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Interim Measure Work Plan to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons

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1.0 INTRODUCTION

The Los Alamos and Pueblo watershed, including Los Alamos and Pueblo Canyons and their tributaries, includes several current and former technical areas (TAs) at Los Alamos National Laboratory (LANL or the Laboratory). Investigations of the nature, extent, transport, and potential risk from chemicals of potential concern (COPCs) in the watershed were presented in the “Los Alamos and Pueblo Canyons Investigation Report” (LAPCIR) (LANL 2004, 087390). Following a notice of disapproval (NOD) from the New Mexico Environment Department (NMED) (2005, 088463), the Laboratory prepared a supplemental investigation report for Los Alamos and Pueblo Canyons (LANL 2005, 091818). NMED issued an approval with direction (AWD) for this report (NMED 2007, 098284), with requests to conduct actions to mitigate the transport of polychlorinated biphenyls (PCBs) in stormwater. The Laboratory agreed to prepare a work plan to address this transport (LANL 2007, 099169), which is contained in this document. The regulatory context and approach for this work plan is presented in section 2. A conceptual model for the sources, transport, and deposition of PCBs is presented in section 3, followed by proposed actions in section 4. Section 5 presents the monitoring and sampling program associated with this work, and section 6 presents the schedule and deliverables for this work. The references cited in this plan are presented in section 7.

2.0 REGULATORY CONTEXT

Pursuant to Section VII.B of the Consent Order, the Laboratory proposes to implement an interim measure to reduce migration of contaminants within the Los Alamos and Pueblo watershed.

2.1 Background

Investigation of canyon watersheds at the Laboratory is a requirement of the Consent Order and the requirements for investigating Los Alamos and Pueblo Canyons (other than intermediate and regional groundwater) were addressed in LAPCIR (LANL 2004, 087390), submitted to the NMED Hazardous Waste Bureau (HWB) on April 29, 2004. HWB approved this report with modifications on May 11, 2005 (NMED 2005, 088756) and required the Laboratory to conduct a supplemental investigation to address concerns identified in an NOD (NMED 2005, 088463). The supplemental investigation report, submitted to HWB on December 15, 2005 (LANL 2005, 091818), included the results of additional sediment investigations in Pueblo Canyon and updated human health risk assessments.

The human health risk assessments in LAPCIR and its supplement showed no unacceptable human-health risk based on current and reasonably foreseeable future land uses in the canyons. The human-health risk assessment indicated that the largest contributors to human health risk are polycyclic aromatic hydrocarbons (PAHs). The investigation results indicate that the dominant source of PAHs is runoff from the Los Alamos townsite, not Laboratory solid waste management units (SWMUs) or areas of concern (AOCs). The baseline ecological risk assessment showed no adverse effects to terrestrial and aquatic receptors in the canyons.

The LAPCIR supplemental report was approved with direction by HWB on August 30, 2007 (NMED 2007, 098284). This approval directed the Laboratory to implement actions in Los Alamos and Pueblo Canyons to mitigate migration of contaminated sediments. The Department of Energy (DOE) and the Laboratory responded to the AWD (LANL 2007, 099169) with a commitment to prepare this work plan.

2.2 Regulatory Approach

2.2.1 Consent Order

Releases of contaminants from SWMUs and AOCs are subject to corrective action requirements under the Consent Order. The Consent Order requirements for investigating these releases in the Los Alamos and Pueblo watershed have been satisfied through LAPCIR and its supplemental report (LANL 2004, 087390; LANL 2005, 091818), which have been approved by HWB (NMED 2005, 088756; NMED 2007, 098284). As noted in LAPCIR, contaminated sediments pose no current unacceptable risk to human health or the environment within the Los Alamos and Pueblo watershed, although continued migration of contaminated sediment occurs within the watershed during stormwater runoff events.

Section VII.B of the Consent Order establishes the use of interim measures as a mechanism to reduce or prevent migration of contaminants while long-term corrective action remedies are evaluated and implemented. Pursuant to Section VII.B of the Consent Order, the Laboratory proposes implementing an interim measure to reduce the migration of contaminated stormwater and sediments within the Los Alamos and Pueblo watershed as part of an overall watershed-scale approach. While the interim measure is being implemented, the Laboratory will conduct further watershed-scale evaluations of hydrologic processes in Los Alamos and Pueblo Canyons to identify additional actions that may be undertaken to further control migration of contaminated sediments. As a result of this evaluation and based on the results of the interim measure, additional actions may be identified that should be implemented as either a new interim measure or as part of the existing interim measure.

2.2.2 Other Requirements

Actions taken to control contaminated stormwater and sediments in Los Alamos and Pueblo Canyons may also be subject to a number of other requirements. Several of these are noted below.

- The National Environmental Policy Act (NEPA) requires assessments of potential environmental impacts of major federal actions. Based on similar past projects, it is expected that construction of weirs or other control structures in canyons would require preparation of an Environmental Assessment (EA) under NEPA. DOE is the administrative authority for NEPA compliance.
- The portion of Los Alamos Canyon on Laboratory property and Pueblo Canyon upstream of NM 502 have been listed as impaired waters by the NMED Surface Water Quality Bureau pursuant to Section 303(d) of the Clean Water Act (CWA). As a result, NMED is responsible for developing total maximum daily loads (TMDLs) for pollutants identified in the impaired waters listing, including PCBs. Once developed, these TMDLs may incorporate sediment mitigation activities being conducted in Los Alamos and Pueblo Canyons.
- Section 404 of the CWA regulates dredge and fill into waters of the United States. It is expected that any projects involving excavation or placement of fill in canyons will require a dredge and fill permit. This permitting program is administered by the U.S. Army Corps of Engineers.
- Portions of Pueblo Canyon are located on land owned by Los Alamos County. Actions taken on County property require consent by the County and must comply with various County codes and ordinances. Some of these County requirements may place restrictions on the types of activities that may be conducted on County property (e.g., construction of structures that would result in visual impacts or impede access to utilities).

- Portions of Los Alamos and Pueblo Canyons may be habitat for threatened or endangered (T&E) species regulated under the federal Endangered Species Act or the New Mexico Wildlife Conservation Act (e.g., peregrine falcons in Pueblo Canyon). Activities performed in T&E habitat may require controls to mitigate adverse impacts to T&E species and include coordination with the U.S. Fish and Wildlife Service or the New Mexico Department of Game and Fish.

- Structures that impound water may be subject to regulation by the New Mexico State Engineer and may require a permit issued by the State Engineer.

- Work that occurs within highway right-of-ways requires review and approval by the New Mexico Department of Transportation (NMDOT).

Compliance with these and other related requirements will be integrated into the planning and implementation of specific mitigation actions. Because of the important role of Los Alamos County, the Laboratory has already begun to involve the County in the planning process. Representatives from the Laboratory and the County have met to discuss issues related to implementing stormwater and sediment control measures in Los Alamos and Pueblo Canyons. In addition, the County reviewed HWB's AWD letter and provided written comments identifying significant concerns with implementing the actions identified in the letter (Los Alamos County 2007, 100144).

3.0 CONCEPTUAL MODEL

The nature, sources, extent, fate, and transport of contaminants associated with sediment in the Los Alamos and Pueblo watershed are discussed in section 7.1 of LAPCIR (LANL 2004, 087390), as part of a physical system conceptual model for the watershed, and additional insights have been gained from subsequent work. In this section aspects of a conceptual model for PCBs and associated sediment and stormwater transport are discussed that are relevant for mitigating PCB transport in the Los Alamos and Pueblo watershed. These include (1) sources and current distribution of PCBs; (2) sources of runoff; (3) sediment particle-size effects; and (4) sediment deposition areas. Locations of investigation reaches, TAs, gaging stations, and other sites discussed in this section are shown in Figure 3.0-1.

3.1 Sources and Current Distribution of PCBs

PCBs are widely distributed in sediment deposits in the Los Alamos and Pueblo watershed, and their spatial distribution indicates that they have multiple sources, including both Laboratory and non-Laboratory (Los Alamos townsite) sources. Figure 3.1-1 (Figure 7.1-22 of LAPCIR) shows spatial variations in the average concentration of Aroclor-1254 and Aroclor-1260 in fine-grained sediment deposits in investigation reaches. The highest PCB concentrations were measured for Aroclor-1254 in the South Fork of Acid Canyon (reach ACS) and downcanyon in reach AC-3 (note that the sediment deposits with the highest PCB concentrations in ACS were removed during an interim action in 2001, and current concentrations are lower than shown in Figure 3.1-1) (LANL 2002, 073660). The highest concentration of Aroclor-1260 in the Pueblo Canyon watershed was also measured in ACS, and Aroclor-1260 was also detected upcanyon from the South Fork (reaches AC-1 and AC-2) and in Pueblo Canyon upcanyon from Acid Canyon (reaches P-1FW and P-1W). In DP and Los Alamos Canyons, the highest concentration of Aroclor-1254 was measured in reach LA-1W, and the highest concentrations of Aroclor-1260 were measured in reaches DP-1C, LA-1C, and LA-2FE.

Los Alamos and Pueblo Canyons have also been assessed by the NMED Surface Water Quality Bureau (SWQB) pursuant to Section 303(d) of the CWA to determine if they are impaired waters. The portion of Los Alamos Canyon within the Laboratory and Pueblo Canyon from NM 502 to its headwaters (which includes the reaches referred to in the AWD) are listed as impaired waters for PCBs and other constituents in the 2006–2008 State of New Mexico Integrated Clean Water Act §303(d)/§305(b) Report prepared by the SWQB. Information associated with the listing is summarized in Table 3.1-1. The assessment, which was based on the results of stormwater sampling, identified multiple probable sources of impairment, both Laboratory-related and non-Laboratory-related.

Erosion of sediment deposits in the canyon bottom containing PCBs is probably the primary source, at present, of continued PCB transport in stormwater in the Los Alamos and Pueblo watershed. To help identify which parts of the canyons have the largest amounts of PCBs and to help understand past transport processes, data on PCB concentrations and sediment volumes presented in LAPCIR were used to estimate inventories of Aroclor-1254 and Aroclor-1260 along the lengths of Acid, DP, Los Alamos, and Pueblo Canyons. These inventories were calculated by the same method used for radionuclides in LAPCIR (section D-1.4) and are shown graphically in Figures 3.1-2 to 3.1-5 of this work plan. Each figure includes both normalized inventories in each reach (estimated mass in each reach divided by reach length, in units of kg/km of channel) and a cumulative inventory (units of kg). Of the total estimated combined PCB inventories of about 20 lb, 73% is contained within Los Alamos and DP Canyons (predominantly Los Alamos Canyon), and over 80% of this inventory is Aroclor-1260. The Aroclor-1260 is distributed at low concentrations over a distance of greater than 6 mi along Los Alamos Canyon, with the largest part of the inventory occurring in large sediment deposits in reach LA-2FE, downcanyon from the confluence with DP Canyon and immediately upcanyon from the TA-53 drainage, in a reach with wide floodplains and thick sediment deposits. This distribution indicates the potential importance of natural sediment deposition areas in attenuating contaminant transport (e.g., Malmon et al. 2005, 093540) and also the significance of the part of Los Alamos Canyon downcanyon from DP Canyon as a potential secondary PCB source.

In contrast to Aroclor-1260 in Los Alamos Canyon, Aroclor-1254 in Los Alamos Canyon and both Aroclor-1254 and Aroclor-1260 in Acid and Pueblo Canyons have smaller inventories that are largely contained in upcanyon reaches, with no detects in downcanyon reaches (although small quantities of these PCBs certainly occur in these downcanyon reaches at concentrations below detection limits for the Aroclor method).

Consistent with the data from sediment deposits, analytical data from stormwater samples indicate that PCB concentrations are higher in Los Alamos Canyon near NM 4 than in lower Pueblo Canyon, and that Aroclor-1260 is present at higher concentrations than Aroclor-1254. The maximum detected concentration for Aroclor-1260 at gaging station E042 in Los Alamos Canyon above the low-head weir is 0.57 µg/L, and for Aroclor-1254 is 0.39 µg/L. In contrast, the maximum detected Aroclor-1260 concentration at gaging station E060 in lower Pueblo Canyon is 0.23 µg/L, and Aroclor-1254 has not been detected.

3.2 Sources of Runoff

Rainfall patterns and stream discharge records indicate that at present the most important source for stormwater in both Los Alamos and Pueblo Canyons is urban runoff. Figure 3.2-1 compares measured peak discharges at gaging station E030, in Los Alamos Canyon immediately above the confluence with DP Canyon, with discharges at gaging station E038 in DP Canyon, for water years 2001 to 2007 (October 2000 to September 2007). Despite its smaller drainage area, DP Canyon has both larger and more frequent stormwater runoff events than Los Alamos Canyon. This effect results from the urbanized nature of the DP Canyon headwaters in the Los Alamos townsite, rapid runoff from paved areas and rooftops, and a stormwater runoff system that feeds directly into the head of the canyon. In Pueblo Canyon, the largest peak discharge in the period of record occurred on August 8, 2006 (Romero et al. 2007, 100140, p. 35), during a storm that had the highest rainfall intensity on the Los Alamos townsite. Field observations support the conclusion that urbanized areas, not the Cerro Grande burn area, constituted the primary source area for runoff during this event. The Los Alamos townsite has become a more important source for runoff in Pueblo Canyon after the Cerro Grande fire because of development in Quemazon community and other areas and because of construction of a large culvert beneath the Diamond Drive fill bridge that allows runoff from the upper watershed to pass beneath Diamond Drive unimpeded. Erosion and sediment transport in Los Alamos and Pueblo Canyons is thus enhanced by urban runoff, and controlling urban runoff may help reduce downstream sediment and contaminant transport.

3.3 Effects of Sediment Particle Size

PCBs in the Los Alamos and Pueblo watershed are preferentially associated with fine-grained sediment particles, and concentrations are higher in fine-grained sediment that represents suspended load in floods than in coarse-grained sediment that represents bedload transport (section 7.1.3.2 and Table D-1.6.3 of LAPCIR). As an example, this relationship is seen in plots of concentrations of Aroclor-1254 and Aroclor-1260 versus silt and clay content for 20 sediment samples collected from the sediment retention basin above the Los Alamos Canyon low-head weir (Figure 3.3-1). Although approximately 40% of the sediment volume in this basin consists of coarse-grained sediment (dominated by medium to very coarse sand and gravel), these coarse deposits account for <10% of the PCB inventory. Therefore, any mitigation measures designed to reduce transport of PCBs should focus on fine-grained sediment.

3.4 Areas of Sediment Deposition

Areas of significant historical (post-1942) sediment deposition occur along Los Alamos and Pueblo Canyons where floodwaters have been able to spread laterally across broad floodplains, causing flow depth and sediment transport capacity to decrease. These areas contain significant portions of the contaminant inventory in these canyons. An example for PCBs in Los Alamos Canyon, reach LA-2FE, was discussed previously in section 3.1 (Figure 3.1-5). In Pueblo Canyon, the lower 2 km below the former Bayo wastewater treatment plant (WWTP) has wide areas of post-1942 sediment deposition where plutonium-bearing sediment was deposited (LANL 2004, 087390; Reneau et al. 2004, 093174). Deposition in some of these areas has continued after the Cerro Grande fire, and up to 1 m (3.3 ft) of postfire deposition of fine-grained sediment has been observed in the wetland in reach P-3E. The deposition in the wetland is enhanced by thick vegetation (particularly reed canary grass, *Phalaris arundinacea*), which adds roughness and decelerates the flow (Figure 3.4-1). Field observations indicate that one effect of this deposition has been an increase in the elevation of the floodplain relative to the channel bed, in turn reducing the frequency of overbank flooding. At present, most of the floods do not appear to go out of bank in many areas, which reduces the potential for deposition of sediment and associated contaminants. For deposition in these areas to increase, floodwaters would have to go out of bank more frequently.

Significant sediment deposition has also occurred in the area between the former Bayo WWTP outfall and the current Los Alamos WWTP outfall, in the vicinity of Hamilton Bend (reach P-3W). Up to 1 m (3.3 ft) of postfire channel aggradation, dominated by coarse sediment, has been measured in this reach (Lyman et al. 2005, 089414). One effect of this deposition in the channel is to increase the potential for transmission losses into the stream bed, which in turn helps attenuate flood peaks. An additional effect of channel aggradation is to help protect the adjacent banks from erosion and to allow more frequent overbank floods. Since October 2007, this area has received treated effluent from the new Los Alamos WWTP, and the potential exists to increase sediment deposition in this area by establishing riparian or wetland vegetation, which would stabilize the surface and slow floodwaters.

Since the Cerro Grande fire, the lower end of Pueblo Canyon has been unstable and eroding from the combined effects of more frequent and higher-magnitude floods and channel constriction caused by construction of the NM 4–NM 502 interchange (the “White Rock Y”). A headcut that first developed in the area of the constriction has migrated upstream, destabilizing the lower end of the wetland (Ford-Schmid and Englert 2004, 100148) and reducing the ability for sediment deposition to occur in this area (Figure 3.4-2). Low levels of some COPCs (e.g., plutonium-239,240) (LANL 2004, 087390; Reneau et al. 2004, 093174) are also remobilized by this erosion. Continued headcut migration has occurred during large floods (e.g., August 8, 2006), and further headcut erosion and wetland loss is expected unless the lower canyon is stabilized.

A sediment deposition area was created in Los Alamos Canyon above NM 4 in the summer of 2000 after the Cerro Grande fire, when the low-head weir was constructed and a settling basin was excavated immediately upstream (Figure 3.4-3) (DOE 2000, 100192). This structure has been effective at reducing off-site transport of sediment and associated contaminants (Gallaher and Koch 2004, 088747), and approximately 5900 m^3 (7700 yd^3) of sediment has been deposited there as of January 2008, of which approximately 60% is fine-grained sediment (medium to very fine sand, silt, and clay). Analysis of suspended sediment concentration (SSC) in stormwater samples from 2001 to 2005 upstream (gaging station E042) and downstream (gaging station E050) of the weir indicates that, on average, SSC has been reduced by approximately 30% to 50% as floodwaters pass through the weir. Because the trapping efficiency of the settling basin is expected to decrease as it fills up with sediment, sediment deposition should increase if the basin were excavated. Other enhancements to the weir should further reduce off-site transport (e.g., by reducing flows through the open-framework gabion structure).

3.5 Summary

The transport of PCBs and other contaminants associated with sediment in stormwater can be reduced in one of three ways: (1) reduce the magnitude and/or frequency of runoff events; (2) reduce the erosion of contaminated sediment deposits during runoff events; or (3) enhance sediment deposition during runoff events, particularly of fine-grained sediment. The following sections propose actions that address each of these three processes, with emphasis on the enhancement of sediment deposition, which was the focus of the actions specified in NMED’s AWD (i.e., construction of low-head weirs).

4.0 PROPOSED ACTIONS

In its acceptance of the Laboratory’s proposed submittal date for this work plan (NMED 2008, 099820), NMED requested that six items be included in this work plan or a proposal for substantive alternatives be presented. The six items are as follows:

1. the proposed location and specific design of a new low-head weir in Los Alamos Canyon below the confluence with DP Canyon
2. the proposed location and specific design of a new low-head weir in Pueblo Canyon between the confluences with Graduation and Kwage Canyons
3. proposed measures to enhance and stabilize the Pueblo Canyon wetland
4. the design and locations of surface water monitoring stations below new weirs
5. specific steps to characterize, remove, and dispose of accumulated sediments at the existing Los Alamos Canyon low-head weir
6. proposed enhancements to the existing Los Alamos Canyon low-head weir

Because of constraints imposed by infrastructure and land ownership, two of these actions are not feasible, and the Laboratory proposes alternative approaches to obtain the overall goal of reduced contaminant transport. The proposed new low-head weir in Los Alamos Canyon is not feasible because that part of the canyon contains a shallowly buried natural gas pipeline owned by the Public Services Company of New Mexico and a road used for fire protection and to access a Los Alamos County drinking water supply well (Otowi 4). A weir large enough to dissipate flood energy and reduce sediment transport, while being able to withstand a design flood (e.g., a 25-yr return period flood), would impinge on the pipeline and road, and relocating the pipeline is not feasible. The proposed new low-head weir in Pueblo Canyon is not feasible because that part of the canyon is the property of Los Alamos County, and the landowners have expressed their opposition to the construction of a weir in that area for several reasons (Los Alamos County 2007, 100144). These reasons include the presence of a County sewer main and associated maintenance road and the location of the proposed structure within the Los Alamos County Open Space System in a high-use area of the County Trail Network, in a critical viewshed, and within the nesting area of peregrine falcons, a threatened avian species.

Three of the specific actions requested by NMED appear to be practicable, and these actions are discussed in subsequent sections of this work plan. The sixth requested action, monitoring below two new low-head weirs, is no longer applicable. Furthermore, the Laboratory proposes other actions, specifically enhanced stormwater monitoring in Los Alamos and Pueblo Canyons, stormwater management, and bank stabilization; these actions are also discussed below. This work would use an adaptive management approach, where sediment transport and changes in the watersheds are monitored and additional actions are taken in the future, if warranted.

4.1 Stabilization and Enhancement of Pueblo Canyon Wetland

The Pueblo Canyon wetland serves the valuable function of dissipating flood energy and allowing suspended sediment and adsorbed contaminants to be deposited. The Laboratory proposes several actions to stabilize and enhance the wetland. These include (1) constructing a base-level grade-control structure to stabilize the lower end of the wetland; (2) planting of willows along the channel below the new Los Alamos WWTP outfall to increase the upstream extent of wetland vegetation; and (3) constructing a pilot wing ditch to evaluate the feasibility of spreading water in the wetland and enhancing sediment deposition. The gaging station network would also be expanded and improved to help measure the effectiveness of the enhanced wetland in reducing transport of suspended sediment and associated contaminants. One new gaging station would be constructed upcanyon from the wetland, and the existing downcanyon gaging station (E060) would be relocated to a point downstream from the grade-control structure.

4.1.1 Grade-Control Structure

The Laboratory proposes constructing a grade-control structure in lower Pueblo Canyon in the vicinity of the NM 4–NM 502 interchange, approximately 230 m (755 ft) downcanyon of the current E060 gaging station, as shown in Figure 4.1-1. General conceptual aspects of the structure are discussed here, and a full engineering design that accommodates a design flood and protects the adjacent highway from flooding will follow approval of this plan. Coordination with and approval by NMDOT may be required for this work. One additional constraint on this activity is that the targeted location is close to the boundary with Pueblo de San Ildefonso, and representatives of the Pueblo have indicated that the Tribal Council may not grant approval to do any work on Pueblo land. Therefore, constructing a grade-control structure is contingent on having a suitable location and engineering design that does not impact Pueblo land.

Conceptually, the proposed structure may utilize aspects of the basic design used for the Los Alamos Canyon low-head weir (URS 2000, 100301), specifically abovegrade rock-and-mesh gabions spanning the width of the active channel and adjacent abandoned channels and active floodplains. The height of the structure would be designed to allow the currently incised channel to backfill with sediment and establish a new grade that eventually buries the headcuts near E060, which are associated with progressive wetland loss. In the process, a defined channel would be replaced with a broad aggraded wetland surface where floodwaters would spread and further increase sediment deposition. As with the existing Los Alamos Canyon weir, the Pueblo Canyon structure would have a broad rectangular notch on top to establish the location of the channel subsequent to backfilling, away from both the highway to the south and the hillslope to the north. A slightly higher extension of the structure to the north would act as an emergency spillway in large flood events. The structure would be located east of where headcuts have formed on the edge of the north-side floodplain and west of the channel constriction adjacent to the highway where flow is currently being funneled. Design considerations may include extending the base below the existing grade to prevent tipping and extending the sides upcanyon to prevent floodwaters from bypassing around the edges. A rock mat would be emplaced immediately below the lip of the structure to prevent downstream incision that could compromise the structure, and additional grade control may be required downstream. Any material excavated during construction would be placed west (upgradient) of the structure to aid in backfilling.

After backfilling with sediment, the structure would have to be able to accommodate a flood of approximately 2000 cubic feet per second (cfs), the largest flood on record (August 8, 2006), without overtopping or compromising the highway. This requirement may place constraints on the maximum height of the structure. If the structure is not high enough to cause backfilling to the headcuts near E060, one or more additional smaller structures may be required to the west in the future.

As part of the downstream engineering work, the E060 gaging station would be relocated below the structure to measure discharge and to serve as a location for monitoring transport of sediment and associated contaminants. Channel geometry here is also better for measuring discharge than at the existing location. However, the design would have to avoid Pueblo de San Ildefonso land, which occurs a short distance downcanyon and to the north. A possible location for this gaging station is shown in Figure 4.1-1.

4.1.2 Enhancement of Upstream Wetland

The Laboratory proposes establishing riparian vegetation in the area between the current Los Alamos WWTP outfall and the existing Pueblo Canyon wetland (Figure 3.0-1). This work would have the combined goals of stabilizing surfaces, dissipating flood energy, increasing sediment deposition, and enhancing ecological habitat. Approximately 3000 native willow stems (*Salix spp.*) would be planted along 1 km (0.6 mi) of channel downstream from the current outfall, including in reach P-3W, where they have a high probability of establishing successfully because of the high water table currently present there. The County of Los Alamos has successfully established willows upcanyon on its land, and the County supports similar work in the part of Pueblo Canyon on Laboratory land (Los Alamos County 2007, 100144).

4.1.3 Pilot Wing Ditch

The Laboratory proposes constructing a pilot wing ditch in the part of the Pueblo Canyon wetland near the access road (reach P-3E; Figure 3.0-1) to enhance the spreading of water over the wetland, dissipation of flood energy, and deposition of suspended sediment. The ditch would extend to approximately one-half the depth of the existing channel to intercept and divert runoff that would otherwise remain within the banks. It would extend obliquely from the channel and taper out on the existing aggraded sediment surface. Excavated sediment would be bermed on the downstream side of the ditch to help prevent a new channel from establishing during floods. The downstream reentry point(s) for the dispersed water would be monitored and stabilized if needed (e.g., if new headcuts formed). If the pilot wing ditch is successful, remains stable and has no unintended adverse consequences, additional similar structures may be constructed in the wetland. However, if it is unsuccessful, the ditch will be backfilled.

4.1.4 Upcanyon Gaging Station

The Laboratory proposes constructing a new gaging station in Pueblo Canyon west of the current Los Alamos WWTP outfall and east of Kwage Canyon (Figure 3.0-1), which would also serve as a location for monitoring sediment transport. The goal would be to quantify stream discharge and transport of suspended sediment and associated contaminants for comparison with data from a relocated E060 gaging station near the White Rock Y (see section 4.1.1).

4.2 Excavation and Enhancement of Basin above Los Alamos Canyon Low-Head Weir

The sediment retention basin immediately west of the Los Alamos Canyon low-head weir has accumulated approximately 5900 m^3 (7700 yd^3) of sediment since it was constructed in summer 2000, or about 44% of its maximum capacity of approximately 13,400 m^3 (17,500 yd^3). Although considerable storage capacity remains, its trapping efficiency could be increased, particularly for the fine-grained sediment carried in suspension, if some or all of the existing sediment deposits were excavated and the system enhanced.

The floor of the sediment retention basin has basalt bedrock mounds that were encountered during excavation, resulting in significant variations in the thickness of overlying sediment deposits. These variations are shown in Figure 4.2-1, and three general subbasins are present, separated by basalt (unit Tb), that progressively thicken to the east. The Laboratory proposes excavating sediment in these three areas, leaving intervening sediment deposits in place, and creating three separate closed basins (Figures 4.2-1 and 4.2-2). Some of the excavated sediment would be used to raise the ground surface on the north side between the basins to direct drainage over the thin deposits to the south. The replacement of the existing east-sloping surface bounded by open-framework gabions with three closed basins will enhance deposition of the finest-grained sediment and associated contaminants. An approximately 3-m-(10-ft-) wide undisturbed strip of sediment would also be left next to the weir so drainage would first occur through sediment instead of directly through the gabions, in effect adding a filter. Cuttings from existing willows and cottonwoods affected by excavation would be replanted in this strip and elsewhere in the basin above the weir, enhancing the riparian habitat.

Previous studies have shown that rapid infiltration occurred from ponded water behind the weir into underlying fractured basalt, creating a potential fast-pathway for dissolved-phase contaminants to reach groundwater (Stone et al. 2004, 087379; Levitt et al. 2005, 100232). The main dissolved-phase contaminant in Los Alamos Canyon is strontium-90 (LANL 2004, 087390), and the Laboratory proposes reducing the potential for downward migration of strontium-90 by lining the bottom of the basins with either an impermeable barrier or a reactive medium such as mineral apatite (calcium phosphate).

The proposed sediment excavation would total approximately 5000 m^3 (6500 yd^3), or approximately 87% of the volume of accumulated sediment. This material will be managed in accordance with all applicable regulatory requirements. In November 2007, analytical data were obtained from six sediment samples collected from the basin above the weir for purposes of waste characterization, integrating the complete thickness of sediment in six auger holes. These analytical data indicate the sediment deposits contain low levels of inorganic, organic, and radionuclide COPCs, below soil screening levels and screening action levels for protective (residential) land use scenarios. Sediment excavated from this area during original construction in 2000 was placed on the hillslope immediately north of the sediment retention basin, as shown in Figure 4.2-1. If appropriate, the newly excavated sediment would be placed in this same area, on top of the existing fill, followed by regrading and reseeding.

4.3 Upgrades to Los Alamos Canyon Gaging Stations

As part of this interim measure, the Laboratory proposes upgrading the existing gaging stations immediately above and below the Los Alamos Canyon low-head weir (stations E042 and E050, respectively; Figure 3.0-1). These upgrades would consist of adding controls to improve the channel geometry, such as installing v-notched weirs or flumes, and would result in improved discharge and sediment flux estimates. These data are required for the most accurate evaluation of weir performance.

4.4 Stormwater Management

Runoff from urban areas in the Los Alamos townsite contributes significantly to flood discharge and therefore to downstream erosion and sediment transport in Los Alamos and Pueblo Canyons. Los Alamos County recognizes this problem and has taken steps to manage stormwater (Los Alamos County 2007, 100144). These steps include a revision to the County's Engineering Standards and proposed changes to the County Development Code. Additional projects to reduce peak flows were developed and implemented through a CWA Section 319 grant to the Pajarito Plateau Watershed Partnership. The Laboratory will continue coordinating with the County to help address stormwater management in the Los Alamos and Pueblo watershed, as appropriate and feasible.

4.5 Bank Stabilization

Stabilizing stream banks containing contaminated sediment is one method to reduce contaminant flux. Because contaminants are dispersed along many miles of canyon, it is not practicable to stabilize all banks, but the Laboratory proposes stabilizing some banks in reaches impacted by urban runoff near the major contaminant sources. Specifically, banks would be targeted in Acid Canyon reach AC-3, where the highest measured PCB concentrations are present in sediment deposits, along with radionuclides and other COPCs, and DP Canyon reach DP-2, where the highest concentrations of some radionuclides have been measured (Figure 3.0-1). Installation of jute matting to cover and help stabilize banks is proposed for sites in these reaches. Banks will be selected that expose young (post-1942) deposits and that are continuous for more than approximately 3 m (10 ft) along the channel. This bank stabilization work would follow work performed by the Laboratory along Pueblo Canyon on Los Alamos County land in 2005, when 3000 willow stems were planted and jute matting was emplaced along approximately 900 m (3000 ft) of bank. An example of jute matting and willows installed in Pueblo Canyon in 2005 is shown in Figure 4.5-1. Rock armoring of banks may also be appropriate in some areas. The focus will be on abandoned channel units (e.g., "c2" unit), because these deposits contain most of the contaminant inventory susceptible to mobilization in floods. Seed and mulch will be applied under the jute matting where a sufficient slope exists on the banks for these materials to remain where placed.

5.0 MONITORING PROGRAM

The effectiveness of the actions for reducing the transport of PCBs and other COPCs proposed in this work plan will be evaluated using stream discharge data and sampling and analysis of stormwater collected upcanyon and downcanyon from the primary sediment deposition areas in Los Alamos and Pueblo Canyons. In Pueblo Canyon, discharge will be measured and samples collected at a new gaging station upcanyon from the new Los Alamos WWTP and at a relocated E060 gaging station to be located downcanyon from the proposed grade-control structure near the NM 4–NM 502 interchange.

In Los Alamos Canyon, discharge will be measured and samples collected at gaging stations E042 and E050, located upcanyon and downcanyon from the Los Alamos Canyon low-head weir, respectively.

Stormwater samples collected from the same events at upcanyon and downcanyon stations in each canyon will be analyzed for SSC and key COPCs, including PCBs. Because SSC is strongly dependent on time after arrival of flood bores (i.e., the leading edge of flood water) (Malmon et al. 2004, 093018; Malmon et al. 2007, 100194), samples will be collected as close as possible to the same locations on hydrographs at upcanyon and downcanyon stations in each event. At least two runoff events will be sampled in each canyon every year, unless fewer events occur. In the first year, multiple samples will be collected and analyzed through the hydrograph at each station from at least two events in each canyon to define the relations between SSC, COPC concentration, and time after the flood bore arrives. These data will be combined with discharge measurements to calculate total flux of suspended sediment and associated COPCs in sampled events and throughout the year at each station.

6.0 SCHEDULES, DELIVERABLES, AND REPORTING

Activities proposed in this work plan will begin immediately following approval of the plan by NMED. Initial activities include obtaining necessary contracts, permits, and approvals for this work, and preparing a formal engineering design for the grade-control structure in lower Pueblo Canyon. An EA will be prepared for the proposed grade-control structure concurrently with other preliminary activities, in anticipation of obtaining a NEPA finding of no significant impact. The proposed planting of willows in Pueblo Canyon will begin in March 2008 because this time is optimum for successfully establishing the plants, before stems begin budding. Los Alamos County has granted approval of any such work on county land.

An initial interim measure report will be submitted to NMED by January 31, 2009, that includes documentation of all activities conducted in calendar year (CY) 2008. The Laboratory expects that the following activities will be completed in CY2008 and included in this report:

1. excavation of sediment from the sediment retention basin west of the Los Alamos Canyon low-head weir
2. planting of willows in Pueblo Canyon east of the Los Alamos WWTP
3. installation of jute matting in Acid and DP Canyons
4. installation of a new gaging station in Pueblo Canyon west of the Los Alamos WWTP
5. upgrading the E042 and E050 gaging stations in Los Alamos Canyon
6. construction of a pilot wing ditch in the Pueblo Canyon wetland
7. engineering design of the proposed Pueblo Canyon grade-control structure

The schedule for some activities may be delayed if approval from NMED or required permits or NEPA determinations are delayed. If possible, the proposed Pueblo Canyon grade-control structure and the associated relocated E060 gaging station will also be installed in CY2008, although the target completion date for these is before the 2009 thunderstorm season and associated stormwater runoff events begin (i.e., by June 1, 2009).

A second interim measure report that includes all field activities conducted in CY2009, analytical data from stormwater samples collected through the 2009 thunderstorm season, an evaluation of the effectiveness of the interim measure, and recommendations for future work and reporting will be submitted to NMED by December 20, 2009.

7.0 REFERENCES

The following list includes all documents cited in this plan. Parenthetical information following each reference provides the author(s), publication date, and ER ID number. This information is also included in text citations. ER ID numbers are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

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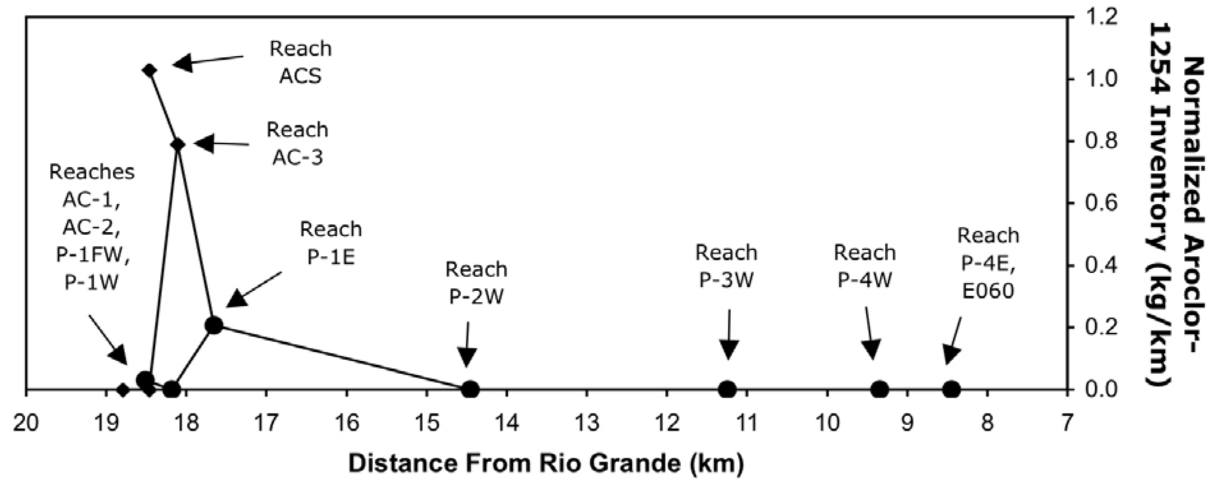
(11x17”)

Figure 3.0-1 Map of the Los Alamos and Pueblo watershed, showing sediment investigation reaches, TAs, gaging stations, and other features mentioned in text

(11x17 back of page 19)

**Figure 3.1-1	Estimated average concentrations of Aroclor-1254 (top) and Aroclor-1260 (bottom) in fine facies sediment in the Los Alamos and Pueblo watershed (Figure 7.1-22 of LAPCIR)**



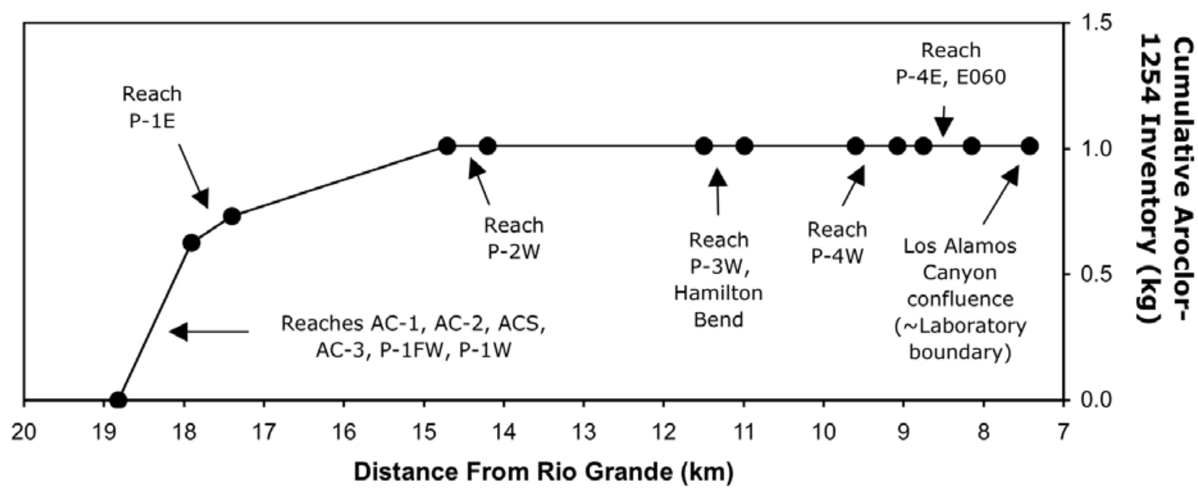
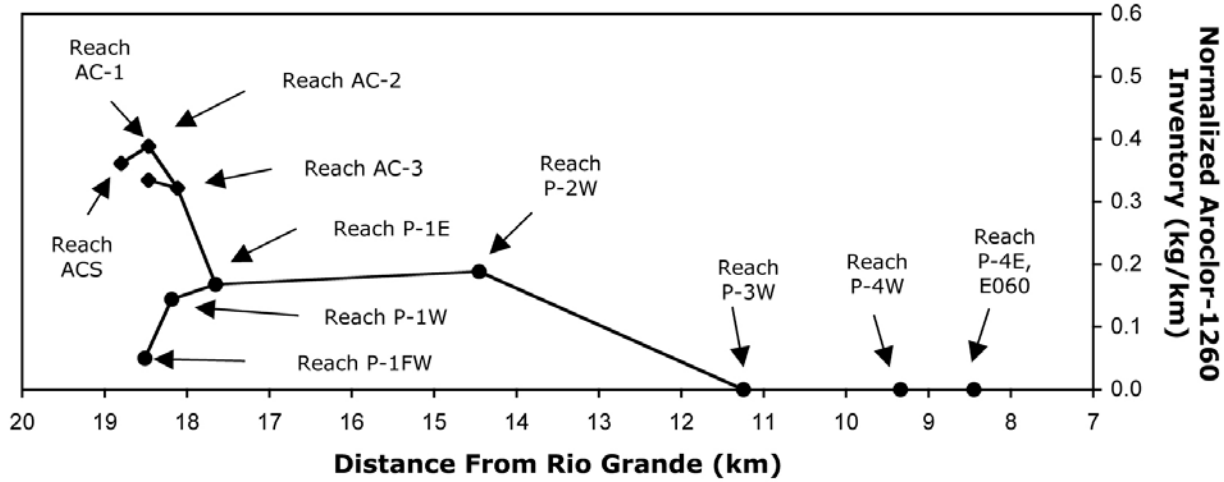


Figure 3.1-2 Plots of normalized Aroclor-1254 inventory (top) and cumulative Aroclor-1254 inventory (bottom) in Acid and Pueblo Canyons



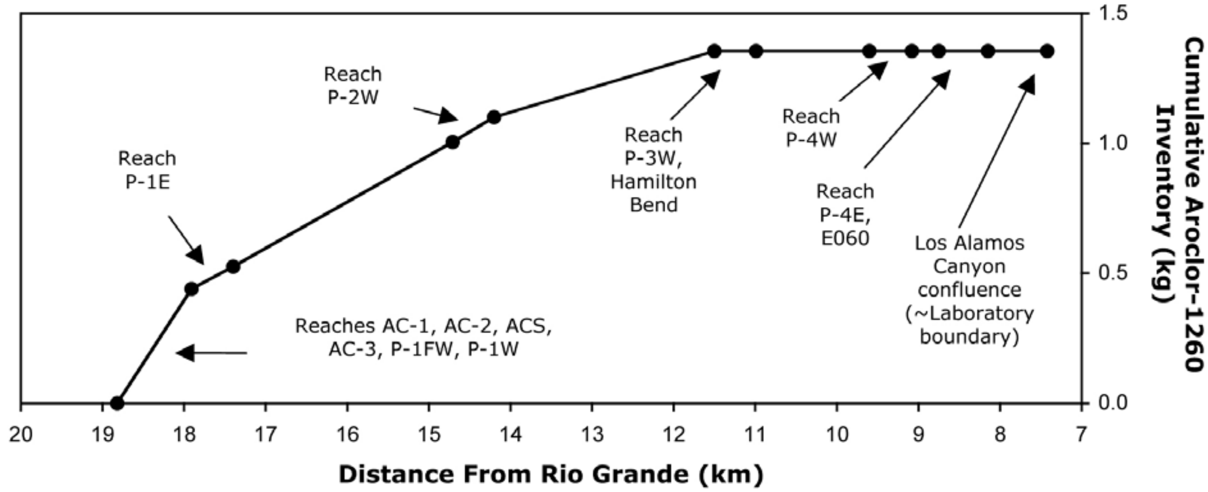
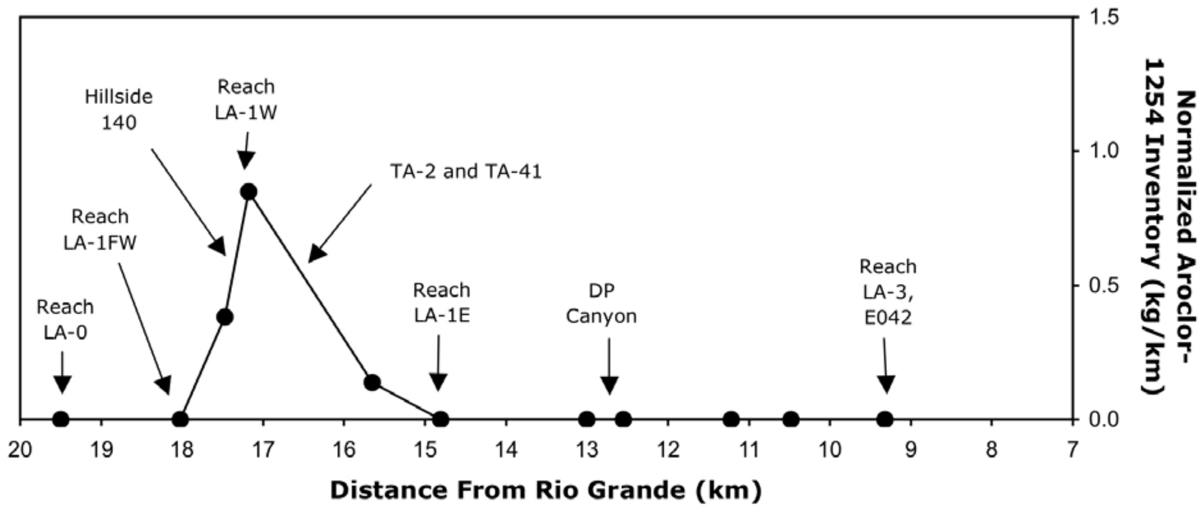


Figure 3.1-3 Plots of normalized Aroclor-1260 inventory (top) and cumulative Aroclor-1260 inventory (bottom) in Acid and Pueblo Canyons



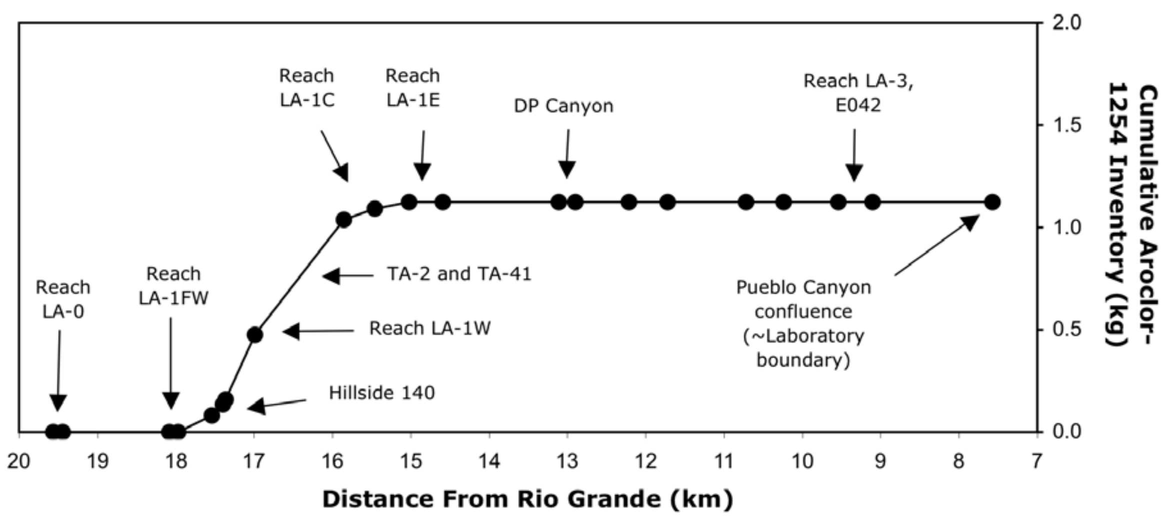


Figure 3.1-4 Plots of normalized Aroclor-1254 inventory (top) and cumulative Aroclor-1254 inventory (bottom) in DP and Los Alamos Canyons

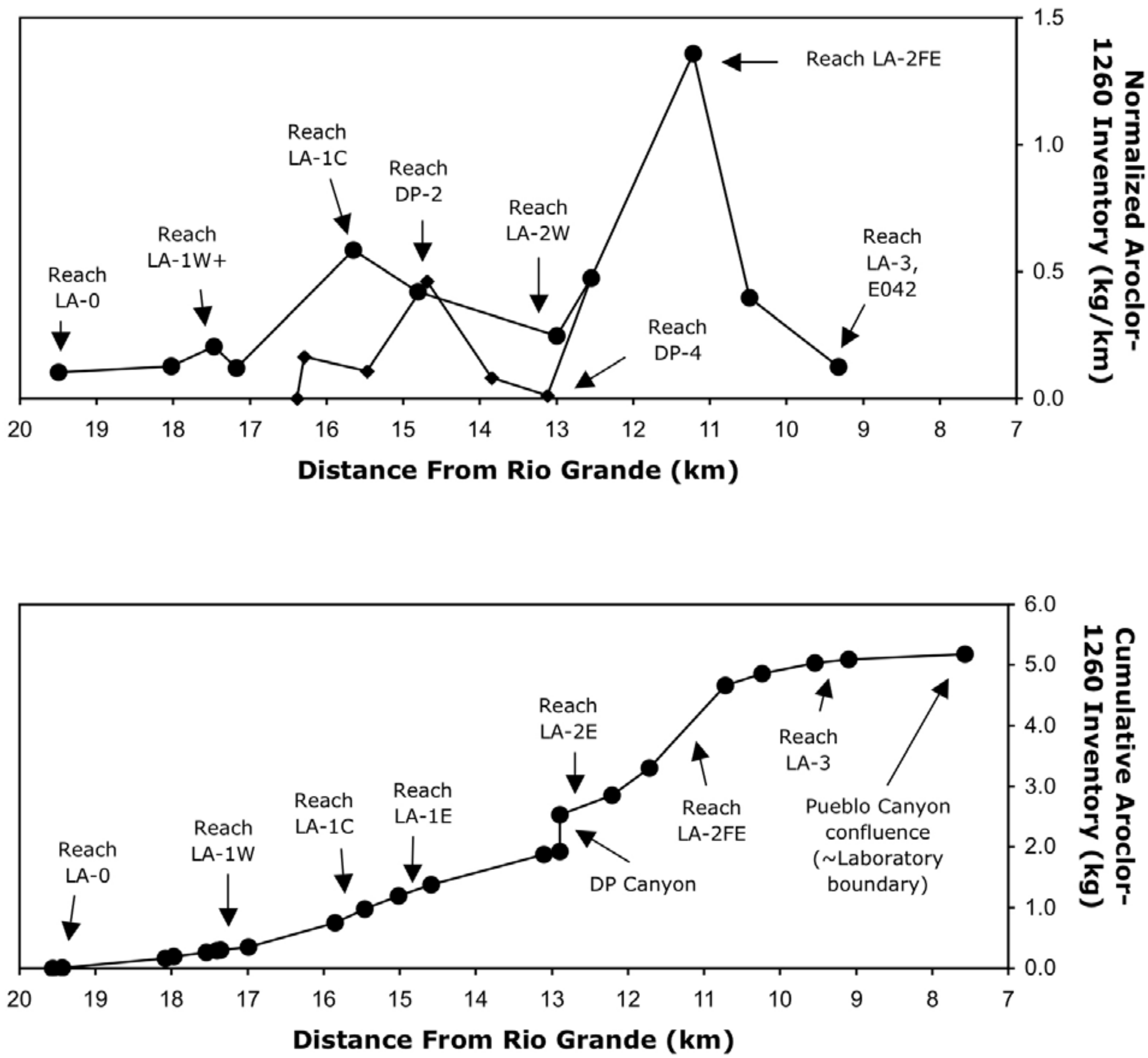


Figure 3.1-5 Plots of normalized Aroclor-1260 inventory (top) and cumulative Aroclor-1260 inventory (bottom) in DP and Los Alamos Canyons

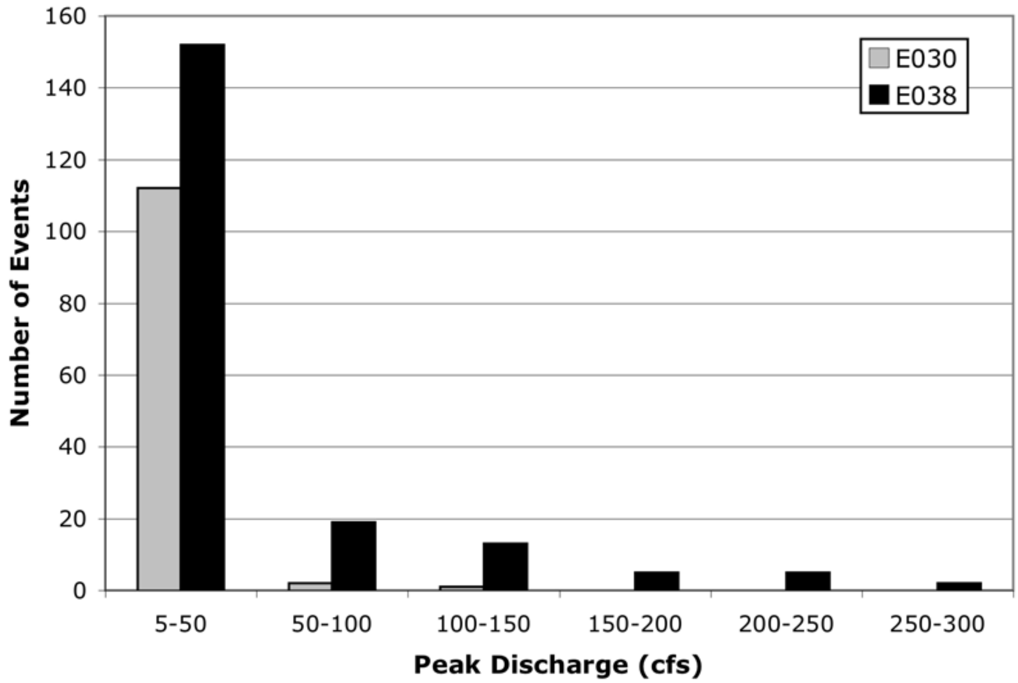
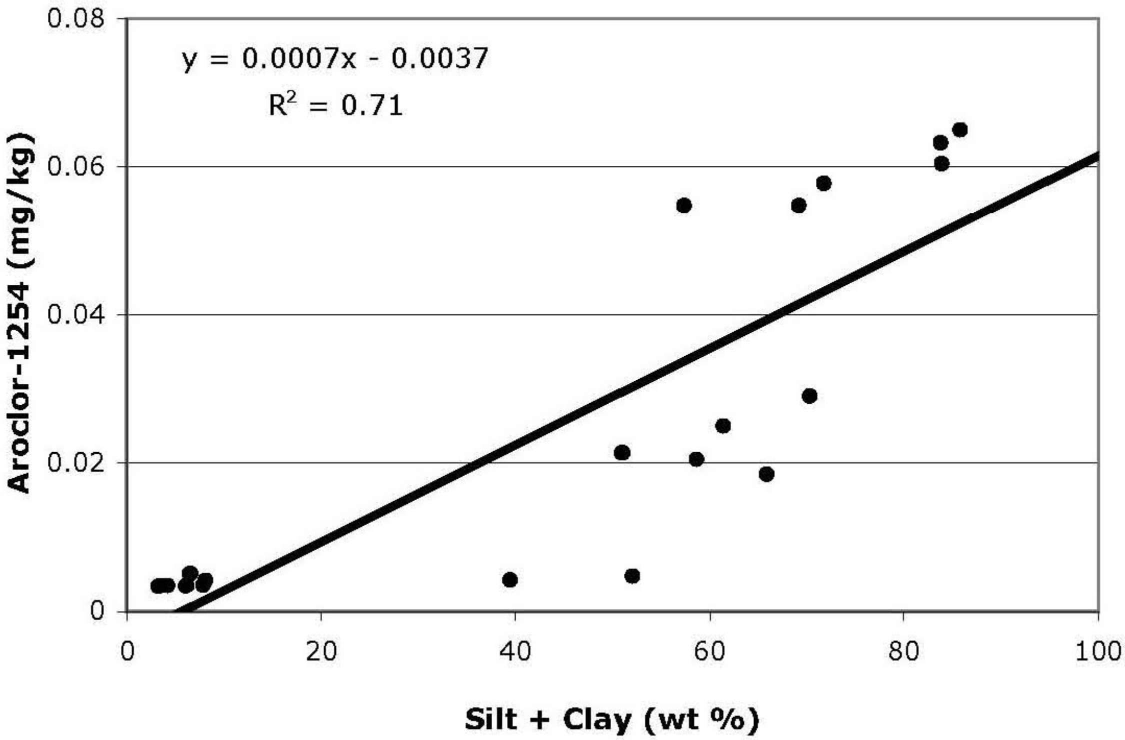


Figure 3.2-1 Histogram comparing peak discharges at gaging stations E030 in Los Alamos Canyon and E038 in DP Canyon from October 2000 to September 2007



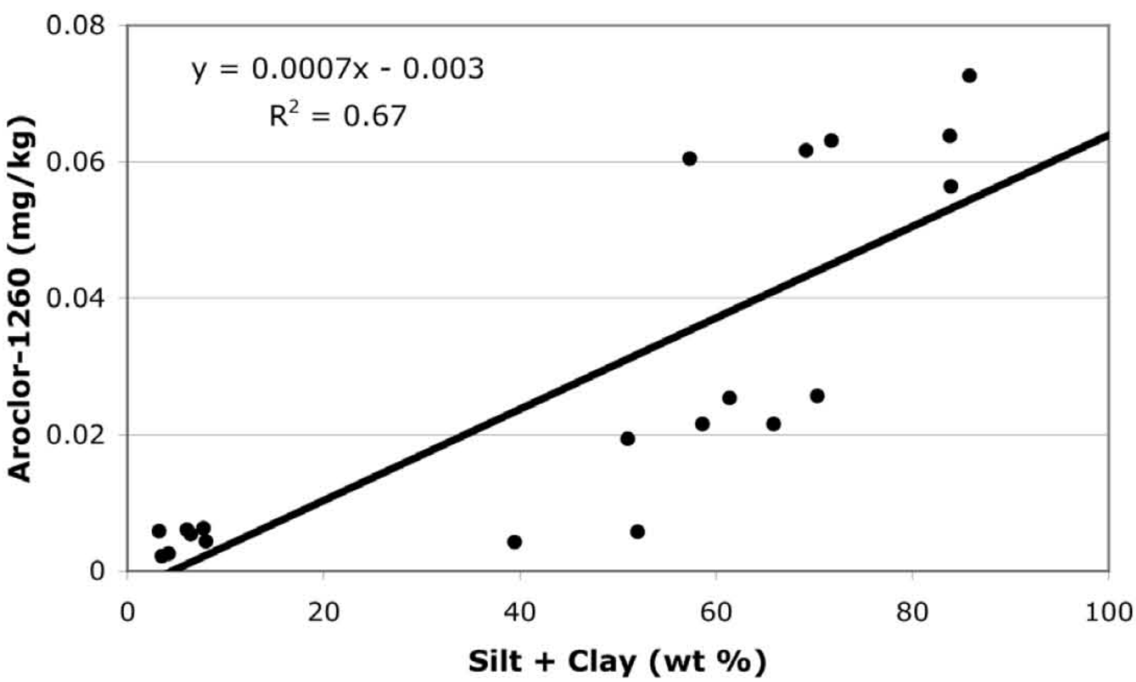


Figure 3.3-1 Concentrations of Aroclor-1254 (top) and Aroclor-1260 (bottom) versus silt and clay content in sediment samples from the basin above the Los Alamos Canyon low-head weir

Figure 3.4-1 Photographs of wetland vegetation (reed canary grass, *Phalaris arundinacea*) in lower Pueblo Canyon, June 2003 (top; view to the north), and 0.9 m (3.0 ft) thick postfire sediment deposit in wetland, with dark ash-rich sediment layer at base (bottom)

Figure 3.4-2 Photographs of headcut and eroded channel in Pueblo Canyon below E060 gaging station, February 26, 2007, looking upstream (top; view to the west) and downstream (bottom; view to the east)

Figure 3.4-3 Photographs of Los Alamos Canyon low-head weir and upstream sediment retention basin on March 30, 2001 (top; view to the west) and July 10, 2006 (bottom; view to the north)

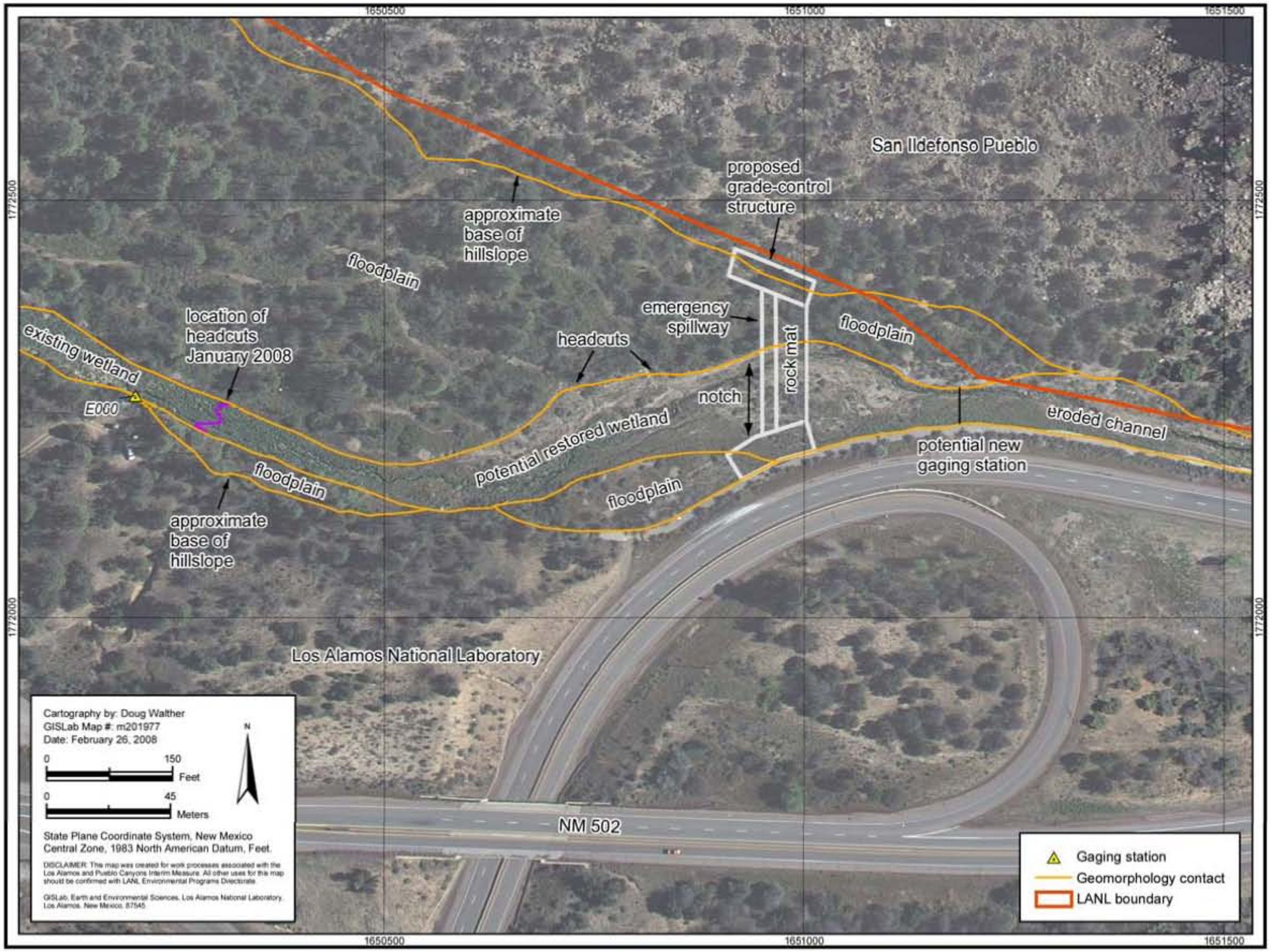


Figure 4.1-1 Orthophotograph of lower Pueblo Canyon showing location of proposed grade-control structure, proposed new E060 gaging station, and headcuts near current E060 gaging station

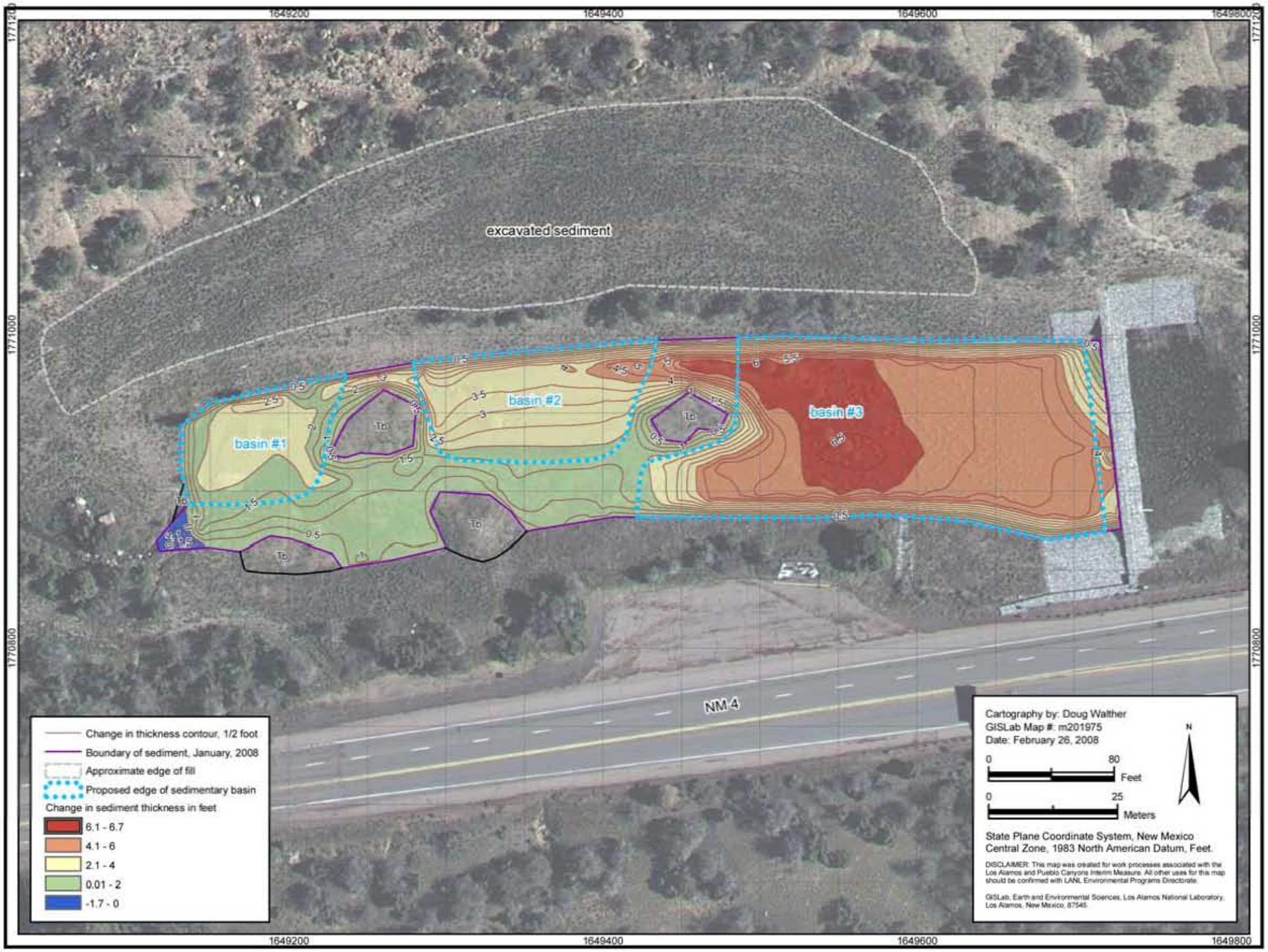


Figure 4.2-1 **2000 to 2007 sediment thickness behind the Los Alamos Canyon low-head weir, proposed subbasins to be excavated, and the area of fill resulting from initial excavation in summer 2000**

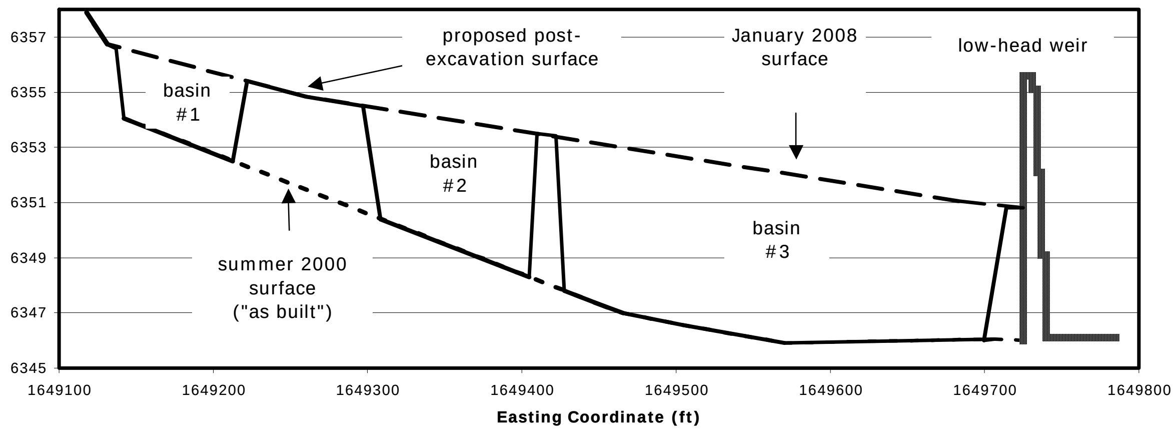


Figure 4.2-2 Longitudinal profile through sedimentation basin above Los Alamos Canyon low-head weir, showing surveyed ground surfaces in summer 2000 and January 2008 and proposed post-excavation surface

Figure 4.5-1 Photograph of jute mats and willows (*Salix spp.*) used to stabilize banks in Pueblo Canyon, spring 2005 (view to the west)

Table 3.1-1
Impaired Waters Listing Information for Los Alamos and Pueblo Canyons

Canyon Segment	Probable Causes of Impairment	Probable Sources of Impairment
Los Alamos Canyon (within the Laboratory)	Aluminum Gross Alpha Radioactivity Mercury PCBs in Water Column Selenium	Inappropriate Waste Disposal Industrial/Commercial Site Storm water Discharge (Permitted) Natural Sources Post-development Erosion and Sedimentation Watershed Runoff Following Forest Fire
Pueblo Canyon (NM 502 to headwaters)	Aluminum Gross Alpha Radioactivity Mercury PCBs in Water Column Radium-226 Radium-228 Selenium	Contaminated Sediments Impervious Surface/Parking Lot Runoff Inappropriate Waste Disposal Industrial/Commercial Site Storm water Discharge (Permitted) Municipal (Urbanized High Density Area) Natural Sources Post-development Erosion and Sedimentation Resource Conservation and Recovery Act (RCRA) Hazardous Waste Sites Source Unknown Watershed Runoff Following Forest Fire