Australian Government

Australian Nuclear Science and Technology Organisation

Little Forest Burial Ground Scenario

Overview

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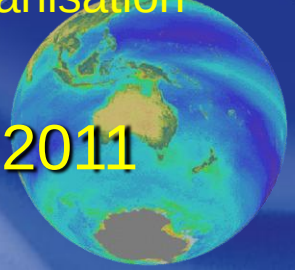
Australian Nuclear Science and Technology Organisation



EMRAS II, WG 4, IAEA Vienna, Jan 2011

Overview of talk

- Schedule
- Participants
- Scenario refresher

Schedule

- Jan 2009 - Jan 2010 at EMRAS II mtgs, a series of presentations on Little Forest Scenario as a Biota Dose model comparison exercise for terrestrial organisms
- 22 April 2010 – Scenario details sent out and call for participants
- June - Aug 2010 – Participant's results submitted
- Sept 2010 – Participants presented their approaches and initial results discussion at EMRAS mtg
- Sept 2010 – Abstract submittal to ICRER
- Nov - Dec (Jan) - 2010 Final QA'd results submitted
- Dec 2010 – Notice that abstract accepted for ICRER
- Jan 2011 (today) – Presentation/discussion on final results
- Proposed - March 2011 review of first draft Journal article
- 2011 - Submittal of Journal article

Thanks for input to the abstract, hope to see you at ICRER

Dose modelling comparison for terrestrial biota; IAEA EMRAS II Biota Working Group's Little Forest Burial Ground Scenario

MP Johansen1, CL Barnett, NA Beresford, JE Brown, M Černe, BJ Howard, S Kamboj, D-K Keum, B Smodiš, JR Twining, H Vandenhove MD Wood and C Yu

This model intercomparison conducted under the IAEA EMRAS II programme considered transfer of Am-241, Co-60, Cs-137, Sr-90, Pu-238/239, Th-232, and U-234/238 from soils to wildlife at the Little Forest Burial Ground site near Sydney, Australia. Although this site is small, and has only trace levels of surface contamination, it offers a diverse range of ten terrestrial species to assess, including indigenous Australian species. It also has exposure routes that challenged model capabilities such as the prediction of dose to an acacia tree which has part of its root system in a waste trench. Such a configuration is not generally available in models but does represent a realistic situation for shallow waste sites.

The participants included the code developers/custodians for the ERICA Tool, FASTer-lite, K-Biota, and RESRAD-BIOTA dose assessment codes, as well as users with various levels of experience. All participants made use of probabilistic parameterisation of whole-organism concentration ratios (CRwo) and input data, typically using log-normal distributions, to better encompass variability. The exercise was designed such that participants used a range of methods to derive CR wo values including use of model defaults, values from the draft IAEA handbook on radionuclide transfer parameters for wildlife, biokinetic modelling, and journal references. The different approaches resulted in a range of CR wo values that varied from less than one order of magnitude for species such as earthworm, up to four orders of magnitude for endemic Australian species such as the echidna and wallaby.

Model results included the prediction of internal, external, and total dose rates as well as whole-organism tissue concentrations. Variation among mean total dose rates was lowest (typically less than one order of magnitude) for Co-60 and Cs-137, compared with higher variation (up to four orders of magnitude) among the transuranics.

Participants

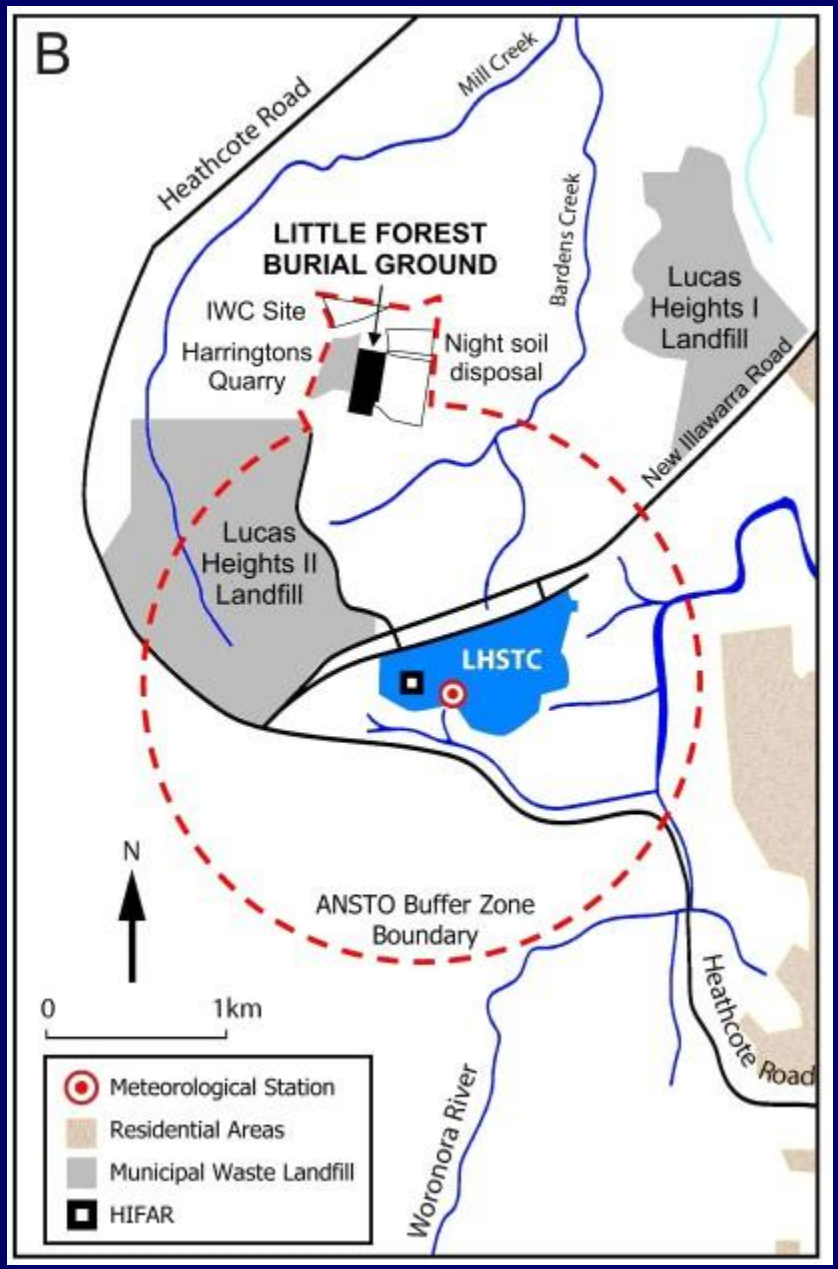
Participant	Contacts	Code
CEH **Centre for Ecology & Hydrology, Lancaster, UK**	**N. Beresford,** **B. Howard,** **C. Barnett**	**ERICA**
SCK-CEN **Belgian Nuclear Research Centre, Mol, Belgium**	**H. Vandenhove,** **J. Vives i Batlle**	**ERICA**
JSI **Jozef Stefan Institute, Ljubljana, Slovenia**	**M.Černe,** **B. Smodiš**	**ERICA**
NRPA **Norwegian Radiation Protection Authority, Oesteraas, Norway**	**J. Brown**	**FASTer-lite Suite includes:** **ERICA (CR transfer to organism food)** **EIKOS (Probabilistic for Co, Cs, and U where equilib reached quickly – i.e. steady-state transfer). Else, ECOLOGO (Dynamic food chain uptake for 50% Organism lifespan)**
KAERI **Korea Atomic Energy Research Institute, Daejeon, Republic of Korea**	**D-K. Keum**	**K-Biota**
ANL **Argonne National Laboratory, IL, USA**	**S. Kamboj** **C. Yu**	**RESRAD-Biota**
U. of Liverpool/ (Manchester?)	**M. Wood**	**RESRAD-Biota**

Scenario Objectives

- Demonstrate state-of-practice for use of biota dose assessment codes
- Demonstrate new model capabilities (probabilistic functionality, organism definitions, etc.)
- Compare among model codes (ERICA, RESRAD-Biota, etc.)
- Compare effects of user assumptions
- Provide user feedback to code development/updates
- Linkage to new Wildlife Handbook TRS & database

Site Location

- Located near Sydney, New South Wales, Australia.



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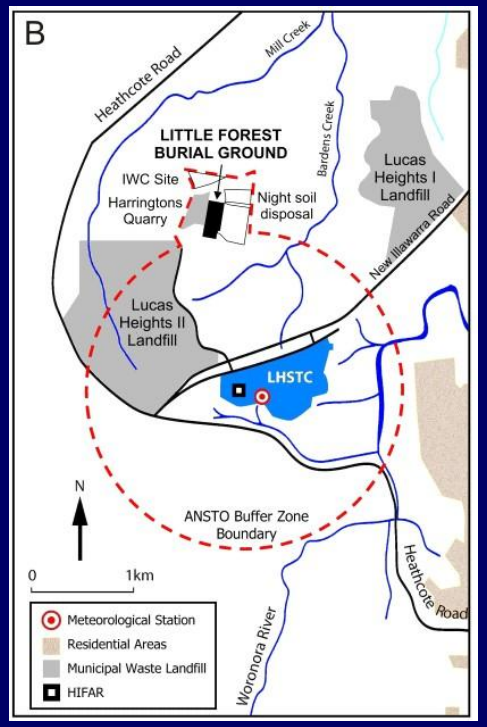
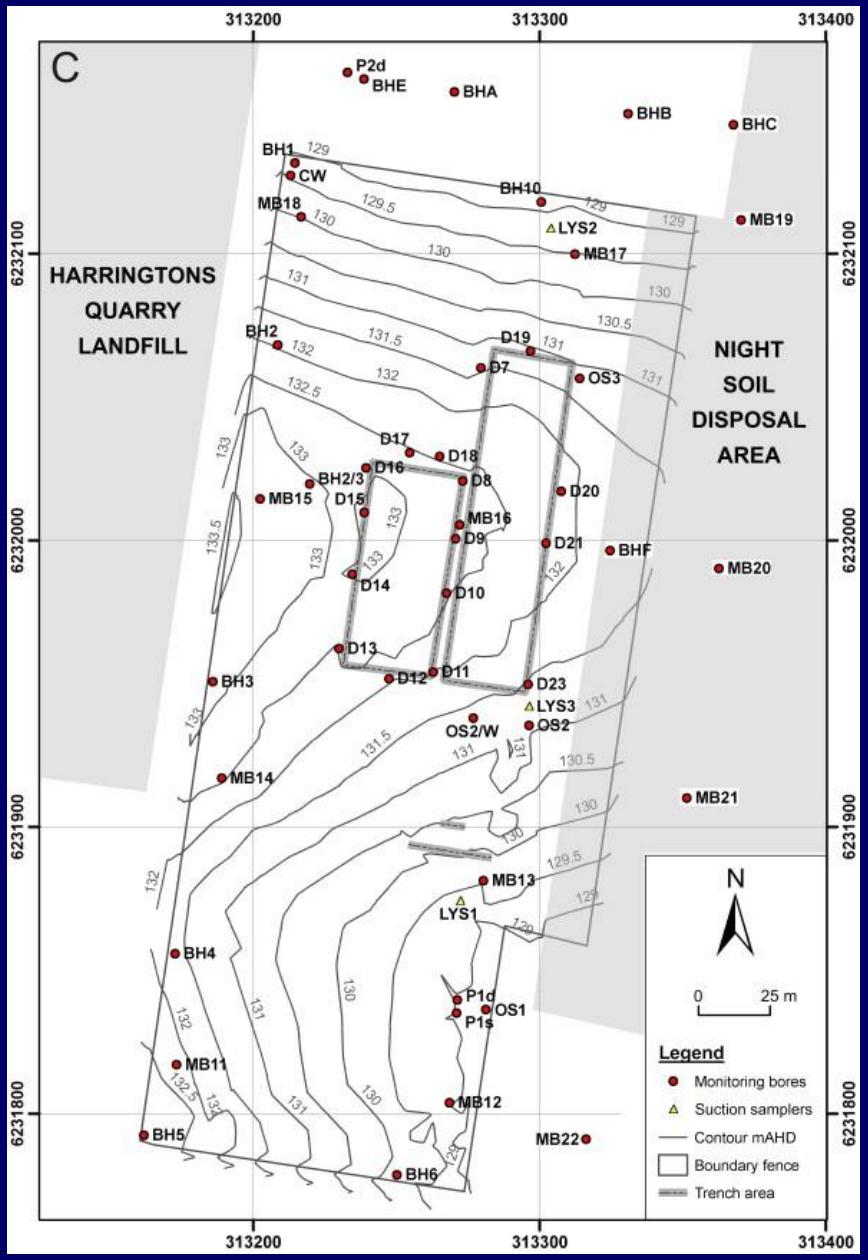




Waste Disposal

- Waste disposed in 1960-68.
- Waste was from reactor, medical, other academic research.
- 79 trenches extending from ~1.0 to ~3.0 m below the ground surface.
- ~150 GBq of radionuclides, including many short-lived isotopes as well as H-3, Co-60, Sr-90, Cs-137, Th-232, U-233, -235, -238, Pu-238/240, Am-241 among others
- various forms and types of packaging.

1960-68 Disposal at LFBG

Site after disposal

- In 1983, ~30 cm of topsoil was placed over trenches.

Present state

- Grass-dominated vegetation cover,
- Bordered by low forest & scrub representative of original vegetation.
- Site is maintained with fencing, signage, grass mowing, and regular monitoring.

Ten Representative Species

Plant – Grass

Plant, tree – Acacia

Plant, root crop – Yam

Annelid – Earthworm

Arthropods - Insects (grasshopper)

Reptile – goanna

Bird - raven (representing raven, magpie, kookaburra)

Mammal, monotreme – Echidna

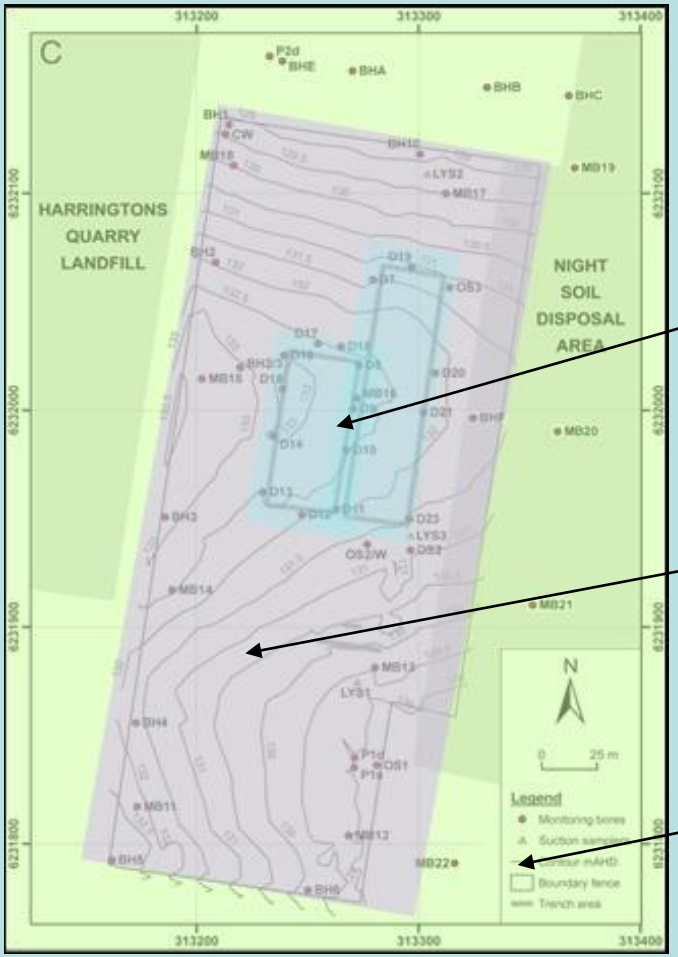
Mammal, placental canine – Fox

Mammal, marsupial macropod – Wallaby

Representative Species Data

		Weight (kg)	Dimension of head and body a,b,c (cm)	notes
graminoids	Grass	0.01	20, 1, 1	0-10 cm root depth
Vigna lanceolata	Pencil yam	0.1	15, 3, 3	Assume <1 m yam root depth
Acacia	Acacia	845	1500, 25, 25	Assume 0-2 m root depth
Octochaetidae	Earthworm	0.0052	10, 1, 1	Lives 0-1 m deep in soil. Eats organic matter w/soil ingestion
Insecta	Insects (grasshopper)	0.001	1, 0.4, 0.2	This category of insect lives 100% at soil surface. Eats organic matter, scavenger
Varanus varius	Goanna	8	70, 16, 12	Lives 80% at soil surface, 20% in tree. Eats insects, eggs, smaller reptiles, carrion.
Corvus coronoides	Raven	0.6	40, 14, 10	Lives 70% in tree/air, 30% at soil surface. Eats 34% carrion, 42% invertebrates, 24% plants
Tachyglossus	Echidna	4	40, 20, 15	Lives 60% in soil, 40% at soil surface. Eats invertebrates (ants) high dust inhalation
Vulpes vulpes	Fox	8	68, 18, 14	Lives 60% in soil, 40% at soil surface. Eats invertebrates, berries, grasses, carrion, rabbits, wallaby
Wallabia bicolor	Wallaby	14	75, 30, 22	Lives 100% at soil surface. Eats grass, forbs.

Assumed Contaminant Exposure Zones



- Zone 1 – Beneath-ground, within waste material (within original trenches)
- Zone 2 – Ground surface, and beneath-ground (soil), within 4m of trenches
- Zone 3 –All other area within site boundary
- Zone 4 – All areas outside of site boundary

Occupancy Factors

"Reasonable Worst Case" member of the local species population

	Zone 1	Zone 2	Zone 3	Other areas
Grass		100%		
Acacia	50%	50%		
Yam			100%	
Earthworm	10%	90%		
Insects		100%		
Goanna		10%	20%	70%
Raven		30%		70%
Echidna		10%	20%	70%
Fox		10%	20%	70%
Wallaby		30%	20%	50%

Soil Concentrations – Current conditions

	Zone 1	Zone 2	Zone 3
	ave, max, min, stdv	ave, max, min, stdv	ave, max, min, stdv
Co-60	2211, 4000, 108, 1330	2, 10, 0.6, 2	1,2, 0.5, 0.6
Sr-90	1000, 1500, 500, 500	28, 207, 3, 43	4, 5, 3, 0.7
Cs-137	472, 1000, 171, 315	3, 9, 1, 2	2, 3, 1, 0.3
Th-232	500, 650, 250, 200	54, 68, 43, 8	12,16, 8, 4
U-233, 234	475, 938, 49, 200	47, 87, 34, 15	7, 8.0, 6, 1
U-238	400, 600, 300, 300	38, 49, 30, 4	4, 5, 3, 0.7
Pu-238/39/40	4220, 1.1E5, 439, 2000	3, 16, 0.1, 5.4	0.01, 0.02, 0, 0.01
Am-241	710, 1290, 130, 820	4, 24, 0.3, 8	0.01, 0.02, 0, 0.01

No highlight indicates information was derived from observed data.
Dark highlight indicates the information was derived by extrapolating from observed data.
Light highlight indicates the information is hypothetical.

Standard data template for site data, assumptions, and output

Little Forest Burial Ground - terrestrial modelling scenario

Soil

Area		Co-60	Sr-90	Cs-137	Th232	U-234	U-238	Pu-238	Pu-239	Am-241
		Bq/kg dw	Bq/kg dw	Bq/kg dw	Bq/kg dw	Bq/kg dw	Bq/kg dw	Bq/kg dw	Bq/kg dw	Bq/kg dw
Summary Statistics										
Zone 1										
Within waste trenches	mean	2211	1000	470	500	480	400	75	4200	710
(1-3 m underground)	max	4000	1500	1000	650	940	600	1964	110000	1300
	min	108	500	170	250	49	300	8	440	130
	std	1300	500	320	200	200	300	36	2000	820
Zone 2										
Soil <4 m from trenches	mean	2	28	3	54	47	38	0.1	3	4
	max	10	207	9	68	87	49	0.3	16	24
	min	0.6	3	1	43	34	30	0.002	0.1	0.3
	std	2	43	2	8	15	4	0.10	5	8
Zone 3										
Soil >4 m from trenches	mean	1	4	2	12	7	4	0.0002	0.01	0.01

Summary - Scenario common basis

- Nine radionuclides (Am-241, Co-60, Cs-137, Sr-90, Pu-238/239, Th-232, and U-234/238)
- Four zones of soil concentrations (mean, std dev, min, max provided for each zone)
- Ten organisms (sizes, weights, and some notes on living and feeding habits provided)
- Ten sets of occupancy factors - proportion each species was exposed from each soil contamination zone - (However, some participants modified these to interesting effect)

Use of the same basic data set focused the variation among participants to a set of manageable but interesting factors.

Additional Information: Goanna

Additional Information: Raven

Additional Information: Echidna

Additional Information: Fox

Additional Species Information: Wallaby