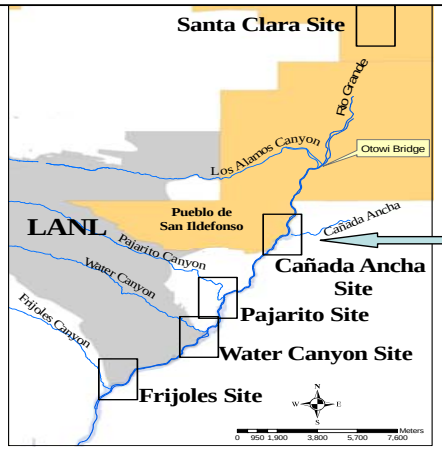
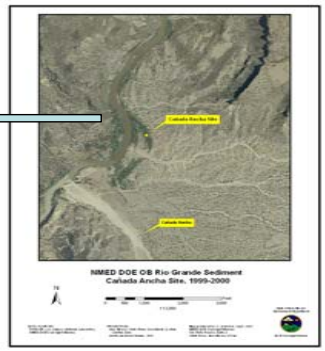
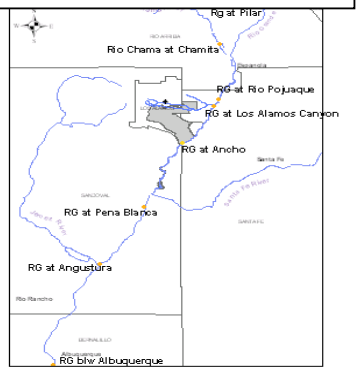
Distribution of LANL Contaminants Along the Rio Grande

Core and Terrace Sediment Samples



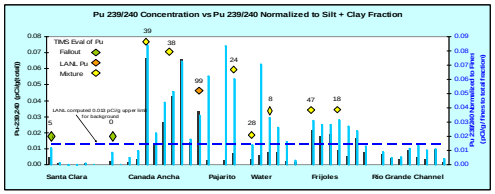


Rio Grande Channel Sediments



Rio Grande Channel Sediment Locations

239/240Plutonium alpha spec and TIMS measurements from cores and the Rio Grande channel samples normalized to fine grain content, note relative concentration differences between Santa Clara, Rio Grande channel, and measurements in cores and outcrops and Background reference value. Bubbles identify TIMS measurements and mixtures associated with LANL legacy materials.

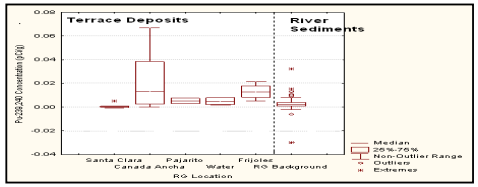


Distribution of Radionuclides in Northern Rio Grande Fluvial Deposits near Los Alamos National Laboratory, New Mexico

By David Englert, Michael Dale, Kim Granzow, and Richard Mayer, 2006

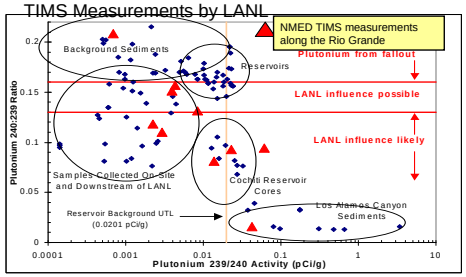
The New Mexico Environment Department's Department of Energy Oversight Bureau identified radionuclide contamination originating from the Los Alamos National Laboratory (LANL) in abandoned channels, old flood plains, and other fluvial deposits along the Rio Grande. The highest proportions of LANL contaminants in sediments are nearest to the discharge sources. Sediment sorting by fluvial processes throughout the past 60 years contributed contaminant concentrations in White Rock Canyon. Sediments were collected from multiple depth intervals in cores and outcrops at five sites along the Rio Grande and from within the active Rio Grande channel at 8 sites. We identified contaminant sources by evaluating atom ratios of plutonium isotopes 239 and 240, by statistical comparisons of downstream radiochemical measurements to background reference conditions, by comparing NMED data to LANL historical background values, and by investigating grain-size distribution and contaminant concentration relationships. We selected a site at Santa Clara Pueblo ~ 12 km upstream of the Los Alamos Canyon and Rio Grande confluence at Otowi Bridge to demonstrate background conditions. The remaining four sites are downstream of the Otowi Bridge. Cañada Ancha is ~ five km downstream, while the Pajarito and Water canyon sites are about 11 and 14 km below the bridge, respectively. The Frijoles Site, farthest downstream, is approximately 19 km below the bridge. Most of the LANL legacy contaminants in sediments along the Rio Grande were derived from the Los Alamos watershed. We found that $^{239/240}$plutonium was the most persistent radionuclide found in terraces downstream of LANL. By far, the largest concentrations were found at the Cañada Ancha site followed by the Frijoles site, and then the Water Canyon site. Elevated ^{137}cesium and uranium isotope concentrations were also found at Cañada Ancha, followed by the Frijoles site. Strontium-90 was found to be elevated at the Cañada Ancha site and ^{241}americium was elevated at the Frijoles site. Contaminant measurements at the Pajarito site were all indistinguishable from background, although we identified legacy contaminants at levels diluted below the background references. Eight active-channel sediments were collected within the Rio Grande including locations 61 km (38 miles) north of the Otowi Bridge at Pilar, New Mexico to 134 km (83 miles) south of the Otowi Bridge to Albuquerque. The three sites upstream of Otowi Bridge represent upper Rio Grande background reference values while the five sites downstream of Otowi Bridge represent the downstream sample population. Upstream and downstream channel sediments were indistinguishable and reflect radionuclide concentrations similar to global fallout levels.

Box and Whisker Presentation of $^{239/240}$Pu



We compared contaminant measurements from the core and terrace outcrop populations to the Santa Clara core and LANL background river sediment populations using Wilcox and t-test statistical tests. Note the difference in $^{239/240}$plutonium measurements between the Canada Ancha site and the reference conditions. These tests were also used to identify differences in ^{241}Americium, ^{137}Cesium, ^{90}Strontium, and Uranium isotopes measurements in sediments below the Laboratory and reference conditions.

Relation of Thermal Ionization Mass Spectroscopy (TIMS) measurements from this project to earlier TIMS Measurements by LANL



TIMS evaluations are capable of identifying Laboratory $^{239/240}$plutonium measured at levels below statistical reference values. Note the measurements of samples collected "On-Site and Downstream of LANL, and Cochiti Reservoir Cores" relative to the 0.0201 pCi/g Reservoir Background Upper Tolerance Level (UTL).

8/8/06 Example of Contaminant Transport in Los Alamos Watershed Stormwater

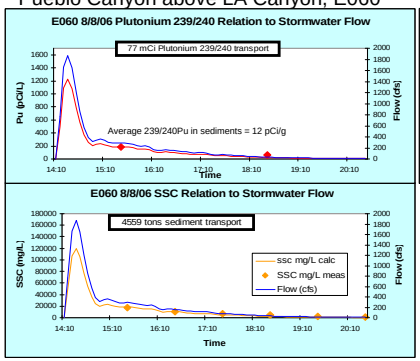
Examples of stormwater plots for an August 8, 2006 event, the largest single flood since Cerro Grande Fire, and estimates for $^{239/240}$ plutonium and sediment mass transport from lower Pueblo Canyon and lower Los Alamos Canyon are demonstrated to the right.

These studies may also identify the affects of wetlands in Pueblo Canyon and the low-head weir in Los Alamos Canyon in regard to reduction of contaminant transport from Laboratory boundaries to the Rio Grande.

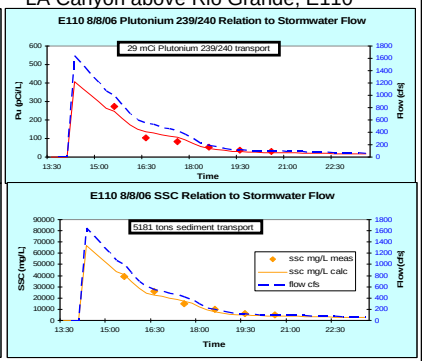
A report was released in 2003 describing transport in 2000 to 2002 stormwater events. A 2003 to 2006 stormwater report is in progress and early estimates by Ralph Ford-Schmid (2007) have identified at least 198 mCi $^{239/240}$plutonium in 45,535 tons of sediment transported beyond Pueblo Canyon since the fire to the end of 2006. These estimates are preliminary and listed in the following table.

Year	Number of Storm Flows events > 10 cfs	Maximum Flow	Mean Flow	Median Flow	Total Plutonium 239/240 Transport	Total Suspended Sediment Transport
		cfs	cfs	cfs	mCi	tons (metric)
2000	6	147	64	50	8.4	1,933
2001	17	1440	145	25	54.3	12,552
2002	17	583	65	16	24.4	5,453
2003	9	749	142	59	28.2	6,606
2004	15	504	71	21	23.6	5,428
2005	4	129	93	101	8.1	1,863
2006	6	1926	387	79	51.1	11,701

Pueblo Canyon above LA Canyon, E060



LA Canyon above Rio Grande, E110



Maximum 239/240plutonium concentration in the Rio Grande below the Los Alamos Canyon confluence is estimated to be 192 pCi/L and may have been as high as 287 pCi/L based on measurements and derived concentrations at E110 and the USGS daily mean flow of 686 cfs for August 8, 2006 at the Otowi gage.