Section I.H. Snake River Aquifer Contamination

The Snake River Plain Aquifer (SRPA) underlies the INL, and is a critical regional sole water resource in southeastern Idaho high desert extending approximately 320 km (200 mi) from Ashton, Idaho in the northeast to Hagerman, Idaho on the southwest where it empties into the Snake River at Thousand Springs. The aquifer consists of a series of basalt flows with inter-bedded sedimentary deposits and pyro-classic materials. The SRPA was designated as a sole source aquifer by the EPA in 1991 because it is the only viable source of drinking water for most communities on the Snake River Plain. [1]

"Radioactive, inorganic, and organic wastes releases from active and inactive waste sites have resulted in contamination of the Snake River Aquifer." [DOE/EH/OEV-22-P,p.3-166 + 115] "Some of the injection wells, such as at Test Reactor Area, Power Burst Facility, Test Area North, and INTEC (ICPP), disposed of the wastes directly into the Snake River Aquifer." [2] This practice of injecting radioactive waste water to "hot" to dump in open percolation ponds because of high radiation fields, was wide spread despite the fact that nearby aquifer wells were used by workers for drinking water. DOE knew the potable well water was contaminated but continued the practice until ID Governor Andrus forced them closed ~1982.

Significant spills and leaks have frequently occurred over INL's history. "Most spills have been the result of line and tank failures, leaking valves, and equipment and tanks overfilling. [Spill and/or leak] volumes range up to 45,000 gal.." [Ibid. @3-116]

"It should be noted that rather large quantities of chemicals were routinely disposed of via the ICPP disposal well." AEC documents acknowledge discharging on average "4.5 times the maximum permissible concentrations as given in Handbook 52". [IDO-14334 @12]

"The average level of activity discharged to the water table by the approximate 30 million gallons of water per month is on the order of 10^{-5} micro curies/milliliter [10,000 Pico curies per liter]. Ordinarily, the radionuclides which approach [1960] drinking water tolerance in the disposal well are iodine-131 and strontium-90. Radioactive decay is relied upon to reduce the iodine-131 to permissible levels and adsorption to reduce the concentration of strontium-90 should either of these radionuclides momentarily exceed drinking water tolerances during discharge." [IDO-14502 @10-11]

Other INL documents acknowledge ICPP injection well discharges exceeding 0.22 beta except for 7 curies of I-131 per million gallons. [IDO-14532 @13] "Chemicals used at ICPP such as metallic sodium and metallic potassium were disposed of by "pumping the solution on the desert." [ERDA-1536@II-102]

Idaho Division of Environmental Quality in April 1998, acknowledged that the ICPP drinking water wells were contaminated with the chemical TCE requiring DOE to install special treatment process before it went into the system. During a tour of the RWMC in 1996, the author found all the restroom sinks with signs warning not to drink the water. [3]

The State of Idaho in the late 1980s persuaded INL to stop injecting radioactive and chemical wastes into the aquifer. Currently, the wastes including plutonium, are dumped into unlined ponds and ditches. Waste discharged to these ponds continues to percolate into the aquifer. [Statesman/3/79] ICPP discharge rates range from 1 to 2.6 million gallons per day. [DOE/EH/OEV-22-P,p. 4-188] The large volumes are a deliberate attempt to dilute the contamination. The State mostly convinced DOE to phase out the use of percolation ponds, but only at the slow rate that DOE and NRF considers building new lined evaporation ponds.

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[1] 56 Federal Register 50634, October 7, 1991

[2] INEEL Subregional Conceptual Model Report, Vol. 3 September 2003, INEEL/EXT-03-01169 Rev.2, pg. 3-1.

[3] Snake River Plain Aquifer at Risk January 2019 Revision No. 40
http://environmental-defense-institute.org/publications/AquiferRPT40.pdf

INL Radioactive and Chemical Waste Injection Wells

Injection Well	History	Contamination	Status
Test Area North			
Technical Support Facility (TSF-05)	Drilled 1953 used to 1972 305 feet	Radioactive and Volatile Organic	Now used as extraction well for groundwater remediation
Initial Engine Test (IET-06)	Drilled 1953 used to1978 329 feet IET Engine coolant and fuel	Radionuclides and chemicals	Converted to a monitoring well 1982
LOFT-04	Drilled 1957 used to 1980s	Cold waste water	Converted to a monitoring well 1980s
WRRTF well (WRRTF-05)	Drilled 1957 used to 1984 313 feet	50 mCi Cobalt-60 212 liter (56 gal) Turbine Oil	Abandoned 1984
Test Reactor Area (TRA-05)	Drilled 1964 used to 1982	Radionuclides and chemicals + Chromium	Converted to monitoring well 1982
Test Reactor Area (USGS-53)	Drilled 1960	Radionuclides and chemicals + Chromium	Converted to monitoring well 1964
INTEC (ICPP)			
(CPP-23)	Drilled 1952 580 feet	21,302 Curies of Rad. And chemicals	Pressure grouted closed 1989
(USGS-50)	Drilled 1960 Used to present	Radionuclides and chemicals	Currently used for emergency disposal (CPP-23 failure)
Auxiliary Reactor Area			
(PBF-15)	Used 1972 to 1984	Sulfuric acid, Sodium Hydroxide & chromium	Capped in 1979
(PBF-05)	Used 1972 to 1984 Discharge reactor coolant	Radionuclides and chemicals	Capped in 1984
MFC/ANL-W ANL-10 ANL-15 ANL-17	Discharge reactor coolant		

[ICPP RI/FS] [USGS Report 00-4222, DOE/ID-22168][INEEL/EXT-03-01169 Rev.2, pg. 3-1to 9.]

"Major discrepancies were discovered between recorded volumes of water pumped from the aquifer for [ICPP] production use when compared with water used and disposed or lost from February 1990 to December 1990. Approximately 20 million gallons were unaccounted for in June 1990 alone." "Since 1988, water level in a perched body of water approximately 370 feet below the tank farm rose nearly six feet. Measurements were taken in a well about 500 feet southwest of the tank farm." [IDEQ Oversight 92 @17] Also see Section IV(H) for more discussion on ICPP groundwater contamination.

The utter disregard for onsite workers using wells for drinking water is seen in this DOE document quote: "The service waste activity is allowed to average no more than three times drinking water tolerance in any isotope with the exception of very short-lived ones like iodine-131."[IDO-14532,p.49]

The Operable Unit (OU) 3-14 Feasibility Study is for the high-level waste tank farm soil and groundwater located at the Idaho Nuclear Technology and Engineering Center (INTEC):

> "Concentrations of strontium-90 (Sr-90), technetium-99 (Tc-99), iodine-129, and nitrate-N currently exceed State of Idaho groundwater quality standards (maximum contaminant levels [MCLs]) in the Snake River Plain Aquifer (SRPA). The baseline risk assessment [BRA] concluded that Sr-90 concentrations in the SRPA would exceed MCLs beyond the year 2095 and that cesium-137 concentrations in the soil will exceed risk-based levels after 2095. It also concluded that the other aquifer contaminants will meet MCLs by 2095.

"The BRA concluded that cesium-137 (Cs-137) concentrations in the soil will continue to exceed risk-based levels after 2095 for soil inside the tank farm boundary but will meet risk-based levels before 2095 for the two sites outside the boundary. The groundwater beneath INTEC currently exceeds State of Idaho groundwater quality standards at one or more monitoring wells for strontium-90 (Sr-90) and iodine-129 from the former injection well and for technetium-99 and nitrate measured as nitrogen from historical tank farm releases. Modeling results predicted that Sr-90 concentrations in the SRPA would continue to exceed the State of Idaho groundwater quality standard beyond the year 2095, but all other contaminants would meet the standards before 2095. Remedial action objectives and preliminary remediation goals are defined in the FS based on the BRA predictions.

"**In summary, the revised INTEC groundwater model predicts that, absent any remedial action, all contaminants except Sr-90, will be below Idaho groundwater quality standards by the year 2095. Contaminants that are highly retarded, such as Pu-239 and Pu-240, which also have long half-lives, and mercury, were modeled out to their peak concentration, which was well beyond the year 2095**." [4] [emphasis added]

Radioactive Waste Management Complex (**RWMC)** "One test well emitted organic gas levels 30 times the safe worker exposure limit and had to be sealed. Samples from the Waste Management Complex show the presence of tetrachloride and other organic compounds." [DOE/EH/OEV-22-P,p.3-166] An on-site drinking water well became so contaminated that it had to be shut down. [DOE/EH/OEV-22-P,p.ES-3] Purgable [sic] organics exist in concentrations 200-800 times maximum safety levels in perched aquifers. [Olsen Notes,7/31/89]

In addition to hundreds of thousands of gallons of bulk chemicals dumped in the SDA Acid Pit, containerized chemicals were dumped in other pits and trenches such as Pit-9 where 23,600 gallons were dumped.[EGG-WM-9966 @Apendix. A] The Acid Pit at the RWMC received 160,000 gallons of radioactive and chemical liquids between 1954 and 1961. [WMP-77-3 @2][IDO-22056 @9][Oversight(c), 1/6/96][INEL-94/0241][EGG-WM-10903@2-7] [5]

EPA and State regulators went along with DOE on a no-action (no cleanup) Record of Decision even though the risk assessment showed Pad-A would be contaminating ground water in excess of drinking water standards within 100 years. [EGG-WM-9967 @ 7-2]

Test Area North's (TAN) waste injection wells contaminated their own drinking water wells with trichloroethylene (TCE) at levels three times the drinking water standards. Other contaminates injected into the aquifer were PCE's, plutonium 238, 239, 240, Americium 241, cesium 137, cobalt 60, strontium 90 and tritium. [INL Oversight 7/91]

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[4] Operable Unit 3-14 Tank Farm Soil and Groundwater Feasibility Study May 2006, DOE-ID-11247

[5] Also see; EG&G-WM-10903; A Comprehensive Inventory of Radiological and Non Radiological Contaminates in Waste Buried In the Subsurface Disposal Area of the INEL RWMC During the Years 1952-1983,June 1994, Lockheed.

EGG-WM-9973; Remedial Investigation Feasibility Study Central Facility Area Motor Pool Ditch Oak Ridge National Laboratory, June 1992

EGG-9967; Remedial Investigation/Feasibility Study For Pad-A, Operable Unit 7-12 Waste Area Group 7 Radioactive Waste Management Complex, Idaho National Engineering Laboratory, Volume 1 of 2, V. Halford, et. al., EG&G Idaho.

EG&G-M-24884; Investigation of the Subsurface Environment at the INEL, Radioactive Waste Management Complex, B. Russell et al., 1985.

EG&G-WM-10090; Sampling and Analysis Plan for RWMC Subsurface Disposal Area, EG&G Idaho April 1992.

EG&G-WM-10903; A Comprehensive Inventory of Radiological and Non Radiological Contaminates in Waste Buried In the Subsurface Disposal Area of the INEL RWMC During the Years 1952-1983,June 1994, Lockheed.

EG&G-WTD-9438; A Brief Analysis and Description of Transuranic Wastes in the Subsurface Disposal Area of the Radioactive Waste Management Complex at INEL, Arrenholtz and Knight, Remedial Investigation Feasibility Study, RWMC, Administrative Record, EG&G Idaho, August 1991.

INEL-94/0241; Preliminary Scoping Track 2 Summary Report for Operable Unit 7-01, December 1994, Lockheed Martin, Idaho National Engineering Laboratory.

INEL-95/0310; (Formerly EGG-WM-10903) Rev.1; Volume 3; August 1995; A Comprehensive Inventory of Radiological and Non-Radiological Contaminates in Buried Waste in the Subsurface Disposal Area of the INL RWMC During the Years 1952 – 1983, Volume 3.

WMP-77-3; Waste Management Program, History of Buried Transuranic Waste at INEL, W. M. Card, EG&G Idaho, Idaho Falls, Idaho, March 1977.

TAN-TSF-05 injection well

* " Inventory of waste is estimated as ranging from 350 to 35,000 gal of TCE. Records of TCE use at TAN show that 25,670 gal were used from 1955-1972.
* " Suspected discharges of heavy metals.
* " From 1972 to the early 1980s, the well could have been used for overflow, but no records are available.
* " Release of contaminants from the secondary source sludge has been modeled.
* " Additional research is being performed through and in support of remedial activities." [6]

The LOFT reactor at TAN alone contributed 150 Ci/yr. to the peculation pond. [ERDA-1536@II-120] See Section IV (C) below for more details on TAN contamination issues.

Test Reactor Area (TRA) contains the Materials Test Reactor, Engineering Test Reactor, Advanced Test Reactor, ATR Critical Facility, TRA Hot Cell Facility, Advanced Reactivity Facility (2 reactors), and three other research labs. Currently the only reactors operating are the Advanced Test Reactor and the ATR Critical Facility. TRA leads all other INL areas for radioactive waste discharges. Between 1952 and 1981 50,840 curies were released through percolation ponds or injection wells, or 83% of INL's total liquid discharges for the period. [ID-10054-81] Beta-Gamma radioactivity concentrations in wastes dumped in the ponds was 1.1×10^{-2} uCi/ml [11,000,000 pCi/L]. [ERDA-1536@II-147]

The soils at INL are very porous. DOE studies on the transmissivity of contaminates in INL soils show that tests in the vicinity of TRA showed transmissivity as high as 18,000,000 gal/day/ft. and porosity of the aquifer as high as 15%. [EGG-ER-8644 @ 35] A February 1999 USGS study put the aquifer transmissivity under INL in a range as high as 32,000 feet per day (6.06 miles/day). [DOE-ID-22155] This means contaminate in the aquifer can move rapidly down gradient in the direction of the Snake River.

Four TRA percolation ponds, received 80.39 billion gallons of waste. [TRA ROD @ 5] Between 1952 and 1974 these ponds alone received 41,049 Ci of radioactivity. [ERDA-1536@II-109,150,III-61] The reason for the high volumes of water was the once through cooling for the reactors requiring dilution. TRA pond algae registered 100 mR/hr. Migrating ducks (usually 25 at any one time) using the pond registered radionuclide concentrations in tissue samples. [Ibid. @ III-75-76] Also see Section IV(B) Test Reactor Cleanup Plans for the Warm Waste Pond. Chromium used to retard corrosion in the reactors was dumped in concentrations of 500 ppm when the standard in 1974 was 0.05 ppm, or 10,000 times over regulatory standards.[Ibid. @III-79] Also see Section IV(B). TRA radioactive dumping migrated to the perched water under the site in the following Pico curie per liter (pCi/L) concentrations: [Administrative Record Analytica-ID-12782-1]

Plutonium-239,240, and Pu-238 in Test Reactor Area leaching ponds were found in net plankton in concentration ranges (CRs) from 40,000 to 400,000. [DOE/ID-12111,P.39] Plants and animals concentrate these contaminants within their systems. Current monitoring of the Snake River Aquifer by the USGS indicates the presence of tritium, sodium, strontium-90, chloride, nitrate, and iodine-129 contamination plumes". [DOE/EH/OEV-22-P,p.3-167]

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[6] INEEL Subregional Conceptual **Model Report** Volume 3: Summary of Existing Knowledge of Natural and Anthropogenic Influences on the Release of Contaminants to the Subsurface Environment from Waste Source Terms at the INEEL September 2003 INEEL/EXT-03-01169 Rev. 2, Pg 3-4.

Contaminates in TRA Perched Water

Nuclide	Concentration	Nuclide	Concentration
Cobalt-60	12,200,000 pCi/l	Cesium-137	21,000,000 pCi/l
Americium-241	16,700 pCi/l	Strontium-90	18,000 pCi/l
Tritium	3,940,000 pCi/l	Cesium-134	62,400 pCi/l

[Administrative Record Analytica-ID-12782-1]][Also see Section IV.D ATR Cleanup Section for a full listing]

Between these TRA reactors there are 15 radioactive waste tanks, some of which have leaked. Two injection wells were also used to dispose of radioactive coolant water which contained hazardous chemicals. Injection well No. 53 received 3.89 x 10^{+9} (3.89 billion) gallons containing 31,131 lbs. of carcinogenic hexavalent chromium. Well No. 05 received 2.2 x 10^{+8} (220 million) gallons between 1964 and 1982. Between 1952 and 1972 the three TRA reactors discharged 55,353 lbs. of Cr(VI). [Administrative Record Analytica-ID-12782-1 Aniliticia @F-4-25&6]

The high water volume was due to once through coolant for the reactors and the fuel storage canal. Collective TRA waste water disposal volumes to ponds and injection wells are 84.5 billion gallons. [TRA ROD@5] Currently the injection wells are not used, but the percolation ponds are in use. INL dumped huge quantities of chemicals into pits and in sub-surface leach fields. 600 tons of sulfuric acid, 300 tons of sodium hydroxide, and 50 tons of sodium chloride were dumped in the TRA waste ponds. [ERDA.@II-79&80] See Section IV (A) below for more details on TRA contamination issues.

The following representative figures show that chemical contamination is equally a significant part of the problem at INL. Chemicals included tributyl phosphate, Hexone Methyl Isobutyl ketene. [Ibid.@E-8]

Hazardous Chemicals Dumped at INL (1975-76)

	1975	1976
Surface Chemicals Disposed	3,053,000 gal.	2,989,000 gal.
Sub-Surface Chemicals Disposed	1,550,000 gal.	1,508,000 gal.

[ERDA -1536 @ E-8]

"The results of the groundwater risk assessment are presented in Table 1-3. The groundwater currently exceeds MCLs in one or more aquifer monitoring wells for strontium-90, technetium-99, iodine-129, and nitrate measured as nitrogen. However, there are no receptors because workers are provided drinking water from wells located upgradient of INTEC. The groundwater model predicts that strontium-90 concentrations will continue to exceed MCLs beyond the year 2095. Strontium-90 was identified as the primary contaminant from the OU 3-14 tank farm sources that could adversely impact groundwater quality beyond the year 2095. The model predicts that the SRPA will meet drinking water standards before 2095 for all other contaminants from INTEC sources. Although the model underpredicts current technetium-99 concentrations in two aquifer wells (measured concentrations are three times the model prediction), the concentrations are predicted to be 10 times below the MCL before 2095. Assuming that all peak contaminant concentrations occur at the same time, the maximum cumulative risk to a future resident from all carcinogens would be 3E-05. The hazard index is 0.05 for noncarcinogens (mercury and nitrate).

"Workers and the public are assumed to be provided safe drinking water until 2095. After 2095, it is assumed that hypothetical future residents living outside the industrial use area can drill wells and be exposed to contaminated water." [pg.-21] [7]

[7] Operable Unit 3-14 Tank Farm Soil and Groundwater Feasibility Study May 2006, 1.3.10 Groundwater Risk Assessment, DOE-ID-11247. "However, there are no receptors because workers are provided drinking water from wells located upgradient of INTEC," is not a true statement because the contaminate plumes show they extend

The above DOE predictions use gross underestimates of the speed of groundwater movement and the soils ability to filter contaminates. See below Aley 1980 study of ground water movement. All of these predictions rely on institutional control for 100 years which is absurd. The State of Idaho is barely 100 years old! These contaminates have a biological impact long past their half-lives. The bottom line is workers and future generations are being condemned to contaminated water. DOE is relying on putting soil caps over its contaminate sites to limit the migration into the aquifer.

> "Capping to meet [remedial action objective] RAOs I and II would require reducing infiltration rates sufficiently that Sr-90 concentrations after 2095 would not exceed applicable groundwater quality standards in the SRPA. Given that RI/BRA base case modeling indicated that Sr-90 concentrations will remain above the maximum contaminant level (MCL) until 2129, the cap is assumed to have to remain effective at controlling infiltration for at least 117 years. The required areal extent of an infiltration control cap to meet RAOs I and II is discussed in Section 4. [Pg. 3-21]
>
> [BUT]
>
> "Because the predicted peak concentrations from each non-CERCLA source are much less than the MCL of 900 pCi/L and occur post-2095, and the peak predicted concentration post-2095 from CERCLA sources (10 pCi/L) is also much less than the MCL, there would be no concerns for cumulative risk, even if the maximum predicted concentrations from the non-CERCLA INTEC sources occurred at the same place and time and were summed." [8] [pg. 1-20]

DOE and the commercial nuclear industry have consistently discounted the health impacts of tritium contamination. However, a growing body of independent research has challenged this position. Dr. Charles Huver, a retired University of Minnesota biology professor who studies tritium for the Minnesota Pollution Control Agency, says the 20 Pico-curies per milliliter tritium standard is at least 1,000 times too high because of tritium's "chromosome-breaking ability". [Spokesman (a)] Tritium from INL dumping has migrated the 50-miles via the aquifer to the Snake River. USGS 1994 to 1999 spring discharges to the Snake River sampling data show significant tritium concentrations near Twin Falls and Hagerman areas. [DOE/ID-22180]

Also, 1993 USGS monitoring found Iodine-129 from the ICPP 3.4 square mile ground water plume, with concentrations of 0.25 pCi/l, in two wells eight miles south of the INL boundary near Big Southern Butte. [Environmental Science Foundation July 1997] The INL DEIS also acknowledges the tritium and I-129 plumes have migrated off-site. Iodine-129, a byproduct of the fission of uranium, is of concern because of its 15.7-million-year half-life. Because of this it is considered by EPA to be a permanent environmental pollutant and the drinking water standard for I-129 is set at one pCi/l.

Government estimates do not consider the effect of irrigation when predicting the speed with which contaminates migrate. Agriculture in the INL region is expanding rapidly. As a warm desert ecology, farming relies solely on irrigation to produce high yield products. Idaho uses 22 million gallons per day - second highest amount of water used for agriculture in the nation. [UIWR]

On a total per capita water usage basis, Idaho ranks first in the nation with 22,000 gallons/person/day - with second place going to Wyoming at 13,052 gal/person/day. [UI WR # 887] So much water is being drawn from the aquifer that the water table has dropped three feet in the late 1980's. [AP(a),1/1/89] Municipal water for 41 communities also adds to the drain on this aquifer. [UI WR # 887] Three years of drought have exacerbated these conditions requiring even greater demands on the aquifer. [AP(a),1/1/89] Drought conditions continue with June 1992 Snake River average flow of 3.7 billion gallons per day. The previous low was in 1977 at 5.2 billion gallons per day. [Times-News(d)] USGS studies show Snake River Plain Aquifer draw-down in excess of recharge is 410,000 acre feet/yr. [Times News (f) 7/19/92] Recharge from the 1996-1997 winter show pack run off halted this trend but it is unclear whether previous loses were completely made up.

Snake River Aquifer springs feeding the Snake River provide the entire river flow west of Twin

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upgradient of water wells used by INTEC and many workers use water down gradient of INTEC such as CFS/RWMC.

[8] DOE-ID-11247, pg. 1-20 and Pg. 3-21.

Falls. The river flow east of Twin Falls is almost entirely diverted for irrigation. Irrigation of over 3 million acres of farm land is drawn from the Snake River Aquifer. [UI WR # 887] Rapidly growing agriculture and municipal water needs may pull INL's pollution back to the surface much faster than predicted. Reduced recharge and aquifer lower volume may increase the concentration level of INL contaminates.

A six member ground water study team commissioned by EG&G, an INL contractor, was canceled after its preliminary results showed that contamination "could move from INL to the Magic Valley within months." [Aley, 1980] Their findings revealed the presence of lava tubes that move water rapidly through the aquifer and exit at Thousand Springs on the Snake River. The Big Lost River that flows onto the north end of the Snake River Plain totally disappears into the underlying soils.

Earlier DOE studies of aquifer contamination plume movement from ICPP to Central Facilities Area (CFA) between 1953 to 1958 document a seven foot/day or one-half mile/yr. Contaminate travel time from surface disposal to the aquifer is approximately 4-6 weeks or 10 feet/day. [ERDA-5316@II-120&III-81]

Because the aquifer is not a homogenous geologic structure, but rather a very heterogeneous mix of different strata, and therefore, no generalized characterization about water movement within the aquifer is valid. For instance, the entire volume of the Big Lost River literally disappears into the porous Snake River Plain. The significant gradient change from 200 feet in the north east to 600 feet in the south west aids the water movement through the aquifer.

As previously noted, a 1993 US Geologic Survey water sampling has disclosed Iodine-129 in wells south of the INL boundary. [AP(e) 2/13/93] Well number 11 located 4 miles south of INL and 3.5 miles west of Big Southern Butte contained concentrations of I-129 of 1×10^{-5}. Well number 14 located 8 miles south of INL and 6 miles southeast of Big South Butte has I-129 concentrations of 3×10^{-5}. [Phone conversation with Oversight 2/18/93]

DOE announced in 1990 that radioactive chlorine-36 from the ICPP has also been detected off-site in concentrations of 0.2% of the drinking water standard. [Environmental Science and Research Foundation, July 1997] "Our computer modeling has predicted for years that these contaminants would be detected off-site," according to Brad Bugger, INL spokesman. [AP (e)Daily News 2/14/93] These are significant DOE admissions which contrast decades of denials that INL contamination would migrate off-site.

In a 1994 study of sorption of radionuclides in basalt and interbed materials of the Snake River Plain found breakthrough of Sr-90 of 43%; Cs-137 of 94%; U-233 of 89%; Pu-239 of 33.5%; Am-241 of 9%; and Co-90 of 0.9%. [Goff] This study contradicts DOE's contention that the basalt underlying the INL is a good filter for radionuclides and the aquifer is not at risk from migration of contaminates dumped into percolation ponds and injection wells. INL's Health and Safety Division found:

"A tracer study using fluorescein dye and a 'slug' amount (10 tons) of common salt was initiated during October [1958] for the purpose of determining the rate of movement of the underground water. The dye was detected in four wells at distances up to 900 feet. A maximum rate of movement of approximately 100 feet per day was indicated."..."On December 9, 1958, an unidentified source at the CPP began discharging liquid waste at levels which averaged ten times the maximum permissible concentration for Strontium 90, in addition to other fission products. Traces of this material began to appear in the monitoring wells at a distance of 700 to 800 feet on December 15 which substantiated the flow rate as determined by the tracer." [IDO-12082(58)@60]

A 2001 USGS report confirms the above contaminate migration prediction. Plutonium-238, 239/240, Americium-241, and Cesium-137 were detected in wells 20 miles south of the INL boundary. The report shows Plutonium concentrations of 0.01 pCi/l in Grazing Well # 2, and Grazing Service CCC # 3. [DOE/ID-22175]

The Snake River flows into northern Idaho where it turns west at Lewiston, Idaho and joins the Columbia near the Tri-Cities, Washington. Any radioactive and chemical wastes which INL puts into the Snake River Aquifer may eventually reach northern Idaho, southern Washington, and northern Oregon. The affected water pathway populations studied may need to be extended beyond the immediate vicinity of the INL site with special emphasis on down-gradient populations of the Snake River Aquifer. Oregon's

Health Division found in studies of the State's surface waters that after the Hanford reactors were shut down and ended direct reactor coolant dumping into the Columbia, that the Snake River contributed the highest levels of radioactivity to the Columbia River. [Oregon @ 1]

Snake River Aquifer Water Sampling

INL's southern boundary is about 53 miles from the Rupert area and about 110 miles from the Hagerman area (see map below). INL over the past five decades has dumped vast quantities of radioactive waste into shallow pits, trenches, and unlined percolation ponds. Billions of gallons of radioactive waste water was also injected directly into the aquifer until the early 1980's when then Governor Cecil Andrus forced the federal government to end the practice. A 1995 U.S. Geological Survey report notes:

> "In the past, wastewater containing chemical and radio chemical wastes generated at the INEL was discharged mostly to ponds and wells. Since 1983, most aqueous wastes have been discharged to infiltration ponds. Many of the constituents in the wastewater enter the aquifer indirectly following percolation through the unsaturated zone." [DOE/ID-22130,p.3]

The following table shows U. S. Geologic Survey (USGS) 1989-1996 water sample data from 33 of the 55 monitoring wells in the Snake River Aquifer south of INL between Rupert on the east and Hagerman on the west. These monitoring wells are in the Magic Valley group of wells checked by USGS in three sampling campaigns (1989, 1990-92, and 1994-96). The sample data show gross beta and alpha radioactivity over the period and is used as a screening method to determine if additional testing is needed.

The comparative water sample data is a means of identifying trends in the migration of radioactive contaminates. The USGS emphasizes that the Magic Valley monitoring wells remain below the Environmental Protection Agency maximum concentration level (MCL) standard for drinking water. If increasing trends are confirmed, then additional isotope specific tests may be needed to identify the source of the contamination.

The following two tables compare gross beta and gross alpha particle radioactivity, which is a measure of the total radioactivity given off as beta or alpha particles during the radioactive decay process. USGS instruments were calibrated for dissolved cesium-137 (gross beta) and dissolved thorium-230 (gross alpha). The concentrations of gross beta/alpha particle activity are for reference only and do not imply that the radioactivity is attributed to these specific isotopes. The numbers in the table are the mean or middle number between an analytic plus or minus (±) uncertainty range published in USGS reports.

Snake River Aquifer Water Sample Data
Gross Beta (dissolved Cesium-137)(pCi/L)

Well #	1989	1990-92	1994-95	1996-98	1999-00
MV-01	7.8 ±1.21	7.3 ±1.65		6.86 ±1.76	10.7±2.4
MV-02	10.65 ±1.65	7.57 ±2.01	7.64 ±1.58	11.1±4.3	8.09 ±2.68
MV-03	4.88 ±0.77	4.33 ±1.28	4.58 ±2.91	5.84 ±1.36	
MV-04	6.54 ±1.2	7.38 ±1.67		5.83 ±3.11	7.43± 2.6
MV-05	7.36 ± 1.29	6.69 ± 1.51	12.0 ± 5.38	6.99 ± 1.89	
MV-06	6.12 ± 1.02	8.01 ± 1.63	7.93 ± 4.86	6.12 ± 1.61	
MV-07	4.62 ± 0.77	4.00 ± 1.26	6.49 ± 4.24	7.1 ± 4.2	
MV-09	10.6 ±2.0	8.96 ±2.31		10.2±4.2	17.34 ±5.36
MV-10	10.60 ± 1.7	9.67 ± 2.23	9.93 ± 1.96		8.31 ±3.43
MV-11	11.50 ± 1.90	13.40 ± 2.85	8.20 ± 3.5	8.2 ± 3.5	9.67 ±5.18

MV-12	7.26 ±1.25	7.34 ±1.78		7.22 ±1.89	3.72 ±4.68
MV-13	9.31 ± 1.5	7.50 ± 1.54	10.1 ± 5.9	8.24 ± 1.72	
MV-14	5.36 ±1.17	3.56 ±1.12		5.78 ±1.89	5.79 ±2.6
MV-15	8.25 ± 1.39	10.60 ± 2.22	8.12 ± 2.07	8.12±2.07	4.65 ±4.85
MV-16	4.39 ± 0.73	3.99 ± 1.26	4.66 ± 1.15	7.6 ± 4.1	5.06 ±2.46
MV-17	4.64 ± 0.79	4.15 ± 1.24	7.01 ± 4.14	5.10 ± 2.84	
MV-18	7.73 ±1.38	7.51 ±1.86		6.24±2.6	8.5 ±4.93
MV-19	6.8 ±1.07	4.7 ±1.4	6.5 ±1.44	3.2±3.9	4.61 ±2.42
MV-20	6.17 ± 1.01	4.51 ± 1.14	5.48 ± 1.27	7.4 ± 4.1	5.36 ±2.05
MV-21	4.98 ±0.8	4.6 ±1.29		4.43±1.13	5.01 ±1.39
MV-23	9.37 ± 1.53	8.41 ± 1.89	4.39 ± 1.04	8.83±3.45	7.69 ±2.65
MV-24			11.0 ±2.39		
MV-24-A				8.38±3.62	11.4 ±3.65
MV-25	22.21 ±2.85	9.13 ±2.08	10.5 ±2.2	11.5± 4.4	
MV-26	5.99 ± 0.92	5.40 ± 1.26	9.02 ± 4.63	4.44 ± 1.47	7.81 ±2.63
MV-27	6.81 ± 1.04	6.73 ± 1.51	9.57 ± 5.18	6.06 ± 1.54	
MV-29	5.43 ±0.9	3.96 ±1.2	4.68 ±1.36	4.11±1.12	1.13 ±4.3
MV-30	7.16 ±1.22	6.25 ±1.62		6.59±3.19	7.93 ±4.93
MV-31	6.80 ± 1.22	7.32 ± 1.55	13.1 ± 4.37	9.53 ± 1.64	8.02 ±3.39
MV-32	8.38 ± 1.38	8.15 ± 1.91	9.45 ± 1.9	7.5 ± 4.2	
MV-33	4.82 ± 0.78	3.27 ± 1.06	4.39 ± 1.04	4.39 ±1.04	5.74 ±1.79
MV-36	5.44 ± 0.91	4.80 ± 1.18	7.03 ± 4.22	4.2 ± 1.05	
MV-37	6.83 ±1.07	4.75 ±1.45		3.75±1.21	2.93 ±4.36
MV-38	3.65 ± 0.69	3.87 ± 1.21	4.71 ± 3.85	3.93 ± 1.06	
MV-39	8.56 ±1.52	7.81 ±1.88		5.26 ±3.08	7.34 ±2.73
MV-40	5.93 ±0.9	4.11 ±1.19	4.13 ±1.18	5.4±4.0	4.67 ±4.44
MV-41	6.39 ± 1.04	7.33 ± 1.89	7.24 ± 1.81	7.0 ± 4.2	6.89±2.41
MV-42	6.00 ± 0.94	0.71 ± 0.58	8.65 ± 4.36	6.03 ± 1.18	
MV-43	10.1 ±1.71	9.17 ±2.13		6.68 ±3.32	8.91±5.06
MV-45	4.69 ± 0.78	4.45 ± 1.30	6.10 ± 4.19	4.0 ± 3.9	
MV-46	4.49 ±0.73	4.17 ±1.25	4.21 ±1.24	4.08 ± 1.03	3.49 ±1.67

MV-47	4.82 ± 0.76	4.07 ± 1.06		3.6 ± 3.9	5.06 ±1.8
MV-49	3.62 ± 0.7	2.52 ± 0.87	3.15 ± 0.95	4.2 ± 3.9	4.79 ±2.43
MV-50	7.51 ± 1.25	8.75 ± 1.77	9.43 ± 1.87	4.95 ±3.1	8.96 ±3.39
MV-51	8.06 ± 1.53	7.22 ± 1.83		11.2 ± 4.4	3.96±4.7
MV-52	9.56 ± 1.44	8.93 ± 1.88	8.44 ± 1.68	8.4 ± 4.2	8.81 ±3.42
MV-53	9.43 ± 1.58	9.94 ± 2.06	9.57 ± 5.4	10.7 ± 2.23	
MV-54	8.82 ± 1.52	9.19 ± 2.12	9.40 ± 2.05	8.4 ± 4.3	10.37 ±4.88
MV-55	4.80 ± 0.92	3.55 ± 1.10	8.46 ± 4.25	6.04 ± 1.37	
MV-56	4.89 ± 0.86	4.73 ± 1.32	5.21 ± 1.24	3.8 ± 3.9	0.48±4.33
MV-57	4.11 ± 0.67	2.81 ± 0.85	3.48 ± 1.06	3.25 ± 1.03	
MV-59	5.35 ± 0.83	4.37 ± 1.24	6.13 ± 2.37	8.44 ±2.75	2.78±4.53
MV-61	4.65 ±0.85	4.70 ±1.35		6.13 ±2.37	-.55±4.28

Gross Alpha (as dissolved thorium-230) (pCi/L)

Well #	**1989**	**1990-92**	**1994-96**	**1997-1998**	**1999-2000**
MV-03	2.62 ±0.65	2.0 ±0.76	0.218 ±1.2	4.48 ± 2.89	
MV-05	4.65 ± 0.85	2.22 ±0.8	3.56 ± 2.96	5.26 ± 3.39	
MV-06	1.88 ± 0.5	1.67 ± 0.65	4.22 ± 3.11	6.23 ± 3.36	
MV-07	2.46 ± 0.62	1.51 ±0.63	3.36 ± 2.71	2.17 ± 2.48	
MV-10	2.87 ± 0.65	3.35 ± 0.97	3.22 ± 2.14	2.3 ± 2.7	0.62 ±0.85
MV-11	3.05 ± 0.65	3.91 ± 1.04	5.79 ± 3.79		1.88 ±2.59
MV-12	2.7 ±0.66	2.28 ±0.79	2.56 ±1.98		6.08 ±3.62
MV-13	5.12 ± 0.97	2.15 ± 0.72	4.20 ± 3.09	4.55 ± 3.07	
MV-15	2.30 ± 0.54	2.58 ± 0.82	4.84 ± 2.86		3.39 ±3.24
MV-16	2.32 ± 0.66	1.95 ± 0.73	1.42 ± 0.95	1.1 ± 2.1	1.33 ±1.47
MV-17	1.07 ± 0.59	1.31 ± 0.06	0.103 ± 1.82	5.1 ±2.84	
MV-20	1.08 ± 0.52	1.92 ± 0.074	3.02 ± 1.62	5.5 ± 3.0	1.19 ±0.78

MV-23	1.85 ± 0.48	2.39 ± 0.79	3.54 ± 2.77		-.21 ±2.43
MV-26	2.32 ± 0.62	1.59 ± 0.65	2.22 ± 2.36	0.96 ±2.35	0.81 ±1.26
MV-27	4.09 ± 0.8	2.62 ± 0.82	2.56 ± 2.73	4.83 ±3.12	
MV-31	3.04 ± 0.72	2.31 ± 0.77	10.9 ± 4.65	9.22 ±3.8	1.42 ±1.73
MV-32	6.00 ± 1.04	3.75 ± 1.05	2.85 ± 2.06	3.9 ± 3.1	
MV-33	0.68 ± 0.46	2.29 ± 0.81	1.19 ± 1.3		0.72 ±0.52
MV-36	5.12 ± 1.0	2.10 ± 0.70	4.54 ± 3.08	2.64 ±2.34	
MV-37	4.75 ±0.99	4.15 ±1.06	1.94 ±1.61		4.05 ±3.37
MV-38	1.86 ± 0.51	1.19 ± 0.58	1.62 ± 2.26	4.58 ±2.73	
MV-41	4.76 ± 0.98	5.24 ± 1.15	7.21 ± 3.16	4.3 ± 3.2	3.13 ±3.2
MV-42	2.08 ± 0.55	3.18 ± 0.93	3.21 ± 2.72	2.76 ±2.46	
MV-43	5.01 ±0.92	4.58 ±1.13	4.49 ±3.01		4.64 ±3.25
MV-46	1.82 ±0.53	1.10 ±0.54	0.73 ±0.79	4.4 ± 2.62	1.23 ±0.66
MV-45	18.70 ± 2.4	1.27 ± 0.54	3.96 ± 2.85	2.1 ± 2.2	
MV-47	1.66 ± 0.51	2.02 ± 0.73	0.8 ±1.9		0.3 ±0.54
MV-49	0.00 ± 0.7	1.56 ± 0.63	3.04 ± 1.49	2.8 ± 2.4	1.36 ±1.51
MV-50	7.74 ± 1.33	3.09 ± 0.87	2.12 ± 2.09		1.95 ±1.35
MV-51	2.92 ± 0.67	3.15 ± 0.93	3.2 ±3.0	3.2 ± 3.0	5.15 ±3.45
MV-52	3.80 ± 0.73	4.00 ± 1.02	4.15 ± 2.2	2.8 ± 2.8	2.16 ±1.92
MV-53	3.25 ± 0.69	2.89 ± 0.87	1.55 ± 1.27	8.95 ± 4.2	
MV-54	3.87 ± 0.75	2.38 ± 0.84	4.51 ± 2.6	4.4 ± 3.5	2.18 ±2.97
MV-55	2.38 ± 0.65	1.57 ± 0.63	0.80 ± 1.44	3.33 ± 2.79	
MV-56	1.97 ± 0.59	1.48 ± 0.66	1.11 ± 1.01	2.1 ± 2.3	2.05 ±2.83
MV-57	0.03 ±0.29	1.34 ±0.058	1.71 ± 0.93	-.12 ±1.78	
MV-58	2.08 ±0.54	1.02 ±0.5	0.58 ±1.03	-.12 ± 1.83	
MV-59	0.31 ± 0.26	1.76 ± .67	2.19 ± 2.0		2.56 ±2.91
MV-61	11.2 ±1.6	2.97 ±0.95	3.68 ±2.43		

Sources for above tables from USGS: DOE/ID-22124, DOE/ID-22130, DOE/ID-22133, DOE/ID-22141; DOE-IDO-22161; DOE/ID-22152; DOE/ID-22169; DOE-ID-22176

The above table unit's abbreviation - pCi/L - stands for pico curies per liter or one trillionth of one curie per liter. The maximum contaminate levels (MCL) for selected radioactivity and selected radionuclides in drinking water are established by the Environmental Protection Agency. For

comparison, the MCL for the beta emitter strontium-90 is 8 pCi/L, and the MCL for cesium-137 it is 120 pCi/L based on an average concentration assumed to produce a total body or organ dose of 4 millirem per year. The MCL for gross alpha particulate radioactivity is 15 pCi/L.

It is important to recognize that staying just below the MCLs will probably not protect human health. Public health goals are typically 0 for radionuclides. For a listing of beta emitter limits in pCi/L to equal 4 mrem/yr for an individual radionuclide, see Thatcher's report table referenced below. [9]

Tritium, although a beta emitter, is considered separately with MCL 20,000 pCi/L. Gross alpha is limited to 15 pCi/L, excluding uranium, Uranium is limited to 30 micrograms/L, and combined Radium-226/-228 is limited to 5 pCi/L.

As with all water sampling techniques, there is a range of uncertainty from instrument and sampling procedure variation. So the sample concentration is stated as the mean or middle of the uncertainty range which in turn is stated as plus or minus (±). A slight increase or decrease in different samples from the same well may be a result of this analytic uncertainty or variation. A major component of uncertainty is the standard deviation which varies with each sample. USGS uses a factor of two times the sample's standard deviation to identify the uncertainty range which is noted as a plus or minus number after the mean concentration number. The USGS uncertainty range appears to vary widely between sampling periods.

For instance the average uncertainty in 1989 and 1990-92 sample campaigns was about 21 percent whereas the average uncertainty in 1994-95 was nearly 60 percent. More detailed testing of a broad range of isotopes may be needed to identify the sources of this well contamination. The State INL Oversight Program, Idaho State University, and the Environmental Research Foundation are also doing testing, however their instruments are according to USGS, a thousand times less sensitive than the USGS's National Water Quality Laboratory. The usefulness of the above tables is to demonstrate trends in contaminate levels in the Snake River Aquifer south of the INL and factor this information into waste management decisions.

For more information see "Tritium at 800 pCi/L in the Snake River Plain Aquifer in the Magic Valley at Kimama: Why This Matters, Environmental Defense Institute Special Report, By Tami Thatcher, December 31, 2016 (updated January 2017) available on EDI's website including the following Thatcher reports:

* "The Hidden Truth About INL Drinking Water, A Long Legacy of Aquifer Contamination at INL;" http://environmental-defense-institute.org/publications/INLdrinkwaterR1.pdf
* INL Contamination and the Snake River Plain Aquifer – The Essentials"; http://environmental-defense-institute.org/publications/aquiferRev4.pdf
*"An Alarming Change in the Status of Technetium-99 in the Vadose Zone and Aquifer at INL"; http://environmental-defense-institute.org/publications/alarmingtc2.pdf
* "Important Long-Lived Contaminants at INL's RWMC Not Remediated." http://environmental-defense-institute.org/publications/RWMCunrem.pdf

[9] Tritium at 800 pCi/L in the Snake River Plain Aquifer in the Magic Valley at Kimama: Why This Matters, Environmental Defense Institute Special Report, By Tami Thatcher, December 31, 2016 (updated January 2017) http://www.iem-inc.com/information/tools/maximum-contaminant-levels-for-water .