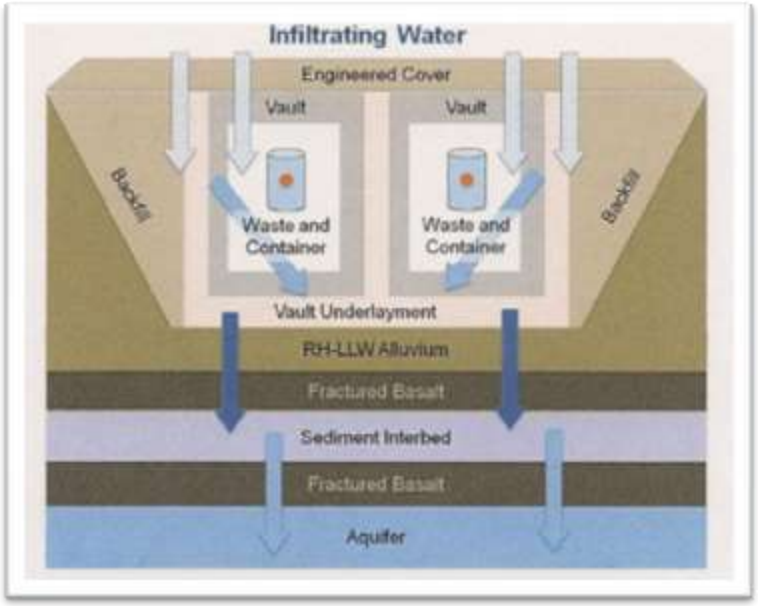
Unwarranted Confidence in DOE's Low-Level Waste Facility Performance Assessment

The INL Replacement Remote-Handled Low-Level Waste Facility Will Contaminate Our Aquifer for Thousands of Years.

Slated to be built soon, the design of Idaho National Laboratory (INL) Replacement Remote-Handled Low-Level Waste facility, [1] with concrete vaults and steel canisters, may appear robust in comparison to Radioactive Waste Management Complex (RWMC) where pictures of barrels buried in soil are familiar to many. But while it may delay contaminating the aquifer; ultimately, it will not protect Idaho or the Snake River Plain aquifer.

According to DOE's own analysis, long-lived radioisotopes will leach into the aquifer over time. Many of them will continue to leach into the aquifer for thousands of years, adding to the long-lived leaching of contaminants from other INL facilities including INTEC's historically leaking tank systems and injection wells, buried waste at RWMC, the superfund CERCLA site slated for closure in 2017,[2] and the ATR Complex's perched water from historical reactor waste water percolation ponds.



In the Department of Energy's NEPA Environmental Assessment, DOE refuses to call the waste "greater-than-class C" or anything other than "low level" waste, despite the waste being long-lived and more appropriately disposed of in a deep geologic repository. DOE's optimistic estimates are reassuringly referred to as "conservative." But the estimates of how much and when the contaminants reach the aquifer rely on many assumptions that are subject to error, vast oversimplification, and the inevitably changing local environment.

The EA presents peak doses but lacks depiction of the contaminate concentrations over time, obscuring the thousands of years the contaminants will be trickling into our aquifer. See Figure 1 and Table 1. Once in the aquifer, the contaminants will know no boundaries as the aquifer flows downstream for Thousand Springs, the Snake River, the Columbia River and Pacific Ocean.

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[1] US Department of Energy, "Environmental Assessment for the Replacement Capability for Disposal of Remote-Handled Low-Level Radioactive Waste Generated at the Department of Energy's Idaho Site," Final, DOE/EA-1793, December 2011. http://energy.gov/sites/prod/files/EA-1793-FEA-2011.pdf

[2] Department of Energy, "Record of Decision for Radioactive Waste Management Complex Operable Unit 7-13/14," DOE/ID-11359, September 2008. http://yosemite.epa.gov/r10/CLEANUP.NSF/sites/INEEL/$FILE/INL-ROD-9252008-Radioactive-Waste-mgmt-complex.pdf

The estimates of contaminant concentration are predicted to stay below regulatory maximum contaminant levels (MCLs) for water (see Table 2) and below the DOE regulatory dose limit of 25 mrem/yr from DOE Order 435.

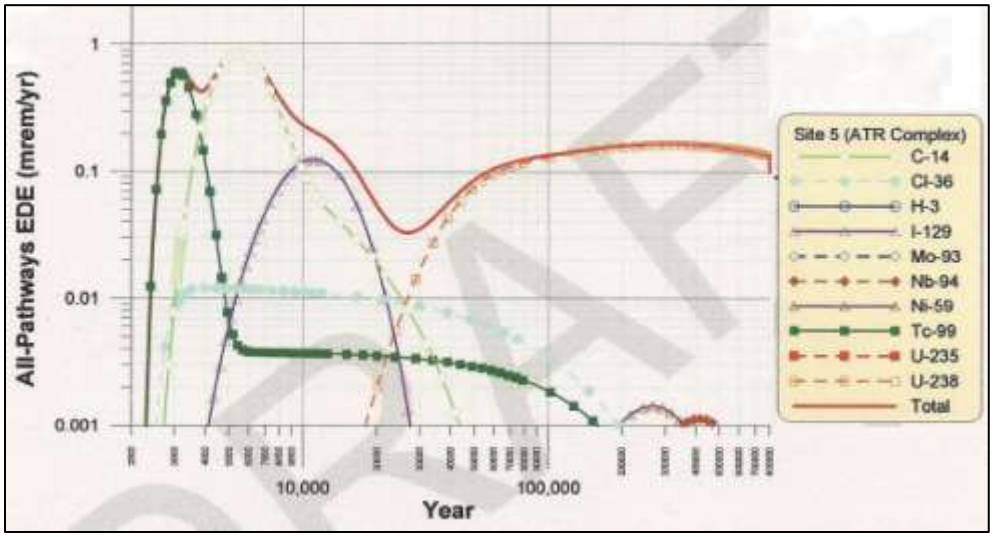

Figure 2. All-pathways dose as a function of calendar year.

Table 1. Final peak predicted groundwater contamination time of occurrence.

Element	Half-life (year)	Calendar Year Peak Occurs[a]	Approximate Time Span of Contamination exceeding 0.001 mrem/yr[b] (years)
Carbon-14 (C-14)	5,730	5500	40,000
Chorine-36 (Cl-36)	301,000	3900	200,000
Tritium (H-3)	12.3	2200	0[d]
Iodine-129 (I-129)	17,000,000	11000	30,000
Nickel-59 (Ni-59)	76,000	270000	120,000
Plutonium-239 (Pu-239)	24,110	260000	0[d]
Technetium-99 (Tc-99)	213,000	3100	100,000
Uranium-238 (U-238)[c]	4,470,000,000	130000	Exceeds 1,000,000

Notes:

a. Predicted calendar year peaks are published in the Department of Energy, "Environmental Assessment for the Replacement Capability for Disposal of Remote-Handled Low-Level Radioactive Waste Generated at the Department of Energy's Idaho Site," Final, DOE/EA-1793, December 2011

b. Time spans are my rough approximations based on Figure 15 of analysis supporting DOE/EA-1793, a report by the Idaho National Laboratory, "Evaluation of Groundwater Impacts to Support the Natural Environmental Policy Act Environmental Assessment for the INL Remote-Handled Low-Level Waste Disposal Project," INL/EXT-10-19168, Rev. 3, August 2011. http://www.osti.gov/scitech/servlets/purl/1032018

c. For brevity, U-235 and progeny and the progeny of U-238 have not been included in the table, but they are shown in Table 4-1 of INL/EXT-10-19168.

d. The DOE's final analysis predicted very low contaminant concentrations for tritium and plutonium.

Table 2. Final peak predicted groundwater concentrations.

Element	Inventory (curie)	Peak Concentration (pCI/L)[b]	MCL[a] (pCi/L)	Percent of MCL
C-14	432	150	2,000	7.5
Cl-36	260	0.12	700	<0.1
H-3	3920	0.000023	20,000	<<0.1
I-129	0.133	0.19	1	19
Ni-59	3240	5.8	300	1.9
Pu-239	0.47	3.1E-13	15	<<0.1
Tc-99	16.7	110	900	12
U-238[c]	16.2	0.097	10	(2 [c])

Notes:

a. MCL is the maximum contaminant level from EPA, adopted by Idaho regulations.

b. Predicted calendar year peaks are published in the Department of Energy, "Environmental Assessment for the Replacement Capability for Disposal of Remote-Handled Low-Level Radioactive Waste Generated at the Department of Energy's Idaho Site," Final, DOE/EA-1793, December 2011.

c. Uranium-238 concentration, including progeny is about 2 percent of the MCL.

Performance assessment of RH-LLW facility requires the estimation of the radioactive inventory, vault construction (it is designed with holes in the bottom so infiltrating water does not pool and the concrete construction affects pH as materials degrade), water infiltration rate based on precipitation and soil and plant characteristics that restrict infiltration, corrosion and release rate models, radionuclide-specific tendency to move through the soil and sediment layers or "sorb" to the soil, characterization of the site's soil and sediment layers, depth to the aquifer, and velocity of the aquifer.

Over fifty years of investigation of monitoring contaminants at the INL and modeling contaminant transport and aquifer flows support the EA's model. The modeling is, as the EA states, "used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses."

The problem is that defensibly conservative modeling and assumptions would predict extensive contamination, exceeding acceptable maximum contaminant levels and accepted dose limits results. So, various optimistic assumptions were used to lower the doses, including the choice of contaminant distribution coefficients, K_ds. Even if the model were perfect, which it is not, this level of modeling refinement makes evaluation of the parameter and result uncertainty imperative if the results are to be understood. The EA assures us that "the concentrations and doses in Table 4-1 and 4-2 are within the (5th and 95th) percentile confidence limits, providing assurance that the potential groundwater impacts have been bounded by the analysis." This statement is nonsense and no information about the uncertainty distribution of the results is provided in the EA.

The US Geological Survey report in a review of a similar INL buried waste contaminant migration analysis concluded that while calculations may be performed for assessing design features, no one would reasonably expect the predictions of contaminant concentrations and time

frames to be either realistic or conservative.[3] Basically, they stated that the estimates might be conservative and they might not. **There are too many scientific unknowns to say, especially over such long time spans.** Peak concentrations, as well as peak times cannot be accurately predicted.

Higher infiltration rates increase the rate of aquifer contamination. And while flooding was analyzed in a supporting document, concluding that periodic flooding might increase peak doses by a factor of 3,[4] the final analysis ignored increased leaching of contaminants due to episodic flooding or water infiltration variation due to weather variations. The statements in the EA concerning flooding say that only a small portion of the disposal site is within the 10,000-year floodplain, directly contradicting the 500-year recurrent flooding issues that found higher peaks of radionuclide concentrations, as investigated in INL/EXT-10-18191.

A candid discussion of unreliability of the estimates of radionuclide transport concentrations, timing and subsequent radiation dose is absent from DOE's EA. DOE promoted its choice of a preferred dump site at INL and DOE's response to important public comments concerning the inadequacy of the EA was to point out that no one identified specific technical problems with DOE's modeling. Had reviewers known their comments only mattered if they cited specific technical problems, perhaps more commenters would have done so. Close examination of the EA's supporting documents, a difficult and time-consuming endeavor, is particularly difficult under the short review periods, especially when the documents are not available, as was the case with the prime supporting document, INL/EXT-10-19168, Rev. 3.

While the annual all pathway doses are estimated to be less than 1 mrem/yr, the analysis model was found to be 1500 times less conservative than the recent DOE Greater-Than-Class C Environmental Impact Statement. Part of the conservatism of the DOE GTCC EIS model was due to lack of tailoring to a specific location. However, DOE GTCC EIS included non-conservative assumptions relative to the EA such as assuming zero infiltration for 500 years and higher uranium distribution coefficients, highlighting the inconsistent assumptions and modeling used by DOE.[5]

What little guidance there is available in performing contaminant migration performance assessments does not assure any consistency or accuracy, even if the state of scientific knowledge would support it. The limited uncertainty analysis performed was in Revision 3 of a supporting document for the EA was not released until December 2011, too late to be available

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[3] US Geological Survey, "Review of the Transport of Selected Radionuclides in the Interim Risk Assessment for the Radioactive Waste Management Complex, Waste Area Group 7 Operable Unit 7-13/14, Idaho National Engineering and Environmental Laboratory, Idaho." DOE/ID-22192, USGS 2005-5026, February 2005. http://pubs.usgs.gov/sir/2005/5026/pdf/Vol1.book.pdf

[4] Idaho National Laboratory, "Assessment of Potential Flood Events and Impacts at INL's Proposed Remote-Handled Low-Level Waste Disposal Facility Sites," INL/EXT-10-18191, September 2010. http://www.inl.gov/technicalpublications/documents/4633207.pdf

[5] Idaho National Laboratory, "Explanation of Significant Differences Between Models Used to Assess Groundwater Impacts for the Disposal of Greater-Than-Class C Low-Level Radioactive Waste and Greater-Than-Class-C-Like Waste Environmental Impact Statement (DOE/EIS-0375D) and the Environmental Assessment for the INL Remote-Handled Low-Level Waste Disposal Project (INL/EXT-10-19168)," INL/EXT-11-23102, August 2011. http://www.inl.gov/technicalpublications/documents/5144355.pdf

for public comment. Important radionuclides, uranium and plutonium, known to have a wide range of distribution coefficients, were not included in the limited uncertainty analysis that was performed.

Unverified Distribution Coefficients

Radionuclide "sorbing," long-term clinging to soil rather than leaching to the aquifer, is modeled based on choosing distribution coefficients, K_ds. Lower values result in more contamination to the aquifer and more rapid transit. Literature searches and INL experiment data were used in the selection of values; however, the values were not subject to the specific chemistry expected as the concrete vault and metal containers degrade.[6] See Table 3.

Table 3. Distribution coefficients used in the screening and final analysis.[a,b]

Element	Screening K_d (mL/g)	Final K_d (mL/g), Alluvium and Interbed	Ratio of Final to Screening K_d
Carbon	0	2, 0.5 [c]	>1 [d]
Chlorine	0	0, 0	1
Tritium	0	0, 0	1
Iodine	0	0.3, 3	>1 [d]
Nickel	100	30, 100	0.3, 1
Plutonium	22	1480, 1140	67, 52
Technetium	0	0.01, 0.1	<1 [d]
Uranium	1.6	10, 10	6.25

Notes:

a. Report by the Idaho National Laboratory, "Evaluation of Groundwater Impacts to Support the Natural Environmental Policy Act Environmental Assessment for the INL Remote-Handled Low-Level Waste Disposal Project," INL/EXT-10-19168, Rev. 3, August 2011. Tables 4 and 9.

b. A distribution coefficient of 0 results in no sorbing of the radionuclide to soil, the most rapid transit and the highest amount of contamination reaching the aquifer.

c. The distribution coefficient for Carbon as 30 times resulted in 30 times more effective retardation than assumed in the DOE's recent Greater-Than-Class C Environmental Impact Statement. See Department of Energy, "Environmental Assessment for the Replacement Capability for Disposal of Remote Handled Low-Level Radioactive Waste Generated at the Department of Energy's Idaho Site," Final, DOE/EA-1793, December 2011

d. Value not computed. However, in typical soil conditions, a K_d of 5 would have a 7-fold decrease in concentration relative to a K_d of 0. (p. 21 of INL/EXT-11-23102).

Distribution coefficients, K_ds, of zero, meaning no sorbing to soils, were used for Carbon and Chlorine in both the screening and final analysis. But, for other radionuclides, the K_ds used in the final analysis were higher than screening values by factors as high as 67 for plutonium. And no uncertainty analysis was conducted for plutonium, despite its wide range of K_ds and its known tendency to both sorb and then de-sorb. [7]

[6] Idaho National Laboratory, "Assessment of Geochemical Environment for the Proposed INL Remote-Handled Low-Level Waste Disposal Facility," INL/EXT-10-19385, Rev. 1, 2011. p. 59 and Tables 15 and 16.

[7] US Environmental Protection Agency, "Understanding Variation in Partition Coefficient, Kd, Values," EPA 402-R-99-004A, August 1999. http://www.epa.gov/rpdweb00/docs/kdreport/vol1/402-r-99-004a.pdf The EPA discusses

The screening results provide an important perspective on the importance of the final selection of K_d values. With conservative values selected, a screening analysis for the EA showed that the MCLs could be exceeded by several orders of magnitude, see Table 4.

Table 4. Radionuclide concentrations using screening K_d values.[a]

Element	Inventory (curie)	Screening K_d (mL/g)	Screening concentration (pCI/L)	Regulatory MCL[b] (pCi/L)	Screening Percent of MCL
C-14	432	0	1,700,000	2,000	85000
Cl-36	260	0	616	700	88
H-3	3920	0	280,000	20,000	1400
I-129	0.133	0	537	1	53700
Ni-59	3240	100	5679	300	1893
Pu-239	0.47	22	4	15	27
Tc-99	16.7	0	67,000	900	74444
U-238	16.2	1.6	2258	10	22580

Notes:

a. Report by the Idaho National Laboratory, "Evaluation of Groundwater Impacts to Support the Natural Environmental Policy Act Environmental Assessment for the INL Remote-Handled Low-Level Waste Disposal Project," INL/EXT-10-19168, Rev. 3, August 2011. Table 9.

b. MCL is the maximum contaminant level from Environmental Protection Agency, EPA, adopted by Idaho regulations.

Idaho "Wasted" Without Leadership

Beyond the pretense of contaminant transport model adequacy, the accepted regulatory limits for annual dose do not account for the 6 to 8 times the risk of fatal cancer for children, the genetic effects, or increasing knowledge of numerous health effects of uranium including neurotoxic effects.[8] And MCLs, as California discovered by experience with hexavalent chromium, are not necessarily protective and they passed a law 10 times more restrictive than the EPA MCL.

And the waste doesn't have to stay in Idaho. It could continue being shipped out of Idaho to the Nevada National Security Site where DOE predicted no groundwater impacts. While the State of

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the technical issues associated with the measurement of Kd values and its use in contaminant migration. The EPA report states "It should also be noted that the adsorption of contaminants to soil may be totally to partially reversible. As the concentration of a dissolved contaminant declines in groundwater in response to some change in geochemistry, such as pH, some of the adsorbed contaminant will be desorbed and released to the groundwater. . ..An important limitation of the constant Kd model is that it does not address sensitivity to changing conditions... (*e.g.*, pH and solution ionic strength)."

[8] Arjun Makhijani, PhD. and Brice Smith, PhD., Institute for Energy and Environmental Research, "Costs and Risks of Management and Disposal of Depleted Uranium from the National Enrichment Facility Proposed to be Built in Lea County New Mexico by LES," November 24, 2004.

Nevada disagrees with DOE's statement,[9] Nevada does have even greater depth to groundwater and less water infiltration, and a low level waste disposal facility.

The only thing the DOE's EA "isolates" is the public from a realistic understanding of how large the uncertainties are in the estimates of timing and concentration of the radionuclide contaminants that will be released to the Snake River Plain aquifer. By DOE's own analysis, it is not a matter of "if" but only a matter of "when," "for how long," and "how much."

The 1995 Settlement Agreement that promoted cleanup of contaminants at INL does not address "low level" waste to be placed in this facility, despite it being long-lived greater-than-Class C remote-handled LLW analogous to transuranic or TRU waste which is acknowledged to need a geologic repository. Unless stopped, this INL Replacement LLW facility will undermine Idaho's water and our citizen's health for generations.

The healthy skepticism of DOE's claims is lacking, as Idaho's Department of Environmental Quality unquestioningly accepts DOE's model results and the certainty of future radioactive contamination from this disposal facility. The desire to protect future generations from exposure to radioactive contamination is absent from Idaho's state leadership and no change is on the horizon, no matter which gubernatorial candidate wins this upcoming election. This absence of leadership in Idaho could have devastating long-term consequences.

Comparison of the INL Replacement RH-LLW Disposal Facility to DOE's Proposed Greater-Than-Class C Waste Disposal Performance Assessment

The Idaho National Laboratory remains a candidate for the Department of Energy's Greater-Than-Class C waste disposal evaluated in DOE/EIS-0375D.[10] DOE has not yet selected a site for the GTCC waste and the performance assessment in the EIS resulted in significantly higher radiation doses than the proposed INL Replacement Remote-Handled Low Level Waste disposal facility. The differences in inventories and contaminant migration estimates were examined in an Idaho National Laboratory report, INL-EXT-11-23102.[11]

A comparison of the inventories for the two facilities is GTCC waste is shown in Table 5.

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[9] See various documents posted by the State of Nevada concerning waste burial at http://www.state.nv.us/nucwaste/nts.htm

[10] Department of Energy, "Draft Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-like Waste," DOE/EIS-0375-D), February 2011. http://www.gtcceis.anl.gov/guide/gtcclw/index.cfm

[11] Idaho National Laboratory, "Explanation of Significant Differences Between Models Used to Assess Groundwater Impacts for the Disposal of Greater-Than-Class C Low-Level Radioactive Waste and Greater-Than-Class-C-Like Waste Environmental Impact Statement (DOE/EIS-0375D) and the Environmental Assessment for the INL Remote-Handled Low-Level Waste Disposal Project (INL/EXT-10-19168)," INL/EXT-11-23102, August 2011. http://www.inl.gov/technicalpublications/documents/5144355.pdf

Table 5. Summary of key radionuclide inventories for the GTCC EIS and INL RH-LLW disposal facility groundwater impacts analyses from INL/EXT-11-23102.

	GTCC EIS		RH-LLW Disposal Facility EA		RH-LLW Disposal Facility Inventory as a % of the GTCC EIS Inventory	
Radionuclide	Total Curies in Activated Metals	Total Curies - not in Activated Metals	Total Curies in Activated Metals	Total Curies not in Activated Metals	Activated Metals	Nonactivated Metals
C-14	3.37E+4	2.82E+02	3.74E+02	5.78E+01	1.1	20.5
I-129	4.00E+00	2.76E+00	1.34E-05	1.33E-01	0.00035	4.8
Tc-99	6.40E+03	1.91E+02	8.71E+00	8.02E+00	0.014	4.2
Np-237	6.70E-02	5.02E+00	8.46E-06	0.003	0.0126	0.0598
Am-241	7.48E+02	1.65E+05	0.306	0.0847	0.039	5.13E-5
Cl-36	-	-	0.153		N/A	N/A
Mo-93	1.57E+02	5.50E-05	1.99	27.1	1.27	4.93E+07
Ni-59	1.84E+05	1.62E+02	3085	157	1.68	96.9
Nb-94	8.70E+02	1.27E-01	102	8.7	11.7	6,850
U-232	1.40E+00	5.58E+01	1.25E-04	2.34E-04	0.00893	0.00042
U-233	3.80E+00	8.18E+02	1.15E-04	3.44E-06	0.003	4.21E-07
U-235	7.20E-02	4.24E+00	8.19E-06	5.16E-03	0.0114	0.122
U-236	1.10E-01	1.34E+00	2.27E-05	1.07E-04	0.0206	0.00799
U-238	8.40E-01	1.43E+01	2.89E-04	1.62E+01	0.003	113
U-234	2.00E-01	9.40E+01	2.63E-04	9.37E-04	0.13	0.00099
Th-230	1.3E-04	8.87E-01	6.82E-08		0.052	
Ra-226	1.5E-06	9.1E+00	7.99E-11		0.00532	
Pb-210	3.30E-07	4.12E-06				

Overall, the INL RH-LLW disposal facility would have an inventory that is roughly 20 percent of the C-14, 5 percent of the I-129, 97 percent of the Ni-59, and 113 percent of the U-238 of the yet-to-find-a-home GTCC facility.

The GTCC facility would have 476 curies of uranium, the RH-LLW facility would have 66 curies, a factor of 7 difference. However, during the 100,000-year timeframe, the dose is dominated by isotopes of uranium. The initial inventories of U-238 are similar; however, the inventory of U-234 is about 5 million times larger in the GTCC inventory. Daughters of U-234 will be retained near the disposal facility and the large U-234 inventory will lead to a much higher groundwater dose than predicted in the RH-LLW, peak dose after 100,000 years.

The radiation doses estimated for GTCC waste disposal described in Environmental Impact Statement DOE/EIS-0375D were significantly higher than the proposed INL Replacement RH-LLW facility because of differences in inventory and differences in contaminant migration modeling assumptions.

Both the RH-LLW and the GTCC radiation dose results are dominated by C-14, I-129, and Tc-99 during the first 10,000 years and uranium isotopes afterward. Both facilities trickle out contamination for hundreds of thousands of years, in amounts that are significant portions of maximum contaminant levels for various radionuclides.

From INL/EXT-11-23102, “The peak total dose during the 1,000-year time of compliance is 0.62 mrem/yr for the RH-LLW facility to be located southwest of the ATR Complex. This peak (which occurs 1,000 years after closure) represents the cumulative dose from all radionuclides in

the groundwater 100 m from the downgradient facility boundary. . . The peak dose over all is 0.88 mrem/year and occurs 3,500 years after closure. This dose primarily is due to C-14 (0.85 mrem/year), with small contributions from I-129 (0.013 mrem/year), Cl-36 (0.012 mrem/year), and Tc-99 (0.004 mrem/year). After several thousands of years, isotopes of uranium arrive in groundwater."

For the GTCC waste inventory at INL, the EIS predicted doses within 10,000 years of 2,300 mrem/yr for the vault method, far exceeding DOE's 25 mrem/year limit. However, the estimates used differing assumptions, models, and contaminant distribution coefficients. Revised estimates could result in lowering the estimated dose of GTCC disposal.

The continuous flow of contaminants over these time spans is supposed to be acceptable because the DOE's annual 25 mrem dose limit and federal maximum contaminant levels are not predicted to be exceeded. However, discussion of the enormous level of uncertainty in peak dose predictions over thousands of years and the duration unrelenting continuation of contaminant release has been minimized in order to provide a seeming certainty that the dose estimates would not be exceeded and would have small impact.

Chronic low level ingestion of radionuclides would pose a much more serious health concern to children and developing fetuses than some of these low doses would indicate. And experience with exposures near maximum contaminant levels show that MCLs are not necessarily protective, especially for prolonged, chronic exposure.

The GTCC waste rightfully belongs in a deep geologic repository along with spent fuel and high level waste and should be stored in a retrievable configuration for its ultimate disposal in such a facility.

Article written by Tami Thatcher, former nuclear safety analyst at INL and nuclear safety consultant. Initially posted November 2014.

INL's Proposed Remote-Handled Low-Level Waste Dump Includes Greater-Than-Class C Waste

Regarding the Idaho National Laboratory's proposed remote-handled low-level waste facility,[12] just in case there was any doubt, some of the waste destined for this new facility is Greater Than Class C low-level waste. The fact that this waste contains GTCC waste has been deliberately obscured by the Department of Energy.

GTCC waste is generally considered to be a hazard comparable to that of spent fuel, and several radionuclides at the proposed RH-LLW facility do exceed GTCC concentration levels. See INL/EXT-09-17427 [13] for curie per cubic meter concentrations and -17152 [14] for the admission that "a portion of the waste exceeds Class C" but later versions scrub this admission.

GTCC criteria address the concentration in curies per cubic meter, not total quantity. Some proponents have argued that the quantities of long-lived radioactive nuclides in this waste are small.

But when alternate disposal sites were evaluated, it was found that if a non-federal facility accepted the class B and C portion of this waste, the "significant quantities of carbon-14, nickel-63, nickel-59, cobalt-60, and tritium . . . could have significant impact on disposal facility's license radiological limits." Does that seem small to you?

Dominant contributors to radiation ingestion dose from aquifer contamination, including uranium-238, though not GTCC are far from safe after 500 years. The "controlled release" into the aquifer will continue for hundreds of thousands of years. See Table 6 for waste concentrations and curie amounts.

During the bad old days of INL's INTEC disposal injection wells, approximately 0.94 curies of iodine-129 were discharged into the aquifer and maximum contaminant levels (MCLs) inside INL boundaries were exceeded.[15] The proposed new facility will unnecessarily add 0.13 curies of iodine-129 with a 15.7 million year half-life into the aquifer providing a thyroid organ dose disproportionately harming the young.

Over 16 curies of technetium-99 to be disposed of at the RH-LLW facility[16] roughly matches estimates of what INTEC released to the aquifer which also exceeded the MCL. Tc-99 with a

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[12] US Department of Energy, "Environmental Assessment for the Replacement Capability for Disposal of Remote-Handled Low-Level Radioactive Waste Generated at the Department of Energy's Idaho Site," Final, DOE/EA-1793, December 2011. http://energy.gov/sites/prod/files/EA-1793-FEA-2011.pdf

[13] Idaho National Laboratory, Battelle Energy Alliance, "Conceptual Safety Design Report for the Remote-Handled Low-Level Waste Disposal Facility," INL/EXT-09-17427, February 2010. p. 13, Table 2.

[14] Idaho National Laboratory, Battelle Energy Alliance, "Remote-Handled Low-Level Waste Disposal Project Alternatives Analysis," INL/EXT-09-17152, October 2009. p. 3-4, Table 3-1.

[15] U.S. Geological Survey, "Iodine-129 in the Eastern Snake River Plain Aquifer at and near the Idaho National Laboratory, Idaho, 2010-12," DOE/ID-22225, Report 2013-5195, 2013.

[16] Idaho Completion Project, Bechtel BWXT Idaho LLC, "Evaluation of Tc-99 in Groundwater at INTEC: Summary of Phase 1 Results," ICP/EXT-04-00244, September 2004. p. 2-2. http://pbadupws.nrc.gov/docs/ML0609/ML060930199.pdf

213,000 half-life, harms the thyroid. Embryos have thyroids at 70 days of gestation, but organ doses were not presented.

And radionuclide- and site-specific soil distribution coefficients for I-129 and Tc-99 that model how readily the waste moves to the aquifer were not conservative relative to similar studies.[17]

Weapons fallout in the 50s and 60s rained out very high levels of tritium, and wells downstream of INTEC, like USGS 14 south of INL attributed high levels of tritium in the 60s to unspecified fallout.[18] In the late 80s, INL was still claiming that no aquifer contamination attributed to INL could be detected offsite. Since 1990, offsite wells, including USGS 14, have been found to have contamination specific to INTEC disposal wells.

Tritium was disposed of at INTEC, beginning in the 1950s was not monitored until 1960. Tritium disposed of at INTEC starting in the 1950s may have made its way offsite to USGS 14 long before it was officially recognized as plausible. [19] [20] [21] [22] [23]

Contaminant levels from the RH-LLW facility depend on infiltration rate. Models of contaminant infiltration rates have used from 1.0 cm/year to 4.0 cm/yr without capping over the waste facility, when precipitation is an average 20 cm/yr. [24] Isn't there a conflict between saying an infiltration rate of 1 cm/yr is representative of contaminant movement through the soil, yet very high tritium levels in a well over 500 ft deep were due to weapons fallout?

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[17] Idaho National Laboratory, "Assessment of Geochemical Environment for the Proposed INL Remote-Handled Low-Level Waste Disposal Facility," INL/EXT-10-19385, Rev. 1, 2011. p. 59 and Tables 15 and 16.

[18] US Geological Survey, "Water-Quality Characteristics and Trends for Selected Sites at and near the Idaho Natioanl laboratory, Idaho, 1949-2009," DOE/ID-22219, Report 2012-5169, 2012. ! which does not show the tritium readings taken for this well that show up in the USGS Mapper data for 1965, were verified as valid by USGS by email, and are shown in USGS report 84-714.

[19] US Geological Survey website link: http://id.water.usgs.gov/projects/INL and INL bibliography at http://id.water.usgs.gov/INL/Pubs/INL_Bibliography.pdf

[20] Using http://maps.waterdata.usgs.gov/mapper/index.html, the data for USGS well 14, about 12 miles south if INL facility INTEC can be viewed. Data from parameter code 07005 from 1965 shows tritium at 9000 picoCuries/Liter.

[21] Between 1952 and 1988, approximately 30,900 curies of tritium were discharged in waste water from Idaho National Laboratory's INTEC and Test Reactor Area facilities. See USGS June 1990 report 90-4090.

[22] Background levels of tritium in Idaho were estimated to range from 75 to 150 picoCuries/Liter, see USGS report 93-102, or USGS report 91-4015, and the EPA maximum contaminant level for tritium is 20,000 pCi/L. Various background estimates exist but background levels of tritium are currently stated as being below 150 pCi/L and many well measurements are considerably below 150 pCi/L.

[23] US Geological Survey, "Water-Quality Data for Selected Wells On or Near the Idaho National Engineering Laboratory, 1949 through 1982," Report 84-714, June 1985. http://pubs.usgs.gov/of/1984/0714/report.pdf See p. 317 for USGS well 14 tritium (H-3) data for 1965 to 1982, in pCi/mL. Multiply pCi/mL value by 1000 to convert to pCi/L . Examining tritium data for this report, I can find no sudden spikes—which, due to extensive and frequent weapons testing, would have shown up in other wells during the 1960s. So, the excuse that USGS well 14 had a spike in tritium levels due to weapons fallout—really does not hold up to scrutiny.

[24] Idaho National Laboratory, "Explanation of Significant Differences Between Models Used to Assess Groundwater Impacts for the Disposal of Greater-Than-Class C Low-Level Radioactive Waste and Greater-Than-Class-C-Like Waste Environmental Impact Statement (DOE/EIS-0375D) and the Environmental Assessment for the INL Remote-Handled Low-Level Waste Disposal Project (INL/EXT-10-19168)," INL/EXT-11-23102, August 2011. p. 10, 14, 16. http://www.inl.gov/technicalpublications/documents/5144355.pdf

Some find a silver lining in the fact that the RH-LLW waste will be contained in the early years, over the thousands of years contaminants will trickle out. One should remember that the Titanic met all regulatory requirements — and recognize our moral responsibility to protect future generations.[25]

Table 6. Proposed INL Remote-handled low-level waste disposal facility partial inventory.

Isotope [26] [27] (Half-life, yr)	Maximum Activity Concentration (Ci/m^3) [28]	NRC Class C Limit [29] (Ci/m^3)	Activated Metal (Ci)	Resin (Ci)	Debris (Ci)	Comment [30]
Carbon-14 5,730 yr	5	8 debris 80 activated metal	3.7E2	2.6	5.5E1	60 percent of GTCC limit. 20 percent of DOE's GTCC EIS inventory for nonactivated metals
Iodine-129 17,000,000 yr	7E-7	0.08	1.33E-5	1.33E-1	3.7E-4	4.8 percent of DOE's GTCC EIS inventory for nonactivated metals
Techetium-99 213,000 yr	6.0E-3	3	8.708	5.0	2.9	4.2 percent of DOE's GTCC EIS inventory for nonactivated metals
Uranium-235 703,800,000 yr	?	?	8.19E-6	2.06E-5	5.14E-3	
Uranium-238 4,468,000,000 yr		?	2.89E-4	4.30E-8	1.6E1	113 percent of DOE's GTCC EIS inventory for nonactivated metals
Plutonium-241 14.4 yr	?	3500 nCi/g	2.60E1	1.13E-1	1.03	
Plutonium-238	?	100 nCi/g	2.49E-1	3.98E-1	5.83E-2	

[25] A shortened version of this article appeared as a "letter to the editor" Post Register, January 27, 2015.

[26] Some basic background information for long-lived low-level waste radionuclides: Idaho National Engineering and Environmental Laboratory, Lockheed Martin Idaho Technologies Company, "National Low-Level Waste Management Program Radionuclide Report Series," INEEL/CON-98-00837, Waste Management conference, February 28,1999-March 4, 1999. http://www.inl.gov/technicalpublications/Documents/3314426.pdf

[27] More basics about low-level waste: Pacific Northwest National Laboratory, "Low-Level Radioactive Waste Classification, Characterization, and Assessment: Waste Streams and Neutron-Activated Metals," NUREG/CR-6569, August 2000. http://pbadupws.nrc.gov/docs/ML0037/ML003752437.pdf

[28] Idaho National Laboratory, Battelle Energy Alliance, "Conceptual Safety Design Report for the Remote-Handled Low-Level Waste Disposal Facility," February 2010. p. 13, Table 2.

[29] 10 Code of Federal Regulations Part 61, definition of Class C waste.

[30] Idaho National Laboratory, "Explanation of Significant Differences Between Models Used to Assess Groundwater Impacts for the Disposal of Greater-Than-Class C Low-Level Radioactive Waste and Greater-Than-Class-C-Like Waste Environmental Impact Statement (DOE/EIS-0375D) and the Environmental Assessment for the INL Remote-Handled Low-Level Waste Disposal Project (INL/EXT-10-19168)," INL/EXT-11-23102, August 2011. Table 3. http://www.inl.gov/technicalpublications/documents/5144355.pdf

87.7 yr						
Plutonium-239 24,100 yr	?	100 nCi/g	3.05E-1	7.23E-2	1.18E-1	
Molybdenum-93 3500 yr	1.36E-2		1.993	0	2.71E1	4.93E7 percent of DOE's GTCC EIS inventory for nonactivated metals
Nickel-59 76,000 yr	**500**	**220**	**3.08E3**	**3.03E1**	**1.26E2**	**Exceeds Class C** 96.9 percent of DOE's GTCC EIS inventory for nonactivated metals
Nickel-63 96 yr	**55,000**	**700 debris 7000 activated metal**	**3.79E5**	**3.67E3**	**9.62E3**	**Exceeds Class C**
Niobium-94 20,000 yr	**2**	**0.2**	**1.02E2**	**2.12**	**6.58**	**Exceeds Class C** 6,850 percent of DOE's GTCC EIS inventory for nonactivated metals
Chlorine-36 300,000 yr	2.5E-2	?	1.53E-1	0	0	
Neptunium-237 2,100,000 yr	?	?	8.46E-6	2.67E-4	2.72E-3	
Cesium-137 30 yr	3.0E-1	4600	1.9E1	3.61E1	6.22E3	
Strontium-90 29 yr	5	7000	9.407	6.16E1	6.11E3	

Note: Primary sources: INL/EXT-11-23102, INL/EXT-09-17427.

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