Oregon Response to the Waste Management Area-C WIR Evaluation

The Oregon Department of Energy has developed an initial response to US DOE's proposed waste classification determination, published on October 4th.

Limited paper copies are available on the back table.

To read the letter online, visit:

https://tinyurl.com/wmacwir-or

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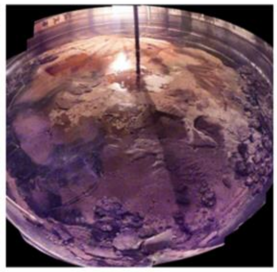
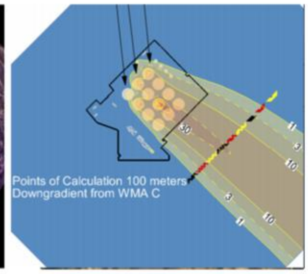
Hanford Radioactive Tank Wastes

Waste Management Area – C

Waste Incidental to Reprocessing





Oregon Public Meeting

Jeff Burright
October 16, 2018

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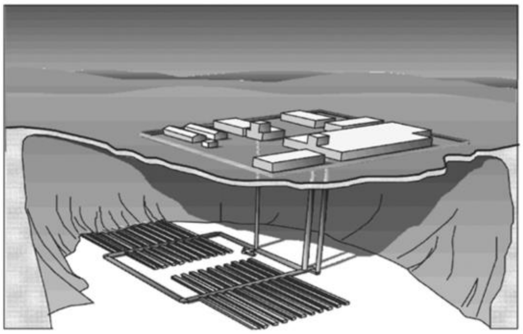
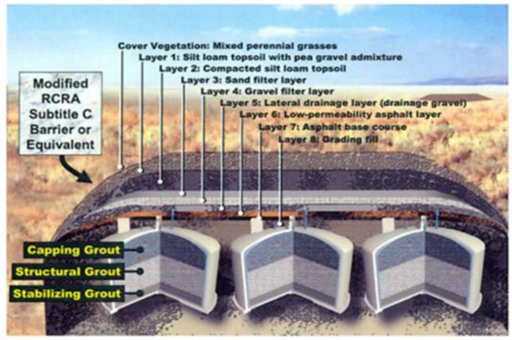
Tonight we are here to talk about a decision that has implications for long term uncertainty and risk. DOE has been working for nearly 20 years to retrieve waste from the first tank farm at Hanford, and the waste classification process underway right now is intended to address the leftover waste in tanks that were not able to be retrieved. The process to close a tank farm has many parts, and this is one of the first in a long chain for the closure of the first tank farm at Hanford.

Decision: Can the waste left over in the C-Farm Tanks at Hanford be managed as "low-level waste"?



If it is high-level, it must be disposed in a Deep Geologic Repository for high-level radioactive waste, which does not yet exist in the United States.

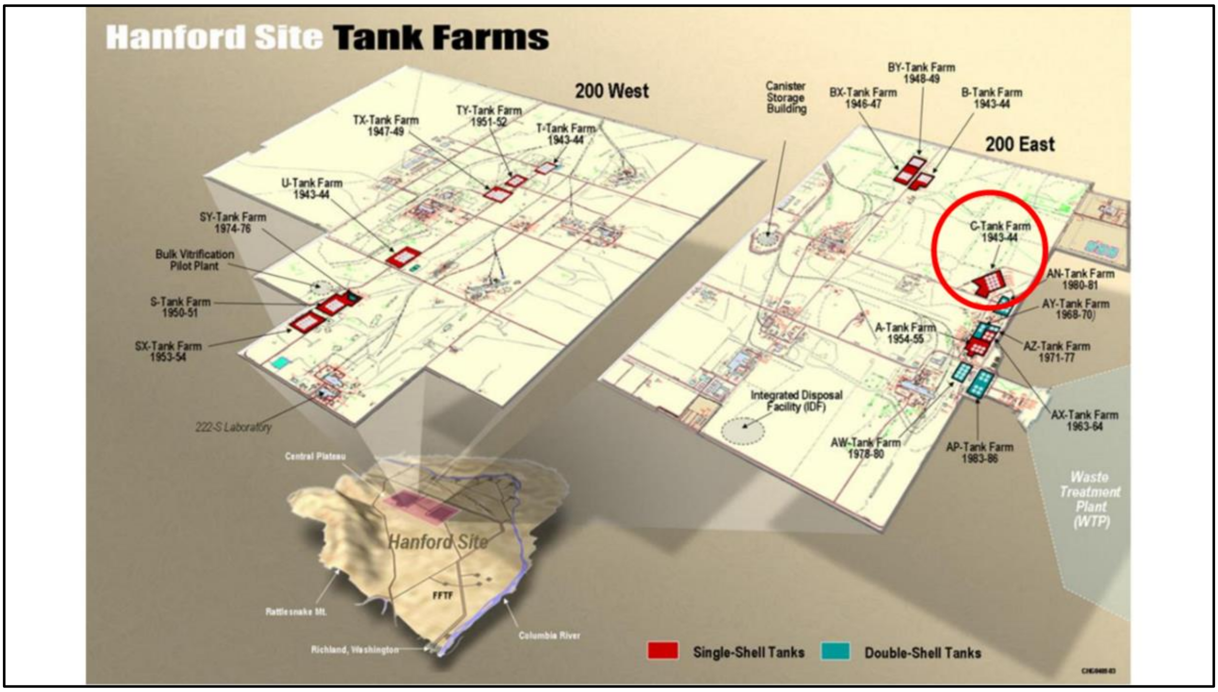


If it is low-level, the tanks and residual waste heels can be closed in place forever at Hanford, assuming long-term safety can be "reasonably expected."

DOE proposed to use its authority under the Atomic Energy Act to make a determination that the tanks and residual waste at WMA-C may be managed as "other than high level waste". This determination is a necessary precursor to DOE's plans to close the tank farm in place at Hanford, because by law, high level waste must be disposed in a deep geologic repository.

Note: the figure of tank closure is conceptual in nature. The actual design of the cap and grout are still under development.

Hanford is located on the Columbia River 30 miles north of the Oregon border. The eastern edge of the tank farms are approximately 7 miles from the Columbia River. The tank farms are situated on the Central Plateau, which is approximately 250-300 feet above an aquifer that is expected to flow SE toward the river into the future.

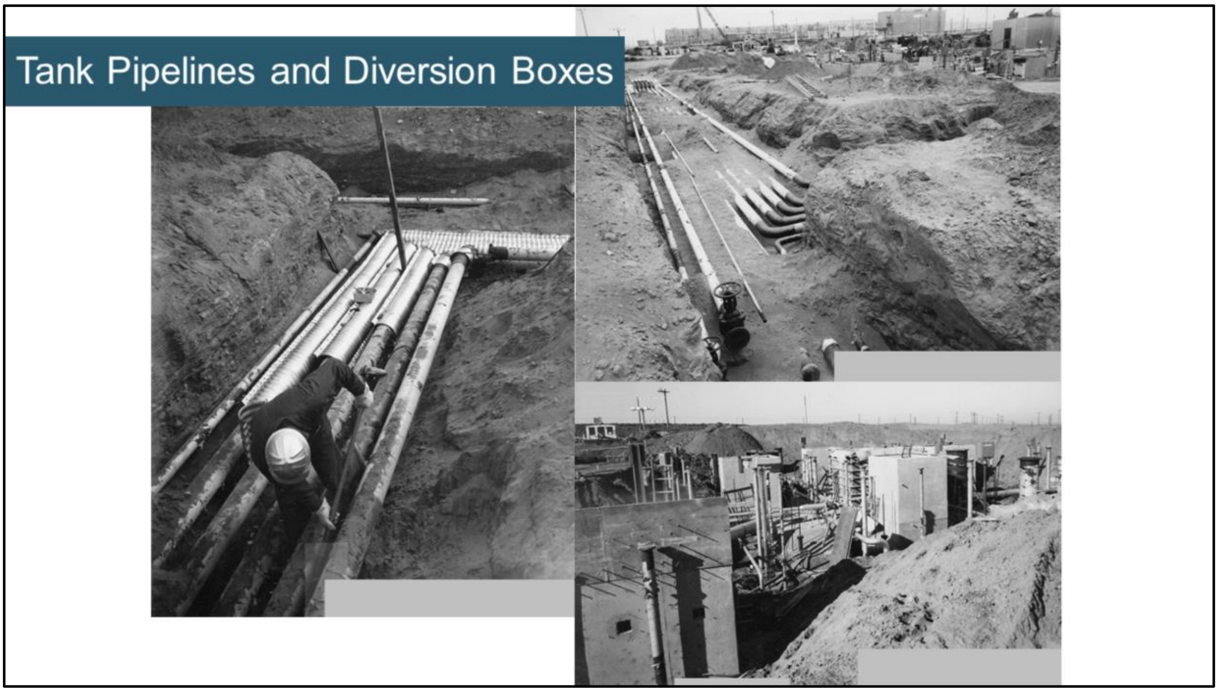


Another look at the 200 West and East areas and the various tank farms. WMA-C is circled in red.

A view of one of the 500,000 gallon tanks at Hanford to give a sense of scale. The C-Tank Farm at Hanford was built in 1943-1944.

View from inside one of the tanks

The tanks were built in clusters or “farms”. Tanks were built of concrete with a carbon steel liner and buried under ~8 feet of soil for radiation shielding purposes. The bottoms of the tanks are approximately 40 feet below ground surface.



C Tank Farm also included approximately 7 miles of pipelines and junction boxes to facilitate waste transfer. These pipelines are included within the scope of the waste determination for WMA-C.

High Level Radioactive Waste
and
Waste Incidental to Reprocessing (WIR)

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High level radioactive waste is the result of dissolving irradiated uranium and fission byproducts in acid to extract plutonium (about 1.5 pounds of plutonium were extracted from every ton of uranium processed), then neutralizing the acid with additives to protect the tanks from corrosion. The waste in the tanks are the leftover “stew” after the plutonium was extracted. Waste sampling at Hanford has identified over 1,500 compounds in the tanks.

Definition of High Level Waste

Nuclear Waste Policy Act of 1982:

The term "high-level radioactive waste" means—

- (A) the highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and
- (B) other highly radioactive material that the (Nuclear Regulatory) Commission, consistent with existing law, determines by rule requires permanent isolation.

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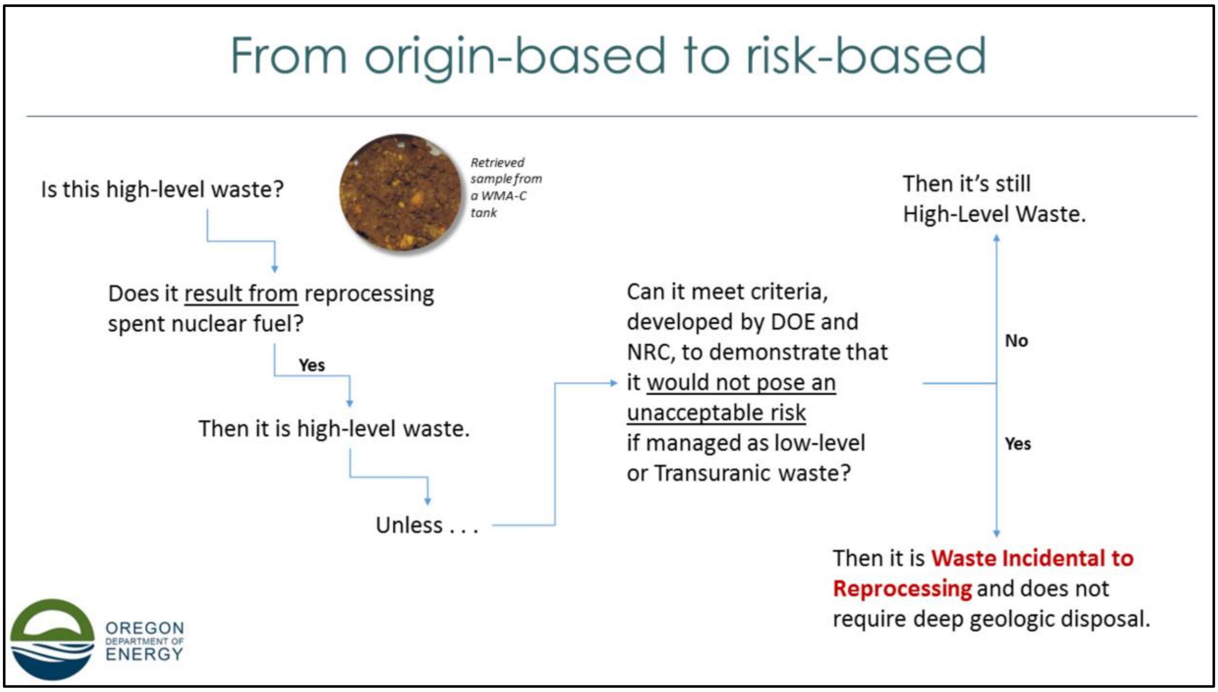
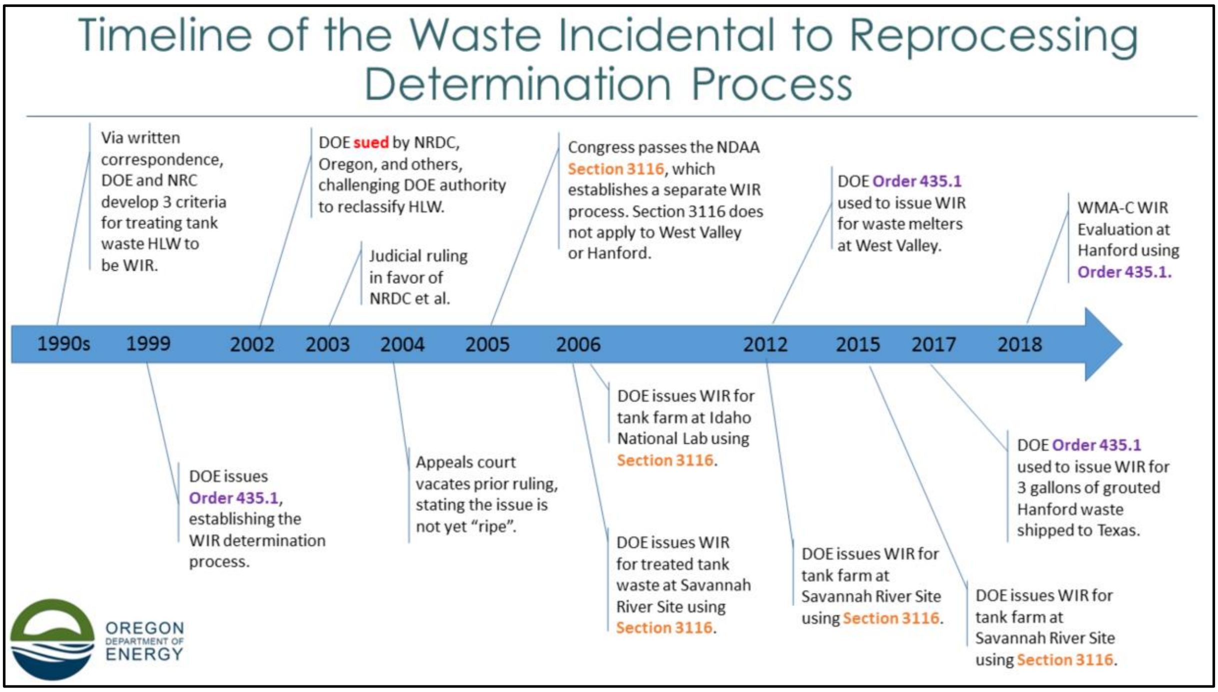
DOE has the authority to manage its radioactive waste as its own regulator under the Atomic Energy Act. However, the definition of high level waste (HLW) comes from Congress, and this same act (the NWPA) requires that HLW must be disposed to a deep geologic repository. The congressional definition of HLW includes the process that created the waste, or in other words its origin. The definition also includes risk-based language such as “highly radioactive” and “sufficient concentrations”, but these terms are somewhat ambiguous and open to interpretation, which has led to the waste classification concept DOE is currently pursuing.



Over the years, the concept has emerged to change the way HLW is defined to focus more on the risk it presents than on its origin. This diagram gives a very basic sense of how this concept is being proposed to be applied at Hanford. The classification is known as "Waste Incidental to Reprocessing" (WIR).



Here I will describe the moment in history that the current decision occupies. After the challenge to Order 435.1 (DOE's self-regulation for waste management, which includes the WIR process) was ruled "not yet ripe" for judicial review, Congress developed an alternative process for WIR determinations that applies only in SC and ID. Since 2012, DOE has applied 435.1 to WIR determinations for smaller waste sources and not been legally challenged, but there is an outstanding question whether the WMA-C WIR will finally represent a moment of ripeness to answer whether DOE has authority to reclassify waste under Order 435.1.

Waste Incidental to Reprocessing (WIR) Criteria Application

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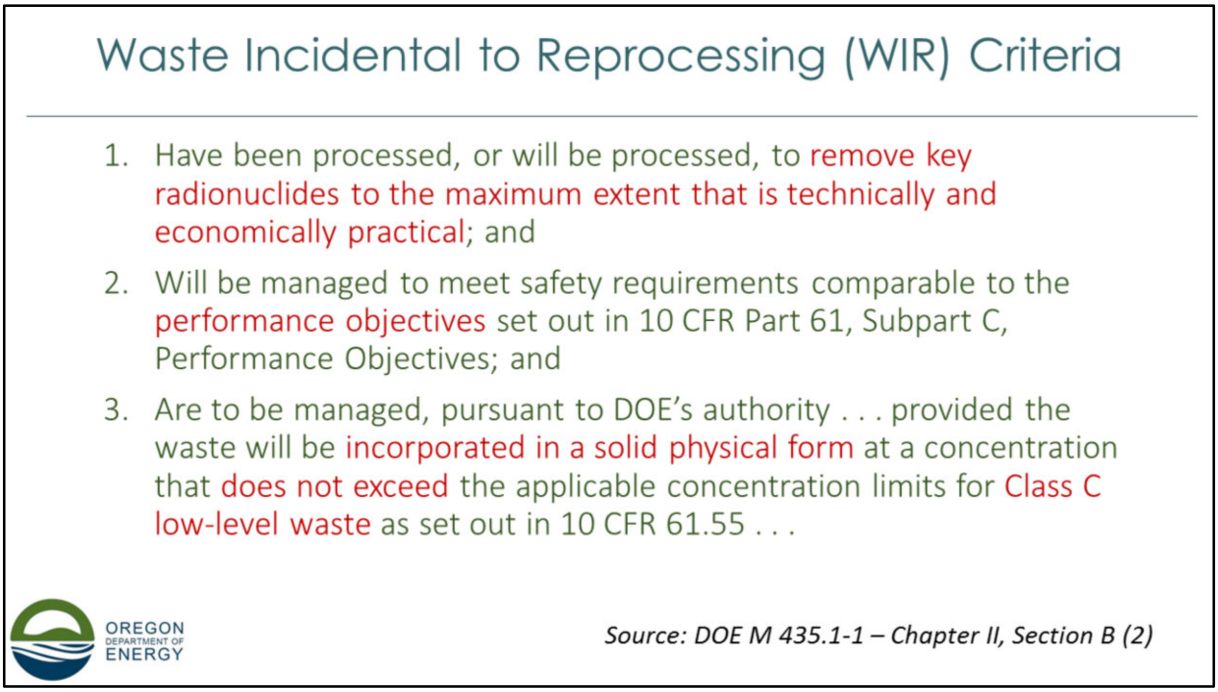

Consistent with the previous slide, DOE in consultation with NRC developed the following three criteria that could be applied to a source of HLW to determine that the waste is Waste Incidental to Reprocessing and can be managed as a different waste type (i.e., does not require deep geologic disposal from a risk perspective). These criteria were codified in DOE's internal self-regulation, Order 435.1.

#1: Removal of Key Radionuclides to the Maximum Extent Tech. & Econ. Practical

- Tank retrievals use several technologies
- Simple sluicing with supernatant
- More aggressive jet spraying (e.g. MARS)

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DOE’s approach to achieving Criteria #1 has involved bulk material retrieval from the tanks using various technologies.

Tank Retrievals

- Other technologies (e.g. Foldtrak)

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Retrieval in C-Farm: 16 tanks in 19 years

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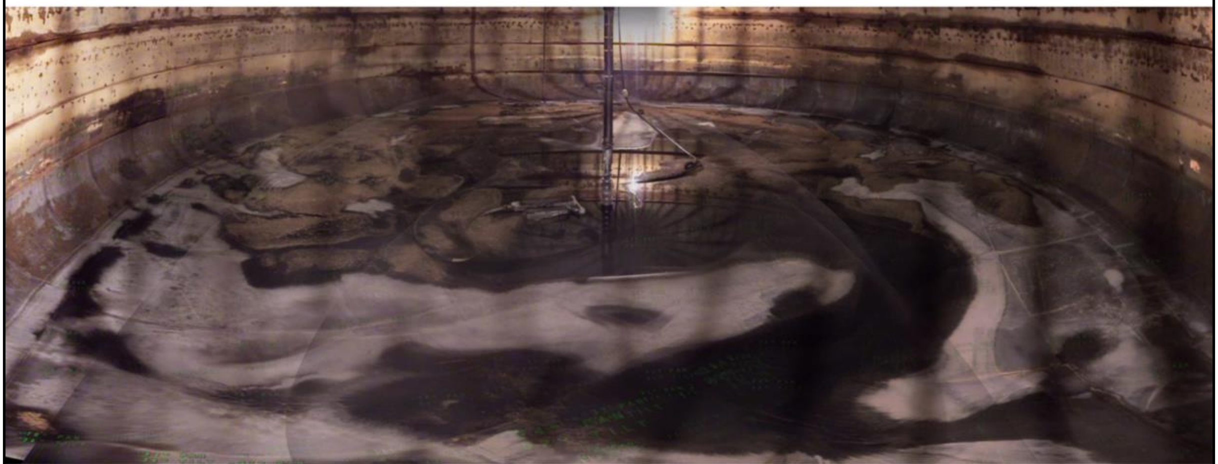
Retrieval was an involved process that took many years. C-Farm was the first tank farm at Hanford to undergo retrieval and was conceived as a proving ground for retrieval technologies.

After tank waste retrieval



Tank C-110 – with the Foldtrak near the center

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Example of a “successful” waste retrieval campaign.

Difficult waste retrieval

Tank C-102 – difficult sludge heel

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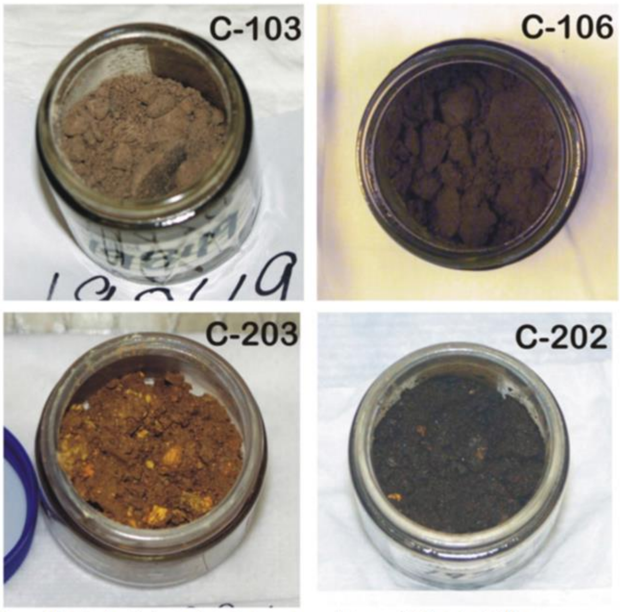
Example of a difficult waste retrieval effort. Solids larger than grains of sand were too heavy for the pumps to bring to the surface, and some stubborn wastes could not be dislodged from the tank inner surfaces.

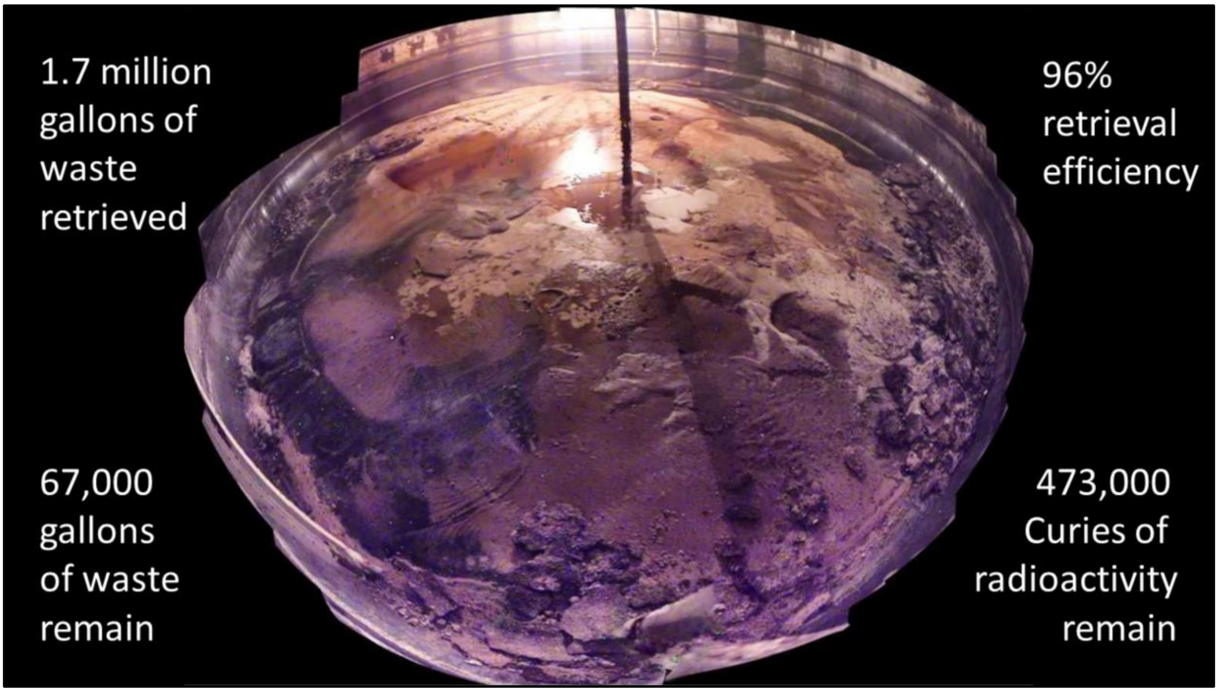
A closer look at the kind of materials left in the tanks.

Figure 5-1. Photographs of As-Received, Post-Final Retrieval Residual Waste Samples from Tanks 241-C-103, 241-C-106, 241-C-202, and 241-C-203.



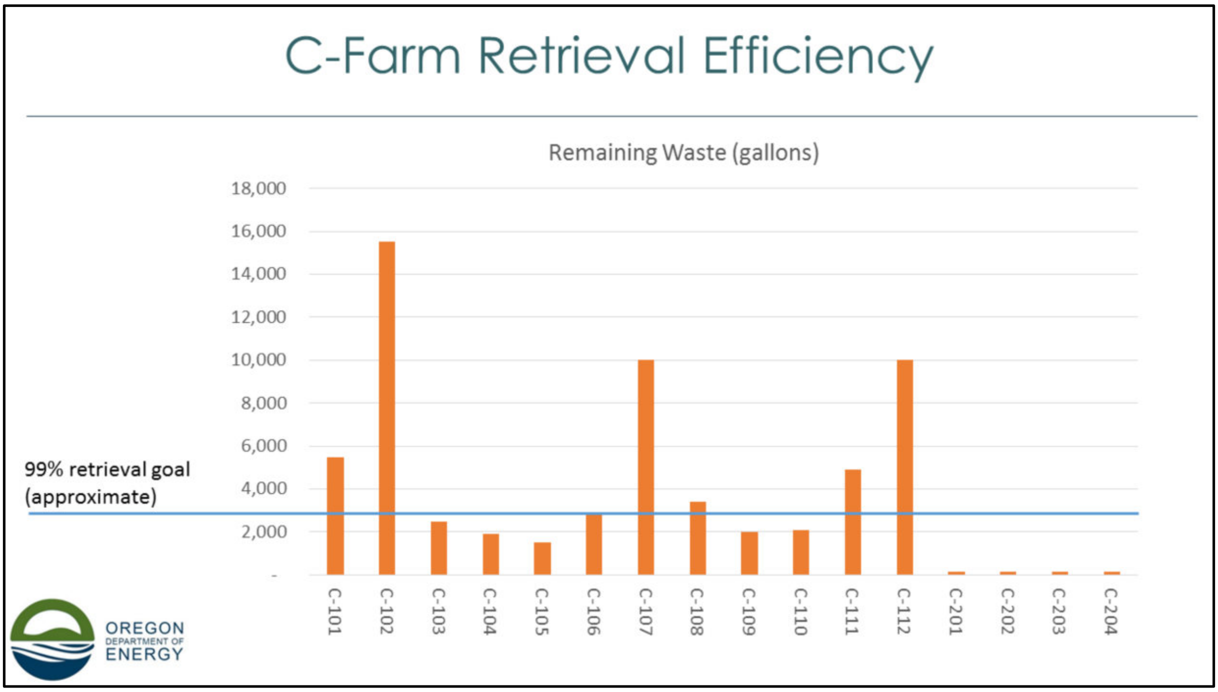
Source: "Hanford tank residual waste – Contaminant source terms and release models" (Deutsch et al. 2011).

An even closer look at samples taken from the tanks following retrieval. These samples were analyzed to determine what constituents were present, and this information supported DOE's current estimates of what's in the waste left behind in the tanks.

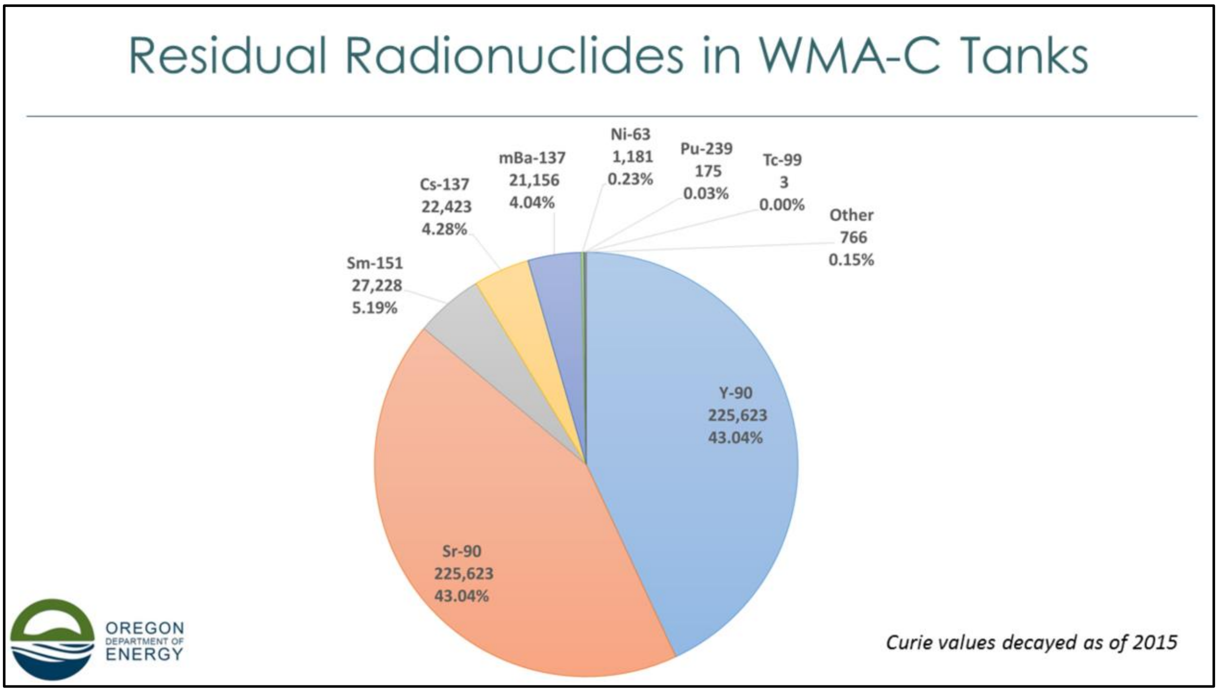


Basic statistics for the C-Farm retrieval effort.

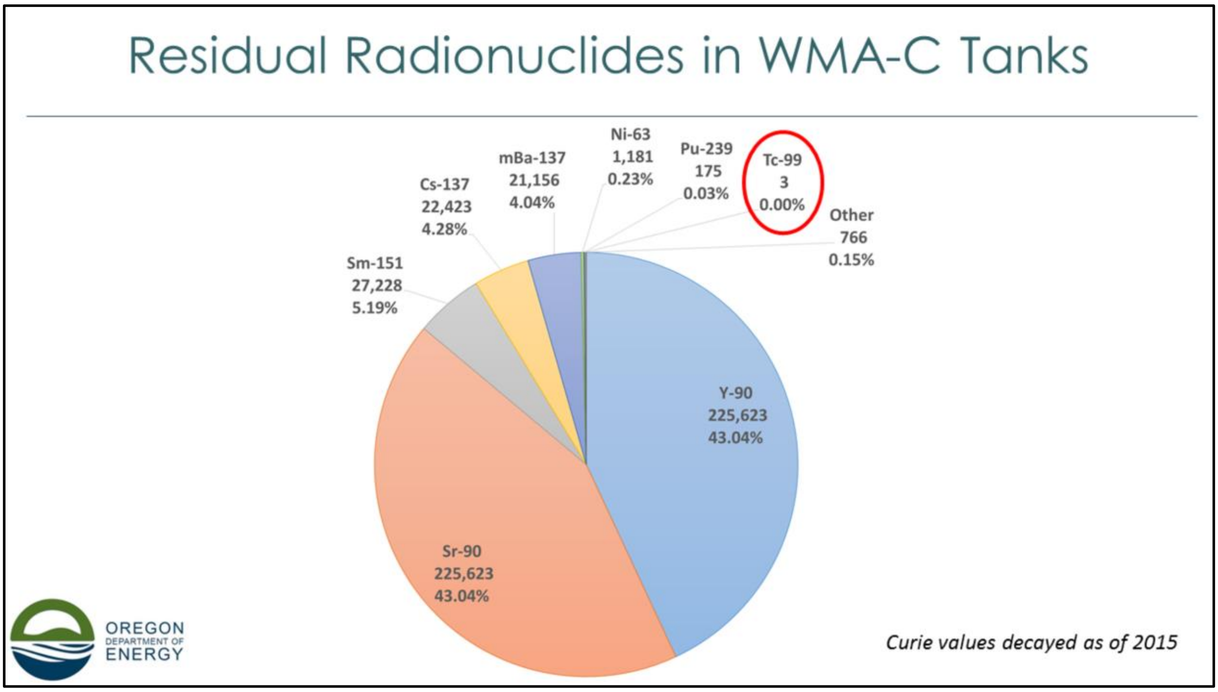
* The remaining curie inventory is decayed to 2020 as the starting point for the analysis.



This figure shows the volume of remaining waste in the tanks. The largest amount corresponds to the “difficult retrieval” photo shown on a previous slide. Per the Tri-Party Agreement and DOE’s record of decision for tank closure based on the 2012 EIS, the goal for retrieval was 99%, or roughly 2,700 gallons by volume.



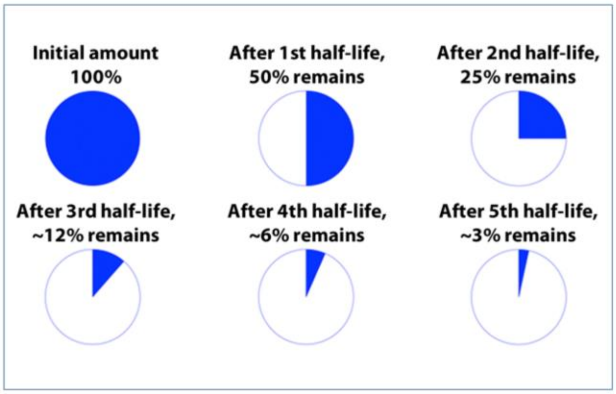
This is a breakdown of the estimated remaining radionuclides in WMA-C following retrieval. Notice that Sr-90, Cs-137, and their daughter products comprise approximately 94% of the radioactivity. These radionuclides are not very mobile in the environment and have a relatively short half-life.



For the purposes of the WMA-C WIR, Tc-99 is an important radionuclide because it is long-lived and highly mobile in the environment ("moves like water"). This is the leading "tracer" for future groundwater risk and will be important in a few minutes. The remaining amount of Tc-99 is so small because it is so mobile, and the tank flushing was successful at mobilizing it out of the tanks during retrieval.

Half Lives (in Years)

- Strontium-90 29
- Cesium-137 30
- Samarium-151 90
- Plutonium-239 24,100
- Technetium-99 211,000
- Iodine-129 15.7 million



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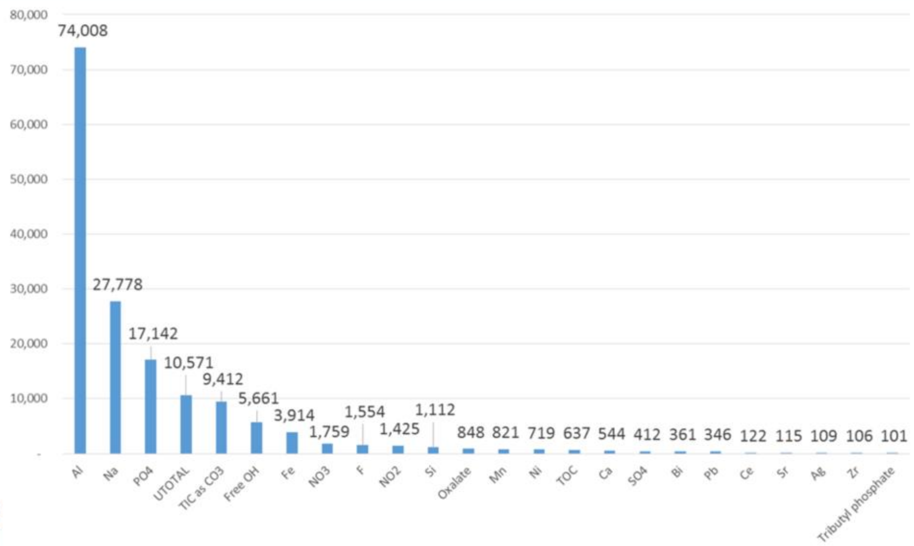
Rule of thumb is 10 half lives until something has reached “virtually zero.” However this breaks down when you have 400,000 curies of something. You’d still have 400 curies after 10 half lives.

Residual Constituents by Mass (kg)



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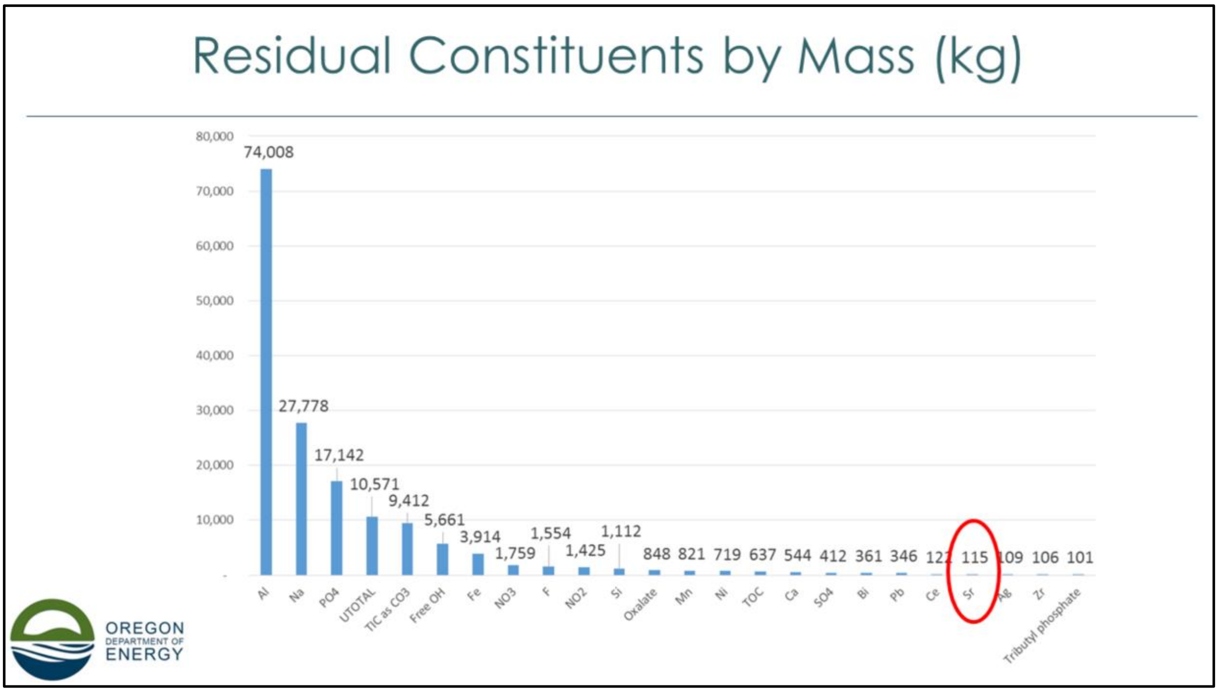
When considering the bulk mass of remaining waste, the primary constituents are aluminum from the spent nuclear fuel cladding (the can surrounding the uranium to keep it dry inside the reactor), the uranium itself, and the chemicals used to alternately dissolve the fuel and to neutralize the acid.

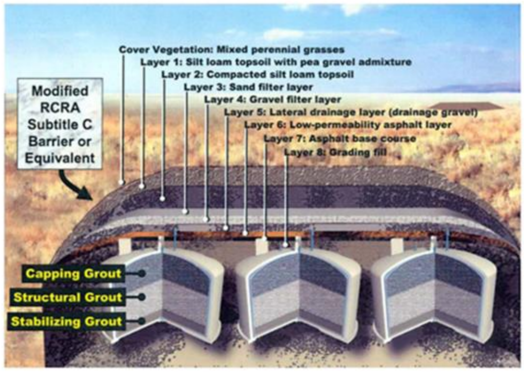


Here is where Strontium sits on the spectrum. This illustrates that high radioactivity can come in a small volume.

#2: Meet Performance Objectives Comparable to 10 CFR Part 61

Part 61 sets performance objectives for low-level radioactive waste disposal facilities (which the Hanford tanks would become if closed on site).

1. 25 millirems/year for any member of the public.
2. 500 millirems/year to an inadvertent intruder after active institutional controls are removed (assumed to occur after 100 years).
3. Various groundwater standards (4 mrem/yr beta; alpha; radium; uranium; others)
4. Protective assurance period for 1,000 – 10,000 years.



Conceptual tank closure design (still under development)

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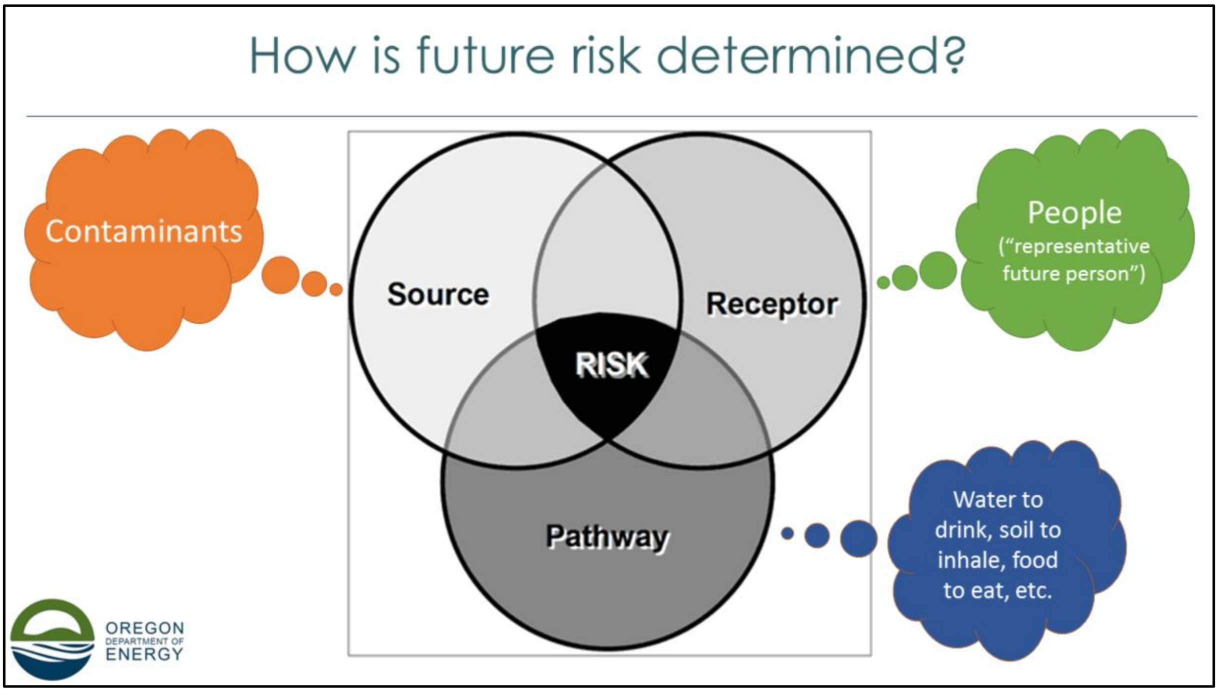
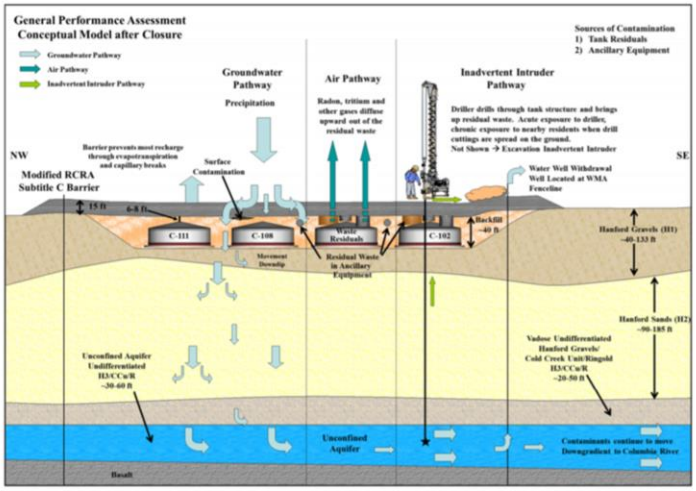
Criteria #2 relates to the 10 CFR Part 61 performance objectives, developed by the NRC, for a new LLW disposal facility, which the Hanford tanks would become. DOE must show that if this waste is managed as low level waste via a WIR, it can actually meet the same performance as LLW for a very long time. The performance objectives are based on a radiation dose standard to future receptors on site.



To demonstrate compliance with Criteria #2, DOE developed a performance assessment that must provide "reasonable expectation" that the risk to future populations will be below the standards. When determining future risk, these three components are combined in a performance assessment, which is essentially a complex mathematical representation of how a natural system behaves. If one of these circles is missing, then the risk is not present. Because of the very long timescales that DOE must demonstrate performance, the model has to account for uncertainties in natural, engineered, and human social systems.

Future Exposure Scenarios in the C-Farm Performance Assessment

- Evaluates a future residential user, living 100 meters away, who grows crops, keeps livestock, and drinks groundwater.
- Evaluates an intruder after 100 years who lives onsite and drills a groundwater well through a buried pipeline.
- Model extends to 10,000 years.
- Assumes cap fails after 500 years.



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The Performance Assessment model focused primarily on two classes of future public receptors as described here. [explain aspects of the figure such as water being the mobilizing force for waste, the downgradient well, and the intruder]. DOE has stated an intent to retain ownership and control of the Hanford Central Plateau in perpetuity, so for these receptor scenarios to take place, institutional controls, including government ownership, would need to have failed.

- C Tank Farm closure modeling shows maximum of 30 pCi/L in downgradient water wells, 1,500 years from now
  - Drinking water standard = 900 pCi/L
- Maximum dose to a future resident estimated at 0.1 millirem/year
  - DOE standard = 25 mrem/yr
  - Background radiation =
    - ~90 mrem/yr (Hanford area)
    - ~350 mrem/yr (US average)
- Oregon: Uncertainty in the modeling

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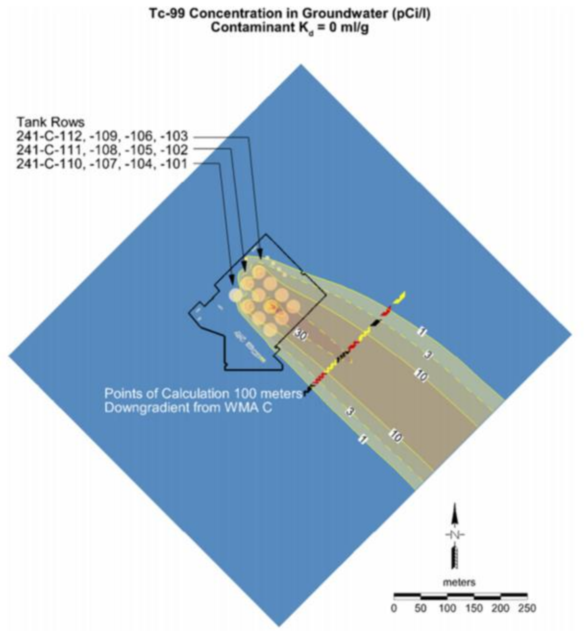
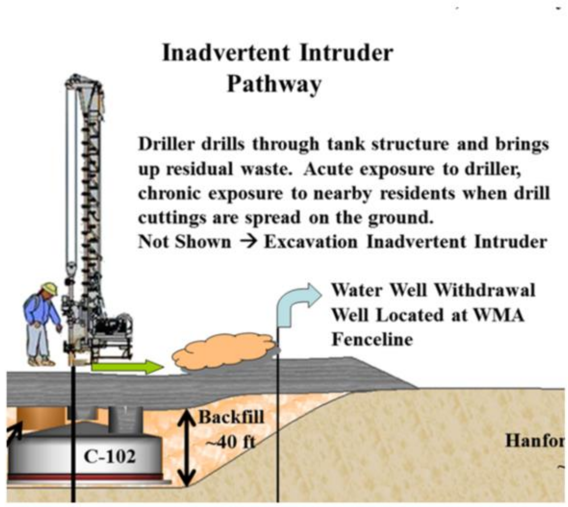
Figure 7-24. Extent of Technetium-99 Plume in Groundwater 1,570 Years after Closure at the Time of the Maximum Concentration at the Point of Compliance.



This is DOE's projection of the maximum amount of key radionuclide contamination in groundwater if they close the C Tank Farm in place. This equates to about 0.1 mrem/year in 1,500 years. Our background radiation dose is around 350 mrem. The performance assessment also included uncertainty analysis that tested how sensitive the model was to varying parameters, as well as a suite of "what if" curveball scenarios such as early grout or cap failure. Based on our review of the Performance Assessment, Oregon has determined that there are remaining uncertainties in how the model was constructed and tested, and which warrant further management.

- Inadvertent Intruder modeling shows a maximum acute dose to a well driller = 36 millirem
  - Standard = 500 mrem
- Maximum chronic dose to an agricultural receptor spreading drill cuttings on crop land = 8.2 mrem/year
  - Standard = 100 mrem/year



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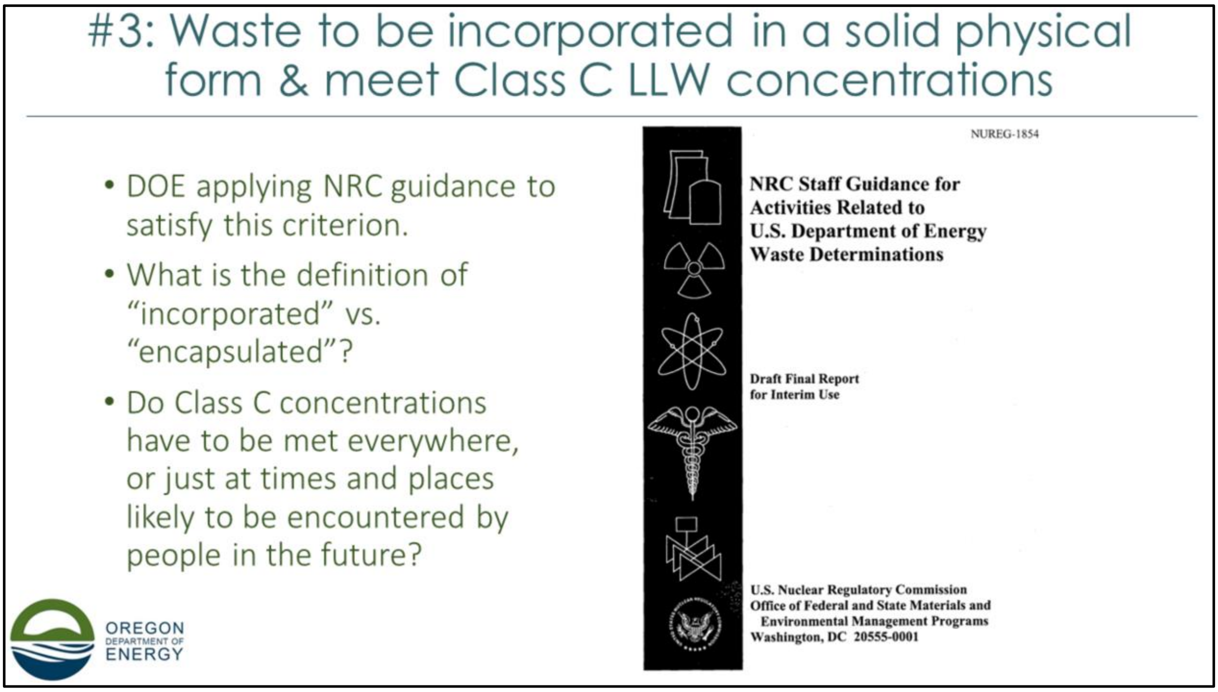
The intruder dose is also projected to be below the applicable standards. Oregon's technical comments point out that a future well driller would also encounter the existing contamination in soil, so these numbers may be low compared to the actual future risk considering all sources.



DOE used a complicated process to demonstrate compliance with Criteria #3, using guidance developed by the NRC. Oregon is interested to see the NRC Technical Evaluation Report findings associated with DOE's use of their guidance. For example, there have been discussions among stakeholder groups regarding whether it is possible to meet the definition of "incorporation" when pouring stabilizing grout over a waste heel. Also, DOE's approach involves a series of arguments about where, when, and how the Class C concentrations apply to the different wastes in C-farm, for which we are interested to hear NRC's perspective on whether this meets their intent when the Class C classification was originally developed.

Decision Scope:

Tanks vs. Soils

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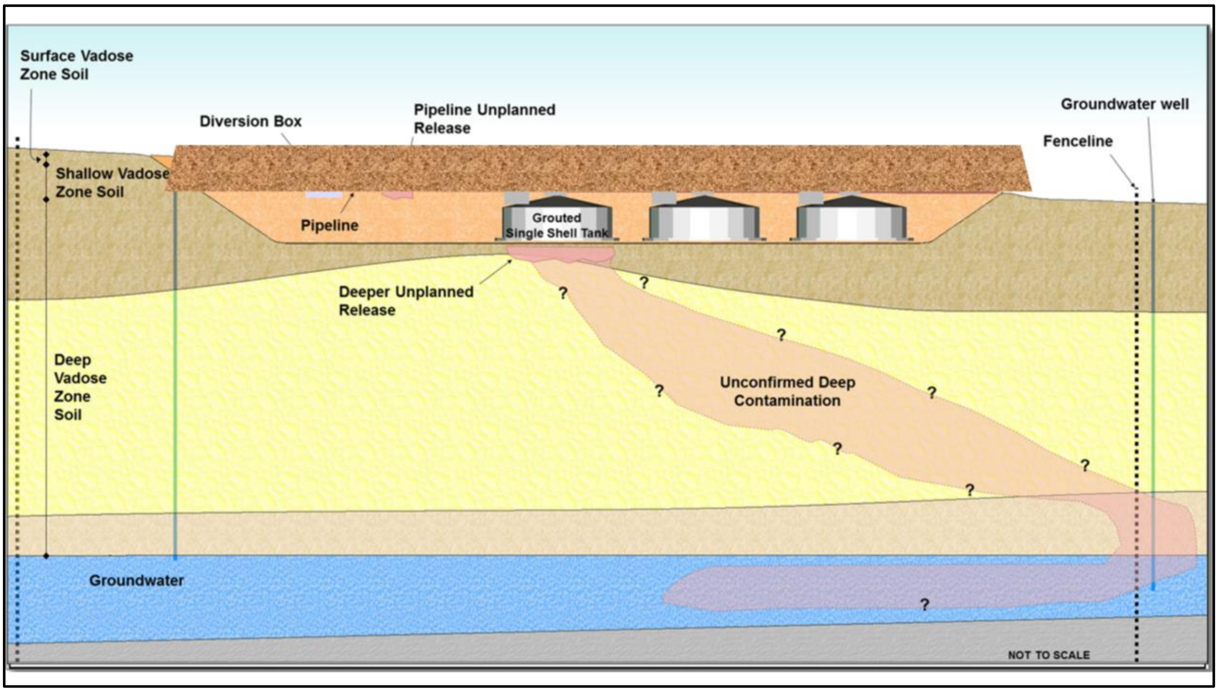
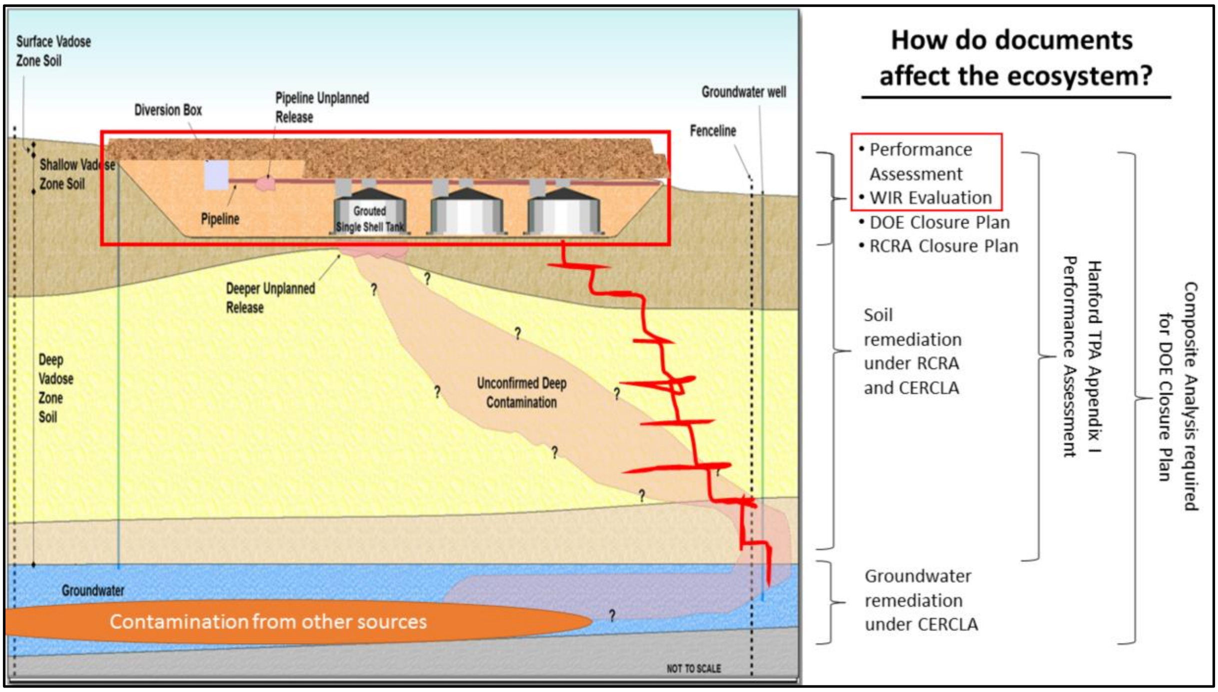
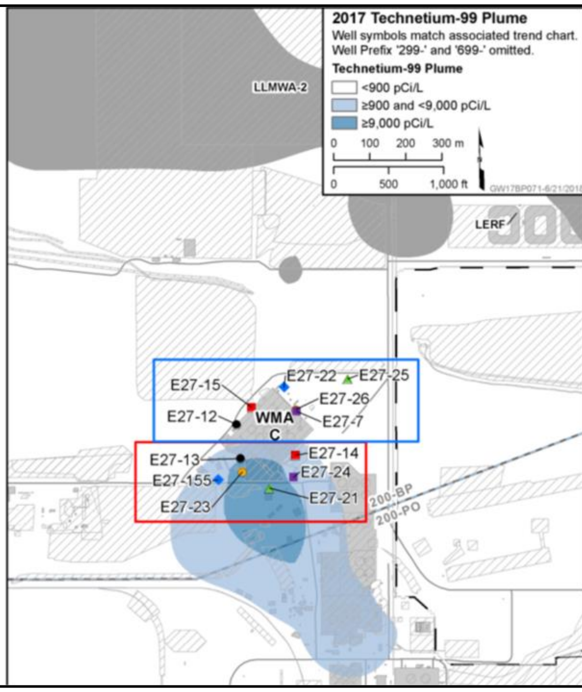


This is a conceptual cartoon of the proposed end state for WMA-C if DOE closes it in place following a WIR determination. Note that the remedy for contamination in soil has not yet been determined, so this is an imperfect representation of the actual future state.



The WIR decision is only a single piece of the regulatory puzzle of tank closure. There is a "nesting doll" of different analyses that when combined are intended to demonstrate that the cumulative risk of all cleanup decisions for WMA-C will not present an unacceptable risk to human health and the environment. The documents in red are the "first out of the gate" and are so far the only parts of the puzzle that are available for public review. These other processes have different standards of safety (cancer risk vs. dose), so it is important that this WIR decision must be compatible with standards that will apply later.

Oregon is particularly interested in the Composite Analysis. You will also notice that a WIR for the tank waste in soils is not part of this regulatory process.



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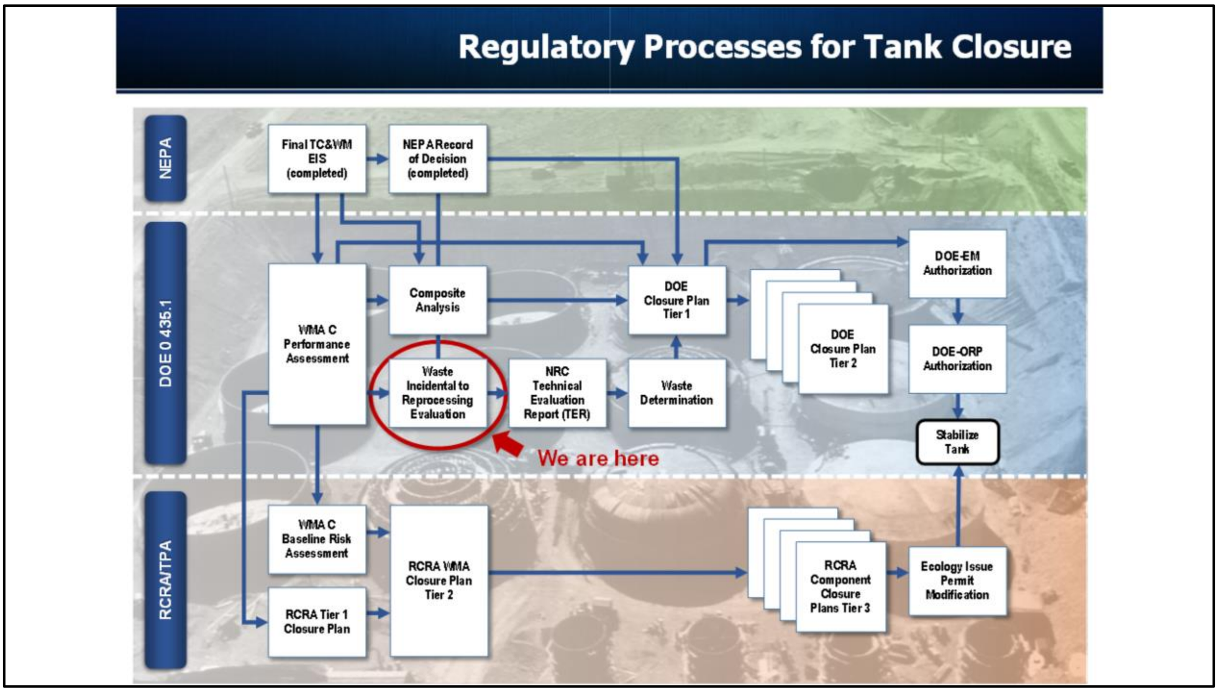
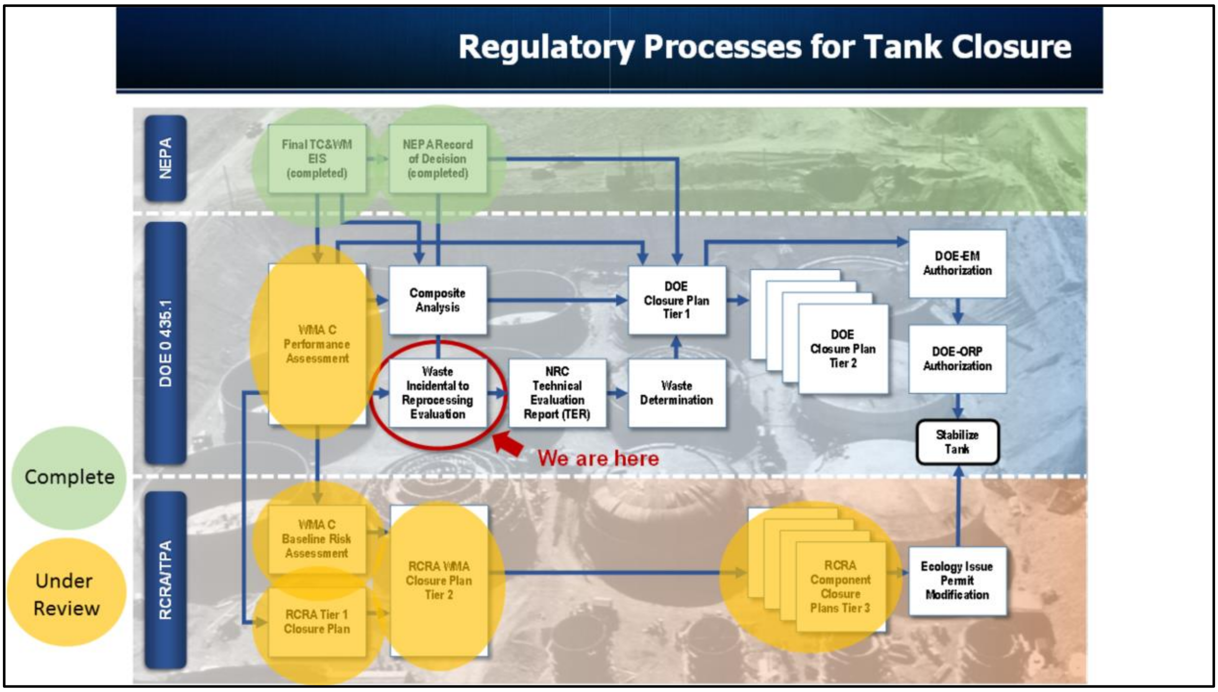
This figure comes from the latest groundwater monitoring report for WMA-C. It illustrates that contamination sources in the soil from past tank leaks are already migrating to groundwater in excess of groundwater standards. It is worth noting that the future groundwater risk predicted in the DOE models (30 pCi/L) are significantly less than the current groundwater source in soil. This further demonstrates that the WIR decision for the tank farm is only a part of a larger picture.



The red circle indicates where we are in the overall tank closure process.



The red circle indicates where we are in the overall tank closure process. The NRC technical review is ongoing, and the Composite Analysis is estimated to be available in 2020. DOE has also submitted RCRA closure plans to Ecology for review, which is still ongoing.

Oregon's Recommendations for the WIR

1. Additional uncertainty analysis is needed for compound effects.
2. Include the full "decision package" in this WIR, including Composite Analysis and Performance Assessment Maintenance Plan.
3. Include Oregon and the public in developing the PA Maintenance Plan. (How will we know later if today's decision is wrong?)

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Oregon's Recommendations for the WIR

4. Oregon expects to see a WIR evaluation for past tank leaks to soil.
5. DOE should look for more powerful waste retrieval technologies before grouting the tanks.
6. Do not proceed with tank closure actions at least until the Waste Treatment Plant is operational.

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