Submission by the Community Advisory Committee for the Gondwana Rainforests of Australia World Heritage Area

Re: the Draft Coastal Integrated Forestry Operations Approval (IFOA) and its cumulative impacts on the Gondwana Rainforests of Australia World Heritage Area

Background

The Gondwana Rainforests of Australia World Heritage Area (World Heritage Area) is a serial cross-jurisdictional World Heritage property, listed for its value to the global community, meeting the following criteria for listing:

> Criterion viii: to be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features;
>
> Criterion ix: to be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals;
>
> Criterion x: to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

Under the World Heritage Convention, there is an obligation to ensure the identification, protection, conservation, presentation, and rehabilitation where appropriate, of the area and its Outstanding Universal Value (OUV). Schedule 5 of the Environment Protection and Biodiversity Conservation Regulations 2000 states the management of a World Heritage Area should provide for continuing community input in management of the property.

The Community Advisory Committee (the Committee) to the World Heritage Area provides advice relating to the identification, management, protection, conservation, presentation, and transmission to future generations of the cultural and natural heritage of the World Heritage Area - from the viewpoint of the community - to the ministers with responsibilities for the World Heritage Area.

Summary

Members of the Committee have reviewed the Draft Coastal Integrated Forestry Operations Approval (IFOA) presently on public display. At its recent meeting, the Committee agreed to provide information and mapping images to support its submission and request enhanced protective measures for the World Heritage Area in the Draft IFOA (see Figure 1 for a complete mapping of the World Heritage Area in relation to the proposed logging zones.)

There is concern that the increase in proposed timber harvesting in NSW's coastal and inland forests adjacent to the World Heritage Area, and to areas that are outlined on Australia's Tentative List for addition to the World Heritage Area, will increase cumulative and significant impacts on the OUV of the World Heritage Area.

Specifically, there is concern that timber harvesting conducted under the Draft IFOA may:

- fragment, isolate or substantially damage habitat important for the conservation of biological diversity in the World Heritage Area itself;
- reduce or modify habitat for plant or animal species in forests adjacent to the World Heritage Area (p.16, Matters of National Environmental Significance: Significant Impact Guidelines 1.1, 2013 – attachment to this submission), and,
- dramatically affect the inherent intrinsic Aboriginal culture and heritage values present within the landscape. Impacts will affect both the tangible and intangible components of Aboriginal culture and heritage and this must be recognised by Government when developing policy directives regarding land management.

Consistent with the Australian World Heritage Management Principles, as outlined in the EPBC Act, the primary purpose of management of a World Heritage property **must be** the protection and management of World Heritage values. All activities occurring in properties adjacent to the World Heritage Area must be consistent with this. It therefore must be demonstrated that the proposed Draft IFOA activities will not significantly, and cumulatively, impact the World Heritage values.

The Committee asks the Minister to review the Draft IFOA from the perspective of ongoing responsible management and protection of our state's forests and their vital role in buffering the World Heritage Area from the cumulative impacts that selective logging of the old growth forests adjacent to the existing World Heritage Area will create.

Essential changes to the planned mapping exercise

The Committee advises that the planned mapping exercise to "*gain a better understanding of key state forest sites"* (Draft IFOA) must involve a fair and reasonable assessment from the perspective of the protection and management of the OUV of the World Heritage Area including:

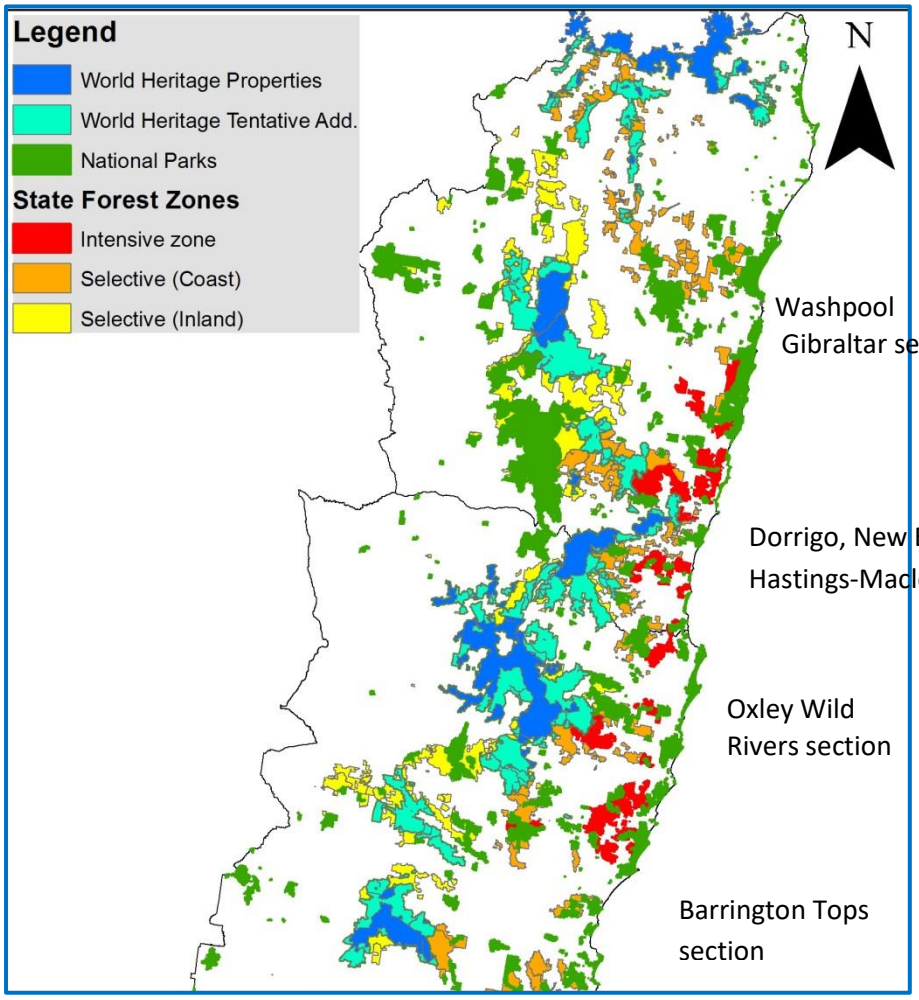
- identification of areas where EPBC requirements would be applied, noting that the EPBC Act provides the protective "buffer" for Matters of National Environmental Significance, including World Heritage;
- transparent assessment of whether the proposed activities may have a significant impact on World Heritage values which may trigger the EPBC Act, and,
- identification of actions to ensure there will be no significant impact on the OUV of the World Heritage Area and adjacent forests.

We understand that this would include:

- protection from timber harvesting for areas containing World Heritage values;
- assurance that high-level logging intensity is excluded from lands directly adjacent to the Gondwana Rainforests reserves (that is, buffers are maintained to ensure there are no significant cumulative impacts on the OUV of the World Heritage Area);
- protection from the impacts of adjacent timber harvesting for those areas already mapped and identified on Australia's World Heritage Tentative List for assessment as additions to the World Heritage Area;
- protection of Aboriginal culture and heritage;
- assessment of opportunities to link corridors between the World Heritage reserves, ensuring no interruptions to east west corridors that will be required as flora and fauna seek refugia from the impacts of climate change which continue to be demonstrated in current research programs;

- identification of key corridors and areas required to enhance the viability of NPWS Estate which contributes to the protection and management of the OUV of the Gondwana Rainforests (e.g. mobile and migratory species, pollen transfer);
- maintenance of existing stream buffer logging boundaries, and closure of old growth forests and stream forests to logging, thus ensuring there will be no increased erosion and sedimentation of streams.

Figure 1 (Below) Mapping of Draft IFOA proposed NSW logging zones in relation to the World Heritage Area. Intensive zone: means 45ha coupes clear-felled; Selective (coast/inland): means double the current harvesting rate. Source: Forestry Corporation, NPWS, and North East Forests Alliance (NEFA).



Key amendments to timber harvesting protocols

The Committee notes that a "no logging" option in old growth and forests adjoining the World Heritage Area has not been considered or evaluated in the Draft IFOA. Given the potential impacts on the species and habitats that have been identified as being of World Heritage significance, the Committee argues that the retention of old growth forests is urgently needed to conserve World Heritage and biodiversity, to maintain crucial ecosystem services, and for future forest growth in protected areas. In support of the Committee's viewpoint, recent data argues strongly for 'a global nature conservation strategy with "a focus on ends, not just means, with measurable targets for the

retention of nature to avoid an irreversibly impoverished natural world" (Maron, Simmonds and Watson 2018).

The Committee finds it alarming that the Draft IFOA proposes that each intensive harvesting coupe can be up to 45 ha in size, with clumps to be retained covering only 10 to 13% of the coupe, and adjoining 45 ha coupes can be clearfelled 10 years later. Clearfelling these adjacent coupes again in 30 years is planned on the grounds that it will facilitate "*improved regeneration outcomes by maximising light and preparing the seed bed through soil disturbance*" (Draft IFOA).

Lutz, et al (2018) builds on other long term research to confirm the relationship between large-diameter trees and overall forest function to be a vital one, suggesting that forests without old growth large trees cannot sequester large amounts of aboveground carbon, and they have reduced structural heterogeneity. Most importantly, large diameter old growth trees provide a buffer for all species within the forest, assisting in maintaining other ecosystem functions.

Logging trees of >140cm diameter will effectively remove old growth trees from NSW forests, the cumulative impacts of which will deeply affect both faunal and floral species. There is an urgent need for stringent and enforceable protections to be put in place to ensure the long-term protection of buffering forests, and thus, the outstanding universal value of the World Heritage Area.

Key impacts on hydrology and soils in the World Heritage property

The Draft IFOA states timber harvesting will occur to within 5 metres of streams and rivers - a substantial decrease in current stream buffer zones. The Committee believes that this will increase soil erosion and creek sedimentation. The Committee is also concerned that long established exclusion areas along numerous streams which have provided protection for recorded threatened frogs and other species are to be removed.

In addition to what will be loss of key threatened species from these riparian zones, it is clear to the Committee that gullying, mass movement and sedimentation can potentially take place in these environments if disturbance crosses particular environmental thresholds. Given the scale of the proposed forestry works and their probable impact on both the forest streams and canopy, the question of soil erosion and sedimentation needs to be addressed as, once the hydrological system has been changed by erosion, it is effectively impossible to return the landscape to its original condition. The environmental consequences of such a shift in ecosystem balance will be dramatic.

The following document is attached to the Committee's submission and may assist the Minister and the Forests NSW to address this issue:
Thompson, B. (2007) *The distribution of erosion in the upper catchments of the Logan and Albert Rivers*. Report prepared by Land Resource Assessment and Management Pty Ltd. for Logan and Albert Catchment Assoc. Inc. and Southeast Queensland Catchments.

In summary, the Committee believes that the Draft IFOA is inconsistent with the commitments NSW made under the National Forest Policy Statement in 1992, including the concept of ecologically sustainable forest management. As the Draft IFOA is to be consistent with the Upper North East Forestry Agreement with the Australian Government, we suggest further measures need to be included to ensure the protection and management of the Gondwana Rainforests is consistent with EPBC requirements, and hence the World Heritage Convention.

The Committee provides a copy of the Statement of Outstanding Universal Value for the Gondwana Rainforests of Australia World Heritage Area as an attachment to the submission document. We request that these values be held in mind when areas of forest are being assessed for logging. The Committee also strongly advocates for the Forestry Commission to consider recommending forest areas exhibiting those values for possible inclusion in current and future extensions to the World Heritage Area.

There are also significant concerns about possible impacts on the Aboriginal cultural heritage within and around the forests facing changed timber harvesting regimes. Affected Lands Councils need to be involved in the development of protocols and be able to provide guidance on matters of identification, protection, and maintenance of this cultural heritage.

The Committee appreciates the opportunity to provide advice on aspects of the Draft IFOA, and would be happy to provide further clarification or advice, as required.

Yours sincerely,

[redacted]

Dr Mahri Koch
Chair, Community Advisory Committee
Gondwana Rainforests of Australia World Heritage Area
[redacted]

References

Department of Environment. (2013) Matters of National Environmental Significance: Significant Impact Guidelines 1.1 – Environment Protection and Biodiversity Conservation Act 1999. Commonwealth of Australia.

Lutz et al. (2018) *Global Importance of large- diameter Trees*. Global Ecology and Biogeography.

Maron, Simmonds and Watson. (2018) *Bold Nature Retention Targets are Essential for the Global Environment Agenda*. Nature Ecology and Evolution.

Thompson, B. (2007) *The distribution of erosion in the upper catchments of the Logan and Albert Rivers*. Report prepared by Land Resource Assessment and Management Pty Ltd. for Logan and Albert Catchment Assoc. Inc. and SEQ Catchments.

Australian Government

Department of the Environment

Matters of National Environmental Significance

Significant impact guidelines 1.1

Environment Protection and Biodiversity Conservation Act 1999

Photo:
Front – Budgee Creek in the Barmah State Forest (John Baker)
Back – Carnaby's black cockatoo (Leonie McMahon)

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Introduction

The purpose of these guidelines is to assist any person who proposes to take an action to decide whether or not they should submit a referral to the Australian Government Department of the Environment (the Department) for a decision by the Australian Government Environment Minister (the minister) on whether assessment and approval is required under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)[1].

Under the EPBC Act an action will require approval from the minister if the action has, will have, or is likely to have, a significant impact on a matter of national environmental significance.

These guidelines outline a 'self-assessment' process, including detailed criteria, to assist persons in deciding whether or not referral may be required. Important terms and phrases are explained in the shaded boxes. The appendix to the guidelines provides further assistance for specific industry sectors.

These guidelines may also assist members of the public or interest groups who wish to comment on actions which have been referred under the EPBC Act.

[1] Note that an action does not require approval under the EPBC Act if it meets the criteria for the 'prior authorisation' or 'continuing use' exemptions. These criteria are explained in the Practice Guide entitled *Prior Authorisation and Continuing Use Exemptions – Sections 43A and 43B*, available on the Department's web site at: **www.environment.gov.au/epbc/publications/exemptions.html**
Further exemptions include:

- certain activities allowed in the Great Barrier Reef Marine Park "as of right" (that is, without a permission) under a *Great Barrier Reef Marine Park Act 1975* (GBRMP Act) zoning plan (EPBC Act section 43)
- certain forestry operations in Regional Forestry Agreement Areas (EPBC Act section 42), and
- certain actions requiring separate authorisation by an Australian Government agency or employee and subject to an alternative assessment and advice process under section 160 of the EPBC Act

What is an action?

'Action' is defined broadly in the EPBC Act and includes: a project, a development, an undertaking, an activity or a series of activities, or an alteration of any of these things.

Actions include, but are not limited to: construction, expansion, alteration or demolition of buildings, structures, infrastructure or facilities; industrial processes; mineral and petroleum resource exploration and extraction; storage or transport of hazardous materials; waste disposal; earthworks; impoundment, extraction and diversion of water; agricultural activities; aquaculture; research activities; vegetation clearance; culling of animals; and dealings with land.

Actions encompass site preparation and construction, operation and maintenance, and closure and completion stages of a project, as well as alterations or modifications to existing infrastructure.

An action may have both beneficial and adverse impacts on the environment, however only adverse impacts on matters of national environmental significance are relevant when determining whether approval is required under the EPBC Act.

What are matters of national environmental significance?

The matters of national environmental significance are:

- world heritage properties
- national heritage places
- wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed)
- nationally threatened species and ecological communities
- migratory species
- Commonwealth marine areas
- the Great Barrier Reef Marine Park
- nuclear actions (including uranium mining)
- a water resource, in relation to coal seam gas development and large coal mining development.

A person who proposes to take an action that will have, or is likely to have, a significant impact on a matter of national environmental significance must refer that action to the minister for a decision on whether assessment and approval is required under the EPBC Act. Substantial penalties apply for taking such an action without approval (civil penalties up to $5.5 million or criminal penalties up to seven years imprisonment).

What is a significant impact?

A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. You should consider all of these factors when determining whether an action is likely to have a significant impact on matters of national environmental significance.

When is a significant impact likely?

To be 'likely', it is not necessary for a significant impact to have a greater than 50% chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.

If there is scientific uncertainty about the impacts of your action and potential impacts are serious or irreversible, the precautionary principle is applicable. Accordingly, a lack of scientific certainty about the potential impacts of an action will not itself justify a decision that the action is not likely to have a significant impact on the environment.

What is a referral?

'Referral' of an action involves filling out a referral form and sending it to the Department of the Environment. A referral identifies the person proposing to take the action and includes a brief description of the proposal, the project location, the nature and extent of any potential impacts, and any proposed mitigation measures. The EPBC Act referral process is outlined in more detail at the end of these guidelines.

If you represent a Commonwealth agency or you propose to take an action which is either situated on Commonwealth land or which may impact upon Commonwealth land, you should also refer to the *Significant impact guidelines 1.2: Actions on, or impacting upon, Commonwealth land and actions by Commonwealth agencies*. However, if referral is necessary, you need only submit one referral that includes all relevant matters.

Determining whether an action is likely to have a significant impact on a matter of national environmental significance

These guidelines are intended to assist you in undertaking a 'self-assessment' to decide whether or not your action is likely to have a significant impact on any matters of national environmental significance. Your self-assessment should be as objective as possible and based on sufficient information to make an informed judgement. If you complete a self-assessment and you are still unsure whether the action you propose to take is likely to have a significant impact on a matter of national environmental significance then you should refer the action to the Department of the Environment. In considering taking this step, you may like to discuss the matter with the Department's referral business entry point. The referral business entry point can be contacted through the Department's community information unit on **1800 803 772** or by emailing **epbc.referrals@environment.gov.au**

To make a decision as to whether or not to refer an action to the Minister, you should consider the following:

1. Are there any matters of national environmental significance located in the area of the proposed action (noting that 'the area of the proposed action' is broader than the immediate location where the action is undertaken; consider also whether there are any matters of national environmental significance adjacent to or downstream from the immediate location that may potentially be impacted)?
2. Considering the proposed action at its broadest scope (that is, considering all stages and components of the action, and all related activities and infrastructure), is there potential for impacts, including indirect impacts, on matters of national environmental significance?
3. Are there any proposed measures to avoid or reduce impacts on matters of national environmental significance (and if so, is the effectiveness of these measures certain enough to reduce the level of impact below the 'significant impact' threshold)?
4. Are any impacts of the proposed action on matters of national environmental significance likely to be significant impacts (important, notable, or of consequence, having regard to their context or intensity)?

1. Are there any matters of national environmental significance located in the area of the proposed action?

The EPBC Act protected matters search tool allows you to search for matters of national environmental significance in an area where you propose to take an action[2]. The search tool is located on the Department's web site: **www.environment.gov.au/erin/ert/epbc/index.html**

Lists of threatened species and ecological communities can be accessed from the following web page: **www.environment.gov.au/epbc/protect/species-communities.html**

A list of migratory species can be accessed from the following web page: **www.environment.gov.au/epbc/protect/migratory.html**

A list of Australia's Ramsar Wetlands and a map showing their location can be accessed from the following web page: **www.environment.gov.au/epbc/protect/wetlands.html**

Information about the Commonwealth marine environment can be found at: **www.environment.gov.au/epbc/protect/marine.html**

A list of Australia's World Heritage properties and a map showing their general location can be found at: **www.environment.gov.au/epbc/protect/heritage.html**

A list of National Heritage places and a map showing their general location can be found at: **www.environment.gov.au/epbc/protect/heritage.html**

Information about the Great Barrier Reef Marine Park can be found at **www.gbrmpa.gov.au**

Information about a water resource, in relation to coal seam gas development and large coal mining development can be found at **www.environment.gov.au/epbc/about/water-trigger.html**.

2 In relation to listed threatened species and ecological communities and listed migratory species, the EPBC Act protected matters search tool is intended to be of guidance only and should not be regarded as definitive. Surveys in the area where you propose to take an action can assist in verifying the results of the EPBC Act protected matters search tool. It is also important to note that some species may be detectable at certain times of the year only. Surveys should be timed appropriately, and undertaken for a suitable period by a qualified person.

2. Considering the proposed action at its broadest scope, is there potential for impacts on matters of national environmental significance?

If there are matters of national environmental significance in the vicinity of your proposed action, you need to consider whether there is potential for your proposed action to impact upon those matters.

The proposed action should be considered at its broadest possible scope. This includes all stages and components of the action, all related activities, and all related infrastructure such as roads and powerlines, if applicable.

If the action consists of a series of activities or a number of related activities, you should consider the impacts of each activity, and then consider the combined impacts of those activities.

It is also necessary and important to consider off-site and indirect impacts of your proposed action on matters of national environmental significance (refer to shaded box on page 6).

3. Are there any proposed measures to avoid or reduce impacts on matters of national environmental significance?

It is important to consider the environmental impacts of the proposed action early in the planning of the proposal. Careful planning of the action can avoid, or reduce, the likelihood of a significant impact on matters of national environmental significance. Where possible and practicable it is best to avoid impacts. If impacts cannot be avoided then they should be minimised or mitigated as much as possible.

You should consider impacts on matters of national environmental significance in relation to the following:

- site selection and the location of buildings or activities on the selected site
- the timing of the action or its component activities, and
- the design of any buildings, or other structures or infrastructure.

However you should not conclude that a significant impact is not likely to occur because of management or mitigation measures unless the effectiveness of those measures is well-established (for example through demonstrated application, studies or surveys) and there is a high degree of certainty about the avoidance of impacts or the extent to which impacts will be reduced.

4. Are any impacts of the proposed action on matters of national environmental significance likely to be significant impacts?

In order to decide whether an action is likely to have a significant impact, it is necessary to take into account the nature and magnitude of potential impacts. In determining the nature and magnitude of an action's impacts, it is important to consider matters such as:

- the sensitivity of the environment which will be impacted
- the timing, duration and frequency of the action and its impacts
- all on-site and off-site impacts
- all direct and indirect impacts
- the total impact which can be attributed to the action over the entire geographic area affected, and over time
- existing levels of impact from other sources, and
- the degree of confidence with which the impacts of the action are known and understood.

Indirect and offsite impacts

When considering whether or not an action is likely to have a significant impact on a matter of national environmental significance it is relevant to consider all adverse impacts which result from the action, including indirect and offsite impacts.

Indirect and offsite impacts include:

a. 'downstream' or 'downwind' impacts, such as impacts on wetlands or ocean reefs from sediment, fertilisers or chemicals which are washed or discharged into river systems;

b. 'upstream impacts' such as impacts associated with the extraction of raw materials and other inputs which are used to undertake the action; and

c. 'facilitated impacts' which result from further actions (including actions by third parties) which are made possible or facilitated by the action. For example, the construction of a dam for irrigation water facilitates the use of that water by irrigators with associated impacts. Likewise, the construction of basic infrastructure in a previously undeveloped area may, in certain circumstances, facilitate the urban or commercial development of that area[3].

Consideration should be given to all adverse impacts that could reasonably be predicted to follow from the action, whether these impacts are within the control of the person proposing to take the action or not. Indirect impacts will be relevant where they are sufficiently close to the proposed action to be said to be a consequence of the action, and they can reasonably be imputed to be within the contemplation of the person proposing to take the action.

It may be helpful to consider the following:

- 'But for' the proposed action would the indirect impacts occur?
- Is the proposed action a 'material and substantial' cause of the indirect impacts?
- Are the potential impacts of any subsequent or third party actions known, or would they be expected to be known, by the person proposing to take the action (particularly where the subsequent or third party actions are an intended outcome of the proposed action)?

If the answer to these questions is 'yes', then it is necessary to consider whether these impacts are likely to occur, and whether they are likely to have a significant impact on a matter of national environmental significance. If so, as much information as possible should be provided to assist the minister in determining whether the impacts are relevant, and whether approval under the EPBC Act is required.

Notes:

- When deciding whether or not a proposed action is likely to have a significant impact on a matter of national environmental significance, the precautionary principle is relevant. Accordingly, where there is a risk of **serious** or **irreversible** damage, a lack of scientific certainty about the potential impacts of an action will not itself justify a decision that the action is not likely to have a significant impact on a matter of national environmental significance.
- When deciding whether or not a proposed action is likely to have a significant impact on a matter of national environmental significance, you should consider only the adverse impacts that the action is likely to have. Beneficial impacts cannot be offset against adverse impacts. For example, a hydro-electricity scheme may have both beneficial and adverse impacts on the environment, however, only the adverse impacts are relevant when determining whether approval is required under the EPBC Act. If a project does require approval, beneficial impacts are considered during the assessment and approvals stages of the process.

3 Note that consideration of the impacts of 'facilitated actions' during the assessment and approval of the original action has no effect on the requirement of the proponent of the facilitated action to make a referral when that action eventuates, if that action will have, or is likely to have, a significant impact on a matter of national environmental significance.

Significant impact criteria

The 'significant impact criteria', set out on the following pages, for each matter of national environmental significance, are intended to assist you in determining whether the impacts of your proposed action on any matter of national environmental significance are likely to be significant impacts.

The criteria are intended to provide general guidance on the types of actions that will require approval and the types of actions that will not require approval. They are not intended to be exhaustive or definitive. If you are still unsure whether the action you propose to take is likely to have a significant impact on a matter of national environmental significance you should refer the action to the Department of the Environment for a binding decision on whether approval is required.

The particular facts and circumstances of a proposed action will need to be taken into account in determining whether that action is likely to have a significant impact on a matter of national environmental significance. Remember that the general test for significance is whether an impact is 'important, notable or of consequence, having regard to its context or intensity'.

Listed threatened species and ecological communities

An action will require approval if the action has, will have, or is likely to have a significant impact on a species listed in any of the following categories:

- extinct in the wild
- critically endangered
- endangered, or
- vulnerable.

An action will also require approval if the action has, will have, or is likely to have a significant impact on an ecological community listed in any of the following categories:

- critically endangered, or
- endangered.

Notes:

- Species in the extinct and conservation dependant categories of species listed under the EPBC Act, and listed ecological communities in the vulnerable category of ecological communities listed under the EPBC Act, are not matters of national environmental significance for the purposes of Part 3 of the EPBC Act (requirements for environmental approvals).
- Species and ecological communities listed under the EPBC Act may differ from those listed under State and Territory legislation. This is due to the different status of some species and ecological communities in the different States and Territories, and nationally.

Extinct in the wild species

Significant impact criteria

An action is likely to have a significant impact on extinct in the wild species if there is a real chance or possibility that it will:

- adversely affect a captive or propagated population or one recently introduced/reintroduced to the wild, or
- interfere with the recovery of the species or its reintroduction into the wild.

Critically endangered and endangered species

Significant impact criteria

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of a population
- reduce the area of occupancy of the species
- fragment an existing population into two or more populations
- adversely affect habitat critical to the survival of a species
- disrupt the breeding cycle of a population
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat
- introduce disease that may cause the species to decline, or
- interfere with the recovery of the species.

What is a population of a species?

A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- a geographically distinct regional population, or collection of local populations, or
- a population, or collection of local populations, that occurs within a particular bioregion.

What is an invasive species?

An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.

What is habitat critical to the survival of a species or ecological community?

'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- to maintain genetic diversity and long term evolutionary development, or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

Vulnerable species

Significant impact criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species
- reduce the area of occupancy of an important population
- fragment an existing important population into two or more populations
- adversely affect habitat critical to the survival of a species
- disrupt the breeding cycle of an important population
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- introduce disease that may cause the species to decline, or
- interfere substantially with the recovery of the species.

What is an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

Critically endangered and endangered ecological communities

Significant impact criteria

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

- reduce the extent of an ecological community
- fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines
- adversely affect habitat critical to the survival of an ecological community
- modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns
- cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting
- cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
  - assisting invasive species, that are harmful to the listed ecological community, to become established, or
  - causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or
- interfere with the recovery of an ecological community.

Further information on listed threatened species and ecological communities

The following information on listed threatened species and ecological communities is available on the Department's web site:

- General information: **www.environment.gov.au/biodiversity/threatened/index.html**
- Copies of recovery plans and threat abatement plans:
  www.environment.gov.au/biodiversity/threatened/recovery.html
  www.environment.gov.au/biodiversity/threatened/tap/index.html
- Species profile and threats database (information about individual listed threatened species and ecological communities): **www.environment.gov.au/sprat**

Listed migratory species

An action will require approval if the action has, will have, or is likely to have a significant impact on a listed migratory species. Note that some migratory species are also listed as threatened species. The criteria below are relevant to migratory species that are not threatened.

Significant impact criteria

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species
- result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

What is important habitat for a migratory species?

An area of 'important habitat' for a migratory species is:

a. habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or

b. habitat that is of critical importance to the species at particular life-cycle stages, and/or

c. habitat utilised by a migratory species which is at the limit of the species range, and/or

d. habitat within an area where the species is declining.

What is an ecologically significant proportion?

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an 'ecologically significant proportion' of the population varies with the species (each circumstance will need to be evaluated). Some factors that should be considered include the species' population status, genetic distinctiveness and species specific behavioural patterns (for example, site fidelity and dispersal rates).

What is the population of a migratory species?

'Population', in relation to migratory species, means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries including Australia.

Further information on Listed Migratory Species

- General information on listed migratory species is available on the Department's website: **www.environment.gov.au/epbc/protect/migratory.html**

Wetlands of international Importance

Approval is required for an action occurring within or outside a declared Ramsar wetland if the action has, will have, or is likely to have a significant impact on the ecological character of the Ramsar wetland.

A 'declared Ramsar wetland' is an area that has been designated under Article 2 of the Ramsar Convention or declared by the minister to be a declared Ramsar wetland under section 16 of the EPBC Act.

The 'ecological character' is the combination of the ecosystem components, processes and benefits/ services that characterise the wetland at a given point in time. The phrase 'at a given point in time' refers to the time of designation for the Ramsar List.

Descriptions of the ecological character of listed Ramsar wetlands can be obtained from the Australian wetlands database at: **www.environment.gov.au/water/wetlands/database/index.html**

Significant impact criteria

An action is likely to have a significant impact on the ecological character of a declared Ramsar wetland if there is a real chance or possibility that it will result in:

- areas of the wetland being destroyed or substantially modified
- a substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland
- the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependant upon the wetland being seriously affected
- a substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health, or
- an invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland.

Further information on Ramsar wetlands

The following information on Ramsar wetlands is available on the Department's web site:

- General information: **www.environment.gov.au/epbc/protect/wetlands.html**
- Ramsar wetlands fact sheet (including list and general location map): **www.environment.gov.au/water/publications/environmental/wetlands/ramsar.html**
- Australian wetlands database (including location maps and information for individual wetlands): **www.environment.gov.au/water/wetlands/database/index.html**

The Commonwealth marine environment

An action will require approval if:

- the action is taken in a Commonwealth marine area and the action has, will have, or is likely to have a significant impact on the environment, or
- the action is taken outside a Commonwealth marine area and the action has, will have, or is likely to have a significant impact on the environment in a Commonwealth marine area.

A 'Commonwealth marine area' is defined in section 24 of the EPBC Act. Maps showing Commonwealth marine areas are available through the Department's website at **www.environment.gov.au/epbc/protect/marine.html** or by contacting the Department's community information unit on 1800 803 772.

Marine protected areas are marine areas which are recognised to have high conservation value. Actions in or near marine protected areas, or other areas with high conservation value, have a greater likelihood of significant impacts on the Commonwealth marine environment. A map of marine protected areas is available on the Department's web site:
www.environment.gov.au/coasts/mpa/index.html

Significant impact criteria

An action is likely to have a significant impact on the environment in a Commonwealth marine area if there is a real chance or possibility that the action will:

- result in a known or potential pest species becoming established in the Commonwealth marine area
- modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results
- have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution
- result in a substantial change in air quality[4] or water quality (including temperature) which may adversely impact on biodiversity, ecological integrity; social amenity or human health
- result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected, or
- have a substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck.

Further information on Commonwealth marine areas

The following information relevant to Commonwealth marine areas is available on the Department's web site:

- General information: **www.environment.gov.au/epbc/protect/marine.html**

World Heritage properties

Approval under the EPBC Act is required for any action occurring within or outside a declared World Heritage property that has, will have, or is likely to have a significant impact on the World Heritage values of the World Heritage property.

A 'declared World Heritage property' is an area that has been included in the World Heritage list or declared by the minister to be a World Heritage property. World Heritage properties are places with natural or cultural heritage values which are recognised to have outstanding universal value.

Example of World Heritage values – Kakadu National Park World Heritage property

The Kakadu National Park World Heritage property, located in the far north of Australia's Northern Territory, has both natural and cultural World Heritage values. These values include:

- diverse, expansive and relatively undisturbed natural landscapes, including coastal areas, river systems and floodplains, lowlands, wetlands, plateau complexes, escarpments and outliers
- diverse and relatively unmodified vegetation types, including open mangrove swamps, forest and woodlands, lowland and sandstone rainforests, shrubland and heath, wetland, riverine, floodplain and coastal vegetation
- diverse, endemic, relict and abundant plant and animal species
- extensive and diverse habitats, including open forest and woodlands, monsoon rainforest areas, heaths and shrublands, freshwater wetlands, mangrove and estuarine areas, foreshore and beach areas
- significant plant associations and plants with conservation significance
- animals with conservation significance, including mammals, reptiles, birds, invertebrates and fish
- exceptional natural beauty
- outstanding, diverse, unique and ancient Indigenous archaeological remains and rock art recording a continuous cultural development and environmental change, and
- a rich collection of Indigenous cultural sites with strong spiritual associations and connections to continuing practice of traditional beliefs.

A more comprehensive description of the World Heritage values of Kakadu National Park World Heritage Area can be found at: **www.environment.gov.au/heritage/places/world/kakadu/values.html**

4 The Commonwealth marine area includes any airspace over Commonwealth waters.

Significant impact criteria

An action is likely to have a significant impact on the World Heritage values of a declared World Heritage property if there is a real chance or possibility that it will cause:

- one or more of the World Heritage values to be lost
- one or more of the World Heritage values to be degraded or damaged, or
- one or more of the World Heritage values to be notably altered, modified, obscured or diminished.

Examples

The following examples provide an indication of levels of impact on World Heritage values that are likely to be significant. They are not intended to be exhaustive.

World Heritage properties with natural heritage values

An action is likely to have a significant impact on natural heritage values of a World Heritage property if there is a real chance or possibility that the action will:

Values associated with geology or landscape	• damage, modify, alter or obscure important geological formations in a World Heritage property • damage, modify, alter or obscure landforms or landscape features, for example, by excavation or infilling of the land surface in a World Heritage property • modify, alter or inhibit landscape processes, for example, by accelerating or increasing susceptibility to erosion, or stabilising mobile landforms, such as sand dunes, in a World Heritage property • divert, impound or channelise a river, wetland or other water body in a World Heritage property, and • substantially increase concentrations of suspended sediment, nutrients, heavy metals, hydrocarbons, or other pollutants or substances in a river, wetland or water body in a World Heritage property.
Biological and ecological values	• reduce the diversity or modify the composition of plant and animal species in all or part of a World Heritage property • fragment, isolate or substantially damage habitat important for the conservation of biological diversity in a World Heritage property • cause a long-term reduction in rare, endemic or unique plant or animal populations or species in a World Heritage property, and • fragment, isolate or substantially damage habitat for rare, endemic or unique animal populations or species in a World Heritage property.

Wilderness, natural beauty or rare or unique environment values	
	• involve construction of buildings, roads, or other structures, vegetation clearance, or other actions with substantial, long-term or permanent impacts on relevant values, and • introduce noise, odours, pollutants or other intrusive elements with substantial, long-term or permanent impacts on relevant values.

World Heritage properties with cultural heritage values

An action is likely to have a significant impact on cultural heritage values of a World Heritage property if there is a real chance or possibility that the action will:

Historic heritage values	
	• permanently remove, destroy, damage or substantially alter the fabric[5] of a World Heritage property • extend, renovate, refurbish or substantially alter a World Heritage property in a manner which is inconsistent with relevant values • permanently remove, destroy, damage or substantially disturb archaeological deposits or artefacts in a World Heritage property • involve activities in a World Heritage property with substantial and/or long-term impacts on its values • involve construction of buildings or other structures within, adjacent to, or within important sight lines of, a World Heritage property which are inconsistent with relevant values, and • make notable changes to the layout, spaces, form or species composition in a garden, landscape or setting of a World Heritage property which are inconsistent with relevant values.

5 'Fabric' means physical material including structural elements and other components, fixtures, fittings, contents and items with historic value

Other cultural heritage values including Indigenous heritage values	• restrict or inhibit the existing use of a World Heritage property as a cultural or ceremonial site causing its values to notably diminish over time; • permanently diminish the cultural value of a World Heritage property for a community or group to which its values relate • alter the setting of a World Heritage property in a manner which is inconsistent with relevant values • remove, damage, or substantially disturb cultural artefacts, or ceremonial objects, in a World Heritage property, and • permanently damage or obscure rock art or other cultural or ceremonial features with World Heritage values.

Notes:

- The above examples are general examples and their application will depend on the individual values of each World Heritage property. Alteration or disturbance which is small in scale may have a significant impact if a feature or component of a World Heritage property embodies values that are particularly sensitive or important.
- To have a significant impact on World Heritage values, it is not necessary for an action to impact upon the whole of a World Heritage property, all of the values of a World Heritage property, or a whole value of a World Heritage property. It is sufficient if an action is likely to have a significant impact on a part, element, or feature of a World Heritage property, which embodies, manifests, shows, or contributes to the values of that property.

Further Information on World Heritage properties

The following information on World Heritage properties is available on the Department's web site:

- General information: **www.environment.gov.au/heritage/about/world/index.html**

National Heritage places

Approval under the EPBC Act is required for any action occurring within, or outside, a National Heritage place that has, will have, or is likely to have a significant impact on the National Heritage values of the National Heritage place.

The National Heritage List contains places or groups of places with outstanding heritage value to Australia – whether natural, Indigenous or historic[6] or a combination of these.

Example of National Heritage values—Brewarrina Aboriginal fish traps (Baiames Ngunnhu)

The Brewarrina Aboriginal fish traps on the Barwon River in New South Wales, have indigenous National Heritage values. These values include:

- providing an example of a dry-stone fish trap of rare size, design and complexity
- demonstrating an unusual and innovative development in pre-European Aboriginal technology, which exhibits a thorough understanding of dry stone wall construction techniques, river hydrology and fish ecology
- providing a strong social, cultural and spiritual association with Aboriginal people
- demonstrating a delineation of responsibility for use and maintenance of particular traps between different aboriginal groups under Aboriginal law in accordance with the wishes of the ancestral creation being, Baiame
- historical and current use as a significant meeting place for Aboriginal people with connections to the area, and
- demonstrating an unusual aspect of Indigenous tradition, arising from the association between an ancestral being and the creation of the built structures of the fish traps.

A more comprehensive description of the National Heritage values of the Brewarrina Aboriginal Fish Traps can be found at: **www.environment.gov.au/heritage/places/national/brewarrina/index.html**

Significant impact criteria

An action is likely to have a significant impact on the National Heritage values of a National Heritage place if there is a real chance or possibility that it will cause:

- one or more of the National Heritage values to be lost
- one or more of the National Heritage values to be degraded or damaged, or
- one or more of the National Heritage values to be notably altered, modified, obscured or diminished.

6 For historic built heritage places in the National Heritage List that are within the Australian jurisdiction, approval will be required where an action that has, will have or is likely to have a significant impact on the National Heritage values of the place will be taken by: a constitutional corporation; the Commonwealth or a Commonwealth agency; or a person for the purposes of trade or commerce between Australia and another country, between States, between Territories, or between a State and a Territory. There are no restrictions on the application of the EPBC Act in relation to natural or Indigenous heritage places in the National Heritage List, or places in a Commonwealth area or Territory, or outside the Australian jurisdiction.

Examples

The following examples provide an indication of levels of impact on National Heritage values that are likely to be significant. They are not intended to be exhaustive.

National Heritage places with natural heritage values

An action is likely to have a significant impact on natural heritage values of a National Heritage place if there is a real chance or possibility that the action will:

Values associated with geology or landscapes	• damage, modify, alter or obscure important geological formations in a National Heritage place • damage, modify, alter or obscure landforms or landscape features, for example, by clearing, excavating or infilling the land surface in a National Heritage place • modify, alter or inhibit landscape processes, for example, by accelerating or increasing susceptibility to erosion, or stabilising mobile landforms, such as sand dunes in a National Heritage place • divert, impound or channelise a river, wetland or other water body in a National Heritage place, and • substantially increase concentrations of suspended sediment, nutrients, heavy metals, hydrocarbons, or other pollutants or substances in a river, wetland or water body in a National Heritage place; permanently damage or obscure rock art or other cultural or ceremonial features with World Heritage values.
Biological and ecological values	• modify or inhibit ecological processes in a National Heritage place • reduce the diversity or modify the composition of plant and animal species in a National Heritage place • fragment or damage habitat important for the conservation of biological diversity in a National Heritage place • cause a long-term reduction in rare, endemic or unique plant or animal populations or species in a National Heritage place, and • fragment, isolate or substantially damage habitat for rare, endemic or unique animal populations or species in a National Heritage place.

Wilderness, aesthetic, or other rare or unique environment values	• involve construction of buildings, roads or other structures, vegetation clearance, or other actions with substantial and/or long-term impacts on relevant values, and • introduce noise, odours, pollutants or other intrusive elements with substantial and/or long-term impacts on relevant values.

National Heritage places with cultural heritage values

An action is likely to have a significant impact on historic heritage values of a National Heritage place if there is a real chance or possibility that the action will:

Historic heritage values	• permanently remove, destroy, damage or substantially alter the fabric[7] of a National Heritage place in a manner which is inconsistent with relevant values • extend, renovate, refurbish or substantially alter a National Heritage place in a manner which is inconsistent with relevant values • permanently remove, destroy, damage or substantially disturb archaeological deposits or artefacts in a National Heritage place • involve activities in a National Heritage place with substantial and/or long-term impacts on its values • involve the construction of buildings or other structures within, adjacent to, or within important sight lines of, a National Heritage place which are inconsistent with relevant values, and • make notable changes to the layout, spaces, form or species composition of a garden, landscape or setting of a National Heritage place in a manner which is inconsistent with relevant values.
Other cultural heritage values	• restrict or inhibit the continuing use of a National Heritage place as a cultural or ceremonial site causing its values to notably diminish over time • permanently diminish the cultural value of a National Heritage place for a community or group to which its National Heritage values relate • destroy or damage cultural or ceremonial, artefacts, features, or objects in a National Heritage place, and • notably diminish the value of a National Heritage place in demonstrating creative or technical achievement.

7 'Fabric' means physical material including structural elements and other components, fixtures, fittings, contents and items with historic value

National Heritage places with Indigenous heritage values

An action is likely to have a significant impact on Indigenous heritage values of a National Heritage place if there is a real chance or possibility that the action will:

Indigenous heritage values

- restrict or inhibit the continuing use of a National Heritage place as a cultural or ceremonial site causing its values to notably diminish over time
- permanently diminish the cultural value of a National Heritage place for an Indigenous group to which its National Heritage values relate
- alter the setting of a National Heritage place in a manner which is inconsistent with relevant values
- remove, destroy, damage or substantially disturb archeological deposits or cultural artefacts in a National Heritage place
- destroy, damage or permanently obscure rock art or other cultural or ceremonial, artefacts, features, or objects in a National Heritage place
- notably diminish the value of a National Heritage place in demonstrating creative or technical achievement
- permanently remove, destroy, damage or substantially alter Indigenous built structures in a National Heritage place, and
- involve activities in a National Heritage place with substantial and/or long-term impacts on the values of the place.

Notes:

- The above examples are general examples and their application will depend on the individual values of each National Heritage place. Alteration or disturbance which is small in scale may have a significant impact if a feature or component of a National Heritage place embodies values that are particularly sensitive or important.
- To have a significant impact on National Heritage values, it is not necessary for an action to impact upon the whole of a National Heritage place, all of the values of a National Heritage place, or a whole value of a National Heritage place. It is sufficient if an action is likely to have a significant impact on a part, element, or feature of a National Heritage place which embodies, manifests, shows, or contributes to the values of that place.

Further information on National Heritage places

The following information relevant to National Heritage places is available on the Department's web site:

- General information: **www.environment.gov.au/epbc/protect/heritage.html**
- Australian heritage places inventory: **www.heritage.gov.au/ahpi**

Nuclear actions

A nuclear action will require approval if it has, will have, or is likely to have a significant impact on the environment.

Significant impact criteria

All nuclear actions, as detailed in section 22 of the Act, should be referred to the Department of the Environment for a decision on whether approval is required.

These actions are:

- establishing or significantly modifying a nuclear installation or a facility for storing spent nuclear fuel
- transporting spent nuclear fuel or radioactive waste products arising from reprocessing;
- establishing or significantly modifying a facility for storing radioactive waste products arising from reprocessing
- mining or milling uranium ore
- establishing or significantly modifying a large-scale disposal facility for radioactive waste
- de-commissioning or rehabilitating any facility or area in which an activity described above has been undertaken, or
- establishing, significantly modifying, decommissioning or rehabilitating a facility where radioactive materials at or above the activity level specified in regulation 2.02 of the Environment Protection and Biodiversity Conservation Regulations 2000 (EPBC Regulations) are, were, or are proposed to be stored.

Electronic copies of the EPBC Act and EPBC Regulations can be accessed from the Department's web site at: **www.environment.gov.au/epbc/about/index.html**

Great Barrier Reef Marine Park

An action will require approval if:

- the action is taken in the Great Barrier Reef Marine Park and the action has, will have, or is likely to have a significant impact on the environment, or
- the action is taken outside the Great Barrier Reef Marine Park and the action has, will have, or is likely to have a significant impact on the environment in the Great Barrier Reef Marine Park.

The Great Barrier Reef Marine Park is established under the *Great Barrier Reef Marine Park Act 1975*. Maps showing the Great Barrier Reef Marine Park are available from **www.gbrmpa.gov.au**.

The Great Barrier Reef Marine Park is an area recognised to have high conservation value.

What is the Environment?

'Environment' is defined in the EPBC Act as:

a. ecosystems and their constituent parts including people and communities ('ecosystem' is defined in the EPBC Act as 'a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functioning unit'
b. natural and physical resources
c. qualities and characteristics of locations, place and areas
d. heritage values of places ('heritage value' is defined in the EPBC Act as including 'the place's natural and cultural environment having aesthetic, historic, scientific or social significance, or other significance, for current and future generations of Australians.' 'Indigenous heritage value' is defined as meaning ' a heritage value of the place that is of significance to Indigenous persons in accordance with their practices, observances, customs, traditions, beliefs or history'), and
e. the social, economic and cultural aspects of a thing mentioned in paragraphs (a), (b) or (c).

Significant impact criteria

An action is likely to have a significant impact on the environment of the Great Barrier Reef Marine Park if there is a real chance or possibility that the action will:

- modify, destroy, fragment, isolate or disturb an important, substantial, sensitive or vulnerable area of habitat or ecosystem component such that an adverse impact on marine ecosystem health, functioning or integrity in the Great Barrier Reef Marine Park results
- have a substantial adverse effect on a population of a species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution
- result in a substantial change in air quality or water quality (including temperature) which may adversely impact on biodiversity, ecological health or integrity or social amenity or human health
- result in a known or potential pest species being introduced or becoming established in the Great Barrier Reef Marine Park
- result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, or social amenity or human health may be adversely affected, or
- have a substantial adverse impact on heritage values of the Great Barrier Reef Marine Park, including damage or destruction of an historic shipwreck.

Other protected matters potentially relevant to the Great Barrier Reef

- **The values of World Heritage properties –** The Great Barrier Reef is a World Heritage property
- **The values of National Heritage places –** The Great Barrier Reef is a National Heritage place
- **The ecological character of a Ramsar wetland –** a number of Ramsar wetlands are located adjacent to the Marine Park, including Shoalwater and Corio Bays and Bowling Green Bay
- **Listed threatened species and ecological communities –** a number of listed threatened species are located in the Marine Park
- **Listed migratory species –** a range of listed migratory species are found in the Marine Park
- **Commonwealth land –** a number of islands within the Marine Park are Commonwealth land
- **The environment of a Commonwealth marine area –** The majority of the Marine Park is within the Commonwealth marine area, and
- **Nuclear actions**.

Further information on the Great Barrier Reef Marine Park

- Further information on the Great Barrier Reef Marine Park is available on the Great Barrier Reef Marine Park Authority (GBRMPA) website: **www.gbrmpa.gov.au**
- General information: **www.gbrmpa.gov.au**

Note:

For actions/activities taken within the Great Barrier Reef Marine Park a permission may be required under the *Great Barrier Reef Marine Park Act 1975* (GBRMP Act). A permission under the GBRMP Act may be required even if significant impact on the environment of the Great Barrier Reef is not likely. Further information is provided on the Great Barrier Reef Marine Park web site at **www.gbrmpa.gov.au**

Protection of water resources from coal seam gas development and large coal mining development

Information on the protection of water resources from coal seam gas development and large coal mining development

The draft *Significant Impact Guidelines: Coal seam gas and large coal mining developments—Impacts on water resources* provides further details on the protection of water resources from coal seam gas and large coal mining developments website: **www.environment.gov.au/epbc/about/water-trigger.html**.

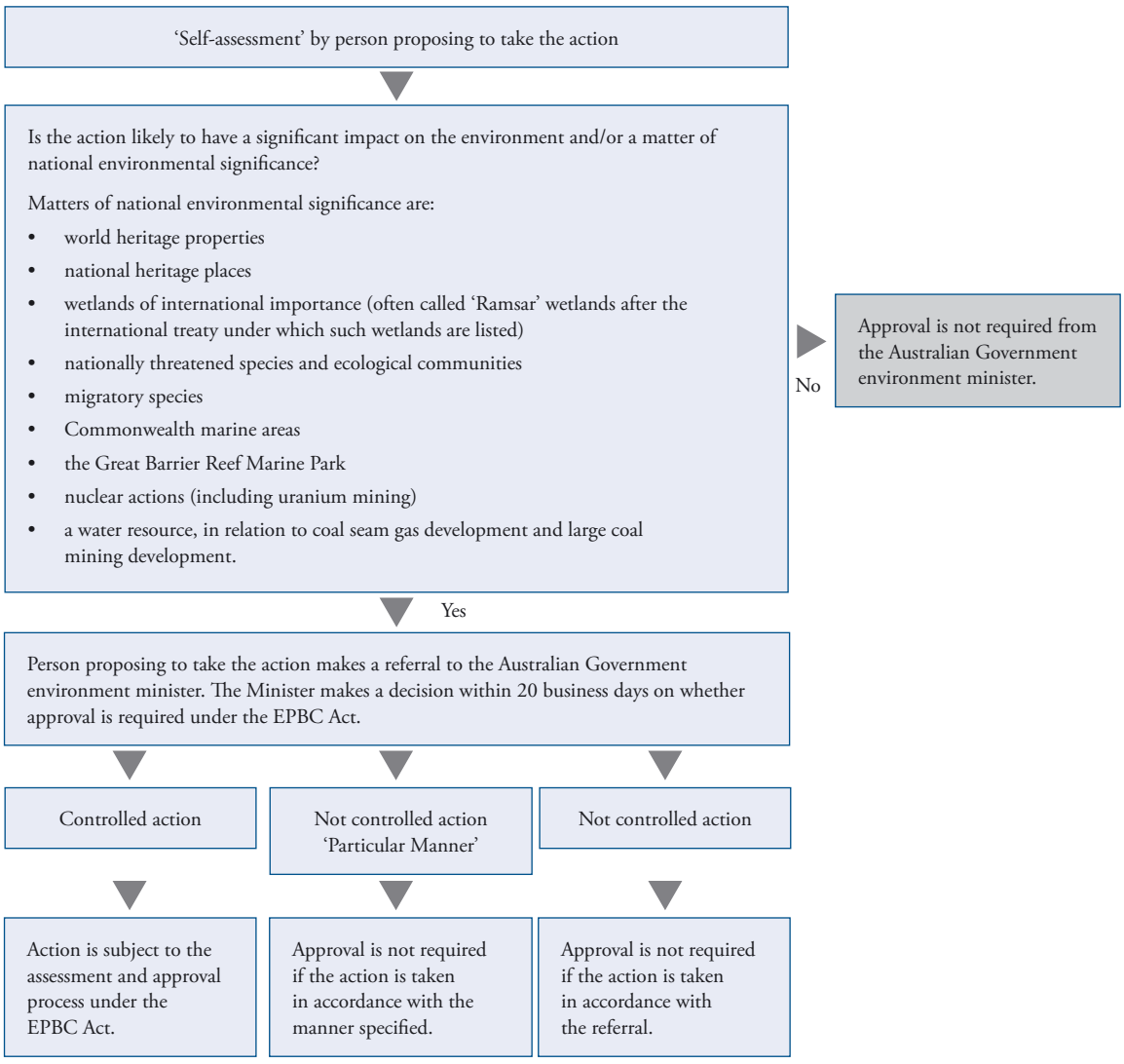
The referral, assessment and approval process

Referral process

If after undertaking a self-assessment you conclude that your action is likely to have a significant impact on a matter of national environmental significance, or if you are unsure, you should refer the action to the Australian Government environment minister. Substantial penalties apply for taking an action that has, will have or is likely to have a significant impact on a matter of national environmental significance without approval.

Referral forms and a guide to assist in filling out the referral form can be obtained from the Department's community information unit on 1800 803 772, or from the Department's website at: **www.environment.gov.au/epbc/assessments/referral-form.html**. The EPBC Act referral process is summarised in Figure 1 below.

Figure 1: EPBC Act referral process



After receiving a referral, the minister will decide whether the action is likely to have a significant impact on a matter of national environmental significance:

- if the minister decides that the action is likely to have a significant impact on a matter of national environmental significance, then the action requires approval under the EPBC Act (it is a controlled action), and
- if the minister decides that the action is not likely to have a significant impact on a matter of national environmental significance, then the action does not require approval under the EPBC Act (it is a not controlled action).[8]

The minister may also decide that an action is not likely to have a significant impact on a matter of national environmental significance, and does not require approval under the EPBC Act, because it will be taken in a 'particular manner'. However, the action must be undertaken in a way that is consistent with the manner specified in this decision, or penalties apply.[9]

The minister is generally required to make a binding decision on whether an action requires approval within 20 business days of receiving a referral. If the minister's decision is that an action does not require approval, a person will not contravene the Act if the action is taken in accordance with that decision.

Assessment and approval process

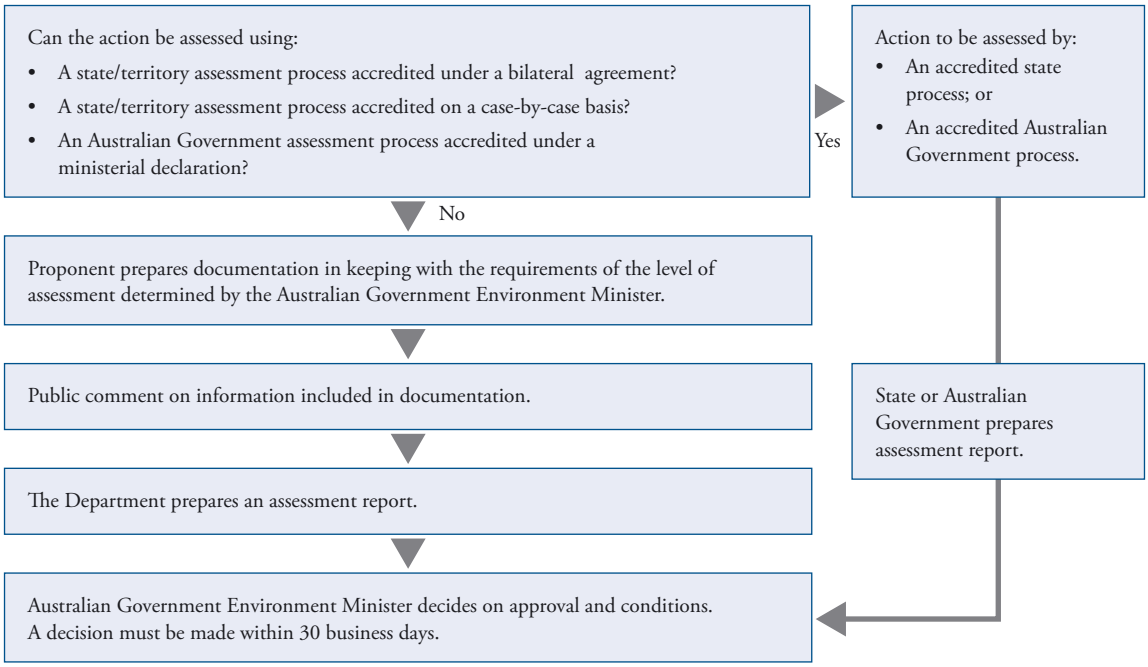
If the minister decides that an action requires approval, then an environmental assessment of the action must be carried out. If a bilateral agreement is in place the action may be assessed by the state or territory in which the action is to be undertaken, using the processes accredited under the bilateral agreement. If a ministerial declaration is in place accrediting another Australian Government assessment process, the action may be assessed by the process accredited under that declaration. Otherwise, the assessment will be undertaken by one of a range of assessment approaches outlined under the EPBC Act. An assessment report will then be prepared.

After considering the environmental assessment report, the Australian Government Environment minister decides whether to approve the action, and what conditions (if any) to impose. The EPBC Act assessment and approval process is summarised in Figure 2.

8 Please note that, regardless of whether approval is required under the EPBC Act, separate environmental assessment and approval may be required under state/territory and/or local government legislation.

9 More information about particular manner decisions can be found in the Practice Guide entitled *Application of 'Particular Manner' decision making under the EPBC Act*, available on the Department's web site at: **www.environment.gov.au/epbc/publications/manner.html**

Figure 2: EPBC Act assessment and approval process



General information

A range of other EPBC Act policy statements are available to assist you in determining whether you are likely to have a significant impact on a matter of national environmental significance.

EPBC Act Policy Statements can be obtained from the Department's community information unit on 1800 803 772 or can be downloaded from the Department's web site at: **www.environment.gov.au/epbc/publications/guidelines.html**

The Australian Natural Resources Atlas provides national, state and regional information about a range of environmental and land-use attributes: **www.anra.gov.au/**

Please note that the Department does not hold all of the information that may be required to assess the impacts of your action. state and territory government agencies also have a range of information that may be useful, including geographic information.

The sectoral information contained in the Appendix to these guidelines is intended to illustrate the application of the criteria for matters of national environmental significance in relation to specific industry sectors, and should be read in the context of, and in conjunction with, the significant impact criteria in these guidelines.

Appendix – Information for industry sectors

The purpose of this Appendix is to provide more detailed assistance in relation to whether, and in what circumstances, some selected sectoral activity is likely to have a significant impact on a matter of national environmental significance.

The examples in this appendix should be read in conjunction with the significant impact criteria in the guidelines and should not be taken to be conclusive.

This guidance relates to the following sectoral activities:

- mineral exploration
- urban development
- local government, and
- marine activities.

EPBC Act policy statements which provide further guidance in relation to specific industry sectors[10] are available from the Department's community information unit or the Department's web site: **www.environment.gov.au/epbc/publications/guidelines.html**

Mineral exploration activity

Terrestrial exploration

Surface geological mapping examining rock outcrops and exposures, which may involve the taking of small samples, would not normally be expected to have a significant impact on a matter of national environmental significance.

Surface geochemical sampling, using both regular grid pattern and irregular pattern methods to collect small samples, would not normally be expected to have a significant impact on a matter of national environmental significance.

Surface geophysical surveys including airborne surveys, gravity, magnetic and electromagnetic surveys, would not normally be expected to have a significant impact on a matter of national environmental significance.

Other geophysical surveys that include seismic surveys would not normally be expected to have a significant impact on matters of national environmental significance. However, an action involving seismic surveys (shot hole method or vibroseis) may have a significant impact on an endangered or critically endangered species if, for example, it is likely to damage habitat critical to the survival of the species or disrupt the breeding cycle of a population of the species. Such an action may also have a significant impact on listed threatened ecological communities where, for example, it adversely impacts on habitat. (See the criteria relating to endangered and critically endangered species and ecological communities.)

10 Industry-specific guidelines that have been, or are being, developed include guidelines for offshore seismic operations, offshore aquaculture, wind farms, agricultural land clearance, urban development, and actions undertaken by local government.

All exploratory drilling (including new field, wildcat, and appraisal drilling, auger, rotary air blast (RAB), open hole percussion, reverse circulation (RC), diamond drilling and wide diameter drilling), including the construction of drill pads, would not be expected to have a significant impact on a matter of national environmental significance where the discharges, emissions and waste from the drilling are contained and managed in an environmentally sensitive manner. However, an action involving exploratory drilling may have a significant impact on an endangered or critically endangered species if, for example, it is likely to damage habitat critical to the survival of the species or disrupt the breeding cycle of a population of the species. Such an action may also have a significant impact on listed threatened ecological communities where, for example, it adversely impacts on habitat. (See the criteria relating to endangered and critically endangered species and ecological communities.) Such an action may also have a significant impact if it occurs within a National Heritage place, for example, if it disturbs Indigenous burial grounds or artefacts with National Heritage values. It will also be necessary to consider the Ramsar criteria if the exploratory drilling is to occur in or immediately adjacent to a Ramsar wetland.

Costeaning and trenching (small scale) would not be expected to have a significant impact on a matter of national environmental significance where small trenches are excavated using hand tools. However, an action involving costeaning and trenching (small scale) may have a significant impact on an endangered or critically endangered species if, for example, it is likely to damage critical habitat for the species or disrupt the breeding cycle of a population of the species. Such an action may also have a significant impact on listed threatened ecological communities where, for example, it adversely impacts on habitat. (See the criteria relating to endangered and critically endangered species and ecological communities.) It will also be necessary to consider the National Heritage criteria and the Ramsar criteria if the costeaning or trenching is to occur in or immediately adjacent to a National Heritage place or a Ramsar wetland.

Costeaning and trenching (large scale), surface bulk sampling (such as establishing a trial pit, sinking shafts or driving decline tunnels deep into the target) and underground exploration and development (such as underground sampling, drilling and mine construction): whether or not these exploration activities are likely to have a significant impact on a matter of national environmental significance will depend upon the particular facts and circumstances of the proposed activity. It is necessary to apply the criteria in the guidelines to assist in determining when an action is likely to have a significant impact on a matter of national environmental significance. For example, if surface bulk sampling occurs in an area that is not in or near a Ramsar wetland, and if it is not damaging the habitat of a threatened species or important habitat for a migratory species, then the proposed exploration activity is not likely to have a significant impact on a matter of national environmental significance. However, if the proposed activity will result in the pollution of a Ramsar wetland then it is likely to have a significant impact on the ecological character of the Ramsar wetland.

Offshore exploration

Aerial surveys and diving for samples would not normally be expected to have a significant impact on a matter of national environmental significance.

Offshore exploratory drilling would be expected to have a significant impact if it is undertaken in an area that contains habitat for threatened or migratory species and the seismic activity is likely to interfere with breeding, feeding or migration, or if habitat critical to the survival of the species (or important habitat for a migratory species) is damaged by the drilling. Offshore exploratory drilling would also be expected to have a significant impact on a Ramsar wetland or the Commonwealth marine environment if drilling occurs in a sensitive area (for example, sea mounts and other areas with high biodiversity value or which contain important habitat). Offshore exploratory drilling may also potentially have a significant impact on historic shipwrecks in the Commonwealth marine area.

Other issues

The above discussion does not address issues associated with mineral exploration activity in a World Heritage property or National Heritage place. In addition, it does not take into account any impacts associated with gaining access to the exploration site, especially where heavy machinery is used.

Urban development

Repairing, maintaining, or making alterations to **commercial and domestic buildings and properties** would not be expected to have a significant impact on a matter of national environmental significance, unless the repairs, maintenance or alterations are being made to a World Heritage property or a National Heritage place and are inconsistent with the values of the property or place.

Repairing and maintaining existing distribution infrastructure for **utilities for power, water and sewage** would not normally be expected to have a significant impact on a matter of national environmental significance, unless there is a substantial expansion or modification of these utilities.

Establishing a **new subdivision** in an existing suburb, with established infrastructure designed to manage environmental impacts, upstream of a large Ramsar wetland (such as the Moreton Bay Ramsar wetland) would not be expected to have a significant impact on the wetland.

By contrast, establishing a **new subdivision** in the vicinity of a smaller Ramsar wetland is likely to have a significant impact on the wetland if it involves extensive vegetation clearing, clearing riparian vegetation, modifying the flow of water to or within the wetland, or if it will result in significant discharges of pollutants into the wetland.

Establishing a **new subdivision** within or adjacent to the Great Barrier Reef Marine Park, a World Heritage property or a National Heritage place is likely to have a significant impact on the World or National heritage values of that property or place.

Building a house on land in an existing subdivision in the vicinity of a Ramsar wetland or a World Heritage property would not normally be expected to have a significant impact on these matters of national environmental significance.

However, **building a house** in close proximity to a National Heritage place may have a significant impact on the values of the place, in particular where the place is located in a non-urban environment or where the proposed development would obstruct or detract from the viewing axes of the heritage place, where applicable.

Proposed urban development for a **housing subdivision or an industrial estate** on an area which contains nationally listed threatened species or ecological communities, or immediately adjacent to the Great Barrier Reef Marine Park, is likely to be significant under the EPBC Act and should be referred to the minister.

Local government

Maintaining existing facilities such as visitor centres and roadside facilities would not be expected to have a significant impact on a matter of national environmental significance.

Routine vegetation management to maintain existing roads in or adjacent to a World Heritage property, a National Heritage place, a Ramsar wetland or a listed threatened species or ecological community would not normally be expected to have a significant impact on a matter of national environmental significance.

A proposed **new road** through a World Heritage property, a National Heritage place, or a Ramsar wetland or a road that would require clearing of native vegetation that contains nationally listed threatened species or ecological communities is likely to be significant under the EPBC Act and should be referred to the minister. It will also be necessary to consider the environment of the Great Barrier Reef Marine Park if the proposed new road occurs immediately adjacent to the Great Barrier Reef Marine Park.

Where **road verge maintenance** is carried out regularly (for example, every one or two years) it would not be expected to have a significant impact on a critically endangered or endangered plant species.

On the other hand, if a population of a **critically endangered or endangered plant species** becomes established on a road verge (because the verge has not been graded or weeded for a number of years), then clearing that road verge is likely to have a significant impact on a matter of national environmental significance.

Widening an existing road would not normally be expected to be significant under the EPBC Act where the road verge has previously been cleared or the vegetation beside the road has been heavily modified. However, if road widening would require removal of native vegetation that contains critically endangered or endangered plant species or ecological communities, it is likely to have a significant impact and should be referred to the minister.

Development of a tourist resort in or adjacent to the Great Barrier Reef Marine Park, a World Heritage property or a National Heritage place is likely to be significant under the EPBC Act and should be referred to the minister. However, a **residential development** such as a block of units or other accommodation in an existing city or coastal town would not normally be expected to have a significant impact on an adjacent World Heritage property.

Marine activities

Otherwise lawful **recreational fishing and recreational boating** would not normally be expected to have a significant impact on a matter of national environmental significance.

Routine ship transits where appropriate precautions have been taken against translocating potential pest species would not normally be expected to have a significant impact on a matter of national environmental significance.

Ballast water operations from vessels in Australian waters, undertaken in accordance with an approved Australian Government arrangement for the management of ballast water, would not normally be expected to have a significant impact on the Commonwealth marine environment.

Small scale infrastructure projects such as new jetties within an existing port would not normally be expected to have a significant impact on a matter of national environmental significance.

Large scale infrastructure projects such as a large pontoon, new aquaculture proposals, construction of a jetty, or a tourist facility (for example, a marina) in the Great Barrier Reef Marine Park may have a significant impact on the environment of the Great Barrier Reef Marine Park and should be referred to the minister.

Expansion of an existing port which requires land reclamation or spoil disposal in a World Heritage property, a National Heritage place, in or adjacent to the Great Barrier Reef Marine Park, a Ramsar wetland or an area containing nationally listed threatened species or ecological communities, or which involves modifying an area of important habitat for a nationally listed migratory species, is likely to have a significant impact on a matter of national environmental significance.

Construction of a new port in a Commonwealth marine area, in or adjacent to the Great Barrier Reef Marine Park, a World Heritage property, or a National Heritage place is likely to have a significant impact on a matter of national environmental significance.

Dredging of a new shipping channel through a World Heritage property, a National Heritage place, through or next to the Great Barrier Reef Marine Park, a Ramsar wetland, or an area containing nationally listed threatened species or ecological communities, or which involves modifying an area of important habitat for a nationally listed migratory species, is likely to have a significant impact on a matter of national environmental significance.

Dredging to maintain existing navigational channels would not normally be expected to have a significant impact on the environment where the activity is undertaken as part of normal operations and the disposal of spoil does not have a significant impact.

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BIO70.0913

Land Resource Assessment and Management Pty. Ltd.
ABN 65 446 117 882
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The distribution of erosion and salinity in the upper catchments of the Logan and Albert Rivers

Prepared for the Logan and Albert Catchment Association Inc and South East Queensland Catchment NRM Group.
July 2007

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Executive Summary

Erosion

Erosion within the Logan and Albert Catchments is strongly correlated to geology driven landscape factors and land use.

The more severely eroded areas are those derived from the sandstone group of geologies which have produced soils of limited fertility and structural integrity. These are also the soils with the highest sodium content.

Despite the fact that the landforms based on volcanic geologies are for the most part characterized by steeper slopes, erosion is less severe in these areas. In part this is due to the presence of convex slopes in many of these landscapes as opposed to concave slopes in the more severely eroded landscapes. The high fertility, better structured and lower sodicity soils derived from the volcanic landscapes are also far more resistant to erosion.

Sheet, rill, gully and tunnel erosion as well as , landslides, land slips and soil terracing/creep are all present in the areas.

Some of these forms are present at background levels – or levels which one could reasonably assume existed prior to settlement. 35% of the area is rated as in this condition and a large part of this is within the National Park estate. 54% of the area shows evidence of erosion increasing above background levels but not to a stage irreversible degradation is occurring. 11% has major or severe erosion causing irreversible degradation and most of this is located in the catchments of Knapps and Cannon Creeks which contain the lands with the most erosion prone landscapes.

Whilst terrain soils and geology provide the basis for the extent of erosion, past land use has also played a major role. The current land managers and the rural land uses they currently pursue are in most cases not the generation that experienced the surge in erosion which was associated with unsustainable land management and industry arrangements in the last 75 years of the last century. Land management changes will be more readily adopted if this fact is recognized and the solutions based on current land use paradigms.

Similarly, in the worst eroded areas, the design and maintenance of roads also plays a major part. In other parts of Queensland, road design manuals and practices have recently been upgraded – this work should be extend to these areas.

The frontpiece photograph shows heavily grazed alluvial flats with strongly sheet eroded uplands in the background within the Marburg formation group of geology. The condition of the livestock also shows that livestock condition is not necessarily well correlated to grazing land health.

Salinity

Salinisation of soils and waters associated with elevated ground water tables is currently restricted to two major and one minor area within the Logan and Albert Catchments.

The Veresdale Scrub area and the Cyrus Creek catchment is the largest salinity area. The geological and possibly hydrogeological drivers for this area extend to the south of Beaudesert town where salinity is currently less of problem.

The Boonah Hoya area in the Teviot catchment forms part of another outbreak. This outbreak is only a small part of a much larger outbreak area that lies in the Warrill Creek catchment of the Bremer. This area in total is the largest outbreak in the '*Scenic Rim*' region.

Both the Veresdale Scrub/Beaudesert and Boonah/Hoya area includes areas of urban and rural residential developments within the potentially impacted area. As a consequence management alternatives involve both land management (or biological) as well as engineering strategies

Immediately upstream of Flanagan's Reserve in the upper Logan, saline base flows occur in the dysfunctional drainage lines that flow from the eastern catchment.

All of these expressions of salinity are related to the Walloon Scrub geological sequences which have been intruded by volcanic materials such as rhyolite, dolerite and basalt. It is these volcanic areas that act as the primary intake areas for the saline groundwaters within the Walloon areas.

The presence of the Beaudesert Bed geological groups (complexes of saline sodic mudstones and claystones with various volcanic instructions) at Veresdale may also partly explain the greater severity of salt flows in this area.

The geological factors implicated in the above outbreaks (confined poorly drained dysfunctional clayey alluvium immediately downslope of Walloon and Volcanic catchments), is also present in the Allandale and Greenhills Rd areas of the Teviot where salt flows also occur. There is also a large area within the Teviot above Boonah that has some of geological controls conducive to salinisation development.

In the basalt dominated eastern parts of the Logan and Albert Catchments, most ground water flows are either relatively non saline and important to both economic water and environmental base flow uses. In the western part of the catchment ground water flows are intercepted by deeply incised sandy stream channels systems such as the Allan, Knapps and Cannon Creeks in the Marburg and Heifer Creek sandstone areas – all areas with limited surface expression of groundwater salinity.

1 Introduction

The report describes the key broad hectare landscape erosion processes for the upper catchment of the Logan and Albert Rivers within Boonah and Beaudesert Shires. Areas within these catchment have been identified as providing significant suspended sediment and base load exports from the catchments to the southern coast of south east Queensland.

2 Methodology

The study has been completed in three stages:

- Initially observations were made in the field across the whole area where the incidence of various forms of erosion and its relationship to geology was recorded.
- The distribution of the extent of erosion was then mapped directly onto 2005/6 Spot Imagery by traditional field mapping exercises
- The resultant data set was then interrogated against an updated version of the geology mapping of the area[1].

In addition to the above tasks, the incidence of salinity was noted. The results of this are discussed separately in Annex A to this report.

3 Classification Methods for Erosion

3.1 Overview of Classification Methods

A number of methods to classifying erosion exist.

Point Based Paradigms – These methods all involve describing the erosion condition and inferred process at a given point. At its simplest level classifying erosion by types is common (for example sheet, rill, gully, tunnel etc). The main advantage of this approach is that erosion type is strongly linked to erosion process and this type of approach is therefore directly relevant to possible control measures. Less commonly, site based characterization of the erosion type by measurement and observation is also used.

The disadvantages of this method is that does not provide an accurate assessment of the distribution of erosion unless an extremely large number of random sites are evaluated or unless a strategic knowledge framework based on other paradigms is used to allow more efficient sub sampling of erosion incidence. These can be very costly undertakings.

Remote Sensed Paradigms - These have existed in a large number of formats since the advent of computerized methods of modeling which rely on surrogate data sets. There are a number of approaches.

Strict remote sensing using a small number of surrogate data sets which can be remotely sensed as indicators of erosion. An examples used in SEQ has been bare area mapping where the extent of bare areas is remotely sensed and used as a surrogate of extent of erosion. This method has one key advantage and a number of disadvantages. Its key advantage is that it

[1] Insert reference to Willmont when finally compiled by SEQC

allows large areas to be assessed repeatedly over time in what can be a cost effective manner. Its key disadvantages include:

- There are a large number of factors that determine whether an area is bare of ground cover – erosion is only one of these and erosion to the extent that it exposes large areas is far less common than some of the other factors. Enhancing accuracy to remove this uncertainty in the complex spatial spectral signal data sets that characterize large areas does rapidly mitigate the cost effective advantages.
- The method is less effective in identifying bare areas and hence erosion in shrubland, some forms of woodland and forests landscapes.
- The method gives no real information on the form of erosion.

The other form of remote sensed methods involve the use of algorithms based on a number of surrogate data sets to predict erosion. Typically these methods use digital elevation models, soils/geology mapping, land use mapping and other remote sensed data (including land cover). These algorithms are commonly generic derivates of the Universal Soil Loss Equation where the movement of soil by erosion is assumed to be a function of soil erodibility, slope, rainfall erosivity and extent of land cover. The SedNet series of models which forms the basis of the Barrier Reef Water Quality Plan as well as the Healthy Waterways SEQ modeling and latter derivatives such as EMSS are of this type. Like Bare Area type remote sensed mapping, this method offers the prospect of covering large areas very quickly and also offers scope for predicting long term sediment and nutrient exports from catchments. The method, however, has a significant number of disadvantages:

- Fundamentally the methods predict erosion export in terms of long term averages. In other words it does not directly or indirectly measure what is happening now or in the recent past.
- The method uses erosion form as an algorithmic input. Because of this it assumes which forms of erosion occur in what parts of he landscape and therefore does not classify erosion as such.
- The method is only as accurate as its input data. The benefits gained by using a detailed DEM will be negated if the basic soil or land cover inputs are at regional scales of accuracy
- Because of the need to have reasonable quality data inputs, the method may not have the time and cost efficiency benefits commonly assumed.

Field Mapping Paradigms – These paradigms are widely used for the mapping of geology, soils, regional ecosystems and environmental values. They have been less widely used for land degradation status despite the fact that a very similar type of methodology is used. Historically in Queensland soil erosion was the province of soils conservation within the ambit of arable cropping and the focus has therefore been largely on site based paradigms because of their close relationship to remedial within paddock management.

Field mapping paradigms suffer many of the same advantages and disadvantages of each of the above. The method involves describing enough ground truthing or mapping sites to allow patterns on imagery (in this case ECW versions of Spot imagery) to be mapped and characterized. The method requires enough field sites to allow a strategic knowledge framework to be used for an efficient sub sampling of erosion incidence and thus allow a mapping classification to be developed. These sites also need to adequately represent the range of variation of resource values. In this project the geology mapping (1:100,000 scale)

as updated by Willmont combined with the bare area mapping was used as the primary data sets. The method also requires good quality imagery.

The weaknesses in the method is that the type of results, whilst more accurate invariably fall somewhere between those which might be derived from site based and modeling methods. Unlike site based methods it provides little in the way of detailed data on particular incidences. Instead it qualitatively ranks the type of erosion by severity. It is a qualitative not quantitative ranking of severity. Like modeling methods it allows areas to be ranked. This ranking is however based on the qualitative rankings of severity and not on calculations or estimates of actual long term exports. Finally like remote sensed mapping, it does map the distribution of erosion. It does this at higher degree of accuracy in terms of form of erosion but it does not pin point actual locations (such as bare areas).

Despite its limitations a field mapping methodology has been used. The areas in the Logan and Albert selected for this study had been identified by modeling and remote sensed paradigms as potential sources of sediment, however the severity and form of erosion remained unclear. The field mapping methodology described below aimed to directly negate these unknowns.

3.2 Field Mapping Results

3.2.1 Field Sites

Sixty sites were evaluated. The co-ordinates of these sites and associated data is given in Annex B.

Data recorded at the sites included the following.

Geology – 26 sites were associated with various forms of basalt, 12 with the Marburg group of sandstones and 15 with Walloons.
Land Cover – This was estimated as the percentage of soil surface with vegetation cover. 24 sites had less than 30% cover which is generally considered to be a minimum target for protection of soil from erosion. Dairying day paddocks and horse paddocks were common land uses across all geology types that had these low ground cover conditions (Photo 1 and 2). None of the Marburg geology group sites had better than 40% cover irrespective of land use (Map 1).
Soils - 23 sites were dominated by sodic duplex soils. The distinguishing feature of these soils is that they have dispersive clay subsoils. Those associated with the Marburg series of geology invariably have very low soil fertility and have very sandy surface soils. It is these soils which are most prone to erosion and in particular gully and tunnel erosion (Photo 3). Those associated with the Walloon geology often have higher sodicity (and salinity) in their subsoils, but they have higher fertility loamy type surface soils. A few sites had very stony lithosols whilst the remainder were dominated by prairie soils and non cracking clay soils associated with basalt geology (Photo 4).

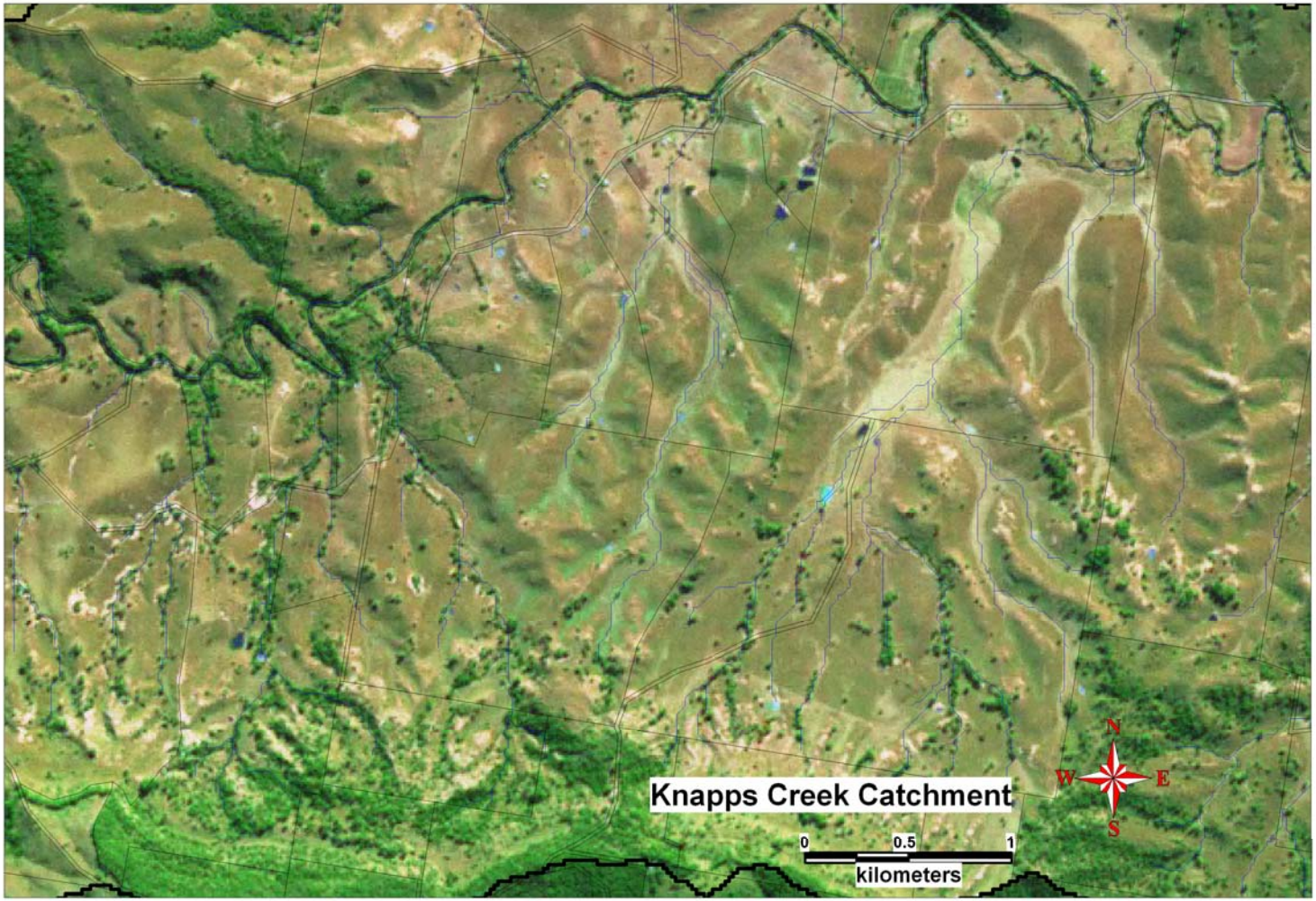
Photo 1 *Sheet eroded convex sodic duplex soils associated with day paddocks close to horse yards – Knapps Creek*

Photo 2 *Sheet eroded fertile non cracking clay soils on basalt associated with dairy day paddocks.*

Photo 3 *Subsoil tunnel erosion in a gully developed in Knapps Creek in the table drain where the subsoil of a sodic duplex soil has been exposed*

Photo 4 *Deep fertile permeable non cracking clay soils on basalt – prone to land slips terracing and sheet erosion – gully and tunnel erosion rare*

Map 1 *Knapps Creek catchment showing severe sheet erosion with low ground cover along drainage lines and numerous bare sheet and gully eroded areas away from streams.*



Slope Form - 37% of sites had a concave slope form and the majority of these were on the Walloon or Marburg geology areas (Photo 5). Concave slope forms have overland flow patterns that concentrate flow into drainage lines. This concentration of runoff is often a precursor to gullying erosion. The most severe examples of erosion in the shire are associated with concave slope forms. Convex forms are spreading overland flow forms and are most common in the Basalts and some of the scrub Walloon areas (Photo 6). They typically may have a sediment apron at the base of slopes where sheet overland flow deposits sediment (Photo 7) . Such sediment aprons are less common at the base of concave slopes.

Erosion – 20 sites had more than 50% of the area affected by sheet erosion. 20 sites also had more than 10% of area with unstable gully erosion whilst 13 sites had unstable small scale slope terraces over 20% of the area and 16 sites had active land slips or slides.

Photo 5 *Concave side slopes of Walloon Forest lands leading to a central and unstable drainage line which has incised into the underlying Marburg (Heifer Creek) Formation.*

Photo 6 *Convex side slopes and benches within Basalt lands. Interfluve areas are stable*

Photo 7 *Stable Interfluve areas (sediment fans) at base of convex slopes formed in Walloon Forest lands.*

Attempts to use this data to produce an assessment of erosion severity are limited by the fact that a site based assessment provides clear information about process but little about extent.

The obvious process drivers from the site results are as below and are summarized for each of the various forms of erosion in Table 3.1:

- Concave slopes are far more prone to erosion than convex slopes
- Extent of ground cover is strongly correlated to extent of erosion. Areas with < 40% ground cover invariably had higher proportions of the area suffering sheet erosion than others.
- Infertile sodic duplex soils are more prone to irreversible forms of erosion than others.
- Grazing practices where feed is imported to supplement grazed pastures are strongly correlated to severe erosion – the dairy and horse sectors all retain animals on feed.

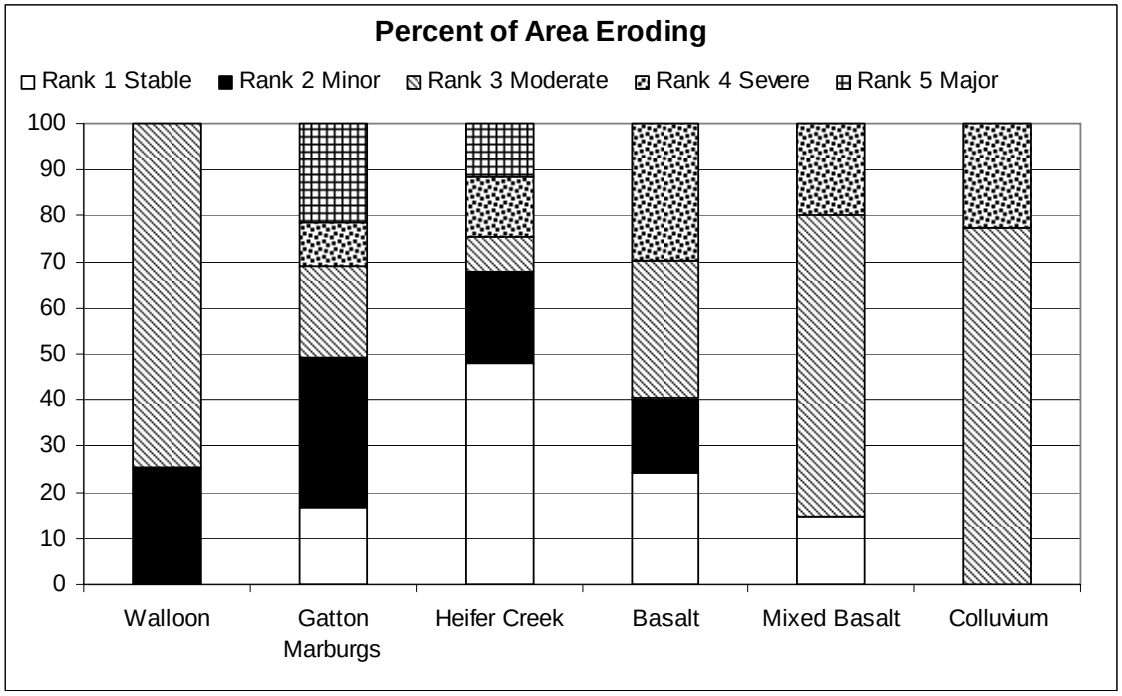
The other process determinate is slope. However in most of the area studied slopes are over 10% and commonly over 30%. At these slope levels, slope is not a major process differentiator. The only areas of more gently sloping terrain were the Marburg areas and these invariably were the most severely eroded because of soil as opposed to slope factors.

3.2.2 Erosion Mapping

Areas which had similar combinations of erosion conditions were mapped directly onto Spot 5 imagery. However, in order to do this a mapping classification schema was developed.

This system is described in Table 3.2 and uses a simple 5 class rank system. The distribution of rank classed is summarized in Figure 1 by geology group.

Figure 1 *Distribution or erosion rank by geology*



Rank 1 to 3 are areas with increasing extents of erosion but which currently are not irreversibly degraded.

Rank 1 areas have little or no erosion that is above background levels one would normally associate with these geomorphic forms. Many of these areas are within the National Park estates but a significant number are freehold and some at least have been cleared but conservatively managed.

Rank 2 areas have higher levels of erosion but only in small parts of the area.

Rank 3 areas have erosion occurring over much of the landscape but signs of irreversible degradation are not widely evident.

Ranks 4 and 5 are the high priority areas. These areas show widespread degradation (Rank 4) and signs that the rate of erosion is accelerating (Rank 5).

25% of the Walloon geology is ranked as Minor and 75% as Moderate. The moderate eroding areas are largely the Walloon Forest landscapes.

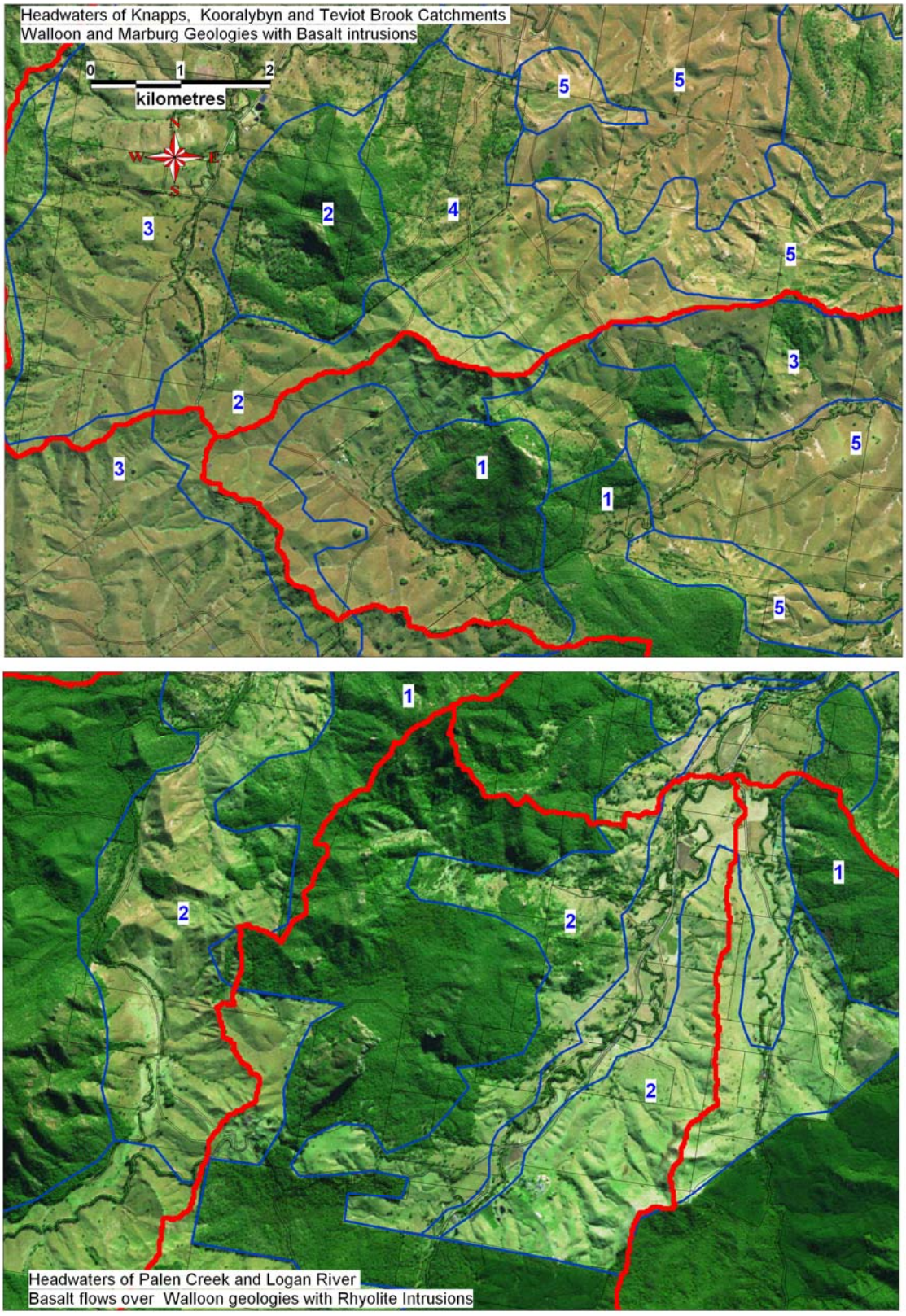
The basalt and scrub Walloons that characterize the upper Logan and Palen Creek areas have limited erosion (Map 2).

The Gatton Marburgs have just over 20% of their areas as Major erosion with another 10% as Severe. The Heifer Creek sandstone component of the Marburg geology areas have 25% of their areas as Severe or Major and most of these are within the Knapps Creek Greenhills Road (Cannon Creek) catchments (Map 2).

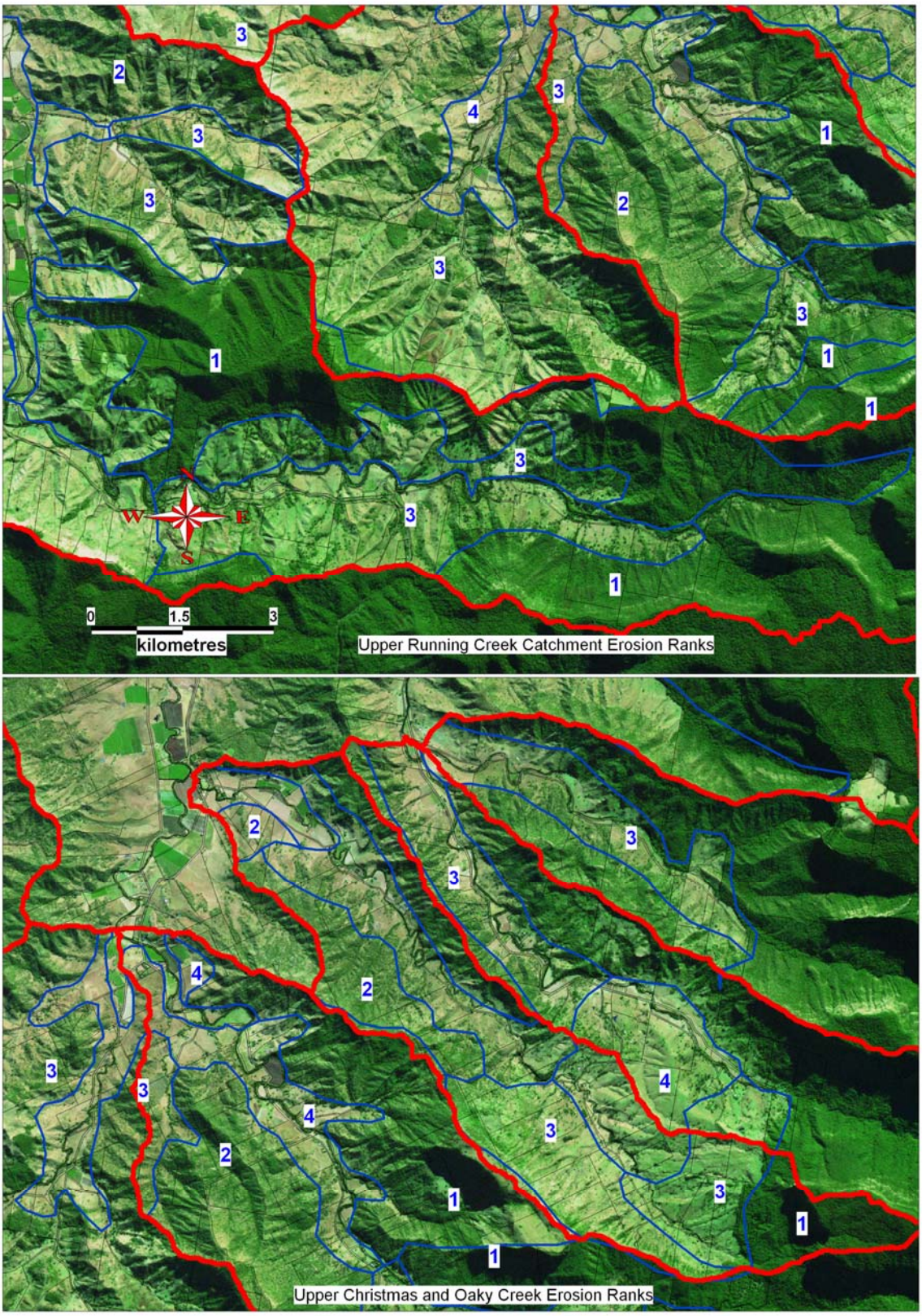
The Albert basalt group that characterizes much of lower foothill lands east of the Logan River have up to 30% of their areas as severe and this is restricted to a small number of catchments.

The younger basalt areas of Running Creek (characterized by slip bench topography) are not as badly eroded (Map 3).

Map 2 *Distribution of overall erosion ranks in upper Knapps, Palen and Logan areas*



Map 3 *Distribution of Erosion Ranks within Running Christmas and Oaky Creek Catchments*



Map 4 *Distribution of Erosion Ranks in Canungra Creek Catchment*

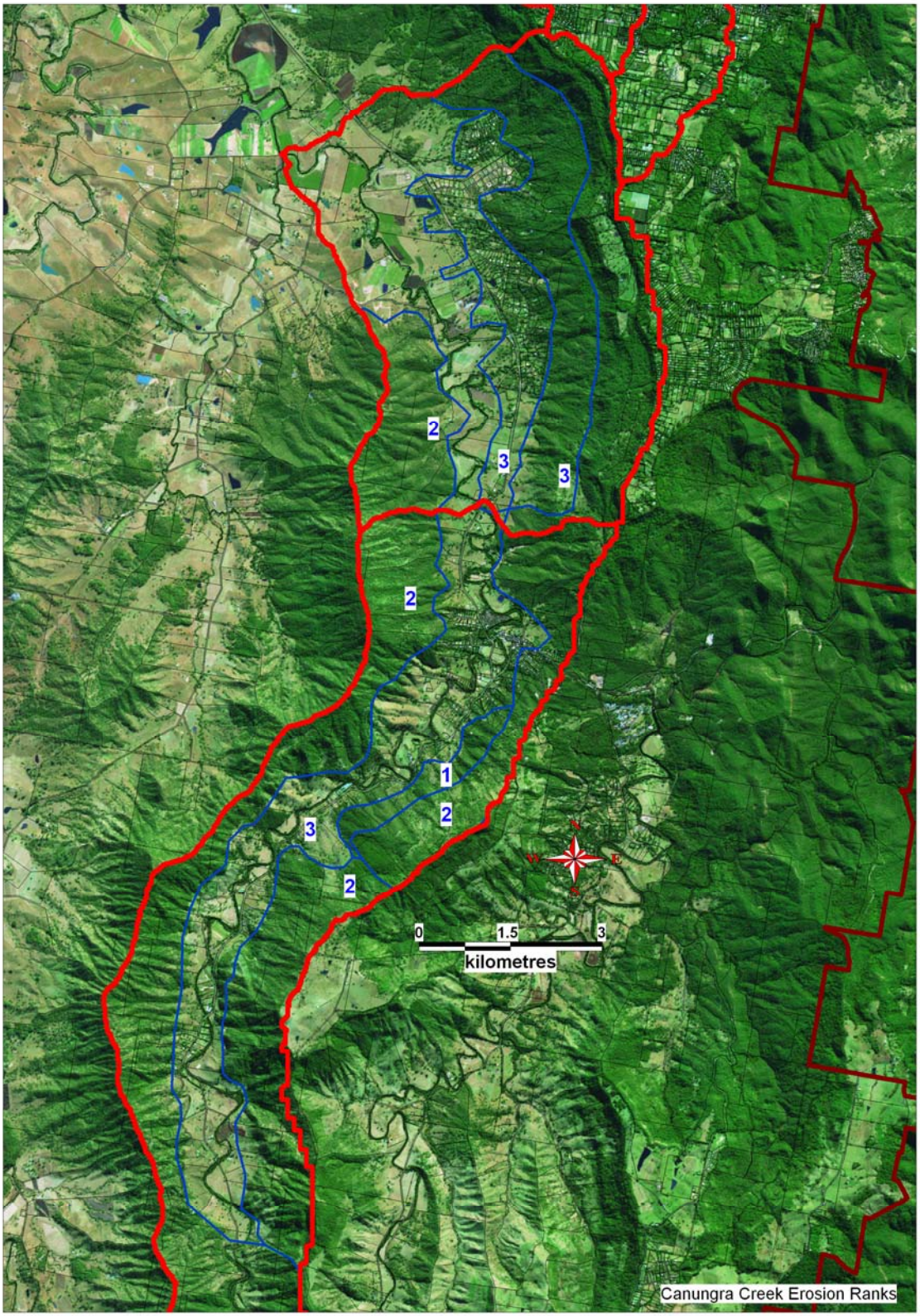


Table 3.1 *Erosion Models from Logan and Albert Catchments*

	Sheet/Rill	Gully Erosion	Tunnel Erosion	Soil Creep/Terracing	Debris Flows/Slides	Land Slips
Description	Overland Flow of runoff removing uppermost layer of soil. Sediment moved as suspended and physical loads	Occurs in areas of concentrated overland flow. Suspended and physical loads common	Dispersion of clay subsoils and resultant flow of dispersed material as suspended sediment to gullies/drainage lines.	Mass movement of wet surface and subsoils under their own weight on slopes. Commonly produces terracing cattle pad effects that can be exaggerated by livestock grazing on slopes.	Larger scale version of Soil Creep where clay sand rocks and boulders slide down a saturated drainage line. The structural integrity of the original matrix is often lost.	Slippage of whole blocks of topsoils with subsoil and often the upper layer of weathered rock remaining in vertical sequence but shifting down slope. Often results in benched landscapes.
Pathways to Sediment Export	Rarely delivers physical loads direct to streams – a major component of movement (pte physical load) is redeposited in sediments beds at base of slopes Suspended loads pass direct to streams and minor natural sediment basin	Commonly will deliver physical loads and suspended loads direct to streams – often by re mobilizing base of slope sediment deposits derived from other forms of erosion.	Typically associated with an erosion gully – but also found on some stream levees – leading to levee slips. Tunnel erosion delivers large amounts of suspended sediment direct to drainage lines. It may produce downslope mud type deposits if the erosion gully or slip is not in direct contact with a drainage line.	This is displacement in situ of a soil profile by the order of a few meters or less than a meter on steep slopes. Unless these areas also have gully, sheet debris flows or other slips that delivers sediment direct to streams, these may not be major export sources. Can act as a precursor to Debris Flows and Landslips/slides	Normally in narrow steep valleys where debris is delivered direct to streams including rivers. Debris flow paths can be a few tens to a hundred meters long.	Unless incised by a drainage line/erosion gully or associated with debris flows little sediment may be exported.
Factors effecting Pathway	Convex slopes commonly have significant sediment aprons. Concave slopes may have increasing frequencies of rill erosion where flow is concentrated.	Uncommon on convex slopes (unless associated with tunnel erosion) – primarily found on concave slopes.	Found on both concave and convex slopes. An erosion gully on a convex slope that extends to the top of the slope is commonly caused by tunnel erosion. Requires sodic/magnesic subsoils – often with low activity clays.	Generally requires a loamy to clayey soil with fair to good structure and high levels of structural stability.	Can occur in most geologies but more common in soils and geologies with highly fractured base rocks and shallow stony soils.	Slope and geology type along with the type and direction of bedding within the geology is a major factor – Basalts and Mudstones of the Walloon group.

	Sheet/Rill	**Gully Erosion**	**Tunnel Erosion**	**Soil Creep/Terracing**	**Debris Flows/Slides**	**Land Slips**
Land Use Factors	Overgrazing with or without high frequency burning with or without clearing that removes ground cover protecting soil surface from rain drop impact exacerbates this natural phenomena.	Requires same conditions as Sheet and Rill along with surface soil disturbance – roadside table drains, tracks and cattle pathways.	Requires exposure of sodic dispersible subsoils by table drains, stump holes, tracks etc to be initiated. Will then expand rapidly as a series of gullies to the crest of the slopes or to the end of the sodic subsoils.	Associated with grazing of cleared landscapes. In forested grazed areas, the shrub and tree root mass reduces movement. Very common on scrub Walloons, Albert/Beechmont/ Lamington Basalts and Rhyolite/syneites.	Found in both cleared and uncleared areas – severity greatest in cleared areas	Most of these areas have been cleared but many of the slip benches pre date clearing.
Most prone types of geological landscapes	Found on all geologies and slopes, however the Marburg geology formation and parts of the 'forest Walloons are most at risk – primarily because these are low fertility soils that do not quickly re-establish ground cover.	Very common in heavily grazed areas of the Marburg sandstone – particularly areas mapped as Gatton sandstone. Also found in the Heifer Creek sandstone and in sediment colluvial fans at base of basalt areas	Largely restricted to Gatton and to a lesser extent Heifer Creek sandstone. Very rarely found on Forest Walloons and then only on the red sodic duplex soils under Gum Top Box. Will occur on both Marburgs and Walloons in dams	Very common on scrub Walloons, Albert/Beechmont/Lamington Basalts and Rhyolite/syneites.	Found on steep scree slopes of the Albert, Beechmont Hobee Basalts – often in areas mapped as Tertiary Quaternary scree slopes. Landslides can be found in most steep areas of geology but appear most prevalent in the Heifer Creek areas	Landslips are common in most basalt areas but are less common on the older Albert Basalt. Basalts and associated colluviums account for 75% of mapped slips, the Marburg sandstones 15% and the Walloons less than 10%.
Degree of difficulty to manage	Fire, grazing water point location and in lower slope areas pasture re-establishment are feasible strategies. In infertile lands (such as Marburg geology) long term spelling will be required	Difficult to control without physically controlling stock access and overland flow. Some areas may require high cost engineering interventions. Rate of recovery in lower fertility landscape will be slow once physical measures are implemented. Stock water and road table drain management are key initiatives		Short term adjustment of stocking rates over the wet season is most effective.	Extremely difficult to control – these areas and areas downslope should not have infrastructure built on or below them.	These can range from very stable areas requiring no major management changes to areas which are unstable. Not recommended for infrastructure uses.

	Sheet/Rill	**Gully Erosion**	**Tunnel Erosion**	**Soil Creep/Terracing**	**Debris Flows/Slides**	**Land Slips**
Bare area issues	Appears as diffuse bare coalesced pixels in the Marburg geologies. In the Basalt and Walloon geology groups. Remote Sensing may underestimate the bare areas	Appears as linear patterns with accentuated diffuse areas along boundary. Again, more easily pixellated in Marburg and related geologies		Only where slides and slips result is this obvious	Rarely obvious as these areas vegetate over quickly. Only in the Heifer Creek sandstone where sodic infertile weathered sandstone is exposed are bare areas obvious.	Rarely seen effectively on satellite imagery – can however be inferred from DEM.

Table 3.2 *Erosion Mapping Summary Classification*

Code				
1	**2**	**3**	**4**	**5**
Form of erosion present but at a low background level – unit may contain natural sediment traps and basins.	Form of erosion is present and accelerating but only in part of the landscape	Form of erosion is present over most of the landscape but not at a level which is creating irreversible degradation	Form of erosion is present over most of the landscape and is associated with significant bare areas that are permanent degraded.	Form of erosion is severe and is delivering significant sediment directly to streams at an accelerating rate from permanently degraded areas
For sheet or rill erosion the percent of area that has less than 30% ground layer cover other than tussocks and is effected by erosion				
<10	10 to 40	40 to 60	60 to 80	More than 80
For gully erosion the percent of sub catchments area that has gullies with unstable headwalls				
0	<10 and confined to creeks drainage lines and roadways	<20 but includes gullies within broader area	<20 and gullies form an interlined network	>20
For tunnel erosion the percent of subcatchments that has tunnel erosion				
0	<10	<10 and linked to unstable gullies	<20 and linked to unstable gullies	>20
For soil creep/terracing the percent of area that has soil creep/terracing				
0	<10	<20	<40 and terraces are bare and compacted	>40 and terraces are bare and compacted
For debris flow and slides the percent of subcatchments affected				
<1 and stable	< 10 and stable	<20 and stable	<20 and recently active	>20 and recently active

4 Prioritizing Catchments

Table 4.1 summarises data for each catchment within Table 4.2 (land slippage data) and Figures 2, 3 and 4 which show the proportions of the major forms of erosion.

Table 4.1 *Highest Priority Catchments*

Highest Overall Erosion	**Highest Sheet Erosion**	**Highest Gully Erosion**	**Highest Density of Land Slips**	**Highest Intensity of Land Slips**
Knapps (50% of areas as Major Erosion	Knapps	Knapps	Widgee	Widgee
Cannon (25% as major or Severe)	Cannon	Cannon	Albert Right	Upper Logan
Widgee (25% as Severe)		Lower Burnett	Cannon	Chingee
		Albert Right		Albert Right

Knapps and Cannon Creek have the largest areas and proportion of broad hectare forms of sheet and gully erosion. Both of these catchments are dominated by Heifer Creek and Marburg Sandstones. In the case of Cannon Creek, the areas south of Greenhills Road in Boonah Shire are as badly eroded as the Knapps Creek catchment in Beaudesert Shire.

Cannon Creek also ranks relatively high on the density of land slips. This catchment along with the Widgee Creek catchment are the only two catchments where both sheet and gully erosion along with mass movement forms of land degradation are common.

The highest priority catchments can thus be described as:

- Knapps and Cannon Creek catchment where broad hectare erosion of infertile soils has produced a highly degraded landscape with relatively intractable erosion problems.
- Widgee Catchment (upper reaches) where there is a high density and intensity of land slips associated with broad hectare erosion.
- Albert Right Catchment where gully erosion is significant in areas with relatively high intensity land slips

Over the remainder of the study area broad hectare erosion is in the range of moderate to stable. This does not mean that in all areas of these catchments that there is no significant erosion. Local examples of severe erosion occur in all catchments but it is only in the ones prioritized above where the erosion problems appear to be systemic.

Table 4.2 Incidence *of Slips within each catchment (based on Willmont Data)*

CATCHMENT	Catchment ha	Meters of Slips	Number of Slips	Meters of slip in 100 ha	Density of slips ha per slip
Albert Left	3433	1482	5	43	687
Albert Right	3112	9367	32	301	97
Back Creek	2098	0	0	0	
Cannon	11012	25086	119	228	93
Chingee	3264	11360	22	348	148
Christmas	6136	10708	27	175	227
Flagstone	6121	5041	27	82	227
Knapp	7439	8486	18	114	413
Logan Rathdowney	1379	0	0		
Logan Tilley	354	0	0		
Lower Albert	19599	8274	15	42	1307
Lower Burnett	7856	7958	27	101	291
Lower Canungra	2563	2537	6	99	427
Lower Logan	4848	4942	27	102	180
Lower Palen	3772	6644	13	176	290
Lower Running	1218	0	0		
Middle Logan	1794	1811	5	101	359
Oaky Creek	4985	10000	23	201	217
Running	12197	17205	60	141	203
Tambrookum	2966	1646	8	55	371
Tartar	2070	3756	8	181	259
Upper Canungra	9702	9171	20	95	485
Upper Logan	6560	26674	62	407	106
Upper Palen	3419	893	2	26	1710
Widgee	2678	13245	41	495	65

Figure 2 *Ranks for Overall Erosion Severity*

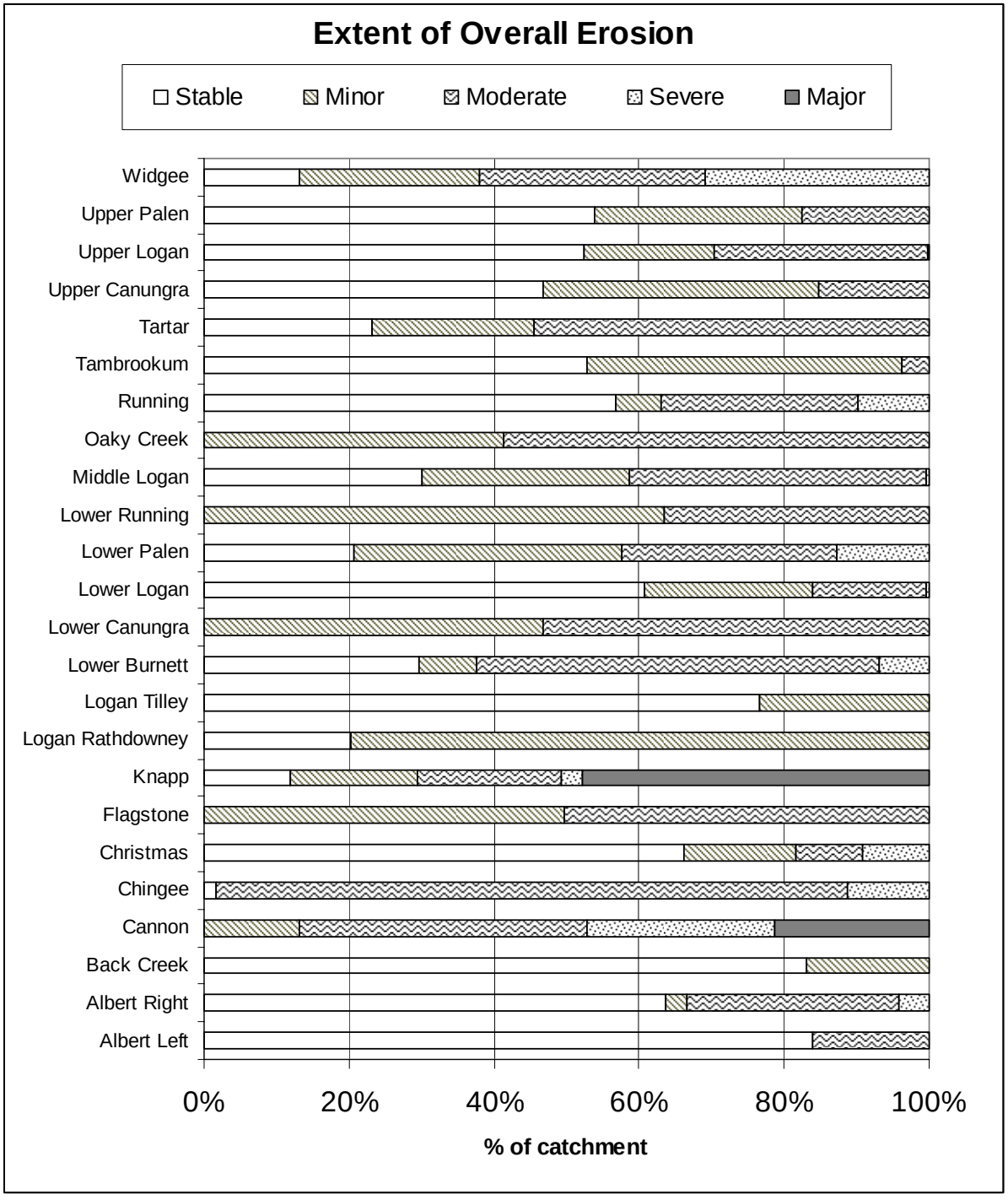


Figure 3 *Ranks for Sheet and Rill Erosion Severity*

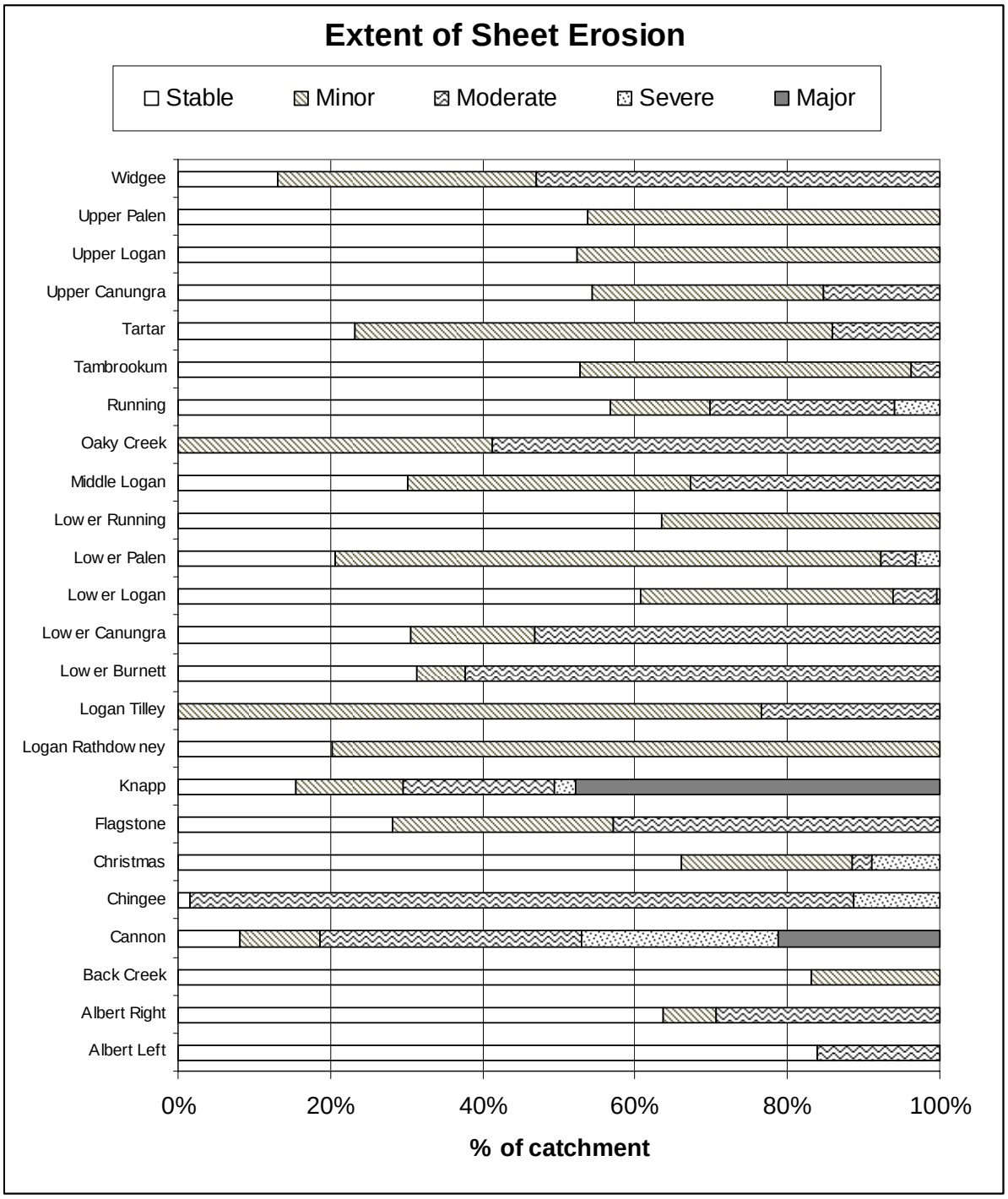
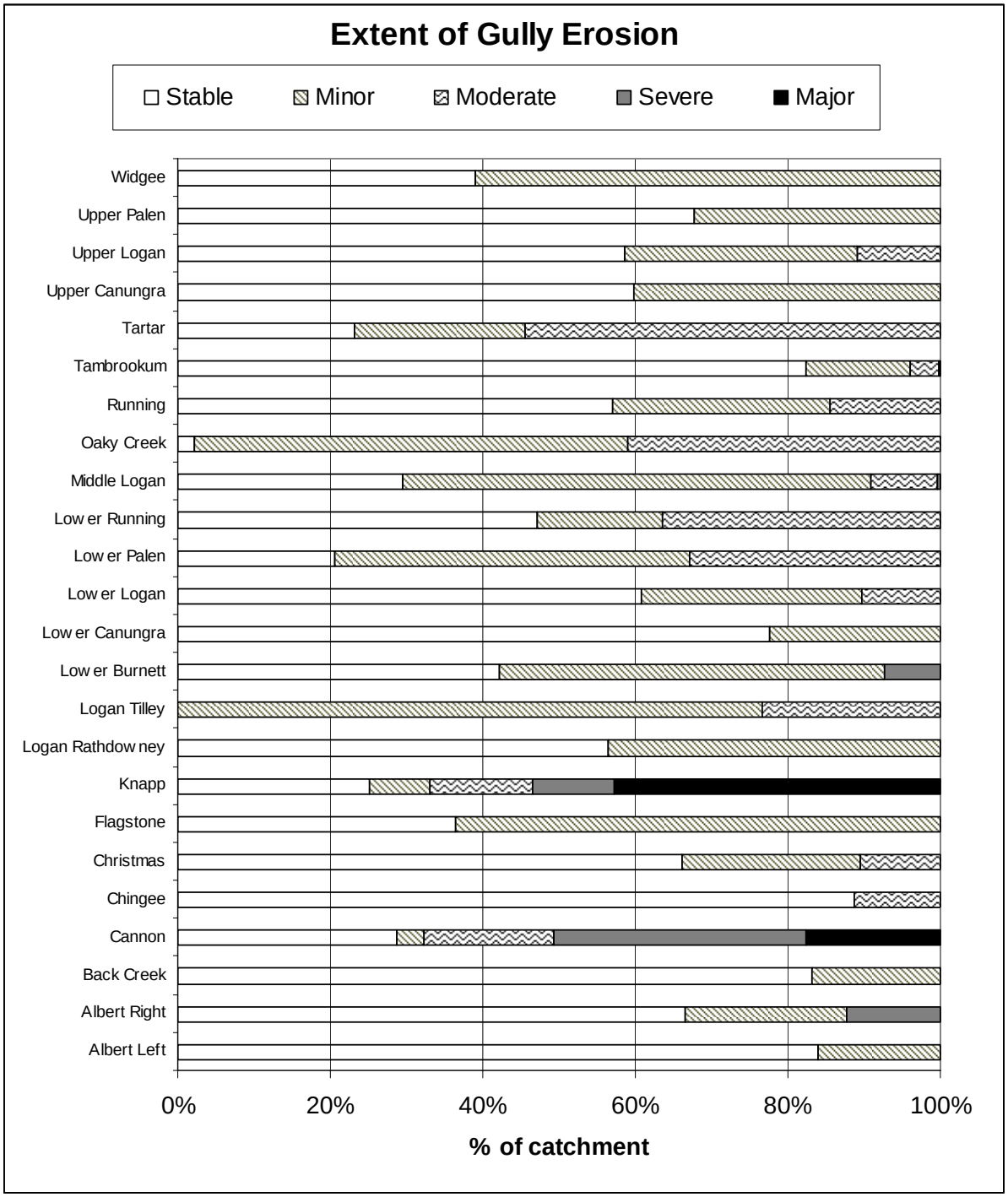


Figure 4 *Ranks for Gully Erosion Severity*



5 Management Factors

5.1 Factors that predispose an area to erosion

In the catchment areas of this study, a number of factors appear directly related to the incidence and severity of erosion. Soil types and terrain are the key resource parameters. The convex shaped slopes of the Basalt and Walloon Scrub landforms with their base slopes and interfluve areas of sediment aprons and deep more permeable and fertile soils are far less prone to erosion than the more infertile soils on concave slopes of the Marburg and Heifer Creek geologies.

Slope shape (concave versus convex) determines how far up the slope runoff concentrates into defined waterways. In convex slopes runoff does not concentrate into defined waterways until near base of slopes and the change in gradient often results in sediment contained within the runoff being deposited as sediment aprons. This is the defining feature of much of the Walloon and Basalt landscapes.

Concave slopes form defined water courses with concentrated runoff in the middle to upper slopes whilst gradients are still high and hence the energy within the runoff still high. In these situations erosion can be accelerated within the runoff waterway and sediment rapidly moved out of the landscape. This is the defining feature of the worst eroded parts of the Marburg, and Heifer Creek based landscapes.

If slope shape and gradient are controlling factors, then soil type and properties potentially act to mitigate or exacerbate erosion potential.

In basalt areas, the most common soils are non cracking (or at best weakly cracking) well structured clay soils with relatively high cation exchange capacity. Not only are these soils permeable, but they also have a strong capacity to retain nutrients against leaching and have a low erosivity. This when combined with the fact that basalts are often high in phosphorous, means that these soils can sustain quite vigorous plant growth. When cleared, the nutrients release further enhances grass growth. Similar soils and circumstances apply to the Walloon Scrub areas. The end result of erosion in these landscapes is:

- Removal of often highly fertile surface soils and their deposition at the base of slopes.
- Some export of suspended clay based sediments (with significant phosphorous content) is possible in the absence of easily observed erosion.
- Unless areas are eroded to the weathered rock, the in situ soil profile is often able to sustain ground cover growth.

In the sandstone area of the Marburg geology, the soils are often duplex soils with tough subsoils containing sodium. The subsoil clays are often underlain by weathered sandstones and the surface soils are invariable poorly structured infertile sandy loams. Surface soils are highly erosive with little structure and subsoils often disperse and lose their structural strength when wet. These soils are easily eroded and can produce extensive sand and clay export.

There is one suite of landscapes which is intermediate between the two above extremes. The Walloon Forest areas also contain sodic duplex soils, however these often have higher fertility and better structured surface soils.

When evaluating site based erosion, the first assessment should be on slope form and shape. Physical works such as contour banks may act to concentrate runoff in convex parts of slopes leading to highly undesirable outcomes. In concave slopes, physical works may well be needed to spread flow away from points of concentration that are unstable.

When the effect of terrain has been determined, soil fertility and the properties of the subsoil should be assessed. Fertile soils may well respond to simply reducing land use pressure for a period of time to re-establish ground cover – infertile soils may not recover unless fertility and or soil amendments are applied.

5.2 Management Impacts

5.2.1 Land management within an historical setting

Management impacts need to be seen in an historical and socio-economic context.

In an historical context land management within the area has followed a number of phases.

Initially areas of scrub (dominantly in the Basalt and Walloon scrub areas) were cleared for both timber and dairying/dryland cropping. At the same time the narrow alluvial flats of less than a few hundred meters width were developed for irrigated or partly irrigated cropping.

The next phase of land management was the selective clearing of the grazing lands. As in other river systems in south east Queensland, the Albert basalt and Walloon Forest soils areas have been almost totally cleared. In this area however, this large scale clearing (by ring barking, fire and later chemical treatment) extended into the lower value and lower fertility Marburg areas.

The above phases lead to development of vibrant rural communities based on the beef, grain, forage, dairy and pig industry as well as the timber sector. Population in these areas was probably at its highest in this period.

From the 1960's onwards a number of factors started to influence land management and use in these areas. These included:

- Structural change in some industries (particularly forestry and dairying) resulted in these industries loosing their competitive advantage vis a vis other parts of the region.
- The initial 'kick' in productivity generated from clearing declined and fertility had to imported to the soils of the area effectively increasing costs of production.
- In some situations the cumulative effect of two to three generations of farming and grazing meant that there was an irreversible loss in productivity just at a time when

producers needed to increase their production and economies of scale to offset declining terms of trade.

By the turn of the century these factors had produced irreversible socio economic and land use changes in the area. These changes include:

- Those catchments dominated by poorer quality soils (Cannon and Knapps Creek) are now highly degraded and commercial scale cropping and beef grazing has declined dramatically. Individual land portions have been purchased by outsiders whose focus is the equine industry – primarily the recreational sectors. This form of land use in these catchments is reliant on supplementary feeding regimes. The high levels of historical subdivision in Beaudesert Shire means that the supply of lands of suitable lot sizes will not limit this form of land use.
- The equine industry has also invested in other catchments with higher quality soils. In these areas the higher value thoroughbred sector has tended to dominate and in fact expand from its historic baseline in these areas. Whilst also reliant on supplementary feeding regimes, this form of land use in the higher quality soils areas also uses and maintains higher quality improved pasture lands.
- The dairy industry has seen a decline in the number of dairies and the remaining dairies invariably have access to higher quality alluvial flats. These dairies now have larger herd sizes and are reliant on extensive bought in feeding regimes. The dryland pasture paddocks close to the dairy sheds and feeding stalls are largely used as day paddocks and can suffer high levels of erosion.

In terms of soil erosion, these three new or modified forms of land use pose the greatest erosion risk. The main reasons is that the grazing animals or what they produce are of such a value and high replacement cost (financial or emotional) that the land managers will maintain grazing on areas long after strategic spelling and de-stocking should have occurred thereby exposing the soils to excessive erosion. This situation is analogous to erosion hazards generated in the 1960's and 70's when dryland cropping on the Walloon Scrub and Basalt areas continued even though the degradation from erosion was becoming increasingly evident.

In the traditional commercial beef grazing model, supplementary hand feeding of beef herds has been rare. With the exception of stud animals and animals being weaned, hand feeding is considered an uneconomic practice. The traditional production system is based around the selling of drafts of animals (and hence lowering of grazing pressure) when they are at their peak condition (typically from January through to June). The fragmentation of existing beef holdings into rural lifestyle based enterprises which are less dependent on the income from sales of animals has however seen substantive change in this business model and there is now a higher use of hand feeding with consequent overgrazing than has been the traditional situation.

Finally there is one major difference between the socio economic settings of the erosion hazards of the 1960,s and those of 2000. In the 1960, and 70's declining terms of trade and resource productivity combined to generate the highest erosion hazards at a time when rural land owners were least well positioned financially to manage the risk. Erosion joined a long list of other factors that resulted in the closure of significant number of family farms and with that loss there was a consequent in field based knowledge and understanding of landscapes

as well as a subsequent decline in external advisory services for soil conservation, pastures and land management.

The new industries associated with the severest forms of erosion (equine sector and large scale dairies and lifestyle grazing) understand the importance of investing capital into physical assets in order to maintain their systems and are generally in a better financial position in terms of land asset values than their predecessors. The challenge lies in diverting relatively small proportions of the capital investment in production facilities into less tangible inputs into land management. Associated with this challenge is the need to support this investment by re-building key aspects of the landscape knowledge capital lost when the previous generation of land holders and extension officers were lost from the area.

5.2.2 Land management strategies

With the exception of those catchments where erosion is ranked as severe or major, most of the erosion concerns in the area can be addressed by relatively simple changes in existing land management. Whilst these changes may be simple, they may run counter to perceived priorities of some forms of land use – particularly within the dairy and equine industry.

These strategies are summarized in Table 5.1.

For the equine and dairy industry where day paddocks associated with yards and stabling or feeding facilities, very high stocking rates are common. Sheet erosion can be severe (Photos 1 and 2) and long term pasture degeneration and low levels of ground cover are very common. Adjoining grazed paddocks are also often overgrazed. The strategies shown in Table 5.1 involve working with the two industries on the design layout and land condition targets for both grazed day paddocks and the broader grazing areas. In the case of both industries, day paddocks are essentially extensions of yards where animal are fed daily. Whilst low levels of ground cover are probably unavoidable, such paddocks need to be selected so that soils and terrain of significant erosion hazard and areas incorporating drainage lines should be avoided. In the case of grazed paddocks, there is scope for pasture improvement, spelling and paddock rotations to be used, however, the reality is that in severely eroded areas such as Knapps Creek and Cannon Creek on infertile sodic soils, such programs in the absence of reduced stocking, physical works to contain erosion will not be effective.

For the broader beef grazing sector there are a number of areas of concern. Whilst sheer overgrazing is an issue, it is the distribution of grazing pressure that is of primary concern. The most common effects are cattle pads along fence lines leading to watering points and these effects are found on all land types as shown in Photo 8 (Marburg Formation) and Photo 9 (Walloon and Albert Basalt lands).

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Photo 8 *Gentle sloping lands of the Marburg geology group with eroding cattle pads leading to a water point..*

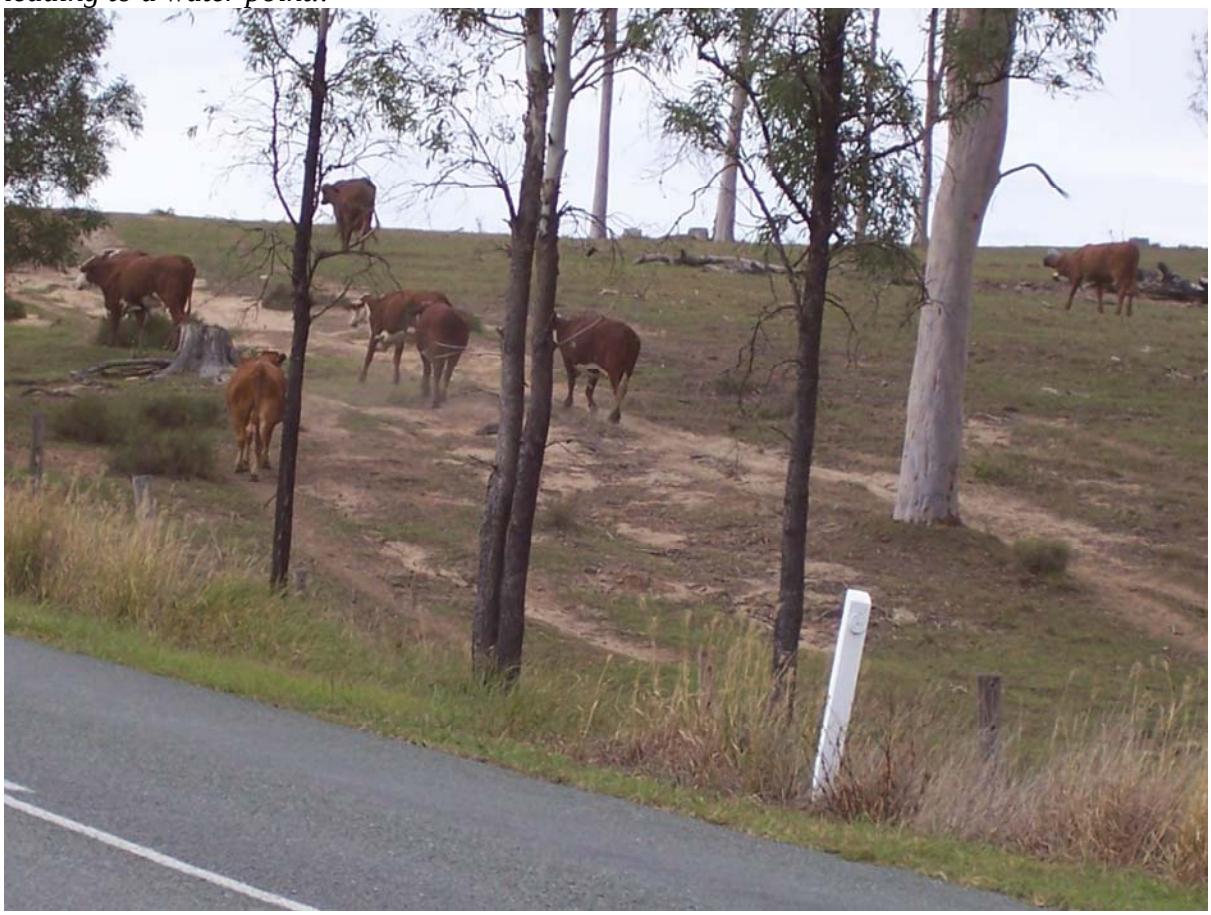


Photo 9 *Fence line erosion on cattle pads leading to water points in Albert basalt and Walloon geology areas.*

The watering points are often high disturbed and eroded. In Photo 10 the watering point is located on a highly erosive sodic duplex soil which is also prone to tunnel erosion. Attention to the distribution of water points and the way livestock access these water points along with appropriate grazing land management would have significant impacts on these areas.

Photo 10 *Severely eroded water point at base of Walloon Forest lands.*

Two other land use sectors are also included in Table 5.1. Grazing land management (both equine and beef) does have major impacts on yields of sediment from areas. However, the design and management of the road drainage systems and riparian zones does have a major impact on whether sediment is exported from the grazing lands. As discussed earlier in this report the movement of sediment in overland flow is commonly limited at the base of the slopes by sediment aprons and other forms of narrow alluvial deposits. Roads and their table drains construct red across these slopes and the management of riparian corridors can increase the rate of sediment movement out of the area but more importantly mobile the sediment previously accumulated in the sediment aprons.

Addressing grazing land management without including management of roads and riparian zones in more severely eroded areas will have limited impact on long term sediment yields (see Photo 11 and 12).

Photos 11 and 12 show two examples from the more heavily eroded areas of the Marburg geology.

Photo 11 shows the typical fence line effect of a cleared versus a uncleared area. The more extensive erosion on the cleared side of the fence reflects grazing land management as much as it does the effect of clearing.

Photo 11 *Sheet terrace and minor slides in cleared grazed lands of Marburg geology..*

Photo 12 shows a strongly active gully within an uncleared road reserve with cleared lands immediately upslope and showing limited erosion.

Photo 12 *Table drain induced severe and unstable gully erosion in uncleared lands of the Marburg geology group.*

Table 5.1 recommends that work which has been initiated by the Department of Main Roads in Central Queensland and in the areas immediately west of Ipswich on road drainage design be extended to cover these areas. This work details design characteristics for table drains to reduce gully and tunnel erosion. Table 5.1 also recommends that in the more severely eroded catchments that priority be given to riparian zone mitigation programs.

Table 5.1 Land *Management Strategies to Manage Erosion*

Strategy	**Project Activities**	**Objective**	**Priority Areas**
Riparian Zone Rehabilitation Initiatives	Off stream watering and fencing off for strategic grazing of unstable gully eroded areas	Primarily to stabilize unstable stream banks of unconsolidated sediment which are being mobilized into the Logan River.	Knapps and Cannon Creek and tributaries which contain surface water. Whole of these catchments
Road Table Drainage Initiatives	Adapt existing Main Roads drainage and design criteria for the soils and terrain of the area	This would adapt existing work in Central Queensland and the Western Bypass Corridor to the problem soils and produce design criteria for future road investment	Existing work on the gullying and tunneling in the Marburg/Heifer Creek Gatton geology groups could be adapted. Work to extend coverage to Basalts (mainly Albert basalt) and Walloon areas required. Result would be of use in Bremer Logan and Albert Catchments
	Develop partnership arrangements with shire and Main Roads for remediating unstable erosion gullies in areas where adjoining land holders undertake remedial land management works	Within Priority Catchments develop functional working relationships between all parties at priority sites. It is these sites which appear to be producing the highest site based sediment yields.	Greenhills Road in Cannon Creek (Boonah Shire) and Knapps Creek Road and minor parts of Tambrookum and Widgee catchments. All Rank 4 or 5 areas.
Equine and Dairy Industry Land Management Initiatives	Development Land Management Targets for Dairy and Equine Sector	Establish targets for stocking rates and land cover for each of the main geology soil groups in the area.	Priority groups are the Heifer Creek, Marburg and Walloon Forest areas as well as the Albert basalt lands – currently favored by the equine sector.
	Land Management Initiatives for Dairy and Equine Sector	Develop fact sheets on pasture improvement/ fertility and paddock design and layout. Include fact sheets on remediating	

Strategy	Project Activities	Objective	Priority Areas
		Rank 4 and 5 areas and release fact sheets at Equine field day.	
		Identify co-operating land holders to participate in whole of property planning exercises and initiate an incentive scheme for these areas	In Knapps, Widgee and one other catchment (possibly Running Creek Albert Basalt dairy lands)
Grazing Industry Land Management Initiatives	Development Land Management Targets Beef Sector	Establish targets for stocking rates and land cover for each of the main geology soil groups in the area.	Priority groups are the Heifer Creek, Marburg and Walloon Forest areas as well as the Albert basalt lands – currently favored by the equine sector.
	Land Management Initiatives for Beef Sector	Develop fact sheets on pasture improvement/ fertility and paddock design and layout. Include fact sheets on remediating Rank 4 and 5 areas and release fact sheets at Beef grazing field day.	The focus on this areas should be the Walloon and Basalt areas.
		Identify co-operating land holders to participate in whole of property planning exercises and initiate an incentive scheme for these areas	This may overlap to recent GLM project.

Annex A - Distribution of Salinity within Beaudesert Shire.

Introduction

This study identifies a broad set of salinisation models within the Logan and Albert Catchments and wherever possible to map the distribution of these models. The methodology involved the field measurement of base flow discharge to streams and relating this to the geology and land forms within the hydrological catchment. There is a very limited network of catchment wide bore monitoring locations and the few that do exist are primarily located in the alluvial aquifers of riparian zones – the zone least involved in landscape salinisation.

Types of Salinisation in the Catchment Areas.

Whilst soil salinity (and the related sodicity) are common in some of the landscapes of the area, occurrences where this is directly associated with contemporaneous secondary salinisation due to rising water tables are rare. Where this does occur it is highly localized and related to local landscape parameters – one of which is the high level of historic salt loads in some of the geological sequences. In other words not all current salinity/sodicity effects are due to changes in the hydrological balance of these catchments.

Non Saline Seeps

This is the most extensive expression of groundwater effects in the study area. They are important for a number of reasons:

- They provide the basis for the base flow in streams that sustains stock and domestic and environmental flows during periods of no rain.
- In some locations, they result in wet land environments
- They form part of the process in some landscapes associated with land slips and slides

They are common in most of the basalt landscapes with seeps and springs occurring in many incised streams and around the periphery of the basalt flows where they overlying other types of geology.

Many of these seeps and springs predate land clearing – although it is highly likely that flow rates and size of these springs has increased following land clearing.

Saline Seeps

Typically these occur where saline ground water rises to within a couple of meters of the land surface and soil salts are mobilized to the land surface. Such occurrences need a number of very specific landscape related hydrogeological process to be present.

Recharge being transmitted to the affect area must exceed that rate at which saline ground water flows out of the area – and there are two broad types of these phenomena.

The first type is where vertical recharge from rainfall or irrigation exceeds a soils capacity to deep drain and a perched water table develops, rises towards the land surface and salts are deposited at the land surface by capillary rise. These salts can then be mobilized by runoff or artificial drainage aimed at correcting the associated waterlogging problem to surface water

supplies where the salts are effectively recycled by other downstream water users. This is one of the Murray Darling Irrigation Area phenomena and it is not present in the study area. For this phenomena to occur highly specific irrigation command design, command and management failings have to be applied to very specific groundwater hydrology conditions over a long period of time as has occurred in the MDIA in southern Australia. These conditions do not exist in the Logan or Albert catchments.

The second type is far more common in Queensland and in the western slopes of Murray Darling Basin – it is often referred to as landscape salinisation. Essentially, it involves groundwater flows from an **intake** area moving via a **transmission** area to a **discharge** area. Where the transmission zone and the discharge zones are relatively permeable and freely draining, the groundwater will ultimately drain away without any significant surface expression of salinity.

There are a number of key features to this type:

- If rate at which recharge from an intake area moves into a discharge area exceeds the rate at which it drains away, water tables will rise.
- If the distance between intake and recharge areas is short, these rises can occur in a very short period of time – if long distances are involved many generations of land use may pas before rises become apparent.
- Even if the source of the recharge is non saline, saline materials within the transmission zone will result in the groundwater at the discharge area being saline.
- Even if the transmission zone is low salinity, the discharge area itself may have historic accumulations of salt that will be mobilized.
- Whilst not always the case high permeability transmission and discharge areas often have low salt content. The converse of this is that where high salinity groundwaters occur in discharge or transmission area, the actual mass of salt being moved may be quite small[2] and it may require very large areas to be yielding this low rate base flow for significant downstream impacts to occur.
- In some areas, discharge areas with poorly incised or dysfunctional surface drainage systems become landscape salt sinks. Outbreaks in the Lockyer Warrill and probably the Veresdale area show some evidence of this phenomena.

Saline seeps of any significant extent are found only in a small number of locations where quite specific conditions occur. Theses are where high rate low salinity intake areas in very close proximity to saline transmission area provide recharge towards discharge areas that are not freely draining. These occur upstream of Flanagan's Reserves on the Logan, in the Hoya and Boonah Township area of the Teviot and in the Cyrus Creek, Veresdale Scrub to Beaudesert area. Baseflow in the steams of these areas is very saline and there are some examples of saline soils close to discharge points.

Scalded Areas

Scalded areas are the most common form of salinity expression in the study area. However. Few if any of these occurrences are related to saline groundwaters. Just as an input of low

[2] A medium level base flow of 10000 ppm at 10L/sec in a saline discharge area like Cyrus Creek would produce as much salt transport as a flow of 500 ppm at 200 L/sec – a flow rate that is common in streams like Running Creek.

salinity recharge to a discharge area will mobilize subsoil salts to the land surface, simply eroding away the top soil will result in saline and sodic materials exposed at the near land surface.

There are a number of situations where this exists. The most common is within the Heifer Creek and Marburg sandstone units where both land slips and water erosion has exposed saline and sodic subsoils and in parts of the Cannon and Knapps Creek catchment sodic saline weathered base rocks. It is far less common in the Walloon Coal Measure areas, but is found on the complex series of claystones and mudstones known as the Beaudesert Beds in the Beaudesert Cyrus Creek area where it is coincident with the landscape salinisation processes discussed above.

Salt Models within the Hydrogeological Systems

Table 1 summarises the major features of the hydrogeological systems in the study area. The table describes the following:

- Components of the hydrogeological system which list intake, transmission and discharge area characteristics in terms of salinity
- Geology and Landforms most commonly associated with the above components[3]
- Groundwater flow systems[4]
- Salinity Expression

Figure 1 maps the components of these models.

Figure 1 also shows the locations of current salinity areas.

The Beaudesert Veresdale Scrub Salinity area.

This area comprises the westward flowing creeks and gullies and their associated catchments extending from immediately south of Beaudesert to Jimboomba.

The Veresdale Scrub area forms the catchment of Cyrus Creek and has very high salinity levels in the base flow. The Cyrus Creek alluvial plain is underlain by a shallow highly saline aquifer.

The Veresdale Scrub area is based on the Scrub Walloons – basically old marine mudstones which weathered to produce high quality soils, but which contain extensive salinity at depth. This is the main transmission component of the groundwater flow systems in the area. The intake components include highly complex set of dykes and intrusive geologies with saline intake areas and mudstones claystones (the Beaudesert Beds) as well as a number of unmapped intrusive plugs. The lowest discharge points in the landscapes are the sheets of clay sediment deposited by the creeks (such as Cyrus) and gullies. These have poorly defined drainage networks and weak stream incision and it is in these areas where saline groundwater are close to the land surface.

[3] The amended geology mapping supplied with this report for the area has attributes for each of these components added.
[4] Recharge areas are often only hundreds or thousands of m from discharge areas for local systems, tens of kms for intermediate and many hundreds of km for regional systems. Changes in intake area hydrology for local GFS may be reflected in a few seasons at the discharge point, within a few decades for intermediate GFS and within possibly hundred of years for regional systems.

Of all the salinity areas within the study area, this is the one which is likely to show some expansion over time. Factors likely to causes this expansion include:

- Increased recharge from on site household wastewater systems. Typical loadings on disposal areas are around 400 L/household per day onto 250 square meters of disposal area. This loading is the equivalent of an irrigation loading of 7ML/ha/annum. The area north of Beaudesert contains some 2000 individual land portions – one third of which are less than 3 ha in size – there is therefore considerable scope for recharge to the groundwater systems in the area to be increased.
- Increased land use pressure and decreased ground cover. Whilst most of the area remains rural in nature (despite the high level of subdivision) there is extensive overgrazing of the area. The biomass available to transpire excess water is simply not present – it is immaterial whether the missing biomass is trees shrubs or grass – if past cultivation and erosion and subsequent overgrazing by livestock reduces the biomass to an insignificant level, recharge will continue to increase.
- The Beaudesert Beds with their very complex Intake/Discharge components will make control and management very difficult.

The Boonah Hoya Salinity Area

This area is part of a far larger system incorporating the Kalbar, Obum Obum and Milbong areas of the Warrill Catchment immediately to the north and east. The area has a number of features in common with the Veresdale area:

- Walloon Coal Measures dominate the catchment and these are the Walloon Scrub areas.
- Whilst the area lacks the complex Beaudesert Bed component it does have extensive rhyolite and basalt dykes and flows which provide high rate recharge areas.
- Just as in the case of Cyrus Creek, the drainage line is dominated by clay deposits and has a poorly incised stream network.

Unlike the Beaudesert area, further expansion appears unlikely. The catchment areas are not as heavily subdivided, Boonah uses a common effluent drainage scheme as a well as household treatment systems and the catchment areas are not as badly eroded as the Veresdale area.

The Flanagan's Reserve Salinity Area

This area comprises the westward draining catchments of the Upper Logan River. These catchment drain Walloon Scrub lands which have a significant number of unmapped intrusions of both rhyolite and basalt. The upper parts of the catchment are veneered by a basalt flow which overlies the Walloon Coal Measure geology.

Salinity expression is limited to saline seeps within the poorly incised drainage gullies. Base flow within these seeps is low but saline – this contrasts with the base flow in the Logan River above Flanagan's reserve which is largely derived from volcanic and extrusive land forms and is non saline and of a much higher flow rate.

Other Potential Areas

Few other locations in the study area have the same combination of features as the above three areas. However, areas along Allandale and Greenhills Road and areas upstream of Boonah in the Teviot catchment all have extensive areas of narrow alluvial plains within the Walloon geology group along with numerous intrusions of basalt and rhyolite. Break of slope salinisation effects do occur in these areas and it is conceivable that outbreaks may continue to develop under specific local hydrogeological conditions.

The remainder of the study area is dominated by low salinity type intake areas formed from volcanic geologies (the majority of the eastern Logan catchment and all of the Albert catchment) or is dominated by moderately permeable sandstone based geologies which are more likely to acting as transmission zones to the deeply incised streams such as Allans/Cannon and Knapps Creek.

Remediation Strategies

Remediation strategies for groundwater induced soil salinisation and its related problem of saline base flows are all based on either reducing recharge or on increasing discharge.

Identifying discharge areas is a relatively simple process – it is the area where saline groundwater appears in surface streams or where salt is accumulating at the land surface. The major difficulty with increasing discharge is that the discharged salt has to be relocated somewhere and this somewhere needs to be an area where its negative impacts are acceptable.

Increasing discharge rates normally has 2 components:

- Where a receiving water body can be shown to be unlikely to be significantly impacted, engineering solutions can be applied at the discharge area – such as well field and subsurface drains etc. Such approaches are often only economically feasible where the asset being protected (i.e. the areas prone to salinisation) are of a major value and override any downstream impacts from increased saline drainage. At the current scale of these problems such large cost interventions are unlikely to be justified[5].
- Changing land use within the discharge area to increase water use and increase leaching. Some benefit may be obtained by conversion of the cultivated lands at Cyrus Creek to permanent pastures and/or agro forestry. However, this approach is only applicable where soil salinisation within the discharge area is significant as it aims primarily to reduce the depth to the water table enough for improved leaching outcomes within the root zone. Increasing plant water use will lower water tables but it also will result in salt stores building up in the soil profile.

Reducing recharge in intake rates has long been advocated as the primary strategy – primarily because it offers the capacity to reduce salt effects without exporting the salt 'problem' further down catchment. However, the tool is only effective with reduced negative collateral impacts if it is applied precisely[6].

[5] The Boonah Hoya Road area has had some drainage works installed to relive waterlogging and improve leaching of the surface soils. The benefited are is the public playing fields in the middle of township.

[6] Imprecise application of the technique that reduces low salinity flows in non target areas can result in negative impacts of reduction in base flows in catchments and reduction in groundwater available for stock and domestic uses

The requirements for a precise application of both biological and engineering strategies are summarized below:

- One set of engineering based approaches aims to convert an increased amount of what normally infiltrates in the intake area to runoff. Care with the design of roads and tables drains and use of out of catchment land based disposal systems (eg common effluent drainage schemes) can produce this outcome.
- Another engineering based approach is to encourage conjunctive use of groundwater in those parts of the intake area directly resulting in increased salinity downslope. At some point in the landscape, groundwater quality within the recharge area would be suited for a wide variety of uses and land owners in those areas should be discouraged from using on property dams and encouraged to use groundwater bores. The critical feature is that the point in the landscape where this should be applied is often not well known.

A widely recognized strategy is increasing the biomass within the intake/recharge areas and thereby converting deep drainage or recharge into plant water use. Just as for the conjunctive use strategy, the locations of these areas needs to be critically defined for the strategy to be effective. Once these areas are identified appropriate methods would include:

- Encouraging forestry within the critical intake areas
- Improved grazing land management and pasture improvement programs

Both of these strategies require levels of land management skills and expertise which may not necessarily be present in some of these areas. In addition, these approaches need to be applied across a number of properties and often these same properties are not the ones who suffer from saline water tables downslope.

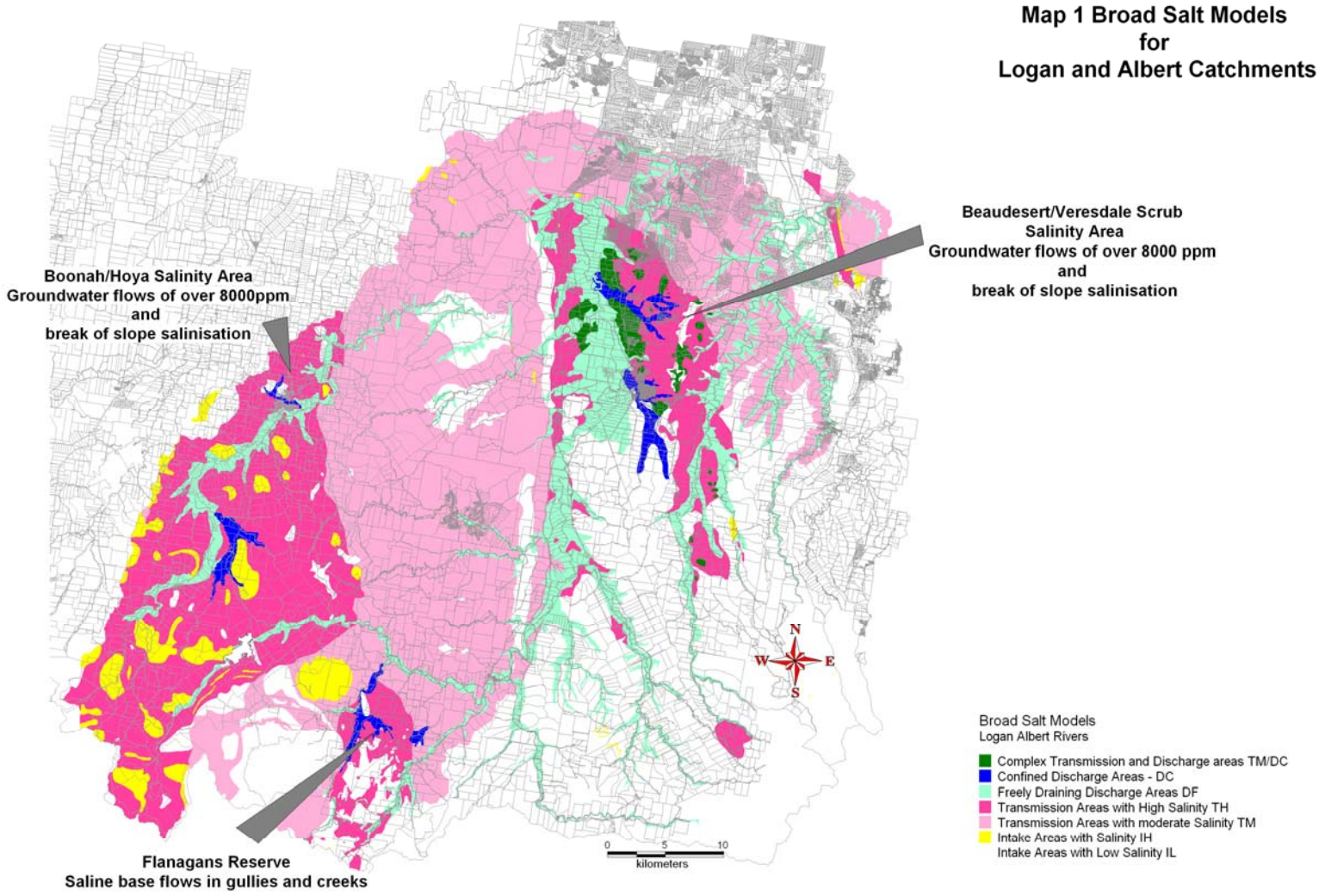
Table1 Landscape salinity models for Logan and Albert Rivers

Component	Geology and Landforms	Groundwater Flow Systems	Salinity Expressions	Other
Freely Draining Discharge areas	Quaternary river terraces and open flood plains	Mostly Local Systems linked to incised streams such as Logan, Albert and major creeks. Recharged during floods – major economic aquifers of area	Rare for groundwater salinity to effect surface soils. Intermittent perched water tables of low salinity may exist under irrigation. Groundwater salinity commonly less than 1000 ppm	Around the margins of these areas, higher salinity but lower flow rate inflows from older geology occurs but these rarely develop as surface seeps because of high permeability of alluvial aquifers.
Confined Discharge areas	Narrow high clay content Quaternary alluvial plains surrounded by transmission and intake areas with moderate to high salinity	Local to intermediate systems confined to Salt Gully in Boonah Hoya areas, Cyrus Creek below Veresdale Scrub and Upper Logan tributaries above Flanagans Reserve and poorly defined drainage lines within Beaudesert township and its immediately south.	Base flow salinity into these weakly incised drainage lines in these areas ranges from >8,000 ppm at Boonah and Cyrus Creek to just over 3000 ppm at Flanagans Reserve	The clayey alluvium of these flat alluvial plains and shallow stream incision effectively confines the saline groundwater within the alluvial plain and around its margins. Break of slope soil salinity outbreaks are common and gullies and creeks run very saline flows.
Complex Intake and Discharge Areas	Small Tertiary age complexes of saline sediments heavily intruded by Basalt dykes (the Beaudesert Beds)	Mostly local systems with basalt areas acting as intake areas for salt discharges from the saline sediments	Surface soil expressions uncommon, but high salinity flows to Walloon Coal measures that adjoin this unit increases salinity movement in the general areas	Concentrated along the Birnam Range from Beaudesert to Jimboomba on the Albert Logan watershed. Most salinity flows appear to be towards the confined discharge areas to the west (Cyrus Creek and similar catchments).
Transmission areas with low to moderate salinity	Mixed intake and transmission areas through highly weathered Jurassic to Devonian very old metasediments,	A mix of intermediate and local groundwater flow systems occurs, mostly of low to moderate volume	Minor low volume base flow salinity discharges into local creeks is commonly less than 2000 ppm. There are however small lenses of very saline very low flow salinity discharges.	These are largely transmission areas which move groundwater from high intake areas to discharge areas – commonly the incised major streams. They dominate the areas west of the Logan and in the

Component	Geology and Landforms	Groundwater Flow Systems	Salinity Expressions	Other
	sediments of the Neranleigh Fernvale Beds and the Gatton/Marburg and Heifer Creek Sandstones.		Erosion exposes sodic subsoils in some areas and this scalding is often mistaken for groundwater salinity effects.	Jimboomba Tamborine Village areas.
Transmission areas with moderate to higher salinity	Mostly Walloon Coal Measures of Jurassic age. These are mostly transmission areas often with overlying or intruded younger basalt and related geologies which act as intake areas	Both local and intermediate systems occur.	Moderate levels of salinity are mostly associated with the so called Walloon Forest areas (these are mostly sandstone or coarse shales) and high levels of salinity are associated with the mudstones and claystones. Base of slope salinisation is most extensive in the Hoya and Veresdale scrub areas but is less common in the upper Logan.	The coal layers in this sequence often contain high volume flows and in parts of the Teviot, high flow seepage to streams is associated with coal close to land surface. Most streams draining the Walloon Scrub areas will run saline waters in the dry season even though there is no soil salinisation.
Intake areas with moderate to high salinity	Wide variety of intrusive and extrusive geologies and associated pyroclatics and flows mostly of Tertiary age. Commonly volcanic plugs/dyke type formations	Possibly intake origin of both small scale local and larger scale intermediate flow systems.	Moderate levels of salinity recharging lower permeability systems of the contiguous Walloon geologies. Surface soil salinisation is rare.	Possibly localized important recharge areas fulfilling a similar role to the Complex Intake and Discharge areas.
Intake areas with low salinity.	These are the various basalt rhyolite and conglomeritic	Mostly local flow systems feeding local and intermediate systems in adjoining and underlying older	Invariably low salinity and commonly high flow rate discharges into incised streams	A small number of larger scale naturally fresh water springs and mounds exist in the area.

Component	Geology and Landforms	Groundwater Flow Systems	Salinity Expressions	Other
	geologies that form the upper parts of the catchments.	geologies.	such as Palen Christmas, Oakey, Canungra, Running Creeks and. Upper Logan/Albert Rivers. An important irrigation and stock water resource as well as providing base environmental flows in the upper catchment.	

Figure 1 – Distribution of Landscape Salinity Model Components



Annex B

Legend Sites for Erosion Descriptions

Xcoord	Ycoord	WP	Site	Geol	Land Cover	Soil	Slope Form	Sheet	Gully	Tunnel	Terracing	Slides/Slip	Other	Comment
465884	6894597	67	67	walf	40	sd	v	40			30			
465919	6894277	68	68	walf	70	sd	v	10						
465835	6893850	69	69	walf	30	sd	v	60	10					
465279	6892288	70	70		80			10						
465611	6891079	71	71	walf	40		c	50						
465464	6885374	72	72	basalt	70	pr	v	5						
466155	6884437	73	73	basalt	70	pr	v	0						
468537	6883282	74	74	basalt	20	pr	v	40			80	5		
470796	6883978	75	75	basalt	20	pr	v	40			80	5		
477219	6882854	76	76	marb	40		c	10						
475053	6883800	77	77	marb	25	sd	c	20	10		80	1		
474276	6883524	78	78	walf	30	sd		70			20	25		
468376	6883111	79	79										photo	
473088	6884095	80	80										locat	
472968	6884754	81	81	marb	40		c	20				10		
472967	6886594	82	82	basalt	70	pr	v	5			1	1	photo	
471658	6888217	83	83	walf	70	pr/sd	v				10	5		
471641	6889051	84	84	walf	10	sd	c	80	20		30	1	photo	Water Point Erosion
473430	6894032	85	85	walf	10	sd/r	c	80			100			
471679	6896326	86	86											Sugarloaf
489069	6889726	87	87	marb	30	sd	c	50	10				Photo	Knapps
483882	6889605	88	88	marb	10	sd	c	80	20	20				
482695	6888211	89	89	marb	10	sd	c	40	5	5				
482131	6887959	90	90	marb	10	sd	c	100	40	30			Photo	
481218	6887839	91	91	marb	20	sd	c	70	30	20				
486011	6889802	92	92	marb	40	sd	c	40	10					
486479	6884031	94	94											Tambrookun
482610	6884194	95	95											Tambrookum
484888	6883932	96	96											Tambrookum
491159	6873271	97	97	basalt	40	pr	v	60	20					Dairy Effect
490996	6869953	98	98	basalt	15	pr	v	40	15		20			

Xcoord	Ycoord	WP	Site	Geol	Land Cover	Soil	Slope Form	Sheet	Gully	Tunnel	Terracing	Slides/Slip	Other	Comment
491143	6868215	99	99	basalt										photo
473606	6883684	100	100											T Tree Flats
474467	6883493	101	101	marb	20	sd	c	60	30					Intersecion Cotswold
474647	6881417	102	102	rhy										rock picked area
474814	6881917	103	103	walf		sd			40					Road effect
479112	6878407	104	104	wals	40	pr	v	20	10		10			
478919	6875588	105	105	basalt	60	pr	c	10						
478851	6873143	106	106	rhy	60	li	c	10						
484326	6873285	107	107	marb	50	sd	c	20						sediment fans
484326	6872235	108	108	walf	30	sd	c	50	10					
476145	6866555	109	109	basalt	90	pr	v	1	1	1	1	10		stable slip lands
478754	6869261	110	110	basalt marb	30	sd	v	40	5					cattle yard effect
497957	6885191	1	111	basalt	10	pr	c	70	1					Dairy Day Yard
498892	6883600	2	112	basalt										Imp Past
496872	6883436	3	113	basalt marb	20	sd	c	70	10					
497122	6883492	4	114	basalt										Old dump eros
499377	6881836	5	115	basalt	1	pr	c	100	10		30			Dairy Day Yard
502957	6877771	6	116	basalt	20	pr	c	40	10		10			
503673	6878200	8	117	basalt	20	pr	c	80	20		10			
507094	6875373	9	118											Basalt rhy bdy
504029	6879332	10	119	basalt	40	pr	c	20	1		30	1		
510673	6893191	11	120	basalt	60	pr	c	20	1		5	1		
514847	6899773	12	121	basalt	60	pr	c	20	1		5	1		

Xcoord	Ycoord	WP	Site	Geol	Land Cover	Soil	Slope Form	Sheet	Gully	Tunnel	Terracing	Slides/Slip	Other	Comment
514443	6892566	13	122	basalt	60	pr	c	20	1		20	1		
514118	6891131	14	123	basalt	60	pr	c	20	1		20	1		
513885	6888757	15	124	basalt	40	pr	c	50	20		35	10		
515213	6886805	16	125	basalt	40	li	c	5	2		5	80		House below debris flow
445851	6908380	17	126	hc	20	sd	c	100	40	5	20			
476142	6895835	18	127	hc	20	sd	c	80	40		10			
478443	6896189	19	128	walf	70	sd	c	20	5		5			
477698	6877521	20	129	walf	40	sd	c	40	10		5			End of Seepage area
477039	6878171	21	130	walf	40	sd	c	40	10		5			Flanagan Res
476889	6876758	22	131	walf	50	sd	c	20			10			Seep Lines
475997	6875642	23	132	walf	70	sd	c	20	5		5			Seep Lines
474113	6872040	24	133											Old Rock Picked area
478531	6873659	25	134											End of Seepage area

Submission on Draft Biodiversity Conservation Investment Strategy 2017 – 2037 and the Draft NSW National Parks System Directions Statement 2017

Submission by the Gondwana Rainforests of Australia World Heritage Area Community Advisory Committee

Background

The Gondwana Rainforests of Australia World Heritage Area (Gondwana Rainforests) is a serial cross-jurisdictional World Heritage property, listed for its value to the global community, meeting the following criteria for listing:

> Criterion viii: to be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features;
>
> Criterion ix: to be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals;
>
> Criterion x: to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

The Gondwana Rainforests advisory committee (Community Advisory Committee), provides advice to the ministers with responsibilities for World Heritage management and protection.

Submission points

Members of the Gondwana Rainforests Community Advisory Committee have reviewed the Draft Biodiversity Conservation Investment Strategy 2017- 2037 and NSW National Parks System Directions Statement. These significant documents clearly highlight the direction that will be taken to acquire land for addition to the protected area estate across New South Wales, based on a prioritisation framework. The committee applauds both the short and long term planning initiatives and their commitment to meeting the Aichi target 11.

The documents also demonstrate a cost effective method by which decisions will be made to build the state's biodiversity, protect the existing values, provide opportunities for community, and highlight the ecosystem services that will be provided by a targeted approach.

By dividing the regions into bioregions and then into subregions, and then high priority landscapes clearly demonstrates how a comprehensive, adequate and representative reserve system can be prioritised and achieved and hopefully, easier to monitor and maintain.

The Draft Biodiversity Conservation Investment Strategy 2017-2037: The concepts put forward in the Strategy appear worthwhile. The guiding principle of the Strategy is that 'areas of high environmental value should be prioritised'. However, we find that there is no concern with any historical, prehistoric and cultural (both Aboriginal and European) values that the landscape might possess. The physical landscape is ignored entirely, despite the fact that this may play a fundamental role in the nature of the biological environment. We believe it would be valuable to cast the net wider to include these values.

Connecting landscapes through private conservation programs: The Strategy will guide the Biodiversity Conservation Trust to deliver a comprehensive private land conservation program which will complement/guide the NSW National Parks System Directions Statement. Conservation of private land is important for protecting biodiversity.

Firstly though, a state-wide corridors strategy needs to be undertaken which will allow targeted landholders to build those corridors identified in the Strategy, that is, a hub and spoke system linking multiple unviable reserves/ecosystems to enhance their potential to function as they should - through private land, thence forming multiple hubs to connect with the Great Eastern Ranges Corridor.

As most of the National Park estate remains presently in small isolated islands (reserves), the ability of the system to conserve habitats, ecosystems, plant and animal species is severely impacted. A recent review of the Bongil Bongil NP Plan of Management exposed a reluctance to include mention of a linking corridor from Bongil Bongil to Bindarri NP as being politically sensitive, when the health, genetic diversity and well-being of arguably the State's most viable Koala population is at stake. If that tiny link were to be made, two coastal Koala populations at Coffs Harbour and Port Macquarie would be linked, and thus remain potentially viable into the future.

Environmental Accounting: The Statement makes a reasonable case for the economic impacts, linkages, interactions and benefits between the environment, the economy and the community and so should improve decision-making. It highlights a system of environmental-economic accounting for the ecosystem services provided by a healthy environment such as provisioning and production of food and water; regulating, controlling and mitigating floods, droughts and land degradation; supporting nutrient cycles and crop pollination as well as cultural, spiritual, recreational, religious, other non-material benefits. These links are poorly understood by most sectors of the community, business, and governance, so hopefully this type of accounting will start a change of direction in planning for better environmental outcomes into the future.

The Draft NSW National Parks Systems Directions Statement

Saving our Species investment in threatened, vulnerable, and endangered species within the Gondwana Rainforests of Australia World Heritage Area would be a wise venture that would support the Federal Government's responsibility to uphold the Outstanding Universal Value of this World Heritage Area. To date, very little has been proposed to happen in this area, and the advisory committees have a number of research scientists who can provide information and data that would assist in saving species there.

Monetary Incentive: Incentives are important in the private sector to encourage investment in ecological sustainability and mitigation of climate change impacts. The Statement sets clear priorities where this money needs to be directed.

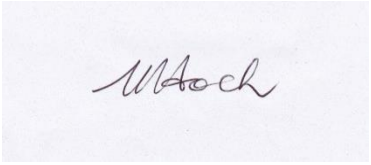
Creating predator-proof exclosures on park: Predator proof exclosures have been demonstrated to cause severe imbalances in ecosystems as the natural flow of species is either interrupted or completely halted. Investment dollars would be better spent on more intense and diverse cross tenure invasive species control programs.

"As social expectations change it is vital that public land management approaches change to meet them. The national parks system will continue to be the foundation of conservation. The question is, what can be built on this foundation to ensure our environment and heritage is valued, protected, enjoyed and supports a prosperous and healthy New South Wales." Does this commentary forecast the continued laying out of "red carpet" ease of approval for private investment and developments in National Parks? Private investment will not fund or fulfil the obligations NPWS has to maintain our National Parks into the future. Those dollars will go out to the investors' pockets. The Development Application process as it currently stands provides subtle approval to investors to build on park, even before adequate E.I.S. is done. This must change to ensure adequate measures are in place for approved developments before they are constructed. Development Applications on or neighbouring Parks require careful consideration of their possible longterm impacts on the environment. The Committee feels promotion of such developments will break down ongoing healthy existence of the landscape and species that need complex ecosystems to survive into the future.

Regional Priorities – Coast and coastal bioregions (Page 28): Table 2 (Regional Priorities) does not tell what the (2) landscapes are lacking to meet the national target nor does it tell what the percentage of representativeness of those landscapes is in the table.

The Gondwana Rainforests of Australia Community Advisory Committee appreciates the opportunity to provide advice on aspects of the proposal, and would be happy to provide further clarification or advice, as required.

Yours sincerely,



Dr Mahri Koch

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Gondwana Rainforests of Australia World Heritage Area
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World Heritage criteria	Values	Attributes contributing ...
outstanding examples representing major stages in the earth's evolutionary history	CERRA World Heritage rainforests are an outstanding example of ecosystems and taxa from which modern biota are derived. Ecosystems demonstrating this value include subtropical, warm temperate and cool temperate rainforest types. These rainforests are exceptionally rich in **primitive and relict species**, many of which are similar to fossils from Gondwana.	**Ferns** from families having origins in Pangea, including tree ferns.
		All **conifers and cycads**, pre-Angiosperm groups with their ancestry in Gondwana. Hoop pine (Araucaria cunninghamii),a member of the most ancient section of Araucaria, is of particular importance
		Early angiosperm lineages in Austrobaileyales and Magnoliids, which contribute to CERRA being a secondary centre of endemism for early angiosperm lineages that complements the Wet Tropics. Specific genera and families include Trimenia, Atherospermataceae, Monimiacea, Lauraceae, Annonaceae, Eupomatiaceae, Aristolochiaceae, Piperaceae, Peperomiaceae and Winteraceae.
		the important families include Proteaceae, Nothofagaceae, Casuarinaceae, Berberidopsidaceae, Myrtaceae, Eucryphiacea, Cunoniaceae, Escalloniaceae and Pittosporaceae.
		A primitive group of the Corvidae, one of the two major groups of the **true songbirds**. The oldest members of this group include lyrebirds, bowerbirds, tree-creepers and the Rufous Scrub bird
		Other birds dating from **Gondwana** including the Pale-yellow Robin, thornbills, scrubwrens and gerygones.
		F**rogs** having Gondwanan origins - all families in Myobatrachidae and Hylidae
		Reptiles with a long history in Australia including chelid turtles, Leaf-tailed Gecko and the Angle-headed Dragon.
		A range of invertebrates with origins in Gondwana. Examples are fresh-water crayfish, land snails, velvet worms, a number of beetle families including flightless carabid beetles, the Richmond Birdwing Butterfly and glow-worms.
	CERRA World Heritage Area includes an outstanding range of ecosystems and taxa which demonstrate the origins and rise to dominance of cold adapted and dry adapted flora.	**Cool temperate rainforest, dry rainforest and wet sclerophyll ecosystems** demonstrate this value. Members of the families Myrtaceae and Proteaceae are of particular importance; these families are today widespread in Australian ecosystems in cold and dry locations.
	CERRA WHA includes outstanding geological features associated with the erosion of shield volcanoes.	Two shield volcanoes – the Tweed Shield Volcano and the Ebor Volcano contribute to this value. The Tweed Shield Volcano Caldera is possibly the best preserved erosion caldera in the world, notable for its size and age, and for the presence of a prominent central mountain mass and all three stages in the erosion of shield volcanoes – the planeze, residual and skeletal stages. The remnants of the Ebor Volcano represent the best example in eastern Australia of a radial drainage pattern related to a specific centre of eruption.
outstanding examples representing significant ongoing geological processes, biological evolution and the interaction of humans with their environment	CERRA WHA includes significant centres of endemism where ongoing evolution of flora and fauna species is taking place. Ecosystems that are of particularly important as centres of endemism include **cool temperate rainforest, subtropical rainforest, warm temperate rainforest, dry rainforest, wet sclerophyll forest, montane heathlands and rocky outcrops.** The Border Ranges area is particularly important as a centre of endemism.	Species groups demonstrating high levels of endemism include: - Many Magnoliid genera, particularly Winteraceae, Atherospermataceae, Monimiaceae and Lauraceae. - Genera in other Gondwanic families, including Proteacea, Cunoniaceae, Euphorbiaceae, Escalloniaceae, Davidsoniaceae, Pittosporaceae, Myrtaceae, Elaeocarpaceae and Sterculiaceae. - All fauna of low motility that occur in more than one isolated pocket of CERRA. - Frogs such as *Philoria* and the *Litoria pearsoniana / phyllochroa* complex that occur in scattered habitats along the Great Escarpment. - Invertebrates such as snails, earthworms, fresh-water crayfish, velvet worms and carabid beetles show particularly high incidences of generic and species endemism
containing the most important and significant natural habitats where threatened species of plants and animals of outstanding universal value from the point of view of science and conservation still survive	CERRA WHA includes the principal habitats of a large number of **threatened species** of plants and animals. These species are of outstanding universal value from the point of view of science and conservation, including relict and primitive taxa.	The Gondwana Rainforests provides the principal habitat for many species of plants and animals of outstanding universal value, including more than 200 rare and threatened species of plant and animal, and relict and primitive taxa.Many of the rare and threatened flora and fauna species are rainforest specialists and their vulnerability to extinction is due to a variety of factors including the rarity of their rainforest habitat. The Gondwana Rainforests also protects large areas of other vegetation including a diverse range of heaths, rocky outcrop communities, forests and woodlands. These communities have a high diversity of plants and animals that add greatly to the value of the Gondwana Rainforests as habitat for rare, threatened and endemic species. The complex dynamics between rainforests and tall open forest particularly demonstrates the close evolutionary and ecological links between these communities. Species continue to be discovered in the property including the re-discovery of two mammal species previously thought to have been extinct; the Hastings River Mouse (Pseudomys oralis) and Parma Wallaby (Macropus parma).

Source: Gondwana Rainforests SoOUV and Hunter, 2004, *World Heritage and Associative values of the Central Eastern Rainforest Reserves of Australia*