LMS/SAL/S06677

Sample Analysis Results

Confirmatory Tree Sampling for Tritium in Trees at the Salmon Site, Mississippi

June 2010

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1.0 Background

The State of Mississippi is acquiring surface ownership of the former U.S. Atomic Energy Commission (AEC) test site identified as Salmon, located in Lamar County, Mississippi. The U.S. Department of Energy (DOE), as successor agency to AEC, will carry out the transfer of ownership under the authority of the 1997 National Defense Authorization Act, Public Law 104-201, September 23, 1996, Section 2851, Land Conveyance, Tatum Salt Dome Test Site, Mississippi. The site will be known as the Jamie Whitten Forest Management Area. The State of Mississippi intends to harvest trees from the site for commercial sale as part of the forest management plan for the site.

2.0 Purpose

The Mississippi Forestry Commission has conducted extensive sampling for tritium in trees at the Salmon Site in preparation for the upcoming transfer of site ownership from DOE to the State of Mississippi. The State selected tritium as the contaminant of interest because it is the most mobile of the contaminants introduced by the AEC testing at the site. Tritium's environmental mobility makes it an excellent early indicator of contaminant migration. In all, the Mississippi Forestry Commission sampled approximately 400 trees, including at off-site locations. DOE supported the Mississippi Forestry Commission by conducting confirmatory tree-wood sampling and tritium analysis of approximately 10 percent of the trees sampled by the Mississippi Forestry Commission, including at off-site locations. The tree-wood sample analyte was tritium in free water and organically bound tritium. Discussion is provided to establish a perspective from which to judge the sample analysis results. This perspective includes understanding the reasons that some amount of tritium exists in the natural environment and, therefore, may be detected by the sample analyses.

3.0 Tritium in the Environment

Tritium is a radioactive isotope of hydrogen; it has the same chemical properties as hydrogen. The half-life of tritium is 12.3 years. Tritium in the natural environment comes from two primary sources: (1) ongoing interactions of cosmic radiation with the earth's atmosphere, and (2) fallout from aboveground nuclear testing. The tritium is brought to the earth's surface by precipitation in the form of tritiated water[1]. Therefore, any living organism that uses water derived from precipitation can be expected to contain some amount of tritium. Atmospheric tritium from radioactive fallout peaked in the early 1960s and has since decayed to much lower levels. Tritium occurrence in the natural environment today is essentially in equilibrium with the tritium produced by cosmic radiation in rainfall.

[1] Water is made up of two hydrogen atoms bound to an oxygen atom. Tritiated water consists of one hydrogen atom, one tritium atom, and one oxygen atom.

4.0 Sampling

The sampling was conducted on April 20, 21, and 22, 2010. DOE acquired 36 samples for analysis, approximately 10 percent of the total number of samples the Mississippi Forestry Commission acquired. The plan was to sample trees that the Mississippi Forestry Commission also sampled, so that a tree-by-tree comparison of analysis results could be made. The Mississippi Forestry Commission provided DOE with latitude and longitude coordinates, determined by a global positioning system (GPS), for each sampled tree. The Mississippi Forestry Commission also placed a blaze-orange number on each sampled tree. DOE used a GPS unit to assist in locating trees for sampling.

DOE acquired one sample from an off-site location to have a reference for comparison to on-site results if necessary. The other 35 samples were acquired on site, for a total of 36 samples. Figure 1 shows the sampling locations, the sample identifiers DOE assigned, and the corresponding tree numbers the Mississippi Forestry Commission assigned.

5.0 Laboratory Analysis Methods

GEL Laboratories in Charleston, South Carolina, conducted the sample analyses. The analysis method is designated as Modified EPA Method 906.0. The method analyzes the tritium content of the water contained in the wood sample and the organically bound tritium contained in the wood pulp as two separate analyses. Therefore, for each sampled tree, there are two reported analysis results, or a total of 72 (2 times 36) completed and reported analyses.

The water analysis entailed heating the wood sample to drive the water out of the wood, collecting the water, and then counting radioactive decay events in the collected water in a liquid scintillation counter for 90 minutes. This analysis result is reported as “Tritium” in Table 1. The average minimum detectable concentration (MDC) for tritium in water was 7.43 picocuries per gram (pCi/g).

The organically bound tritium analysis entailed oxidizing the remaining dried wood portion of the sample, collecting the oxidation products, and then counting radioactive decay events in the collected oxidation products in a liquid scintillation counter for 90 minutes. This analysis result is reported as “Tritium, Organically Bound” in Table 1. The average MDC for organically bound tritium was 26.5 pCi/g.

6.0 Sample Analysis Results

Table 1 lists the sample analysis results. The reported concentrations for both analyses for all 36 trees were very low and were flagged with the laboratory qualifier “U,” meaning the results were below the MDC. The MDC represents the concentration that the measurement system is expected to be capable of detecting, given the characteristics and capabilities of the measurement system components.

When the results of the Mississippi Forestry Commission’s analysis are available, they will be compared to the results DOE obtained. The intent is to confirm that the State’s analysis results represent tritium content in the sampled trees.

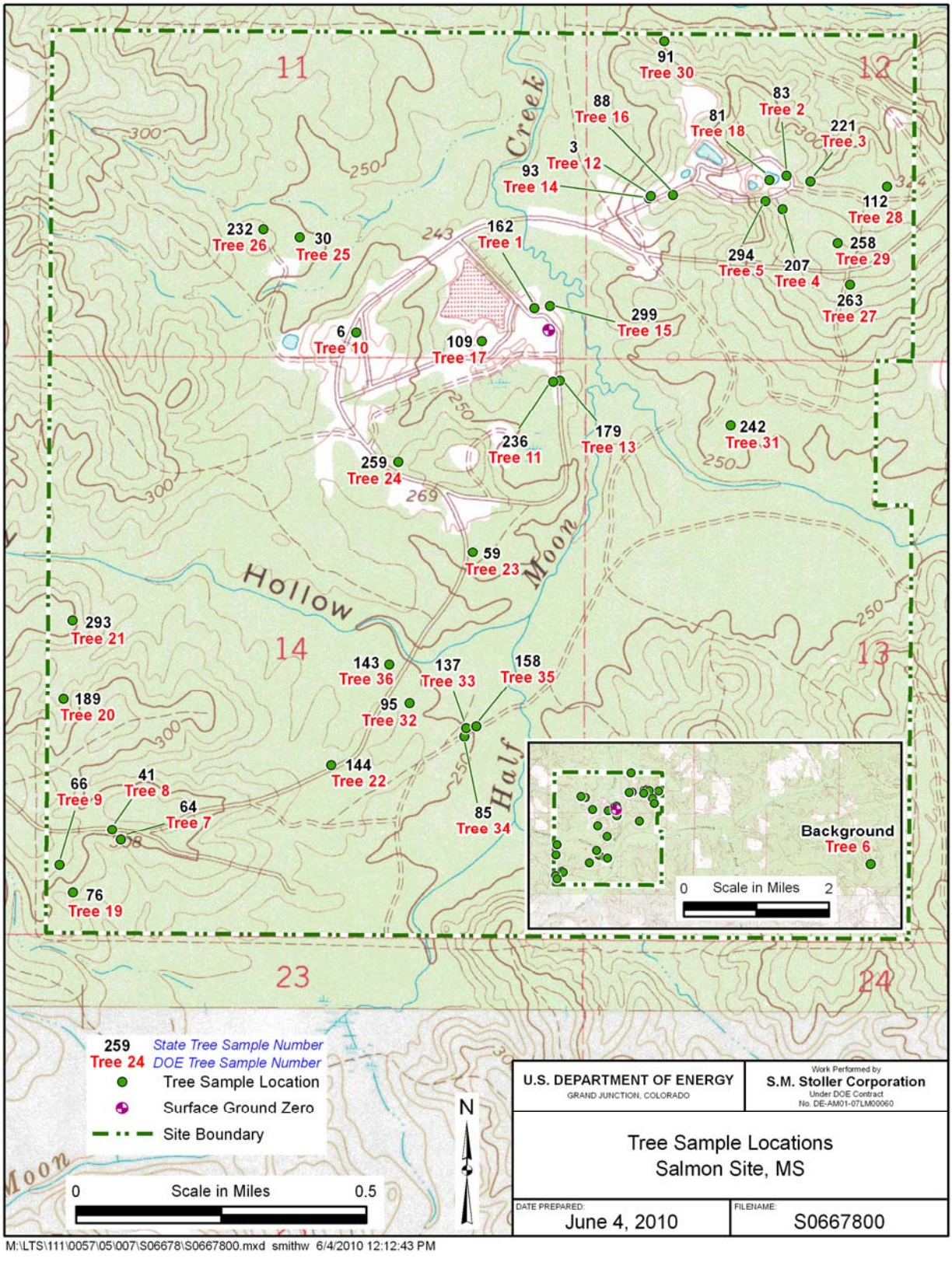

Figure 1. Tree Sample Locations Salmon Site, MS

7.0 Conclusions

As discussed in Section 3.0, tritium is present in all precipitation in the natural environment. Additionally, at the Salmon Site, tritium has been detected in shallow groundwater and surface water near surface ground zero, presumably a result of the detonations at the Salmon Site. Consequently, it was anticipated that tritium would be present in trees at the Salmon Site.

As part of the due diligence for the upcoming transfer of site ownership from DOE to the State of Mississippi, Mississippi State University developed a statistically based sampling plan to test for tritium in the trees at the site. The Mississippi Forestry Commission sampled approximately 400 trees for tritium, including at off-site locations. In support of the Mississippi Forestry Commission's efforts, DOE conducted confirmatory sampling of approximately 10 percent of the trees the Mississippi Forestry Commission sampled. At this time, analysis results from the Mississippi Forestry Commission's sampling are not yet available. Therefore, the confirmatory aspects of this sampling analysis results report cannot yet be completed. However, the DOE sample analysis results are very encouraging. Tritium concentrations in the sampled trees at the Salmon Site were too low to be quantified.

Table 1. Sample Analysis Results

Sample ID[a]	State Tree Number[b]	Tree Species	Date Sampled	Analyte	Result	Units[C]	Lab[d] Qualifier	Uncertainty	MDC[e]
Tree 1	162	Loblolly	04/20/2010	Tritium	3.97	pCi/g	U	5.34	9
	162	Loblolly	04/20/2010	Tritium, Organically Bound	-8.89	pCi/g	U	15.6	29.5
Tree 2	83	Loblolly	04/20/2010	Tritium	-3.71	pCi/g	U	3.64	8.29
	83	Loblolly	04/20/2010	Tritium, Organically Bound	-13	pCi/g	U	15.3	29.4
Tree 3	221	Loblolly	04/20/2010	Tritium	2.49	pCi/g	U	4.59	8.05
	221	Loblolly	04/20/2010	Tritium, Organically Bound	0.678	pCi/g	U	15.6	28
Tree 4	207	Longleaf	04/20/2010	Tritium	-0.944	pCi/g	U	2.59	5.31
	207	Longleaf	04/20/2010	Tritium, Organically Bound	1.27	pCi/g	U	15.7	28.2
Tree 5	294	Longleaf	04/20/2010	Tritium	-2.18	pCi/g	U	2.8	6.14
	294	Longleaf	04/20/2010	Tritium, Organically Bound	-4.08	pCi/g	U	16	29.5
Tree 6	NA	Pine	04/20/2010	Tritium	0.903	pCi/g	U	3.7	6.86
	NA	Pine	04/20/2010	Tritium, Organically Bound	2.69	pCi/g	U	16.2	28.7
Tree 7	64	Longleaf	04/20/2010	Tritium	0	pCi/g	U	3.58	6.92
	64	Longleaf	04/20/2010	Tritium, Organically Bound	4.71	pCi/g	U	16.4	28.9
Tree 8	41	Longleaf	04/20/2010	Tritium	-0.396	pCi/g	U	4.39	8.61
	41	Longleaf	04/20/2010	Tritium, Organically Bound	0	pCi/g	U	15.9	28.7
Tree 9	66	Longleaf	04/20/2010	Tritium	-4.89	pCi/g	U	10.1	18.8
	66	Longleaf	04/20/2010	Tritium, Organically Bound	2.1	pCi/g	U	16.9	30.3
Tree 10	6	Loblolly	04/20/2010	Tritium	-2.47	pCi/g	U	3.18	6.96
	6	Loblolly	04/20/2010	Tritium, Organically Bound	-1.48	pCi/g	U	13	24.3
Tree 11	236	Loblolly	04/20/2010	Tritium	0.317	pCi/g	U	3.61	6.88
	236	Loblolly	04/20/2010	Tritium, Organically Bound	-2.03	pCi/g	U	16	29.2
Tree 12	3	Loblolly	04/20/2010	Tritium	-1.03	pCi/g	U	2.84	5.82
	3	Loblolly	04/20/2010	Tritium, Organically Bound	-13.5	pCi/g	U	14.4	27.9
Tree 13	179	Slash	04/20/2010	Tritium	0.49	pCi/g	U	3.05	5.73
	179	Slash	04/20/2010	Tritium, Organically Bound	4.54	pCi/g	U	15.8	27.9
Tree 14	93	Loblolly	04/20/2010	Tritium	-1.98	pCi/g	U	2.98	6.4
	93	Loblolly	04/20/2010	Tritium, Organically Bound	8.77	pCi/g	U	16.8	29.1

Table 1 (continued). Sample Analysis Results

Sample ID[a]	State Tree Number[b]	Tree Species	Date Sampled	Analyte	Result	Units[C]	Lab[d] Qualifier	Uncertainty	MDC[e]
Tree 15	299	Loblolly	04/20/2010	Tritium	-1.26	pCi/g	U	2.71	5.65
	299	Loblolly	04/20/2010	Tritium, Organically Bound	1.29	pCi/g	U	16	28.7
Tree 16	88	Longleaf	04/20/2010	Tritium	-1.14	pCi/g	U	3.13	6.42
	88	Longleaf	04/20/2010	Tritium, Organically Bound	-12.6	pCi/g	U	14.1	27.3
Tree 17	109	Loblolly	04/20/2010	Tritium	0	pCi/g	U	3.65	7.06
	109	Loblolly	04/20/2010	Tritium, Organically Bound	4.01	pCi/g	U	24.1	42.8
Tree 18	81	Loblolly	04/20/2010	Tritium	-1.65	pCi/g	U	4.54	9.31
	81	Loblolly	04/20/2010	Tritium, Organically Bound	-3.1	pCi/g	U	18.1	33.2
Tree 19	76	Longleaf	04/20/2010	Tritium	-1.72	pCi/g	U	2.58	5.56
	76	Longleaf	04/20/2010	Tritium, Organically Bound	-5.25	pCi/g	U	15.4	28.6
Tree 20	189	Slash	04/21/2010	Tritium	-0.302	pCi/g	U	3.34	6.56
	189	Slash	04/21/2010	Tritium, Organically Bound	6.99	pCi/g	U	15.9	27.6
Tree 21	293	Longleaf	04/21/2010	Tritium	-0.553	pCi/g	U	6.19	11.3
	293	Longleaf	04/21/2010	Tritium, Organically Bound	-12.6	pCi/g	U	10.2	20.5
Tree 22	144	Loblolly	04/21/2010	Tritium	5.61	pCi/g	U	4.64	7.13
	144	Loblolly	04/21/2010	Tritium, Organically Bound	2.81	pCi/g	U	13	23.1
Tree 23	59	Loblolly	04/21/2010	Tritium	4.6	pCi/g	U	4.53	7.25
	59	Loblolly	04/21/2010	Tritium, Organically Bound	-10.2	pCi/g	U	11.9	23.2
Tree 24	259	Longleaf	04/21/2010	Tritium	5.46	pCi/g	U	3.93	5.81
	259	Longleaf	04/21/2010	Tritium, Organically Bound	-7.25	pCi/g	U	11.9	22.7
Tree 25	30	Loblolly	04/21/2010	Tritium	2.21	pCi/g	U	3.8	6.56
	30	Loblolly	04/21/2010	Tritium, Organically Bound	-3.41	pCi/g	U	12.5	23.2
Tree 26	232	Loblolly	04/21/2010	Tritium	3.2	pCi/g	U	4.58	7.75
	232	Loblolly	04/21/2010	Tritium, Organically Bound	-7.39	pCi/g	U	12.1	23.1
Tree 27	263	Longleaf	04/21/2010	Tritium	2.68	pCi/g	U	3.84	6.51
	263	Longleaf	04/21/2010	Tritium, Organically Bound	-7.44	pCi/g	U	12.2	23.3
Tree 28	112	Loblolly	04/21/2010	Tritium	2.32	pCi/g	U	5.06	8.92
	112	Loblolly	04/21/2010	Tritium, Organically Bound	-9.57	pCi/g	U	11.9	23
Tree 29	258	Loblolly	04/21/2010	Tritium	2.92	pCi/g	U	5.03	8.69
	258	Loblolly	04/21/2010	Tritium, Organically Bound	-3.44	pCi/g	U	12.6	23.4

Table 1 (continued). Sample Analysis Results

Sample ID[a]	State Tree Number[b]	Tree Species	Date Sampled	Analyte	Result	Units[C]	Lab[d] Qualifier	Uncertainty	MDC[e]
Tree 30	91	Longleaf	04/21/2010	Tritium	2.38	pCi/g	U	3.4	5.77
	91	Longleaf	04/21/2010	Tritium, Organically Bound	-6.86	pCi/g	U	12.3	23.3
Tree 31	242	Shortleaf	04/21/2010	Tritium	3.42	pCi/g	U	4.53	7.6
	242	Shortleaf	04/21/2010	Tritium, Organically Bound	-2.83	pCi/g	U	12.6	23.3
Tree 32	95	Loblolly	04/22/2010	Tritium	4.17	pCi/g	U	4.1	6.56
	95	Loblolly	04/22/2010	Tritium, Organically Bound	-5.76	pCi/g	U	12.4	23.4
Tree 33	137	Longleaf	04/22/2010	Tritium	0.505	pCi/g	U	3.6	6.65
	137	Longleaf	04/22/2010	Tritium, Organically Bound	-9.01	pCi/g	U	11.8	22.9
Tree 34	85	Loblolly	04/22/2010	Tritium	3.9	pCi/g	U	4.27	6.97
	85	Loblolly	04/22/2010	Tritium, Organically Bound	-2.26	pCi/g	U	12.4	22.7
Tree 35	158	Loblolly	04/22/2010	Tritium	5.76	pCi/g	U	4.76	7.32
	158	Loblolly	04/22/2010	Tritium, Organically Bound	-1.12	pCi/g	U	12.8	23.3
Tree 36	143	Loblolly	04/22/2010	Tritium	5.02	pCi/g	U	4.15	6.37
	143	Loblolly	04/22/2010	Tritium, Organically Bound	-3.96	pCi/g	U	12.3	22.9

[a] Sample location identifier assigned by DOE.
[b] Sample location identifier assigned by the Mississippi Forestry Commission.
[c] "pCi/g" means picocuries per gram.
[d] Result flag assigned by GEL Laboratories. "U" means the analytical result was below the minimum detectable concentration.
[e] Minimum detectable concentration. The concentration that the measurement system employed by the lab would be expected to detect based on the characteristics and capabilities of all components and aspects of the measurement system combined.

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