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November 13, 2002

**Subject: Recommendations for enhanced monitoring and assessment of Pueblo Canyon**

Dear Mr. Turner:

The DOE Oversight Bureau of the New Mexico Environment Department has evaluated preliminary storm water data from the June 22, 2002 storm event in Pueblo Canyon. Analysis of our data indicates an increase in plutonium-239 compared to pre-Cerro Grande fire estimates. We estimate that 14.4 mCi of plutonium-239 was transported out of Pueblo Canyon over two hours and ten minutes; most of the plutonium (14.1 mCi) was associated with suspended sediment. Additionally, all four samples (corrected for uranium isotopes) significantly exceeded the gross alpha Livestock Watering Standard of 15 pCi/L. Samples from three other storm events have been submitted for analysis and will be addressed in subsequent transmittals. This letter details the sampling strategy, data, and results of calculations of inventory of plutonium-239 transport off site during the event, and Oversight Bureau recommendations.

**Sampling strategy**

The Oversight Bureau collected four storm water samples during the June 22, 2002 event at LANL's E060 gage station using an ISCO® automatic water sampler. The peak flow recorded by LANL at E060 gage was 712 cfs at 01:00 and flow continued above 10 cfs for at least 24 hours. This was the second largest flow event in Pueblo Canyon on record since the Cerro Grande Fire. The first sample was collected on the rising leg of the hydrograph and three additional samples were collected at 40 – 45 minute intervals. All water samples were analyzed for total isotopic uranium, total isotopic plutonium, total gross alpha & beta, and suspended sediment concentration. Suspended sediments were separated from the water samples and were analyzed separately for gross alpha & beta, and isotopic plutonium. The hydrograph for E060 was obtained from Dave Shaull of ESH-18 and used to calculate inventory released from Pueblo Canyon over the two hours and ten minutes covered by the four samples.

**Results in water**

All water data is provided in Table 1 and summarized below.

Total plutonium-239/240 in water ranged from 123 pCi/L to 197 pCi/L (avg. 157 pCi/L).

Total plutonium-238 in water ranged from 0.44 pCi/L to 0.96 pCi/L (avg. 0.75 pCi/L).



Total gross alpha corrected for uranium isotopes ranged from 1,454 pCi/L to 3,071 pCi/L (avg. 1,962 pCi/L).

Suspended sediment concentration ranged from 19,500 mg/L to 84,500 mg/L (avg. 42,250 mg/L).

Total uranium (sum of U-234, U-235, & U-238) ranged from 75.5 pCi/L to 278.7 pCi/L (avg. 152.5 pCi/L).

Total gross beta ranged from 1,290 pCi/L to 3,280 pCi/L (avg. 1,930 pCi/L).

### **Results in Suspended Sediment**

All sediment data is provided in attachment Table 2 and summarized below.

Gross alpha ranged from 11.5 pCi/g to 15.3 pCi/g (avg. 12.8 pCi/g).

Gross beta ranged from 10.0 pCi/g to 11.2 pCi/g (avg. 10.7 pCi/g).

Plutonium-238 was below the minimum detectable concentration.

Plutonium-239 ranged from 1.67 pCi/g to 5.83 pCi/g (avg. 3.93 pCi/g).

### **Inventory Calculations**

All flows, concentrations used, formulas, and calculations are provided in attachment Tables 3 and 4 and are summarized below.

We converted flow values of cubic feet per second to liters per second. We calculated an average flow value from the five-minute flow readings for each interval between samples (40 – 45 minutes). We calculated average plutonium-in-water concentration, plutonium-in-suspended sediment and suspended sediment concentration for each flow interval. Inventory was calculated for both total plutonium in water and suspended sediment for the 2 hours and 10 minutes sampled (4 samples).

The calculated inventory discharged over the first 40 minutes as totals in water was 6.8 mCi and 7.7 mCi in suspended sediments. The calculated inventory discharged over the following 45 minutes as totals in water was 5.0 mCi and 4.3 mCi in suspended sediments. The calculated inventory discharged over the last 45 minutes sampled as totals in water was 2.7 mCi and 2.1 mCi in suspended sediments. Total inventory released over the 2 hour and 10 minute period was 14.4 mCi as totals in water and 14.1 mCi in suspended sediments. The two methods of calculation differ by less than 3% and indicate that the bulk of the plutonium-239/240 is bound to the suspended sediment fraction.

### **Recommendations**

The three gage/monitoring stations in Pueblo Canyon do not provide the ability to determine from what portion of the Pueblo canyon watershed these elevated levels are coming from. The Bureau recommends an additional watershed monitoring and gage station be installed between reach P2 and reach P3 west to differentiate the source of elevated PU-239 (i.e., reaches P-1& P-2, or reaches P-3 & P-4).

To better understand the dynamics of sediment transport in Pueblo Canyon, the Bureau recommends that LANL implement a bed load and suspended sediment sampling program in this watershed.

The Bureau recommends LANL initiate a Data Quality Objective process to determine the best sampling strategy for understanding of off site contaminant transport in Pueblo Canyon. Participants in this process should include the Water Quality and Hydrology group, the Environmental Restoration group, the Oversight Bureau, San Ildefonso Pueblo, and DOE.

The Bureau recommends that LANL use multiple grab samples across the storm event hydrograph to determine inventory transported vs. magnitude of runoff event rather than the time-weighted-

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composite strategy it currently uses. Multiple samples would enhance understanding of the dynamics of contaminated sediment transport off site from Pueblo Canyon and provide more realistic and accurate estimates.

The Bureau recommends that LANL acquire expertise in riparian corridor restoration to evaluate actions (e.g., low impact, long-lived) that will reduce the accelerated erosion of contaminated sediments found in Pueblo Canyon. These proposed measures would then be evaluated for their ability to reduce off site contaminant migration to levels as low as reasonably achievable and implemented as needed to demonstrate DOE's commitment to long-term stewardship of legacy contaminants present in Pueblo Canyon.

These data are provided to DOE for review and comment prior to their release as final to other State of New Mexico and Federal agencies, the Pueblos, our website and interested members of the public. The complete data package, including all manipulations (in Excel spreadsheet form) is provided as attachments and on CD. Please contact Ralph Ford-Schmid at 428-2559 if you have any questions about this data, interpretations, or recommendations.

Sincerely,

*Barbara Horditchek for Steve Yanicak*

Steve Yanicak,  
Point of Contact/LANL  
NMED, DOE OB

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Table 1 Pueblo Canyon Water Data 6-22-02																						
Lab ID	Location ID	Location Description	Date	Time	Matrix	Collection Method	Dissolved/ Total	Gross Alpha (pCi/L)	Unc. (+/- 2 TPU)	MDC	Gross Alpha Corrected for Uranium (pCi/L)	U 234 (pCi/L)	Unc. (+/- 2 TPU)	MDC	U 235 (pCi/L)	Unc. (+/- 2 TPU)	MDC	U 238 (pCi/L)	Unc. (+/- 2 TPU)	MDC	Suspended Sediment Load (SSC)	
0208047-1	PU 0.3	Pueblo at E060 Gage	6/22/2002	1:49	Storm Water	ISCO Automatic Sampler	Total	3350	550	220	3071.3	129	17	1.3	14.7	2.9	0.84	135	18	0.84	84500	
0208047-1-D1	PU 0.3	Pueblo at E060 Gage	6/22/2002	1:49	Storm Water	ISCO Automatic Sampler	Total					127	17	1.3	13.6	2.8	1.3	132	18	0.89		
0208047-2	PU 0.3	Pueblo at E060 Gage	6/22/2002	2:29	Storm Water	ISCO Automatic Sampler	Total	2070	350	190	1920.8	69.9	9.4	0.44	6.2	1.4	0.55	73.1	9.8	0.64	40800	
0208047-3	PU 0.3	Pueblo at E060 Gage	6/22/2002	3:14	Storm Water	ISCO Automatic Sampler	Total	1510	250	110	1403.3	50	6.7	0.6	6.3	1.3	0.52	50.4	6.8	0.48	24200	
0208047-4	PU 0.3	Pueblo at E060 Gage	6/22/2002	3:59	Storm Water	ISCO Automatic Sampler	Total	1530	240	85	1454.46	35.1	4.7	0.48	3.84	0.82	0.28	36.6	4.9	0.09	19500	
MDC = Minimum Detectable Concentration							Average	2115			1962.465	82.2			8.928			85.42			42250	
Table 1 Pueblo Canyon Water Data 6-22-02																						
Lab ID	Location ID	Location Description	Date	Time	Matrix	Collection Method	Dissolved/ Total	PU 238 (pCi/L)	Unc. (+/- 2 TPU)	MDC	Lab Qualifier	PU 239 (pCi/L)	Unc. (+/- 2 TPU)	MDC	Gross Beta (pCi/L)	Unc. (+/- 2 TPU)	MDC					
0208047-1	PU 0.3	Pueblo at E060 Gage	6/22/2002	1:49	Storm Water	ISCO Automatic Sampler	Total	0.44	0.41	0.6	U	161	21	0.89	3280	500	280					
0208047-1-D1	PU 0.3	Pueblo at E060 Gage	6/22/2002	1:49	Storm Water	ISCO Automatic Sampler	Total	0.89	0.53	0.53		152	20	0.66								
0208047-2	PU 0.3	Pueblo at E060 Gage	6/22/2002	2:29	Storm Water	ISCO Automatic Sampler	Total	0.96	0.48	0.57		197	25	0.38	1720	280	190					
0208047-3	PU 0.3	Pueblo at E060 Gage	6/22/2002	3:14	Storm Water	ISCO Automatic Sampler	Total	0.75	0.28	0.18		151	19	0.07	1430	220	140					
0208047-4	PU 0.3	Pueblo at E060 Gage	6/22/2002	3:59	Storm Water	ISCO Automatic Sampler	Total	0.69	0.32	0.34		123	16	0.19	1290	190	96					
MDC = Minimum Detectable Concentration							Average	0.746				156.8			1930							

**Table 2 Pueblo Canyon Suspended Sediment Data 6/22/02**

Lab ID	Location ID	Location Description	Date	Time	Matrix	Collection Method	Dissolved/ Total	Gross Alpha (pCi/g)	Unc. (+/- 2 TPU)	MDC	Gross Beta (pCi/g)	Unc. (+/- 2 TPU)	MDC	PU 238 (pCi/g)	Unc. (+/- 2 TPU)	MDC	Lab Qualifier	PU 239 (pCi/g)	Unc. (+/- 2 TPU)	MDC
0208047-5	PU 0.3	Pueblo at E060 Gage	6/22/2002	1:49	Suspended Sediment	ISCO Automatic Sampler	Total	11.5	2.1	0.6	10.8	1.8	1.1	0.015	0.017	0.028	U	1.67	0.28	0.024
0208047-5-D1	PU 0.3	Pueblo at E060 Gage	6/22/2002	1:49	Suspended Sediment	ISCO Automatic Sampler	Total							0.009	0.014	0.025	U	1.99	0.33	0.012
0208047-6	PU 0.3	Pueblo at E060 Gage	6/22/2002	2:29	Suspended Sediment	ISCO Automatic Sampler	Total	11.2	2	0.58	10	1.7	1.1	0.01	0.017	0.036	U	4.82	0.75	0.023
0208047-7	PU 0.3	Pueblo at E060 Gage	6/22/2002	3:14	Suspended Sediment	ISCO Automatic Sampler	Total	13.1	2.3	0.78	11.1	1.9	1.2	0.014	0.017	0.027	U	5.52	0.85	0.027
0208047-8	PU 0.3	Pueblo at E060 Gage	6/22/2002	3:59	Suspended Sediment	ISCO Automatic Sampler	Total	15.3	2.7	0.65	11.2	1.9	1.2	0.017	0.019	0.032	U	5.63	0.84	0.011
MDC = Minimum Detectable Concentration							Average	12.775			10.775			0.013				3.926		

**Table 3 6-22-02 Flows from Hydrograph and Transported Inventory Calculations**

14.45		14.09												
milicuries of PU-239 discharged over first 2 hours and 10 minutes of event using total water data		milicuries of PU-239 discharged over first 2 hours and 10 minutes of event using suspended sediment data												
		Water Total PU 239/240 pCi/L	Water Total PU-238 pCi/L	Average Liters per Second (LPS)	Average LPS over period	pCi PU-239/240 discharged over previous time	mCi Pu-239/240 discharged over previous time	Suspended Sediment Pu 239/240 pCi/g	Suspended Sediment Concentration	pCi PU-239/240 discharged over previous time (in Susp. Sed.)	mCi Pu-239/240 discharged over previous time (in Susp. Sed.)			
Time: Date:	Flow @ E060													
00:40_06/22/2002	196.67	161	0.44	5569.694				1.67	84500					
00:45_06/22/2002	706.71			20014.03										
00:50_06/22/2002	636.15			18015.77										
00:55_06/22/2002	575.66			16302.69										
01:00_06/22/2002	712.52			20178.57										
01:05_06/22/2002	620.48			17571.99										
01:10_06/22/2002	561.33			15896.87										
01:15_06/22/2002	519.51			14712.52										
01:20_06/22/2002	480.23	197	0.96	13800.11	15762.47	6771557742	<b>6.77155774</b>	4.82	40800	7690796706	<b>7.690796706</b>			
01:25_06/22/2002	459.42			13010.77										
01:30_06/22/2002	423.39			11990.4										
01:35_06/22/2002	393.23			11136.27										
01:40_06/22/2002	364.85			10332.55										
01:45_06/22/2002	351.16			9944.851										
01:50_06/22/2002	331.34			9383.549										
01:55_06/22/2002	318.6			9022.752										
02:00_06/22/2002	324.92			9201.734										
02:05_06/22/2002	297.23	151	0.75	8417.554	10604.06	4981785434	<b>4.98178543</b>	5.52	24200	4276191558	<b>4.276191558</b>			
02:10_06/22/2002	288.31			8164.939										
02:15_06/22/2002	274.06			7761.379										
02:20_06/22/2002	265.72			7525.19										
02:25_06/22/2002	257.57			7294.382										
02:30_06/22/2002	249.61			7068.955										
02:35_06/22/2002	241.83			6848.626										
02:40_06/22/2002	239.21			6774.427										
02:45_06/22/2002	231.73			6562.594										
02:50_06/22/2002	224.43	123	0.69	6355.858	7277.39	2691906709	<b>2.69190671</b>	5.63	19500	2127566916	<b>2.127566916</b>			
							<b>14.4452499</b>	Total inventory released for 130 minutes of event (totals in water)			<b>14.09455518</b>	Total for 130 minutes of event (totals in suspended sediment)		
								0.97572249	Correlation between inventory calculations suspended sediment data vs. water data					

**Table 4 Formulas Used To Calculate Inventory Transported Off Site During First Two Hours and ten minutes of 6-22-02 Storm E**

**Inventory discharged over time interval (pCi - PU-239) (using totals in water):**

Cubic feet per second to liters per second = CFS \* 28.32

Average Flow = average of five minute interval flows over sampling interval (40 - 45 minutes)

Inventory discharged over time interval (pCi - PU-239) = Avg. concentration pCi/L (over time interval) \* Average Liters/second (over interval) \* 60 seconds/minute \* 40 or 45 minutes (length of interval)  
conversion from pCi to mCi = pCi / 1,000,000,000

Total inventory discharged = sum of discharged for each interval

**Inventory discharged over time interval (pCi - PU-239) (using totals in suspended sediments):**

Cubic feet per second to liters per second = CFS \* 28.32

Average Flow = average of five minute interval flows over sampling interval (40 - 45 minutes)

Inventory discharged over time interval (pCi - PU-239) = Avg. concentration pCi/g (over time interval) \* Average SSC mg/L (over time interval) \* (grams/1000mg) \* Average Liters/second (over interval) \* 60 seconds/minute \* 40 or 45 minutes (length of interval)

Total inventory discharged = sum of discharged for each interval