GAM example

MARALINGA

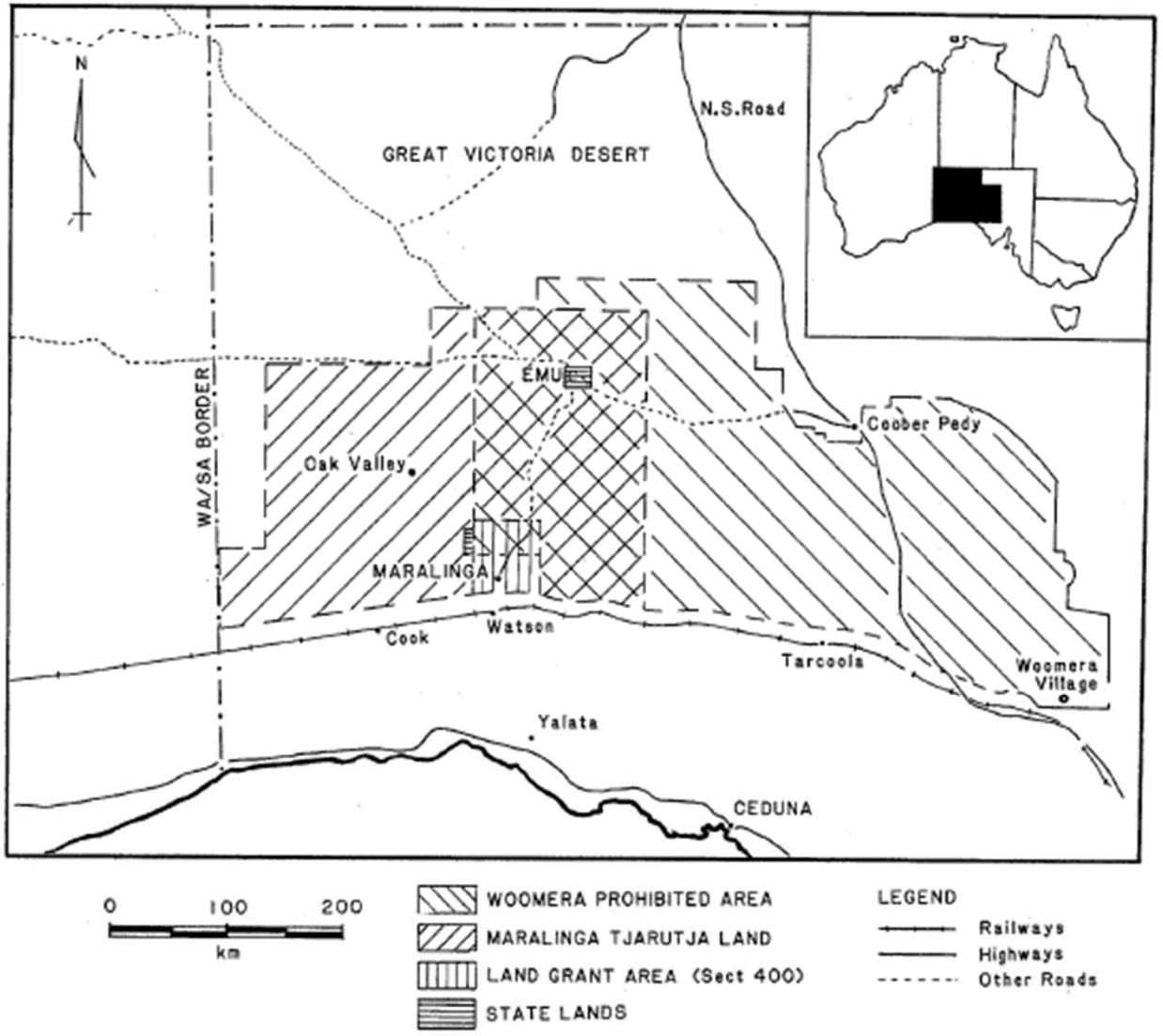
(former nuclear test site)

General remediation methodology

- Site characterisation
- Risk assessment
- Establishment of cleanup criteria (goals)
- Cleanup
- Verification

Nuclear tests in Australia

- 1952 – first British atomic bomb explosions at the Monte Bello Islands off the WA coast
- 1953 – Britain conducted two atomic explosions at Emu in SA
- 1956 – two more tests at the Monte Bello islands
- 1956 -1957 – Britain conducted seven atomic explosions at Maralinga.
- 1957 – 1963 – hundreds of “minor trials” were also conducted at Maralinga, contaminating the environment with plutonium and other radioactive debris.
- 1966 – first cleanup by British – operation “Brumby”


N
GREAT VICTORIA DESERT
N.S.Road
WA/SA BORDER
EMU
Coober Pedy
Oak Valley
MARALINGA
Cook
Watson
Tarcoola
Woomera Village
Yalata
CEDUNA
0
100
200
km
WOOMERA PROHIBITED AREA
MARALINGA TJARUTJA LAND
LAND GRANT AREA (Sect 400)
STATE LANDS
LEGEND
Railways
Highways
Other Roads

Maralinga – 1980 to

- Operation Brumby was supposed to have left the Maralinga site in an acceptable condition
- Preliminary studies by the Australian Radiation Laboratory (ARL) during 1984 and 1985 indicated that contamination levels were significantly higher than previously reported
- A technical assessment group (TAG) was set up by the Australian government in 1986 to oversee further technical studies of the site and to advise on rehabilitation options
- More detailed studies in the late 1980's showed extensive contamination by plutonium over well-defined plumes corresponding to the wind direction at the time of each minor trial

Site characterisation

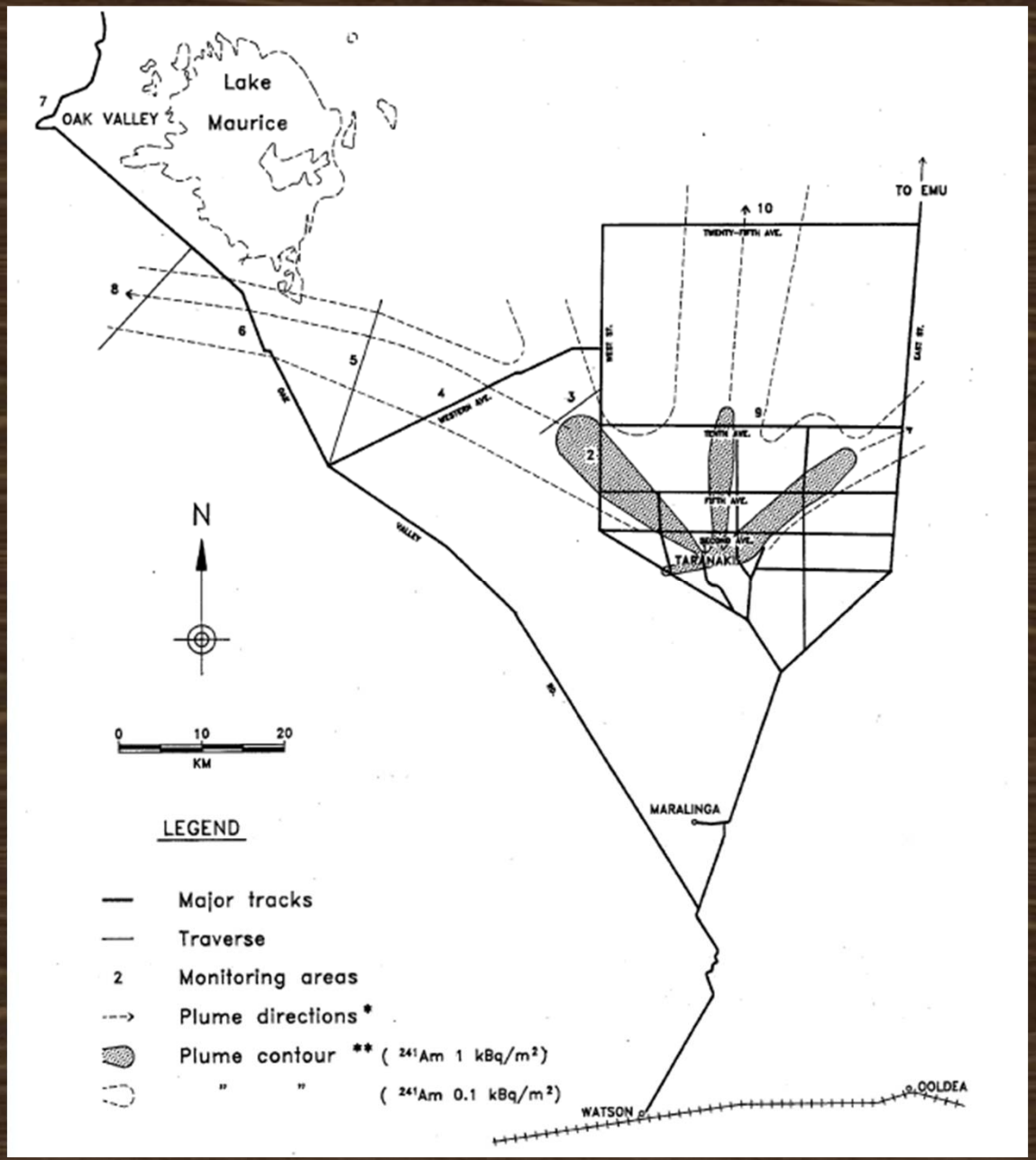
- Most of the contamination was still within 10-20 cm of the surface (low rainfall) and consisted of three components
  - Fragments of plutonium-contaminated debris (visibly identifiable)
  - Finely divided material (potentially inhalable), consisting of grains of plutonium oxide or contaminated soil - more or less uniformly distributed
  - Sub-millimetre “hot” particles of soil or other material, randomly distributed
- Many of the fragments had already been placed in 22 burial pits which were capped with concrete

Stakeholders

- Australian Government
- South Australian Government
- Maralinga Tjarutja people
- Pastoralists
- Tourists
- Radiation Protection Community

General Approach

- In 1993 the Maralinga Technical Assessment Committee (MARTAC) was established to evaluate the risks and determine acceptable cleanup criteria – this committee included experts from Australia, the USA and Great Britain
- The initial MARTAC assessment established that the group most at risk would be indigenous people passing through and camping (and possibly hunting) on the site
- The risk assessment was based on a study of the diet, habits, etc., of these people
- The exposure pathway of greatest concern was found to be inhalation of dust by children playing around camp sites


Lake
Maurice
OAK VALLEY
7
8
6
5
4
3
2
9
10
TO EMU
TWENTY-FIFTH AVE.
TENTH AVE.
FIFTH AVE.
WEST ST.
EAST ST.
WESTERN AVE.
TARANAKI
N
0
10
20
KM
LEGEND
Major tracks
Traverse
2 Monitoring areas
Plume directions *
Plume contour ** (241Am 1 kBq/m2)
" " (241Am 0.1 kBq/m2)
MARALINGA
WATSON
COOLDEA

Cleanup criteria

- Maximum dose of 5 mSv per year to any individual, for full-time occupancy by indigenous people living an outstation lifestyle
  - this corresponds to a risk of fatal cancer of 1 in 10,000 by the 50th year of life
- The final cleanup criteria were chosen to enable this dose constraint to be met:
  1. A maximum concentration of plutonium per square metre in finely divided material
  2. A maximum number of particles per square metre
  3. Visible fragments to be collected

Cleanup procedure

- The top 10-20 cm of soil was removed by scraping
- This material was placed in burial pits and covered with 5 m of clean soil
- 11 of the burial pits were treated by in-situ vitrification (ISV) – material from the remainder was exhumed and placed in another large burial pit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Radiation protection issues during the cleanup

- The main health physics problem was inhalation of plutonium attached to airborne dust particles – dust suppression was achieved by spraying water on the haulage routes
- A strict health physics regime was applied to all personnel working in the contaminated areas to minimise the probability of inhalation or ingestion of contaminated material
  - Strict hygiene rules
  - Measurements of contamination on hands, clothing, etc
  - Personal decontamination where necessary
- Vehicles were checked before being allowed to leave contaminated areas to minimise transfer of contamination

Verification

- Purpose of the verification measurements – to show that the cleanup criteria had been met
- Two measurement systems were built by ARL in the early 90's, corresponding to the need to verify the two main cleanup criteria
  - Average plutonium concentration per square metre
  - Number of particles per square metre
- In addition, measurements of plutonium in suspended dust were made to check that the airborne concentrations of plutonium were at acceptable levels (Lawrence Livermore National Laboratory and ARL)
- The verification process was carried out while the site was being cleaned up

Was the cleanup successful?

- A post-cleanup assessment suggested that the estimated doses after remediation were a factor of approximately 5 lower than the doses on which the cleanup criteria were based

- The procedures developed and used at Maralinga have been used and/or adapted for similar situations in other countries