The Hidden Truth About INL Drinking Water

A Long Legacy of Aquifer Contamination at INL

The Idaho National Laboratory (INL) that began in 1949 as the National Reactor Testing Station has disposed of radionuclide and chemical contaminants into the Snake River Plain Aquifer since the early 1950s. Radionuclide and chemical contaminants have exceeded federal maximum contaminant levels (MCLs) at some INL drinking water wells. Much of the history of contaminant levels, especially prior to 1988, remains veiled and with good reason: contaminant levels were over or a significant fraction of the MCLs.

The history of which wells were used for drinking water, what was sampled, and what the resulting contaminant levels were is largely obscured behind an ever-changing mosaic of documents by the Department of Energy, US Geological Survey, and INL contractors. [1]

In one of the few USGS reports to discuss INL drinking water contamination, only one INL drinking well was identified and only a single year of tritium data was provided, despite much higher levels in previous years. [2] The well was Central Facilities Area CFA-1. This well, it admitted, for 1988, exceeded the federal MCL for tritium. There is no mention of the extremely high levels of tritium at all Central Facilities wells, exceeding five times the MCL, through the 1960s when tritium monitoring began and still reaching the MCL in the mid 1990s. [3]

In the early years of aquifer monitoring, monitoring lagged the presence of contamination sometimes by years if not decades. Sometimes detection levels were unable to detect contamination that would now be considered significant. Monitoring, when performed, often did not include important contaminants on a regular basis. Many chemical contaminants were not monitored prior to 1988. And INL workers drinking the water were not informed of the toxic brew of chemical and radionuclides they were drinking on a daily basis during their careers at INL.

According to a 1990 US Geological Survey report, from 1952 to 1988, the Idaho National Laboratory disposed of approximately 80,900 curies of tritium at INTEC (formerly the Idaho Chemical Processing Plant) and the ATR Complex, formerly the Test Reactor Area. Tritium is also released by above- and below-ground weapons testing and by normally operating nuclear reactors and by reactor accidents.

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[1] Many Department of Energy and Idaho National Laboratory reports can be found at these websites: www.osti.gov/scitech, www.ar.inel.gov (the Administrative Record for the INL CERCLA superfund site), http://www.id.doe.gov/foia/archive.htm, https://www.inl.gov/about-inl/general-information/doe-public-reading-room/, http://www4vip.inl.gov/library/searchreadingroom2.shtml,, https://www.inl.gov/about-inl/general-information/research-library/ and https://inldigitallibrary.inl.gov/SitePages/Home.aspx .

[2] USGS Report 90-4090, L.J. Mann and L.D. Cecil, "Tritium in Ground Water at the Idaho National Engineering Laboratory, Idaho," June 1990. p. 32 and 34. http://pubs.usgs.gov/wri/1990/4090/report.pdf

[3] 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 . Select individual wells at the USGS mapper at http://maps.waterdata.usgs.gov/mapper/index.html

Disposal of radioactive waste water at INTEC contained not only tritium, it also contained a host of other radionuclides that were generally not monitored or mentioned. See Table 1 for an overview of contaminants dumped into the aquifer and Table 2 for their half-life and MCL.

As researchers in the nuclear industry began to recognize the significance of long-lived radionuclides in radioactive waste [4] as significant contributors to radiation ingestion dose, the Idaho lab continued to avoid mentioning long-lived radionuclides it had been dumping for years. Several long-lived radionuclides monitored by the USGS were tucked away in a closed-access journal article in 1998. This research by Beasley was not given the customary USGS and DOE report numbers and it has not been part of the USGS bibliography until recently. [5] The conscious decision by the DOE to not mention or monitor long-lived radionuclides was described in a scientist's comments documented in the 1977 ERDA NEPA document concerning waste issues at INL. [6]

At INTEC, disposal injection wells were discontinued as percolation ponds were put in use in 1984. But the ponds only slowed the rate some contaminants reached the aquifer. The sorbing characteristics of some radionuclides means that they bind to soils and move much less readily. But non-sorbing radionuclides like tritium, technetium-99, iodine-129 and chlorine-36 move readily through soil into the aquifer. The INTEC plume has contaminated INTEC and downstream Central Facilities, the Rifle Range and the Radioactive Waste Management Complex (RWMC). The INTEC plume continued south of the INL boundary.

At the ATR Complex, the percolation ponds leached water which has become perched over the aquifer. An injection well disposed of hexavalent chromium [7](although the 1960 report does not specially call out hexavalent chromium). The MCL for hexavalent chromium was not deemed to be adequate in California; they tightened the state standard 10-fold for this contaminant after their experience with people ingesting it. [8] The contamination levels of this perched water are sometimes not mentioned as aquifer contamination is presented. The only remaining reactor

[4] US Geological Survey Circular 779, "Geologic Disposal of High-Level Radioactive Wastes Earth-Science Perspectives," First printing 1978. The radiotoxic hazard over millions of years to our water supplies and difficulty of geologic disposal is recognized. Iodine-129, Neptunium-237 and other spent fuel radiotoxic hazards are included. These problems were recognized in the 1950s.

[5] T. M. Beasley, P. R. Dixon, and L. J. Mann, "^{99}Tc, ^{236}U, and ^{237}Np in the Snake River Plain Aquifer at the Idaho National Engineering and Environmental Laboratory," *Environmental Science & Technology*, 32:3875-3881, 1998.

[6] ERDA-1536, "Waste Management Operations, INEL Final Environmental Impact Statement, US Energy Research and Development Administration, September 1977. This document is deemed not releasable due to security concerns on the DOE NEPA website and the government's osti.gov website. But it is available at government website ar.inel.gov, the Administrative Record for CERCLA actions at the Idaho National Laboratory.

[7] US Atomic Energy Commission Idaho Operations Office, *Annual Report of Health and Safety Division 1960*, IDO-12019, September 1961. p. 123 discusses infiltration capability and disposal well usage. Yet no contaminants or contaminant levels are specified. It describes the USGS work as "directed toward establishing adequate safeguards for waste disposal without imposing economically prohibitive limits on the development of the nuclear industry." If you had any belief that the health and safety reports were concerned with human health, get rid of it: the chief concern was the health of the nuclear industry.

[8] In July 2014, California passed a maximum contaminant level (MCL) for chromium-6 of 0.01 mg/L or 10 ppb.[8] The EPA standard for maximum concentration of chromium-6 remains 10 times higher at 0.1 milligrams per liter or 100 parts per billion (ppb). See http://www.valleywater.org/services/chromium-6.aspx

waste water pond at the ATR Complex has been a lined pond since that late 1990s. And the waste water is filtered using resins to retain more radionuclides. The tritium that is now not leaching into the aquifer is emitted directly to the atmosphere and no attempt is made to even estimate the released amount by the facility. [9]

In a peculiar shell game, now rather than the unfiltered waste water percolating to the aquifer in unlined ponds, the filtered waste water sent to lined ponds that release volatile contaminants to the atmosphere. And the resins that filter radionuclides are buried a few feet underground at RWMC and will be buried at the new Replacement facility for RWMC, the remote-handled low-level waste facility. These buried resins that concentrated various long-lived radionuclides will slowly leach into the aquifer. [10] [11]

The ATR Complex and INTEC plumes join together in the aquifer south of these facilities. The aquifer flows generally from northeast to southwest and continues to the Snake River. The further north the contaminant source, the deeper the contamination in the aquifer will be further south. Higher use of wells draws more of the contaminant plume toward the well. Past USGS monitoring of wells south of INL may have missed much of the contamination due to shallow monitoring of infrequently used wells monitored years after peak contamination. USGS well 14, five miles south of the INL, has been shown to be in the INTEC plume because of Chlorine-36 analysis, yet the data for this well for often not included in USGS reports of contaminants flowing toward Thousand Springs. [12]

History of Obscuring INL Drinking Water Contamination

The 1959 annual health and safety report (IDO-12014) discusses contamination found in a production well at INTEC (then called CPP). [13] It doesn't say which production well and it does not specify which production wells were used for drinking water at INTEC. It also does not say what contaminants or what levels of contamination were found. This is what passed for a health and safety environmental monitoring report at INL.

Online USGS mapper data for INTEC production wells CPP 1, 2 and 4 only have data beginning in 1972, yet three wells, CPP 1, 2 and 3, are shown on a figure in the 1959 document.

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[9] US Department of Energy, *Technical Basis for Environmental Monitoring and Surveillance at the Idaho National Laboratory Site*, DOE/ID-11485, February 2014.

[10] Department of Energy Radioactive Waste management Complex (RWMC) Performance Assessment/Composite Analysis DOE/NE-ID-11243, September 2007 and DOE/NE-ID-11244, September 2008. See DOE-ID Public Reading room online documents.

[11] 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/IA-1793-FEA-2011.pdf

[12] U.S. Geological Survey, "Evaluation of archived water samples using chlorine isotopic data, Idaho National Engineering and Environmental Laboratory, Idaho 1966-93," DOE/ID-22147, Report 98-4008, 1998. http://pubs.er.usgs.gov/usgspubs/wri/wri984008

[13] US Atomic Energy Commission Idaho Operations Office, *Annual Report of Health and Safety Division*, 1959, IDO-12014, p. 152, 153.

"Production wells" are wells used for pumping water for the facility and usually provide drinking water. USGS data at the ATR Complex, (formerly the Test Reactor Area, TRA), well TRA 1 shows 1960 readings and then no data for many years until 1972. See Table 3 for a list of INL drinking wells, their USGS identifier and highlights of the contamination levels monitored.

The USGS mapper does show data for the Central Facilities wells, CFA 1 and 2. The tritium contamination levels are far in excess of the current federal maximum contaminant level of 20,000 pCi/L. Remember to multiply readings in pCi/milliliter by 1000 to obtain pCi/L. The Central facilities production wells were down gradient from the INTEC disposal well and contamination had reached these wells prior to their monitoring in the early 1960s.

It was not until 1988 that drinking water reporting by INL contractors was initiated. Assigned public drinking water system identifiers by the state, INL began providing radiological and non-radiological well monitoring data to the Idaho Department of Environmental Quality.

Through the early 1990s, tritium levels in Central Facilities production (drinking water) wells were still high and very near to the federal MCL. So, close in fact, that it was reported right at the MCL of 20,000 pCi/L. INL documents would begin a long tradition of saying the MCLs "had not been exceeded" even though they historically had been exceeded and they had reached the MCL in the 1990s for tritium at Central Facilities. Quarterly and annual averaging of monitored results also masks maximum levels monitored. [14]

The DOE and INL contractors have often compared the monitored results to the DOE's "derived concentration guideline (DCG)." The DCG allows 100 mrem/yr and uses different dose conversions than the EPA federal standards. Generally, the DCG is 100 times more permissive than the federal MCLs. [15] [16]

It is important to remember that when more than one radionuclide is present, total organ dose should be determined. A simple summation of MCLs has been used in the nuclear industry, see 10 CFR 20. Thus, when tritium was a 20,000 pCi/L, the addition of iodine-129 or strontium-90 would have effectively meant that in fact the total maximum contaminant levels for radionuclides had been exceeded.

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[14] Idaho National Laboratory Site, Environmental Surveillance, Education, and Research Program, "1997 INEEL Annual Site Environmental Report." Fig. 6.6 omits unsightly tritium peaks. http://www.gsseser.com/Annuals/1997Annual.htm

[15] US DOE Idaho Operations Office, *The Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1989*, DOE/ID-12082(89), June 1990. See page 20 and Table B-6 on page B-8. Page 20 states: "The highest annual average concentration of tritium in Site drinking water (at CFA) is 1.2% of the derived concentration guide for radiation protection. For Sr-90, the highest annual average concentration (at ICPP) was 0.06% of the derived concentration guide." The problem is that the federal Maximum Contaminant Levels (MCLs) are about 100 times more restrictive. The tritium concentration of 24,000 pCi/L (or 24 pCi/ml) was at 120 percent of the MCL (or derived concentration guide). And the strontium-90 level of 1.400 pCi/L was 6 percent of the MCL.

[16] U.S. Department of Energy, Idaho Operations Office, RESL, D.L. Hoff et al., "The Idaho National Engineering Laboratory Site Environmental Report for Calendar year 1992," DOE/ID-12082(92). June 1993. Executive summary and p. 26 and Table B-5 compare drinking water to the DOE's lenient dose concentration guideline.

In 1995, the DOE requested that Idaho Department of Environmental Quality (IDEQ) no longer request radionuclide drinking water data. The IDEQ granted this request despite chronic radionuclide contamination in INL drinking water wells and the current drinking water monitoring showing tritium right at the MCL. [17] And simultaneously, the DOE decided not to provide the drinking water data to its independent environmental monitoring organization that provides annual environmental monitoring.[18] The inability to track samples and trend the wells would facilitate keeping the problem under the radar, especially important for health liability issues, minimizing public perception of aquifer contamination and retaining unfettered ability to contaminate the aquifer in future programs. The INL drinking water radiological monitoring data were no longer provided to IDEQ after 1995 although chemical monitoring data is provided.

The IDEQ did not break laws by agreeing that INL was not required to provide the radiological data because INL's wells were "non-community" wells. Idaho law does not require Nontransient Noncommunity Systems at INL to report radionuclides prior to its use as a drinking water source. This is consistent with adoption of CFR 141.26 which only requires the reporting of radionuclides for community wells. However CFR 141.35 allows reporting of unregulated contaminants to be requested.

Initially, IDEQ did require INL drinking water systems to provide both radiological and non-radiological water monitoring data. IDEQ should never have granted that request and it can and should now request INL's drinking water radiological monitoring information along with the numerous chemical constituent monitoring data IDEQ continued to require of INL's drinking water systems. IDEQ's laws permits Idaho to request the radiological data from INL and with the historically high levels it should do so. [19] IDEQ's drinking water website is available on-line, but only includes chemical data for INL's drinking water. [20]

Tritium at Central Facilities Area from the INTEC Plume

According to the 1990 USGS report, background levels of tritium from atmospheric weapons testing are less than 200 pCi/L. But this reflects an elevated background level of tritium as often water samples below this level, often below 70 pCi/L. It is also important to understand that detection capability for tritium improved significantly over time and uncertainty bands were reduced, but the water sample analysis laboratory capabilities vary.

By 1961, tritium injected at INTEC had migrated at least as far at the production wells at INL's Central Facilities Area. (p. 18, USGS Report 90-4090) And in 1961, the analytical method of

[17] Letter from Brad D. Anderson, INEL Drinking Water Coordinator, to Blaine Drewes, Idaho Department of Environmental Quality, March 31, 1995, BDA-31-95, "Record of Conversation on February 27, 1995 at Idaho Falls Water and Wastewater Office Building." Letter is onfile at IDEQ Idaho Falls office.

[18] Environmental surveillance, education and research (ESER) contractor (Stoller and now Gonzales-Stoller) for INL off-site monitoring, onsite wildlife and game, Annual Site Environmental Report (ASER) preparation at www.gsseser.com .

[19] IDAPA 58.01.08, 2010, "Idaho Rules for Public Drinking Water Systems," Idaho Administative Procedures Act. 009. MONITORING. The Department may, in its discretion, alter the monitoring or sampling requirements for any contaminant otherwise specified in these rules if the Department determines that such alteration is necessary to adequately assess the level of such contamination. (IDAPA 58, page 23)

[20] Idaho Department of Environmental Quality, http://dww.deq.idaho.gov/IDPDWW/.

detection was not able to detect levels below 5000 pCi/L. The federal maximum contaminant level for tritium is 20,000 pCi/L. Therefore, levels below one quarter of the MCL would have not been detected. By 1968, tritium detection of 400 pCi/L was possible, despite USGS responses in 2015 that tritium monitoring until 1982 was "experimental."

The understanding of the health impact of tritium has resulted in the recognition by some researchers that the MCL is far too high. California created a health goal of not exceeding 100 pCi/L of tritium in drinking water. The EPA goal is zero. The nuclear industry, including the Department of Energy, however, cannot control its tritium releases and works hard to keep regulatory levels high. In 1986, the industry hoped the MCL would be raised to 90,000 pCi/L. [21]

In 1961, the USGS describes the average concentration of tritium in 26 selected wells as 250,000 pCi/L. But this averaging of wells is not as informative as lines of equal tritium concentration drawn. The concentration of tritium reaching CFA in 1970 was 50,000 pCi/L. [22] The changes to waste water practices reduced tritium levels of 1988 from the levels of 1977 in areas near the facilities. However, as the aquifer contamination flows southwest, the peak contamination levels would increase at later times than peaks closer to the originating facility. Naturally, the tritium plumes are well-behaved and always are depicted as staying within the INL boundary.

Tritium concentrations at the Central Facilities wells CFA 1 and 2 and the Rifle range nearby are plotted in a figure for 1988 through 1992. Tritium levels above 30,000 pCi/L in 1988 decrease but stayed near the MCL at 20,000 pCi/L in 1992. [23]

First arrival of tritium at the wells near the southern boundary of INL was detected in 1983 by the USGS. However, now with multi-level wells, it is now known that contamination levels can vary with depth sampled by over an order of magnitude.

In the 1990 USGS report 90-4090, it is stated that 27 wells at INL were used for drinking water. The report only identifies one drinking water well, CFA-1, which exceeded the tritium MCL level of 20,000 pCi/L. The tritium concentration in the water at CFA-1 is only given for one year, 1988 when the tritium level was 27,300 pCi/L, significantly lower than previous peaks above 100,000 pCi/L.The USGS report does not identify the other drinking water wells or document their contamination levels for tritium or any other radionuclide.

Iodine-129 Contamination from the INTEC Plume

Iodine-129 has a half-life of 17 million years. It was disposed of in the INL's INTEC disposal well along with tritium. But I-129 was often not monitored, not mentioned, and deliberately so. Dumping long-lived radionuclides in the aquifer doesn't sound good. Presenters like to claim

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[21] USGS Report 90-4090, L.J. Mann and L.D. Cecil, "Tritium in Ground Water at the Idaho National Engineering Laboratory, Idaho," June 1990. p. 32 and 34. http://pubs.usgs.gov/wri/1990/4090/report.pdf

[22] USGS Report 90-4090, fig. 5.

[23] US DOE Idaho Operations Office, *The Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1992*, DOE/ID-12082(92), June 1993. See Appendix B-3, B-9. Table B-5 gives the percent of the derived concentration guideline as 0.9 in well CFA-1 for tritium. This corresponds to 90 percent of current federal MCL.

that very little contamination has migrated off-site and that the contamination on-site will decay away. INL presentations tend to focus on tritium and strontium, each with moderate half-life, 12.3 yr and 29.1 yr, respectively.

It was estimated that between 0.1 and 0.136 curie per year of I-129 were disposed of in the INTEC disposal well between 1953 to 1983.[24] Lesser amounts were disposed of when the percolation ponds were put into service at INTEC. From 1953 to 1988, approximately 0.941 curies of I-129 were discharged at INTEC. [25] The 2012 USGS report about I-129 includes data from 1990 to 2012. The levels of I-129 at CFA in 2007 were 30 percent of the MCL.

In 1977, the wells at Central Facilities (CFA-1 and -2 wells) and INTEC (CPP-2 well) were 70 to 80 percent of the Iodine-129 maximum contaminant level of 1 pCi/L. The levels prior to 1977 may have been higher. In 1981, at CPP-1 the I-129 level was 5.8 pCi/L; over 5 times the MCL. Iodine-129 data for this well are curiously absent for 1977 despite other wells having been for monitored for I-129 in 1977. Workers drinking this water for many years were not told of this contaminant or the level of contamination. [26]

Volatile Organic Chemicals at TAN and RWMC

Test Area North and Radioactive Waste Management Complex sampling found contaminant levels in the aquifer exceeding federal MCLs in the late 1980s. But how long had the water been used for drinking water before these organic chemicals were found?

Chemical contaminants are reported to IDEQ. However, data recently presented by the USGS to the INL Citizens Advisory Board showed increasing contamination levels which exceeded the MCLs for carbon tetrachloride at RWMC. Yet, these higher levels were not included in IDEQ's drinking water database which showed no results exceeding the MCL for carbon tetrachloride since 2007.

Workers at TAN and RWMC may be using bottled water at least some of the time, but I found no publically available reports documenting this. The chemical contaminants are monitored by IDEQ whether or not the workers are given bottled water to drink.

Workers Not Told and NIOSH Ignores Historical INL Drinking Water Contamination

The National Institute of Occupation Safety and Health that performs radiation dose reconstruction for former INL workers has failed to consider the radiation contribution from drinking water that certainly affected the health of people who worked for years at these facilities.

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[24] U.S. Geological Survey, L. J. Mann and others, *Iodine in the Snake River Plain Aquifer at the Idaho National Engineering Laboratory, Idaho,* Report 88-4165, September 1988.

[25] U.S. Geological Survey, R. C. Bartholomay, *Iodine-129 in the Eastern Snake River Pain Aquifer at and near the Idaho National Laboratory Idaho, 2010-12,* Report 2013-5195, 2013.

[26] Idaho National Laboratory Site, Environmental Surveillance, Education, and Research Program, "1997 INEEL Annual Site Environmental Report." p. 6-14. "For perspective, the proposed EPA drinking water standard for I-129 in drinking water is 21 E-9 microCi/ml." But this 21 fold increase in the I-129 standard never happened. http://www.gsseser.com/Annuals/1997Annual.htm

Would decades of drinking highly contaminated drinking water at INL explain the NIOSH INL worker epidemiology results showing overall healthier INL workers when compared to surrounding states, but significantly elevated cancer deaths for certain cancers, among both radiation workers and non-radiation workers? Elevated rates of brain tumors, leukemia and lymphatic cancers were found in INL workers whether or not they were radiation workers. NIOSH conducted INL and Savannah River DOE federal site worker epidemiology studies. Both studies found that some cancers were elevated for both radiation and non-radiation workers.

Neither study addressed the drinking water contaminants, which were elevated for both chemical and radiological contaminants. [27] [28] Existing available INL well monitoring data would not be adequate to characterize the contamination. An analysis would be needed to identify all the contaminants and estimate the levels of the contamination that were not monitored or were inadequately monitored.

Summary

Contaminants began flowing into the aquifer in the 1950s. USGS started measuring various attributes of the water in 1949, but monitoring of radionuclide or chemical contaminants came years after the contamination occurred. Well sampling by USGS has been at irregular intervals and is available for some of the wells, some of the time. USGS and DOE reports typically do not identify which wells were used for drinking water and when the wells were used for drinking water or were taken out of service for that purpose.

Historical detection limits have improved over time, but in early decades were insensitive to low levels of the contaminants. Some contaminants reading zero may have been present in health significant amounts, like Iodine-129. Only a limited set of contaminants were sampled for, now known to be an incomplete set based on increased understanding of the waste waters disposal.

It is important to understand that the DOE's dose concentration guideline are 100 times more lenient that federal drinking water standards. And independent researchers estimate that industry-accepted radiation risk models understate the risks of internal radiation emitters from ingestion by at least a factor of 100. [29] MCLs are treated by regulators as though safe as long at they are not exceeded, but no one drinking the water should assume that.

Long-lived radionuclides have often been omitted from monitoring and reporting programs at INL, despite being among dominant contributors to radiation dose ingestion risk.

Piecing together the full history of chemical and radionuclide contamination in INL drinking water would require filling in the gaps of unmonitored contaminants now known to be present.

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[27] "An Epidemiology Study of Mortality and Radiation-Related Risk of Cancer Among Workers at the Idaho National Engineering and Environmental Laboratory, a U.S. Department of Energy Facility, January 2005. http://www.cdc.gov/niosh/docs/2005-131/pdfs/2005-131.pdf and http://www.cdc.gov/niosh/oerp/ineel.htm

[28] Savannah River Site Mortality Study, 2007. http://www.cdc.gov/niosh/oerp/savannah-mortality/

[29] ECRR – 2010 European Recommendations of the European Committee on Radiation Risk – The Health Effects of Exposure to Low Doses of Ionizing Radiation, Regulators' Edition: Brussels 2010. http://www.euradcom.org/2011/ecrr2010.pdf

The health studies of INL workers and radiation dose reconstruction for the energy workers compensation program performed by the National Institute of Occupational Safety and Health (NIOSH) have ignored INL's history of contaminated drinking water, probably because they didn't understand the extent of the problem.

Radiation doses from drinking water contamination may yield low expected doses using currently accepted radiation risk models. But the INL worker epidemiology indicates that non-radiation worker health at INL was harmed. A non-radiation worker's claim that their cancer was caused by work at INL would likely be denied. But the reality is that chemical and radionuclide contamination in INL drinking water at some facilities was extraordinarily high and for decades. The contaminant soup in INL's drinking water is not something that other populations have been subjected to, except at other DOE sites perhaps.

Tell the NIOSH its time they assessed INL drinking water and included it in dose reconstruction and future epidemiology studies.

This 2015 Report by Tami Thatcher, former INL safety analyst and nuclear safety consultant.

Table 1. Summary of selected disposal methods at selected INL facilities.

Facility	Disposal type	Years of disposal	Estimated quantity	Contaminants that have exceeded MCLs
Test Area North	Well, pond, ground contamination	1953 to 1993	61 curie 717 million gallon (Mgal)	Cs-137, tritium, Sr-90, TCE, PCE, DCE
Advanced Test Reactor Complex	Well, ponds, pipe leaks	1952 to 1998	53,879 curie 5,180 Mgal	tritium, chromium
Idaho Nuclear Technology and Engineering Center	Well, ponds, tank farm, retrievable storage systems	1952 to 1998	22,254 curie 19,165 Mgal	tritium, Sr-90, I-129, Tc-99
Central Facilities				tritium plume from INTEC
Radioactive Waste Management Complex	Excavated pits and trenches	1952 to 1970 1952 to 2009	1,532,600 curie 0.09 Mgal 629,000 curie listed in RI/BRA Table 4-2.	Aquifer: CCl4, Tc-99 Lysimeter: Tc-99, tritium, uranium, nitrate
Materials and Fuel Complex	Temporary burial, industrial ponds	RSWF in 1965	Radioactive Scrap and Waste Facility (temporary)	
Naval Reactor Facilities	Well, ponds, open drainage, burial	Since the early 1950s to present		
SL-1 burial grounds	Excavated pit	1960s		

Source: DOE/ID-22209, DOE/ID-11507 Five Year Review 2010-2014 OU 7-13/14, ICP/EXT-04-00244.

Table 2. Typical aquifer contaminants of concern at INL.

Constituent	Regulatory maximum contaminant level[1]	Background level	Location of Primary Interest[2]
Radionuclide (half-life, main decay mode)			
Tritium (12.3 year, beta)	20,000 pCi/L	0 to 150 pCi/L	INTEC, ATRC, RWMC, TAN, NRF, other areas
Carbon-14 (5730 year, beta)	2,000 pCi/L		RWMC
Chlorine-36 (301,000 year, beta)	700 pCi/L		RWMC, INTEC
Iodine-129 [3] (17,000,000 year, beta and gamma)	1 pCi/L	0 to 0.0000054 pCi/L (DOE/ID-22225, 2013)	RWMC, INTEC
Technetium-99 (213,000 year, beta)	900 pCi/L		RWMC, INTEC 2,200 pCi/L and increasing trend.
Neptunium-237 (2,144,000 year, alpha)	15 pCi/L		RWMC
Cesium-137 (30.2 year, beta)	160 pCi/L		RWMC, INTEC, ATRC, TAN, MFC
Strontium-90 (29.1 year, beta)	8 pCi/L		RWMC, INTEC, ATRC, TAN
Uranium-238 (4,470,000,000 year, mixed, alpha)	10 pCi/L		RWMC, TAN, INTEC
Total uranium	(30 microgram/L)		RWMC, TAN, INTEC
Gross alpha [4]	15 pCi/L		
Gross beta/gamma [5]	8 pCI/L (derived from 4 mrem/yr)	7 pCi/L (DOE/ID-11492, 2013)	
Organic Compounds			
Carbon tetrachloride (CCl_4)	5 microgram/L	0	RWMC, INTEC
Methylene chloride	5 microgram/L	0	RWMC
Tetrachloroethylene (PCE)	5 microgram/L	0	RWMC, TAN
Trichloroethylene (TCE)	5 microgram/L	0	RWMC, TAN 1350 microg/L
Inorganic Analytes			
Nitrate	10 mg/L	2 mg/L	INTEC, RWMC, MFC
Chromium	100 microgram/L	0	RWMC, ATRC, MFC, TAN, INTEC, PBF
Sodium	(an indicator of nuclear process waste)	Usually less than 10 mg/L	1.5 million lb/yr discharged by INL during 1989-1991 at INTEC, ATRC, NRF, CFA, MFC

Table 2 notes:
Source: Department of Energy, *Operable Unit 7-13/14 Five-Year Monitoring Report for Fiscal Years 2010-2014*, DOE/ID-11507, August 2014, and Idaho Cleanup Project, *Five-Year Review of CERCLA Response Actions at the Idaho National Laboratory*, DOE/NE-ID-11201, Revision 3, February 2007.
Notes:
1. Maximum contaminant level from US Environmental Protection Agency for drinking water, 10 CRF 141.
2. Some monitored locations indicated here may apply to perched water rather than the aquifer. RWMC soil sampling is also included.
3. "I-129 is monitored for indirectly by analyzing for Tc-99" at the RWMC superfund site; USGS tends to report I-129 but not Tc-99. USGS monitoring of Tc-99 reported in journal articles rather than accessible USGS reports.
4. Gross alpha includes radium-226 but excludes radon and uranium.
5. Gross beta excludes natural sources.
6. Facilities are Advanced Test Reactor Complex (ATRC) formerly the Test Reactor Area and Reactor Technology Complex; Central Facilities Area (CFA); Idaho Nuclear Technology and Engineering Center (INTEC), formerly the Idaho Chemical Processing Plant; Materials and Fuels Complex (MFC) formerly Argonne National Laboratory – West; Naval Reactors Facility (NRF); Power Burst Facility (PBF);Radioactive Waste Management Complex (RWMC); Test Area North (TAN).
7. 1 curie is 37 GBq or 3.7E10 Bq. 1 Bq (Becquerel) is 1 disintegration per second.
1.0E-9 microCurie/mL is 3 pCi/L. 1 pCi/L is 1.0E-12 Ci/L.

Table 3. INL drinking water well information.

INL location, County, IDEQ DWS	Well name	Well identifier and USGS data date range	Historical contaminants from USGS Mapper data, highlights
Central Facilities Butte County 6120008	CFA 1 (651)	433204112562001 1957 to 2015	Tritium exceeding MCL; 140,000 pCi/L in 1968 Iodine-129 50% of MCL; 0.5 pCi/L in 1986 (USGS code 29913) 70% of MCL; 0.7 pCi/L in 1977 (USGS code 18501)
	CFA 2 (642)	433144112563501 1961 to 2014	Tritium exceeding MCL; 39,000 pCi/L in 1961; 76,000 pCi/L in 1974; 3670 pCi/L in 2014 Iodine-129 10% of MCL; 0.1 pCi/L in 1981 70% of MCL; 0.7 pCi/L in 1977
Near CFA 6120025	Rifle range	433243112591101 1988-2014	Tritium 1800 pCi/L in 2002 Cs-137 19% of MCL, 31 pCi/L in 2010 Chromium 16.7ug/L in 2002
INTEC Butte 6120012	CPP 1	433433112560201 1950, USGS data since 1972	Tritium exceeding MCL in 1972 at 26,000 pCi/L and 1983 at 27,200 pCi/L Iodine-129 50 % of MCL; 0.5 pCi/L in 1986 580 % of MCL; 5.8 pCi/L in 1981 (No data for 1977, see USGS report 88-4165. Now, why would there be no data?)
	CPP 2	433432112560801 1951, but no radiological data before 1972.	Tritium 83 % of MCL in 1981 at 16,700 pCi/L. Iodine-129 10 % of MCL; 0.1 pCi/L in 1986 120 % of MCL; 1.2 pCi/L in 1981 80 % of MCL; 0.8 pCi/L in 1977
	CPP 3	1951 data only	
	CPP 4	433440112554401 1983 to 2015	Tritium 2300 pCi/L in 1983, 130 pCi/L in 1993
ATR Complex	TRA 1	433521112573801 1950-2013, no data before 1972 except one year, 1960.	Tritium 230 pCi/L in 2013 Chromium slightly over 50% of MCL.
	TRA 3	433522112573501 1972-2014	Tritium 300 pCi/L in 1984 Chromium up to 50% of MCL.

INL location, County, IDEQ DWS	Well name	Well identifier and USGS data date range	Historical contaminants from USGS Mapper data, highlights
	TRA 4	433521112574201 1972-2013	Tritium 400 pCi/L in 1972; 50 pCi/L in 2008
TAN Butte 6120021	CTF 1 (FET 1)	435120112432101 1958-1987 No tritium monitoring until 1968	Tritium (pCi/L) < 2000 (1968) 0.0 (1987)
	CTF 2 (FET 20	435119112431801 1958-1987	Tritium 75% of MCL at 15,000 in 1968. Cs-137 25% of MCL at 40 pCi/L in 1987 Sr-90 20% of MCL at 1.6 pCi/L in 1987 Chromium up to 100% of MCL. Phenoloic compounds
	TSF 1 (TAN 1)	43505611242001 1953-1987 Most data for 1987 only.	Tritium 45% of MCL at 9000 pCi/L in 1968. Cs-137 over 6% of MCL at 11 pCi/L in 1987. TCE 154% of MCL at 7.7 ug/L in 1987 Sr-90 (ug/L) 260 (1977) 290 (1984)
	TSF 2 (TAN 2)	435100112420701 1953-1987 Most data for 1987 only.	Tritium at 4000 pCi/L in 1968 Cs-137 43% of MCL at 70 pCi/L in 1987 TCE over 100% of MCL at 5.4 ug/L in 1987 PCE over 25% of MCL at 1.1 ug/L in 1987
SMC (TAN) Butte 6120013	TAN 614		?
RWMC Butte 6120021	WMF-604 RWMC-604 Prod well	433002113021701 1974 to 2015	Tritium 2300 pCi/L in 1982 Cs-137 34 pCi/L in 2012 Carbon tetrachloride has exceeded 200 % of the MCL in 2010, yet IDEQ drinking water records do not reflect this.
MFC Bingham 6060036	EBRII-2	433544112391301 1957-1987	Sr-90 25% of MCL at 2 pCi/L in 1987 Cs-137 25% of MCL at 40 pCi/L in 1987

INL location, County, IDEQ DWS	Well name	Well identifier and USGS data date range	Historical contaminants from USGS Mapper data, highlights
NRF Butte 6120016	NRF 1	433859112545401 1982-1995	Gross alpha over 33 % of MCL at 8.1 pCi/L in 1995 Gross beta over 137 % of MCL at 11 pCi/L in 1995
	NRF 2	433854112545401 1951-2014	Gross alpha 54 % of MCL at 5 pCi/L in 1993 Gross beta over 137 % of MCL at 11 pCi/L in 1995
	NRF 3	433858112545501 1956-2014	Gross alpha over 60 % of MCL at 9.1 pCi/L in 1995 Gross beta over 150 % of MCL at 12 pCi/L in 1995 Bis(2-ethyl-hexylthalate (2013) 4 ug/L
	NRF 4	433853112545901 1989-1995	Gross alpha over 64 % of MCL at 9.7 pCi/L in 1995 Gross beta over 150 % of MCL at 12 pCi/L in 1995

Facility Area Acronyms: Advanced Test Reactor Complex (ATRC) formerly the Test Reactor Area and Reactor Technology Complex; Central Facilities Area (CFA); Idaho Nuclear Technology and Engineering Center (INTEC), formerly the Idaho Chemical Processing Plant; Materials and Fuels Complex (MFC) formerly Argonne National Laboratory – West; Naval Reactors Facility (NRF); Power Burst Facility (PBF);Radioactive Waste Management Complex (RWMC); Test Area North (TAN). Not listed are Butte County INL wells for EBR-I, ARA, WRRTF, OMRE, and Fire Station #2 that IDEQ collects non-radiological information for.
US Geological Survey Mapper Data: See well data at http://maps.waterdata.usgs.gov/mapper/index.html. For USGS data, I find it easiest to type in the 15 digit well identifier to display the well, which will be highlighted in yellow. Click on the well, click "access data" and select water quality data. You can display all stored data by selecting the "table of data" option. Data for a radionuclide may have be stored in multiple codes over time, i.e., iodine-129 used code 29913 and also 18501. Tritium has used 07000 and 07005.
Idaho Department of Environmental Quality Drinking Water: INL Site drinking water compliance data for chemical but not radionuclide data can be publicly accessed on the internet at http://dww.deq.idaho.gov/IDPDWW/ .