



U.S. DEPARTMENT OF
ENERGY

OFFICE OF
**ENVIRONMENTAL
MANAGEMENT**

Presentation for Environmental Management Advisory Board

Office of Technology Development EM-3.2

December 3, 2019

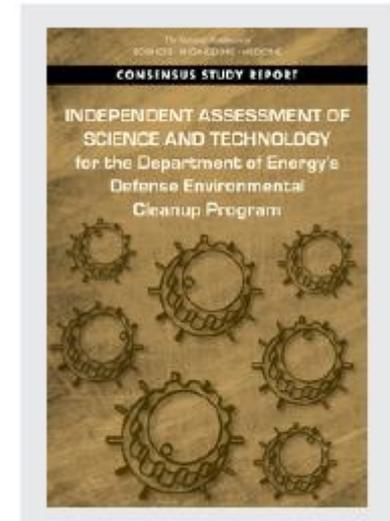
- **Charge to EMAB regarding Technology Development**
- **Background: National Academy Study (2017-2019): Independent Assessment of Science and Technology for the Department of Energy's Defense Environmental Cleanup Program**
 - **Findings**
 - **Information Supplied to the NAS**
 - **EM's past and most recent TD program (In-briefing)**
- **EM Recent Actions: Site reviews, Planning, etc**
- **Budget Realities**
- **Desired Outcome from EMAB**
- **Questions**

Charge to EMAB regarding Technology Development

- Provide prioritized recommendations on a path forward for the best use of departmental resources to assist EM in successfully using science and technology to complete its cleanup mission
- The processes developed should help EM to reduce cleanup lifecycle costs, schedules, risks, and uncertainties.
- EMAB should review the Academies' report, strategic planning and management plans developed by the EM Technology Development Office, and benchmark against relevant federal agency and private sector technology development plans.
- Develop a draft Management Plan by Spring 2020.
- Following a review by EM HQ and Field management, the suggested management plan should be finalized following receipt of comments at the summer 2020 meeting of EMAB.

National Academy Study: Independent Assessment of Science and Technology for the Department of Energy's Defense Environmental Cleanup Program

- Kickoff: December 2017
- Out-brief & Final Report: February/March 2019
- Major Recommendations:
 - DOE-EM should obtain an independent assessment of the cleanup program's lifecycle costs and schedules and use this assessment to reevaluate the adequacy of its technology development investments.
 - DOE-EM should implement a formal management process to successfully use Science and Technology to complete its cleanup mission.
 - A portion of the technology development effort for the DOE-EM cleanup program should focus on breakthrough solutions and technologies that can substantially reduce cleanup lifecycle costs, schedules, risks, and uncertainties.
- EM-1 request to EMAB: reaction to the NAS report



National Academy Study: Independent Assessment of S&T for EM

**Finding: Technology & Alternative Approaches for Breakthrough S&T
(to be managed by ARPA-E)**

- **Waste chemistry at bulk and interfacial scales to facilitate treatment and disposal**
- **Nuclear properties of waste to facilitate treatment and disposal**
- **Human involvement in cleanup activities to increase cleanup efficiencies and reduce worker risks**
- **Interrogation approaches to characterize wastes and monitor cleanup remedies and environmental impacts**
- **Modelling and visualization approaches to manage large cleanup-related data sets and improve predictive capabilities**
- **Disposal pathways to increase waste disposition options**
- **Decision-making approaches to improve the quality and durability of cleanup decisions**

National Academy Study: Independent Assessment of S&T for EM

Information supplied to the NAS

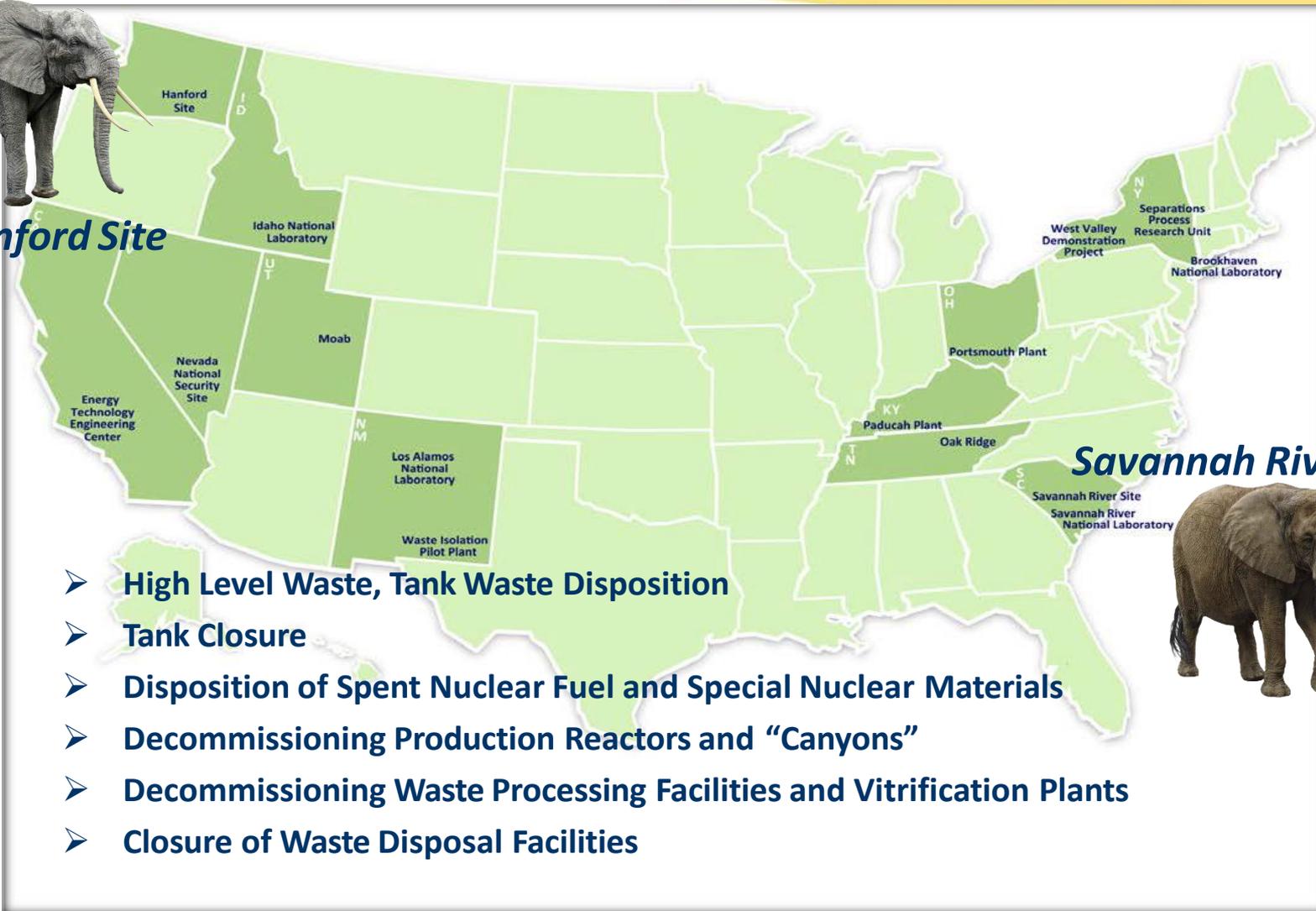
- Overview Briefing (DOE History through current EM program)
- EM Innovation and Technology Plan (most recent, signed December 2016)
- Technology Roadmaps for areas covered in the I&T Plan:
 - Glass
 - Technetium
 - Mercury
 - Soil & Groundwater
 - Test Beds
 - Robotics
- All Information available for public release

National Academy Study: Independent Assessment of S&T for EM Information supplied to the NAS

**Review of the EM Science & Technology Program
(Selected Background Slides from December 2017 In-Briefing)**



Hanford Site

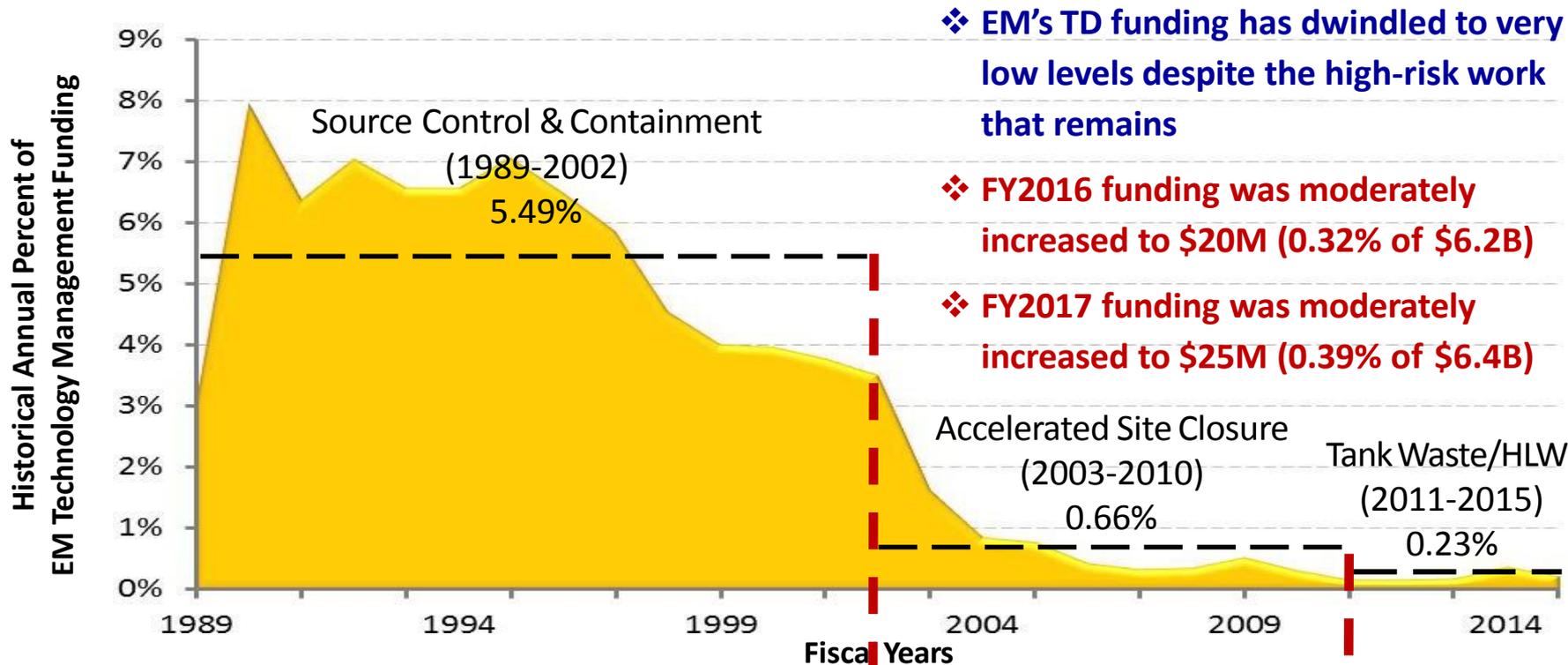


Savannah River Site



- High Level Waste, Tank Waste Disposition
- Tank Closure
- Disposition of Spent Nuclear Fuel and Special Nuclear Materials
- Decommissioning Production Reactors and “Canyons”
- Decommissioning Waste Processing Facilities and Vitrification Plants
- Closure of Waste Disposal Facilities

Background: NAS Briefing – Historical Technology Development Funding



❖ EM's TD funding has dwindled to very low levels despite the high-risk work that remains

❖ FY2016 funding was moderately increased to \$20M (0.32% of \$6.2B)

❖ FY2017 funding was moderately increased to \$25M (0.39% of \$6.4B)

FY	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
EM (\$B)	1.7	2.3	3.6	4.3	5.5	6.0	5.8	6.1	6.0	5.9	5.9	5.9	6.4	6.7	7.0	7.0	7.3	6.6	6.2	5.8	6.0	6.0	5.7	5.7	5.3	5.8	5.9
TD (\$M)	52	183	230	303	362	394	410	396	352	269	237	235	242	236	114	61	58	29	21	21	32	20	10	10	10	22	14
%	3.1	8.0	6.4	7.1	6.6	6.6	7.1	6.5	5.9	4.6	4.1	4.0	3.8	3.5	1.6	0.9	0.8	0.4	0.3	0.4	0.5	0.3	0.2	0.2	0.2	0.4	0.3

- ❖ **Secretary of Energy Advisory Board (SEAB) Report (December 2014)**
 - **Recommendation**: Fund at 3% of annual budget → \$5B to \$6B ≅ \$150M to \$180M
 - **Portfolio**: \$140M to \$185M
 - **High impact technologies: \$75M to \$100M**
 - Outside program routines, target big challenges and breakthroughs
 - **Incremental technologies: \$30M to \$50M**
 - Improve efficiency and effectiveness of existing cleanup processes
 - **Fundamental research: \$25M**
 - Provide knowledge and capabilities that bear on EM challenges
 - **University collaboration: \$10M**
 - Gain more direct access to advances in science and engineering
 - Build a pipeline for future workforce

Background: Updated – FY 2017-2019 Funded Technology Areas

	EM TD TOTAL	FY 2017 25,584	FY2018 35,236	FY2019 23,343
High Impact Technologies	\$K	10,519	12,015	7,430
Tc-99 Challenge	\$	2,000	2,000	0
Mercury Challenge	\$	1,000	1,350	0
Cs-137 & Sr-90 Challenges - SRS TCCR	\$	4,075	250	0
EM Test Bed/Low Activity Waste	\$	590	4,402	6,860
Enhanced Worker Safety/Science of Safety (robotics and remote systems)	\$	2,854	2,463	570
Glass, Concrete, Binders, Grout	\$	0	1,550	0
Incremental Technologies	\$K	3,387	3,210	0
Enhanced Waste Processing/Disposition	\$	1,110	1,385	0
Enhanced Environmental Operations	\$	1,550	875	0
State of Art Tooling	\$	727	950	0
Program Support/Services, Other Mandates	\$K	11,678	20,011	15,913
SBIR/STTR	\$	913	1,277	913
Spent Nuclear Fuel Program (Congress)	\$	4,000	5,000	5,000
Clean Air (HEPA filtration) Technologies (Congress)	\$	3,500	5,000	5,000
Consortium for Risk Evaluation with Stakeholder Participation-CRESP (Congress)	\$	0	5,000	5,000
Program Support/Services	\$	2,865	3,335	0
NDAA 3131 - NAS TD Study (Congress)	\$	400	399	0

☆☆☆ Considers SEAB-Based Structure ☆☆☆

EM Recent Actions:

- **TD Office – Reviews of Field-sponsored TD**
 - **Savannah River Site**
 - **Hanford: Office of River Protection & Richland Field Office**
 - **Oak Ridge**
 - **Idaho**
 - **Yet to come: Portsmouth, Paducah, Carlsbad, Small sites?**
- **TD Program Planning: Internal discussions (TD Office) & with SRNL for Strawman Program/Thrust Areas**

Budget Realities – FY2020

➤ Continuing Resolution

➤ Earmarks

**Congressional Budget – Department of Energy – Office of Environmental Management
Technology development – FY2020 (Both sides \$25 M)**

House Language

Within Technology Development and Deployment, \$5,000,000 is provided for the National Spent Nuclear Fuel Program to address issues related to storing, transporting, processing, and disposing of Department-owned and managed spent nuclear fuel.

Within these amounts, the Department shall use funding to address the need for additional assessments into material degradation that may occur as a result of multiple decades of EM spent nuclear fuel storage facilities, nuclear material measuring and monitoring in the Department’s storage systems, and other activities recommended by the U.S. Nuclear Waste Technical Review Board in its 2017 report on the Management and Disposal of U.S. Department of Energy Spent Nuclear Fuel.

The Committee appreciates the Department’s work to improve worker safety and up to \$5,000,000 is provided to consider exploring options to develop and deploy wearable robotic devices to enhance worker safety.

The Committee encourages the Department to continue independent review, analysis, and applied research to support cost-effective, risk-informed cleanup decision-making.

(p. 126)

Senate Language

The Committee recommends \$25,000,000 for Technology Development and Demonstration.

The Committee supports the Department's efforts to expand technology development and demonstration to address its long-term and technically complex cleanup challenges.

Within the amount recommended, not less than \$5,000,000 is recommended for work on qualification, testing and research to advance the state-of-the-art on containment ventilation systems.

Further, the Department is directed to take the necessary steps to implement and competitively award a cooperative university affiliated research center for that purpose.

Within the amount recommended, not less than \$5,000,000 is recommended to fund the existing cooperative agreement with the Consortium for Risk Evaluation with Stakeholder Participation [CRESP] and not less than \$5,000,000 is recommended for research and development of robotics to enhance worker safety. (P. 132)

Desired Outcome from EMAB

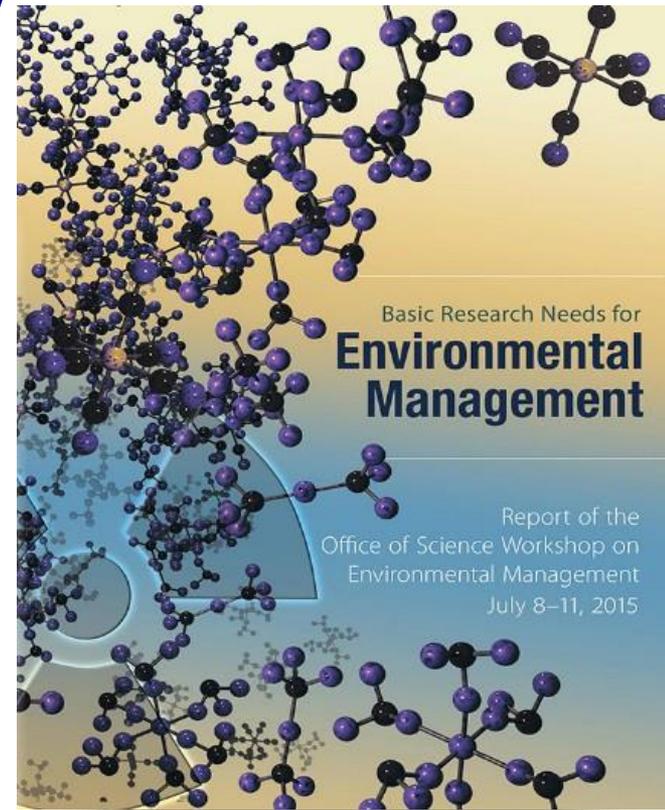
- **Management Plan**
- **Prioritized recommendations on a path forward for EM S&T program**
- **How? – Thoughts:**
 - **Comment on the NAS report/recommendations**
 - **Overarching Program Structure**
 - **HQ program vs Field program**
 - **Setting priorities**
 - **Managing/Leveraging the Earmarks**
 - **Substantive Engagement with External Entities:**
 - **Office of Science - Energy Frontier Research Centers**
 - **ARPA-E**
- **Questions**

Backup Slides

EM SSAB Recommendations regarding the NAS report

- 1. The EM SSAB Chairs support the development of a programmatically integrated, (under one identified EM government program) robust S&T effort that is fully funded in order to: a) identify and pursue development of the technologies necessary to successfully achieve risk based reduction of radiological and other hazardous waste material; b) to integrate decisions that are common between sites with similar remediation needs; c) to identify scientific challenges common to sites.**
- 2. A portion of the technology development effort for the DOE-EM cleanup program should focus on breakthrough solutions and technologies that can substantially reduce cleanup costs, schedules and uncertainties as stated in the NAS report.**
- 3. The EM SSAB Chairs recommend exploring already developed, usable computer platforms to see if they are flexible enough to systematize verification of Best Practices decisions.**
- 4. The EM SSAB Chairs recommend EM explore the path of working with the Advanced Research Projects Agency-Energy (ARPA-E) office, coupled with public outreach and transparency to implement a directional shift towards better control.**

- ❖ **Energy Frontier Research Centers (FFRC) formed that focus on EM research**
 - **Center for Actinide Science and Technology (CAST), Florida State University**
 - **Center for Performance and Design of Nuclear Waste Forms and Containers (WastePD), The Ohio State University**
 - **Center for Hierarchical Waste Form Materials (CHWM), University of South Carolina**
 - **Interfacial Dynamics in Radioactive Environments and Materials (DREAM), Pacific Northwest National laboratory**



❖ Program Capabilities → Test Beds

- Support testing and demonstration of novel technologies and solutions
- Using actual radioactive waste and/or nuclear materials
- In radiologically controlled areas and/or radiation areas
- In DOE nuclear facilities and/or in relevant environments
- Using virtual reality tools to simulate EM facilities and environments

❖ Worker-oriented test bed demonstrations

- Conducted in the field (at facilities where work is being performed)
- As appropriate, emphasis is placed on the workers to conduct the demonstrations

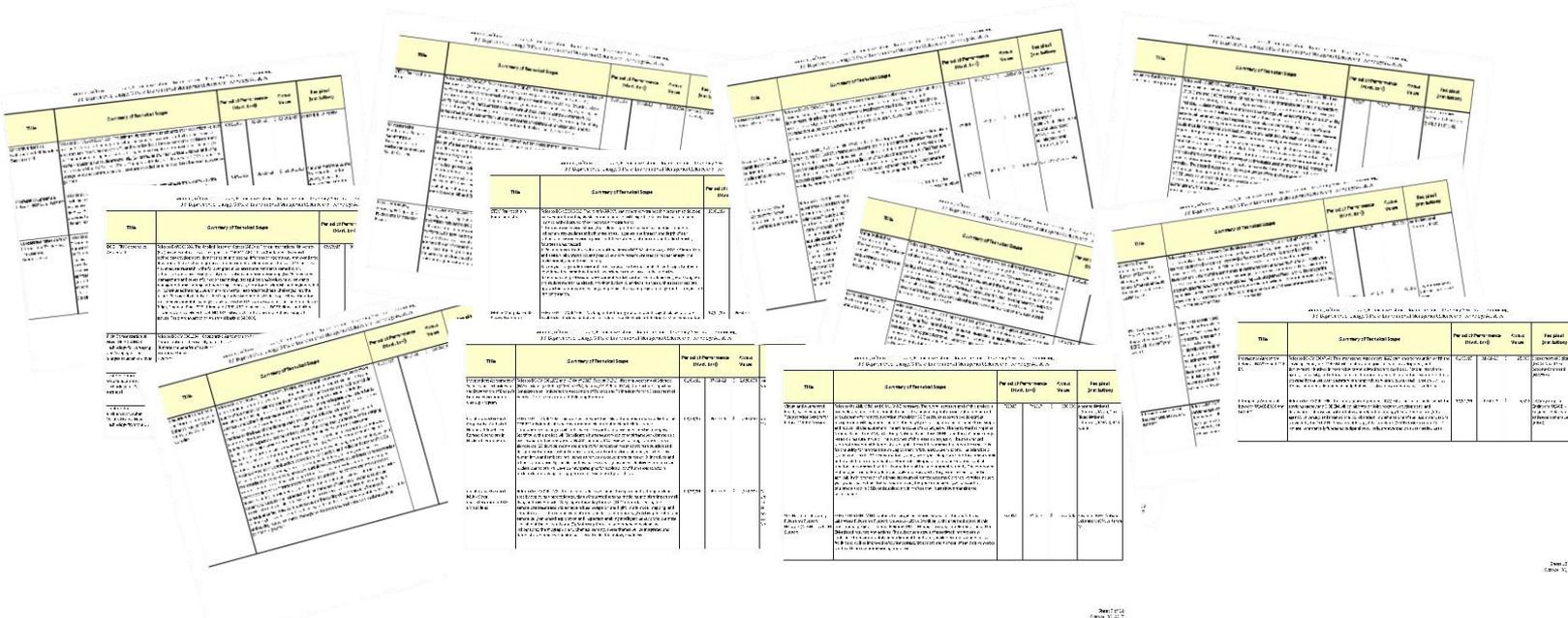
EM Innovation and Technology Portfolio

❖ College and University Collaborations

➤ Minority Serving Institutions

❖ Interagency Collaborations

➤ Leverage science and technology expertise and assets of other federal agencies and programs → stretch the taxpayers' dollar



- ❖ **Colleges and Universities serve as**
 - **Expert-based resource for conducting basic and applied scientific research and for providing engineering solutions**
 - **Facilities are at national lab quality and capability**
 - **Gateways to other research and academic expertise and capabilities**
 - **Incubators and pipelines for EM's future workforce**
 - **Pool of recognized subject matter experts**
 - **Independent, objective technical advisors**
 - **Testing, validation and verification**

- ❖ **Federal Executive Departments and Independent Agencies**
 - **Common and overlapping mission challenges and gaps → R&D and TD needs**
 - **Leverage federal funding → stretch the taxpayer dollar**
- ❖ **Collaborating for**
 - **Knowledge and technology transfer**
 - **Sharing, use and re-use of assets and facilities (laboratories, test beds)**
 - **Leverage programs, capabilities and contracts**
 - **Access to other FFRCs, colleges and universities**
 - **Sharing SMEs (proposal evaluations, program reviews, technology evaluations, etc.)**
 - **Serve as “trusted agents”**

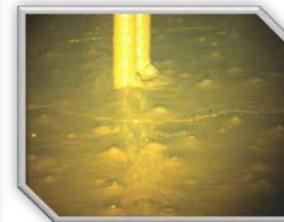
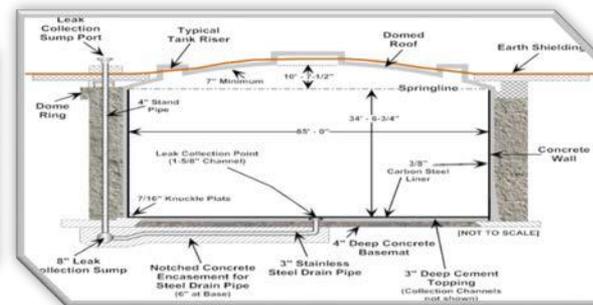
Nuclear Facility Decommissioning



Soil and Water Cleanup



Liquid Radioactive Waste Processing & Disposition



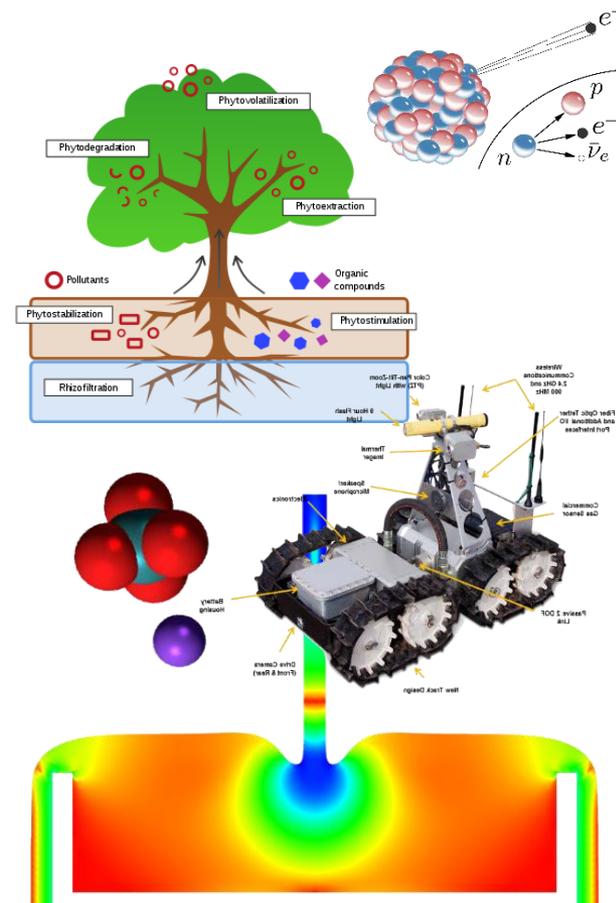
Solid Radioactive Waste Treatment, Storage & Disposal



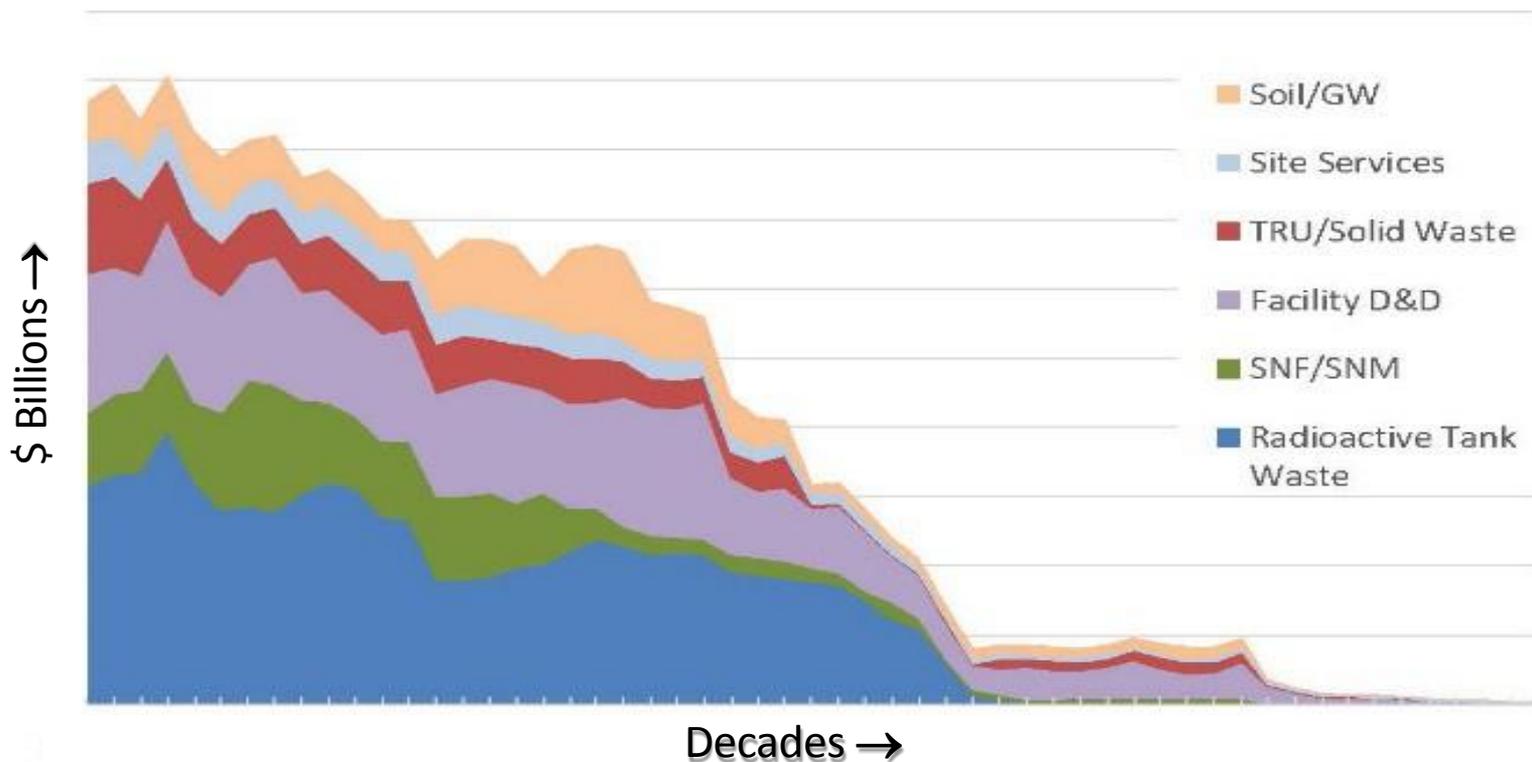
Nuclear Materials & Spent Nuclear Fuel Management



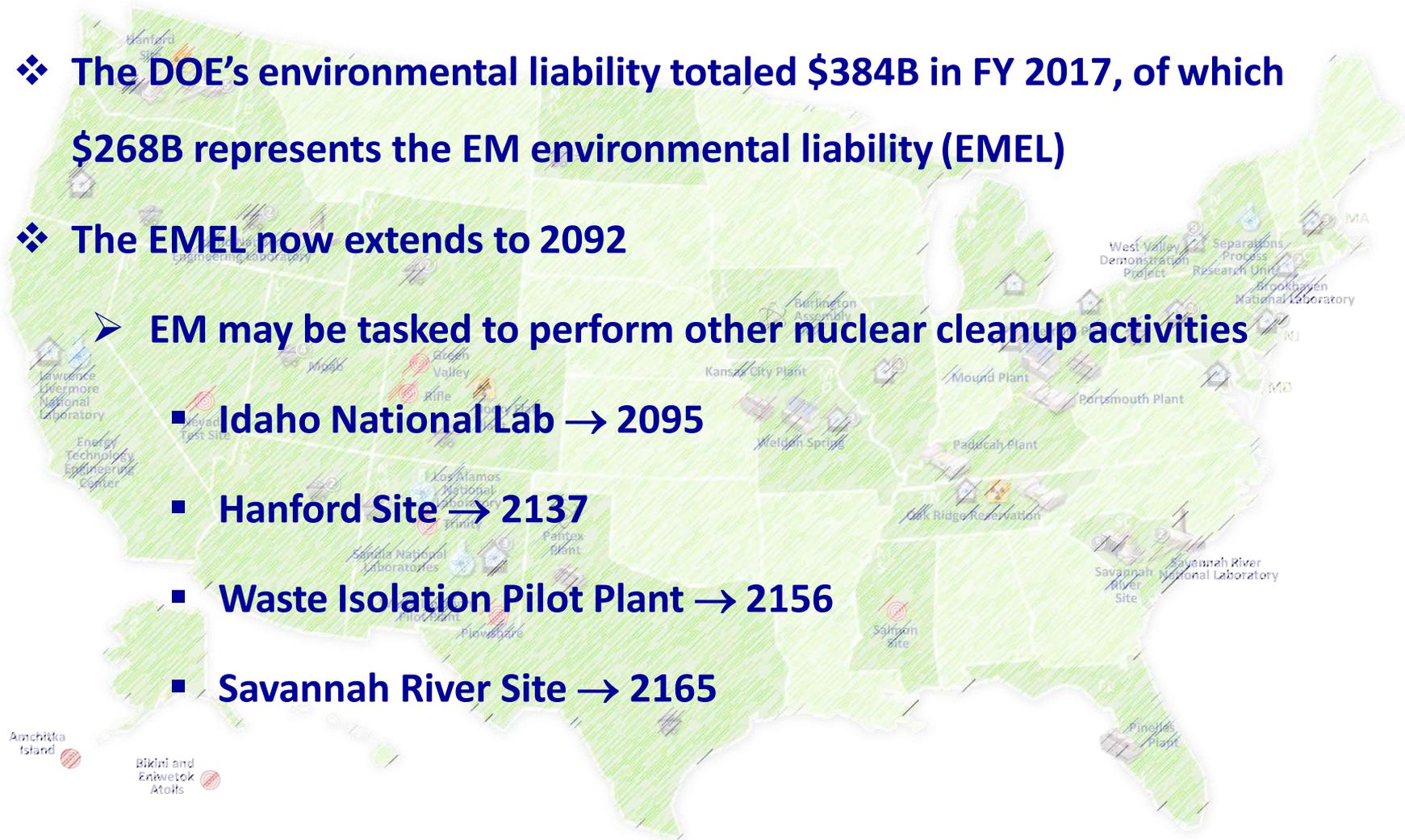
Science & Technology



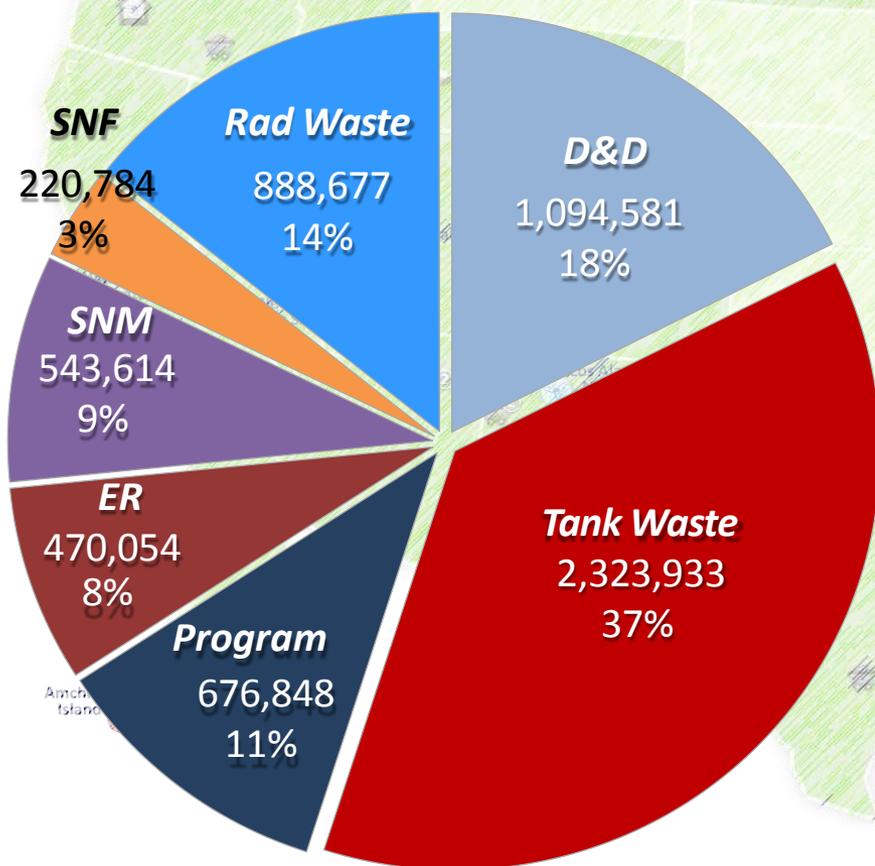
- ❖ Remaining EM mission → high-hazard, high-consequence, high-risk work
- ❖ Several key technical uncertainties and challenges exist... expect more...
- ❖ Continuing need to reduce the environmental liability



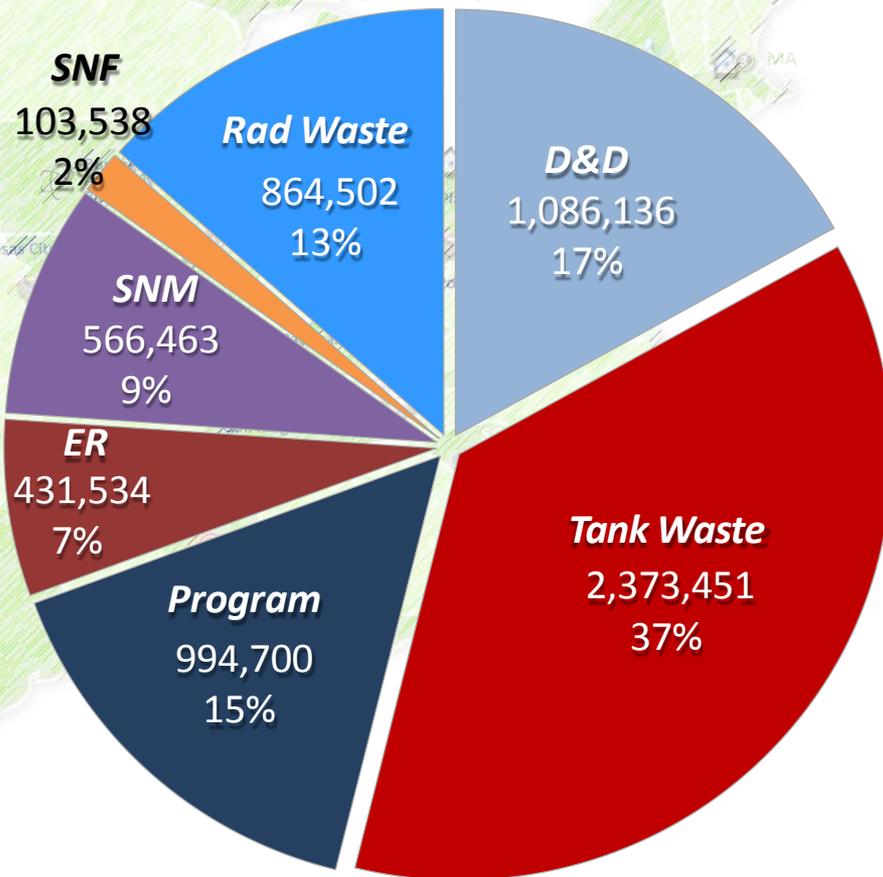
- ❖ The DOE's environmental liability totaled \$384B in FY 2017, of which \$268B represents the EM environmental liability (EMEL)
- ❖ The EMEL now extends to 2092
 - EM may be tasked to perform other nuclear cleanup activities
 - Idaho National Lab → 2095
 - Hanford Site → 2137
 - Waste Isolation Pilot Plant → 2156
 - Savannah River Site → 2165



FY 2016 Enacted Budget \$6,218,491



FY 2017 Enacted Budget \$6,420,324



- ❖ Secretary of Energy Advisory Board (SEAB) Task Force on EM TD (May 2014)
 - Chartered by former Secretary Moniz to advise on
 - Opportunities and barriers for science and technology development for cleanup
 - Means to implement a program to develop such technologies
 - Funding of the program
- ❖ SEAB Report (December 2014)
 - **Conclusion: Successful completion of EM's remaining cleanup work will require advances in science and technology... there is no real choice but to make investments in technology that can enable success**

- ❖ **High Impact Technologies (mission-critical)**
 - **Technetium-99**
 - **Mercury**
 - **Cesium-137 and Strontium-90**
 - **EM Test Beds**
 - **Enhanced Worker Safety**
- ❖ **Incremental Technologies (mission-enhancing and mission-enabling)**
 - **Enhanced Waste Processing and Waste Disposition**
 - **Enhanced Environmental Operations**
 - **State-of-the-Art Tooling**
- ❖ **Fundamental Research**
 - **Office of Science → Energy Frontier Research Centers**