INL Contamination and the Snake River Plain Aquifer – The Essentials

This report summarizes key aspects of the contaminants disposed of at INL into and over the Snake River Plain aquifer, past and future dumping practices, and the movement of contaminants in the aquifer. A key point is that at no time was the contamination expected or reported until years after the dumping. Revelations of larger than expected concentrations, additional contaminants and larger plume spread have been largely underemphasized, even deliberately obscured, as the conversation is routinely steered toward saying contaminants are less than MCLs and are decreasing. The message should be that cessation of nuclear operations and dumping are the only things that have prevented greater contamination and that citizens were not informed of the contamination as it was occurring.

Radioactive and chemical waste contaminants have been disposed of into the Snake River Plain aquifer and more are poised to leach into the aquifer at the Idaho National Laboratory (INL), a Department of Energy nuclear research laboratory. There were primarily two ways INL put contaminants into the Snake River Plain aquifer: one is by waste water streams directed into disposal wells or percolation ponds; the other is by burying wastes or above above-ground leaks. See Table 1 for a listing of disposal practices by facility site.

Past waste water practices. The liquid waste-intensive practice of reprocessing government-owned spent fuel at the Idaho Nuclear Technology and Engineering Center (INTEC) ceased in 1992. From 1952 to 1984, wastewater at INTEC was discharged directly to the aquifer from a 600 ft deep disposal well. Millions of gallons of waste water, nearly a million gallons per day, about 21,100 curies of tritium from 1953 to 1988, [1] were disposed of. Unlined percolation ponds were then used until fuel reprocessing operations ceased. Leakage from INTEC's high level waste storage tank farm in 1972 contaminated soil and the aquifer including thousands of curies of strontium-90 and cesium-137 and other radionuclides. Chloride, fluoride, nitrate, sodium and sulfate were discharged in waste water and the contaminants from INTEC extend far south of INTEC.[2] [3]

Despite U.S. Geological Survey "constant scrutiny" of groundwater at INL, in each case, the public was not informed of the contamination until years after the fact. [4]When USGS put forth a report about INTEC contamination in 1990, it gave it a positive spin by emphasizing

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

[2] US Geological Survey, An Update of Hydrologic Conditions and Distribution of Selected Constituents in Water, Snake River Plant Aquifer and Perched Groundwater Zones, Idaho National Laboratory, Idaho, Emphasis 2006-08, DOE/ID-22212, Report 2010-5197, 2010.

[3] 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.

[4] 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

the radioactive decay of a major contaminant, tritium, only monitored since 1961 and the reduction in annual disposal since 1988.

Wastewater from reactor operations at the Advanced Test Reactor Complex (ATRC) entered groundwater from percolation ponds and disposal wells. Hexavalent chromium was a significant chemical contaminant in waste water at the ATRC. The reactor radioactive wastewater ponds are now lined. But there are tradeoffs; more contamination is put into the atmosphere, and resins used to capture contaminants prior to waste water disposal are later placed in the ground above the aquifer at places like the Radioactive Waste Management Complex to slowly leach into the soil, then aquifer.

Disposal wells, ponds and wastewater dumping have now ceased at Test Area North (TAN) and the Naval Reactors Facility (NRF). Chemical wastes disposed of at TAN and buried at RWMC now require vacuum extraction. All of these INL sites became high priority cleanup sites under CERCLA superfund remediation.

Buried Waste: Past, Present and Future: Radioactive waste is basically plowed under at many sites at INL such as ATRC past percolation ponds and the burial site for the SL-1 reactor accident. [5] But most wastes were buried in unlined soil pits and trenches at INL's Radioactive Waste Management Complex. Radioactive wastes from INL and from around the DOE complex and U.S. were dumped at RWMC since 1952 based on the assumption the contaminants would take thousands of years to migrate.

The chemical and radioactive waste from DOE's Rocky Flats weapons plant has been given the most focused attention by the State of Idaho[6] where chemical wastes continue to exceed maximum contaminate levels. Transuranic waste [7] from the Rocky Flats Plant included extensive amounts of chemical solvents were buried at RWMC until 1970. An estimated 88,400 gal of organic waste included 24,400 gal of carbon tetrachloride; 39,000 gal of lubricating oil; and about 25,000 gal of other organic compounds, including trichloroethane, trichloroethylene, perchloroethylene, toluene, and benzene. About 17,100 Ci of plutonium-238, 64,900 Ci of plutonium-239, 17,100 Ci of plutonium-240, and 183,000 Ci of americium-241 were buried during 1952 to 1999.[8] [9]

After Rocky Flats waste was supposedly no longer "buried" for "temporary" storage at RWMC, some of the waste that was to be "retrievable" was placed on "Pad A." For this particular

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[5] US EPA, EPA Superfund Record of Decision: Idaho National Engineering Laboratory (USDOE) 12/01/1995, EPA/ROD/R10-96/147, 1996. http://www.epa.gov/superfund/sites/rods/fulltext/r1096147.pdf

[6] See more about Idaho's Settlement Agreement at https://www.deq.idaho.gov/inl-oversight/oversight-agreements/1995-settlement-agreement.aspx

[7] Tranuranic waste (TRU) contains isotopes above uranium in the periodic table of chemical elements. They are long-lived by-products of weapons fabrication, fuel assembly and reprocessing. Unfortunately, uranium was not included in the definition, although it is also a long-lived contaminant and poses a threat to the environment and human health when in concentrated leachable forms.

[8] ibid DOE/ID-22212.

[9] Idaho Cleanup Project for the for DOE-NE Idaho Operations Office, "Five-Year Review of CERCLA Response Actions at the Idaho National Laboratory," DOE/NE-ID-11201, Revision 3, February 2007. https://ar.inl.gov/images/pdf/200702/2007022600146TUA.pdf

waste, the barrels were stacked on an asphalt pad, plywood was placed over the barrels, and a few feet of soil were placed over the uranium and nitrate-laden oxidizing waste. With the WIPP accident in February 2014 from an explosive mixture of nitrates and organic kitty liter, [10] [11]it is understandable that this waste might not have been welcome at WIPP. Attempts to grow vegetation on the soil have repeatedly failed. Nitrate and Uranium concentrations keep increasing and the proposed solution is to leave Pad A there and stop monitoring near Pad A. I'm not kidding! (See the DOE/NE-ID-11201 Rev. 3 Five Year Review.)

Don't worry – institutional control will be maintained until the 5 year reviews for the CERCLA site end. They simply say that institutional controls will be in effect for "at least 100 years" — knowing that the wastes will trickle out health significant levels of contaminants for hundreds of thousands of years.

Most of what was buried at RWMC will remain buried there—that is except Pad A, which was never actually buried and will supposedly be protected by a contoured cap — a feature that the proposed INL Replacement Facility says cannot be maintained and is actually detrimental.

While retrieving buried waste for CERCLA cleanup at great effort and expense, DOE has continued to add radioactive waste to RWMC. As the CERCLA cleanup of long-lived transuranic waste from Rocky Flats was being retrieved to be sent to WIPP as agreed to by DOE, Idaho Department of Environmental Quality, and the Environmental Protection Agency, other long-lived contaminants like technetium-99 and iodine-129 have quietly been added in the form of resins and other remote-handled wastes from Naval and DOE reactor operations. [12]

So, while volatile chemicals continue to be vacuum extracted, the dominant radionuclide contributors to aquifer contaminants will be technetium-99 and iodine-129 from INL wastes regardless of meeting the Idaho Settlement Agreement to ship about 6 acres of the 35 acres of buried transuranic waste from RWMC.

Plans for additional buried waste at INL have been made for the Replacement Remote-Handled Low-Level waste facility at ATRC.[13] Don't let the words "low-level waste" fool you: the waste at RWMC and Replacement RH-LLW facility will contaminate the aquifer for hundreds of thousands of years and in health significant quantities. At the Replacement RH-LLW facility, waste in welded metal canisters will be placed in concrete vaults with holes in

[10] WIPP Department of Energy website: http://www.wipp.energy.gov/wipprecovery/recovery.html

[11] Mark Oswald, Albuquerque Journal, "LANL changed rules on handling WIPP waste; red flag on nitrates removed," http://www.abqjournal.com/527111/news/nitrates-believed-to-be-part-of-wipp-leak-cause.html and WIPP woes due to wrong word?" February 6, 2015 http://www.abqjournal.com/537476/news/wipp-woes-due-to-wrong-word.html

[12] Mark R. Arenaz, US Department of Energy, "Remediation of Buried Waste at the Idaho National Laboratory Site," WM2010 Conference, March 7-11, 2010 Phoenix, AZ. http://www.wmsym.org/archives/2010/pdfs/10065.pdf

[13] 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

the bottom to prevent water build up. No clay liner like neighboring Idaho CERCLA Disposal Facility a couple of miles away and no magically contoured soil cap to supposedly prevent water infiltration and subsequent contaminant leakage as RWMC's remediation relies on. The modeled rate of contamination trickling into the aquifer is orchestrated to never exceed maximum contaminant levels by the wonders of biased science and by assuming away variations in precipitation and episodic flooding.

What sort of contaminants were poured into the aquifer? Tritium, cesium-137, strontium-90, plutonium and uranium, and later recognized long-lived radionuclides such as iodine-129, technetium-99, neptunium-237, and chlorine-36. Most never identified until years after they were dumped. Chemicals including hexavalent chromium, carbon tetrachloride and many others. The INL disposal well at INTEC started injecting huge amounts of tritium and other radioactive and chemical wastes in 1952. But, USGS monitoring of tritium did not start until 1961 and tritium measurements even years after that were characterized by USGS as "experimental." And while an assortment of radionuclides were monitored, important long-lived radionuclides were not monitored. See Table 2 for a list of radionuclide and chemical contaminants in the INL aquifer.

Where do contaminants in the aquifer go and how fast do they go there? Pollutants plume like wet ink on paper, but then generally go with the prominent aquifer flow from northeast to southwest, to Thousand Springs and the Snake river at Hagerman Idaho. Contaminants that must first migrate through the soil take longer to get into the aquifer than those disposed of in large waste water streams.

The aquifer was once thought to take thousands of years to reach Thousands Springs. It takes about one hundred years to travel its entire length. [14] Wastes with a short half life may decay substantially before reaching Thousand Springs. But, long-lived radionuclides like Tc-99, Cl-36, I-129 and Np-237 will virtually be in the environment forever in the aquifer and downstream.

In 2009, the USGS performed an analysis of water quality at wells at INL since 1949. [15] Wells were selected for analysis with the intention of selecting wells not influenced by INL waste water disposal practices; but several wells showed influence of historical waste water disposal practices. So, fifty years after the contamination began spreading, the USGS still didn't know where it had spread. Reports examining tritium often dismissed the readings as due to weapons fallout with no serious analysis. But, chlorine-36 levels and sodium levels have shown indisputable INTEC wastewater influence. [16]

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[14] U.S Geological Survey, *Estimated Age and Source of the Young Fraction of Ground Water at the Idaho National Engineering and Environmental Laboratory*, Report 01-4265 (DOE/ID-22177), November 2001 (the aquifer spans from north of INL to Thousand Springs.)

[15] U.S. Geological Survey, *Water-Quality Characteristics and Trends for Selected Sites At and Near the Idaho Laboratory*, Idaho 1949-2009, Report 2012-5169 (DOE/ID-22219), 2012.

[16] 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

A USGS analysis of radioactive chlorine-36 and the ratio of stable chlorine examined archived waster samples from 1966 to 1993. The report states : "archived water samples indicates the chlorine-36 from INEEL operations was detectable at well USGS 14 no later than 1982; the minimum velocity calculated from this estimate of first arrival is 2.4 meter/day. The chlorine-36 concentration in waster from well USGS 14 in 1982 was . . .about 3 times the estimated background (including weapons-test contributions). . ." [17] While the amount of chlorine-36 detected is small, USGS 14 is miles farther away from the INTEC disposal well than most sampled wells—over 14 miles south of the INTEC disposal well and 5 miles south of the INL southern boundary. The detection of chlorine-36 "no later than 1982" is also in contrast to INL claims in the mid-1990s that there was no detectable contamination beyond the INEL boundary.

If samples were archived since 1966, why wasn't a sample earlier than 1982 available for the Chlorine-36 analysis of USGS 14 in Report 98-4008? With knowledge now of the variation of contaminant levels that can occur at different elevations in a well, shouldn't the sampling depths of the wells monitored south of INL be reassessed? Given that now USGS 14 (also labeled MV-61) is acknowledged to be inside the plume path of INTEC disposal, its inconsistent coverage in analyses of wells south of INL could result in inadequate analysis of past contamination. [18]

Approximately 0.94 curies of iodine-129 were discharged to the disposal injection well and infiltration ponds at INTEC between 1952 and 1990. This caused elevated levels of iodine-129 in the aquifer near and downstream of INTEC, near or exceeding the maximum contaminant levels (MCLs) in 13 wells when first sampled for I-129 in 1977 in wells less than 3 miles from the disposal well. Detection sensitivity increased 4-fold between 1977 and 1981, increasing the size of the I-129 plume.

Detection sensitivity was increased again in 1990, resulting in detectable concentrations of I-129 downgradient of INTEC that were used to calculate groundwater flow velocities of "at least 6 ft/day." [19]

Maximum contaminant levels of iodine-129 were exceeded in 11 wells in 1990. By 2012, the number of wells exceeding the MCL decreased to only one well, USGS 67 (see Table 3 of DOE/ID-22225). But, as wells near INTEC decrease in detected levels of iodine-129, wells farther south have continued to increase in detected levels of iodine-129 (see p. 16 of DOE/ID-22225 for wells USGS 137A, 108, and 103.) So, the contamination takes time to spread south of INTEC, determined by the volume of waste water, natural water recharge flow, and the highly spatially dependent and variable aquifer flow rate.

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[17] 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

[18] U.S. Geological Survey, *Historical Development of the U.S. Geological Survey Hydrologic Monitoring and Investigative Programs at the Idaho Engineering and Environment Laboratory, Idaho, 1949 to 2001*, Report 2005-1223 (DOE/ID-22195), 2005. See listing of reports for contamination from the southern boundary of INL to Hagerman, Idaho, not all are available online.

[19] 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. p. 6 and Table 3.

Weapons Fallout and More Fallout. The 1950s and early 1960s were bang up years for above ground weapons testing until the 1963 above ground weapons testing ban. [20] [21]So why was fallout so prevalent in 1965 and 1966, for example? Foreign weapons tests? INL releases? The brevity of short sentences display a curious lack of curiosity at USGS. It seems there are basically two get-out-of-responsibility ploys: (1) it was likely due to weapons fallout, and (2) we didn't budget to monitor that well or that contaminant. Oh, and (3) the dog drank the sample.

The USGS measured high levels of tritium from numerous INL wells and later attributed it to weapons fallout, dismissed the high values as "false positives" without analysis of what weapons tests or how their sample results became contaminated. [22] [23]A well "measures hot"? The USGS approach might surprise you. Their answer was apparently to just stop monitoring – there are years of lapses in monitoring of the north end of INL between 1963 and the mid 1970s. Or pretend the well wasn't there: when I asked about a 93,000 pCi/L spike in tritum in 1966 at the Mud Lake well, I was informed that the well was not dug in the 1970s – until I produced USGS report with 1960s data for the well. Citizens get an unwarranted comfortable appearance of monitoring and DOE gets to control and delay what gets monitored and reported.

Chemical Hazards Ignored Until CERCLA. The INL was proposed for listing on the National Priorities List in July 1989. The listing was proposed by the EPA under authorities granted by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980. This act is also referenced by the acronym "CERCLA" or as the "Superfund." The act was amended by the Superfund Amendments and Reauthorization Act of 1986. References to CERCLA include the amendments of 1986. The National Priorities List identifies the highest risk sites, as determined by a screening and ranking process, which are to be remediated via the CERCLA process. The INL was officially placed on the National Priorities List in November 1989. Subsequent to the CERCLA listing, the DOE, the EPA, and the IDHW (collectively referred to as the agencies) negotiated a Federal Facility Agreement and Consent Order and an Action Plan for remediation of the INEL. The documents were signed in December 1991.[24] So, about four decades late, chemical contaminants became recognized as being a threat to the environment and human health along with radionuclide contaminants.

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[20] US Geological Survey, G. L. Stewart and C. M. Hoffman, "Tritium Rainout over the United States in 1962 and 1963," Geological Survey Circular 520, 1966. http://pubs.usgs.gov/circ/1966/0520/report.pdf

[21] National Cancer Institute, interactive webpage for Radioactive I-131 from Fallout. To see counties affected by weapons tests and dates, see http://www.cancer.gov/cancertopics/causes/i131 and https://ntsi131.nci.nih.gov/

[22] 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 USGS well 14 and the Mud Lake well for tritium (H-3) spikes. Multiply picocurie/milliliter (pCi/mL) by 1000 to convert to picocurie/Liter (pCi/L).

[23] US Geological Survey, *Water-Quality Characteristics and Trends for Selected Sites at and near the Idaho National Laboratory, Idaho, 1949-2009*, Report 2012-5169 (DOE/ID-22219) 2012. The report recognizes only a few 1960s tritium spikes and does not discuss the now assumed to be "false positives."

[24] See the Administrative Record at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) documents for documents associated with this cleanup action, including "Record of Decision" documents and EPA mandated Five-year Reviews at http://ar.inel.gov

Waste Repository Studies or What They Knew and When They Knew It. In 2003, when INL contractors discovered high amounts of technetium-99 contamination at INTEC, later attributed to tank farm leakage, they wrote a report citing USGS research by Beasley in 1998. Tc-99 was found to be present in the aquifer at concentrations approximately twice the derived maximum contaminant level for Tc-99 of 900 pCi/L. [25] What is fascinating about this is that the Department of Energy never gave the Beasley report a number or place along with all of the INL USGS reports. This research which estimated the amount of Tc-99 dumped by INTEC disposal wells and aquifer contamination by other long-lived radionuclides was tucked away in a closed access journal article.[26] Apparently, DOE didn't want to worry Idahoans about long-lived radionuclides it had never before mentioned or predicted. Until I mentioned the missing report to USGS in 2015, neither it nor any other tecnhnetium-99 report were given any mention in the INL USGS bibliography. The Beasley 1998 report discussion includes significant INL contamination due to technetium-99, iodine-129, neptunium-237, and chorine-36—all long-lived contaminants that dominant health risks when leached into groundwater.

Technetium-99 has been detected in the vadose zone (the soil, sediment and rock layers above the aquifer) at the Radioactive Waste Management Complex at Zone 1, R2004 —at concentrations well above the derived MCL of 900 pCi/L. This same location has also yielded concentrations of nitrate, tritium, and total uranium that exceeded respective MCLs. Tc-99 continues a generally upward trend. [27]

Real Uncertainties in Aquifer Contamination Monitoring. In addition to the spread of contamination over time with the general direction of aquifer flows, the addition of multilevel wells in 2009 [28] has shown that contamination levels vary with well depth. For new multilevel monitoring wells, measured levels show variability of up and exceeding one order of magnitude (or by a factor of 10). The new wells prevent mixing of various levels as would be the case to various degrees in typical well sampling. This revelation puts a whole new spin on the uncertainty of the detected level: levels with detection level uncertainties for the sample (plus or minus a delta amount due to ability to detect radiation in the sample) need to be viewed with new understanding of the factor of 10 variability in detected levels of USGS well monitoring due to variations of contamination at different depths in the aquifer.

The wells that are monitored, the depth sampled, the analytes analyzed, and detection limits all affect the reported concentration of contaminants. We now know that over one order of magnitude variation in contaminant concentration can exist due to sample depth. But only the

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[25] 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. http://pbadupws.nrc.gov/docs/ML0609/ML060930199.pdf

[26] 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.

[27] Department of Energy, "Operable Unit 7-13/14 Five-Year Monitoring Report for Fiscal Years 2010-2014, DOE/ID-11507, August 2014. p. 31-32. https://ar.inl.gov/images/pdf/201409/2014091800949BRU.pdf

[28] 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.

uncertainty limits for detection limits of a given sample are evaluated. Results and plume maps are presented that seem to imply greater accuracy than exists. Contamination due to injection further upstream may result in the contaminants being deeper in the aquifer and well. Could the bulk of the plume have passed Rupert Idaho by the time cancers were reported and samples were taken? It appears plausible because the bulk of INTEC waste began in 1952 and could have reached Rupert by 1972. More investigation by USGS is needed.

Myth: MCLs are Protective. Nuclear promoters will rapidly pooh-pooh any adverse effects from tritium, pointing out it is just a beta emitter, shielded by a sheet of paper and basically just like water. You, as a rationale, informed person are supposed to be comfortable with the safety of anything below federal MCLs. California developed a tritium public water health goal of 400 pCi/L [29]—that's a lot lower than the federal 20,000 pCi/L MCL which reflects industry lobby influence more than it reflects human health risks. After Colorado became experienced with plutonium contamination of public water from surface water supplies, they lowered the MCL for plutonium from 15 pCi/L to 0.15 pCi/L.[30] And California's experience with hexavalent chromium caused them to enforce a limit 10 times below the federal MCL. [31]

What INL Workers Were Drinking. I only knew one guy who brought his drinking water to work at the site. He said he had friends in the lab that tested the water and knew what was in it. I didn't take his concerns seriously. I assumed if the water wasn't OK, they would tell us. The mix of radionuclides and chemical contaminants may have tasted good in coffee but may not have been good for workers at INL. It appears that the soup of drinking water contaminants were not adequately monitored, particularly between 1952 and 1988. During the early high times of tritium disposal at INTEC in the 1950s, tritium was not monitored, nor much else. High levels monitored in later years were discounted as near MCLs or less than proposed higher standards. I would have been interested to know how many contaminants were being detected and at what fraction of the MCLs—it was very deliberately kept quiet.

Around 1990, USGS had 76 wells in and south of INTEC and ATRC; 14 had tritium concentrations that exceeded 20,000 pCi/L drinking water standards.[32] Of 27 wells used for drinking water, the USGS disclosed only that one well exceeded drinking water standards for tritium and not the extent of contamination in the other wells. Nor is there any mention of contaminant results for any other chemical or radionuclide constituents. It's not easy to find out what was actually monitored and when, but given the history of inadequate monitoring and inadequately protective MCLs, workers health was likely affected. [33]

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[29] California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, "Public Health Goal for Tritium in Drinking Water," March 2006. http://oehha.ca.gov/water/phg/pdf/PHGtritium030306.pdf

[30] Arjun Makhihani, "Bad to the Bone," September 2005. http://ieer.org/wp/wp-content/uploads/2012/02/13-3.pdf

[31] In July 2014, California passed a maximum contaminant level (MCL) for chromium-6 of 0.01 mg/L or 10 ppb.[31] 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

[32] 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. http://pubs.usgs.gov/wri/1990/4090/report.pdf

[33] Summary of Historical Environmental Monitoring – A Supplement to the INL Site Environmental Report for 2013. It highlights the monitoring that was done— just not what was done or what was detected. Since INL

Sweet-sounding Statements About Aquifer Contamination: Be aware that as authors or presenters describe the radioactive contamination of the aquifer caused by INL, they know their job is to minimize the appearance of contamination from INL and the nuclear industry. For example:

- ***"Only trace amounts of contamination have been detected in the aquifer offsite"*** First of all, they were trying hard not to look offsite. There are unexplained gaps in monitoring and the presentation of data that often excludes offsite wells. And trace amounts can be harmful. In 1961 when tritium monitoring began, they could only detect 5000 pCi/L. The 1960s monitored values of 9000 pCi/L of tritium in USGS 14 and 93,000 pCi/L at Mud Lake have never been discussed in USGS reports.
- ***"No detected contamination exceeded MCLs*"** You are supposed to be comfortable with the safety of anything below federal MCLs but as discussed above, the MCLs are often 10 or more times too lax and are not protective of human health.
- ***"Levels of radioactive contamination are decreasing"*** There are general decreasing trends as contamination is diluted and as well as radioactive decay of shorter half-life contaminants. But should dilution be the solution to pollution? Sometimes trends have zig-zagged, especially regarding well 55, a perched water well and presenters/authors tend to promote optimistic trends. And touted decreasing trends can simply be due to flushing the waste downstream to the Snake River at Thousand Springs.
- ***"Attenuation of contaminants is reducing the level of radioactivity"*** This is relevant for the shorter half-life radionuclides that tend to move more slowly through soil. However, non-sorbing radionuclides like tritium, technetium-99, and iodine-129 move rapidly and the lack of historical detections comes from several reasons: the radionuclide wasn't monitored for that period of time, the radionuclide was periodically sampled but the detection level in earlier years wasn't able to detect low but significant levels, and the choice of wells and radionuclides sampled or presented in reports just happen to obscure INL releases or off-site contamination.
- ***"It hasn't contaminated the aquifer beneath the ATR Complex"*** But they may leave out the high levels of perched water contamination underneath it that will reach the aquifer eventually.
- ***"The drinking water for INL workers was monitored and below the MCLs"*** Improvements in monitoring took place in 1988, but detection limits and MCLs have also varied. Since levels of tritium contamination in the 1950s were not monitored until 1961, there appears to have been a variation in water monitoring programs over the years which has tended to be glossed over, even by the National Institute for Occupational Safety and Health in their dose reconstruction efforts.

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chemical contaminants were ignored until the late 1980s, one can safety assume that radionuclide contaminants were not comprehensively monitored nor were chemical contaminants monitored prior to 1988. In this cheerful optimistic publication, I keep expecting to read "The Snake River Happy Valley, where all the radionuclides in our milk and water help us grow big and strong."
http://www.gsseser.com/Annuals/2013/Supplements/Monitoring-History-Supplement%202013.pdf

If you are expecting that the government agencies will tell you if the water is contaminated, just don’t be surprised if they are not telling you the whole story and telling you only after it is too late to do anything about it.

Article 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

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 Engineerign 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).