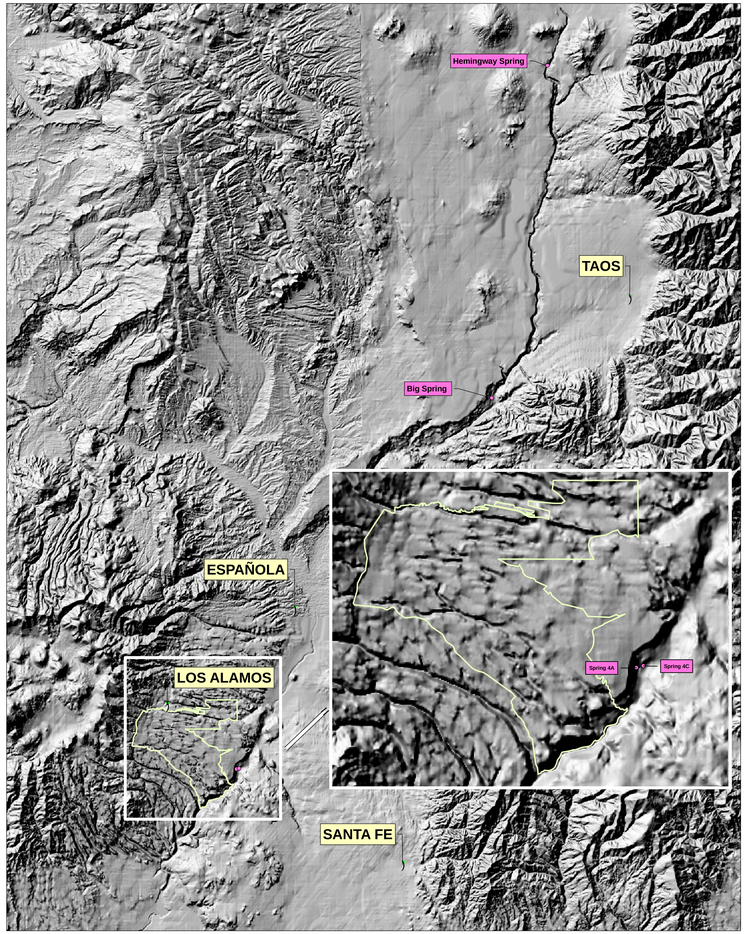

Locations of Springs Sampled for Contaminant Concentrations In Water and Bryophytes

1 1:200,000 Miles 0 5 10 20 30 40 50

Town Sites
Spring Location
LANL Boundary

DATA SOURCES:
RRES Remediation Services Project
Los Alamos National Laboratory
NMED DOE Oversight Bureau

PROJECTION:
New Mexico State Plane Coordinate System
Central Zone
North American Datum, 1983

Map Produced by K. Granzow, February, 2005
NMED DOE Oversight Bureau
134 State Road 4, Suite A
White Rock, NM 87544

State of New Mexico
Environment Department
DOE Oversight Bureau

CONTAMINANT CONCENTRATIONS IN WATER AND BRYOPHYTES FOUND IN FOUR SPRINGS LOCATED ALONG THE UPPER RIO GRANDE, NEW MEXICO

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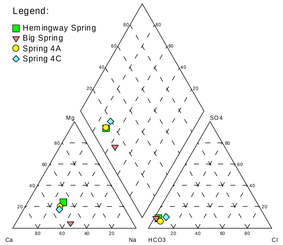
In November 2003, The RadioActivist Campaign (TRAC) published a report identifying detectable 137Cs in water and bryophytes (aquatic mosses) from Spring 4A. Spring 4A is located downgradient of Los Alamos National Laboratory (LANL) near the Rio Grande in White Rock Canyon. The report states that the detected 137Cs was of LANL origin and was the first confirmed detection of LANL radioactivity entering the Rio Grande from a ground-water pathway. In 2004, the New Mexico Environment Department's Department of Energy Oversight Bureau collected and analyzed samples of bryophytes and water from Springs 4A and 4C (a nearby spring), and two springs (Big Spring and Hemingway Spring) located 70 km and 125 km upstream on the Rio Grande. Springs 4A and 4C show anthropogenic impact/influence such as elevated levels of tritium, chloride, nitrate, and perchlorate. While this indicates that some fraction of recharge to the springs is of a young age (<50 years) and possibly from past LANL discharges, we could not confirm the TRAC detections of 137Cs in water or bryophytes at Springs 4A or 4C using the best analytical technology available to NMED. Springs 4A and 4C discharge from the upper portion of the regional aquifer or from deep perched intermediate units beneath the Pajarito Plateau. As noted earlier, Springs 4A and 4C show anthropogenic impacts indicating some portion of recharge that is of a shallow/youthful source. The two upstream springs discharge from Rio Grande basin sediments and are tritium-free indicating very old water (>100 years), and are used here to represent background conditions.

Spring samples were analyzed for 137Cs, tritium, perchlorate, 90Sr, 238Pu, 239/240Pu, major anions, and dissolved and total metals. Bryophytes were dried for low-level perchlorate analysis, and reduced to ash for analysis for 137Cs and other gamma-emitting radionuclides, 90Sr, 238Pu, 239/240Pu, and total metals. Spring samples were purged through a series of filters to determine if colloidal or dissolved 137Cs was detectable in the spring waters. Approximately 100 liters of water were filtered through 0.45 and 0.2 µ cellulose filters followed by a 3M Empore ™ Cesium Rad Disk. The 0.2 filters were digested and analyzed to determine if detectable levels of greater than 0.2 µ (and less than 0.45 µ) colloidal bound 137Cs were present in the water. The Cesium Rad Disks (0.1 µ) were used to extract cesium present in the dissolved and/or colloidal <0.2 µ but >0.1 µ fraction. These methods reduced 137Cs detection limits by two orders of magnitude for water and bryophytes.

137Cs and 90Sr were not detected in the spring waters or bryophytes. Perchlorate was not detected in bryophytes but was detected in all four spring-water samples. The uranium isotopes 234, 235, and 238 were detected in all bryophytes and water samples, with the exception that 235U was not detected at Springs 4A and 4C water. 239/240Pu was not detected in spring waters but was detected in all bryophyte samples. 238Pu may have been detected in both bryophyte and water at Spring 4C but was not detected in any other spring or bryophyte sample. Concentrations of gamma emitters detected in bryophytes were generally low and near detection limits. When concentrations of metals or radionuclides in both water and bryophyte tissue were greater than detection limits, bioconcentration factors are provided.

Field Duplicate Sampling for Cesium-137



Piper Diagram Illustrating Major Hydrochemical Characteristics

Dissolved Cs-137 and Coloidal Bound (less than 0.2 microns)

Sample ID	Date	Filter Type	Cs-137 pCi/L	Unc. pCi/L	MDC pCi/L		Liters of water pumped through filters
Spring 4A	15-Apr-04	3M	< -0.007	0.010	0.017	U	101.2
Spring 4C	22-Apr-04	3M	< -0.010	0.011	0.019	U	100.3
Big Spring	29-May-04	3M	< 0.006	0.009	0.015	U	100.6
Big Spring (Field Dup.)	29-May-04	3M	< 0.001	0.015	0.026	U	100.4
Hemingway Spring	5-May-04	3M	< -0.016	0.046	0.026	U	50 (3M filter only, no pre-filters)
Hemingway Spring	7-May-04	3M	< 0.001	0.020	0.012	U	101.6
Hemingway Spring (Lab Dup)	7-May-04	3M	< 0.0047	0.015	0.009	U	101.6

Cs-137 in particulate or colloid material less than 0.45 microns & greater than 0.2 microns

Sample ID	Date	Filter Type	Cs-137 pCi/L	Unc. pCi/L	MDC pCi/L		Liters of water pumped through filters
Big Spring	29-May-04	0.2 micron cellulose	< -0.005	0.015	0.027	U	100.6
Big Spring (Field Dup.)	29-May-04	0.2 micron cellulose	< -0.017	0.015	0.026	U	100.4
Spring4A	15-Apr-04	0.2 micron cellulose	< -0.012	0.015	0.027	U	101.165
Spring 4C	22-Apr-04	0.2 micron cellulose	< 0.009	0.015	0.024	U	100.3
Spring 4C (Lab Dup)	22-Apr-04	0.2 micron cellulose	< -0.009	0.015	0.027	U	100.3
Hemingway Spring	7-May-04	0.2 micron cellulose	< -0.0197	0.028	0.016	U	101.6

< = Less than
Unc. = Uncertainty = 2 times the Total Propagated Uncertainty
U = Result is less than the sample specific minimum detectable concentration
MDC = Minimimum Detectable Concentration

Cs-137, Pu-238, Pu-239, and Sr-90 in Aquatic Moss Tissue

Sample ID	Cs-137 pCi/g DW	Unc.	MDC	Pu-238 pCi/g DW	Unc.	MDC	Pu-239 pCi/g DW	Unc.	MDC	Sr-90 pCi/g DW	Unc.	MDC
Spring 4A -Moss	< 0.005	0.029	0.050	< 0.00000	0.00033	0.00062	0.0003	0.0003	0.0002	< 0.003	0.017	0.038
Spring 4C - Moss	< -0.016	0.037	0.063	0.00003	0.00005	0.00003	0.0006	0.0004	0.0002	< 0.004	0.019	0.044
Big Spring- Moss	< -0.017	0.026	0.047	< -0.00007	0.00032	0.00048	0.0008	0.0005	0.0005	< -0.006	0.017	0.042
Big Spring - Moss (Field Dup.)	< 0.001	0.029	0.049	< -0.00006	0.00032	0.00047	0.0005	0.0004	0.0002	< 0.004	0.020	0.046
Hemingway Spring - Moss	< 0.013	0.038	0.065	< 0.00028	0.00039	0.00065	0.0012	0.0008	0.0002	< 0.012	0.018	0.040
Hemingway Spring Moss (Lab Dup)	< 0.000	0.030	0.051	< -0.00007	0.00035	0.00075	0.0023	0.0010	0.0006	< 0.002	0.017	0.039

DW = Dry weight
MDC = Minimum Detectable Concentration
Unc. = Uncertainty as two times the Total Propagated Uncertainty

U-234, U-235, and U-238 in Aquatic Moss Tissue

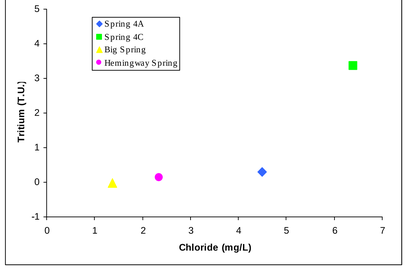
Sample ID	U-234 pCi/g DW	Unc. pCi/g	MDC pCi/g	U-235 pCi/g DW	Unc. pCi/g	MDC pCi/g	U-238 pCi/g DW	Unc. pCi/g	MDC pCi/g
Spring 4A -Moss	5.230	0.985	0.001	0.1438	0.0294	0.0011	2.58	0.49	0.001
Spring 4C - Moss	8.993	1.771	0.001	0.2562	0.0531	0.0027	4.88	0.95	0.001
Big Spring- Moss	3.859	0.651	0.001	0.1039	0.0183	0.0011	1.38	0.23	0.001
Big Spring - Moss (Field Dup.)	3.890	0.654	0.001	0.1016	0.0187	0.0012	1.39	0.23	0.001
Hemingway Spring - Moss	6.072	1.108	0.001	0.1397	0.0277	0.0012	2.98	0.54	0.001
Hemingway Spring - Moss (Lab Dup)	5.345	0.970	0.001	0.1397	0.0277	0.0012	2.59	0.47	0.001

DW = Dry weight
MDC = Minimum Detectable Concentration
Unc. = Uncertainty as two times the Total Propagated Uncertainty

Total Radionuclide Concentrations in Water

Sample ID	Pu-238 pCi/L	Unc. pCi/L	MDC pCi/L	Pu-239 pCi/L	Unc. pCi/L	MDC pCi/L	Sr-90 pCi/L	Unc. pCi/L	MDC pCi/L	U-234 pCi/L	Unc. pCi/L	MDC pCi/L	U-235 pCi/L	Unc. pCi/L	MDC pCi/L	U-238 pCi/L	Unc. pCi/L	MDC pCi/L
Spring4A	< 0	0.01	0.006	< 0	0.01	0.006	< 0.11	0.17	0.29	0.8	0.2	0.07	< -0.01	0.02	0.08	0.37	0.12	0.06
Spring 4C	0.008	0.01	0.006	< 0.002	0.01	0.010	< 0.01	0.15	0.27	0.77	0.19	0.04	< 0.03	0.03	0.04	0.33	0.11	0.04
Big Spring	< 0.002	0.01	0.010	< 0.005	0.01	0.006	< 0.06	0.14	0.25	1.69	0.36	0.05	< 0.03	0.04	0.05	0.8	0.21	0.06
Big Spring (Field Dup)	< 0.002	0.01	0.010	< 0	0.01	0.010	< 0	0.13	0.24	1.77	0.35	0.07	0.05	0.04	0.05	0.74	0.18	0.06
Hemingway Spring	< 0.003	0.01	0.007	< 0	0.01	0.007	< 0.21	0.16	0.26	1.36	0.29	0.04	0.04	0.03	0.02	0.74	0.19	0.04

< = Less than
MDC = Minimum Detectable Concentration
Unc. = Uncertainty as two times the Total Propagated Uncertainty



Tritium Concentrations vs. Chloride Concentrations

Concentration of Total Metals in Aquatic Mosses (mg/kg dry weight)

	Ag mg/kg DW	Al mg/kg DW	As mg/kg DW	Ba mg/kg DW	Be mg/kg DW	Ca mg/kg DW	Cd mg/kg DW	Co mg/kg DW	Cr mg/kg DW	Cu mg/kg DW	Fe mg/kg DW	Hg mg/kg DW
Spring 4A	< 0.113	192	0.43	204	0.32	24906	0.113	< 1.1	14.7	1.13	181	< 0.01
Spring 4C	< 0.136	232	0.69	120	0.55	21802	0.104	0.3	16.4	1.36	300	< 0.01
Big Spring	< 0.114	206	0.65	171	0.65	25119	0.064	7.0	9.2	1.60	308	< 0.01
Big Spring (Lab Dup)	< 0.114	199	0.68	178	0.66	25119	0.069	7.2	9.2	1.58	272	< 0.01
Big Spring (Field Replicate)	< 0.117	187	0.79	187	0.61	28033	0.072	< 1.2	9.2	1.75	280	< 0.01
Hemingway Spring	< 0.115	139	0.39	82	0.31	25396	0.127	2.7	11.1	4.16	104	< 0.01

DW = Dry Weight
< = Less than

	K mg/kg DW	Mg mg/kg DW	Mn mg/kg DW	Na mg/kg DW	Ni mg/kg DW	Pb mg/kg DW	Sb mg/kg DW	Se mg/kg DW	Tl mg/kg DW	V mg/kg DW	Zn mg/kg DW
Spring 4A	5208	3283	26	317	1.4	< 0.34	< 0.23	1.70	< 0.11	10.3	17.0
Spring 4C	3952	2725	42	327	1.5	0.45	< 0.27	4.09	< 0.14	15.0	9.1
Big Spring	4796	1370	78	502	2.6	< 0.34	< 0.23	1.05	< 0.11	11.4	10.5
Big Spring (Lab Dup)	4887	1359	79	504	2.4	< 0.34	< 0.23	1.00	< 0.11	12.0	10.6
Big Spring (Field Replicate)	5139	1285	70	537	2.1	0.50	< 0.23	0.84	< 0.12	11.4	10.3
Hemingway Spring	3694	4271	15	266	3.8	0.35	< 0.23	0.59	< 0.12	13.9	7.6

DW = Dry Weight
< = Less than

Trace Element Bioconcentration Factors (BCFs)[1]

Sample Locations	Al	As	Ba	Ca	Cr	Cu	Fe	K	Na	Ni	Pb	Se	V	Zn
Spring 4A	64151	358	5094	1245	3873	--	2588	2264	25	--	--	--	1472	1306
Spring 4C	--	409	2998	1000	4672	379	4283	1486	24	--	409	3716	1874	1014
Big Spring	--	210	1338	930	2102	1142	3425	1115	19	1382	152	--	816	1167
Hemingway Spring	--	123	4553	1451	6519	1807	1732	1310	22	--	247	--	1154	--

[1] = concentration of trace element in native bryophyte tissue divided by dissolved concentration of trace element in water
-- = unable to determine because concentrations of trace elements in water or native bryophytes were below reporting level

Radionuclide Bioconcentration Factors (BCFs) [1]

Sample Location	Pu-238	U-234	U-235	U-238
Spring 4A	--	6538	--	6976
Spring 4C	3.9	11680	--	14782
Big Spring	--	2284	--	1727
Big Spring (Field Dup)	--	2197	2032	1878
Hemingway Spring	--	4465	3492	4025

[1] = concentration of radionuclide in native bryophyte tissue divided by (total) concentration of radionuclide in water
-- = unable to determine because concentrations of trace elements in water or bryophytes were below reporting level