Computational Tools Used by NRC Staff for LLW Risk Analysis

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Overview

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- Role of NRC
- Independent modeling and analysis
- Tools/products
- Examples
- Conclusions

Role of NRC

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- All currently operating LLW disposal facilities are located in Agreement States
- NRC does not perform independent modeling of facilities located in Agreement States
- NRC performs technical analysis of many analogous programs:
  - Incidental waste (DOE)
  - Decommissioning
  - Uranium recovery

Independent Modeling and Analysis

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- Independent modeling has many benefits:
  - Better understanding
  - Ability to risk-inform the review
  - Shortens review time
  - Better identify critical issues in complex systems

LLW Modeling– Do's and Don'ts

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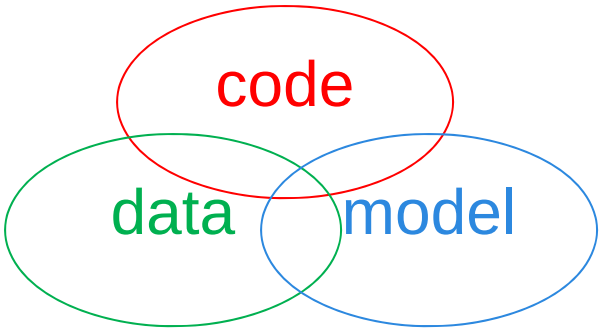
Do's

- Select code for problem
- Improve code if needed
- Ensure QA
- Provide model support
- Account for uncertainty and variability



Don'ts

- Force code to fit problem
- Limit analysis to scope of code
- Use codes without QA
- Use sophisticated codes when you have little data
- Select codes based solely on familiarity

Codes Used by NRC PA Staff*

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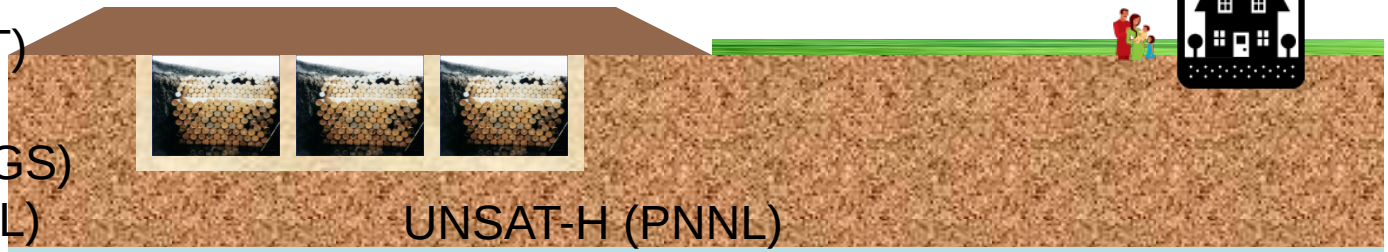
GoldSim (GTG), RESRAD (ANL), D&D (ANL)

HELP (US COE)
Siberia (Telluric Research)

GENII (PNNL)
BDOSE (CNWRA)



4SIGHT (NIST)
BLT (BNL)
PHREEQC (USGS)
DUST-MS (BNL)
Geochemist's Workbench (Rockware)

UNSAT-H (PNNL)
PORFLOW (ACRi)
TOUGH2 (LBNL)
GMS (AquaVeo)
MODFLOW/MT3DMS (USGS)

Others – Microshield (Grove Software)
Mathematica (Wolfram)
Neuralworks Predict (NeuralWare)
ArcGIS (ESRI)
MVS (Ctech)
Earthvision (Dynamic Graphics)
MCNP (LANL)
SADA (U of Tenn)

*NRC general usage of codes is not an endorsement of any specific code for a specific site

NRC Code Usage – Example #1

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- Using GIS to generate information for a performance assessment model
- West Valley Demonstration Project site near Buffalo, NY (decommissioning)
- Combined ArcView and GoldSim (eventually added Siberia and BDOSE)
- Esh and Gross (WM06)

NRC Code Usage – Example #1

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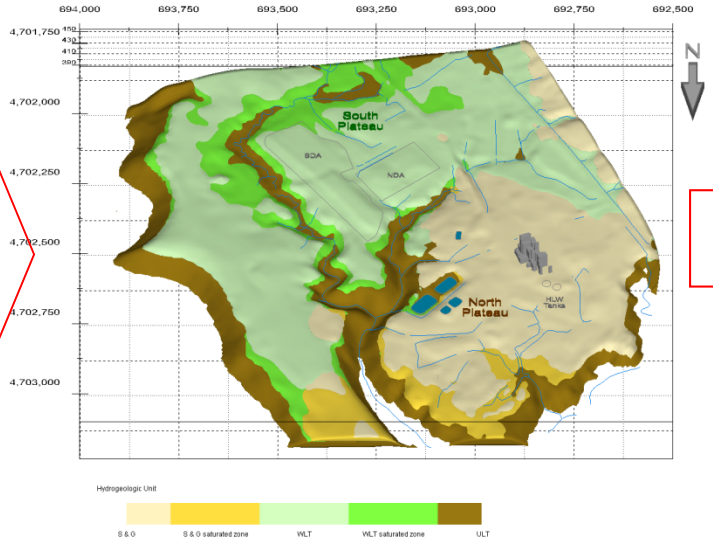

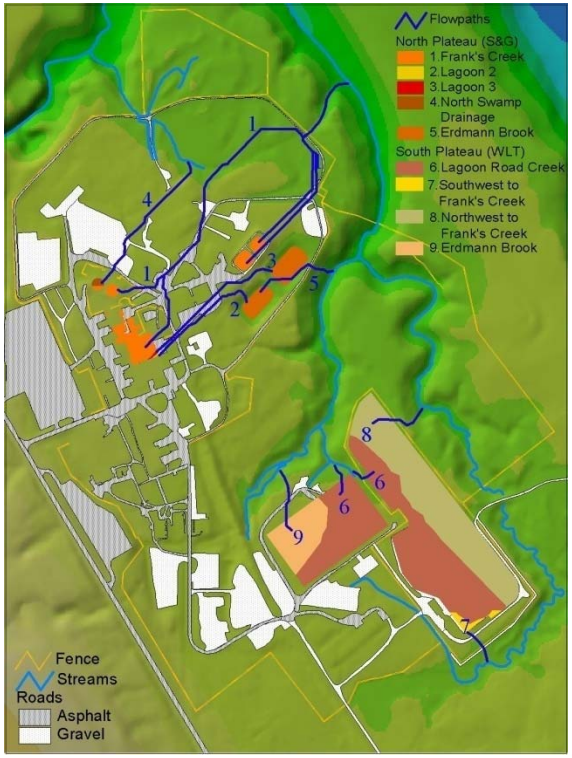

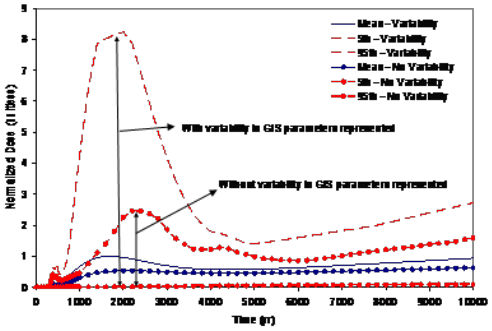

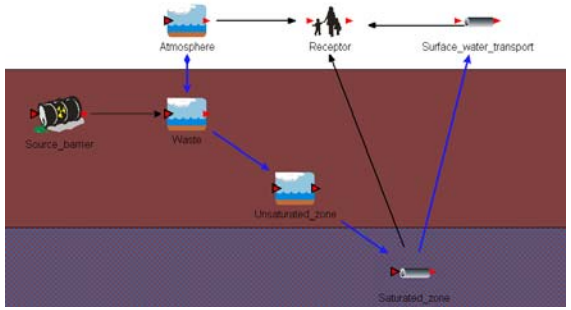

NRC Code Usage – Example #2

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- Developed a performance assessment model to perform independent modeling of a waste disposal facility
- Savannah River Site Saltstone Disposal Facility near Aiken, SC
- Developed completely in GoldSim
- Esh, Ridge, Thaggard (WM06)

NRC Code Usage – Example #2

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- GoldSim® software
- Probabilistic assessment
- Specialized elements facilitate radionuclide transport modeling
- 2,600 GoldSim elements, more than 300 stochastic elements
- Numerous submodels
  - Degradation of engineered cap
  - Oxidation of cementitious waste
  - Physical degradation of cementitious waste
  - Advective and diffusive releases
  - Transport in unsaturated and saturated zones
  - Dose assessment
- Modeling used abstractions

NRC Code Usage – Example #2

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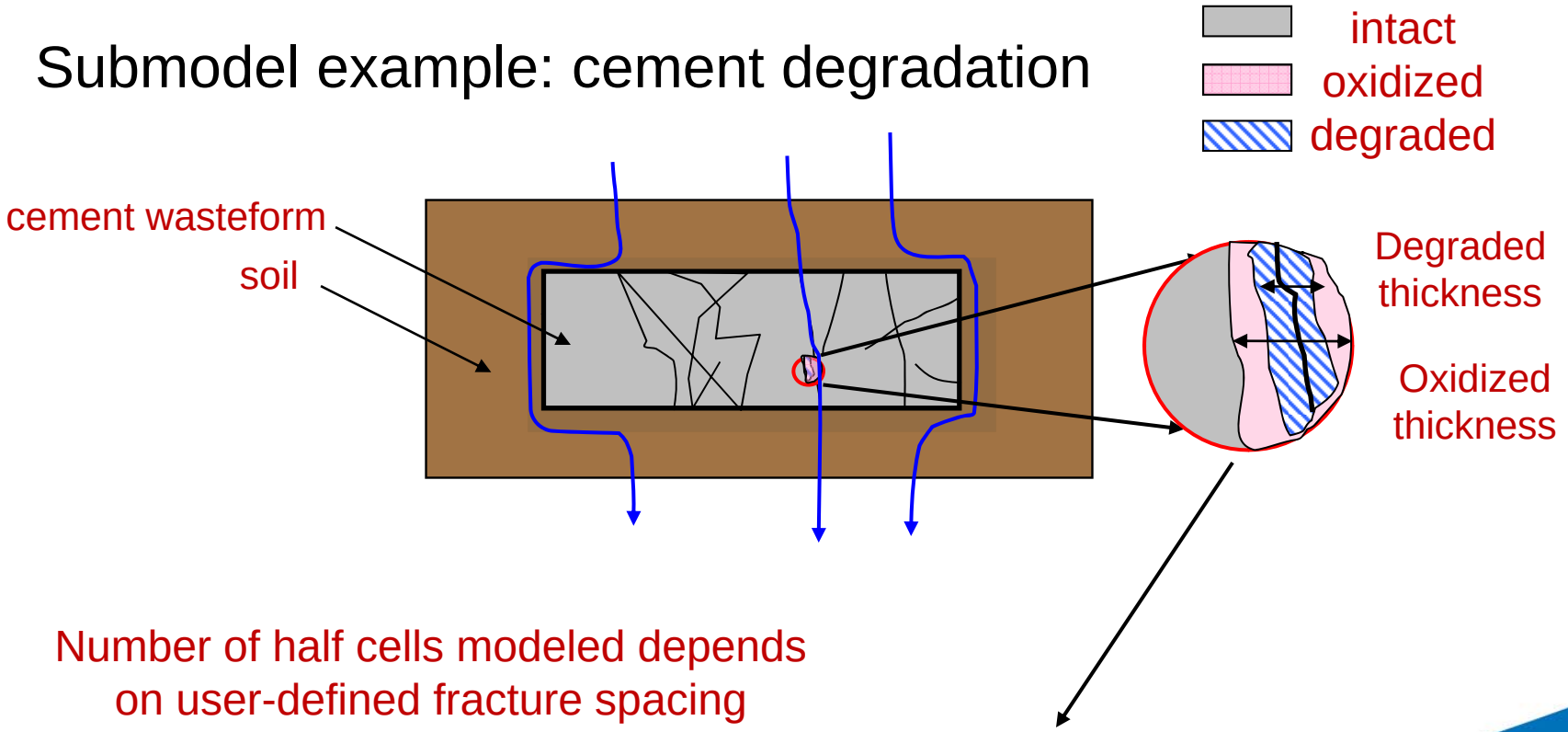
Submodel example: cement degradation



NRC Code Usage – Example #2 (Uncertainty Analysis with Neuralworks Predict)

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Variable	Description	Importance Factor
Grout_deg_start	Time at which degradation of the wasteform can begin	0.98
Nm	MacMullin number. The effective diffusion coefficient is a product of Nm and the molecular diffusion coefficient.	0.93
Degraded_grout_Kh	Hydraulic conductivity for degraded region of the wasteform.	0.36
TransFactor_indoor	Factor to account for shielding of radiation when an individual is inside a residence.	0.29
Se_solubility	Solubility of Se in the pore fluid of the wasteform.	0.21
Kd_waste_Sr_ox	Distribution coefficient for Sr in the oxidized region of wasteform.	0.11
Vent_light_activity	Breathing rate for an individual during light activity.	0.11
SZ_dispersivity_factor	Used with the transport length in the saturated zone to develop the saturated zone dispersivity.	0.10
Kd_Waste_Eu	Distribution coefficient for Eu in the intact portion of the wasteform.	0.08

NRC Code Usage – Example #3

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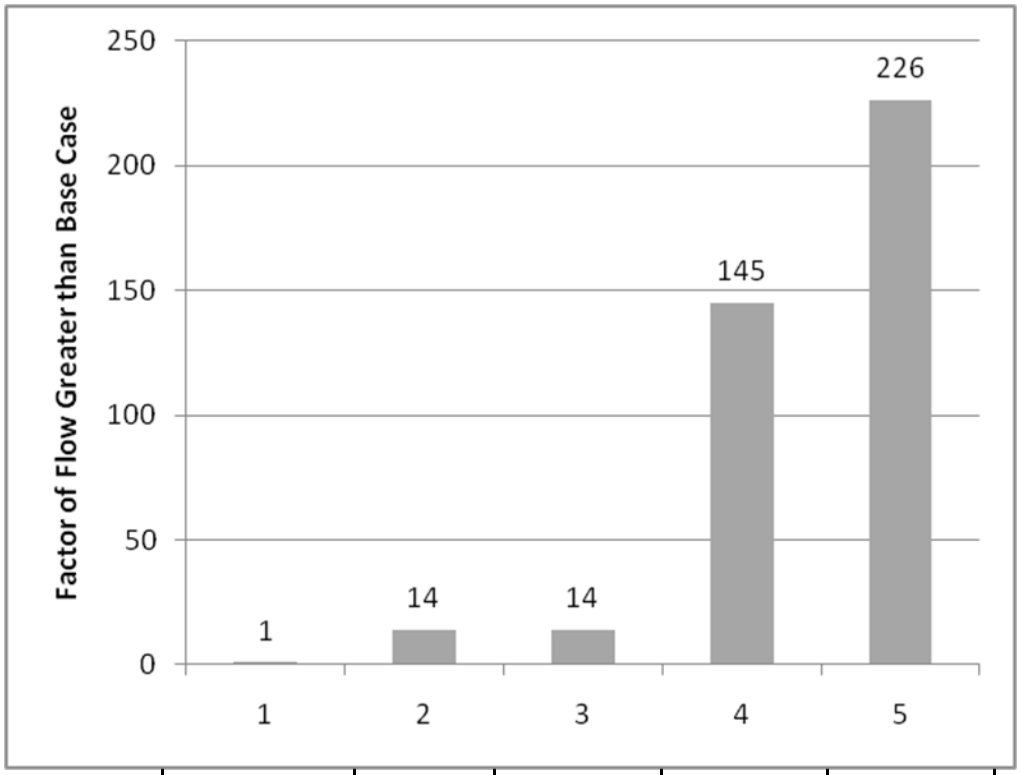
- PORFLOW was used as one submodel in a performance assessment model (DOE)
- Staff independently ran PORFLOW to test assumptions
- Staff identified key assumptions and uncertainties
- Without independent modeling, it would have been very difficult to risk-inform the review

NRC Code Usage – Example #3



Base Case	Revised: MCC for Saltstone and Clean Grout	Revised: LDL	Revised: K for Saltstone and Clean Grout	Revised: LDL; K and MCC for Saltstone and Clean Grout

Conclusions

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- NRC uses a toolbox of products to perform independent modeling
- Products must be selected for the specific problem being evaluated
- QA and model support are essential to successful LLW modeling
- It can be difficult to risk-inform a review without performing independent modeling