# Nuclear Indiana Coalition

April 2nd, 2026

# Welcoming Remarks

Secretary Jaworowski

# State Actions Supporting Nuclear Energy

- NEI Status Report
  - State Legislation and Regulations Supporting Nuclear Energy

# INDIANA

## Legislation: S.B. 258

**Enacted February 2026**

Repeals provisions that prohibit an individual from constructing, operating, or increasing the capacity of a nuclear power-generating facility or a nuclear fuel reprocessing plant without a permit from the Department of Environmental Management.

## Legislation: H.B. 1007

**Enacted May 2025**

Provides a credit against state tax liability for expenses incurred in the manufacture of a small modular nuclear reactor (SMR) in the state.

## Legislation: S.B. 423

**Enacted May 2025**

Establishes a small modular nuclear reactor pilot program.

## Legislation: S.B. 424

**Enacted April 2025**

Authorizes a public utility to petition the Indiana Utility Regulatory Commission (IURC) for approval to incur, before obtaining a certificate, project development costs for the development of one or more small modular nuclear reactors.

# The Geopolitics of Energy:

## What Has Happened
## To Our
## Nuclear Waste Disposal Program?

**Dr. James Conca and Dr. Patrick Brady, FANCO**
First American Nuclear Company
Trustee of the Herbert M. Parker Foundation at WSU

**April 2026**
jconca@fanuclear.com

FIRST AMERICAN
NUCLEAR

# Disclaimer

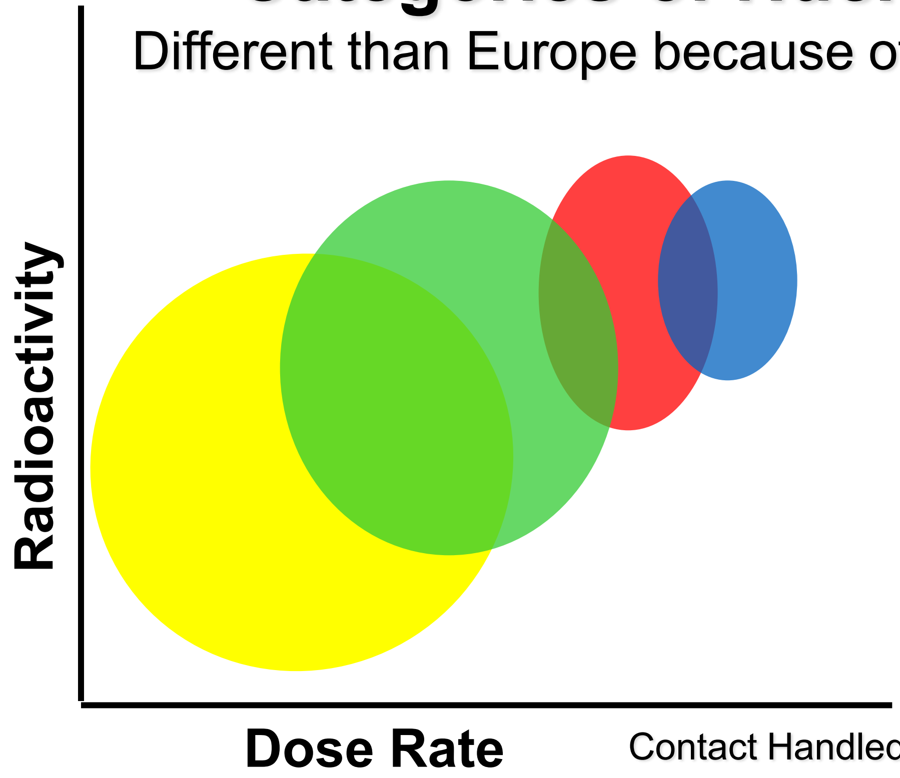
The information contained in this document has been prepared by representatives of 1ST AMERICAN NUCLEAR CO. (“FANCO” or “Company”) and is provided for general informational purposes only and reflects the views and opinions of the presenter as of the date of delivery. It is not intended to represent formal positions, commitments, or technical specifications of the Company. Certain statements may relate to future concepts, potential development pathways, or anticipated industry trends. Such statements are inherently uncertain and subject to change based on ongoing engineering, regulatory engagement, and business considerations.

Descriptions of technologies, including the EAGL-1 reactor and associated systems, are illustrative in nature and may not reflect final design configurations, licensing positions, or commercial deployment strategies. This presentation does not constitute engineering, legal, regulatory, or operational guidance and should not be relied upon for decision-making purposes. Any reliance on the information presented is at the sole discretion of the audience.

Company assumes no obligation to update or revise the information presented, and no representation or warranty is made as to its completeness or accuracy.

# Categories of Nuclear Waste In the U.S.

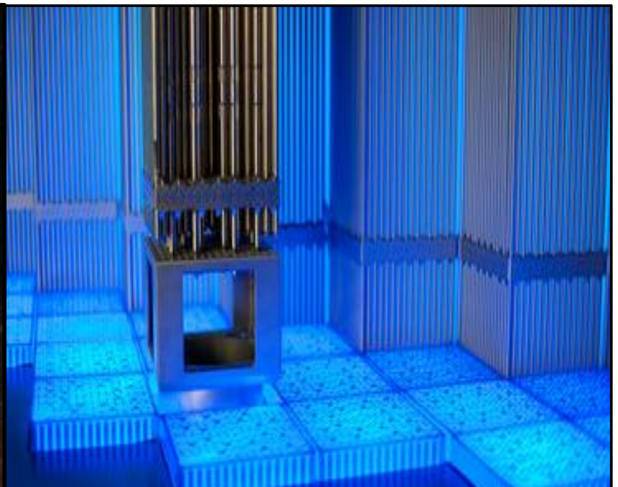
Different than Europe because of the larger amount of defense waste




- **Spent Nuclear Fuel (SNF/UNF)**
- **High Level Waste (HLW)**
- **Transuranic Waste (TRU-CH&RH)**
- **GTCC (ILW in EU; FP+unburned Ac)**
- **Low Level Waste (LLW)**

Contact Handled (CH) < 200 mrem/hr < Remote Handled (RH) < 23 Ci/liter

***Deep Geologic Disposal is required for SNF, HLW, TRU and GTCC***



## a short nuclear primer

*Natural uranium exists mainly as an ore, that is mined like any ore, and milled to produce yellowcake.*

**Uranium-ore**

*When hit by a neutron $^{235}U$ splits (fissions) easily while $^{238}U$ does not.*

*Natural U is 0.7% $^{235}U$ and 99.3% $^{238}U$*

**Yellowcake**
$U_3O_8$

*This low amount of $^{235}U$ is not enough to sustain a chain reaction so the material must be enriched:*

*Nuclear fuel is enriched to ~4% $^{235}U$, with ~96% still as $^{238}U$*

*The higher the enrichment, up to 20% $^{235}U$, the more energy is produced and the longer the fuel can stay in the reactor*

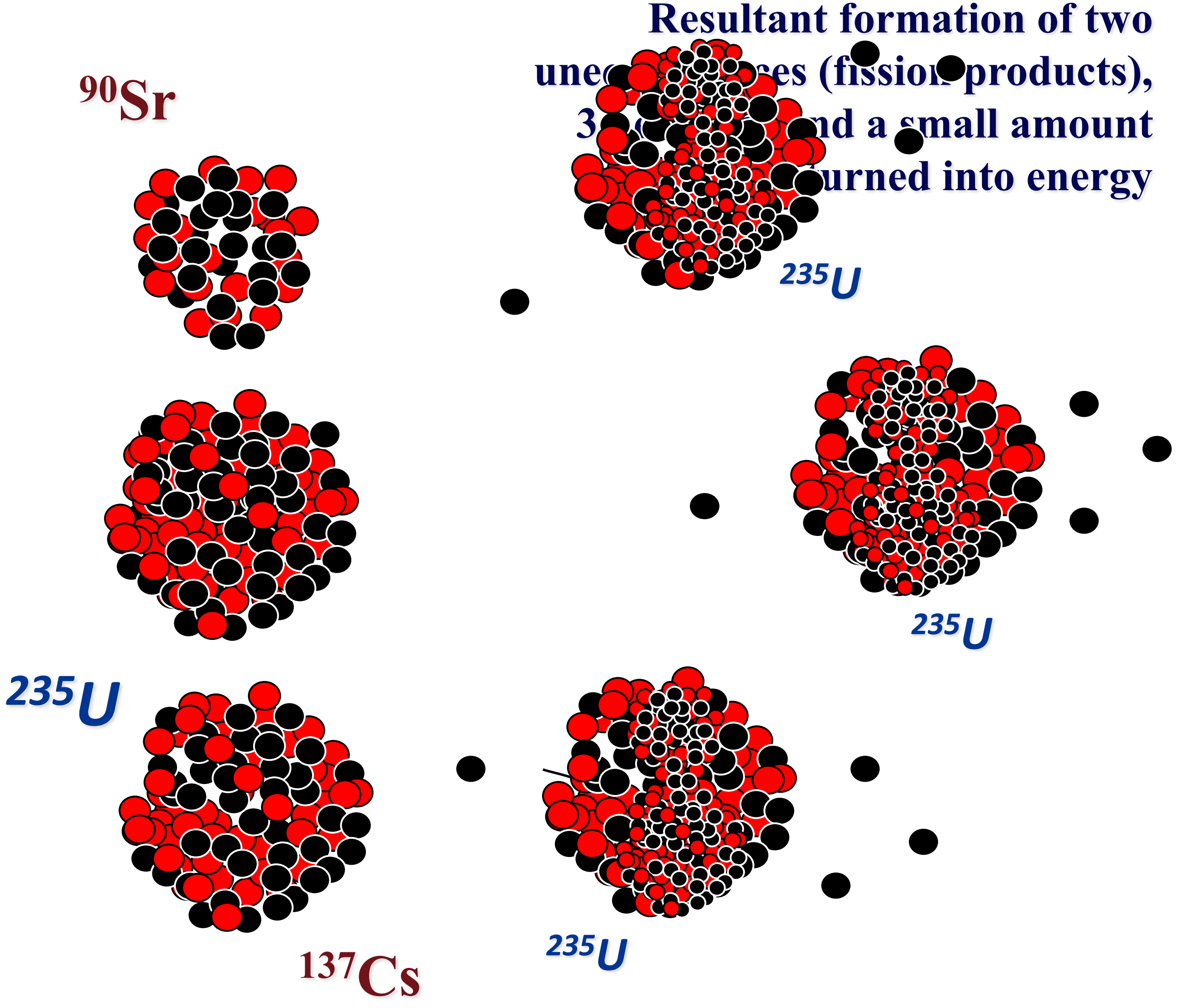
*Nuclear weapons must be enriched to >93.5% $^{235}U$ or 100% $^{239}Pu$*

***You cannot make weapons from used or spent commercial fuel***

# *Fission of $^{235}U$ (similar for $^{239}Pu$)*

proton

neutron

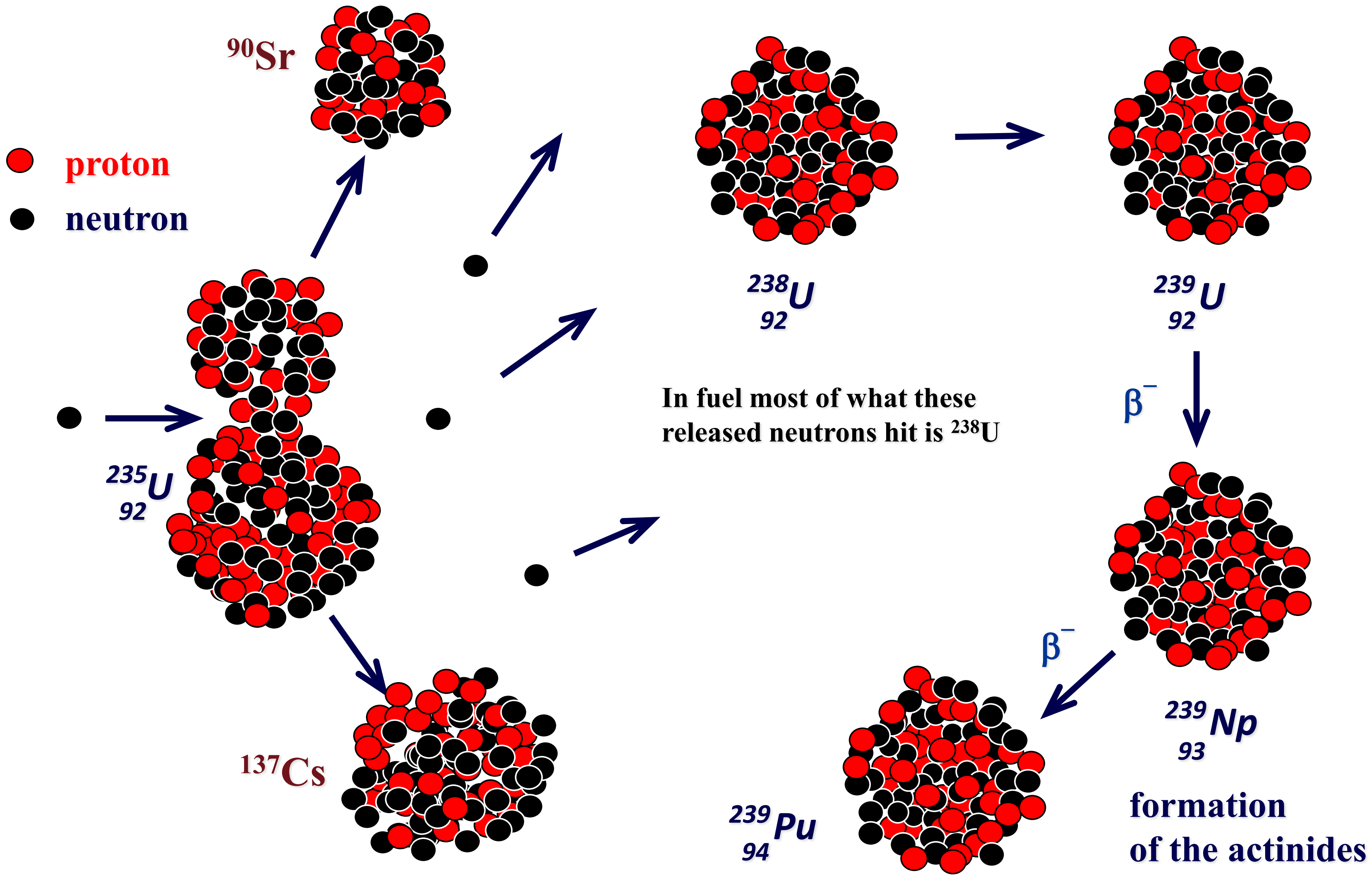



92 protons

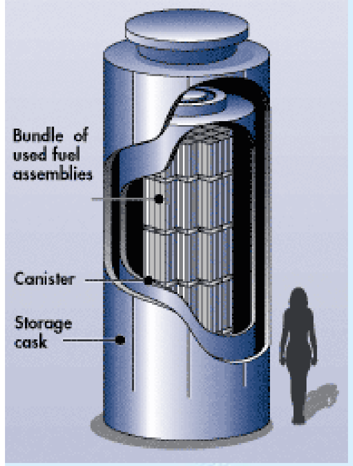
\+ 143 neutrons

235 total

# Breeding New Fuel
# Neutron Capture by $^{238}U \Rightarrow {}^{239}Pu$



One cannot make a nuclear weapon from used commercial fuel

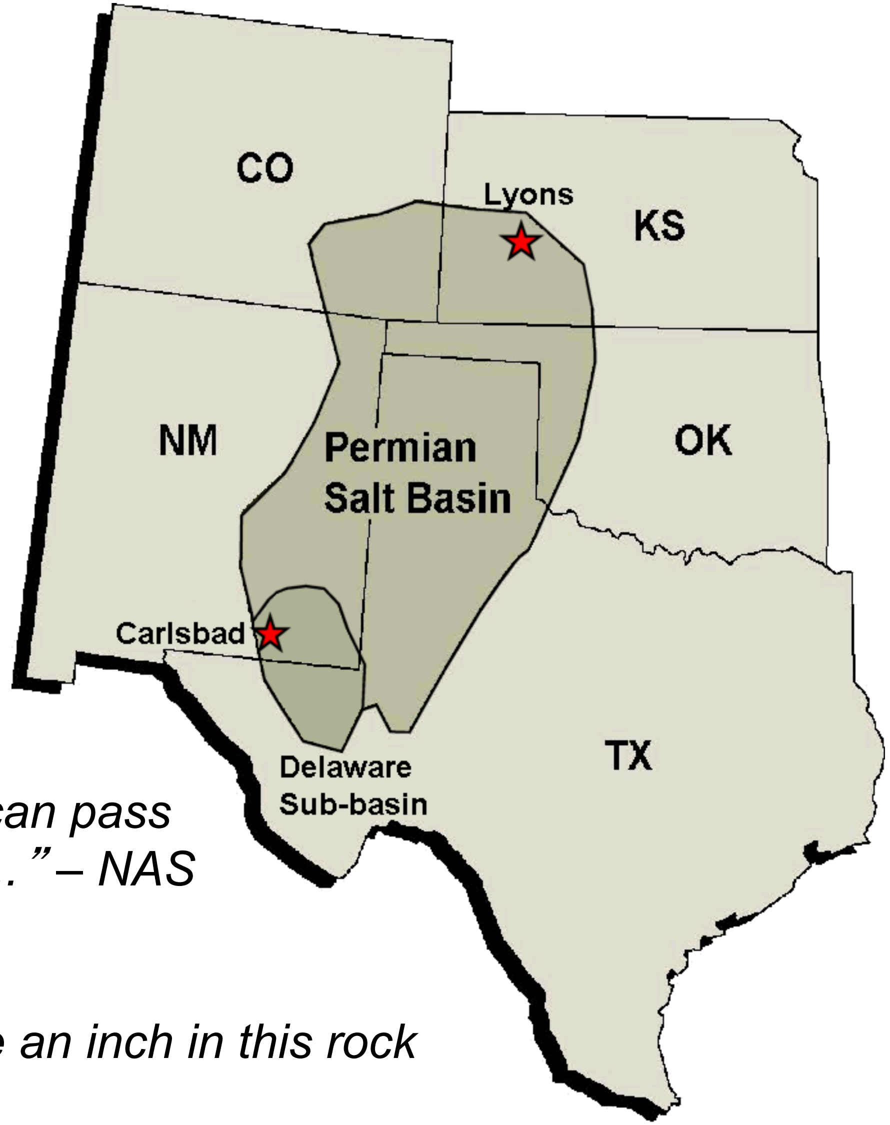



# Interim Storage for Commercial Spent Fuel

**ideal for >160 years, enough time for SNF to cool significantly, be burned in fast reactors in the near future and be abundant sources for medical isotopes such as $^{99}$Mo, $^{99}$Tc, $^{225}$Ac, $^{131}$I, and $^{213}$Bi**

National Academy of Sciences (NAS) concludes in 1957 that the most promising disposal option for all radioactive waste is in massive salt deposits

**1957**




*"Salt at great depth 'flows.' It will encapsulate any waste placed at depth and isolate it from the surface environment for eons." - NAS*

*"The great advantage is that no water can pass through salt. Fractures are self healing.." – NAS*

*It takes a billion years for water to move an inch in this rock*

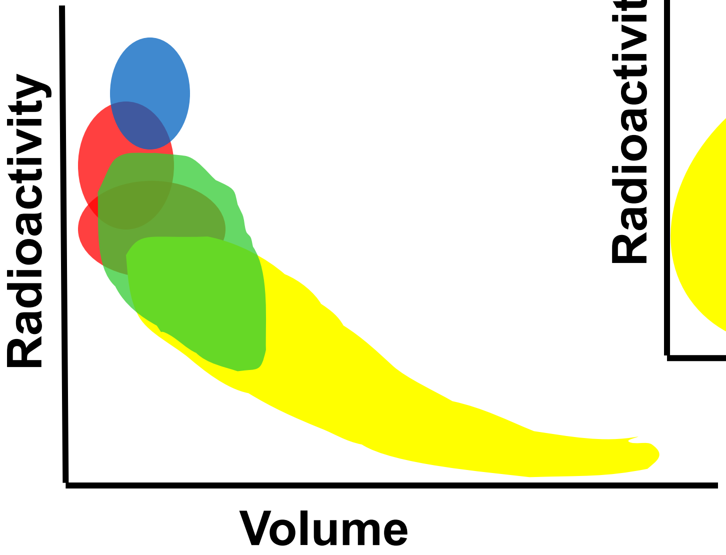
# Disposal options for different waste streams begins to diverge in the 1970s

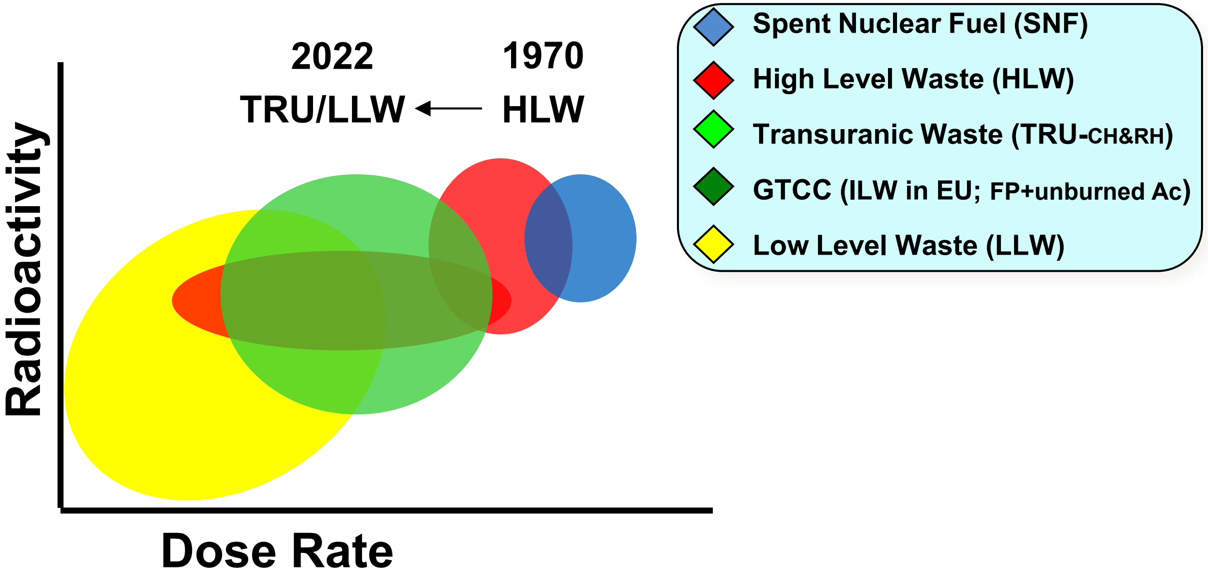
1957 - deep geologic disposal adopted; salt chosen as best

1970 - AEC establishes new category for transuranic waste, distinct from low- and high-level radioactive waste but with significant overlap in radioactivity. EPA formed.

1976 – reprocessing of commercial spent fuel put on hold; separate retrievable disposal concept born for SNF/HLW not to go into salt; TRU still to go into salt.

1982 – Nuclear Waste Policy Act…




Contact Handled (CH) < 200 mrem/hr < Remote Handled (RH, up to 23 Ci/L)

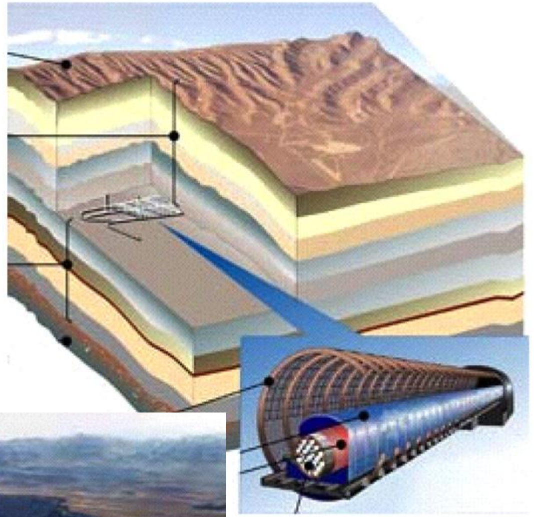

**….seventeen candidate sites for *two* high-level and commercial waste sites selected in 1982 after the NWPAct**

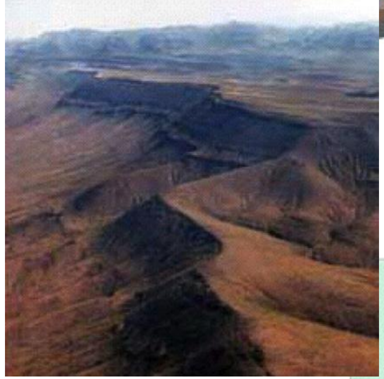
**🡐 Sites considered for the *first* repository**


**Sites considered for 🡒 a *second* repository**

**But the idea of retrieving SNF in the future took hold, killing salt as the host rock and by 1987 the candidate sites were narrowed from 17 to 3:**

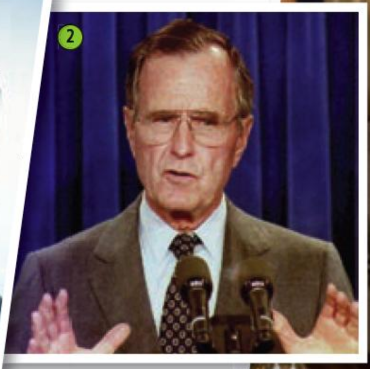
- **Yucca Mt, Nevada**
- **Hanford, Washington State**
- **Deaf Smith, Texas**



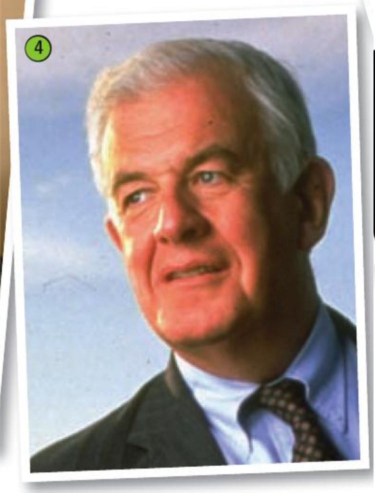


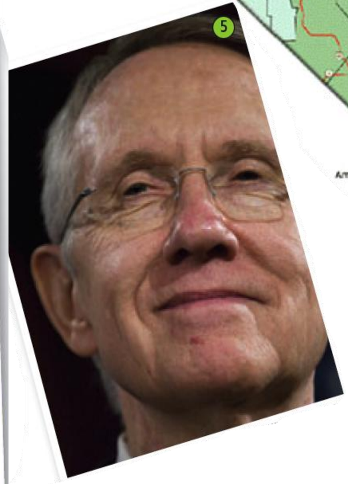
In 1987, Speaker of the House was Jim Wright from *Texas*, House majority lead was Tom Foley from *Washington State*. A new junior, Harry Reid, was from *Nevada*. So Nevada was chosen. Harry Reid led the effort to shut down the Yucca Mountain project. Reid became Senate Majority Leader in 2006. In 2008, the YM license application was submitted. In 2009, YMP was halted and President Obama put a Blue Ribbon Commission together to develop a new strategy.









## What Makes A Good Deep Geologic Nuclear Waste Repository?

There are seven criteria used to evaluate the suitability of a site for a deep geological repository

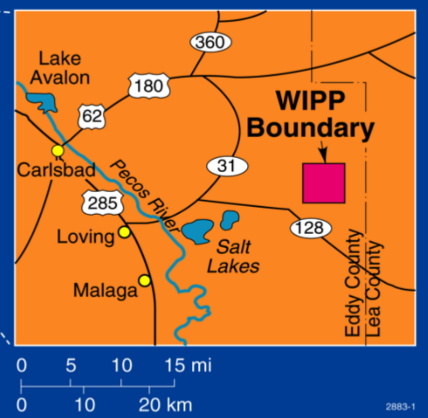
- **a simple hydrogeology,**
- **a simple geologic history,**
- **a tectonically interpretable area,**
- **isolation robustly assured for all types of wastes (no vitrification or reforming necessary),**
- **minimal reliance on engineered barriers to avoid long time extrapolation of models for certain types of performance,**
- **performance that is independent of the canister, i.e., canister and container requirements are only for transportation, handling and the first several hundred years of peak temperature after emplacement in a repository, and**
- **a geographic region that has an existing and sufficient sociopolitical and economic infrastructure that can carry out operations without proximity to a potentially rapidly growing metropolis (unlikely to ever have human habitation anywhere near the site).**

Unknown to most, transuranic waste (bomb waste) continued on into the salt as planned, leading to the Waste Isolation Pilot Plant.

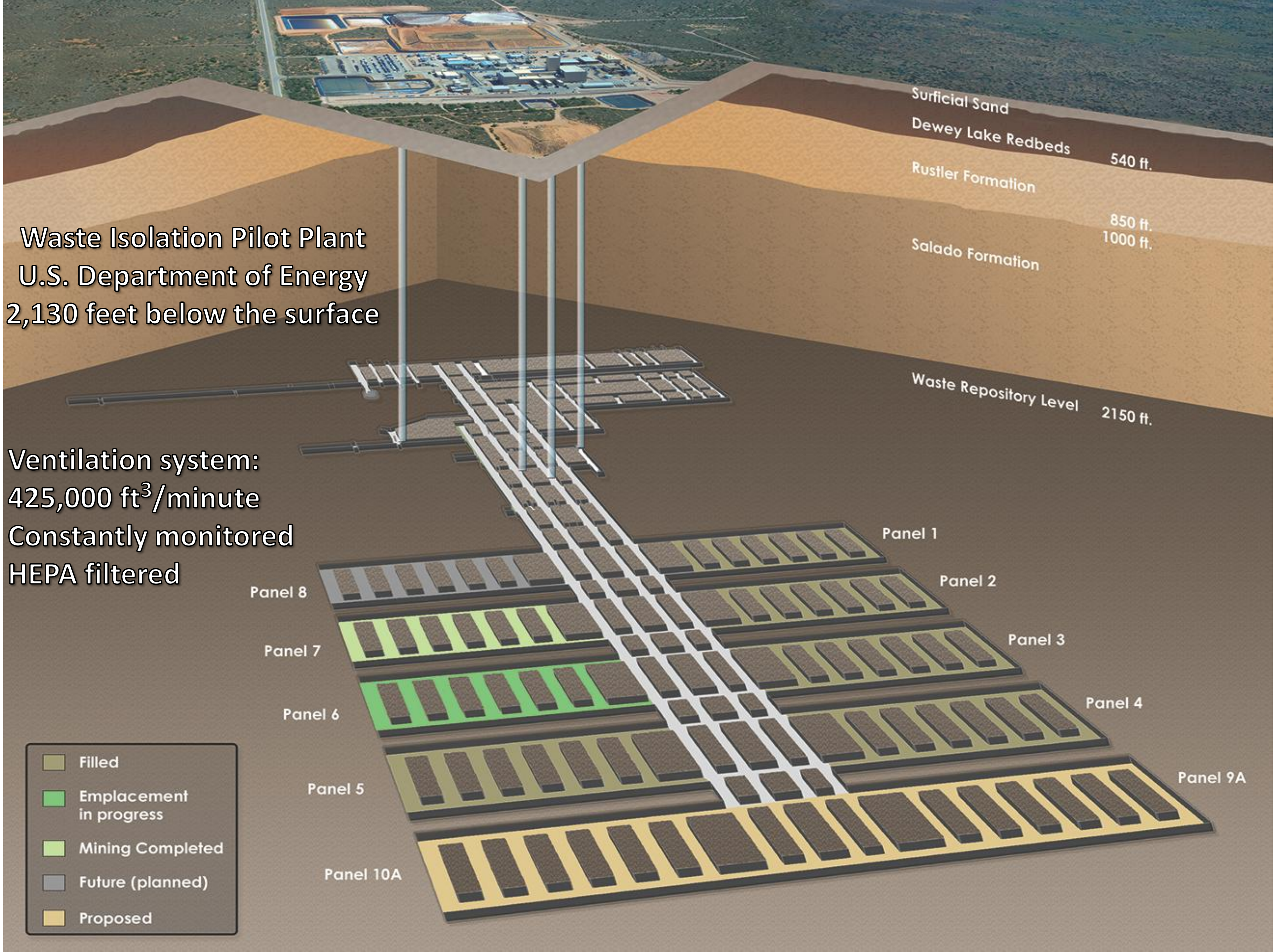
GTCC Waste considered to go here

Only defense-generated TRU waste *presently* permitted: 100 nCi/g to 23 Ci/L of alpha-emitting $^{239}Pu$ equivalents but WIPP was originally designed and built to handle all nuclear waste

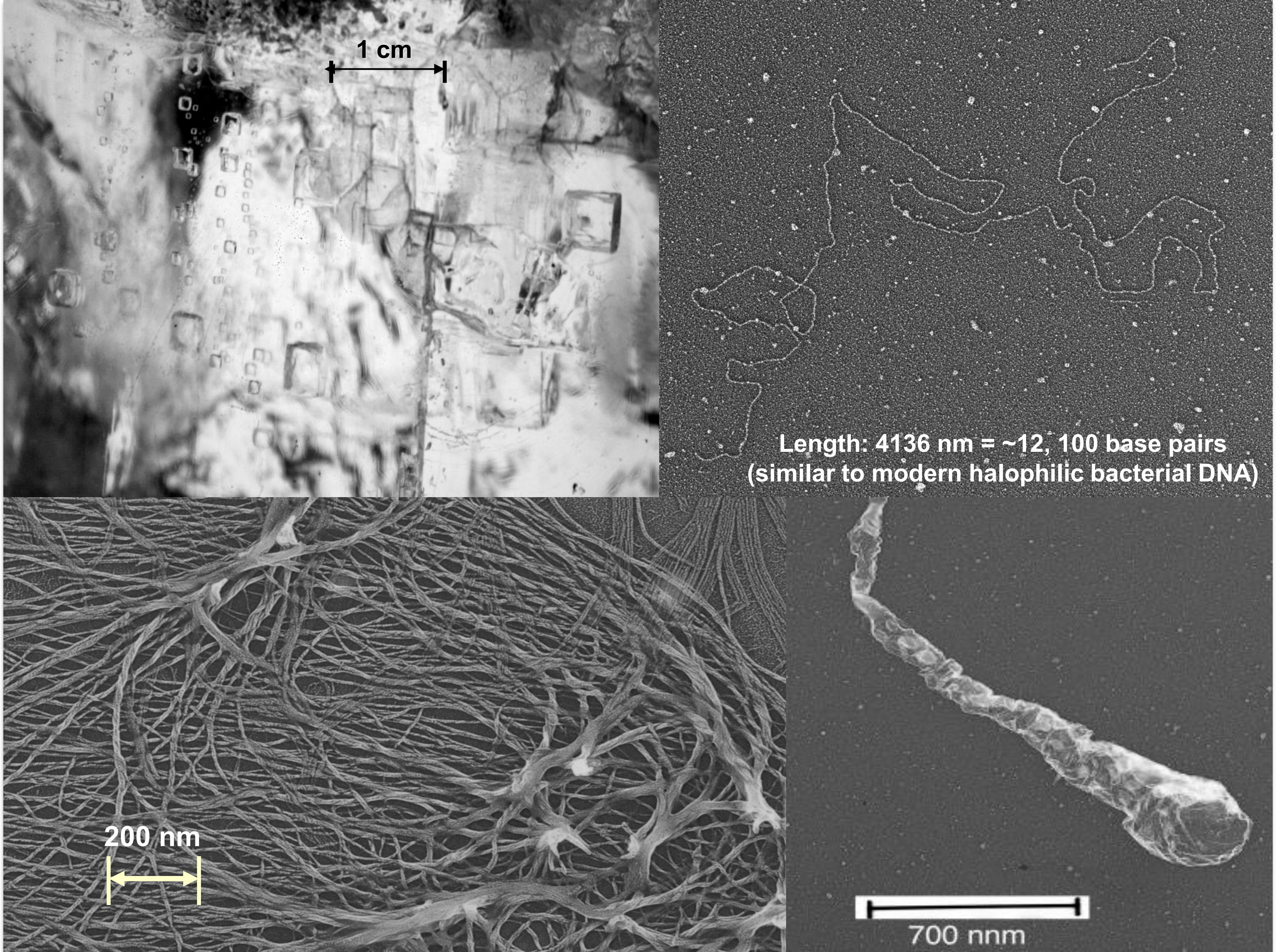

## Location of WIPP

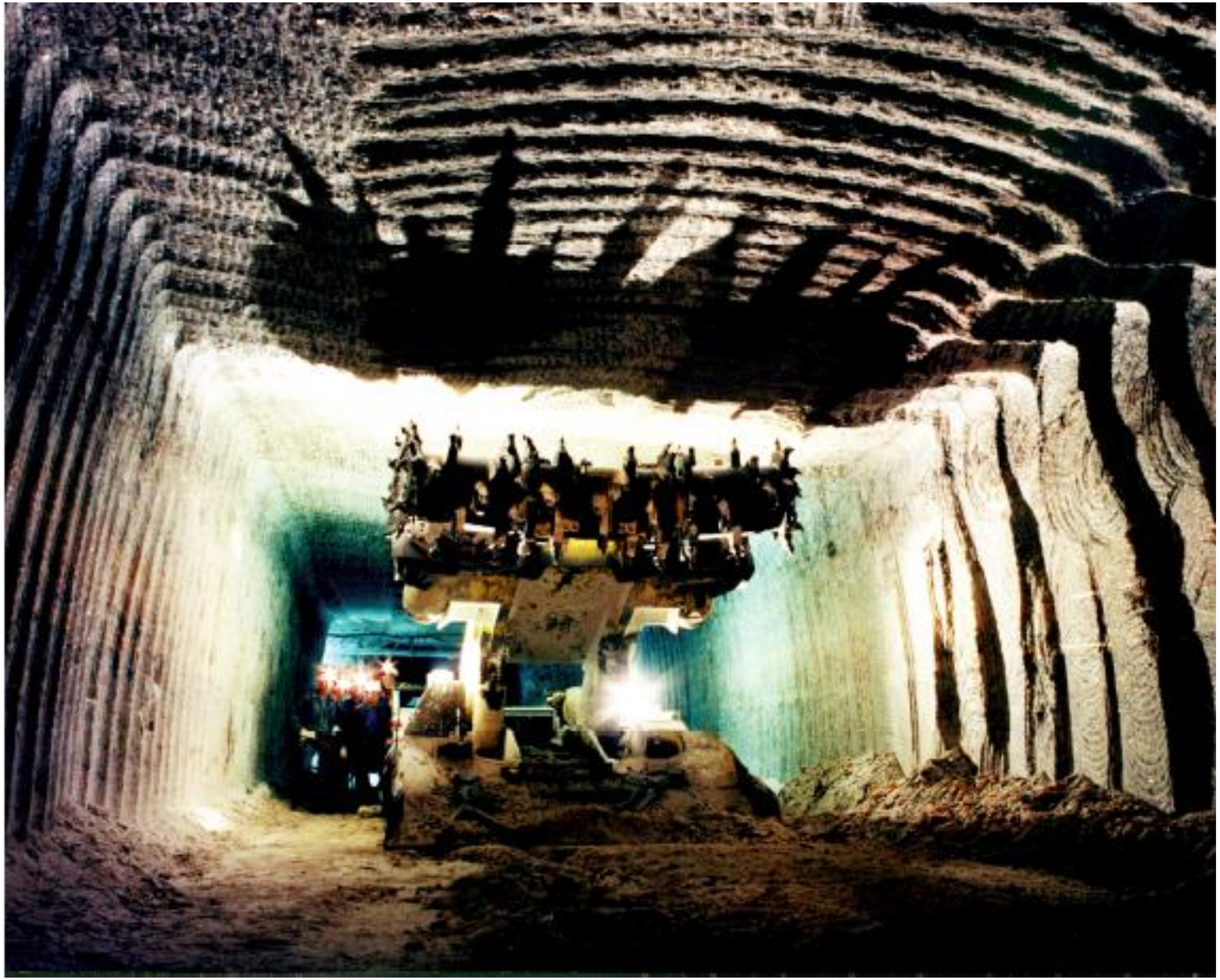

16 miles² set aside in the 1992 Land Withdrawal Act
- when WIPP is full, <1 mile² will have been used



Waste Isolation Pilot Plant
U.S. Department of Energy
2,130 feet below the surface
Ventilation system:
425,000 $ft^3$/minute
Constantly monitored
HEPA filtered
Surficial Sand
Dewey Lake Redbeds
540 ft.
Rustler Formation
850 ft.
1000 ft.
Salado Formation
Waste Repository Level
2150 ft.
Panel 1
Panel 2
Panel 3
Panel 4
Panel 9A
Panel 8
Panel 7
Panel 6
Panel 5
Panel 10A
Filled
Emplacement in progress
Mining Completed
Future (planned)
Proposed


1 cm
Length: 4136 nm = ~12, 100 base pairs
(similar to modern halophilic bacterial DNA)
200 nm
700 nnm

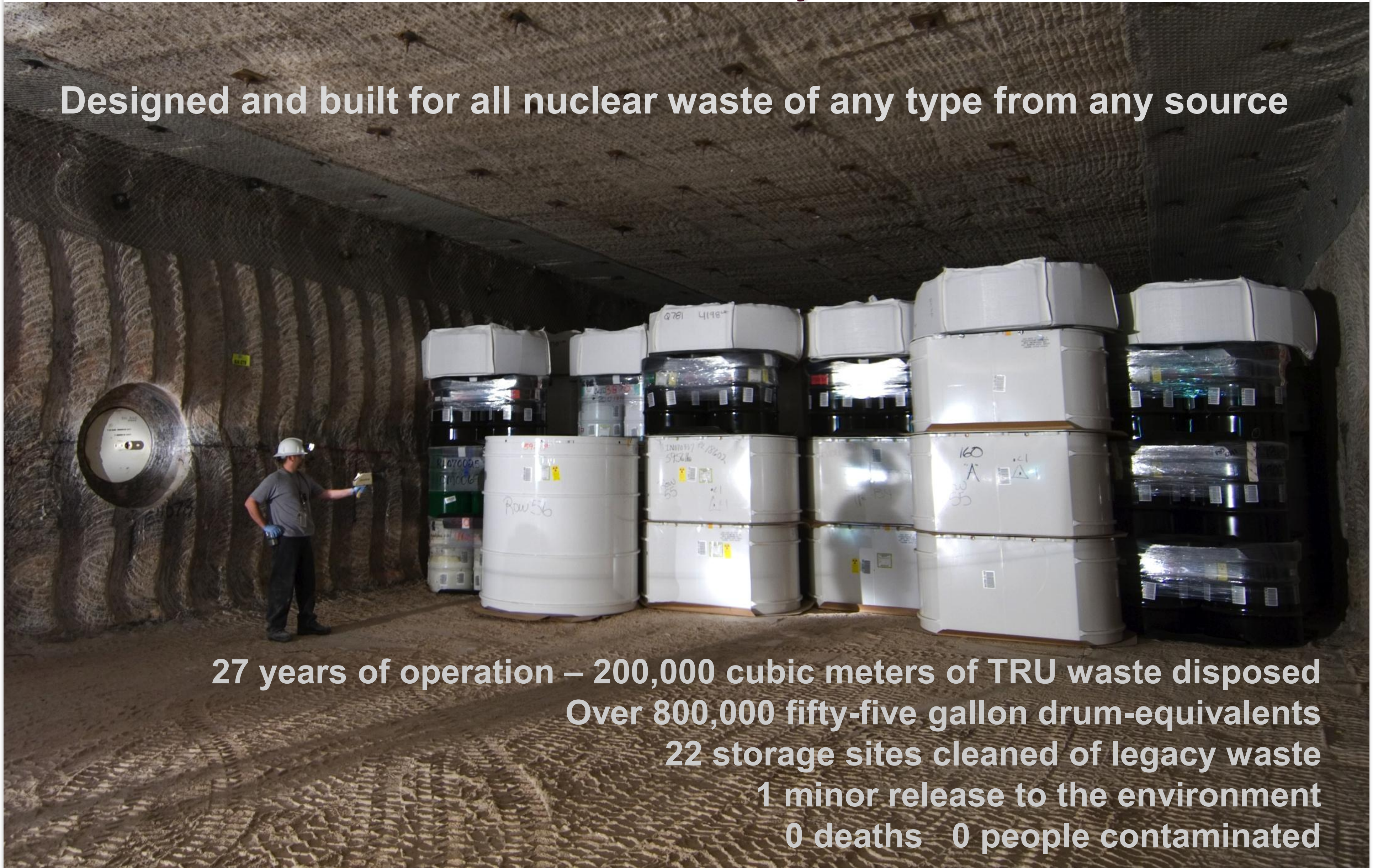
# Mining the Salado is the easiest and safest mining operation in the world



# January 2007, high activity waste began shipping to WIPP; up to 1000 R/hr surface and 23 Curies/liter (87 Curies/gallon)

# The higher activity waste is remotely plunged into boreholes in the room walls prior to filling with the lower activity waste

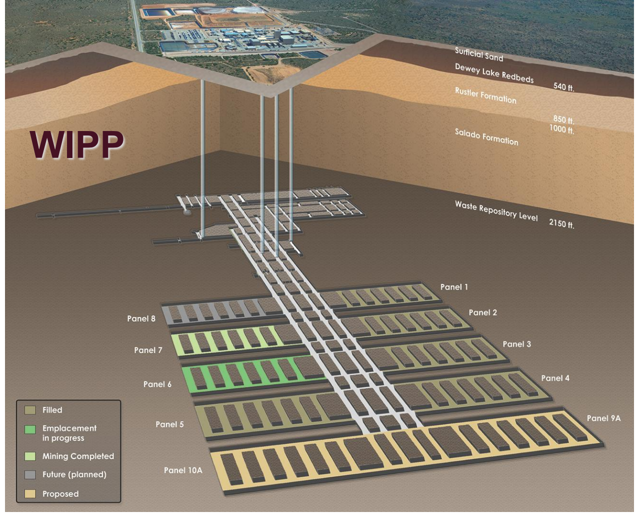
**At the 2000 lbs/inch$^2$ pressure at this depth, the salt exhibits significant creep closure, i.e., the salt completely closes all fractures and openings, even micropores, making the salt extremely tight, such that water cannot move even an inch in a billion years**



**Designed and built for all nuclear waste of any type from any source**

**27 years of operation – 200,000 cubic meters of TRU waste disposed**
**Over 800,000 fifty-five gallon drum-equivalents**
**22 storage sites cleaned of legacy waste**
**1 minor release to the environment**
**0 deaths   0 people contaminated**

# Probable Outcomes for U.S. Nuclear Waste (also supported by the BRC)



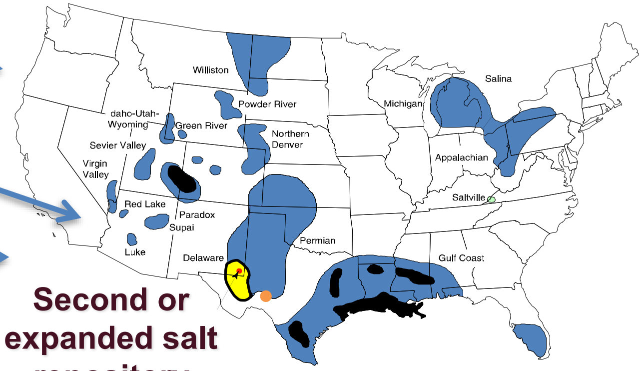

## Defense Waste (TRU and HLW)

stays right where it is
(EISs show no actual problem)

HLW redefined as TRU

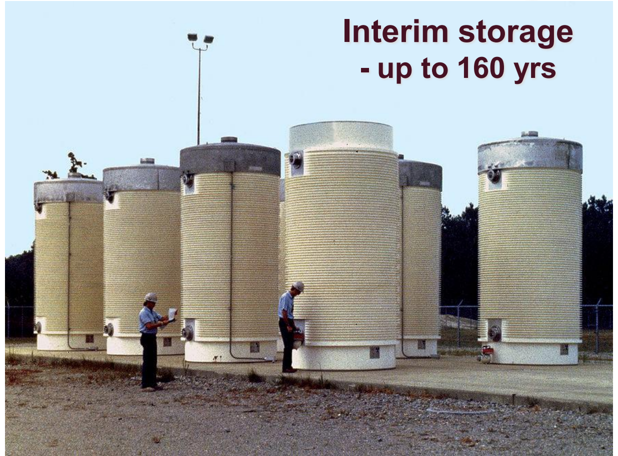
2nd salt repository - cheap

HLW redefined as LLW to TX, SC




Second or expanded salt repository

## Commercial nuclear used fuel



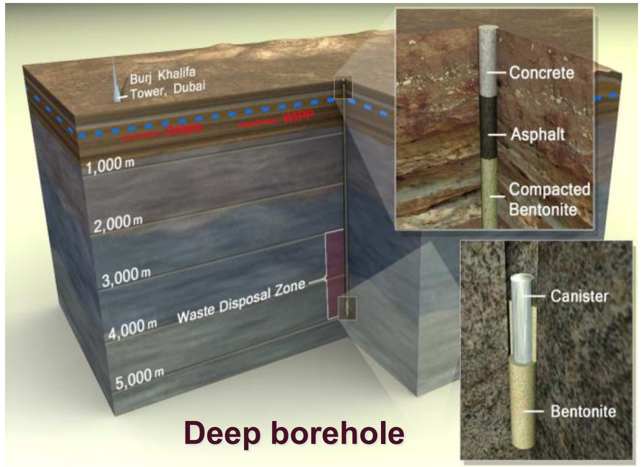

Eagl-1
240MWe

Burn in fast reactors

Recycle for new fuel and radioisotopes

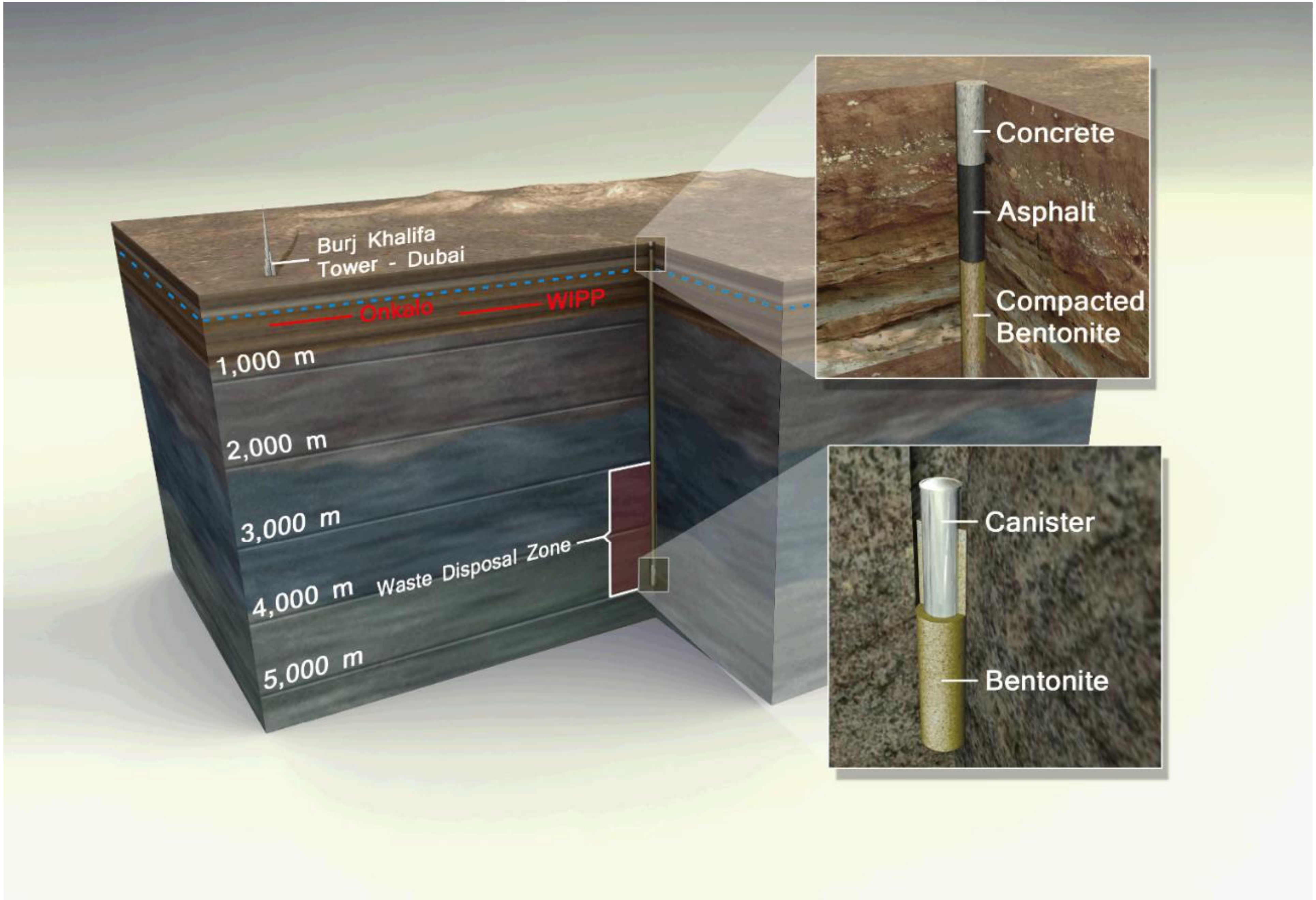
GTCC Waste

+ other

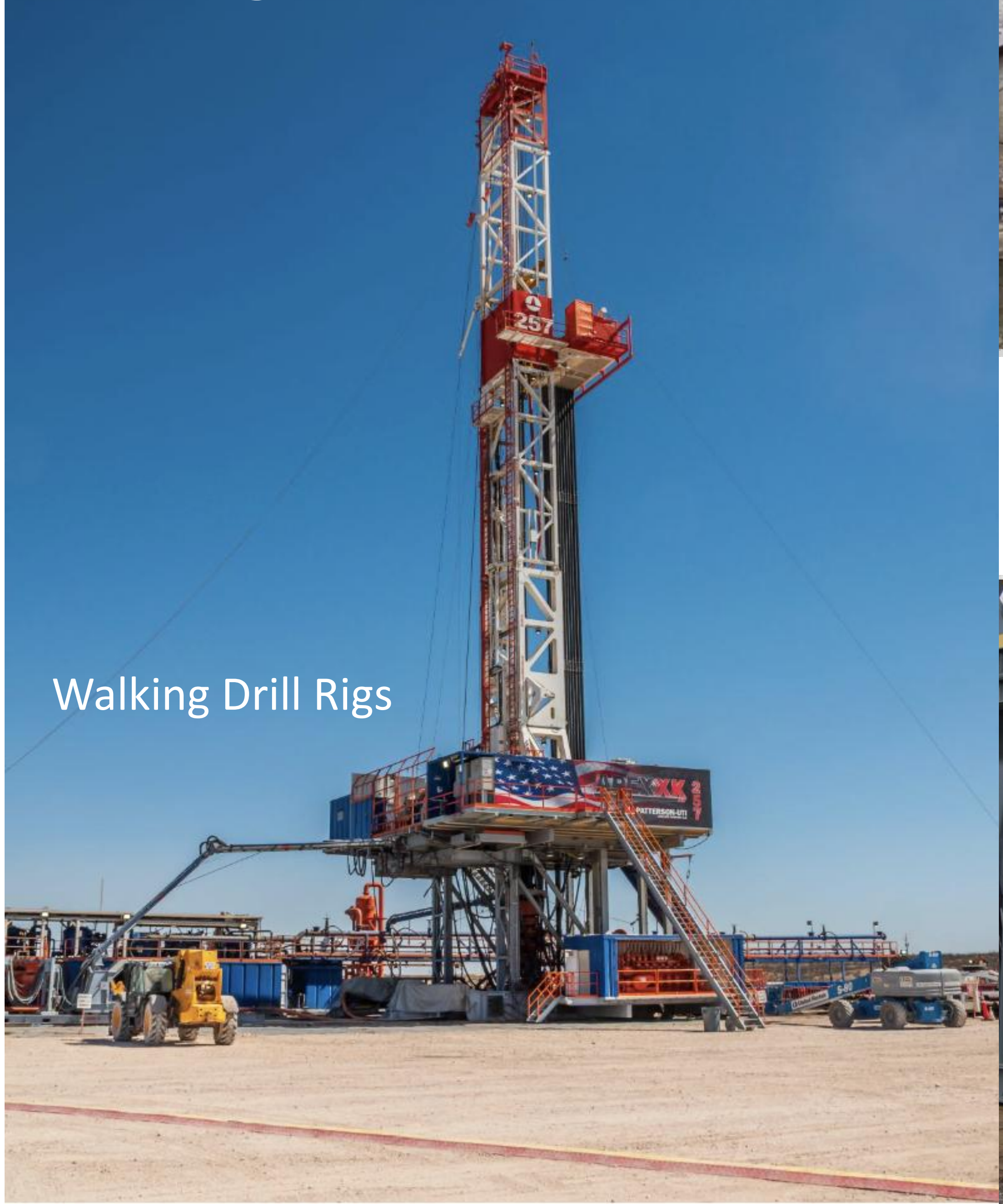



Deep borehole

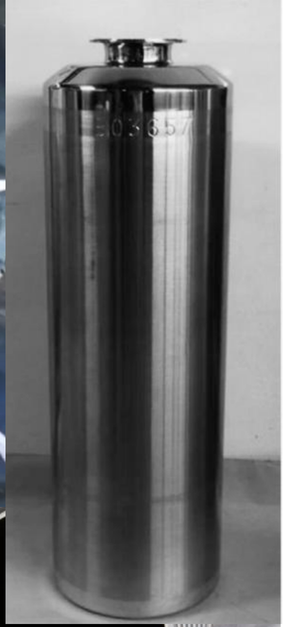
# Deep Borehole Disposal of Nuclear Waste



# Drilling is even easier now




Walking Drill Rigs



# Deep Borehole Disposal of Nuclear Waste

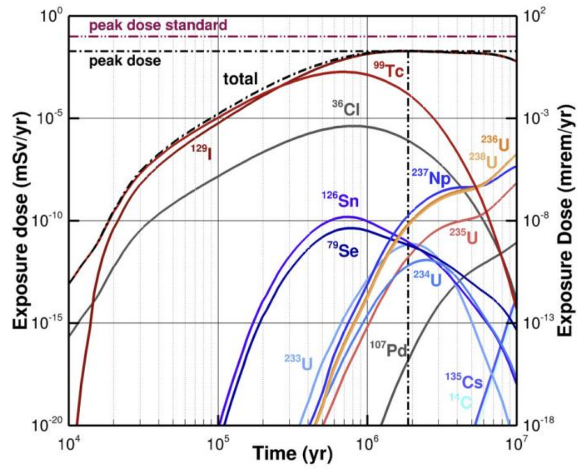
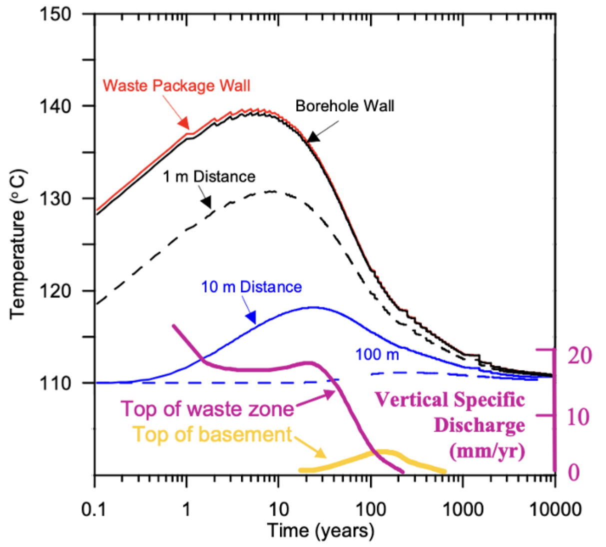
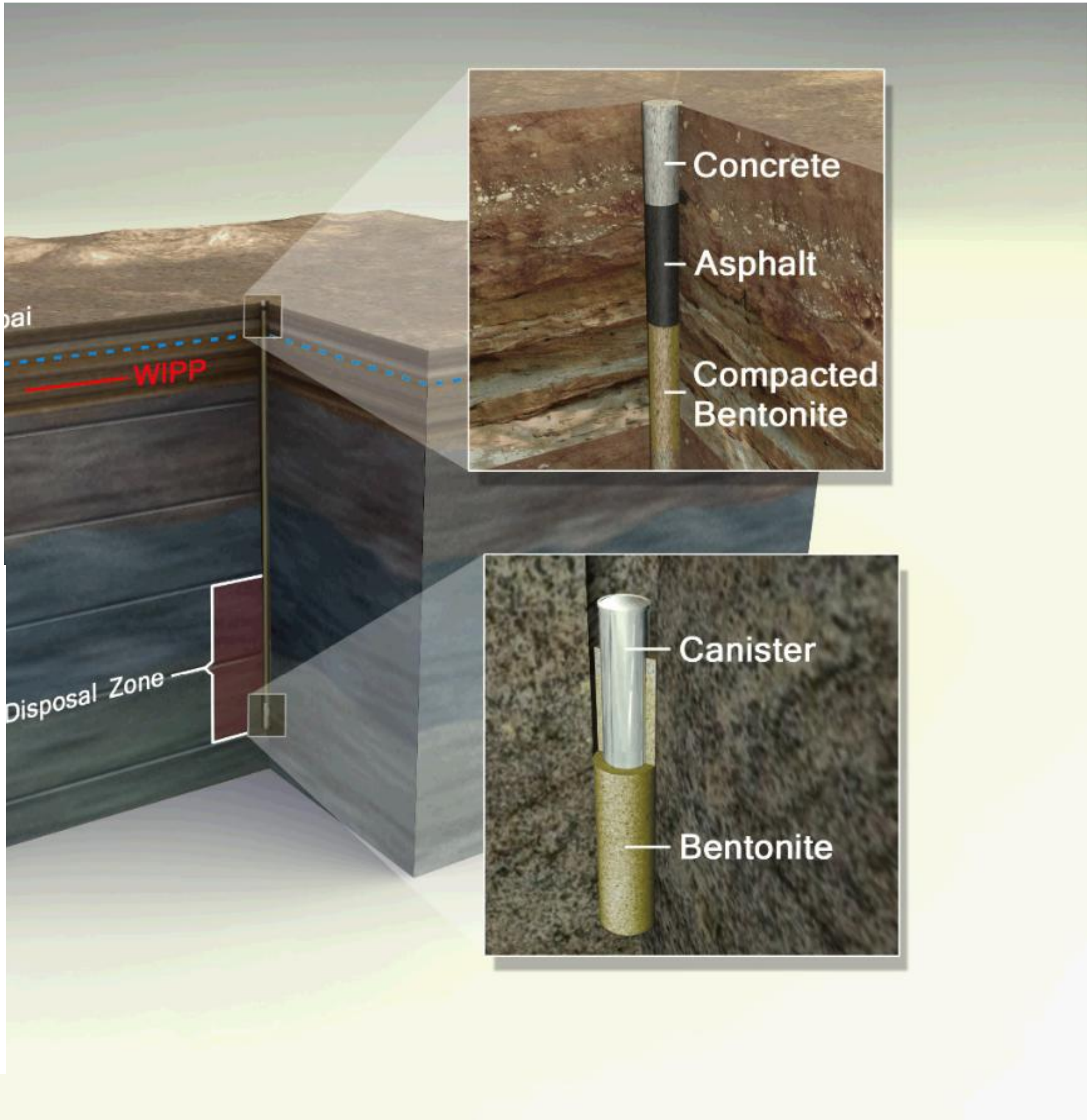



FIGURE 6
Exposure dose as a function of time for radionuclides tracked in the comprehensive PA model for a vertical borehole repository sited in fractured crystalline rock. Only 14 of the 36 tracked radionuclides exceed a peak dose of $10^{-20}$ mSv $yr^{-1}$.



## How Many Disposal Boreholes?

~150 metric tons of nuclear waste per disposal borehole

– all fission products plus unburnt actinides: GTCC only, no UNF/SNF/HLW/TRU

Size and depth will be optimized

– 15 inch (38 cm) diameter borehole drilled to 16,000 ft (5 km)

– disposal zone 16,000 ft (5 km) to 10,000 ft (3km)

– holds ~150 $m^3$ of waste, no structures such as assemblies,

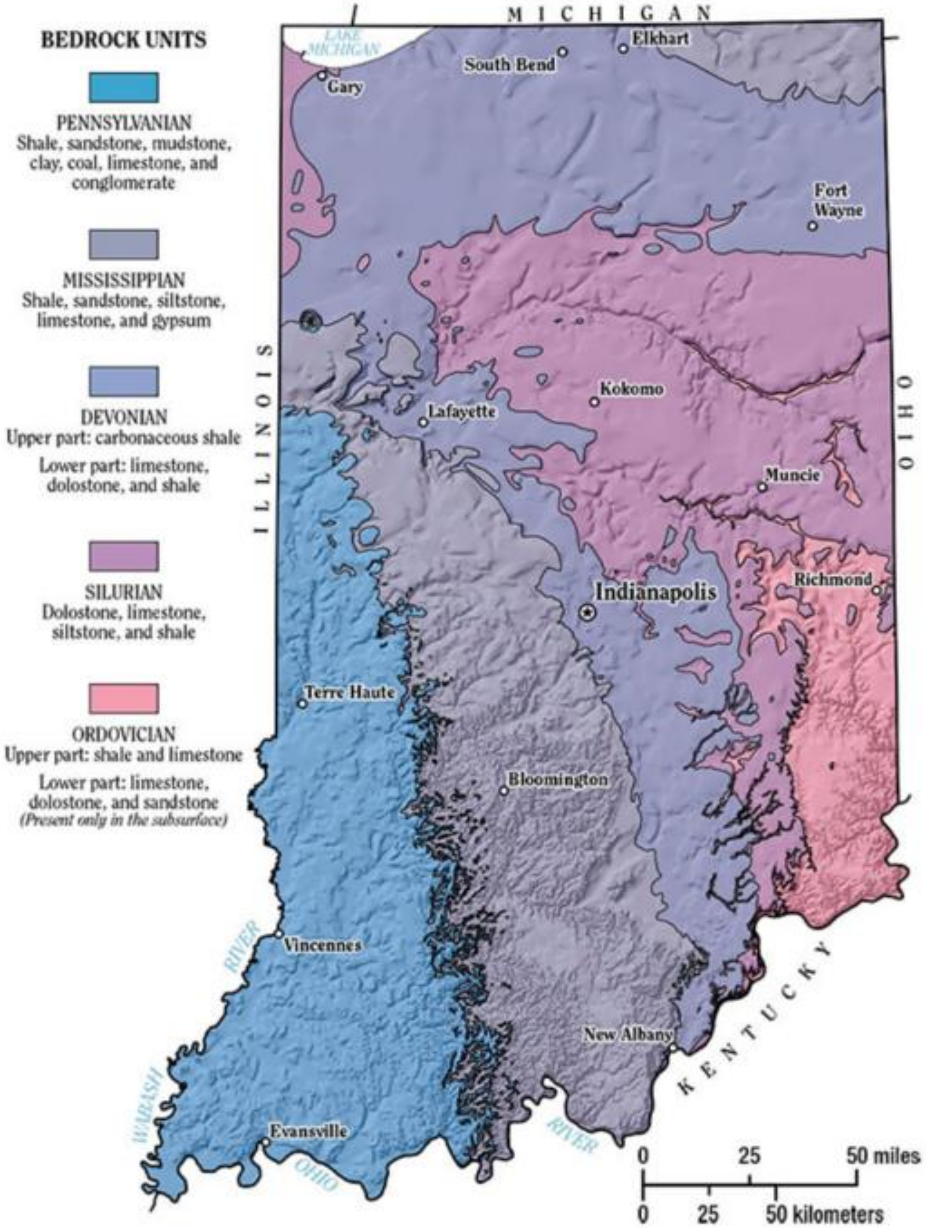
– 15 inch (38 cm) diameter borehole drilled to 16,000 ft (5 km) at a cost of $50 M, or $400,000 per metric ton of waste, much less than the cost of YMP's $3,000,000 per metric ton of waste

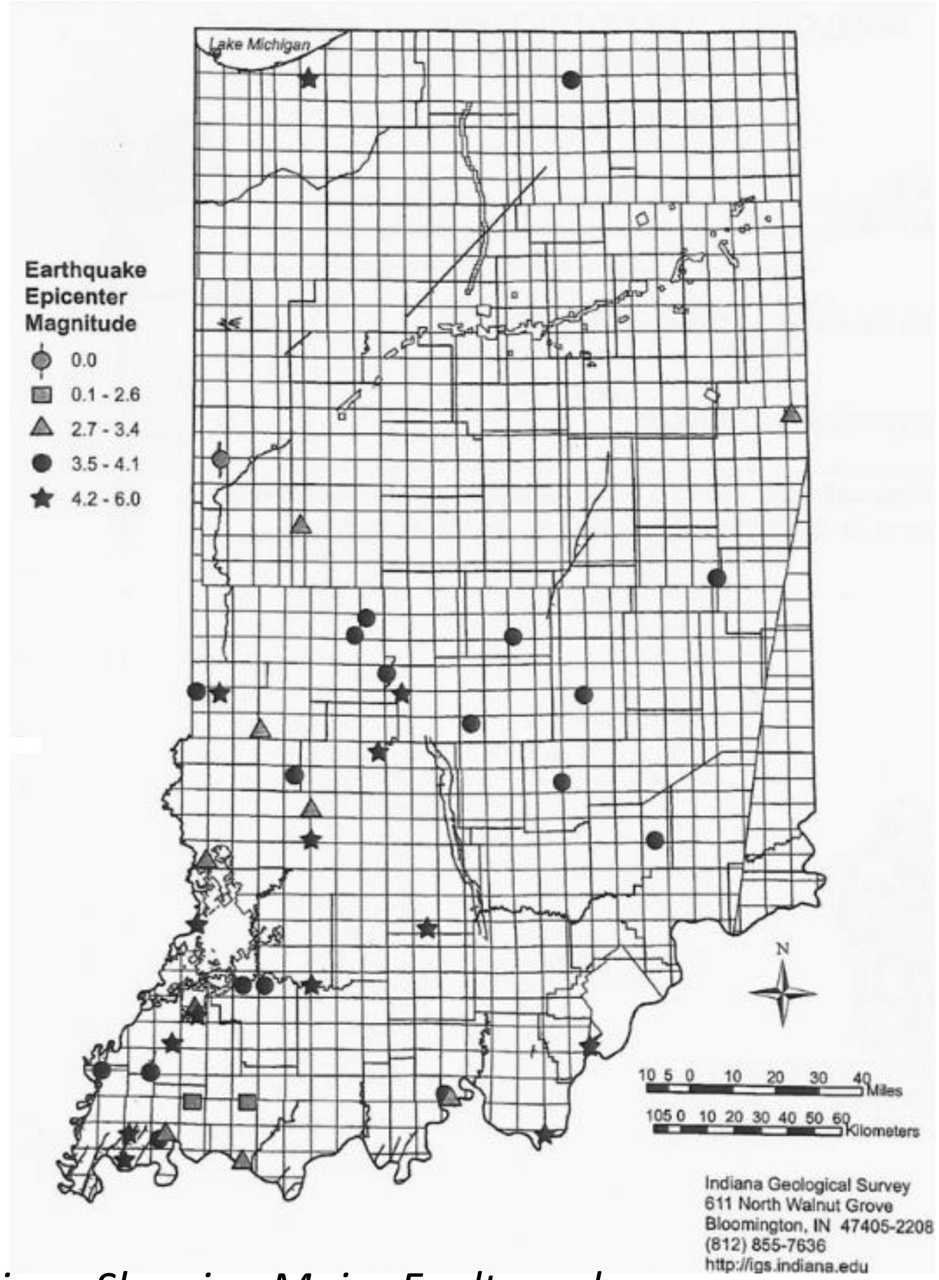
10 boreholes will handle EAGL-1 final waste for 40 yrs

– all fission products plus unburnt actinides: GTCC only, no UNF/SNF

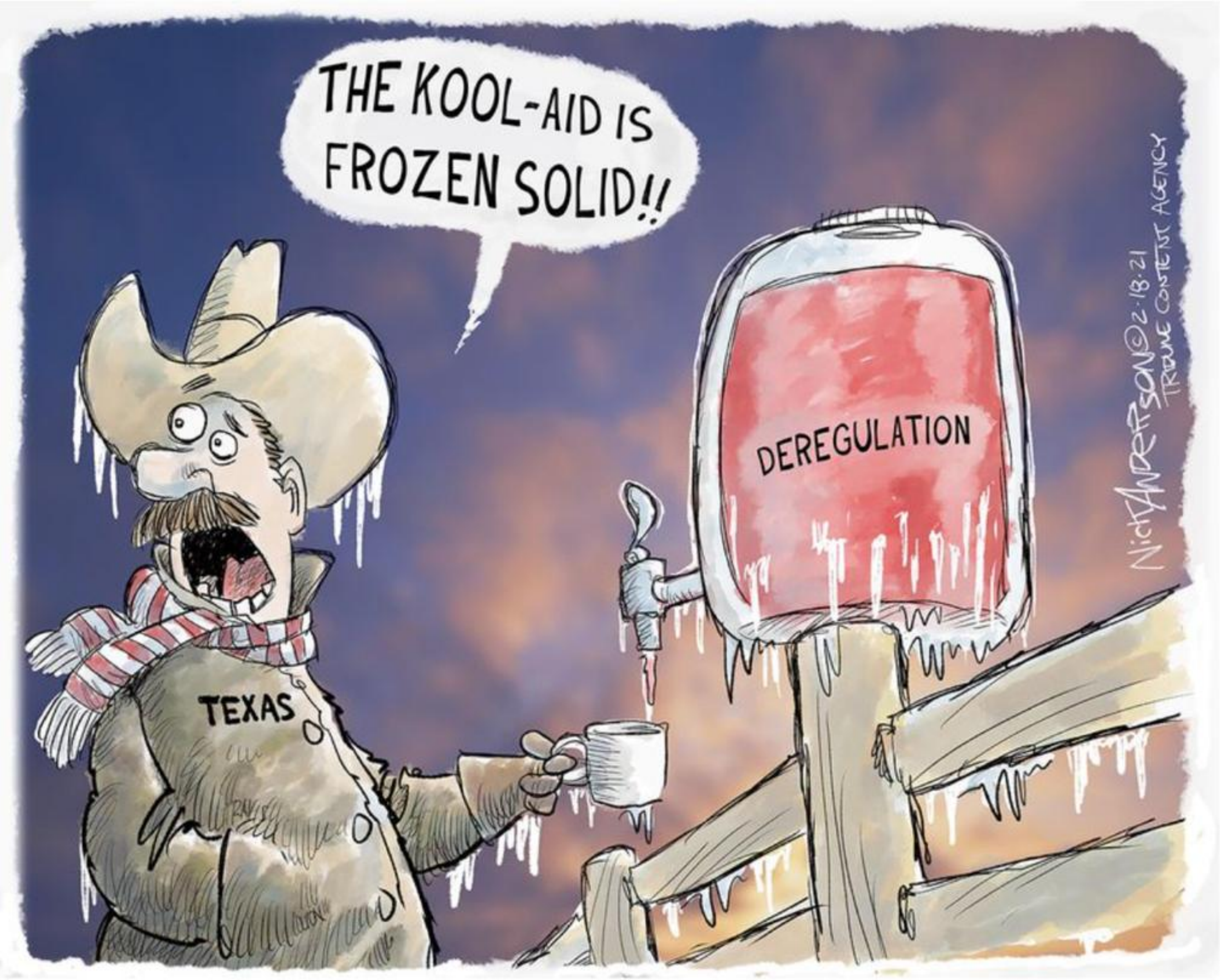
– no transport over state lines, little transport at all.

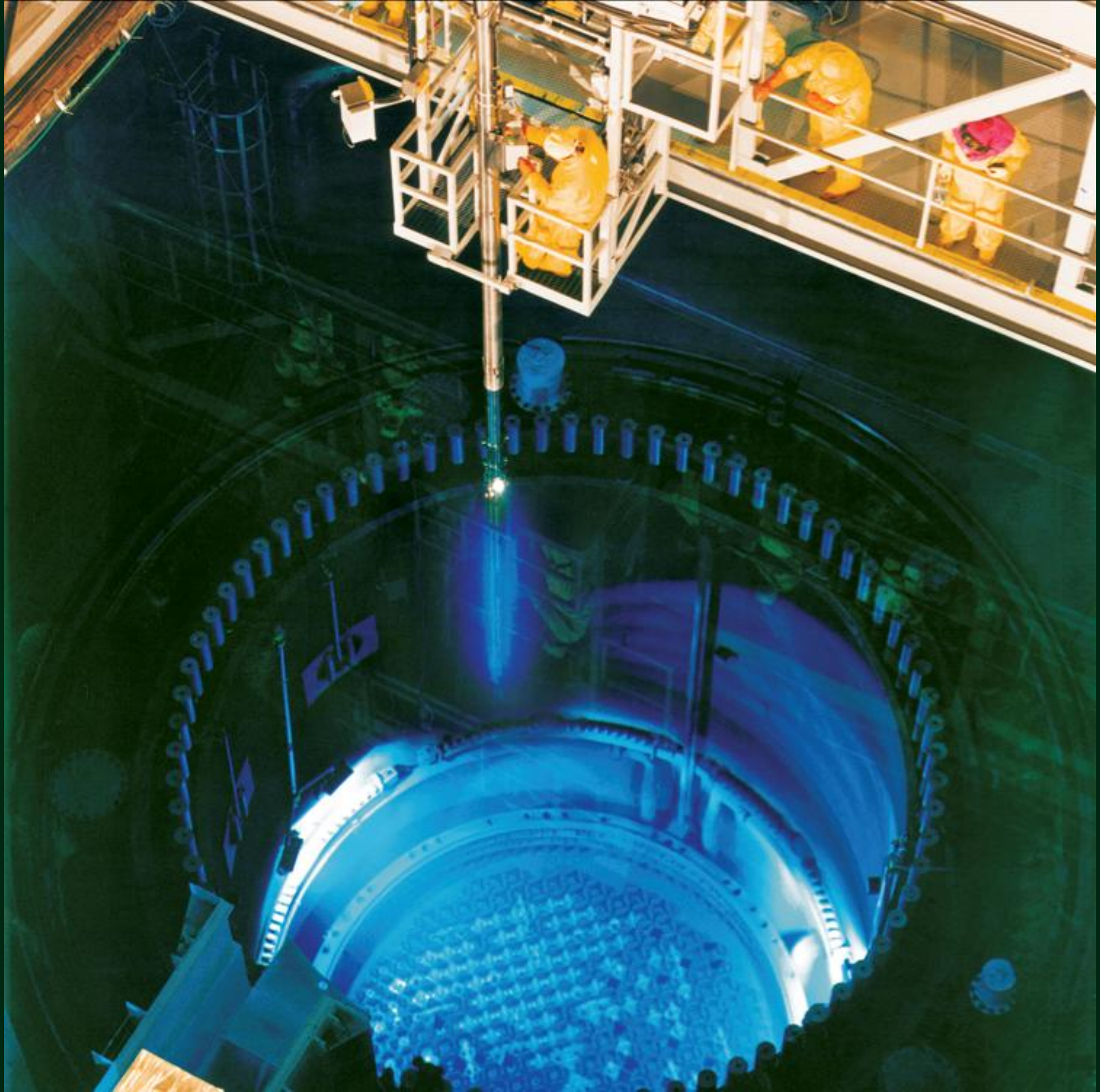
No taxpayer dollars needed



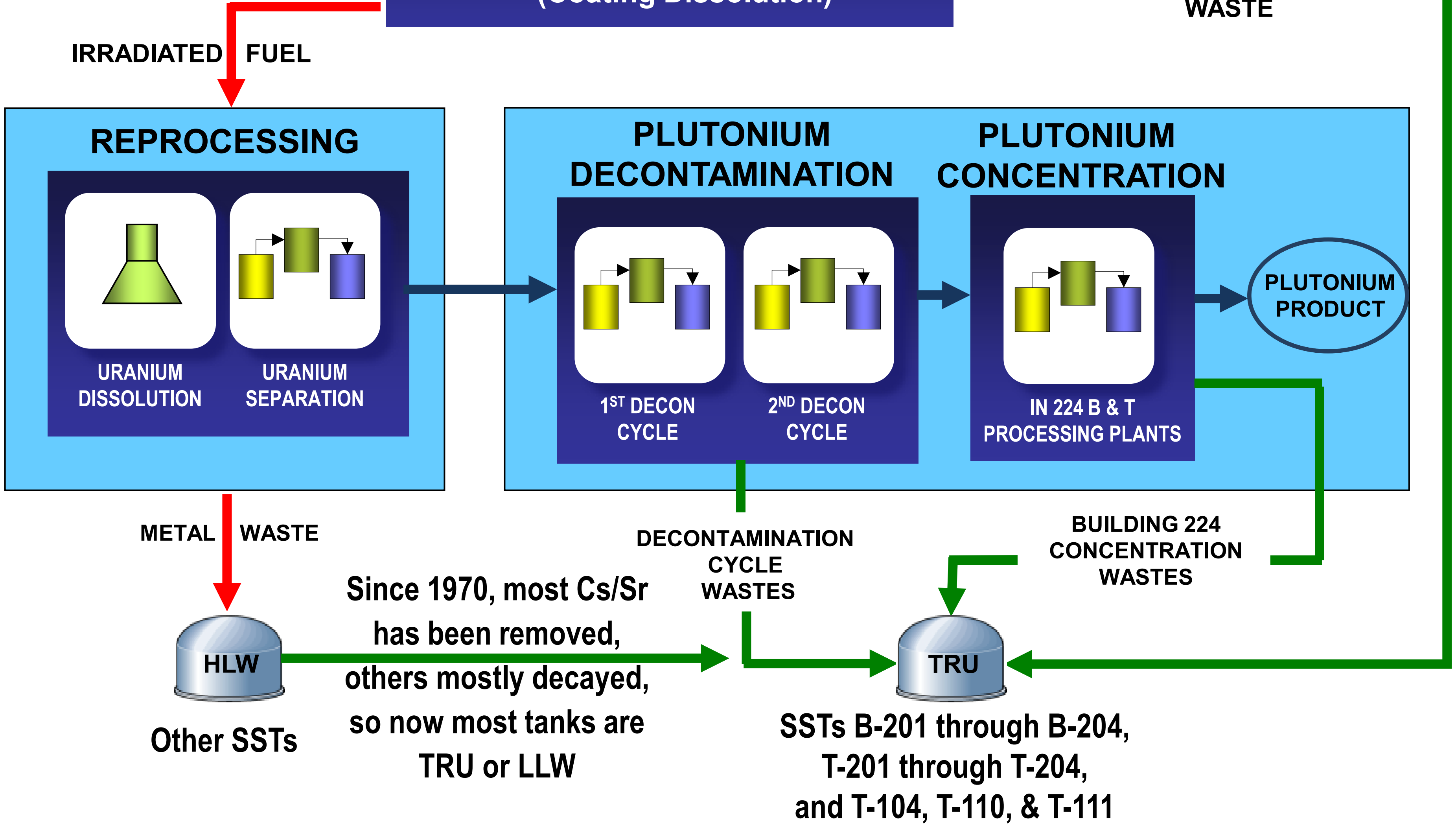




*Deep Geology of Indiana and Map of Indiana Showing Major Faults and Earthquake Epicenters (1827 – 2002).*


THE KOOL-AID IS FROZEN SOLID!!
DEREGULATION
TEXAS
NickANDERSON©2-18-21
TRIBUNE CONTENT AGENCY



- 57 million gallons at Hanford
- most is now TRU or LLW
~ 600k gallons are HLW



# Nuclear Lifecycle Innovation Campuses

**INDIANA OFFICE OF ENERGY DEVELOPMENT**
Luke Wilson, Chief Policy Officer

4/2/2026

# OUTLINE

- Background
- Nuclear Lifecycle Innovation Campuses (NLIC) RFI Overview
- Indiana's Response

# BACKGROUND

# BACKGROUND

President Trump set a goal of expanding American nuclear energy capacity from approximately 100 GW in 2024 to 400 GW by 2050.

# BACKGROUND

Governor Braun has set a moonshot goal of deploying an SMR in Indiana within 8 years.

# BACKGROUND

- President Trump issued four nuclear energy Executive Orders in May 2025.
- Executive Order 14302 was focused on reinvigorating America’s nuclear industrial base.
- The EO commissioned the study of ways to develop and deploy advanced fuel cycle capabilities to establish a safe, secure, and sustainable long-term fuel cycle.
  - Policy goal of achieving energy independence while maximizing the efficiency and effectiveness of nuclear fuel.

# BACKGROUND

- Spent fuel is currently kept onsite at nuclear power plants, first in spent fuel pools and then in concrete and steel casks.

- President Reagan lifted a moratorium on reprocessing nuclear waste
  - Reprocessing aims to extract uranium and plutonium and re-use those in a reactor.
  - Little commercial development due to costs.

- U.S. DOE has hundreds of billions of dollars in lending capacity that can be deployed for nuclear plants and to advance the American nuclear industry.

# BACKGROUND

- Previously, the federal government planned on developing Yucca Mountain as a single repository for all U.S. spent fuel but the project was cancelled.

- After the cancellation, DOE focused on consent-based siting for spent nuclear fuel but no specific plans for a single permanent storage site.

# NLIC RFI OVERVIEW

# NLIC RFI OVERVIEW

- U.S. DOE issued RFI on January 28, 2026 inviting states to express interest in hosting Nuclear Lifecycle Innovation Campuses and/or provide feedback on the proposed structure of the Innovation Campuses.

- DOE sought to information on approaches that would:
  - Prioritize private & state capital.
  - Rely on targeted, conditional, and time-limited federal support.
  - Include robust financial assurances to protect taxpayers from open-ended liabilities.

# NLIC RFI OVERVIEW

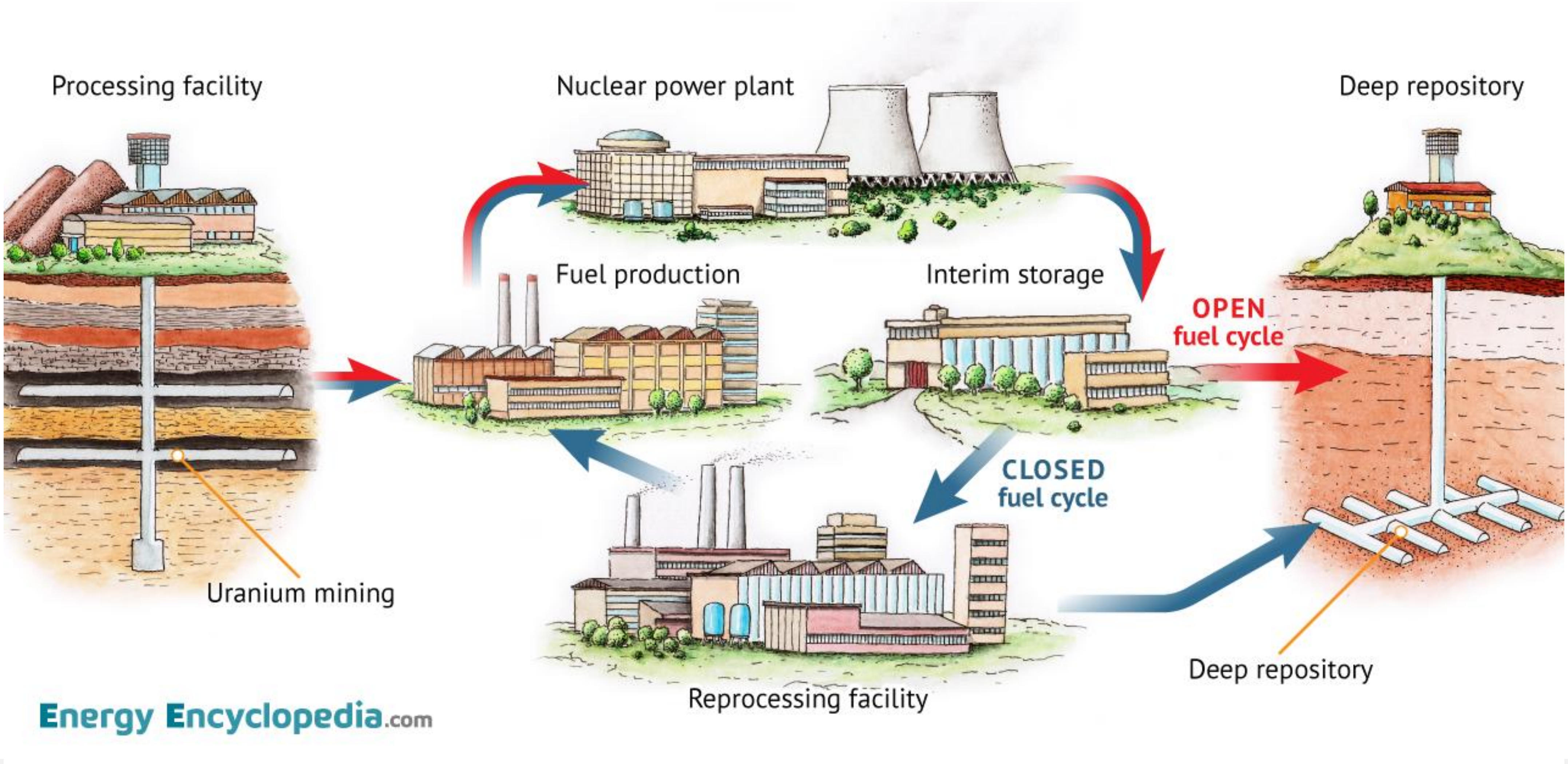
- The Innovation Campuses could support activities across the full nuclear fuel lifecycle, including:
  - Fuel fabrication
  - Enrichment
  - Reprocessing used nuclear fuel
  - Disposition of waste

- The Innovation Campuses would be private-sector led and would need significant workforce development needs that prioritize training, apprenticeships, and partnerships with higher education institutions.

# NLIC RFI OVERVIEW

- DOE prefers that Innovation Campuses be deployed quickly, with first facilities coming online in 2027.
- DOE offered 17 different functions and characteristics for the Innovations Campuses, including:
  - Nuclear Fuel Reprocessing or Recycling
  - Fuel Fabrication for Fresh & Reprocessed Material
  - Uranium Enrichment
  - Data Center Construction & Operations
  - Advanced Reactor Deployment
  - Isotope Production for Medical, Industrial, & National Security

# NLIC RFI OVERVIEW



# NLIC RFI OVERVIEW

- DOE envisions tens of thousands of jobs being needed at Innovation Campuses, workers for research & Development, fuel cycle operations, reactor deployment, data centers, and support industries.
  - 50,000 direct workers could also generate an additional 100,000-150,000 indirect jobs.

- The Innovation Campuses would expand local tax bases, help provide reliable and affordable energy to the grid, and serve America’s national security interests.

# NLIC RFI OVERVIEW

- The RFI asked states to answer 23 questions to better understand opportunities, infrastructure, and strategic visions.
- RFI responses were due April 1, 2026.
- Other states expressing public interest include Utah, Idaho, South Carolina, Tennessee, Washington, and Colorado.

# INDIANA’S RESPONSE

# INDIANA'S RESPONSE

- The RFI does not authorize construction, waste disposal, or reprocessing – it represents a step to better understanding DOE's intent & alignment.
- Goal is to position Indiana in order to attract advanced nuclear reactor deployment, energy intensive industries, and high-quality jobs as part of a federal initiative.
- DOE's objective is to advance America's domestic nuclear supply chains, accelerate reactor commercialization, and enhance long-term fuel cycle resilience.

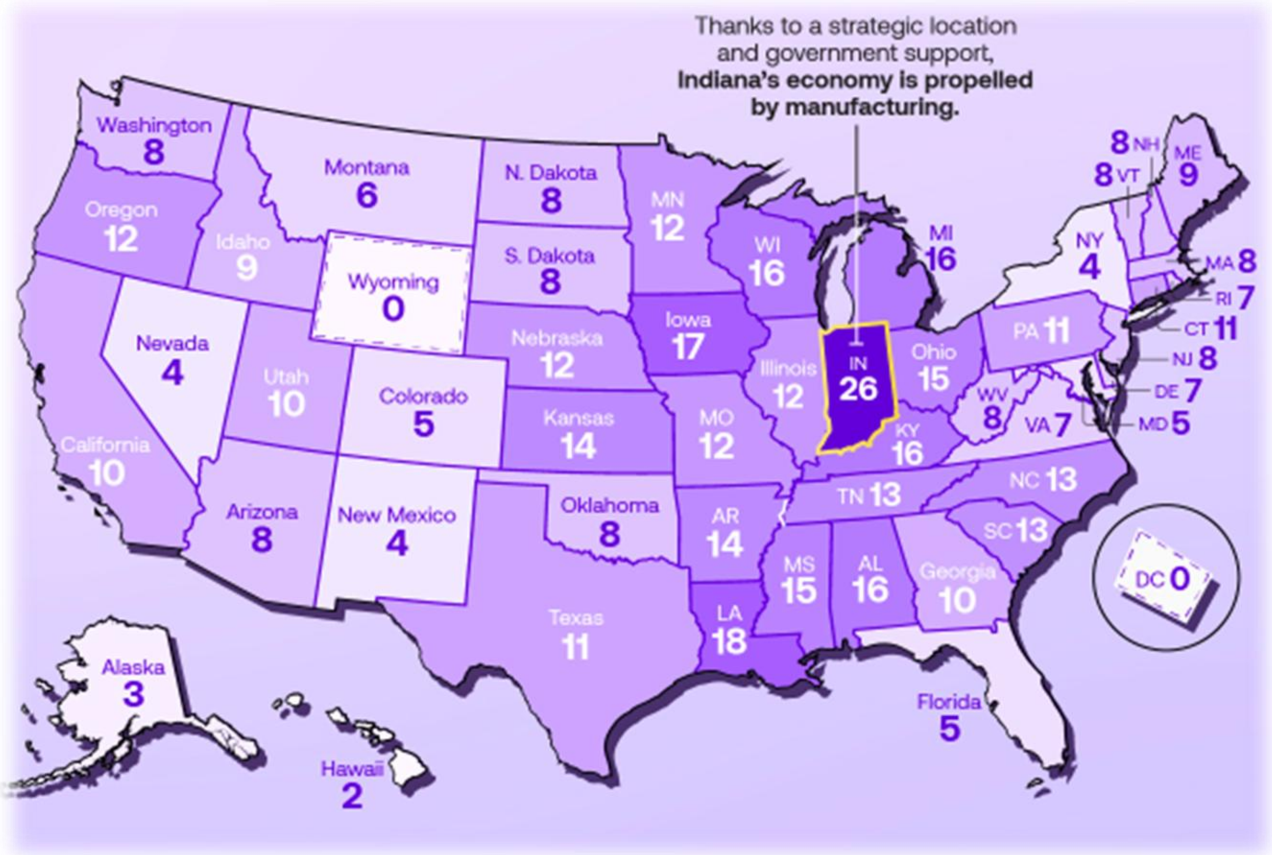
# INDIANA'S RESPONSE

- Indiana's interest centered on a fully integrated nuclear enterprise platform that would support a complete fuel cycle.
  - From fuel manufacturing to advanced reactor deployment, and then to recycling.
  - Enrichment would happen at an off-site location.
  - Would seek to have a firm off-taker for electricity from the facility - possibly a data center as an anchor tenant.

- Financed through private capital, revenue from tenant customers, and targeted federal credit and funding support.

# INDIANA'S RESPONSE

- Indiana has a strong advanced manufacturing base that would serve as a foundational piece to hosting an Innovation Campus.
  - Indiana is ranked #1 for percentage of GDP comprised of manufacturing
  - High concentration of advanced manufacturing employment per capita.



# INDIANA'S RESPONSE

- Indiana's position as the "Crossroads of America" a significant advantage in terms of multimodal logistics – including robust interstate highway, railroad, and port facilities.

- The state's strong industrial base means Indiana has well-established logistical systems and pathways to both the country and the globe.

# INDIANA'S RESPONSE

- Indiana would enjoy strong support from private and public partners.
- U.S. National laboratory partners, including Pacific Northwest National Laboratory, Argonne National Laboratory, and Idaho National Laboratory would support advanced scientific research and provide technical expertise.
- Private sector partners include FANCO, AtkinsRéalis, BWXT, Edgewater, Zeno Power, & capital financing partners

# INDIANA'S RESPONSE

- Indiana higher education institutes would also support research and workforce development.
  - Purdue University – nuclear engineering & reactor research capabilities
  - Notre Dame – materials sciences and modeling expertise
  - Ivy Tech – statewide technical workforce training
  - Indiana University – regulatory analysis

# INDIANA’S RESPONSE

- Stakeholder & community engagement would be vital to any successful Innovation Campus project.

- Four key principles:
  - Early & transparent communication
  - Structured participation mechanisms
  - Clear delineation between federal & state roles
  - Sustained engagement throughout the full development lifecycle

# INDIANA'S RESPONSE

- Items to work through:
  - Public knowledge & perception gaps
  - Local technical capacity
  - Preparedness training for first responders
  - Federal-State coordination (depending on Innovation Campus location)
  - Electric grid modernization

# THANK YOU

**INDIANA OFFICE OF ENERGY DEVELOPMENT**

Luke Wilson, Chief Policy Officer

# Indiana Nuclear Coalition Update on Nuclear Education Curriculum

OED’s Sustainable Energy Education Program

Indiana Office of Energy Development (OED)

Presenter: Henry Wilhelmus, OED

# Why Early Nuclear Education Matters for Indiana

Indiana Michigan Power- Cook Plant

- Prepares Hoosiers to engage with real energy decisions, including Indiana's evaluation of advanced nuclear technologies.
- First step in addressing a real workforce crisis in nuclear energy.
- Establishes a factual foundation before students form opinions based on incomplete or inaccurate information about nuclear safety, waste, and risk.

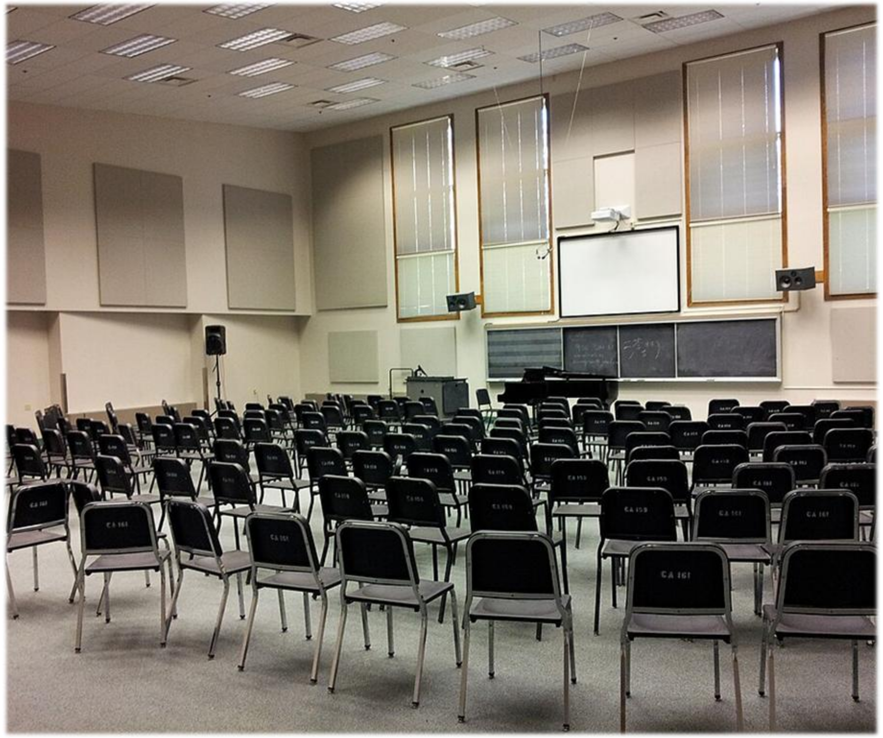
# OED's Sustainable Energy Education Program

- OED commissioned Indiana FFA to develop a structured, standards-aligned curriculum material for Indiana educators.
- Covers multiple energy types including solar, wind, and nuclear, providing balanced technically accurate instruction across emerging and traditional resource types.
- Designed for integration into existing education frameworks.

INDIANA
AGRICULTURAL EDUCATION

INDIANA OFFICE OF ENERGY DEVELOPMENT

# Built for Indiana Classrooms: The FFA Partnership



- Indiana FFA serves more than **14,000 student** members across **230+ chapters**, brings direct insight into what resonates with students and agricultural/applied STEM educators across the state.
- FFA's involvement ensured the materials are **educator-ready**, practically framed, and appropriate for integration into existing science courses.
- The result is a curriculum built by **practitioners**, one that reflects how Indiana students and teachers engage with technical content.

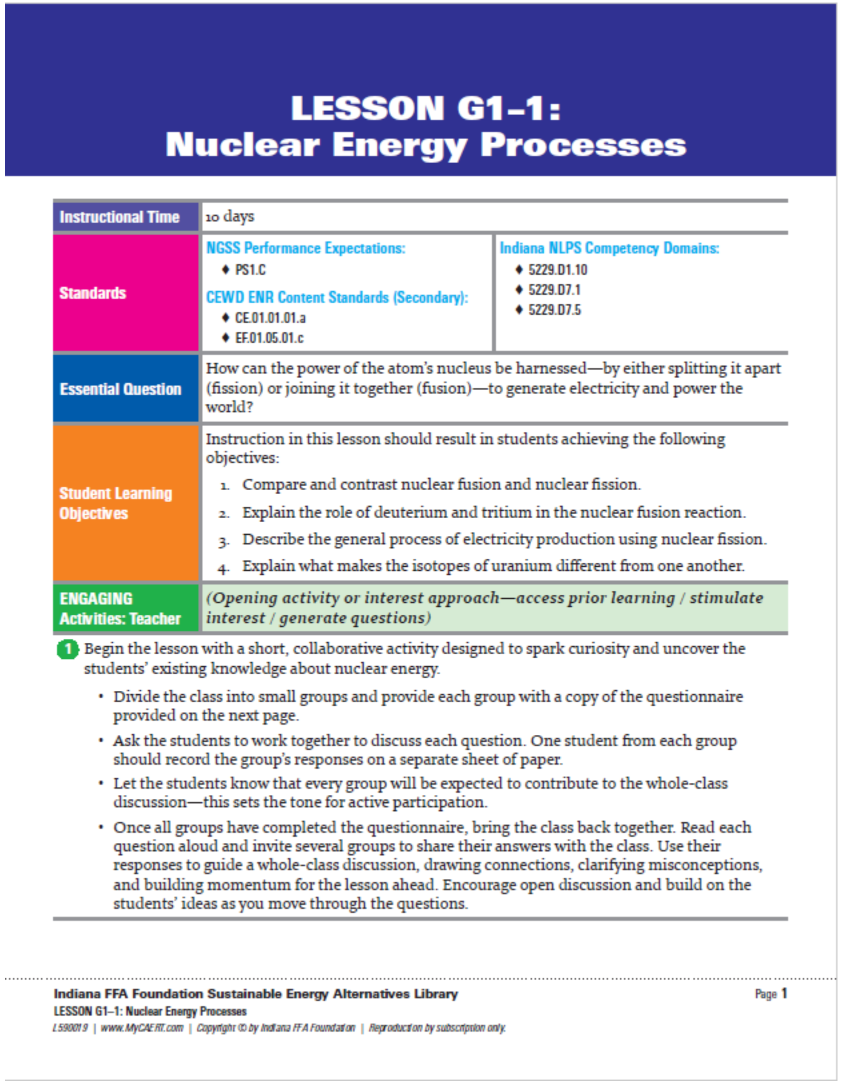
# Unit G: Nuclear Energy Curriculum Overview

Unit G contains two modules totaling 17 instructional days
· **G1-1: Nuclear Energy Processes** | 10 days | *Students learn how the power of the atom's nucleus can be harnessed, by either splitting it apart (fission) or joining it together (fusion).*
· **G1-2: Nuclear Energy Implications** | 7 days | *Students explore how nuclear compares to traditional energy sources.*

Each module includes both a structured lesson component and a hands-on activity section, giving educators flexibility to adjust depth based on course level and available time.

# Module G1-1: Nuclear Energy Processes

- Compare and contrast nuclear fusion and fission as energy-producing reactions.
- Identify the role of deuterium and tritium as fuel sources in the fusion reaction.
- Describe how nuclear fission generates electricity, from reactor to grid.
- Explain the significance of different uranium isotopes.



## LESSON G1–1: Nuclear Energy Processes

| | | |
|---|---|---|
| **Instructional Time** | 10 days | |
| **Standards** | **NGSS Performance Expectations:**<br>♦ PS1.C<br>**CEWD ENR Content Standards (Secondary):**<br>♦ CE.01.01.01.a<br>♦ EF.01.05.01.c | **Indiana NLPS Competency Domains:**<br>♦ 5229.D1.10<br>♦ 5229.D7.1<br>♦ 5229.D7.5 |
| **Essential Question** | How can the power of the atom's nucleus be harnessed—by either splitting it apart (fission) or joining it together (fusion)—to generate electricity and power the world? | |
| **Student Learning Objectives** | Instruction in this lesson should result in students achieving the following objectives:<br>1. Compare and contrast nuclear fusion and nuclear fission.<br>2. Explain the role of deuterium and tritium in the nuclear fusion reaction.<br>3. Describe the general process of electricity production using nuclear fission.<br>4. Explain what makes the isotopes of uranium different from one another. | |
| **ENGAGING Activities: Teacher** | *(Opening activity or interest approach—access prior learning / stimulate interest / generate questions)* | |

1 Begin the lesson with a short, collaborative activity designed to spark curiosity and uncover the students' existing knowledge about nuclear energy.

- Divide the class into small groups and provide each group with a copy of the questionnaire provided on the next page.
- Ask the students to work together to discuss each question. One student from each group should record the group's responses on a separate sheet of paper.
- Let the students know that every group will be expected to contribute to the whole-class discussion—this sets the tone for active participation.
- Once all groups have completed the questionnaire, bring the class back together. Read each question aloud and invite several groups to share their answers with the class. Use their responses to guide a whole-class discussion, drawing connections, clarifying misconceptions, and building momentum for the lesson ahead. Encourage open discussion and build on the students' ideas as you move through the questions.

# Module G1-1: Making Connections

- Each module connects classroom instruction to real nuclear careers through dedicated "On the Job" profiles.
- Knowledge checks are included for educators to assess student comprehension of core vocabulary and concepts.

## On the Job … CAREER CONNECTION

### Industrial Radiographer

An industrial radiographer performs a specialized type of nondestructive testing (NDT) by inspecting materials such as steel, concrete, and plastic for hidden internal flaws. Industrial radiography uses radioactive sources or X-ray equipment to assess the integrity of pipelines, welds, boilers, and parts used in vehicles and aircraft. By capturing radiographic images, radiographers can detect defects like cracks, voids, or poor welds that could compromise safety and performance.

To enter the field, candidates typically need a high school diploma or GED, followed by specialized training to earn an industrial radiographer certification. This certification includes instruction in radiation safety, equipment operation, and image interpretation. The role requires precision, focus, and a strong understanding of radiation protocols—since missing a flaw in a critical component could have serious consequences.

Industrial radiographers work in controlled environments, such as shielded enclosures or designated on-site areas at construction and manufacturing facilities. While the job involves potential exposure to radiation, strict safety regulations and personal monitoring devices help minimize risk. Strong demand across industries ensures job stability and opportunities for advancement.

## Checking Your Knowledge:

**Part One: Matching**

*Instructions:* Match the term with the correct definition.

a. half-life
b. tailing
c. alpha radiation
d. nuclear decay
e. background radiation
f. ionizing radiation
g. ore
h. kilowatt-hour
i. electromagnetic radiation
j. beta radiation




_____ 1. the natural radiation that is always present in the environment
_____ 2. the time it takes for half of the atoms in a radioactive substance to decay into a more stable form
_____ 3. a naturally occurring material that contains one or more valuable substances that can be extracted and sold
_____ 4. a form of energy that travels through space as waves
_____ 5. a type of radiation that has enough energy to remove electrons from atoms, creating ions
_____ 6. the process by which an unstable atomic nucleus loses energy by emitting subatomic particles, resulting in a more stable nucleus
_____ 7. the leftover material that remains after valuable minerals or metals have been extracted from mined ore
_____ 8. a unit of energy that is equal to the amount used by a 1-kilowatt appliance operating for one hour
_____ 9. a type of particle radiation consisting of high-energy, high-speed electrons released from an atom's nucleus during radioactive decay
_____ 10. a type of particle radiation in which energy is released through alpha particles—each made of two protons and two neutrons—emitted by unstable atomic nuclei

# Module G1-2: Nuclear Energy Considerations

- Compare energy output and efficiency of **nuclear fission** against **coal combustion**.
- Describe environmental impacts associated with uranium mining, including **open-pit** and **in-situ leach** methods.
- Identify and distinguish **radiation types** associated with nuclear energy production.
- Explain radioactive decay and the concept of **half-life**, including how decay rates inform **waste management** timelines.

**E-UNIT G1–2**

## Nuclear Energy Considerations

Nuclear energy produces more power from less fuel than any other known source. Because nuclear power plants are not constrained by geography, weather, or intermittent technology, they can reliably generate large amounts of clean energy—enough to power entire cities. However, nuclear energy is not considered sustainable due to the limited supply of uranium in Earth's crust, and it poses environmental risks that must be carefully managed. Understanding these trade-offs is essential for making informed decisions about how to power the world sustainably and responsibly.

**Objective:**

Analyze the energy production, environmental impacts, radiation types, and radioactive decay processes associated with nuclear energy.

**Key Terms:**

| | | |
|---|---|---|
| acute radiation exposure | gigawatt (GW) | ore |
| alpha radiation | half-life | particle radiation |
| background radiation | in-situ leach (ISL) mining | radiation |
| beta radiation | ion | radioactive |
| chronic radiation exposure | ionizing radiation | subatomic particle |
| coal | kilowatt-hour | tailing |
| electromagnetic radiation | milling | underground mining |
| emission | neutron radiation | wavelength |
| gamma ray | nuclear decay | |
| Geiger counter | open-pit mining | |

# Module G1-2: Hands on Learning

- Activities are intentionally simulation-based, given the nature of the subject matter.
- Virtual Giger-Müller tube lab explores how radiation interacts with protective barrier materials.
- Skittles decay modeling connects half-life concepts to real waste management considerations.

**EXPLORING**
**Activity 2: Student**

Name_______________________

## Geiger-Müller Tube Investigation

**PURPOSE**

The purpose of this activity is to use a virtual Geiger counter to measure radiation.

**OBJECTIVE**

Explore how different barriers affect three types of radiation: alpha, beta, and gamma.

**MATERIALS**

- device with internet access

**INSTRUCTIONS**

Go to the website for the Geiger-Müller Tube Virtual Lab. You will use the simulation to take radiation readings under different conditions and record your results.

**EXPLORING**
**Activity 1: Student**

Name_______________________

## Modeling Half-Life with Candy

**PURPOSE**

The purpose of this activity is to simulate radioactive decay in order to better understand the concept of half-life and how the amount of a radioactive substance decreases over time.

**OBJECTIVE**

Model radioactive decay using Skittles candy to collect and analyze data that illustrates how half-life works, including its consistency over time and its real-world scientific implications.

**MATERIALS**

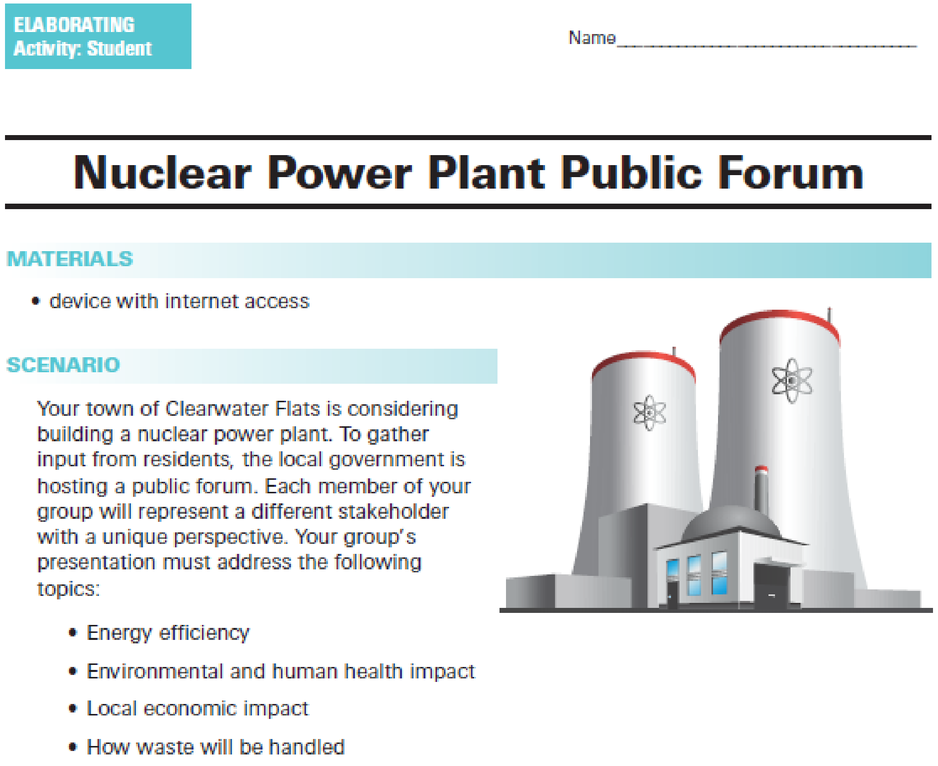
- 50 Skittles
- cup
- colored pencils (2 different colors)
- graph paper or provided grid
- paper plate

**INTRODUCTION**

In this activity, each Skittle represents a radioactive atom. You will simulate nuclear decay by shaking the Skittles in a cup to determine which atoms have decayed into a new element and which remain unchanged. By recording and graphing your results, you'll observe how the number of undecayed atoms decreases in a consistent pattern over time—a pattern known as half-life. A half-life represents the amount of time it takes roughly half a sample to decay into more stable elements.

# Module G1-2: Civic Learning Exercise

- Students roleplay as community stakeholders in a simulated public forum debating a proposed nuclear power plant in the fictional town of Clearwater Flats.
- Each group defends a distinct stakeholder position, addressing environmental and health impacts, local economic effects, and waste management.



ELABORATING
Activity: Student

Name________________________________

## Nuclear Power Plant Public Forum

**MATERIALS**

- device with internet access

**SCENARIO**

Your town of Clearwater Flats is considering building a nuclear power plant. To gather input from residents, the local government is hosting a public forum. Each member of your group will represent a different stakeholder with a unique perspective. Your group's presentation must address the following topics:

- Energy efficiency
- Environmental and human health impact
- Local economic impact
- How waste will be handled

# Module G1-2: Civic Learning Exercise

- Students also prepare questions from the public perspective, developing thoughtful questions for each stakeholder role represented in the forum.
- This builds skills in evidence-based argumentation, perspective-taking, and civic participation in grid-level decisions.

**Questions from the Public**

Group Members: ______________________________

______________________________

______________________________

______________________________

Prepare eight thoughtful questions—two for each role—that your classmates will ask during the forum.

1.

2.

# Module G1-2: Applied Fuel Comparisons

- Students complete a structured comparison chart contrasting coal and nuclear power plants across fuel source, energy output per kilogram of fuel, and plant MW output.
- Provides educators opportunities to explore nuclear fuel sourcing, energy density, waste production, and radioactivity potential.

**EXPLAINING**
**Activity: Student**

Name ____________________________

## Coal Versus Nuclear Power: Operation and Outputs

### MATERIALS

- device with internet access

### INSTRUCTIONS

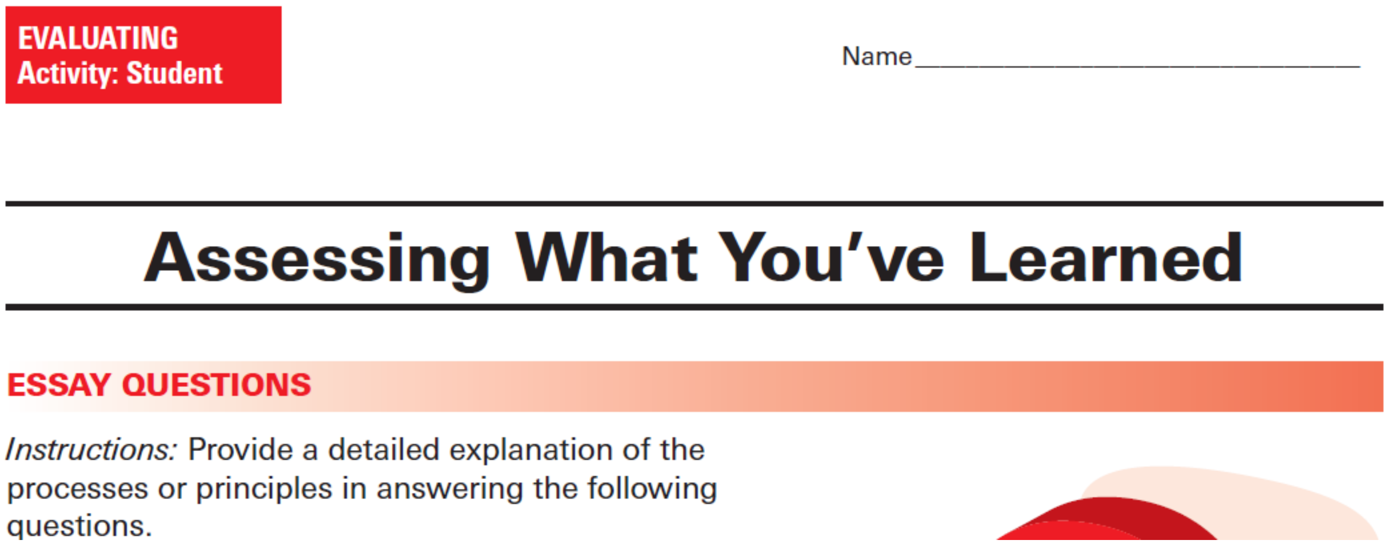
Use online resources to research coal power plants and nuclear power plants. Focus on how each type of plant operates and the kinds of outputs they produce. As you explore, fill in the comparison chart with accurate and specific information. Then, respond to the analysis questions using complete sentences and thoughtful reasoning.

**Coal vs. Nuclear Comparison Chart**

| Feature | Coal Power Plant | Nuclear Power Plant |
|---|---|---|
| Fuel source | | |
| Energy output per kilogram of fuel | | |

# Module G1-2: Summative Assessment

- The module concludes with a written essay assessment requiring students to explain nuclear science concepts, fuel production processes, and fission’s role as an energy source in their own words.
- Educators are provided structured essay prompts with clear instructions, reducing preparation burden and ensuring consistent assessment standards across classrooms.



**EVALUATING**
**Activity: Student**

Name________________________________

## Assessing What You’ve Learned

**ESSAY QUESTIONS**

*Instructions:* Provide a detailed explanation of the processes or principles in answering the following questions.

# What Comes Next

- Curriculum rollout continues through Indiana FFA educator networks, with classroom and educator feedback monitored.
- The FFA/OED partnership allows for future updates through curriculum sale proceeds, meaning the program self-sustains and improves itself without requiring additional appropriations.
- As SMR and advanced nuclear develop, the curriculum is positioned for supplemental content expansion to keep pace with Indiana’s evolving energy landscape.

# Thank you

Indiana Office of Energy Development (OED)

# Closing Remarks