# Applying the SAFEGROUNDS Key Principles in the real world:

# A case study at Hunterston A - the VLLW Disposal Area

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**Amended version to support Version 2 of SAFEGROUNDS Case Study, November 2011 (*denotes updated/new slides)**

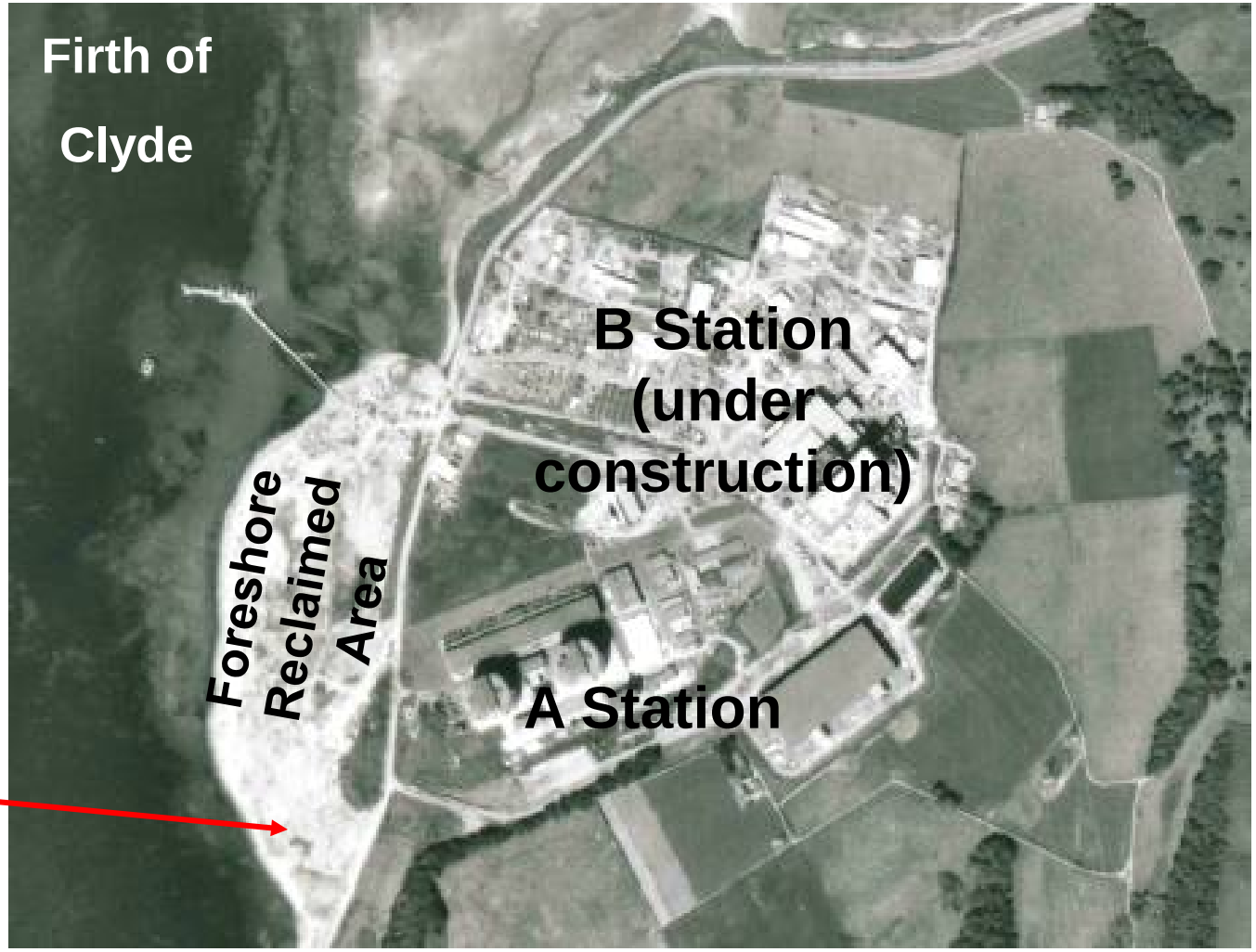
Magnox

# Hunterston A Site, North Ayrshire

- Construction started 1957
- Two Magnox-type reactors generated electricity 1964-1990
- Now undergoing decommissioning
- Licensed to Magnox Ltd (originally to SSEB)
- Owned by NDA since 2005

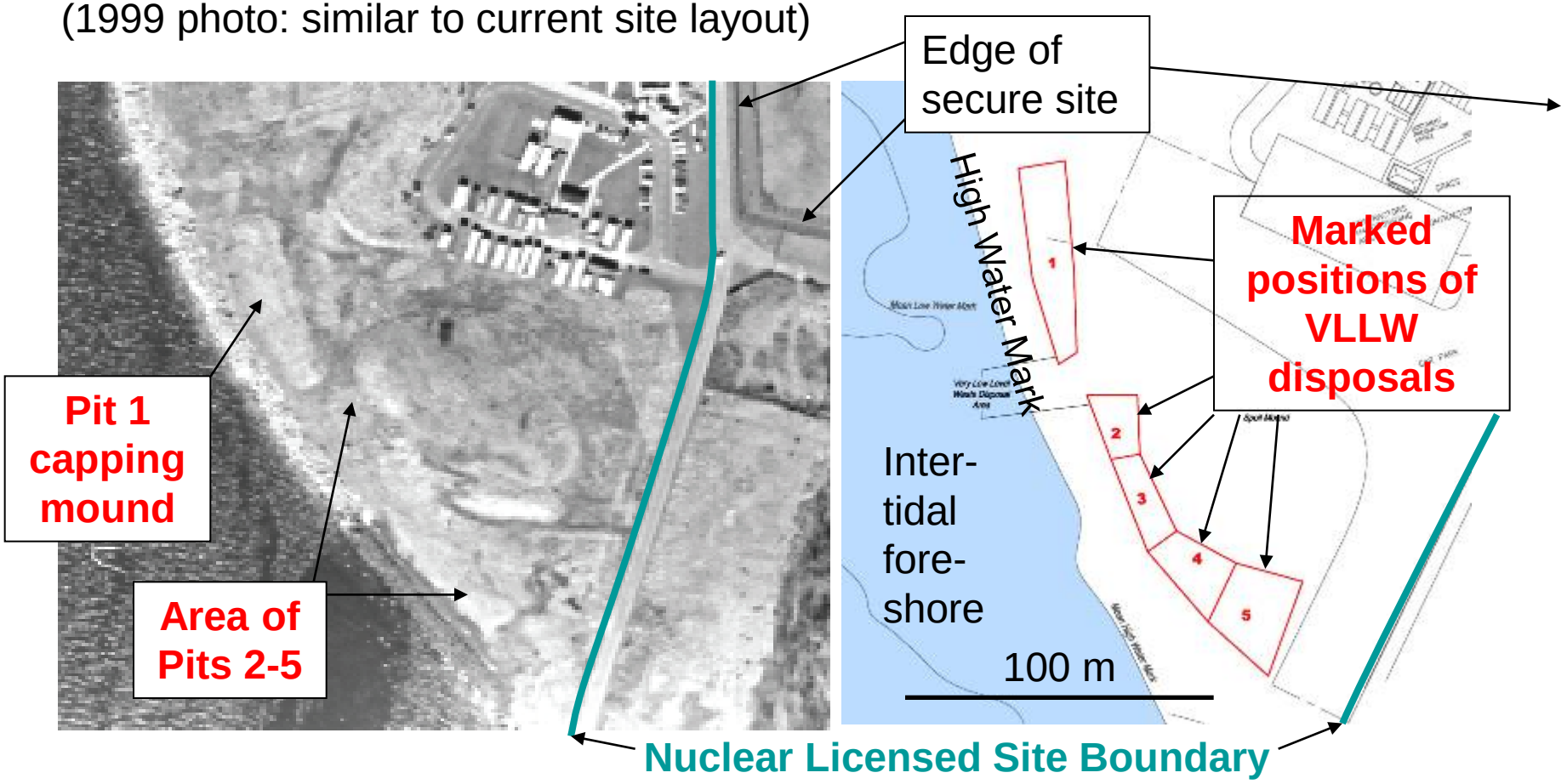
# Setting of VLLW Disposal Area

(1971)

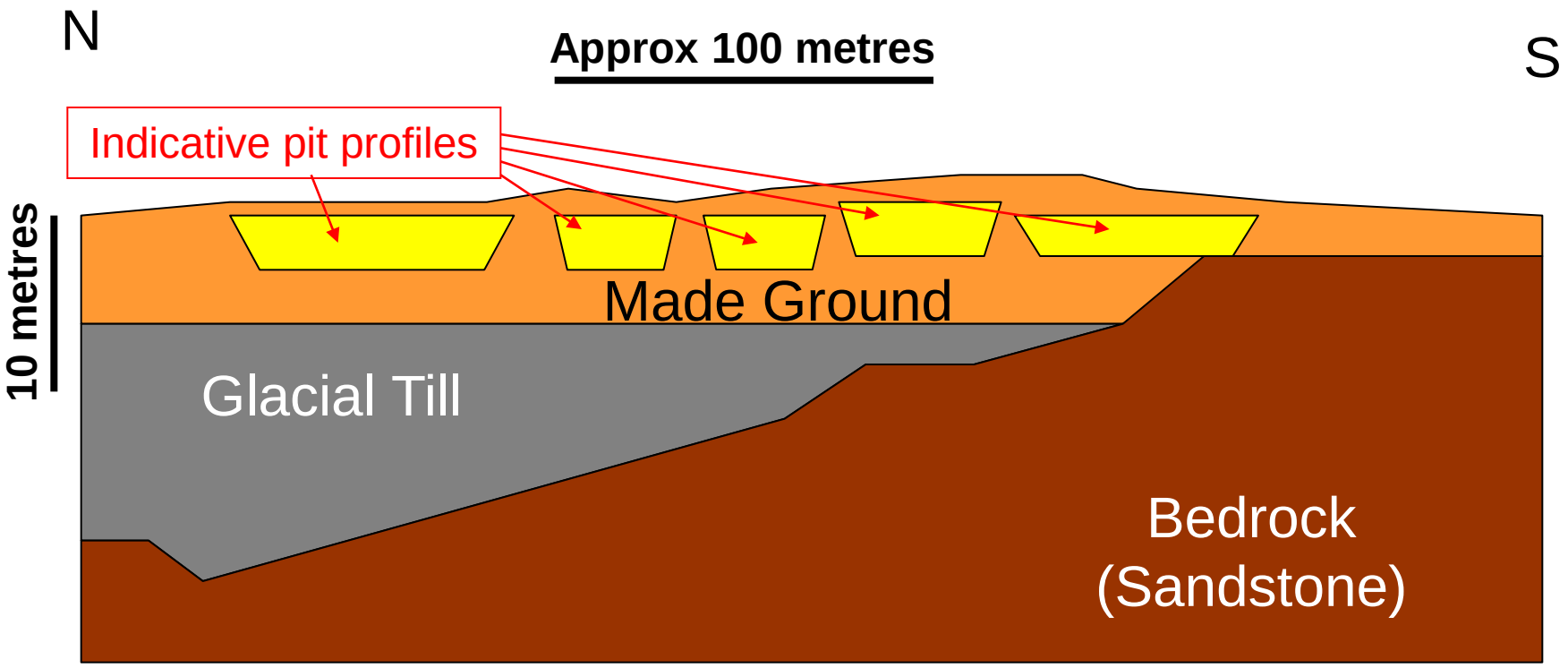


# VLLW Disposal Area Location

(1999 photo: similar to current site layout)



# Geological setting of VLLW disposals



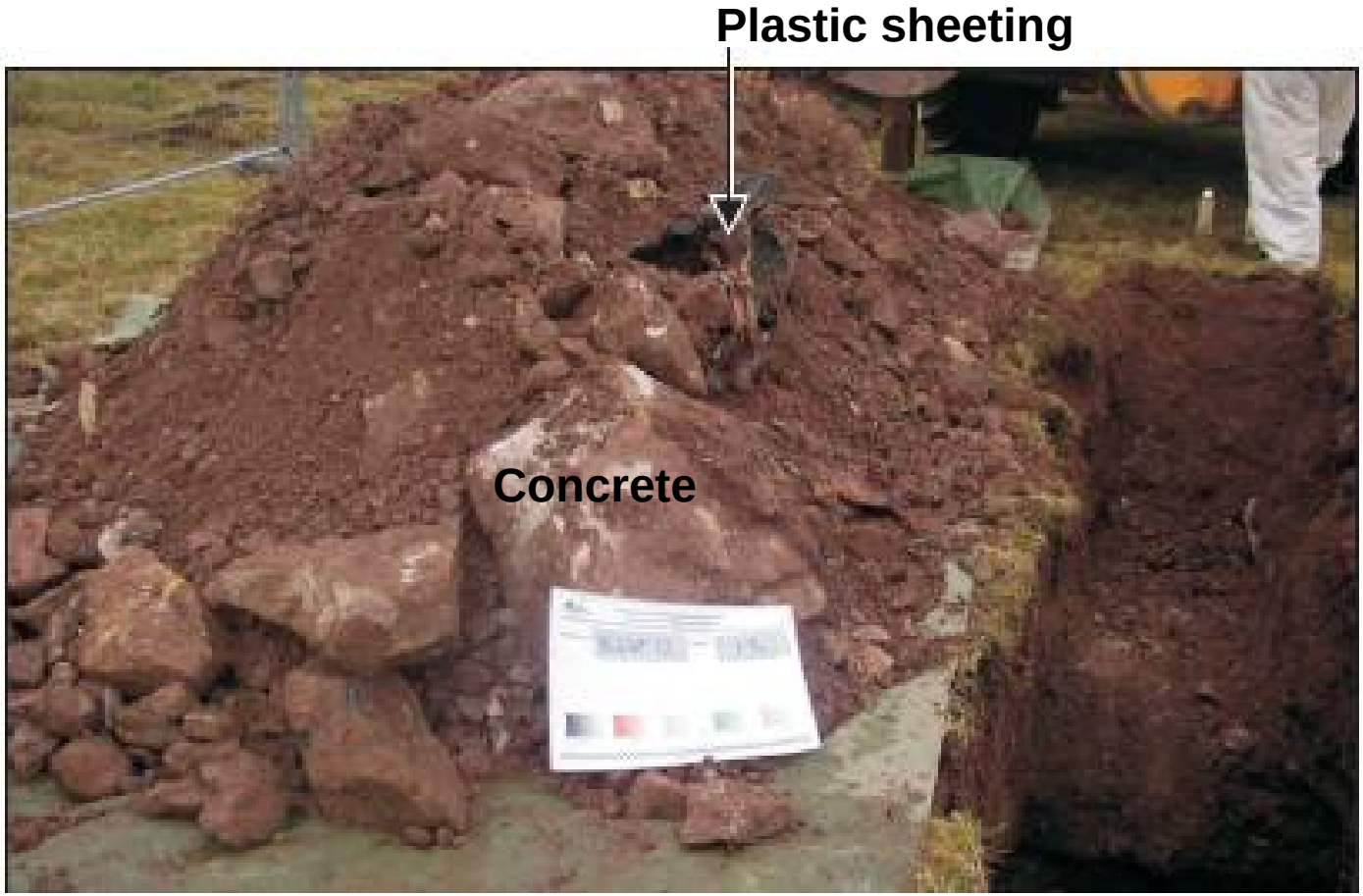
# The VLLW Disposal Area - brief history

- Operator (SSEB) obtained RSA60 authorisations from Scottish Development Department for “disposal of radioactively contaminated waste by burial in pits”
- Disposals took place 1978 to 1982
- Authorisations ‘revoked’ (closed out) by regulator in 1983
- Area subject to ongoing routine reassurance monitoring using ‘health physics’ equipment
- Coastal protection works reinforced at various times
- No stakeholder concerns until 2005/06

# Conditions of VLLW disposal authorisations

- Specified coordinates for locations of burial pits
- Solid waste of specified types (soil, vegetation, concrete, rubble) – not containerised
- Limits on radioactivity levels
  - 3.7 Bq/g for ~90% by volume (equivalent to modern category of ‘High Volume Very Low Level Waste’)
  - <19 Bq/g for ~10% by volume
- Limits on volumes per pit (total 6400 $m^3$)
- Implied limit on total radioactivity (56 GBq)
- Burial below 1.5 m of uncontaminated soils

# Typical waste (2005 trial pit investigation)



# How the VLLW Disposal Area looks now

# Some challenges …

- VLLW Disposal Area outside Nuclear Licensed Site, with no restrictions on access
- Area inherently prone to coastal erosion
- Operator's consignment records badly damaged by water leak into archive store building and discarded
  - (but records of correspondence with regulator retained)
- Regulator's copy of records not transferred to successor (SEPA)
- Marker posts do not correspond to coordinates of burial pits specified in authorisations
- High resolution gamma survey of area (2005) revealed surface contamination (caesium-137) that should not have been there

# The SAFEGROUNDS Key Principles

1. "a high level of **Protection of People and the Environment**"
2. "**Stakeholder Involvement** … particularly to inform decision-making"
3. "a comprehensive, systematic and consultative assessment of all possible options" when "**Identifying the Preferred Land Management Option**"
4. "**Immediate Action**", "on confirmation of … land contamination being present"
5. "**Record-Keeping**" – "make comprehensive records … kept and updated as necessary"

# The “Real World”?

***(Sunday Herald, 15 January 2006)***

NEWS

‘Fiasco’ of secret nuclear waste tips

HUNTERSTON: POLLUTION FEARS

- Probe into Ayrshire dumps
- Questions over lost records
- Concerns of erosion due to global warming and rising seas

Contaminated waste was dumped on public land for years

# Initial perceptions of performance against the Key Principles? (Quotes from Sunday Herald article)

1. **Protection of people & the environment**

   "… we have no idea of the threat that the pits pose to public health…" (Site Stakeholder Group member)

2. **Stakeholder involvement**

   "… contaminated waste was secretly dumped …" (journalist)

3. **Systematically identifying the preferred land management option**

   "… if there is a real risk of erosion, flooding or leakage, waste will need to be dug out and taken elsewhere…" (Site Stakeholder Group member)

4. **Immediate action**

   "… critics are calling for urgent action to clean up the mess" (journalist)

5. **Record-keeping**

   "… official records of what the pits contain have been destroyed" (journalist)

# How did the operator actually manage the situation?

- Timely (‘immediate’) action – KP4
- Rigorous characterisation and risk assessment – KP1
- Improved stakeholder involvement – KP2
- Appropriate options appraisal – KP3
- Improved record-keeping – KP5

# ‘Immediate Action’ (KP4)

- Interim remediation of patch of surface contamination found by 2005 survey (Jan 2006)

Clean soil placed over ‘marker’ layer of geofabric

Borehole headworks (not related to remediation)

# ‘Immediate Action’ (KP4)

- Coastal defences damaged by severe storm, night of Hogmanay 2006
- Reinforcement work implemented 2007-08

# ‘Protection of people & environment’ (KP1)

- Short-term risks addressed by ‘immediate action’
- Longer term risks needed quantifying to ensure proportionate response
- Operator confident of low hazard and risk
- BUT… loss of detailed consignment records led to stakeholder concerns that “anything could be in there …”
- Key uncertainties that needed to be addressed by characterisation:
  - Location of disposed wastes
  - Residual contamination levels in disposed wastes

# Confirming the location of the wastes

- Aerial photo-interpretation – Pit 1 capping mound within marker posts (but no features seen for other pits)
- Geophysics – inconclusive
- Trial pitting across inferred edges of pits – inconclusive
- Overall conclusion: radioactive contamination (caesium-137) probably the best guide to the location of the wastes
- Need for a large number of sub-surface contamination data points, but not ‘at any cost’
- Opportunity for innovative intrusive method, developed jointly with VT Nuclear Services and Golder Associates

# Direct push installation of temporary boreholes for down-hole gamma spectrometry (1)

Track-mounted cone penetrometer testing rig

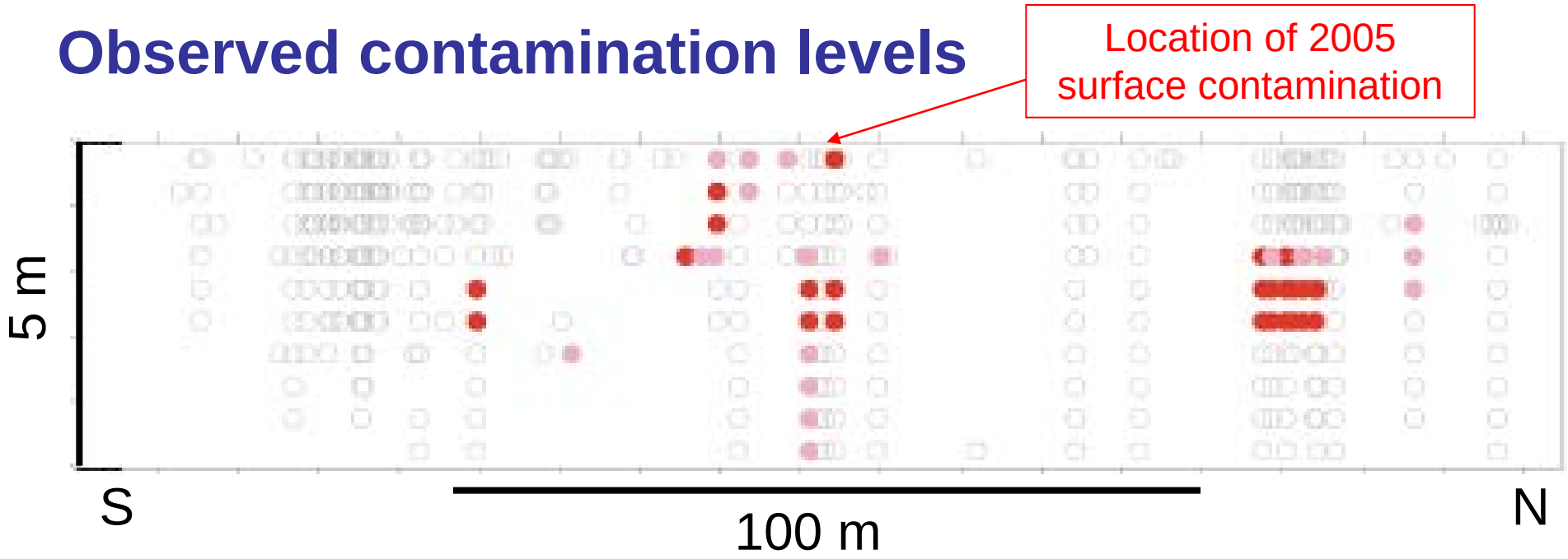
Metal rods and sacrificial tip used to drag plastic pipe into the ground

# Direct push installation of temporary boreholes for down-hole gamma spectrometry (2)

Down-hole high-resolution gamma probe ready for deployment

Probe deployed in temporary borehole

# Observed contamination levels




Results projected on to S-N section through VLLW Disposal Area

- Total **844** sub-surface measurements (down-hole gamma + some cores)
- **Red dots** > SoLA exempt level, **Pink dots** > 0.1 Bq/g Cs-137, others < 0.1 Bq/g
- Maximum 1.1 Bq/g caesium-137
- **Mean 0.062 Bq/g caesium-137** (95% UCL, including LOD values)
- Other nuclides – tritium 0.048 Bq/g, Sr-90 0.011 Bq/g, Eu-152 0.013 Bq/g (mean)

# What is a ‘high level of protection’? (KP1)

- Relevant regulatory regime is “Part 2A” Radioactive Contaminated Land (Scotland) Regulations 2007
  - A ‘safety net’ regime designed to avoid ‘unacceptable’ risks to human health (**>3 mSv/year**) (and the water environment in Scotland).
- The area is adjacent to a Nuclear Licensed Site, for which eventual de-licensing requires a fatality risk below 1 in a million per year (HSE criterion).
- Risk of 1 in a million per year = dose criterion ‘of order’ **10 µSv/year** (HSE, based on ICRP etc)
  - More than 2 orders lower than “Part 2A” criterion
- Magnox North sought parity of risk criteria on & off the Licensed Site.

# Tiered risk assessment (CLR11 & new SAFEGROUNDS terminology)

1. Preliminary qualitative risk assessment
2. Generic quantitative risk assessment
3. Detailed (site-specific) quantitative risk assessment

- *Terminology may be applied somewhat differently to radioactive contamination compared to non-radioactive – there is no equivalent to radiation 'dose' for non-radioactive contamination.*

# Preliminary qualitative risk assessment

- Is there a **source**?
  - **Yes** – radioactive contamination in the VLLW Pits
- Is/are there **receptor**(s)?
  - **Yes** – area open to public access
- Are there actual or potential **pathways**?
  - **Yes** – radioactive contamination has been exposed at surface and might recur in future
- Potentially significant **pollutant linkage(s)** exist, so **generic quantitative risk assessment needed**

# Generic quantitative risk assessment

- Dose criterion ‘of order’ 10 µSv/year
- Generic scenario of ‘Recreational’ land use in NRPB (HPA) assessment methodology (NRPB-W36)
- Pessimistic assumption in ‘Exposed Patchy Contamination’ scenario that 10% of land area has exposed contamination
- We assumed exposed contamination is at average level found in sub-surface measurements
- Calculated dose rate to ‘general park user’ 1.6 µSv/year (almost all from direct gamma radiation from caesium-137)
- **Dose well below target, so detailed quantitative risk assessment not required**

# Stakeholder views

- Calculated dose rates do not warrant remediation, but do stakeholders share that view?
- SEPA consulted, but no statutory role identified
  - Closed authorised waste disposal
  - Dose far below levels for regulation as “Radioactively Contaminated Land”
- Planning Authority consulted, but no statutory role identified
- Scottish Natural Heritage consulted, because area technically within SSSI, but SNH minded to exclude whole foreshore reclaimed area from redefined SSSI
- **Main concerns from members of Site Stakeholder Group (SSG) other than regulators**

# ‘Stakeholder involvement’ (KP2)

- SSG Land Quality Subgroup set up, chaired by local Community Council representative from main SSG
- Other Subgroup members include Chair of main SSG and representatives of Community Councils, National Farmers’ Union & neighbouring land-owner
- First meeting (July 2008) was for exchange of information and views, including visit to VLLW Disposal Area
  - Dispelled some expectations of “large open pit-like structure”
- Subgroup members made aware of extensive characterisation and risk assessment undertaken since the Sunday Herald article
- Plans for strategic options appraisal explained

# Approach to options appraisal (KP3)

- Factors considered:
  - Need to consider options at strategic level
  - Limited range of strategic options available
  - Limited scale and complexity of problem
  - No regulator concerns (authorised disposal)
  - Stakeholder interest limited to locality (Scottish national press coverage did not prompt sustained wider interest)
- **Used (draft) SAFEGROUNDS options comparison guidance** to assist in selection of appropriate methodology:
  - version of "**direct evaluation**" method
- **Independent peer review** supportive of approach

# Short-listing of options

- Short list of options achieved by screening out unacceptable options (e.g. contrary to Govt. policy) and by consolidating some similar long-listed options
- Short list
  - ‘Stop monitoring’
  - Continue to ‘monitor and maintain’
  - ‘Improve containment’
  - ‘Remove hazard’ (involving full or selective excavation of waste)

# Order of preference assessment

Preferred option

| Attributes ↓ / Options → | Stop monitoring | Monitor & maintain | Improve contain-ment | Remove hazard |
|---|---|---|---|---|
| Public Safety (during works, including transport risks) | Best | Best | Best | Worst |
| Worker Safety | Best | Best | Mid | Worst |
| Additional Waste Volume | Best | Mid | Best | Worst |
| Transport (excluding safety) | Best | Best | Best | Worst |
| Other Environmental Impacts | Worst | Worst | Best | Mid |
| Technical Performance | Worst | Mid | Best | Best |
| Cost | Best | Mid | Mid | Worst |

# *Continuing stakeholder involvement (KP2)

- Outcome of Magnox North strategic options appraisal (KP3) presented to 2nd Land Quality Subgroup meeting in Sept 2008
- **Non-technical summary** of options appraisal provided to Subgroup and main SSG
- Outcome of options study in line with Subgroup expectations
- **Subgroup accepted that they and other stakeholders did not need to be "involved" in decision-making in this case**
- Subgroup Chair stated expectation to be informed in the event of further "pertinent decisions" or "non-completion of works"
- SSG consulted on whether to replace marker posts after completion of restoration works (marker posts replaced)
- SSG informed of implementation of restoration works, early 2011

# *Spoil mound to be used for restoration soils

# *Inputs to Implementation

- Further characterisation work to confirm suitability of existing soil mound for use as part of restoration cap
- Ecological survey:
  - To identify any protected or locally rare species or important habitats that might be affected by restoration works (locally rare parsley water dropwort found);
  - To determine whether the restoration cap should include measures to minimise potential for burrowing into the waste (not required)

# *Design of restoration cap

- Technical options considered:
  1. No engineered barrier under restoration soils (just a separator geotextile marker layer)
  2. High-density polyethylene (HDPE) geomembrane ‘liner’ (+ protective geotextile
  3. As Option 1, with addition of ‘rabbit mesh’ ~0.2 m below ground level

- Option 2 adopted as ‘standard practice’ for a landfill cap
- No need for ‘rabbit mesh’

# *Works in progress – Levelling with sand

# *Works in progress – HDPE membrane

# *Works in progress – protective geotextile

# *Translocation of Parsley Water Dropwort

# *Completed cap - 1

# *Completed cap – 2

# *Cap vegetation recovering (Autumn 2011)

# *‘Record-keeping’ (KP5)

- Failures of record-keeping by operator and regulator contributed significantly to perceived risks and actual costs of this issue
- Magnox Ltd now have a Land Quality File for Hunterston A along lines recommended in SAFEGROUNDS guidance
- Key records retained in Land Quality File include:
  - factual characterisation reports,
  - options appraisal document,
  - record of decision on the chosen option,
  - detailed design for the chosen option,
  - records of the implementation of the chosen option,
  - records of post-implementation verification and/or monitoring (where applicable - not in this case)

# Learning Points – 'Could have done better'

- Loss of records has caused much cost, time, trouble for site and stakeholders
  - but robust Land Quality File approach should avoid similar recurrence (KP5 – Record Keeping)
- The magnitude of the problem perceived by some stakeholders reflected lack of information
  - but subsequently rectified by setting up Land Quality Sub-Group (KP2 – Stakeholder Involvement)

# *Learning points – ‘Went well’

- Interim actions (KP4 – Immediate Action) have paid dividends in stakeholder perceptions
- Risk assessment used more onerous criteria than required by the relevant legal framework (KP1 – High Level of Protection)
- Land Quality Sub-Group facilitated consensus on facts and a proposed way forward (KP2 – Stakeholder Involvement)
- Peer review was useful to confirm an appropriate approach to options appraisal (KP3 – Identifying the preferred option)
- In this instance, stakeholders did not wish to be ‘involved’ or ‘consulted’ in the decision-making process (KP2 + KP3)
- Stakeholder involvement was ‘proportionate’
- Restoration works implemented safely and without significant off-site environmental impact

# *Learning points – ‘Other’

- Even though there was no regulatory requirement or expectation to undertake restoration works, stakeholder concerns were taken seriously.
- The decision to implement restoration works was driven at least partly by non-technical factors.
- This exemplifies a common situation in land quality management (not just in the nuclear industry), where remedial action may be undertaken to demonstrate that risks perceived by stakeholders have been robustly addressed, even where not warranted by the magnitude of the risks assessed on a technical or legal basis.

# Actual benefits of SAFEGROUNDS guidance?

- **Site Characterisation guidance** (2000) – pitfalls of downhole rad. measurements avoided
- Original **Land Management Guidance** doc (2002) not used
- **Risk Assessment** doc (2005) not used
- **Records** guidance (2007) helps specification of Land Quality File
- **Options Comparison** guidance (draft 2008) very useful to help justify a simple approach to options appraisal
- **Community Stakeholder Involvement** doc (2005) – not used directly
- Revised draft main **Land Management Guidance** (2008/09) – incorporation of CLR11 tiered risk assessment approach into LMGv2 helps justify its application to rad. contamination

# *Acknowledgements


- Magnox North Ltd / Magnox Ltd Hunterston A:
  - Successive project managers: Martin McGarvey, John Hulme, Alastair Todd, Lorna Lavelle, Jon Dolphin, Donald Ashburn
  - Technical staff: Stephen Saunders, Donald Ashburn, Ian Willis, Reuben Phillips, Bill Stirton
- Golder Associates: main site characterisation contractor & designer/supervisor for restoration works
- VT Nuclear Services (and predecessors): specialist radiological characterisation contractor
- ERM + Royal Haskoning: Coastal erosion assessment
- BAM Nuttall: Coastal defences improvement works
- Land Engineering Ltd: Implementation of restoration works
- Enviros Consulting: independent peer review for land quality work

*(Some companies have changed name/ownership since their input to the work)*