# INDEX

## A

Aboriginal people xiv, 2, 3, 4, 5, 31, 34, 38, 47, 48, 62, 63, 75, 87–9, 97, 106, 107, 108, 111 *see also* traditional owners; indigenous people

administrative arrangements 94-104

Alligator Rivers Region (ARR) xiv–xvi, xvii, xx, 1–4, 5–6, 33–34, 36, 38, 40, 46, 48, 57, 62, 64–70, 84, 87, 105

- Alligator Rivers Region Advisory Committee (ARRAC) xx, 6, 84, 90
- Alligator Rivers Region Technical Committee (ARRTC) xv, xx, 35, 40, 85–6, 105–116
- alpha spectrometry 50
- animal experimentation ethics approvals 103
- aquatic animals 22–6, 31, 56–7, 87, 114 see also macroinvertebrates; fish
- assessments 5–38 *see also* ecological risk assessment 61–74, 75, 82, 107
- Atomic Energy Act 26
- audits xiv, 1, 5–6, 13, 26, 27, 32–3, 84, 91 AS4801 by ANSTO and ARPANSA 26
- Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) xx, 26, 34, 96
- Authorisation and approvals 6, 13–14, 17, 27, 28, 29, 32, 8, 100

## В

BACIP 55 Basslink 92 Bayesian Belief Network 82, 83 Bayesian Habitat Suitability Model 67, 74 bioaccumulation 46-7, 107 of radionuclides 46-7 biological monitoring xv, 17, 18, 20, 22-6, 31, 41, 42-43, 57, 59, 60-61, 64, 65, 104 black-banded rainbowfish 22, 24, 66 black soils 52 Boggy Plain 63, 70 Buba Billabong (Nourlangie Creek) 57 Bush tucker, bush food 46-7, 107 see also Magela Creek Bush Tucker Spatial Information System 47-8 business planning, new processes 98

# С

Cameco 32, 34 care and maintenance regime at Jabiluka xiv, 2, 3, 5, 27, 28, 29, 31, 105, 112 Charles Darwin University (CDU) 67, 83, 84, 92, 103 chemical monitoring xiv, 17, 19, 22, 26, 29, 41, 57-8, 72, 76, 84, 92 see also water quality chequered rainbowfish 25, 43, 45, 62 cladoceran 43 climate change 63, 77 committed effective dose 15, 38, 47 see also effective dose, dose rate communication 2, 34, 48, 83, 84, 87-93, 95, 97, 115 science communication 92 concentration factor 38, 47, 48 conferences, international 93 Coonjimba Billabong 57 Coonjimba Creek 11 Corridor Creek 7, 11, 12, 16, 41, 58, 107 creekside monitoring 22-4, 59-61, 87, 104 cross-cultural training 89 Cyclone Monica xiv, 9, 17, 20, 28, 31, 32, 97

## D

Darwin, staff in 94 Department of the Environment and Heritage (DEH) xii, xv, xx, 1-2, 4, 75, 76, 87, 96, 97, 98.99 Department of Industry, Tourism and Resources (DITR) xx, 26 dissolved organic carbon 42, 43, 108 Djalkmara Billabong 9, 12, 41 Djarr Djarr camp 27, 28 dose conversion factor 37, 47 dose rate 47, 107, 109, 115 see also radiation dose drinking water, contamination of, see potable water contamination incident duckweed 41, 43, 44 dust 9, 10, 12, 16, 35, 36, 108, 109, 115

#### Е

early detection studies 22 ecological risk assessment 61-74, 75, 107 Bayes's Theorem 67, 70, 74, 82 exposure probabilities for contaminants 67, 71, 72, 73 mining vs non-mining impacts xv, 41, 61 Monte Carlo simulation 70, 71, 72 sensitivity analysis 71-2 ecosystem establishment 91, 110 ecosystem-level response 22 ecosystem rehabilitation, Nabarlek xiv, 3, 31-2, 40, 47, 113 ecotoxicology 40-43, 94, 107, 112 ecotoxicological testing, see toxicity testing education and training, see training programmes effective dose 15, 38, 39, 47, 48 see also dose rate; radiation dose egret 62, 64, 66 Eleocharis 62-7 employment of Aboriginal people 87-9 Energy Resources of Australia (ERA) xiv, xx, 3, 6-19, 26, 29, 31, 36, 37, 41, 58, 85, 89, 91, 115 environmental management 3, 5, 8, 27 Mining Management Plan 14, 28 radiological monitoring 84, 86 Environment Centre of the Northern Territory (ECNT) 5 Environment Protection (Alligator Rivers Region) Act 1978 - see legislation Environment Protection (Impact of Proposals) Act 1974 – see legislation environmental assessments 5-39 environmental audits see audits environmental management, on-site 3, 5, 8-16, 27 - 8Jabiluka 27 Nabarlek 32 Ranger 8 Environment Management System 99 environmental protection, off-site 17-25, 29-30, 33, 57, 105 Jabiluka 29-30 Nabarlek 33

Ranger 17–25, 57

environmental protection of tropical rivers xv, 1, 40, 41, 75-83, 103 Environmental Requirements of the Commonwealth of Australia for the Operation of the Ranger Uranium Mine xx, 10, 13, 98, 105, 106, 108, 110 environmental research and monitoring 40-83, 105 - 116Environmental Research Institute of the Supervising Scientist (eriss) xiv, xx, 1, 40-83 biological monitoring - see biological monitoring chemical monitoring - see chemical monitoring performance summary 1-2 ERA - see Energy Resources of Australia erosion 32, 33, 63, 106, 109 EWLS (Earth Water Life Sciences) xx, 91, 115 exploration, mining 2, 4, 7, 14, 32, 34, 114 exposure pathways 35, 36, 38, 42, 45, 107, 110, 113 extension activities, NCTWR 92

## F

facilities 97-8 Jabiru Field Station xv, 41, 87, 97 library 98 laboratories 97 feral animals 63, 69, 77 pigs 63, 69 finance 96 fire 31, 32, 53, 62, 63, 70-72, 74, 110, 112 fish 22, 23, 25, 38, 41, 43, 45, 48, 60, 62, 66, 83, 87, 90, 102, 103, 104 community structure monitoring 24-6, 31 larval 23, 24, 104 focus catchment 75-83 freshwater snail 22, 23, 43, 60 egg reproduction 22, 23, 60, 61 functions and role - see role and functions

# G

G8210009 xx, 22, 50, 57, 58, 64, 65, 85 gamma radiation 35, 36, 109, 115 General Authorisation – *see* Ranger General Authorisation geomorphic classification 77, 78 Georgetown Billabong 56, 57 GIS 62, 76, 82 glassfish 25, 62, 66 green alga 43 groundwater pathways 49, 99, 101 gudgeon, purple-spotted 43, 45, 102 Gulungul Creek 11, 14, 17, 19, 20, 21, 22, 49– 52, 55–6, 57, 61 Gunbalanya Open Day 90, 91 Gundjeihmi Aboriginal Corporation 3, 5

#### Η

Hanson Pty Ltd 31, 32, 33, 85 hydra, *see* green hydra hydrological classification 77, 80, 81 hydrology 77, 80, 81, 110, 114 hyperspectral data 53, 55 *see also* multispectral, remote sensing hyperspectral imaging 55 *see also* multispectral, remote sensing

## I

incidents 5, 15-17, 28, 32 potable water contamination 26 indicator species 56, 62, 66 native vegetation (wetlands) 63, 66, 67, 74, 82 waterbirds 62, 64-6 weeds 53, 62, 63, 64, 66-8, 77 indigenous people see Aboriginal people; traditional owners Inductively Coupled Plasma Mass Spectrometry (ICPMS) 50 ingestion pathway 36, 38, 47 inhalation pathway 35, 36, 37 inland waters 2,96 inspections 5, 15, 32, 34 Routine Periodic Inspections 5-6, 8 international activities, conferences 93 International Atomic Energy Agency (IAEA) xx, 38, 48, 93

International Commission on Radiological Protection xiv, xx, 34, 35, 36, 91 Internet, *see also* web site monitoring results on internet 17 ARRAC & ARRTC documents on Internet 84, 85 Intranet 90, 96 Investor in People 89, 95 ionising radiation – *see* radiation levels irrigation 107 irrigation, Ranger 10, 12, 14, 16, 17 ISO 14001 99

## J

Jabiluka Project xiv, 2, 3, 5, 6, 15, 27–31, 36, 37, 38, 40, 41, 84, 85, 88, 105, 106, 112, 115 Jabiru xiv, 3, 9, 12, 17, 20, 37, 41, 50, 57, 84, 89, 90, 91, 94 Jabiru Field Station xv, 41, 87, 97, 100 James Cook University xv, 41, 92, 103

## K

Kakadu National Park xv, 2, 3, 4, 34, 41, 54, 56, 62, 89, 91, 105, 110 see also Jabiluka Project; Ranger mine landscape analysis 62–74
Kakadu Research Advisory Committee 89 key knowledge needs (ARRTC) 40, 84, 86, 105–116
knowledge management 47, 89, 106, 115
Koongarra uranium deposit 2, 4, 105, 114

## L

land application 9, 10, 12, 16, 17, 59 *see also* irrigation landscape analysis xv, 41, 52, 61–74, 113 landscape-scale 'threats' 63 climate change 63 feral animals 63, 69, 77 fire 62, 63, 70, 71 ground disturbance 63, 69, 70 infrastructure 63 invasive species 63, 67 para grass 62–64, 66, 67, 68, 74 pigs 63, 68, 69, 70, 72 saltwater intrusion 62 weeds 62, 63, 66 larval fish *see* fish, larval legislation 5 *Aboriginal Land Rights (Northern Territory) Act 1976* 2, 4 *Atomic Energy Act* 26 *Environment Protection (Alligator Rivers Region) Act 1978* xiii, 1, 40, 84, 94, 98 *Mining Management Act (NT)* 6 *Uranium Mining (Environment Control) Act (NT)* 6 library 98 library, spectral 52–5

long lived alpha activity (LLAA) – see dust

#### Μ

macroinvertebrate communities, monitoring of 23, 31, 56-57 Magela Creek 3, 11, 12, 16, 49, 55, 61-62 biological monitoring xv, 22-26, 41, 42-43, 57, 60-61, 64, 65, 104 chemical monitoring 17-19, 20, 38, 40, 42, 50, 58-59, 72 ecological risk assessment 61-75 radionuclides in bush food 36, 38, 107, 108 water quality objectives 17, 18, 29 Magela floodplain 4, 68, 70 ecological risk assessment xv, 3, 41, 61-74 fire 63, 70, 71 invasive species 63, 67 magpie goose 62, 64, 65 para grass 66, 67, 68 pigs 68-70 saltwater intrusion 62 waterbirds 62, 64-66 weeds 63, 66-68 World Heritage values 62, 63, 66 magnesium 18, 20, 31, 59, 72-73, 74, 107 magpie goose 62, 63, 64-66, 82 metadata 53, 54, 76 see also remote sensing mimosa 63, 64, 67, 71 Minesite Technical Committees xx, 5, 8, 13, 14, 28, 33, 35, 84 Jabiluka 5,28 Nabarlek 5, 33

Ranger 5, 8, 13, 14 mining - see uranium mining Mining Management Act (NT) - see legislation Mining Management Plan xx, 14, 28, 31, 32, 33 Nabarlek 31, 32 Minister for the Environment and Heritage 33, Minister for Industry, Tourism and Resources 34 Ministerial directions 98 Mirarr 3, 88, 89 monitoring xiv, xv, xix, 1, 2, 5, 6, 17, 32, 33, 40--83, 87, 88, 89, 90, 91, 92, 97, 98, 104, 105, 108, 109, 112–113, 114 biological 20, 22-26, 56, 57, 59, 60, 62, 86, 92, 108 chemical 17-19, 29-31, 49, 58, 86, 92, 108 groundwater 28, 33, 111 radiological 35, 36, 38, 39, 49, 50-52, 84, 85, 86, 92, 108, 114 toxicity 57, 60-61 water quality xv, 40, 57-59, 60, 87, 109 Mudginberri, radiological exposure at 24, 38-39 Mudginberri Billabong 24, 25, 38 Multispectral 53, 55-see also hyperspectral data mussels 38, 43, 87, 88, 104

#### Ν

Nabarlek minesite xiv, 2, 3, 5, 31–33, 47, 48, 84, 85, 86, 105, 106, 110, 113-115 Nabarlek rehabilitation bond 31-32 National Centre for Tropical Wetland Research (NCTWR) xx, 1, 92, 103 Natural Resources. Environment and the Arts. Department of (NRETA) xx, 58, 83 Newsbrief 89,95 Ngarradj (Swift Creek) 3, 29-31 biological monitoring 31 chemical monitoring 29-31 radiological monitoring 29-31, 38 Northern Land Council (NLC) xx, 3, 4, 5, 6, 13, 17, 27, 29, 31, 32, 34, 85, 88, 89, 114 Northern Territory Environment Centre - see Environment Centre Northern Territory

Northern Territory Mining Management Act – see Mining Management Act (NT) – see legislation

Nourlangie Creek 24

#### 0

occupational health and safety 26, 60, 95-96

Office of the Supervising Scientist (*oss*) xx, 1, 5, 6, 13, 14, 15, 16, 17, 27, 32, 34, 85, 87, 94, 95, 100 *Oryza meridionalis* 62

Overview - Supervising Scientist's xiv-xvi

## Р

Para grass 53, 62, 63, 64, 66, 67, 68, 71, 72, 74
Parks Australia North (PAN) xx, 4, 85, 88, 91, 97, 98, 100, 115
performance summary 99–102
Primary Industry, Fisheries and Mines, Department of (DPIFM) xx, 5, 13, 27, 85, 89
Pits 13, 111
Pit 1 8, 12, 13, 14, 111
Pit 3 xiv, 7, 9, 10, 11, 12, 13, 14, 16, 41
pond water 7, 10–12, 17, 41–43
Portfolio Budget Statement 1, 96
PBS output costs 96
potable water contamination incident 15, 26
process water 7, 8, 10, 14, 43, 111
publications 41, 92, 98, 99, 117–121

# Q

Queensland Mines Pty Ltd 3 see also Hanson Pty Ltd 31, 32, 33, 85

## R

radiation clearance procedures 26 radiation dose 34, 35, 36, 47, 106, 107, 109, 113, 115 – *see also* dose rate radiation, employee exposure 35–36 – *see also* exposure pathways radiation, public exposure 36–38 – *see also* exposure pathways radiologically anomalous area 32, 33 radiological protection xiv, 34, 38, 47, 91 radiological risk 47, 107, 110 radionuclides 36, 38, 39, 46–47, 55, 107, 108 radon 33, 35, 36, 37-39, 74, 108, 109, 111, 115 decay products 35, 36, 37, 39 exhalation 109, 115 progeny 37, 108 rainbowfish see black-banded & chequered Ramsar 61, 62, 106 Ranger Environmental Requirements xx, 10, 13, 98, 105, 106, 108, 110 Ranger General Authorisation 13, 14, 35 Ranger uranium mine xiv-xvii, 2, 3, 5, 6, 7-25, 35, 36, 49, 55, 56, 57, 58, 59, 61, 62, 64, 72, 74, 84, 85, 86, 87, 88, 91, 98, 104, 105, 106-112, 113, 114, 115 key knowledge needs xx, 40, 84, 86, 105-117 reflectance 53-see also remote sensing rehabilitation and remediation of minesites xiv, xv, 2, 3, 4, 6, 27, 28, 31-32, 33-34, 38, 45, 47, 52-55, 74, 84, 86, 105, 106, 108, 109, 110, 111, 112, 113, 114 Jabiluka 36, 40 Nabarlek xiv, 2, 3, 31-32, 33, 40, 47, 48, 105, 113 Ranger 6, 40, 47, 48, 55, 105, 106, 108, 112, 113 South Alligator River valley xv, 2, 4, 40, 114 remote sensing 54, 113 research - see environmental research and monitoring research support and communication 87-91 Retention Pond (RP) 12, 14, 16, 57, 58, 59 RP1 11, 12, 58, 59 RP2 11 revegetation 2, 3, 31, 33, 52, 53, 106, 109, 110, 113 Nabarlek 2, 3, 31, 33, 113 Ranger 106, 109, 110 risk assessments xv, 40, 41, 47, 61-83, 107, 108, 110, 114, 115 ecological 40, 61-83, 107 landscape-scale 70, 71, 74 radiological 47, 110 role and functions see Supervising Scientist, role and functions Routine Periodic Inspections (RPIs) xx, 8, 15

#### S

saltwater intrusion 62 salvinia 63, 64, 71, 91 Sandy Billabong (Nourlangie Creek) 24, 25, 38, 57 seepage barrier 8 snail egg reproduction 23, 60, 61 South Alligator Valley 4, 5, 33, 34, 47, 48, 84, 86.114 spectral library 52, 55xiv, xv, xvi, 5, 32, 34, 41, 60, 85, 87-94, 94-102 - see also remote sensing staff development activities 95 levels 89 publications by 41, 92, 99, 117-121 stakeholder engagement (TRIAP) xv, 41, 75-76, 81, 82, 83, 92, 103 stockpile sheeting 12 structure and organisation 94, 95 students 93 sulfate 18, 20, 31, 33, 49, 59, 72, 73, 74, 107 see also magnesium sulfate Supervising Scientist xiii, xiv-xix, xx, 1-2, 4, 5, 6, 8, 10, 13, 17, 19, 22, 23, 24, 25, 26, 27, 29, 31, 33, 35, 39, 40, 41, 53, 57, 62, 84, 85, 86, 87, 91, 92, 93, 94, 95, 96, 97, 98, 100, 101, 103, 106 overview by xiiv-xvi role and functions 1, 91 web site 17, 84, 85 supervision processes 5-6 surface water monitoring 17-19, 29, 33 suspended sediment - Gulungul Creek 55, 108 Swift Creek (Ngarradj) see Ngarradj

## Т

tailings 6, 8, 12–13, 14, 15–16, 49, 50, 52, 109, 111, 114 Tailings Dam 6, 8, 12, 13, 14, 49, 50, 52, 109, 111 terrestrial fauna 38, 46, 47, 48, 110 terrestrial flora 38, 46–48, 110 terrestrial food 36, 38–40, 44, 46–48, 60, 62, 63, 64, 66, 107, 108, 110 - *see also* bush tucker toxicity 40-46, 59, 60-61, 73, 104, 107-108, 110 - see also monitoring toxicity testing 43, 59, 104 toxicology 40-43, 94, 107, 112 traditional owners 2, 38, 47, 48, 87, 88, 89, 91, 108, 110, 111 - see also Aboriginal people; indigenous people training programmes 89, 95 cultural training for SSD staff 89 NCTWR xx, 1, 92, 103 staff development activities 95 treated pond water 12, 41-43 trigger values 57, 72 - see also water quality objectives action levels 13, 74 guidelines 6, 17, 18, 43, 56, 57, 73 limits 17, 35, 42, 43, 45, 106 Triple Bottom Line reporting xx, 98, 99, 101 Tropical Rivers Inventory and Assessment Project (TRIAP) xv, xx, 41, 64, 75-84, 92, 103 tropical wetlands 2,96 tubers 47

#### U

uranium decay series 47 uranium isotopes 50, 52

- uranium, effects of 1, 40, 45, 46, 84
- uranium, fate of 44
- uranium mining xiv, xv, 1–2, 4, 5, 6, 22, 35, 36, 40, 41, 46, 74, 84, 85, 93, 96, 105, 106, 110, 114, 115, 116
- uranium, uptake of 44, 45 *see also* biological monitoring; chemical monitoring; radiation levels
- Uranium Mining (Environment Control) Act (NT) – see legislation

Urochloa mutica – see para grass

unplanned events 5

#### V

vegetation xiv, 2, 3, 14, 31, 33, 52, 53, 54, 55, 62, 63, 64, 66, 67, 70, 74, 78, 79, 82, 91, 105, 106, 109, 110, 113 – *see also* revegetation Magela floodplain 63, 64, 68, 70, 71, 72 Ranger *see* rehabilitation and remediation

## W

waste rock management, 11, 109, 110, 111, 112
waterbirds 62, 64, 66, 67
water management 6, 7, 8–12, 14, 16, 25, 27, 57, 74, 84, 107
Jabiluka 27
Ranger 6, 7, 8–12, 14, 57, 74, 84
water quality xv, 10, 17, 21, 23, 25, 29–31, 40, 43, 56–59, 60, 73, 77, 87, 89, 107, 109, 110, 112
groundwater 8, 28, 33, 107, 108, 111, 113, 114
Jabiluka 29-31
Ranger 17–21
surface water 17–21, 29–31, 33, 49, 50, 62, 72, 73, 74, 89, 107, 108, 112, 113

water inventory 7, 8, 10
Water Quality Guidelines (ANZECC & ARMCANZ) xx, 43, 56, 57, 73
water quality objectives 17, 18, 29
water treatment plant xx, 7, 8, 9, 12, 41
web site *see* internet 17, 84, 85
weeds 53, 62, 63, 66–68, 77, 91, 110, 112
wetlands 1, 2, 11, 40, 41, 61, 75, 76, 93, 96, 106, 111, 112
wetland filters 7, 9, 11, 12, 14, 107, 111
sentinel wetlands 111
wild rice 62, 66, 67
World Heritage values xv, 2, 41, 62, 63, 66, 105