Scenario Development: An International Perspective

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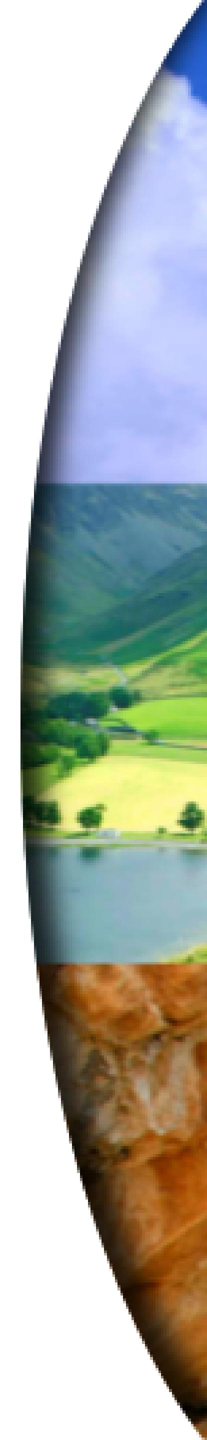


Quintessa

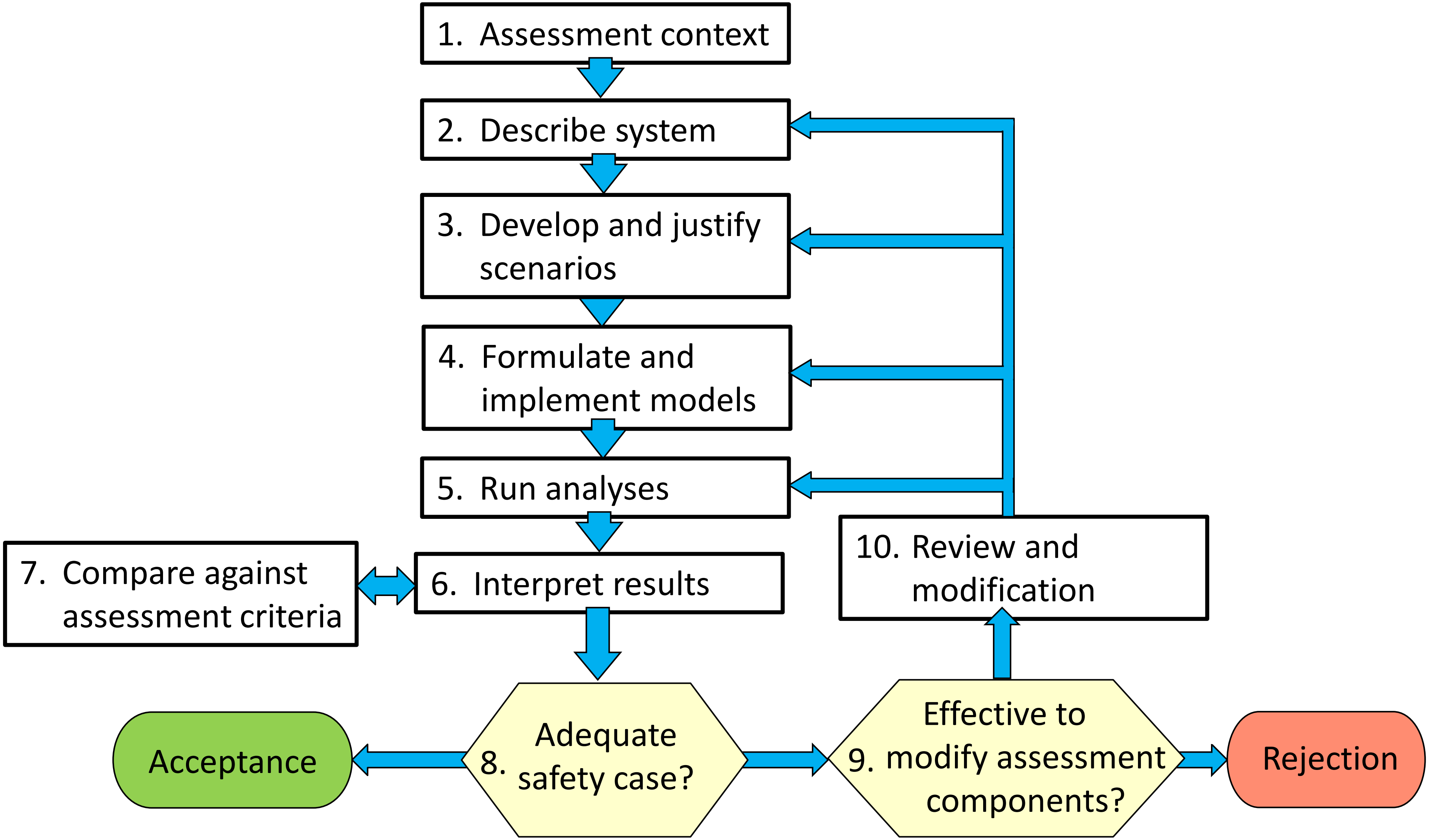
Outline

- The IAEA ISAM project
  - Background
  - ISAM approach
  - Scenario identification and justification
- Examples
  - DGR for OPG's L&ILW in Canada
  - LLWR in the UK
  - Summary of these examples
- Conclusions

ISAM: Background

- IAEA Co-ordinated Research Project (CRP)
  - *I*mprovement of *S*afety *A*ssessment *M*ethodologies for Near Surface Disposal Facilities (ISAM)
    - International consensus involving 35 countries
    - Ran from 1997 to 2001
  - Documented in two reports:
    - Volume 1: Methodology
    - Volume 2: Hypothetical Test Cases
  - Followed by ASAM and PRISM projects

ISAM: Approach



ISAM: Features

- Importance of context
  - Assessments should be ‘fit for purpose’
- Importance of confidence building
  - Recognise all stakeholders
  - Build confidence by
    - Systematic approach
    - Recognise and manage uncertainties
    - Justification of scenarios, models and data
    - Transparent documentation and modelling
    - Quality assurance

ISAM: Uncertain Future

- Uncertainties unavoidable in assessing safety into the future
  - Need to explicitly recognise uncertainties
  - Manage and, if possible, reduce uncertainties
- Recognise different types of uncertainties
  - Uncertainties about the future, models and data
  - Each type can be managed differently
- Scenarios help to address uncertainties about the future by addressing a range of potential futures

ISAM: Scenarios

- Important component of safety assessment
  - Often focus of stakeholder interest
- Use a systematic approach
  - ISAM does not prescribe a specific approach
    - ‘bottom-up’ or ‘top-down’ both valid
  - Provides guidance and tools e.g. ISAM FEP list
- Recognise influence of regulatory criteria
  - Dose or risk based criteria
  - Distinguish ‘normal’ and ‘disruptive’ scenarios

ISAM: FEP List Structure

0. Assessment Context

1. External Factors

- 1.1 Repository issues
- 1.2 Geological processes and events
- 1.3 Climatic processes and events
- 1.4 Future human actions

2. Internal Factors

- 2.1 Wastes and engineered features
- 2.2 Geological environment
- 2.3 Surface environment
- 2.4 Human behaviour

3. Radionuclide and Contaminant Factors

- 3.1 Contaminant characteristics
- 3.2 Release/migration factors
- 3.3 Exposure factors

Impact

ISAM: External Factors

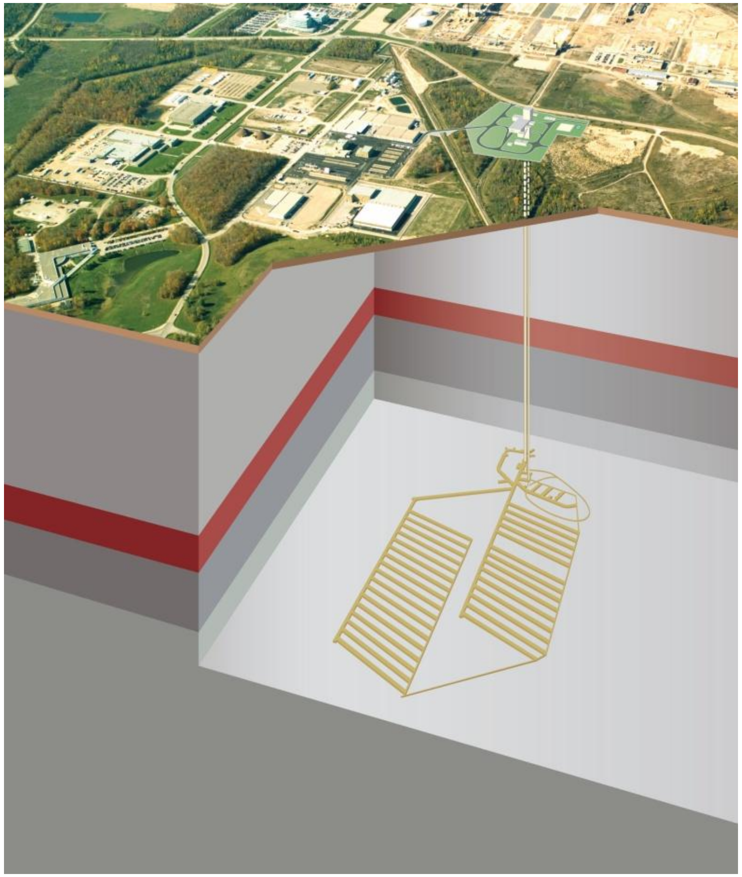
- External factors drive scenarios
  - Different internal factors represent variants to scenarios
- ISAM external factors
  - Repository issues
    - e.g. design, waste allocation, site operation and closure
  - Geological processes and events
    - e.g. seismicity, regional erosion and sedimentation
  - Climatic processes and events
    - e.g. global climate change and regional effects
  - Future human actions
    - e.g. knowledge issues, site development

Examples

- Consideration of different assessment contexts
  - Selected a couple that show differing approaches
- DGR in Canada
  - Geological, relates to OPG's L&ILW
    www.nwmo.ca/dgr
- LLWR, UK
  - Re-assessment of existing surface LLW facility
    www.llwrsite.com/environmental-safety-case/esc-documentation

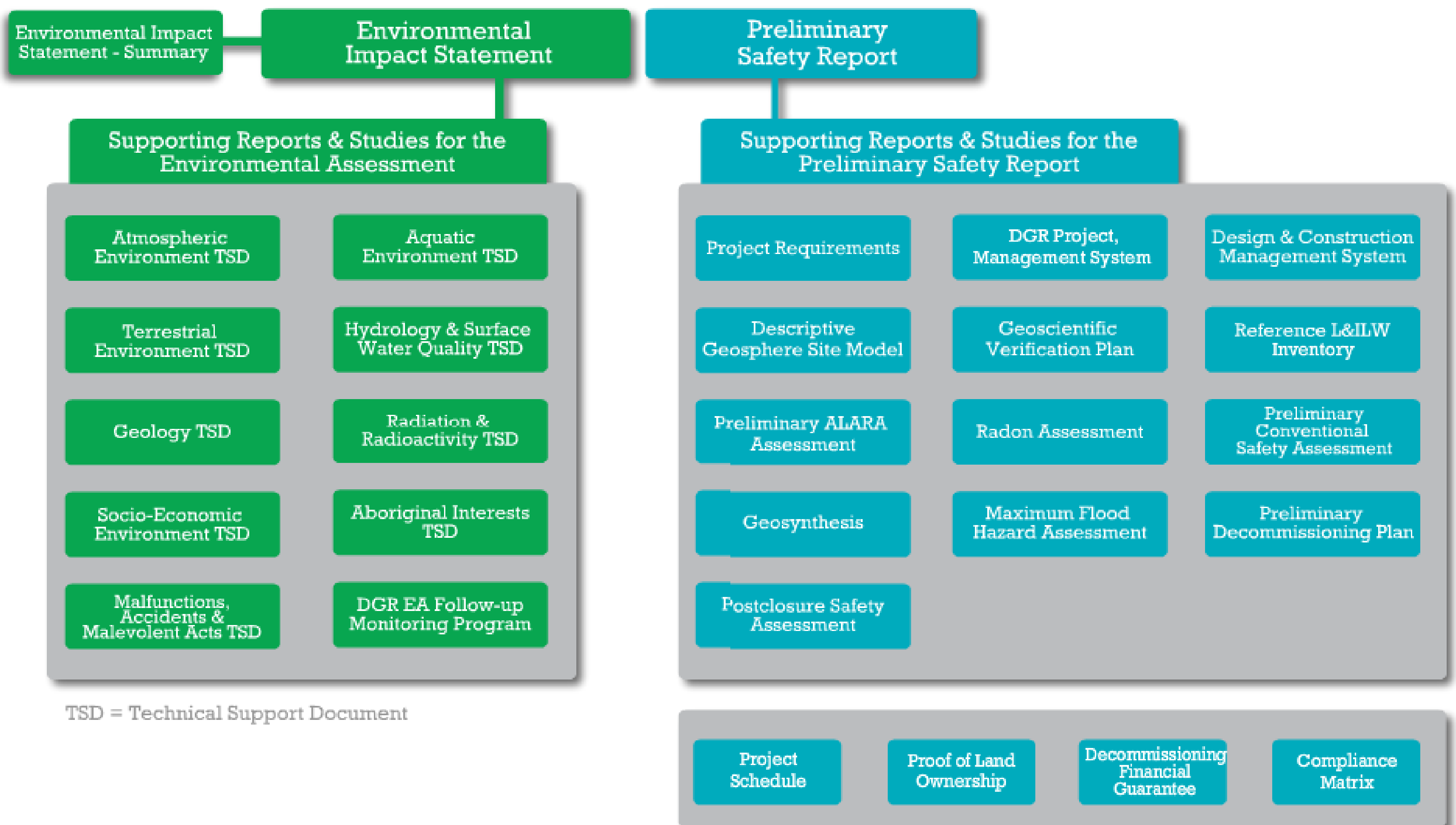
OPG’s DGR: Context

- Proposed Deep Geologic Repository at the Bruce nuclear site for OPG’s L&ILW
  - Operational & refurb. wastes
  - 680 m deep in saline limestone
- Community engagement
  - hosting agreement and positive community poll
- 2011 regulatory submission for construction
  - currently within regulatory review phase
  - decision anticipated early-2014



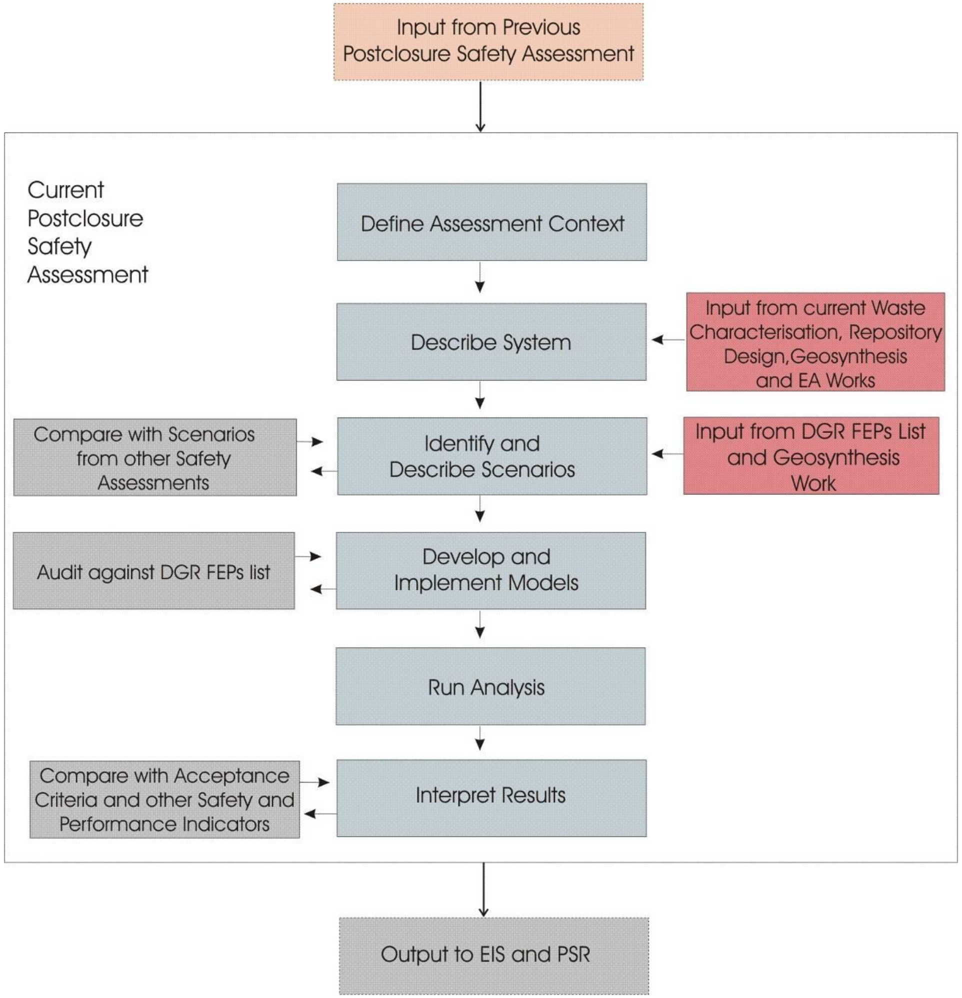
OPG's DGR: 2011 Submission

OPG's L&ILW DGR Documents Roadmap



OPG’s DGR: Approach

- Regulatory guidance
  - Recognises ISAM
  - Distinguishes likely normal from unlikely disruptive scenarios
- DGR-specific FEP list
  - Drives scenario identification
  - Audit tool for models



OPG’s DGR: Normal Evolution

- Development of normal evolution scenario
  - Draw on system description
  - Review External FEPs for those ‘likely’ to affect the system

Seismicity	Included	Although likely magnitude and frequency will be limited
Global climate change	Included	After initial warming, it is likely that glacial/interglacial cycling continues
Knowledge and motivational issues	Excluded	No human intrusion due to its depth and the lack natural resources

  - Describe likely ‘reference case’
- Use about 20 variant cases to explore sensitivities
  - e.g. vertical head gradients, gas pressures, climate change
  - Models supported by review against FEPs

OPG's DGR: Disruptive Scenarios

- Development of disruptive scenarios
  - Identify key safety arguments
  - For each argument, review all FEPs to identify those that may compromise argument

Multiple barriers provide containment	Ice sheet erosion	No, will not significantly reduce deep host rock on timescale considered
	Exploration borehole	Yes, low probability but potential to bypass barriers
	Poor construction	Yes, low probability but potential to compromise barriers
	Undetected feature	Yes, low probability but potential

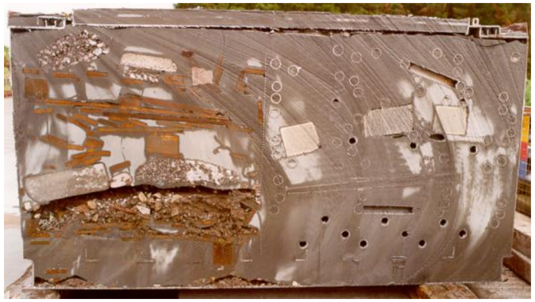
  - Group FEPs into Disruptive ('what-if') Scenarios
    - (1) Human intrusion, (2) Severe shaft seal failure, (3) Poorly sealed borehole, (4) Unidentified vertical fault
  - Comparison against other assessments

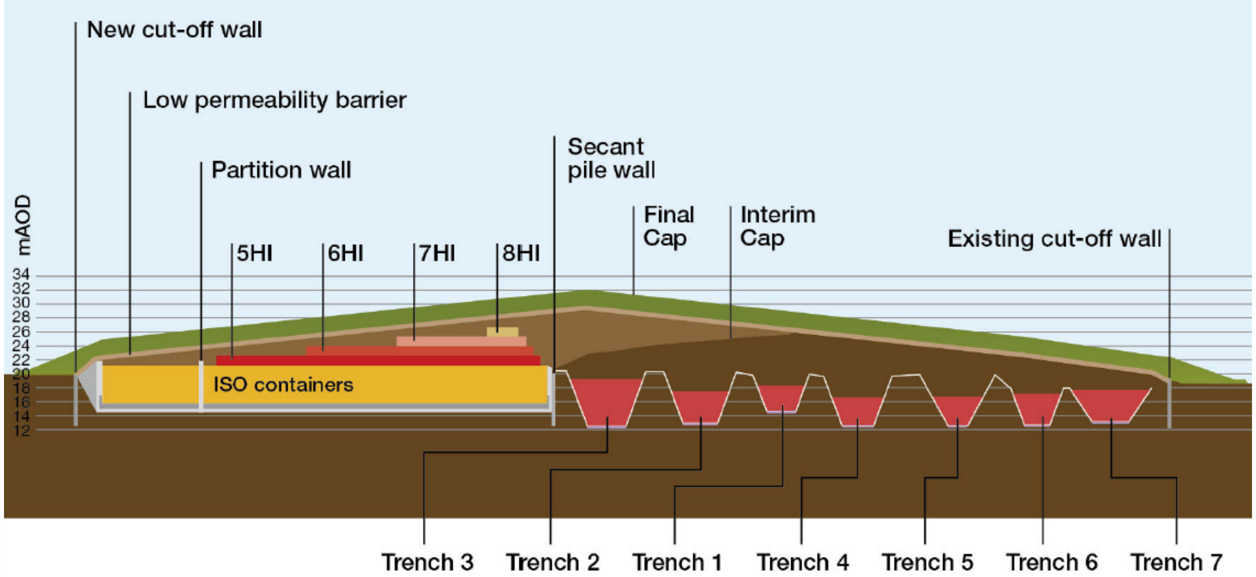
OPG's DGR: Scenarios

- Normal evolution scenario
  - Plus about 20 variant cases
- Four disruptive ('what if') scenarios:
  - Human intrusion scenario
    - Borehole drilled directly into repository
    - Release to surface and shallow groundwater
  - Severe shaft seal failure scenario
    - Rapid and severe seal degradation
  - Poorly sealed borehole scenario
    - Site investigation/monitoring borehole 100 m from repository
  - Vertical fault scenario
    - Hypothetical transmissive fault in vicinity of repository

UK LLWR: Context

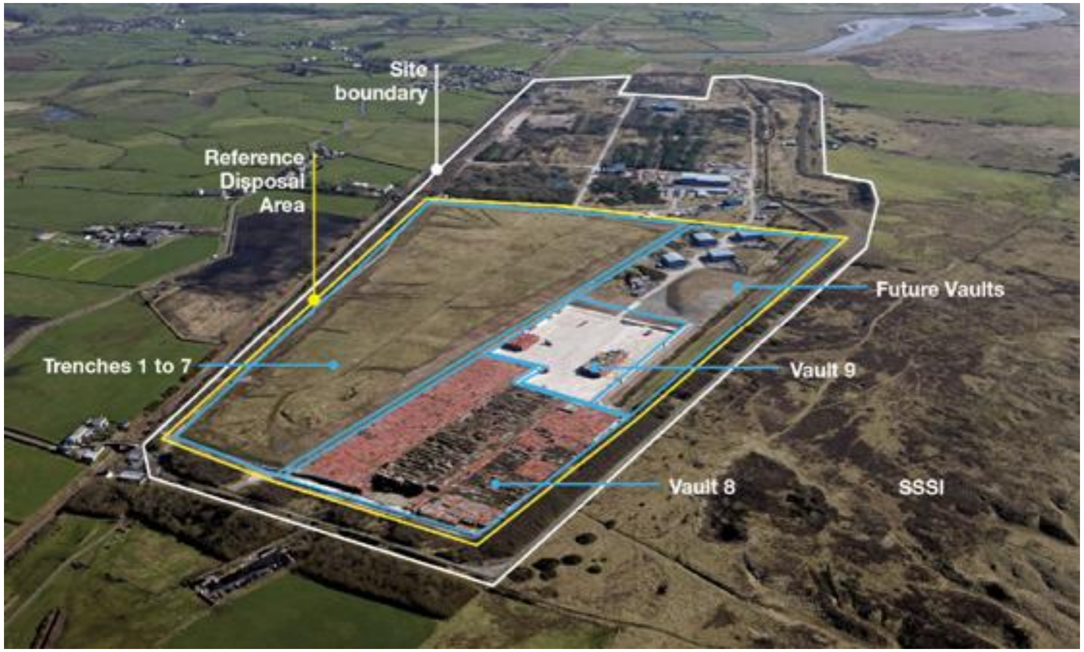
- UK's principal facility for solid LLW
- Disposals:
  - LLW disposal since 1959
  - Tipped into trenches until 1995
  - Upgraded from 1987 to include concrete vaults
  - Now grouted in HH ISOs and stacked
- To be capped at closure





UK LLWR: Context

- Updated ESC required in 2011 by regulator
- Updated design based on
  - Previous iterations
  - Optimisation study



- For post-closure safety:
  - Risk guidance level of 10^{-6} per year for ‘natural evolution’
  - Dose guidance level 3 to 20 mSv per year for intrusion
  - Guidance describes distinct assessment of scenarios

UK LLWR: Approach

- 2002 PCSC
  - Developed LLWR FEP list of over 1400 items
  - Use of FEPs did not build confidence
    - Overly detailed – many not actually modelled
    - Difficult to link to assessment in a transparent manner
- 2011 ESC
  - Refined FEP list to about 300
  - Used in support of modelling
- Key pathways identified in previous assessments
  - Considered threats to performance for each pathway

UK LLWR: Approach

- Separate models for different pathways
  - Groundwater, gas, natural disruption and human actions
  - Scenarios and variants considered for each pathway
- Define an ‘Expected Natural Evolution Scenario’
  - LLWR disrupted by coastal erosion on a period of a few hundred to a few thousand years
  - Used for groundwater, gas, natural disruption pathways
  - Variants considered for each pathway, e.g. cap failure, delayed erosion
- Human intrusion
  - Consider modes of intrusion
  - Cases discussed with regulator in advance

UK LLWR: Scenarios

- Expected natural evolution scenario
  - Groundwater pathway
  - Gas pathway
  - Natural disruption pathway
- Human intrusion scenario
  - Geotechnical investigations, boreholes and trial pits
  - Housing development on cap
  - Smallholding on cap
  - Informal scavenging during period of erosion
  - Local organised material recovery during erosion

Summary of Examples

- OPG's DGR in Canada
  - Used EFEPs to define normal evolution scenario
  - For disruptive scenarios
    - Identified FEPs that compromised safety arguments
    - Sanity check against scenarios from other assessments
- LLWR in the UK
  - Pathways and scenarios already established
    - Iterative assessments and dialogue with regulator
  - FEP list provides a supporting role

Conclusions

- ISAM provides useful guidance
  - Systematic, rigorous, transparent
  - FEP lists help build confidence
- Approach taken will reflect context
  - Purpose of the assessment
  - Regulatory guidance and criteria
- More than one way to develop scenarios
  - Also shaped by preference, organisational structure etc.
  - Flexibility to choose approach have confidence in
  - Key to (1) communicate scenarios and (2) show complete
    - There’s the challenge

Thank you for your attention

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