Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Waste Characterization and Intruder Scenarios: A Canadian Perspective

US Nuclear Regulatory Commission
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Presentation Outline

- Overview of the Canadian Nuclear Safety Commission
- Waste characterization
- Human intrusion
  - Scenarios and examples

Canadian Nuclear Safety Commission

Established May 2000, under the ***Nuclear Safety and Control Act***

Replaced the AECB of the 1946 ***Atomic Energy Control Act***

Canada's Independent Nuclear Regulator

Our Mission Is Clear

Protect the **health**, **safety** and **security** of persons and the **environment**; and respect Canada's **international commitments** on the peaceful use of nuclear energy

Canada's Nuclear Watchdog

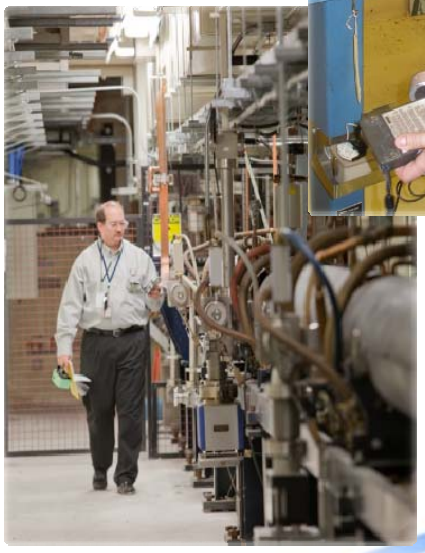
Independent Commission

- Quasi-judicial administrative tribunal
- Commission members are independent
- Commission hearings are public and Webcast
- Supported by a Secretariat and independent legal services

Transparent Decision-Making

CNSC Regulates All Nuclear-related Facilities and Activities

- Uranium mines and mills
- Uranium fuel fabricators and processing
- Nuclear power plants
- Waste management facilities
- Nuclear substance processing
- Industrial and medical applications
- Nuclear research and education
- Export/import control



…From Cradle to Grave

Canada's Radioactive Waste Classification

Management of Low- and Intermediate-Level Radioactive Waste (N292.3-08)

- High-level radioactive waste (HLW)
- Intermediate-level radioactive waste (ILW)
- Low-level radioactive waste (LLW)
- Uranium mine and mill tailings

HLW

ILW

LLW

Uranium mine & mill tailings

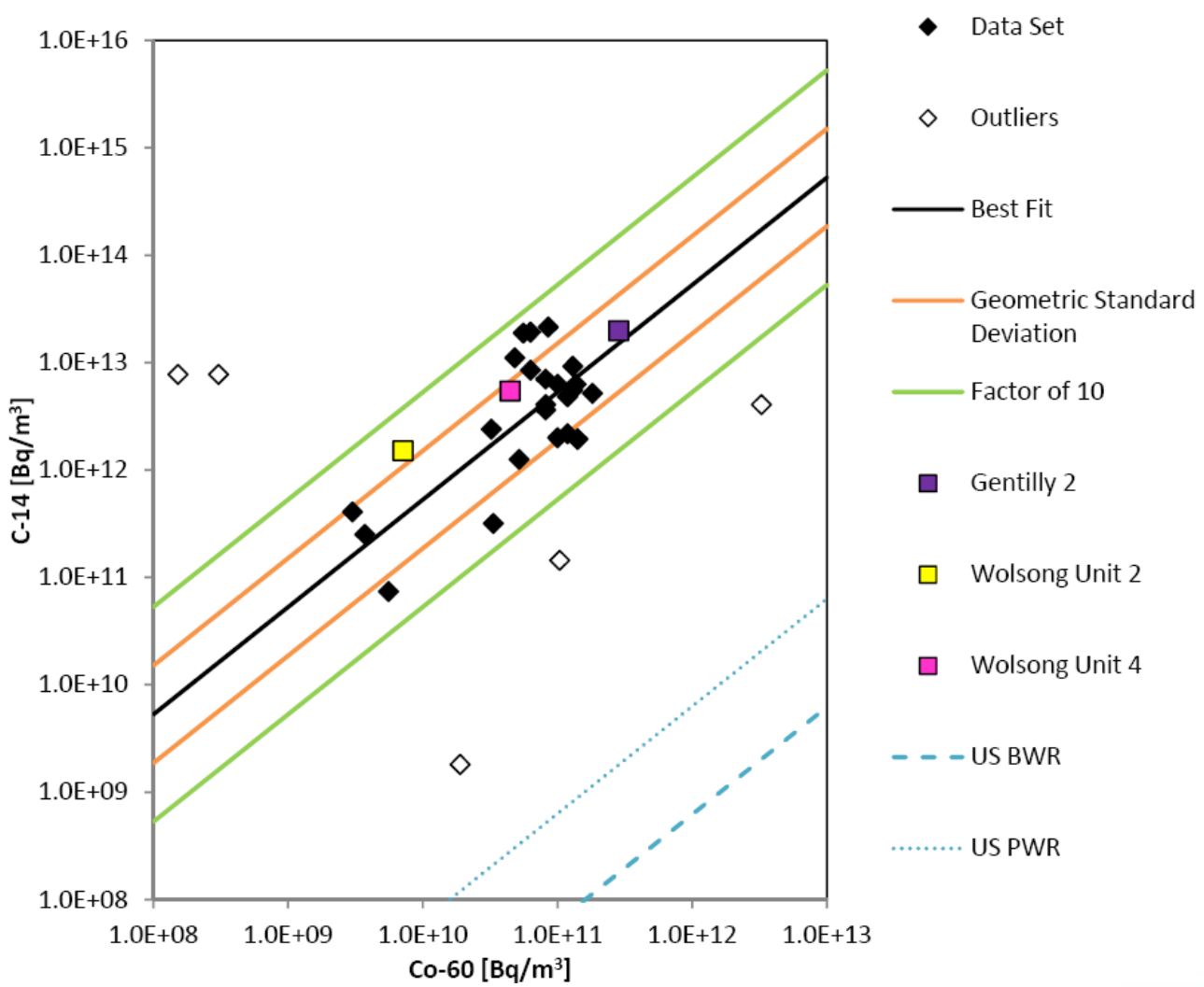
Waste Characterization

- Characterization ‘follows’ classification
- Supports assessment of hazards
- Provides information needed to develop waste inventory
- Informs waste management decision
  - workers are protected
  - public is protected
  - environment is protected

Waste Characterization - Methods

- Radionuclide activity concentrations based on:
  - direct measurement for ‘easy to measure’ radionuclides (e.g., Co-60 and Cs-137)
  - scaling factors for difficult to measure radionuclides
    - Beta emitters (e.g., C-14 and Sr-90)
    - Alpha emitters (e.g., Pu-238)
  - Used fuel inventory ratios – for long lived but low concentration radionuclides
  - Neutron activation calculations – for irradiated metals (modelled)

Difficult to Measure Radionuclides



Waste Characterization - Samples

- Number of samples commensurate with risk
  - Disposal facility on surface
  - Deep Geological Repository (DGR)

Does protection of a DGR justify more limited sampling?

Waste Characterization – Verification

- Develop confidence in the inventory estimates to be assured that bounding estimates are accurate for C-14, I-129, and Cl-36
- To account for:
  - variability in radionuclide activities
  - assure representativeness
  - trending and updating

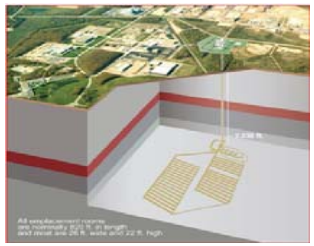
A need for continuous characterization

Human Intrusion

- Scenarios of human intrusion (HI) assume intruder not aware of what they have encountered
- Risk scenarios should be case-specific
- Risk should be predicted
  - both the likelihood and the dose consequences should be reported
- Reasonable efforts to:
  - limit dose from a high-consequence intrusion scenario, and
  - design to reduce the probability of intrusion occurring

Human Intrusion

1. Existing CNSC guidance:
   Regulatory Guide G-320 (2006) *Assessing the Long-Term Safety of Radioactive Waste Management*
2. Examples of HI scenarios



Port Hope Long-term Waste Management Facility

- Surface facility for low-level radioactive waste

Deep Geological Repository

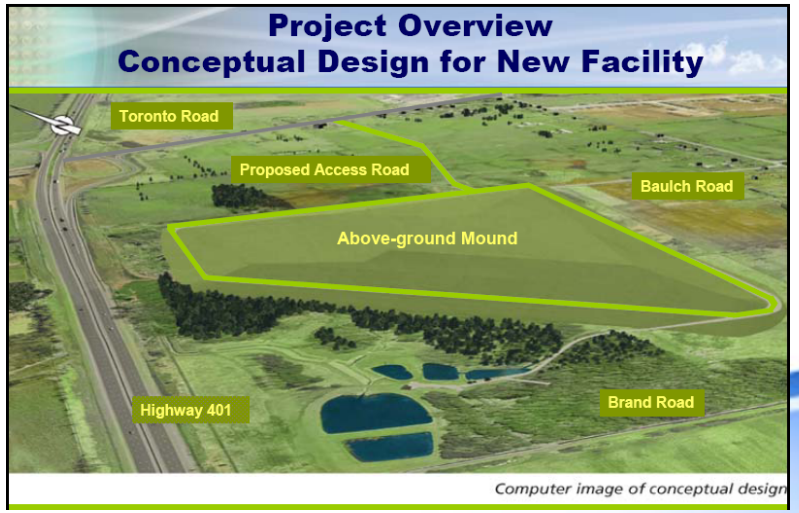
- Low and intermediate-level radioactive waste

Deep Geological Repository

- High-level waste (spent fuel)

Example 1:
Port Hope Area Initiative (PHAI)

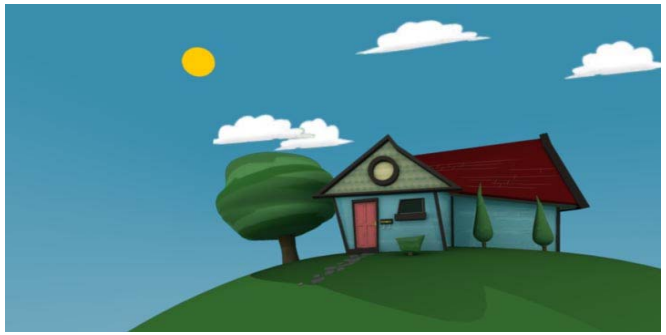
- Long-term management of approximately 2 million cubic metres of low-level radioactive waste
- Construction expected 2014-2015
- Surface disposal



Source: AECL, www.phai.ca

Example 1: PHAI
Human Intrusion - Scenario 1

Construction and occupation of residence on Long-term Waste Management Facility



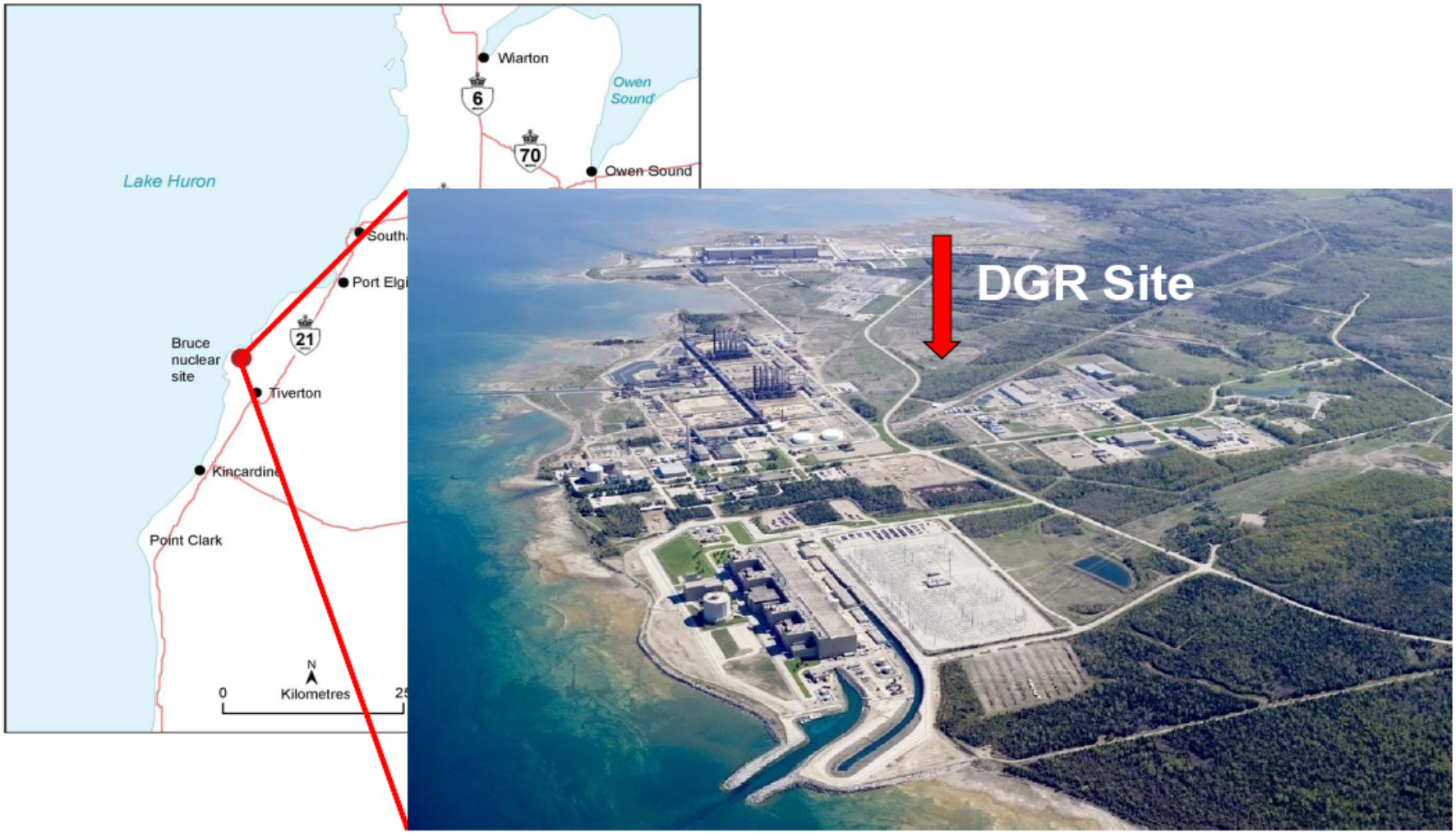
- Excavate through cover layers to build house foundation on top of waste
- Occupant spends 75% of the time indoors in the home (main floor, basement)
- Pathways: gamma radiation and radon from radionuclides

Example 1: PHAI
Human Intrusion - Scenario 2

Exposure to Low Level Radioactive Waste (LLRW) during excavation

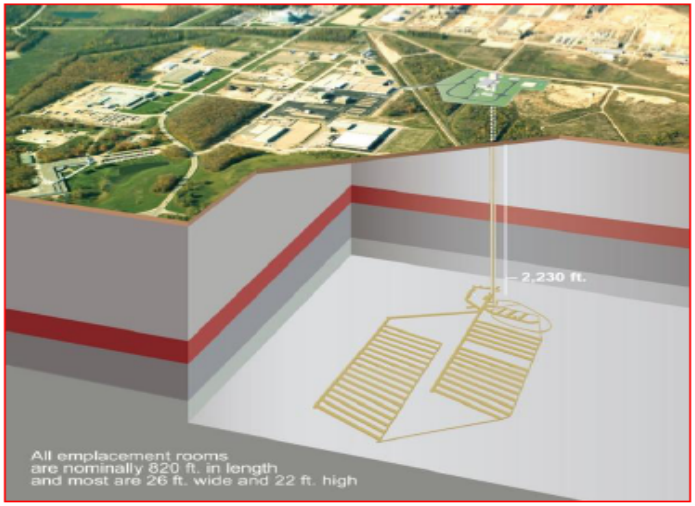
- Cut 4 m x 4 m square area through the cover to the LLRW
- One person on a backhoe and one person watching
- Exposed for three hours
- Backfilled the hole with 1 m of clean soil
- Remain for one more hour after backfilling

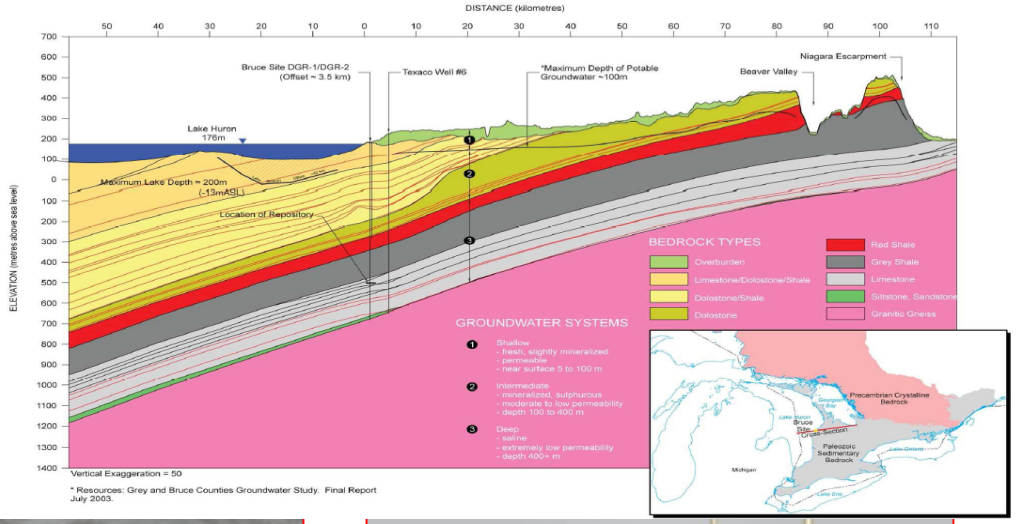
Example 2: Deep Geological Repository



Example 2: Deep Geological Repository

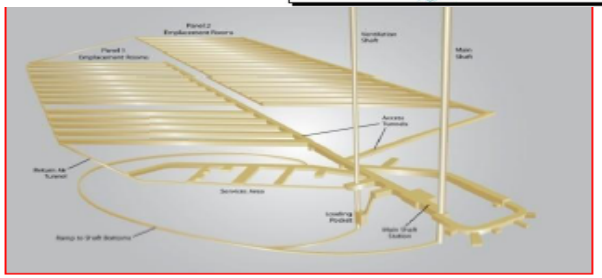
OPG's L&ILW Deep Geologic Repository, Municipality of Kincardine, Ontario





Typical LLW emplacement room

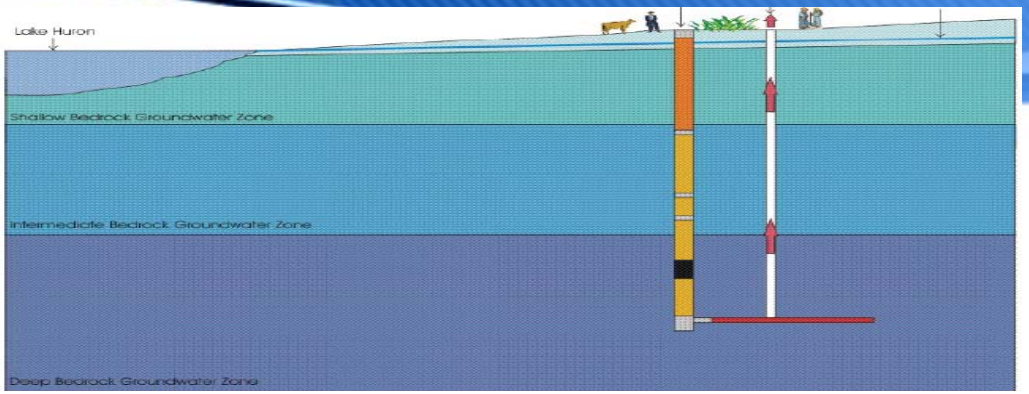
Resin shields – typical ILW emplacement room



Underground facilities design

Source: OPG

Example 2: DGR HI Scenario – Exploration Drilling

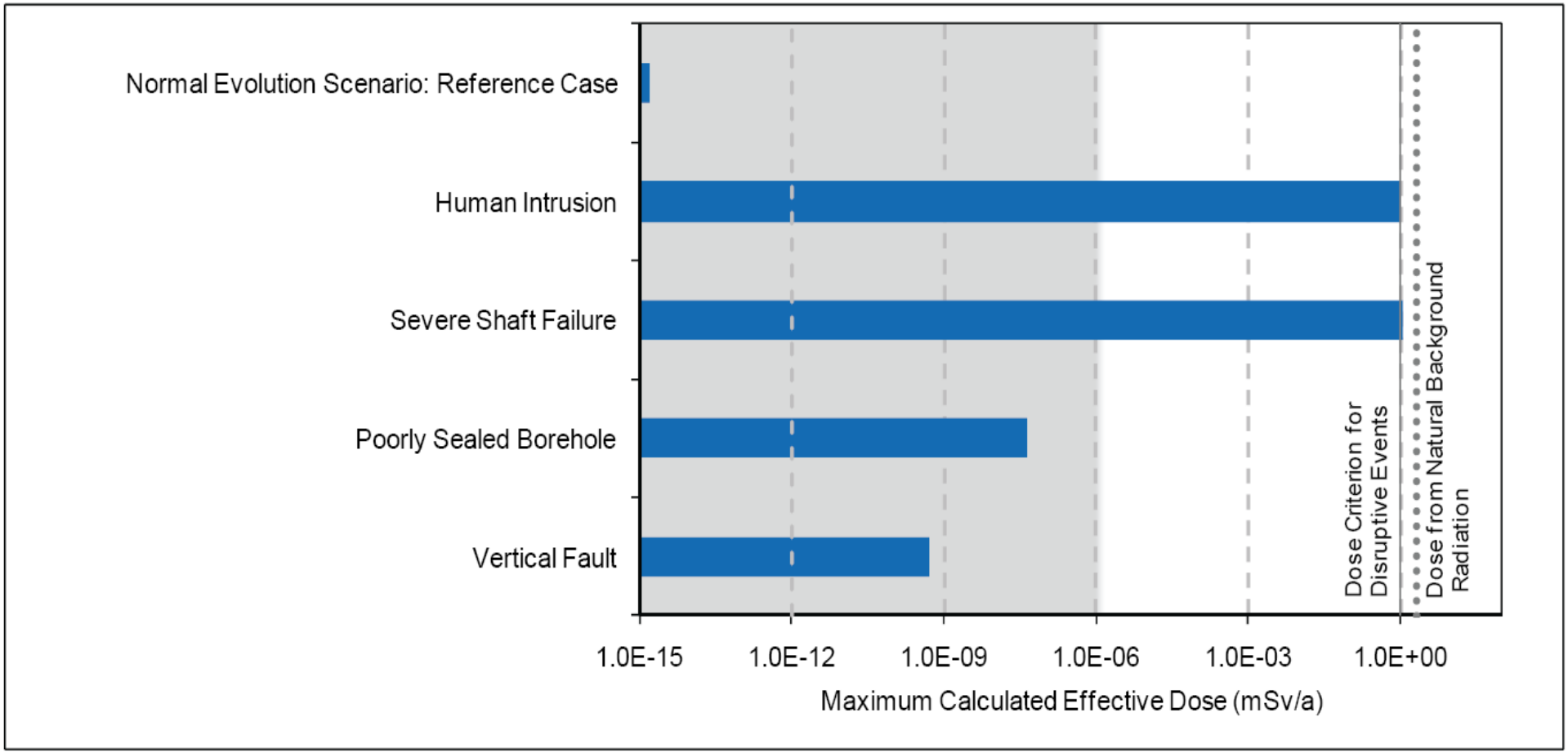


Exposure Situations for the Human Intrusion Scenario

Critical Group	Direct Release to Surface		Release to Shallow Bedrock Groundwater Zone
	Release Mechanism:		Release Mechanism:
	Gas	Drill Core	Groundwater
Drill crew at wellhead	✓		
Resident near to drill site	✓		
Laboratory technician		✓	
Future resident using contaminated soil		✓	
Future site resident using contaminated groundwater			✓

Source: OPG

Example 2: DGR HI Scenario – Exploration Drilling



Disruptive Scenarios: Maximum Calculated Doses for Base Case Calculations

Source: OPG

Concluding Comments

- Human intrusion is one of the scenarios to cause the highest dose
- Human intrusion scenarios based on characteristics of waste and repository
- Important topic for stakeholders – asked at outreach meetings
- Need for international co-operation on credible and conservative human intrusion scenarios

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