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Radioactive Waste and the Future of Nuclear

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ANS Teachers' Workshop

at Grand Casino Resort, Reno, NV

June 14th, 2014

Questions about radwaste.



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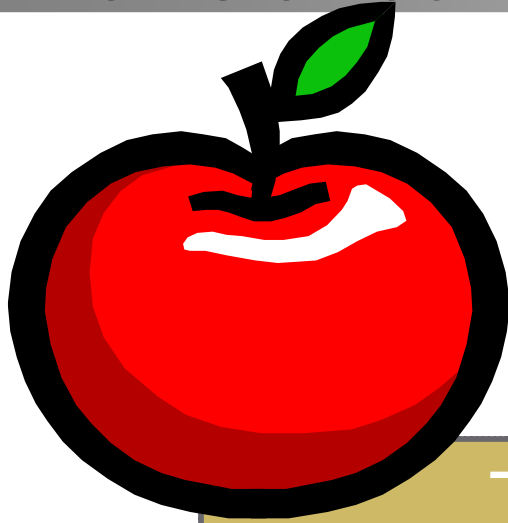
- What is it?
- Where does it come from?
- Can we handle it safely?

What and where?



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It all started with the Manhattan Project . . .



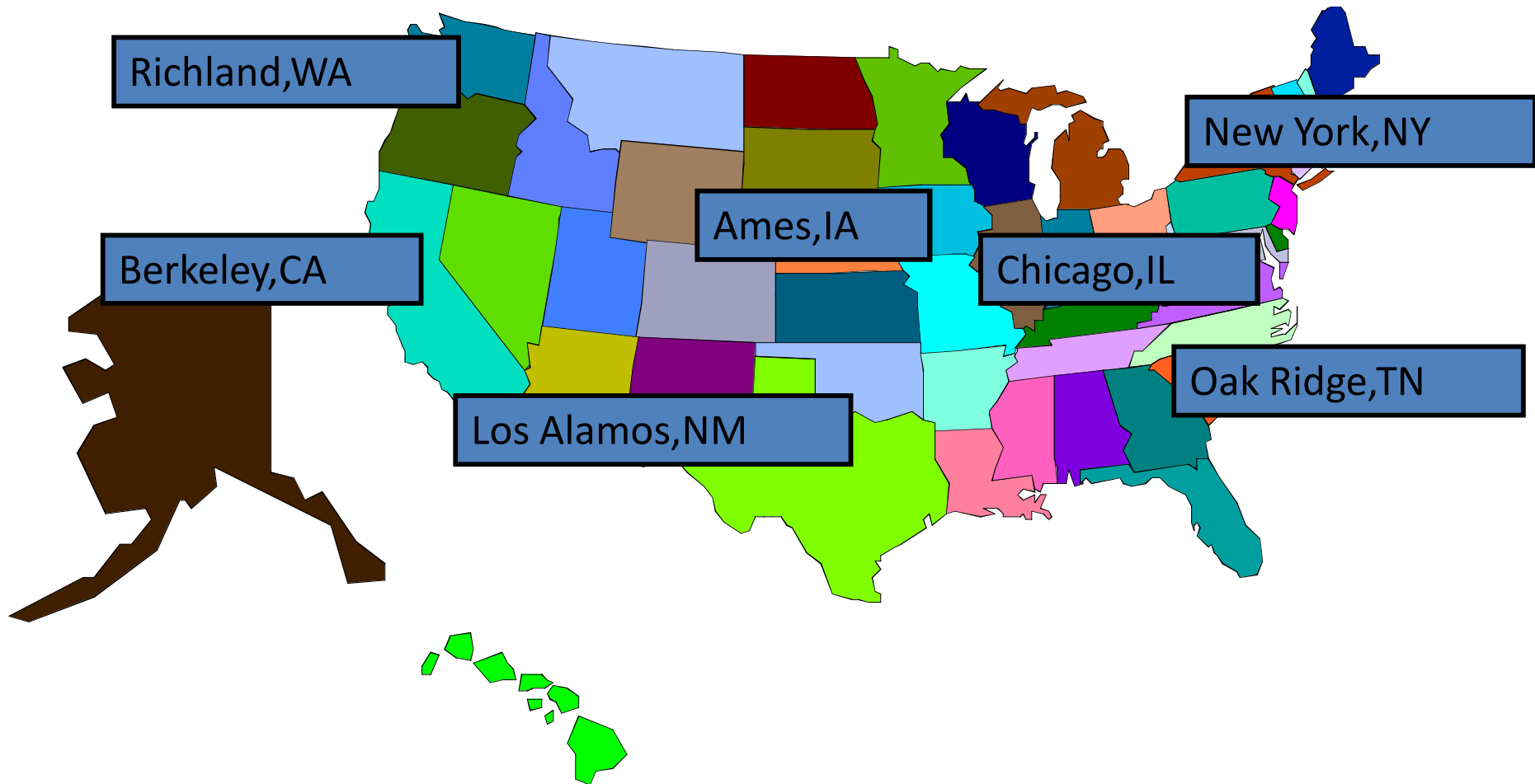
The Manhattan Project
(WWII nuclear weapon development)

???

The Manhattan Project



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What and where? (cont'd)



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The Manhattan Project
(WWII nuclear weapon development)

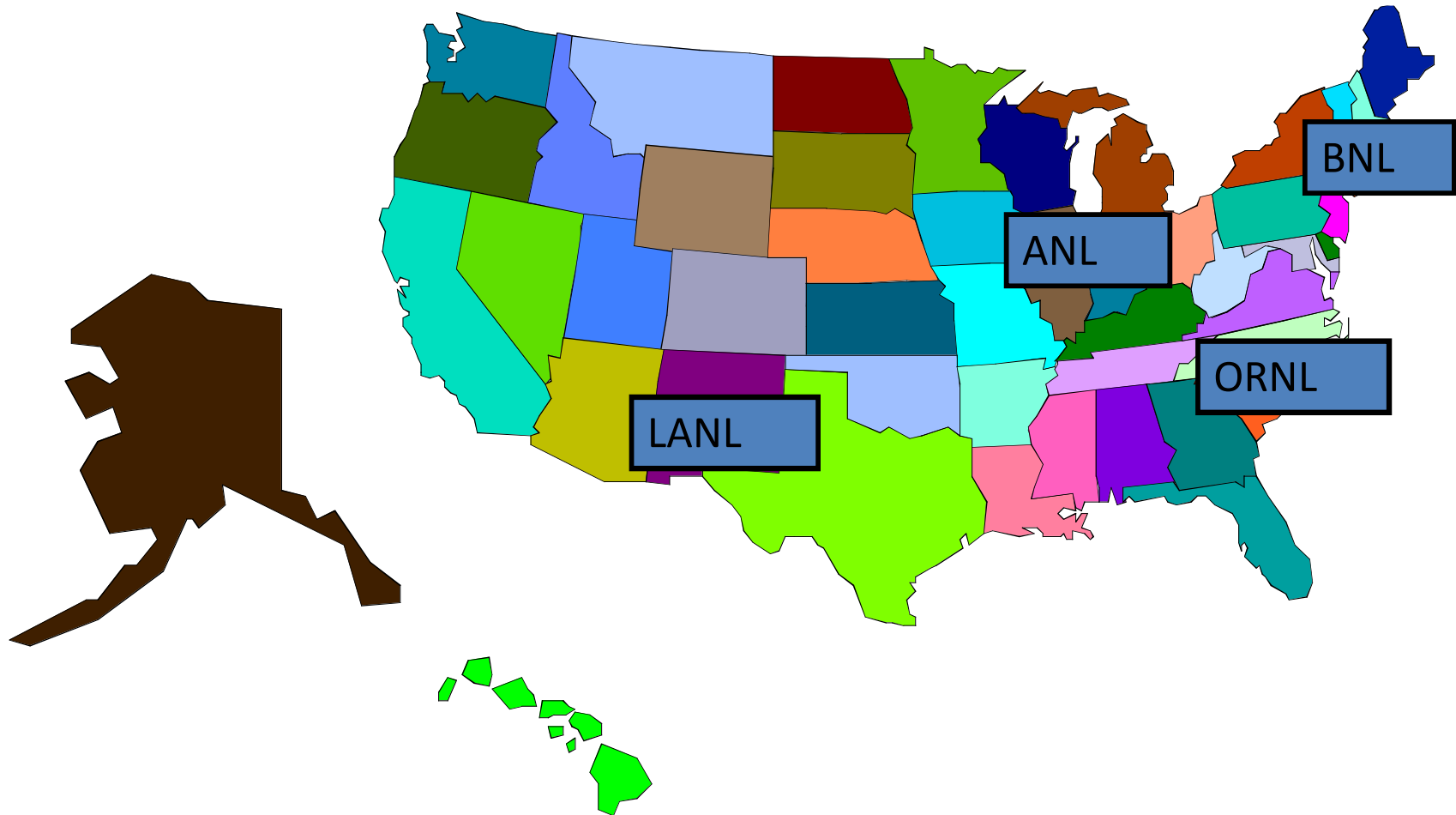
1946
Atomic Energy Agency
(today the Nuclear Regulatory Commission)

National Laboratories created

The First National Labs



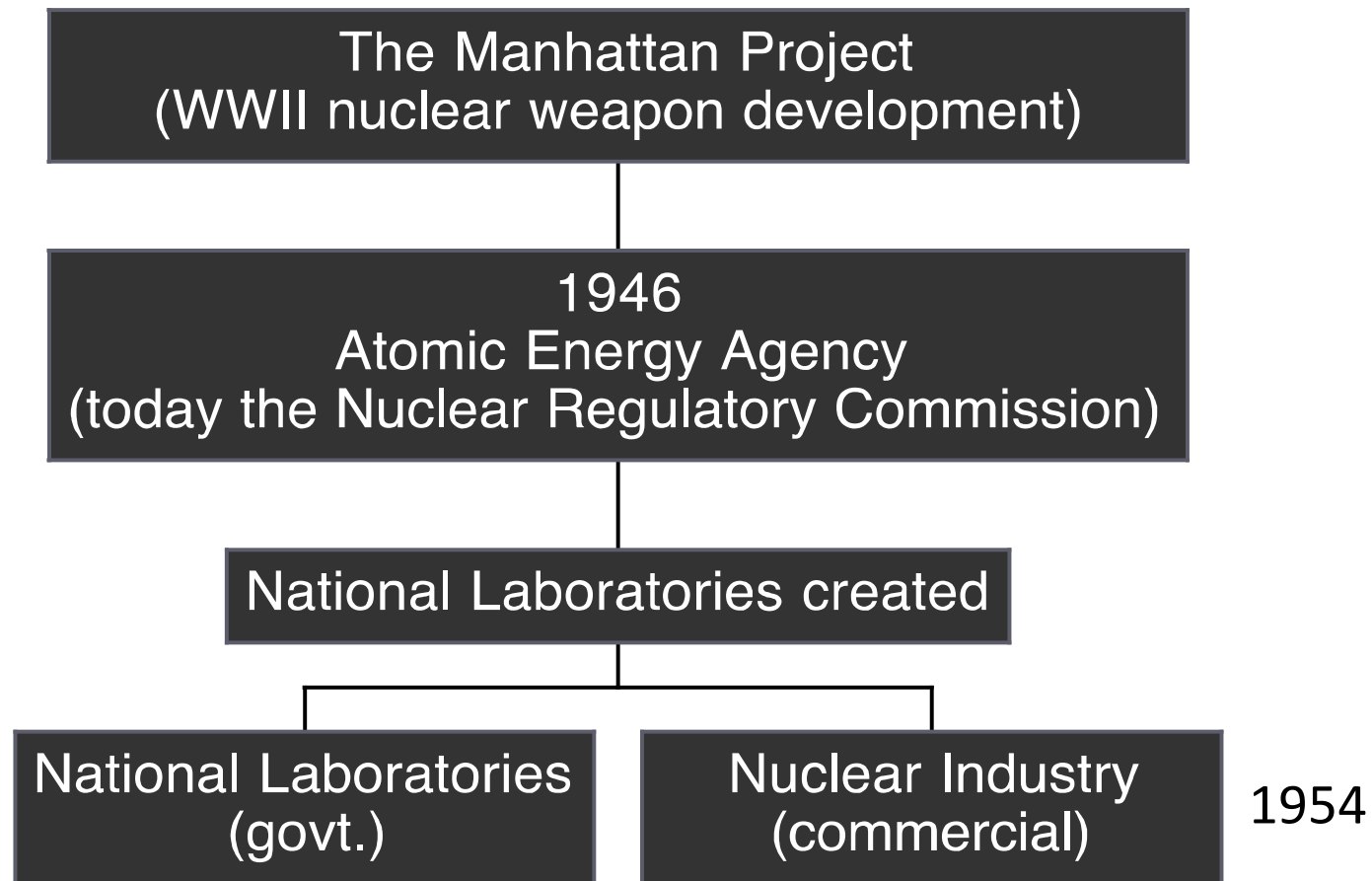
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What and where? (cont'd)



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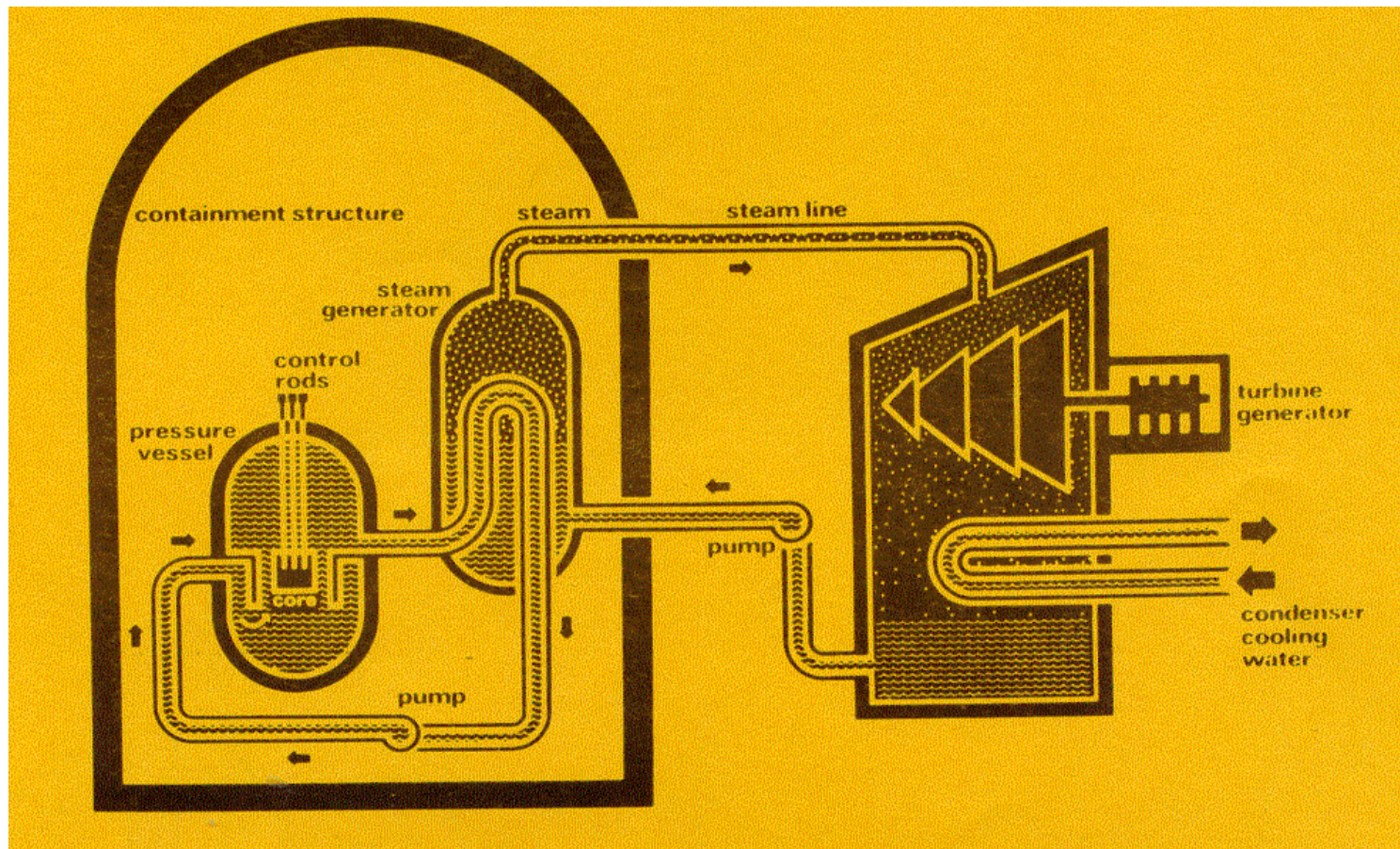
1957

1st commercial nuclear power plant



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Shippingport, PA

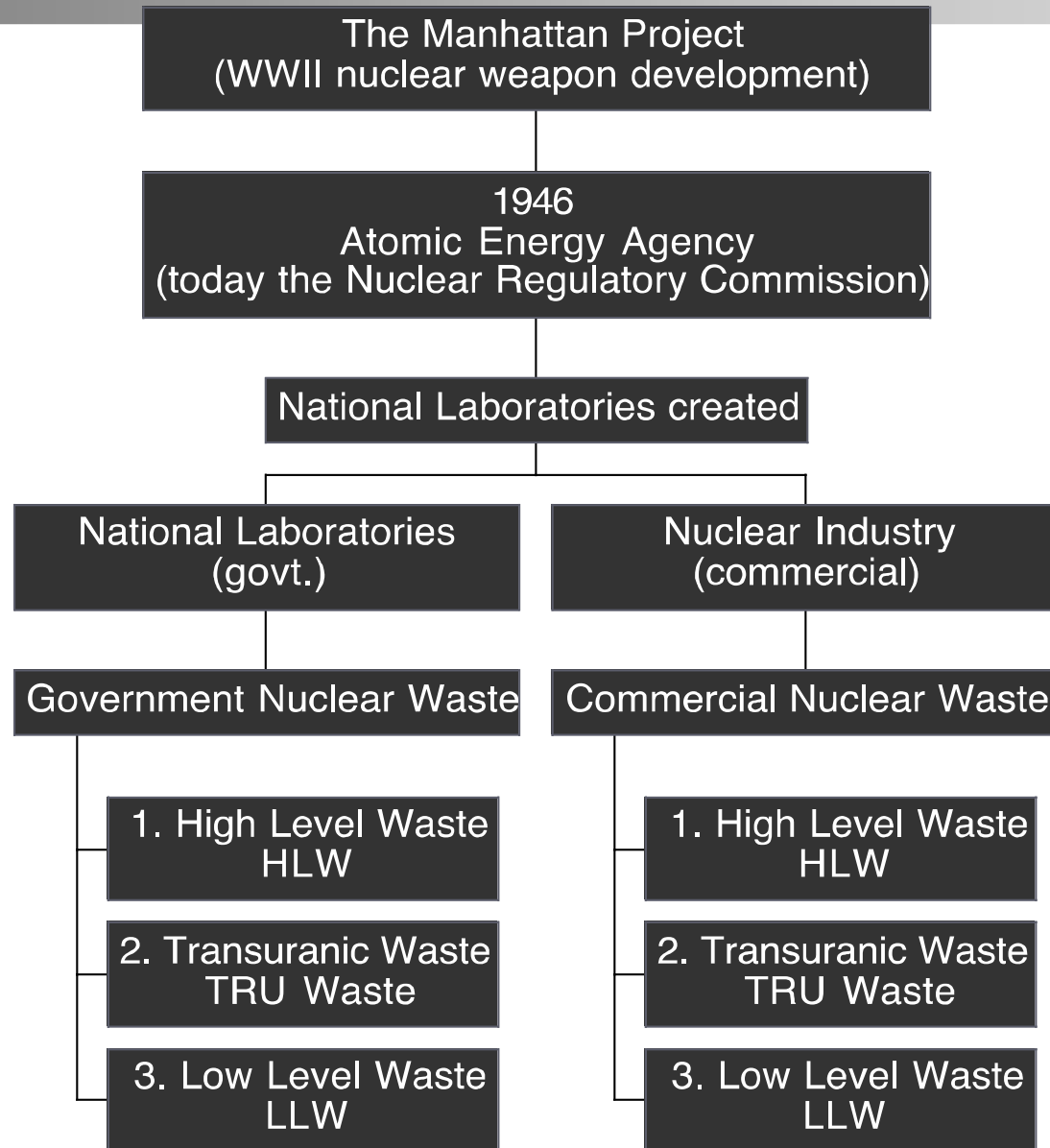


Pressurized Water Reactor (PWR)

What and where?



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Radioactive waste – What is it?



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Low Level Waste

- Slightly contaminated protective clothing, paper products, tools, containers, etc.

High Level Waste

- Mostly used nuclear fuel from power plants
- Also government waste from weapons, military and research

TRansURanic Waste

- Materials contaminated with α -emitting, transuranic isotopes





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Radioactive waste

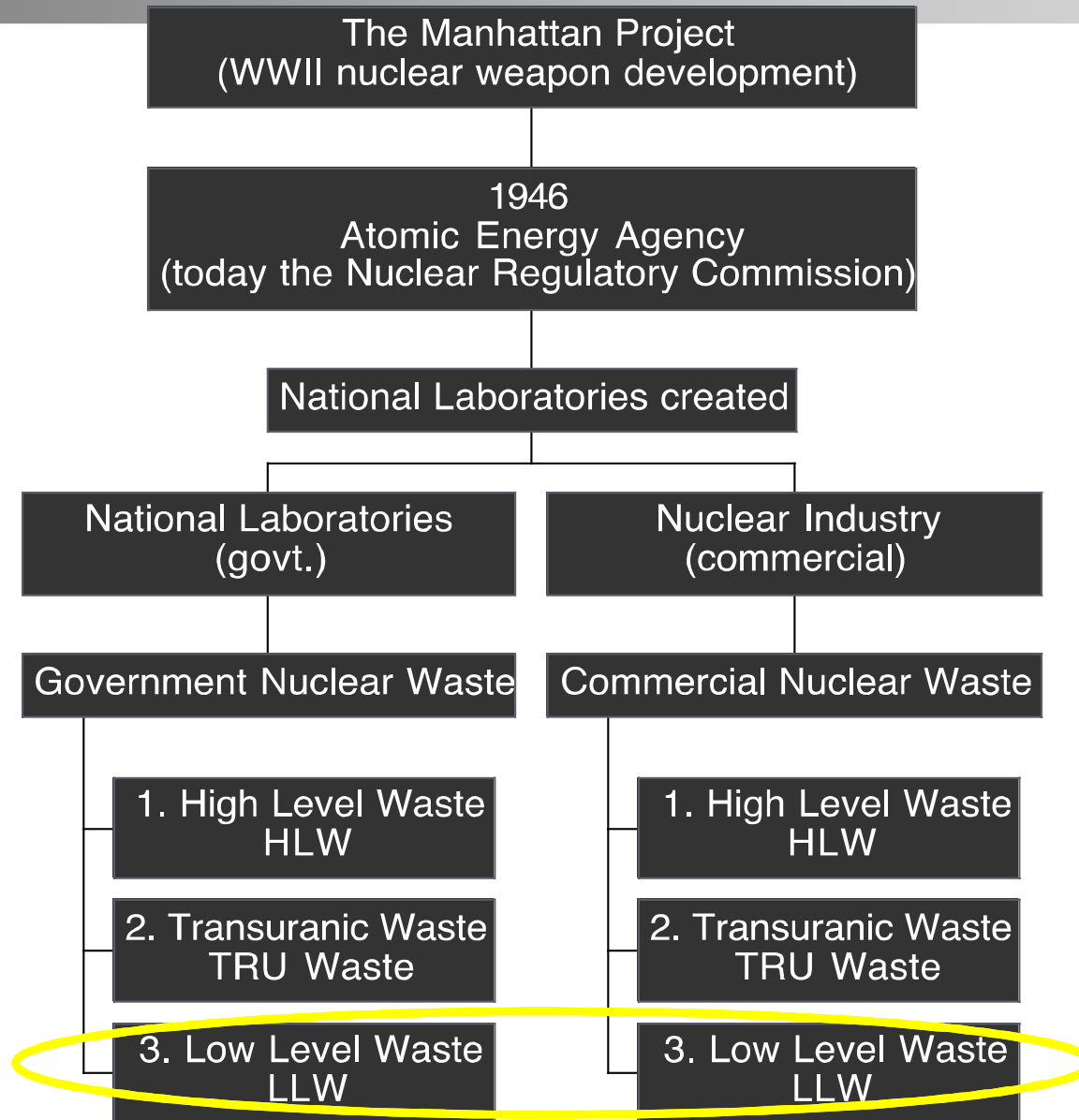
Where is it?



What and where?



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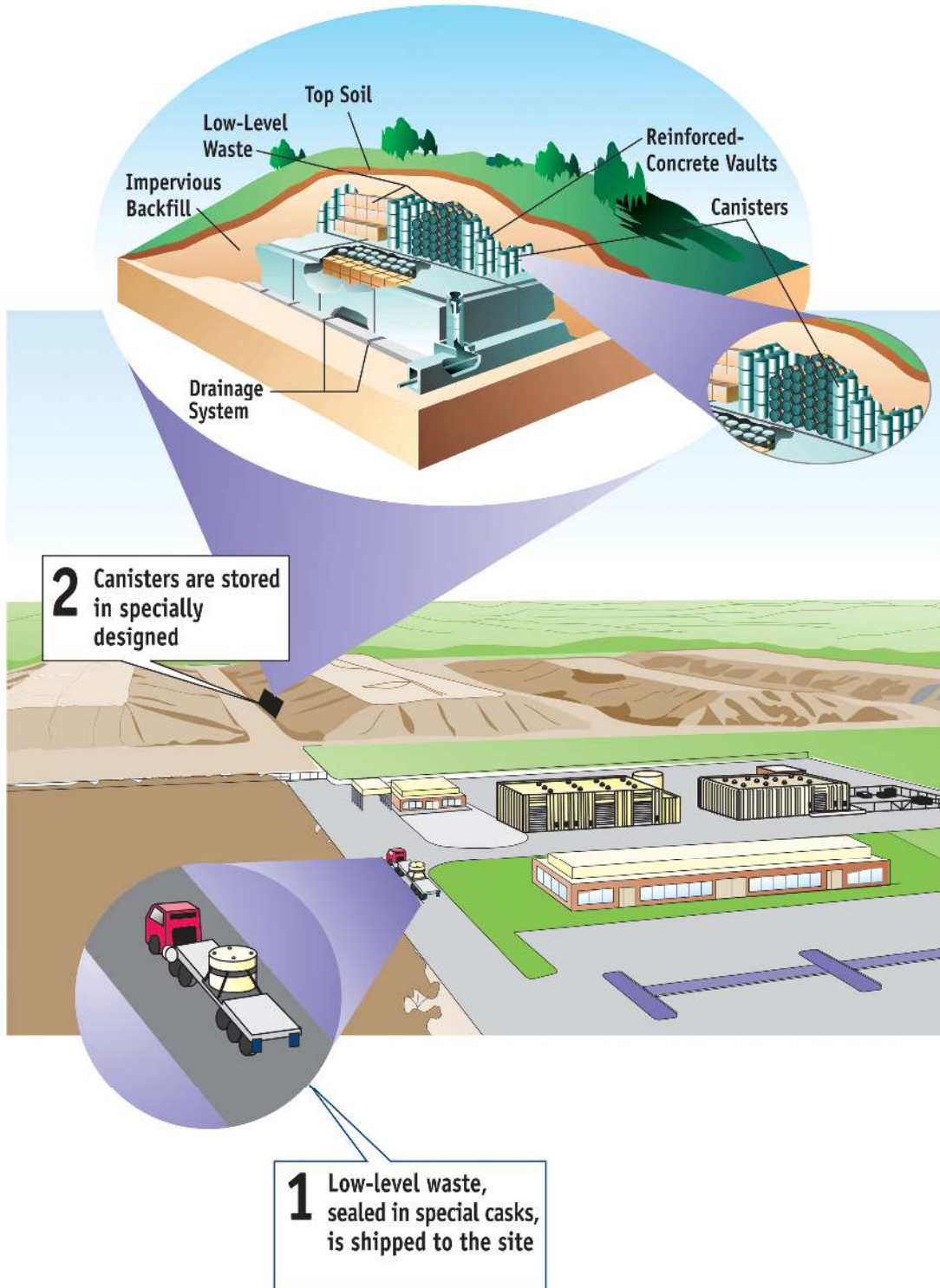
LLW disposal sites



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Low-Level Waste Disposal Site

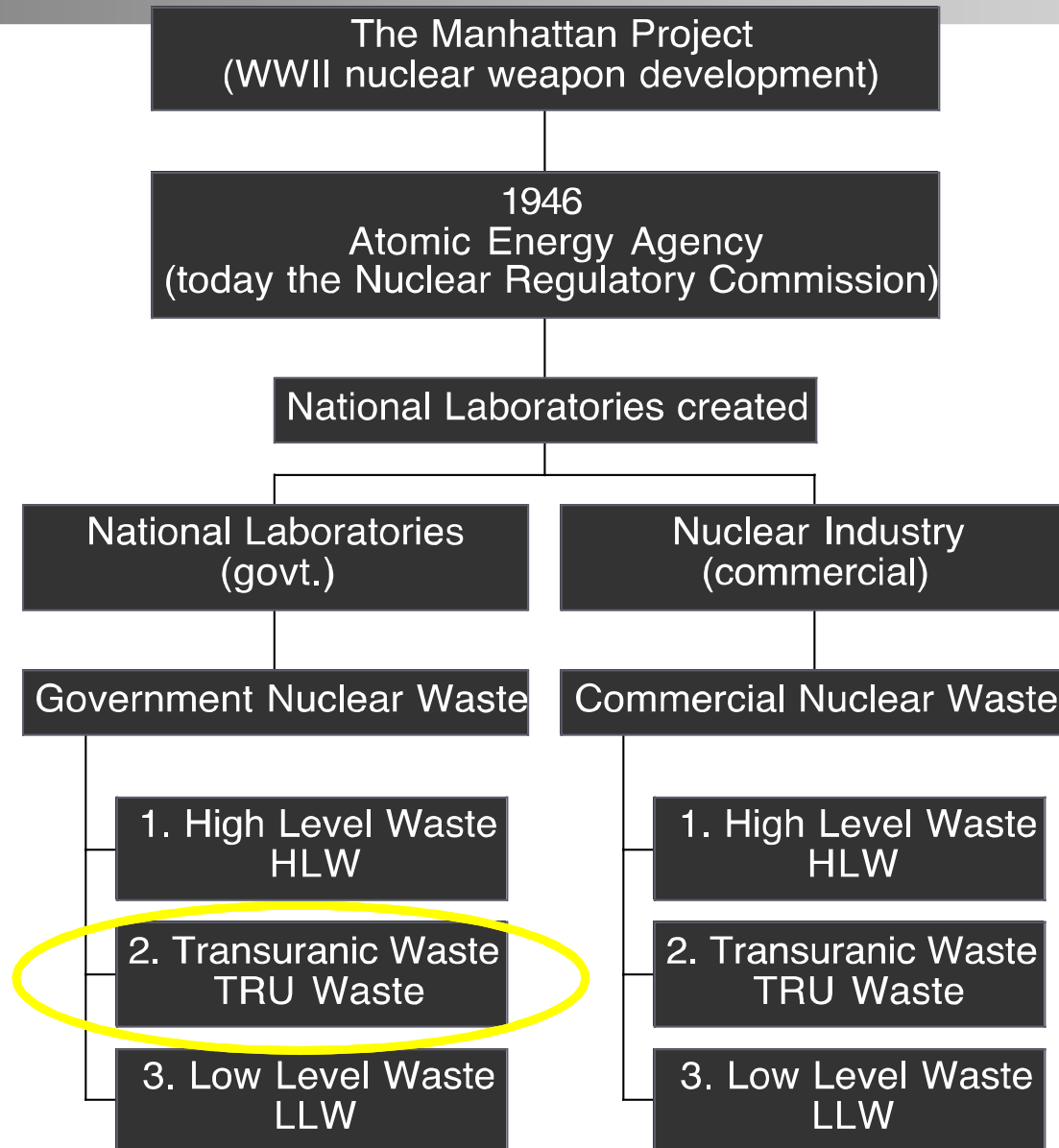


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What and where?

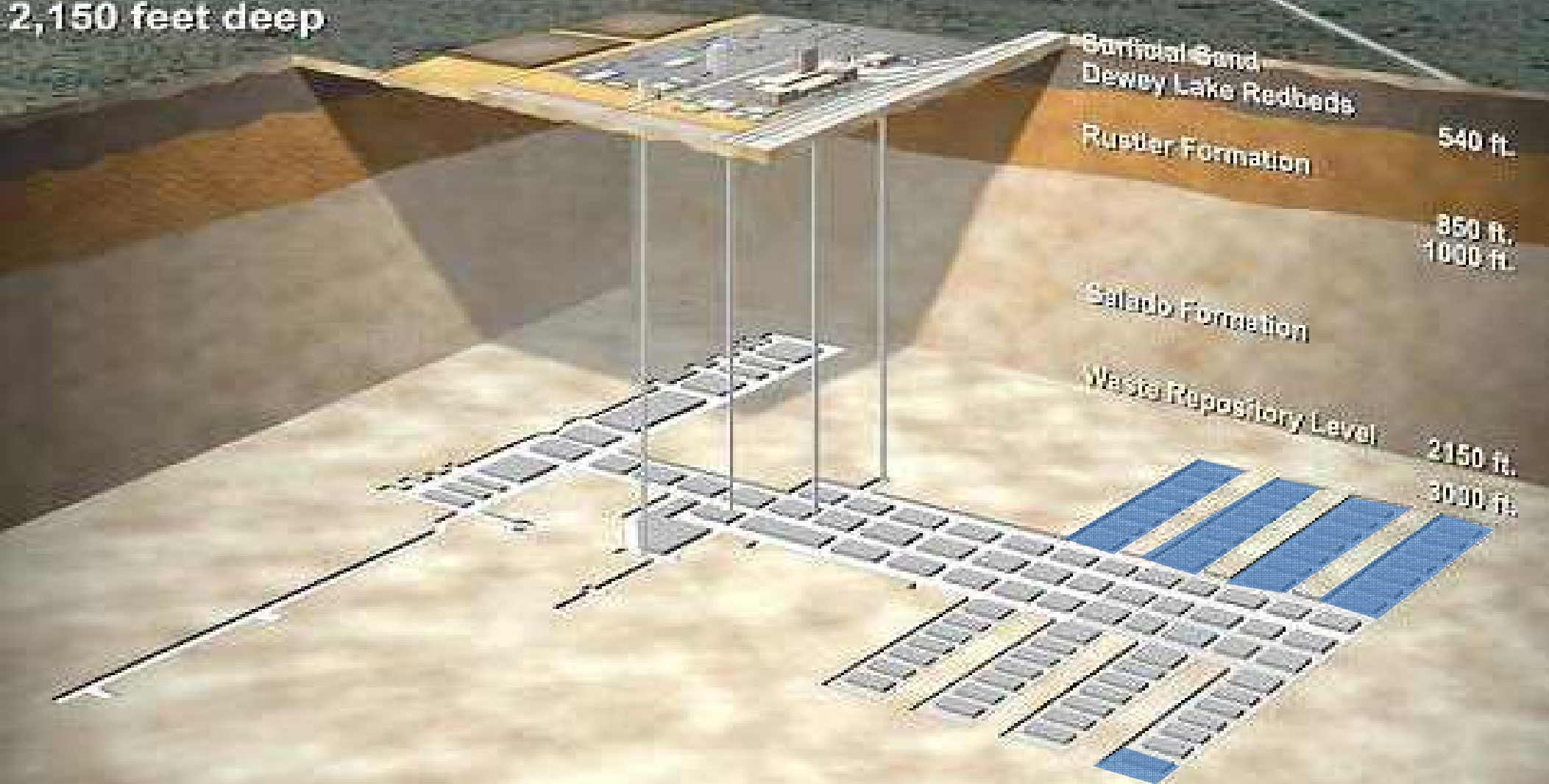


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Waste Isolation Pilot Plant

U.S. Department of Energy facility
Designed for permanent disposal
of transuranic radioactive waste
2,150 feet deep



WIPP came to Carlsbad because of a combination of a depressed potash mining industry, strong local mayor and community leaders, and a basic understanding of risk that is endemic to a multi-generational mining town

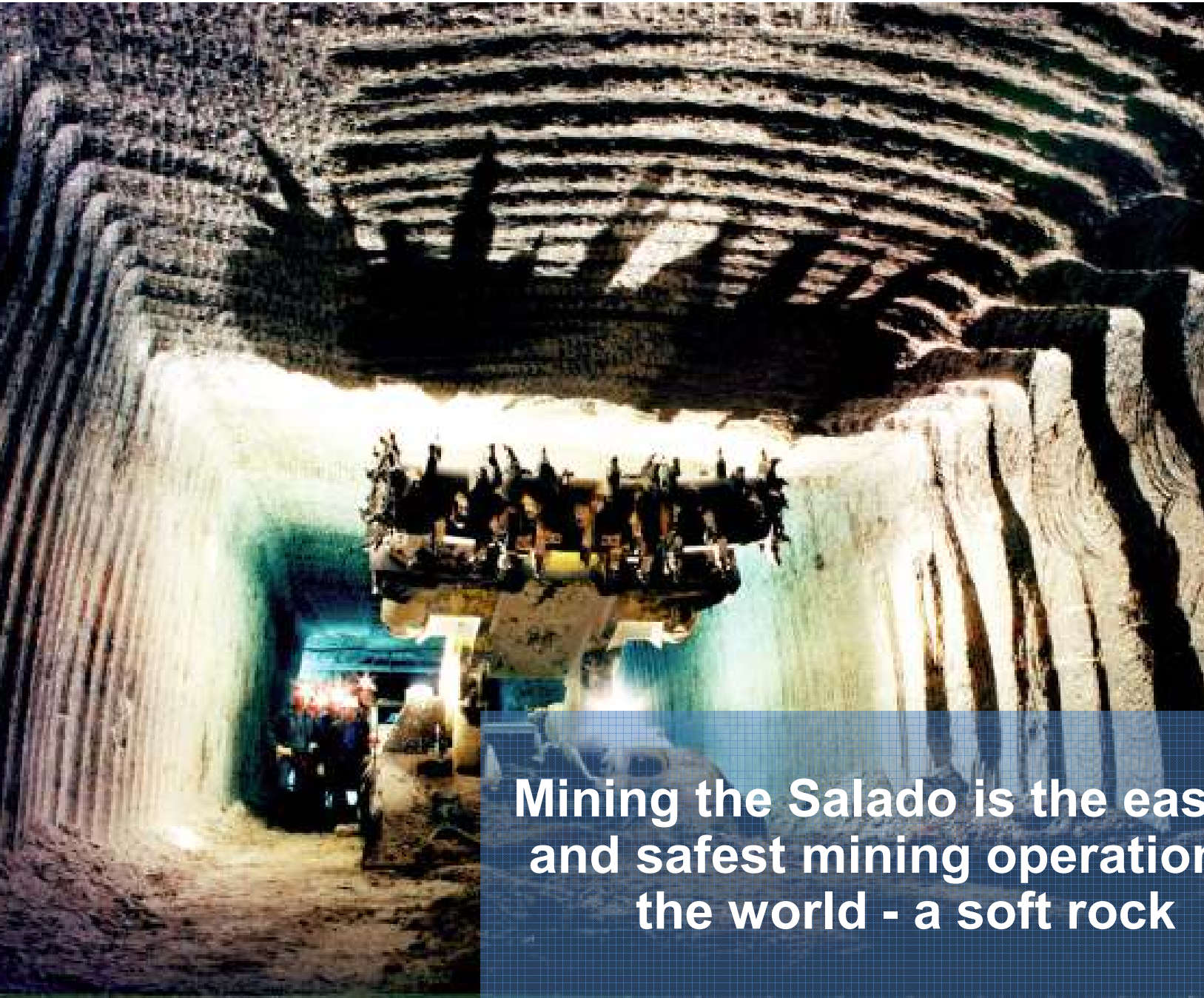
Location of WIPP



16 miles² set aside in the 1992 Land Withdrawal Act - when WIPP is complete, only 1 mile² will be used



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**Mining the Salado is the easiest
and safest mining operation in
the world - a soft rock**

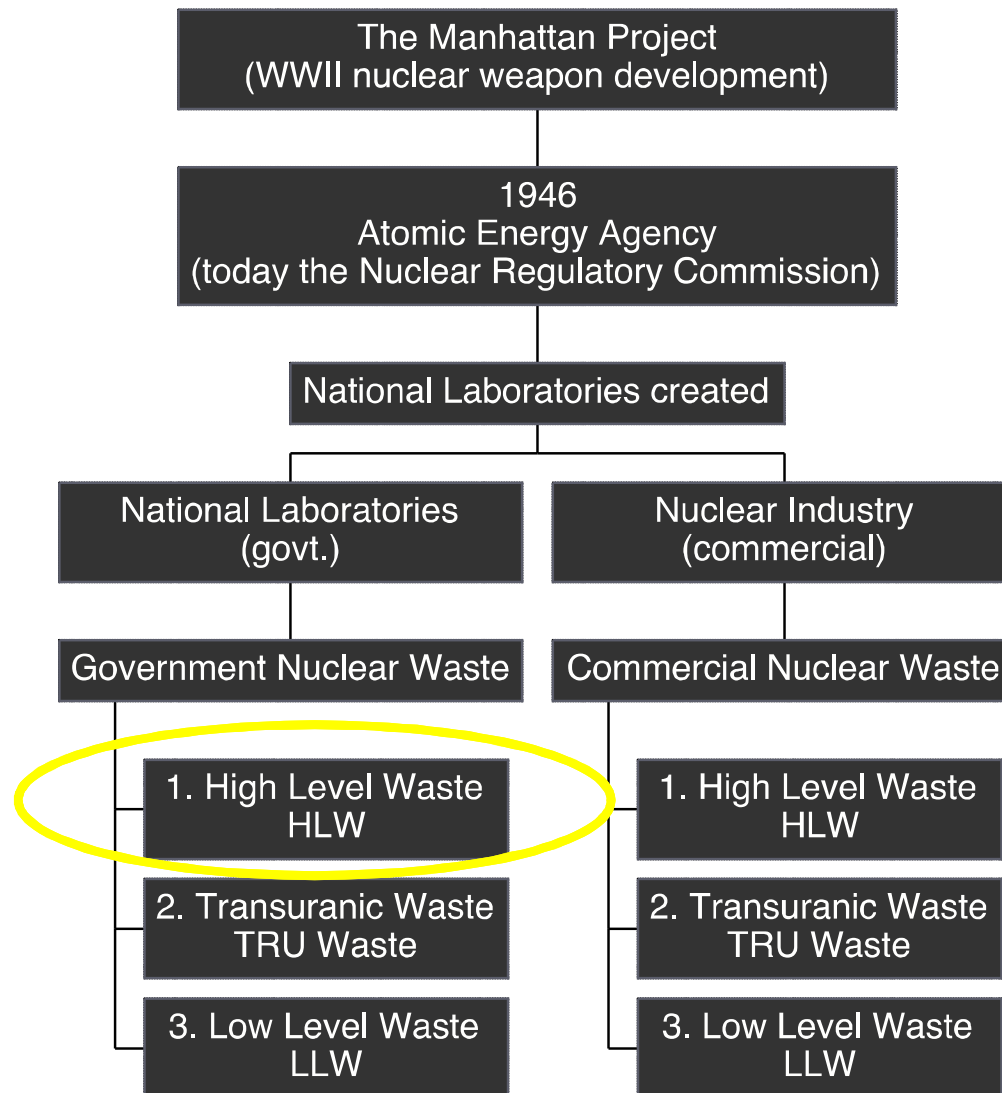
Shown are 10,000 nuclear waste drums and standard waste boxes filling one of 56 rooms. As of June 2009, about 200,000 have been disposed. MgO is only engineered barrier - one is required by EPA.



What and where?



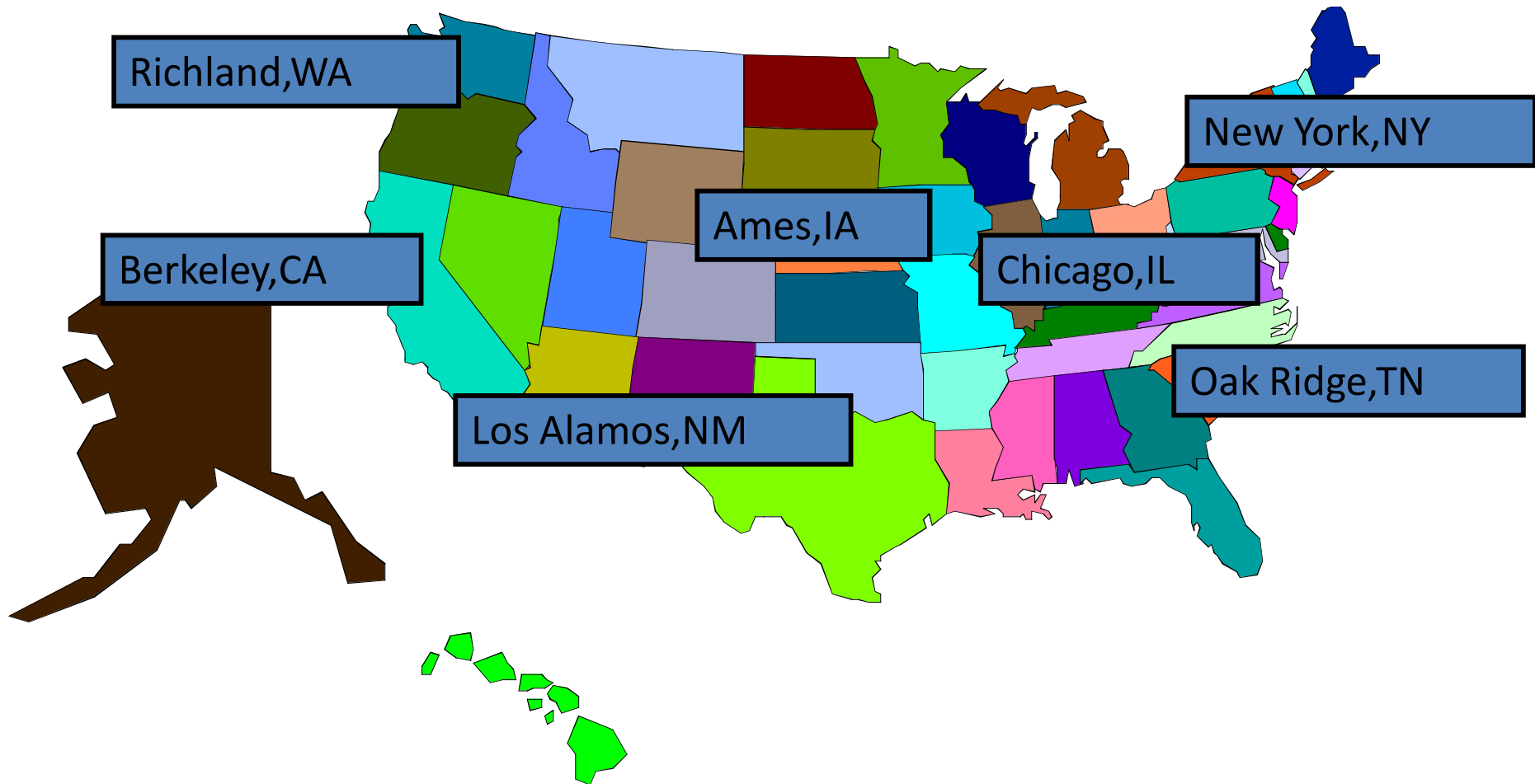
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The Manhattan Project



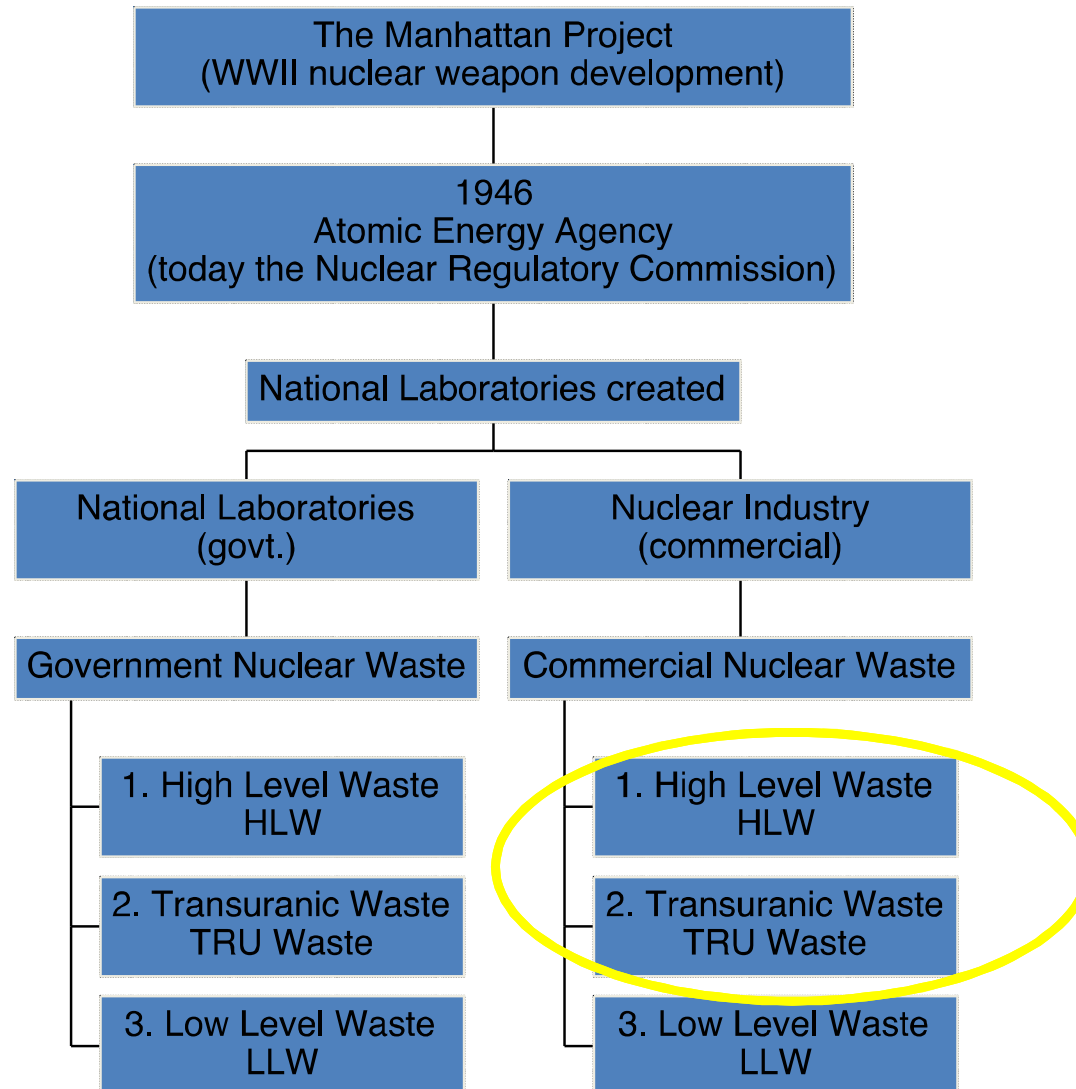
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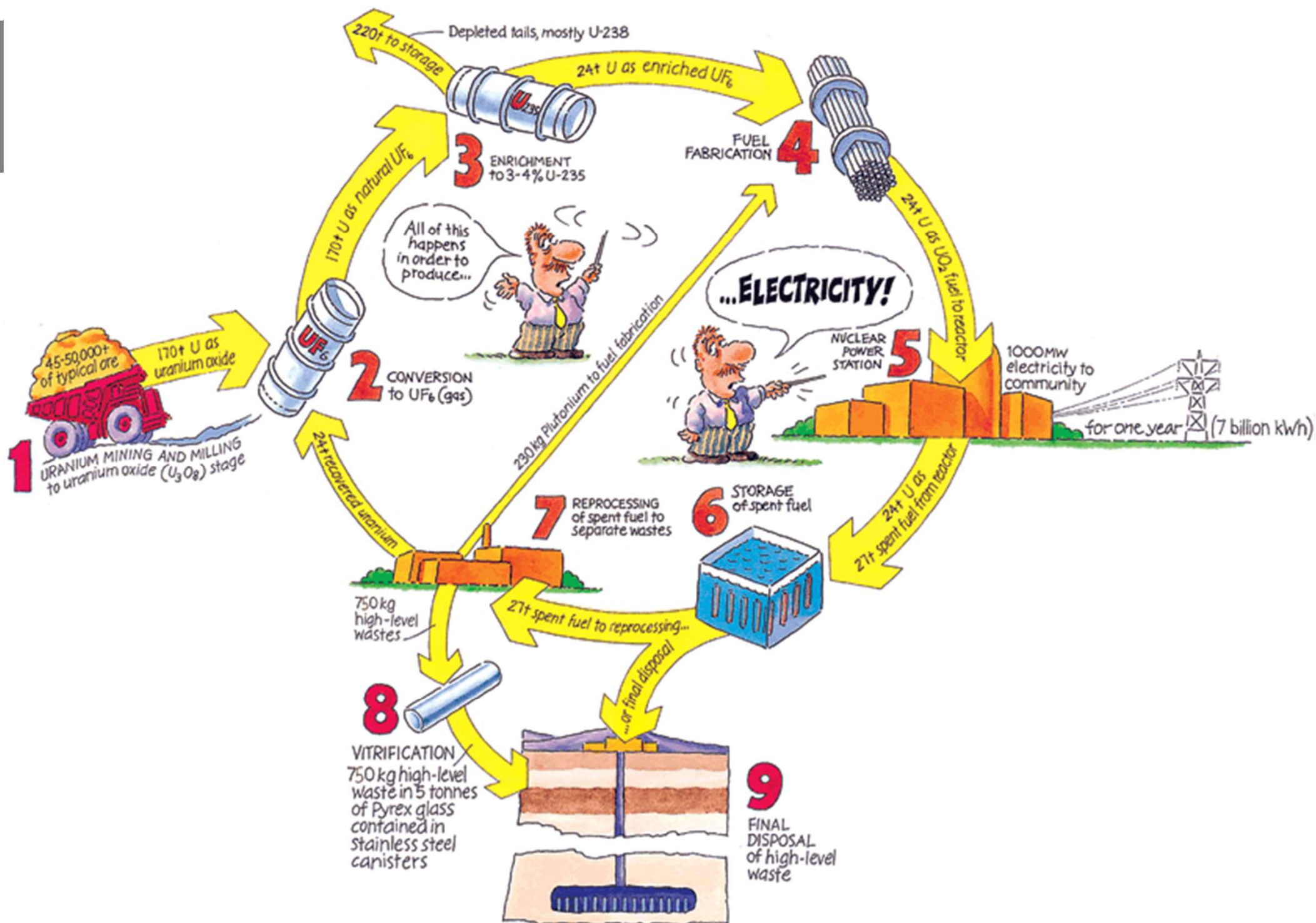


What and where?



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The nature of “spent” or “used” nuclear fuel



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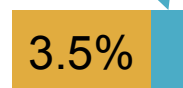
- Fuel is in reactor for 4 – 6 years
- U consumed, fission products and transuranics (mostly Pu) produced

Fresh Fuel



^{238}U

^{235}U



U

Pu

Used Fuel

Transuranics
(or Actinides)

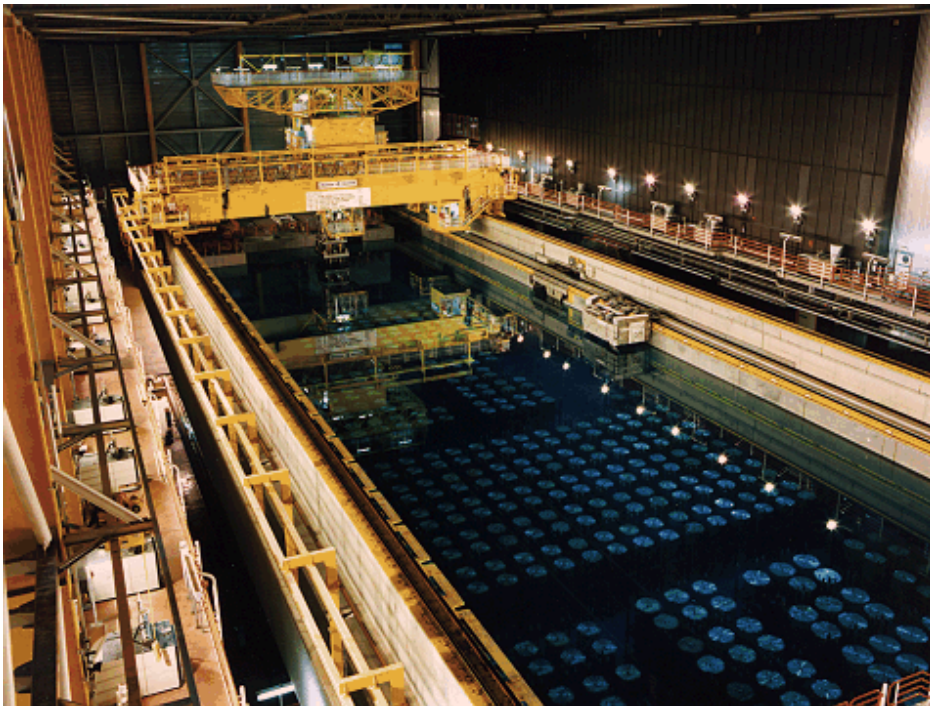
Fission
Products

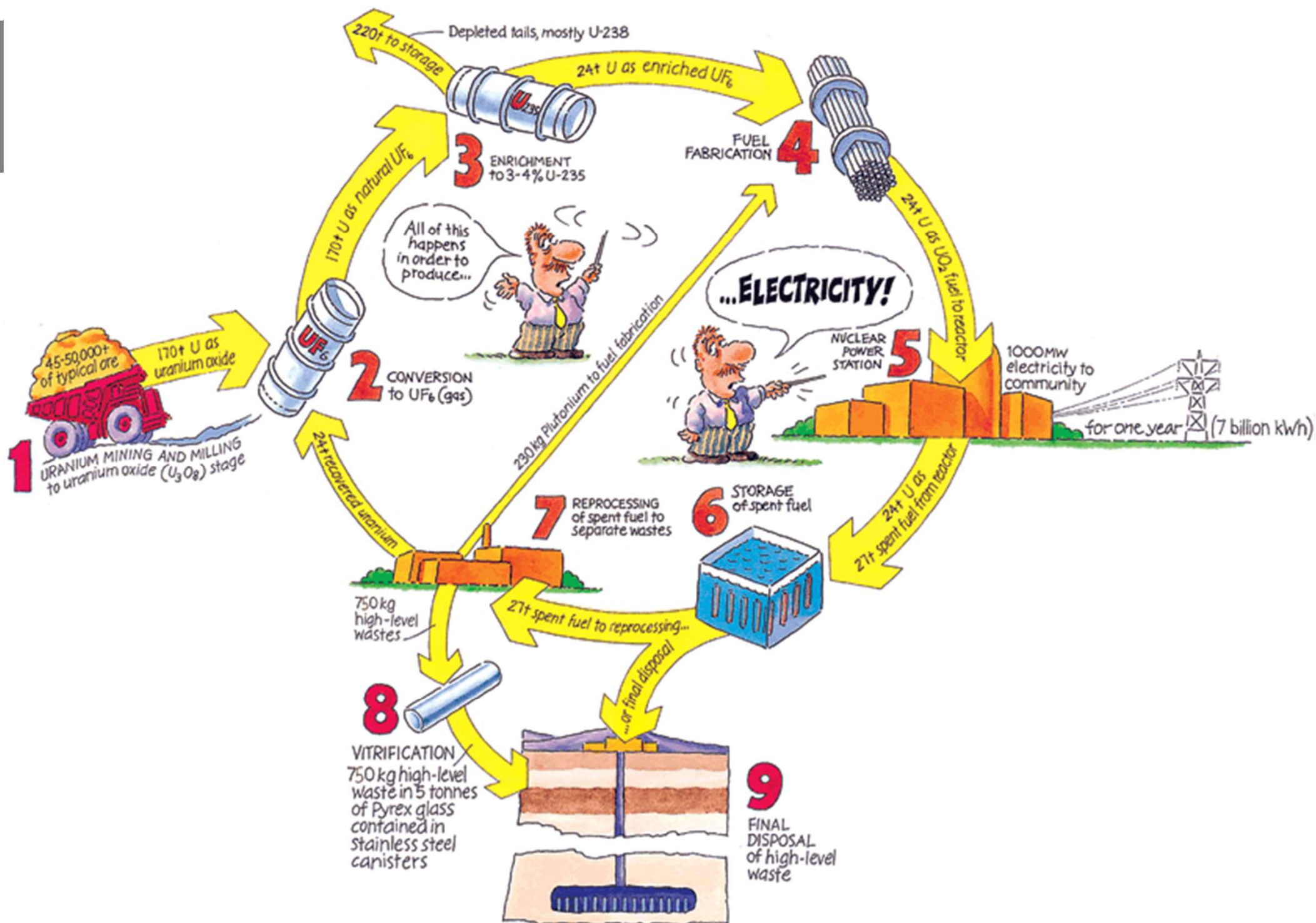
Storage of Used Nuclear Fuel



- Used fuel assemblies give off a lot of heat
- Stored in pools of water
- Water acts as a coolant and radiation shield

Can also be dry stored and cooled by air

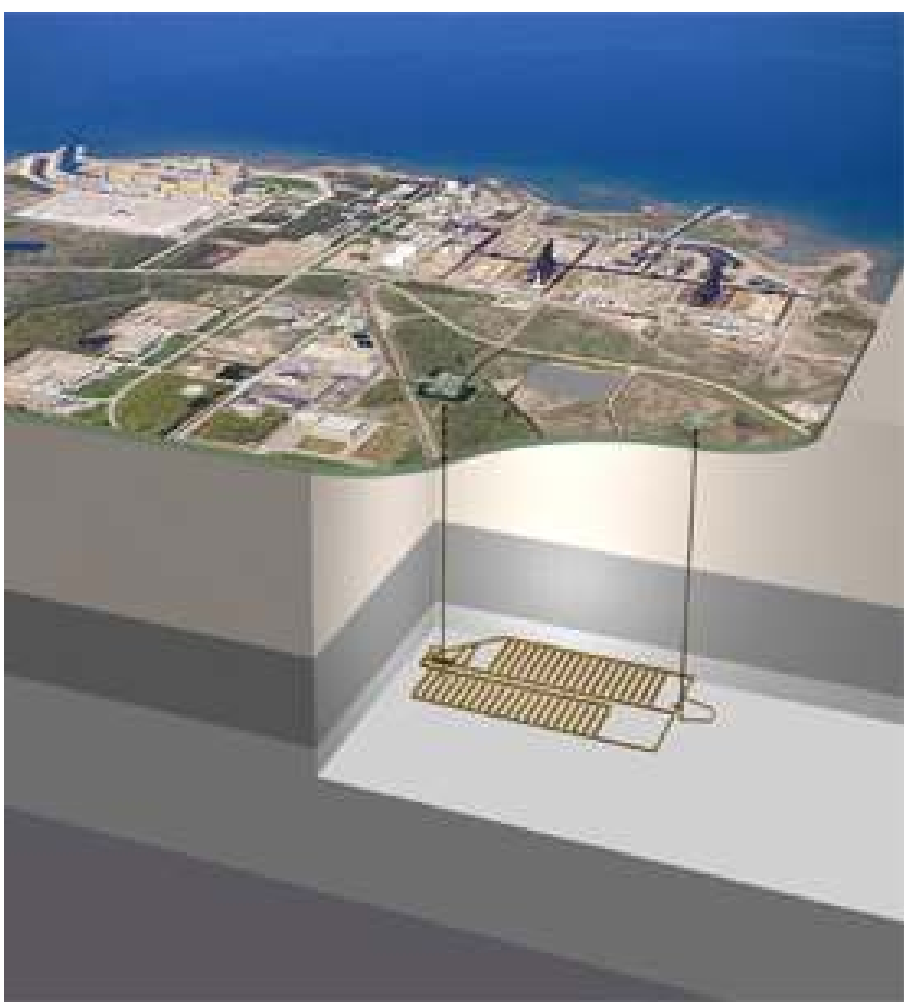




Geologic Repository

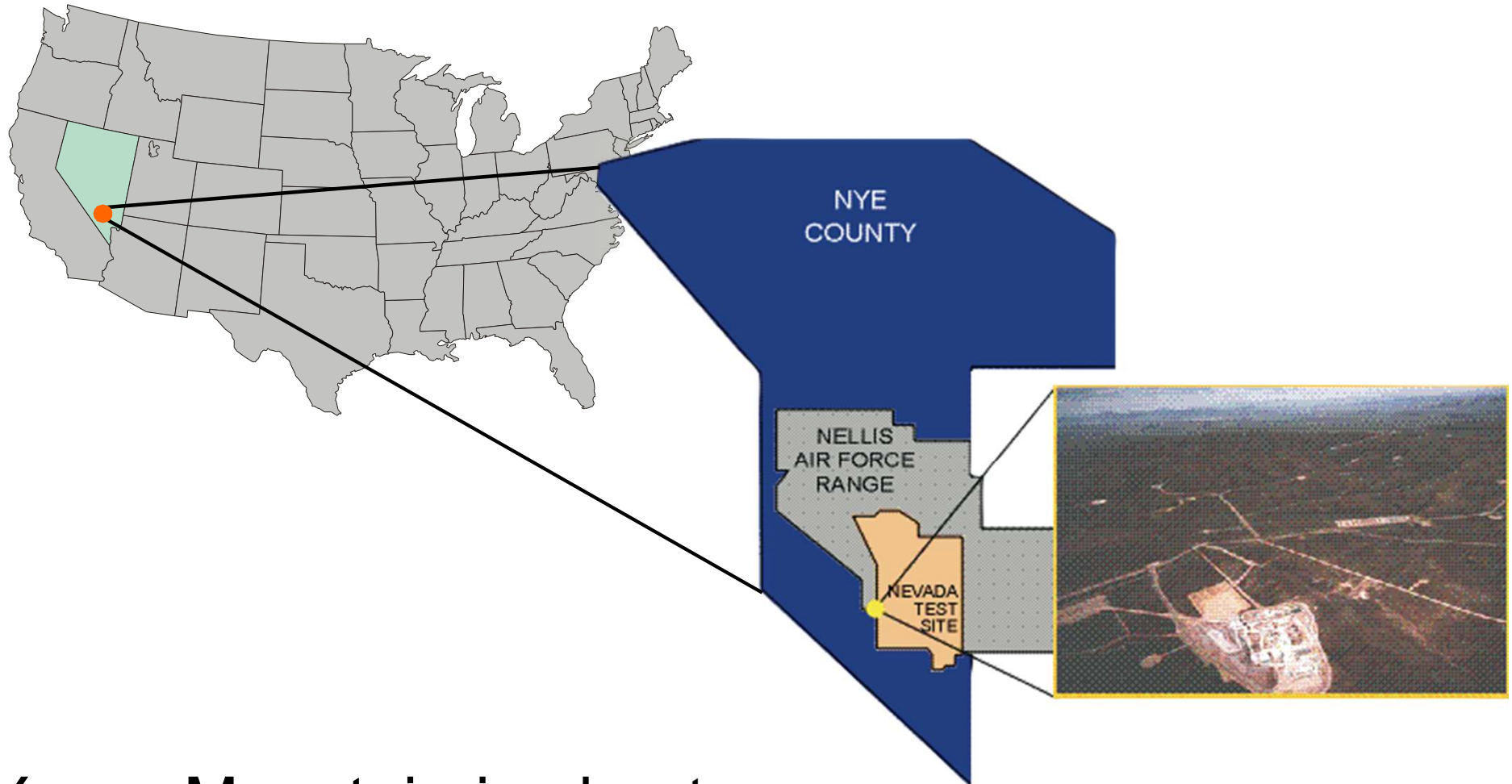


- The choice of countries worldwide
- U.S. has studied Yucca Mt., Nevada as potential location



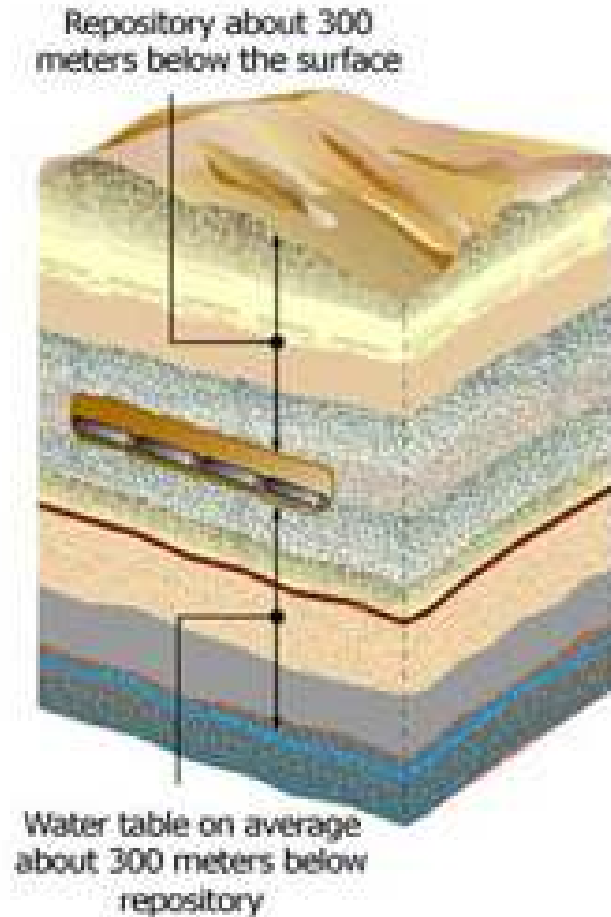


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Yucca Mountain is about
100 miles northwest of Las Vegas, Nevada.

Repository-Yucca Mountain ANS



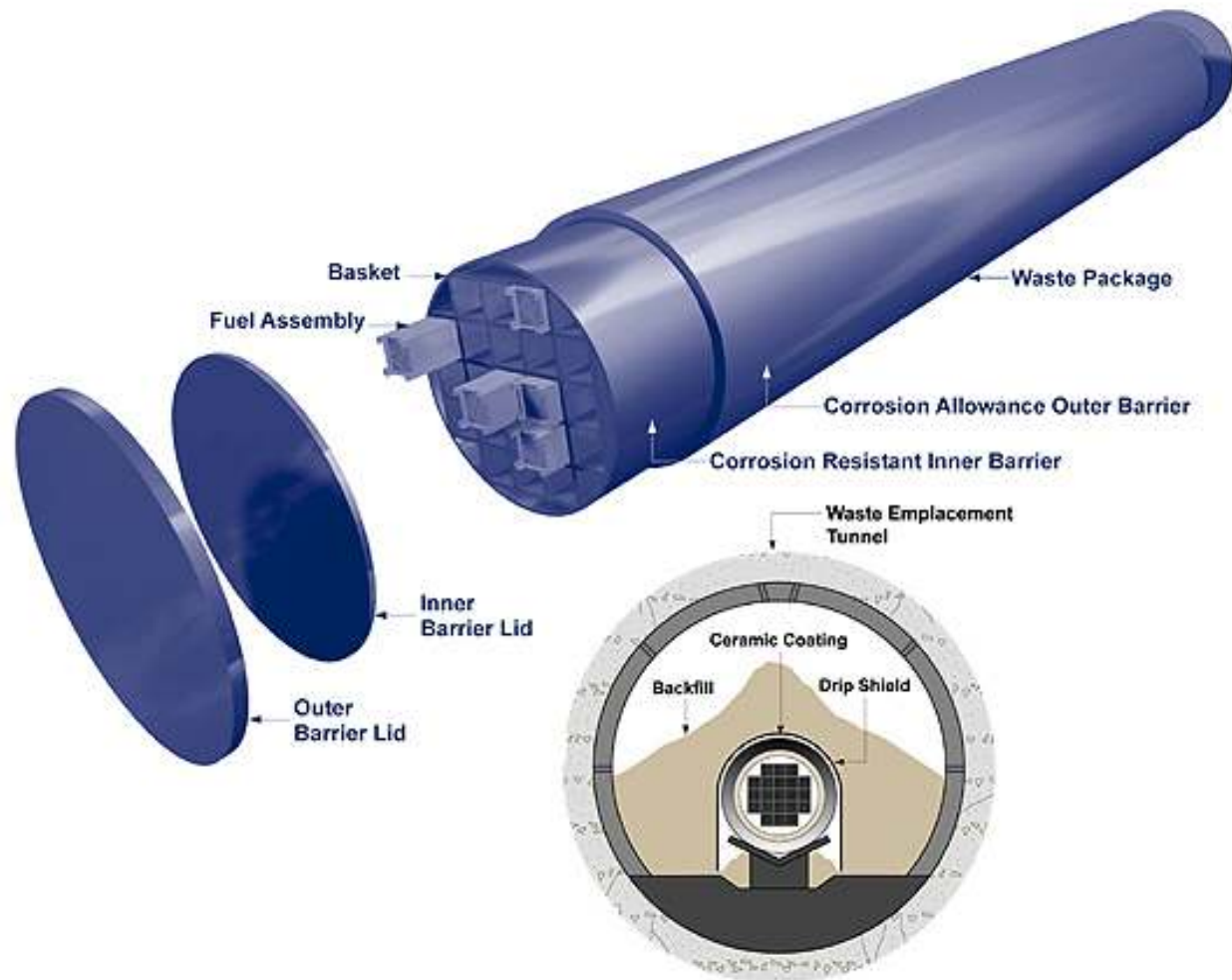
Why Yucca Mountain?

- Stable geology
- Dry climate
- Deep water table
- Remote location
- Restricted location
- Closed water basin

Repository-Yucca Mountain



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Engineered barrier systems

Testing Transport Cylinders



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Yucca Mountain Project



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2008 - DOE submitted operating license application to NRC

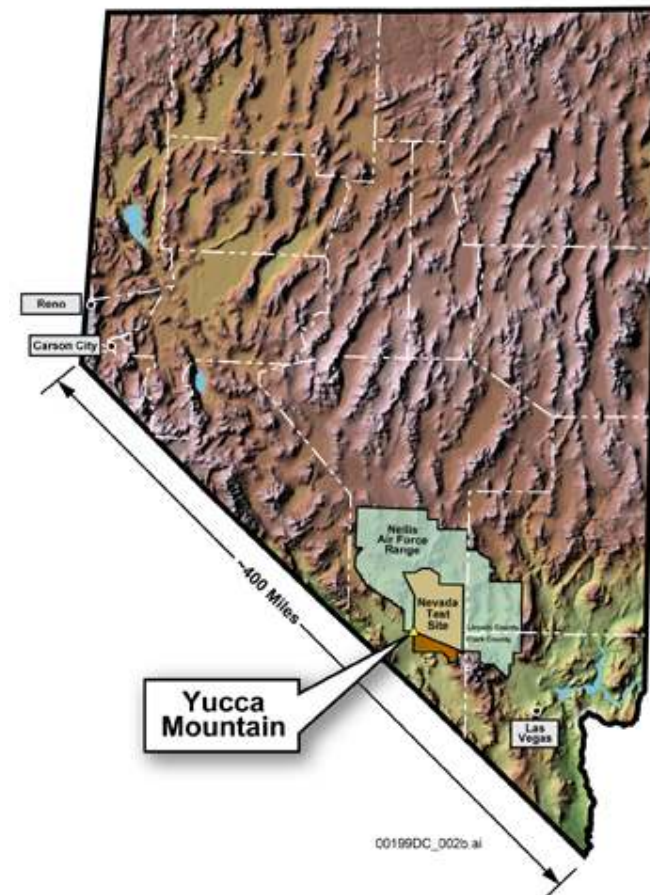
2009 – NRC stopped application review per Obama administration

2010-2012 – Blue Ribbon Commission to study options for waste management

2010-2013 – legal action against NRC

June 2013 – Nuclear Waste Administration Act

August 2013 – Appeals court says NRC continues to break the law and grants writ of mandamus



Producing electricity creates waste . .



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Coal-primary waste output

400+ tons of ash per day
35,000 tons of CO₂ per day
250 tons of SO₂ per day
20 tons of NO_x per day



Nuclear-primary waste output

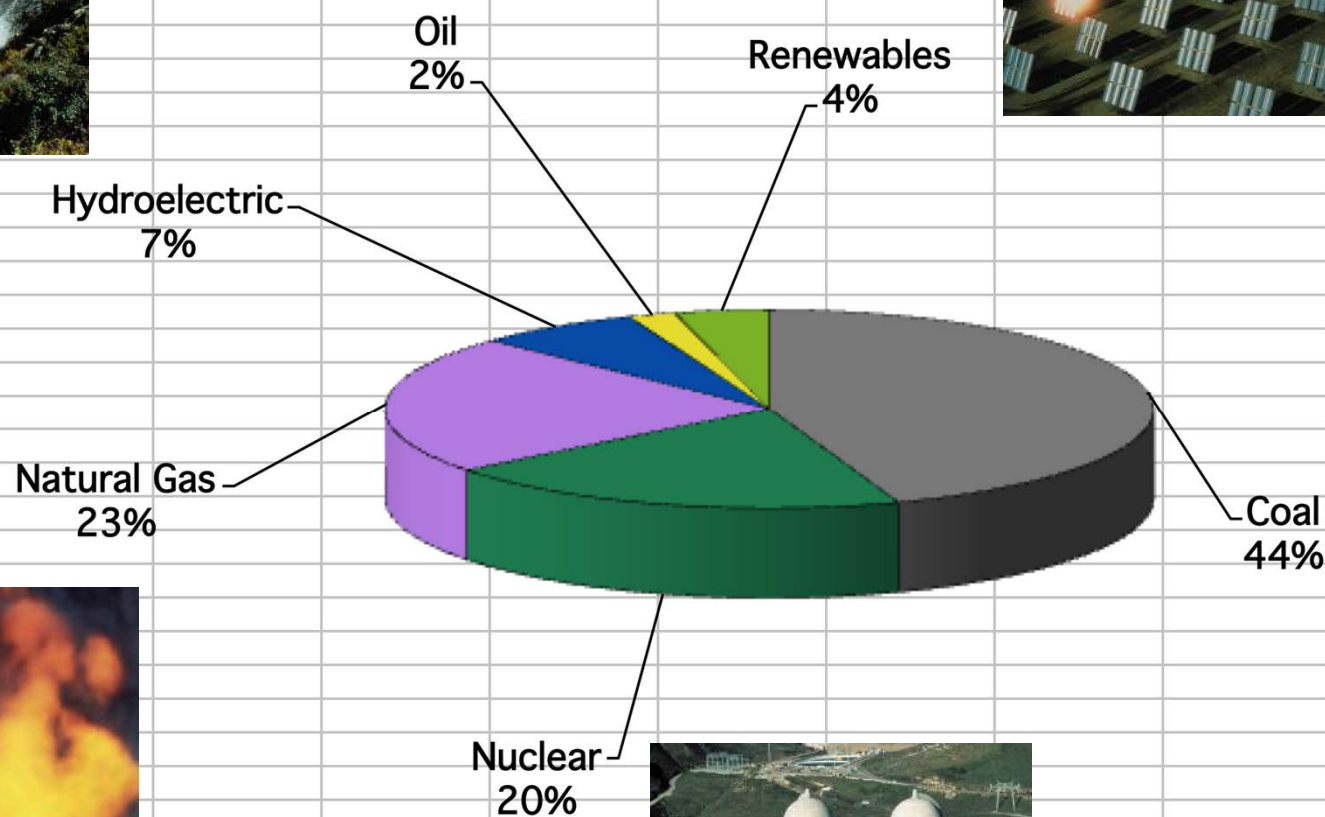
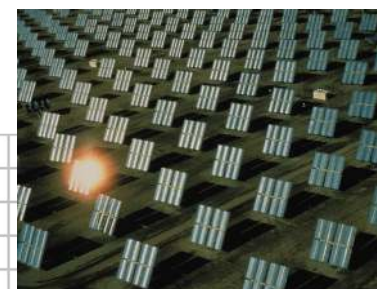
– 300 m³ low level and mixed waste per YEAR
– 25 tons worth of radioactive spent nuclear fuel assemblies per YEAR



U.S. Electricity Sources (2010)



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“There is no sensible alternative to nuclear power if we are to sustain civilization.”

- James Lovelock, world leader in the development of environmental consciousness. Founder of Greenpeace.



Questions?

- 
- A nighttime photograph of the Utah State Capitol building, featuring its prominent dome and classical columns, illuminated from within. The building is set against a backdrop of a city skyline with various other structures and lights visible in the distance.
- **Waste**
 - Yucca Mountain license app
 - Blue Ribbon Commission
 - Nuclear Waste Legislation (S.1240)
 - Nuclear Waste Policy Act ('85) and Amendment ('87)

Eight Key Elements in the Strategy Recommended by the Blue Ribbon Commission



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1. A new, consent-based approach to siting future nuclear waste management facilities
2. A new organization dedicated solely to implementing the waste management program and empowered with the authority and resources to succeed
3. Access to the funds nuclear utility ratepayers are providing for the purpose of nuclear waste management
4. Prompt efforts to develop one or more geologic disposal facilities
5. Prompt efforts to develop one or more consolidated interim storage facilities
6. Early preparation for large-scale transport of SNF/HLW to storage & disposal facilities
7. Support for continued U.S. innovation in nuclear energy technology and for workforce development
8. Active U.S. leadership in international efforts to address safety, waste management, nonproliferation, and security concerns

Nuclear Waste Administration Act (S1240)



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Referred to Congressional Committee 27 June 2013

Establishes as an independent agency in the executive branch:

- 1) the Nuclear Waste Administration (NWA) to provide for the permanent disposal of nuclear waste, including the siting, construction, and operation of additional repositories, a test and evaluation facility, and additional storage facilities; and
- 2) the Nuclear Waste Oversight Board.

Transfers to the NWA Administrator specified functions of the Secretary of Energy (Secretary). Prescribes guidelines for nuclear waste facilities and for the identification and suitability of candidate sites.

Directs the Administrator to:

- 1) establish a Storage Facility Program to provide interim storage for spent nuclear fuel and high-level radioactive waste, and
- 2) request proposals for cooperative agreements for a pilot program for the storage of priority waste.

Requires the Administrator, prior to selecting a storage facility site, to enter into a consent agreement to host the facility with:

- 1) an authorized official of the state in which the site is proposed to be located;
- 2) each affected unit of general local government or Indian tribe; and
- 3) submit to Congress a program plan, a list of proposed storage facility sites, and cost estimates for licensing, constructing, and operating each storage facility.



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Requires the Secretary to issue guidelines, evaluate potential sites, as well as select sites for repositories.

Subjects construction and operation of a storage facility or repository to:

- 1) applicable standards for the protection of the general environment from offsite releases of radioactive material, and
- 2) the licensing and regulatory jurisdiction of the Nuclear Regulatory Commission (NRC).



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Requires the Secretary to arrange for the Administrator to dispose of defense wastes in a repository developed under this Act.

Authorizes the Secretary to arrange for the Administrator to store defense wastes in storage facilities developed under this Act pending disposal in a repository.



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Confers upon the Administrator responsibility for transporting nuclear waste under this Act.

Establishes in the Treasury the Nuclear Waste Administration Working Capital Fund.

Amends the Nuclear Waste Policy Act of 1982 to reflect the amendments made by this Act.



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Terminates those authorities of the Secretary regarding siting, construction, and operation of repositories, storage facilities, or test and evaluation facilities which were not transferred to the Administrator under this Act.

Nuclear Waste Policy Act of 1982



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- **Mandated establishing**
 - milestones for major decisions on federal storage/repositories
 - procedures for public involvement
 - Nuclear Waste Fund
 - separate office to direct program (OCRWM)
- **Screw Nevada 1**

NWP Amendment Act (1987)



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- **Dropped all but Yucca Mt. specific sites**
- Added 5 years to schedule for first repository
- Nullified Oak Ridge MRS siting proposal
- Established MRS Review Commission
- DOE prohibited from follow-on repository but empowered to negotiate “benefits” for hosts

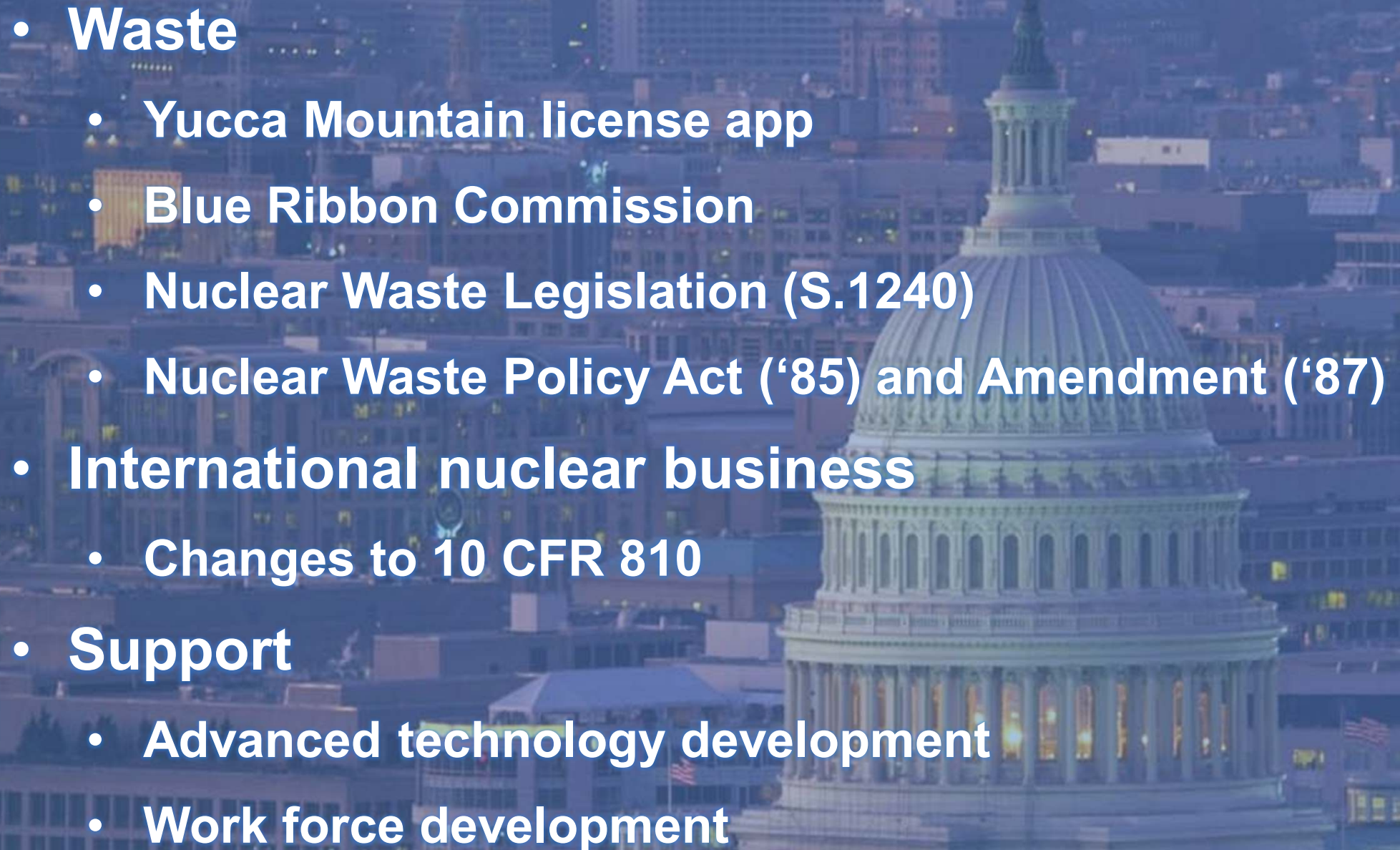
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- **Waste**
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 - **International nuclear business**
 - Changes to 10 CFR 810

10 CFR 810



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- Implements section 57b of Atomic Energy Act
- Unlawful for any person to engage in production of SNM outside US
 - Unless DOE Secretary says not “inimical” to US interests
 - Same for weapons or commercial activity
- Updates/changes needed to reflect current global nuclear market
- Changes to
 - Levels of authorization required for certain host countries and technologies
 - Length of process required for higher levels of authorization

- 
- **Waste**
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 - **International nuclear business**
 - Changes to 10 CFR 810
 - **Support**
 - Advanced technology development
 - Work force development

Spent Nuclear Fuel Pros and Cons



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PROS

Solid form

Small volume

Easily transported

Can be recycled!!

CONS

Radioactive

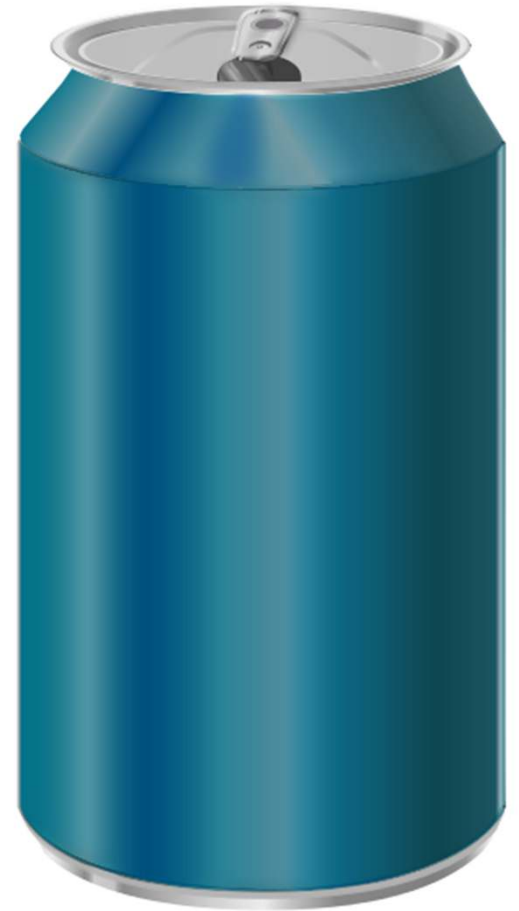
Contains long-lived
radionuclides

The Three C's of Used Nuclear Fuel **ANS**

Compact....

Suppose

- You live for 80 years
- All electricity is nuclear
- Your share of used nuclear fuel



The Three C's of Used Nuclear Fuel

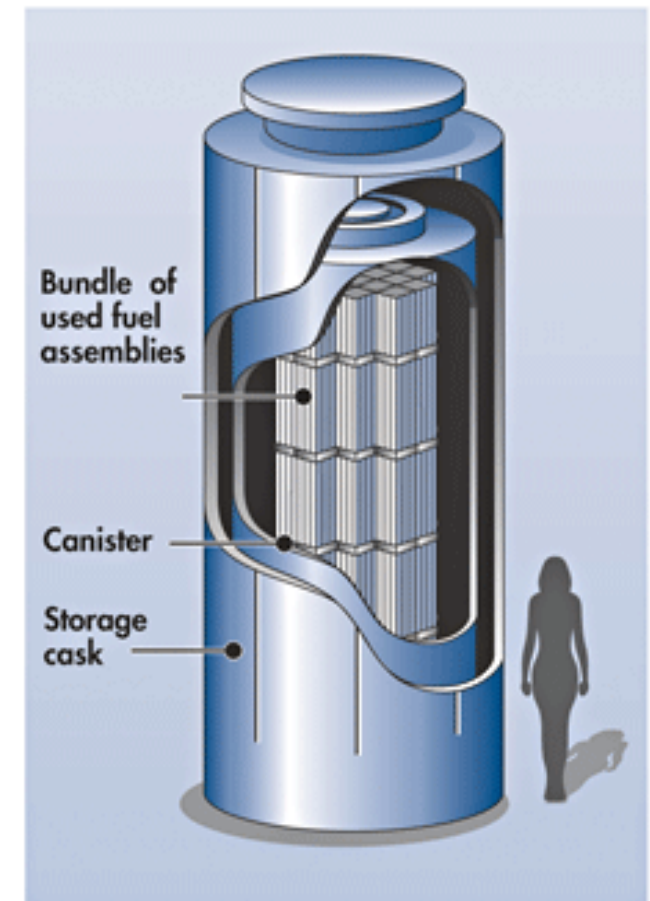


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Compact.... Contained....

- Solid fuel pellet, inside...
- Metal fuel rod, inside...
- Steel canister, inside...
- Storage or shipping cask

Dry Storage of Spent Fuel



The Three C's of Used Nuclear Fuel **ANS**

Compact.... Contained.... Cared for....

- Carefully tracked
- Decades of safe handling experience
- Easy to detect and monitor
- Paid for in Nuclear Waste Fee