Environmental Regulation of Uranium Mining

Submission of the Supervising Scientist to the Senate Standing Committee on Environment, Communications, Information Technology and the Arts

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1 Introduction

This report is the submission of the Supervising Scientist to the Inquiry into Environmental Regulation of Uranium Mining being conducted by the Senate Environment, Communications, Information Technology and the Arts Reference Committee.

The terms of reference of the Inquiry are to inquire into and report upon:

> The regulatory, monitoring, and reporting regimes that govern environmental performance at the Ranger and Jabiluka uranium operations in the Northern Territory and the Beverley and Honeymoon *in situ* leach operations in South Australia, with particular reference to:
>
> (a) the adequacy, effectiveness and performance of existing monitoring and reporting regimes and regulations;
>
> (b) the adequacy and effectiveness of those Commonwealth agencies responsible for the oversight and implementation of these regimes; and
>
> (c) a review of Commonwealth responsibilities and mechanisms to realise improved environmental performance and transparency of reporting.

The responsibilities of the Supervising Scientist with respect to uranium mining are limited to the Alligator Rivers Region of the Northern Territory. For this reason, this submission only addresses the terms of reference of the Inquiry as they relate to the Ranger and Jabiluka mines operated by Energy Resources of Australia (ERA).

This submission addresses each of the above terms of reference but, for overall clarity of presentation, presents the issues in the order:

- Commonwealth responsibilities for uranium mining in the Alligator Rivers Region
- Regulation, monitoring and reporting of the Ranger and Jabiluka operations, and
- Implementation of the Supervising Scientist's responsibilities in the Alligator Rivers Region.

2 Commonwealth responsibilities for uranium mining in the Alligator Rivers Region

2.1 Ranger Uranium Environmental Inquiry

The first proposal to mine uranium in the Alligator Rivers Region (ARR) came jointly from the then Australian Atomic Energy Commission and Ranger Uranium Mines Pty Ltd for the development of the Ranger deposits. However, there were strong concerns by parts of the Australian community regarding the potential environmental impacts and impacts to Aboriginal culture of uranium mining and the risks associated with nuclear power. Consequently, the Ranger Uranium Environmental Inquiry (RUEI) was established in 1975 under the *Environment Protection (Impact of Proposals) Act 1974* to examine all the issues associated with developing a uranium industry, especially the Ranger mine, in the ARR.

The First Report of the RUEI, which considered the broad question of whether Australia should mine and export uranium, was completed in October 1976. The First Report concluded that the hazards of mining and milling uranium, and of the ordinary operations of nuclear power reactors, if properly regulated and controlled, did not justify a decision not to mine and sell Australian uranium.

The Second Report of the RUEI, which considered the proposed development of the Ranger uranium mine, was completed in May 1977. It concluded that the development of the Ranger mine should not be permitted unless the recommendations made by the Inquiry were accepted and implemented.

In August 1977, the Government announced its decision to authorise the mining and export of uranium, under the very strict requirements for environmental control recommended by the RUEI.

Essential elements of the plan adopted by the Commonwealth Government to protect the environment and to insulate, to some extent, the Aboriginal people of the Region from the social disruptions inevitably associated with such a major development, were:

- the granting of land to the traditional owners under the *Aboriginal Land Rights (Northern Territory) Act 1976*,
- the establishment of Kakadu National Park, part of which comprised Aboriginal land leased back to the Commonwealth Government for incorporation in the Park, and
- the establishment of a Supervising Scientist to assist in the development of measures for the protection of the environment and oversee their implementation.

The Commonwealth also agreed, in an exchange of letters between the Prime Minister (Mr Malcolm Fraser) to the Northern Territory Chief Minister (Mr Paul Everingham) in June 1978 (see Appendix 1), that uranium mining in Territory should be regulated to the maximum extent possible through the laws of the Northern Territory.

2.2 Development of the role and responsibilities of the Supervising Scientist

2.2.1 Role and responsibilities of the Supervising Scientist 1978–1994

The position of the Supervising Scientist and its functions and powers were established in the *Environment Protection (Alligator Rivers Region) Act 1978* (EP(ARR) Act). In 1978 these functions were listed as:

> 5. The functions of the Supervising Scientist are:
>
> (a) to devise and develop programs for research into, and programs for the collection and assessment of information relating to, the effects on the environment in the Alligator Rivers Region of uranium mining operations in the Region
>
> (b) to co-ordinate, and supervise, the carrying out of programs referred to in paragraph (a);
>
> (c) to devise and develop, and to promote and assist in the devising and development of:
>
> (i) standards, practices and procedures in relation to uranium mining operations in the Region for the protection of, or in so far as those standards, practices and procedures affect, the environment in the Region; and
>
> (ii) measures for the protection and restoration of the environment in the Region from the effects of uranium mining operations in the Region;

(d) to co-ordinate, and supervise, the implementation, in relation to uranium mining operations in the Region, of requirements of or having effect under prescribed instruments in so far as those requirements relate to any matter affecting the environment in the Region;

(e)to advise the Minister with respect to:

(i) the effects on the environment in the Alligator Rivers Region of uranium mining operations in the Region;

(ii) standards, practices and procedures in relation to uranium mining operations in the Region for the protection of, or in so far as those standards, practices and procedures affect, the environment in the Region;

(iii) measures for the protection and restoration of the environment in the Region from the effects of uranium mining operations in the Region; and

(iv) requirements of or having effect under prescribed instruments in relation to uranium mining operations in the Region in so far as those requirements relate to any matter affecting the environment in the Region and the implementation of those requirements;

(f) to perform such other functions, in relation to uranium mining operations in the Region, as are conferred on him by or under a prescribed instrument (including this Act); and

(g) to do anything incidental or conducive to the performance of any of the foregoing functions.

The research functions of the Supervising Scientist are carried out by the Environmental Research Institute of the Supervising Scientist (***eriss***) and the supervisory functions by the Office of the Supervising Scientist (***oss***).

A cooperative approach to regulation was established with the Northern Territory Government. A document entitled 'Agreed Working Arrangements for Co-ordinating the Regulation of the Environmental Aspects of Uranium Mining in the Alligator Rivers Region' was formally endorsed in an exchange of letters between the Prime Minister and the Chief Minister in September 1979 (Appendix 1). Key provisions of this document covered consultative arrangements.

The Co-ordinating Committee was established under the EP(ARR) Act because of the number of government agencies involved in the research and monitoring programs and because of the interest of the Park authorities and the Northern Land Council (NLC). The committee was the major institutional mechanism through which coordination and regulatory supervision could be effected. It had no powers of enforcement but made recommendations to the Supervising Scientist.

Following discussions between the Supervising Scientist, the Northern Territory Co-ordinator General (NT Department of Chief Minister) and NT Supervising Authorities, on the need for a clearer definition of the roles and responsibilities in the regulatory process, a joint statement entitled 'Environmental Regulation of Uranium Mining — Philosophy of Compliance' was submitted to and endorsed by the Co-ordinating Committee in November 1981.

The agreed roles of the parties were:

- The mining companies are obliged to carry out their operations in compliance with the requirements of the regulatory regime and to demonstrate their compliance through monitoring and reporting.

- The NT Supervising Authorities are responsible for the regulatory regimes under which mining and processing may take place and are responsible for undertaking surveillance and monitoring to verify that the companies are complying with the regulatory regime.
- The Supervising Scientist promotes and assists in the establishment of the regime and advises the Minister on the effectiveness with which these are implemented, including deficiencies observed, and conducts research.

Thus, through the functions defined in the EP(ARR) Act and the various agreements between governments that were reached following promulgation of the Act, the key responsibilities of the Supervising Scientist in 1978 were:

- Supervision of the regulatory activities of the Northern Territory including inspections of mine sites, assessment of environmental performance and the provision of advice to the NT regulators,
- Scientific research on the effects, or potential effects, of uranium mining on the environment,
- The development of standards, practices and procedures for the protection and restoration of the environment, and
- Provision of advice to the Commonwealth Government on the adequacy of environmental protection in the Region.

Notably, the Supervising Scientist did not have powers of enforcement and did not have responsibility for environmental monitoring. These roles and responsibilities remained unchanged until amendment of the *Environment Protection (Alligator Rivers Region) Act 1978* in 1994.

2.2.2 Role and responsibilities of the Supervising Scientist 1994-2000

In the late 1980s/early 1990s there were several public reviews that examined the role and operation of the Supervising Scientist:

- a formal review by Professor G Taylor in 1989;
- Industry Commission Inquiry into Mining and Minerals Processing in Australia, 1991;
- Joint Committee of Public Accounts Inquiry into Public Sector Research and Development, 1992; and
- an independent review of the Environmental Research Institute of the Supervising Scientist by Dr NJ Barrow in 1994.

In 1993/94 the Government accepted many recommendations of these inquiries and the *Environment Protection (Alligator Rivers Region) Act 1978* was amended.

Amendment of the Act

The amendment of the Act in 1994 provided for the statutory position of the Supervising Scientist to be appointed under the Public Service Act. The Office of the Supervising Scientist was incorporated within the Department of Environment, Sport and Territories. Amendments to the Act also allowed the Supervising Scientist to provide, on the Minister's request, scientific and technical advice on environmental matters outside the ARR. In addition, the Environmental Research Institute of the Supervising Scientist was empowered to conduct more general scientific research on a commercial basis.

The Co-ordinating Committee was replaced with two new committees, the Alligator Rivers Region Advisory Committee (ARRAC) and the Alligator Rivers Region Technical Committee (ARRTC) to improve the effectiveness of proceedings.

The Alligator Rivers Region Advisory Committee (ARRAC) is a forum for information exchange on environmental matters with stakeholder groups, including mining companies, government authorities of the Northern Territory and the Commonwealth, and environmental, Aboriginal and community groups. The current membership of ARRAC is at Appendix 2.

The ARRAC receives and provides feedback on various reports including environmental audits or Environmental Performance Reviews, environmental monitoring, and ERA's annual Environmental Reports for Ranger and Jabiluka. The Supervising Scientist also provides a Six Monthly report to ARRAC which summarises environmental monitoring data, significant developments including approvals on the minesites, and any other issues that have been raised since the previous ARRAC meeting.

The functions of ARRAC stated in the Act do not include making recommendations, except where the Alligator Rivers Region Technical Committee (ARRTC) has made a recommendation to the Minister on research and ARRAC wishes to express a view on that recommendation. In this case, ARRAC can provide comments on the recommendation to the Minister for the Environment and Heritage. ARRAC's role is to facilitate discussion between the stakeholders on environmental issues associated with uranium mining in the ARR. It also provides a formal mechanism by which information is brought into the public domain and from that perspective is very important in maintaining transparency in the system of supervision and regulation of uranium mining in the ARR.

The Alligator Rivers Region Technical Committee (ARRTC) is a committee of scientific and technical representatives of stakeholders and interested parties. Its principal functions are to review research programs on the effects of uranium mining on the environment of the Region and to make recommendations to the Minister, as appropriate, on the research needed and the best organisations to carry out this research. From its formation until 2001, ARRTC considered environmental research but not supervisory issues. Appendix 3 contains the membership of ARRTC prior to 2001 and the current membership.

Revision of the Working Arrangements

The Government decision leading to the amendment of the Act called for discontinuation of those activities of the Supervising Scientist that were regarded as duplicating the day-to-day regulatory and inspectorial activities of the Northern Territory and encouraged a new emphasis by the Supervising Scientist on environmental outcomes rather than detailed on-site assessment.

For this reason, the 'Agreed Working Arrangements for Co-ordinating the Regulation of the Environmental Aspects of Uranium Mining in the Alligator Rivers Region' was revised to integrate and streamline the mechanisms used by the Supervising Scientist and the Northern Territory Department of Mines and Energy. The new Working Arrangements focussed the Supervising Scientist on the receiving environment (Kakadu National Park) and reduced his activities related to mine-site environmental management. An MOU (Appendix 4) between the Commonwealth and Northern Territory giving effect to the Revised Working Arrangements was signed by the Hon John Faulkner, Commonwealth Minister for the Environment, Sport and Territories, the Hon Bob Collins, Commonwealth Minister for Primary Industries and Energy and the Hon Mike Reed, NT Minister for Mines and Energy on 28 September 1995.

Under the new arrangements, the primary mechanism used by the Supervising Scientist to directly assess onsite environmental management practices of mining companies in the Alligator Rivers Region was the bi-annual Environment Performance Review (EPR) program. These reviews were conducted jointly with the NT Department of Mines and Energy (now the Department of Business, Industry and Resource Development, DBIRD) and focussed on environmental outcomes and continual improvement. The Revised Working Arrangements required that the Supervising Scientist cease undertaking site inspections, except in association with the EPRs or to investigate reported incidents. In this respect, the presence of the Supervising Scientist on the mine site was significantly diminished by the Revised Working Arrangements. The NT Department of Mines and Energy, as the regulatory authority, continued to make routine site inspections and undertook to promptly provide reports of these inspections to the Supervising Scientist.

The revision of the Working Arrangements did not change the responsibilities of the Supervising Scientist, mining companies or NT regulator (DBIRD) with respect to environmental monitoring. That is, the mining company continued to be responsible for implementing the statutory monitoring program stipulated by the NT regulator in consultation with the Supervising Scientist, the NT Regulator continued to be responsible for undertaking check monitoring and the Supervising Scientist continued to be responsible for undertaking environmental research rather than routine environmental monitoring.

The revised Working Arrangements required the mine operators to report, in addition to infringements of its Authorisation or the Environmental Requirements, any incident which could cause adverse impact on the environment surrounding the mine, cause harm to people living or working in the area, or cause concern to Traditional Owners or the broader public.

Minesite Technical Committees were established under the new Working Arrangements. These committees meet to discuss matters of a technical nature relating to environmental protection and management at each of the uranium minesites. For instance, most applications made by the mining company and the more significant reports submitted by the mining company are discussed at MTC meetings. They comprise technical representatives from the ***oss***, NT DBIRD, the mining company and the Northern Land Council (NLC). The committees may co-opt other expertise as required.

2.2.3 Role and responsibilities of Supervising Scientist after 2000

Changed role of Supervising Scientist

During the 1999–2000 Wet season there was a leak of tailings water (or process water) from the Ranger tailings water return pipeline in the bunded tailings corridor on the Ranger minesite and a subsequent leak of some of this water to the external environment. The leak commenced in February 2000 and continued until early April, but it was not reported to the authorities until the end of April. The Minister for the Environment and Heritage and the Minister for Industry, Science and Resources requested that the Supervising Scientist prepare a report on the incident. This report was tabled in the Senate on 27 June 2000.

The principal conclusion of the report was that no adverse impact occurred on the ecosystems of Kakadu National Park as a result of the tailings water leak nor was there any significant radiological impact on members of the public, particularly local Aboriginal people living downstream from the mine. Nevertheless, a number of deficiencies were identified in ERA's management of the site, in its maintenance procedures, and in its communications with stakeholders.

The then Minister for Industry, Science and Resources, the Hon Nick Minchin, provided a response to the report's recommendations on behalf of the Minister for Environment and Heritage, Senator Hill. In his speech Senator Minchin made it clear that:

- It was the Government's expectation that the Supervising Scientist would carry out on-site inspection and on a more rigorous basis, noting that this had not been done in a rigorous way since 1995,
- The Supervising Scientist develop and implement a routine environmental monitoring program to ensure that the community has confidence in the results of the monitoring program, and
- The minimum processes in place at Ranger and Jabiluka with respect to inspection and audit processes meet the ISO 14000 series of standards.

In early 2001, monthly site inspections of Ranger and Jabiluka by the Supervising Scientist were introduced and the EPR system was replaced by a new environmental audit regime. The new audit regime complies with ISO 14001 and is a more rigorous and detailed assessment than the system it replaced.

Also in early 2001, the Supervising Scientist commenced the development of an independent routine environmental monitoring program. This marked the first time that the Supervising Scientist has ever taken on this role. The program consisted of aquatic biological monitoring, chemical water quality monitoring and atmospheric monitoring. The rationale behind the development of this program was that the Supervising Scientist should have sufficient data collected independently of ERA or the NT Government to allow him to comment authoritatively and independently on the extent to which the environment has been protected.

However, a competing imperative was to ensure that resources were applied to maximum advantage by reducing duplication of effort to an acceptable level. Consequently, the Supervising Scientist's routine environmental monitoring program focuses on upstream and downstream monitoring of the waterways that pass through the Ranger and Jabiluka lease areas, ERA maintains sole responsibility for on-site monitoring for management purposes and NTDBIRD continues its check monitoring program. The Supervising Scientist's chemical water quality and biological monitoring programs were fully implemented during the 2001/02 Wet season. The purchase of additional equipment also allowed the Supervising Scientist to commence radiological monitoring (dust and radon) in 2002.

In summary, since 2001 the onsite role of Supervising Scientist has been significantly increased, returning it to the level which applied prior to 1995 when the Working Arrangements were amended. Further, the Supervising Scientist now implements a routine environmental monitoring program at Ranger and Jabiluka which has not previously formed part of his role.

Changed role and membership of ARRTC

The membership and role of ARRTC were amended in 2001 to implement one of the recommendations arising from an international assessment of the Jabiluka Project in 1999 and 2000. This assessment was undertaken by the Independent Science Panel (ISP) of the International Council of Science Unions (ICSU) as part of a review by the World Heritage Committee (WHC) of the risks posed by the Jabiluka Project to the natural World Heritage values of Kakadu National Park. The ISP assessment included an extensive review of the Supervising Scientist's report to the World Heritage Committee, a visit to Australia in July 2000 to inspect Jabiluka and Ranger, and to undertake detailed discussions with the Supervising Scientist and his staff, ERA, Australian scientists and Parks Australia North.

Although the final report of the ISP concluded that the principal risks had been identified and shown to be very small or negligible, the ISP made 12 recommendations to address several procedural concerns. One recommendation proposed the establishment of an independent scientific advisory committee to review research activities in the region and address perceived concerns about openness and transparency. The Australian Government accepted the intent of the recommendation. Rather than establishing a new Committee, the Government proposed revising the membership and role ARRTC. This was accepted by the ISP and WHC at its meeting in Cairns in December 2000.

The revised ARRTC now comprises 13 members. Seven members are independent scientists nominated by the Federation of Australian Scientific and Technological Societies for their technical expertise in each of the following areas.

- Radiation protection and health physics
- Environmental chemistry as applied to surface water systems
- Ecotoxicology as applied to surface water systems
- Freshwater ecology
- Geomorphology
- Hydrology and hydrogeology
- Plant ecology as applied to mine site revegetation

The remaining six members represent key stakeholder organisations:

- the Northern Land Council
- ERA (Ranger and Jabiluka)
- Hanson Australia Ltd (Nabarlek)
- Parks Australia
- the Northern Territory Department of Business Industry and Resource Development
- the Supervising Scientist

The primary aim of the revised ARRTC is to ensure that the quality of the science used in the research into, and assessment of, the protection of the ARR environment from the impact of uranium mining is of an appropriately high standard. The Committee reviews the research activities of ***eriss*** and ERA. It also reviews the quality of the science used by ***oss*** and the NT authorities in the review and examination of proposals by the companies to alter their procedures and practices.

Following a request from the World Heritage Committee, the Minister for the Environment and Heritage decided, in June 2002 to appoint a suitably qualified person to ARRTC to represent environmental NGOs. At the time of writing, the process for nomination and selection of an environmental NGO representative has yet to be finalised.

Clarification of the powers of the Commonwealth in respect of uranium mining in the Northern Territory

An important commitment made to the World Heritage Committee in Paris, July 1999, was that: 'The security of environmental management at the Ranger and Jabiluka mines will be further improved by amending the legal regime governing enforcement of environmental conditions to strengthen the role of the national government.' This commitment was

implemented through the revision of the agreement between the NT and Commonwealth governments on the regulation of uranium mining in the NT. The agreement was signed by the Hon Daryl Manzie, Northern Territory Minister for Resource Development and Senator the Hon Nick Minchin, Commonwealth Minister for Industry, Science and Resources on 17 November 2000 (see Appendix 5).

Under the revised agreement, before granting or varying an Authorisation under the *Uranium Mining Environment Control Act* (UMEC) or any legislation that replaces this Act, the Northern Territory Minister is required to refer the matter to the Supervising Scientist for comment. The Territory Minister must not act until that comment is received. Where the Supervising Scientist has advised the Territory Minister that the matter has been referred to the Commonwealth Minister for Industry, Science and Resources, the Territory Minister must act in accordance with the advice of the Commonwealth Minister.

The Commonwealth also exercises control over the export of uranium under the *Customs (Prohibited Exports) Regulations 1958* (the Regulations). Amendments to the regulations in August 2000 strengthened Commonwealth control over uranium exports by enabling export permissions (or licences) for uranium to be granted subject to conditions. The amendment was in response to Recommendation 9 in the 1999 Majority Report of the Senate Inquiry into the Jabiluka Uranium Mine Project that Commonwealth environmental conditions 'should also be made the explicit conditions of the issue of export licences by the Commonwealth'.

The amendment provides the Commonwealth Minister for Industry, Tourism and Resources with a clear and administratively efficient mechanism by which he/she can place legally binding conditions, including mine-site environmental conditions, on the export of uranium.

2.3 Broader Commonwealth responsibilities in the Region

In addition to the Commonwealth's role through the Supervising Scientist under the EP(ARR) Act, the Commonwealth has a number of other specific responsibilities with respect uranium mining in the Region.

The Commonwealth Minister for Industry, Tourism and Resources is ultimately responsible for the regulation of uranium mining at Ranger under the s41 Authority issued under the *Atomic Energy Act 1953. The Minister also* administers *the Customs (Prohibited Exports) Regulations 1958* under which uranium exports are controlled.

The Commonwealth Minister for Environment and Heritage administers the *Environment Protection and Biodiversity Conservation Act 1999* which contains provisions for the protection of World Heritage Properties and Commonwealth Reserves.

These additional Commonwealth responsibilities are discussed in the next section.

3 Regulation of uranium mining in the Alligator Rivers Region

When the Northern Territory was granted self Government in 1978, the Commonwealth agreed that the regulation of uranium mining in the Northern Territory would be through laws of the Northern Territory to the maximum extent possible. The regulator of Ranger and Jabiluka is the Northern Territory Department of Business, Industry and Resource Development. It administers legislation that provides for the application of detailed regulatory requirements, processes, and sanctions. The Commonwealth ultimately has very significant powers in respect of uranium mining activities in the Northern Territory, however, with the

exception of nuclear non-proliferation controls, it does not have legislation which provides for the full scope of specific administrative and regulatory processes associated with regulation.

3.1 Northern Territory

Mining operations at Ranger and Jabiluka are regulated by the Northern Territory Department of Business, Industry and Resource Development, under the *Mining Management Act 2001(MMA)*. Prior to 2001, the Uranium Mining (Environment Control) Act (UMEC) was the legislation under which the NT Government regulated Ranger and Jabiluka.

The primary regulatory instrument is the General Authorisation (GA) which is issued for each mine, ie there is a Ranger General Authorisation and Jabiluka General Authorisation. The GA, which was originally issued under UMEC and remains in force under the MMA, sets out the conditions with which ERA must comply. Some of these conditions are stipulated in detail in the Authorisation; examples are the statutory environmental monitoring program and limits on the increase in concentration of mine derived contaminants downstream of Ranger. However most of the detailed procedural requirements are contained in the reports or plans which are required under the General Authorisation and assessed by the Regulator.

The promulgation of the MMA in 2001 established a new requirement that mine operators submit for approval a Mining Management Plan (MMP) with which the mining company is required to comply. Section 40 of the MMA stipulates that the MMP include the following information:

a) the identification and description of the mining activities;

b) particulars of the implementation of the management system to address safety and health issues;

c) particulars of the implementation of the management system to address environmental issues;

d) a plan and costing of closure activities;

e) particulars of the organisational structure;

f) plans of current and proposed mine workings and infrastructure and other information or documents required by the Minister.

Thus some or all of the plans and reports that are required to be produced by ERA for Ranger and Jabiluka under the relevant current General Authorisation are likely to be incorporated into the new MMP. Consequently, it is expected that the current General Authorisations will require amendment once the new MMPs have been assessed and approved.

3.2 Commonwealth

The Commonwealth administers the *Nuclear Non-Proliferation (Safeguards) Act* which has the objective of ensuring the physical security of nuclear materials within Australia. It also administers the *Customs (Prohibited Exports) Regulations 1958* under the *Customs Act 1901* under which the export of uranium is controlled. Under the regulations the Minister can place legally binding conditions, including mine-site environmental conditions, on the export of uranium.

Thus, in respect of the physical security and export of uranium, the Commonwealth regulates all Australian uranium mines. However, there is no Commonwealth legislation equivalent to

the *Northern Territory Mining Management Act*. Hence, the Commonwealth is not the regulator of Ranger and Jabiluka in relation to the control of mining activities on a minesite.

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) administered by the Minister for the Environment and Heritage is the omnibus Commonwealth legislation made for the purpose of protecting the environment. It contains provisions related to the protection of World Heritage properties and Commonwealth reserves. Ranger and Jabiluka are surrounded by Kakadu National Park, a World Heritage property. If the activities at Ranger or Jabiluka caused environmental damage to Kakadu National Park, the Commonwealth could take action against ERA under the EPBC Act.

The Supervising Scientist, established under the *Environment Protection (Alligator Rivers Region) Act 1978*, has a monitoring, research and supervisory role with respect to mining activities in the ARR. The nature of this role has been described in the previous section.

In addition to the Acts noted in the previous paragraphs, there are other Commonwealth instruments specific to Ranger and Jabiluka which provide the Commonwealth with powers. Those powers differ slightly between Ranger and Jabiluka due to the different mechanisms by which they were originally established.

The Ranger mine is situated within the Ranger Project Area which is established under the Authority to Mine issued under Section 41 of the Commonwealth *Atomic Energy Act 1953* which is administered by the Minister for Industry Tourism and Resources. The Commonwealth has defined Environmental Requirements (ERs) for Ranger to ensure the adequacy of environment protection arrangements. The ERs are appended to the s41 Authority and have been integrated into the Ranger General Authorisation (under the NT MMA) by NT DBIRD to the extent that such integration is appropriate. It is a requirement that ERA comply with the s41 Authority and the ERs. Failure to comply provides the Minister for Industry, Tourism and Resources with the opportunity to take action against ERA. Such action could include prosecution for an offence under the Atomic Energy Act. The Ranger ERs, originally drafted in the late 1970s, were revised over a period of approximately 4 years commencing in 1996 to reflect modern environmental protection principles. The revised ERs came into force in January 2000 (see Appendix 6). The ERs reflect the role of the Commonwealth; that is, they set the Primary and Secondary Environmental Objectives and broadly identify mechanisms for meeting those objectives with very little prescription.

Jabiluka is established by a Mining Lease issued by the NT Minister for Resources under the NT Mining Act. The Commonwealth has defined Environmental Requirements for Jabiluka and these are attached to the Jabiluka Mineral lease. ERA must comply with the Jabiluka ERs and the NT Minister for resources must enforce them when considering approvals and amendments to mining authorisations.

The Commonwealth Minister for Industry, Science and Resources is the action Minister in relation to the Environmental Impact Statement (EIS) and Public Environment Report (PER) for the Jabiluka proposal conducted under the *Environment Protection (Impact of Proposals)* Act 1974 (this Act was repealed on the commencement of the EPBC Act in 1999, however, Jabiluka remains subject to that Act in accordance with the *Environmental Reform (Consequential Provisions) Act 1999*). As action Minister he must consider the extent to which ERA has met requirements arising from the assessment of the EIS and PER for Jabiluka when taking the action, ie issuing an export permit for uranium mined at Jabiluka (mining has not commenced).

4 The monitoring regime for Ranger and Jabiluka

For most of the operational phase of mining that has occurred in the Alligator Rivers Region since 1978, the Operator has been responsible for monitoring the extent to which the environment has been protected while the Regulator has been responsible for checking the veracity of the results obtained. Thus, ERA has carried out the monitoring programs at Ranger and Jabiluka and the NT DBIRD has carried out a check-monitoring program.

As outlined above, the Commonwealth Government decided in 2000 that the Supervising Scientist should carry out an independent routine monitoring program to enhance community confidence in the results obtained from monitoring. This program was initiated in 2000–2001 and was fully implemented in 2001–2002.

Since the main thrust of the current Senate Inquiry is directed at Commonwealth responsibilities in uranium mining, this report provides a brief description of the ERA and DBIRD monitoring programs and a more extensive description of the Supervising Scientist's program.

4.1 ERA and DBIRD monitoring programs

The statutory environmental monitoring programs conducted by ERA at both Ranger and Jabiluka are set down in the respective General Authorisations. The complete details of the programs may be seen in the Authorisations which are attached as Appendices 8 and 9. The exact nature of the programs is determined by a process whereby ERA makes an application to the NTDBIRD to undertake a particular activity. The application is then assessed by the OSS and NLC, a process which may be undertaken by correspondence or, in the case of significant changes, through consultation and discussion at a meeting of the relevant Minesite Technical Committee (MTC). Once agreement on the outcome of the application has been obtained, any required changes are made to the General Authorisation and the revised program is implemented.

The present monitoring program at Ranger has been in place for many years. It covers surface waters, ground waters, and the atmosphere. In 2001, members of the MTC decided that it would be appropriate to examine options for a revision of techniques as well as the actual numbers and types of observations being made. This is being undertaken partly to see if greater efficiency could be achieved but also to examine from first principles the rationale for monitoring from the environmental protection perspective and therefore to ensure that the program meets current environmental protection expectations. For these reasons, the MTC requested that ERA should review the system in consultation with stakeholders to establish what improvements, if any, could be made. The initial report from ERA has been submitted to the MTC and discussions and assessment are expected to be completed in 2002 before the next Wet season commences.

In addition to its statutory monitoring program, ERA conducts additional monitoring at various locations within the mine site for internal management or investigative purposes. Data from these internal programs have generally not been formally reported to stakeholders but have been made available on request. Following the acceptance of the recommendations in the Supervising Scientist's report on the leak of tailings water in 2000, ERA agreed to provide the Supervising Scientist with all data obtained in its research and investigation projects. In addition, ERA has recently implemented a new data management system and access to the full data sets is now available to the Principle Stakeholders on-line.

The NT DBIRD undertakes a program of environmental check monitoring which includes surface and ground waters at Ranger and Jabiluka. The primary aim of the program is to establish the veracity and accuracy of the statutory programs carried out by ERA at both Ranger and Jabiluka. The details of the programs are described in the NTDBIRD six monthly surveillance reports which are published each year for the periods ending 31 March and 31 September respectively. These reports are discussed at the meetings of ARRAC.

4.2 Supervising Scientist Division monitoring program

The Supervising Scientist implemented a routine environmental monitoring program at Ranger and Jabiluka in 2001 following the acceptance by the Government of the recommendations contained in the Supervising Scientist Report on the Investigation of the Process Water Leak at Ranger. The monitoring program has been determined on the basis of the research program of ***eriss***. These programs provided information on the biophysical conditions of the region, in particular the aquatic environment, and led to the development of monitoring techniques suited to implementation under local conditions. Thus, whilst not having previously directly and routinely monitored the environment in the vicinity of the mining operations, a substantial amount of baseline information was available. This information had previously been reported to other stakeholders through ARRTC and by publication in Annual Reports, Supervising Scientist research publications and in the broader scientific literature.

The monitoring programs at Ranger and Jabiluka entails biological, physical and chemical components. Important aspects of the biological monitoring component are undertaken using a sampling design that can provide optimal certainty regarding whether any detected change in measured parameters is due to mining. That is, the design contains sampling sites in catchments not affected by mining activities as well as sites upstream and downstream of the mine sites.

While the current program is considered best practice, it is accepted that future modifications and improvements will be introduced as a consequence of continuing research, changing circumstances and changing community expectations. A principle to be maintained when addressing changes in the sampling regime is that the integrity of previous data is not compromised.

The main risk identified for ecosystems surrounding mine sites in the Alligator Rivers Region (ARR) is from dispersion of mine waste waters to streams and shallow wetlands during the intense and highly seasonal Wet seasons. For this reason, the environmental monitoring programs instigated for ARR mine sites focus almost entirely on aquatic ecosystems.

For highly-valued sites such as those in the ARR, comprehensive environmental monitoring and assessment are required, integrating measurements of key chemical and biological indicators collected from strategically important sites (including controls) and times. The monitoring programs instigated for both the Ranger and Jabiluka mine sites accord with national and international frameworks for monitoring and baseline data collection, and have both a predictive or early detection capability as well as the ability to report on important indicators of biological diversity. The rationale, justification and techniques used in the Ranger and Jabiluka monitoring programs are described in a background paper. This paper and the results obtained in the program can be found on the ARR monitoring web site (http://ea.gov.au/ssd/monitoring) and in a review paper prepared recently for the Alligator Rivers Region Technical Committee (Johnston & Milnes 2002).

4.2.1 Monitoring of the Ranger operation

Water physico-chemistry monitoring

The principal water monitoring points for the Ranger operation are in Magela Creek, the main water course flowing past the Ranger mine and on into Kakadu National Park (figure 1). Two monitoring points have been selected; the *control* site is upstream of any mine influence and the *potential impact* site is at Gauging station GS8210009 is located about five kilometres downstream from the mine before the Magela Creek enters the Park.

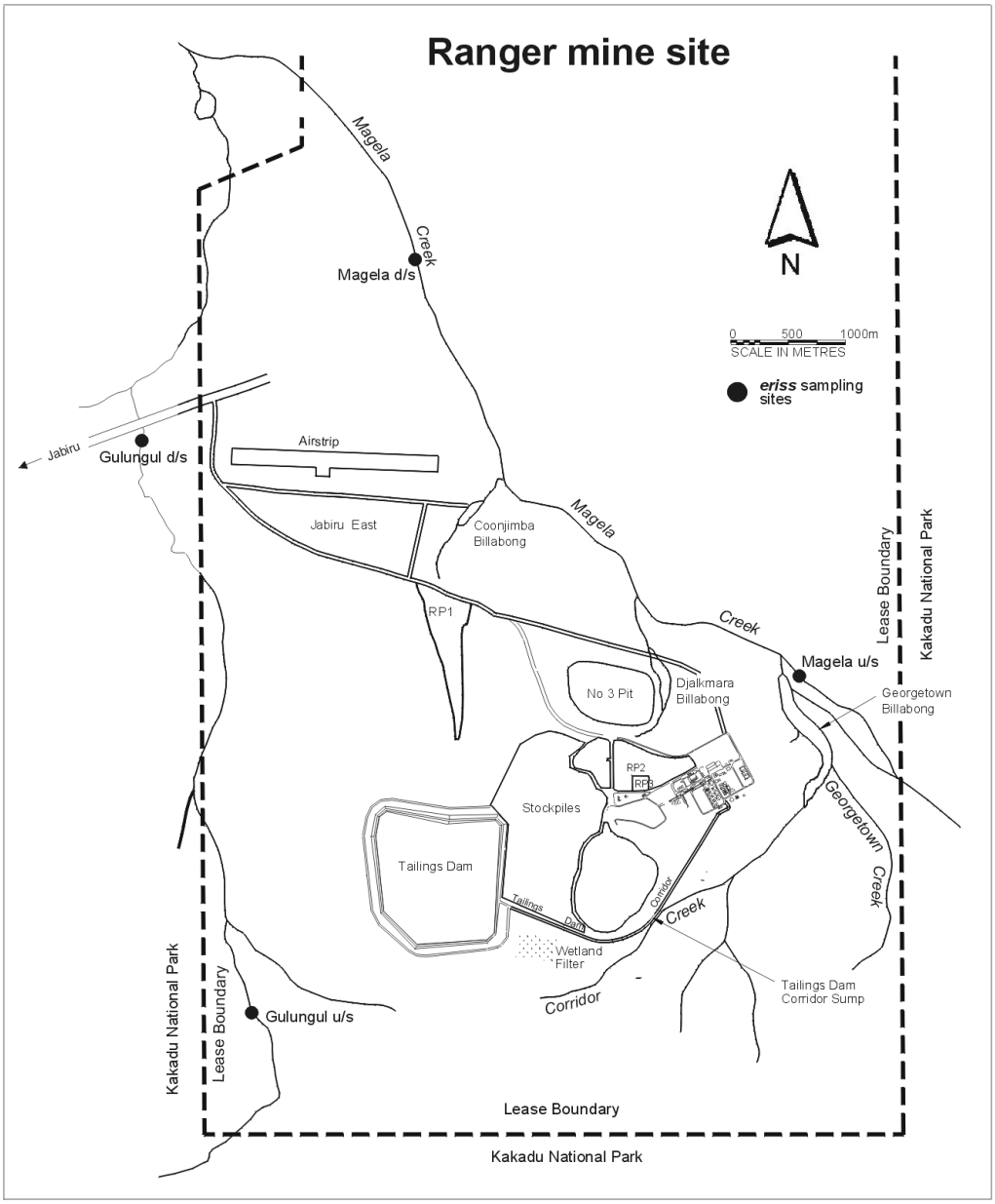

Figure 1 Location of sampling sites on Magela Creek

Gulungul Creek is a tributary of Magela Creek which drains the southern region of the Ranger mine and enters Magela Creek at a point within the Park downstream of GS8210009. For this reason, subsidiary monitoring points have been established on Gulungul Creek both upstream and downstream of the mine.

Water samples are collected from these monitoring points on a weekly basis throughout the annual Wet season. Samples are analysed for :

Chemical indicators: acidity, conductivity and turbidity

Major ions: calcium, magnesium, nitrate, nitrite, phosphorus and sulphate

Trace elements: aluminium, copper, iron, manganese, lead and uranium.

Samples for radium analysis are collected on a fortnightly basis for Magela Creek.

Monitoring data for water quality in Magela Creek upstream and downstream of Ranger show that the median concentrations of sulphate, magnesium, manganese and uranium are generally higher downstream of the mine. In relation to the *maximum allowable additions*, the increases in concentration arising from mining activities were well below thresholds that might signify deleterious effects on the environment, except on one occasion when the limit for manganese was exceeded in a Supervising Scientist sample. This sample was collected from an isolated pool at incipient cessation of flow. Magela Creek hyporheic water in the vicinity of GS8210009 contains a naturally high manganese concentrations, and this shallow groundwater forms a dominant proportion of discharge at extreme recessional flow.

Approach to biological assessment at Ranger

A two-fold approach to biological assessment is used in the SSD program at Ranger: (1) pre-release toxicity testing of waters subject to controlled discharge to Magela Creek, and (2) biological monitoring to detect the occurrence of any adverse off-site effects of mining on the aquatic ecosystems.

Toxicity testing was of more significance in previous years when routine controlled discharges of water took place from Retention Pond 4 which drained a significant portion of the waste rock dump at Ranger and when controlled discharges of water from Retention Pond 2 were being considered. Retention Pond 4 has been removed from the water management system at Ranger and ERA has made a commitment not to seek approval for releases of water from Retention Pond 2 except under extreme climatic events. Thus toxicity testing is currently restricted to waters in that part of Djalkmara Billabong which is within the water management system.

The principal aim of the biological monitoring program is to have in place a biological assessment program which is capable of assessing the extent to which operations at Ranger are having an effect on the biological diversity of the downstream aquatic environment. This is achieved through monitoring of the structure of communities of fish and macroinvertebrates. This community structure monitoring program is a seasonal assessment and results are not quickly available. Thus there is a need to have a more rapid biological assessment. This is achieved through the use of creekside monitoring. The creekside monitoring program is carried out throughout the Wet season and seeks rapid toxicological responses in animals exposed to waters downstream of the mine site.

These biological assessment programs are described briefly below.

Pre-release toxicity testing

Local-species toxicity tests are used to directly assess the toxicity of some mildly-contaminated Ranger waste waters prior to their release into Magela Creek during the Wet season. Since the mid 1990s, routine toxicity testing of Ranger Retention Pond 4 and/or Djalkmara Billabong waters was undertaken by Ranger's Environmental Division, with an informal supervisory and 'check-monitoring' role by the SSD. ***eriss*** now carries out this testing as part of the Supervising Scientist's routine assessment program. The dilution of the

whole waste required to render it harmless is used as a control parameter to regulate its discharge. In practice, the toxicity of the waste water to three test species is assessed. To calculate a 'safe' dilution ratio for the water, the NOEC (No Observed Effect Concentration) of the most sensitive of the species is divided by a safety factor of 10.

Water from Djalkmara Billabong is currently tested using three local species, a cladoceran, *Moinodaphnia maclaeyi*, the green hydra, *Hydra viridissima* and the purple spotted gudgeon, *Mogurnda mogurnda*. The endpoints used in the three tests are reproduction for the Cladocera, population growth for hydra and larval survival for gudgeon. In each test a series of dilutions of the test water with water from Magela Creek is used. The results obtained are provided to ERA and any discharges from Djalkmarra Billabong are then subject to a minimum dilution determined by the lowest NOEC value as specified above.

Creekside monitoring

In this form of monitoring, effects of Ranger mine waste water dispersion are evaluated using responses of aquatic animals held in tanks on the creekside and exposed to effluent waters. The responses of two test species are measured over a four-day period: (i) reproduction (egg production) in the freshwater snail, *Amerianna cumingi*, and (ii) survival of the larvae of black-banded rainbowfish, *Melanotaenia nigrans*.

Animals are exposed to a continuous flow of water pumped from upstream of the mine site (control site) and to water collected from the creek at gauging station GS8210009, some 5 km downstream of the mine. At the end of each 4-day trial, the mean number of eggs per snail pair and mean number of fish surviving per replicate, are noted and compared for each of the upstream and downstream sites. Since about 1996, creekside trials have been performed approximately every other week during the Wet season. Trials usually commence in December and cease in early April, the period of significant creek flow in Magela Creek.

The results obtained in these creekside tests from 1992 until 2002 are shown in figure 2. These results have been obtained both from the research and development stage and from the more recent implementation stage of the tests in the Supervising Scientist's routine monitoring program. From these results, it is concluded that there have been no adverse effects of mine waste waters on either of the creekside test species throughout the last decade.

Monitoring using macroinvertebrate and fish community structure

Macroinvertebrate communities have been sampled from a number of sites in Magela Creek at the end of significant Wet season flows each year from 1988 to the present. The design and methodology have been gradually refined over this period to meet the needs of cost efficiency and improved ability to confidently attribute any observed changes to mining impact. The most significant refinement that took place in the study occurred in 1994 following recommendations made at a special Biological Monitoring Workshop held in Canberra to assess the biological monitoring program being developed by SSD. There was a reduction from 10 sites sampled in Magela Creek to three and the commencement of sampling at sites in three additional control streams.

The design for the current macroinvertebrate study uses the principle of gathering macroinvertebrate samples from sites in Magela Creek and Gulungul Creek upstream and downstream of Ranger, and also from similar paired upstream and downstream sites in two adjacent 'control' streams that are generally unaffected by any mining activity. Samples were collected from each site at the end of each Wet season between April and May. Processing of samples is a resource-intensive task and normally results of annual sampling are not available until the end of the calendar year in question.

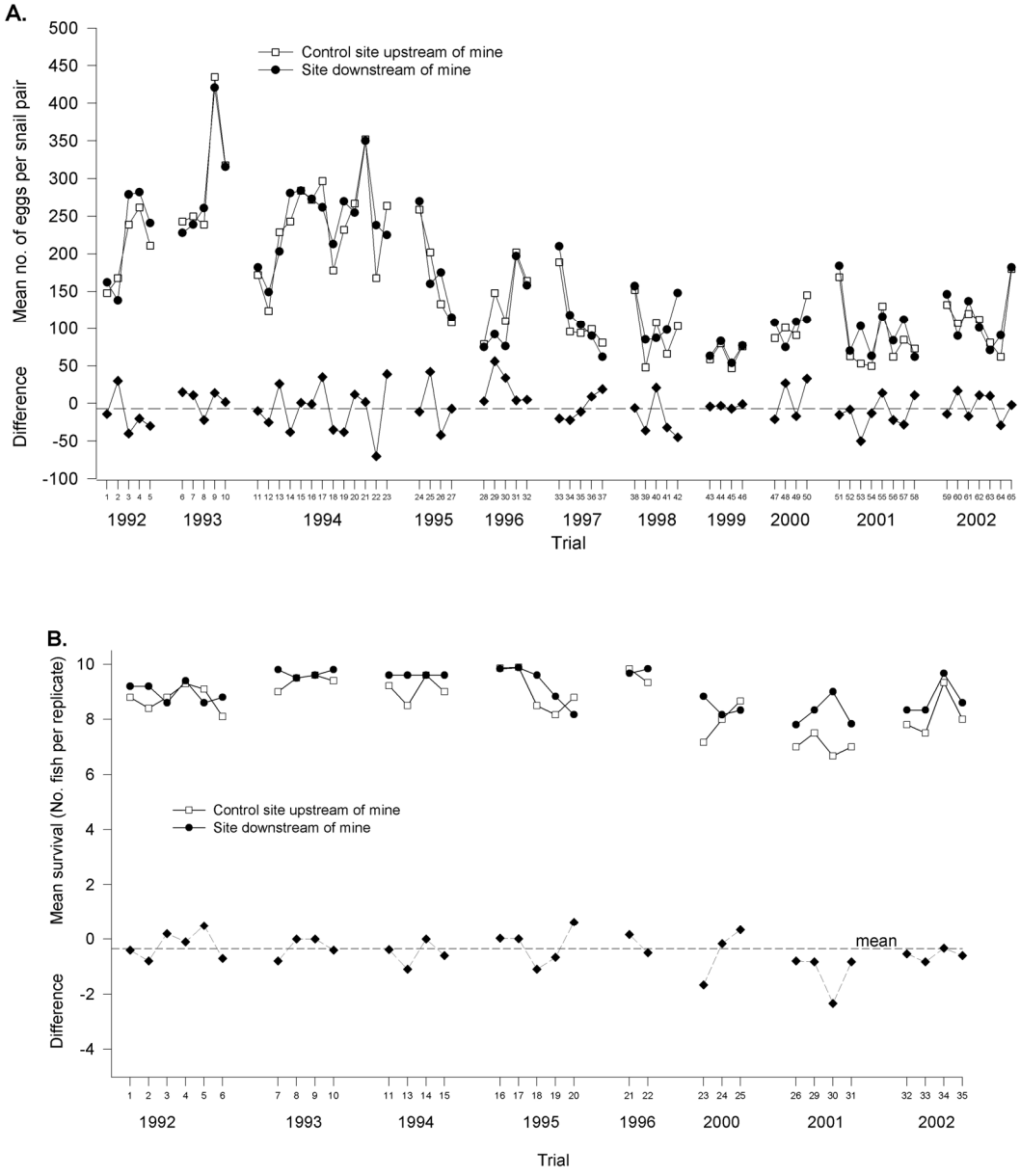

Figure 2 Creekside monitoring results in Magela Creek for: A. freshwater snail egg production, and B. larval black-banded rainbowfish survival, for Wet seasons between 1992 and 2002.

The results obtained in the macroinvertebrate community structure program over the period 1994 to 2001, the period over which sampling in additional control streams occurred, are shown in figure 3. These data show that the macroinvertebrate community relationship (similarity) between the Magela Creek upstream and downstream sites is virtually the same as the paired site relationships found in the other three streams. This provides good evidence that changes to water quality downstream of Ranger as a consequence of mining in the period 1994 to 2001 are not sufficient to have adversely affected macroinvertebrate communities.

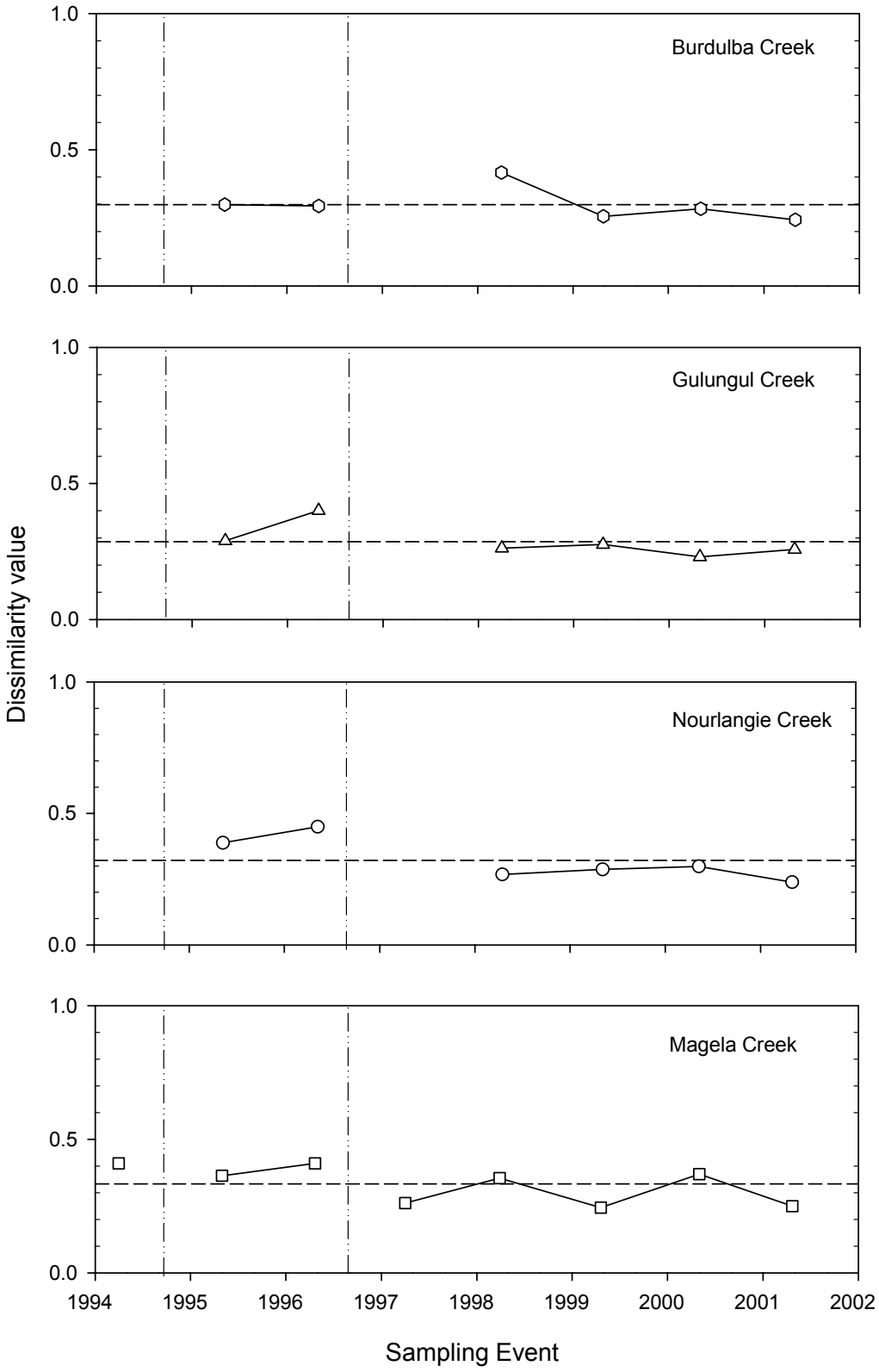

Figure 3 Paired upstream-downstream dissimilarity values (using the Bray-Curtis measure) calculated for community structure of macroinvertebrate families in several streams in the vicinity of the Ranger Uranium Mine for the period 1994 to 2001. The dashed vertical lines delineate periods for which a different sampling and/or sample processing method was used. (Data for Burdulba, Gulungul and Nourlangie creeks for 1994 are not yet available.)

Sampling of fish communities in billabongs is conducted in late April to the end June of each year. Three types of billabong are sampled:

- 'exposure' billabongs in Magela Creek downstream of Ranger
- 'unexposed' billabongs in Magela Creek ('pseudo'-controls, not receiving directly mine waste waters)
- 'unexposed' billabongs in Nourlangie Creek (true controls)

The design is amenable to the following comparisons:

- exposure billabong(s) vs control billabong(s) from an independent catchment (Nourlangie Ck); and/or
- 'exposed' billabongs vs 'unexposed' billabongs in Magela Creek, recognising that this second approach is confounded by possible movement of fish between the two billabong types.

Data gathered from shallow lowland billabongs in the pre-mining period 1978 to 1979, and again from 1994 to the present (2002) have been analysed and compared. These analyses have shown that the fish community relationship (similarity) amongst the three site groupings — 'exposure' and 'unexposed' Magela billabongs and 'unexposed' Nourlangie billabongs — has changed little over the 24 year period. For example, the mean dissimilarity values between 'exposed' and 'unexposed' sites for the three time periods (1978, 1993-96, and 1998-2002) are almost constant at 0.247, 0.275 and 0.269 respectively. These results provide reasonable assurance that changes to water quality downstream of Ranger as a consequence of mining in the period 1979 to 2002 are not sufficient to have resulted in major changes to fish communities.

A similar long-term study and analysis were completed on the fish communities sampled from 10 sites along Gulungul Creek (which flows past the western boundary of the Ranger lease area). Sampling was conducted annually during an early sampling period, 1978–90, and again recently in 2001. Fish communities have changed very little between the early and recent sampling period indicating that the very small quantities of mine wastes reaching the creek downstream of the mine are not directly harming resident fish communities.

4.2.2 Monitoring of the Jabiluka operation

Water physico-chemistry monitoring

The principal water monitoring points for the Jabiluka operation are in Swift Creek (Ngarradj), the main water course flowing past the Jabiluka project and on into Kakadu National Park (figure 4). Two monitoring points have been selected; the *control* site is upstream of any mine influence and the *potential impact* site is at a gauging station downstream from Jabiluka beyond the point at which all tributaries of Swift Creek which could be affected by the development of the Jabiluka project enter the main creek channel.

In addition to these principal sites for the SSD independent routine program, samples are collected from the two principal tributaries of Swift Creek which pass the mine, North and Central Tributaries. These samples are collected for investigatory purposes to ensure that, should effects be observed in Swift Creek, additional data will be available to investigate any potential mine related effect.

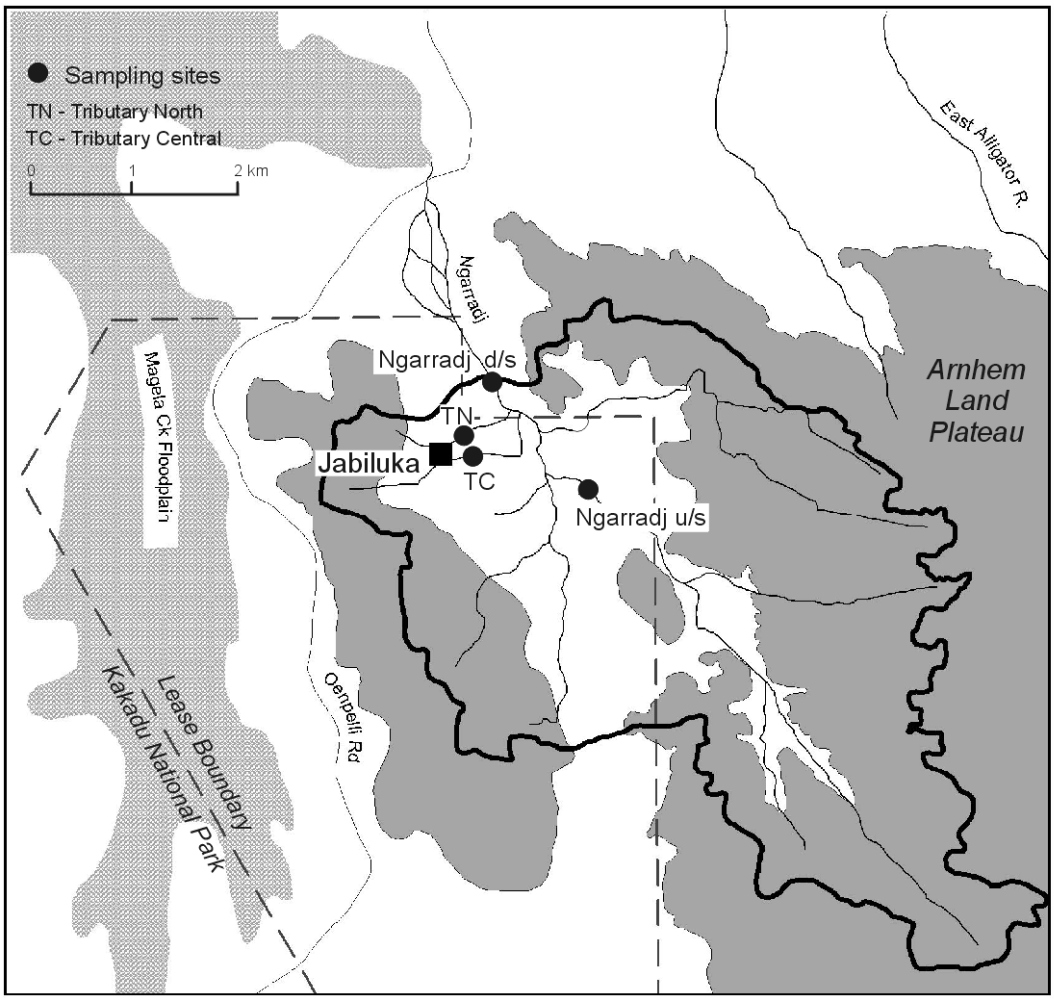

Figure 4 Location of sampling sites in Swift Creek (Ngarradj)

Water samples are collected from these monitoring points on a weekly basis throughout the annual Wet season. Samples are analysed for :

Chemical indicators: acidity, conductivity and turbidity

Major ions: calcium, magnesium, nitrate, nitrite, phosphorus and sulphate

Trace elements: aluminium, copper, iron, manganese, lead and uranium.

Samples for radium analysis are collected on a fortnightly basis for the Swift Creek sites.

The SSD data for uranium in Swift Creek upstream and downstream of Jabiluka are plotted in figure 5. The mean values of the uranium concentrations at each site obtained from 1998 until 2002 are plotted and it is clear that no change in the mean value for uranium has taken place since monitoring commenced. The data also reveal that a small natural difference in uranium concentrations is detectable between the upstream and downstream sites. The detailed SSD data for uranium in Swift Creek at the upstream and downstream sites in 2001–2002 are shown in figure 6. The data sets are very similar throughout the season with, however, a tendency for slightly higher concentrations at the downstream site. As was noted above, however, the historical data for Swift Creek show that the mean uranium concentration is naturally slightly higher at the downstream site and the difference in 2001–02 is consistent with that observed in previous years.

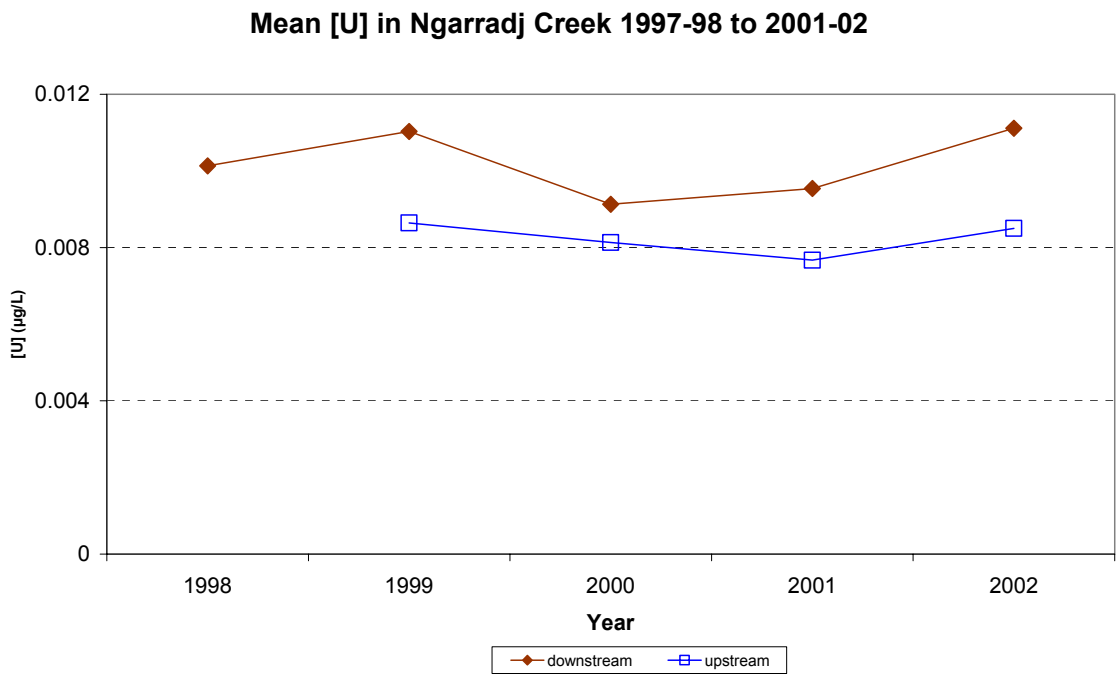

Figure 5 Variation in the mean concentration of uranium at the Swift Creek (Ngarradj) upstream and downstream sites from 1998 until 2002

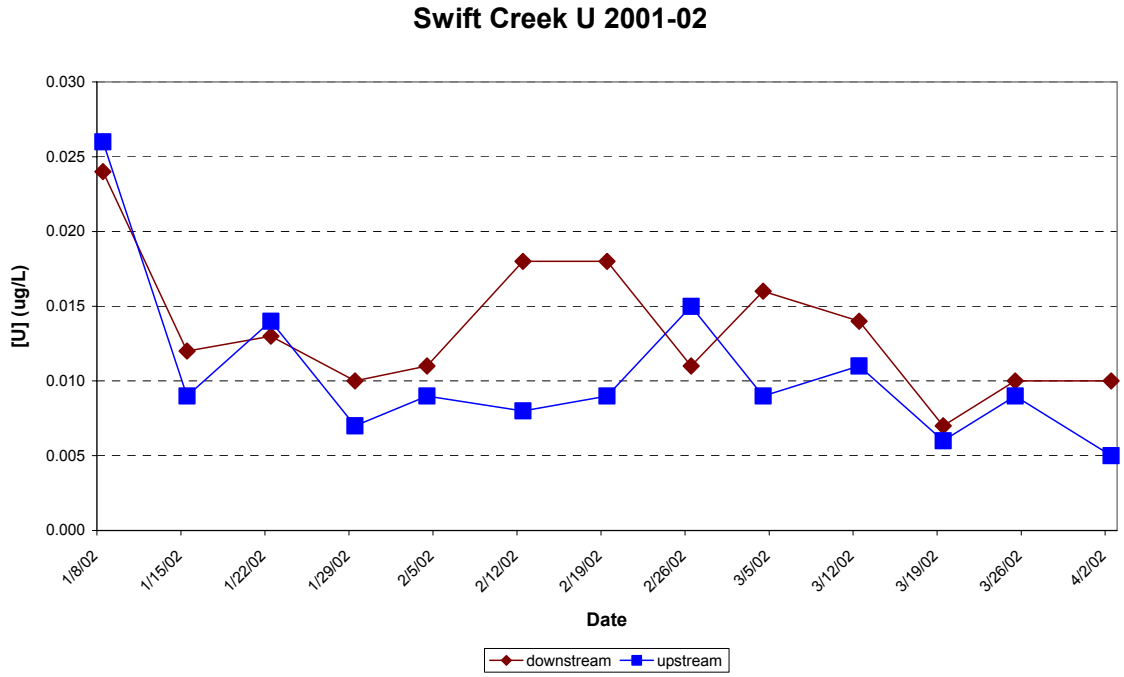

Figure 6 ***eriss*** data for the concentration of uranium at the upstream and downstream sites in Swift Creek (Ngarradj) during 2001–02

The magnesium guideline was exceeded in Swift Creek in the last two weeks of the 2001–2002 Wet season in both the Supervising Scientist and the ERA sample sets, a condition not reflected upstream of the mine. There is a natural source of magnesium present between the upstream and downstream monitoring sites. When the surface flow decreases at the end of the Wet season, the magnesium rich groundwater mixing with the decreased volume of surface water leads to elevated magnesium levels. This natural source of magnesium is the reason that the magnesium 'trigger' level is a guideline only, and exceeding the 'trigger' value does not imply that the environmental requirements have been breached.

No mine-related impact on suspended mud concentrations was observed in Ngarradj in the past four years of data collection. Similarly, channel stability monitoring has indicated no adverse impacts from the mine.

It is concluded, therefore, that developments at the Jabiluka site to date have had no impact on the water chemistry of Swift Creek as it enters Kakadu National Park.

Approach to biological assessment at Jabiluka

The approach adopted by the Supervising Scientist to biological monitoring at Jabiluka is slightly different to that adopted at Ranger. The principal objective of biological monitoring is the same as at Ranger; that is, the program is directed at establishing whether or not operations at Jabiluka affect the biological diversity of downstream aquatic ecosystems. Hence, similar programs on the structure of communities of fish and macroinvertebrates are conducted.

However, the water management system at Jabiluka does not include discharges of water from the site during the Wet season. Hence there is no requirement for pre-release toxicity testing and the need for creekside monitoring for early detection purposes is less significant. Creekside monitoring is resource intensive and in the case of Jabiluka at his stage could only be conducted using a helicopter for access. This would make it an extremely expensive option for Jabiluka. For these reasons, creekside monitoring does not form part of the SSD current routine monitoring program at Jabiluka. However, to compensate for the lack of creekside monitoring, the community structure program at Jabiluka includes sampling on an approximately monthly basis rather than and end-of-season basis. The establishment of a creekside monitoring program at Jabiluka will be planned if, at any stage in the future, the project is developed to a mining and milling stage.

Monitoring using macroinvertebrate and fish community structure

The design and approach of the macroinvertebrate study for Jabiluka are similar to those described above for the Ranger macroinvertebrate study. Macroinvertebrate samples are gathered from sites in Swift Creek (Ngarradj) upstream and downstream of Jabiluka, and also from paired upstream and downstream sites in three adjacent streams currently unaffected by any mining activity at Jabiluka (control streams). For the three Wet seasons, 1998–1999, 1999–2000 and 2000–20001, samples were collected from each site at three to four weekly intervals for the period of creek flow. During the 2001–02 Wet season, only Ngarradj and another control stream were sampled monthly during the Wet season although the full suite of streams and sites was sampled at the end of the Wet season. As with the Ranger macroinvertebrate study, processing of samples for the Jabiluka study is a resource-intensive task and normally results of annual sampling are not available until the end of the calendar year in question.

Analysis of the macroinvertebrate data set from 1998 to 2001 (figure 7), show that the macroinvertebrate community relationship (similarity) between the Ngarradj upstream and

downstream sites is virtually the same as the paired site relationships found in the other three streams. These results support the conclusion that there have been no adverse effects of runoff from the Jabiluka minesite upon macroinvertebrate communities downstream in Ngarradj in the 1998–99, 1999–00 and 2000–01 Wet seasons.

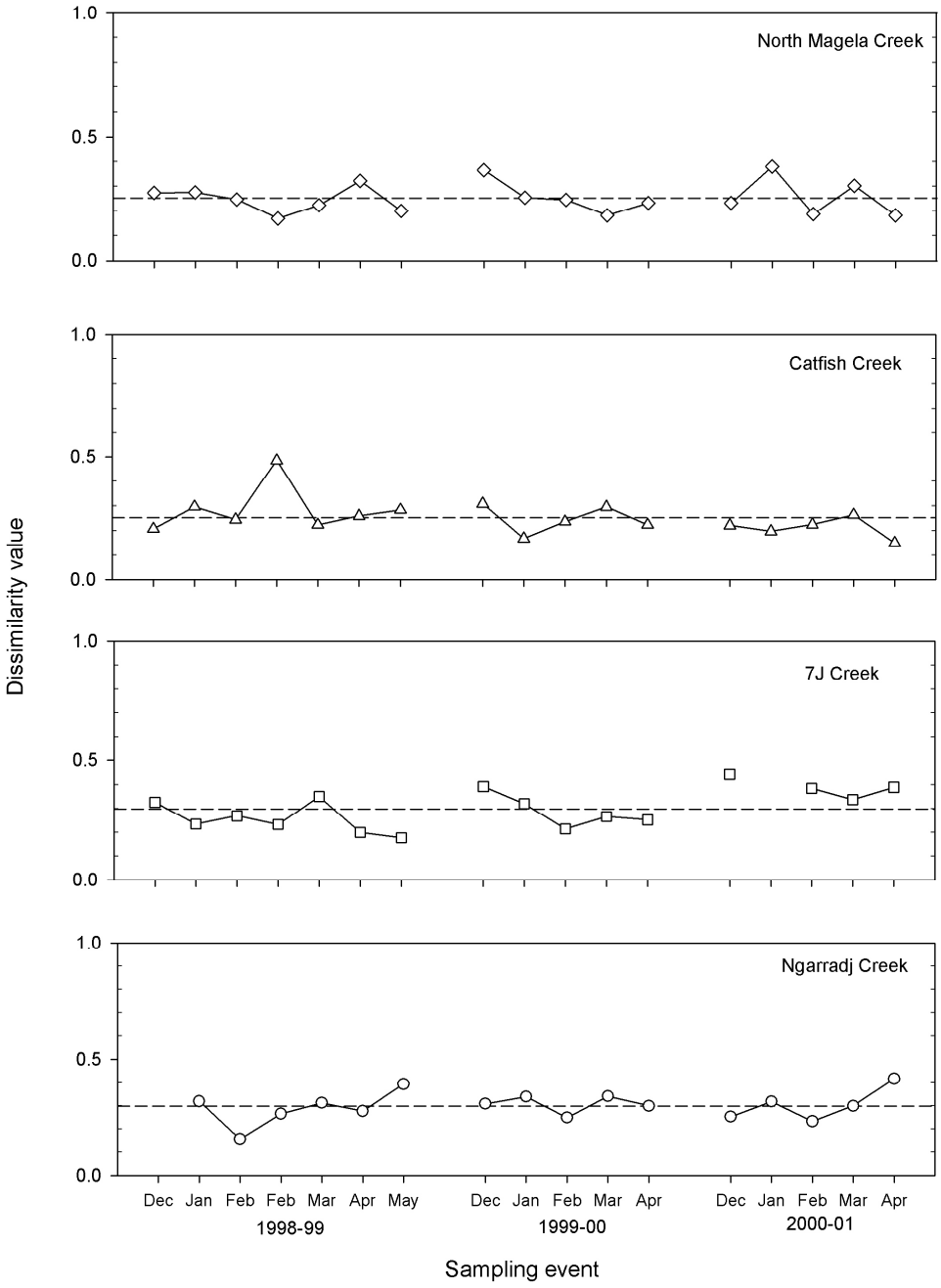

Figure 7 Paired upstream-downstream dissimilarity values (using the Bray-Curtis measure) calculated for community structure of macroinvertebrate families in several streams near the Jabiluka minesite in the 1998–1999, 1999–2000 and 2000–2001 Wet seasons. Missing data (7J Creek, 3rd Wet season) indicate absence of flow.

Fish studies associated with Jabiluka are conducted in billabongs and streams. The stream study has the same design as the Jabiluka macroinvertebrate study described above. Thus, bankside visual observations upon fish communities are gathered from sites in Ngarradj upstream and downstream of Jabiluka, and also from paired upstream and downstream sites in three adjacent streams currently unaffected by any mining activity at Jabiluka (control streams). Data have been collected (figure 8) from each site in March and April of each of the past four Wet seasons, 1998–99 to 2001–02. The fish community relationship (similarity) between the Ngarradj upstream and downstream sites has diverged over the four year period, a pattern which is not matched in the other three streams. However, this trend does not appear to indicate mining impact in Ngarradj. Rather, the increasing dissimilarity over time is associated with reduced numbers of fish in March 2001 and reduced species richness (number) in March 2002 at the Ngarradj *upstream* site, compared with the downstream site.

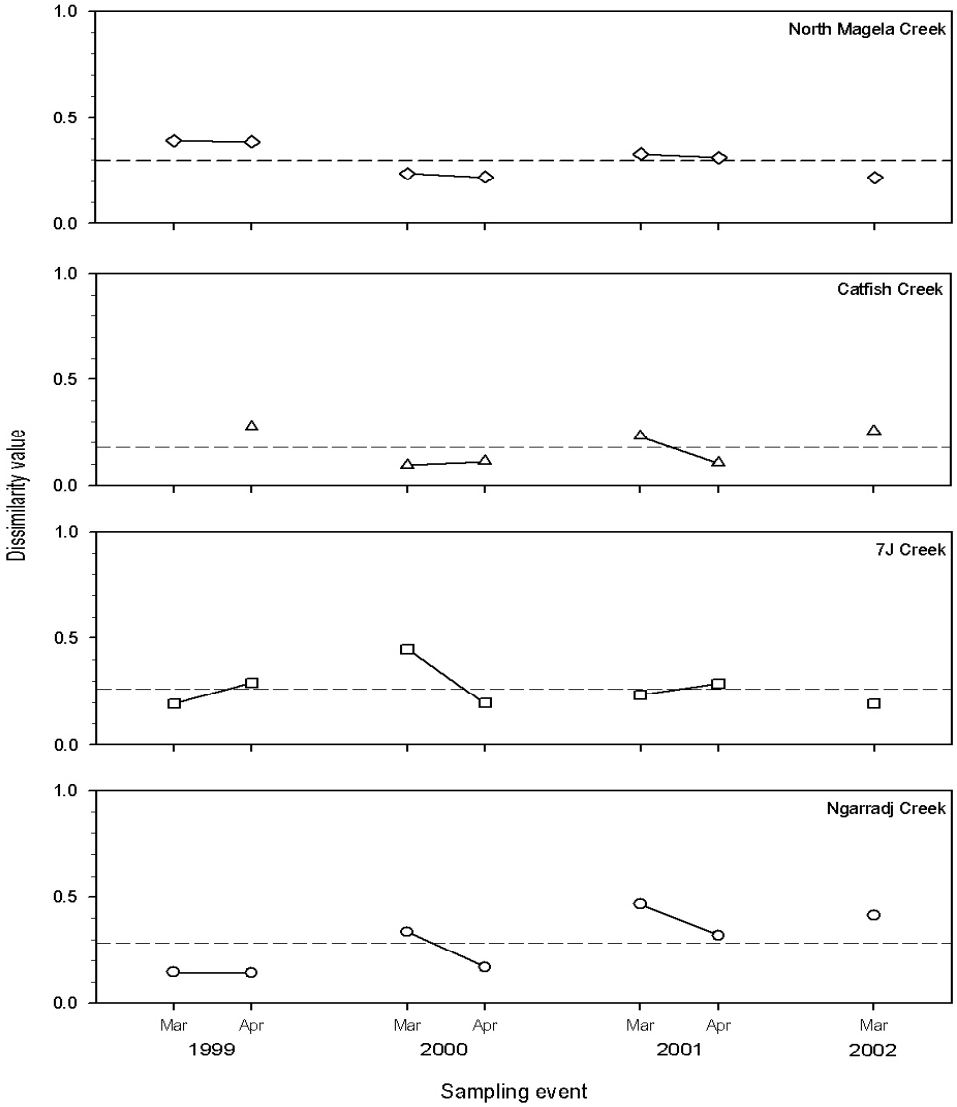

Figure 8 Paired upstream-downstream dissimilarity values (using the Bray-Curtis measure) calculated for community structure of fishes in several streams near the Jabiluka minesite in the 1998–1999 to 2001–2002 Wet seasons. Low flow in April 2002 prevented any sampling.

4.2.3 Regional air quality monitoring

In addition to the water quality and aquatic ecosystem monitoring discussed above, an air quality monitoring station has been established 1 km west of Mudginberri billabong (12 km downstream of Ranger). This site was chosen because it is near the Mudginberri Aboriginal community, and because it is located approximately midway between the Ranger and Jabiluka sites and hence has the potential to be impacted by aerially dispersed radionuclides from both operations over the long term. The main aim is collection of radionuclide concentration data in air for assessment of radiological impact on humans.

Monitoring data collected at the Mudginberri station between February 2000 and March 2002 gave an annual average radon (Rn-222) concentration of 10.5 Bq/m^3. Based on current knowledge of the relation between radon concentrations and those of its radioactivity progeny in the region, this translates to an effective dose rate for full-time occupancy of approximately 0.2 mSv per year. However, this dose is primarily natural and hence not subject to dose limits.

Estimating the contribution from the Ranger minesite to radon and radon progeny concentrations at Mudginberri is difficult because it is certainly much lower than the natural concentrations. An estimate using an atmospheric dispersion model (Martin 2000), gives the contribution to be approximately 0.008 mSv per year, which is less than 1% of the dose limit of 1 mSv per year for a member of the public. The dose limit applies to total dose including all pathways; nevertheless it is plain that the contribution of radon progeny from Ranger to effective dose at Mudginberri is extremely small.

4.2.4 Emerging approaches to monitoring

Often, the ability to draw strong inferences about possible mining impact is constrained by limited pre-mining, baseline data or lack of spatial controls. Further, improvements in analytical chemistry or changes in best practice for biological monitoring can mean that new and old data cannot be validly compared. Even the best-resourced programs, including that developed for the Ranger mine, suffer these deficiencies to some extent.

A rapidly emerging approach internationally that attempts to deal with uncertainty in environmental assessment, of the type described above, is 'multiple lines of evidence' (MLOE) — also termed 'weight-of-evidence'. The approach draws upon epidemiological precepts using multiple causal (mostly circumstantial) criteria to collectively improve inferential strength and better evaluate whether significant risk of harm is posed to the environment. The recently-published *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ 2000a) recommend a MLOE approach, particularly by way of increased monitoring effort, wherever pre-disturbance data are few. Downes et al (2002) provide a comprehensive description of the approach. The causal criteria include:

- *Strength of association.* If large changes in a variable are reported as being typically associated with human disturbance, particularly when such large changes are otherwise very rarely observed, then there is greater confidence of causality.
- *Consistency of association*. An association between a variable and a particular human disturbance has been reported a large number of times before.
- *Specificity of association*. Manufactured chemicals (eg DDT) or unusual chemicals that are specific to a particular or potential disturbance and whose effects are known may provide a strong causal link.
- *Temporality*. The observed change occurred following the onset of human activity and was not observed previously.

- *Biological or ecological gradient*. There is an increase in the magnitude of the effect with increasing intensity of exposure or concentration.
- *Biological or ecological plausibility*. There is a known or at least plausible mechanism of cause-and-effect of the human activity.
- *Experimental evidence*. Manipulative experiments of the human impact in question provide strong evidence of causality between the activity and the observed change, particularly at larger spatial and temporal scales.
- *Analogy*. Related activities or stressors have a similar response to the variable of interest.

There is a formal, iterative approach to deriving and assessing MLOE with literature reviews combined with use of existing information for the site(s) and gathering of new information. The outcome of an analysis of MLOE is the assembly of a sufficiently strong case from a number of weaker lines of evidence to infer causality. The process of assembling the information may usefully influence decisions about which variables to measure and ultimately to decisions about what changes are considered 'important'.

In a recently-published textbook on monitoring impacts in streams, written by some of Australia's leading environmental scientists, a case study using the ***eriss*** biological monitoring program developed for Ranger is presented, exemplifying the principles of MLOE (Downes et al 2002; table 9.5). The approach used by Downes et al (2002) in this analysis is semi-hypothetical and based on ***eriss*** data and information that was published by 1995. The opportunity is taken here to extend the MLOE analysis for Ranger, but less formally than that prepared by Downes and co-authors, using more recent information. This informal MLOE analysis involves chemical and biological response variables gathered from the environmental assessment studies conducted in Magela Creek, near the Ranger mine. The type of information gathered in this assessment program includes: water chemistry data; locally-derived toxicant trigger values based on ecotoxicity of local organisms; field experimental data on bioaccumulation; field mesocosm data; field biological monitoring results; and an ecological gradient.

The field biological monitoring results suffer the problem that no pre-mining (1980), baseline data were gathered for creekside (early detection) or stream macroinvertebrate (biodiversity) responses (though releases of only mildly-contaminated waters have ever occurred). Historical water chemistry data may also not be very accurate. The MLOE causal criteria (from above) that are relevant for the SSD program include:

2. *Consistency of association*. Gill-breathing and soft-bodied species were selected for monitoring because the literature indicates that these groups are sensitive to metals. In 1995, waterbodies of highest mine contaminant concentration (from 5 below) were dominated by pollution-tolerant invertebrates (aerial breathing bugs and beetles).
3. *Specificity of association.* Bioaccumulation of uranium in freshwater mussels and fishes would be linked to the mine because this is the only significant source of uranium in the catchment.
4. *Temporality*. If mining impact was evident, this would be expected to be reflected in differences in biological responses measured at 'exposed' sites downstream of the mine compared with the same responses measured prior to mining.
5. *Biological or ecological gradient*. In 1995, macroinvertebrate communities in Djalkmarra Billabong on the Ranger lease area became increasingly more dissimilar (in relation to control sites) with increasing electrical conductivity (salinity) of surface waters.

6. *Biological or ecological plausibility*. From 2 above, aerial breathing bugs and beetles would be expected to be prominent in contaminated waters as there is no direct exposure of respiratory surfaces.
7. *Experimental evidence*. The sensitivity of several local organisms to uranium and magnesium has been established in laboratory ecotoxicity studies; uptake of U in freshwater mussels has been studied experimentally in the laboratory and field; field mesocosm studies are being conducted for magnesium.

Uranium and magnesium (sulphate) are the main mine contaminants that reach Magela Creek. The maximum U concentrations observed in the creek are typically about 6 times lower than the U trigger value, and two orders of magnitude lower than the NOECs derived for the creekside early-detection species. No off-site effects are observed for any of the biological monitoring response variables, and pre-mining patterns in fish communities have been maintained since mining commenced.

The analysis of local laboratory toxicity studies and mesocosm studies on magnesium are at a preliminary stage. There are indications that magnesium in Magela Creek may reach concentrations that approach those at which effects are observed in laboratory test organisms, but concentrations are usually lower than the NOECs of those derived for either laboratory or creekside test species. In addition, current results do not factor in possible ameliorative effects of calcium in mine waters. No effects are observed for any of the biological monitoring response variables measured off-site, but effects were observed on macroinvertebrate communities in waterbodies on the mine site itself.

This analysis indicates that magnesium sulphate is potentially the main constituent of concern with Ranger mine waters. Concentrations observed in Magela Creek at present, however, do not appear to be sufficient to cause any adverse environmental effects.

4.2.5 Event-based monitoring

The possible use of event-based monitoring in the ARR has been raised in a number of fora recently. It is, therefore, an issue that should be addressed in this submission.

In the chemical monitoring procedures outlined above for the programs conducted by SSD, ERA and DBIRD, samples are collected on a periodic basis, usually one per week, and analysed for a range of constituents. The term ‘event-based monitoring’ refers to a different procedure whereby samples are collected throughout a hydrological event such as individual storms or flood peaks. The much higher frequency of such sampling better enables the determination of maximum concentrations of any particular constituent and, provided the hydrology data (flow rates) are also determined, enables estimates of the loads of such constituents in the stream as well as concentrations. In considering the need for event-based monitoring from the perspective of demonstrating of environmental protection, one needs to distinguish between the two possible objectives: (i) ensuring that maximum concentrations of constituents are detected or (ii) determining loads.

Where the issue is that of ensuring that maximum concentrations are observed, the SSD does not, in general, support the use of event-based monitoring. This is because one should not consider chemical monitoring in isolation. It needs to be considered within the integrated stream monitoring program that encompasses biological, chemical and physical monitoring with both early warning and long-term trend analyses.

The occurrence of a particular concentration of a constituent is not, in itself, the primary concern. The primary concern is whether or not that concentration causes harm to animals and plants. For example, a biological test lasting one week integrates the effect of all

concentrations of the constituents of the water over that week even if the chemical sampling program only records a single concentration during that period. And the community structure monitoring carried out at Ranger and Jabiluka assesses whether or not there has been any impact of these operations at the community level over an entire Wet season.

Consideration of loads of constituents rather than concentrations is a different issue. From the environmental protection perspective, the loads of constituents entering the aquatic ecosystems in the ARR are not a major issue. For radionuclides, the limits are set in load terms but the loads of radionuclides entering the Magela and Swift (Ngarradj) Creek systems are orders of magnitude below the recommended limits and a detailed load assessment using event-based monitoring would not be justified. Similarly, in terms of ecological impact, the loads of all constituents leaving the mine sites are very low compared to the corresponding loads that are present naturally in the sediments of the Magela flood plain or which are cycled annually in the vegetation of the floodplain. This issue was considered by the Independent Science Panel of the World Heritage Committee which, after examining the issue in some detail, accepted the position of the Supervising Scientist.

However, while the use of event based monitoring is not supported as an integral part of the monitoring program to demonstrate environmental protection, it does have a potential role from an investigative or early warning perspective, particularly at specific locations on the mine lease. In the current review of the ERA monitoring program, it has been proposed that continuous data loggers be introduced at the weir of Retention Pond 1 and in Corridor Creek. These loggers will provide a continuous record of water flow rate and the major chemical and physical indicators of acidity, electrical conductivity and turbidity. These data will be able to provide a rapid indication of some major events on the mine site and will certainly be of value in interpreting and understanding events. SSD is considering the introduction of similar devices at the downstream monitoring sites in the Magela and Swift creeks to assist in the interpretation of any events that occur.

4.2.6 SSD monitoring program in a national and international perspective

The Supervising Scientist monitoring program is an integrated program and is a major advance on the programs previously undertaken by ERA and the NT authorities. We believe that the program is appropriate for monitoring the potential impact of mining on the conservation of the values of Kakadu National Park.

The biological monitoring methods now being used in the ARR were assessed in 1993 at a scientific workshop held in Canberra. This workshop addressed the efficacy of the sampling approaches being proposed and whether or not it could be stated that, if no effect were to be observed in such a program, the environment of Kakadu had been protected. The workshop participants welcomed the opportunity to review the biological program and noted that it was far in advance of other programs available and should be maintained and extended as necessary. One of the changes that was introduced following this workshop was the introduction of paired sampling sites in creeks within other catchments. The recommendations from this workshop were considered by and wholeheartedly supported by the Barrow Review of the Supervising Scientist in 1994.

A key recommendation arising from the 1993 external review referred to above was that the ***eriss*** program be used as a template for situations elsewhere in Australia where such comprehensive monitoring was required. The opportunity to influence national approaches to monitoring in this manner arose in the drafting of the new *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ 2000a) for which ***eriss*** was the technical coordinator. The revised Guidelines recognise three ecosystem

conditions — highly disturbed, slightly to moderately disturbed, and high conservation value ecosystems — warranting progressively higher standards of protection respectively. Through the revision of the Guidelines, key principles and elements of the ***eriss*** environmental monitoring and assessment programs for the ARR — water physico-chemistry monitoring, toxicity testing and biological monitoring — were also adopted for similar areas of high conservation value in Australia.

In practice, development of the Guidelines and refinement of the ***eriss*** monitoring and assessment programs occurred in parallel. Input to the Guidelines' revision from external authors, agencies and the public also influenced the approach recommended for water quality guideline derivation, and monitoring and assessment in areas of high conservation value in Australia. As a consequence, the external input also influenced the approach now to be adopted at mine sites in the ARR. The current ARR programs certainly provide a template for others applying the new Guidelines to high conservation areas.

At the international level, the ***eriss*** biological assessment programs are also being used to develop a conceptual framework for wetland risk assessment (Finlayson et al 1998) and monitoring (Finlayson 1996) for the Ramsar Wetland Convention and have influenced approaches being tested by ***eriss*** for vulnerability assessment of wetlands due to climate change and sea level rise (Bayliss et al 1997).

The sampling methods used in the ***eriss*** monitoring program are being documented according to national pro forma (eg ANZECC & ARMCANZ 2000a,b) and are compatible with international protocols espoused under the Ramsar Wetlands Convention (Resolution VI.1). Those for the biological components of the program are in draft format and have been submitted to ARRTC on two previous occasions for appraisal. Those for chemical and physical (stream sediments and radionuclides) monitoring are being similarly prepared in the same format. All documentation will be published. The World Heritage Convention does not have a similar monitoring protocol, but has agreed with the Ramsar Convention to work together and adopt, where appropriate, common approaches for monitoring. Similarly, the UNESCO Man and the Biosphere (MaB) program and the Convention on Biological Diversity have agreed to work with the Ramsar Convention on such issues.

Based on the national and international recognition given to the SSD program and the absence of similarly intense or integrated programs elsewhere in Australia, we believe that our monitoring program is suitable for the purposes we have described. This does not mean that we should not endeavour to enhance the efficacy of the program. We are keen to ensure that not only do we have a scientifically valid monitoring program, but that we maintain this and ensure that we provide assurance through the program to a national and international standard. To this effect we are in contact with international organisations and scientists engaged in monitoring and assessing the consequent data. We also welcome further scientific input to the monitoring program and have supported collaborative efforts to ascertain whether other approaches may enhance our capability to monitor the mine sites in the ARR.

5 Reporting regime for Ranger and Jabiluka

5.1 ERA — Ranger

There is a comprehensive reporting regime in place which requires ERA to notify the NT DBIRD, OSS and NLC of all aspects of the operation through a range of report types and at varying intervals. The overall program of reporting is set down in the Ranger General

Authorisation where it appears as Annex C 'Reporting Requirements'. The Authorisation is attached as Appendix 7.

This program covers reporting the results of the Environmental Monitoring Program and the Radiation Protection Monitoring Program as well as a range of statutory reports on aspects of the operation such as water management, tailings management and tailings dam surveillance. Water quality and chemistry data are reported monthly but are augmented by quarterly reports which must include some trend analysis and the Annual Interpretive Report which is the overall assessment of the monitoring data for the whole year. During periods of water discharge from site, eg when the weir at RP1 is overflowing, the company is required to report key water chemistry parameters weekly. The Radiation Protection Monitoring Program is reported quarterly with an extended Annual Interpretive Report. Environmental monitoring reporting is based on the 'water year' from October to September whilst radiation protection monitoring is reported on a calendar year basis.

In addition to these formal reporting requirements, ERA is required by its Authorisation and the Environmental Requirements to report promptly on a range of incidents and events. The company must notify the Commonwealth Minister for Resources, NT DBIRD, the Supervising Scientist and the Northern Land Council of all breaches of any of the Environmental Requirements and any mine-related event which:

- results in significant risk to ecosystem health; or
- which has the potential to cause harm to people living or working in the area; or
- which is of or could cause concern to Aboriginals or the broader public.

This reporting regime for water quality has been clarified in recent years by the introduction of trigger values for the main parameters. For the key variables, focus levels, action levels and limits have been established through a review of water quality data for Magela Creek and toxicological data. This review established what may be considered the 'normal' range of values encountered through a Wet season. The system takes account of the abnormal conditions that exist at the commencement of the Wet season with so-called 'first flush' effects.

For normally distributed constituents, values for the significant parameters at each site are compared to the standard deviation valued obtained from statistical analyses. If the values lie within one standard deviation (SD) of the mean value then no action is required. If a value exceeds the mean plus one SD the focus level has been reached and a 'watching brief' is instigated. The action level is set at the mean plus 2xSD. If an action level is exceeded, ERA is required to immediately report the event to the authorities, initiate an investigation and take corrective action if required.

The limit is either determined from toxicological testing using local native species of animals and plants or, where such information is not available, the value is set at the mean plus 3xSD level. If a limit is exceeded, ERA is required to provide a written report to the authorities providing all relevant data, the circumstances surrounding the exceedence, a description of corrective actions taken and options for further corrective action. When a limit is exceeded and, in the opinion of the Supervising Scientist, the exceedance is attributable to operations at Ranger, the Supervising Scientist will advise the Commonwealth Minister for Resources on the circumstances surrounding the exceedance and whether, in his opinion, there has been a breach of the Environmental Requirements.

An additional system of informal reporting of minor events has been adopted by ERA since 2000. Unplanned events are reported weekly through the unplanned events register. This is a voluntary system adopted by ERA to ensure that the principal stakeholders are fully aware of issues on the site and to raise awareness in its workforce of the importance of environmental issues and reporting.

5.2 ERA — Jabiluka

The reporting regime for Jabiluka is broadly similar to that at Ranger and is set down in the Jabiluka General Authorisation. Annex B of the Authorisation details the Environmental Monitoring Program, Annex C the Occupational Health Monitoring Program and Annex D the Reporting Requirements. The Jabiluka Authorisation is attached as Appendix 8.

A monthly environmental monitoring report of preliminary data is provided by ERA with trend analysis and data summary reports are provided quarterly. A comprehensive Interpretive Report is required annually. The reporting period for Jabiluka is 1 May to 30 April. The Radiation and atmospheric monitoring program is reported quarterly based on the calendar year with an annual Interpretive Report being required by 30 April each year. In addition ERA is required to submit an annual Environmental Management Plan for Jabiluka for the period 1 September to 31 August annually.

The reporting of incidents and events at Jabiluka is undertaken in the same manner as at Ranger although this is not yet a legal requirement. The NT Authorities and the Supervising Scientist have discussed amending the Jabiluka Authorisation to make this system of reporting mandatory at Jabiluka. Discussions are continuing.

5.3 NT DBIRD

The Minerals and Energy Division of the NT Department of Business, Industry and Resources (NT DBIRD) implements an environmental check monitoring and surveillance program at the Ranger and Jabiluka mine sites. The results of the program are reported formally to the other stakeholders every six months for periods ending on 31 March and 31 August each year. The reports are tabled at ARRAC meetings where a supporting presentation is made by NT personnel.

In the event of incidents, infringements or anomalous data being discovered at other times procedures exist through the working arrangements for the NT authorities to contact the other stakeholders and advise them of their findings. There are frequent meetings of the MTC as well as informal sessions at which data are discussed and exchanged.

5.4 Supervising Scientist

The Supervising Scientist produces an Annual Report which is tabled in the Commonwealth Parliament each year. This report covers all aspects of the work of the Supervising Scientist and includes a summary of research activity, supervision and audit activities, community relations, and the administrative arrangements. The outcomes of research at ***eriss*** are reported throughout the year with the publication of internal reports, peer reviewed reports in the Supervising Scientist Report series and publications in the scientific literature.

The Supervising Scientist also reports to the ARRAC and ARRTC committees each time they meet. The ARRAC meetings are currently held twice per year in August and December. The reports cover all aspects of the Supervising Scientist's activity in the region for the previous period including assessment of mining company applications, routine periodic inspections,

environmental monitoring data, outcomes of meetings of the MTCs and working groups, and environmental performance reviews and environmental audits for which SSD has been responsible.

The results of Supervising Scientist's independent routine monitoring program are reported to stakeholders by e-mail and to the broader community on the SSD website. They are also reported in the Supervising Scientist's annual report.

6 Implementation of the Supervising Scientist's role and responsibilities

The role and responsibilities of the Supervising Scientist have been described in section 2 of this submission. In summary they may be broadly categorised as research into the potential environmental impacts of uranium mining, supervision of environmental aspects of uranium mining, and environmental monitoring in relation to uranium mining. The monitoring program of the Supervising Scientist, which is relevant to the terms of reference of the Inquiry, has been described in detail in section 4. The remaining issue that needs to be addressed in this submission is the implementation of the Supervising Scientist's supervisory responsibilities with respect to the mining of uranium in the Alligator Rivers Region.

The Office of the Supervising Scientist (***oss***) is responsible for undertaking the supervisory, assessment, policy and corporate functions of the Supervising Scientist Division to support the Supervising Scientist in discharging his responsibilities under the *Environment Protection (Alligator Rivers Region) Act 1978*. The mechanisms by which the ***oss*** undertakes its supervisory and assessment functions at Ranger and Jabiluka are:

- The review of all applications made to the regulator by ERA to introduce new, or amend existing procedures.
- The review of environmental data collected by ERA.
- The review of environmental management plans and reports produced by mining companies.
- The conduct of an Annual Environmental Audit and a Mid Term Review of the Ranger and Jabiluka mines with NTDBIRD and the NLC. This replaces the Environmental Performance Reviews previously undertaken at Ranger and Jabiluka.
- The conduct of monthly site inspections of Ranger and Jabiluka, coordinated with NTDBIRD and NLC if available.
- Participation in Minesite Technical Committees and Working Groups which consider operational, technical, procedural and regulatory issues in detail.
- Assisting ***eriss*** in developing and implementing a routine environmental monitoring program, and the review of data arising from that program.
- Facilitating the review of the science applied to ***oss*** supervisory and assessment processes by the reconstituted Alligator Rivers Region Technical Committee.
- Facilitating the exchange of information between stakeholders through the Alligator Rivers Region Advisory Committee.

6.1 Minesite Technical Committee

The MTCs are a very important component of the general process of discussion and consideration of environmental issues and so are briefly described here.

The MTC for Ranger was established by the 1995 Working Arrangements (see Appendix 9). The Jabiluka MTC was established more recently by agreement between the OSS, NT DBIRD, NLC and ERA after the Commonwealth approved the Jabiluka EIS and PER. Their membership comprises representatives of the mining company, ***oss***, NLC and are chaired by NT DBIRD. Their role is specified in the Working Arrangements however it is broadly to facilitate formal discussion, consideration and resolution of matters associated with environmental and human health protection in connection with mining operations. In other words, the MTCs are technical problem solving fora. They operate both reactively, eg assessing applications made by the mining company, and proactively, eg developing explanatory material for publication under the Ranger Environmental Requirements. Decisions are made on the basis of consensus rather than by majority vote. MTCs also undertake a coordinating role for ongoing or complex processes such as the implementation of the recommendations of the report on the Tailings Water leak at Ranger.

Whilst an issue may be discussed and an outcome ultimately agreed by the MTC, the more complex issues usually require significant work outside of the MTC. This work might be undertaken by a Technical Working Group constituted by the MTC, by one of the members of the MTC, or by a consultant or ***eriss***.

6.2 Review of Applications, Plans and Reports

As noted previously, the Supervising Scientist does not regulate the mining activities at Ranger or Jabiluka. The regulator is NT DBIRD. However, the Working Arrangements which establish procedures for consultation between the NT regulator and the Supervising Scientist require that the regulator:

- consult and have regard to the views of the Supervising Scientist prior to granting an approval or authorisation, or issuing a licence or permit, in connection with environmental aspects of uranium mining operations in the ARR
- consult with and have regard to the views of the Supervising Scientist prior to setting standards in connection with any permit, licence, etc., relating to environmental aspects of uranium mining
- provide to the Supervising Scientist copies of all authorisations, approvals and directions issued by the NT Minister.

The Working Arrangements also state that:

> Wherever practicable, the NT DME will consult with the Northern Land Council (NLC) and have regard to their views prior to the issuing of any approval, authorisation, licence or permit, or the setting of any standard, relating to environmental aspects of uranium mining in the ARR.

The requirement of the NT regulator to consult with the Supervising Scientist was strengthened in the more recent *Agreement Between the Commonwealth of Australia and the Northern Territory of Australia in Relation to Principles to be Applied in the Regulation of Uranium Mining in the Northern Territory of Australia*, signed by Hon Nick Minchin, Commonwealth Minister for Industry, Science and Resources and the Hon Daryl Manzie, Northern Territory Minister for Resource Development on 17 November 2000 (see Appendix 5). Section 11 of the Agreement states:

1) In the exercise or performance of a duty, power or function under the UMEC[1] Act relating to the grant or variation of an authorisation under that Act, the Territory Minister:

   a) will refer the matter to the Supervising Scientist for comment; and

   b) shall not act until he or she receives comments from the Supervising Scientist. Such comments are to be made within fourteen (14) days unless the urgency of the situation requires an earlier response;

2) Where the Supervising Scientist has advised the Territory Minister that he or she has referred the matter to the Commonwealth Minister[2], the Territory Minister shall not exercise his duties, powers, functions and authorities under the UMEC Act otherwise than in accordance with the advice of the Commonwealth Minister.

Consequently, the ***OSS*** participates in the assessment and approval processes of NTDBIRD with respect to the regulation of the environmental aspects of uranium mining activities at Ranger and Jabiluka. Applications made by ERA to amend the Ranger or Jabiluka General Authorisation are copied to the ***OSS*** (and the Northern Land Council) for comment. The ***OSS*** assesses the application and provides comments to NTDBIRD and copies those comments to NLC and ERA. For simple applications of a routine nature, eg modifying the Maximum Operating Level of a retention pond due to the commencement of the Dry season, consensus between NT DBIRD, NLC and ***OSS*** is usually reached on the application through the basic process outlined above. NT DBIRD then refers the application as supported by the stakeholders to the NT Minister for approval.

Where ERA plans to make a more complex application, it will usually discuss its proposal with ***OSS***, NT DBIRD and NLC prior to making the application. These initial discussions may be informal or may occur within a formal Minesite Technical Committee meeting. In both cases, ***OSS*** considers the information provided by ERA and advises ERA, copied to NT DBIRD and the NLC, of issues that ***OSS*** wishes to see addressed in its application. NT DBIRD and NLC provide similar comments. ERA is then able to ensure that those issues are addressed in its application when submitted. After submission, applications of a more complex nature will be formally considered by the MTC. Possible outcomes are not approving the application, approving the application as submitted, or approving the application with conditions. As noted in the previous paragraph, the consensus position is conveyed to the NT Minister by NT DBIRD including any conditions which should be placed on the application if the MTC has supported the application.

Plans, reports etc which are required by the General Authorisation to be submitted to the regulator for assessment are dealt with in an identical fashion. That is, they are copied to ***OSS*** and NLC for comment, comments are exchanged and the document discussed and when consensus between ***OSS***, NLC and NT DBIRD is reached, the document is approved (where approval is required). More significant examples of these plans or reports include the Water Management System Operations Manual, Annual Plan of Rehabilitation, Annual Environmental Report and quarterly Environmental Monitoring Interpretive Reports.

A tool used to assess applications by ***OSS*** and the Minesite Technical Committee is a Best Practicable Technology (BPT) Assessment. This is a process which allows the comparison of

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[1] UMEC means *Uranium Mining (Environmental Control) Act*. This Act was repealed and replaced by the *Mining Management Act on 1 January 2002*

[2] The Commonwealth Minister is the Minister administering Section 41 of the *Atomic Energy Act*, presently the Minister for Industry, Tourism and Resources.

options to determine the best option, all relevant matters considered. BPT is defined in Section 12 of the Ranger Environmental Requirements as:

> That technology from time to time relevant to the Ranger Project that produces the maximum environmental benefit that can be reasonably achieved having regard to all relevant matters including:
>
> a) the environmental standards achieved by uranium operations elsewhere in the world with respect to
>
> i) level of effluent control achieved; and
>
> ii) the extent to which environmental degradation is prevented;
>
> b) the level of environmental protection to be achieved by the application or adoption of the technology and the resources required to apply or adopt the technology so far as to achieve the maximum environmental benefit from the available resources;
>
> c) evidence of detriment, or lack of detriment, to the environment;
>
> d) the physical location of the Ranger Project;
>
> e) the age of the equipment and facilities in use on the Ranger Project and their relative effectiveness in reducing environmental pollution and degradation
>
> f) social factors including the views of the regional community and possible adverse effects of introducing alternative technology.

The promulgation of the revised Ranger Environmental Requirements in 2000 provided for the first time the Supervising Scientist with the capacity to publish Explanatory Material under the ERs. During 2000–2001, the Supervising Scientist published Explanatory Material on BPT (Appendix 10) under section 19.2 of the Ranger ERs. This document provides guidance on the interpretation of BPT, including an explanation of the relevant matters (a-f) to be considered in a BPT assessment.

Following this, the Minesite Technical Committee developed a BPT matrix (Appendix 11) which quantifies the BPT assessment process by providing for the allocation of a score between 0 and 3 for each of the relevant matters to be considered. Guidance is provided in each case on what constitutes each score. There is no weighting given to any of the matters as they are considered equally important. The output of this process is a ranking, by total score, of the options considered. This ranking is extremely useful in determining BPT, noting that the option with the highest score will not necessarily be determined by the MTC to be BPT — the BPT assessment process is a tool used to determine BPT, it is not the outcome in itself.

In all cases, in order to be determined to be BPT, the proposal must comply with the Primary Environmental Objectives outlined in the Ranger ERs. The Jabiluka ERs have not yet been revised, however BPT at Jabiluka is being applied in the same manner as it is at Ranger according to the Explanatory Material on BPT published by the Supervising Scientist and the BPT Matrix developed by the MTC.

In addition to the assessment processes in which ***OSS***'s role is primarily reactive, ***OSS*** also operates in a proactive sense. Some notable examples of recent processes or activities that have been driven by ***OSS*** include:

- revising the Ranger Environmental Requirements to reflect modern best practice in regulation.
- deriving new dose conversion factors for the calculation of radiation doses to workers from the inhalation of radioactive dusts based on current standards

- establishing the new audit and inspection processes at Ranger and Jabiluka
- drafting and publishing guidance on the application of Best Practicable Technology, and
- establishing the system of focus, action and limit level triggers for water quality in Magela Creek and Ngarradj and updating these annually

6.3 Audit and Inspection

Commencing in 2001, the Environmental Performance Reviews were replaced by a new system of Annual Environmental Audits at Ranger and Jabiluka. The 2001 Audit was undertaken by accredited environmental auditors from the ***oss***, NLC and NT DBIRD. As a further enhancement, the team for the 2002 audit was led by a suitably qualified independent auditor to add transparency to the process.

The Annual Environmental Audit is based upon ISO14000 Series criteria, and takes the form of an Environmental Management System (EMS) Audit. In addition to the Annual Environmental Audit, the same audit team, excluding the external consultant auditor, undertakes a Mid-Term Review each year. The main purpose of the Mid-Term Review is to follow up on actions arising from the previous Annual Environmental Audit.

The Audit system provides a mechanism, traceable to Australian and international standards, for the comprehensive assessment of the management systems in place at Ranger and Jabiluka to protect the environment. The audit process complies with *AS/NZ ISO 14010:1996 Guidelines for environmental auditing — General principles*, *AS/NZS ISO 14011:1996 Guidelines for environmental auditing — Audit procedures — Auditing of environmental management systems* and *AS/NZS ISO 14012:1996 Guidelines for environmental auditing — Qualification criteria for environmental auditors*. The benchmark or criteria against which the Environmental Management System at Ranger and Jabiluka is audited is also traceable to Australian and international standards, ie, *AS/NZS ISO 14001:1996 Environmental management systems — Specification with guidance for use* and *AS/NZS ISO 14004:1996 Environmental management systems — general guidelines on principles, systems and supporting techniques*.

Also commencing in 2001 were monthly site inspections of Ranger and Jabiluka by ***oss*** — typically one officer from the Darwin Office and the Jabiru Field Station Manager based in Jabiru undertake RPIs. RPIs are also attended by NT DBIRD and NLC. The inspections utilise a checklist which has been developed for each site and focuses on potential sources of pollution, potential or actual contaminant release points, and environment protection infrastructure. The RPIs are not concerned with issues of mining engineering unless they are relevant in an environmental protection context. The RPIs also include an inspection of any area that has been the subject of an Approval since the previous RPI.

It is possible to inspect all environmental protection aspects of the Jabiluka site during a single inspection due to the very small size of the site, however, this is not possible at Ranger due to its large size and complexity. Consequently, each RPI at Ranger tends to focus on a particular issue or area and only higher risk areas of the site, such as the Tailings Corridor, will be inspected at every RPI. For instance, new works on site are inspected to determine if they are/have been undertaken in compliance with requirements. Sites of minor incidents reported by ERA are also inspected during RPIs. Reports are written following each RPI summarising what was observed, any issues identified and making recommendations for actions if required.

RPIs occur once every month. ***oss*** officers also attend the site for a variety of other reasons such as to attend meetings, or workshops hosted by ERA, or to view significant new developments such as the Pilot Process Water Treatment Plant that ERA operated late in 2001.

More serious incidents are inspected as soon as possible. Previously, more serious incidents were typically inspected the following day as the ***oss*** officer was required to drive to Jabiru from Darwin. However the establishment of the Jabiru Field Station and the recruitment of the Jabiru Field Station Manager has established an ***oss*** position in Jabiru. This is the first time that the Supervising Scientist has had a position with audit/inspection responsibilities in Jabiru. Consequently, more serious incidents can now be inspected by ***oss*** immediately, significantly improving ***oss*** response time.

6.4 Review of environmental data

Environmental chemical monitoring data collected by the mining company is provided to the ***oss*** on a monthly basis. The data are examined in order to identify trends, spikes or results which exceed trigger levels. In the vast majority of cases, the data are consistent with historical data and no further consideration is required. On other occasions, appropriate follow up action is taken to confirm the validity of the data and if necessary instigate appropriate investigations and interventions. For example, the observed increase in the concentration of uranium in Retention Pond 1 at Ranger during the 2001–02 Wet season, which was unexpected on the basis of previous action, resulted in significant investigations and interventions being taken following a request for assessment by ***oss***.

The mining company also produces quarterly and annual interpretive reports on environmental and radiological monitoring data which are reviewed by ***oss*** with written comments being communicated to the company and NTDME. These reports are subject to a more formal review process usually involving discussion at meetings of the MTC in regard to the annual report.

Following the commencement of the Supervising Scientist's routine environmental monitoring program, ***oss*** and ***eriss*** also review the chemical, biological and radiological data from that program. Similar to the review of ERA data, the identification of trends or spikes and comparison of the data with historical data and applicable trigger values/limits is undertaken.

6.5 Overall performance of the regulatory regime

Having briefly discussed what the ***oss*** does to supervise the environmental aspects of Ranger and Jabiluka, it is useful to provide some information on the approach taken by the regulatory regime in respect of risk management and the overall performance of the regulatory regime.

The prime purpose of the environmental management regime at Ranger and Jabiluka is to protect the environment from any detrimental impact arising from the mining operations and associated activities. The nature of mining and milling means that there are a number of environmental hazards, thus hazard identification, risk assessment and risk management are major components of the environmental management regime. The hazard identification process has to cover all pathways however it has been established that atmospheric transport and transport in water are the vectors by which contamination may leave the site. In particular it is in the area of surface water management that most effort is placed for monitoring and risk assessment as this has been identified as the principal pathway for contaminant transport that

could cause harm to the environment or human health. Thus a comprehensive water management system incorporating defence in depth principles such as secondary and tertiary containments and barriers working in conjunction with internal control monitoring points has been developed.

Evidence that the existing system is working and protecting the environment can be found in the examination of two recent incidents at Ranger. The two examples are the process water system leak of April 2000 and the stockpile runoff incident in early 2002.

The process water leak has been described and reported in detail in Supervising Scientist Report (SSR) 153. In summary the pipeline used to bring process water back from the tailings dam to the mill developed a leak during the 1999–2000 Wet season. The location of the leak was not discovered by ERA until early April, up to 85 days after the leak started.

The subsequent investigation carried out by the Supervising Scientist concluded that there had been no adverse impact to Kakadu National Park as a result of the incident. In fact, the monitoring program could not detect any increase in the concentration of any contaminants in Magela creek at the compliance point located on the Ranger Project Area upstream of Kakadu National Park. This is despite an estimated two million litres of process water leaking from a pipe over a period of up to three months. This incident was rendered environmentally benign by the passive containment system within which the process water is managed. The process water pipes are within a bunded area designed to collect spills. Anything that escapes the bunded area passes through a wetland filter system before leaving the minesite. In this case, it is estimated that over 95% of the process water was retained within the bunded area with 5% passing into the wetland filter system — the end result is that any contamination of the environment was not detectable. The performance of these passive safety features was such that the pipe would have had to have leaked at a rate approximately 120 times larger than what had occurred in order to detect a change in water chemistry at the compliance point. A leak of this magnitude would have been immediately evident in the process plant. Even then, the concentrations of contaminants would not have been environmentally significant. This is an example of measures being put in place to address the risk posed by a specific hazard and those measures being proven effective when required.

In February 2002 there was an incident involving runoff of stormwater from a low grade stockpile. Failures in ERA management systems resulted in the discharge to the Corridor Creek Wetland Filter System of water containing uranium at higher than normal concentrations. This incident was also investigated in depth by the SS and reported in SSR 170 '*Investigation of the stockpiling and reporting incidents at Ranger and Jabiluka 2002*'. Once again, the wetland filter system ensured that the environment of Kakadu National Park was protected with uranium concentrations leaving the Ranger minesite being approximately a factor of 20 below the limit for uranium in Magela Creek.

There have been a large number of reportable incidents and events at the Ranger mine over the life of the mine. The Supervising Scientist has investigated every such incident and, with two exceptions, has concluded that there has been no significant environmental impact at the time of the incident nor has there been any lasting environmental detriment.

One of these exceptions was the incident on 5 July 1982, which involved the health and safety of two workers in the packing plant. Following the incident, the Supervising Scientist undertook a specific study of radiation safety standards at Ranger and submitted a special report to the Minister for the Environment on 11 November 1983. The Supervising Scientist concluded that some radiation protection procedures at Ranger could be improved but, despite

some reservations about training, assessed that radiation exposures of workers during routine operations were likely to have been below the appropriate regulatory dose limit.

The second significant incident resulted from a spill of diesel from tanks at the power station at Ranger followed by drainage into Retention Pond 2 on 6 December 1995. This resulted in the death of 40 water birds. The Supervising Scientist concluded that this was the first unacceptable environmental impact that had arisen as a consequence of operations at Ranger, although it should be noted that this impact occurred on the Ranger Project Area, not in Kakadu National Park.

Apart from the two incidents noted above, all incidents have been assessed by the Supervising Scientist as being of little or no environmental significance. A question that is often asked, however, is 'On what basis was this assessment of environmental significance made?' To address this question, the Supervising Scientist has developed a simple matrix to explain, in relatively simple terms, the basis used for assessing ecological significance. The matrix is shown in figure 9.

The significance of an ecological impact may be considered in terms of two issues: how severe the impact is and how long it lasts. Assessment of impact severity is based on the actual damage to the ecosystem or landscape. In the matrix chosen, severity of impact has been classified in one of five categories ranging from 'no detectable change' in the physical, chemical or biological variables that characterise the environment through various categories to one in which change occurs 'at the ecosystem level'. The duration of an impact has been classified, in increasing significance, from less than one month to indefinite impact. The **position** within the matrix in which any particular incident is characterised provides a technical description of the environmental impact arising from that incident. This description is given in general terms by the label on the appropriate cell.

While it is possible to determine the severity and duration of an impact with a high degree of objectivity, the interpretation of the significance of an impact is much more subjective. Depending on factors such as an individual's personal relationship with, use of, or appreciation of the areas concerned, the level of the individual's scientific understanding, or the individual's stance on relevant moral or cultural issues, the perception of the significance of an impact can vary significantly.

The **cell shading** shown in figure 9 represents the Supervising Scientist's view of how the significance of environmental impacts should be regarded in the ARR. Cells which are heavily shaded are considered to describe impacts that are ecologically significant and require immediate intervention including, where appropriate, cessation of operations until the cause of the impact is eliminated. Those that are lightly shaded represent impacts of moderate environmental significance which do not meet community expectations on mining company performance and require remedial action. Cells without shading represent impacts that are considered to have no significance to ecosystem health or conservation values of the region. Whilst some stakeholders may consider the shading should be applied differently, it should nevertheless be possible for them to discuss and agree on the technical elements of an impact. Debate would then focus on interpreting the significance of the impact through different approaches to cell shading.

Figure 9 Assessment of ecological impacts arising from incidents at the Ranger mine from 1979 to August 2002

Duration of impact Severity of impact	Less than 1 month	Less than 1 year (less than a complete seasonal cycle)	Within project life (estimate No. of years to recovery)	Indefinite
Change at the ecosystem level	Brief serious impact	Short term serious impact	Extended serious impact	Long-term serious impact
Mortality within some species	Brief moderate impact #(1)[1]	Short term moderate impact	Extended moderate impact	Long-term moderate impact
Stress or behavioural change to individuals	Brief mild impact	Short term mild impact	Extended mild impact	Long-term mild impact
Physical or chemical changes only	Brief non-biological impact #(14)	Short term non-biological impact	Extended non-biological impact	Long-term non-biological impact
No change detectable	No impact #(107)	No impact	No impact	No impact

(Number of environmental incidents)

1 Bird kill in RP2 in December 1995

Heavy shade = significant impact Light shade = moderate impact Clear = insignificant impact (See text for interpretation)

The ecological significance of the 122 incidents reported since 1979 has been assessed by the Supervising Scientist within this framework. The number of incidents that meet the descriptors for each cell in the matrix is shown, in Figure 9, in that cell. Most incidents have given rise to no ecological impact while some, including minor tailings spills, fall into the 'brief non-biological impact' category. One incident (the bird kill on RP2 in December 1995) falls into the category of moderate ecological impact but no incident, in the opinion of the Supervising Scientist, has led to significant ecological impact.

In summary, of the total of 122 incidents that have been reported since mining began at Ranger in 1979, only one incident has been assessed as being of moderate ecological significance and one incident has had significant impact on people working at the mine. While the list of incidents reported appears large, this is a reflection on the rigour of the reporting framework and not a reflection on the standard of environmental performance at the Ranger mine.

References

ANZECC & ARMCANZ 2000a. *Australian and New Zealand guidelines for fresh and marine water quality*. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

ANZECC & ARMCANZ 2000b. *Australian guidelines for water quality monitoring and reporting*. National Water Quality Management Strategy Paper No 7, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Bayliss B, Brennan K, Eliot I, Finlayson CM, Hall R, House T, Pidgeon R, Walden D & Waterman P 1997. *Vulnerability assessment of predicted climate change and sea level rise in the Alligator Rivers Region, Northern Territory Australia*. Supervising Scientist Report 123, Supervising Scientist, Canberra.

Downes BJ, Barmuta LA, Fairweather PG, Faith DP, Keough MJ, Lake PS, Mapstone BD & Quinn GP 2002. *Monitoring ecological impacts: Concepts and practice in flowing waters*. Cambridge University Press, Cambridge.

Finlayson CM 1996. The Montreux Record: A mechanism for supporting the wise use of wetlands, in *Proceedings of the 6th Meeting of the Conference of the Contracting Parties of the Convention on Wetlands* (Ramsar Convention Bureau, Gland, Switzerland). Technical Sessions: Reports and presentations, Brisbane, Australia, Vol. 10/12 B, 32–37.

Finlayson CM, van Dam RA & Humphrey CL 1998. Wetland risk assessment: A framework and methods for predicting and assessing change in ecological character, Technical Report submitted to the Ramsar Scientific and Technical Review Panel, July 1998.

Johnston A & Milnes AR 2002. Review of mine-related research in the Alligator Rivers Region 1978–2002. Report to the Alligator Rivers Region Technical Committee Meeting 25–27 February 2002. In draft.

Martin P 2000. Radiological impact assessment of uranium mining and milling. Section 3.3: Radon and radon progeny. PhD thesis, Queensland University of Technology.

Appendices

(see separate Appendices.pdf)

Appendix 1 Early agreements

Appendix 2 ARRAC membership

Appendix 3 ARRTC membership

Appendix 4 Memorandum of Understanding 1995

Appendix 5 Agreement November 2000

Appendix 6 Ranger ERs

Appendix 7 Ranger Authorisation

Appendix 8 Jabiluka Authorisation

Appendix 9 Working Arrangements

Appendix 10 BPT Explanatory Notes

Appendix 11 BPT Effectiveness Matrix