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MODELLING OF NUCLIDE MIGRATION FOR SUPPORT OF THE SITE SELECTION FOR NEAR SURFACE REPOSITORY IN LITHUANIA

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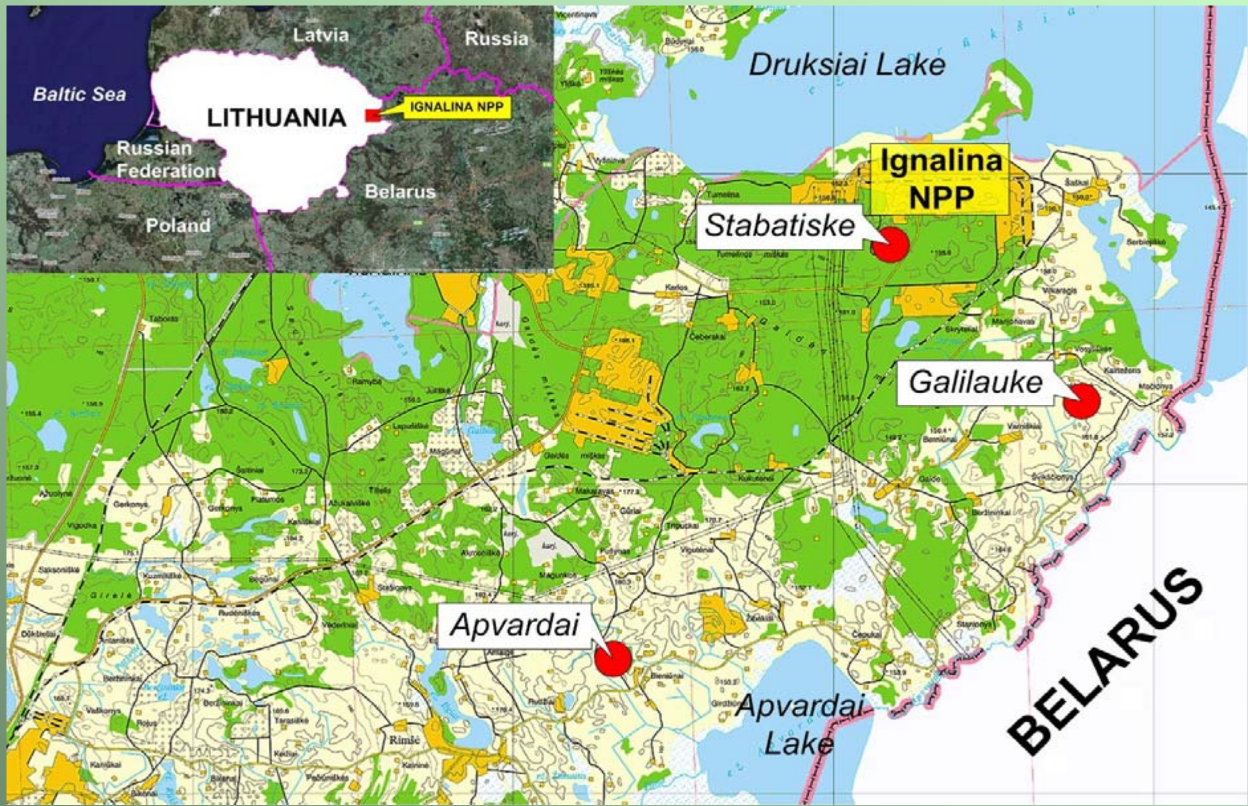
CONCEPTUAL DESIGN OF THE NEAR SURFACE REPOSITORY

1 – entrance, security check
2 – administration, central control room and laboratory
3 – interim (buffer) storage of radioactive waste packages
4 – facility for service systems and equipment
5 – waste disposal area and shelter

- **Construction of the near surface repository for disposal of short lived low- and intermediate- level waste is planned in Lithuania.**
- **Reference design of the repository was prepared in 2002.**
- **According to the conceptual design the repository would consist of 50 vaults with total disposal volume of 100 000 m^3.**
- **Operation of the repository is planned until 2030 while the Ignalina NPP will be dismantled and the conditioning of radioactive waste will be performed.**

THREE CANDIDATE SITES FOR CONSTRUCTION OF NSR



- After geological engineering investigations North-eastern Lithuania and vicinity of Ignalina NPP in particular are identified among the best suitable regions for a near surface repository.
- Short distance from the Ignalina NPP, relatively favourable social-economic conditions and good level of geological characterization are the main positive features of Ignalina NPP region.

METHODOLOGY

- Potential releases of radionuclides to water pathway and expected human exposure after closure of disposal facility are assessed for support of the site selection for NSR intended to construct in Lithuania.
- The assessments have been performed following ISAM methodology recommended by IAEA for safety assessments of near surface disposal facilities. It consists of key components as follows:

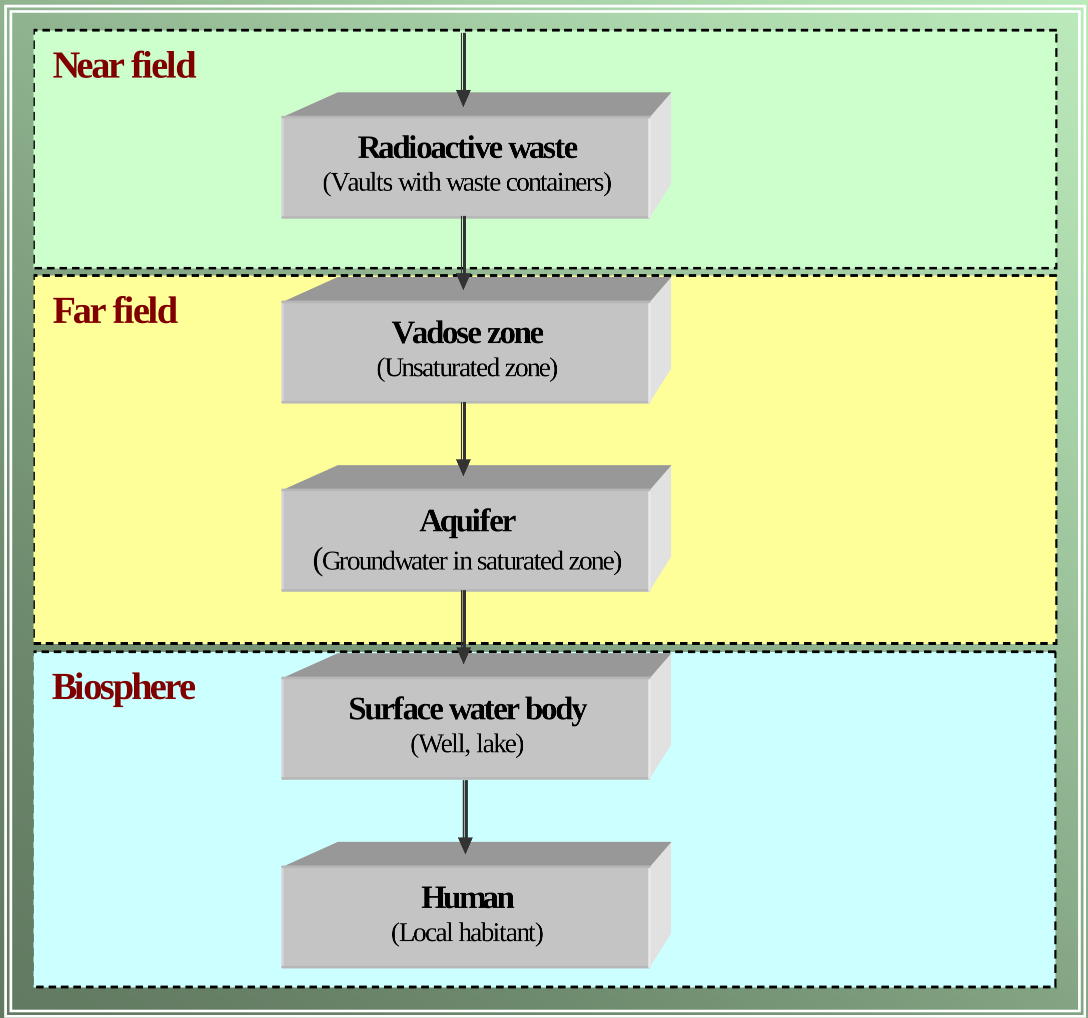
1. Assessment context.
2. Description of the disposal system.
3. Radionuclide migration scenario development and justification.
4. Model formulation and implementation.
5. Calculations.
6. Analysis of the results.
7. Confidence building.

ASSESSMENT CONTEXT

- Dose constraint of 0.2 mSv per year to public is required for nuclear installations in Lithuania and stands for radiological criteria in the present assessment.

- The evolution of the repository within institutional control period for 300 years (*100 years* for active control and *200 years* for passive control) and during subsequent period is considered in order to assess potential releases of long-lived radionuclides.

DESCRIPTION OF THE DISPOSAL SYSTEM: Key components



Disposal system consists of three main components:

1. RAW surrounded by engineered barriers makes up so-called Near Field.

2. Far Field contains the Vadose zone and Aquifer.

3. Surface water bodies and Human are included into the Biosphere.

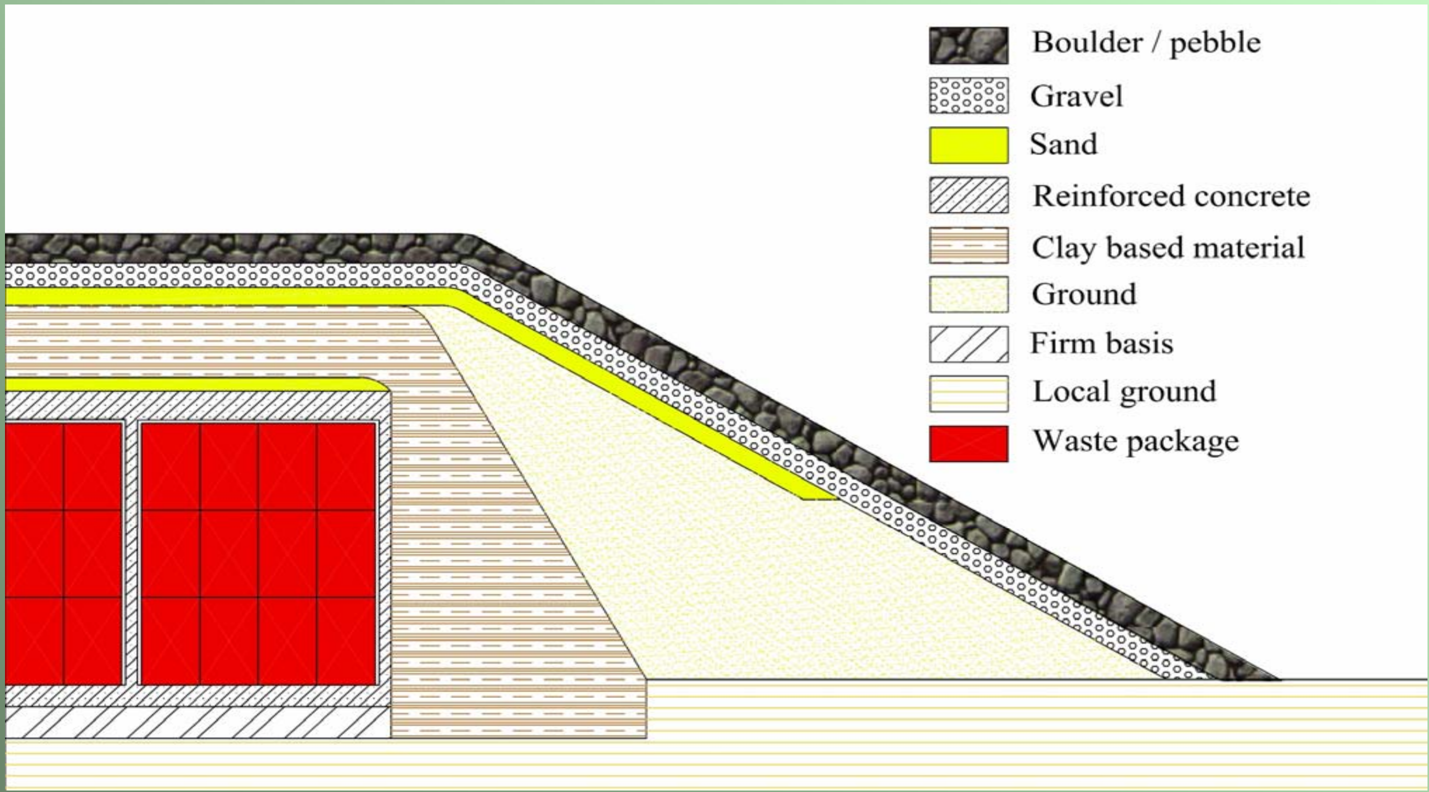
DESCRIPTION OF THE DISPOSAL SYSTEM: Wastes

CLASS		RADIONUCLIDE
Short-lived	Weak sorbtion	H-3
		Cs-137
		Sr-90
	Strong sorbtion	Pu-241
Long-lived	Weak sorbtion	C-14
		I-129
		Ni-59
		Ni-63
	Strong sorbtion	Nb-94
		Tc-99
		Am-241
		U-234
		U-235
		U-238
		Np-237
		Pu-238
		Pu-239
		Pu-240

- Only finally conditioned solid or solidified short-lived low- and intermediate-level waste that meet waste acceptance criteria will be disposed off in the repository.

- The cemented radioactive waste (cement matrixes) containing ion-exchange resins, perlite and sediments with total initial activity estimated to $\sim 1.1 \times 10^9$ MBq are considered in the present safety assessment.

DESCRIPTION OF THE DISPOSAL SYSTEM: Repository



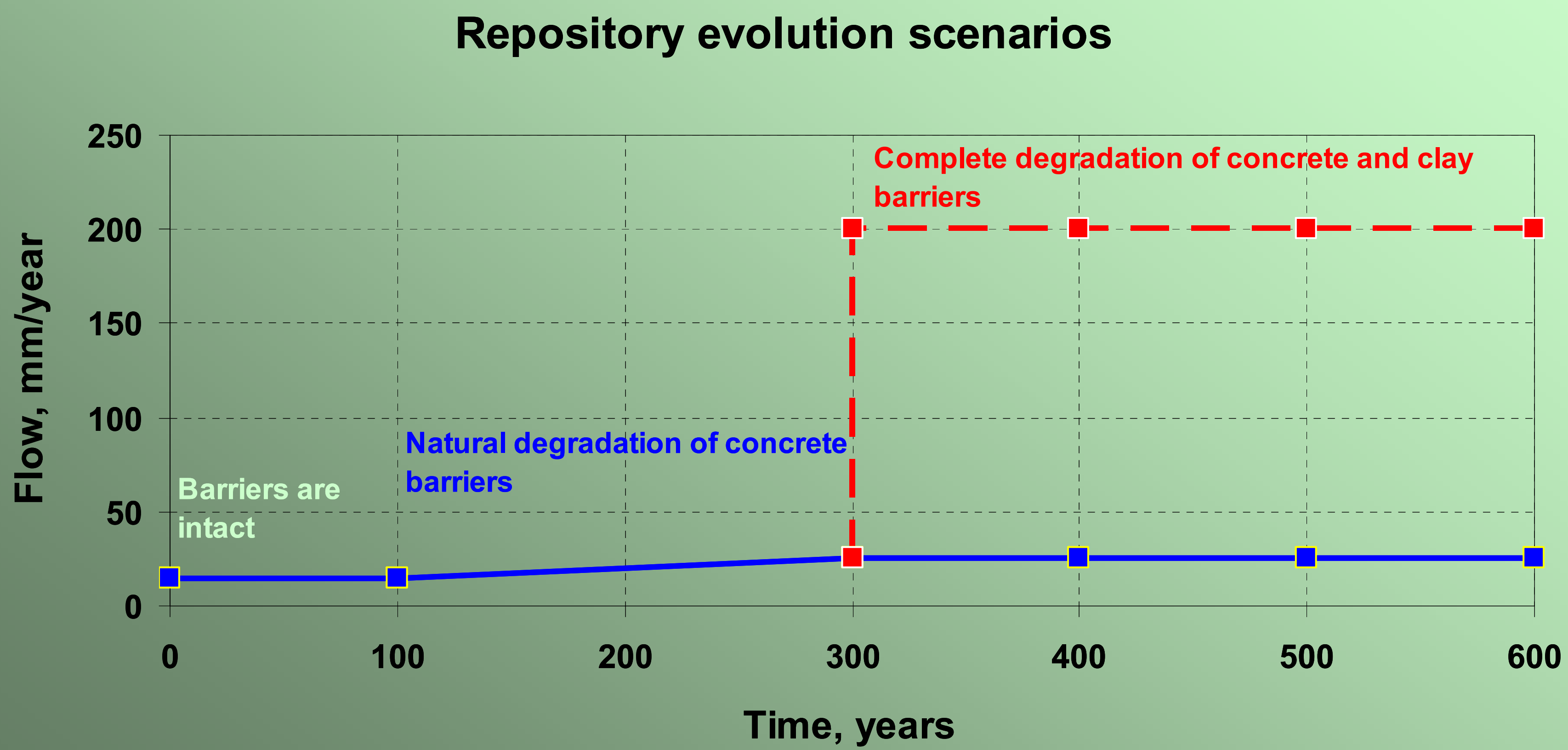
The engineered barriers of the facility consist of *concrete vaults* surrounded by low-permeable *clay-based material* and the whole system is being covered by long-lasting and erosion resisting *cap*.

DESCRIPTION OF THE DISPOSAL SYSTEM: Biosphere

Site	Discharge place
Galilauke	***Well*** at a distance of 150 m from the repository (at the fence)
Apvardai	***Well*** at a distance of 150 m from the repository (at the fence) ***Lake*** at a distance of 1 300 m from the the repository

- **The typical exposure pathway, exactly the well installed 150 m from the edge of the repository (at the fence surrounding the repository), is determined for Galilauke site.**
- **Two exposure pathways, namely the well distant 150 m and the lake distant 1300 m from the edge of the repository have been determined in case of Apvardai.**

SCENARIOS DEVELOPMENT



CALCULATIONS

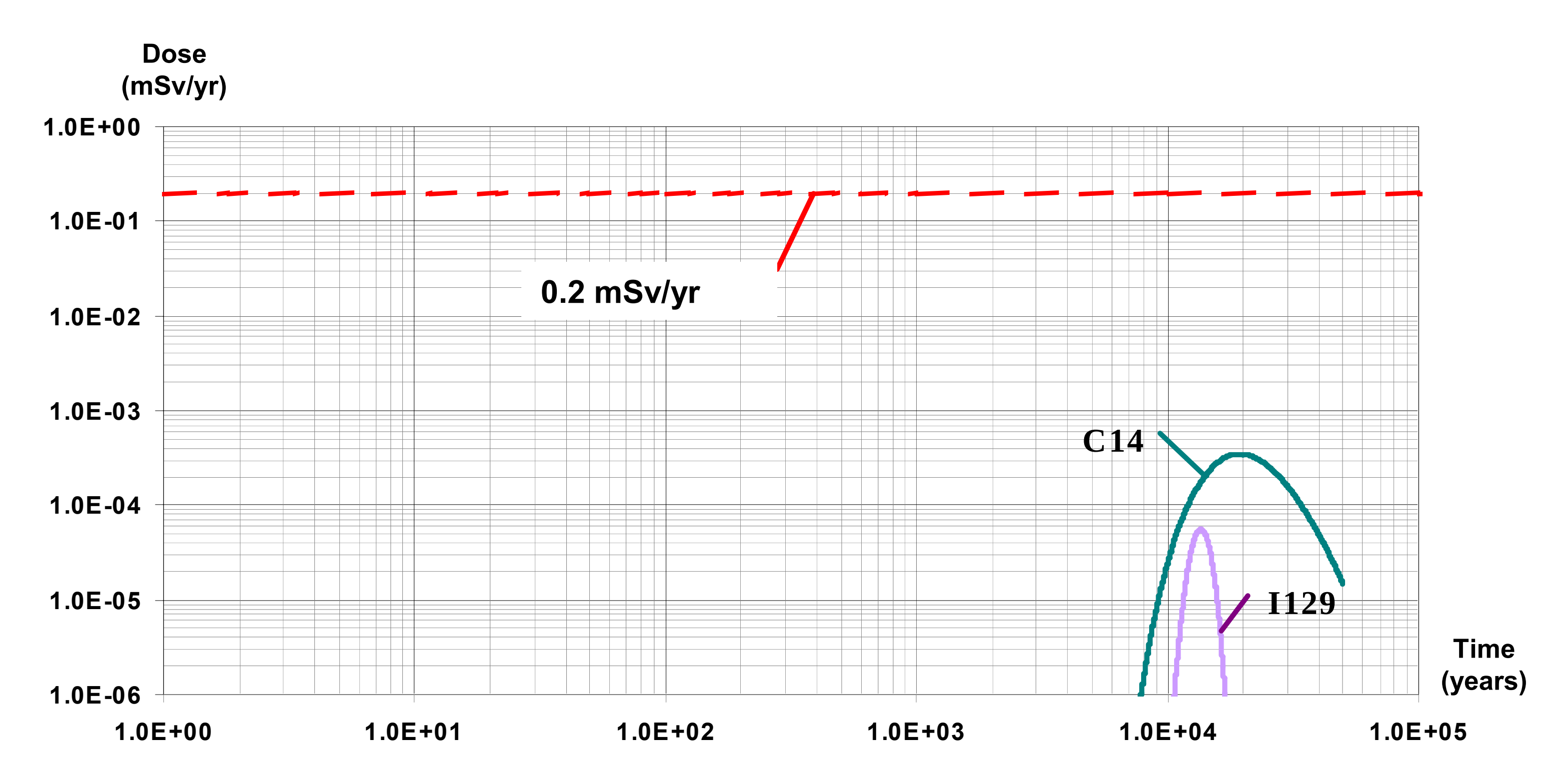
- **Radionuclide migration in the repository and vadose zone has been assessed using 1-D equation of advective-diffusive transfer with respect to processes of dispersion and radioactive decay. Model is implemented in *DUST computer program*.**

- **Radionuclide migration through the aquifer has been assessed solving 1-D equation of advective transfer with respect to processes of dispersion and radioactive decay. Model is implemented in *GWSCREEN computer program*.**

- **Radionuclide transport and potential exposure to human is implemented using *AMMBER software.* 1-D differential equation modelling the radionuclide exchange between the components of the biosphere system has been solved with respect to radioactive decay.**

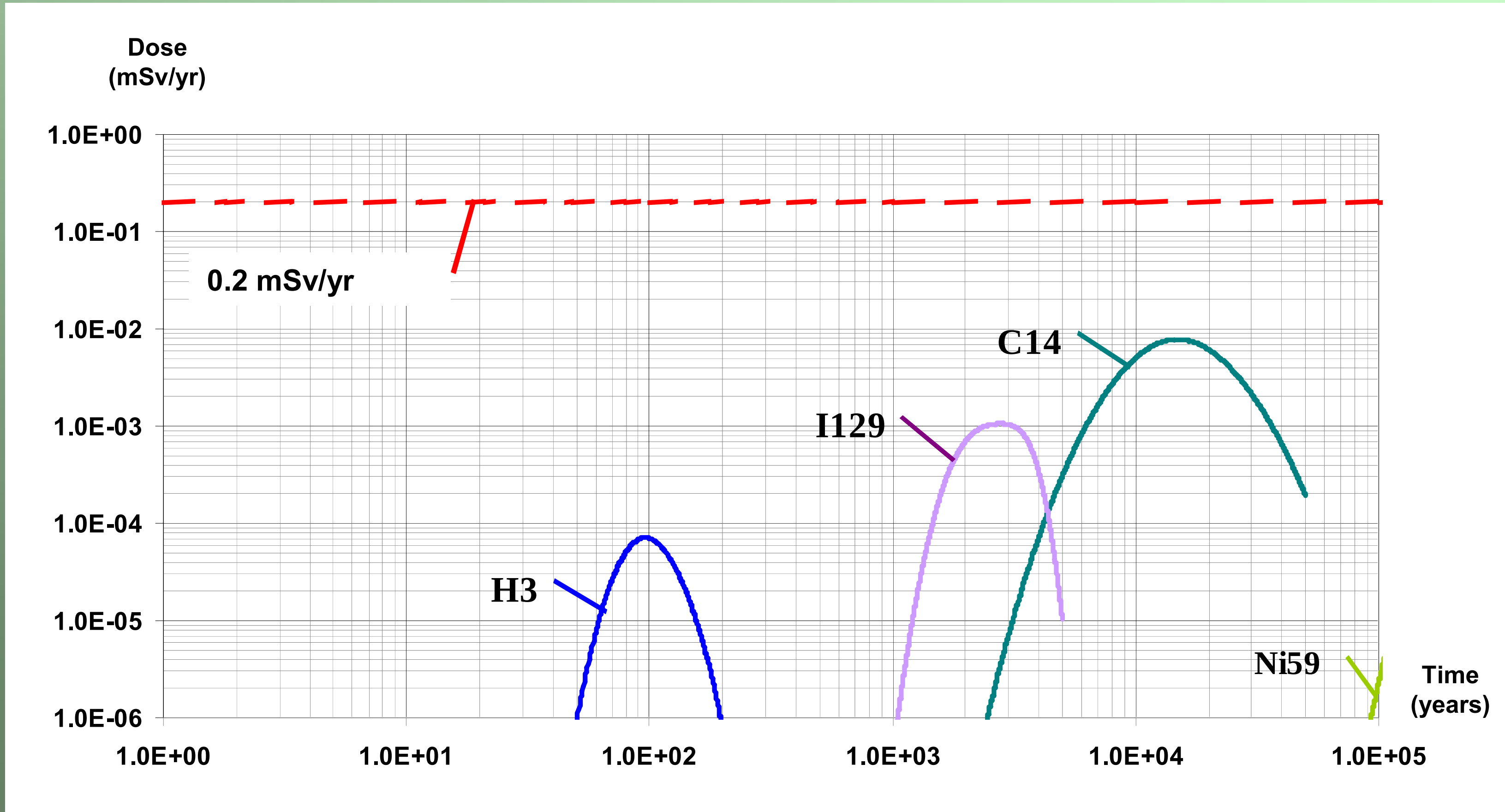
RESULTS: normal evolution scenario

After analysis of radionuclide migration through the disposal system it is found out that only 12 radionuclides will reach biosphere zone. *Cs-137, Sr-90, Pu-238, Pu-241, Ni-63, Am-241* would not reach places of discharge.



Dose rate for *Well* exposure pathway at Galilauke site

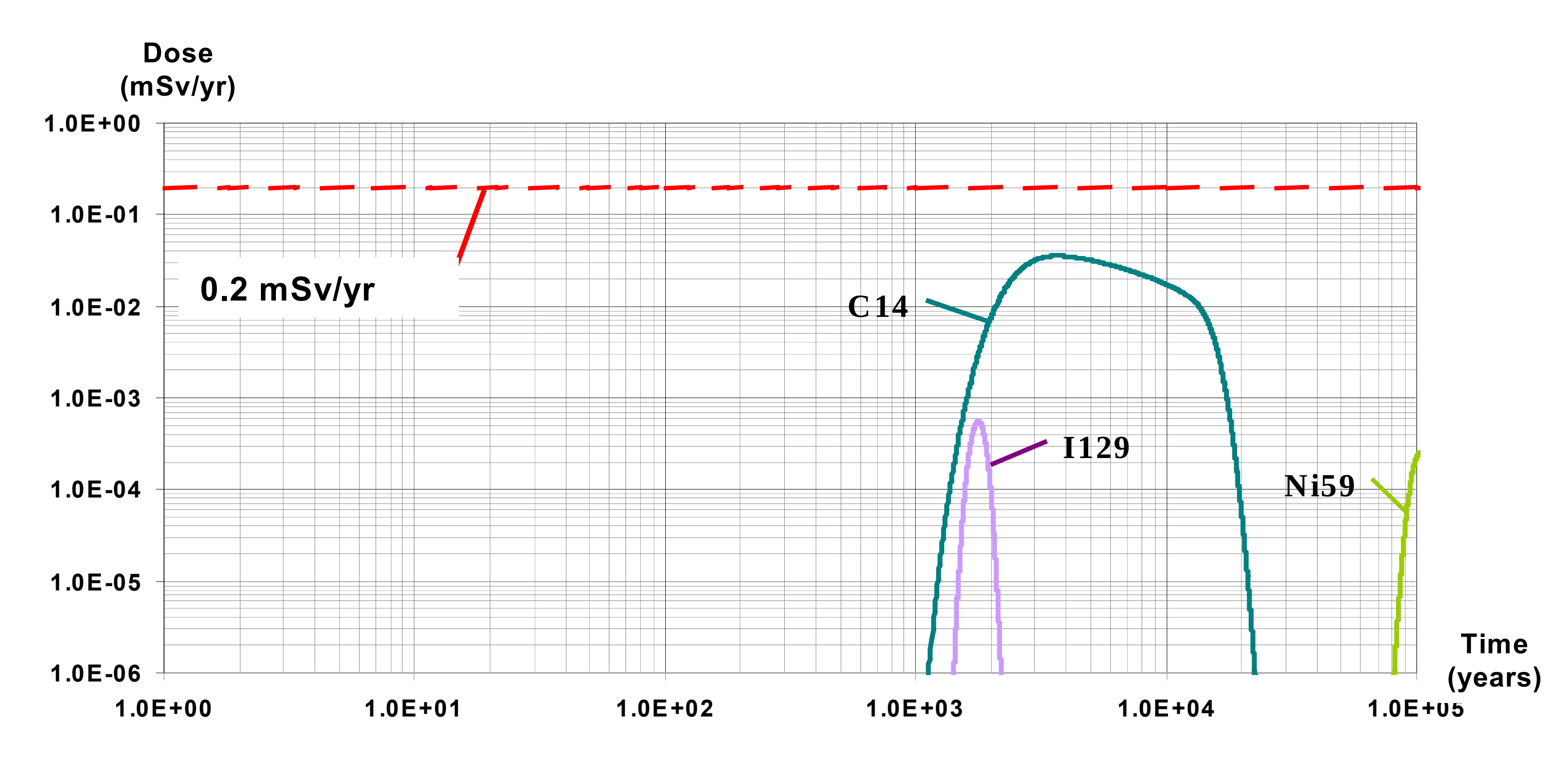
RESULTS: normal evolution scenario



Dose rate for *Well* exposure pathway at Apvardai site

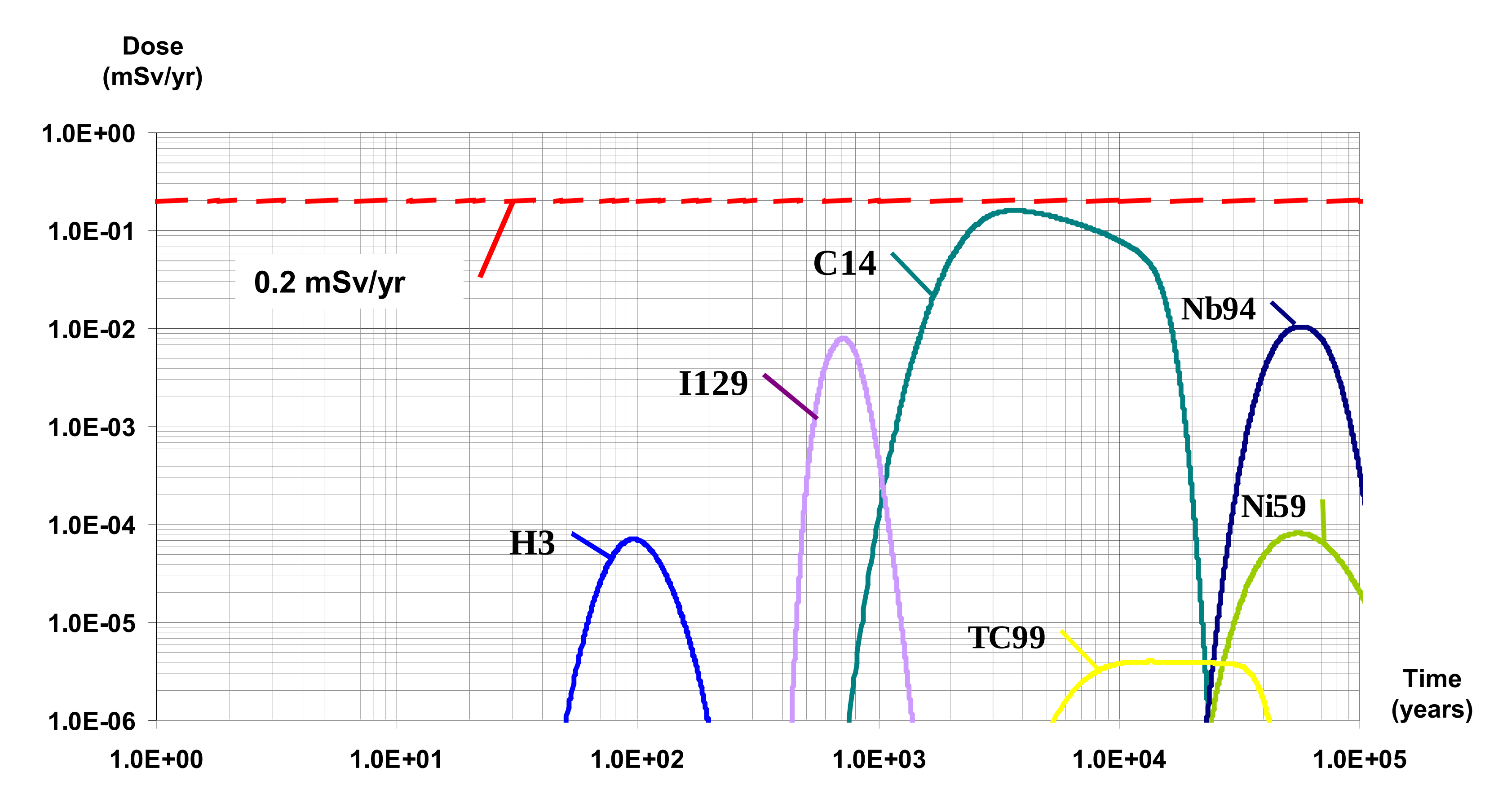
RESULTS: barrier degradation scenario

After analysis of radionuclide migration through the disposal system it is concluded that only 12 radionuclides will reach biosphere zone. *Cs-137, Sr-90, Pu-238, Pu-241, Ni-63, Am-241* would not reach places of discharge.



Dose rate for *Well* exposure pathway at Galilauke site

RESULTS: barrier degradation scenario



Dose rate for *Well* exposure pathway at Apvardai site

CONFIDENCE BUILDING: Conservative assumptions

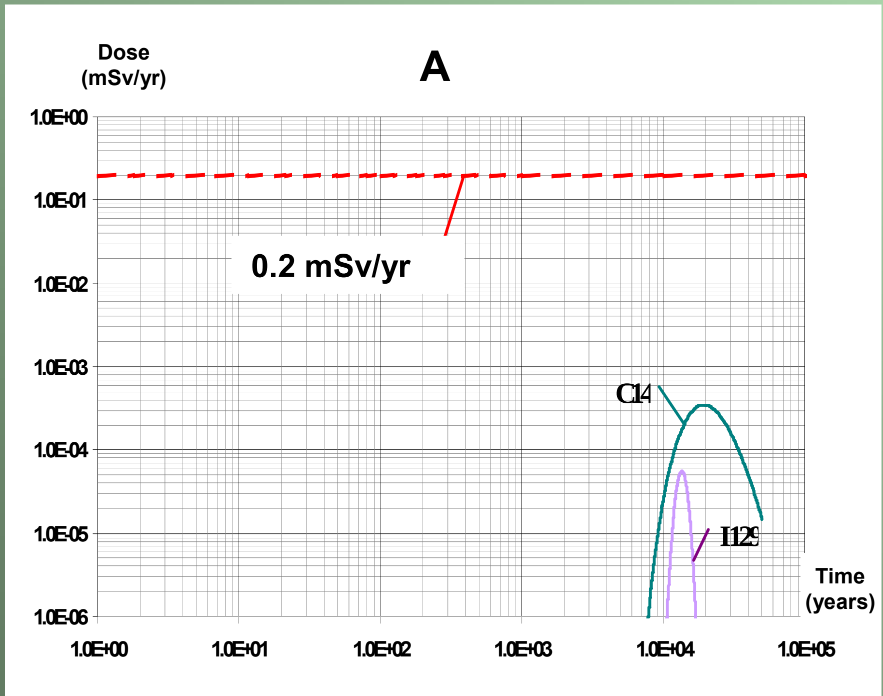
1. The results of estimates should be accepted as conservative due to assumptions as follows:

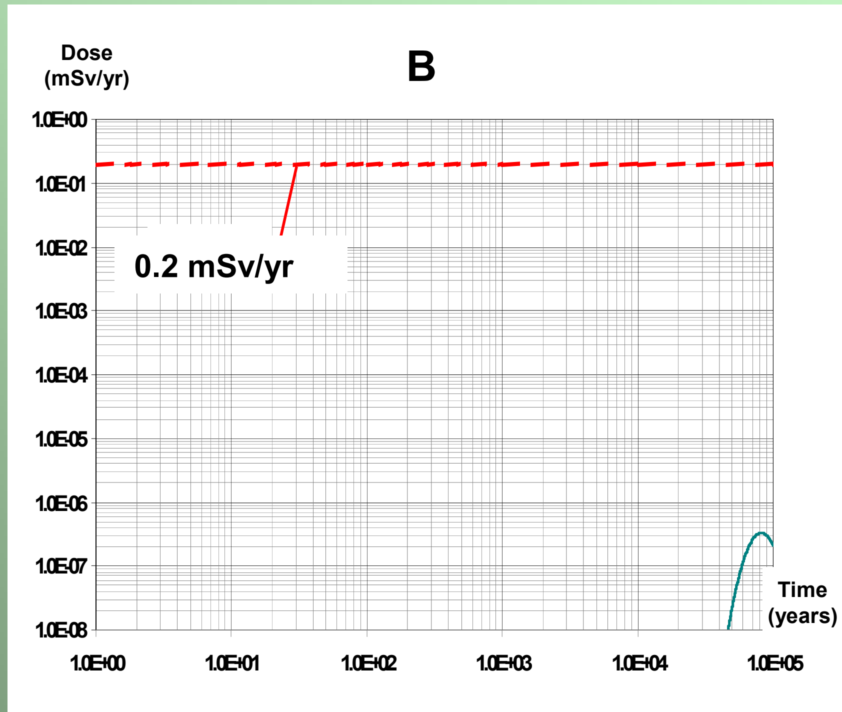
- **The percolation/saturation time through the repository is not taken into account.**
- **The radionuclide leaching from waste matrix was not modelled (instant release is assumed).**
- **Solubility limits of radionuclides are not taken into account.**
- **Initial activities of radionuclides are estimated for the beginning of operation period (not closure).**
- **1-D dispersion is considered in transport analysis in aquifer zone for most radionuclides.**
- **Higher than average values typical for Lithuania for foodstuff consumption rates are used for dose assessment.**
- **Possible restrictions on activities within sanitary protection zone (300 m) were not taken into consideration, i.e. well installed on boundary (at the fence) of the repository (150 m) is assumed.**

CONFIDENCE BUILDING: Uncertainty analysis

2. Three types of uncertainties are analyzed:

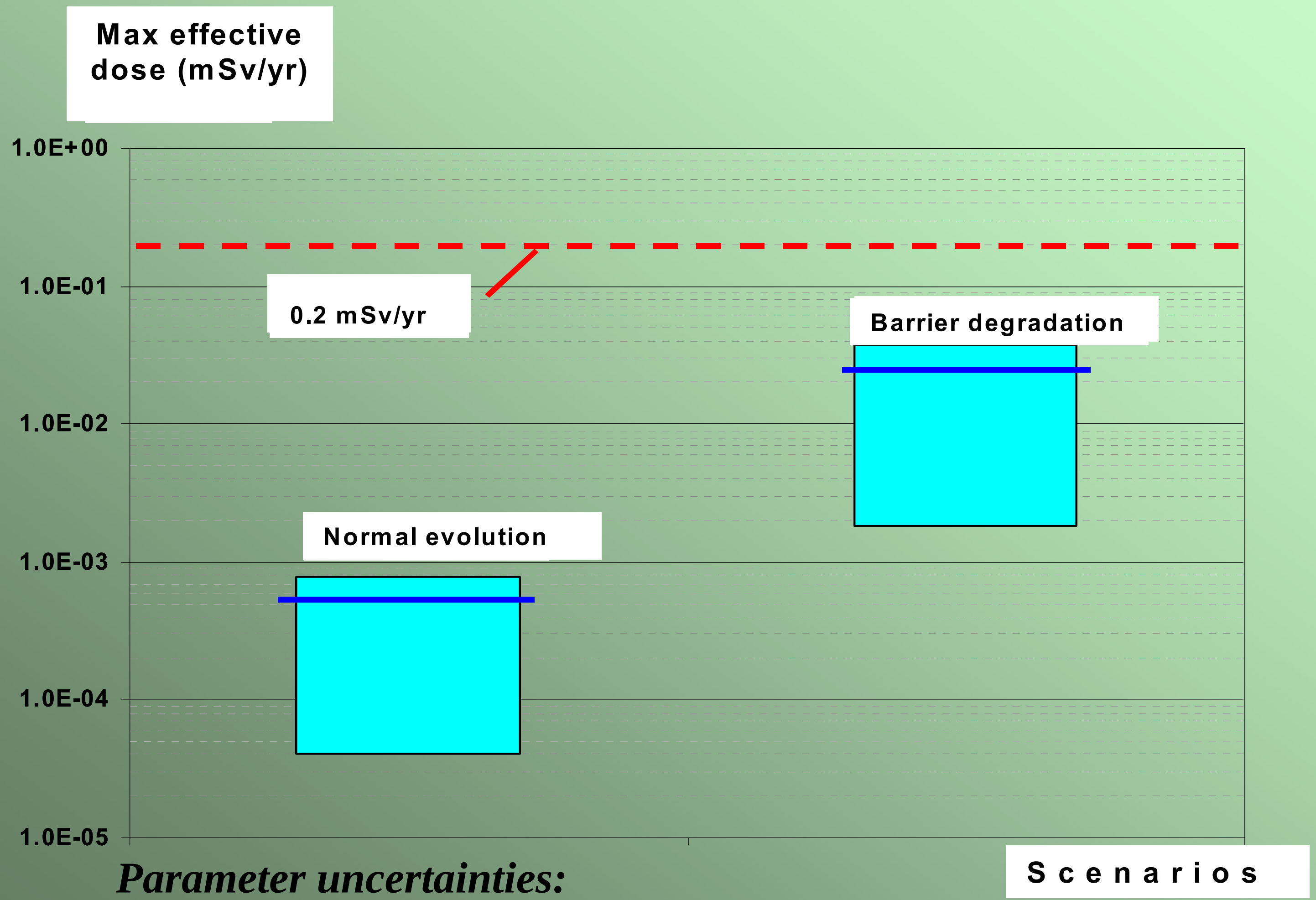
- Scenario uncertainties.
- Parameter uncertainties.
- Model uncertainties.





Scenario uncertainties: **A-vertical flow in vadose zone; B-horizontal flow in vadose zone**

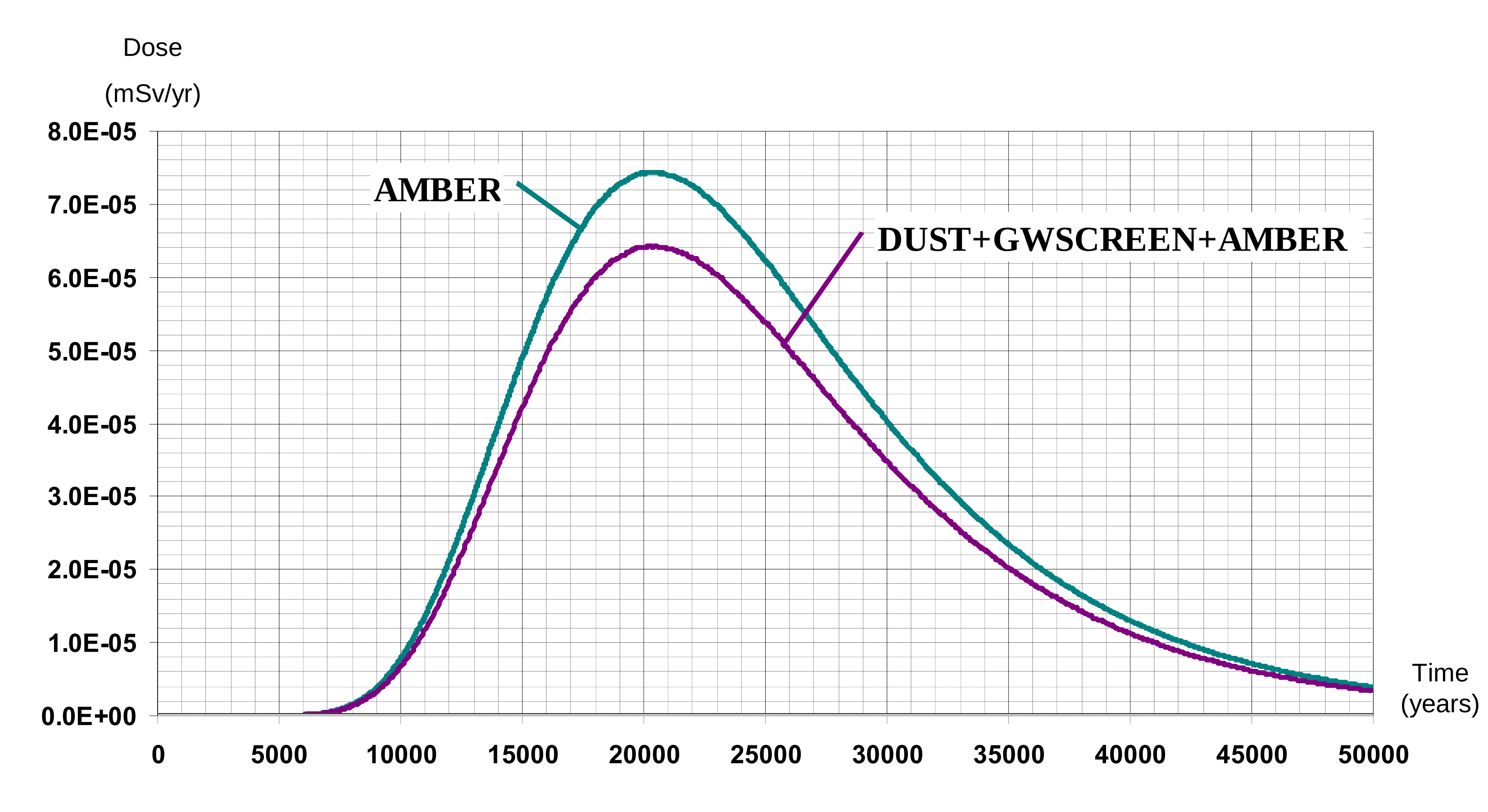
CONFIDENCE BUILDING: Uncertainty analysis



Parameter uncertainties:

Lake model, C-14 radionuclide; dashes – for most likely values

CONFIDENCE BUILDING: Uncertainty analysis



Model uncertainties: **normal evolution scenario; C-14 radionuclide**

CONCLUSIONS

After preliminary assessment of the potential releases of radionuclides from the near surface repository to the groundwater pathway with respect to the estimated radionuclide inventory, conceptual design of the disposal facility intended to construct in Lithuania as well as peculiarities of the two candidate sites called Galilauke and Apvardai it is possible to conclude that:

1. **Expected doses estimated for both candidate sites are below the dose constraint of 0.2 mSv per year established by regulations of Republic of Lithuania.**

2. **Expected doses are less in case of Galilauke site in comparison to Apvardai site.**

3. **Due to rather conservative assumptions taken for the analysis of radionuclide migration the estimated doses should be considered as overestimated.**

THANK YOU