



SURFACE

Near Surface Disposal in Finland Seminar

3rd of November 2021

Maaperäloppusijointus Suomessa Seminaari 3.11.2021

Research group: PM Paula Keto (VTT), Professor Gareth Law (HY), Minna Vikman (VTT), Dr. Gianni Vettesse (HY), Pauliina Rajala (VTT), Melany Gouello (VTT), Ville Rinta-Hiiri (VTT), Timothy Schatz (VTT) & Sami Naumer (VTT)



Background

- This seminar is part of Finnish Research Programme on Nuclear Waste Management (KYT2022) 2019-2022 focusing on nationally central research topics. After 2023 part SAFER2028 programme.
- SURFACE project started in 2019 with the aim to study the applicability of a surface disposal concept for radioactive waste in Finland.
- Finland is considering landfill repositories for VLLW (operational waste from NPPs) following the examples of near surface disposal in Sweden with similar types of waste and geological conditions.
- Near surface repositories have also be considered for handling of some decommissioning waste.
- SURFACE project:
 - Task 1: Radionuclide behaviour and transport, Prof. Gareth Law and Dr. Gianni Vettesse (HY), Melany Gouello (VTT)
 - Task 2: Biodegradation of the waste and steel corrosion, Minna Vikman & Pauliina Rajala (VTT)
 - Task 3: Performance of engineered barriers, P. Keto, T. Schatz, V. Rinta-Hiiri & S. Naumer

Webinar program

Session 1. Landfill-type near surface repositories

- **12:00-12:05** Welcoming words and program. Paula Keto, VTT
- **12:05-12:30** Current status of the near surface repository project by TVO. Jere Tammela, TVO.
- **12:30-12:55** Regulatory experiences from shallow land disposal, Anders Wiebert, The Swedish Radiation Safety Authority, SSM.
- **12:55-13:10** Performance of a landfill type near surface repository, Paula Keto, VTT Technical Research Centre of Finland Ltd.
- **13:10-13:20** Discussion on required safety functions and performance targets for a landfill-type near surface repository for VLLW.
- **BREAK 13:20-13:30**

Webinar program

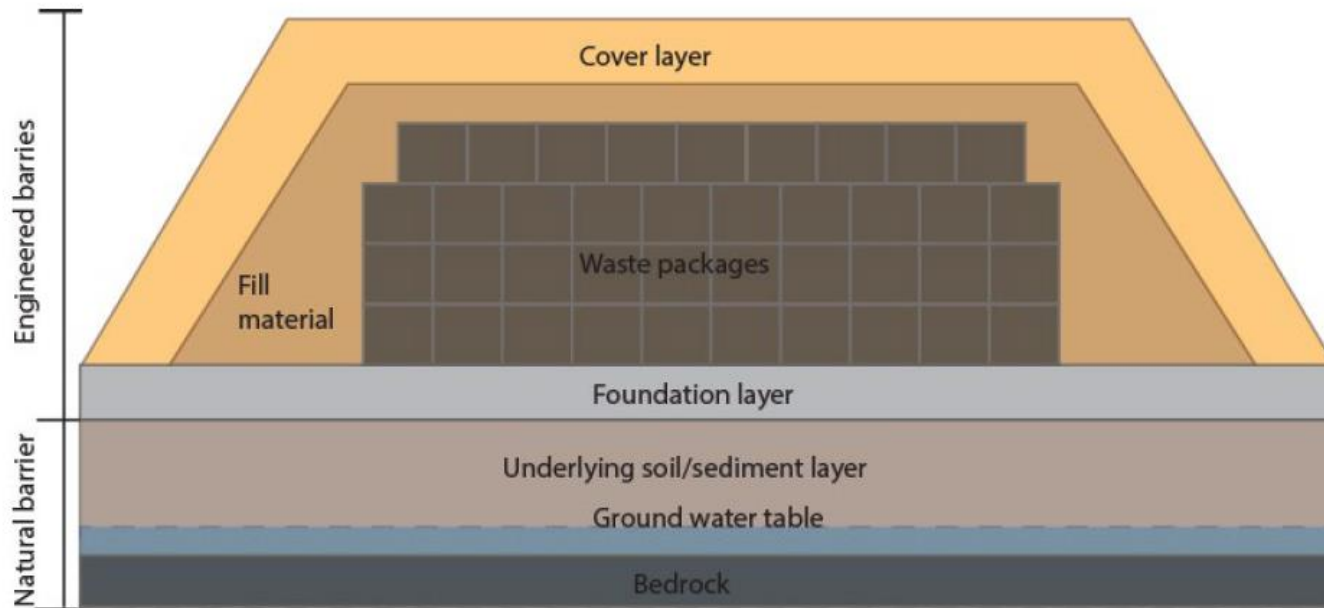
Session 2. Radionuclide migration and evolution of the waste

- **13:30-13:55** A study of methods for analysis of consequences for very low-level radioactive waste disposal, Karolina Stark, SSM
- **13:55-14:20** Radionuclide transport behaviour in barrier materials, Dr. Gianni Vettese, Helsinki University
- **14:20-14:45** Biodegradation of waste and steel corrosion, Minna Vikman & Pauliina Rajala, VTT Technical Research Centre of Finland Ltd.
- **14:45-15:00** Concluding remarks and closure of the seminar.

Performance of a landfill type near surface repository

P. Keto, T. Schatz, V. Rinta-Hiiro & S. Naumer
VTT Technical Research Centre of Finland Ltd.

Disposal concept



Design option based on hazardous waste landfills

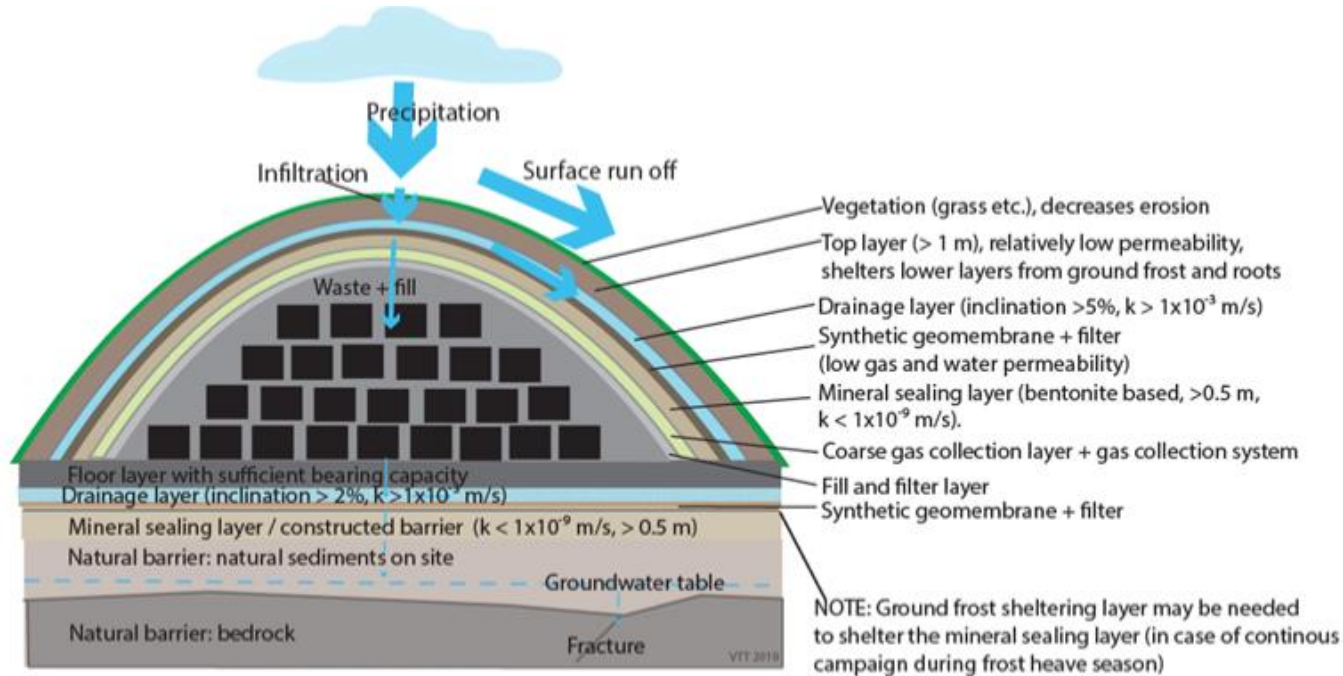


Figure 7-2. Example of a landfill type near surface repository based on Finnish guidelines for hazardous waste landfills (SYKE, 2002, 2008).

Preliminary safety functions / performance targets (1/4)

- Cover layer:
 - Function as a radiation shield (radiation levels at the ground surface should be the same as the natural background level).
 - Limit infiltration of water (surface runoff, precipitation or floodwaters) into the repository (role of drainage layer, synthetic and mineral sealing layer with sufficiently low hydraulic conductivity, e.g., $k \leq 1 \times 10^{-10}$ m/s)
 - Control and/or collect gases generated in the waste.
 - Minimise the effect of erosion and freezing/thawing on the performance of the repository barriers (top layer thickness, grass).
 - Prevent intrusion of vegetation (roots) or animals into the repository (top layer thickness).
 - *Prevent unintended human intrusion (SSM's presentation).*
 - Provide mechanical stability (avoidance of slip planes, uneven settlements).

Preliminary safety functions / performance targets (2/4)

- Fill material around the waste packages:
 - Fill voids between the waste packages.
 - Provide drainage function to minimise corrosion of the waste packages.
 - Provide stable chemical conditions for the waste packages.
 - Provide sorption capacity to retard transport of radionuclides.
 - Minimise uneven settlements within the waste fill and in the overlying layers belonging to the cover structure.

Preliminary safety functions / performance targets (3/4)

- Foundation layer
 - Provide a mechanically stable foundation for the waste packages and overall disposal structure.
 - Control and collect leachates via a drainage system enabling monitoring of radiation levels (see next slide).
 - Prevent infiltration of leachates into the groundwater; the lower sealing layer prevents such infiltration even if the drainage systems doesn't function properly, and also in the case of insufficient natural barrier thicknesses.
 - Retard/limit transport of radionuclides into the surrounding environment.
 - Resistance to freeze/thaw effects if there is risk of freezing before the overlying waste packages and barrier materials are installed.

Preliminary safety functions / performance targets (4/4)

- Drainage systems
 - Inclinations and ditches are needed at the surface level of the repository to direct accumulating surface water away from the repository area.
 - A drainage system is needed in the cover layer to direct infiltrated water away from the waste fill and waste packages.
 - A drainage system shall collect leachates from the foundation layer. The leachates shall be directed to a pool/well for monitoring. The pool/well system shall be designed to handle such leachates.

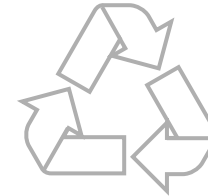
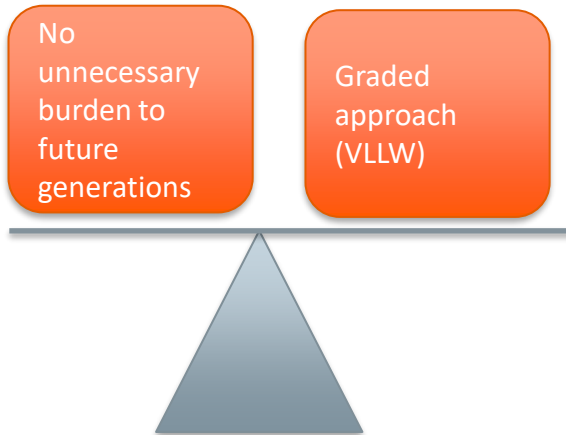
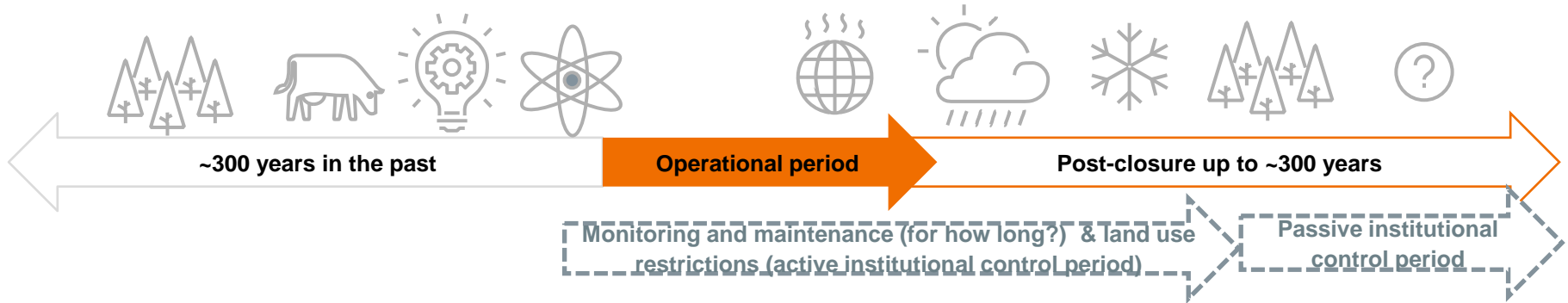
Site

- Natural barriers (soil types and thicknesses)
- Stability
- Hydrology and hydrogeology
 - Flood risks
 - Runoff water directions
 - Groundwater level and fluctuation
 - Groundwater flow directions and velocity
- Biosphere
- Controlled area
- Land-use restrictions after closure

Monitoring and maintenance needs

- Monitoring:
 - Baseline (background radiation)
 - Weather (at least precipitation)
 - Radiation levels (operational phase, post-closure) from air, leachate water well/pool, groundwater pipes).
 - Functioning of the drainage systems
 - Changes in chemical composition leachate and groundwater (electrical conductivity).
 - Gases
 - Settlements, stability and erosion
- Maintenance:
 - Upkeep of the drainage systems during the operational period
 - Cover layer preservation (erosion, vegetation, handling settlements etc.)
 - Similar care and maintenance during a post-closure active institutional control period for a time that is considered sufficient considering the waste inventory.

Life-cycle



To be considered: reduce, pre-treatment (volume reduction, burning), reuse/recycle and recovery (e.g. methane recovery). Especially decommissioning waste.

Reports

- KYT SURFACE Near Surface Repositories in Finland. Keto, P., Gharbieh, H., Carpén, L., Ferreira, M., Somervuori, M., Rinta-Hiiro, V., Laikari, A., Jafari, S. & Vikman, M. 2019. VTT-R-00124-20
- KYT SURFACE Performance of Landfill-Type Near Surface Repository. Interim report 2020. Research report VTT-R-00016-21.
- New interim 2021 report in preparation, summary report in 2022.
- <http://kyt2022.vtt.fi/projektit.htm>

**Kiitos, Tack, Takk, Thank
You, Danke Schön**