



Authorized Limits: Current Status

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What are Authorized Limits?

- Authorized limits is a level of residual radioactive material that shall not be exceeded if the remedial action is to be considered completed and the property is to be released without restrictions on use due to residual radioactive material.
- The basic public dose limits for exposure to residual radioactive material from all sources, in addition to natural occurring “background” exposures, are 100 mrem per year. (10 CFR 835)

Why are Authorized Limits being Discussed?

- Discuss the reason for changing the Authorized Limits and the approval of the new limits for C-746-U Landfill.
- Discuss development and implementation of new Authorized Limits.

Authorized Limits

- General Information:
 - Regulatory authority for Authorized Limits is promulgated in DOE O 5400.5 IV.4 (and DOE Order 458.1).
 - Authorized Limits apply to radioactive material on or within material, equipment, and property which is approved for release by PPPO for disposal at C-746-U Landfill.
 - Since the Authorized Limits were <1 mrem per year, limits approved by a PPPO Manager in consultation with the Chief Health, Safety and Security Officer.
 - New Authorized Limits became effective on November, 1, 2011.

Guidance and Reference Documents

- Guidance Documents for developing Authorized Limits:
 - DOE Order 5400.5, *Radiation Protection of the Public and the Environment* (currently in LATA's contract)
 - DOE Order 458.1, *Radiation Protection of the Public and the Environment* (Replaces O 5400.5)
 - DOE Standard 5506-99, *Guide to Good Practice for Establishing Authorized Limits for the Release of Waste Containing Residual Radioactivity*

Landfill Characteristics

- Total landfill permitted area \approx 59 acres
- 22 of the 59 acres are currently designated to be developed for waste disposal
- Potential disposal capacity \approx 1,200,000 M³
- Construction of the facility and emplacement of wastes is proceeding from the southern end toward the northern end of the landfill

Waste Streams Allowed

- Soil and debris generated from construction, maintenance, environmental restoration, and decontamination and D&D activities
- Scrap metal and other surface contaminated materials

Same as previous AL basis.

Guidance Used To Evaluate Waste Streams

- Release decision-making process is guided by:
 - Multi-Agency Radiation Surveys and Site Investigation Manual (MARSSIM)
 - Multi-Agency Survey and Assessment of Materials and Equipment Manual (MARSAME)

Note: Jointly prepared and endorsed by DOE, EPA, & NRC. These documents provide guidance on how to demonstrate that activities at a site are in compliance with applicable release criteria.

Previous Authorized Limits

- Landfill Authorized Limits were approved by DOE ORO on February 6, 2003
 - Applied to disposal of soil and debris wastes generated from construction, maintenance, environmental restoration, and D&D activities in PGDP C-746-U landfill
 - Authorized Limits projected disposal volume estimates for 7 years' operation
 - Disposal Volume Estimates:
 - 11,795 M³ first year
 - 5000 M³ annually for years 2-7

Allowed Total Activity* in the Landfill under Previous AL

Isotope	Activity (Ci)
Total U	8.777
Tc-99	29.256
Thorium	0.877
Np-237	0.175
Pu-238	0.175
Pu-239/240	0.175
Am-241	0.175
Cs-138	0.175

- Limits did not include entire landfill.
- New limits will be discuss later and are on slide 21.

Outside Review of Authorized Limits

- The DOE-HQ evaluated the current Authorized Limits and tracking system in October, 2008.
- Conclusion of Authorized Limits evaluation
 - PPPO checks the activity by radionuclide being disposed and compares it against annual caps and the overall AL limits.
 - PPPO receives and analyzes weekly and monthly waste stream disposal reports from LATA.
 - On-going authorized limits disposal waste streams are well tracked.

Why New ALs for C-746-U

- Existing Authorized Limits need to be closed and new Authorized Limits need to be developed, approved, and implemented.
 - Current Authorized Limits based on projected PGDP work activities in 2002.
 - ARRA has expedited D&D Work at PGDP.
 - the baseline has been accelerated throughout the site.
 - Landfill area needs to be expanded due to the expedited work.

Dose Assessment – Basis for New AL

- DOE evaluated public and occupational dose by 2 computer models: RESRAD & RESRAD-OFFSITE.

Note : RESRAD and RESRAD-OFFSITE are recognized and used nationally (by EPA and NRC and other government agencies) and internationally.

New Authorized Limit Evaluation

- ORISE has been awarded the contract to perform new Authorized Limits evaluation.
- ORISE is a nationally recognized expert in radiation protection.
- ORISE will use the latest versions of RESRAD and RESRAD OFFSITE to model exposure pathways.
- ORISE will be developing Authorized Limits for PGDP wildlife areas and the C-746-U landfill.

Major Exposure Pathway per RESRAD

- Drinking water ingestion is the limiting exposure pathway per RESRAD (subsistence farmer)
 - This condition is estimated to occur ~9 years post-closure (based on no leachate treatment).
 - This scenario is considered implausible due to deed restrictions.

Projected Waste Volumes

Table 1. Projected Waste For Next 10 Years⁽¹⁾

Year	Volume of Non-Hazardous Waste (ft³)	Volume of Residual Radioactive Waste below Current AL (ft³)	Additional Volume of Residual Radioactive Waste (ft³)
FY 2011	85,980	174,568	102,374
FY 2012	107,668	218,599	57,795
FY 2013	227,052	460,986	135,028
FY 2014	1,016,752	2,064,315	1,062,128
FY 2015	426,712	866,356	832,017
FY 2016	554,028	1,124,846	835,641
FY 2017	302,828	614,833	731,359
FY 2018	3,869	7,854	13,245
FY 2019	4,314	8,759	13,245
FY 2020	3,869	7,854	13,245
Total	2,733,072	5,548,970	3,796,077

Results of Dose Assessment

- Occupational dose projected by RESRAD
 - Total annual maximum projected TED was 4.04 mrem/year
 - Workers are monitored
 - Workers are legally allowed 5000 mrem/yr
 - No detectable exposure to workers has been observed from PGDP activities

- Dose **projected** by RESRAD-OFFSITE
 - Occupational (Maximum) – 0.02 mrem/year
 - Resident (Maximum) – 0.06 mrem/year
 - Subsistence Farmer (Maximum and ultra conservative) – 88.7 mrem/year

Agencies Reviewing AL

- Agencies that reviewed the new Authorized Limits:
 - US Environmental Protection Agency (EPA)
 - Commonwealth of Kentucky (KYEPA)
 - DOE Office of Health, Safety, and Security (HSS)
 - DOE Office of Environmental Monitoring (EM)

Maximum Projected Dose

- Worst case projected dose, ultra-conservative, is to a farmer residing on top of the landfill, growing crops and raising livestock for consumption.
- In this case, the maximum projected annual dose is 88.7 mrem if all controls fail. This is less than the annual public dose limit of 100 mrem/year accepted by the EPA.

Previous and New Limits

Radionuclide	Current AL Concentration (pCi/g)	ORISE Proposed Single Radionuclide Soil Guideline (pCi/g)*	PPPO Volumetric Concentration Limits (pCi/g)
²⁴¹ Am	3	3500	35
¹³⁷ Cs	3	190	19
²³⁷ Np	3	550	5.5
²³⁸ Pu	3	3900	39
²³⁹ Pu	3	3600	36
²⁴⁰ Pu	3	3600	36
⁹⁹ Tc	500	100	52
²²⁸ Th	15	73	8
²³⁰ Th		1600	200
²³² Th		40	8
²³⁴ U	150	18000	160
²³⁵ U		820	6.5
²³⁸ U		3200	160

*ORISE uses Sum of the fractions

Benefits of New Authorized Limits

- Cleanup costs and occupational radiation exposure will be less.
- Less material will be shipped to Nevada for burial saving disposal cost and transportation cost.
- Will not significantly increase exposure to general public around landfill.
- Will increase remediation and cleanup of site.

Review and Approval

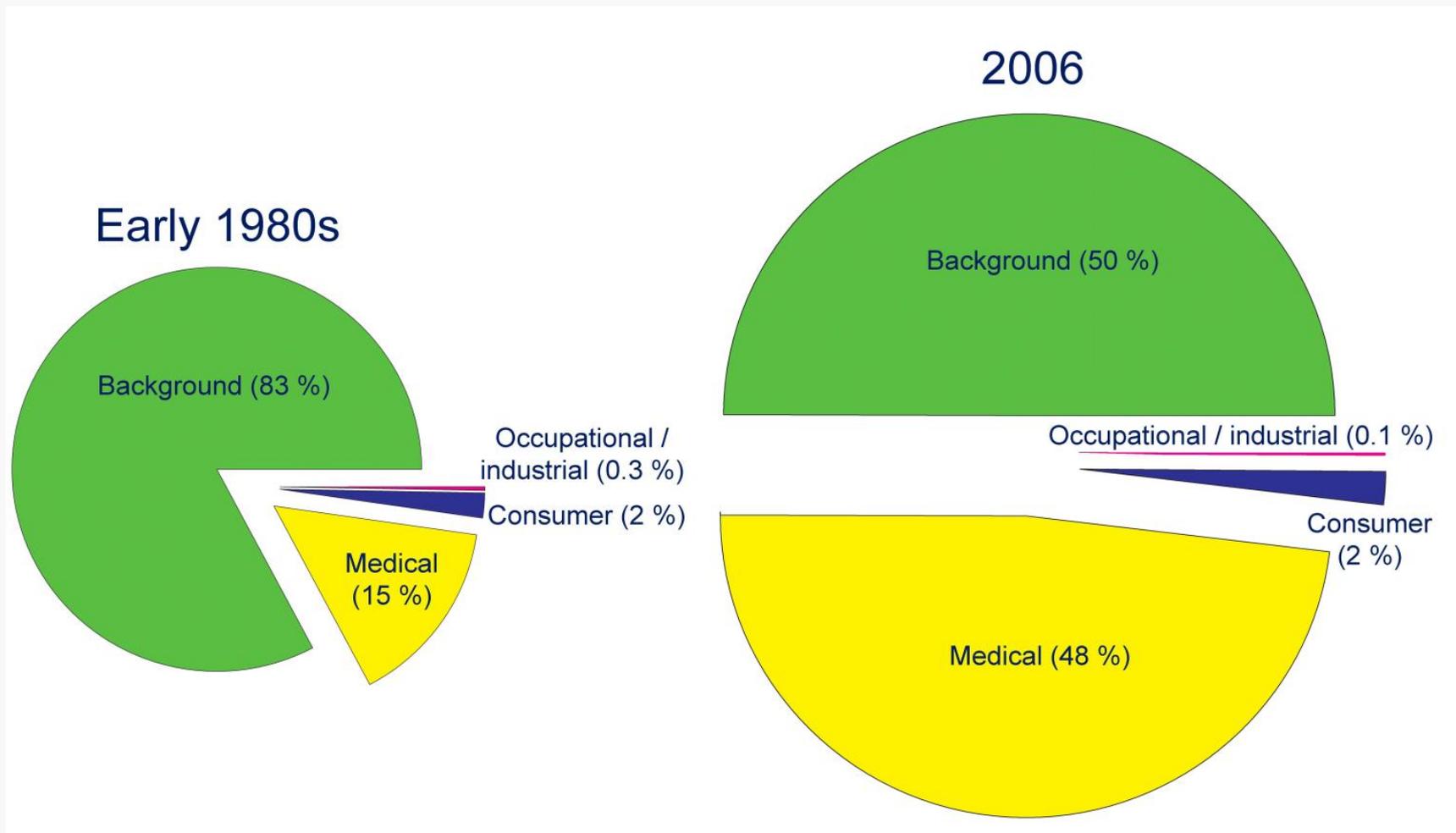
- As with the current Authorized Limits, the USEPA and the Commonwealth of Kentucky will have the opportunity to review the new Authorized Limits.
- Since exposure limit will be set at < 1 mrem per year, the new Authorized Limits will be approved by the PPPO Manager in consultation with the Chief Health, Safety and Security Officer .

Reference Slides

Natural Background Radiation

Radiation Category	Annual Radiation Dose (NCRP 160)
Background	311 mrem
Medical	300 mrem
Consumer Products	1.3 mrem
Industrial Products, Security, Educational and research	0.3 mrem
Occupational	0.5 mrem
Total Annual dose from natural background radiation (rounded)	620 mrem

NCRP 160 Dose Distribution



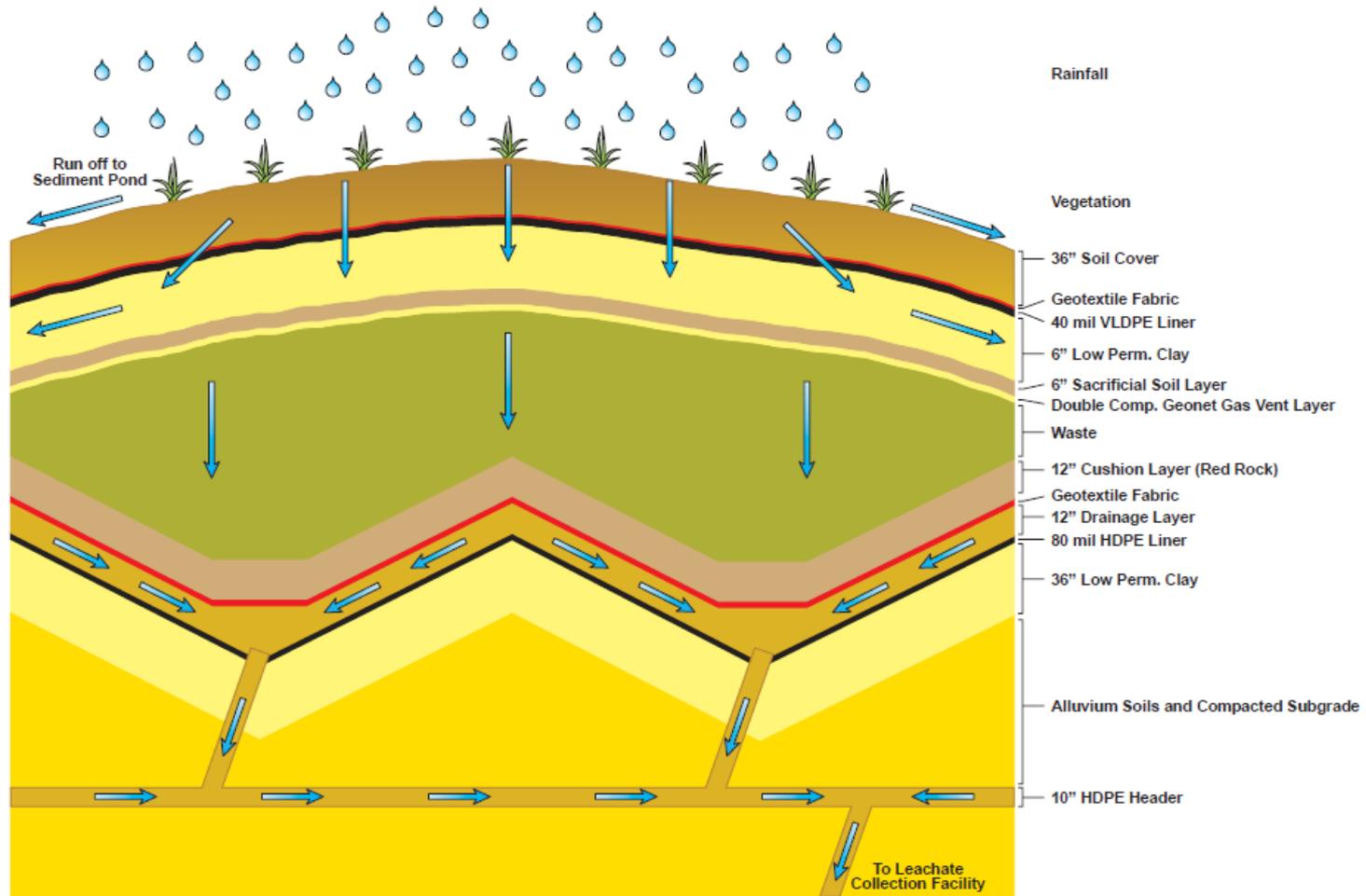
Plausible Scenario Dose Summary

Scenario	Time Period	Peak Dose (mrem/yr)	Time of Peak Dose (year)	Dose Limit
DOE Landfill Worker	Operational Period	32	70	100
DOE Landfill Worker	Institutional Control Period	0.0026	70	100
DOE Excavation Worker	Institutional Control Period	10	70	100
Outdoor Worker	Post-Institutional Control Period	.0026	1050	1
Recreational User	Post-Institutional Control Period	.0012	1050	1
Off-Site Residential Farmer	All Periods	.98	1050	1

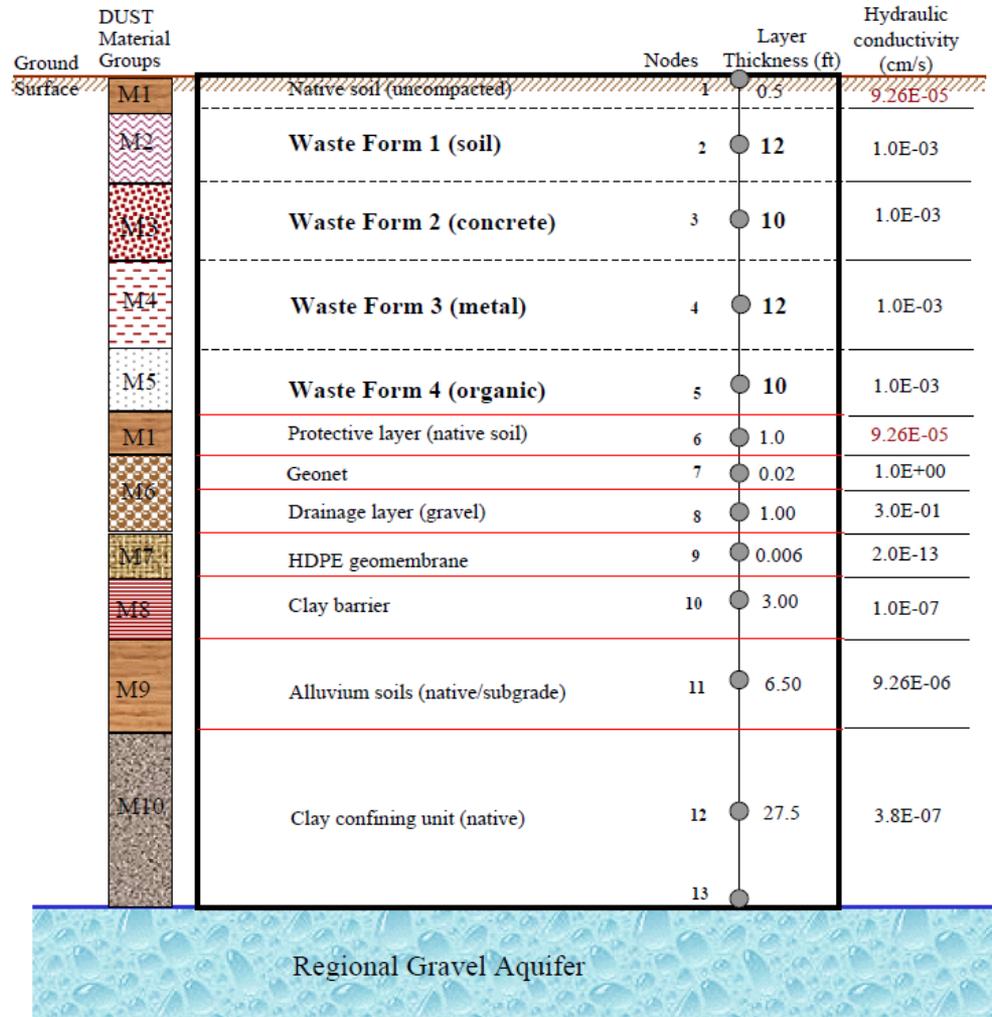
Implausible Scenario Dose Summary

Scenario	Time Period	Peak Dose (mrem/yr)	Time of Peak Dose (year)	Dose Limit
DOE Landfill Worker	Operational Period	64 ⁽¹⁾	70	100
Trespasser	Operational Period	2.1	70	100
Trespasser	Operational Period	4.2 ⁽¹⁾	70	100
DOE Excavation Worker	Institutional Control Period	21 ⁽¹⁾	70	100
Trespasser	Institutional Control Period	10	70	100
Trespasser	Institutional Control Period	21 ⁽¹⁾	70	100
Excavation Worker	Post-Institutional Control Period	10	70	100
Excavation Worker	Post-Institutional Control Period	21 ⁽¹⁾	70	100
On-Site Residential Gardener	Post-Institutional Control Period	6.8	1050	100
On-Site Residential Farmer	Post-Institutional Control Period	21	425	100

C-746-U Landfill Cross-Section

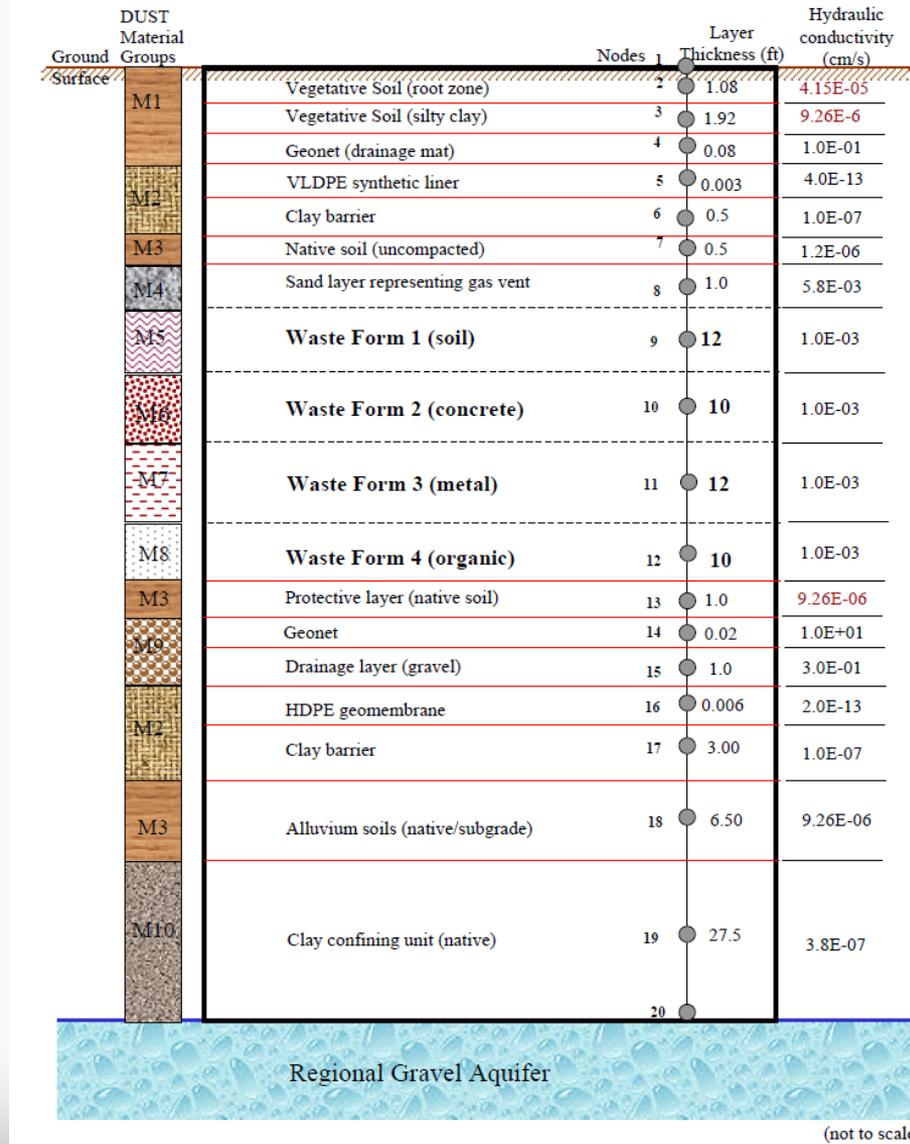


Operational Model of C-746-U Landfill



(not to scale)

Closure Model of C-746-U Landfill



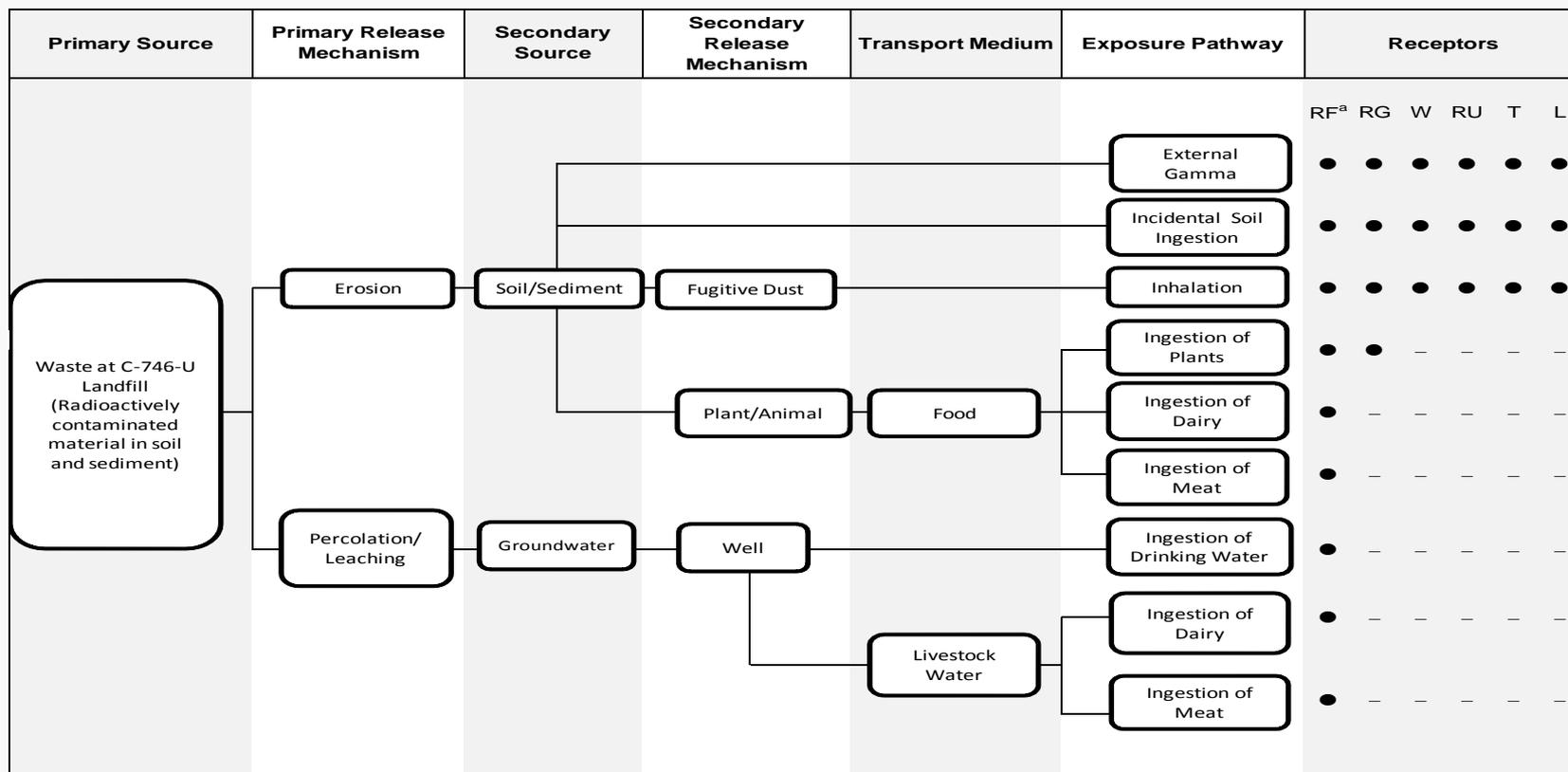
Status under old ALs

Isotope	% of AL
Am-241	3.59%
Cs-137	5.53%
Np-237	6.81%
Pu-238	0.75%
Pu-239/240	7.67%
Tc-99	3.46%
Total Thorium	37.25%
Total Uranium	6.41%

Comparison of Chosen Levels

Isotope	PPPO Authorized Limits (pCi/g)	ANSI/HPS 13.12N Cleanup Guidelines (pCi/g)	DOE Site Cleanup Levels (pCi/g)
Am-241	35	3	
Cs-137	19	30	31-120
Np-237	5.5	3	20
Pu-238	39	3	30-1100
Pu-239	36	3	34
Pu-240	36	3	34
Tc-99	52	3000	15
Th-228	8	3	15-50
Th-230	200	3	15
Th-232	8	3	15
U-234	160	30	30-5400
U-235	6.5	30	13-1100
U-238	160	30	35-5400

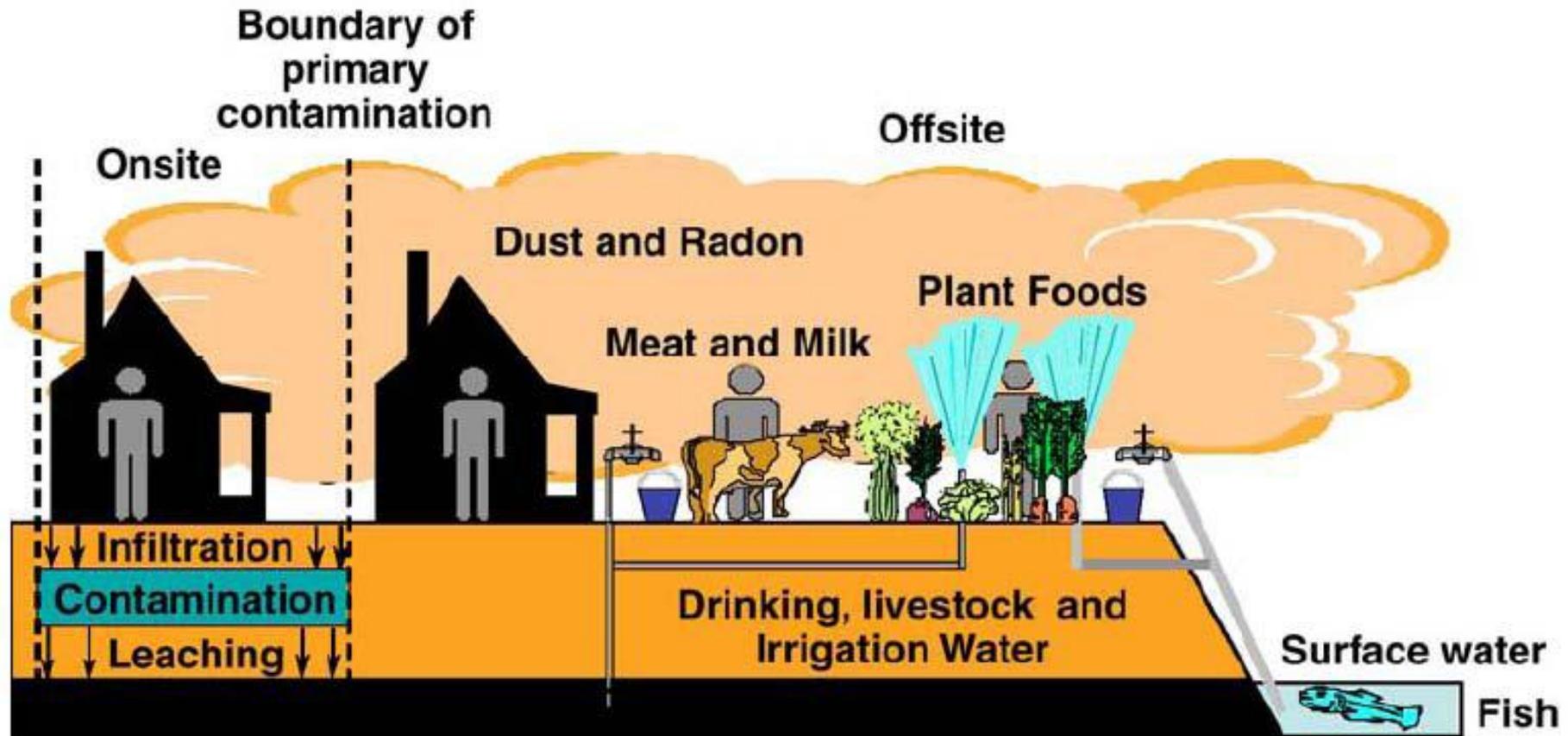
Conceptual Site Model for the PGDP C-746-U Landfill



^a For the offsite scenario, only the Resident Farmer is considered.

- RF= Resident Farmer
- RG= Resident Gardener
- L= Landfill Worker
- T= Trespasser
- W= Outdoor Worker
- RU= Teen Recreational User
- Complete Exposure Pathway
- Incomplete Pathway

Graphical Representation of Conceptual Site Model for the PGDP C-746-U Landfill



Disposal Cost without Using ALs

Year	Volume of Waste that is disposed offsite due to being above DOE O 5400.5 limits (ft ³)	Cost of disposal to Clive, UT using low side gondola (\$22.73/ ft ³)	Cost of disposal to Clive, UT using trucks (\$30.79 / ft ³)
FY2011	276,942	\$6,294,891.66	\$8,527,044.18
FY2012	276,394	\$6,282,435.62	\$8,510,171.26
FY2013	596,014	\$13,547,398.22	\$18,351,271.06
FY2014	3,126,443	\$71,064,049.39	\$96,263,179.97
FY2015	1,698,373	\$38,604,018.29	\$52,292,904.67
FY2016	1,960,487	\$44,561,869.51	\$60,363,394.73
FY2017	1,346,192	\$30,598,944.16	\$41,449,251.68
FY2018	21,099	\$479,580.27	\$649,638.21
FY2019	22,004	\$500,150.92	\$677,503.16
FY2020	21,099	\$479,580.27	\$649,638.21
Total	9,345,047	\$212,412,918.31	\$287,733,997.13

Disposal Costs Using Current ALs

Year	Volume of Waste that cannot be disposed in C-746-U that is above current ALs	Cost of disposal to Clive, UT using low side gondola (\$22.73/ ft ³)	Cost of disposal to Clive, UT using trucks (\$30.79 / ft ³)
FY2011	102,374	\$2,326,961.02	\$3,152,095.46
FY2012	57,795	\$1,313,680.35	\$1,779,508.05
FY2013	135,028	\$3,069,186.44	\$4,157,512.12
FY2014	1,062,128	\$24,142,169.44	\$32,702,921.12
FY2015	832,017	\$18,911,746.41	\$25,617,803.43
FY2016	835,641	\$18,994,119.93	\$25,729,386.39
FY2017	731,359	\$16,623,790.07	\$22,518,543.61
FY2018	13,245	\$301,058.85	\$407,813.55
FY2019	13,245	\$301,058.85	\$407,813.55
FY2020	13,245	\$301,058.85	\$407,813.55
Total	3,796,077	\$86,284,830.21	\$116,881,210.83

Disposal Costs Using New ALs

Year	Volume of Waste that cannot be disposed in C-746-U above proposed ALs (ft ³)	Cost of disposal to Clive, UT using low side gondola (\$22.73/ ft ³)	Cost of disposal to Clive, UT using trucks (\$30.79 / ft ³)
FY2011	20,475	\$465,392.20	\$630,419.09
FY2012	11,559	\$262,736.07	\$355,901.61
FY2013	27,006	\$613,837.29	\$831,502.42
FY2014	212,426	\$4,828,433.89	\$6,540,584.22
FY2015	83,202	\$1,891,174.64	\$2,561,780.34
FY2016	167,128	\$3,798,823.99	\$5,145,877.28
FY2017	146,272	\$3,324,758.01	\$4,503,708.72
FY2018	2,649	\$60,211.77	\$81,562.71
FY2019	2,649	\$60,211.77	\$81,562.71
FY2020	2,649	\$60,211.77	\$81,562.71
Total	676,014	\$15,365,791.40	\$20,814,461.82

ALARA Analysis

Factor	Disposal Cost of Alternative		
	Alternative 1	Alternative 2	Alternative 3
Quantitative			
Shipping cost (average per year)	\$25.00	\$10.20	\$2.04
Dose - worker (a)	\$0.03	\$0.01	\$0.01
Dose - general public (a)	\$.001	\$.001	\$0.00
Totals	\$25.04	\$10.22	\$2.05
Qualitative (b)			
Worker Safety and Transportation	-	+	+
Regulatory	~	~	~
Ecological	~	~	~
Public	-	-	-

(a) Dose evaluated at \$10,000 per person-rem, rounded to one significant figure.

(b) Qualitative results are designated as positive (+), negative (-), or neutral (~).

Alternative 1 - In this Alternative, all waste above the 5400.5 limits is sent offsite.

Alternative 2 - In this Alternative, waste with residual radioactive above the old ALs is sent offsite to a LLW repository.

Alternative 3 - In this Alternative, waste with residual radioactive above the new ALs is sent offsite to a LLW repository.

Annual Dose For ALARA Review

Exposure Source	Isotope of Concern	Alternative		
		1	2	3
		Ship waste offsite	Use current ALs	Use Proposed ALs
Waste packaging	All isotopes	<100 mrem per radiation worker	<100 mrem per radiation worker	<100 mrem per radiation worker
Transportation	Gamma emitting isotopes	No measurable dose above background	No measurable dose above background	No measurable dose above background
Disposal into LLW repository	Gamma emitting isotopes	3.0 person-rem/yr	1.2 person-rem/yr	0.60 person-rem/yr
Disposal into C-746-U Landfill	Gamma emitting isotopes	NA	0.16 person-rem/yr (see Table 6)	0.46 person-rem/yr (See Table 5)
Dose to MEI near LLW repository	⁹⁹ Tc	1.5 mrem/yr ⁽⁰⁾	0.61 mrem/yr ⁽⁰⁾	0.12 mrem/yr ⁽²⁾
Dose to MEI near C-746-U Landfill	⁹⁹ Tc	NA	9.3 mrem/yr	0.98 mrem/yr
Cumulative dose to general public near LLW repository	⁹⁹ Tc	0.51 person-rem/yr ⁽⁰⁾	0.21 person-rem/yr ⁽²⁾	0.041 person-rem/yr ⁽²⁾
Cumulative dose to general public near C-746-U Landfill	⁹⁹ Tc	NA	0.90 person-rem/yr (see Table 8)	0.49 person-rem/yr (see Table 7)

Last Annual Report for Old ALs



9th Year Authorized Limits Summary

From worksheets

Inventory Control 5/22/11 to 10/31/12

Total Disposed 5/21/03 to 5/21/12

Isotope	Activity (Ci)	Isotope	Activity (Ci)	Inventory		Activity (Ci)	Inventory	
				Allowed	% Inventory Used		Allowed	% Inventory Used
Am-241	2.13079E-05	Am-241	2.13079E-05	0.021	0.10%	0.00585	0.155	3.77%
Cs-137	1.06248E-05	Cs-137	1.06248E-05	0.021	0.05%	0.00984	0.155	6.35%
Np-237	1.05405E-05	Np-237	1.05405E-05	0.021	0.05%	0.01110	0.155	7.16%
Pu-238	1.33294E-06	Pu-238	1.33294E-06	0.021	0.01%	0.00159	0.155	1.03%
Pu-239/240	6.8469E-06	Pu-239/240	6.8469E-06	0.021	0.03%	0.01344	0.155	8.67%
Tc-99	0.000778912	Tc-99	0.000778912	3.5	0.02%	1.00152	25.8	3.88%
Th-228	3.03753E-05	Total Thorium	0.000156831	0.105	0.15%	0.33622	0.825	40.75%
Th-230	9.49653E-05	Total Uranium	0.000718682	1.05	0.07%	0.57975	7.75	7.48%
Th-232	3.14901E-05							
Total Uranium	0.000718682							

Note: Total inventory allowed not increased beyond 7th year

Yearly Waste Streams 7

Total Waste Streams 226

Yearly Waste Streams Open 0

Total Waste Streams Open 0

Total residually contaminated weight: 1.73E+08 grams

Total weight disposed: 5.25E+10 grams

3.81E+05 pounds

1.16E+08 pounds

1.90E+02 tons

5.79E+04 tons



Annual Report for 2011 with New ALs



2011 Authorized Limits Summary

Previous Activity		Inventory Control 11/1/11 to 12/31/11		Total Disposed 5/21/03 to 12/31/11				Unity Factor	
Isotope	Activity (Ci)	Isotope	Activity (Ci)	Isotope	Activity (Ci)	Source Term Limit	% Inventory Used		
Am-241	0.005864508	Am-241	0.000500384	Am-241	0.00636	79	0.01%	0.0003	
Cs-137	0.009859183	Cs-137	0.001817637	Cs-137	0.01168	43	0.03%	0.0011	
Np-237	0.011123995	Np-237	0.000579386	Np-237	0.01170	12	0.10%	0.0038	
Pu-238	0.001609444	Pu-238	0.000451099	Pu-238	0.00206	88	0.00%	0.0001	
Pu-239/240	0.013459954	Pu-239/240	0.000293057	Pu-239/240	0.01375	162	0.01%	0.0003	
Tc-99	1.006107732	Tc-99	0.145889134	Tc-99	1.15200	117	0.98%	0.0385	
Th-228	0.067247458	Th-228	0.00073783	Th-228	0.06799	9	0.76%	0.0296	
Th-230	0.201742374	Th-230	0.002214066	Th-230	0.20396	230	0.09%	0.0035	
Th-232	0.067247458	Th-232	0.000737838	Th-232	0.06799	9	0.76%	0.0296	
U-234	0.284185889	U-234	0.026185395	U-234	0.31037	360	0.09%	0.0034	
U-235	0.011599424	U-235	0.001068792	U-235	0.01267	15	0.08%	0.0033	
U-238	0.284185889	U-238	0.026185395	U-238	0.31037	360	0.09%	0.0034	
		Yearly Waste Streams	12	Total Waste Streams		238	Number of cells		5
		Yearly Waste Streams Open	12	Total Waste Streams Open		12	Volume of cells (yd ³)		386169
				Tons Disposed this year		0.00	Remaining		79480
				Tons Disposed to date		57,890.08	Headspace (yd3)		
				% Landfill used		26%			

Note: If the Unity Factor is over 1, the PPPO Manager and Paducah Site Lead must be notified.

Old inventory of residual radioactive materials has rolled into new AL inventory.



Off-Site Resident Tc-99 Dose per Pathway

