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Draft Waste Incidental to Reprocessing Evaluation for Vitrified Low-Activity Waste Disposed of Onsite at the Hanford Site, Washington

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Purpose

Inform Participants of Contents of the Draft Waste Incidental to Reprocessing (WIR) Evaluation for Vitrified Low-Activity Waste (VLAW)

- Background
- WIR criteria in DOE M 435.1-1, *Radioactive Waste Management Manual*
- Conclusions

Hanford Site Map

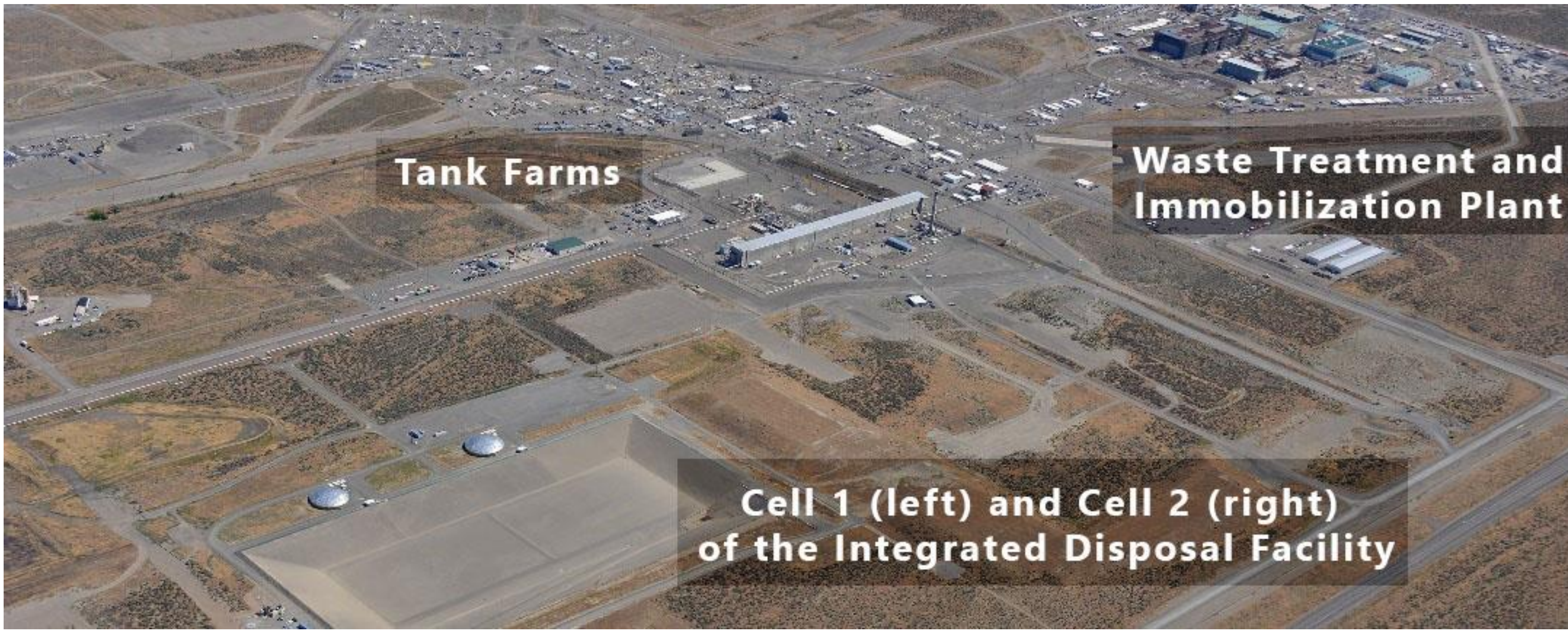
Draft WIR Evaluation for VLAW

- The Draft WIR Evaluation addresses approximately 23.5 million gallons of separated, pretreated and vitrified low-activity waste from underground tanks at the Hanford Site. The Draft WIR Evaluation assesses whether the VLAW is low-level radioactive waste that may be disposed of at the Integrated Disposal Facility (IDF) at the Hanford Site.
- The Draft WIR Evaluation does not address other wastes, equipment, facilities, systems, or treatment of supplemental low-activity waste (LAW).

Draft WIR Evaluation for VLAW (cont.)

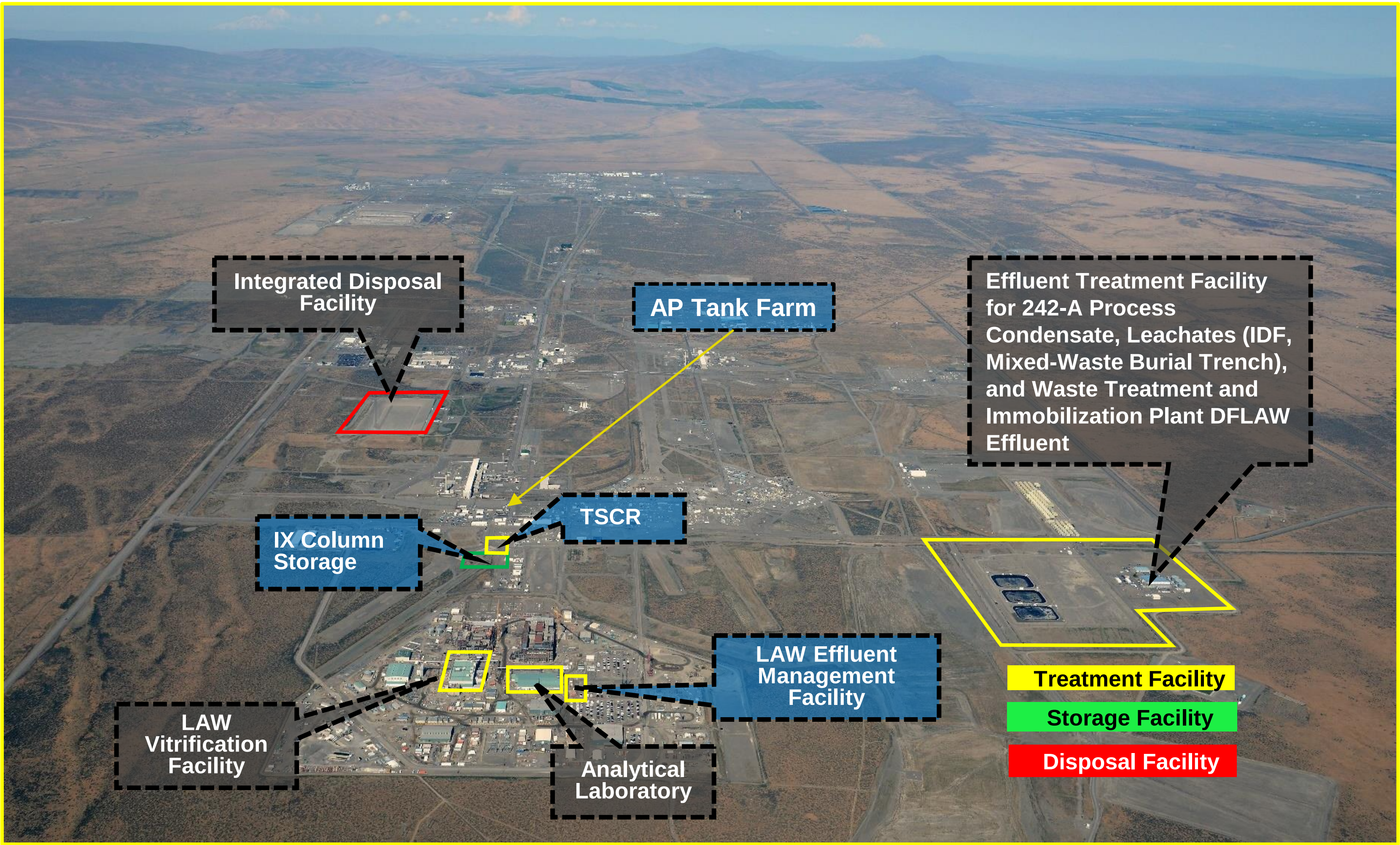
- The waste addressed by the Draft WIR Evaluation will be pretreated using the Direct-Feed Low-Activity Waste (DFLAW) approach.
- The DFLAW approach is two phases, Tank-Side Cesium Removal (TSCR) (Phase 1) and either additional TSCR unit or filtration/cesium removal capability (Phase 2).
- Supernate/dissolved saltcake will be pretreated by settling, decanting, and filtering followed by removal of cesium by ion exchange
- Pretreated low-activity waste (LAW) will be vitrified (mixed with glass formers at high temperature) to form Vitrified Low-Activity Waste (VLAW) at the LAW Vitrification Facility beginning by late 2023.
- VLAW is planned to be disposed at the IDF in approximately 13,500 containers

DFLAW Approach Related Sites



DFLAW is the acronym for the Direct Feed Low Activity Waste approach.

DFLAW Approach Treatment and Storage



DFLAW Approach Treatments

The DFLAW approach will entail the following pretreatment for certain tank waste

- In-tank settling and decanting to separate supernate and dissolved saltcake from the solids in which insoluble, long-lived radionuclides (actinides) tend to be entrained
- Filtering to remove most remaining insoluble radionuclides. Following filtration, no visibly-detectable solids are expected to be present. The majority of the radionuclides present in the resulting liquid will be those that are partially or completely soluble, including cesium-137, technetium-99, iodine-129, and possibly strontium-90.
- Passing through crystalline silicotitanate (CST) ion exchange media to remove cesium-137 and large fractions of uranium, strontium-90, neptunium, and plutonium if present in soluble form
- Over 99% of the cesium-137 will be removed

DOE M 435.1-1 Three WIR Criteria

The criteria in Chapter II.B.(2)(a) of DOE M 435.1-1 are, in relevant part, that the wastes:

"1. Have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical; and

2. Will be managed to meet safety requirements comparable to the performance objectives set out in 10 CFR 61, Subpart C, *Performance Objectives*; and

3. Are to be managed, pursuant to DOE's authority under the *Atomic Energy Act of 1954*, as amended, and in accordance with the provisions of Chapter IV of this Manual, provided the waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste as set out in 10 CFR 61.55, *Waste Classification*…"

WIR Criterion #1

DOE M 435.1-1 Chapter II, Section B(2)(a) provides in pertinent part that the wastes:

"1. Have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical; and"

Key Radionuclides

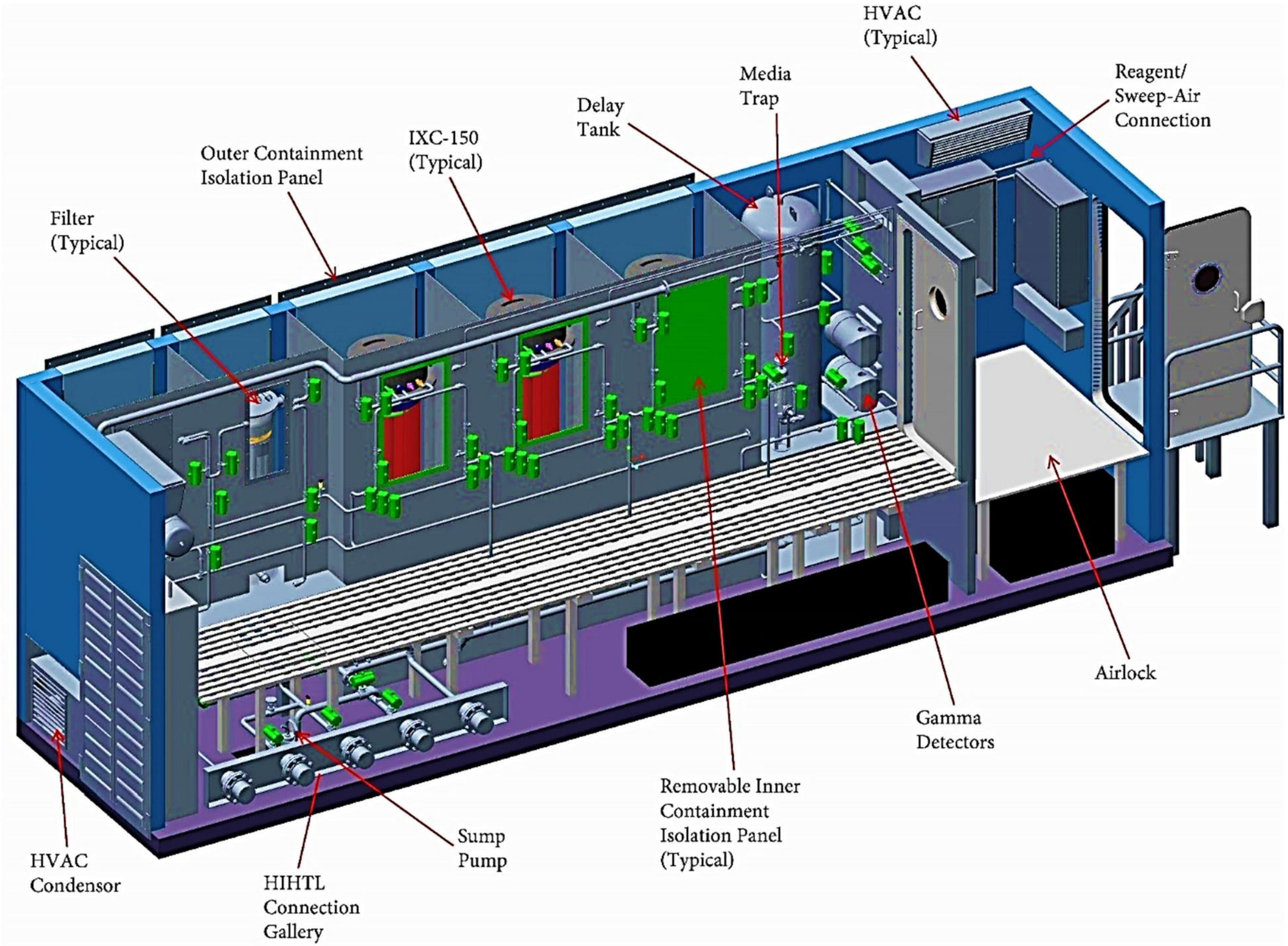
- Per DOE G 435.1-1, "... it is generally understood that [the term] key radionuclides applies to those radionuclides that are controlled by concentration limits in 10 CFR 61.55, *Waste Classification*."
- This Draft WIR Evaluation also considers radionuclides important to meeting requirements comparable to the performance objectives in 10 CFR 61, *Licensing Requirements for Land Disposal of Radioactive Waste*, Subpart C, *Performance Objectives*, specifically those radionuclides of importance identified in the IDF performance assessment (PA).

Key Radionuclides

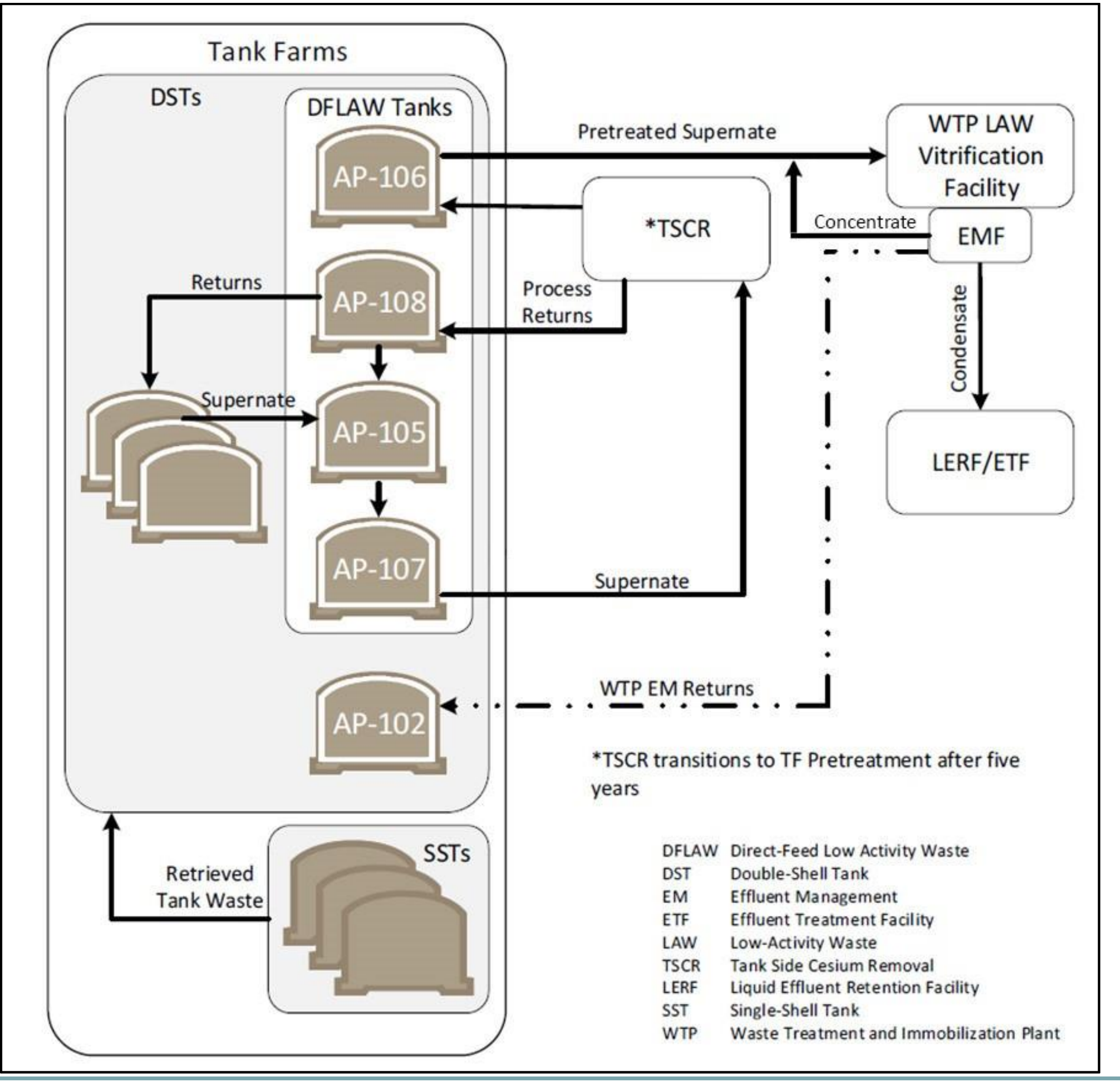
Radionuclide	10 CFR 61.55 Long-Lived Radionuclides	10 CFR 61.55 Short-Lived Radionuclides	Radionuclides in VLAW Important in the IDF PA
^{3}H		X	
^{14}C	X		
^{60}Co		X	
^{59}Ni	X		
^{63}Ni		X	
^{64}Nb	X		
^{90}Sr		X	X
^{99}Tc	X		X
^{129}I	X		X
^{137}Cs		X	X
^{228}Rn			X
^{229}Th			X

Radionuclide	10 CFR 61.55 Long-Lived Radionuclides	10 CFR 61.55 Short-Lived Radionuclides	Radionuclides in VLAW Important in the IDF PA
^{232}Th			X
^{234}U			X
^{238}U			X
^{237}Np	X		X
^{238}Pu	X		
^{239}Pu	X		
^{240}Pu	X		
^{241}Pu	X		
^{242}Pu	X		
^{241}Am	X		
^{243}Am	X		
^{242}Cm	X		
^{243}Cm	X		
^{244}Cm	X		

Cesium Removal by TSCR System



Tank Waste Treatment Flow Path



WIR Criterion #2

DOE M 435.1-1 Chapter II, Section B(2)(a) provides in pertinent part that the wastes:

“2. Will be managed to meet safety requirements comparable to the performance objectives set out in 10 CFR Part 61, Subpart C, Performance Objectives; and”

10 CFR 61, Subpart C

Subpart C, *Performance Objectives* (for low-level radioactive waste land disposal facilities)

61.40 General requirement
61.41 Protection of the general population from releases of radioactivity
61.42 Protection of individuals from inadvertent intrusion
61.43 Protection of individuals during operations
61.44 Stability of the disposal site after closure

Performance Assessment

To comply with:

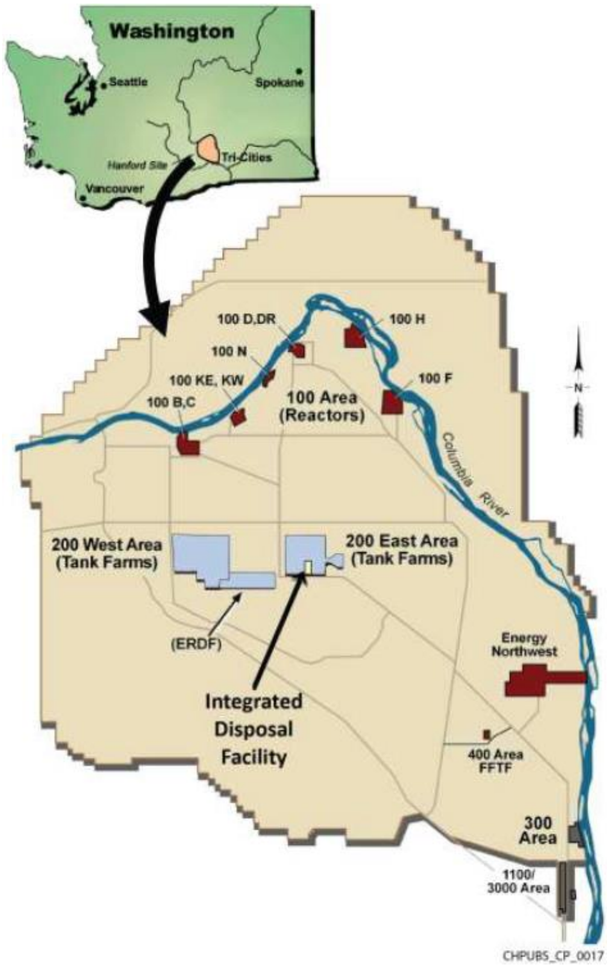
- DOE Manual 435.1-1, post-closure performance objectives and performance measures
  - All Pathways Exposure (< 25 mrem/yr)
  - Air Pathway Exposure (< 10 mrem/yr)
  - Radon Flux (< 20 pCi/m^2/s)
  - Inadvertent Intrusion (Acute: < 500 mrem; Chronic: < 100 mrem/yr)
  - Groundwater Protection

- State of Washington Resource Conservation and Recovery Act Permit (IDF Chapter)

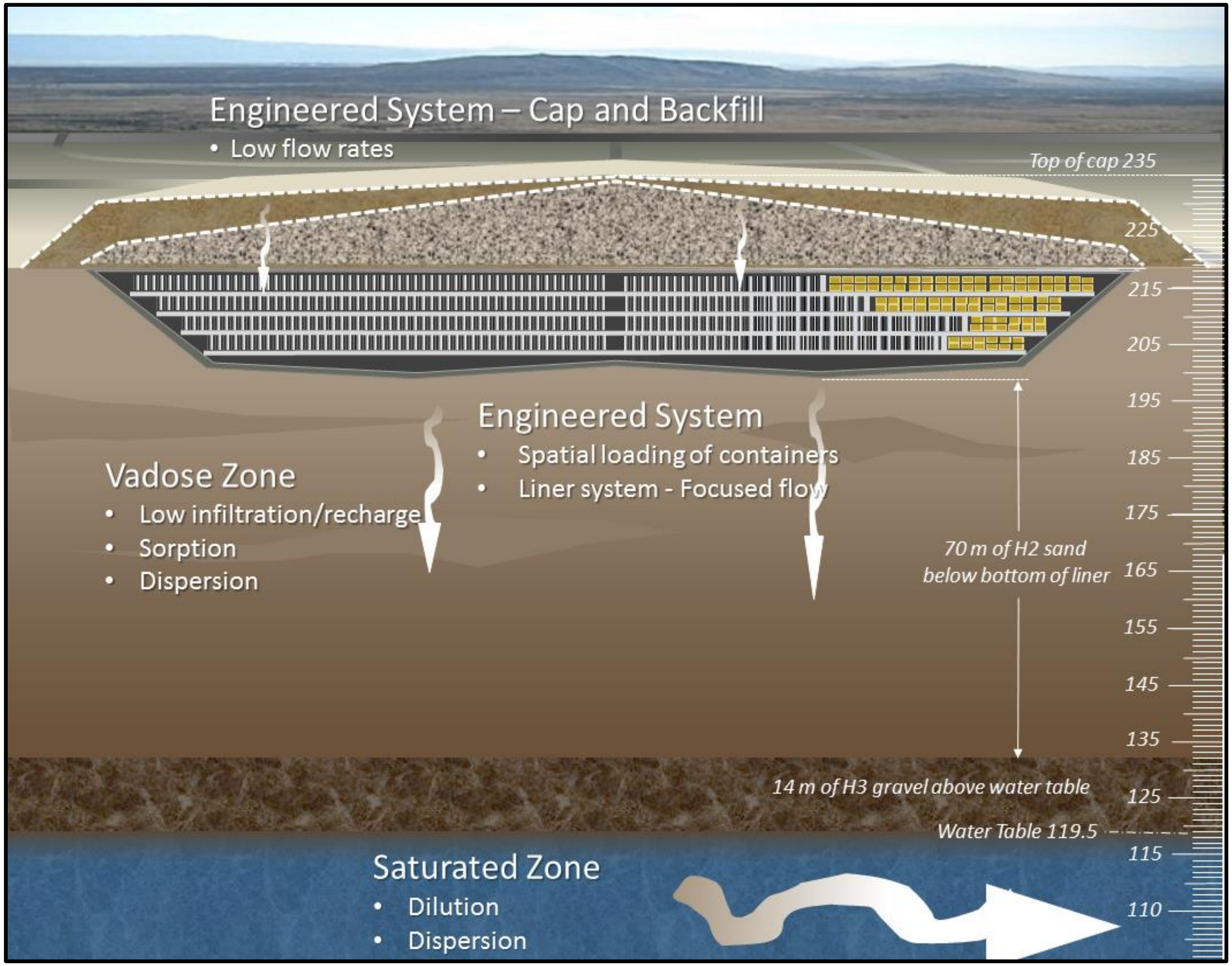
  A performance assessment that provides a reasonable basis for assurance that each glass formulation will, once disposed of in IDF in combination with the other waste volumes and waste forms planned for disposal at the entire IDF, be adequately protective of human health and the environment; and will not violate or be projected to violate all applicable state and federal laws, regulations and environmental standards. (Resource Conservation and Recovery Act (RCRA) permit condition III.11.I.2.a.ii)

  Note: While a Washington RCRA Permit is required for IDF permitting, it is outside the scope of this Draft WIR Evaluation.

Integrated Disposal Facility

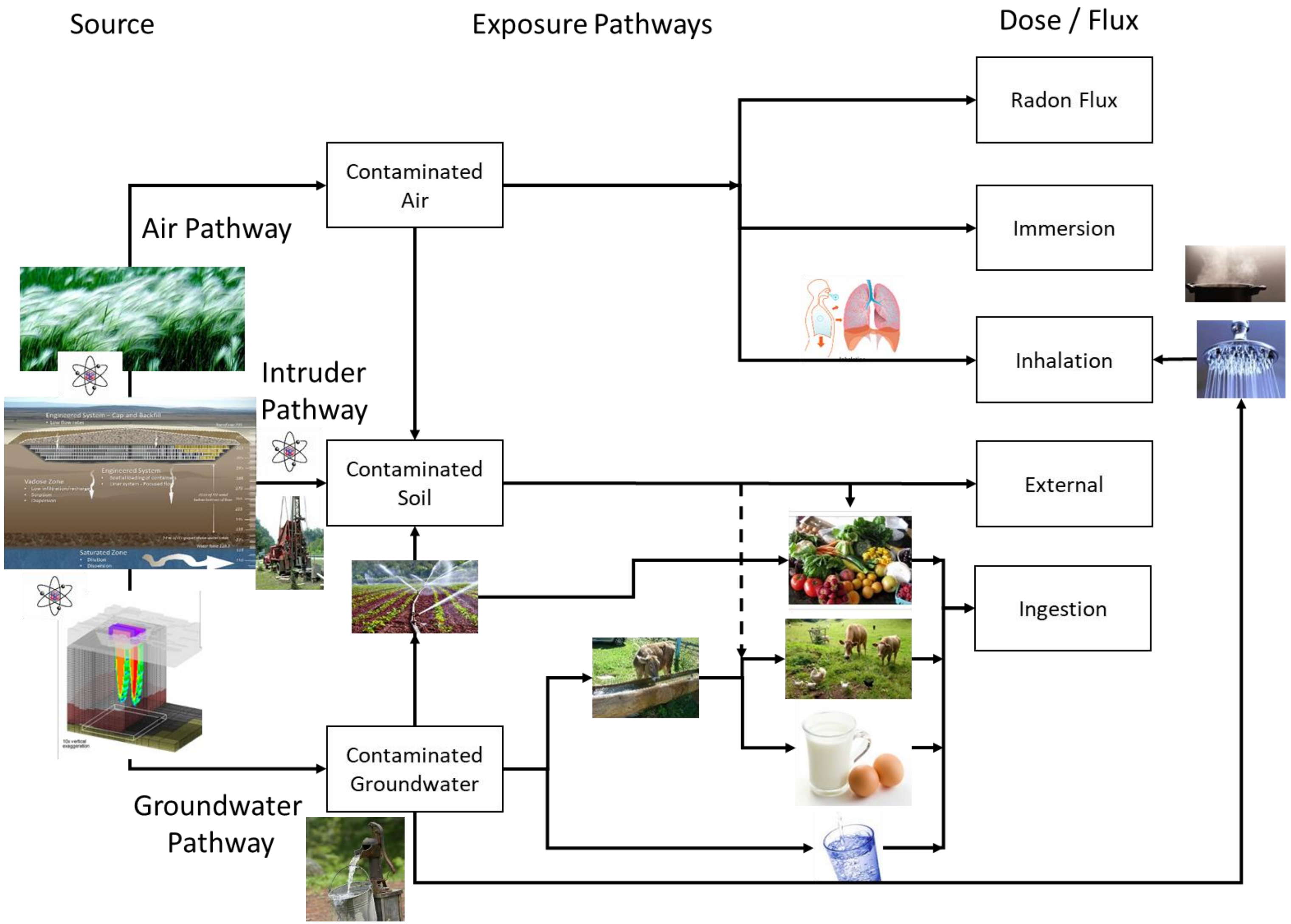


Features Important to IDF Performance



RPP-RPT-59958 Rev.1A Figure 1-9

IDF Performance Analysis



IDF Performance Assessment Results

Performance Objective and/or Measure	Standard	Post-Closure Compliance Period (0 – 1000 years)	Post-Compliance Period (1,000 – 10,000 years)
All Pathways Dose	25 mrem/yr[1]	0.19 mrem/yr	1.5 mrem/yr
Atmospheric Dose	10 mrem/yr[1,2]	0.19 mrem/yr	0.01 mrem/yr
Atmospheric Flux	20 pCi m^{-2} s^{-1} radon flux (at surface of disposal facility)[1,3]	0.016 pCi m^{-2} s^{-1}	0.016 pCi m^{-2} s^{-1}
Acute Inadvertent Intruder Dose	500 mrem[1]	9.28 mrem	NA
Chronic Inadvertent Intruder Dose	100 mrem/yr[1]	43.3 mrem/yr	NA
[1] DOE M 435.1-1 Chg 1; [2] 40 CFR 61, Subpart H; [3] 40 CFR 61, Subpart Q			

RPP-RPT-59958 Rev.1A Table 1-1

These results include other waste streams in addition to VLAW produced during the DFLAW approach.

Atmospheric Pathway and All Pathways Dose

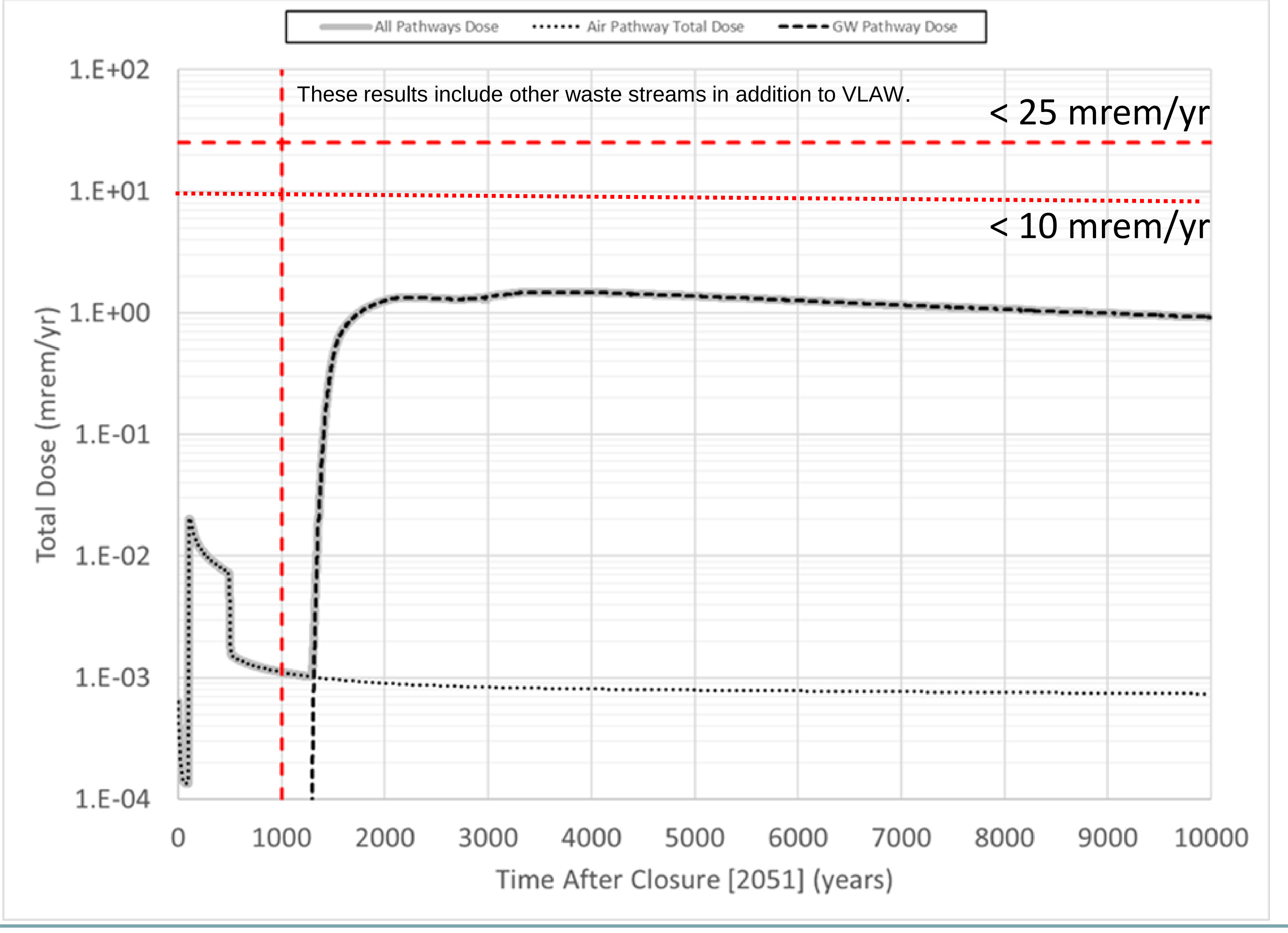


Figure 5-3 in Draft VLAW WIR Evaluation

Groundwater Pathway Radionuclide Dose

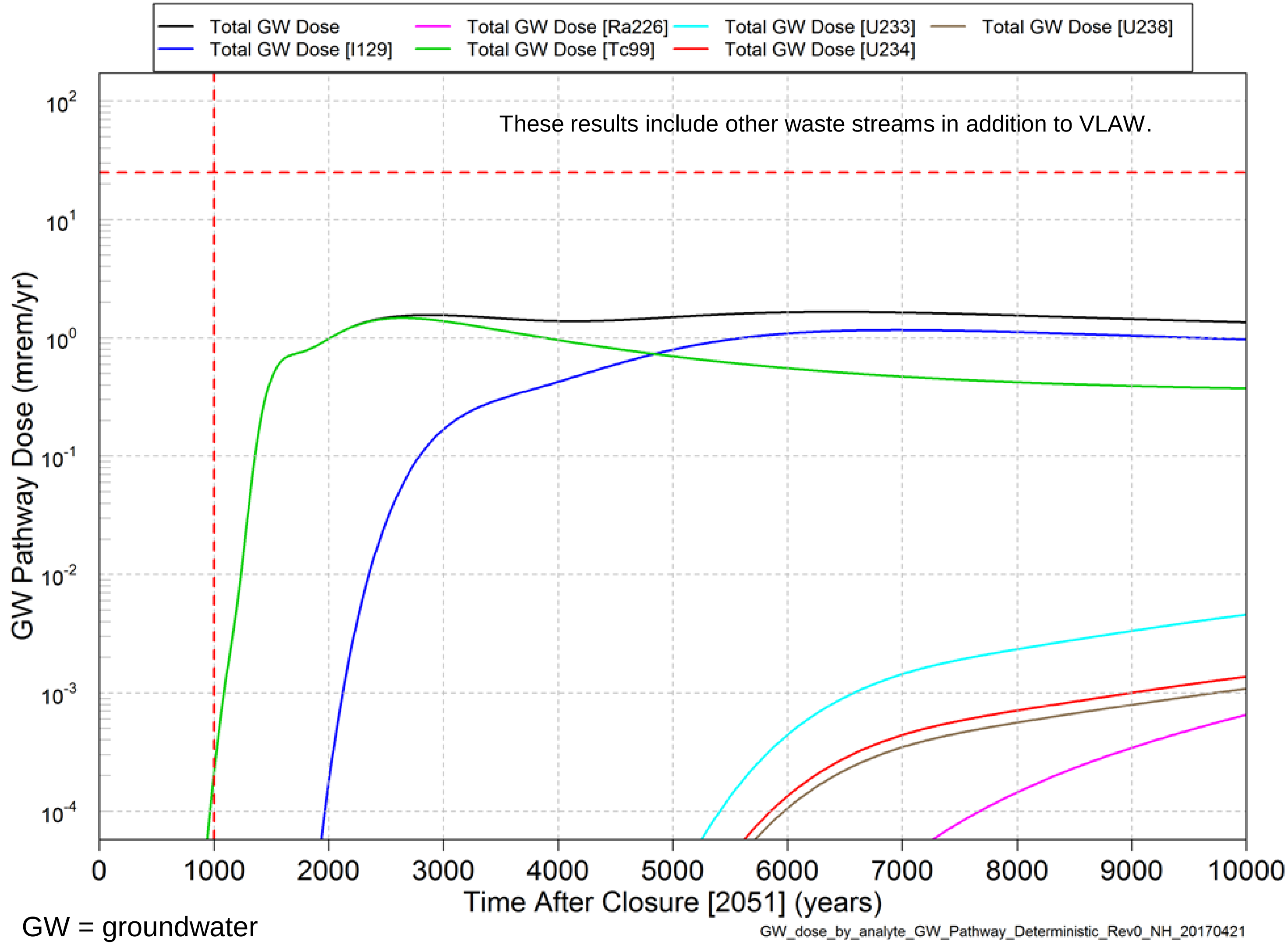


Figure 5-4 in Draft VLAW WIR Evaluation

GW = groundwater

Groundwater Dose

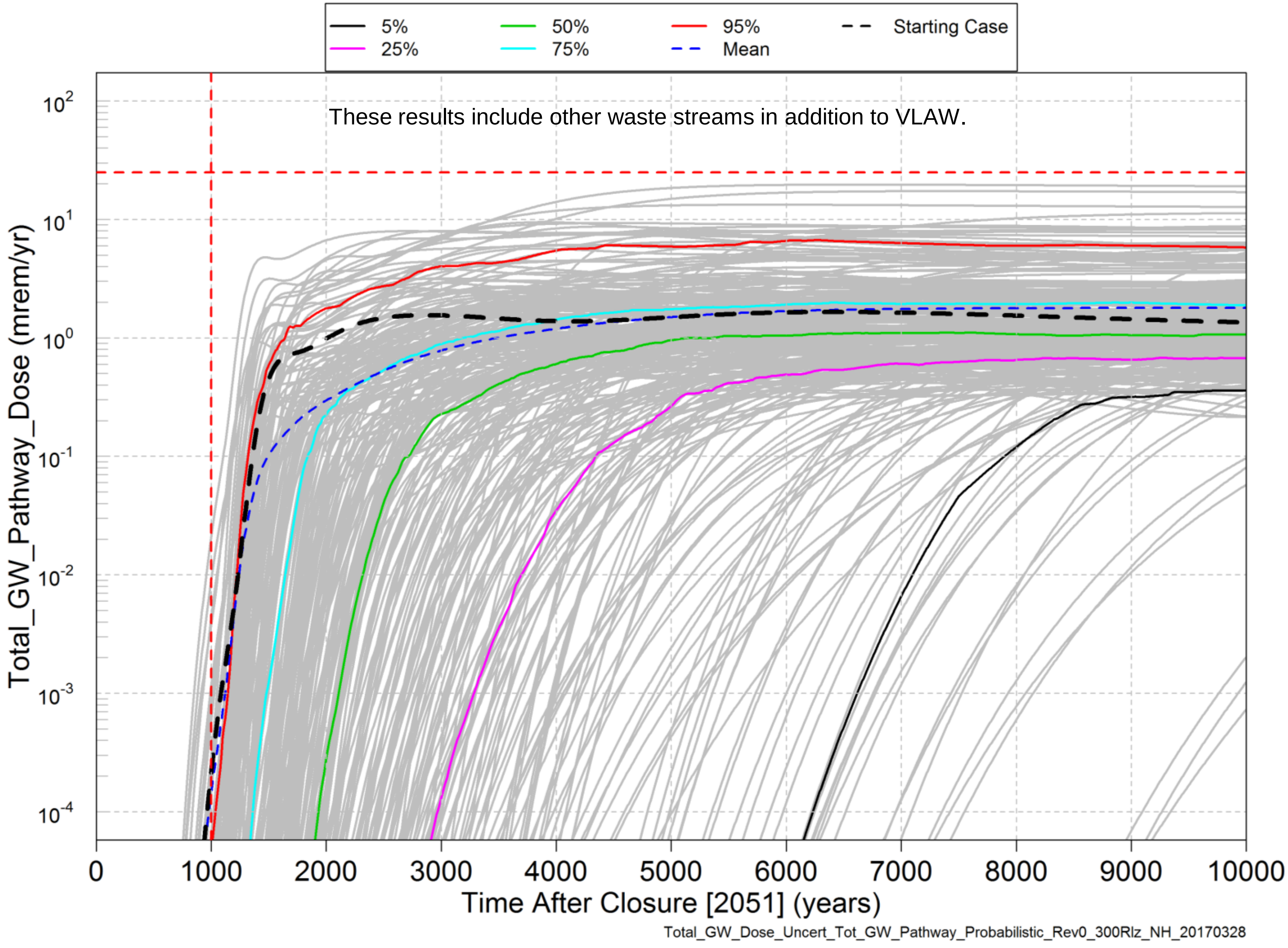


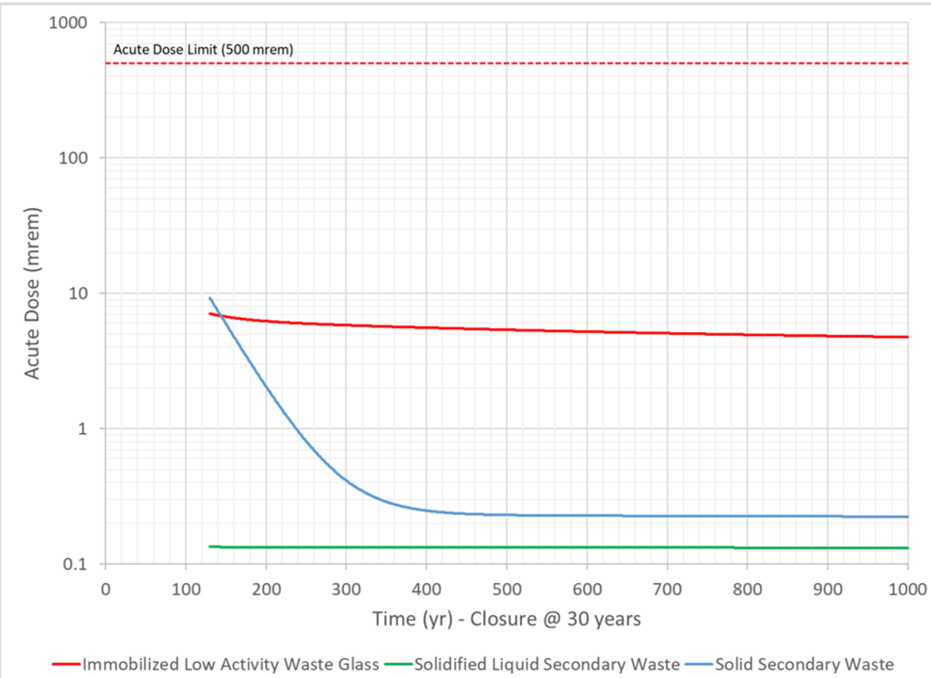
Figure 5-6 in Draft VLAW WIR Evaluation

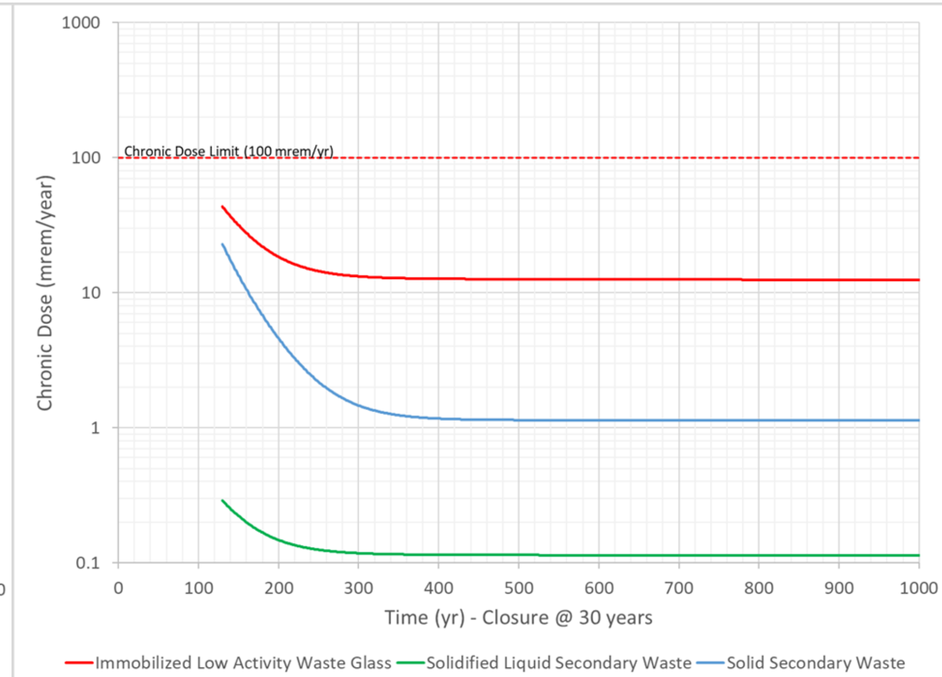
Inadvertent Intruder Dose

< 500 mrem

< 100 mrem/yr

These results include other waste streams in addition to VLAW.





Acute (well driller)

Chronic (rural pasture)

NOTE: The plotted dose is received over a 40-hour period.

Figures 5-8 and 5-9 in Draft VLAW WIR Evaluation

Concluding Remarks for the IDF PA and Criterion #2

- DOE has evaluated the potential long-term consequences of disposing of waste, including vitrified waste covered by the Draft VLAW WIR Evaluation
- Model results demonstrate that both engineered and natural features of the disposal system reduce the long-term risk to human health and the environment
- There is a reasonable expectation that the dose to a member of the public in the future from waste disposed of in the IDF will be below DOE's performance objectives and measures, which are themselves below doses that people knowingly or unknowingly expose themselves to every day

WIR Criterion #3

DOE M 435.1-1 Chapter II, Section B(2)(a) provides in pertinent part that the wastes:

"3. Will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste as set out in 10 Code of Federal Regulations 61.55… "

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Class C Concentration Limits

10 CFR 61.55 Class C Table 1, "Concentration Limits"

Radionuclides (long-lived)	Class C Concentration (Ci/m^3)
^{14}C	8
^{14}C in activated metal	80
^{59}Ni in activated metal	220
^{94}Nb in activated metal	0.2
^{99}Tc	3
^{129}I	0.08
Alpha-emitting transuranic nuclides with half-life greater than 5 years	[1]100
^{241}Pu	[1]3,500
^{242}Cm	[1]20,000

[1] Units are in nanocuries per gram.

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Class C Concentration Limits (cont.)

10 CFR 61.55 Class C Table 2, "Concentration Limits"

Radionuclides (Short-lived)	Class C Concentration (Ci/m^3)
Total of all nuclides with less than 5 year half-life	([1])
^{3}H	([1])
^{60}Co	([1])
^{63}Ni	700
^{63}Ni in activated metal	7000
^{90}Sr	7000
^{137}Cs	4600

[1] There are no limits established for these radionuclides in Class C wastes.

VLAW Radionuclide Concentrations Well Below Class C Limits

Direct-Feed Low-Activity Waste Vitrified Low-Activity Waste Glass Maximum Sum of Fractions for 10 CFR 61.55 Table 1, "Radionuclides"

Radionuclide	Class C Limit (Ci/m^3)	Class C Limit (nCi/g)	VLAW Glass Concentration (Ci/m^3)	VLAW Glass Concentration (nCi/g)	Table 1 Fraction
^{14}C	8.00E+00	N/A	0.00E+00	N/A	0.00E+00
^{99}Tc	3.0E+00	N/A	2.62E-01	N/A	8.72E-02
^{129}I	8.00E-02	N/A	3.59E-04	N/A	4.49E-03
^{237}Np	N/A	1.00E+02	N/A	2.65E-02	2.65E-04
^{238}Pu	N/A	1.00E+02	N/A	2.19E-01	2.19E-03
^{239}Pu	N/A	1.00E+02	N/A	4.52E+00	4.52E-02
^{240}Pu	N/A	1.00E+02	N/A	1.04E+00	1.04E-02
^{241}Pu	N/A	3.50E+03	N/A	3.75E+00	1.07E-03
^{242}Pu	N/A	1.00E+02	N/A	4.75E-04	4.75E-06
^{241}Am	N/A	1.00E+02	N/A	5.61E+00	5.61E-02
^{243}Am	N/A	1.00E+02	N/A	3.30E-03	3.30E-05
^{242}Cm	N/A	2.00E+04	N/A	6.66E-02	3.33E-06
^{243}Cm	N/A	1.00E+02	N/A	3.14E-03	3.14E-05
^{244}Cm	N/A	1.00E+02	N/A	5.61E-02	5.61E-04
				Sum of Fractions	**0.208**

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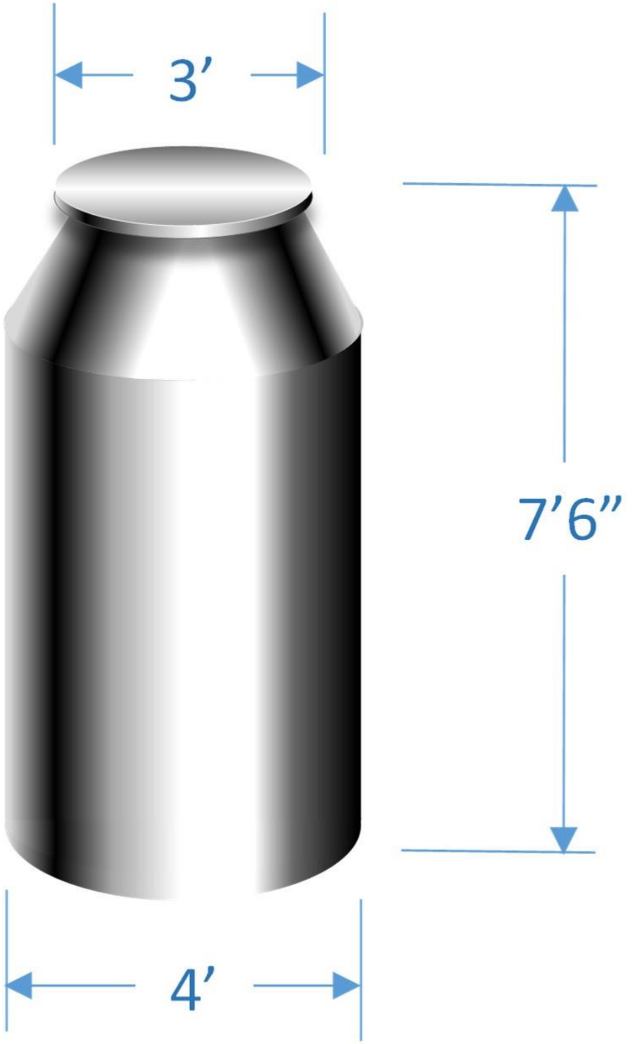
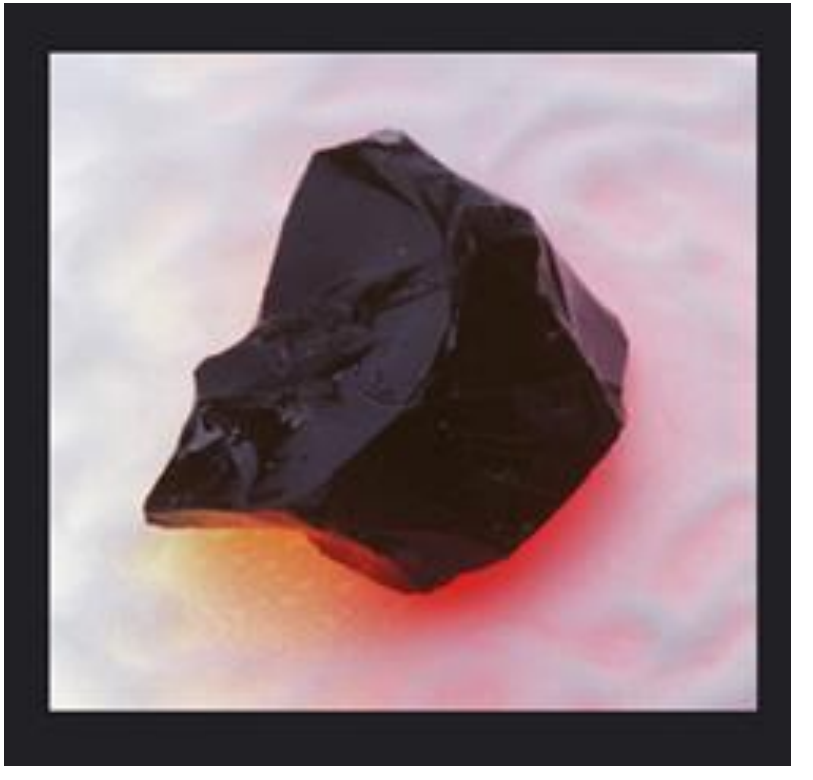
VLAW Radionuclide Concentrations Well Below Class C Limits (cont.)

Direct-Feed Low-Activity Waste Vitrified Low-Activity Waste Glass Maximum Sum of Fractions for 10 CFR 61.55 Table 2, “Radionuclides”

Radionuclide	Class C Limit (Ci/m^3)	VLAW Glass Concentration (Ci/m^3)	Table 2 Fraction
^{3}H	_	0.00E+00	No limits
^{60}Co	_	8.03E-04	No limits
^{59}Ni	7.00E+02	6.61E-02	1.30E-04
^{90}Sr	7.00E+03	6.96E+00	3.52E-03
^{137}Cs	4.60E+03	4.79E-02	1.11E-05
		Sum of Fractions	**0.00367**

VLAW Container and Glass





Simulated vitrified low-activity waste

Draft WIR Evaluation for VLAW Conclusions

Criterion 1 is met by:

- Settling, decanting and filtering of the supernate (including dissolved saltcake and interstitial liquid) removes solids containing nearly all the short-lived strontium-90 and the long-lived radionuclides (uranium, plutonium, americium, neptunium, and curium)
- Removing over 99% of the cesium-137 by ion exchange media in DFLAW approach

Criterion 2 is met by:

- Performance objective results as documented in the IDF performance assessment

Criterion 3 is met by:

- Vitrifying LAW into a solid form with maximum concentrations well below Class C limits


Questions?
The Hanford Reach
White Bluffs Overlooking the Columbia Rive