4.8.2 SUBSURFACE WATER

Subsurface water at INEEL occurs in the underlying Snake River Plain Aquifer and the vadose zone (area of unsaturated soil and material above the aquifer). This section describes the regional and local hydrogeology, vadose zone hydrology, perched water, and subsurface water quality.

4.8.2.1 Regional Hydrogeology

INEEL overlies the Snake River Plain Aquifer as shown in Figure 4-12. This aquifer is the major source of drinking water for southeastern Idaho and has been designated a Sole Source Aquifer by EPA. The aquifer flows to the south and southwest and covers an area of 9,611 square miles. Water storage in the aquifer is estimated at 2 billion acre-feet, and irrigation wells can yield 7,000 gallons per minute (DOE 1995). Depth to the top of the aquifer ranges from 200 feet in the northern part of INEEL to about 900 feet in the southern part (Orr and Cecil 1991). The aquifer, with estimates of thickness ranging from 250 to more than 3,000 feet (Frederick and Johnson 1996), consists of thin basaltic flows, interspersed with sedimentary layers.

The drainage area contributing to the water volume in the Snake River Plain Aquifer is approximately 35,000 square miles (DOE 1995). The recharge to the aquifer is primarily from irrigation water and by valley underflow from the mountains to the north and northeast of the plain. Some recharge also occurs directly from precipitation (Rodriguez et al. 1997).

Discharge from the aquifer is primarily from springs that flow into the Snake River and pumping for irrigation. Major areas of springs and seepages from the aquifer occur in the vicinity of the American Falls Reservoir (southwest of Pocatello), and the Thousand Springs area (near Twin Falls) between Milner Dam and King Hill (Garabedian 1986).

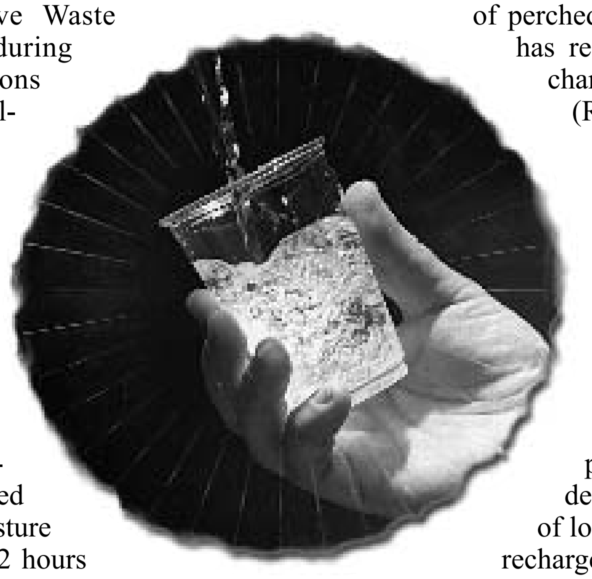
4.8.2.2 Local Hydrogeology

Groundwater directly beneath INTEC generally flows to the southwest and southeast, with some flow to the south. The local groundwater flow is complex and variable, and is influenced by recharge from the Big Lost River (when flow is present), the percolation ponds and sewage ponds, areas of low aquifer transmissivity, and possibly by pumping from the production wells. Groundwater beyond the influence of INTEC recharge sources flows to the south-southwest. The local hydraulic gradient is low, 1.2 feet per mile, compared to the regional gradient of 4 feet per mile (Rodriguez et al. 1997). In the INTEC area the hydraulic conductivity ranges over 5 orders of magnitude (0.10 to 10,000 feet/day), with an average of 1,300 feet/day (Rodriguez et al. 1997). The groundwater velocity beneath INTEC has been estimated at 10 to 25 feet per day (Barraclough et al. 1967). At various locations on and around INTEC in 1995, the depth to the Snake River Plain Aquifer ranged from approximately 460 feet to 480 feet below the ground surface (Rodriguez et al. 1997). Several zones of perched water lie beneath INTEC (see Section 4.8.2.4). These zones are primarily located beneath, and extend outward from, the percolation ponds and the sewage treatment plant lagoons when the Big Lost River is dry. Additional perched water bodies and interactions occur in the northern part of INTEC during periods of flow in the Big Lost River and subsequent infiltration.

FIGURE 4-12
Aquifers of Idaho.

4.8.2.3 Vadose Zone Hydrology

The vadose zone extends down from the ground surface to the regional water table (the top of the Snake River Plain Aquifer). In the vadose zone, the subsurface materials are generally not saturated but contain both air and water. Perched water bodies are the exception (see Section 4.8.2.4 that follows). The vadose zone at INTEC extends from the ground surface to 460 feet to 480 feet below the ground surface. This zone is important because chemical sorption to geologic materials in the vadose zone retards or immobilizes downward movement of some contaminants. During dry conditions, transport of contaminants downward towards the aquifer is very slow. Measurements taken at the INEEL Radioactive Waste Management Complex during unsaturated flow conditions indicated a downward infiltration rate ranging from 0.14 to 0.43 inches per year (Cecil et al. 1992). In another study during near-saturated flow conditions in the same area, standing water infiltrated downward 6.9 feet in less than 24 hours (Kaminsky 1991). During 1994, an infiltration study was conducted at INTEC that showed significant increase in moisture to a depth of 10 feet after 2 hours (LITCO 1995).



4.8.2.4 Perched Water

Perched water occurs in the vadose zone when sediments or dense basalt with low permeability impedes the downward flow of water to the aquifer. Historically at INTEC there have been three zones of perched water, including (1) a shallow perched water zone in the Big Lost River alluvium above the basalt, (2) an upper basalt perched water zone, and (3) a lower basalt perched water zone. Each zone is comprised of a number of smaller perched water bodies that may or may not be hydraulically connected. The perched water zones are thought to be primarily related to wastewater disposal practices at INTEC and the Big Lost River infiltration. The shallow perched water zone in the Big Lost River alluvium in the southern area of INTEC is believed to no longer exist (Rodriguez et al. 1997).

The upper basalt perched water zone occurs between the depths of 100 ***and*** 140 feet. At the northern end of INTEC, there is a body of upper basalt perched water beneath the sewage treatment ponds on the eastern side of INTEC extending towards the west under north central INTEC. The western portion of the northern perched water body receives water from other sources including the Big Lost River, leaking fire water lines, precipitation infiltration, steam condensate dry wells, and lawn irrigation. In the southern area of INTEC, a large body of perched water in the upper basalt has resulted primarily from discharge to the percolation ponds (Rodriguez et al. 1997).

The lower basalt perched water zone occurs in the basalt between 320 ***and*** 420 feet below the ground surface. Two areas of perched water occur in the lower basalt, essentially directly beneath the upper basalt perched water previously described. The northern body of lower basalt perched water is recharged from the sources contributing to the upper perched water. The lower perched water was influenced by the failure of the injection well in the late 1960's and late 1970's that allowed injection of service wastewater directly into the northern lower perched water body. The southern lower basalt perched water body is recharged from the discharge from the percolation ponds (Rodriguez et al. 1997).

4.8.2.5 Subsurface Water Quality

Subsurface water quality is monitored by the U.S. Geological Survey and the ***Bechtel BWXT Idaho, LLC*** Environmental Monitoring Program. An extensive groundwater quality study at INTEC was completed in 1995

(Rodriguez et al. 1997). ***In 2001, a tracer study was conducted on INTEC perched water and monitoring of the Snake River Plan Aquifer was performed (DOE 2002a,b). Results from the groundwater monitoring activities supporting the Remedial Investigation/Feasibility Study and associated Record of Decision are summarized in reports prepared and published by the respective CERCLA Waste Area Groups.*** This section focuses on current groundwater conditions, with emphasis on groundwater quality in the vicinity of INTEC.

DOE performs groundwater monitoring at INTEC and the surrounding area to monitor drinking water, detect unplanned releases to groundwater, identify potential environmental problems, and ensure compliance with Federal, State of Idaho, and DOE groundwater regulations and monitoring requirements. Groundwater monitoring at INEEL is generally divided into four categories: drinking water monitoring, compliance monitoring, surveillance monitoring, and special studies.

DOE monitors drinking water at INTEC to ensure compliance with Federal and State of Idaho drinking water regulations. INTEC drinking water wells are hydrologically upgradient of the INTEC facility. Measured drinking water parameters at INEEL are compared to the maximum contaminant levels established in the Safe Drinking Water Act (40 CFR 141). State regulations are in the Idaho Rules for Public Drinking Water Systems (***DEQ 2001a***). In ***2000***, the most recent year with published data, all drinking water samples collected at INTEC had concentrations below the maximum contaminant levels specified in Federal and State drinking water regulations (***DOE 2001***).

DOE performs compliance groundwater monitoring at INTEC to meet the requirements of the State of Idaho Wastewater Land Application Permits. The two areas monitored include wells in the vicinity of the percolation ponds and near the sewage treatment pond. The permits require compliance with the Idaho Groundwater Quality Standards in specified downgradient groundwater monitoring wells, annual discharge volume and application rates, and effluent quality limits (***DEQ 2001b***). Permit variance limits were granted for total dissolved solids and chloride at the percolation pond compliance monitoring wells. The primary source of total dissolved solids and chloride in the percolation ponds is the INTEC water treatment processes. The data for 1996 indicate that no permit limits (or permit variance limits) were exceeded at the percolation ponds in 1996 (LMITCO 1997).

At the compliance well for monitoring the sewage treatment plant, maximum allowable concentrations were not exceeded. However, at a shallow well (ICPP-MON-P***W***-024) adjacent to the sewage treatment plant, levels of total dissolved solids, chloride, and nitrogen compounds were elevated. DOE monitors this well to evaluate the effectiveness of treatment and to detect unplanned releases. Based on the information obtained from the monitoring data, DOE will alter treatment processes to optimize wastewater treatment and remove elevated nitrogen compounds (LMITCO 1997).

DOE conducts surveillance monitoring at INTEC to meet the requirements of DOE Order 5400.1. This order requires DOE facilities with contaminated (or potentially contaminated) groundwater resources to establish a groundwater monitoring program. The monitoring program is designed to determine and document the impacts of facility operations on groundwater quantity and quality and to demonstrate compliance with Federal, state, and local regulations. Table 4-1*7* summarizes monitoring parameters that exceeded surveillance thresholds. The surveillance thresholds are the Safe Drinking Water Act maximum contaminant levels and secondary maximum contaminant levels.

At the perched-water surveillance wells for the percolation ponds, the constituents elevated above the threshold limits include aluminum, chloride, iron, ***lead***, and strontium-90. The causes for the elevated aluminum and iron concentrations are unknown. The chloride concentration is consistent with historical chloride concentrations and reflects the concentration within the percolation ponds. The source of chloride is the water treatment processes. The strontium-90 concentrations are most likely residual from the historical discharges of radionuclides to the percolation ponds. Most radionuclide discharges to the percolation ponds were discontinued in 1993 when the INTEC Liquid Effluent Treatment and Disposal Facility began operations.

Table 4-17. Monitoring parameters that were exceeded for INTEC surveillance wells.[a]

Location	Exceeded parameter	Maximum concentration	Surveillance threshold[b]
PW-1[c]	***aluminum***	***0.254 mg/L***	***0.05mg/L***
	iron	***26 mg/L***	***0.3 mg/L***
	lead	***0.0036 mg/L***	***0 mg/L***
PW-2[c]	aluminum	***1.49 mg/L***	0.05mg/L
	chloride	287 mg/L	250 mg/L
	iron	***2.2 mg/L***	0.3 mg/L
	strontium-90	8.3 ± 3.4 pCi/L	8.0 pCi/L
PW-4[c]	iron	***2.2 mg/L***	0.3 mg/L
PW-5[c]	***aluminum***	***0.0562 mg/L***	***0.05 mg/L***
	iron	***2.93 mg/L***	***0.3 mg/L***
USGS-036[d]	strontium-90	***9.54 ± 1.34 pCi/L***	8.0 pCi/L
USGS-052[d]	***gross alpha***	***15 ± 3.86 pCi/L***	***15.0 pCi/L***
USGS-057[d]	strontium-90	***21.1 ± 3.43 pCi/L***	8.0 pCi/L
USGS-067[d]	strontium-90	***11.1 ± 1.47 pCi/L***	8.0 pCi/L
ICPP-MON-A-021[e,f]	total coliform	20 col/100mL	<1 col/100mL
ICPP-MON-A-022[e,g]	iron	0.487 mg/L	0.3 mg/L

a. ***Source: DOE (2002a).***

b. Surveillance thresholds are comparison values consisting of maximum contaminant levels and secondary maximum contaminant levels (40 CFR 141).

c. INTEC percolation pond perched water surveillance well.

d. INTEC percolation pond aquifer surveillance well.

e. Source: LMITCO (1997).

f. INTEC upgradient background well (upgradient Sewage Treatment Plant well).

g. INTEC Sewage Treatment Plant surveillance well.

In 1995, surveillance monitoring at the sewage treatment plant wells indicated measurements of total coliform, iron, and strontium-90 above threshold levels. DOE suspects that the total coliform measurement is the result of cross-contamination. The source of iron is unknown. Strontium-90 concentrations are consistent with historical values (LMITCO 1997). ***In 2000, data were available for USGS-52 indicating the gross alpha concentrations were above threshold levels (DOE 2002b).***

Constituents detected above threshold levels in surveillance wells are strontium-90 and tritium. Strontium-90 and tritium values are consistent with historical values and reflect discontinued discharge practices (LMITCO 1997).

In 1995, an in-depth study of soil and groundwater contamination was conducted at INTEC (Rodriguez et al. 1997). ***In 2001, a tracer study was conducted on INTEC perched water and monitoring of the Snake River Plain Aquifer was performed (DOE 2002a,b).*** Tables 4-1***8*** and 4-1***9*** show the maximum concentrations of inorganics and radionuclides in the perched water and the Snake River Plain Aquifer found in ***these studies and monitoring efforts***. The percolation pond perched water body was not monitored as part of the ***1995*** study, but was previously described as part of the discussion of the surveillance monitoring program.

All perched water bodies monitored in the 1995 study had samples exceeding the nitrate/nitrite Federal and state drinking water maximum contaminant level of 10 mg/L. The highest nitrate/nitrite concentration (69.6 mg/L) was found in the northern lower perched water body. For radionuclides, the maximum gross alpha and gross beta concentrations in perched water are in the northern upper perched water body. Tritium, strontium-90, and technetium-99 were found in all perched water bodies.

In 2001, all the perched water bodies again exceeded the maximum contaminant level for nitrate/nitrite. However, only half of the 15 sample results were exceedances. The highest nitrate/nitrite concentration (60.3 mg/L) is

Table 4-18. Maximum concentrations of inorganics and radionuclides in perched water at INTEC.[a]

	Maximum concentration (mg/L or pCi/L)	Well	Perched water body
Inorganics (mg/L)			
Alkalinity	290[b]	MW-5	Northern upper
Carbonate	5.4[b]	MW-17	Southern lower
Chloride	248	PERC Pond B	
Fluoride	0.312	Big Lost River C	Northern lower
Sulfate	12.8	USGS-50	
Total Kjeldahl Nitrogen	1.5[b]	MW-18	Northern lower
Ammonia – N	ND[b]		
NO_3/NO_2 – N	70[b]	MW-1	Northern lower
Aluminum	18.3	MW-20	Northern upper
Antimony	0.0103	MW-6	Northern upper
Arsenic	0.0167	MW-2	Northern upper
Barium	0.541	CPP 37-4	Northern upper
Beryllium	ND	–	
Cadmium	ND	–	
Calcium	114	CPP 37-4	Northern upper
Chromium	2.52	MW-2	Northern upper
Cobalt	0.0509	MW-6	Northern upper
Copper	0.0874	MW-6	Northern upper
Iron	39.5	Central Set B	Northern upper
Lead	0.0338	CPP 37-4	Northern upper
Magnesium	35.9	CPP 37-4	Northern upper
Manganese	6.55	MW-17	Northern lower
Mercury	8.58×10^{-4}	Central Set B	Northern upper
Nickel	0.276	CPP 55-06	Northern upper
Potassium	17.4	MW-17	Northern upper
Selenium	ND	–	
Silver	ND	–	
Sodium	136	Perc Pond B	Southern upper
Thallium	ND	–	
Vanadium	0.0494	MW-2	Northern upper
Zinc	1.73	MW-2	Northern upper
Zirconium	ND	–	
Radionuclides (pCi/L)			
Gross Alpha	1,100 ± 220[b]	MW-2	Northern upper
Gross Beta	5.9×10^5 ± 2,600[b]	MW-2	Northern upper
Tritium	40,400 ± 220	MW-17	Northern upper
Strontium-90	1.36×10^5 ± 18,200	MW-2	Northern upper
Plutonium-238	0.0501± 0.0107	–	
Plutonium-239/240	ND	–	
Americium-241	0.0374 ± 0.0169	PW-5	
Neptunium-237	0.0361 ± 0.012	MW-2	Northern upper
Iodine-129	0.65 ± 0.065	USGS-50	
Technetium-99	457 ± 9.15	MW-18	Northern lower
Uranium-233/234	15.3 ± 1.99	Central Set B	Northern upper
Uranium-235/236	0.142 ± 0.042	CPP 37-4	Northern upper
Uranium-238	6.94 ± 1.21	Central Set B	Northern upper

a. Source: DOE (2002a) unless otherwise noted.
b. Source: Rodriguez et al. (1997).
ND = Not detected.

Table 4-19. Maximum concentrations of inorganics and radionuclides in the Snake River Plain Aquifer in the vicinity of INTEC.

Contaminant	Maximum concentration (mg/L or pCi/L)	Well	Maximum contaminant level[a] (mg/L or pCi/L)	Background[b] (mg/L or pCi/L)
		Inorganics (mg/L)[c]		
Aluminum	ND	–	0.2[d]	
Antimony	4.6×10^{-3}	USGS-59	0.006	
Arsenic	0.011	USGS-59	0.05	
Barium	0.21	USGS-112	2	0.05 - 0.07
Beryllium	ND	–	0.004	
Cadmium	3.0×10^{-3}	USGS-39	0.005	<0.001
Calcium	76	CPP-2	NS	
Chromium	0.039	USGS-39	0.1	0.002 -0.003
Cobalt	1.0×10^{-3}	USGS-85	NS	
Copper	0.014	CPP-2	1.3	
Iron	0.13	USGS-123	0.3[d]	
Lead	0.018	USGS-84	0.015	<0.005
Magnesium	22	USGS-67	NS	
Manganese	0.044	USGS-122	0.05	
Mercury	3.6×10^{-4}[e]	USGS-44	0.002	<0.0001
Nickel	5.0×10^{-3}	USGS-123	0.1	
Potassium	6.80	USGS-122	NS	
Selenium	3.0×10^{-3}	USGS-47	0.05	<0.001
Silver	7.0×10^{-4}	USGS-77	0.1[d]	<0.001
Sodium	77	USGS-59	NS	
Thallium	ND	–	0.002	
Vanadium	0.010	USGS-82	NS	
Zinc	0.45	USGS-115	5[d]	
Zirconium	ND	–	NS	
		Radionuclides (pCi/L)[e]		
Gross Alpha	15 ± 3.86	MW-52	15	0 - 3
Gross Beta	96.5 ± 6	MW-48	<4 mrem/yr[f]	0 - 7
Tritium	1.4×10^{4} ± 771	USGS-114	20,000	0 - 40
Strontium-90	45 ± 7.57	MW-47	8	0
Plutonium-238	ND	–	15	0
Plutonium-239/240	ND	–	15	0
Americium-241	0.742 ± 0.0336	LF2-8	15	0
Neptunium-237	ND	MW-18	15	
Iodine-129	1.06 ± 0.19	LF3-8	1	0
Technetium-99	322 ± 6.6	USGS-52	900	
Uranium-233/234	1.62 ± 0.153	USGS-123	–	
Uranium-235/236	0.146± 0.057	USGS-35	–	
Uranium-238	0.851 ± 0.126	USGS-85	–	

a. Maximum contaminant levels (MCL) from the Safe Drinking Water Act (40 CFR 140) and DOE Order 5400.5 unless otherwise noted.
b. Source: Knobel et al. (1992).
c. Source: Rodriguez et al. (1997).
d. Secondary MCL from the Safe Drinking Water Act (40 CFR 140).
e. Source: DOE (2002b).
f. Beta particle/photon radioactivity shall not produce annual dose equivalent to the total body or internal organ greater than 4 millirem per year.

ND = Not detected; NS = No standard.

slightly lower at the same location (MW-1) of the maximum concentration observed in the 1995 study. The only inorganic found to exceed its maximum contaminant level in perched water was chromium. Chromium exceedances were found in all the perched water bodies. The only organic was methylene chloride from well PW-1. The highest radioactive contaminant levels (strontium-90 and technetium-99) continue to be found in the northern upper perched water body. Tritium is the primary contaminant found in the southern upper perched water body. Gross alpha and beta were not analyzed in 2001. The maximum radiological contaminant levels for strontium-90, technetium-99 and tritium have decreased by as much as 50 percent since the 1995 study (DOE 2002a).

For the Snake River Plain Aquifer, the concentrations measured in the 1995 study are primarily related to the past disposal of waste through the INTEC injection well. The injection well was drilled to a depth of 598 feet (DOE 1993) and was routinely used for disposal of service waste water through 1984, and permanently closed by pressure grouting in 1989. An estimated 22,000 curies of radioactive contaminants were released through the injection well. Most of the radioactivity is attributed to tritium (96 percent). Americium-241, technetium-99, strontium-90, cesium-137, cobalt-60, iodine-129, and plutonium contribute the remaining radioactivity.

Figures 4-1***3***, 4-1***4***, and 4-1***5*** show the 1995 distribution of tritium, strontium-90, and the 1990-1992 distribution of iodine-129 in the aquifer beneath INEEL, respectively (DOE 1997). ***The figures were not updated for 2001 due to the limited data set available for contouring groundwater in 2001 (DOE 2002b).*** Additionally, Table 4-***20*** shows the general trend of decreasing concentrations of these radionuclides over time ***including the most current data from 2001***. The combined tritium disposal to infiltration ponds at INTEC and the Test Reactor Area from 1992 to 1995 averaged 107 curies per year, compared to 910 curies per year from 1952 to 1983 (DOE 1997). The tritium plume with a concentration exceeding 500 picocuries per liter (0.5 picocuries per milliliter) decreased from an area of 45 square miles in 1988 to about 40 square miles in 1991. Since 1991, the concentration has remained nearly unchanged. However, the higher concentration lines have moved closer to their origin at INTEC and the Test Reactor Area.

Prior to 1989, strontium-90 concentrations in the Snake River Plain Aquifer were decreasing. The concentrations from 1992 to ***2001*** have remained fairly constant. This is due to the migration of contamination from the near surface releases into the perched water bodies and subsequently into the Snake River Plain Aquifer (Rodriguez et al. 1997). When the Big Lost River flows the added infiltrating water will tend to reduce the concentrations observed in the Snake River Plain Aquifer due to dilution of the perched water bodies.

Iodine-129 was discharged to the aquifer until 1984 through the injection well previously described. More than 90 percent of the iodine-129 in the aquifer is from the injection well. Smaller contributions include the percolation ponds and contaminated soils. Measurements taken in 1990-1992 indicated the presence of iodine-129 in 32 of 51 wells at INTEC. The concentrations ranged from below the detection limit to 3.82 pCi/L (Rodriguez et al. 1997). ***In 2001, only 2 of 41 wells sampled detected iodine-129 above the maximum contaminant level. The two wells are located south of INTEC at the CFA landfill. In addition, iodine-129 was not detected in the sample analyzed from well USGS-46 as depicted in Table 4-20 (DOE 2002b).*** The Safe Drinking Water Act maximum contaminant level for iodine-129 is 1 pCi/L.

4.9 Ecological Resources

This section discusses the biotic resources of the INEEL including threatened, endangered, and sensitive species, and wetlands. Radioecology studies specific to INTEC are also discussed. A detailed description of INEEL ecology can be reviewed in the Ecological Resources section of Rope et al. (1993) and the SNF & INEL EIS, Volume 2, Part A, Section 4.9 (DOE 1995). ***However, DOE has updated Section 4.9.1, Plant Communities and Associations, with more recent information on range fires that occurred in 1999 and 2000.***

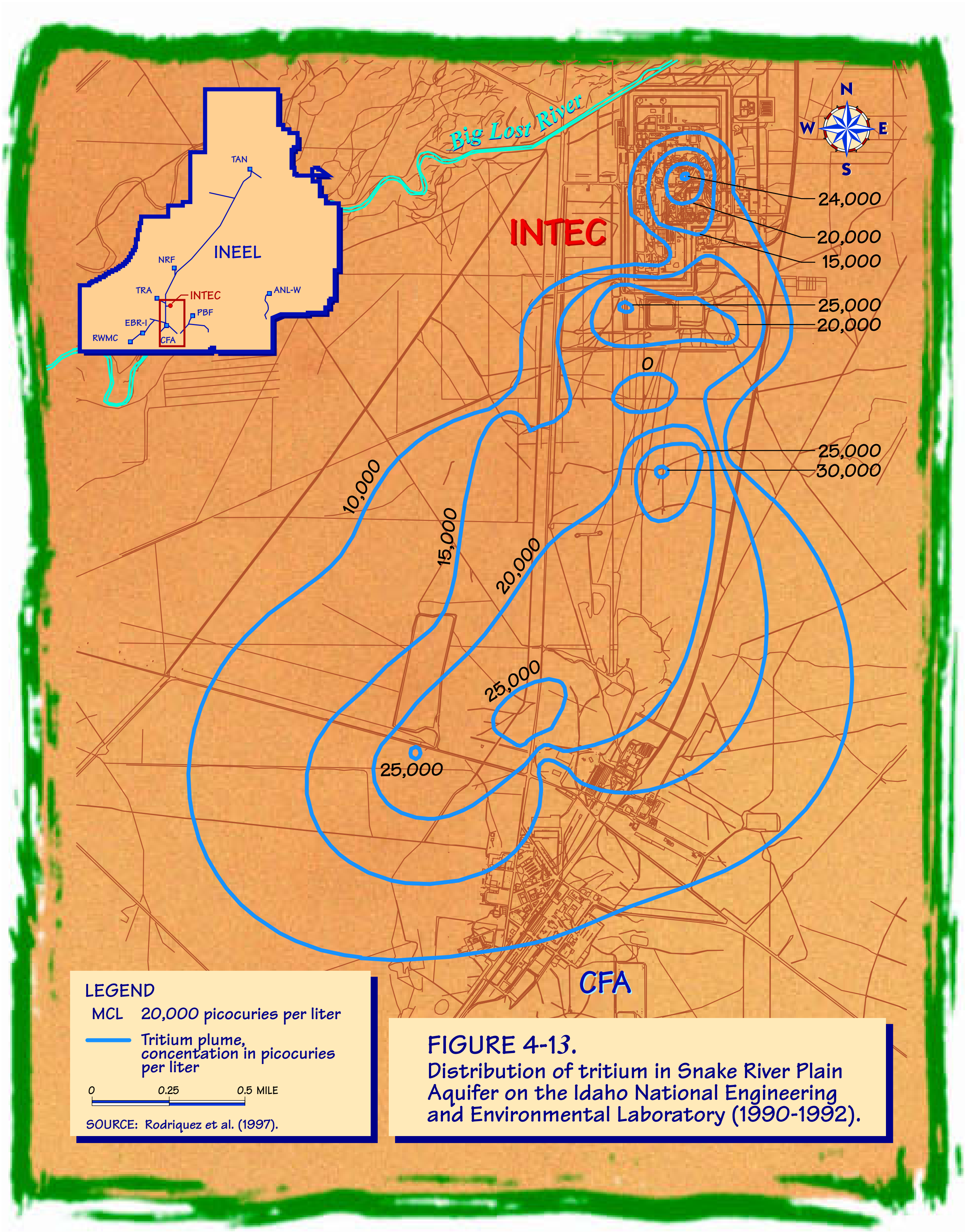


FIGURE 4-13.
Distribution of tritium in Snake River Plain Aquifer on the Idaho National Engineering and Environmental Laboratory (1990-1992).

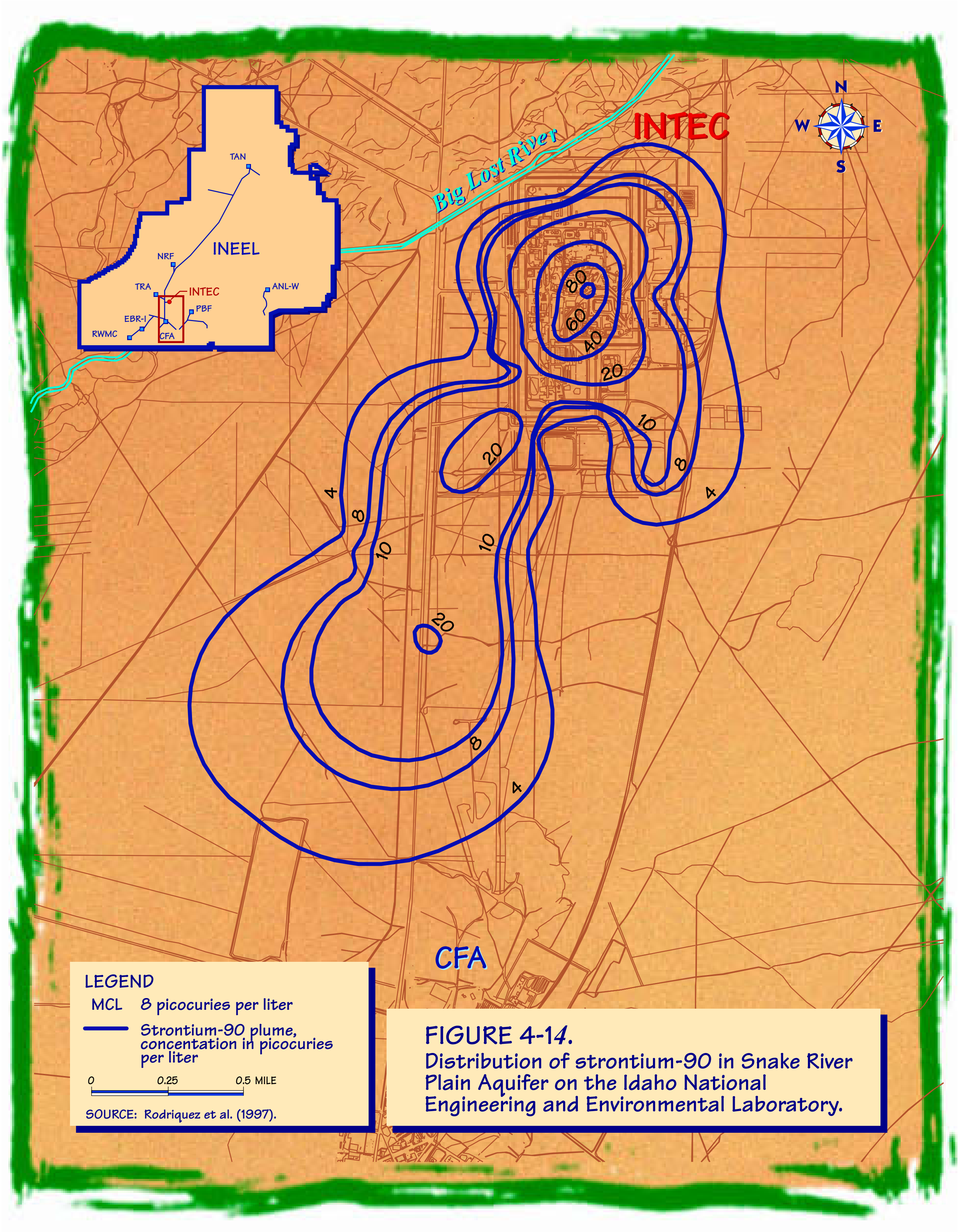


FIGURE 4-14.
Distribution of strontium-90 in Snake River Plain Aquifer on the Idaho National Engineering and Environmental Laboratory.

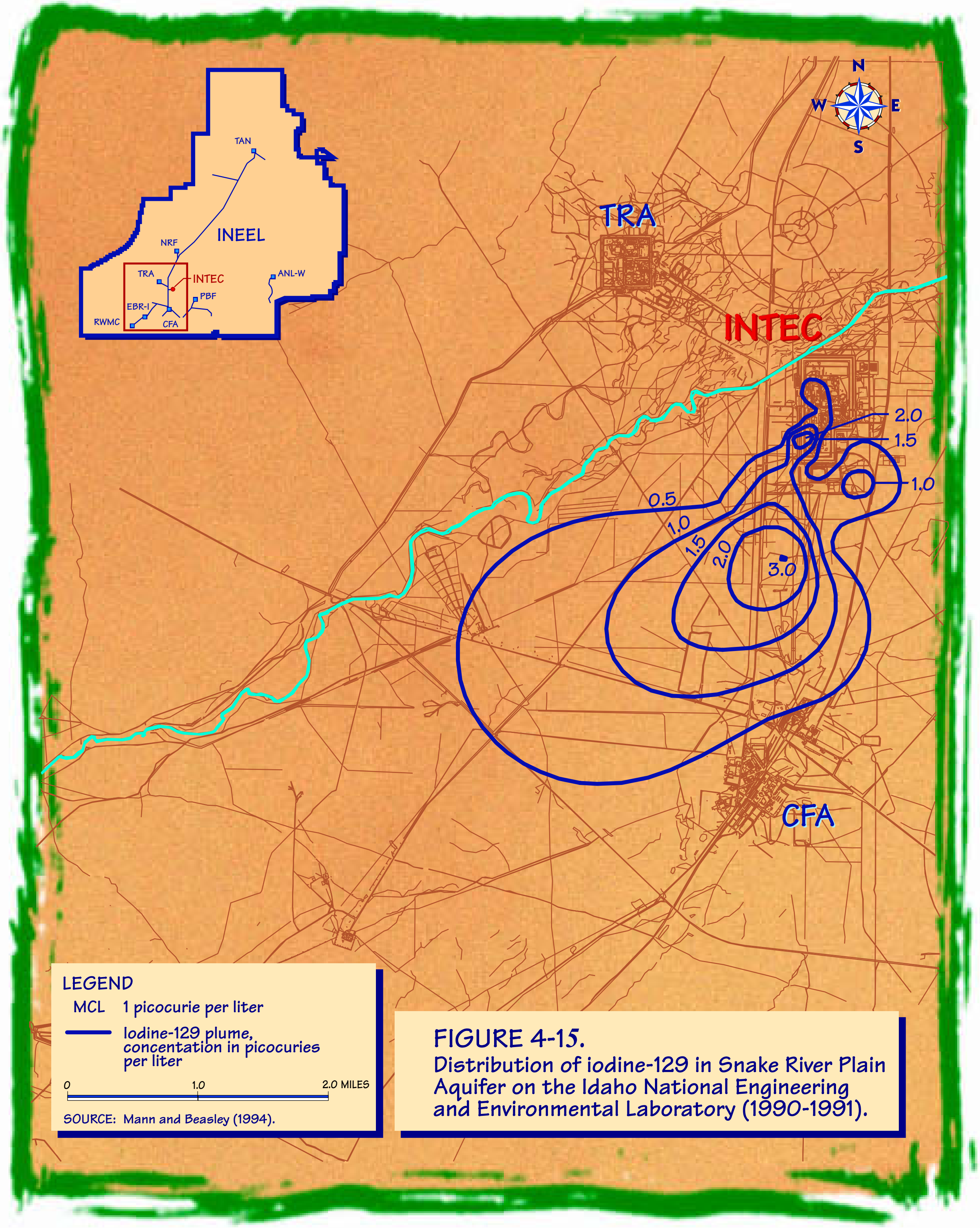


FIGURE 4-15.
Distribution of iodine-129 in Snake River Plain Aquifer on the Idaho National Engineering and Environmental Laboratory (1990-1991).