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Saltstone Disposal Facility Performance Assessment

NRC Request for Additional Information Discussion

January 27, 2011

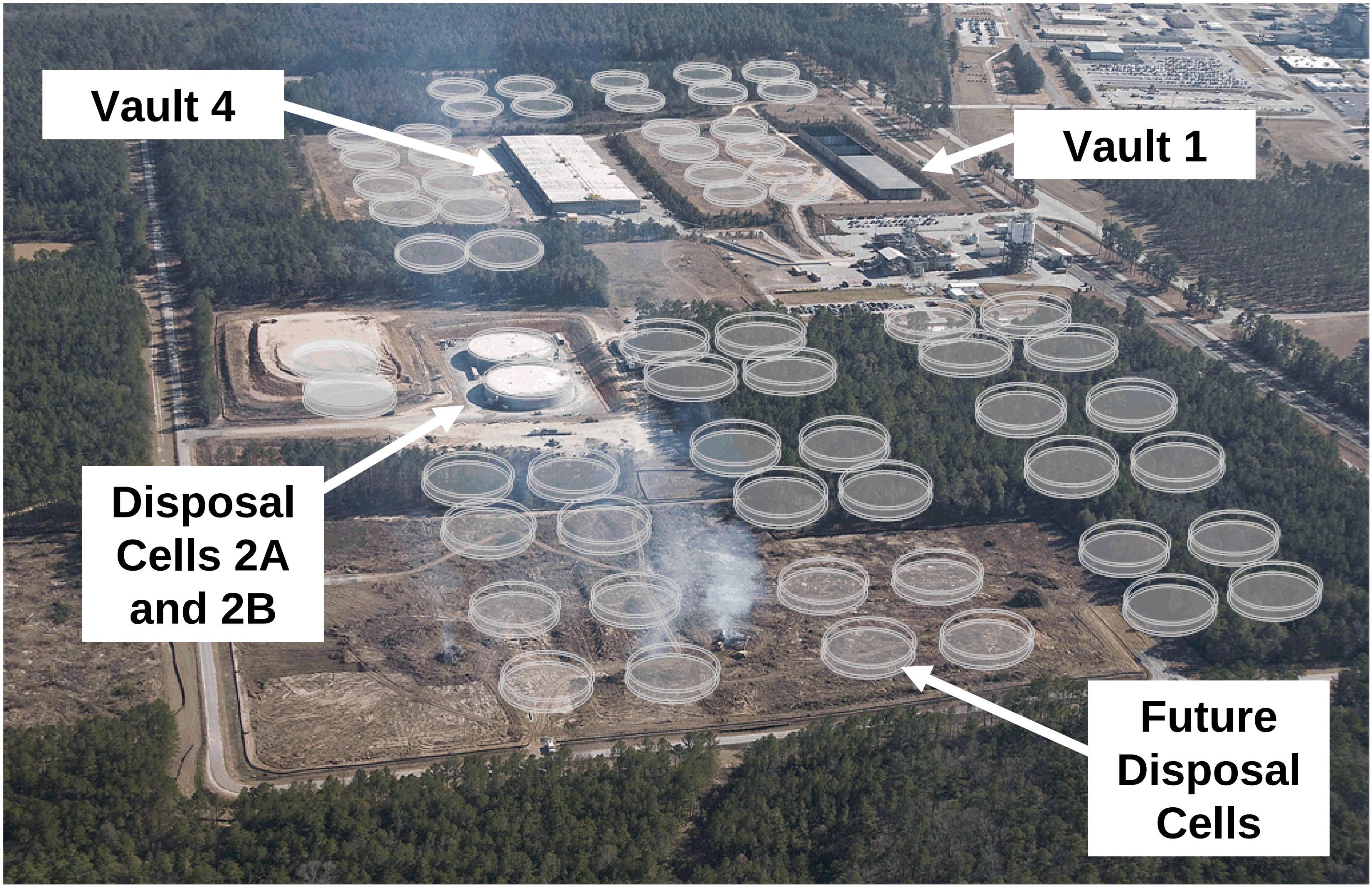
Virginia G. Dickert

Manager, Closure & Waste Disposal Authority

Public Meeting

SRR-CWDA-2011-00008

Saltstone Disposal Facility



Acronym List

ARP	-	Actinide Removal Process (Salt treatment)
Ci	-	Curie
DDA	-	Deliquification, Dissolution and Adjustment (Salt treatment)
DOE-SR	-	Department of Energy Savannah River Field Office
FTF	-	F-Tank Farm
HTF	-	H-Tank Farm
K_d	-	Distribution Coefficient
LFRG	-	Low-Level Waste Disposal Facility Federal Review Group
NDAA	-	Ronald W. Reagan National Defense Authorization Act of Fiscal Year 2005
R&D	-	Research and Development
SDF	-	Saltstone Disposal Facility
SWPF	-	Salt Waste Processing Facility (Salt treatment)
UDQ	-	Unreviewed Disposal Question
WD	-	Waste Determination associated with NDAA Section (§) 3116
Ra-226	-	Isotope of radium (half-life = 1,600 years; decay daughter of Th-230)
Tc-99	-	Isotope of technetium (half-life = 211,000 years; fission product)
Th-230	-	Isotope of thorium (half-life = 75,000 years; decay daughter of U-234)
U-234	-	Isotope of uranium (half-life = 245,000 years; naturally occurring)

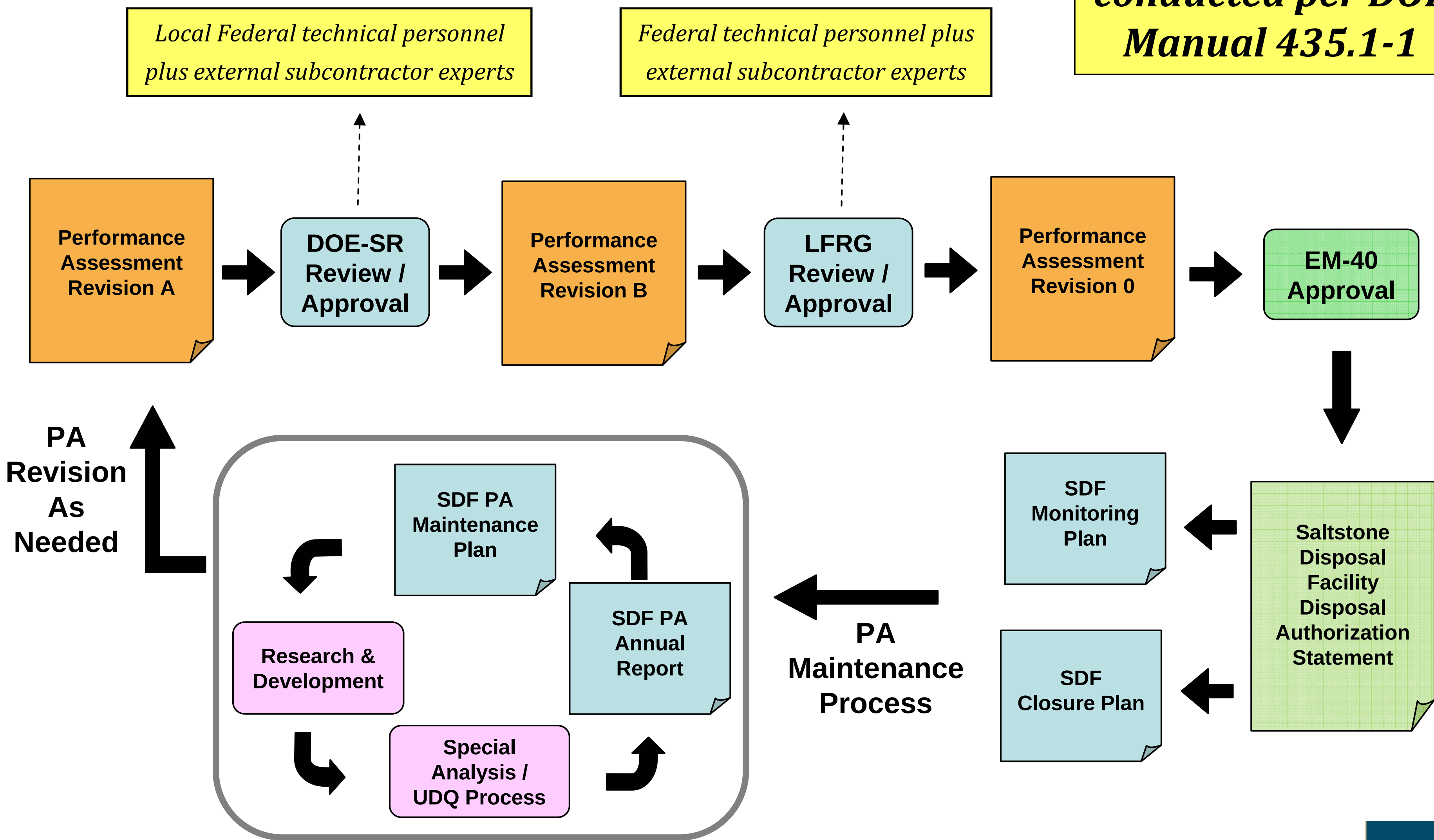
Uranium Decay Series: U-234 → Th-230 → Ra-226

Performance Assessment

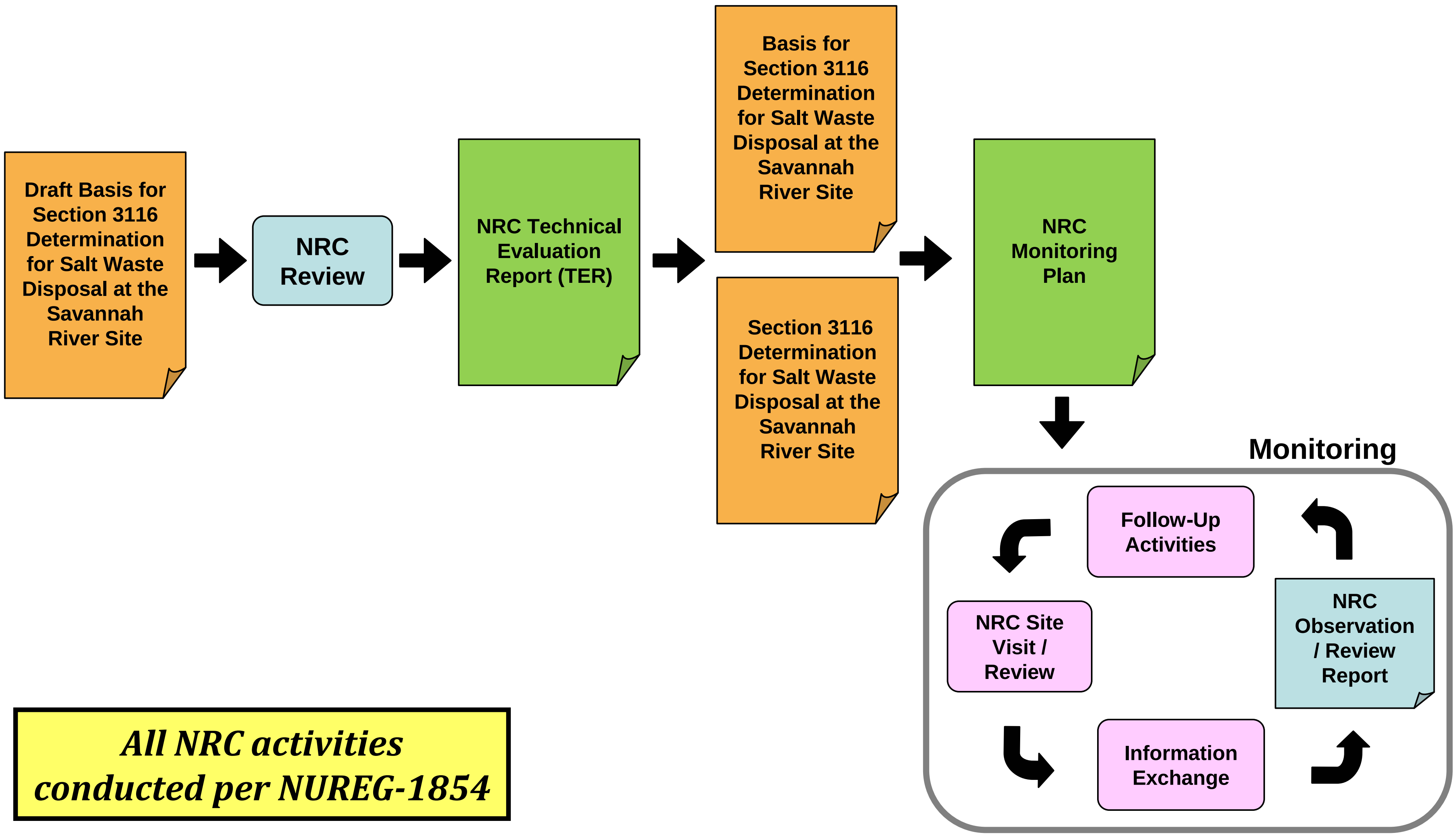
- Single performance assessment (PA) serves as backbone for demonstrating compliance with all performance objectives including DOE Orders, NDAA §3116 and State regulations
- PA = a key risk assessment tool used to inform closure and disposal decisions
  - Models fate and transport of materials over long periods of time to determine potential consequences
  - Utilizes informed assumptions
  - Provides most likely consequences of planned actions
- Provides best estimation of what the consequences will be, both chemical and radiological, over time
- Reflects uncertainty and identifies key parameters for which the model has the greatest sensitivity (importance)

DOE PA Development

All activities conducted per DOE Manual 435.1-1



NDAA §3116 Process



All NRC activities conducted per NUREG-1854

§3116 Monitoring Interactions

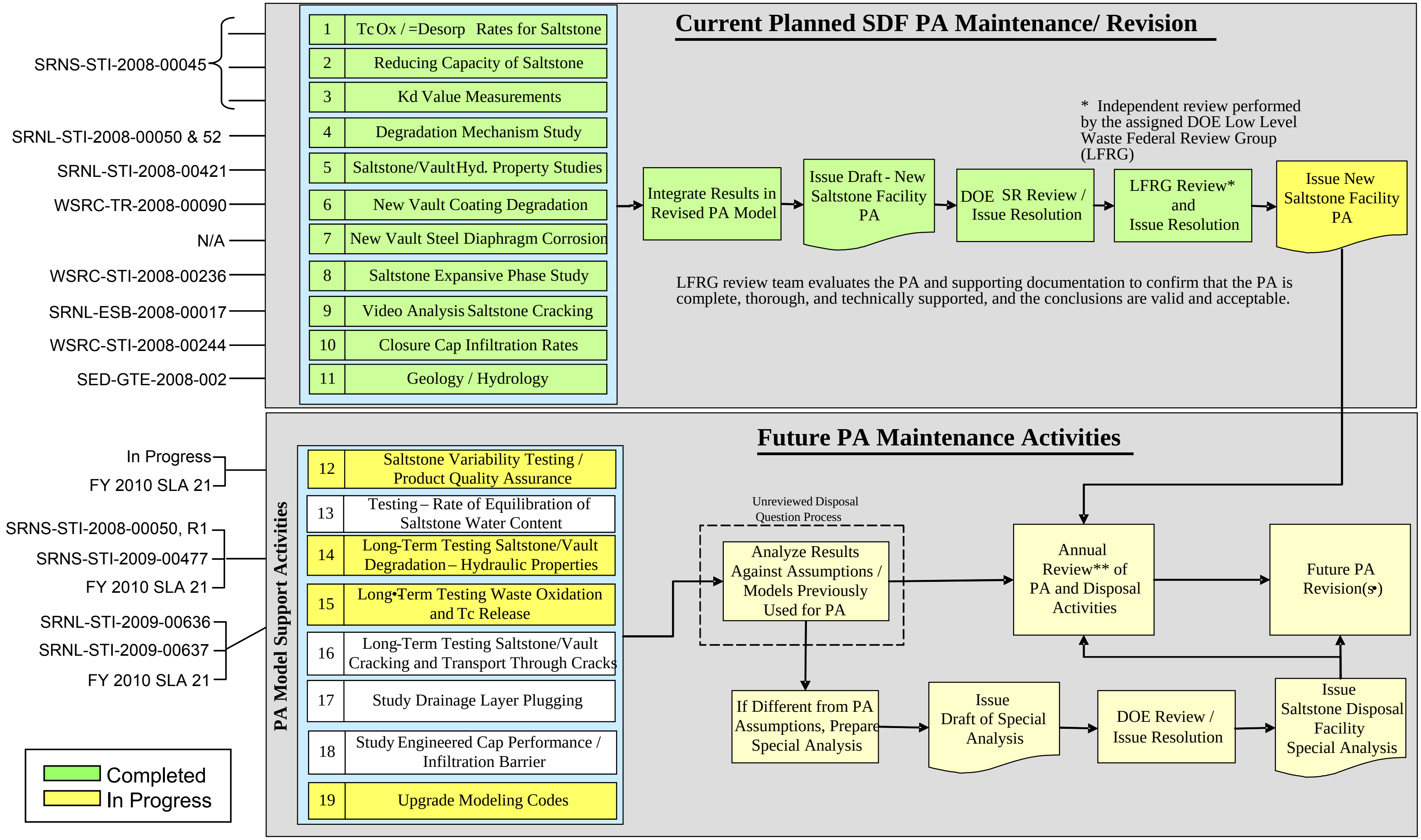
Types of Salt Waste Interactions

– Onsite Observations: NRC staff conducts observations of Salt Waste Disposal Activities at SRS
– Technical Reviews: NRC staff reviews technical reports and other documentation
– Each interaction typically involves:
  - Preparations
  - Conduct of Interaction
  - Follow-up Activities

R&D Overview

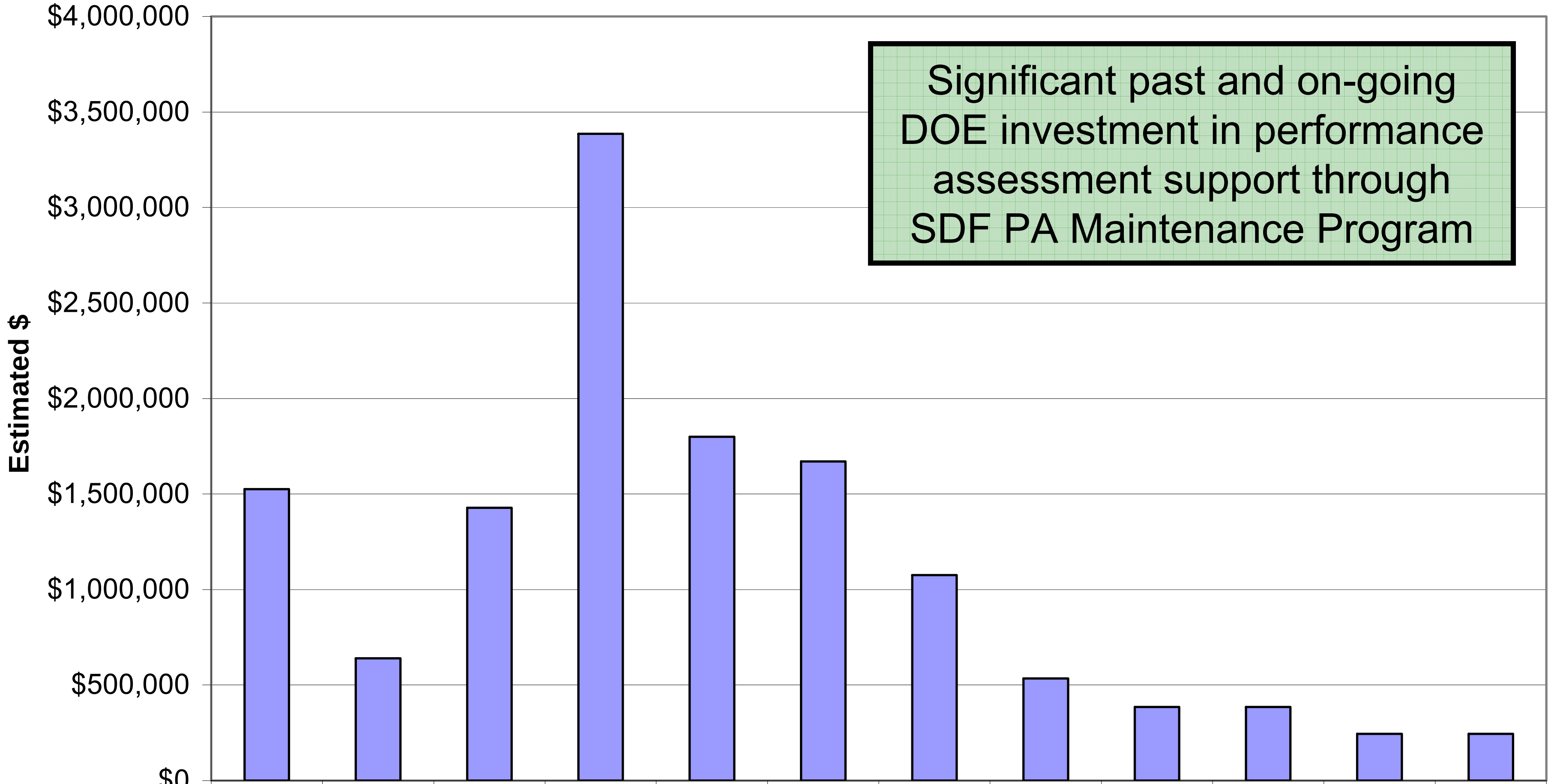
- Ongoing R&D activities are used to support modeling assumptions and reduce uncertainty
- DOE has prioritized activities to align with critical monitoring “factors” that NRC has delineated in their Technical Evaluation Report and Monitoring Plan
- R&D is specialized research and many activities are individually tailored to address specific issues
- R&D results are incorporated into the PA either directly (as the PA is developed) or through the Unreviewed Disposal Question (UDQ) Process

Integrating R&D and the PA



** Includes development of Annual PA Review and updates to PA/CA Maintenance Plan

R&D Resource Commitment



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Estimated $	$1,526 K	$640 K	$1,427 K	$3,385 K	$1,800 K	$1,670 K	$1,075 K	$535 K	$385 K	$385 K	$245 K	$245 K

Fiscal Year

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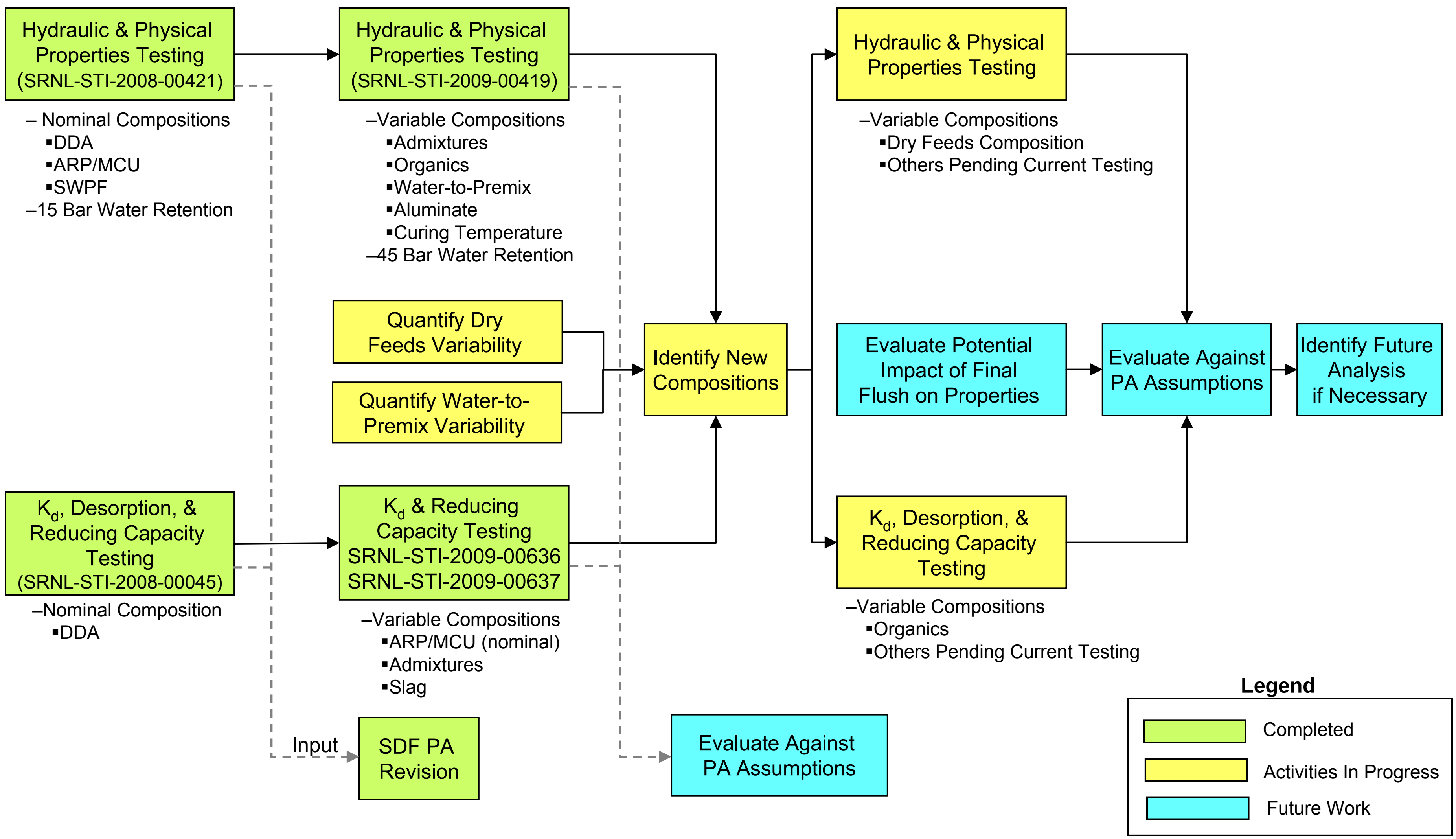
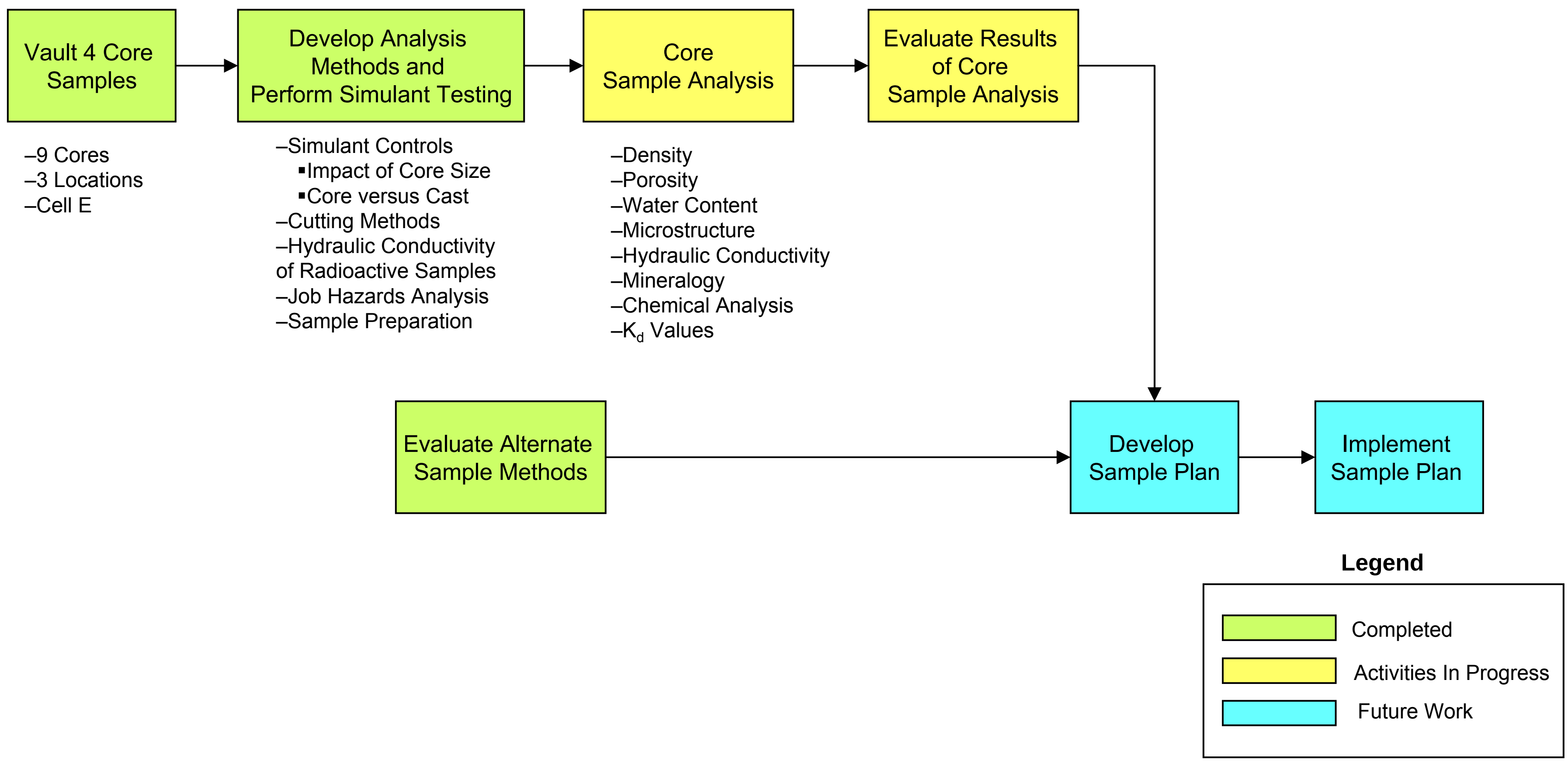
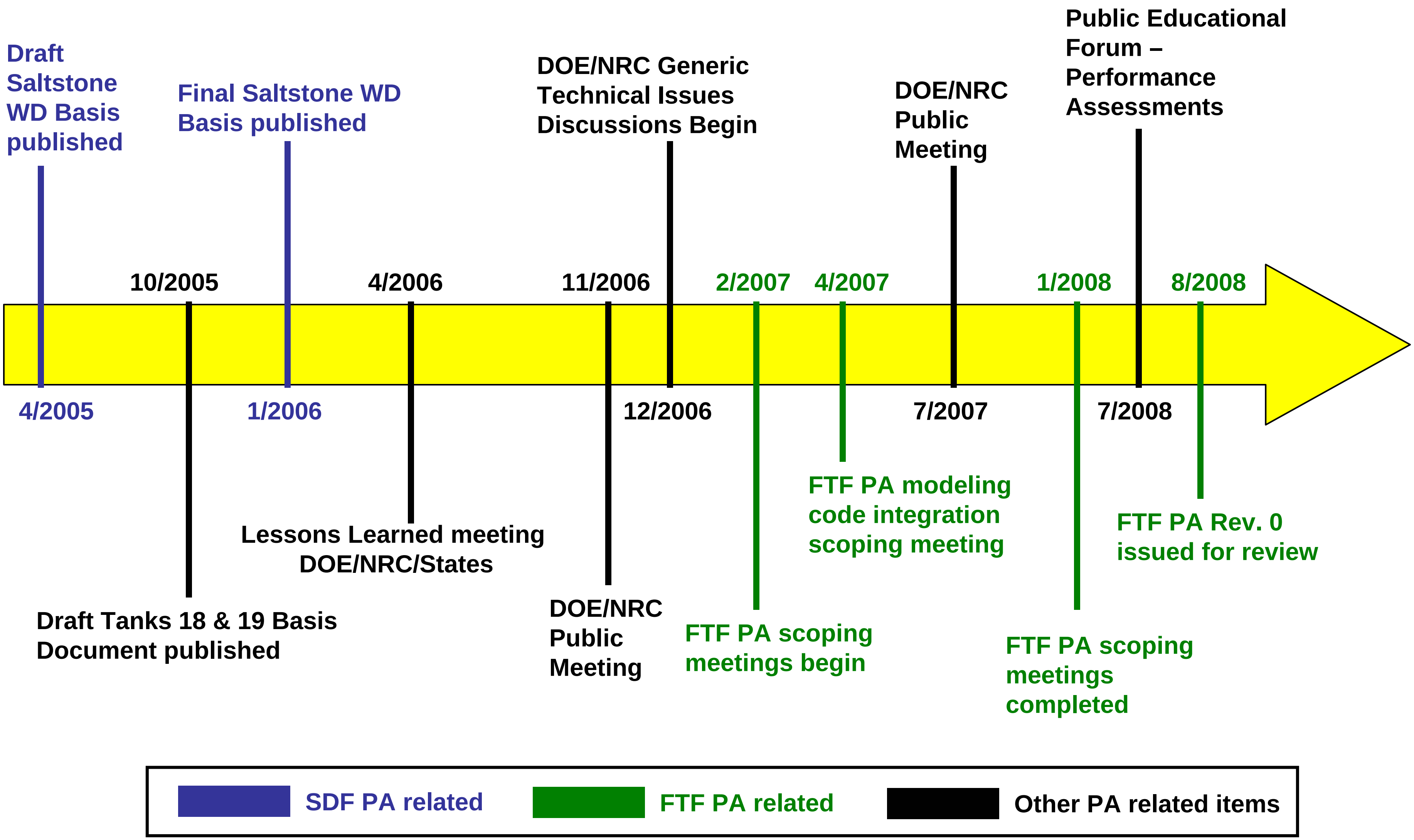
Applying R&D Research



Validating PA Parameters



SRS WD/PA Journey



Optimizing PA Development

- DOE, **SCDHEC**, **EPA** and NRC held numerous scoping meetings during the development of the 3116 process, FTF PA and the HTF PA to discuss inputs and approaches
  - Comments received from SCDHEC, EPA and the public as well as the NRC
- These inputs and approaches were applied, as appropriate, to the SDF PA
- DOE has posted meeting minutes at: http://www.em.doe.gov/stakepages/wmdi_swd.aspx?PAGEID=WMDI
- NRC has posted meeting minutes on their ADAMS system including accession numbers: ML073331049, ML073331050, ML073331053, ML073331058, ML073331061, ML073331062, ML073331065, ML073331070, ML073331074, ML073331081, ML100970781

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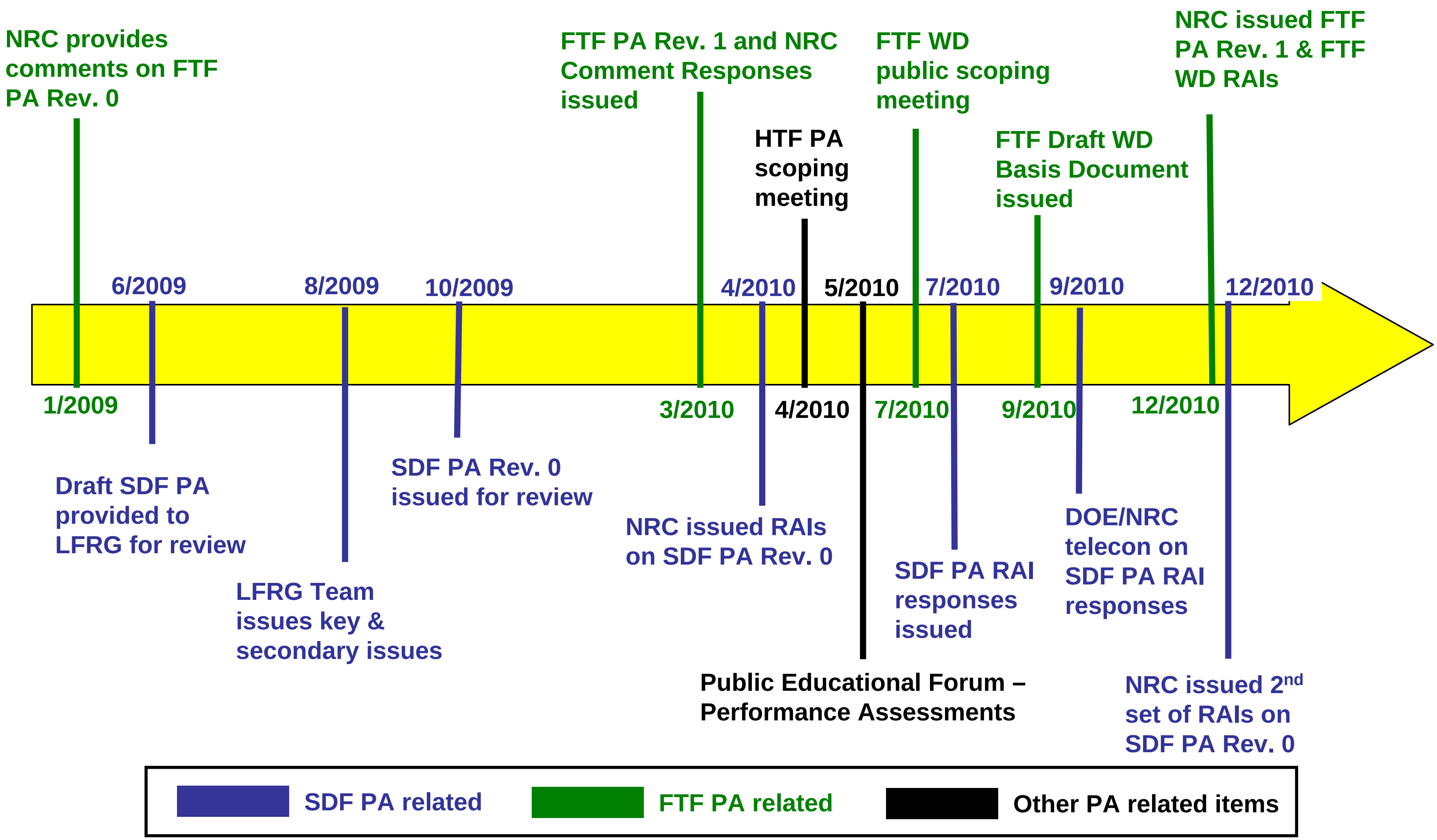
SRS WD/PA Journey



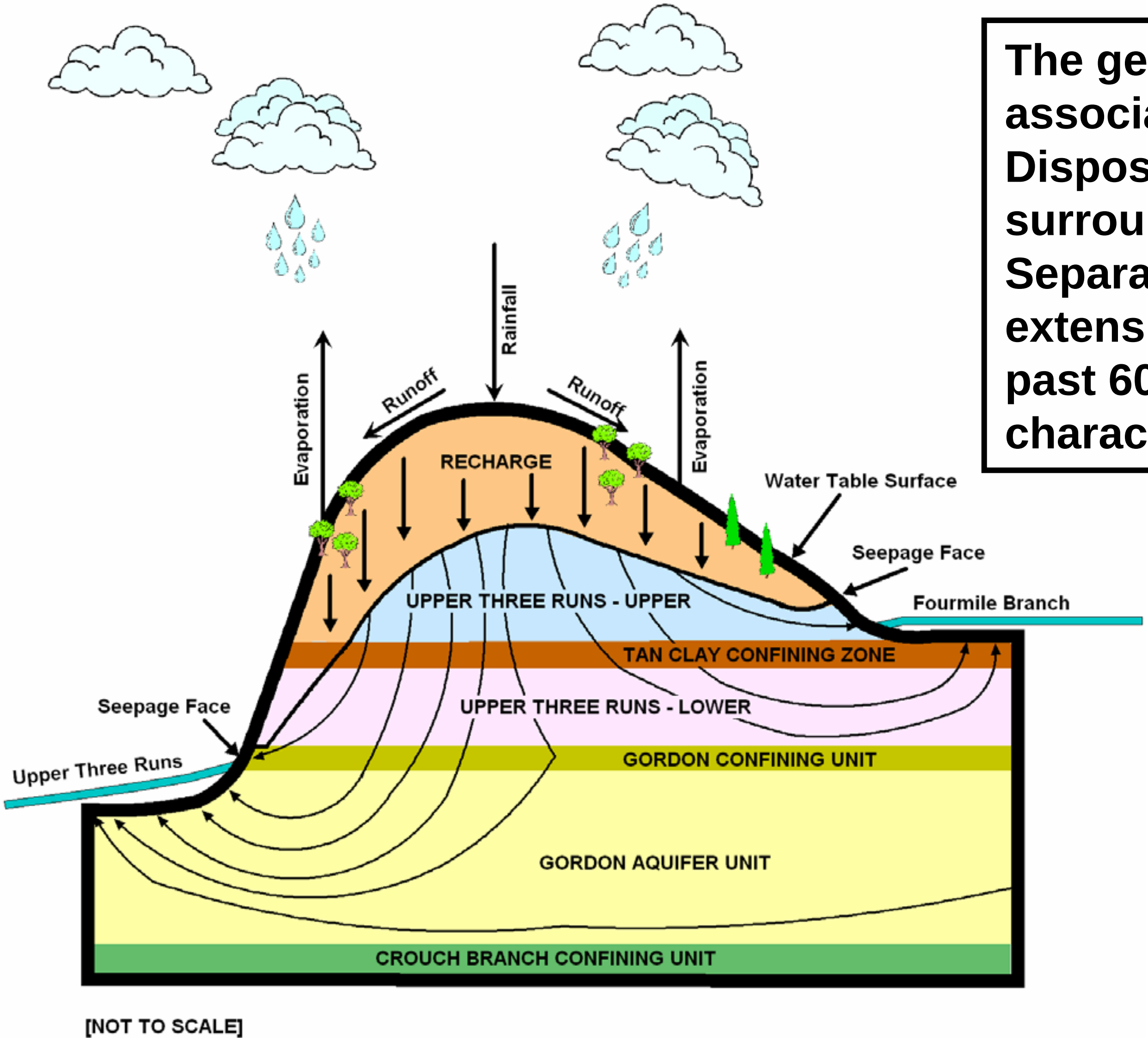
SDF PA LFRG Review Team

- Joel Case, DOE-Idaho Site Office (Co-Lead)
  - M.S., Nuclear & Environmental Engineering, University of Florida
- Martin Letourneau, DOE-EM, EM-41 (Co-Lead)
  - M.P.P, Environmental & Natural Resource Public Policy, Harvard University
- Amanda Anderson, DOE-Health and Safety
  - M.S., Radiological Health Sciences, Colorado State University
- Robert Andrews, Jason Associates
  - Ph.D, Geology/Hydrogeology, University of Illinois at Urbana-Champaign
- Jhon Carilli, DOE-Nevada Site Office
  - B.A., Chemistry, University of Nevada
- Eric Pierce, Pacific Northwest National Laboratory
  - Interdisciplinary Ph.D in Environmental Science (Geology/Env. Eng.), Tulane

SDF PA LFRG Review Team

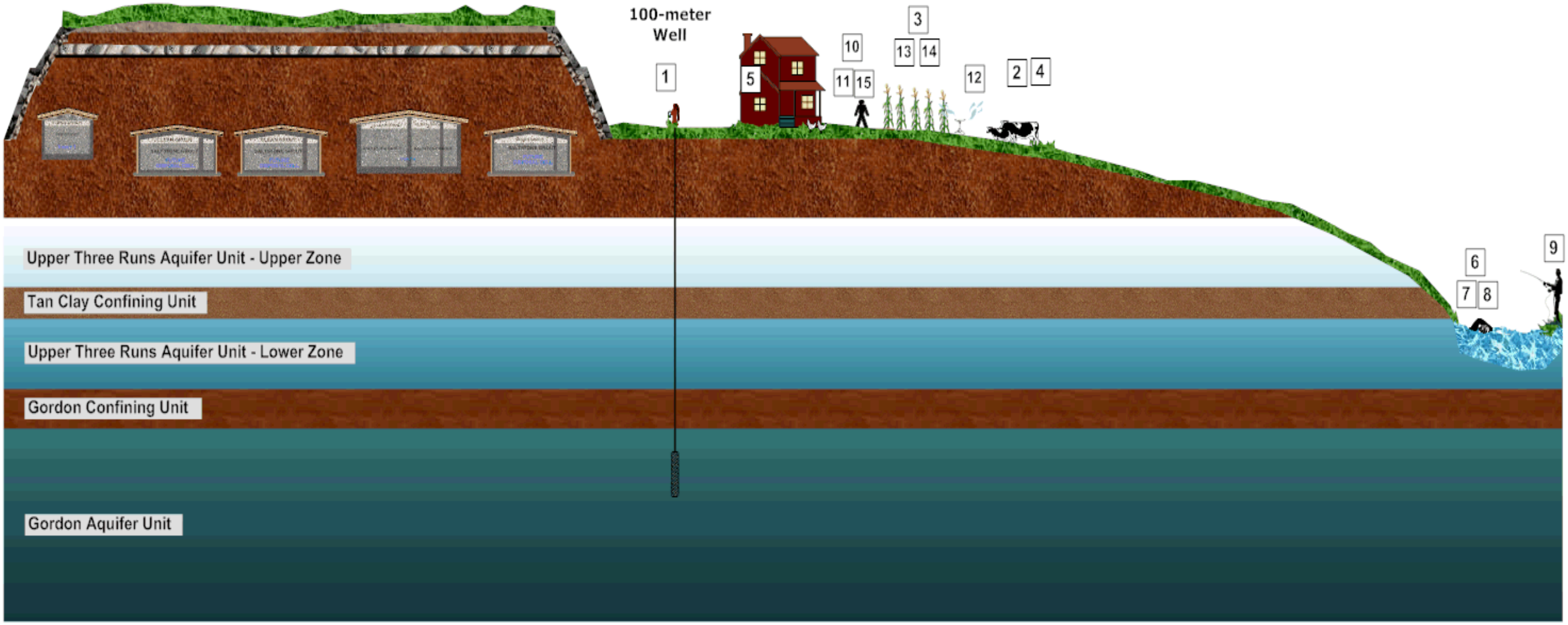
- Howard Pope, Project Enhancement Corporation
  - M.S., Environmental Management, University of South Carolina
- Linda Suttora, DOE-EM, EM-41
  - M.S., Biology, University of Michigan
- John Walton, University of Texas, El Paso
  - Ph.D, Chemical Engineering, University of Idaho
  - M.S., Environmental Engineering, University of Virginia
  - M.S., Chemical Engineering, University of Washington
- Marcus Wood, CH2MHill Plateau Remediation Company
  - Ph.D, Geology, Brown University
- Vefa Yucel, National Security Technologies, LLC
  - M.S., Civil Engineering, Iowa State University

Transport in the Environment



The geology and hydrogeology associated with Saltstone Disposal Facility as well as the surrounding General Separations Area has been extensively studied during the past 60 years and is well characterized.

Conservative Future Scenarios



SCENARIO WITH WELL WATER AS PRIMARY WATER SOURCE

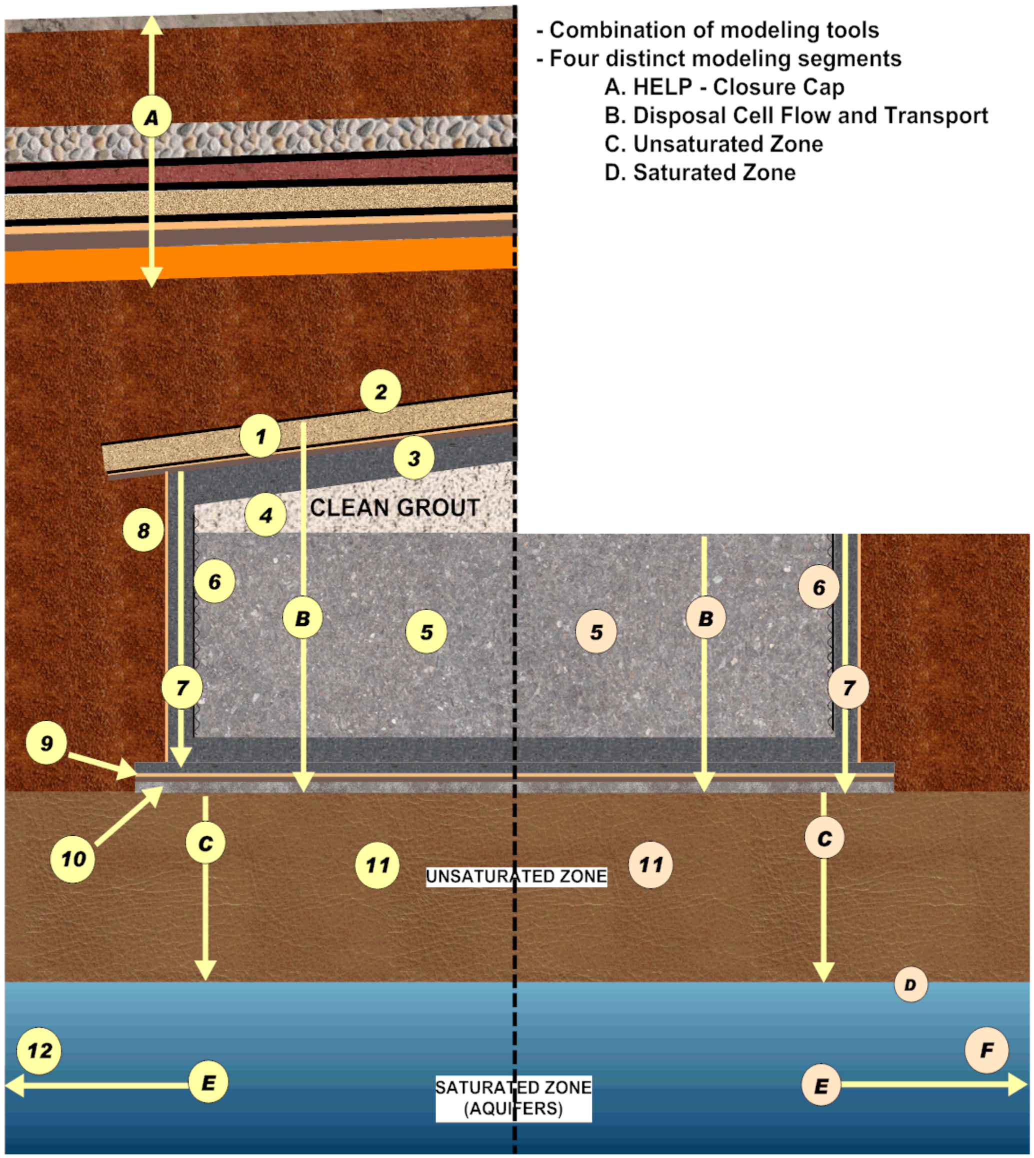
1. Direct ingestion of well water
2. Ingestion of milk and meat from livestock (e.g., dairy and beef cattle) that drink well water
3. Ingestion of vegetables grown in garden soil irrigated with well water
4. Ingestion of milk and meat from livestock (e.g., dairy and beef cattle) that eat fodder from a pasture irrigated with well water
5. Ingestion and inhalation of well water while showing
6. Direct irradiation during recreational activities (e.g., swimming, fishing, boating) from stream water
7. Dermal contact with stream water during recreational activities (e.g., swimming, fishing)
8. Incidental ingestion and inhalation of stream water during recreational activities
9. Ingestion of fish from the stream water
10. Direct plume shine
11. Inhalation
12. Inhalation of well water used for irrigation
13. Inhalation of dust from the soil that was irrigated with well water
14. Ingestion of or dermal contact with soil that was irrigated with well water
15. Direct radiation exposure from radionuclides deposited on the soil that was irrigated with well water

Complex Model Development

- Combination of modeling tools
- Four distinct modeling segments
  - A. HELP - Closure Cap
  - B. Disposal Cell Flow and Transport
  - C. Unsaturated Zone
  - D. Saturated Zone

PORFLOW

- A — Infiltration Rate Through Cap (From HELP Code)
- B — Disposal Cell Flow & Transport (flow fed to GoldSim also)
- 1 — Sand Drainage Layer
- 2 — HDPE-GCL Layer
- 3 — Roof Concrete
- 4 — Clean Grout Cap
- 5 — Waste Transport Through Saltstone via K_d Values
- 6 — Sheet Drains (Fast Flow Path)
- 7 — Wall, Floor, and Upper Mud Mat Concrete
- 8 — HDPE (Outside of Wall)
- 9 — HDPE-GCL Layer
- 10 — Lower Mud Mat Concrete
- C — Flow & Transport Through Unsaturated Zone
- 11 — Soil Properties and K_d Values
- E — Flow & Transport Through Saturated Zone
- 12 — GSA Database Parameters



[NOT TO SCALE]

GOLDSIM

- B — Disposal Cell Flow & Transport (Flow From PORFLOW)
- 5 — Waste Transport Through Saltstone via K_d Values
- 7 — Wall, Floor, and Upper Mud Mat Concrete
- 10 — Lower Mud Mat Concrete
- C — Flow & Transport Through Unsaturated Zone
- 11 — Soil Properties and K_d Values
- D — Benchmarking of Flux
- E — Flow & Transport Through Saturated Zone
- F — Benchmarking of Concentration

PA R&D/Testing Support

- SRS benefits greatly by the presence of a national laboratory at the site
- 50+ years of support for waste storage, treatment and disposal
- Nationally recognized experts in the fields of cementitious materials, geochemistry, hydrogeology, and modeling of environmental transport
- Support of extensive subsurface characterization of the General Separations Area

Improvements in the 2009 PA

- Saltstone Hydraulic Properties
  - Testing has been performed (and continues) to understand site-specific conditions and reduce uncertainties
  - 2009 PA values are two orders of magnitude more pessimistic than 2005 evaluations
- Disposal Cell Concrete Properties
  - Testing has been performed to understand site-specific conditions
- Other Saltstone Properties
  - Testing to understand formula-specific characteristics related to individual elemental transport
- Fracturing of Vault Walls
  - Modeled Vault 1 and Vault 4 as significantly fractured (i.e., not a barrier to flow) and assumed an initial inventory already in walls at closure

Starting Assumptions for Vault 4

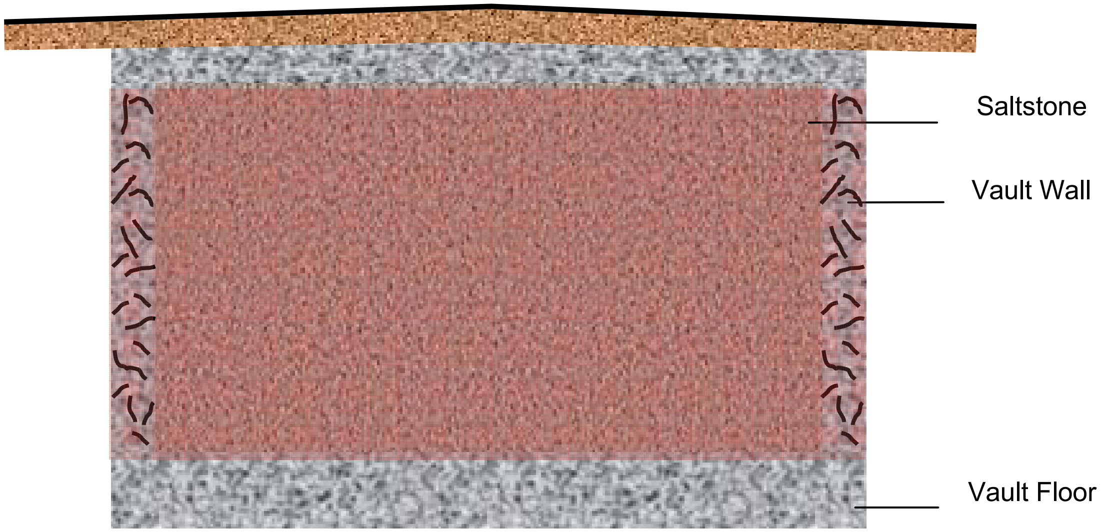
- Base case reflects known conditions of weeping Vault 1 and 4 walls
- Concrete vault walls modeled as having severely degraded initial hydraulic conductivity (i.e., orders of magnitude worse than undisturbed soil)
- Concrete walls modeled as containing significant inventory at time of closure

Wall initial hydraulic conductivity **1.7E-1** cm/sec

(Soil hydraulic conductivity **6.2E-5** cm/sec)

Assumed initial inventory in walls reflecting salt solution filling all available pore spaces

DOE Base Case Initial Conditions at T = 0 years



Floor initial hydraulic conductivity 3.1E-10 cm/sec

Technetium Reduction/Retention

- Development of PA recognized critical nature of the saltstone properties in minimizing releases of Tc-99
- Conducted saltstone formula-specific reduction capacity testing
- Also, conducted saltstone distribution coefficient (K_d) testing
  - Initial testing had flaws that were clearly acknowledged in technical reports and shared with stakeholders as presented in NRC monitoring reports
  - New test methodologies were designed and testing conducted to address the previous issues
  - Preliminary discussions with the researchers indicate that the results will be supportive of the 2009 PA modeling
- Results of the K_d testing as well as other saltstone properties are expected to be shared with NRC and the public in April

Vault 4 Inventory

- Improved waste characterization is reflected in the 2009 PA inventory assumptions
- Inventory values still represent very pessimistic assumptions for radionuclides of concern
  - Use of minimum decontamination factors for salt treatment processes
  - Used bounding ratios to develop assumed initial inventories of U-234/Th-230 (source of Ra-226)
- Inventory disposed to date plus projections at time of closure validate the assumptions for radionuclides of concern

Risk Perspective

- Actual disposal of Tc-99 to date in Vault 4 is only at ~3% of the Class A Concentration Limit (the lowest radioactivity level 10 CFR 61 classification)
- With over 70% of Vault 4 filled, Th-230 inventory is only 0.028 Ci versus an assumed inventory of 7.5 Ci at time of closure
- Inventories for Saltstone Disposal Facility are updated quarterly and posted at: http://sro.srs.gov/saltstone.htm

Disposal actions to date have been conservative relative to the analysis performed for the 2009 SDF PA

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Radiation Dose Perspective

Millirems (mrem) per year

- **5,000** — Federal Annual Limit for "Radiation Workers"
- **620** — Average Annual Dose Received by US Citizen
- **310** — Average Annual Dose from Background Radiation
- **100** — Dose Limit to a Member of the Public
- **25** — DOE & 10CFR61 Performance Objective to a Member of the Public
- **5** — Dose from a Roundtrip Flight to the West Coast
- **<2** — SDF PA Peak Year Dose within 10,000 years