# SAFEGROUNDS:
# Case study on application of the SAFEGROUNDS key principles and guidance:
# management of the very low level waste disposal area at Hunterston A site, 2005-2011

*Version 2.0 (2011 Update)*

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# Introduction and summary

## Background

The five SAFEGROUNDS Key Principles were developed nearly a decade ago and first published in 2002. They represent a widely shared set of expectations for the management of land contamination on nuclear and defence sites. This case study sets out how those expectations have been addressed during the management of a closed authorised Very Low Level (radioactive) Waste (VLLW) Disposal Area adjoining the Nuclear Decommissioning Authority's Hunterston A Site in North Ayrshire, focusing on the period 2005-2011. That period overlaps with the production of the revised main SAFEGROUNDS guidance document and the associated flow diagram.

The first version of this case study was published in April 2010, when it was the first published example of application of the revised guidance published in 2009. This second version includes the implementation of restoration works in early 2011, thus making this a complete case study from problem definition through to implementation of a preferred remedial option.

## Intended Audience

The case study is primarily aimed at technical practitioners using the SAFEGROUNDS guidance, but it is hoped that this summary and some of the commentary addressing 'stakeholder engagement perspectives' may be informative to a wider audience.

## Aims

The case study aims to show that, even with the revised SAFEGROUNDS guidance and flow diagram, the process of managing even a relatively small area of land can be a protracted and complex process, with many iterations and re-visiting of objectives as emerging issues change the context. The flow diagram can only be a rough guide, and it should not be expected that it will be easy to identify an orderly sequence of activities and outputs following the logic of the flow diagram (not least because, as the diagram itself states, it may be applied to one or more different contamination issues relevant to a given area, such that management of different contamination issues may follow different routes). To some extent, this case study is simplified so that the main relevant points in the flow diagram are highlighted, while other points in the flow diagram that were in fact undertaken are 'hidden' within summaries of activities that covered a number of points in the flow diagram.

## How to Navigate this Case Study

The case study should be read in conjunction with the accompanying slides originally compiled for the presentation given by the author to the CIRIA Nuclear Networks conference "Radioactive and chemical contamination on nuclear and defence sites – best practices in land and waste management" held in Manchester, 3-4 June 2009. The presentation has been updated to 2011 and illustrates many of the activities described in the case study. Specific references to the presentation are indicated by [Slide #N], where N is the slide number in the presentation.

The case study is presented in the following sections:

- A 'scene-setting' section (1), which sets out the context as it existed before 2005.
- Two sections (2 and 3) on the risk assessment and characterisation stage of management of the area in two sections:
    - one section before the revised main SAFEGROUNDS guidance was available in any form;
    - a second section covering activities during the period when the revised SAFEGROUNDS guidance started to take shape during 2007/08.
- A section (4) on the options appraisal stage, which was substantially influenced by the emerging SAFEGROUNDS guidance on comparison of options. This section is supported by an accompanying copy of the published Non-Technical Summary of the options appraisal.
- A section (5, new to this version of the case study) on the implementation stage.

All the sections indicate:

- how the various activities relate to the SAFEGROUNDS flow diagram;
- points at which the existing or emerging SAFEGROUNDS guidance documents were influential;
- which Key Principles were particularly relevant; and
- comments on specific points of interest and learning points from both technical and stakeholder engagement perspectives.

## Summary of Main Messages and Learning Points

The main messages from the case study can be summarised as follows:

- In relation to **Key Principle 1** (expectation of "a high level of protection to people and environment") both technical quantitative risk assessment and lay qualitative perceptions of risk had to be addressed. Uncertainties in both quantitative risk and perceived risk were successfully reduced using a phased approach to characterisation reflecting the conceptual model of contaminant distribution.
- In relation to **Key Principle 2** (expectation of proportionate stakeholder involvement) there was a move from reactive engagement prompted in part by stakeholder and political concerns (reflected in press reporting), to a proactive engagement with local stakeholders, facilitated by setting up a land quality sub-group of the Site Stakeholder Group. Having reached a broadly shared view on the very low hazard and risks present, the level of stakeholder concern was reduced and stakeholder 'involvement' in subsequent decision-making was not expected.
- In relation to **Key Principle 3** (expectation of a systematic approach to identification of the preferred land management option) the (then draft) SAFEGROUNDS guidance was used to inform the choice of options comparison methodology. A strategic options appraisal using a 'direct evaluation' methodology was used to identify a preferred option, which was understood to be acceptable to all identified stakeholders. The range of technical options for implementing the preferred strategic option was quite limited and did not warrant a detailed technical options appraisal.
- In relation to **Key Principle 4** (expectation of "immediate action"), small-scale remediation (to achieve the intent of the original authorisations) was undertaken following discovery of minor surface radioactive contamination. In addition, sea defences were reinforced, eliminating the short-term risk of coastal erosion impinging upon the VLLW disposal area.
- In relation to **Key Principle 5** (expectation of good record-keeping), it is acknowledged that a lot of the stakeholder concern arose due to the loss of original detailed disposal records. The site has since developed a Land Quality File as part of the site's records system which provides the functionality recommended by the relevant SAFEGROUNDS guidance.

Main learning points identified from this case study are as follows:

*'Could have done better':*

- Loss of records has caused much cost, time and trouble for site and stakeholders – but a 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 this was subsequently rectified by setting up the Land Quality Sub-Group of the Site Stakeholder Group (KP2 – Stakeholder Involvement).

*'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).
- The 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 in managing the issue was 'proportionate'.
- The restoration works were implemented safely and without significant off-site environmental impact.

*'Other':*

- Even though there was no regulatory requirement or expectation to undertake the restoration of the VLLW Disposal Area, stakeholder concerns were taken seriously.
- The decision to implement restoration works was driven at least partly by non-technical factors.
- This case study 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.

## Acknowledgements:

- Magnox North Ltd (now incorporated in Magnox Ltd):
    - Successive project managers: John Hulme, Alastair Todd, Lorna Lavelle, Jon Dolphin, Donald Ashburn
    - Technical staff: Stephen Saunders, Donald Ashburn, Ian Willis, Reuben Phillips, Bill Stirton
    - Land quality specialist and author of this case study: Hugh Richards
- Golder Associates: main site characterisation contractor, risk assessment consultant and designer/supervisor of capping restoration works
- VT Nuclear Services (and predecessors; now Babcock International Group plc ): specialist radiological characterisation contractor
- ERM + Royal Haskoning: Coastal erosion assessment
- (BAM) Nuttall: Coastal defences improvement works
- Land Engineering Ltd: Capping restoration works
- Enviros Consulting (now SKM Enviros): independent peer review for land quality work

# 1 Scene-setting

| Position on SAFEGROUNDS flow diagram | Approximately sequential narrative | Relationship to SAFEGROUNDS key principles and other guidance | Comments and specific learning points |
|---|---|---|---|
| 1: Define the context etc. | During 2004, the Hunterston A site was required to present a new 'Near Term Work Plan' for decommissioning work at the site, including plans for management of contaminated land. In describing the potential scale of contamination at the site, the Near Term Work Plan mentioned that (on one particular basis of calculation), a volume of up to around 81,000 cubic metres ($m^3$) of ground could potentially be contaminated by radioactivity (mainly caesium-137). | | |
| 1: Define the context etc. | This figure of 81,000 $m^3$ was picked up in a draft 'business plan' document published for public consultation by the shadow Nuclear Decommissioning Authority (NDA) and was highlighted in discussions at the shadow NDA's Scottish Stakeholder forum meeting in October 2004. | KP2 (Stakeholder Involvement): The advent of the NDA was bringing in a new level of open sharing of information with stakeholders at national and local level. | <u>Stakeholder engagement perspective:</u><br>Had the provenance of this figure been checked more thoroughly, it might have been presented differently (or not at all), with less likelihood of alarm being caused. |
| 1: Define the context etc. | The published estimate of low level radioactive waste predicted to arise from remediation of radioactive land contamination at Hunterston A was 5,200 $m^3$. The apparent discrepancy between the two published figures led to a feature *"Exposed: scandal of nuclear leaks at Scots plant"* in the 'Sunday Herald' (31 October 2004), concerns being expressed that the extent of land contamination was "far more than has been admitted at other nuclear sites in Scotland". This was followed by a Westminster Parliamentary Question about apparent gaps in waste volume estimates, put by Llew Smith MP (November 2004). | KP5 (Record-keeping): The operators of the site had been maintaining records of the estimated volume of radioactive land contamination since the late 1990s. | |
| 1: Define the context etc. | In response, the site pointed out that the 81,000 $m^3$ figure was an indication of the volume that could <u>potentially</u> be contaminated, not an estimate of the actually contaminated volume. | | |
| 1: Define the context etc. | In discussions with the regulator (SEPA), the site also pointed out that the 81,000 $m^3$ figure included an estimated volume of 6,500 $m^3$ of 'Very Low Level Waste' (VLLW) which had been disposed of under authorisation from SEPA's predecessor regulator in the late 1970s and early 1980s, by burial in excavated pits on an area of land reclaimed from the foreshore [Slides #3-#9]. This volume was not included in the published estimate of low level radioactive waste predicted to arise from remediation of radioactive land contamination at Hunterston A, because the waste had been legally disposed of and was not expected to need further remediation. | | |

# 2 Risk assessment stage prior to revised SAFEGROUNDS guidance being available

| Position on SAFEGROUNDS flow diagram | Approximately sequential narrative | Relationship to SAFEGROUNDS key principles and other guidance | Comments and specific learning points |
|---|---|---|---|
| 1: Define the context etc. | The operator recognised that, in view of public concerns and the relative lack of hard information on the VLLW Disposal Area, the context for management of this area had changed, and objectives were set as follows:<br>• to provide enough information to make a robust assessment of the potential risks associated with the area;<br>• to determine whether remedial action would be warranted, based on current land use.<br>No over-arching objectives were identified, such as redevelopment or divestment of the area, change of land use, etc. | | |
| 2-3: Preliminary safety and environmental risk assessment / Are there potential risks? | A review of available desk study information qualitatively confirmed the potential for risks in terms of source-pathway-receptor linkages, but there was insufficient information to confirm or dismiss such linkages. In view of the location outside the site security fence, the first step was to survey the ground surface for potential radioactive contamination, while the risk to groundwater was seen as another risk to be assessed in the longer term. | KP1 Protection of people and the environment | |
| 4: Collect more site data | The operator commissioned a thorough radiological survey of the VLLW Disposal Area using mobile high resolution gamma spectrometry. This revealed a very small patch (less than 2 m square) of surface soils contaminated by caesium-137 at levels just below the threshold for exemption from regulation. Follow-up sampling by the operator delineated the contamination more precisely.<br>Results of the survey were lodged in the site records system and reported to the regulators, and a decision made to include a report to the next meeting of the Site Stakeholder Group, due in 3 months' time. | KP2 Stakeholder involvement<br>KP5 Record-keeping | <u>Stakeholder engagement perspective:</u><br>Illustrates a more proactive approach to providing information to stakeholders. |
| 4: Collect more site data (planning) | In March 2005, the operator submitted a new 'Life Time Plan' to the newly-constituted NDA, which now included plans to extend the scope of land contamination investigations (ongoing in stages since 2001) to include the VLLW Disposal Area. | | |
| 4: Collect more site data | The initial exploratory investigations of the VLLW Disposal Area sought to find whether the boundaries of the original disposal pits could be identified using geophysics and/or trial pit excavations, and also included a small number of boreholes that could check for any leaching of radioactivity into groundwater. | | |

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|---|---|---|---|
| 1: Define the context etc.<br>(context changed) | On 31 December 2005, particularly severe winter storms resulted in visible erosion of the shore-line near to the VLLW Disposal Area, highlighting the potential for the contents of the disposal pits to start to be eroded within a decade if no further action were taken. | | <u>Stakeholder engagement perspective:</u><br>This unforeseen event re-defined the context for management of the area. |
| 3: Are there potential risks? | The operator commissioned consultants to further quantify the risks from further erosion of the shoreline. This concluded that more information on erosion rates was needed. | | |
| 1: Define the context etc.<br>(context changed) | In January 2006, the finding of surface contamination on the VLLW Disposal Area was shared with regulators and the Hunterston Site Stakeholder Group. The latter expressed concern that the existence of the VLLW Disposal Area had not hitherto been discussed. | KP2 (Stakeholder Involvement):<br>[The sharing of this information with the Site Stakeholder Group was done proactively, rather than in response to a request for information.] | <u>Stakeholder engagement perspective:</u><br>The site's lack of pro-active communication up to this point about the VLLW Disposal Area and about the loss of records was based in part on an assumption that because the disposals has been authorised according to the standards of the time, there was no continuing requirement to actively manage the area, and no continuing liability, and therefore no need to advertise the existence of the disposals. |
| 1: Define the context etc. | The concerns of some Site Stakeholder Group members increased when the site and regulator stated that both organisations' copies of detailed records of the wastes consigned to the VLLW Disposal Area had been lost. The site records had been disposed of after being damaged by water ingress to the building (not designed for record-keeping) where the records were being stored, while the regulator's copies were effectively lost through not being transferred from the Scottish Development Department to its successor (SEPA). | KP5 (Record-keeping):<br>[The loss of detailed records is an example of the importance of robust, long-term record-keeping.] | <u>Technical perspective:</u><br>Both physical and institutional arrangements for long-term record-keeping need to be robust.<br><u>Stakeholder engagement perspective:</u><br>Had the original record not been lost, much if not all the cost of subsequent investigations and assessment could have been avoided. |
| 1: Define the context etc. | A further article appeared in the 'Sunday Herald' (15 January 2006) under the headline *"'Fiasco' of secret nuclear waste tips"*, [Slides #12-#13] in which a member of the Hunterston Site Stakeholder Group was quoted as saying that the industry had "dumped contaminated waste on public land for years and then managed to lose the records of what it had dumped. As a result, we now have no clear idea of the threat that the pits pose to public health". | | <u>Stakeholder engagement perspective:</u><br>The perceived basis for the 'secret nuclear waste tips' headline arose in part from a lack of pro-active communication about the VLLW Disposal Area. |
| 5-6: Immediate controls<br>[Breaking pathway] | At the end of January 2006, the operator excavated the most contaminated soils exposed at the surface in the VLLW Disposal Area and capped the excavated area with at least 0.3 m of clean soil, leaving no soils exceeding exempt levels present at the ground surface [Slide #15]. A report on this action was prepared and lodged in the site records. | KP4 (Immediate Action):<br>KP5 (Record-keeping) | <u>Technical perspective:</u><br>This remedial action dealt with the immediate issue of radioactive contamination exposed in a publicly accessible area, while leaving the longer-term management of the area to be determined at a later date. |

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|---|---|---|---|
| 16: Detailed quantitative risk/hazard assessment<br>[Done 'out of sequence' with respect to the SAFEGROUNDS flow diagram – see Comments for explanation.] | During 2006, internationally respected consultant Mike Thorne (working for ERM) assessed the potential radiological doses to members of the public from scenarios in which coastal erosion completely disrupted the VLLW Disposal Area. Using results from the 2005 exploratory investigations of the VLLW Disposal Area, the study concluded that such hypothetical doses would be below 10 microsieverts/year – a level generally regarded by regulatory authorities as trivial. | KP1 (Protection of people and the environment) | <u>Technical perspective:</u><br>Despite the low immediate likelihood of such disruption occurring, the assessment was undertaken using the best available information and considering the most stringent statutory radiological protection criteria. Also, a detailed quantitative risk assessment for this scenario was undertaken without going through a generic quantitative risk assessment first.<br>[The concept of generic quantitative risk assessment in a tiered assessment framework (much used in non-radioactive contamination risk assessments) is not yet well established in the context of radioactive contamination assessments.] |
| Continued stakeholder involvement<br>[Applies throughout the SAFEGROUNDS process.] | At Site Stakeholder Group meetings during 2006, some stakeholders continued to express concern about the VLLW Disposal Area and especially the potential for its erosion. | KP2 (Stakeholder Involvement) | <u>Stakeholder engagement perspective:</u><br>The stakeholders' perception was that, in view of the loss of records, wastes with contamination levels well above those encountered by the exploratory investigations might have been (illegally) disposed of. In that case, the assessment based on exploratory data alone was not giving sufficient assurance. |
| 4/14/18: Collect more site data<br>[To inform risk assessments at any tier.] | During 2006, the site commissioned contractors to undertake detailed topographic surveying of the shore-line and initiate monitoring of coastal erosion, with a view to designing repairs/improvements to the coastal defences. | | |
| 4/14/18: Collect more site data<br>[To inform risk assessments at any tier.] | During 2006, the site reviewed the results from the 2005 exploratory intrusive investigations and concluded that the only way to obtain a well-founded understanding of the radioactivity levels in the VLLW Disposal Area was to make several hundred sub-surface measurements. However, there was also a need to avoid generating large amounts of potentially radioactive waste through drilling of many boreholes. Through dialogue with specialist contractors (Golder Associates and British Nuclear Group Project Services – now VT Nuclear Services), an innovative method was developed whereby a powerful ground probing rig was used to advance boreholes using a 'direct push' or 'positive displacement' method, not involving bringing drill cuttings or core to the surface. The resulting plastic-lined | SAFEGROUNDS Site Characterisation guidance contains specialised advice on the use and limitations of down-borehole radiometric measurements. | <u>Technical perspective:</u><br>Advice in the SAFEGROUNDS Site Characterisation guidance was taken into account when specifying the combination of borehole advancement and down-borehole measurement methods.<br>Although the chosen method allowed over 600 sub-surface measurements to be made at a fraction of the cost of conventional drilling and sample analysis, a substantial number of boreholes could not be advanced to their intended full depths, and |

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| | temporary boreholes were then used for measurements using a bespoke down-borehole gamma spectrometry system capable of detecting caesium-137 and other radionuclides at levels well below any regulatory threshold. The fieldwork was completed in March 2007 [Slides #18-#21]. This work won an internal company/NDA award for implementation of a technical innovation. | | some conventionally drilled boreholes were used to fill key gaps in data coverage.<br><br>With hindsight, some sensitivity of the measurements could have been sacrificed to allow use of a smaller down-borehole measurement device, in turn allowing use of narrower diameter direct-push tubes, which might have had more success in reaching the intended depths. |
| 1: Define the context etc.<br><br>[New input from stakeholders.] | During 2006, the NDA engaged in a consultation (sponsored by a sub-group of the Site Stakeholder Group) on the ultimate end-state to be reached for the Nuclear Licensed Site at Hunterston A when NDA has finished its business at the site (i.e. after Final Site Clearance is complete). The VLLW Disposal Area is outside the Nuclear Licensed Site and therefore was not within the formal scope of the consultation. As a precondition for engaging with this consultation, SSG members required the independent consultants' report to record a "premise that all wastes associated with the [VLLW] pits will have been removed and the land remediated prior to the Final Site Clearance Stage of decommissioning". [This is reflected in the NDA document "Output from Stakeholder Consultation for the Site End State: Hunterston 'A'" ref. SMS/TS/A2/1/1/R009, October 2009]. | KP2 (Stakeholder Involvement) | <u>Stakeholder engagement perspective:</u><br><br>This was the first time NDA sought non-statutory stakeholder views on decommissioning strategy (affecting land contamination management) in a structured manner. The documented outcome of the consultation, especially concerning the VLLW Disposal Area, further changed the context for management of the area. |
| 5-6: Immediate Controls<br><br>[Mitigating risk of new pathways] | During 2007 and early 2008, the site commissioned contractors to place new rock armour on the shoreline adjoining the VLLW Disposal Area, to reduce the risk of further coastal erosion of this part of the Foreshore Reclaimed Area [Slide #16]. The rock armour was designed to be resistant to 'normal' storm events (indicatively 1 in 10 year frequency) but upgradeable to withstand more severe storms. [Slide #16] | KP4 (Immediate Action) | <u>Technical perspective:</u><br><br>This remedial action dealt with the immediate presenting issue of erosion approaching the VLLW Disposal Area, while leaving the longer-term strategy for coastal management to be determined at a later date. |

# 3 Continuation of risk assessment stage taking account of SAFEGROUNDS main guidance version 2

| Position on SAFEGROUNDS flow diagram | Approximately sequential narrative | Relationship to SAFEGROUNDS key principles and other guidance | Comments and specific learning points |
|---|---|---|---|
| 1: Define the context etc. and develop the 'Preliminary Land Quality Management Strategy'. | In late 2007 and early 2008, the operator developed a new 'Land Quality Strategy' for the site as a whole, structured around intended land uses for various zones of the site, proposing an adapted version of the regulators' 'CLR-11' guidance flow diagram as a basis for future development of detailed strategies for each zone. | General alignment with SAFEGROUNDS main guidance document flow diagram. | Technical perspective:<br>Adoption of the CLR-11 approach allowed the operator to start developing its strategy in a manner that anticipated the revised (2009) SAFEGROUNDS main guidance document. |
| Continued stakeholder involvement<br>[Applies throughout the SAFEGROUNDS process.] | At the June 2008 Site Stakeholder Group meeting, the site explained the approach to land quality strategy that had been under development during the preceding year, and stated the intention to engage with stakeholders in the course of strategic options appraisals for specific zones affected by radioactive contamination. [Slide #27] | KP2 (Stakeholder Involvement) | Stakeholder engagement perspective:<br>This marks the first occasion on which a Magnox North Ltd licensed site has actively engaged with external stakeholders during options appraisals dealing with land contamination. |
| Continued stakeholder involvement<br>[Applies throughout the SAFEGROUNDS process.] | Also at the June 2008 Site Stakeholder Group meeting, the operator explained that the results of the detailed intrusive investigations of the VLLW Disposal Area had provided no evidence that wastes exceeding the threshold for the recently-defined category of High Volume VLLW (suitable for disposal to landfill with non-radioactive waste) had been disposed of, and indeed that residual levels of radioactive contamination were even lower than assumed in the ERM/Mike Thorne assessment based on the 2005 exploratory investigations. [Slide #21] | KP2 (Stakeholder Involvement) | |
| 2-3, 10-16: Tiered risk assessments<br>[See entries below for details for water environment and human health] | In preparing an interpretative report on the results of all previous investigations of the VLLW Disposal Area, consultants Golder Associates undertook tiered risk assessments considering protection of human health and the water environment. [Slide #23] | KP1 (Protection of people and the environment) | Technical perspective:<br>The use of a tiered approach reflects the risk assessment part of the detailed flow diagram in the revised (2009) main SAFEGROUNDS guidance. It ensures a high level of protection, by undertaking appropriate quantitative risk assessments where preliminary qualitative risk assessment indicates one or more actual or potential 'pollutant linkages' between a contaminant source, pathway and receptor. An assessment for the water environment was included in this assessment as an appropriate means of considering protection of the environment as well as people. |

| Position on SAFEGROUNDS flow diagram | Approximately sequential narrative | Relationship to SAFEGROUNDS key principles and other guidance | Comments and specific learning points |
|---|---|---|---|
| 2-3, 10-13: Preliminary qualitative and generic quantitative risk assessments for water environment (2 tiers of risk assessment needed) | For the water environment, the preliminary qualitative risk assessment indicated the potential for pollutant linkages. Indeed, the measurement of traces of contamination (strontium-90) above background levels in groundwater beneath the VLLW Disposal Area showed that a pathway to groundwater existed (or had existed in the past). However, the generic quantitative risk assessment showed that levels of contamination were not significant, even if a hypothetical receptor were present, and in any case the affected groundwater body in the made ground is of poor (brackish) quality due to its coastal location. | | |
| 2-3: Preliminary qualitative risk assessment for human health – Are there potential risks? | For human health risk assessment, the preliminary qualitative risk assessment was based on the assumption that patches of surface contamination like that dealt with previously might arise in future, so there are potential risks. [Slide #24] | | |
| 5: Can risks be reduced by immediate controls? | No further immediate actions were warranted, so the next step was generic quantitative risk assessment. | | |
| 11: Choice of generic assessment criteria | Generic quantitative risk assessment was undertaken with respect to two types of quantitative generic assessment criteria, as set out in the next two entries. | | |
| 11-13: Generic assessment criteria and generic quantitative risk assessment (with respect to 'Part 2A' criteria) | One set of criteria was the draft Radioactivity in Soil Guideline Values (RSGVs) developed for the Department for the Environment, Food and Rural Affairs in England and Wales. The RSGVs are many times higher than the observed concentrations of radionuclides, and on this basis the VLLW Disposal Area can be eliminated as a potential site of 'radioactively contaminated land' as defined in the Radioactive Contaminated Land (Scotland) Regulations under Part 2A of the Environmental Protection Act 1990. These regulations consider an annual dose of 3000 microsieverts/year or more as a basis for formally designating 'radioactively contaminated land' that could warrant remedial intervention. On this basis, there was no possibility of a direct regulatory requirement for remedial action. [Slide #22] | | |
| 11: Generic assessment criteria (with respect to parity of risks associated with Nuclear Licensed Site) | Recognising that the VLLW Disposal Area is adjacent to the Hunterston A nuclear licensed site, it was decided to assess the parity of risks with respect to the risk criterion that would be applied for de-licensing of a nuclear site, which broadly equates to an annual dose rate of 10-20 microsieverts/year. [Slides #22 & #25] | KP1 (Protection of people and the environment) | <u>Technical & stakeholder engagement perspectives:</u><br>A particularly high level of protection of people (human health) is assured by assessment for parity with nuclear site de-licensing (an increased individual fatality risk of less than 1 in a million per year). This criterion is more than 100 times more demanding than that required by the regulations relevant to the VLLW Disposal Area. |

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|---|---|---|---|
| 11-13: Generic quantitative risk assessment | For the generic quantitative risk assessment with respect to parity of risks associated with the Nuclear Licensed Site, the Health Protection Agency's 'NRPB-W36' methodology was used, which provides the means of assessing doses from a number of generic land use scenarios, representing realistic land uses, including 'recreational' scenarios considered appropriate to the VLLW Disposal Area. On this basis, calculated dose rates were all well below 10 microsieverts/year – i.e. less than would be required for de-licensing of a nuclear site. On this basis, no unacceptable risks were identified, and no remedial action was warranted in terms of protection of human health. [Slide #25] | | |

# 4 Options appraisal stage

| Position on SAFEGROUNDS flow diagram | Approximately sequential narrative | Relationship to SAFEGROUNDS key principles and other guidance | Comments and specific learning points |
|---|---|---|---|
| 21. (Re-)define the context. | Despite the outcomes of the risk assessments, it was recognised that there remained the potential for patches of trace radioactive contamination to arise at the ground surface in future (whether as a result of natural processes or inadvertent disturbance by vehicles, etc). This would lead to a need for continued monitoring of the land surface and potentially further minor 'clean-ups' for 'housekeeping' reasons. Therefore the operator decided to proceed to 'options appraisal' to determine the medium-term strategy (on a timescale of decades) for management of the VLLW Disposal Area. | | |
| 22. Refine Land Quality Management Strategy | The operator undertook preliminary work to identify a preferred method for options appraisal. The preferred method identified was a simple 'direct evaluation' method using a pros and cons assessment of strategic options against relevant attributes. [Slide #28] | The proposed options comparison method was identified using draft SAFEGROUNDS guidance on comparison of contaminated land management options. The draft guidance available at the time was the near-final 2nd published consultation draft (February 2008). | <u>Technical perspective:</u><br>Magnox North involvement in the SAFEGROUNDS Project Steering Group provided early access to this draft guidance document. |
| 23-24. Identification of feasible remediation options | The operator developed a long-list of potential strategic options and then reduced this to a short-list of feasible strategic options, namely:<br>1. 'Stop monitoring'<br>2. Continue to 'monitor and maintain'<br>3. 'Improve containment'<br>4. 'Remove hazard' (involving full or selective excavation of waste)<br>[Slide #29] | | |
| Continued stakeholder involvement<br>[Applies throughout the SAFEGROUNDS process.] | In July 2008, a Land Quality Sub-Group of the Site Stakeholder Group was convened. The initial meeting specifically reviewed the VLLW Disposal Area, including a site visit. The operator presented the detailed characterisation information [Slide #21] undertaken since the January 2006 Site Stakeholder Group meeting and 'Sunday Herald' article. A summary was given of an initial assessment of current radiological risks associated with the VLLW Disposal Area, based on work being undertaken by Golder Associates. [Slide #25] | | <u>Stakeholder engagement perspective:</u><br>The site visit dispelled some Sub-Group members' perceptions that there was still one (or more) large open waste disposal pit present in the VLLW Disposal Area. This perception possibly arose from the frequent use of the term 'VLLW pits' used by the operator's personnel, which would have been appropriate when the disposals took place in the 1970s/80s, but not after they were closed. |
| Continued stakeholder involvement<br>[Applies throughout the SAFEGROUNDS process.] | At the same meeting, the operator also presented the proposed method for determining the preferred strategic option for management of the VLLW Disposal Area over the next few decades, and outlined the feasible options. | KP3 (Identifying the preferred land management option) | <u>Stakeholder engagement perspective:</u><br>A broad range of stakeholders was engaged at the early stages of this options appraisal process. |
| 26: Detailed evaluation of options | The four identified options were assessed by an expert panel of appropriate Magnox North staff in a workshop setting, using a set of attributes that had previously been | | |

| Position on SAFEGROUNDS flow diagram | Approximately sequential narrative | Relationship to SAFEGROUNDS key principles and other guidance | Comments and specific learning points |
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| | defined for a waste strategy options appraisal for another site. The attributes covered public and workforce safety, additional waste volume for disposal, additional long-distance transport (including $CO_2$ emissions), additional local traffic flows, other local environmental impacts, risk of technical failure of the option, and overall cost. For each attribute, the four options were ranked in order [see Slide #30 and the Magnox North Non-Technical Summary of the options appraisal.] | | |
| 27: Can the most appropriate option(s) be identified? | The options appraisal clearly showed that the 4th option of excavating wastes for segregation, sentencing and re-disposal was the least favoured, but the other options were closely matched. However, when attributes with only marginal difference between the other options were excluded, the 3rd option to improve the containment of the area and reduce the scope of monitoring was more clearly favoured and was identified as the preferred option. | | |
| Continued stakeholder involvement<br>[Applies throughout the SAFEGROUNDS process.] | A non-technical summary of the options appraisal study was provided to the Land Quality Sub-Group of the Site Stakeholder Group and taken forward to the main Site Stakeholder Group meeting. [See Magnox North Non-Technical Summary of the options appraisal.]. The outcome of the options appraisal was generally well received, although some Site Stakeholder Group members wished to see specific features incorporated in the implementation, particularly concerning demarcation and signage of the area after restoration. The Chair of the Land Quality Sub-Group asked to be kept informed of progress and any potential changes to this plan. [Slide #31] | | Stakeholder engagement perspective:<br>Even though the regulators and Site Stakeholder Group members were not directly involved in the options appraisal process, the outcome was not controversial and generally supported. |
| Additional information | In an article on 20 September 2009 relating to the adjacent Hunterston B site (run by a different operator) the 'Sunday Herald' referred again to its 2004 and 2006 articles, without update or caveat. | | Stakeholder engagement perspective:<br>The media are not stakeholders and are not accountable for accurately updating the public on stories that they cover. |
| 29-30: Development of the 'remediation strategy'<br>[i.e. an implementable plan] | Magnox North identified a grassed-over mound of spoil [Slide #32] adjoining the VLLW Disposal Area (originally created in the late 1970s) as a potential source of soils for incorporation into a restoration cap, and commissioned additional trial pitting and testing of soils for their suitability (which was confirmed). [Slide #33] | | Technical perspective:<br>The proposed re-use of spoil mound material was consistent with good practice for site restoration, minimising the off-site environmental impacts of the works. |
| 29-30: Development of the 'remediation strategy' | Using an in-house ecologist, Magnox North undertook an ecological survey of the VLLW Disposal Area and adjoining spoil mound, to check for the presence of any protected or locally rare species and to check for evidence of burrowing animals that might warrant additional barriers being incorporated into a restoration cap. This identified the presence of locally rare 'parsley water dropwort' (*Oenanthe lachenalii*) but no evidence of burrowing by either rabbits or | | |

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| | badgers. [Slide #33] | | |
| 29-30: Development of the 'remediation strategy' | Magnox North commissioned consultants to identify a range of restoration capping options to deliver improved containment [Slide #34]. These were:<br>1. Restoration soils from spoil mound overlying a separator geotextile, overlying a ~0.4 m coarse granular layer;<br>2. Restoration soils from spoil mound overlying a 1 mm high-density polyethyelene membrane and protective geotextile;<br>3. Restoration soils from spoil mound overlying a separator geotextile, plus 'rabbit mesh' installed below top 0.2 m of restoration soils. | | |
| 29-30: Development of the 'remediation strategy' | All three options were considered by Magnox North to meet the functional requirements. The 'rabbit mesh' (Option 3) was considered to be unnecessary in view of the findings of the ecological survey and the mostly heavy clay nature of the soils to be obtained from the spoil mound. There was some debate as to whether there was any need to include a low permeability barrier (Option 2), as the levels of groundwater contamination observed in the absence of any such barrier have been trivial and are unlikely to be affected by limiting infiltration. However, a low permeability barrier is a standard component of most landfill caps, and the marginal cost of including such a barrier was not high, so the decision was made to implement Option 2. This decision did not warrant a detailed technical options appraisal. | | |

# 5 Implementation stage

| Position on SAFEGROUNDS flow diagram | Approximately sequential narrative | Relationship to SAFEGROUNDS key principles and other guidance | Comments and specific learning points |
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| 34: Preparation of the implementation plan | Magnox North commissioned consultants to prepare a detailed design of the restoration cap. This incorporated the following features:<br>• A levelling layer of imported sand [Slide #35];<br>• A low permeability HDPE membrane [Slide #36];<br>• A geotextile layer to protect the HDPE membrane [Slide #37];<br>• Cover soils of about 0.6 m depth, increasing locally to produce the required landform;<br>• Cover soils visually checked to exclude large (> 300 mm) stones/lumps of concrete, etc., in order to protect the geotextile and HDPE membrane, and help provide a reasonably smooth finished ground surface;<br>• Final landform designed to encourage a range of habitats (drier and wetter ground conditions) [Slides | | |

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| | #39 & #40];<br>• A thin layer of topsoil won from the spoil mound placed over the coarser restoration soils;<br>• Attempted translocation of locally rare 'parsley water dropwort' to an intended wetter area [Slide #38];<br>• Option to seed with a mix of indigenous grasses if the area does not revegetate naturally at an acceptable rate (not required);<br>• Four existing groundwater monitoring boreholes in the vicinity of (but not within) the VLLW burials preserved to allow potential future use after completion of restoration works. Two boreholes to have headworks extended upwards to accommodate changed ground [one visible in Slide #39]. | | |
| 35: Agreement of the implementation plan | The SSG was consulted on whether the restoration should be finished off with or without replacing the marker posts that were present before the restoration capping works. SSG members indicated a preference to include replacement of the marker posts [replacement posts are visible in Slide #41]. | KP2 (Stakeholder Involvement) | <u>Stakeholder engagement perspective:</u><br>This was an appropriate, non-technical, matter on which to engage local stakeholders. |
| 37-38: Implementation and verification of works | The works were implemented by a reputable groundworks contractor in January 2011, under the supervision of a representative of the designer, applying Construction Quality Assurance (CQA) oversight as would be the case for any landfill cap. | | |
| 40: Update records | A copy of the CQA report was lodged in the Site's Land Quality File [Slide #42]. The CQA Report includes surveyed positions of the marker posts. | KP5 (Record Keeping) | <u>Technical perspective:</u><br>Having the Land Quality File in place gives confidence that the records of restoration will be available in the future. |
| 42: Requirement for long-term monitoring or passive controls | Routine radiological monitoring at the ground surface VLLW Disposal Area is no longer required. There is no requirement to continue monitoring of groundwater quality, but four monitoring boreholes have been retained in the vicinity of the VLLW Disposal Area for the time being.<br>The VLLW Disposal Area has been included in land declared by Magnox Ltd to NDA as 'required for operational purposes' for the foreseeable future, such that Magnox Ltd remains responsible for its management. The area is within a 'Designated Site' under the Energy Act 2004, which prevents its sale by NDA without following a legal process of 'de-designation'. These arrangements, in addition to the recognition of the area as 'Industrial' land within the North Ayrshire Local Plan, provide robust passive institutional controls that would prevent inappropriate development of the area. | KP5 (Record Keeping) | <u>Technical perspective:</u><br>Keeping of records by more than body (for different purposes) gives confidence in passive institutional controls to prevent inappropriate development of the area. |
| 49: Is the area to be delicensed? | Not applicable, as the area was never licensed under the Nuclear Installations Act 1965. | | |
| 52: No further contaminated land management actions required. | For the foreseeable future, the area will remain as it is, managed by Magnox Ltd on behalf of the NDA. | | |

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| 52: No further contaminated land management actions required. | In October 2011, new radioactive substances legislation came into force in the UK (in Scotland by amendment of the Radioactive Substances Act 1993). The UK Government guidance to the legislation now makes it clear (para 2.37) that "any substance is not radioactive material or radioactive waste, where its radionuclide content is suitable to a lawful disposal … where no further act of disposal is foreseen, for example … final closure of a solid waste disposal facility where there is no intent to retrieve the waste". The capping/restoration of the VLLW Disposal Area might be considered a "further act of disposal" beyond that required in the original authorisation, but there is no intent to retrieve the waste, and so the disposed wastes are no longer within the scope of radioactive substances legislation.<br><br>Furthermore, the new radioactive substances legislation introduced new radionuclide-specific values for determining what solid substances are outside the scope of radioactive substances legislation. These new values (including 1 Bq/g for both caesium-137 and strontium-90) mean that only a tiny fraction of the wastes would now be the scope of radioactive substances legislation, in the hypothetical event that wastes were to be "retrieved" (excavated). | KP1 Protection of people and the environment | <u>Technical and stakeholder engagement perspective:</u><br><br>The new radioactive substances legislation represents a clearer but no less rigorous basis for protection of people and the environment than what it replaced. Had the new radioactive substances legislation been in place, it could have been argued that the contents of the VLLW Disposal Area (including any that might become exposed at the ground surface) was no longer radioactive material or radioactive waste and therefore no remedial action was warranted.<br><br>This case study 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. |