna such as the splendid tree-frog.

Area CKxM is also likely to be an important feeding area for bats, as the adjoining hills provide roosts for these animals.

The large sandstone outcrop adjoining the lagoon supports substrate-specific fauna.

Soil Units conserved are 1d, 6b, 8a, and 11b.

### **West side of the Knox Creek Plain (CKxW)**

Area CKxW would include an area of *Astrebla squarrosa* vegetation, which has only been observed to date on the Knox Creek Plain (Ecologia Environmental Consultants 1997). *Astrebla squarrosa* - dominated vegetation is at its northern distribution limit on this plain.

The listed species *Triodia acutispicula* (Priority 3 flora species, Western Australia), *Brachychiton tuberculatus* (Priority 3 flora species, Western Australia; 3r flora species, Northern Territory), *Corchorus fascicularis* (3r flora species, Northern Territory), *Caesia chlorantha* (3r flora species, Northern Territory) and *Striga squamigera* (3r flora species, Northern Territory) also occur in this area.

The species *Eleocharis sundaica*, *Chamaecrista absus*, *Aphyllodium biarticulatum*, *Lophostemon grandiflorus* subsp. *grandiflorus*, *Lophostemon lactifluus*, *Goodenia malvina* and *Nesaea arnhemica* would also be conserved in this area.

Area CKxW would include the foothills of the Pincombe Range, an important habitat for many fauna species, especially reptiles. In addition, the caves and overhanging ledges are believed to provide important roosts for many species of bats.

Soil Units conserved are 1c, 1d, 1d/7f, 1f, 5e, 6e, 7f, 8, 8a, 11, and 11b.

#### **East side of the Knox Creek Plain (CKxE)**

Area CKxE would include riparian vegetation on both sides of the Keep River, and represents areas dominated by *Astrebla squarrosa*. It would also include *Enteropogon minutus*, a species not previously recorded for Western Australia.

Soils in the conservation area include Soil Units 1e and 7f, which are uncommon in the Project Area and have variable micro-habitats for a range of vertebrates and invertebrates.

Towards its southern extremity, area CKxE would be in close proximity to the Keep River National Park. This feature would enhance the conservation value of both areas. Area CKxE would include the species *Heliotropium foveolatum*.

Soil Units conserved are 1c, 1d, 1ds, 1e/7f, 1e, 1g, 5a, 6b, 7a/7b, 7b1, and 7f.

### **10.3.3 Protection of watercourses and rock outcrops**

All rock outcrops and watercourses, including wetlands and billabongs with environmental and cultural significance, would be conserved. To maintain the effectiveness of these areas as fauna habitats, a system of corridors would provide links to adjacent areas of the surrounding Cockatoo Land System.

Vegetation would be maintained along all watercourses and wetlands. The width of these areas would be determined on a case-by-case basis, but as a minimum would be:

- 250 m from the incised channel of rivers
- 250 m from the outer edge of the riparian zone of natural wetlands
- 100 m from the incised channels of significant creeks.

It is envisaged that native title rights would prevail over all watercourses and rock outcrops within the Project Area.

### **10.3.4 Soil types**

All the major soil types that occur in the Project Area would be represented within the conservation areas, although some of the minor soil types represented in small areas would not be protected (Table 10.5).

**Table 10.5 Representation of each soil type in the development area and in the conservation area**

Soil type	Development area (ha)	Conservation area	
		ha	%*
1	16699	5196	24%
1b	1	1	55%
1c	2191	609	22%
1d	3517	775	18%
1d/7f	144	31	17%
1ds	61	3	5%
1e	185	66	26%
1e/7f	11	54	84%
1f	198	74	27%
1g	700	71	9%
2a	256	151	37%
2a/3a	17	30	64%
2b	26	32	56%
2c	35	34	50%
2d	9	6	42%
3a	152	185	55%
3a/3c	16	12	43%
3b	41	0	0%
3c	77	84	52%
3d	32	10	24%
4	0	6	100%
4a	309	335	52%
4b	329	316	49%
4c	496	289	37%
4d	79	468	86%
4e	0	32	100%
5a	3372	1749	34%
5at	89	103	54%
5b	4062	698	15%
5bt	422	105	20%
5c	200	960	83%
5d	15	0	0%
5e	7	184	96%
6	3	200	99%
6a	0	8	100%
6b	1	372	100%
6d	1	120	99%
6e	12	148	92%
7a	96	3524	97%
7a/7b	18	605	97%
7b	31	615	95%
7b1	28	180	87%
7bs	0	20	98%
7f	401	173	30%
8	13	144	92%
8a	34	541	94%
8b	11	168	94%
9a	22	1	3%
9b	46	10	18%
9c	293	33	10%
11	49	692	93%
11b	0	50	100%
Other <sup>†</sup> (mainly rock)	14	20760	100%
<b>Total</b>	<b>34818</b>	<b>41033</b>	<b>54%</b>

\* Indicates the percentage conserved of that particular Soil Unit in the whole of the Project Area (proposed development and conservation areas).

† Area not mapped by soil surveys.

Those soils not included in conservation areas are minor variants of the major soil types. For example, Soil Unit 1ds is the same as 1d but it has a stony surface; 3b and 3a are both red brown earths with solodic soil intergrades, Soil Units 9a, 9b and 9c have varying percentages of gradational calcareous clays in a matrix in land unit 1a; and 5d is a cracking clay with reduced internal drainage.

All rock outcrops, watercourses and natural, permanent water areas important for the conservation of flora and fauna would be included in the conservation areas. The cracking-clay black soil, which would be the focus of farm development, would have approximately 22% of Soil Unit 1 (1–1g inclusive) and approximately 32% of Soil Unit 5 (5a–5e inclusive) conserved.

### 10.3.5 Vegetation associations and flora

All undeveloped land within the Project Area would be managed for conservation. Most of this conservation area would be located around the perimeter of the Project Area, thereby providing an important physical link with the undeveloped areas of land outside the Project Area. In the Northern Territory this would include the proposed extension of the Keep River National Park and in Western Australia, the Point Spring Nature Reserve.

Four vegetation associations of the seventy-two described would not be conserved to some extent in the Project Area. However, the individual species present within each of these associations are represented in other vegetation associations within the conservation areas and the combined extent of these associations is only 133 ha, or 0.4% of the proposed development area (see Table 10.6).

Twelve vegetation associations only occur in the proposed conservation area and therefore would not be affected by development. Of the remaining fifty-six vegetation associations, only one would not have at least 10% represented in the conservation area.

Only one area included in the conservation area is isolated. This is the Cockatoo Land System on Spirit Hills Station. All other conservation areas connect from the perimeter conservation through wide corridors (at least 500 m) to the conservation areas along the Keep River or to another perimeter conservation area. This, together with management, should ensure the long-term viability of the included vegetation associations.

CALM is currently compiling a list of endangered vegetation communities for Western Australia (S. Claymore, Department of Conservation and Land Management, pers. comm., July 1999); however, such a list is not yet available for the Kimberley region. A. Mitchell, a botanist with the Ecologia (1997) survey, indicates that none of the associations within the black-soil plains are restricted (pers. comm., July 1999). The only association of restricted distribution in the Project Area is the *Echinochloa kimberleyensis* - dominated swamp near the foothills of the Weaber Range. This swamp would be included within the proposed conservation area and would be protected.

**Table 10.6 Representation of vegetation associations in the development area and conservation areas (vegetation mapped area only)**

Vegetation association	Development area (ha)	Conservation area (ha)	Percentage conserved (%)
<b>Grassland</b>			
G1	2459	924	27%
G2	190	276	59%
G3	0	12	100%
G4	1513	458	23%
G5	0	224	100%
G6	153	368	71%
<b>Grassland with emergent trees</b>			
Gt1	26	15	36%
Gt2	7210	1838	20%
Gt3	208	22	10%
Gt4	0	162	100%
Gt5	35	0	0%
Gt6	80	28	26%
Gt7	21	298	94%
Gt8	29	11	27%
Gt9	1	164	99%
Gt10	5	412	99%
Gt11	0	15	100%
Gt12	0	26	100%
Gt13	10	21	68%
Gt14	6	180	97%
<b><i>Bauhinia cunninghamii</i> woodland</b>			
Bc1	11	37	77%
Bc2	246	178	42%
Bc3	6116	2136	26%
<b><i>Buchanania</i> woodland</b>			
Bo1	21	174	89%
<b><i>Corymbia bella</i> woodland</b>			
Cb1	0	32	100%
Cb2	180	273	60%
Cb3	7	81	92%
Cb4	1	220	99%
Cb5	418	170	29%
Cb6	123	71	37%
Cb7	619	390	39%
Cb8	26	146	85%
Cb9	26	9	27%
<b><i>Corymbia</i> sp., <i>Brachychiton diversifolius</i> and <i>Gyrocarpus americana</i> woodland</b>			
CBG	5	52	91%
<b><i>Corymbia confertiflora</i> woodland</b>			
Cc1	84	1	1%
Cc2	12	75	86%
Cc3	58	61	51%
Cc4	51	110	68%
<b><i>Corymbia tectiflora</i> woodland</b>			
Ct1	39	0	0%
Ct2	145	45	24%
<b><i>E. microtheca</i> woodland</b>			
Em1	397	180	31%
Em2	135	62	31%
Em4	377	1090	74%
Em3	220	100	31%
Em5	0	39	100%
Em6	106	203	66%
Em7	176	22	11%
Em8	966	116	11%

**Table 10.6 Representation of vegetation associations in the development area and conservation areas (continued)**

Vegetation association	Development area (ha)	Conservation area (ha)	Percentage conserved
Em9	7026	2558	27%
<i>E. microtheca</i> and <i>Melaleuca</i> spp. woodland			
EM1	0	5	100%
EM2	275	1695	86%
<i>E. papuana</i> woodland			
Ep1	0	3	100%
<i>E. microtheca</i> woodland and shrubland of <i>Terminalia oblongata</i> ssp. <i>volucris</i>			
ET1	7	184	96%
ET2	103	67	39%
ET4	16	0	0%
ET5	350	97	22%
ET6	4326	2346	35%
<i>Excoecaria parvifolia</i> woodland			
Ex1	0	23	100%
Ex2	0	160	100%
Ex3	75	71	49%
Ex4	0	128	100%
<i>Melaleuca</i> sp. woodland			
Me1	5	36	88%
Me2	10	312	97%
Me3	43	0	0%
Me4	293	262	47%
<i>E. miniata</i> woodland			
Min1	1	383	100%
Min2	9	1302	99%
<i>Terminalia canescens</i> woodland			
Tc1	2	38	96%
<i>Eucalyptus microtheca</i> and <i>Melaleuca</i> spp. woodland			
EM1	1	12	92%
EM2	21	107	84%
EM3	55	1595	97%
<i>Eucalyptus tetradonta</i> woodland	9	89	91%

No threatened communities covered by the *Endangered Species Protection Act 1992* occur in the Project Area.

One plant species of conservation significance—the tentatively named *Sorghum grande*, which was collected during the Ecologia fieldwork—is not known to be included within the proposed conservation areas. Additional collections of this plant would be required to confirm the species' identity and, if the identification were positive, to determine its distribution. It was not recorded during Kinhill's 1999 survey.

Rare and priority species identified within the Project Area and the relevant conservation area are detailed in Table 10.7.

**Table 10.7 Representation of rare and priority species within conservation areas within the Project Area**

Rare and priority species	Classification and State or Territory	Location in proposed conservation areas									
		CWN	CWW	CWE	CKL	CKS	CKN	CKE	CKxM	CKxW	CKxE
<i>Atalaya salicifolia</i>	3r (NT)	✓									
<i>Brachychiton tuberculatus</i>	P3 (WA), 3r (NT)								✓	✓	
<i>Caesia chlorantha</i>	3r (NT)									✓	
<i>Cleome uncifera</i>	3r (NT)							✓			
<i>Corchorus fascicularis</i>	3r (NT)		✓							✓	
<i>Echinochloa kimberleyensis</i>	P1 (WA)	✓							✓		
<i>Fimbristylis laxiglumis</i>	P2 (WA), 3r (NT)					✓					
<i>Ipomoea aff. agrillicola</i>	3r (NT)					✓					
<i>Lindernia tectanthera</i>	3r (NT)			✓							
<i>Sorghum grande</i>	3r (NT)				Not confirmed in conservation area						
<i>Striga squamigera</i>	3k (NT)									✓	
<i>Tacca maculata</i>	3r (NT)							✓			
<i>Triodia acutispicula</i>	P3 (WA)									✓	
<i>Typhonium liliifolium</i>	3r (NT)			✓		✓					
<i>Vittadinia spechtii</i> var. <i>kimberleyensis</i>	3r (NT)				✓						

### 10.3.6 Native fauna and associated habitats

All the fauna habitats identified by Ecologia (1997) would be represented in the proposed conservation areas within the Project Area. Ecologia separated woodlands into eucalypt and bauhinia woodlands. Kinhill's 1999 survey (Appendix J) concluded there were no significant differences between these habitats; hence they have been combined as 'woodland'. Those considered to include site-specific species would have the majority of their habitat area conserved, as indicated in Table 10.8.

The proposed development would occur in the woodland and grassland fauna habitats. Development would result in the large-scale removal of grass species, trees and shrubs. The grass species are commonly utilised by many fauna species for seed, while the trees and shrubs provide nectar and insect food. It is also expected that some of the fauna in the areas adjacent to the proposed development area would utilise the development area for food and shelter. While the food source would be reduced, it should be noted that the grasses are common throughout the eastern Kimberley region, and it is anticipated that many fauna species would forage in the proposed conservation areas.

**Table 10.8 Representation of fauna habitats in the development area and conservation areas (see Section 8.2)**

Fauna habitat	Development area (%)	Conservation area (%)
Grassland	55	45
Woodland	58	42
Riverine woodland	1	99
Vine thicket	0	100
Wetland*	10	90
Rock outcrop	0	100

\* Includes the man-made wetland on the Weaber Plain.

All rare and specially protected fauna identified within the Project Area would have their usual habitat retained (Table 10.9). As the rivers, creeks, lagoons, temporary creeks, and pools are included in the proposed conservation areas the fish species recorded by Larson (1999) (Appendix L) from the Keep River and Sandy Creek would not be directly affected by development. Of the sixteen mollusc species recorded by Wilson and Stoddard (1979), five were located only in temporary creeks and pools, several of which would be conserved. None should be impacted as these habitats are included in the conservation areas.

Table 10.9 lists the preferred habitat of all rare and protected fauna known to occur in the Project Area.

**Table 10.9 Preferred habitat of rare and specially protected fauna**

Species name	Common name	Habitat preference	Area conserved (%)
<b>Mammals</b>			
<i>Macroderma gigas</i>	Ghost bat	W ,GR ,RW ,WE, RO, VT	51
<i>Hipposideros stenotis</i>	Wart-nosed horseshoe-bat	GR, RW, WE, VT	79
<i>Hydromys chrysogaster</i>	Water rat	W, GR	43
<i>Leggadina lakedownensis</i>	Lakeland Downs mouse	W, GR	4
<i>Phascogale tapoatafa</i>	Brush-tailed phascogale	W, GR, RW	48
<i>Sminthopsis butleri</i>	Butlers dunnart	W, GR	43
<b>Birds</b>			
<i>Accipiter novaehollandiae</i>	Grey goshawk	VT	100
<i>Apus pacificus</i>	Fork-tailed swift	RW, VT	99
<i>Ardea sumatrana</i>	Great-billed heron	RW, WE	99
<i>Ardeola alba</i>	Great egret	RW, DW, W	48
<i>Ardeola ibis</i>	Cattle egret	RW, WE	99
<i>Aviceda subcristata</i>	Pacific baza	W, GR, RW, WE, RO	51
<i>Burhinus grallarius</i>	Bush stone-curlew	W, GR, RW, WE	48
<i>Calidris ruficollis</i>	Red-necked stint	RW, WE	99
<i>Calidris subminuta</i>	Long-toed stint	RW, WE	100
<i>Cisticola juncidis</i>	Zitting cisticola	W, GR, RW, WE	48
<i>Cuculus saturatus</i>	Oriental cuckoo	W, GR, RW, WE	48
<i>Esacus magnirostris</i>	Beach stone-curlew	W, GR, RW, WE	48
<i>Erythrotriorchis radiatus</i>	Red goshawk	W, GR, RW, RO	51
<i>Erythrura gouldiae</i>	Gouldian finch	RW, WE	99
<i>Eurostopodus argus</i>	Spotted nightjar	RO, VT	100
<i>Falco hypoleucos</i>	Grey falcon	W, GR, RO	47
<i>Falco peregrinus</i>	Peregrine falcon	WE, RO	100
<i>Falcunculus frontatus whitei</i>	Kimberley crested shrike-tit	W, RW, VT	48
<i>Geophaps smithii blaauwi</i>	Partridge pigeon	W, GR, RO	47
<i>Haliaeetus leucogaster</i>	White-bellied sea-eagle	RW, WE	99
<i>Hamirostra melanosternon</i>	Black-breasted buzzard	W, GR, RW, WE, RO	51
<i>Ixobrychus flavicollis gouldi</i>	Black bittern	RW, WE, RO, VT	99
<i>Lonchura flaviprymna</i>	Yellow-rumped mannikin	W, GR, RW, WE	48
<i>Lophoictinia isura</i>	Square-tailed kite	W, GR, RW, RO	51
<i>Malurus coronatus coronatus</i>	Purple-crowned fairy-wren	RW, VT	99
<i>Megapodius reinwardt</i>	Orange-footed scrubfowl	RW, VT	99
<i>Merops ornatus</i>	Rainbow bee-eater	W, GR, RW, WE, RO, VT	51
<i>Microeca flavigaster tormenti</i>	Lemon-breasted flycatcher	W, GR, RW	48
<i>Neochmia ruficauda</i>	Star finch	W, GR, RW, WE, VT	49
<i>Ninox rufa rufa</i>	Rufous owl	W, RW, VT	48

**Table 10.9 Preferred habitat of rare and specially protected fauna (continued)**

Species name	Common name	Habitat preference	Area conserved (%)
<i>Plegadis falcinellus</i>	Glossy ibis	RW, WE	99
<i>Poecilodryas superciliosa cerviniventris</i>	Derby white-browed robin	VT	100
<i>Rostratula benghalensis</i>	Painted snipe	WE	90
<i>Tadorna radjah</i>	Radjah shelduck	VT, WE	90
<i>Tringa brevipes</i>	Grey-tailed tattler	RW, WE	99
<i>Tringa glareola</i>	Wood sandpiper	RW, WE	99
<i>Tringa hypoleucos</i>	Common sandpiper	RW, WE	99
<i>Tringa nebularia</i>	Greenshank	RW, WE	99
<i>Tringa stagnatilis</i>	Marsh sandpiper	RW, WE	99
<i>Turnix castanota</i>	Chestnut-backed button-quail	W, GR, RO	47
<i>Tyto novaehollandiae</i>	Masked owl	W, VT	42
<b>Reptiles</b>			
<i>Crocodylus johnstoni</i>	Freshwater crocodile	RW, WE	99
<i>Crocodylus porosus</i>	Saltwater crocodile	RW	99
<i>Varanus glauerti</i>	Glauert's monitor	RO	100
<i>Varanus kingorum</i>	Long-tailed pygmy goanna	RO	100
<b>Amphibians</b>			
<i>Cyclorana vagitus</i>	Wailing frog	W, GR	43
<i>Litoria splendida</i>	Splendid tree-frog	WE, VT	90

W = woodland; GR = grassland; RW = riverine woodland; WE = wetlands; RO = rock outcrops; VT = vine thicket.

Source: Kinhill Pty Ltd (1999), Ecologia (1997).

### 10.3.7 Comparison with other conservation proposals

Ecologia (1997) made recommendations for conservation areas as part of a previous proposal to develop the Project Area for the purposes of irrigated agriculture. The Ecologia recommendations were reviewed by Woinarski and Connors (1997), whose analysis considered plant and terrestrial vertebrate species attributes and terrestrial environments as described by soil mapping. The analysis included an assessment of the occurrence and preservation requirements of plant and animal species in the Project Area vis-à-vis the surrounding region by examining whether any of the relevant species were prevalent in existing reserves elsewhere in the Northern Territory or the Kimberley region. Woinarski and Connors (1997) also considered three alternative conservation scenarios to that proposed by Ecologia, each with differing conservation targets, including representation of soil types and plant and animal species deemed to be of conservation significance. The conclusions were as follows:

- The Ecologia (1997) recommendations were comprehensive and provided a good representation of the broad soil types present in the Project Area, and a fair representation (approximately 50%) of the plant and animal species deemed to be of conservation significance.
- The least frugal of the Woinarski and Connors scenarios (known as Scenario 3) required 100 km<sup>2</sup> to represent all soil types by at least 5% of their extent in the Project Area, and to represent all thirty-five plant species and animal species considered to require conservation.

- The proposed Scenario 3 was superior (in terms of less land required for conservation and greater representation of target attributes), but there was reasonable correlation with the Ecologia (1997) recommendations.

The Woinarski and Connors (1997) Scenario 3 design is shown in Figure 10.3 as an overlay to the current schematic layout of the Project Area. The current conservation strategy for the proposed development includes a greater proportion of black-soil plain in conservation areas, by virtue of the conservation area on the southern Keep River Plain. Woinarski and Connors (1997) suggested individual farm units of black-soil plains be conserved. However, greater representation of this soil type has been achieved by conserving a large area of black-soil plain in the southern Keep River Plain. The conservation of one large area rather than several smaller areas ensures greater integrity of the vegetation and fauna habitats.

Variations in soil types, particularly on the Keep River Plain, have been conserved in both proposals. Similarly a corridor connecting the northern perimeter conservation area via the dolomite hill to Folly Rock and through the southern perimeter conservation area in the Weaber Plain is a feature of both proposals.

Woinarski and Connors (1997) noted that all of their target levels (at least 5% of either broad or fine soil types represented in protected areas) were frugal in comparison to those generally accepted in land planning. For example, the Comprehensive Regional Assessment process flowing from the National Forest Policy Statement sets representation targets of 5–15% of all ecosystems mapped at a scale of 1:100,000, and more adequate representation of threatened species (Anon. 1996).

The issue of satisfying industry targets for adequate representation of ecosystems has been addressed as part of the proposed conservation strategy through dedication of a larger proportion of the black-soil plains in the Project Area to conservation than was proposed by Woinarski and Connors (1997). Table 10.5 shows that 25% of the black-soil plains (Soil Units 1 and 5) within the Project Area would be conserved.

## **10.4 ASSESSMENT OF POTENTIAL IMPACTS**

This section identifies the potential environmental impacts associated with the development and operation of the proposed development, and the predicted level of impact of each. Also, the proposed management measures to mitigate impacts are described in Section 10.5. The proposed development would take place predominately on the black-soil plains. These cracking clays are typically dominated by savanna woodland, a homogeneous habitat consisting of baubinia woodland, eucalypt woodland and grassland.

### **10.4.1 Mammals**

As with any sizeable land development, it is inevitable that individuals of some of the smaller species of mammals may be detrimentally affected during construction activities. Some may move, and survive, within the proposed conservation areas. Other individuals may be displaced and may later succumb to predators, stress or territorial conflicts during attempts to re-establish a home range. However, none would become locally extinct.

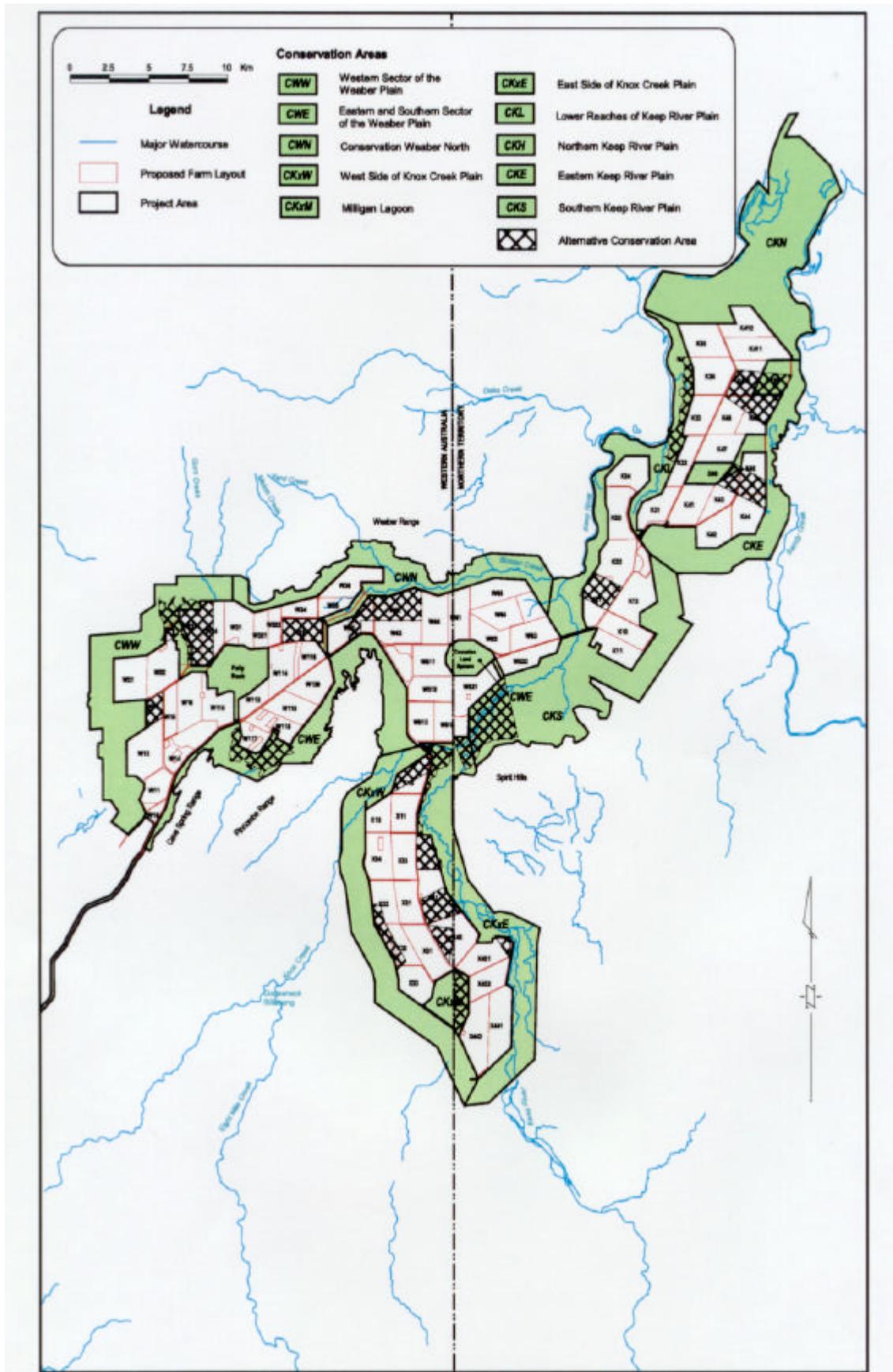


Figure 10.3 The Scenario 3 design of Woinarski and Connors (1997)

Clearing of the black soil vegetation would reduce the foraging habitat for some terrestrial (arboreal) species and some bats, as well as remove some den and roost trees. However, the areas of natural vegetation preserved on the hills and along watercourses within the conservation areas would minimise this particular impact. Data obtained during the most recent fauna survey (Kinhill Pty Ltd 1999) indicated that there was a lower diversity and abundance of bats foraging on black-soil plains than along the watercourses and rock outcrops.

Ghost bats roost during the day in large caves or abandoned mines and range widely at night. These animals would not be adversely affected by the proposed development because their preferred roosting habitat would not be disturbed. However, sufficient areas of its habitat are included in the conservation area to ensure the species survival. Three species of mammals, Water rat, Lakeland Downs mouse and Buttlers dunnat are restricted to the woodland or grassland habitat (Appendix J). At these are the vegetation associations proposed for development, and the impact of development on some of these animals will be great. However the species will continue to survive in the conservation areas and may even adapt to the tall grassland of the sugar canefields.

#### 10.4.2 Birds

Nesting sites and foraging areas for birds may unavoidably be affected during construction activities, but it is envisaged that most individuals would be able to move into the adjoining conservation areas. In ORIA Stage 1, some birds—including broilgas, magpie geese, radjah shelduck, parrots and finches—have benefited from the development of irrigated farms.

Yellow-rumped mannikins are known to prefer areas of permanent water with fringing vegetation. It is unlikely that the population of this species would be reduced since all natural wetlands and rivers would be included in the conservation areas.

Derby white-browed robins inhabit vine thickets and woodlands associated with river systems. The species should not be adversely affected by the proposed development because its habitat would be conserved and adjacent areas.

The Gouldian finch was not recorded during surveys by Ecologia or Kinhill, but has been recorded from near Kununurra (NSR 1992). The preferred habitat for this species is eucalypt woodland with a grass understorey of *Sorghum* spp. However, they have been known to move out of these habitats during the wet season, to return when the *Sorghum* spp. begin to release seed.

The Gouldian finch is known to nest mainly in the hollows of trees, with occasional reports of nests in termite mounds, low bushes, spinifex or tall grasses. Studies in the Northern Territory have recorded Gouldian finch nests in *Eucalyptus brevifolia*, *E. leucophloia*, *E. tintinnans* and *E. miniata*, only the latter being recorded from the Project Area. However, as all areas of *E. miniata* in the Project Area are included in the conservation areas, the preferred nesting habitat of this species would not be impacted.

Red goshawk was not recorded during the Ecologia 1997 survey or the Kinhill 1999 survey, but it may be present in the Project Area. The impact that the proposed development would have on this species (if present) is unknown.

### 10.4.3 Reptiles

Some individuals may relocate to adjoining conservation areas, but some may unavoidably be killed during construction activities. Based on existing information for ORIA Stage 1, most of the reptile species would survive and it is considered likely that some may benefit from the establishment of the irrigation system.

### 10.4.4 Frogs

It is anticipated that most, if not all, species of frogs native to the Project Area would continue to live and thrive in the irrigated areas, as has occurred in ORIA Stage 1. Those with specialist habitat niches—such as Copland’s rock frog, which is restricted to the rock outcrops—would not be affected by the proposed development. The wailing frog is the only species restricted to woodlands or grasslands, but this species should continue to survive in the conservation areas and adapt to the development.

It is of interest to note that the flat-headed frog (*Limnodynastes depressus*), which had been thought to be extinct, has recently been recorded at Cockatoo Lagoon in the Keep River National Park and at Lissadell Station in Western Australia. This frog is endemic to the Ord River catchment and is apparently a naturally rare species. Its close relative *L. tasmaniensis*, which occurs naturally in southern Australia, was accidentally introduced to the Ord River catchment a number of years ago and is now widespread in irrigated areas; it was, for example, recorded by Kinhill in the Project Area in June 1999. Adults of the two species are virtually indistinguishable. The possibility that the very rare *L. depressus* could also exist in the Project Area should not be discounted and if it should be recorded, the information would be provided either to CALM or the Parks and Wildlife Commission of the Northern Territory.

### 10.4.5 Fish and aquatic biota

The proposed conservation areas would include all significant waterways, billabongs and wetlands, and their associated riparian vegetation. Direct impacts upon the habitats of fish and other aquatic biota would therefore be avoided, except in two localised areas associated with the road crossings of the Keep River and Knox Creek.

It is envisaged that insecticides would not be used on sugarcane grown in the Project Area, consistent with current practice in ORIA Stage 1 (see Table 2.1). Furthermore, only minimal volumes of herbicides would be used in the canefields. Herbicide would only be applied to the sugarcane once per year, in the period following harvesting. The tailwater return systems proposed for use on all farms within the Project Area have been designed to collect on-farm herbicide runoff, and to avoid any such runoff into the adjacent aquatic environment (see Chapter 5).

Chapter 5 describes the predicted changes to the hydrology of the Keep River and Sandy Creek from proposed development. These changes would be contained to the lower reaches of these watercourses and would involve:

- an insignificant change in water quality due to the combined effect of proposed management measures for the use of farm chemicals and on-farm water management;
- a minor increase in peak flood velocities and an increase in the occurrence of peak flood levels due to the construction of flood protection levees;

- an increase in average flows during the wet season, and infrequent and minor releases of good quality water during the dry season.

These predicted changes are not expected to result in any significant impacts on fish and other aquatic biota in the Keep River and Sandy Creek. The altered flow regime may cause some localised erosion, but this should stabilise with time. The differential effect of the increased average flows would be greater in drier years and, at these times, the additional flows that would occur earlier and later in the wet season would benefit an environment that would otherwise be under stress.

The groundwater management strategy that would be adopted for the Project involves the recovery of groundwater from strategically located bores in the Project Area. Disposal of the collected groundwater would be either by reuse (subject to quality) as irrigation water, or by pumping to the tidal portions of the Keep River and Sandy Creek, as shown in Figure 6.1. The salinity of the water requiring disposal to the Keep River and Sandy Creek is predicted to be in the range 2,200–20,000 mg/L TDS. Except for times of high flow in these watercourses, the receiving water would be marine, with a salinity of about 35,000 mg/L TDS.

The main issues associated with the discharge of the collected groundwater are the potential effects on water quality and marine fauna due to:

- the slightly elevated levels of total nitrates, predicted to be in the range of 3.1–5.2 mg/L;
- the altered hydrology with respect to continuous discharges of lower salinity water with respect to the receiving water;
- the possibility of elevated levels of insecticides, herbicides and phosphorus, although experience with ORIA Stage 1 would indicate that the risk of these being significantly elevated is remote.

The primary means of managing these potential impacts would be via the selection of the discharge locations. It is anticipated that a period of approximately ten years would be available following the commencement of cropping before discharges might become necessary. This period would be used by the Environmental Management Entity that would be established as part of the Project (see Chapter 16) to undertake further studies aimed at:

- improving the predictions of the quality of the groundwater requiring disposal;
- confirming the adequacy of the discharge locations, or selecting alternative sites in consultation with the DLPE.

The tidal range at the mouth of the Keep River and Sandy Creek is approximately eight metres, providing conditions of swift moving, naturally highly turbid waters. Such conditions would be suitable for dilution and assimilation of any saline discharge, and would diminish the possibility of excessive algal growth that could be caused by elevated nitrate levels. There is a high degree of confidence that the strategy outlined above can be implemented with negligible impacts upon water quality and aquatic fauna.

#### **10.4.6 Insects**

It is not envisaged that insecticide would be applied to sugarcane grown in the Project Area. However, as the development of the Project Area will result in the removal of natural vegetation from the areas earmarked for farming, those native insect species living in these

areas which have very specific food and shelter requirements would certainly be impacted. It is nevertheless anticipated that the conservation areas to be laid aside would provide adequate resources for all these species to survive within and around the Project Area.

#### **10.4.7 Stygofauna**

The sampling that has been undertaken to date has indicated the presence of one species of stygofauna in groundwater in the western portion of the Weaber Plain. The same species was also recorded from the groundwater beneath ORIA Stage 1.

The eastern portion of the Weaber Plain, the Keep River Plain and the Knox Creek Plain are underlain by a palaeochannel similar to the western portion of the Weaber Plain. Hence, sampling in these areas is also likely to indicate the presence of stygofauna.

Chapter 6 describes the predicted changes to the groundwater environment of the Project Area due to the proposed development. In general, these predicted changes would include a rise in groundwater levels; existing habitats would therefore remain flooded, and only minor changes in water quality would result. In particular, that there has been no significant changes to groundwater quality beneath ORIA Stage 1, which has been used for irrigated agriculture for over thirty years, would support this conclusion.

#### **10.4.8 Interbasin water transfers**

The proposed development of the Project Area would result in the transfer of water, via the irrigation water distribution system, from the Ord River basin into the Keep River basin. Potential therefore exists for the transfer of aquatic invertebrates or other biota, via the irrigation water, from the Ord River to the Keep River. However, the risk that the inter-basin transfer of water would result in a change to the ecology of the Keep River is expected to be minimal and would be mitigated by the following factors:

- The Keep River is no longer pristine with respect to inter-basin transfers, as such transfers have been occurring for over 30 years since the establishment of ORIA Stage 1. Water level control in the M1 Channel is currently maintained by allowing continuous discharges, via a drain, on to the Weaber Plain. During the wet season these discharges would have uncontrolled access to the Keep River.
- Project development would include a range of measures designed to eliminate, during normal operations, discharges of irrigation water to the Keep River. These measures are detailed in Chapter 5 and include:
  - the provision of irrigation tailwater return systems to all farms in the Project Area;
  - the establishment of regulating storage dams along the route of the M2 Channel that would provide operational storage, which would obviate the need for discharge of irrigation water to watercourses in the Keep River basin;
  - computer-controlled operation of control structures along the M2 Channel, which would optimise the efficiency of water delivery throughout the Project Area.

#### **10.4.9 Recovery plans for threatened species**

Both the Parks and Wildlife Commission of the Northern Territory and CALM have recovery plans for fauna and flora species. The recovery plan for the Gouldian finch is the only such plan applicable to the proposed development.

As detailed in Section 10.4.2, the Gouldian finch may be disadvantaged by land-clearing associated with the proposed development. However, it would appear the preferred nesting habitat of this species would not be impacted. A requirement of the recovery plan is that any sightings of Gouldian finches feeding or breeding should be reported to one of the above departments.

#### **10.4.10 Existing conservation reserves**

The Keep River National Park is approximately 6 km south of the Project Area. Being upstream of the Project Area, it is unlikely that the Keep River National Park would suffer any significant direct detrimental impact as a result of the proposed development. However, indirect potential impacts could be caused by the introduction and spread of weeds and feral animals, and an increase in the number of visitors to the park.

Point Spring Nature Reserve, less than 1 km north of the Weaber Plain portion of the Project Area, protects a permanent spring, remnant rainforest and a small wetland at the base of the Weaber Range. The Point Spring Nature Reserve is a Class A reserve for the conservation of flora and fauna. This reserve includes small areas of black soil and sandy alluvium. Point Spring is in a groundwater system separate from the adjacent alluvial plains and, as a consequence, would be isolated from any changes in the water-table in the Project Area. However, its close proximity to the Project Area has necessitated the implementation of special management and design considerations, with particular reference to anticipated higher flood water levels and flow velocities. A buffer has been incorporated into the design of the proposed development to insulate Point Spring Nature Reserve from these effects.

To ensure that the existing environmental significance of the Point Spring Nature Reserve is maintained, Wesfarmers–Marubeni and the Water Corporation would cooperate with CALM in implementing its management requirements for the site. The overall responsibility for the management of the reserve would remain with CALM. The conservation area between the proposed farmland and Point Spring Nature Reserve would be managed for the purpose of conservation.

All other conservation reserves in the region are removed by over 100 km from the Project Area and are unlikely to be affected by the proposed development.

#### **10.4.11 National Wilderness**

The Commonwealth Government initiated the National Wilderness Inventory (NWI) in 1986 in response to community concerns about the diminishing extent of remote and natural lands in Australia. The NWI is administered by the World Heritage and Wilderness Branch of Environment Australia. The Branch defines wilderness as:

...land that, together with its plant and animal communities, is in a state that has not been substantially modified, and is remote from, the influences of European settlement or is capable of being restored to such a state, is of sufficient size to make its maintenance in such a state feasible, and is capable of providing opportunities for solitude and self-reliant recreation.

Wilderness values, measured on a continuum from 0 to 20, are developed in consideration of remoteness from settlement, remoteness from access, apparent naturalness (lack of permanent structures), and biophysical naturalness (degree of biophysical disturbance such as grazing, logging, mining etc.).

The Keep River Plain and the Knox Creek Plain have been assigned low Wilderness Quality ratings, mostly between 1 and 9, but sections of the Weaber Plain include areas with ratings of 14 or higher.

The areas surrounding the Project Area are rated with scores above 12. These areas would be included in the conservation areas and, with the removal of cattle and the implementation of active management practices, it is expected that some areas would improve in quality, resulting in a higher rating for Wilderness Quality. Cattle have severely degraded a significant portion of the Project Area by grazing and trampling the vegetation.

#### **10.4.12 Combined and cumulative impacts**

In this ERMP/draft EIS the following definitions are used:

- ‘Combined effect’ refers to the impact on the local area and region due to construction and operation of the proposed development, other ORIA Stage 2 developments and existing ORIA Stage 1 activities;
- ‘Cumulative effect’ refers to the accumulation of effects over time, whether associated with the proposed development alone or in combination with other projects.

The cumulative effects associated with the proposed development relate to groundwater management issues which are addressed in Chapter 6, issues related to greenhouse gas emissions which are addressed in Chapter 13, and landscape ecology which will be addressed through the proposed monitoring programme.

There is currently only limited information available on the other ORIA Stage 2 development projects. Therefore, the comments provided below are only indicative of the possible outcomes of a more thorough combined effects assessment that would be possible only when details of proposed developments are published.

The potential issues include:

- effects of additional use of water from the Ord River for irrigated agriculture;
- regional vegetation clearance effects on plant species and associations and fauna habitats and therefore, on populations of fauna species.

Section 5.2 of this ERMP/draft EIS describes the process being adopted by the Water and Rivers Commission to address the combined effects of the Project and other developments on the ecology and other values of the lower Ord River. This process has commenced with the preparation by the Commission of the draft interim Water Allocation Plan for the Ord River and publication of this plan for public comment and advice of the EPA. Wesfarmers–Marubeni and the Water Corporation have assumed that the final (long-term) water allocation to the Project will be consistent with the interim allocations currently proposed by the Water and Rivers Commission.

Ecologia were commissioned in 1996 by the Department of Resources Development to undertake biological surveys of all the ORIA Stage 2 development areas, including the

Project Area and land suitable for horticultural development of the Riverside Development Areas of the Mantinea Flats, Carlton Plain and the Ord River West Bank area. A comparison of the results of these surveys, provided in Appendix K, shows that while there is a significant overlap between the floristic composition of these sites, the data analysis clearly separates the Project Area from the Riverside Development Areas. The strategy of conserving representative and reasonably sized viable portions of vegetation associations and fauna habitats in the Project Area should therefore be an effective means of mitigating combined regional vegetation clearance effects.

## **10.5 ENVIRONMENTAL MANAGEMENT**

An Environmental Management Plan (EMP) would be prepared prior to development to guide and mitigate any potential environmental impact associated with the proposed development. The EMP would consider both construction and operational activities. An outline of the EMP is discussed in Section 16.5 and presented in Appendix O.

### **10.5.1 Vegetation associations and fauna habitats**

To limit any potential for overclearing, all areas designated for construction works would be clearly marked on development maps and on the ground prior to commencement of works. Vegetation clearance would be staged so that areas are cleared only as required.

In Western Australia a 'Notice of Intention to Clear Land' would be issued to the Commissioner of Soil Conservation, in accordance with the requirements of the *Soil and Land Conservation Act 1945*. In the Northern Territory, an application would be made to the Department of Lands, Planning and Environment to clear land.

Designated conservation areas and vegetation buffers would be clearly established and monitored to ensure they remained undisturbed.

All contractors and consultants would be required to participate in a formal environmental and cultural heritage induction programme on the importance of the natural and social environment.

In Western Australia, an application would be lodged for permission from CALM, under the *Wildlife Conservation Act 1950*, to take Priority flora.

In the Northern Territory an application would be lodged with the Minister for Parks and Wildlife seeking permission to 'take' Specially Protected plants. Another application would be lodged with the Director, Parks and Wildlife for a non-commercial permit to take Protected Flora.

If seeds are collected for rehabilitation within the Project Area, an application would be made to CALM and the Parks and Wildlife Commission of the Northern Territory for a permit for each person undertaking the collection.

### **10.5.2 Fire**

A fire control strategy and plan would be developed for the farms and for the proposed conservation areas. This would include monitoring areas to determine the need for burning.

There is evidence to show that ‘fire stick farming’ was utilised widely by Aboriginal people prior to the European colonisation, and the practice continues across northern Australia. Typically, much of northern Australia has been burnt during the dry season, resulting in changes to the structure and composition of vegetation communities, including degradation of vine thickets and increased frequency of weeds (Government of Western Australia 1997a, b & c).

The preferred season for burning is the end of the wet season when the fires would be less severe (G. Graham, Department of Conservation and Land Management, Kununurra, pers.com., August 1999). This would clear the debris without harming the bushland.

Advice would be sought from CALM and the Parks and Wildlife Commission of the Northern Territory in the preparation of a Fire Management Plan for the Project Area, including the proposed conservation areas. This plan would take into account community assets, environmental values, fire frequency and season, and the impact that fire could have on human life (e.g. those at risk due to fire).

The Environmental Management Entity (see Chapter 16) would apply for membership of the Bushfires Council (Northern Territory).

### **10.5.3 Weeds**

Various mechanisms would be used to control the introduction of weeds to the Project Area. Mandatory interstate quarantine would be maintained to control weeds from other areas. During construction, all construction machinery would be cleaned of soil and other organic debris prior to being transported to the Project Area.

Once construction and development works are complete, each farmer would be responsible for the recognition and control of weeds on their property. The Environmental Management Entity would oversee the environmental management of the Project Area, including the identification of weeds in the Project Area, and provision of advice and assistance about control/eradication.

Acrolein has successfully been used for the control of aquatic weeds in ORIA Stage 1 for many years. Continued use of acrolein is currently subject to an Australia-wide review. Emergent vegetation such as Cumbungi would be restricted and controlled by the use of glyphosate-based herbicide applications (using formulations modified to reduce impact on frogs and other aquatic fauna), as well as mechanical control measures. Effective control of Cumbungi from the time of construction would limit the extent of any ongoing control programme.

If any Declared Weeds or new plants/weeds were introduced into the Project Area, the Weed Science Section of AGWEST, or the Department of Primary Industries and Fisheries (Northern Territory) would be consulted to ensure compliance with relevant legislation and to ensure implementation of appropriate control measures.

The Environmental Weed Strategy for Western Australia (Department of Conservation and Land Management, 1999) lists the environmental invasiveness and impacts of weeds in the Project Area (Table 10.10).

**Table 10.10 Environmental invasiveness and impacts of weeds in the Project Area**

Rating	Species	Common name	Environmental	
			Invasiveness	Impacts
High	<i>Acacia farnesiana</i>	Mimosa bush	Yes	Yes
High	<i>Aerva javanica</i>	Kapok bush	Yes	Yes
High	<i>Calotropis procera</i>	Calotrope, Rubber tree	Yes	Yes
High	<i>Cenchrus ciliaris</i>	Buffel grass	Yes	Yes
High	<i>Passiflora foetida</i>	Stinking Passionfruit	Yes	Yes
Moderate	<i>Clitonia ternata</i>		Yes	–
Moderate	<i>Leucaena leucocephala</i>	Leucaena	Yes	–
Moderate	<i>Parkinsonia aculeata</i>	Parkinsonia	Yes	Yes
Moderate	<i>Urochloa mutica</i>		Yes	–
Mild	<i>Echinochloa colona</i>		Yes	–

Source: Department of Conservation and Land Management (1999) *Environmental Weed Strategy for Western Australia*.

Invasiveness refers to the ability of the species to invade the bushland in good or excellent condition and environmental impacts refers to the ability to change the structure, composition and function of an ecosystem.

Those weeds with a ‘high’ rating indicated these weeds need to be prioritised for control. Those with a moderate rating indicates that control should be considered after those with ‘high’ rating. This strategy would determine the priorities for weed control in the conservation areas of the Project Area.

Details of the necessary monitoring would be developed in the EMP but, as a minimum, would include assessment of the abundance of indicator species, and the prevalence and rate of spread of weeds in the reserves and buffer areas.

Quarantine measures that would be implemented for the control of weeds include the following:

- Interstate quarantine would be maintained.
- During project development, all construction vehicles would be washed down to the standards required by AGWEST to prevent transportation of soils and/or weeds into the Project Area. A wash-down site would be established at the main entrance to the Project Area. All vehicles entering construction areas, even private cars, would be washed down to remove seeds and soil.
- All site vehicles would be site-dedicated as much as possible, thus limiting cross-contamination from outside areas.
- If borrow is required, it would be obtained from surveyed weed-free sites.

Currently, several invasive species have been recorded within the Project Area, including wild passionfruit and parkinsonia. Management of these species would be undertaken as part of the management of conservation areas.

#### 10.5.4 Feral and pest animals

Of the feral and pest vertebrates recorded for the Project Area, the Parks and Wildlife Commission of the Northern Territory has recognised the dingo as an important component of the region's ecosystems, although it can be a significant predator of livestock. Livestock would be removed from the Project Area and, therefore, the presence of this species should not continue to be a problem.

Donkeys, horses and cattle impact greatly on the vegetation along river frontages and other perennial water sources (Government of Western Australia 1997a). As river frontages would be conserved and the area destocked of cattle, it is anticipated that the condition of these areas would improve. CALM has undertaken a successful aerial shooting programme for donkeys at the Lower Ord Ramsar Site (Department of Conservation and Land Management 1998). Within the Project Area donkeys have been largely controlled by aerial shooting and only small populations have survived.

Rats and mice are rarely a problem in ORIA Stage 1 but management of these would be considered prior to the commencement of development. Wide-scale baiting and poisoning would be discouraged as three native *Rattus* species occur in the area, and the potential impact of baiting programmes on the native fauna is not fully understood. In the Herbert River canefields, Bellamy and Robinson (1998) noted that the number of owls in the area decreased as the area of cane-field increased. These birds catch and eat mice and rats. Halvorsen (1998) recorded that a 'single owl family can eat over 2,000 rats per year'. The need for owl nest-roost boxes would be assessed and, if required, incorporated in the Project Area.

Ecologia (1997) recorded feral cats in the Project Area. Cats as domestic pets are sometimes used for the control of mice and rats. In future, pet cats would be prohibited within the Project Area. The impact of cats on native fauna is substantial. They are exceptional predators and eat a wide range of native vertebrate and invertebrate animals reducing the populations of common and threatened native species. The Parks and Wildlife Commission of the Northern Territory and CALM are undertaking research on methods of cat eradication.

There is the potential to introduce animals that would have a damaging effect on some aspects of the biological environment. The spread of cane toad (*Bufo marinus*) from coastal Queensland across Northern Australia is an example. If the current rate of spread continues, the species may reach the Kimberley within the next ten years (Department of Conservation and Land Management 1998). However, it could occur before then if the species were inadvertently introduced into the region or the ORIA.

Mosquitoes are the vectors or potential vectors for several human diseases found across the Kimberley and Northern Australia, including Ross River virus, Barmah Forest virus and Australian encephalitis. In addition, they are nuisance pests. The public health issues associated with mosquito populations are discussed further in Chapter 14.

#### 10.5.5 Public access

A strategy for public access through the proposed conservation areas would be developed. Consideration would be given to developing walk-trails, rather than roads, with adequate parking facilities provided for vehicles. The trails would be obvious yet unobtrusive, well placed and clearly designated.

Areas in and around the Project Area are currently utilised for recreational and, in the case of Miriuwung and Gajerrong people, cultural purposes; however, with improved access, the incidence of human impact could increase as a result of the proposed development. Signage about the Project Area and surrounds, and defined roads or tracks to the more popular areas, should assist with management. At popular areas (e.g. Keep River) camp grounds complete with composting toilets may need to be established.

As required by CALM and the Parks and Wildlife Commission of the Northern Territory, dogs and cats would not be permitted in conservation areas.

#### **10.5.6 Borrow materials and rehabilitation**

Gravel and other borrow materials would be required for road construction and ongoing maintenance. There would be a preference for the utilisation of existing borrow pits and quarries within the Project Area as sources of these materials.

Rehabilitation of any sites disturbed during the proposed development would be undertaken progressively using seed of species collected from the Project Area. Areas disturbed during development of the infrastructure would be rehabilitated as each stage of the work is completed, particularly those drainage channels designated as conservation-vegetation corridors.

Where possible, topsoil would be utilised immediately or removed and stockpiled for later use on disturbed areas. Once the development was complete, the topsoil would be spread over the disturbed areas, allowing seeds and root stock stored in the soil to germinate and become established. Active reseeded of some areas may also take place. Monitoring of the success of rehabilitation would be undertaken.

A seed collection programme would be undertaken before vegetation is cleared. A seed mix appropriate to the area to be rehabilitated would be prepared and scattered over the disturbed areas. Alternatively, seedlings could be germinated and planted out at the commencement of the wet season. Only seeds of plant species endemic to the Project Area would be used in revegetation projects.

#### **10.5.7 Monitoring**

The EMP (Section 16.5 and Appendix O) would include a detailed monitoring component for each of the issues being managed. Some of the features associated with environmental monitoring being considered for use in the proposed development include:

- ongoing data collection to improve the national, State, Territory and local regional databases; biodiversity baselines; environmental effects understanding; and environmental risk assessment. Examples could include Gouldian Finch records and monitoring, additional records of rare and priority flora and fauna species, successful methods of removal of flora and fauna species;
- a rigorous quality assurance/quality control programme;
- justification (including cost estimates) for all monitoring components such as programme design, laboratory analysis, data acquisition, fieldwork, analysis and reporting, and communication and liaison;
- baseline, compliance monitoring;

- interactive feedback and mitigation requirements as part of a continuous improvement cycle;
- auditing requirements;
- community involvement and liaison, including regular reporting to the public and an ongoing schedule of meetings to discuss monitoring information and trends.