

3 Environmental protection in the Alligator Rivers Region

3.1 Environment protection objectives

Before any environmental protection regime can be established, the government's environmental protection objectives need to be specified in a manner that enables regulators to identify criteria against which the adequacy of environmental protection (including the protection of humans) will be judged. Similarly, these criteria are needed by research scientists whose task it is to carry out research on the effects of industrial activity on the environment with the objective of making recommendations on standards, practices and procedures to be adopted by industry for the protection of the environment.

3.1.1 Protection of aquatic ecosystems

The Ranger Uranium Environmental Inquiry (Fox et al 1977) recommended that mining and export of uranium could proceed in the Alligator Rivers Region subject to the adoption of stringent health and environmental standards. While the Inquiry acknowledged the outstanding cultural and natural heritage values of the Region, it also acknowledged that some finite level of detriment would need to be accepted in order for mining to proceed. The problem for regulators and the Supervising Scientist was in specifying a level of detriment that would be acceptable. Very little precedent was available in Australia during the 1970s and 1980s for specifying environmental protection objectives for areas of high conservation value.

As reviewed in Johnston (1994), the approach eventually adopted by the Supervising Scientist was to concentrate on the concept of 'protection' rather than 'detriment'. That is, rather than specifying an acceptable level of 'damage', control measures and monitoring methods were sought that would ensure and demonstrate that the environment has not been harmed and would probably not be harmed by the mining and processing of ores. The Supervising Scientist concluded that the only practical protection target for the highly valued environment of the ARR was that mining operations produce no *observable* biological effect in a suitably defined monitoring program comprising a number of organisms selected from different trophic levels and phyla and using a range of sensitive endpoints.

Since the mid 1990s, this objective has been further refined to take into account nationally-accepted principles and benchmarks for conserving the nation's natural heritage. (Notwithstanding, an important feature of the Supervising Scientist's original objective that is preserved in current ARR and national objectives is the expression of such management goals in terms of ecological criteria.) In particular, two important national developments have led to refinement of the ARR objective:

- The *National Strategy for Ecologically Sustainable Development* (ESD Steering Committee 1992), and two tenets in particular, (i) the precautionary principle, and (ii) conservation and maintenance of biological diversity; and
- Revision of the Australian and New Zealand water quality guidelines (ANZECC & ARMCANZ 2000).

As recommended in the new Water Quality Guidelines — and now accepted by ARR stakeholders — management goals associated with assessment of impact at sites of high

conservation value should be couched around the objective of *no change*¹ to key indicators of biological diversity². An important distinction between the earlier Supervising Scientist definition and the new objective is measurement criteria now linked to ‘important’ ecological changes, as opposed to any biological change such as, for example, sublethal responses measured in bioassays (see footnote 2). Associated with such a management goal for ecosystems of high conservation value are the following principles (ANZECC & ARMCANZ 2000):

- i. Statistical decision criteria for detecting a change should be ecologically conservative (see footnote 1).
- ii. Adopting a precautionary approach, management action should be considered for any apparent trend away from a baseline, or once an agreed threshold has been reached.
- iii. Any decision to relax the physical and chemical guidelines for these ecosystems should only be made if it is known that such a decline in water quality will not compromise the objective of maintaining biological diversity in the system. Therefore, considerable biological assessment data would be required for the system in question, including biological effects data and an ongoing monitoring program based on sufficient baseline data.
- iv. Where there are few biological assessment data available for the system, the management objective should be to ensure no change in the concentrations of the physical and chemical water quality variables beyond natural variation.

3.1.2 Protection of human health

One of the occupational hazards present at a uranium mine is ionising radiation. Workers at the mine or mill will be exposed to ionising radiation as a direct consequence of their employment due to a combination of external irradiation (predominantly by gamma rays), and the inhalation of radioactive dusts and radon progeny. Basic occupational hygiene ensures that the ingestion of radionuclides is a negligible radiation exposure pathway.

Furthermore, uranium mining and milling activities are a source of radiological exposure for people in the surrounding region. Radon, radon progeny and radioactive dusts are carried by wind away from the minesite and may be inhaled by members of the public. Radionuclides from the minesite which enter rivers or creeks may be ingested by people who use the waterway as a source of food or water.

The International Commission of Radiological Protection (ICRP) has developed a system of radiological protection which applies to both occupational exposure and the exposure of members of the public. In general terms, the ICRP states that ‘The primary aim of radiological protection is to provide an appropriate standard of protection for man without unduly limiting the beneficial practices giving rise to the radiation exposure.’ (ICRP 1990). This aim is embodied in the three principles of the system of radiological protection developed by the ICRP (1990), viz:

¹ ‘No change’: In practice and in the absence of information that would define the thresholds of ecological change, refers to statistically conservative changes from a baseline mean or median value, eg change of 10% or one standard deviation, or trend away, from a baseline mean.

² Changes to: species richness, community composition and/or structure; species of high conservation value or species important to the integrity of ecosystems; or, ecosystem processes of a physical, chemical or biological nature.

1. No Practice involving exposures to ionising radiation should be adopted unless it produces sufficient benefit to the exposed individuals or to society to offset the radiation detriment it causes. (The justification of a practice)
2. In relation to any particular source within a practice, the magnitude of individual doses, the number of people exposed, and the likelihood of incurring exposures where these are not certain to be received should be kept as low as reasonably achievable, economic and social factors being taken into account. This procedure should be constrained by restrictions on the doses of individuals (dose constraints), or the risks to individuals in the case of potential exposures (risk constraints), so as to limit the inequity likely to result from inherent economic and social judgements. (The optimisation of protection)
3. The exposure of individuals resulting from the combination of all the relevant practices should be subject to dose limits, or to some control of risk in the case of potential exposures. These are aimed at ensuring that no individual is exposed to radiation risks that are judged to be unacceptable from these practices in any normal circumstances. Not all sources are susceptible of control by action at the source and it is necessary to specify the sources to be included as relevant before selecting a dose limit. (Individual dose and risk limits).

Thus the objective is to ensure that radiation exposures only occur if justified, and then are As Low As Reasonably Achievable (the ALARA principle) *and* below dose limits. The dose limits, which are summarised below, exclude radiation exposure from natural background radiation or from medical procedures.

Type of exposure	Dose Limit
Occupational	20 milli Sieverts per year, averaged over defined periods of 5 years with a maximum dose in a single years of 50 milli Sieverts
Public	1 milli Sievert per year

3.1.3 Rehabilitation of mine sites

The original Environmental Requirements (ERs) were not specific about the standards to be achieved for rehabilitation at mine sites in the ARR. To rectify this, the Commonwealth and Northern Territory Governments, following extensive discussions between Parks Australia and the Northern Land Council, agreed in 1990 upon the Goal and Objectives for Rehabilitation at Ranger. In 1999, the Ranger ERs were revised by the Commonwealth following discussions with the Northern Territory government and the Northern Land Council. These revised ERs now specify that the goal of rehabilitation at Ranger is to establish an environment similar to the adjacent areas of Kakadu National Park such that, in the opinion of the Minister with the advice of the Supervising Scientist, the rehabilitated area could be incorporated into the Kakadu National Park.

The ERs go on to specify three major environmental objectives of rehabilitation at Ranger are:

1. revegetation of the disturbed sites of the Ranger Project Area using local native plant species similar in density and abundance to those existing in adjacent areas of Kakadu National Park, to form an ecosystem the long term viability of which would not require a maintenance regime significantly different from that appropriate to adjacent areas of the park;

2. stable radiological conditions on areas impacted by mining so that, the health risk to members of the public, including traditional owners, is as low as reasonably achievable; members of the public do not receive a radiation dose which exceeds applicable limits recommended by the most recently published and relevant Australian standards, codes of practice, and guidelines; and there is a minimum of restrictions on the use of the area; and
3. erosion characteristics which, as far as can reasonably be achieved, do not vary significantly from those of comparable landforms in surrounding undisturbed areas.

The ERs for Jabiluka, originally specified in 1982, have not yet been revised. However, under an agreement between the Commonwealth and Northern Territory governments (dated 17 November 2000), the Northern Territory has agreed to revise the Jabiluka ERs to ensure that they are similar to the revised Ranger ERs. For this reason, the Jabiluka Minesite Technical Committee, in assessing the annual plan of rehabilitation for Jabiluka, has been working on the premise that the above goal and objectives for rehabilitation for Ranger apply to Jabiluka.

The goal for revegetation at Nabarlek, agreed between the Northern Land Council and Queensland Mines Ltd is:

to produce a self-sustaining woodland community which will blend in with the surrounding environment as well as adequate cover of ground species.

This is reflected in the operating company's stated objectives for its revegetation program which are:

1. long-term surface stabilisation
2. maintenance of an appropriate water balance in the area
3. establishment of woodland communities which will blend in with the surrounding environment

3.2 Rehabilitation of disturbed landscapes

Effective and sustainable rehabilitation of severely disturbed landscapes, as at minesites, is a significant scientific challenge both in Australia and overseas and, despite the rhetoric, is not achieved other than at some strip-mined mineral sands and bauxite operations. Research on natural systems rarely provides a basis for tackling the concepts and developing the strategies needed to deal with the substantial disturbances at hard-rock mines in order to reconstruct landforms, hydrological processes and ecosystems that can function in a predictable and sustainable fashion in concert with climate and earth-surface processes in the local region. Mobilising multi-disciplinary scientific and technical skills in order to make progress in this field is yet another challenge.

For this reason a large number of studies have been carried out on the waste rock landforms at Ranger and the surrounding landscapes by both ERA and *eriss*. ERA and EWL Sciences have concentrated on the waste rock landforms because these will form the foundations of the final landscapes (above grade structures; cappings on tailings-filled mine pits) in the rehabilitated minesites. Investigations thus far can be generally subdivided into:

- the characteristics of the rock materials and the incipient soils forming from them;
- the geotechnical properties of the materials forming the landforms;
- the internal structure of the landforms;
- hydrology and seepage characteristics;

- surface form and erosional behaviour;
- revegetation and ecosystem reconstruction;
- the behaviour of sentinel wetlands; and
- monitoring systems and strategies that measure success.

As well, there has been extensive investigation of issues relating to the storage and consolidation behaviour of tailings.

ERA's primary objective is to establish the basis for constructing landforms and ecosystems that behave and evolve in a predictable manner consistent with the rehabilitated Ranger and Jabiluka minesites being managed in the same way as the surrounding areas of Kakadu National Park. Because of uncertainties in the Ranger mine plan and the development of Jabiluka, it is not yet possible to be definite about the design of the final landforms at Ranger. However, conceptual designs being developed for the landforms and specific designs for target habitats and ecosystems are now being presented to stakeholders for discussion.

3.3 Key issues for research

An issue that always arises in the planning, conduct and reviewing of research carried out on the impact of mining in the ARR is that of deciding the most appropriate structure for the description of the program.

There are a number of logical approaches that could be followed. For example, one approach is to follow a pathway analysis. Thus, the pathways by which offsite environmental impact could occur are by surface water transport, groundwater transport and atmospheric dispersion. Each of these pathways can then be examined in detail to determine their principal components and in this way a logical structure for the program can be defined.

An alternative approach is one based on time scale. Thus, research in the ARR can be categorised into baseline research, research on the impact of mining during the operational phase of mining, and research on the impact of mining during and following rehabilitation. The latter approach was adopted at *eriss* during the 1990s; for details see Figure 4 of Johnston (1994).

Experience has shown that, no matter which approach is adopted, anomalies occur. For example, in the time scale approach, erosion and hydrology research was included in the rehabilitation phase because the principal issue being addressed was erosion of rehabilitated landscapes. But environmental protection issues related to erosion also arise during the operational mining phase. Similarly, if one adopts the pathway analysis approach, a number of water issues relate both to surface water and to groundwater transport.

For these reasons, we have chosen to use a hybrid approach in this review and to specify a number key issues on which research has been, and in many cases continues to be, required to ensure protection of the environment throughout the operation of a mine and following rehabilitation. These key issues, which determine the structure of the remainder of this review are:

- Baseline research
- Surface water management
- Dispersion in groundwater
- Atmospheric dispersion

- Rehabilitation
- Revegetation

Note that, in the above list, revegetation aspects of rehabilitation have been separated from the physical issues such as surface hydrology, erosion and the dispersion of erosion products.

The research carried out by *eriss* and ERA/EWLS on these issues is described in chapter 5.