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Reconnaissance Survey Report for Post–Las Conchas Fire Flooding in Water Canyon and Cañon de Valle



Prepared by the Environmental Programs Directorate

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1.0 INTRODUCTION

Cañon de Valle and Water Canyon are located in the southwest portion of Los Alamos National Laboratory (LANL or the Laboratory) (Figure 1.0-1) (LANL 2011, 207069). They drain 49.6 km^2, approximately 65% of which is located on Laboratory property. Portions of Technical Area 08 (TA-08), TA-09, TA-11, TA-14, TA-15, TA-16, TA-28, TA-37, TA-49, TA-68, and TA-70 lie within the Water Canyon/Cañon de Valle watershed (LANL 2011, 207069). The watershed contains numerous solid waste management units (SWMUs) and areas of concern (AOCs) that are being investigated and remediated as part of the Laboratory's Environmental Programs (EP) Directorate activities (LANL 2006, 091698; LANL 2007, 098192; LANL 2007, 098734; LANL 2011, 111602.33; LANL 2011, 111810.32; LANL 2011, 207069). Most of the contamination related to Laboratory releases is associated with weapons testing, explosives testing, and explosives production. The canyon system itself represents both a site of contamination and a potential secondary source for contamination of groundwater systems (LANL 2011, 207069). Details on this canyon's contamination, the site conceptual models, hydrology, geology, and risk assessments are provided in the Water Canyon/Cañon de Valle investigation report (IR) (LANL 2011, 207069). The upper portions of the watershed were burned in the 2011 Las Conchas fire, and the canyons were affected by large post–Las Conchas fire floods during August 2011 (LANL 2011, 207069).

This document fulfills the requirements in the New Mexico Environment Department's (NMED's) notice of disapproval (NOD) for the Investigation Report for Water Canyon/Cañon de Valle, dated February 14, 2012 (NMED 2012, 211217). The NOD stated,

> The Permittees must conduct a reconnaissance survey of the Water Canyon and Cañon de Valle watersheds to identify reaches and specific sample locations where sample data discussed in the IR is no longer valid due to the effects of the August 2011 flooding. The survey must include identification and documentation of canyon reaches that experienced stream bank and channel erosion, channel scour or undercutting, newly created flow paths and areas of added or new sediment accumulation. Identification and documentation must be of sufficient detail for the Permittees to provide recommendations for future placement of sediment control structures including structures to significantly reduce stream velocities during future storm events and mitigate contaminated sediment transport. Recommendations must also be provided concerning the need for, and placement of, dedicated stormwater monitoring and gauging stations in both watersheds.

This report presents the results of work conducted to fulfill the requirements stated above. The effects of post-fire flooding on water quality are also evaluated to complement the sediment investigations and to evaluate changes in the hydrogeologic system to support the corrective measures evaluation/corrective measures implementation (CME/CMI) for the TA-16 260 Outfall. It also provides recommendations regarding the need for mitigation measures to minimize contaminant transport within the watershed.

This report includes the following sections. Section 1 provides an introduction to the document and outlines its regulatory context. Section 2 provides background information on key contaminants in the flood-affected canyons, a description of the Las Conchas fire in the Water Canyon/Cañon de Valle watershed, and a chronology of flood events in the canyons. Section 3 describes field activities completed to evaluate post-fire flood effects. Section 4 evaluates effects of the fire on contamination in waters in springs, alluvial wells, and stormwater within the watershed. Section 5 describes erosional and depositional effects in Water Canyon and Cañon de Valle that can be attributed to flooding. Finally, Section 6 provides a summary of observations and a series of recommendations. Appendix A includes the acronyms and abbreviations used in this report. Appendix B presents post-fire water data

(groundwater and surface water) and associated plots. Appendix C includes post-flood surveys of affected sediment reaches, and Appendix D includes post-flood photographs.

2.0 BACKGROUND

The Water Canyon and Cañon de Valle watersheds, which also include smaller subsidiary canyons such as S-Site Canyon, Fishladder Canyon, Potrillo Canyon, and Fence Canyon, were characterized in detail, and these characterization efforts were reported in the IR (LANL 2011, 207069). Sediment investigations included geomorphic mapping, associated geomorphic characterization, and sediment sampling in 25 investigation reaches located downgradient of SWMUs or AOCs (Figure 2.0-1). Surface water investigations included evaluating analytical data from samples collected at 35 locations along stream channels and from several springs. These data represent a baseline from which post–Las Conchas flood effects can be evaluated.

The Las Conchas fire burned the headwaters of Cañon de Valle and Water Canyon west of the Laboratory boundary in June 2011 (LANL 2011, 207069). Approximately 16.9 km^2 of the watershed was within the burn perimeter (Figure 1.0-1), comprising 34% of the watershed. Within that burn perimeter, 46% was classed as high- or moderate-severity burn, and 54% was identified as low-severity burn or unburned. The upper Cañon de Valle watershed was burned more intensely than the upper Water Canyon watershed. Sixty percent of the Cañon de Valle watershed within the burned area was classified as high- or moderate-severity burn, whereas only 36% of the upper Water Canyon watershed was severely burned. Floods during July and August 2011 (Table 2.0-1) impacted both canyons, causing localized scouring in parts of these canyons and sediment deposition in downgradient areas (Figure 2.0-2; Appendix D). A list of storm events is provided in Table 2.0-2. The August 21, 2011, flood was the largest; precipitation within the burned headwaters of the Water Canyon and Cañon de Valle watershed approached 6 in. locally. These floods transported ash from the burned areas onto the Laboratory and partially redistributed Laboratory-derived contaminants. Various natural inorganic chemicals and fallout radionuclides are elevated in ash derived from the burn area, similar to the baseline samples collected from post–Cerro Grande fire runoff. This report also documents sediment scour that may have affected the alluvial system hydrology and thus changed contaminant dynamics in the alluvial aquifer. Because recharge areas for some springs are hypothesized to be within the burned headwaters of Cañon de Valle and Water Canyon, it is possible chemical concentrations in the springs will change following the fire.

3.0 FIELD ACTIVITIES

Sediment investigations including geomorphic mapping, associated geomorphic characterization, and sediment sampling were conducted in 25 investigation reaches in 2010 and 2011 using methods described in the Water Canyon/Cañon de Valle IR (LANL 2011, 207069). Fourteen of the 25 investigation reaches are located below areas of the Water Canyon/Cañon de Valle watershed that burned during the Las Conchas fire. Field activities were conducted in summer and fall 2011 and summer 2012 in the 14 fire-affected reaches to evaluate post–Las Conchas fire effects on the Water Canyon/Cañon de Valle watershed.

Field activities completed in June 2012 included relocating all sediment sampling locations within the 14 Las Conchas fire-affected reaches. At each sampling location, the field team determined (1) whether or not the sampled sediment layer is extant at the sampling location; (2) whether or not the geomorphic unit containing the sampled sediment layer is extant at or in the vicinity of the sample location (3) the thickness of post–Las Conchas sediment deposits; and (4) grain size and sedimentology based on field

observations of the post–Las Conchas sediment deposits. In addition, any cross-sections surveyed during the 2010–2011 investigation completed before the August 21, 2011, flood event within the 14 Las Conchas fire-affected reaches were relocated and resurveyed using a hand level, tape measure, and stadia rod. Post–August 21, 2011, cross-sections are compared with pre–August 21, 2011, cross-sections to depict erosion and deposition from post-fire flood events at discrete locations within the sediment investigation reaches (Appendix C). Rebar and metal tags were installed at the starting and ending points of all cross-sections surveyed during the June 2012 field investigation so they can be relocated for any future investigations.

Post–Las Conchas fire fine-grained sediment samples were collected from nine areas within the Water Canyon/Cañon de Valle watershed in fall 2011 to evaluate baseline conditions and the effects of remobilization of sediment from scoured canyon reaches. These areas included six sediment investigation reaches, two upgradient baseline areas, and one area near the Rio Grande. The majority of samples collected contained ash derived from the Las Conchas burn area (Table 3.0-1).

4.0 WATER EFFECTS

The effects on concentrations of constituents in water in canyons downgradient of severely burned areas frequently occur, based on experience following the Cerro Grande Fire (Gallaher and Koch 2004, 088747). These effects can manifest in stormwater and alluvial groundwater (Gallaher and Koch 2004; 088747) and in springs (Hickmott et al. 2001, 072686). Following the Cerro Grande fire, minor short-term increases in bicarbonate, sodium, and calcium were detected in TA-16 springs (Hickmott et al. 2001, 072686). No effects on contaminant concentrations were detected.

The principal goal of this section is to evaluate post–Las Conchas fire effects on constituent concentrations in alluvial groundwater, springs, and stormwater using time-series analysis for key constituents.

The Water Canyon/Cañon de Valle IR (LANL 2011, 207069) identified four key contaminants in water: RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine), barium, boron, and perchloroethene (PCE). Time-series plots for these four key contaminants in water media potentially impacted by post–Las Conchas fire effects are presented in Appendix B. These media include the key contaminated springs at TA-16 (SWSC, Burning Ground, and Martin Springs) (Figure 2.0-1); alluvial wells that have consistently shown levels of contaminants greater than standards (Figure 2.0-1); and surface/stormwater sampling locations upgradient, within, and downgradient of the Laboratory (Figure 1.0-1 and 2.0-1). Two alluvial wells, 16-02657 and 16-02658, within Cañon de Valle were destroyed by the post–Las Conchas fire flooding. Well 16-611923, installed to monitor the TA-16 permeable reactive barrier (PRB), was located near well 16-02658 and therefore is used as a proxy for that well.

4.1 Alluvial Groundwater and Springs

Non-floodwaters within the Water Canyon and Cañon de Valle watershed were sampled twice since the August 2011 floods. This sampling was completed in September 2011 and January 2012 and was implemented in accordance with the 2011 Interim Facility-wide Groundwater Monitoring Plan, Revision 1 (the Interim Plan) (LANL 2011, 208811). Flow in the canyons during both sampling episodes was low, so water was not present at all planned sampling locations. Some alluvial wells were not sampled because they were overtopped by the August 2011 flooding and contained sediment.

Burning Ground, SWSC, and Martin Springs (Figure 2.0-1) were evaluated for fire and flood effects because it is hypothesized these springs are recharged in the burned headwaters of the Water Canyon

and Cañon de Valle watersheds (LANL 2003, 077965). These springs showed the effects of the Cerro Grande fire (Hickmott et al. 2001, 072686). Figures 4.1-1 and 4.1-2 show time series for barium and RDX preceding and postdating the June 2011 Las Conchas fire and the August 2011 floods. No obvious variations in the concentrations of contaminants in these springs following the fire and floods are apparent. The other key water constituents, boron and PCE, also do not show post-fire effects in these springs (Appendix B).

Alluvial wells 16-02655, 16-02656, 16-611923, and 16-02659 (Figure 2.0-1) were evaluated for flood effects on concentrations of key contaminants. Figures 4.1-3 and 4.1-4 show time series for barium and RDX preceding and postdating the August 2011 floods. Well 16-02659 shows a distinct increase in barium concentration in the two sampling events following the August 2011 floods; levels are the highest that have been observed in that well. All other key constituents (RDX, boron, PCE) and barium in the other alluvial wells show contaminant behavior that is within the range of previous data (Figures 4.1-3 and 4.1.4; Appendix B).The increase in barium in 16-02659 is likely the result of the infiltration of ash-derived barium into the Cañon de Valle alluvium (Katzman et al. 2001, 221590). As discussed in section 4.2, stormwater flowing on the Laboratory at upgradient surface water monitoring station E253 shows elevated barium likely derived from ash from the Las Conchas burn area.

4.2 Stormwater

The Water Canyon and Cañon de Valle watershed experienced nine stormwater events, which allowed either flow measurements or sampling at surface water stations within the watershed following the Las Conchas fire of June 2011 (Tables 2.0-1 and 2.0-2). The events of August 3, 2011, and August 21, 2011, represented large flood events that damaged alluvial wells and components of the TA-16 pilot PRB. The latter event was much larger than the former (Table 2.0-1) and damaged stormwater monitoring stations throughout the watershed; thus, no samples were collected during that event. The maximum estimate flow during the August 21, 2011, flood was 3021 cubic feet per second (cfs) at station E252.5, just upgradient of the Cañon de Valle/Water Canyon confluence (Figure 2.0-1 and Table 2.0-1).

Eight of these stormwater events were sampled at one or more locations (Tables 2.0-1 and 2.0-2). The spatial locations of stormwater sampling data are variable across runoff events because (1) for smaller storm events, flow did not reach many of the stormwater sampling locations and (2) all the surface water sampling stations were disrupted on August 21, 2011. Stations E 253 and E253 were repaired on September 1, 2011, and station E265 was reinstalled on September 30, 2011. Stations interior to the Laboratory were not reinstalled because of concerns with future floods.

Of the four key constituents identified for the Cañon de Valle and Water Canyon watershed, RDX and PCE were not detected in either filtered or unfiltered stormwater samples at any of the stormwater sampling localities within the watershed (Appendix B) during the post-fire events. Boron was detected only at low levels (Appendix B). Barium was detected at elevated levels relative to pre-fire stormwater concentrations in both filtered and unfiltered samples (Appendix B) (Figure 4.2-1). Unfiltered barium is elevated both in stations located upgradient of the Laboratory (E252 and E253), stations located within the Laboratory (E256), and a station located just downgradient of the Laboratory boundary (E265) (Figure 2.0-1). Filtered barium is at highest concentrations in station E265, east of NM 4. Because the number of samples collected at all of these locations was limited, it is not feasible to ascertain with certainty the contributions of Laboratory-derived barium relative to burned-area-derived barium.

PCBs are present in stormwater both upgradient of the Laboratory (locations E252 and E253) and downgradient of the Laboratory (E265). Concentrations are higher at upgradient stormwater sampling localities than downgradient locations (Figure 4.2-2).

5.0 SEDIMENT EFFECTS

5.1 Post-Fire Surface Flow Changes

Data on stream discharge after wildfires indicate peak discharge can increase by up to several orders of magnitude relative to pre-fire conditions, and that the largest post-fire floods typically occur within the first 3 yr after a fire. The time period in which runoff remains elevated varies between watersheds and between fires as a function of burn severity, the rate and nature of watershed recovery, and the occurrence of high-intensity rainfall events. Table 5.0-1 presents annual maximum discharges from 1994 to 2009 for gages in watersheds affected by the May 2000 Cerro Grande fire, indicating peak annual discharge increased by up to several orders of magnitude relative to pre-fire conditions. At these gages, peak discharges returned to at or near pre-fire conditions after 1 to 7 yr, although some elevated discharges were not entirely related to hydrologic changes caused by the Cerro Grande fire (e.g., Pueblo Canyon where townsite-generated runoff is a factor). Excluding Pueblo Canyon, flows commonly remained elevated for up to 3 yr, indicating watersheds affected by the June 2011 Las Conchas fire could experience significantly greater flows through 2013.

Supporting information on the effects of wildfires on the hydrology of streams on the Pajarito Plateau is provided by studies of Frijoles and Capulin Canyons in Bandelier National Monument after the June 1977 La Mesa fire and the April 1996 Dome fire (Veenhuis 2002, 082605). After these fires, peak flows increased to about 160 times the maximum recorded before the fire. By the third year, maximum annual peak flows had decreased to about three to five times the pre-fire maximums as the watersheds recovered. The frequency of larger stream flows also increased after the La Mesa and Dome fires, remaining elevated for the first 3 yr. These data from Frijoles and Capulin Canyons support the inference that significantly altered hydrologic conditions could persist through 2013 in watersheds affected by the Las Conchas fire.

Maximum discharge in Water Canyon after the Cerro Grande fire was estimated at 840 cfs, measured at gaging station E252 above NM 501, and decreased downstream to 274 cfs at E265 below NM 4. Maximum discharge in Cañon de Valle was estimated at 740 cfs, measured at E253 above NM 501. A larger discharge flood event occurred on August 21, 2011, following the Las Conchas fire. The E252, E253, and E265 stream gages were destroyed during this flood event; however, peak-flow estimates were made using the area-slope method, based on cross-sections measured between high-water lines and the stream gradient. Flow estimates for the August 21, 2011, flood event range from 1450 cfs for Cañon de Valle above NM 501 to 1500–1600 cfs for Water Canyon above NM 501. Combined discharge in Water Canyon below NM 4, downstream of the confluence of Cañon de Valle and Water Canyon, was estimated at approximately 2400 cfs (Table 2.0-1). The August 3, 2011, flood event had a much lower discharge, estimated at 60 cfs for Cañon de Valle above NM 501, 90 cfs for Water Canyon above NM 501, and 20 cfs for Water Canyon below NM 4 (Table 2.0-1).

The increase in stream discharge and stream power results in an increase in erosion and sediment transport. Reneau et al. (2007, 102886) showed a significant increase occurs in erosion rates and sediment transport in the first year following the Cerro Grande fire in upper Los Alamos Canyon. Over 90% of ash delivered to the Los Alamos Reservoir occurred in the first year after the fire, and post-fire sediment deposition was highest within the first 2 yr after the fire (Reneau et al. 2007, 102886). Runoff slurries dominated by ash as suspended solids resulted from the first storm after the Cerro Grande fire

(Reneau et al. 2007, 102886). Similar trends in erosion and sediment transport may be expected following the Las Conchas fire.

5.2 Geomorphic Evaluation

The field survey conducted in June 2012 examined 162 locations in 14 reaches where sediment samples had been collected before the Las Conchas fire, plus one sampling location at "Beta" site (Table 5.0-2). The survey examined discrete sediment sampling sites to determine if these sample locations are still extant. In many cases where sampling locations no longer existed, only a portion of the entire geomorphic unit was eroded, or the specific sample layer was removed by local scouring of the surface of the deposit but the geomorphic unit is still largely intact. This is particularly true where samples were collected from stream bank exposures; localized erosion along the stream bank resulted in the erosion of the sampling location, while the larger geomorphic surface outside of the immediate influence of the channel remains intact. Therefore, "percentage of sample locations eroded" should not be equated with "percentage of geomorphic unit eroded". Field observations indicate that, in most cases where a sampling location has been eroded, only a portion of the geomorphic unit containing the sampling location was eroded or scoured.

Of the geomorphic units (sediment deposits) containing the majority of the key constituents (barium and RDX) in the watershed (units f1 and, to a lesser extent, c3), 88% of the deposits (representing 69 locations examined) are intact, while 12% (8 locations) have been eroded. Ninety-two percent (48 of 52) of f1 deposits are intact, and 76% (13 of 17) of c3 deposits are intact. A larger percentage of c1 (active channel) and c2 units are eroded; however, these deposits contain relatively low concentrations of the key constituents. Overall, 75% (38 of 51) of c2 units are intact, and 25% of c2 units are eroded.

C1 units represent current channel deposits, c2 and c3 represent earlier (post-Laboratory) channel deposits, and f1 represents post-Laboratory floodplain deposits. Higher concentrations of contaminants are often detected in fine-grained sediment deposits in the f1 and c3 units, and lower concentrations of contaminants are typically found in c1 and, to a lesser extent, c2 units (LANL 2011, 207069). The data showing that 88% of f1 and c3 units are intact demonstrate that a significant portion of the contaminant inventory in the watershed is still in place.

The results of the field investigation show the percentage of sampling locations still present following post–Las Conchas fire flood event varies widely between reaches, from 0% of sampling locations extant in reach WA-2 to 89% of sampling locations extant in reach CDV-1C (Table 5.0-3). Overall, 66% of all sampling locations in the 14 reaches, plus Water at Beta, remain in place after the post-fire floods that occurred in 2011. The field survey indicated that erosion or preservation of sampling locations varied by geomorphic unit; 83% of sampling locations in c1 units, 38% of sampling locations in c2 units, 32% of sampling locations in c3 units, and 12% of sampling locations in f1 units have been eroded (Table 5.0-3).

The reaches where post-1942 deposits are the most extensively eroded (where 50% or more of sampling locations have been eroded) generally occur in the upper part of the watershed (reaches CDVS-1, CDV-1E, and WA-2), and are partially in narrow bedrock controlled reaches cut into resistant unit 2 of the Bandelier Tuff (WA-2). Reach CDV-3 is also situated in a location where the stream has started to incise into the top of unit 2; however, erosion of post-1942 deposits in CDV-3 may also be caused by the presence of a relatively deeply incised channel before the Las Conchas fire. Two upstream tributary reaches (CDVN-1 and CDVNW-1) were not extensively eroded. Reaches downstream of the Water/Valle confluence did not experience extensive erosion of sampling locations, and 63% to 88% of sampling locations were found to be intact in this area (Table 5.0-3; Figure 2.0-1). The only sampling locations

eroded in the reaches downstream of WA-3 (including WA-4W, WA-4, and WA-5) are in c1 and c2 units (Table 5.0-3).

In most of the reaches examined during the June 2011 investigation, the majority of post–Las Conchas sediment is coarse-grained (medium sand or coarser; Table 5.0-2). In the most extensively scoured reach, WA-2, all of the post–Las Conchas sediment observed at sampling locations was coarse grained (Table 5.0-2). In two reaches (CDV-2E and WA-4) more than 50% of sediment at sampling locations was fine grained, and in two other reaches (WA-4W and WA-5), the ratio of fine to coarse grained post–Las Conchas sediment was approximately 1:1 (Table 5.0-2).

In many locations, coarse-grained sediment deposited during the August 21, 2011, flood overlies a muck layer or other fine-grained ashy sediment deposited during the August 3, 2011, flood (Figure 5.2-1; Table 5.0-2). It is apparent the lower-discharge August 3, 2011, flood deposited predominantly ashy fine-grained sediments and muck layers, whereas the larger August 21, 2011, flood deposited mostly coarse-grained sediments throughout much of the watershed. In some cases, fine-grained sediment deposits and thin muck layers are inferred to have been deposited during the waning limb of the August 21, 2011, flood (e.g., location CV-613572 in CDV-3; Table 5.0-2).

Cross-sections from selected reaches depicting areas of erosion, sediment deposition, or areas with minor bank erosion and deposition on adjacent floodplain surfaces are shown in Figures 5.2-2 through 5.2-4 and are described below. Additional cross-sections surveyed after the August 21, 2011, flood event are contained in Appendix C. Cross-section locations are shown in the Water Canyon/Cañon de Valle IR (LANL 2011, 207069).

Figure 5.2-2 is an example of a cross-section surveyed through a narrow, incised portion of reach CDV-3. During the lower discharge flood event of August 3, 2011, little or no erosion of units occurred, and fine-grained muck was deposited on the c2 and f1 geomorphic surfaces. The higher discharge flood of August 21, 2011, resulted in extensive erosion of c1 and c2 units, followed by coarse-grained sediment deposition in the active channel and higher flanking surfaces. Although the lower c1 and c2 units within and next to the channel were eroded, the higher elevation, fine-grained f1 sediment deposits that contain higher concentrations of chemicals of potential concern (COPCs), were not extensively eroded.

In contrast to the example from CDV-3 discussed above, Figure 5.2-3 is a cross-section surveyed in WA-3, immediately upstream of a large log jam that caused extensive sediment deposition (Appendix D). At this section, erosion was mainly limited to pre-1943 alluvium. Deposition of fine-grained muck occurred during the August 3, 2011, flood event. The August 21, 2011, flood resulted in erosion of older (pre-1943) terrace units but caused minimal erosion of young sediment (only a small amount of erosion of August 3, 2011, muck deposited on the f2 surface). Instead, the August 21, 2011, event resulted in thick (>1 m in places) deposits of predominantly coarse-grained sediment that buried post-1942 c1, c2, and c3 units. Relatively thin (up to 15 cm thick) muck deposits observed on higher (f1, f2, and Qt) surfaces are interpreted to represent slack water deposits associated with the waning limb of the August 21, 2011, flood event.

Figure 5.2-4 is a cross-section surveyed in reach CDV-2E that shows a pattern of erosion and deposition commonly observed in the investigation reaches. In this reach both erosion and deposition occurred, with channel and bank erosion removing some or all of the c1 deposits within the active channel and c2 units adjacent to the channel. Some minor scour of f1 deposits also occurred; however, the f1 deposits are largely intact and are overlain by both coarse-grained and fine-grained post–Las Conchas sediment deposits. The August 3, 2011, event resulted in laterally extensive thin muck deposition, with little or no erosion. The August 21, 2011, flood scoured portions of both the post-1942 units and the August 3, 2011, muck before depositing subequal amounts of coarse- and fine-grained sediment.

In each of the cross-section examples provided in Figures 5.2-2 through 5.2-4, whether net erosion or deposition occurred along the section, the survey data demonstrate that erosion is most prevalent in geomorphic units with typically low concentrations of key constituents (c1, c2), while units with typically higher concentrations (c3, f1) are generally intact. Intact geomorphic units are often overlain by post-fire sediment deposits with some areas of local bank erosion or scour. This can also be seen in the additional cross-sections provided in Appendix C. The trend of erosion of coarse-grained c1 and c2 units and preservation of fine-grained f1 units as seen in the cross-sections supports the data from the examination of sampling locations and geomorphic units, which demonstrate a significant portion of the contaminant inventory in the watershed is still in place.

5.3 Post-Fire Sediment Contaminant Evaluation

Barium, RDX, and polychlorinated biphenyl (PCBs) have been identified as key COPCs in the Water Canyon and Cañon de Valle watershed (LANL 2011, 207069). Data from post–Las Conchas sediment samples collected in this watershed (Table 3.0-1) are used to evaluate sources of these constituents on post-fire flood deposits. Samples collected include deposits from both the August 3, 2011, and August 21, 2011 flood events. Other post-fire flood deposits could also be included in the samples collected.

Barium is elevated above the sediment background value (BV) (127 mg/kg) in post–Las Conchas fire baseline sediment samples (CDV-0 and WA-0 above NM 501; Figure 5.3-1) as a result of elevated barium in Las Conchas ash. Barium in post-fire sediment samples increases in reaches below the 260 Outfall (CDV-2E) associated with partial remobilization of contaminated sediment deposits, and then decreases downstream (Figure 5.3-1). Below NM 4 (WA-5 and WA-6) barium in post-fire sediment samples is below concentrations seen in baseline samples; therefore, barium from Laboratory sources is not distinguishable from barium derived from Las Conchas ash in these downgradient areas.

Total PCB concentrations are low (less than 0.0005 mg/kg) in the sediment samples collected upstream of NM 501 (WA-0 and CDV-0) (Figure 5.3-2), reflecting baseline conditions and regional atmospheric sources. PCB concentrations increase downstream from Laboratory sources, with maximum values in single samples ranging between 0.006 and 0.009 mg/kg in reaches CDV-2E, CDV-4, and WA-3 (Figure 5.3-2). Downstream of WA-3 the total PCB concentration decreases to less than 0.002 mg/kg in WA-5 and less than 0.001 mg/kg in WA-6, near the Rio Grande.

PCB congeners from sediment or water samples can be grouped together into 10 homologs, based on the number of chlorine atoms on the biphenyl rings, which allows visual comparison of similarities or differences between samples or groups of samples (Reneau et al. 2007, 102886). The designations for the 10 homologs range from monochlorobiphenyl (or monoCB, with a single chlorine atom) to decachlorobiphenyl (or decaCB, with 10 chlorine atoms). Figure 5.3-3 shows average homolog percentages in each of the sediment samples from Water Canyon and Cañon de Valle collected in 2011. PCB congeners indicate several sources, with at least two sources in the Cañon de Valle watershed (one likely the CDV-2E outfall and another above CDV-1C), and at least one other source in the Water Canyon watershed above the confluence with Cañon de Valle. This finding is consistent with previous sediment data presented in the IR (LANL 2011, 207069).

RDX was only detected in one post-fire sediment sample collected from reach CDV-2E below the 260 Outfall. The single detection was 0.218 mg/kg, less than half the detection limit for other samples in this data set (0.5 mg/kg). Therefore, these data indicate no significant transport of RDX to reaches below CDV-2E occurred during the post–Las Conchas fire floods.

5.4 Summary of Geomorphic Investigation

The August 3, 2011, flood event resulted in deposition of ashy fine-grained sediment deposits on floodplains, and within the active channel in some reaches within the Water Canyon and Cañon de Valle watershed downstream from the Las Conchas burn area. The August 3, 2011, flood did not result in extensive erosion of contaminated sediment deposits. In contrast, the higher-discharge August 21, 2011, flood event resulted in partial erosion of post-1942 sediment deposits throughout the watershed. In total, 34% of all sampling locations were eroded by post–Las Conchas floods in the reaches examined during this investigation. However, the majority of sampling locations and geomorphic units eroded during the post–Las Conchas floods were c1 and c2 units (40 locations total), whereas 9 c3 sample locations and 6 f1 sampling locations were eroded (Table 5.0-3). In many cases where sampling locations no longer existed, only a portion of the entire geomorphic unit was eroded, or the specific sample layer was removed by local scouring of the surface of the deposit but the geomorphic unit is still largely intact. Of the geomorphic units containing the majority of key constituents (units f1 and, to a lesser extent, c3), 88% of the units (representing 69 locations examined) are intact, while 12% (8 locations) have been eroded. Ninety-two percent (48 of 52) of f1 units are intact, and 76% (13 of 17) of c3 units are intact. Because of the higher concentrations of contaminants often detected in fine-grained sediment deposits in the f1 and c3 units and typically lower concentrations of contaminants associated with c1 and, to a lesser extent, c2 units (LANL 2011, 207069), a significant portion of the contaminant inventory in the watershed is likely still in place.

Barium, PCB, and RDX concentrations in fine-grained post–Las Conchas sediment deposits show decreasing concentrations downstream from Laboratory source areas. Barium in post–Las Conchas sediment deposits below NM 4 (WA-5 and WA-6) is below levels seen in baseline samples; therefore, barium from Laboratory sources cannot be distinguished from barium derived from Las Conchas ash in these downstream areas and is likely a small contribution. Similarly, because RDX was not detected below reach CDV-2E in post-fire sediment, these data indicate no significant transport of RDX to downstream reaches during the post-fire floods. Detected PCB concentrations also show a decrease downstream and appear to be derived from both Laboratory and non-Laboratory sources.

6.0 SUMMARY AND RECOMMENDATIONS

The Cañon de Valle and Water Canyon watershed was subjected to significant burn impacts in its headwaters and two flood events that damaged structures in August 2011. To date, there is little evidence of perturbations to key contaminant concentrations in springs, alluvial wells, and surface water. The sole observed effect was an increase in barium concentration in alluvial well 16-02659 in samples collected in September 2011, 1 mo after flooding. Stormwater samples showed increased concentrations in both filtered and unfiltered barium both upgradient and downgradient of the Laboratory. Sufficient data are not available to determine if any of this barium is derived from Laboratory sources. The resultant deposits also show very low concentrations consistent with or less than pre-fire concentrations and significantly less than residential and recreational SSLs.

Because the large post-fire floods in August 2011 resulted in no significant transport of Laboratory-derived contaminants in sediments to downstream reaches, there is no indication of the need for mitigation actions to reduce sediment transport in future floods.

Both the sediment and stormwater data from the Cañon de Valle and Water Canyon watershed together yield a conceptual model in which constituents such as barium and PCBs are mobilized both from non-Laboratory-affected burn areas above the Laboratory property and locally from affected areas on the Laboratory. Constituents from these two source areas likely mix and for most key constituents, Laboratory

contributions are indistinguishable from constituents contributions derived from fire-affected areas. Depositional areas yield contaminant concentrations that are significantly lower in key constituents, such as barium, than were reaches evaluated for risk before the 2011 fires. Thus, risks in depositional reaches are much lower than for reaches evaluated in the IR (LANL 2011, 207069).

The Laboratory proposes the following recommendations:

- Continue monitoring surface water, springs, and alluvial groundwater at a frequency of twice annually and in accordance with the current Interim Plan.
- Continue monitoring stormwater at stations located both upgradient and downgradient of the Laboratory.
- Do not install additional stormwater control structures within the watershed at this time based on the low concentrations of key constituents detected in post-fire sediment deposits.
- To fulfill NMED's requirement for a Phase II work plan to characterize the post-flood contaminant distribution, the Laboratory proposes to conduct a post-monsoon season sediment-sampling effort in the fall of each of the next two years to assess potential impacts from additional flooding. Sampling will follow the methods described in this document for the 2011 post-flood sediment sampling campaign. Additionally, rather than a Phase II investigation report, the Laboratory proposes to prepare summary reports on the results of each year's sediment sampling effort. The summary reports will be submitted by April 30 of 2013 and 2014.
- Defer consideration of the need for the PRBs and replacement of destroyed alluvial wells until 2014 at the earliest. Experience following the Cerro Grande and other fires within the region suggests that large floods are likely for up to 3 yr following severe burning in a watershed's headwaters (Veenhuis 2002, 082605). Nearby alluvial wells with similar concentrations and trends can provide continued alluvial groundwater monitoring for the TA-16 260 monitoring group. The Laboratory will also continue to monitor stormwater only at existing boundary stations because of the potential for continued flood damage for the next several years.
- Reconsider use of the filters currently located at several TA-16 springs. This action would be a useful interim measure pending future decisions on the fate of the PRB. These springs currently provide a large fraction of the mass-flux of RDX within the canyon system. In the absence of the PRB, these storm filters may remove a large percentage of the flux of RDX in the alluvial waters within Cañon de Valle.

7.0 REFERENCES

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Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau 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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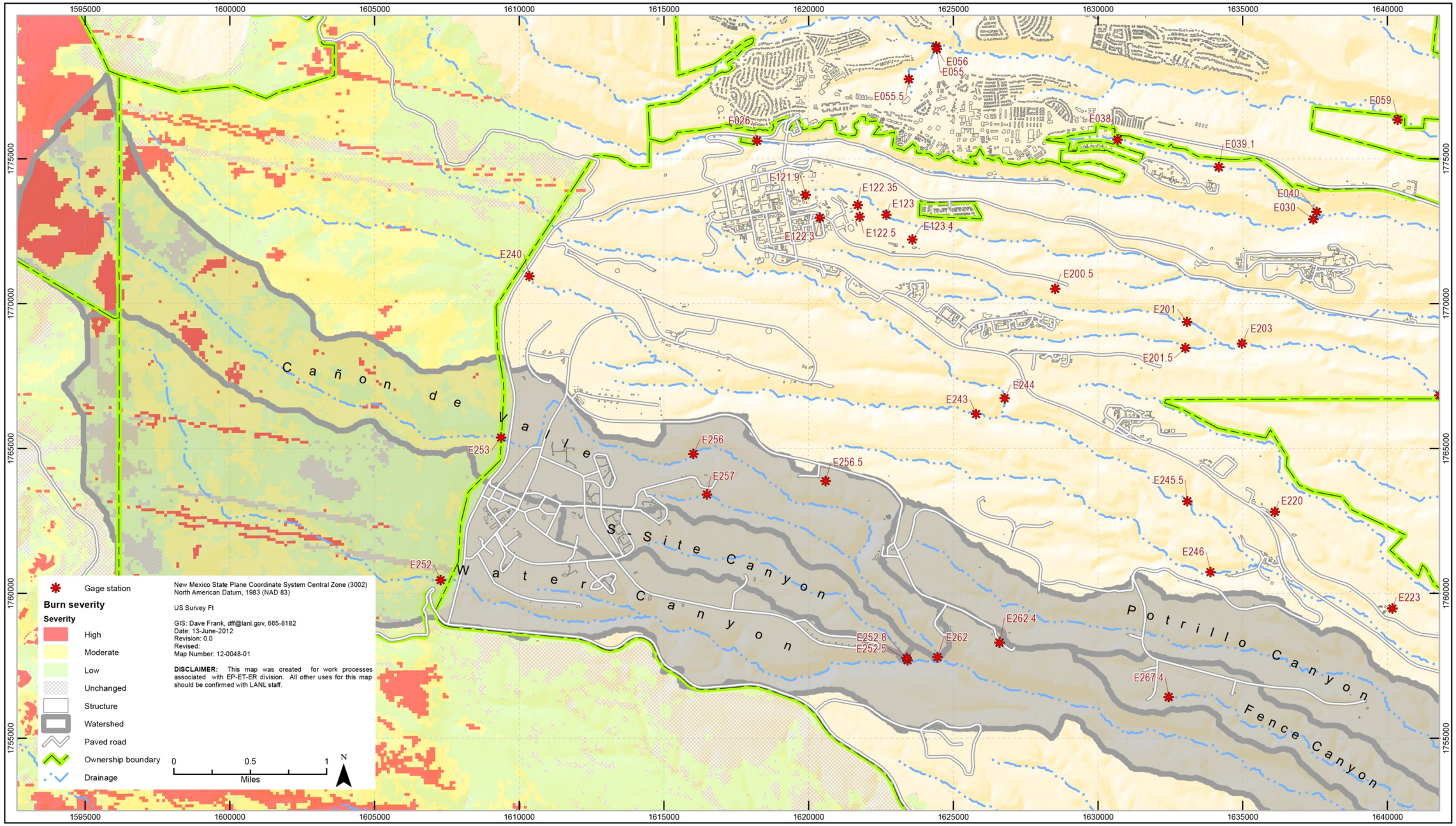


Figure 1.0-1 Water Canyon/Cañon de Valle watershed showing areas burned in the Las Conchas fire and surface water runoff stations

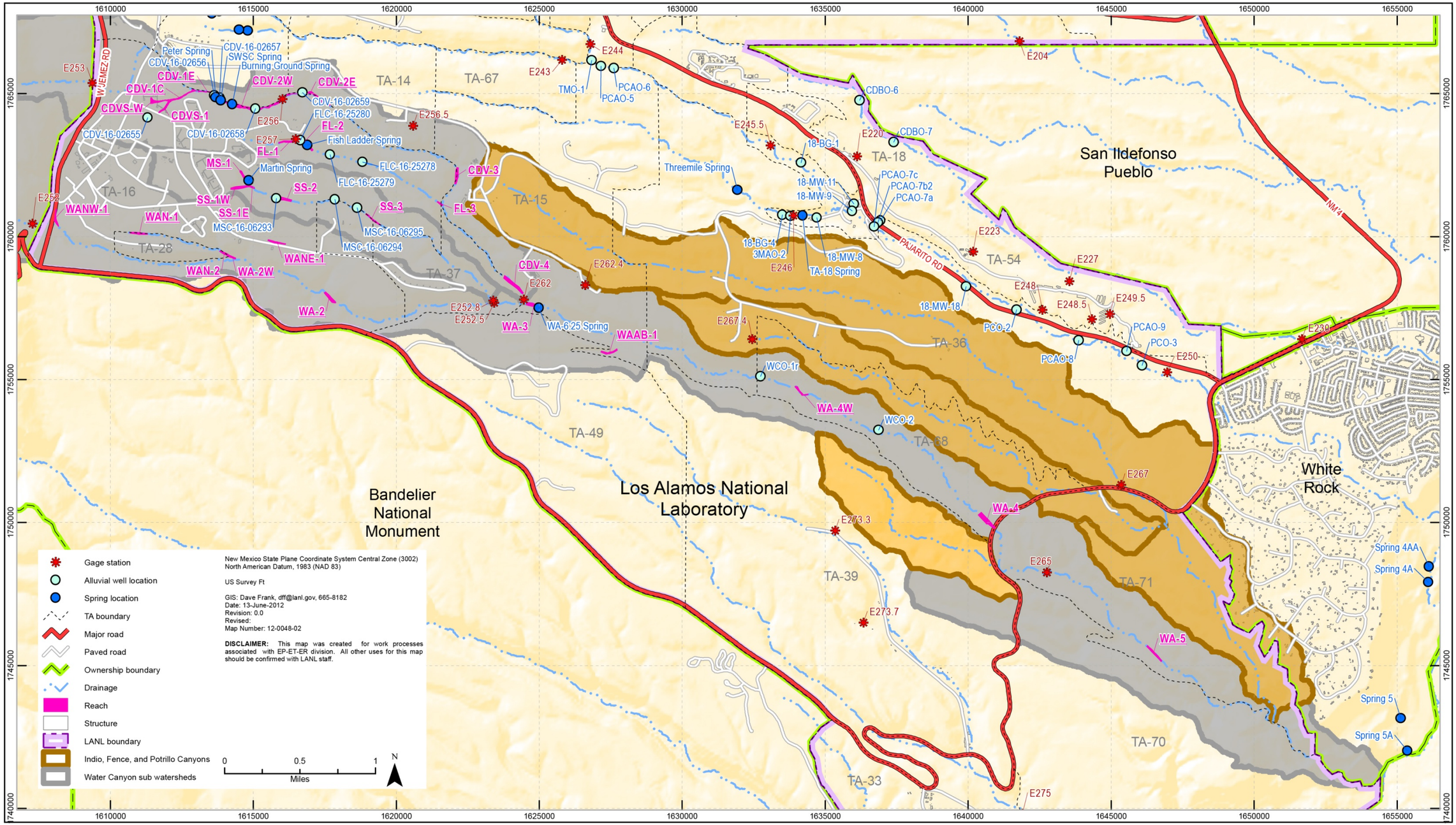


Figure 2.0-1 Water Canyon/Cañon de Valle watershed showing surface water runoff stations, springs, alluvial wells, and sediment reaches

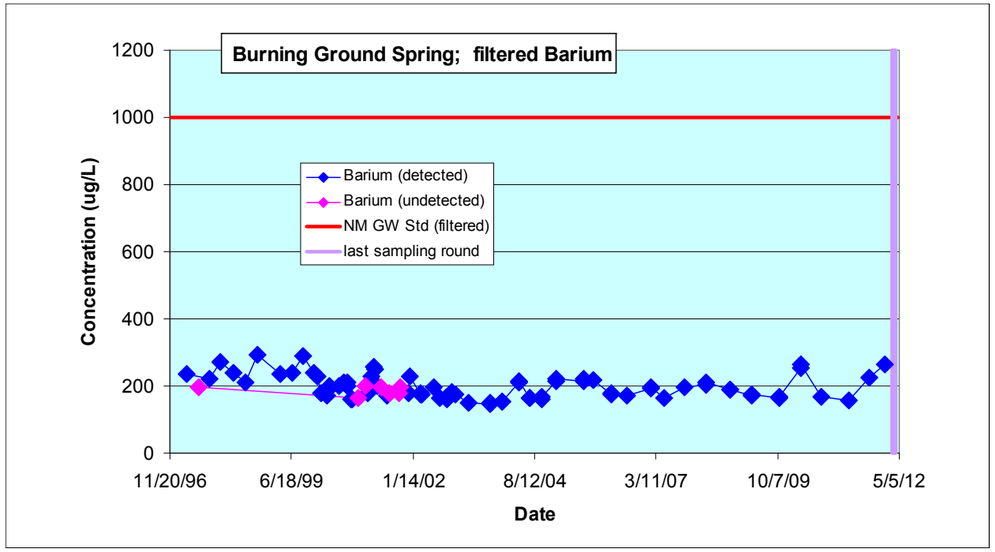


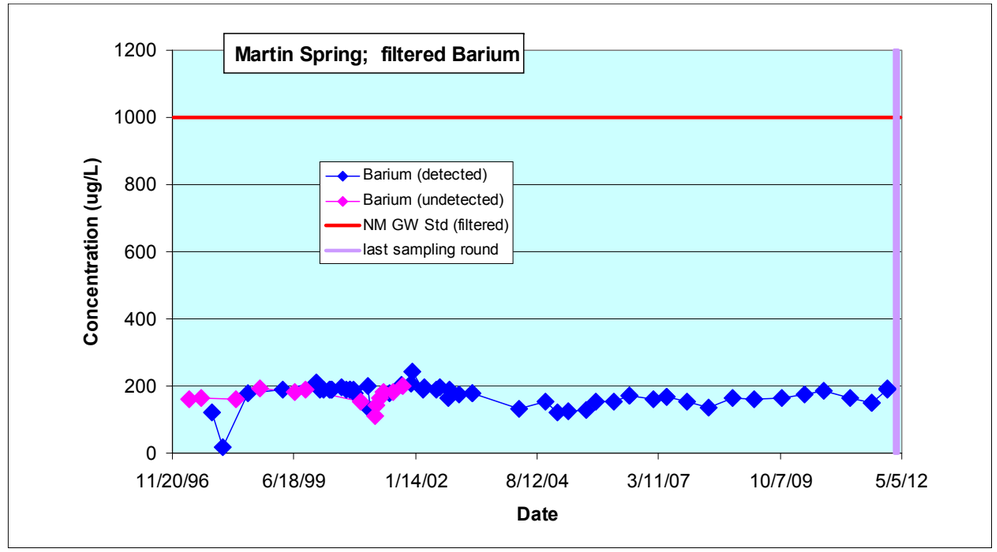






Figure 2.0-2 Post–Las Conchas fire flood effects in the Water Canyon and Cañon de Valle watershed





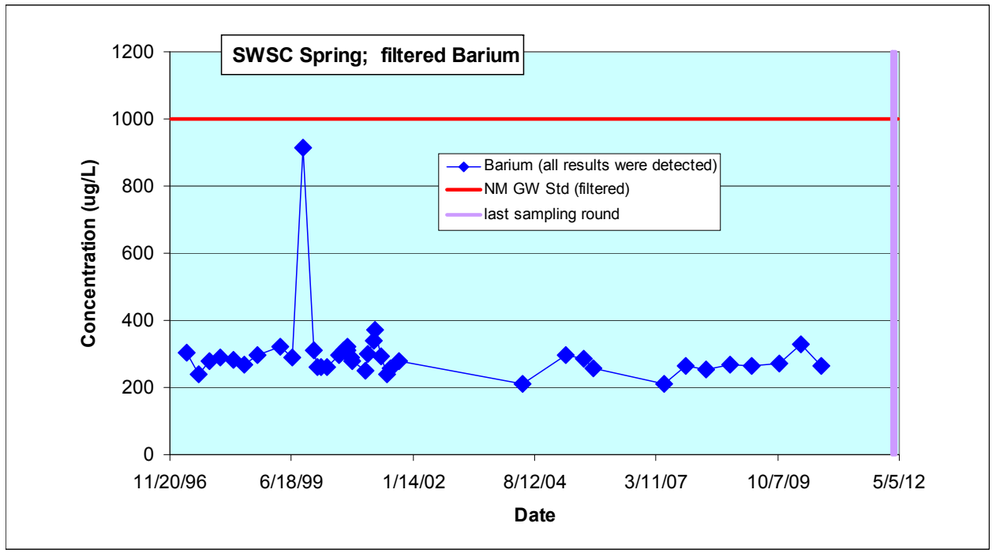
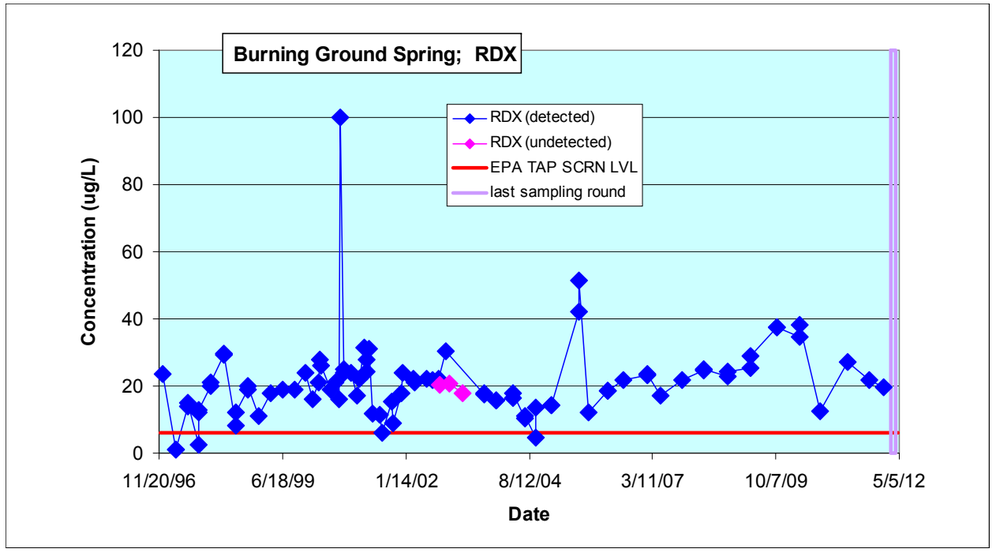
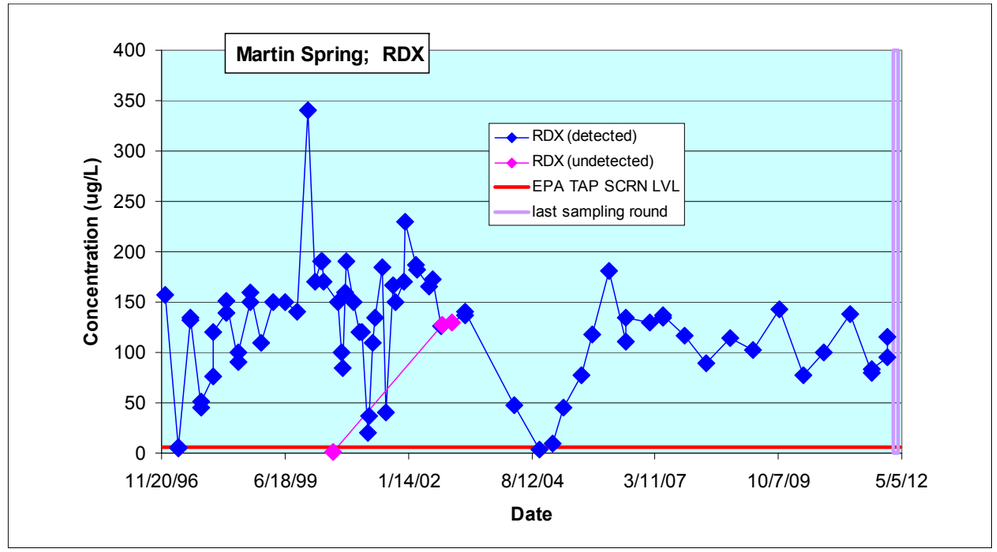


Figure 4.1.1 Time series for barium concentrations in TA-16 springs





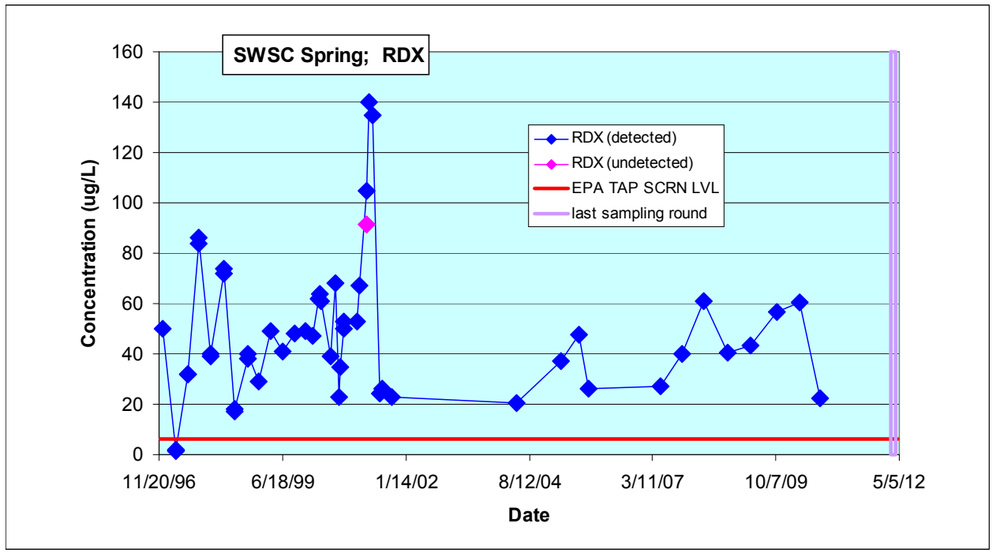
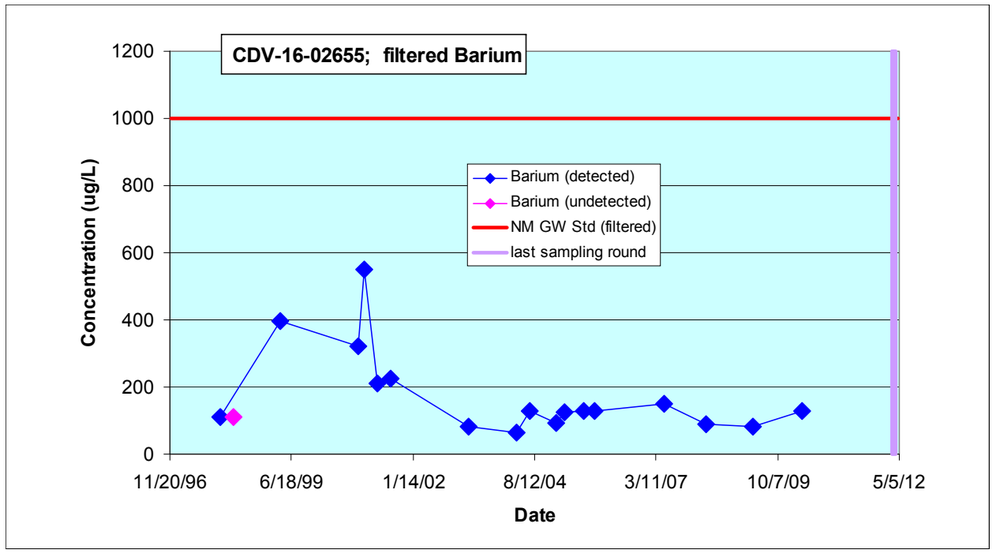
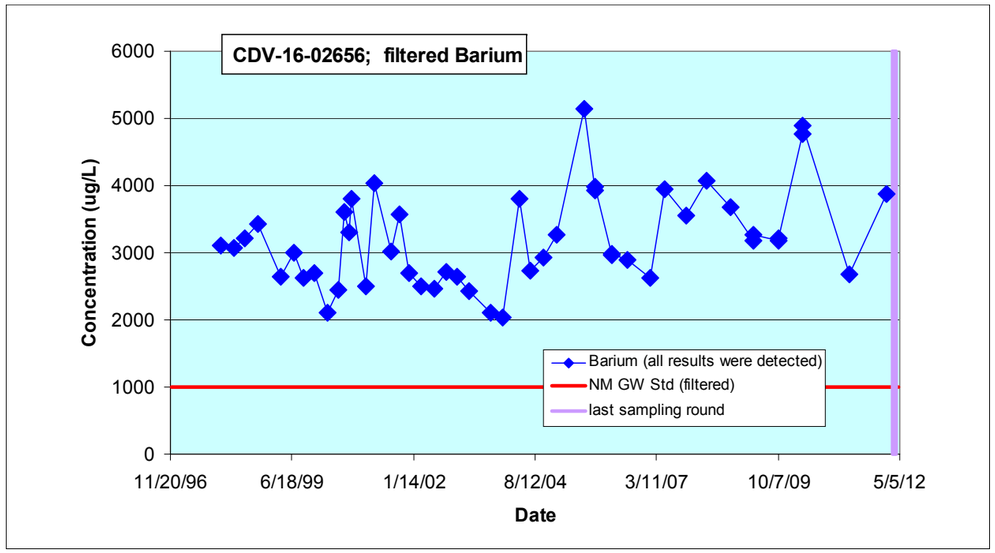
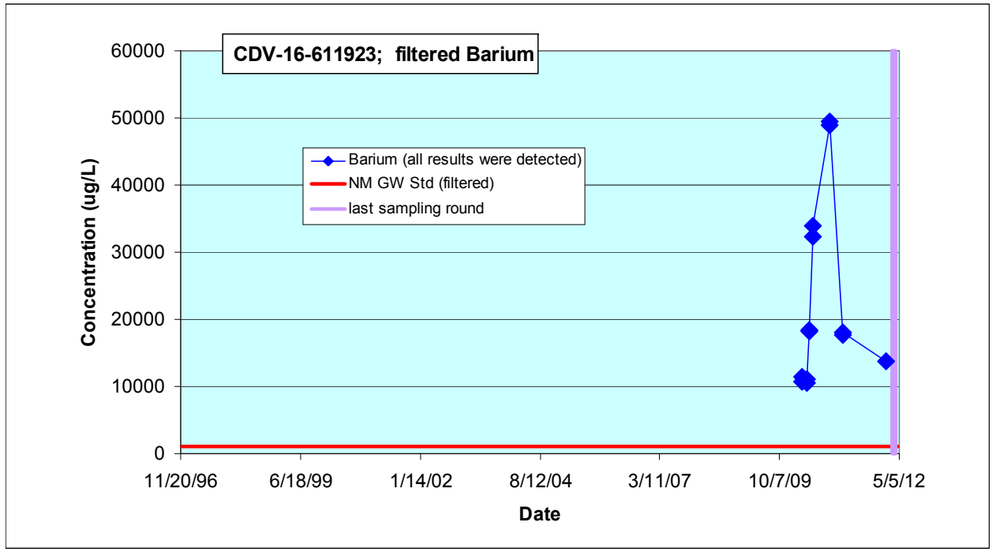


Figure 4.1-2 Time series for RDX concentrations in TA-16 springs







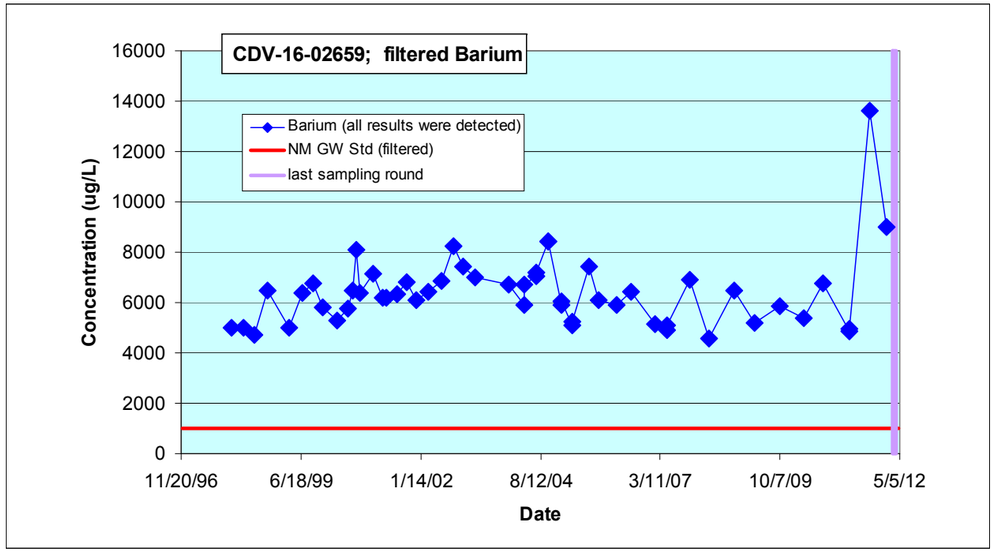
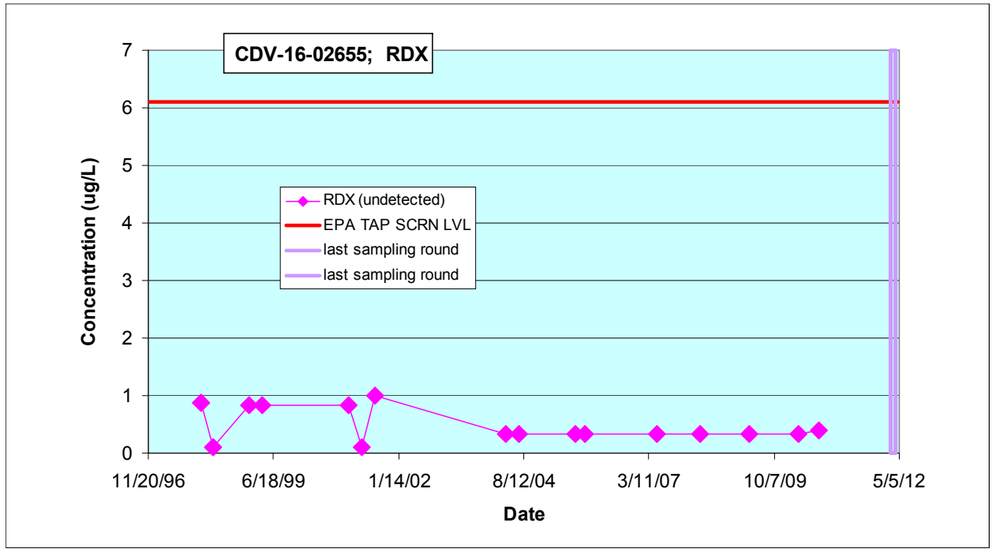
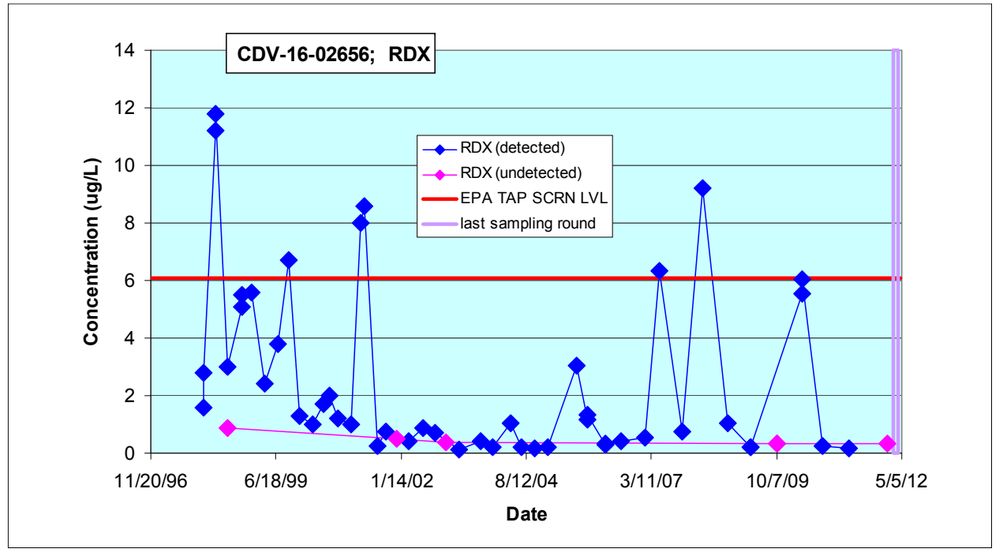
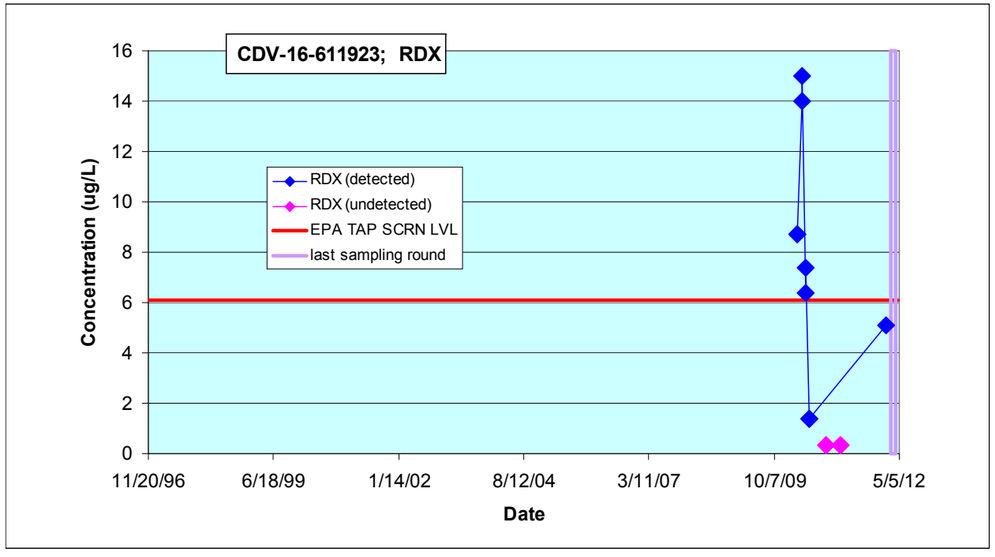


Figure 4.1-3 Time series for barium concentrations in TA-16 alluvial wells







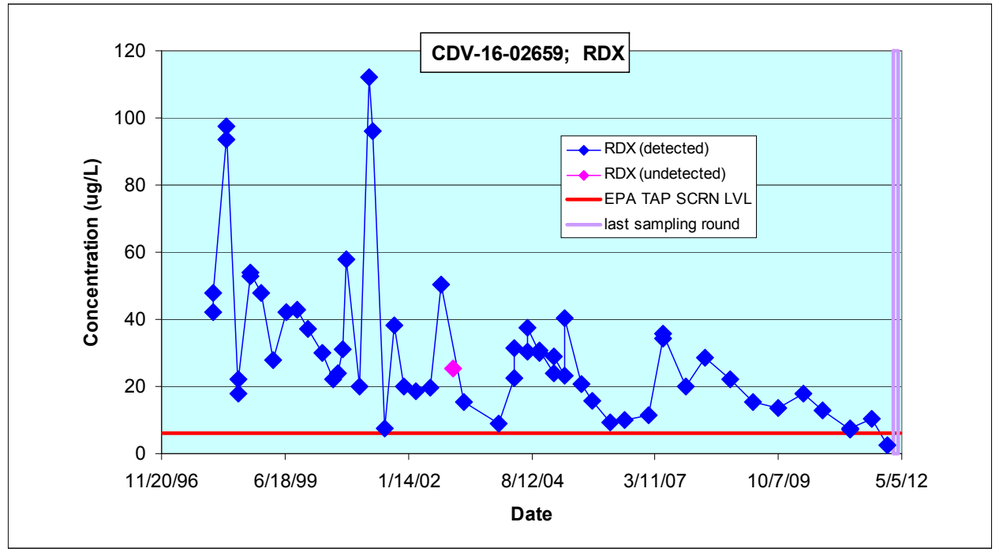
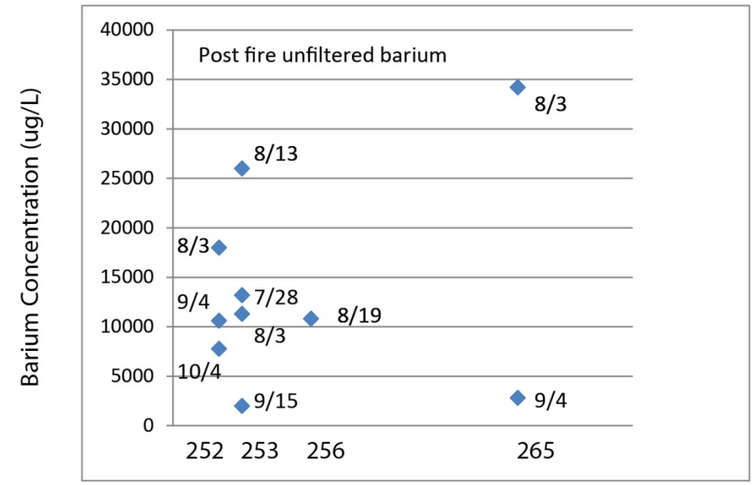


Figure 4.1-4 Time series for RDX concentrations in TA-16 alluvial wells



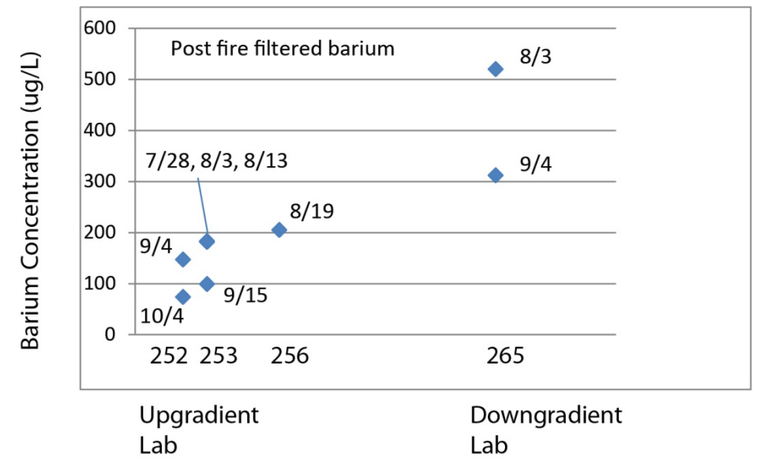


Figure 4.2-1 Barium concentrations in stormwater stations during flood events

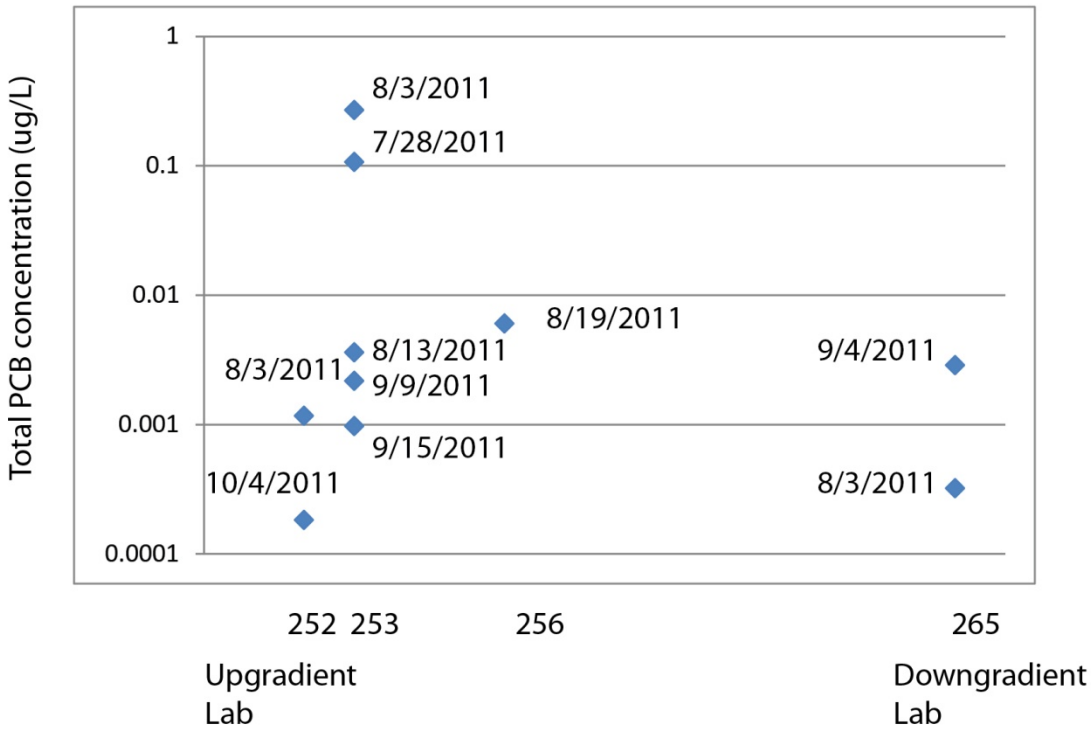
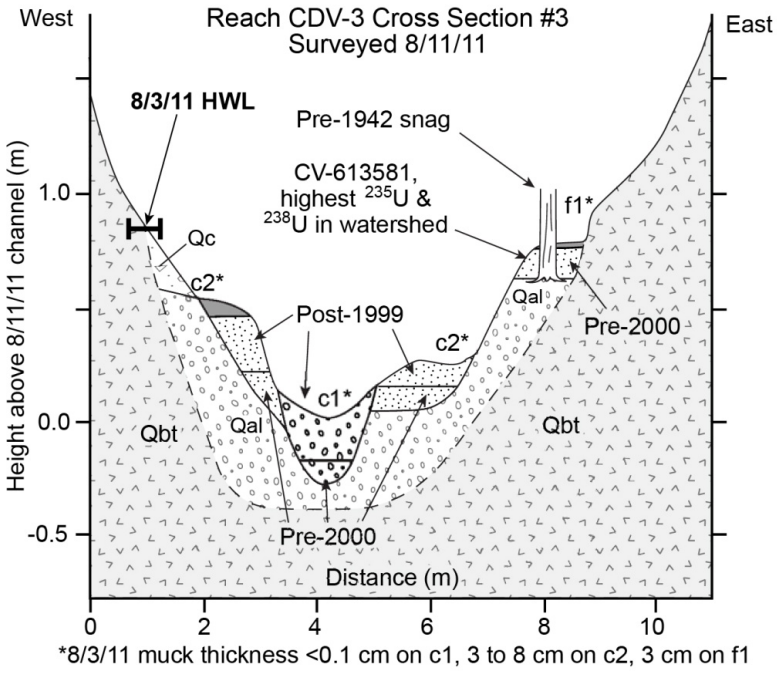
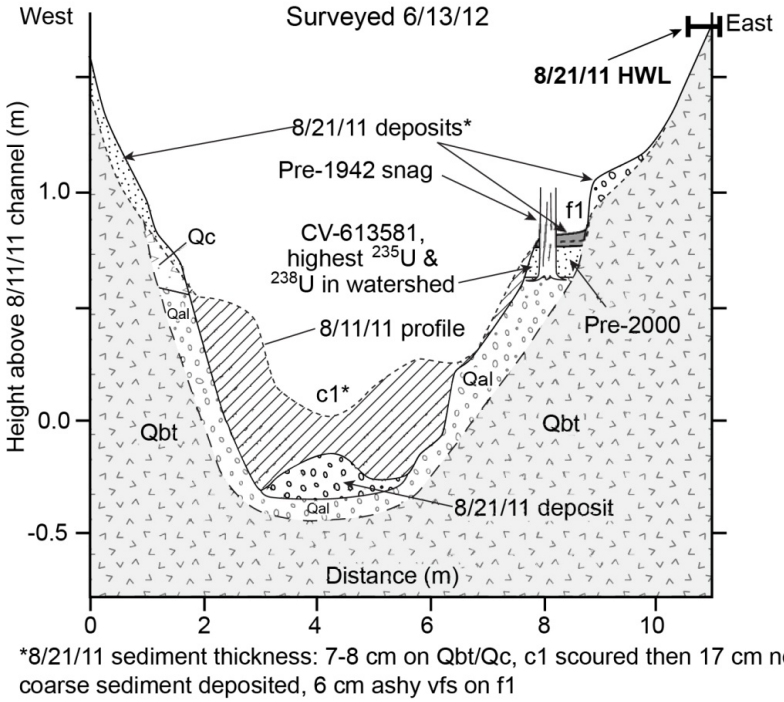


Figure 4.2-2 PCB concentrations in stormwater stations during flood events



Figure 5.2.1 Photograph showing August 21, 2011, coarse-grained sediment deposits overlying August 3, 2011, muck layer





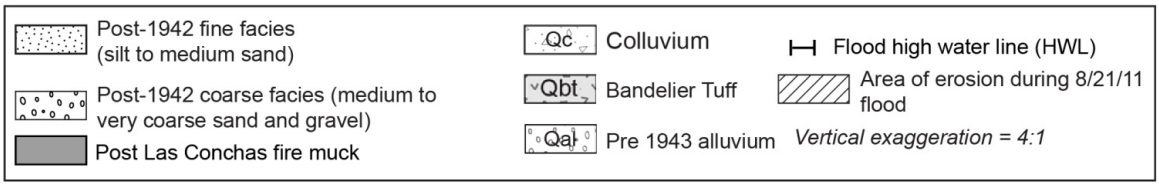


Figure 5.2-2 Geomorphic cross-sections showing post-fire erosion and deposition in reach CDV-3

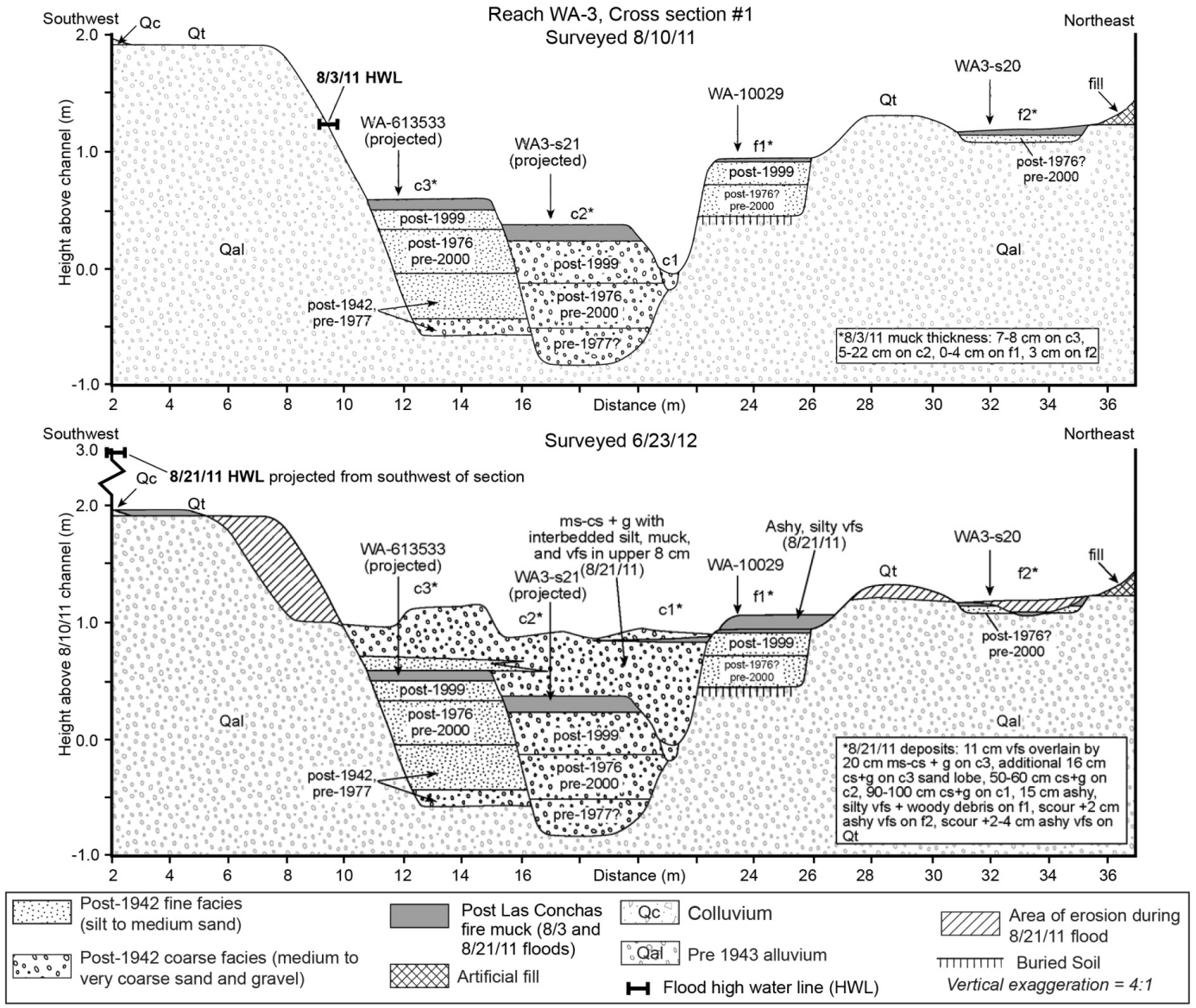


Figure 5.2-3 Geomorphic cross-sections showing post-fire erosion and deposition in reach WA-3

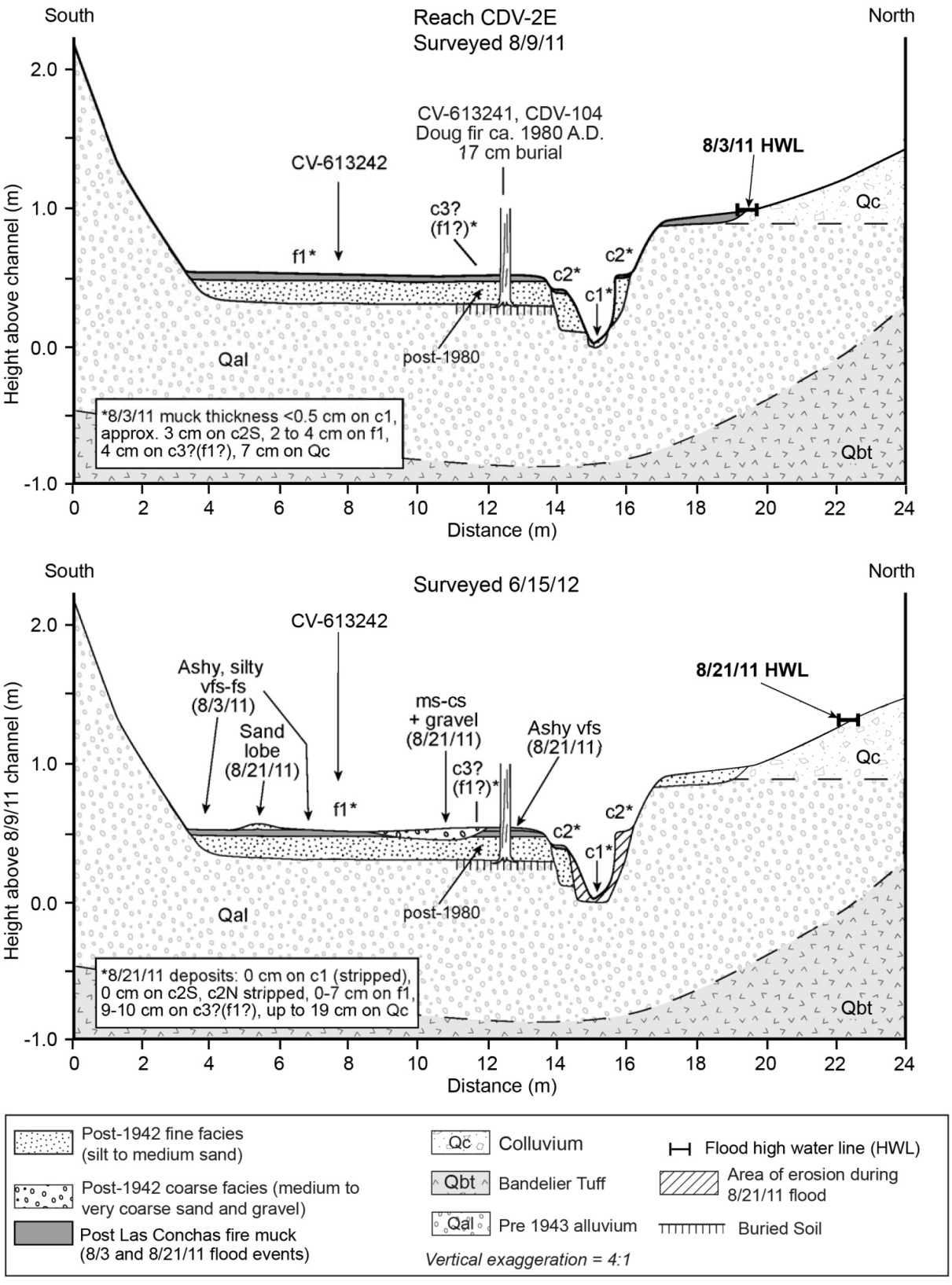


Figure 5.2-4 Geomorphic cross-sections showing post-fire erosion and deposition in reach CDV-2E

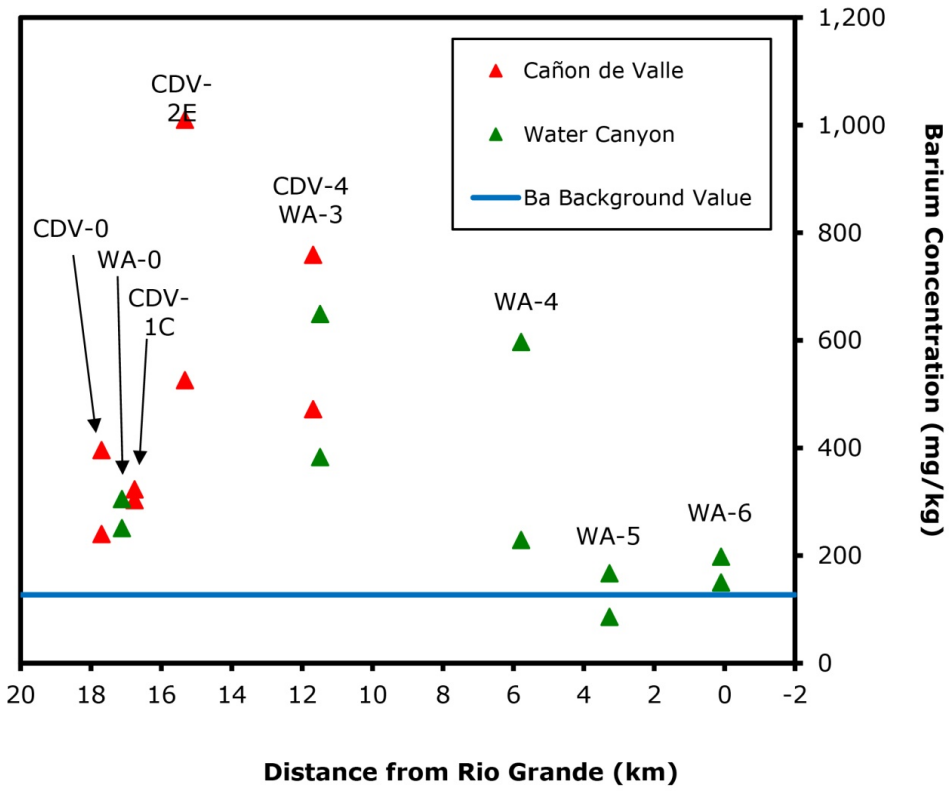


Figure 5.3-1 Post-fire barium concentrations as a function of distance from Rio Grande

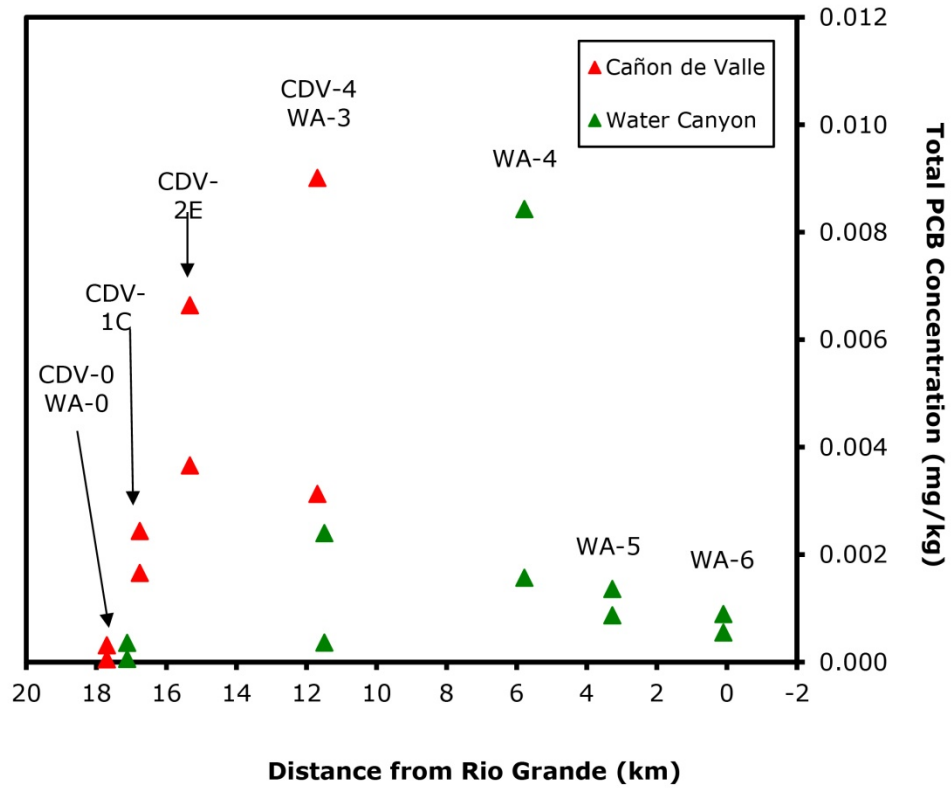


Figure 5.3-2 Post-fire PCB concentration as a function of distance from the Rio Grande

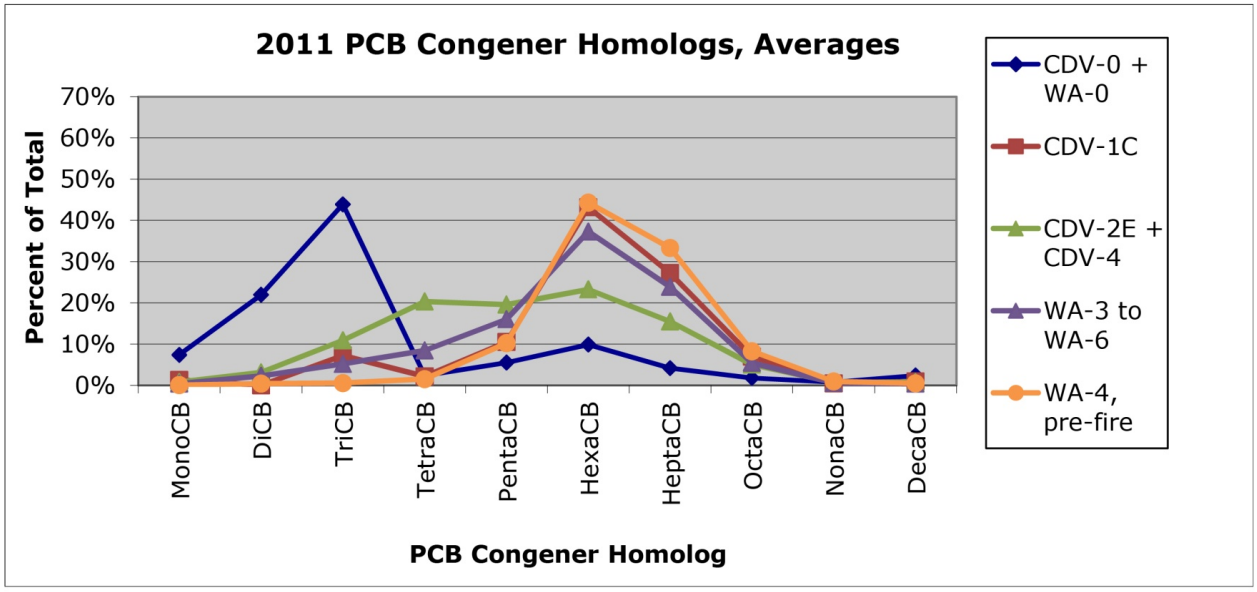


Figure 5.3-3 **Average values for PCB congeners homolog data from post-fire sediment samples collected in the Water Canyon and Cañon de Valle watershed**

Table 2.0-1
Estimated Flows at Surface Gaging Stations
during 2012 Floods in the Water Canyon and Cañon de Valle Watershed

Date	E252	E253	E256	E262	E252.8	E265
8/3/2011	93	63	58	ND*	5	20
8/21/2011	1577	1450	1024	1866	3021	2429
9/4/2011	760	70	ND	ND	ND	ND

Note: All values in cfs. Values either directly measured or estimated from high-water marks at individual stations (for 8/21/11 flood).

*ND = No data.

Table 2.0-2
Sampled Post–Las Conchas Fire Flood and Stormwater Runoff Events

Date	Stormwater Stations Sampled	Notes
7/28/2011	E253	
8/3/2011	E252, E253, E265	
8/13/2011	E253	
8/19/2011	E256	
8/21/2011	None	All sampling stations disrupted by severe flooding
9/4/2011	E252, E265	
9/9/2011	E253	
9/15/2011	E253	
10/4/2011	E252	

Table 3.0-1
Post–Las Conchas Sediment Samples Collected from Water Canyon and Cañon de Valle, Fall 2011

Watershed	Sub-watershed	Location	Sample ID	Date Collected	Unit	Side of Channel	Sediment Facies	Depth (cm)	Median Particle Size	Notes
Water	Valle	CV-614840	CACV-12-1618	11/29/2011	Qc?	S	fine	33–53	vfs	dark grey fs + vfs + some litter; "CDV-0" site 1
Water	Valle	CV-614840	CACV-12-1619	11/29/2011	Qc?	S	fine	53–71	csi	dark si (muck); "CDV-0" site 1
Water	Valle	CV-614842	CACV-12-1620	11/21/2011	Qc	S	fine	0–9	csi	stratified silty vfs, fs, and ashy silty vfs; CDV-1C site 1, ~350 m
Water	Valle	CV-614843	CACV-12-1621	11/21/2011	f1	N	fine	0–3	csi	ashy si (muck); CDV-1C site 2, ~331 m
Water	Valle	CV-614844	CACV-12-1622	11/21/2011	Qt/Qc	N	fine	0–7	vfs	stratified vfs w/ minor ashy layer; CDV-2E site 1, N of CV-613241
Water	Valle	CV-614845	CACV-12-1623	11/21/2011	f1	S	fine	0–13	csi	ashy si + vfs; CDV-2E site 2, +255 m
Water	Valle	CV-614846	CACV-12-1624	11/23/2011	f1	E	fine	0–12	fs	9 cm vfs over 3 cm vfs (fs?); CDV-4 site 1, near CV-613616
Water	Valle	CV-614847	CACV-12-1625	11/23/2011	f1	E	fine	0–5	csi	ashy silty vfs; CDV-4 site 3, next to CDV4-s20
Water	Water	WA-614852	CAWA-12-1630	11/29/2011	f1?	N	fine	0–4	csi	dark silty vfs; WA-0 site 1, 5 m S of gate
Water	Water	WA-614853	CAWA-12-1631	11/29/2011	f1?	S	fine	0–12	csi	si + vfs w/ 1 cm muck at base; WA-0 site 2, 10 m W of excavation
Water	Water	WA-614854	CAWA-12-1632	11/18/2011	c2? f1?	N	fine	0–9	fs	grey vfs-fs; "WA-6" site 1, in tamarisk ~ 5 m W of yellow LANL location stake near Rio
Water	Water	WA-614855	CAWA-12-1633	11/18/2011	c1? c2?	S	fine	0–4	csi	vfs + si w/ thin muck at base; "WA-6" site 2, pocket among boulders below trail crossing

Table 3.0-1(continued)

Watershed	Sub-watershed	Location	Sample ID	Date Collected	Unit	Side of Channel	Sediment Facies	Depth (cm)	Median Particle Size	Notes
Water	Water	WA-614856	CAWA-12-1634	11/23/2011	c3? (f1?)	S	fine	0–7	csi	black silt (muck); WA-3 site 1, S of WA3-s13
Water	Water	WA-614857	CAWA-12-1635	11/23/2011	c3-f1 boundary	N	fine	0–10	csi	interstratified tan si + black silt (muck); WA-3 site 2, W of WA3-s24
Water	Water	WA-614858	CAWA-12-1636	11/23/2011	f1	S	fine	0–8	csi	dark grey + minor brown si; WA-4 site 1, across channel from WA-613153
Water	Water	WA-614859	CAWA-12-1637	11/23/2011	f1	N	fine	0–4	csi	4 cm fs over 6 cm interstratified tan si + black si; WA-4 site 2, NW of WA-10036
Water	Water	WA-614860	CAWA-12-1638	11/21/2011	f1	S	fine	0–4	vfs	vfs; WA-5 site1, near WA-614160
Water	Water	WA-614861	CAWA-12-1639	11/21/2011	Qc/Tb	S	fine	0–9	fs	5 cm vfs over 4 cm black ashy silt (muck); WA-5 site 2, ~54 m

Notes: si = silt; vfs = very fine sand; fs = fine sand; cs = coarse sand; csi = coarse silt.

Table 5.0-1
Annual Maximum Discharge at Gages in Watersheds Affected by Cerro Grande Fire

Station ID	Station Name	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
E060	Pueblo above SR-502	6.3	6.3	7.5	5.8	7.6	11	114	1,440	582	749	504	116	1,930	37	29	4.2
E241	Pajarito above Starmers Gulch	na*	na	na	na	na	0.21	300	108	207	25	4.1	74	20	17	21	2.2
E242	Starmers Gulch above Pajarito	na	na	na	na	na	na	180	103	7.8	2.2	19	93	17	628	100	10
E245	Pajarito above TA-18	26	24	27	30	5.1	12	517	137	140	44	74	373	425	119	13	2.1
E252	Water Canyon above SR-501	na	0.21	0.06	0.29	0.15	0.05	840	255	114	2.1	1.5	1.8	2.5	6.4	1.8	0.21
E253	Cañon de Valle above SR-501	na	0	0	0	0	0	740	19	12	0.97	0.3	8.5	0.13	1.8	0	0
E265	Water Canyon below SR-4	na	21	18	0	0	17	274	96	105	25	100	26	47	72	69	0

Note: Discharge in cfs; gages in Los Alamos Canyon excluded because of effect of Los Alamos Reservoir on peak discharge; data from annual surface water data reports (e.g. Ortiz and McCullough 2010, 109826).

*na = Not available.

Table 5.0-2
Sediment Investigation Reaches within the Water Canyon and Cañon de Valle Watersheds Summarizing Post–Las Conchas Sediment Deposition

Reach	Location ID	Dist. (m)	Side	Unit	Sampled Sediment Layer Extant?	Post–Las Conchas Sediment Thickness (cm)	Notes Describing Post–Las Conchas Fire Sediments and Other Observations	Total Post-Fire Fine Sediment Thickness (cm)	Total Post-Fire Coarse Sediment Thickness (cm)
CDV-1C	CV-613633	223	N	f1	yes	0		0	0
CDV-1C	CV-613634	246	S	c2	yes	2	fine sediment in pine needles	2	0
CDV-1C	CV-613635	260	S	f1	yes	0		0	0
CDV-1C	CV-613636	275	—*	c1	no	5	g + vcs	0	5
CDV-1C	CV-613637	327	N	c2	yes?	>35	cg + cs + ash	0	35
CDV-1C	CV-613639	329	N	f1	yes	3	muck	3	0
CDV-1C	CV-613640	363	—	c1	yes?	50-100	0.5-1.0 m coarse gravelly sand	0	100
CDV-1C	CV-613641	370	N	f1	yes	0	70 cm coarse gravel behind log immediately upstream of sample loc	0	0
CDV-1C	CV-613642	384	N	c2	yes	0		0	0
Average post–Las Conchas sediment thickness at sample locations in reach CDV-1C (n=9)								0.6	15.6
CDV-1E	CV-613592	566	—	c1	no	0	scoured to bedrock	0	0
CDV-1E	CV-613593	591	N	f2? (Qt?)	yes	3	fs	3	0
CDV-1E	CV-613594	635	S	f1	yes	12	1 cm muck over 4 cm ms-cs over 7 cm muck	8	4
CDV-1E	CV-613595	637	—	c1	no	0	scoured to boulders	0	0
CDV-1E	CV-613596	643	S	c2	yes	2	cs - vcs	0	2
CDV-1E	CV-613597	647	N	c2	no	3	fine g + vcs	0	3
CDV-1E	16-6122	698	N	c3?	no	33	3 cm ashy si + vfs overlying 30 cm cobbles	3	30
CDV-1E	CV-613598	700	N	c3	no	43	40 cm cg overlying 3 cm ashy si + vfs w/metal pipe at base	3	40
CDV-1E	CV-613600	713	S	f1	yes	5	ashy vfs	5	0

Table 5.0-2 (continued)

Reach	Location ID	Dist. (m)	Side	Unit	Sampled Sediment Layer Extant?	Post–Las Conchas Sediment Thickness (cm)	Notes Describing Post–Las Conchas Fire Sediments and Other Observations	Total Post-Fire Fine Sediment Thickness (cm)	Total Post-Fire Coarse Sediment Thickness (cm)
CDV-1E	CV-613601	747	N	c2	yes	26	22 cm cs-vcs + g (8/21/11) overlying 4 cm muck + pine needles (8/3/11)	4	22
Average post–Las Conchas sediment thickness at sample locations in reach CDV-1E (n=10)								2.6	10.1
CDV-2E	16-6133	34	S	c3? (c2?)	yes	10	10 cm ashy vfs + si	10	0
CDV-2E	16-6134	55	N	c2	yes	0		0	0
CDV-2E	16-6135	150	S	f2? (f1?)	yes	30	21 cm stratified fs-ms + granules (8/21/11?) overlying 9 cm muck (8/3/11?)	30	0
CDV-2E	CV-613241	182	S	c3? (f1?)	yes	9	9 cm ashy vfs	9	0
CDV-2E	CV-613242	182	S	f1	yes	3	ashy si + vfs	3	0
CDV-2E	CV-613243	206	N	c2	yes	0		0	0
CDV-2E	CV-613244	220	—	c1	no	2	cs-vcs + g	0	2
CDV-2E	CV-613245	271	S	f1	yes	4	ms + minor cs	0	4
CDV-2E	CV-613246	311	S	c2	no	0		0	0
CDV-2E	16-6136	314	N	c2	yes	1	ashy vfs	1	0
CDV-2E	CV-613247	321	S	c3?	no	5	ms-cs	0	5
CDV-2E	CV-613248	335	N	c2	yes	7	cs + g + 1 cm muck at base	1	6
CDV-2E	CV-613249	363	N	c3	yes	4	cs-vcs + g	0	4
CDV-2E	CV-613250	374	N	f2? (f1?)	yes	2	ashy si + vfs	2	0
CDV-2E	16-6137	450	N	c2	yes	0		0	0
CDV-2E	16-6138	450	S	c3? (f1?)	yes	1	vfs	1	0
CDV-2E	16-6139	478	S	f1	yes	1	ashy silty vfs	1	0
CDV-2E	16-6140	502	S	c3? (c2?)	yes	5	ashy vfs + litter	5	0
CDV-2E	16-6141	555	S	c3? (f1?)	no	5	cs + g	0	5
CDV-2E	16-6142	574	S	c2	yes	4	3 cm ashy fs + vfs + 1 cm vcs + cs	3	1
Average post–Las Conchas sediment thickness at sample locations in reach CDV-2E (n=20)								3.3	1.4

Table 5.0-2 (continued)

Reach	Location ID	Dist. (m)	Side	Unit	Sampled Sediment Layer Extant?	Post–Las Conchas Sediment Thickness (cm)	Notes Describing Post–Las Conchas Fire Sediments and Other Observations	Total Post-Fire Fine Sediment Thickness (cm)	Total Post-Fire Coarse Sediment Thickness (cm)
CDV-2W	16-6123	25	N	c2	yes	4	loose ashy fs + granules	4	0
CDV-2W	16-6124	165	S	f1	no	3	loose ashy fs + granules	3	0
CDV-2W	16-6125	170	S	c2	no	2	silty vfs	2	0
CDV-2W	CV-613602	202	S	c2	yes	2	vfs + si	2	0
CDV-2W	CV-613603	237	N	c2	no	0	unit completely eroded; W-CdV IR Fig. B-1.0-1d	0	0
CDV-2W	CV-613605	269	N	c3	no?	>40	g + cs + ash; water at @ 35 cm	0	40
CDV-2W	CV-613606	273	—	c1	yes?	18	3 cm vfs-ms overlying 15 cm cs + g	3	15
CDV-2W	CV-613607	284	S	f1	yes	7	7 cm muck	7	0
CDV-2W	16-6126	285	S	f1	yes	9	vfs + si	9	0
CDV-2W	16-6127	295	N	f1	yes	0		0	0
CDV-2W	16-6128	300	N	c2	no	50	cg	0	50
CDV-2W	CV-613608	323	N	f1	yes	0		0	0
CDV-2W	CV-613609	352	N	c3? (f1?)	yes	0	W-CdV IR Fig. B-1.0-1f	0	0
CDV-2W	CV-613611	363	S	c3? (f1?)	yes	2	ashy silty vfs	2	0
CDV-2W	16-6129	368	S	c3? (f1?)	yes	3	ashy vfs	3	0
CDV-2W	CV-613610	385	S	c3? (f1?)	yes	8	8 cm muck	8	0
CDV-2W	16-6130	400	N	c3? (f1?)	yes	5	silty ashy vfs-fs	5	0
CDV-2W	16-6131	403	N	c3? (c2?)	yes?	23	10 cm cg (8/21/11?) overlying 13 cm muck (8/3/11?)	13	10
CDV-2W	16-6132	428	S	c3	yes	0		0	0
Average post–Las Conchas sediment thickness at sample locations in reach CDV-2W (n=19)								3.2	6.1
CDV-3	CV-613572	7	W	c2	yes	41	2 cm ashy fs-vfs overlying 39 cm cs + g	2	39
CDV-3	CV-613573	12	—	c1	no	0	cobble-boulder lag remains in channel	0	0
CDV-3	CV-613574	43	W	c3	yes	11	fs + granules w/~0.5 cm ashy at base	11	0

Table 5.0-2 (continued)

Reach	Location ID	Dist. (m)	Side	Unit	Sampled Sediment Layer Extant?	Post–Las Conchas Sediment Thickness (cm)	Notes Describing Post–Las Conchas Fire Sediments and Other Observations	Total Post-Fire Fine Sediment Thickness (cm)	Total Post-Fire Coarse Sediment Thickness (cm)
CDV-3	CV-613575	52	W	c3	no	0	approx 2/3 of unit was eroded with new channel	0	0
CDV-3	CV-613576	75	W	c2? (c3?)	no	0	20 cm deep scour; sample interval was 0–18 cm	0	0
CDV-3	CV-613577	96	W	c2	yes	3	ashy vfs	3	0
CDV-3	CV-613578	130	E	c2	no	0	entire c2 unit eroded; stream cut to Qbt	0	0
CDV-3	CV-613579	139	W	c2	no	32	entire c2 unit eroded; 32 cm ashy coarse sandy gravel deposited	0	32
CDV-3	CV-613580	167	E	c2	yes	7	ashy fs-vfs	7	0
CDV-3	CV-613581	181	E	f1	yes	7	ashy cs + fines	0	7
Average post–Las Conchas sediment thickness at sample locations in reach CDV-3 (n=10)								2.3	7.8
CDV-4	CV-613612	10	—	c1	no	0	32 cm of 46 cm sample layer eroded	0	0
CDV-4	CV-613613	28	E	c2	no	4	ms + g	0	4
CDV-4	CV-613614	32	E	f1	yes	2	ashy vfs; some surface scour	2	0
CDV-4	CV-613615	69	W	f1	yes	14	ms-cs + g; new c1 buries f1	0	14
CDV-4	CV-613616	86	E	f1	yes	16	fs-ms with scattered cs	16	0
CDV-4	CV-613617	106	W	f1	yes	13	stratified ms-cs + g; new c1 buries f1	0	13
CDV-4	CV-613619	122	W	c2	yes	9	ms-cs + g; some local surface scour, unit mostly intact	0	9
CDV-4	CV-613620	168	N	c2	yes	0		0	0
Average post–Las Conchas sediment thickness at sample locations in reach CDV-4 (n=8)								2.3	5.0
CDVN-1	CV-614081	4	N	c2	yes	1	fine ash-rich sediment	1	0
CDVN-1	CV-614082	13	—	c1	yes	2	fine ash-rich sediment	2	0
CDVN-1	CV-614083	30	—	c2	yes	1	fine ash-rich sediment	1	0
CDVN-1	CV-614085	39	S	f1	yes	1	fine ash-rich sediment	1	0

Table 5.0-2 (continued)

Reach	Location ID	Dist. (m)	Side	Unit	Sampled Sediment Layer Extant?	Post–Las Conchas Sediment Thickness (cm)	Notes Describing Post–Las Conchas Fire Sediments and Other Observations	Total Post-Fire Fine Sediment Thickness (cm)	Total Post-Fire Coarse Sediment Thickness (cm)
CDVN-1	CV-614087	89	N	c2	yes	0		0	0
CDVN-1	CV-614088	108	S	f1	yes	0		0	0
CDVN-1	CV-614089	152	S	f1	no?	1	fine ash-rich sediment; geomorphic unit remains intact, but sampled layer (0–13 cm) apparently scoured	1	0
CDVN-1	CV-614090	194	S	f1	yes	0		0	0
Average post–Las Conchas sediment thickness at sample locations in reach CDVN-1 (n=8)								0.8	0.0
CDVS-1	CV-613643	48	E	c2	yes	0		0	0
CDVS-1	CV-613644	60	W	c2	no	0	unit eroded	0	0
CDVS-1	CV-613645	73	E	c2	yes	0		0	0
CDVS-1	CV-613646	90	E	c2	yes	0		0	0
CDVS-1	CV-613647	120	W	f1? (c2?)	no	0	unit eroded	0	0
CDVS-1	CV-613648	133	—	c1	no	0	scoured	0	0
CDVS-1	CV-613649	175	—	c1	no	10	fine gravel + vfs	0	10
CDVS-1	CV-613650	185	E	c2	no	0	unit eroded	0	0
CDVS-1	CV-613651	185	—	c1	no	0	scoured	0	0
CDVS-1	CV-613652	196	W	c2	no	0	unit eroded	0	0
Average post–Las Conchas sediment thickness at sample locations in reach CDVS-1 (n=10)								0.0	1.0
WA-2	WA-614111	7	N	f1	no	0	unit eroded	0	0
WA-2	WA-614112	22	S	c2? (f1?)	no	0	unit eroded	0	0
WA-2	WA-614113	38	—	c1	no	50	bouldery gravel deposit	0	50
WA-2	WA-614114	75	—	c1	no	30	cg	0	30
WA-2	WA-614115	113	S	c3	no	0	unit eroded; stripped to bedrock	0	0
WA-2	WA-614116	130	S	f1	no	8	most of unit eroded; 8 cm ms-cs + g post- post–Las Conchas sediment	0	8

Table 5.0-2 (continued)

Reach	Location ID	Dist. (m)	Side	Unit	Sampled Sediment Layer Extant?	Post–Las Conchas Sediment Thickness (cm)	Notes Describing Post–Las Conchas Fire Sediments and Other Observations	Total Post-Fire Fine Sediment Thickness (cm)	Total Post-Fire Coarse Sediment Thickness (cm)
WA-2	WA-614119	188	N	f1	no	50-100	unit eroded; 0.5-1.0 m cg	0	50
WA-2	WA-614120	197	N	c2	no	10-20	unit eroded; 10-20 cm cg	0	20
Average post–Las Conchas sediment thickness at sample locations in reach WA-2 (n=8)								0.0	19.8
WA-3	WA-613530	20	S	c3	yes	28	6 cm muck (8/3/11) overlain by 6 cm ms-cs + 14 cm cg at top (8/21/11)	6	22
WA-3	WA-10024	27	S	c3	yes	9	ms-cs + g	0	9
WA-3	WA-10025	40	N	c3	no	10	2 cm cs + g overlying 8 cm ashy vfs	8	2
WA-3	WA-10026	54	N	c2	no	18	cs + g	0	18
WA-3	WA-613531	54	N	c3	yes	6	ms-cs + g	0	6
WA-3	WA-10027	66	S	c3	no	28	26 cm upward coarsening ashy ms-cs to vcs + g overlying 2 cm muck; new c1	2	26
WA-3	WA-10028	83	S	c2? (c3?)	no	40	stratified ms-cs + g; new c1	0	40
WA-3	WA-613532	83	S	f1	yes	3	vfs-fs	3	0
WA-3	WA-10029	94	N	f1	yes	14	5 cm ashy vfs (8/3/11) overlain by 9 cm cs-vcs + gt	5	9
WA-3	WA-613533	105	S	c3	yes	38	7 cm muck (8/3/11) overlain by 11 cm stratified vfs and ashy vfs + 20 cm ms-vcs +g at top (entire coarse interval 8/21/11)	7	31
WA-3	WA-613535	130	S	c2	yes	2	ashy vfs + pine needles	2	0
WA-3	WA-613536	150	N	c2	yes	4	muck	4	0
WA-3	WA-613537	150	S	c3? (c2?)	yes	2	loose vfs	2	0
WA-3	WA-613538	175	N	c3	yes	6	6 cm loose ashy vfs on scoured surface	6	0
WA-3	WA-613539	179	—	c1	yes	10	cs + pebbly gravel	0	10
Average post–Las Conchas sediment thickness at sample locations in reach WA-3 (n=15)								3.0	11.5

Table 5.0-2 (continued)

Reach	Location ID	Dist. (m)	Side	Unit	Sampled Sediment Layer Extant?	Post–Las Conchas Sediment Thickness (cm)	Notes Describing Post–Las Conchas Fire Sediments and Other Observations	Total Post-Fire Fine Sediment Thickness (cm)	Total Post-Fire Coarse Sediment Thickness (cm)
WA-3E	Water at Beta	-	—	c1	no	20	cs + g	0	20
WA-4	WA-613153	8	N	f1	yes	3	vfs-fs	3	0
WA-4	WA-613154	22	S	f1	yes	2	vfs + pine needles	2	0
WA-4	WA-613155	24	N	f1	yes	6	ashy vfs-fs	6	0
WA-4	WA-613156	33	S	f1	yes	0		0	0
WA-4	WA-613157	62	N	f1	yes	7	ashy vfs	7	0
WA-4	WA-613158	71	N	c2	yes	7	ashy vfs	7	0
WA-4	WA-10035	105	N	Qt	yes	2	ashy vfs	2	0
WA-4	WA-613159	105	N	c2	yes	6	ashy vfs-fs+pumice granules	6	0
WA-4	WA-613160	116	—	c1	no	8	cs + g + ash	0	8
WA-4	WA-603939	120	S	c2	no	5	loose ashy fs (sample layer scoured, unit still present)	5	0
WA-4	WA-10034	126	S	c2	no	3	ashy silty vfs (sample layer scoured, unit still present)	3	0
WA-4	WA-613161	134	N	f1	yes	4	ashy vfs	4	0
WA-4	WA-10033	151	S	f1	yes	2	ashy silty vfs	2	0
WA-4	WA-613162	156	N	f1	yes	3	ashy vfs	3	0
WA-4	WA-603938	160	N	c2	no	3	ashy silty vfs (most of unit scoured)	3	0
WA-4	WA-10032	172	N	f1	yes	4	ashy silty vfs	4	0
WA-4	WA-10031	175	N	c2	no	1	ashy vfs (most of unit eroded)	1	0
WA-4	WA-10036	192	N	f1	yes	16	ashy vfs + minor cs	16	0
WA-4	Water Canyon at SR-4	194	—	c1	no	0	scoured	0	0
WA-4	WA-10030	195	S	f1	yes	1	ashy vfs	1	0
Average post–Las Conchas sediment thickness at sample locations in reach WA-4 (n=20)								3.8	0.4

Table 5.0-2 (continued)

Reach	Location ID	Dist. (m)	Side	Unit	Sampled Sediment Layer Extant?	Post–Las Conchas Sediment Thickness (cm)	Notes Describing Post–Las Conchas Fire Sediments and Other Observations	Total Post-Fire Fine Sediment Thickness (cm)	Total Post-Fire Coarse Sediment Thickness (cm)
WA-4W	WA-614131	29	S	f1	yes	1	ashy vfs + cs; 6 cm of 20 cm thick sample layer scoured	1	0
WA-4W	WA-614132	35	—	c1	no	30	cs-vcs + cobbly g	0	30
WA-4W	WA-614133	70	N	f1	yes	16	3 cm muck (8/3/11) overlain by 13 cm fs (8/21/11)	16	0
WA-4W	WA-614134	85	N	f1	yes	14	4 cm muck (8/3/11) overlain by 10 cm cs + g (8/21/11)	4	10
WA-4W	WA-614136	105	S	f1	yes	6	6 cm muck + litter; 18 cm fs-ms next to location	6	0
WA-4W	WA-614137	157	N	f1	yes	2	muck	2	0
WA-4W	WA-614139	175	S	f1	yes	3	ashy silty vfs; some surface scour	3	0
WA-4W	WA-614140	194	S	c2	yes	4	loose fs-ms + pumice granules	4	0
Average post–Las Conchas sediment thickness at sample locations in reach WA-4W (n=8)								4.5	5.0
WA-5	WA-614151	23	S	f1	yes	2	fine ash-rich sediment; W-CdV IR Fig. B-1.0-4g2	2	0
WA-5	WA-614152	37	—	c1	no	10	coarse sediment; bedrock pothole with water	0	10
WA-5	WA-614153	85	N	c2	no	0	unit completely eroded at sample location, but intact downstream	0	0
WA-5	WA-614154	143	N	f1	yes	0		0	0
WA-5	WA-614157	161	N	f1	yes	4	litter + fine sediment	4	0
WA-5	WA-614158	182	S	c2	yes	0		0	0
WA-5	WA-614159	216	—	c1	no	unk	deep bedrock pothole with water; bottom of pool not examined		
WA-5	WA-614160	234	S	f1	yes	3	fine sediment	3	0
Average post–Las Conchas sediment thickness at sample locations in reach WA-5 (n=8)								1.3	1.4

Table 5.0-2 (continued)

Reach	Location ID	Dist. (m)	Side	Unit	Sampled Sediment Layer Extant?	Post–Las Conchas Sediment Thickness (cm)	Notes Describing Post–Las Conchas Fire Sediments and Other Observations	Total Post-Fire Fine Sediment Thickness (cm)	Total Post-Fire Coarse Sediment Thickness (cm)
WANW-1	WA-613560	26	—	c1	no	0	scoured to bedrock	0	0
WANW-1	WA-613562	62	E	f1	yes	0		0	0
WANW-1	WA-613563	106	E	f1	yes	0		0	0
WANW-1	WA-613564	117	W	c2	yes	3	fine sediment	3	0
WANW-1	WA-613565	123	W	c2	yes	2	fine sediment	2	0
WANW-1	WA-613566	140	E	c2	yes	3	cs	0	3
WANW-1	WA-613567	166	W	c2	yes	7	fs	2	0
WANW-1	WA-613568	167	—	c1	no?	20	cs; channel probably scoured in flood	0	20
WANW-1	WA-613569	198	E	c2	yes	0		0	0
Average post–Las Conchas sediment thickness at sample locations in reach WANW-1 (n=9)								0.8	2.6

Note: si = silt; vfs = very fine sand; fs = fine sand; ms = medium sand; cs = coarse sand; vcs = very coarse sand; g = gravel; cg = coarse gravel [cobbles and boulders]; muck = ashy silt; unk = unknown.

*— = Not applicable.

Table 5.0-3
Sediment Investigation Reaches within the Water Canyon and
Cañon de Valle Watersheds Summarizing Erosion of Sediment Sampling Locations by Post–Las Conchas Floods

Reach	Number of Sampling Locations in Reach	Number of Sampling Locations Preserved	Percentage of Sampling Locations Preserved	Total c1 Locations Eroded	Total c1 Sampling Locations in Reach	Total c2 Locations Eroded	Total c2 Sampling Locations in Reach	Total c3 Locations Eroded	Total c3 Sampling Locations in Reach	Total f1 Locations Eroded	Total f1 Sampling Locations in Reach	Total f2 + Qt Locations Eroded	Total f2 + Qt Sampling Locations in Reach
CDV-1C	9	8	89%	1	2	0	3	0	0	0	4	0	0
CDV-1E	10	5	50%	2	2	1	3	2	2	0	2	0	1
CDV-2E	20	16	80%	1	1	1	7	2	7	0	3	0	2
CDV-2W	19	14	74%	0	1	3	5	1	8	1	5	0	0
CDV-3	10	5	50%	1	1	3	6	1	2	0	1	0	0
CDV-4	8	6	75%	1	1	1	3	0	0	0	4	0	0
CDVN-1	8	7	88%	0	1	0	3	0	0	1	4	0	0
CDVS-1	10	3	30%	3	3	3	6	0	0	1	1	0	0
WA-2	8	0	0%	2	2	2	2	1	1	3	3	0	0
WA-3	15	11	73%	0	1	2	4	2	8	0	2	0	0
Water at Beta	1	0	0%	1	1	0	0	0	0	0	0	0	0
WA-4	20	14	70%	2	2	4	6	0	0	0	11	0	1
WA-4W	8	7	88%	1	1	0	1	0	0	0	6	0	0
WA-5	8	5	63%	2	2	1	2	0	0	0	4	0	0
WANW-1	9	7	78%	2	2	0	5	0	0	0	2	0	0
Total by Unit				**19**	**23**	**21**	**56**	**9**	**28**	**6**	**52**	**0**	**4**

Percentage C1 Locations Eroded	**83%**
Percentage C2 Locations Eroded	**38%**
Percentage C3 Locations Eroded	**32%**
Percentage F1 Locations Eroded	**12%**
Percentage F2 and QT Locations Eroded	**0%**
Total Sampling Locations	**163**
Total Sampling Locations Eroded	**55**
Percentage of Sampling Location Preserved	**66%**

Appendix A

Acronyms and Abbreviations

ACRONYMS AND ABBREVIATIONS

AOC	area of concern
BV	background value
cfs	cubic feet per second
CME	corrective measures evaluation
CMI	corrective measures implementation
COPC	chemical of potential concern
EP	Environmental Programs Directorate
IR	investigation report
LANL	Los Alamos National Laboratory
NOD	notice of disapproval
PCB	polychlorinated biphenyl
PCE	perchloroethene
PRB	permeable reactive barrier
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RPF	Records Processing Facility
SWMU	solid waste management unit
TA	technical area

Appendix B

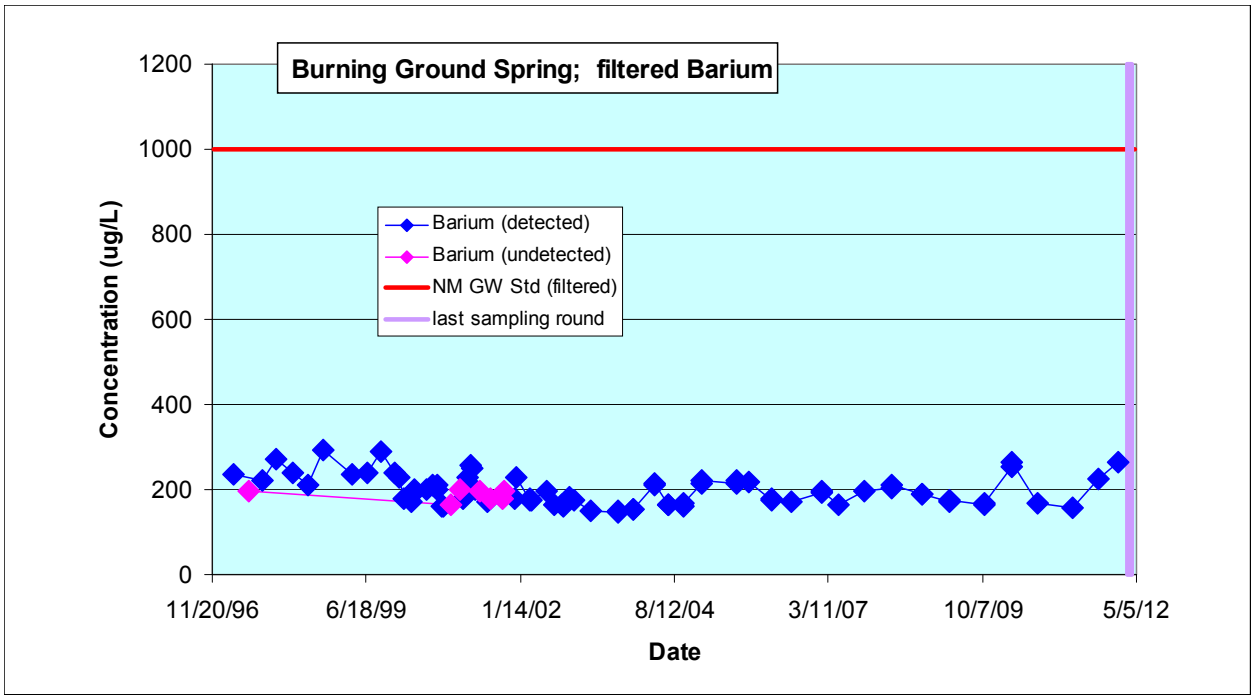
Water Canyon and Cañon de Valle Water Figures and Data

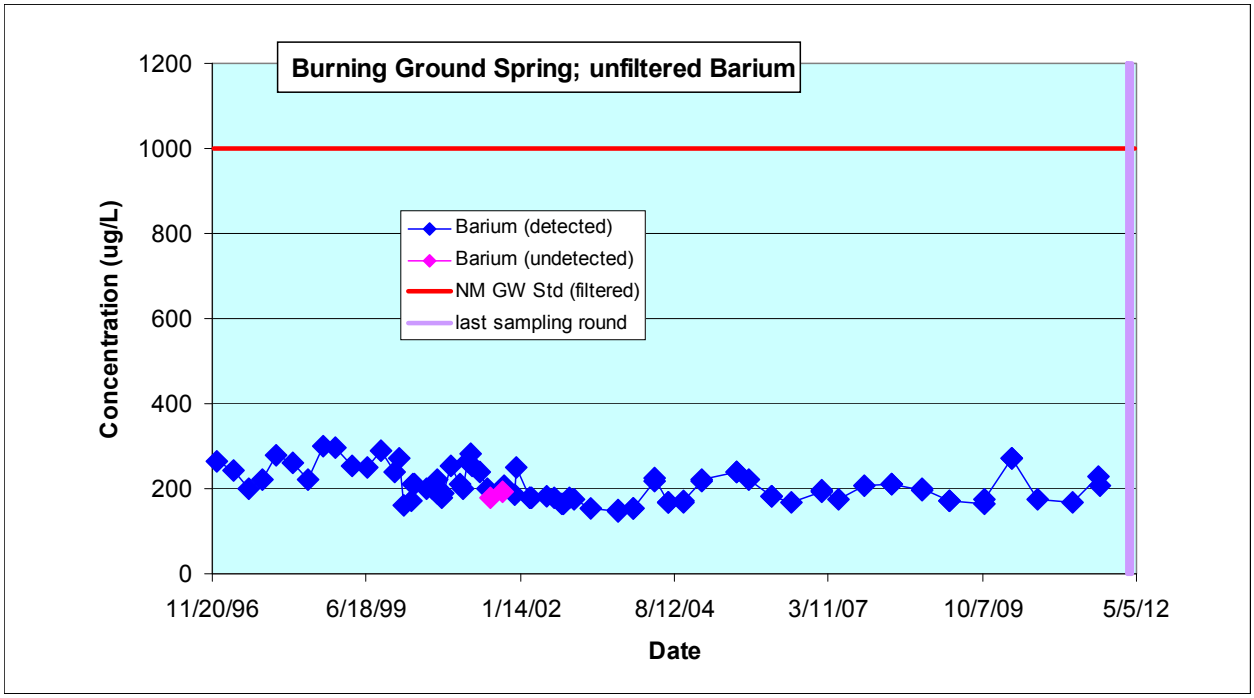
Figures showing alluvial system key constituents versus time include the following:

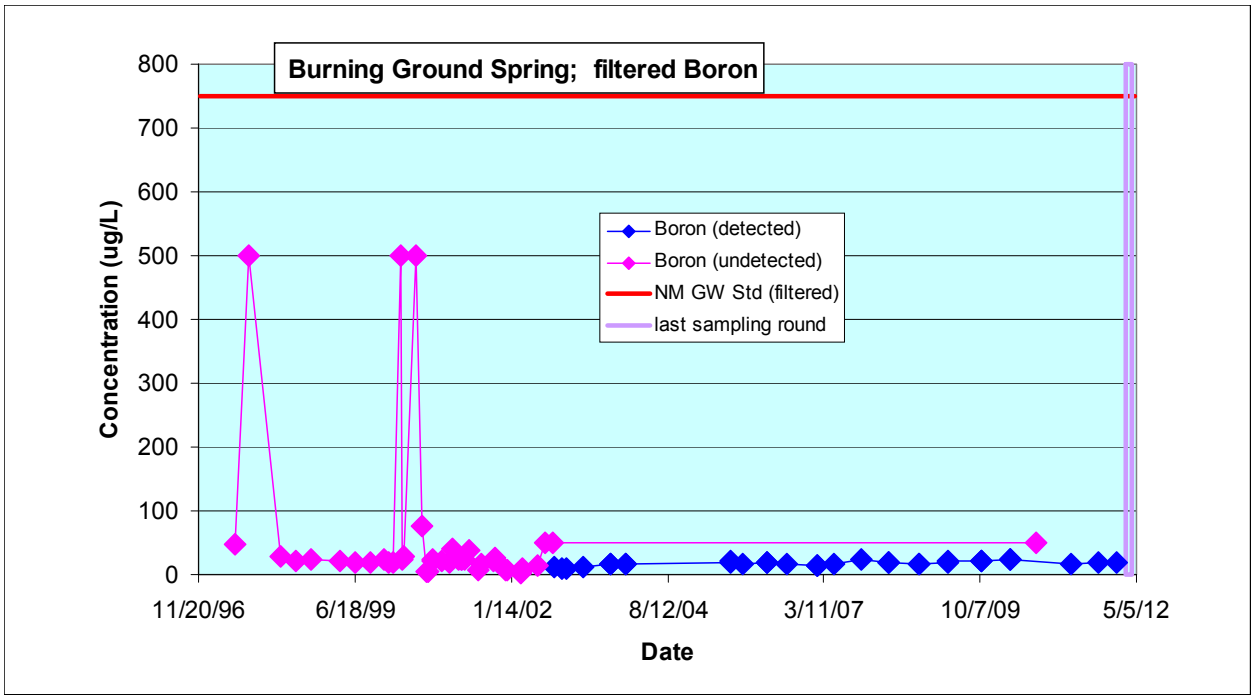
- Springs
- Alluvial wells

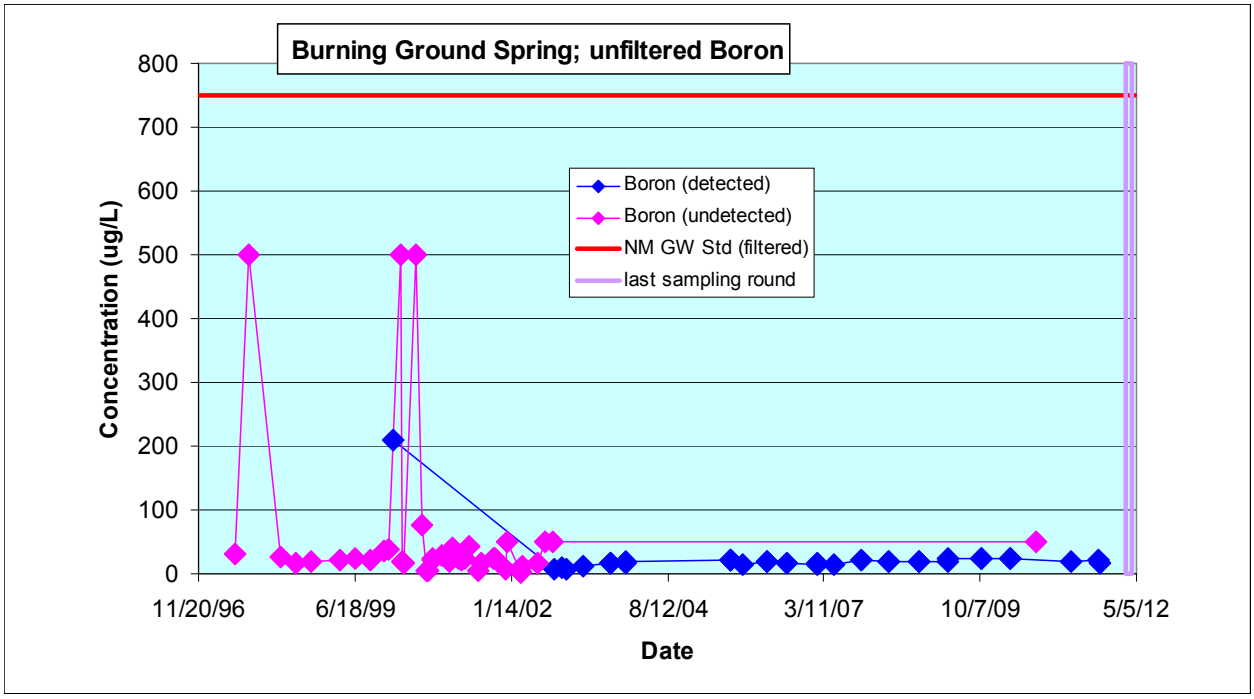
Stormwater data are included on CD as Attachment B-1.

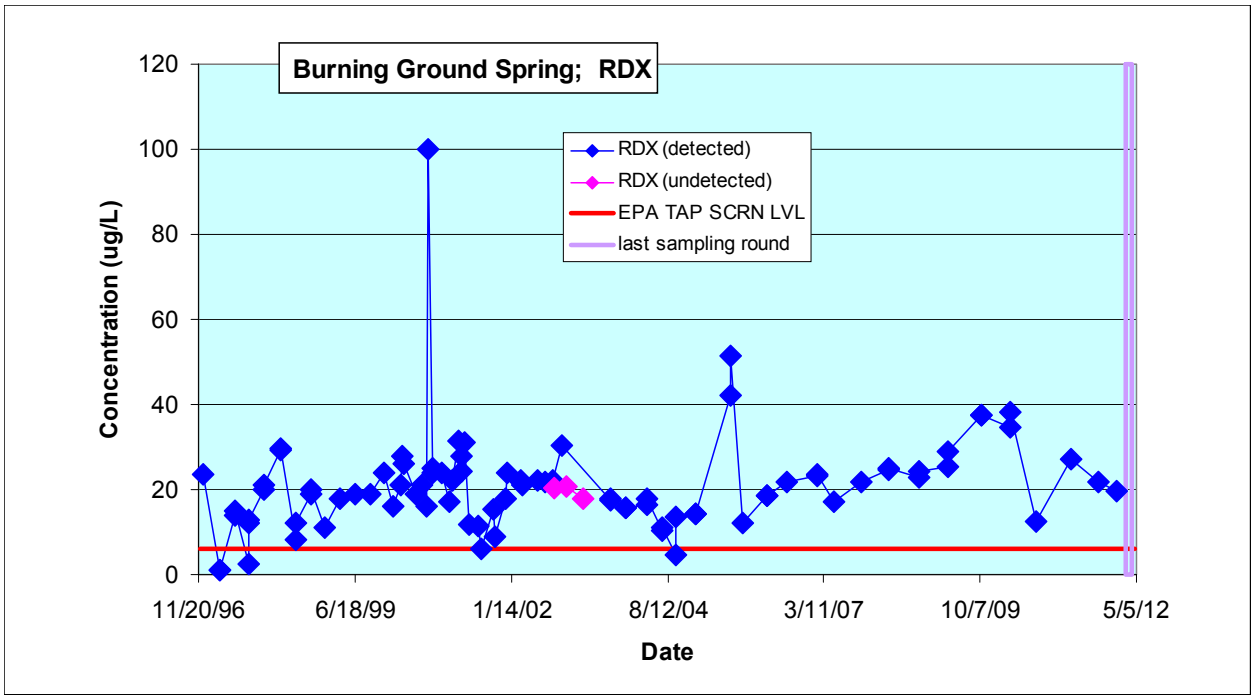
Post-fire water data in affected canyons are included on CD as Attachment B-2.

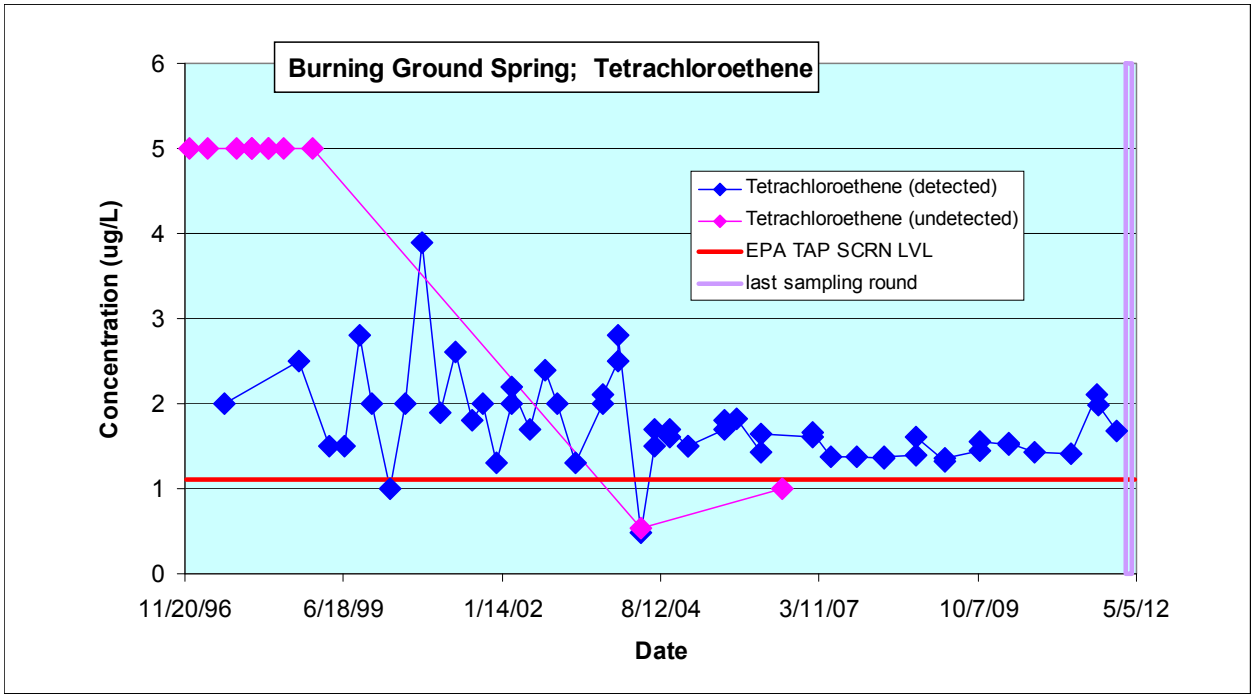

Burning Ground Spring; filtered Barium
Concentration (ug/L)
1200
1000
800
600
400
200
0
Barium (detected)
Barium (undetected)
NM GW Std (filtered)
last sampling round
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

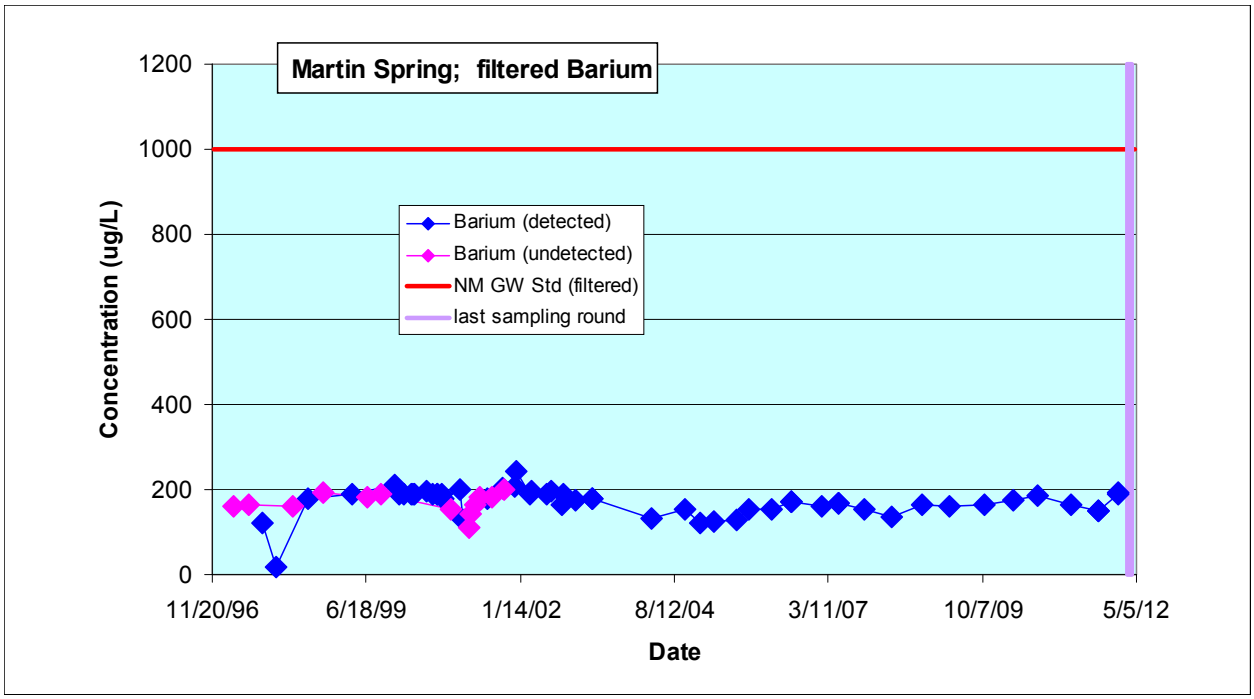

Burning Ground Spring; unfiltered Barium
Concentration (ug/L)
1200
1000
800
600
400
200
0
Barium (detected)
Barium (undetected)
NM GW Std (filtered)
last sampling round
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

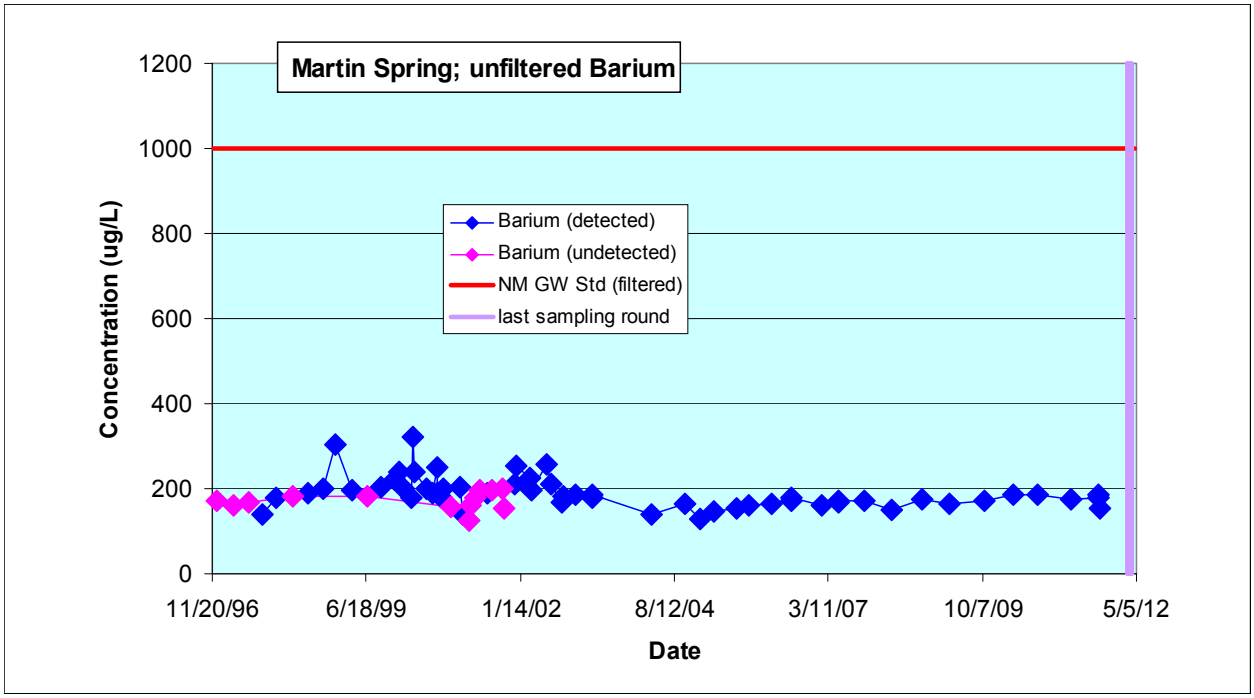

Burning Ground Spring; filtered Boron
Concentration (ug/L)
800
700
600
500
400
300
200
100
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date
Boron (detected)
Boron (undetected)
NM GW Std (filtered)
last sampling round

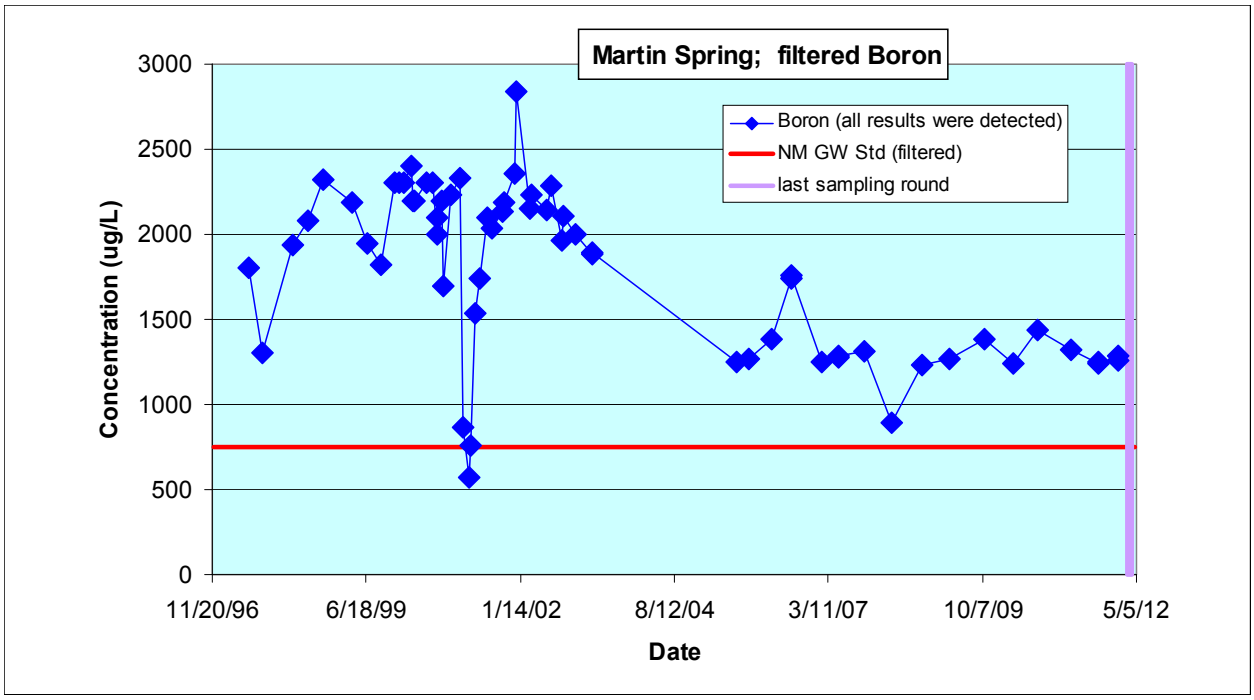

Burning Ground Spring; unfiltered Boron
Concentration (ug/L)
800
700
600
500
400
300
200
100
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date
Boron (detected)
Boron (undetected)
NM GW Std (filtered)
last sampling round

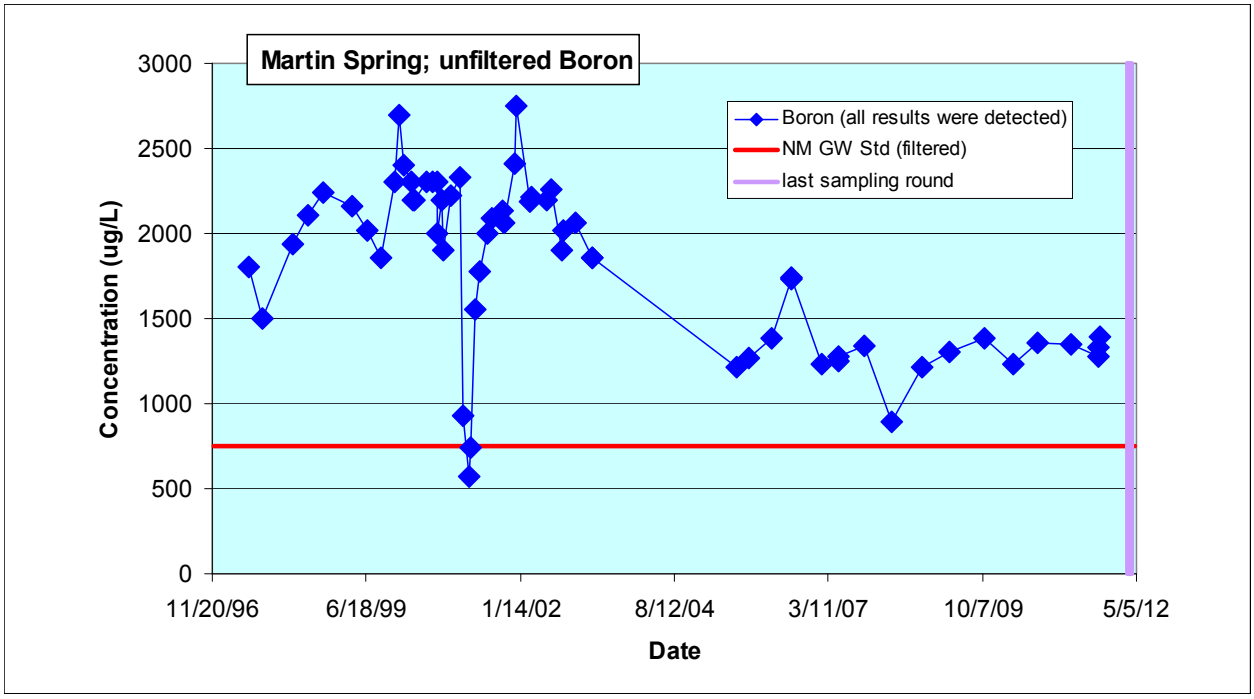

Burning Ground Spring; RDX
RDX (detected)
RDX (undetected)
EPA TAP SCRN LVL
last sampling round
Concentration (ug/L)
120
100
80
60
40
20
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

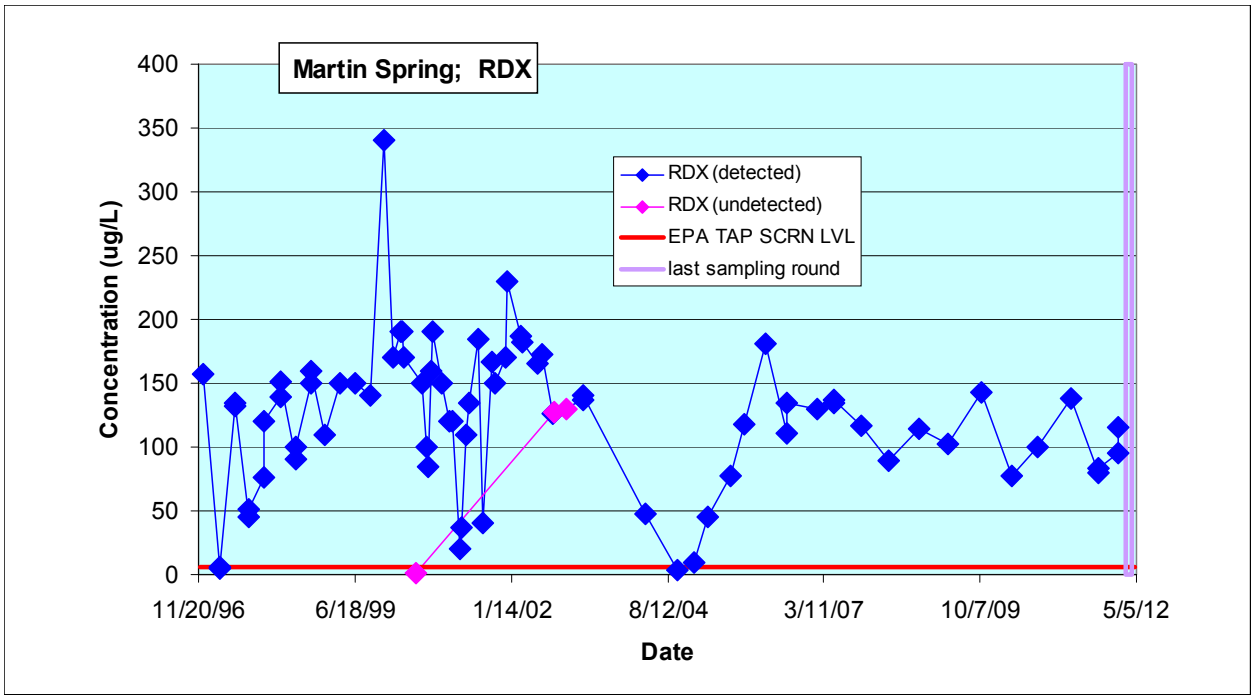

Burning Ground Spring; Tetrachloroethene
Tetrachloroethene (detected)
Tetrachloroethene (undetected)
EPA TAP SCRN LVL
last sampling round
Concentration (ug/L)
6
5
4
3
2
1
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

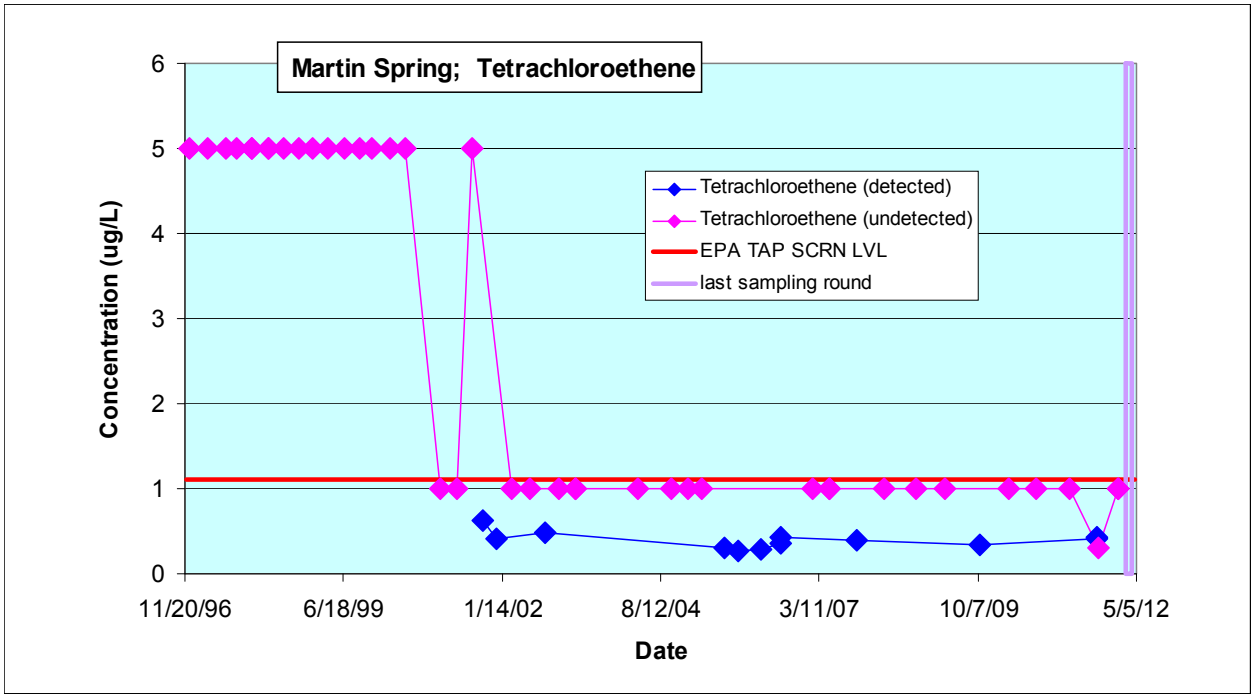

Martin Spring; filtered Barium
Concentration (ug/L)
1200
1000
800
600
400
200
0
Barium (detected)
Barium (undetected)
NM GW Std (filtered)
last sampling round
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

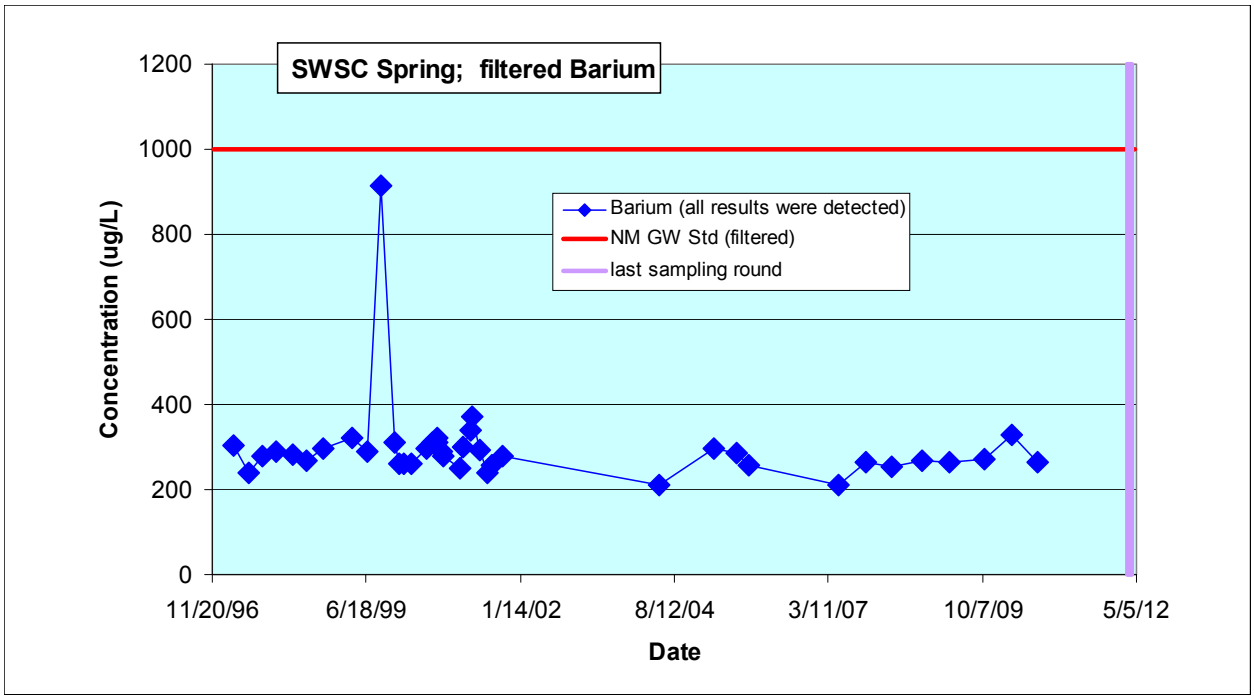

Martin Spring; unfiltered Barium
Concentration (ug/L)
1200
1000
800
600
400
200
0
Barium (detected)
Barium (undetected)
NM GW Std (filtered)
last sampling round
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

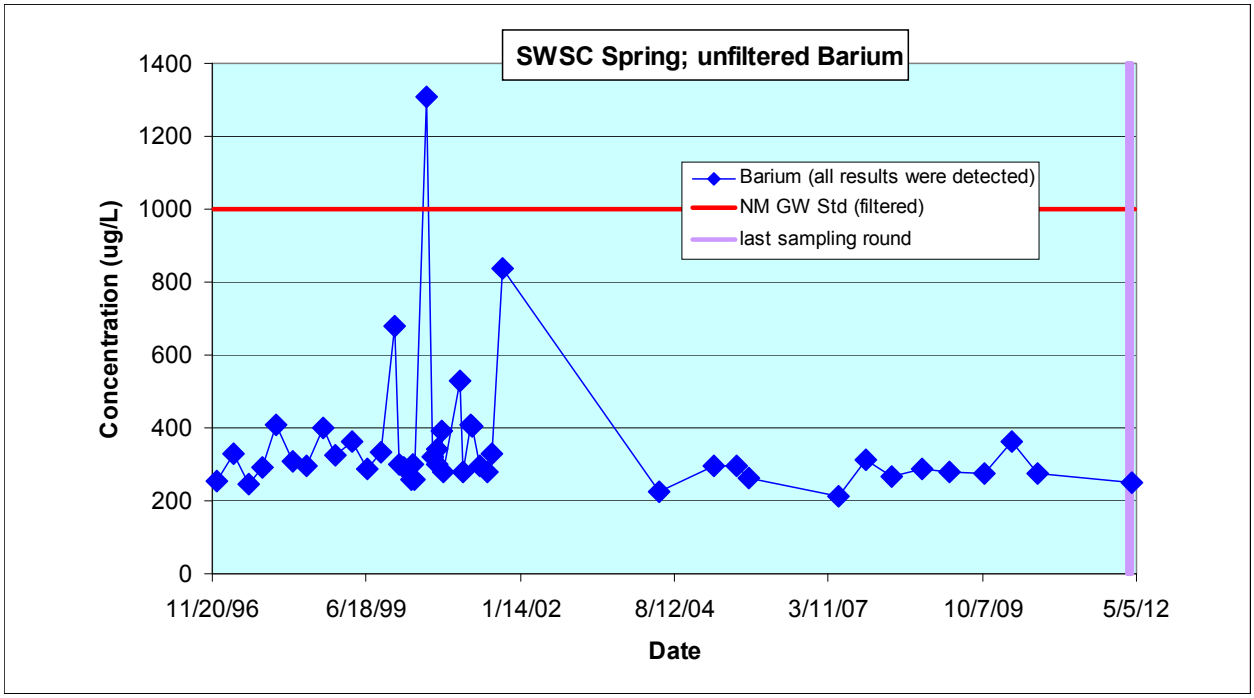

Martin Spring; filtered Boron
Boron (all results were detected)
NM GW Std (filtered)
last sampling round
Concentration (ug/L)
3000
2500
2000
1500
1000
500
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

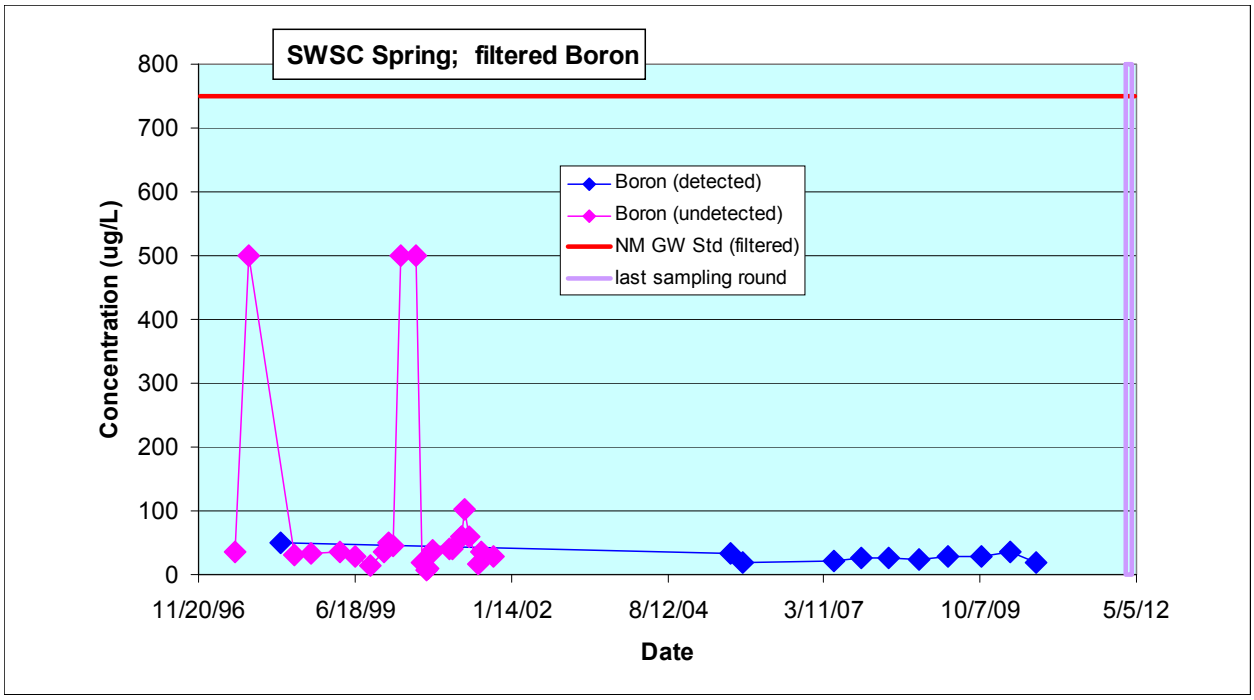

Martin Spring; unfiltered Boron
Boron (all results were detected)
NM GW Std (filtered)
last sampling round
Concentration (ug/L)
3000
2500
2000
1500
1000
500
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

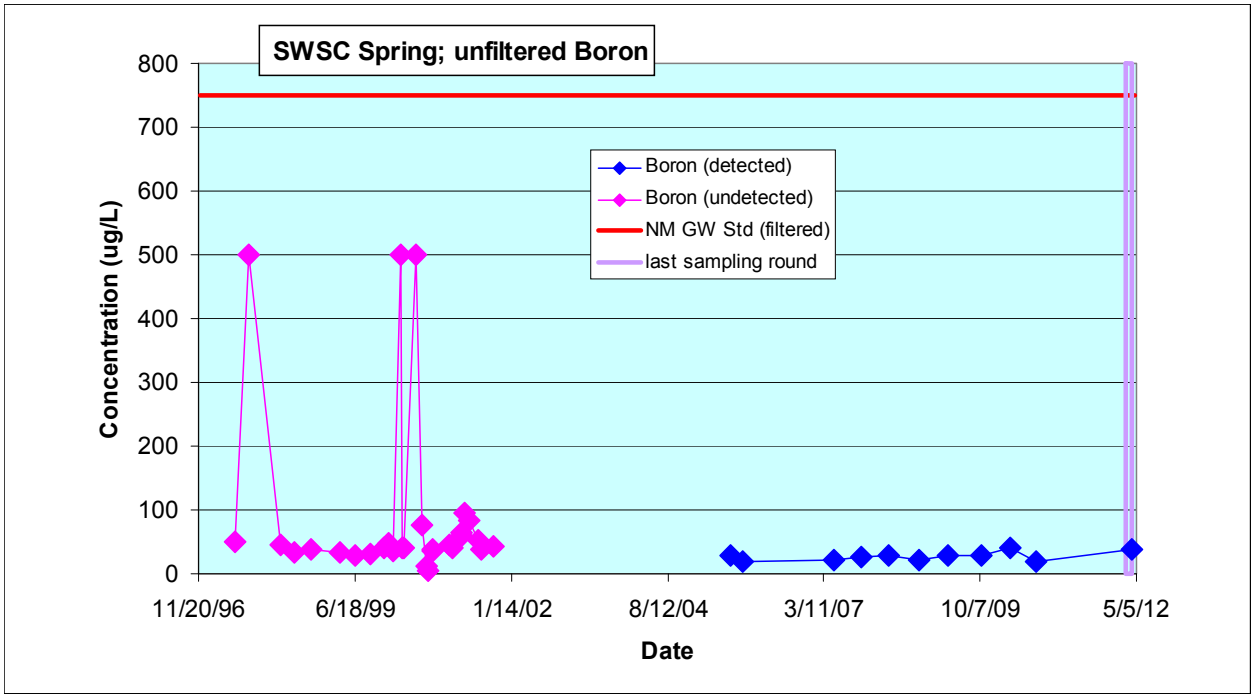

Martin Spring; RDX
Concentration (ug/L)
400
350
300
250
200
150
100
50
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date
RDX (detected)
RDX (undetected)
EPA TAP SCRN LVL
last sampling round

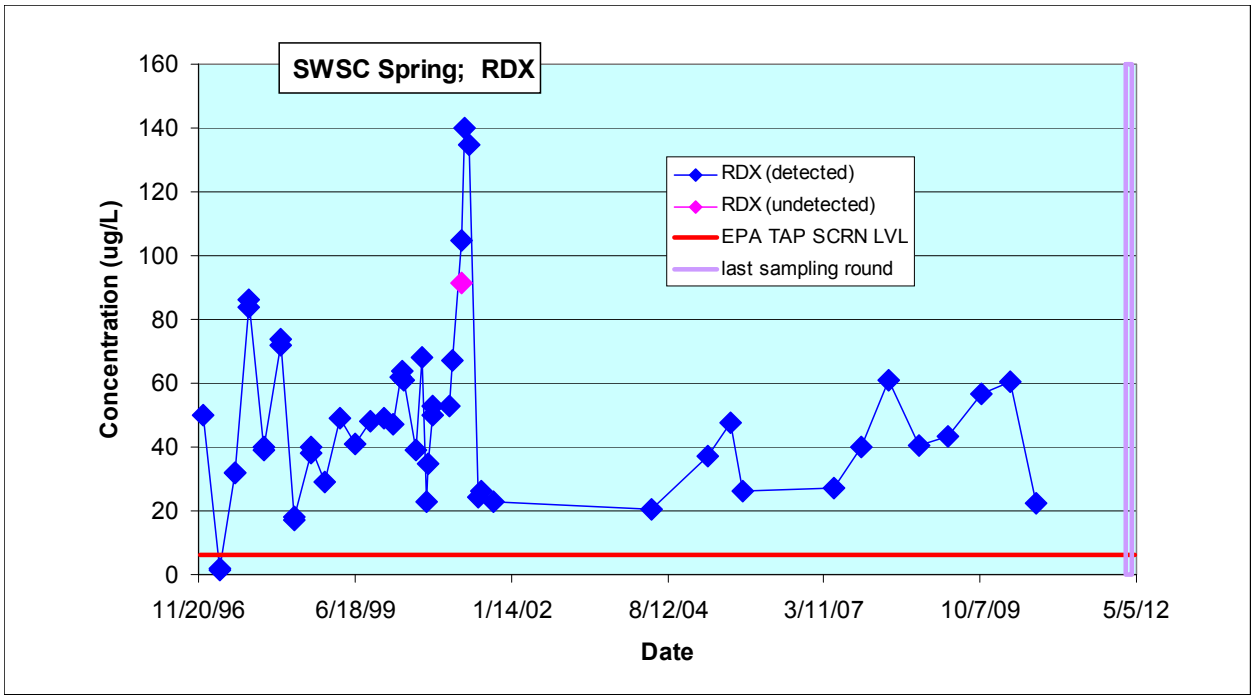

Martin Spring; Tetrachloroethene
Concentration (ug/L)
6
5
4
3
2
1
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date
Tetrachloroethene (detected)
Tetrachloroethene (undetected)
EPA TAP SCRN LVL
last sampling round

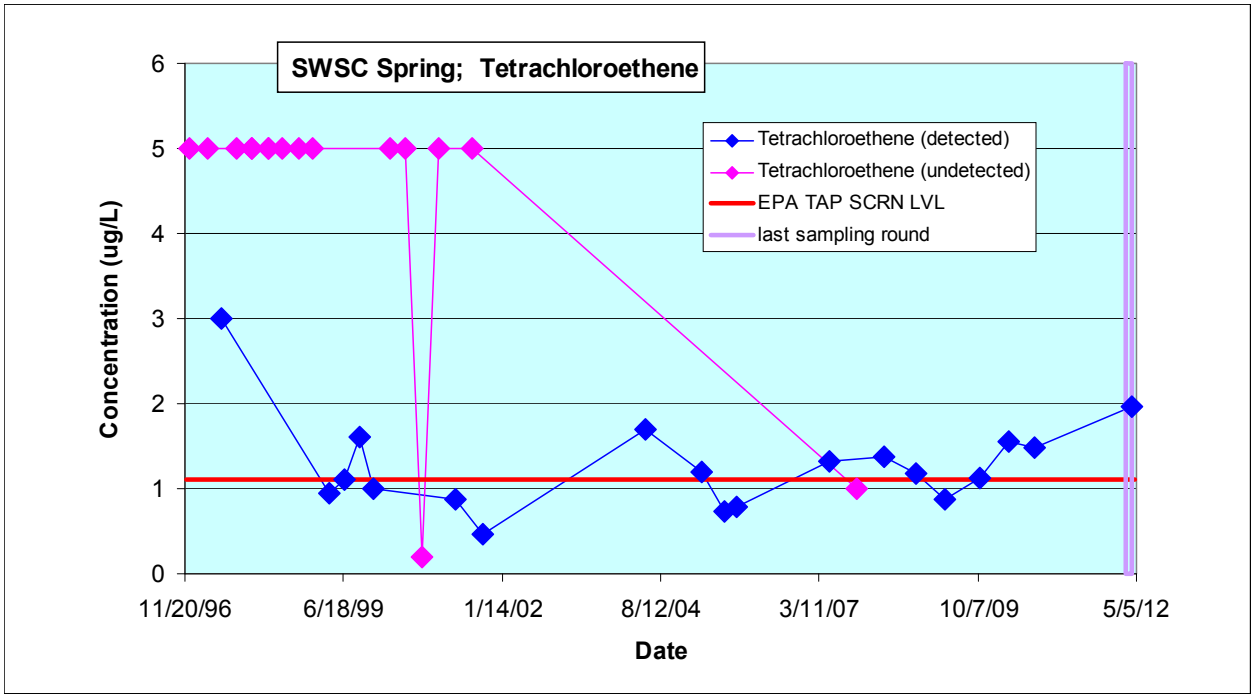

SWSC Spring; filtered Barium
Concentration (ug/L)
1200
1000
800
600
400
200
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date
Barium (all results were detected)
NM GW Std (filtered)
last sampling round

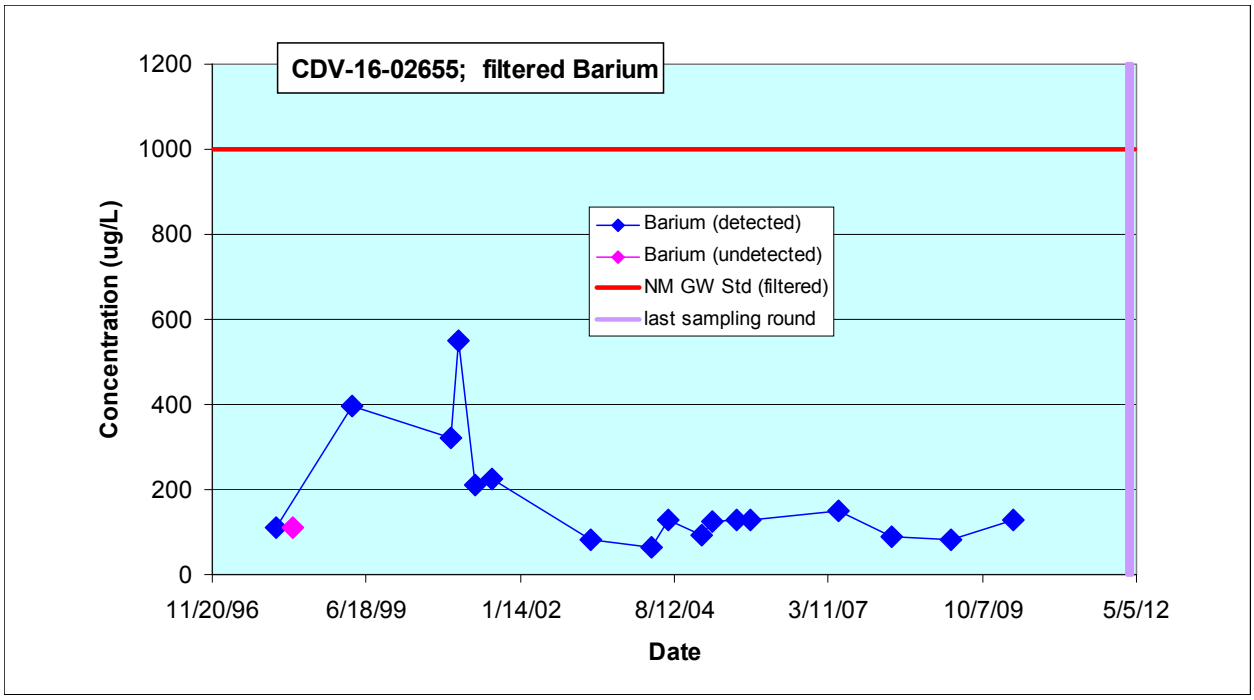

SWSC Spring; unfiltered Barium
Concentration (ug/L)
1400
1200
1000
800
600
400
200
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date
Barium (all results were detected)
NM GW Std (filtered)
last sampling round

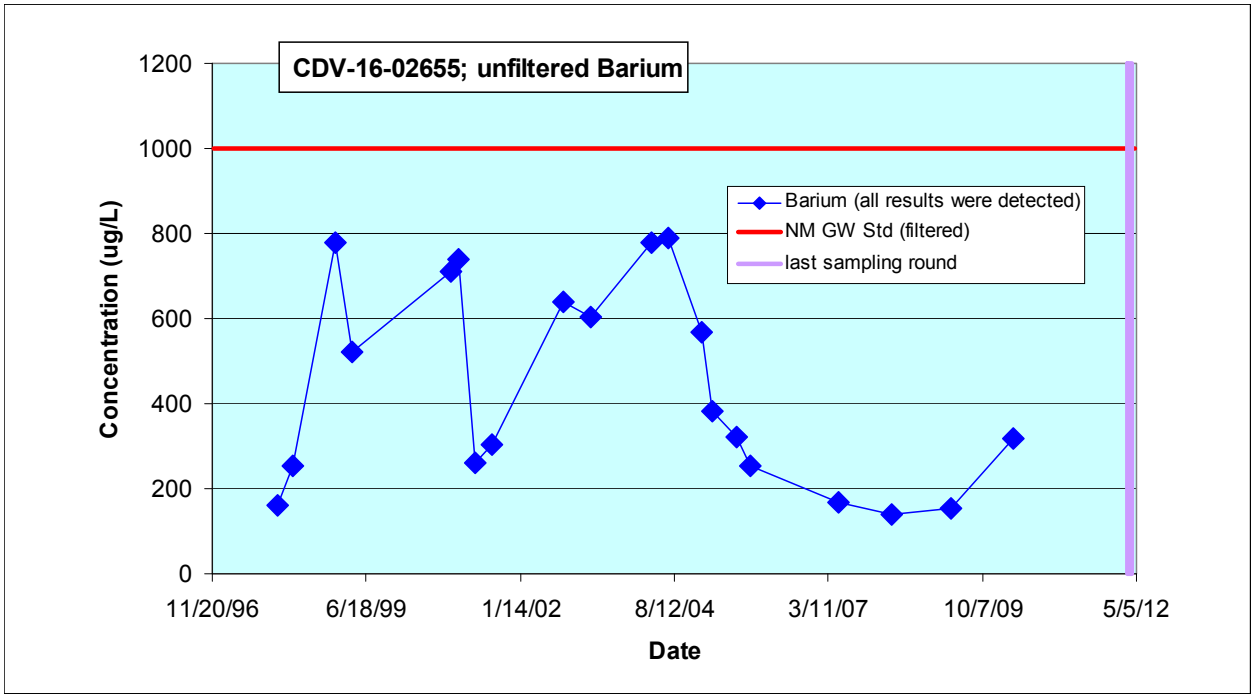

SWSC Spring; filtered Boron
Concentration (ug/L)
800
700
600
500
400
300
200
100
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date
Boron (detected)
Boron (undetected)
NM GW Std (filtered)
last sampling round

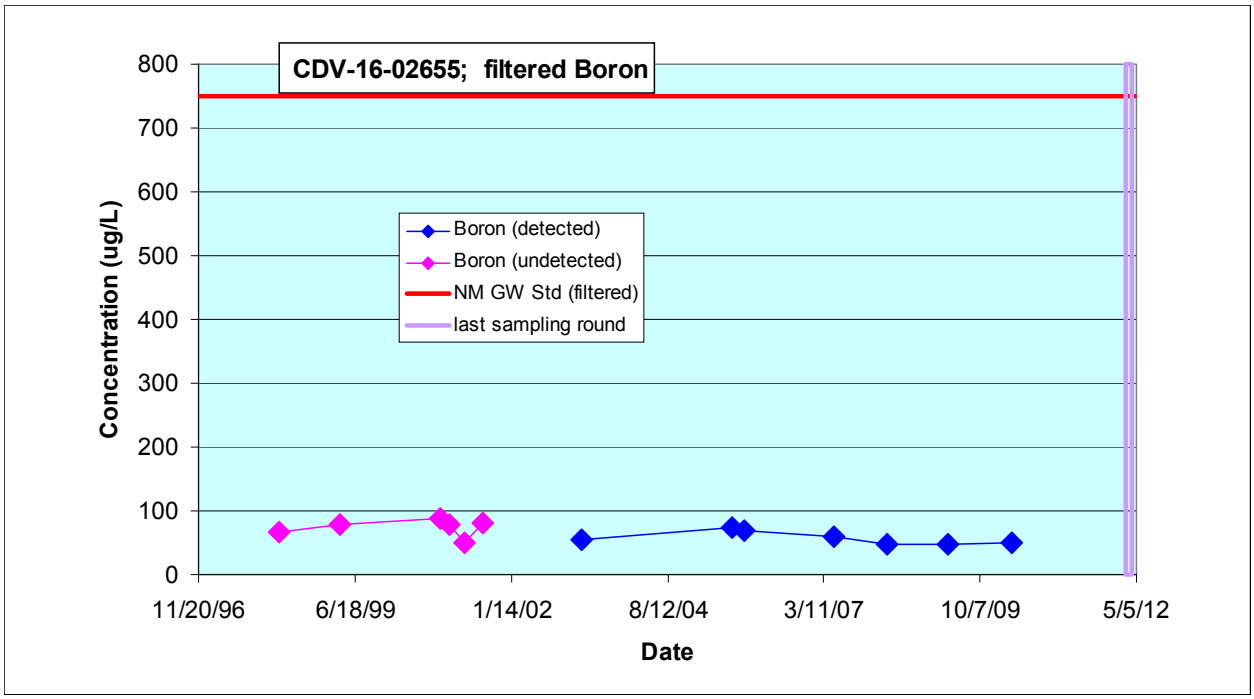

SWSC Spring; unfiltered Boron
Concentration (ug/L)
800
700
600
500
400
300
200
100
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date
Boron (detected)
Boron (undetected)
NM GW Std (filtered)
last sampling round

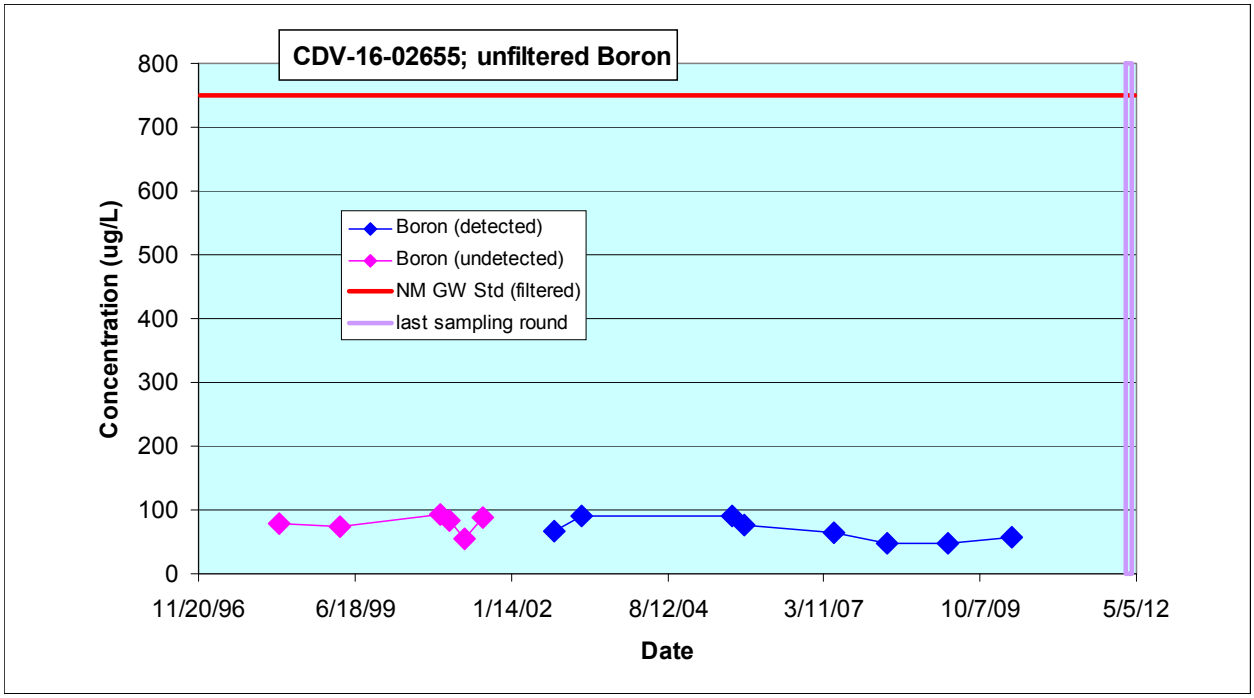

SWSC Spring; RDX
RDX (detected)
RDX (undetected)
EPA TAP SCRN LVL
last sampling round
Concentration (ug/L)
160
140
120
100
80
60
40
20
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

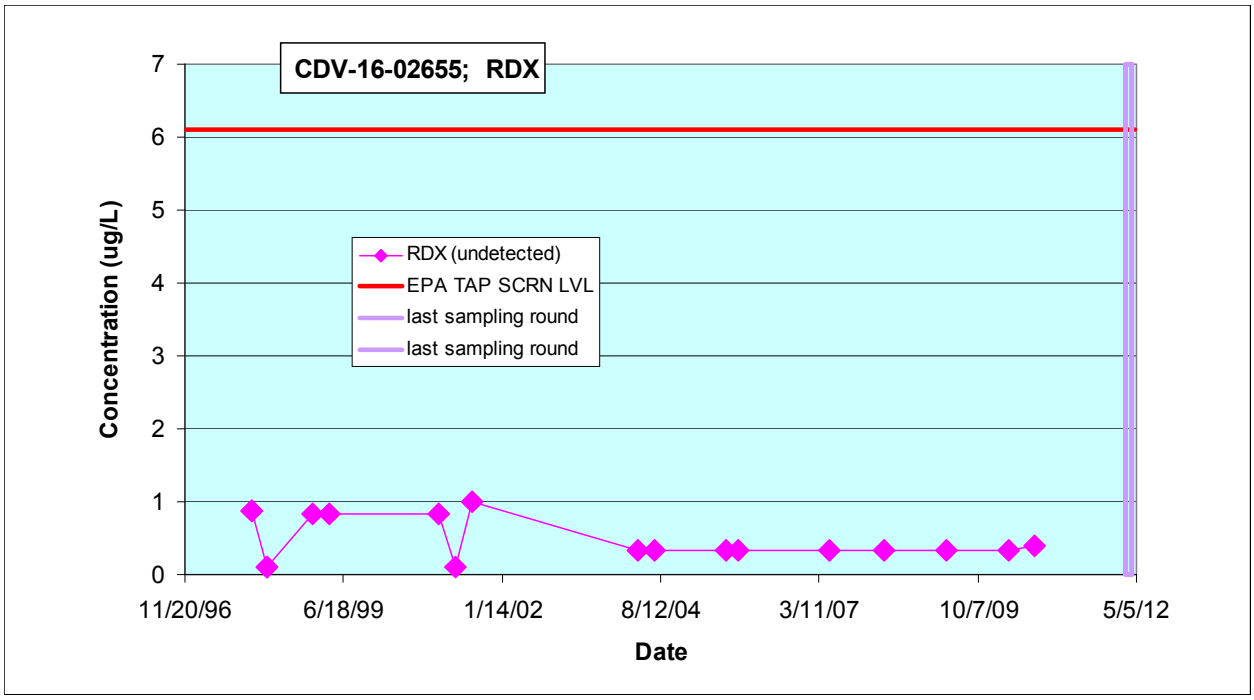

SWSC Spring; Tetrachloroethene
Tetrachloroethene (detected)
Tetrachloroethene (undetected)
EPA TAP SCRN LVL
last sampling round
Concentration (ug/L)
6
5
4
3
2
1
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

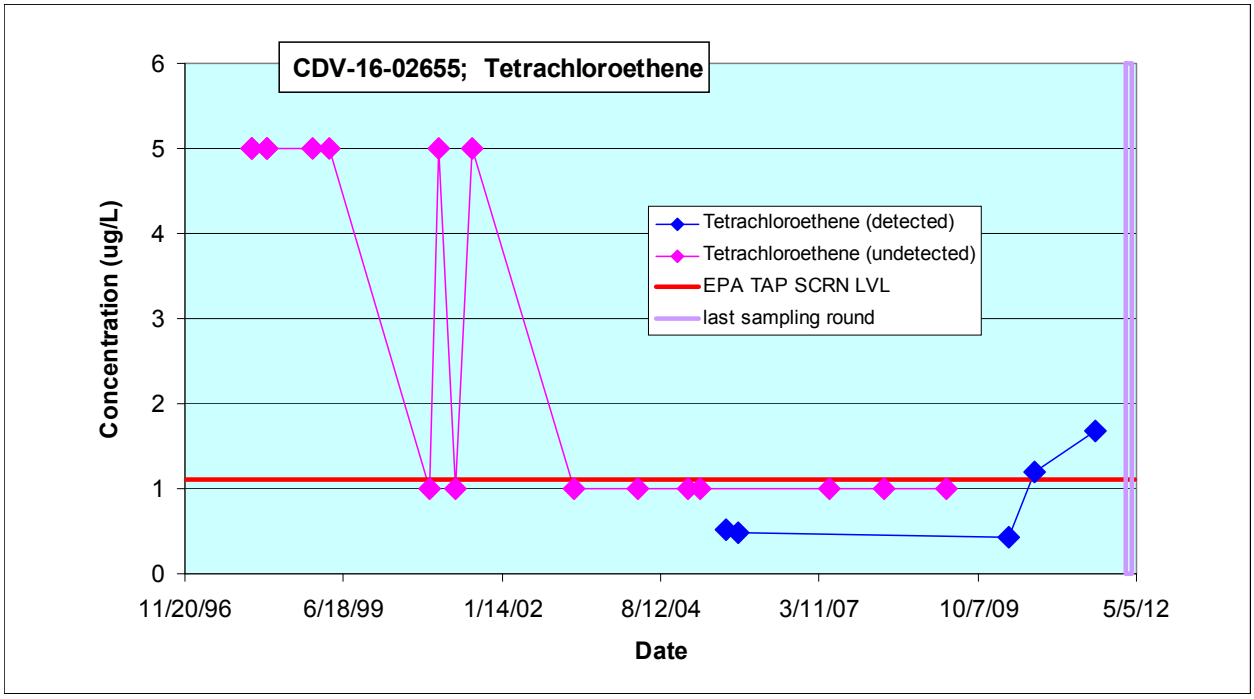

CDV-16-02655; filtered Barium
Concentration (ug/L)
1200
1000
800
600
400
200
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date
Barium (detected)
Barium (undetected)
NM GW Std (filtered)
last sampling round

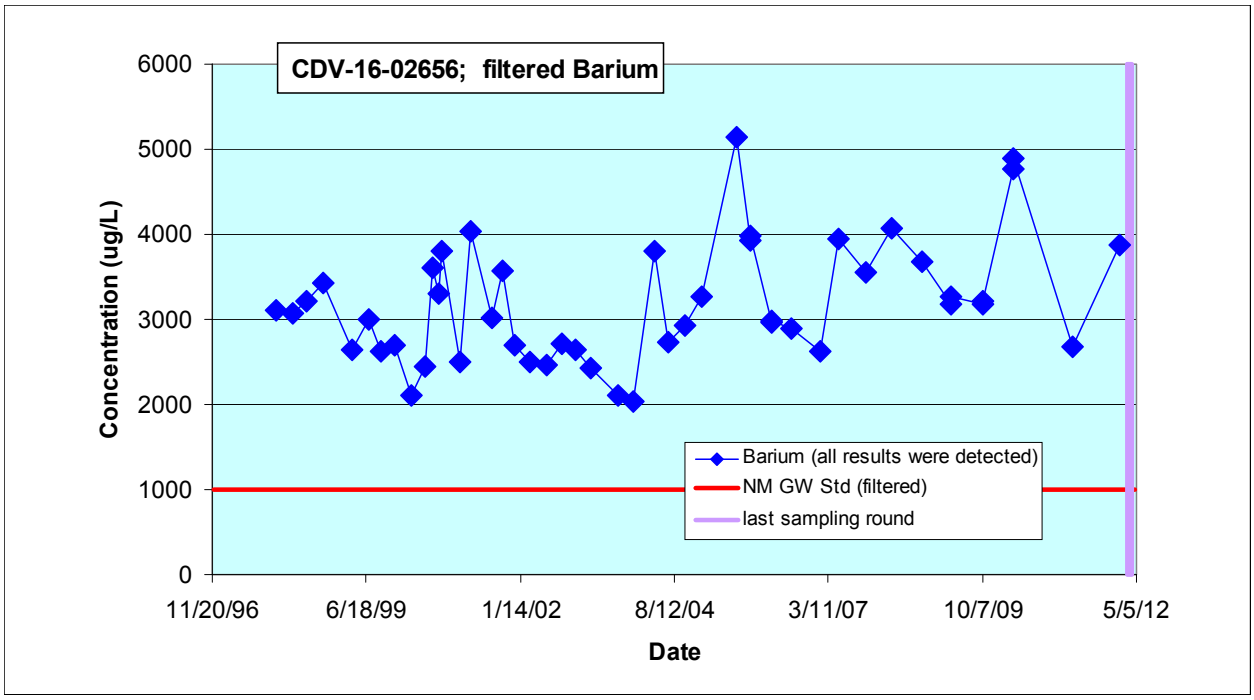

CDV-16-02655; unfiltered Barium
Concentration (ug/L)
1200
1000
800
600
400
200
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date
Barium (all results were detected)
NM GW Std (filtered)
last sampling round

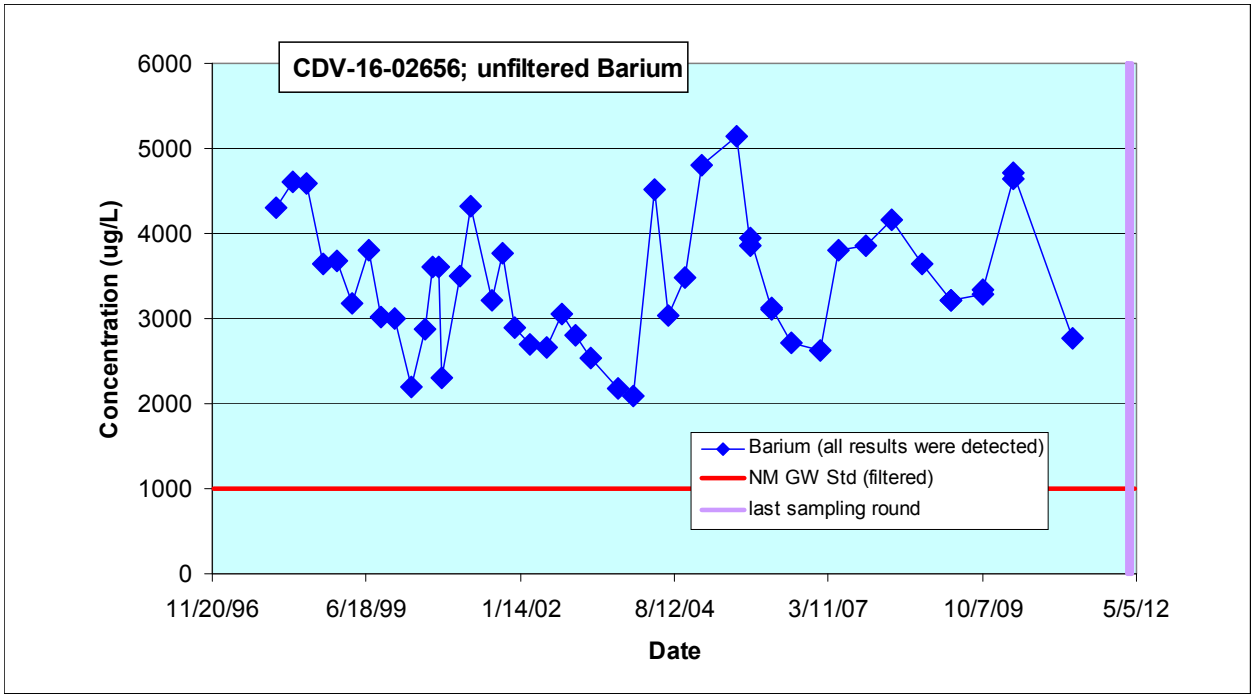

CDV-16-02655; filtered Boron
Concentration (ug/L)
800
700
600
500
400
300
200
100
0
Boron (detected)
Boron (undetected)
NM GW Std (filtered)
last sampling round
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

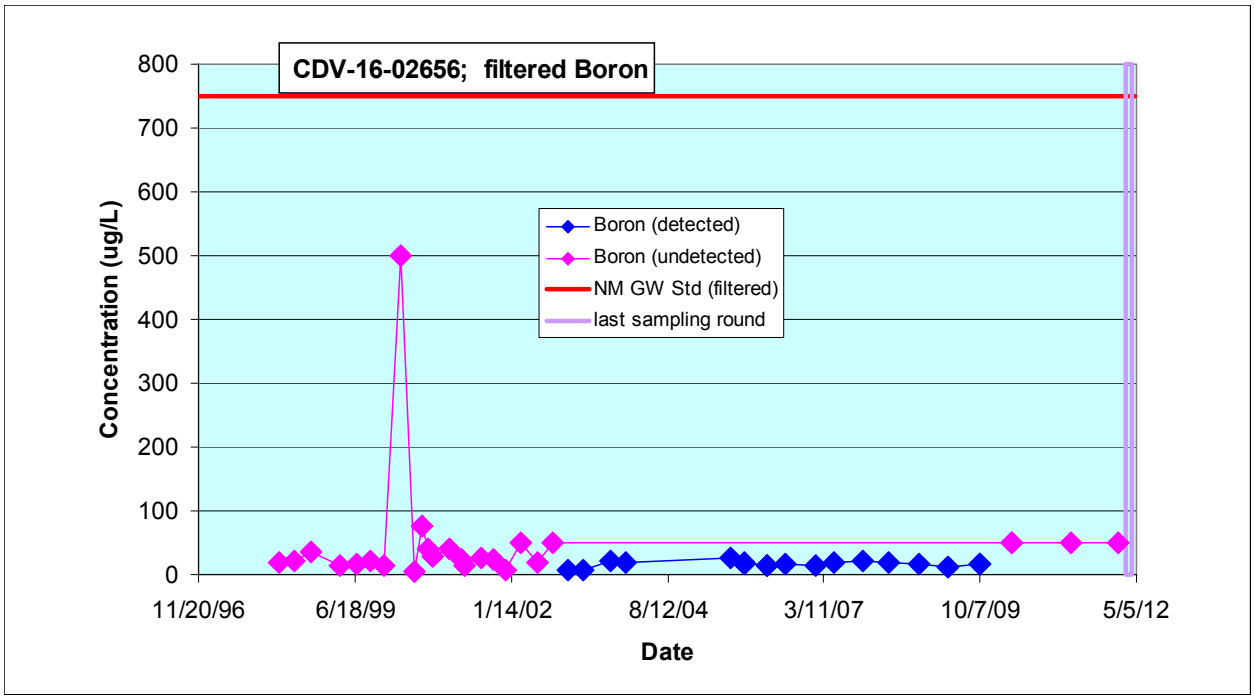

CDV-16-02655; unfiltered Boron
Concentration (ug/L)
800
700
600
500
400
300
200
100
0
Boron (detected)
Boron (undetected)
NM GW Std (filtered)
last sampling round
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

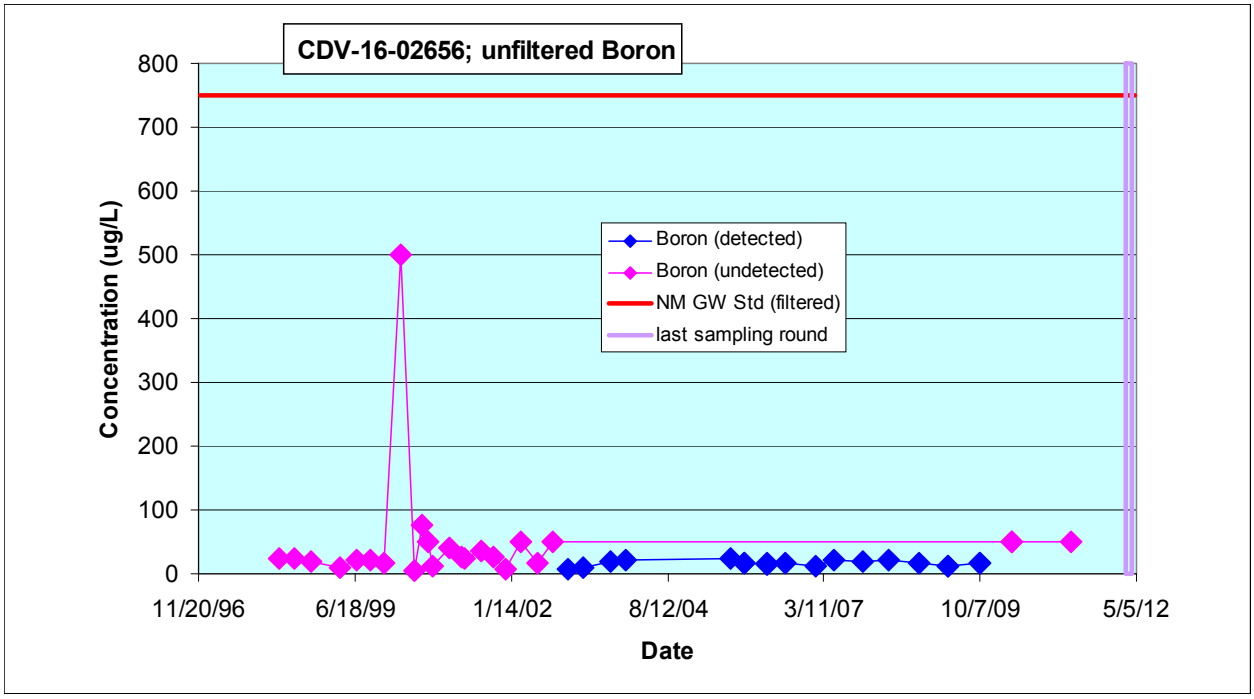

CDV-16-02655; RDX
Concentration (ug/L)
7
6
5
4
3
2
1
0
RDX (undetected)
EPA TAP SCRN LVL
last sampling round
last sampling round
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

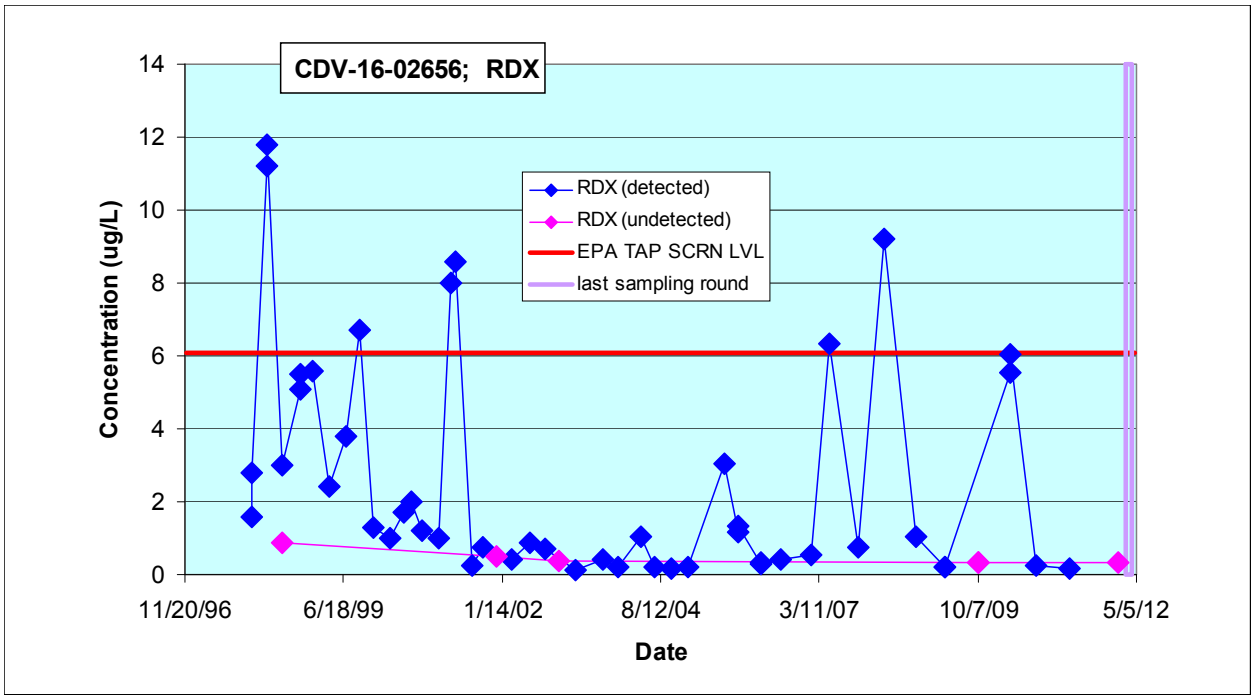

CDV-16-02655; Tetrachloroethene
Concentration (ug/L)
6
5
4
3
2
1
0
Tetrachloroethene (detected)
Tetrachloroethene (undetected)
EPA TAP SCRN LVL
last sampling round
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

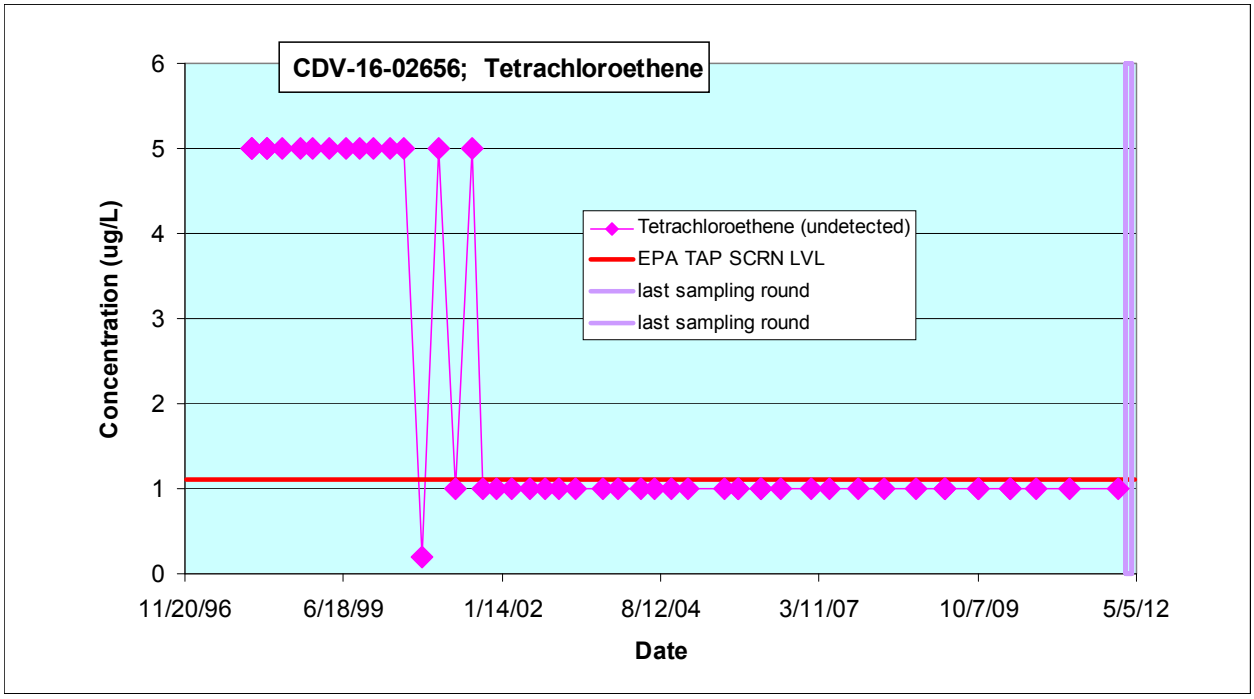

CDV-16-02656; filtered Barium
Concentration (ug/L)
6000
5000
4000
3000
2000
1000
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date
Barium (all results were detected)
NM GW Std (filtered)
last sampling round

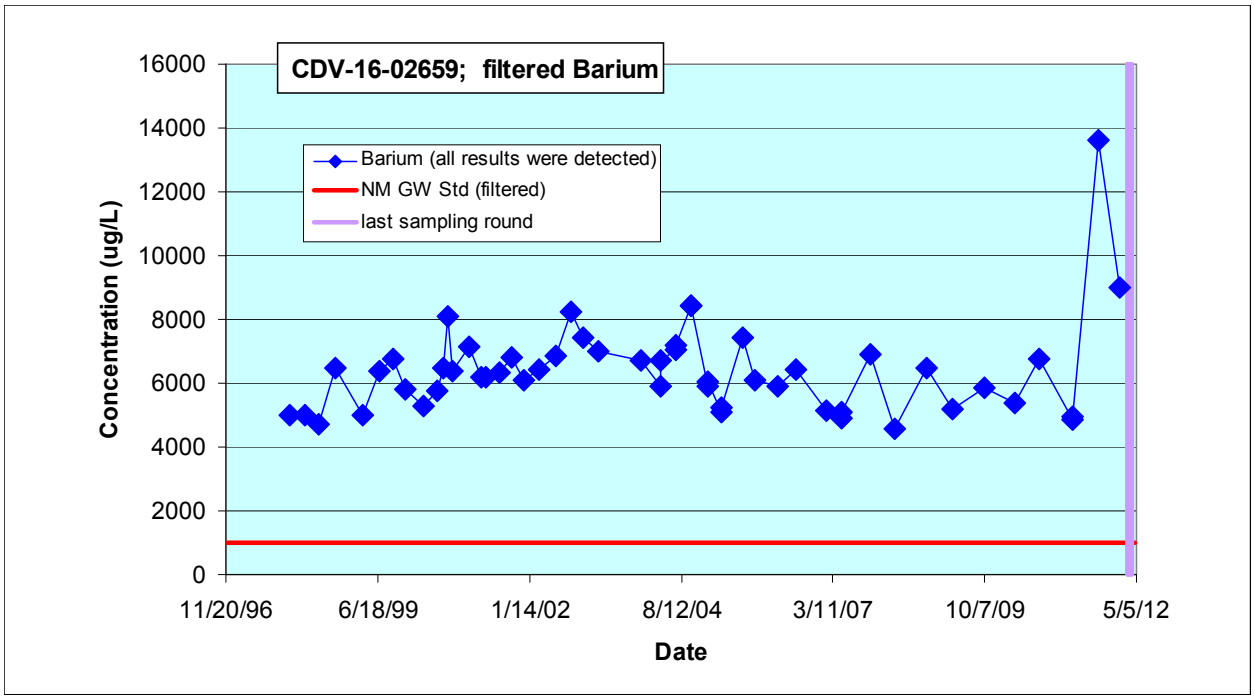

CDV-16-02656; unfiltered Barium
Concentration (ug/L)
6000
5000
4000
3000
2000
1000
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date
Barium (all results were detected)
NM GW Std (filtered)
last sampling round

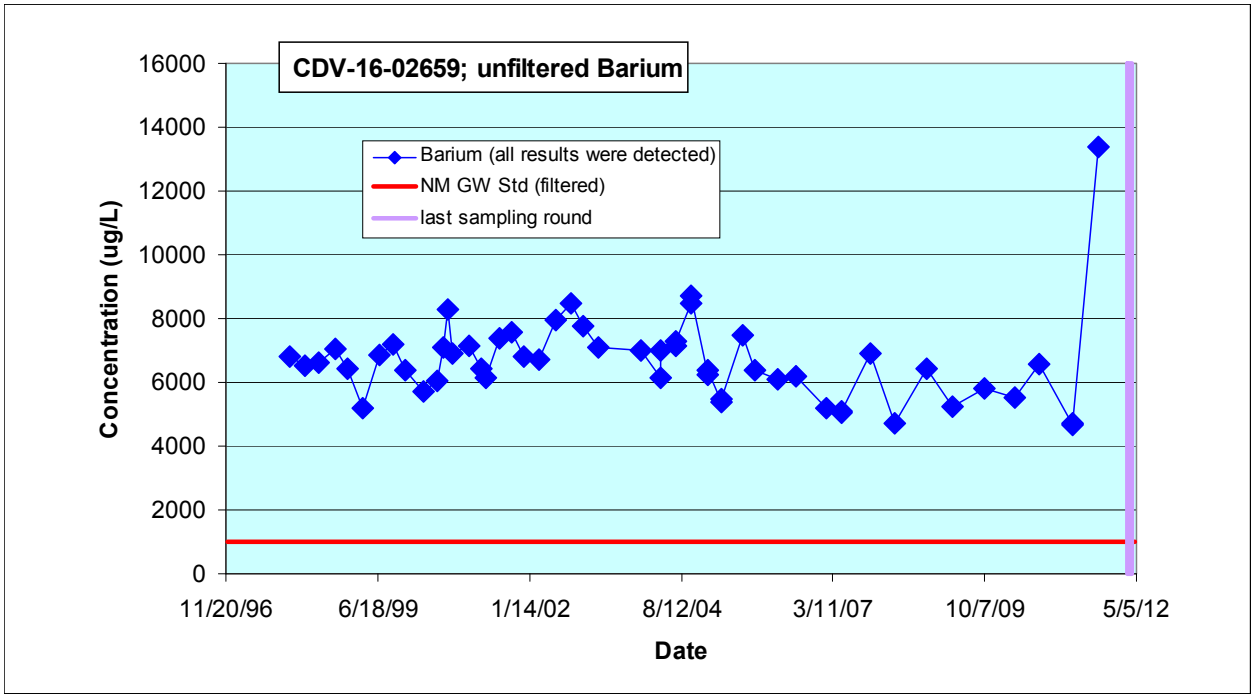

CDV-16-02656; filtered Boron
Concentration (ug/L)
800
700
600
500
400
300
200
100
0
Boron (detected)
Boron (undetected)
NM GW Std (filtered)
last sampling round
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

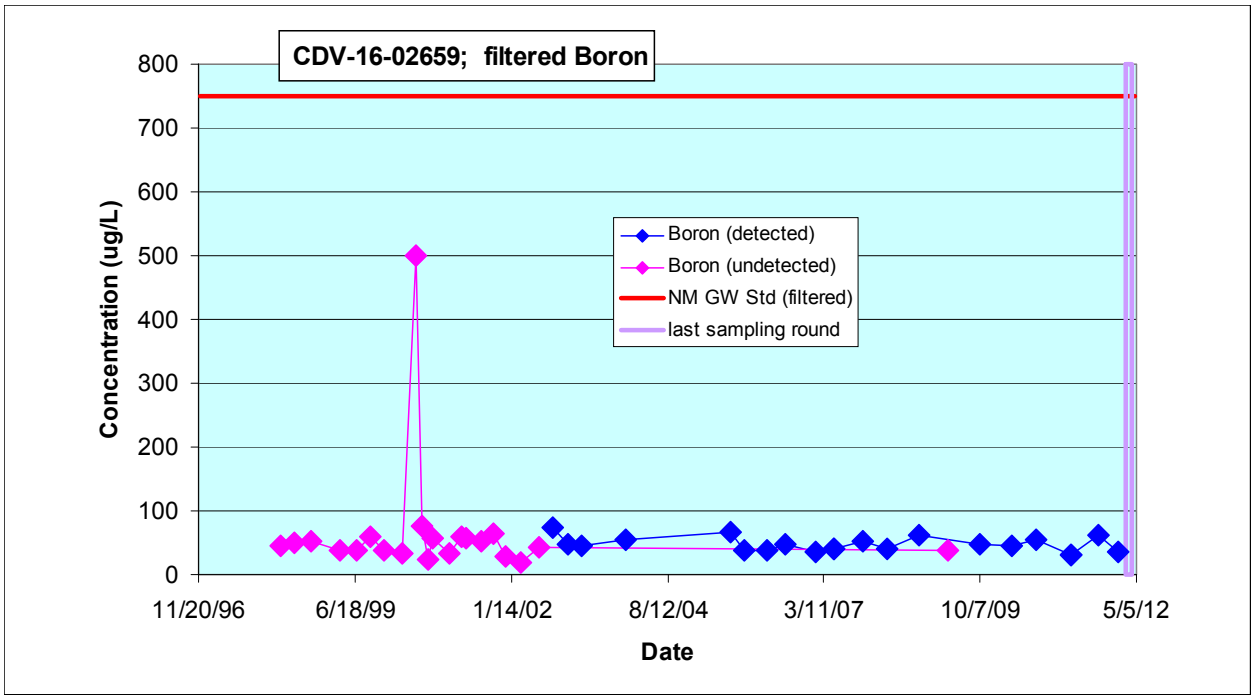

CDV-16-02656; unfiltered Boron
Concentration (ug/L)
800
700
600
500
400
300
200
100
0
Boron (detected)
Boron (undetected)
NM GW Std (filtered)
last sampling round
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

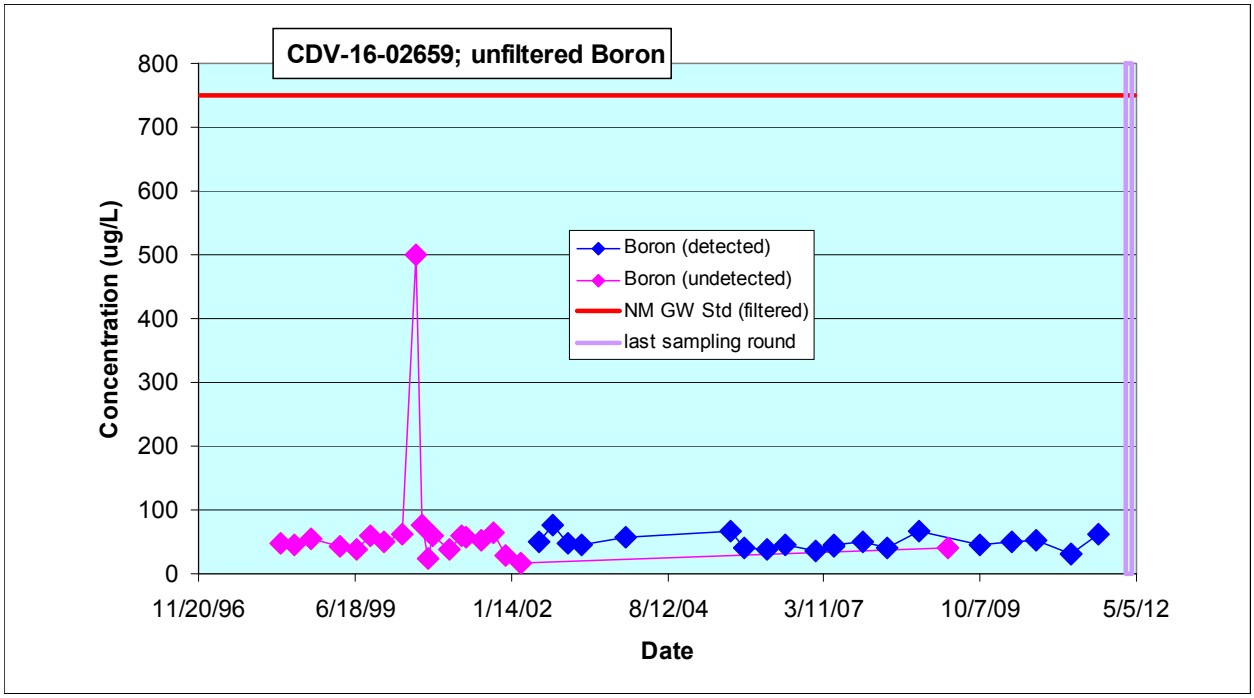

CDV-16-02656; RDX
RDX (detected)
RDX (undetected)
EPA TAP SCRN LVL
last sampling round
Concentration (ug/L)
0
2
4
6
8
10
12
14
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

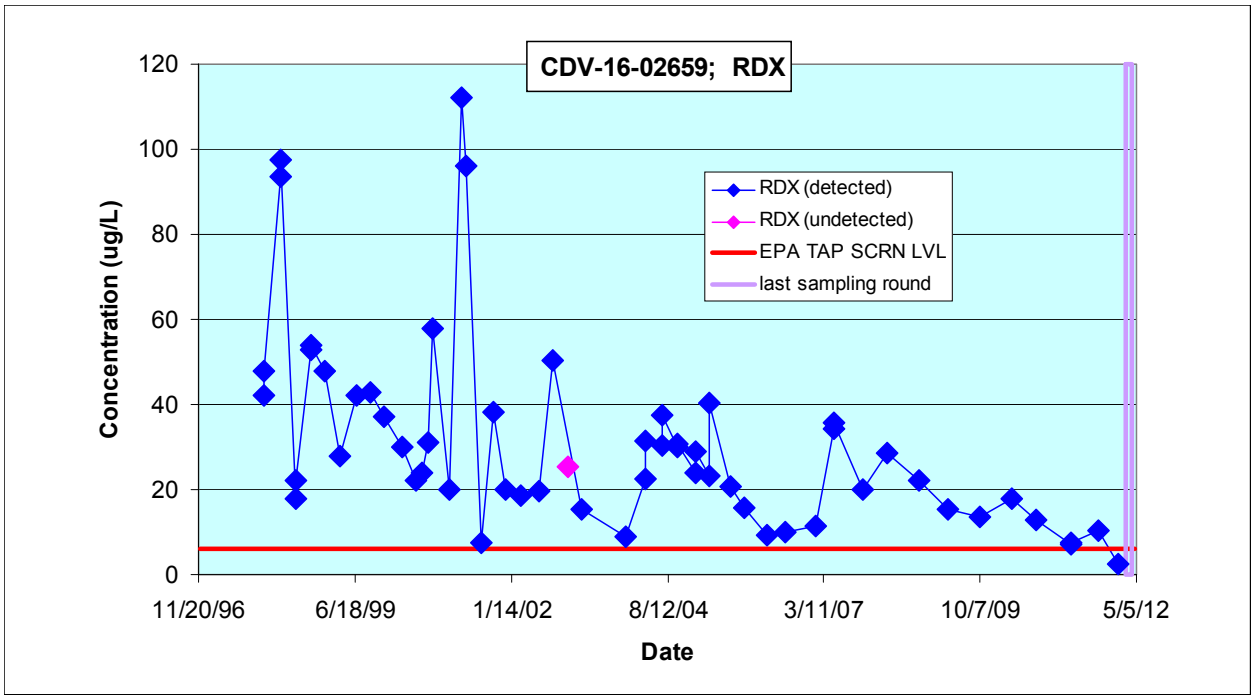

CDV-16-02656; Tetrachloroethene
Tetrachloroethene (undetected)
EPA TAP SCRN LVL
last sampling round
last sampling round
Concentration (ug/L)
0
1
2
3
4
5
6
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

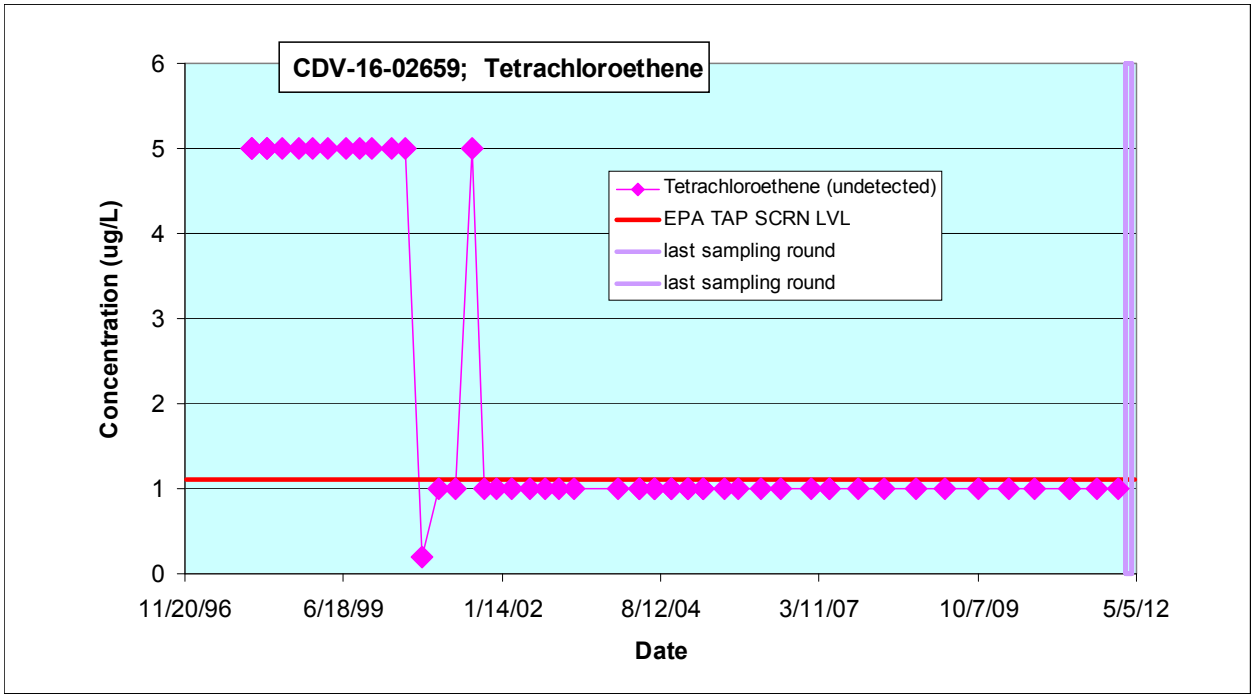

CDV-16-02659; filtered Barium
Barium (all results were detected)
NM GW Std (filtered)
last sampling round
Concentration (ug/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

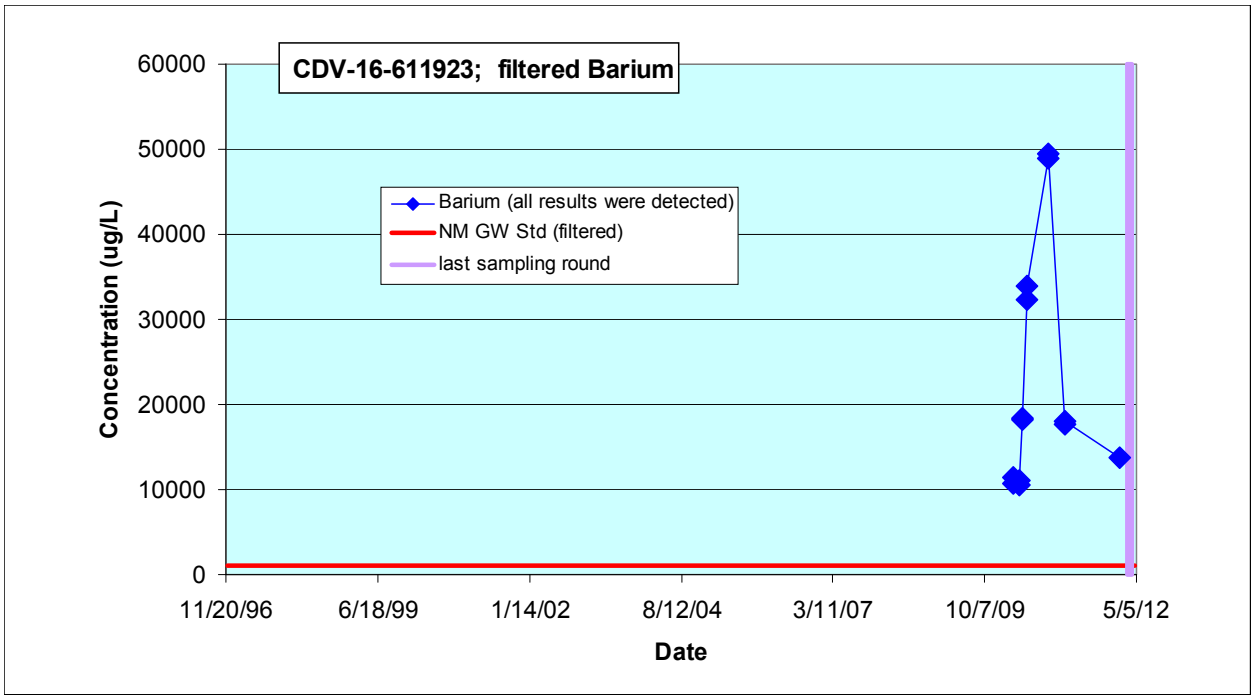

CDV-16-02659; unfiltered Barium
Barium (all results were detected)
NM GW Std (filtered)
last sampling round
Concentration (ug/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

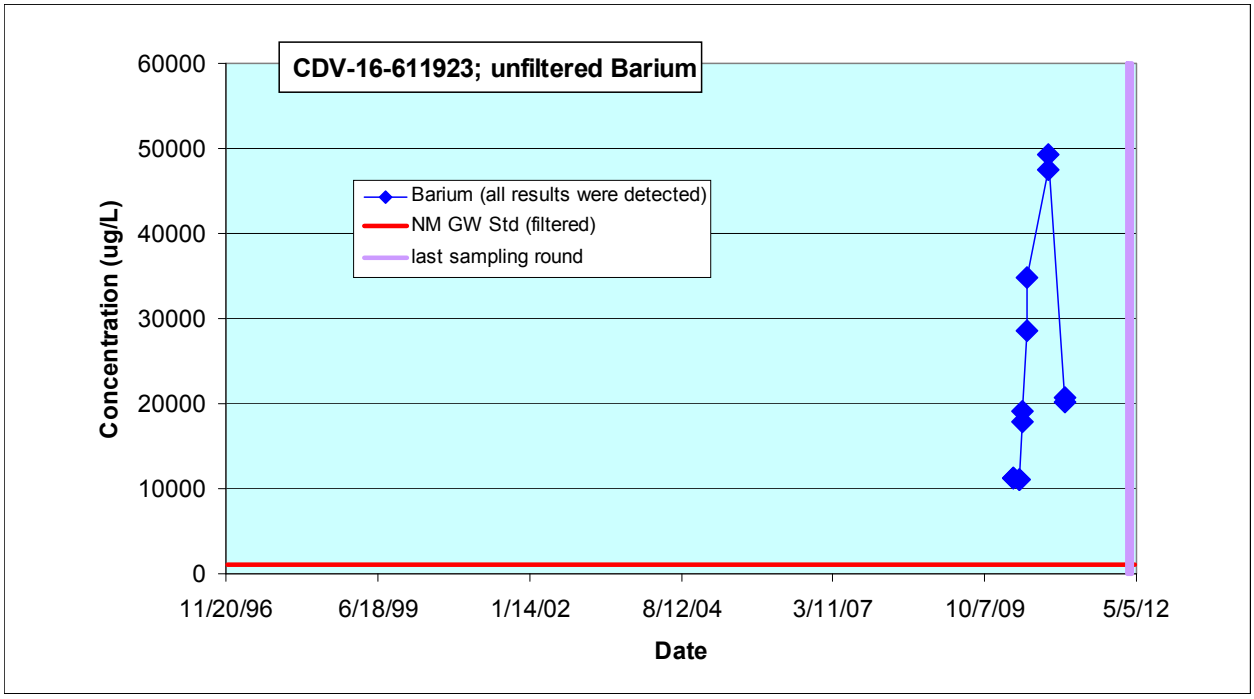

CDV-16-02659; filtered Boron
Concentration (ug/L)
800
700
600
500
400
300
200
100
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date
Boron (detected)
Boron (undetected)
NM GW Std (filtered)
last sampling round

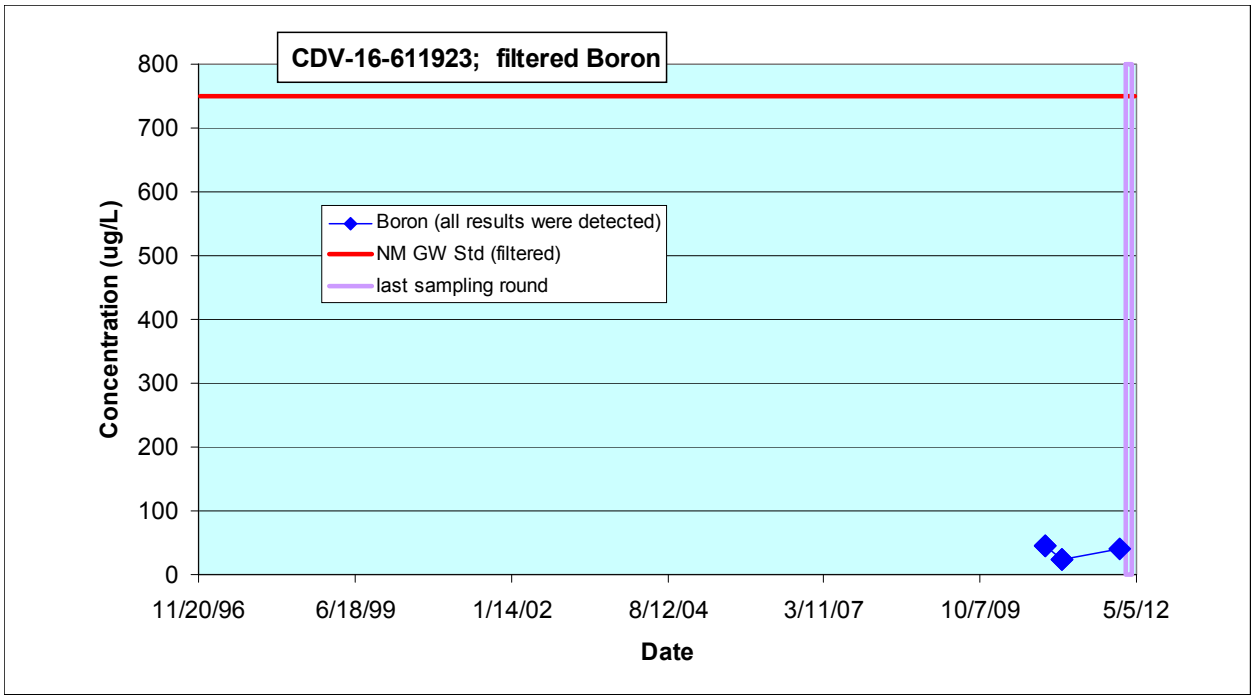

CDV-16-02659; unfiltered Boron
Concentration (ug/L)
800
700
600
500
400
300
200
100
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date
Boron (detected)
Boron (undetected)
NM GW Std (filtered)
last sampling round

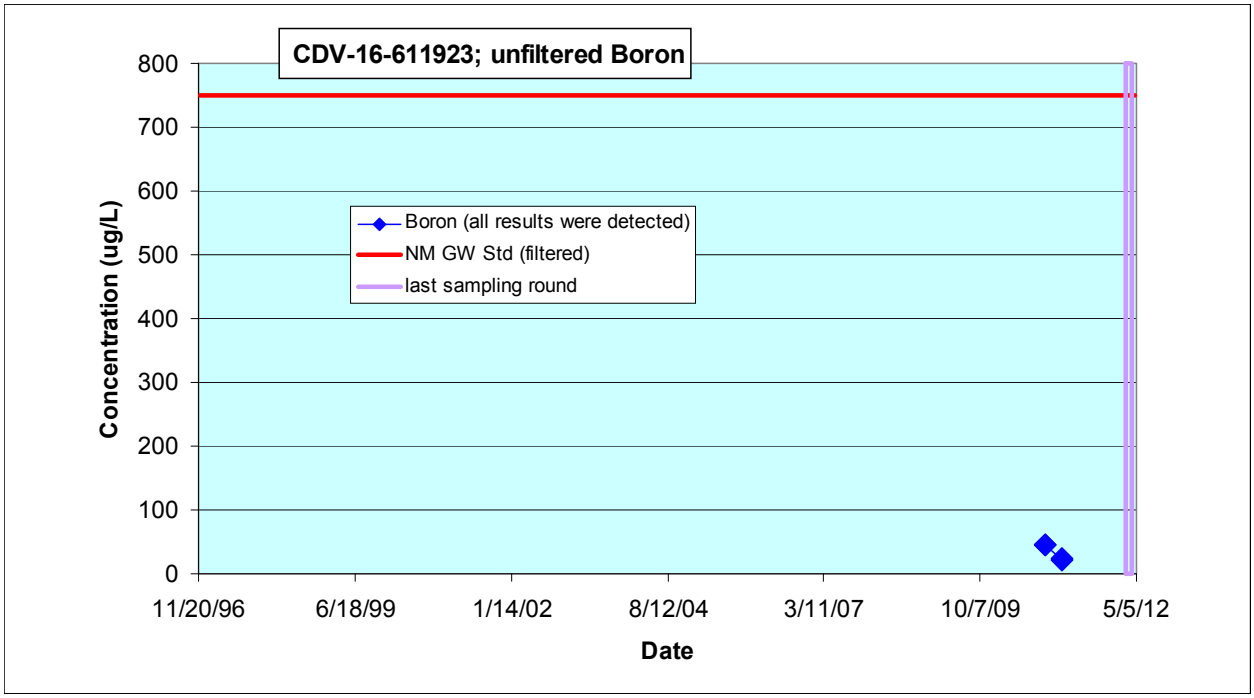

CDV-16-02659; RDX
120
100
80
60
40
20
0
Concentration (ug/L)
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date
RDX (detected)
RDX (undetected)
EPA TAP SCRN LVL
last sampling round

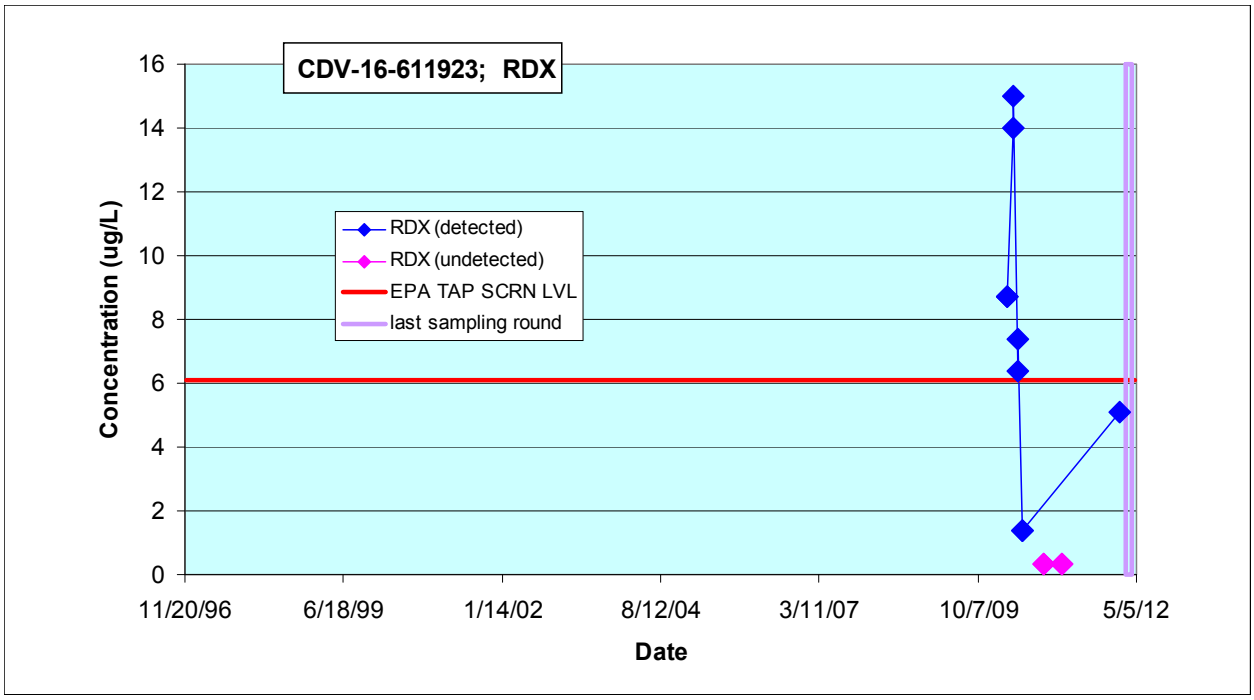

CDV-16-02659; Tetrachloroethene
6
5
4
3
2
1
0
Concentration (ug/L)
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date
Tetrachloroethene (undetected)
EPA TAP SCRN LVL
last sampling round
last sampling round

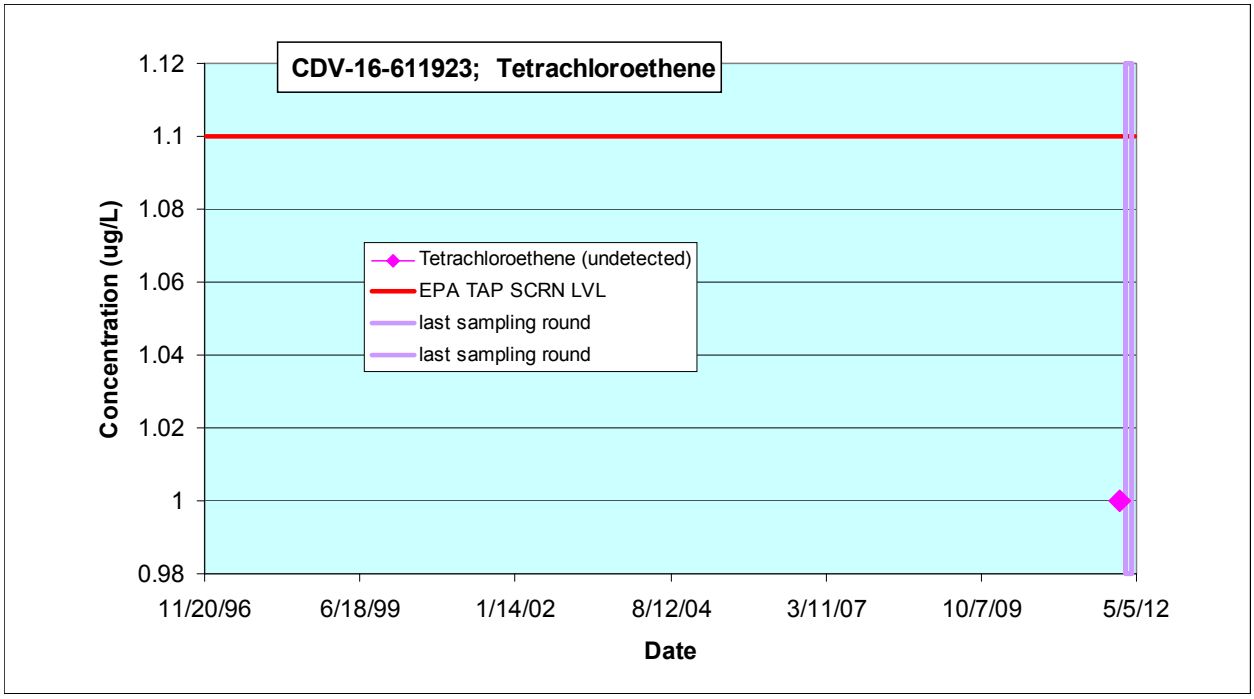

CDV-16-611923; filtered Barium
Barium (all results were detected)
NM GW Std (filtered)
last sampling round
Concentration (ug/L)
60000
50000
40000
30000
20000
10000
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date


CDV-16-611923; unfiltered Barium
Barium (all results were detected)
NM GW Std (filtered)
last sampling round
Concentration (ug/L)
60000
50000
40000
30000
20000
10000
0
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date


CDV-16-611923; filtered Boron
Concentration (ug/L)
800
700
600
500
400
300
200
100
0
Boron (all results were detected)
NM GW Std (filtered)
last sampling round
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date


CDV-16-611923; unfiltered Boron
Concentration (ug/L)
800
700
600
500
400
300
200
100
0
Boron (all results were detected)
NM GW Std (filtered)
last sampling round
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date


CDV-16-611923; RDX
Concentration (ug/L)
16
14
12
10
8
6
4
2
0
RDX (detected)
RDX (undetected)
EPA TAP SCRN LVL
last sampling round
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date


CDV-16-611923; Tetrachloroethene
Concentration (ug/L)
1.12
1.1
1.08
1.06
1.04
1.02
1
0.98
Tetrachloroethene (undetected)
EPA TAP SCRN LVL
last sampling round
last sampling round
11/20/96
6/18/99
1/14/02
8/12/04
3/11/07
10/7/09
5/5/12
Date

Attachment B-1

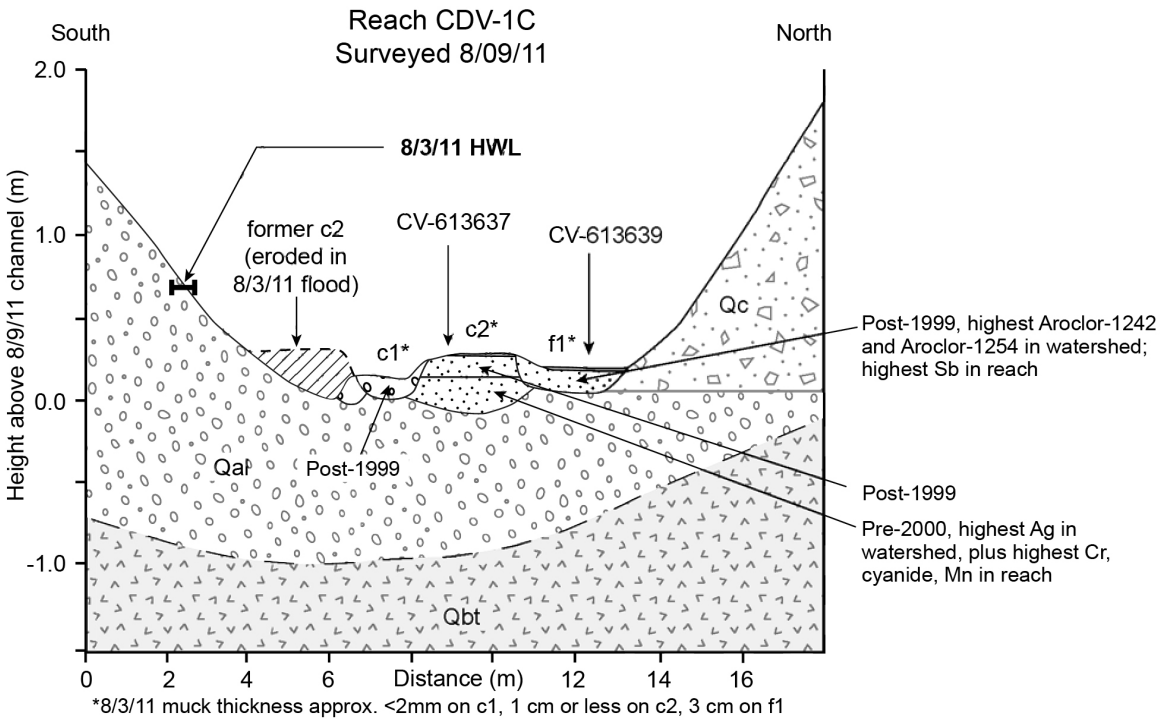
Stormwater Data
(on CD included with this document)

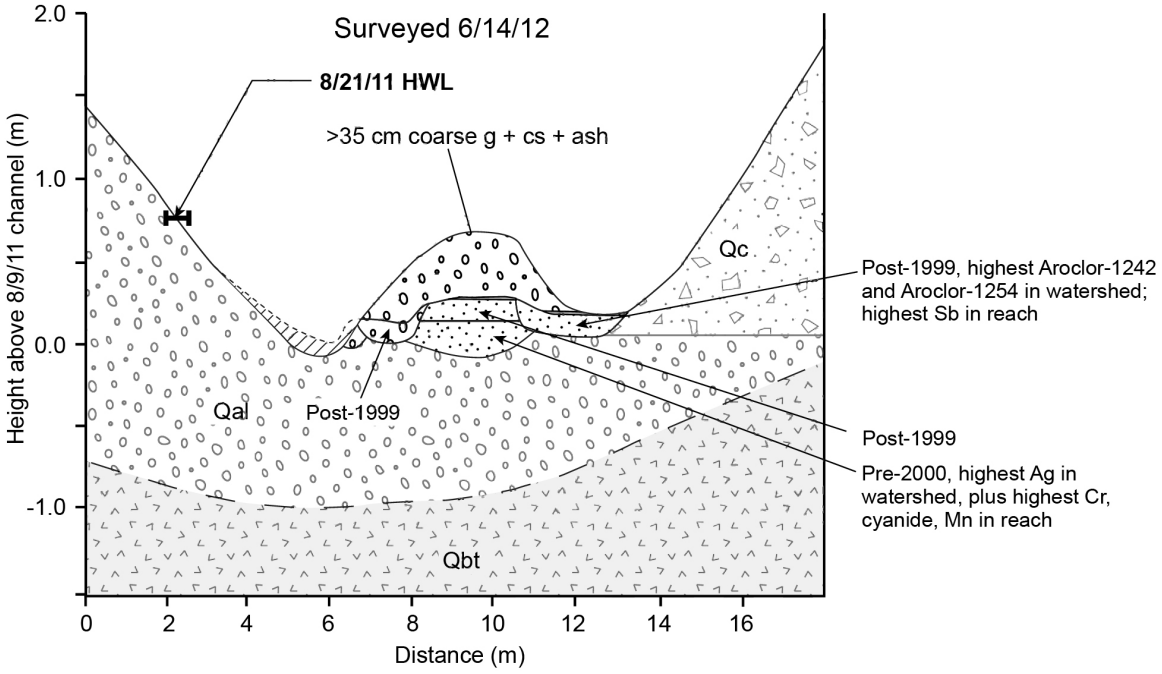
Attachment B-2

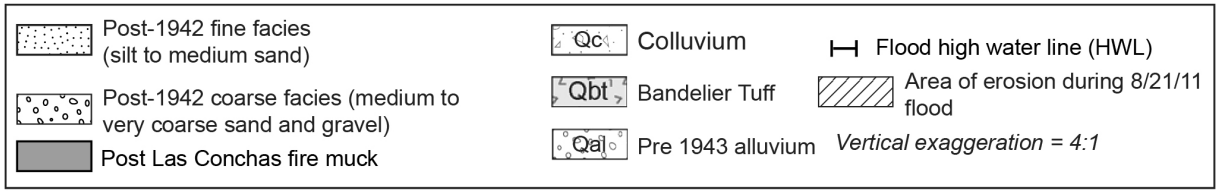
Post-Fire Water Data in Affected Canyons
(on CD included with this document)

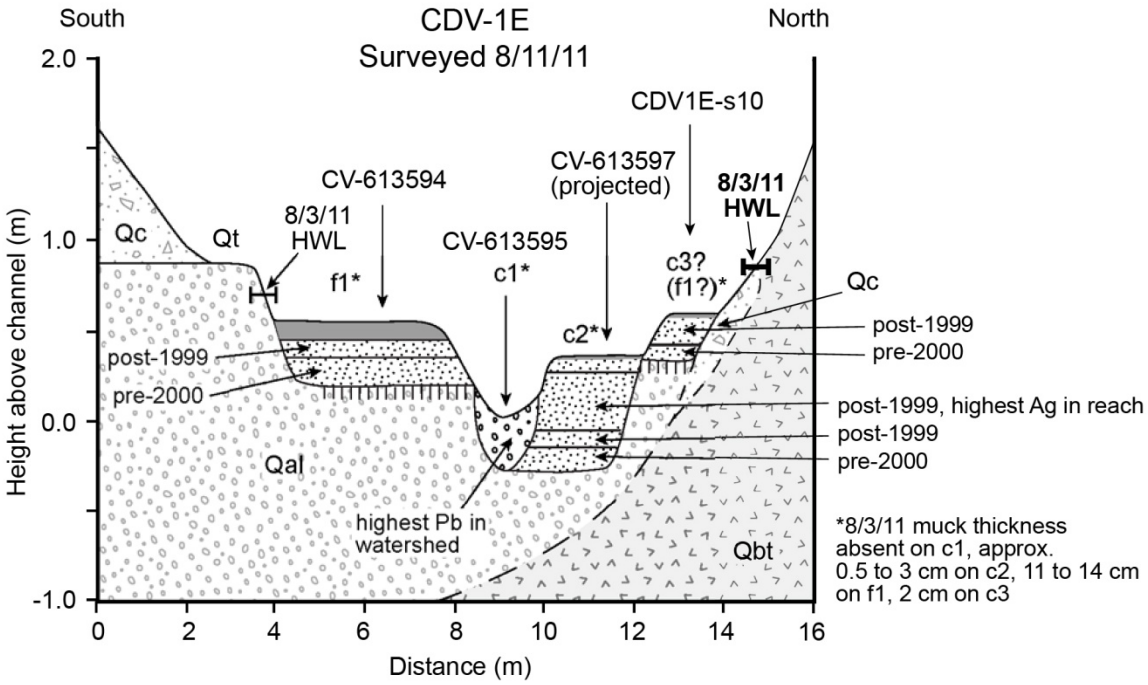
Appendix C

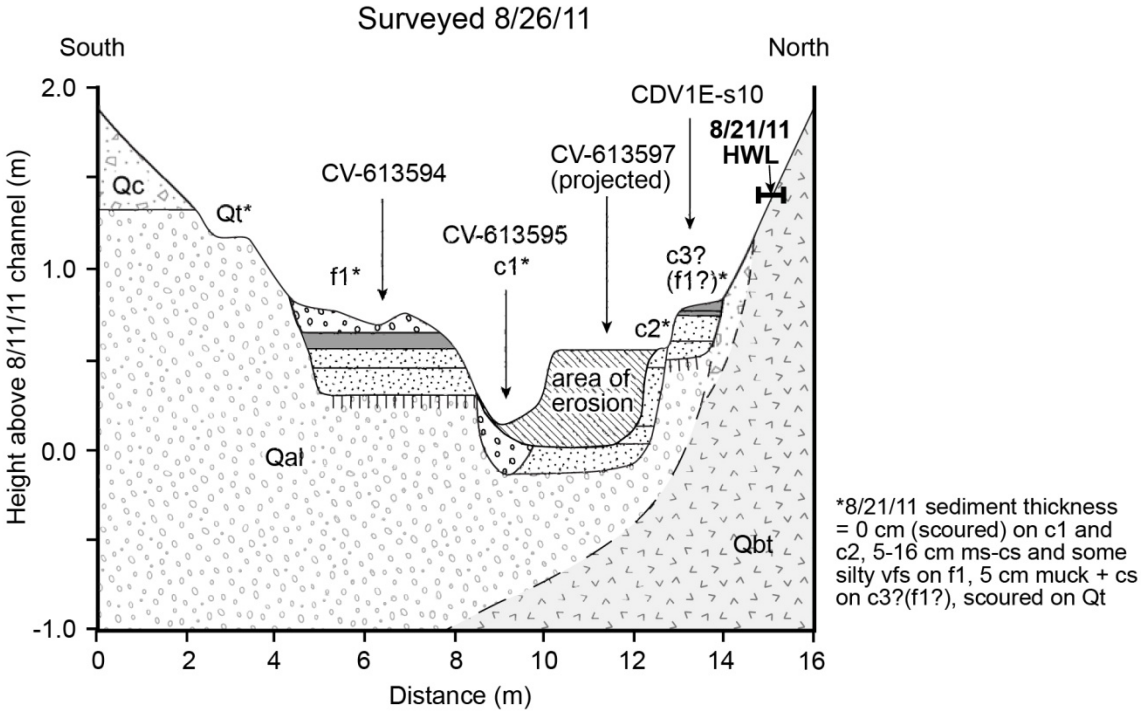
Sediment Reaches

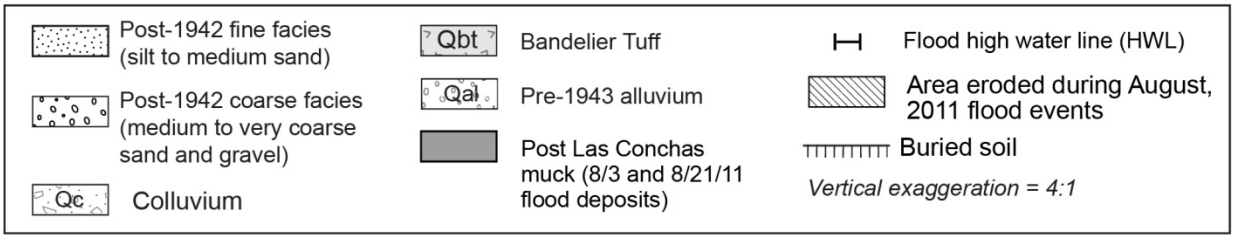

Reach CDV-1C
Surveyed 8/09/11
South
North
Height above 8/9/11 channel (m)
2.0
1.0
0.0
-1.0
8/3/11 HWL
former c2
(eroded in
8/3/11 flood)
CV-613637
CV-613639
c1*
c2*
f1*
Qc
Qal
Post-1999
Qbt
Post-1999, highest Aroclor-1242
and Aroclor-1254 in watershed;
highest Sb in reach
Post-1999
Pre-2000, highest Ag in
watershed, plus highest Cr,
cyanide, Mn in reach
0
2
4
6
Distance (m)
12
14
16
*8/3/11 muck thickness approx. <2mm on c1, 1 cm or less on c2, 3 cm on f1

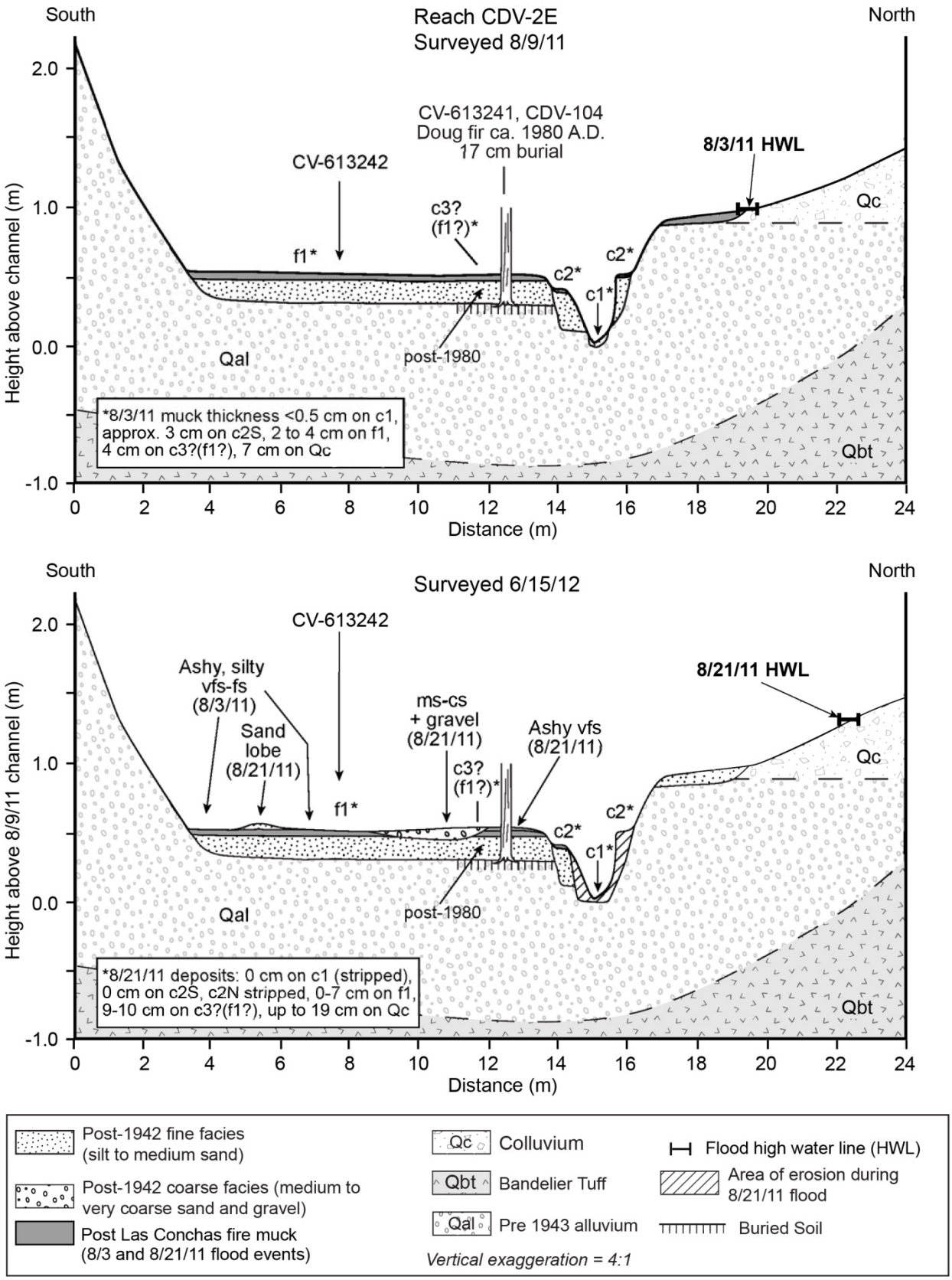

Surveyed 6/14/12
Height above 8/9/11 channel (m)
2.0
1.0
0.0
-1.0
8/21/11 HWL
>35 cm coarse g + cs + ash
Qc
Qal
Post-1999
Qbt
Post-1999, highest Aroclor-1242
and Aroclor-1254 in watershed;
highest Sb in reach
Post-1999
Pre-2000, highest Ag in
watershed, plus highest Cr,
cyanide, Mn in reach
0
2
4
6
8
10
12
14
16
Distance (m)

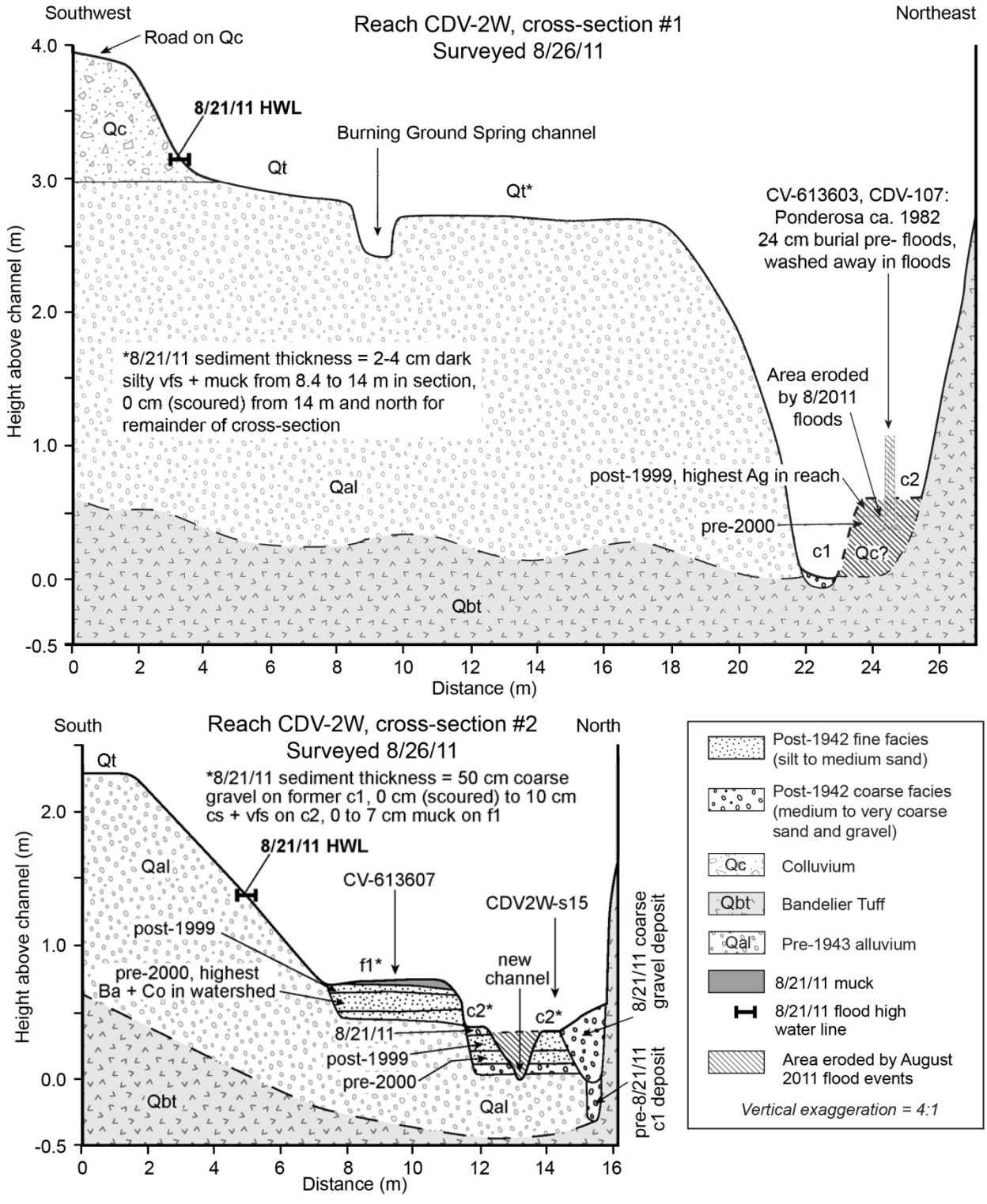

Post-1942 fine facies
(silt to medium sand)
Post-1942 coarse facies (medium to
very coarse sand and gravel)
Post Las Conchas fire muck
Qc
Colluvium
Qbt
Bandelier Tuff
Qal
Pre 1943 alluvium
Flood high water line (HWL)
Area of erosion during 8/21/11
flood
Vertical exaggeration = 4:1

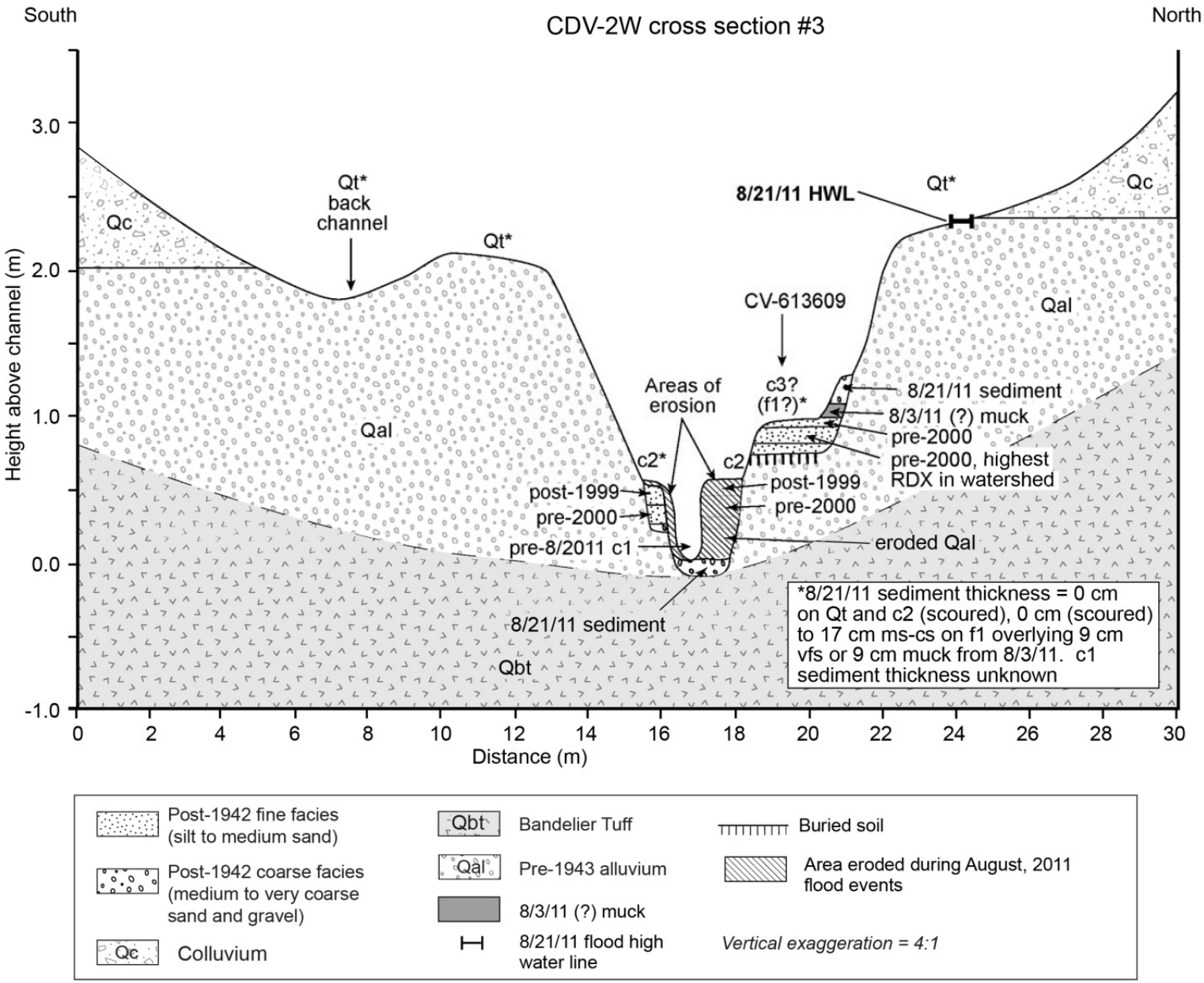

South
CDV-1E
Surveyed 8/11/11
North
CDV1E-s10
CV-613594
CV-613597
(projected)
8/3/11
HWL
8/3/11
HWL
CV-613595
Qc
Qt
f1*
c1*
c3?
(f1?)*
Qc
c2*
post-1999
pre-2000
post-1999
pre-2000
post-1999, highest Ag in reach
post-1999
pre-2000
Qal
highest Pb in
watershed
Qbt
*8/3/11 muck thickness
absent on c1, approx.
0.5 to 3 cm on c2, 11 to 14 cm
on f1, 2 cm on c3
Height above channel (m)
2.0
1.0
0.0
-1.0
0
2
4
6
8
10
12
14
16
Distance (m)

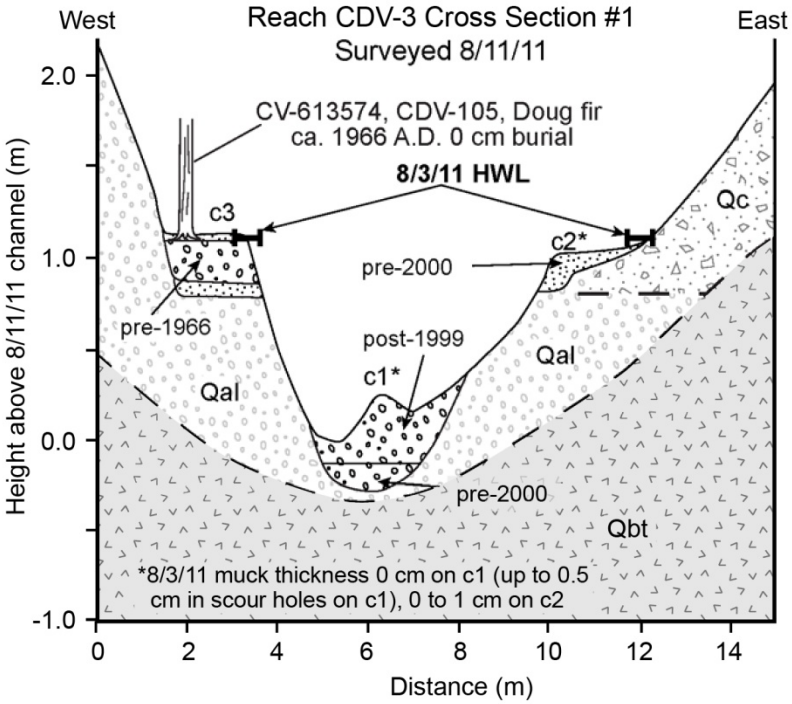

Surveyed 8/26/11
South
North
CDV1E-s10
8/21/11
HWL
CV-613597
(projected)
CV-613594
Qc
Qt*
CV-613595
c1*
f1*
c3?
(f1?)*
c2*
area of
erosion
Qal
Qbt
*8/21/11 sediment thickness
= 0 cm (scoured) on c1 and
c2, 5-16 cm ms-cs and some
silty vfs on f1, 5 cm muck + cs
on c3?(f1?), scoured on Qt
Height above 8/11/11 channel (m)
2.0
1.0
0.0
-1.0
0
2
4
6
8
10
12
14
16
Distance (m)

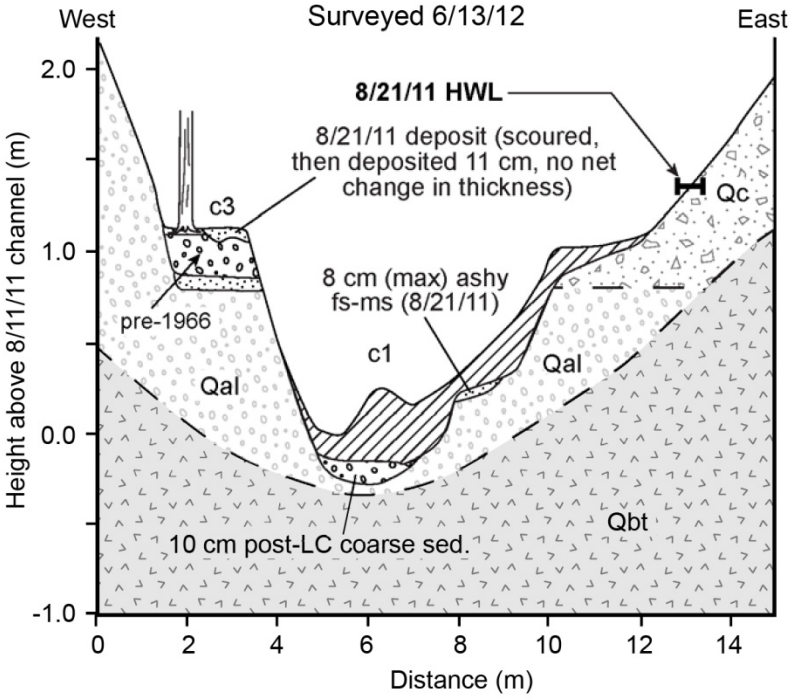

Post-1942 fine facies
(silt to medium sand)
Post-1942 coarse facies
(medium to very coarse
sand and gravel)
Qc
Colluvium
Qbt
Bandelier Tuff
Qal
Pre-1943 alluvium
Post Las Conchas
muck (8/3 and 8/21/11
flood deposits)
Flood high water line (HWL)
Area eroded during August,
2011 flood events
Buried soil
Vertical exaggeration = 4:1

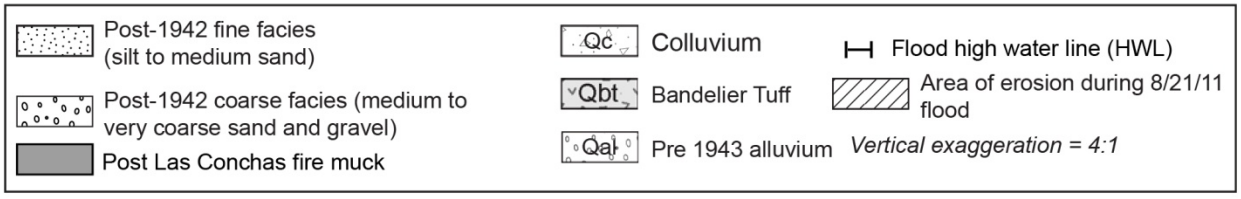

South
Reach CDV-2E
Surveyed 8/9/11
North
CV-613241, CDV-104
Doug fir ca. 1980 A.D.
17 cm burial
CV-613242
8/3/11 HWL
c3?
(f1?)*
f1*
c2*
c2*
c1*
Qc
Qal
post-1980
*8/3/11 muck thickness <0.5 cm on c1,
approx. 3 cm on c2S, 2 to 4 cm on f1,
4 cm on c3?(f1?), 7 cm on Qc
Qbt
Height above channel (m)
Distance (m)
South
Surveyed 6/15/12
North
CV-613242
Ashy, silty
vfs-fs
(8/3/11)
Sand
lobe
(8/21/11)
ms-cs
+ gravel
(8/21/11)
Ashy vfs
(8/21/11)
8/21/11 HWL
c3?
(f1?)*
f1*
c2*
c2*
c1*
Qc
Qal
post-1980
*8/21/11 deposits: 0 cm on c1 (stripped),
0 cm on c2S, c2N stripped, 0-7 cm on f1,
9-10 cm on c3?(f1?), up to 19 cm on Qc
Qbt
Height above 8/9/11 channel (m)
Distance (m)
Post-1942 fine facies
(silt to medium sand)
Post-1942 coarse facies (medium to
very coarse sand and gravel)
Post Las Conchas fire muck
(8/3 and 8/21/11 flood events)
Qc
Colluvium
Qbt
Bandelier Tuff
Qal
Pre 1943 alluvium
Vertical exaggeration = 4:1
Flood high water line (HWL)
Area of erosion during
8/21/11 flood
Buried Soil

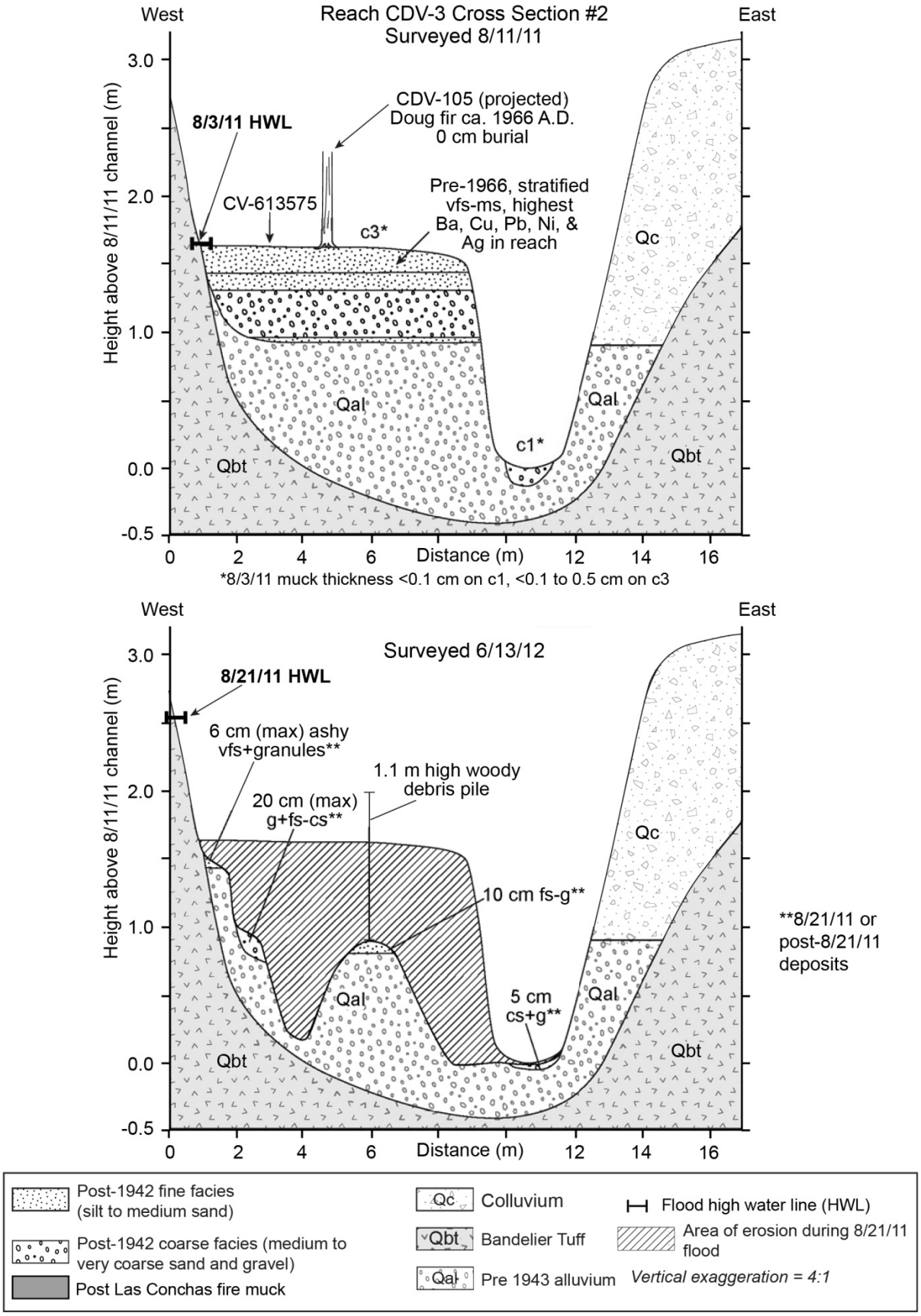

Reach CDV-2W, cross-section #1
Surveyed 8/26/11
Southwest
Northeast
Road on Qc
8/21/11 HWL
Qc
Qt
Burning Ground Spring channel
Qt*
CV-613603, CDV-107:
Ponderosa ca. 1982
24 cm burial pre- floods,
washed away in floods
*8/21/11 sediment thickness = 2-4 cm dark silty vfs + muck from 8.4 to 14 m in section, 0 cm (scoured) from 14 m and north for remainder of cross-section
Area eroded by 8/2011 floods
post-1999, highest Ag in reach
c2
Qal
pre-2000
c1
Qc?
Qbt
Height above channel (m)
Distance (m)
Reach CDV-2W, cross-section #2
Surveyed 8/26/11
South
North
Qt
*8/21/11 sediment thickness = 50 cm coarse gravel on former c1, 0 cm (scoured) to 10 cm cs + vfs on c2, 0 to 7 cm muck on f1
8/21/11 HWL
Qal
CV-613607
CDV2W-s15
post-1999
f1*
new channel
pre-2000, highest Ba + Co in watershed
c2*
c2*
8/21/11
post-1999
pre-2000
Qbt
Qal
8/21/11 coarse gravel deposit
pre-8/21/11 c1 deposit
Post-1942 fine facies (silt to medium sand)
Post-1942 coarse facies (medium to very coarse sand and gravel)
Qc Colluvium
Qbt Bandelier Tuff
Qal Pre-1943 alluvium
8/21/11 muck
8/21/11 flood high water line
Area eroded by August 2011 flood events
Vertical exaggeration = 4:1

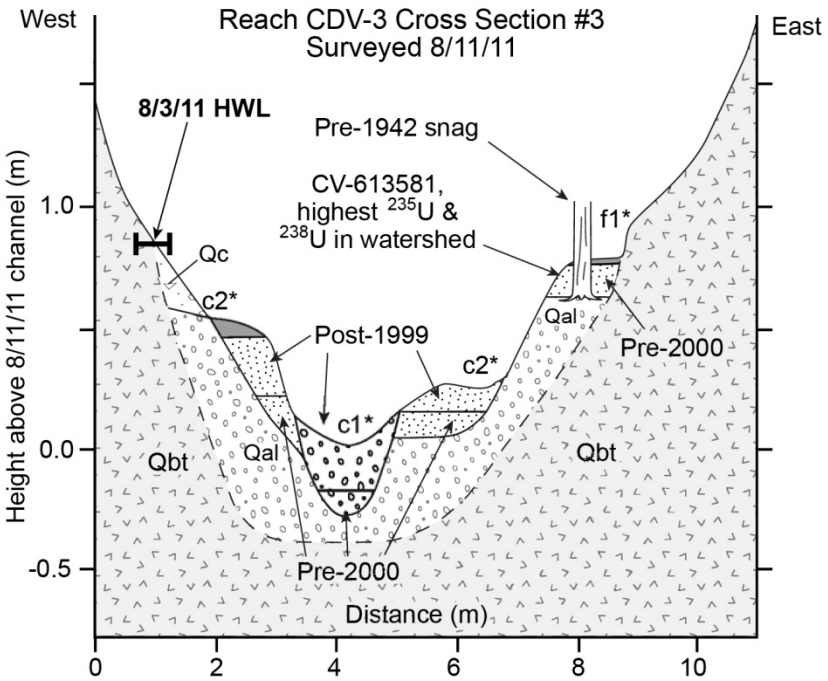

South
North
CDV-2W cross section #3
Height above channel (m)
Distance (m)
Qc
Qt* back channel
Qt*
Qal
Areas of erosion
c2*
c2
post-1999
pre-2000
pre-8/2011 c1
8/21/11 sediment
Qbt
CV-613609
c3? (f1?)*
8/21/11 HWL
Qt*
Qc
Qal
8/21/11 sediment
8/3/11 (?) muck
pre-2000
pre-2000, highest RDX in watershed
post-1999
pre-2000
eroded Qal
*8/21/11 sediment thickness = 0 cm on Qt and c2 (scoured), 0 cm (scoured) to 17 cm ms-cs on f1 overlying 9 cm vfs or 9 cm muck from 8/3/11. c1 sediment thickness unknown
Post-1942 fine facies (silt to medium sand)
Post-1942 coarse facies (medium to very coarse sand and gravel)
Qc
Colluvium
Qbt
Bandelier Tuff
Qal
Pre-1943 alluvium
8/3/11 (?) muck
8/21/11 flood high water line
Buried soil
Area eroded during August, 2011 flood events
Vertical exaggeration = 4:1


West
Reach CDV-3 Cross Section #1
Surveyed 8/11/11
East
CV-613574, CDV-105, Doug fir
ca. 1966 A.D. 0 cm burial
8/3/11 HWL
c3
c2*
Qc
pre-2000
pre-1966
post-1999
c1*
Qal
Qal
pre-2000
Qbt
*8/3/11 muck thickness 0 cm on c1 (up to 0.5 cm in scour holes on c1), 0 to 1 cm on c2
Height above 8/11/11 channel (m)
2.0
1.0
0.0
-1.0
0
2
4
6
8
10
12
14
Distance (m)

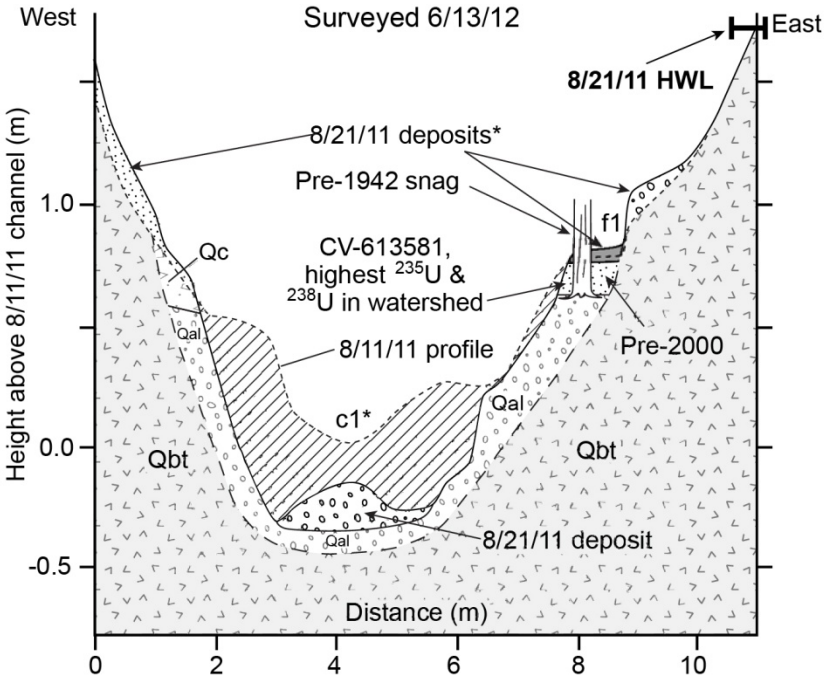

West
Surveyed 6/13/12
East
8/21/11 HWL
8/21/11 deposit (scoured, then deposited 11 cm, no net change in thickness)
c3
Qc
8 cm (max) ashy fs-ms (8/21/11)
pre-1966
c1
Qal
Qal
Qbt
10 cm post-LC coarse sed.
Height above 8/11/11 channel (m)
2.0
1.0
0.0
-1.0
0
2
4
6
8
10
12
14
Distance (m)


Post-1942 fine facies (silt to medium sand)
Post-1942 coarse facies (medium to very coarse sand and gravel)
Post Las Conchas fire muck
Qc
Colluvium
Qbt
Bandelier Tuff
Qal
Pre 1943 alluvium
Flood high water line (HWL)
Area of erosion during 8/21/11 flood
Vertical exaggeration = 4:1

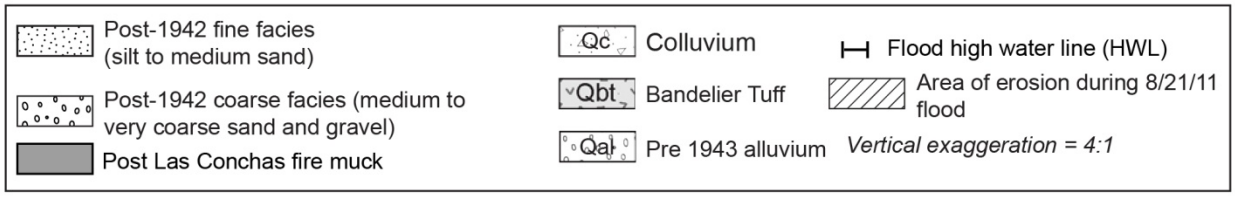

West
Reach CDV-3 Cross Section #2
Surveyed 8/11/11
East
Height above 8/11/11 channel (m)
3.0
2.0
1.0
0.0
-0.5
8/3/11 HWL
CDV-105 (projected)
Doug fir ca. 1966 A.D.
0 cm burial
CV-613575
c3*
Pre-1966, stratified
vfs-ms, highest
Ba, Cu, Pb, Ni, &
Ag in reach
Qc
Qal
Qal
c1*
Qbt
Qbt
0
2
4
6
Distance (m)
12
14
16
*8/3/11 muck thickness <0.1 cm on c1, <0.1 to 0.5 cm on c3
West
Surveyed 6/13/12
East
Height above 8/11/11 channel (m)
3.0
2.0
1.0
0.0
-0.5
8/21/11 HWL
6 cm (max) ashy
vfs+granules**
1.1 m high woody
debris pile
20 cm (max)
g+fs-cs**
Qc
10 cm fs-g**
Qal
5 cm
cs+g**
Qal
Qbt
Qbt
0
2
4
6
Distance (m)
12
14
16
**8/21/11 or
post-8/21/11
deposits
Post-1942 fine facies
(silt to medium sand)
Post-1942 coarse facies (medium to
very coarse sand and gravel)
Post Las Conchas fire muck
Qc
Colluvium
Qbt
Bandelier Tuff
Qal
Pre 1943 alluvium
Flood high water line (HWL)
Area of erosion during 8/21/11
flood
Vertical exaggeration = 4:1

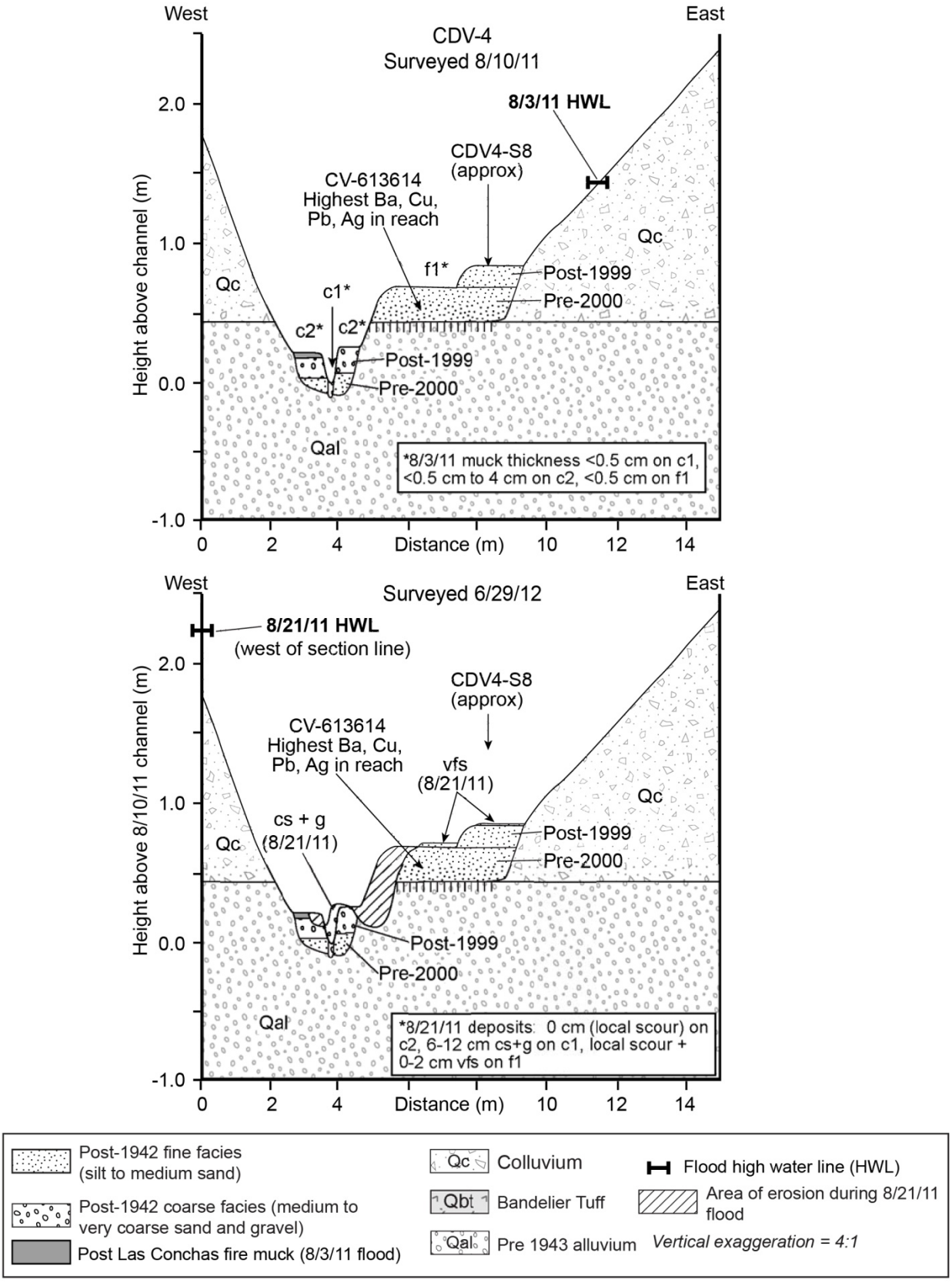


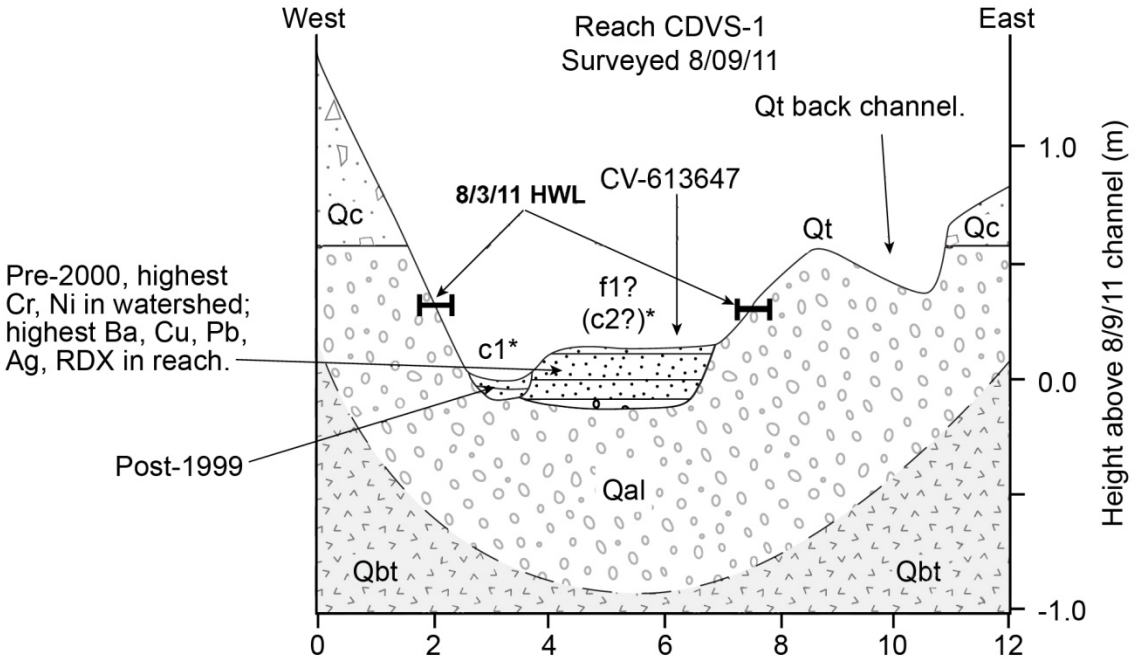
*8/3/11 muck thickness <0.1 cm on c1, 3 to 8 cm on c2, 3 cm on f1



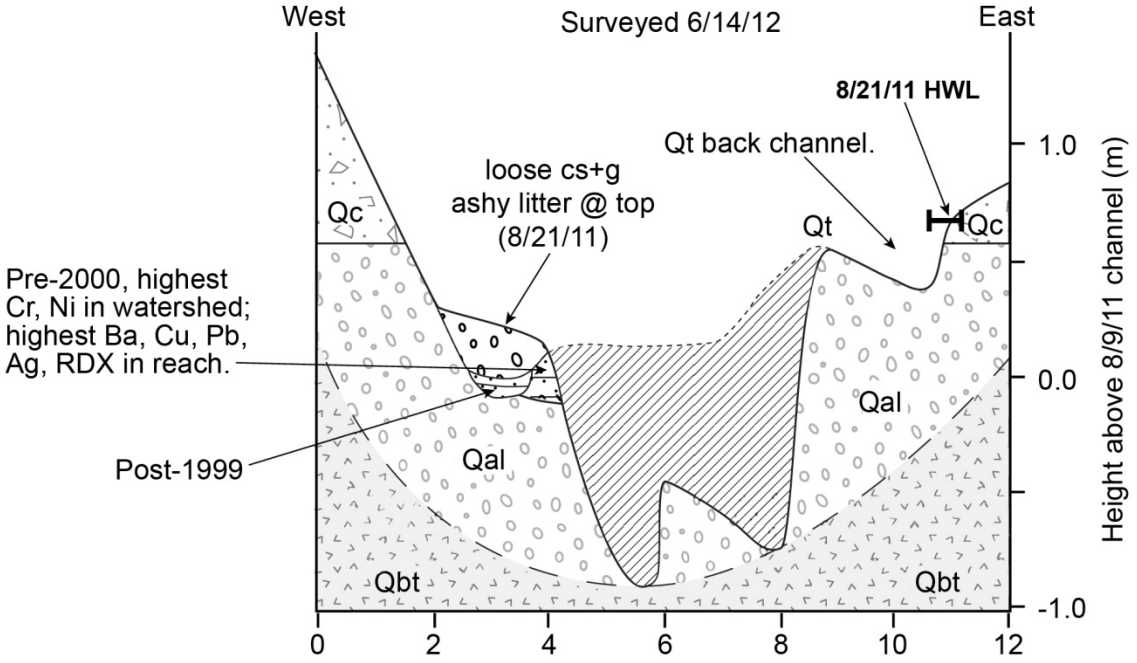
*8/21/11 sediment thickness: 7-8 cm on Qbt/Qc, c1 scoured then 17 cm new coarse sediment deposited, 6 cm ashy vfs on f1

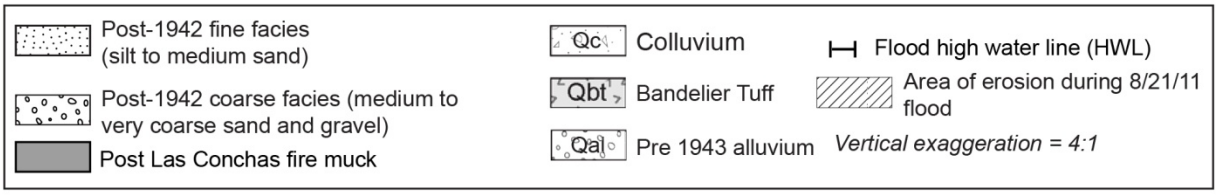


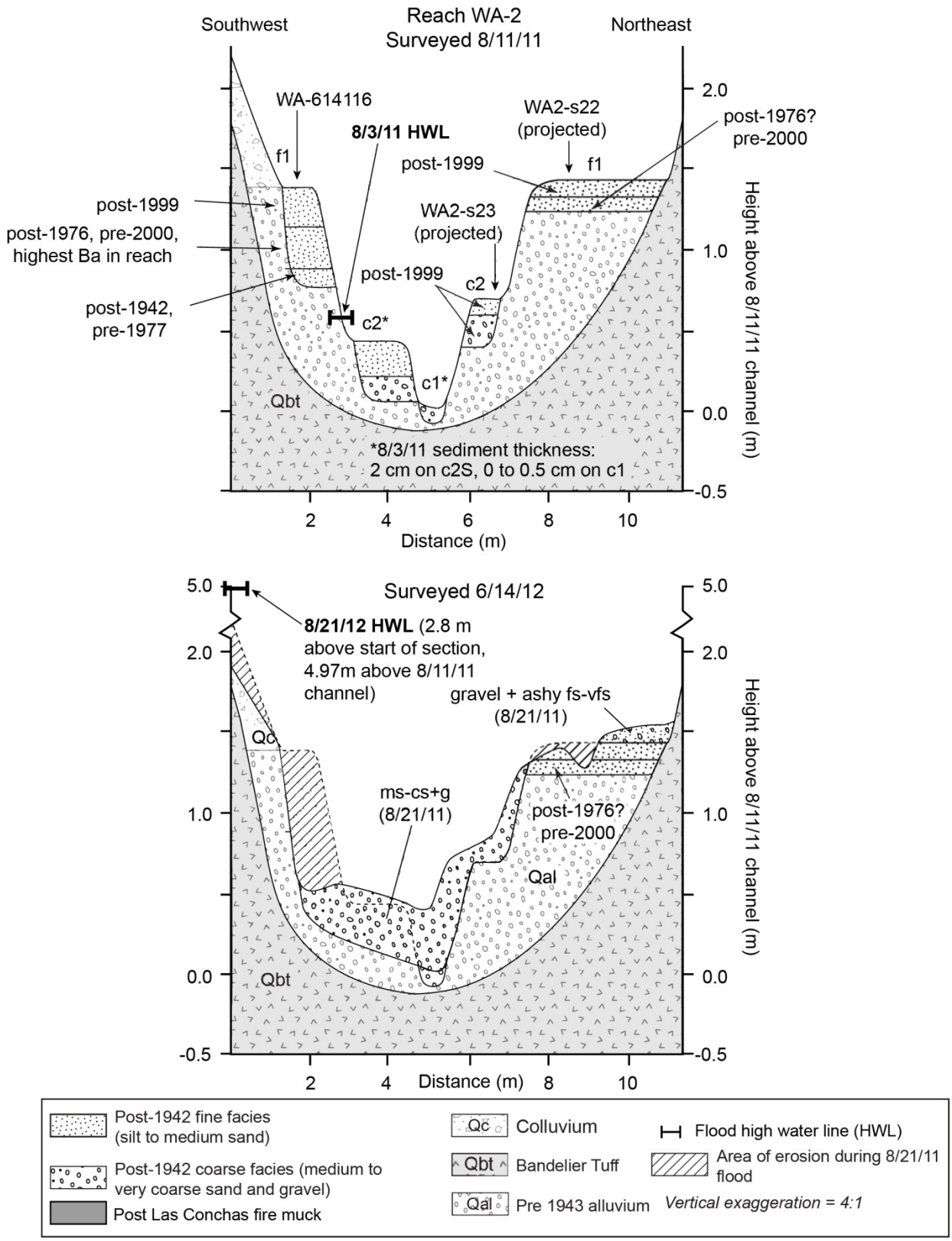

West
East
CDV-4
Surveyed 8/10/11
8/3/11 HWL
CDV4-S8
(approx)
CV-613614
Highest Ba, Cu,
Pb, Ag in reach
Qc
f1*
Post-1999
Pre-2000
c1*
c2*
c2*
Post-1999
Pre-2000
Qc
Qal
*8/3/11 muck thickness <0.5 cm on c1,
<0.5 cm to 4 cm on c2, <0.5 cm on f1
Height above channel (m)
2.0
1.0
0.0
-1.0
0
2
4
Distance (m)
10
12
14
West
East
Surveyed 6/29/12
8/21/11 HWL
(west of section line)
CDV4-S8
(approx)
CV-613614
Highest Ba, Cu,
Pb, Ag in reach
vfs
(8/21/11)
Qc
cs + g
(8/21/11)
Qc
Post-1999
Pre-2000
Post-1999
Pre-2000
Qal
*8/21/11 deposits: 0 cm (local scour) on
c2, 6-12 cm cs+g on c1, local scour +
0-2 cm vfs on f1
Height above 8/10/11 channel (m)
2.0
1.0
0.0
-1.0
0
2
4
Distance (m)
10
12
14
Post-1942 fine facies
(silt to medium sand)
Post-1942 coarse facies (medium to
very coarse sand and gravel)
Post Las Conchas fire muck (8/3/11 flood)
Qc
Colluvium
Qbt
Bandelier Tuff
Qal
Pre 1943 alluvium
Flood high water line (HWL)
Area of erosion during 8/21/11
flood
Vertical exaggeration = 4:1

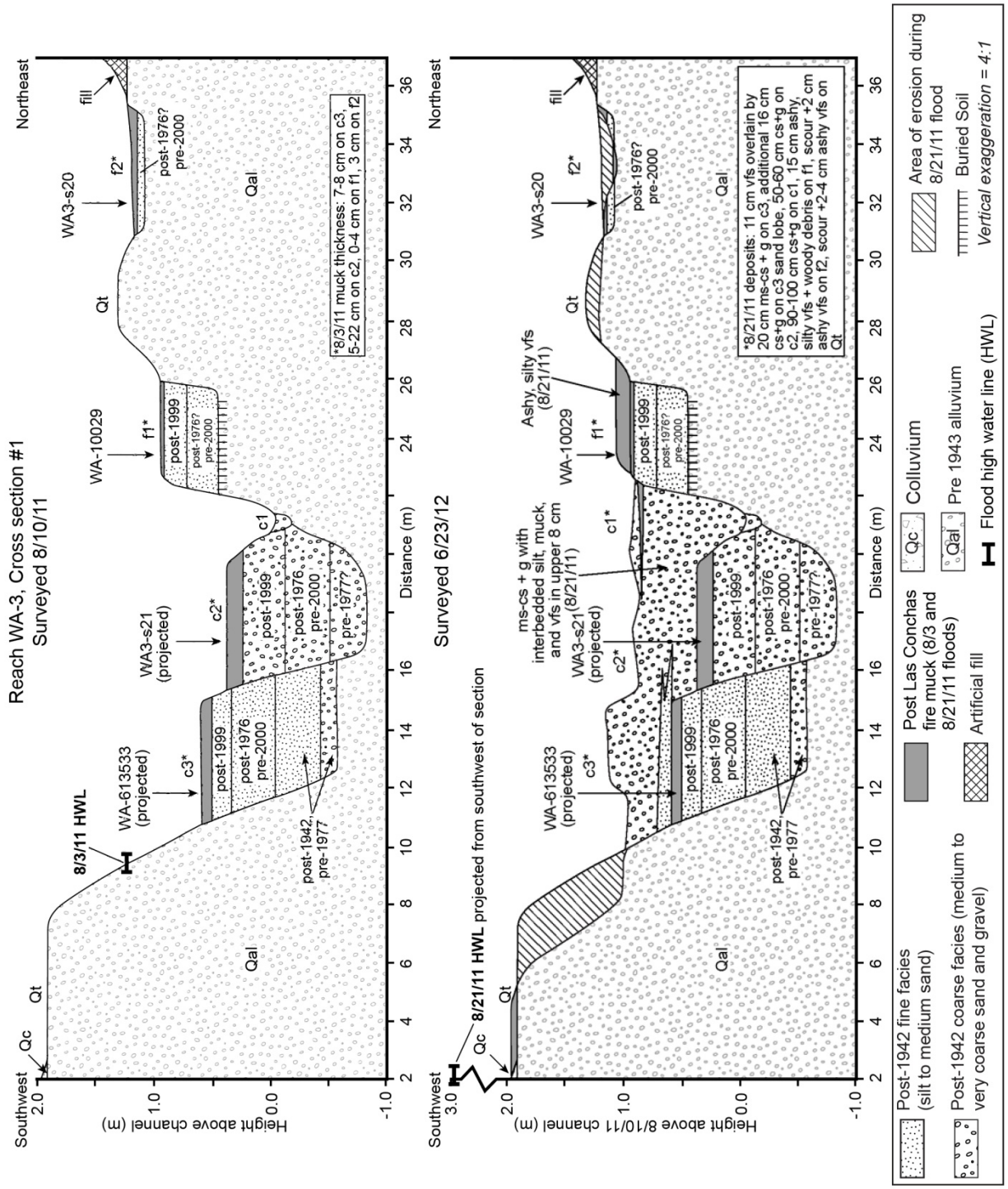


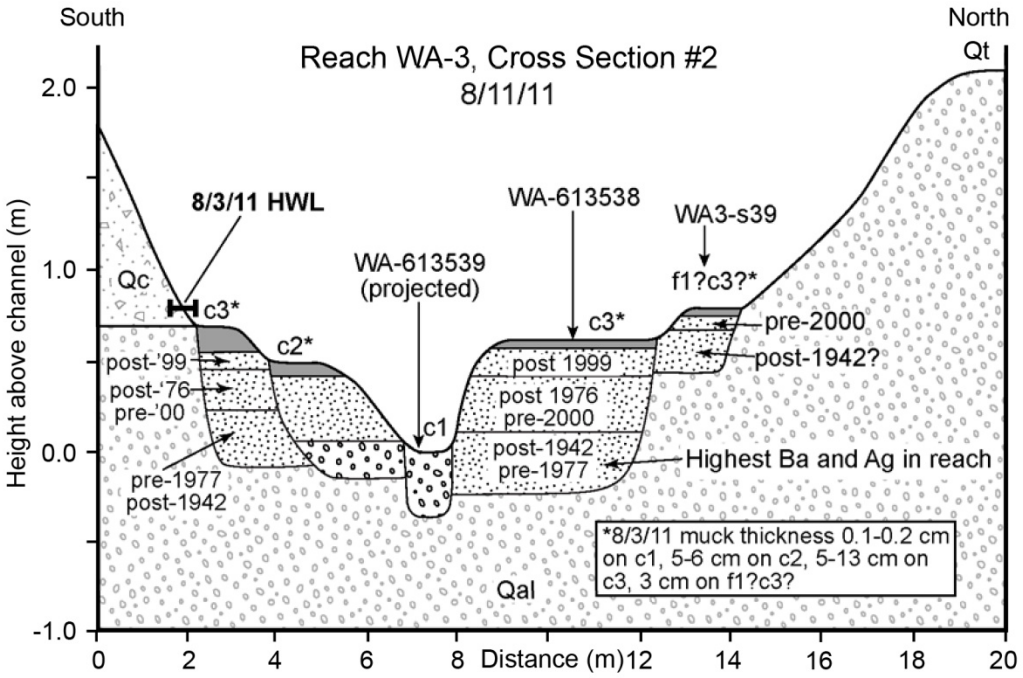
*8/3/11 muck thickness approx. 1 mm on f1?(c2?), < 1 mm on c1.

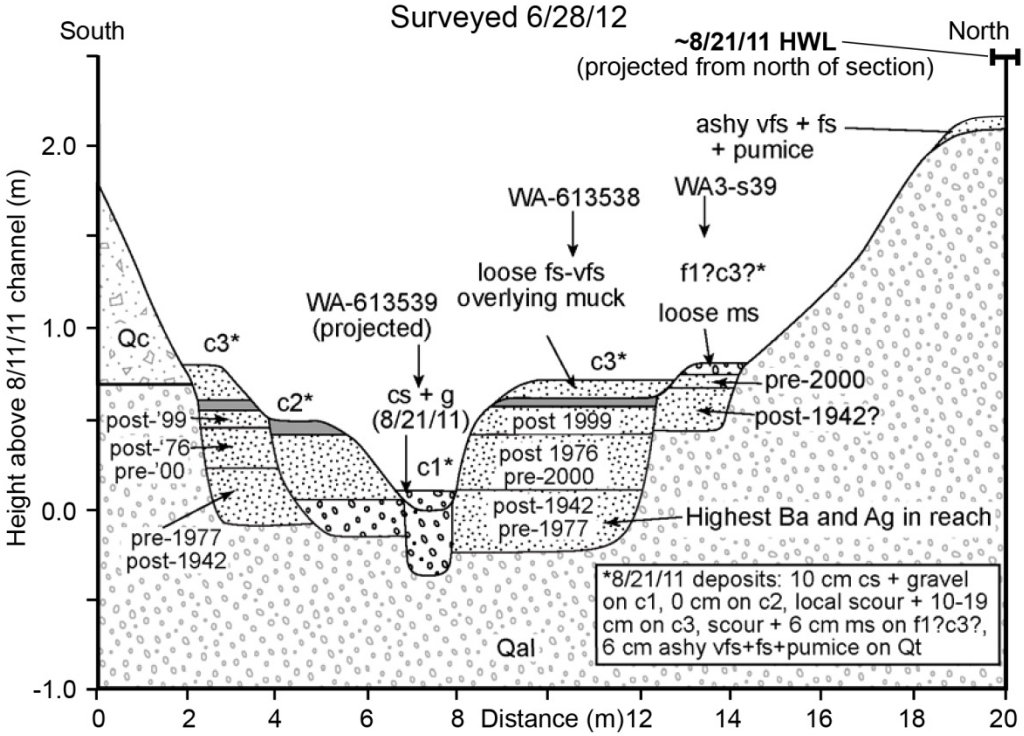


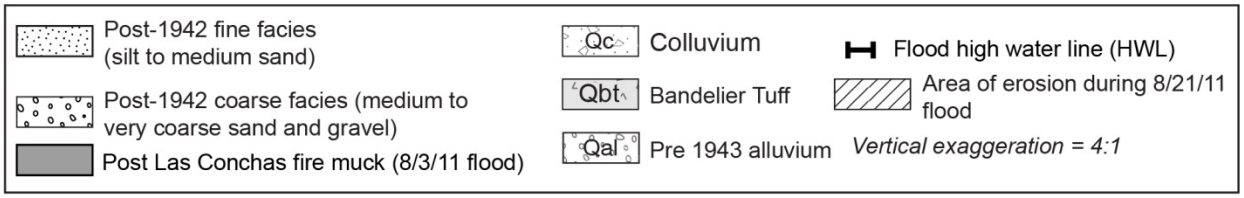


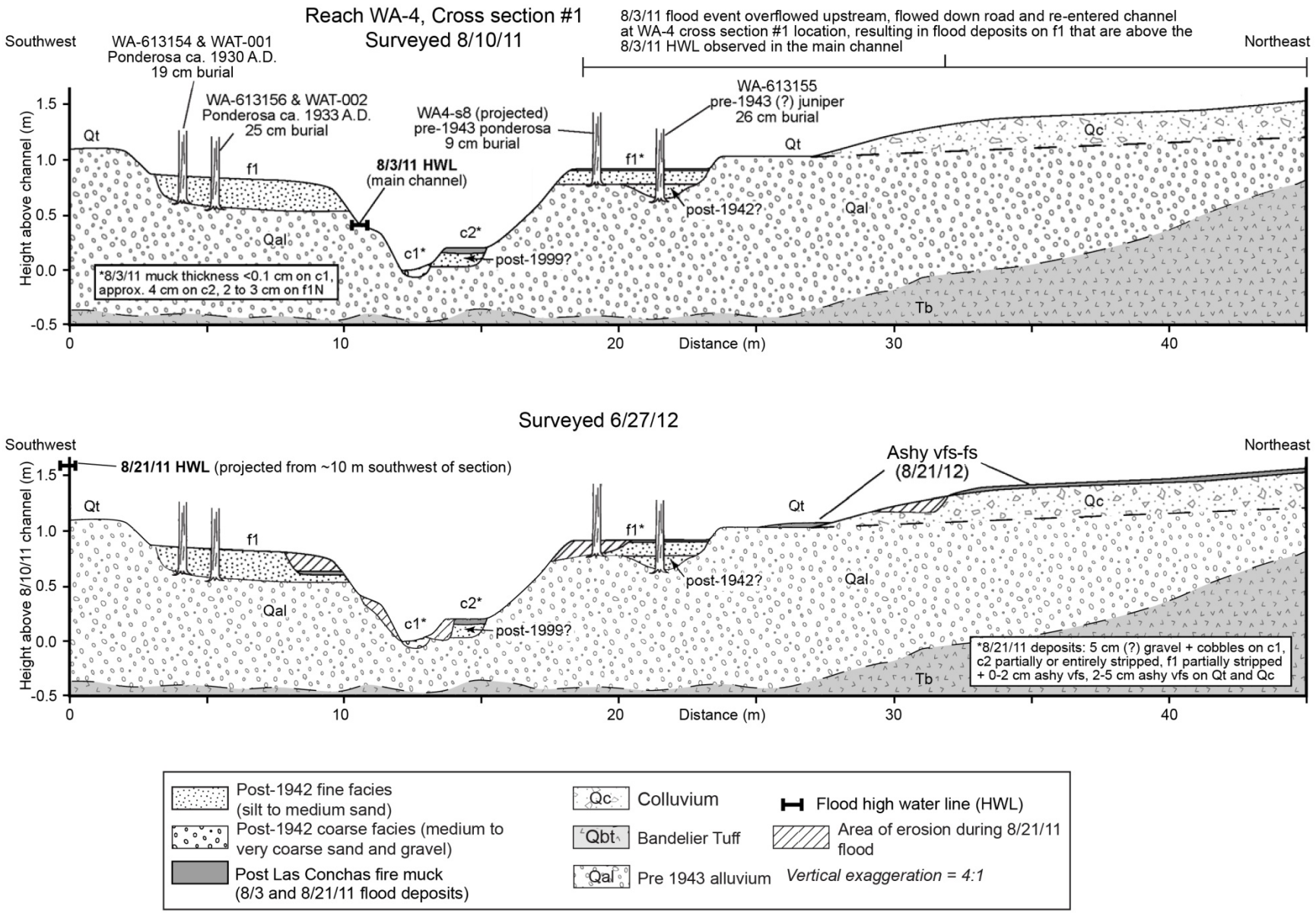

Reach WA-2
Surveyed 8/11/11
Southwest
Northeast
WA-614116
8/3/11 HWL
WA2-s22
(projected)
post-1976?
pre-2000
f1
post-1999
f1
post-1999
post-1976, pre-2000,
highest Ba in reach
WA2-s23
(projected)
post-1999
c2
post-1942,
pre-1977
c2*
c1*
Qbt
*8/3/11 sediment thickness:
2 cm on c2S, 0 to 0.5 cm on c1
Distance (m)
Height above 8/11/11 channel (m)
Surveyed 6/14/12
8/21/12 HWL (2.8 m
above start of section,
4.97m above 8/11/11
channel)
gravel + ashy fs-vfs
(8/21/11)
Qc
ms-cs+g
(8/21/11)
post-1976?
pre-2000
Qal
Qbt
Distance (m)
Height above 8/11/11 channel (m)
Post-1942 fine facies
(silt to medium sand)
Post-1942 coarse facies (medium to
very coarse sand and gravel)
Post Las Conchas fire muck
Qc Colluvium
Qbt Bandelier Tuff
Qal Pre 1943 alluvium
Flood high water line (HWL)
Area of erosion during 8/21/11
flood
Vertical exaggeration = 4:1

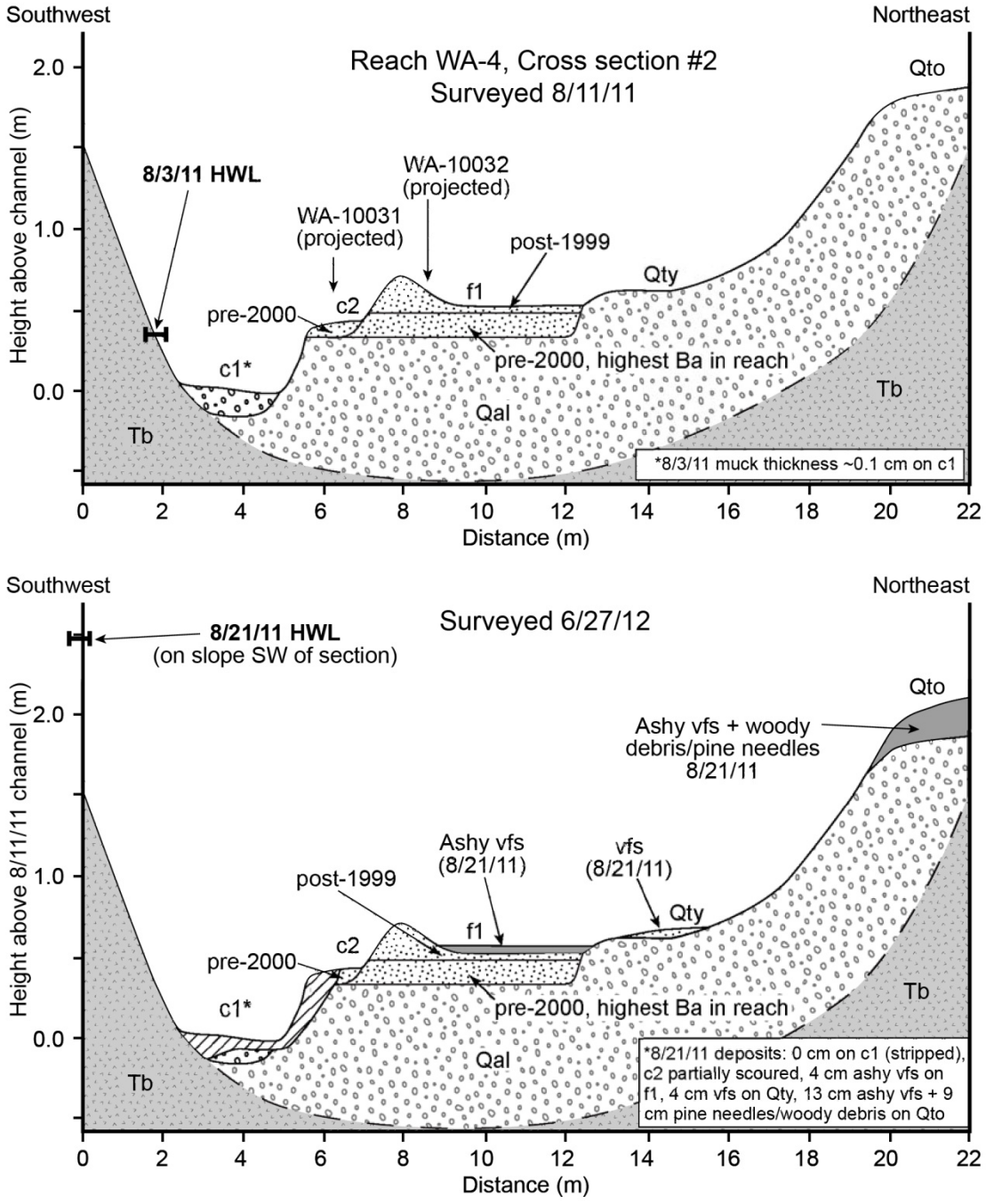

Reach WA-3, Cross section #1
Surveyed 8/10/11
Southwest
Northeast
Qc
Qt
8/3/11 HWL
WA-613533 (projected)
WA3-s21 (projected)
WA-10029
WA3-s20
c3*
c2*
f1*
f2*
c1
fill
post-1999
post-1976 pre-2000
post-1942, pre-1977
post-1976? pre-2000
pre-1977?
Qal
*8/3/11 muck thickness: 7-8 cm on c3, 5-22 cm on c2, 0-4 cm on f1, 3 cm on f2
Height above channel (m)
Distance (m)
Surveyed 6/23/12
8/21/11 HWL projected from southwest of section
ms-cs + g with interbedded silt, muck, and vfs in upper 8 cm (8/21/11)
Ashy, silty vfs (8/21/11)
*8/21/11 deposits: 11 cm vfs overlain by 20 cm ms-cs + g on c3, additional 16 cm cs+g on c3 sand lobe, 50-60 cm cs+g on c2, 90-100 cm cs+g on c1, 15 cm ashy, silty vfs + woody debris on f1, scour +2 cm ashy vfs on f2, scour +2-4 cm ashy vfs on Qt
Height above 8/10/11 channel (m)
Post-1942 fine facies (silt to medium sand)
Post-1942 coarse facies (medium to very coarse sand and gravel)
Post Las Conchas fire muck (8/3 and 8/21/11 floods)
Artificial fill
Colluvium
Pre 1943 alluvium
Flood high water line (HWL)
Area of erosion during 8/21/11 flood
Buried Soil
Vertical exaggeration = 4:1

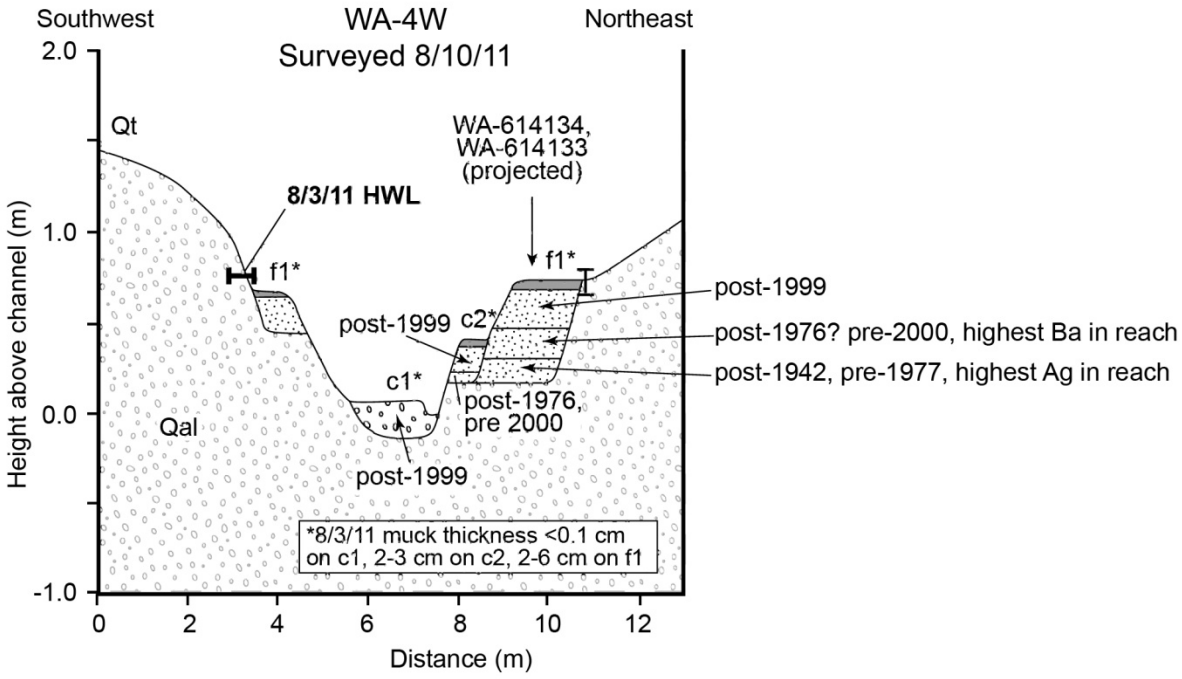

South
North
Reach WA-3, Cross Section #2
8/11/11
Qt
8/3/11 HWL
WA-613538
WA3-s39
WA-613539
(projected)
f1?c3?*
Qc
c3*
c3*
pre-2000
c2*
post-'99
post-1942?
post 1999
post-'76
pre-'00
post 1976
pre-2000
c1
post-1942
pre-1977
Highest Ba and Ag in reach
pre-1977
post-1942
*8/3/11 muck thickness 0.1-0.2 cm on c1, 5-6 cm on c2, 5-13 cm on c3, 3 cm on f1?c3?
Qal
Height above channel (m)
2.0
1.0
0.0
-1.0
0
2
4
6
8
Distance (m)
12
14
16
18
20

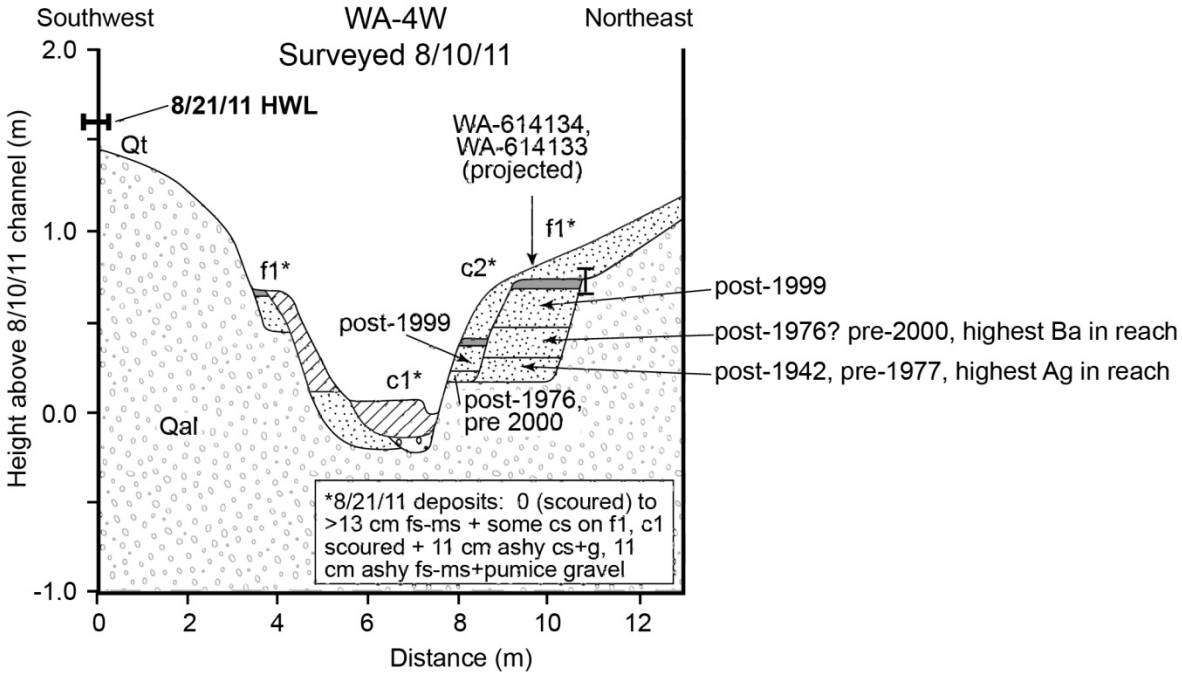

Surveyed 6/28/12
South
North
~8/21/11 HWL
(projected from north of section)
ashy vfs + fs
+ pumice
WA-613538
WA3-s39
loose fs-vfs
overlying muck
f1?c3?*
WA-613539
(projected)
loose ms
Qc
c3*
c3*
pre-2000
c2*
cs + g
(8/21/11)
post-'99
post-1942?
post 1999
post-'76
pre-'00
c1*
post 1976
pre-2000
post-1942
pre-1977
Highest Ba and Ag in reach
pre-1977
post-1942
*8/21/11 deposits: 10 cm cs + gravel on c1, 0 cm on c2, local scour + 10-19 cm on c3, scour + 6 cm ms on f1?c3?, 6 cm ashy vfs+fs+pumice on Qt
Qal
Height above 8/11/11 channel (m)
2.0
1.0
0.0
-1.0
0
2
4
6
8
Distance (m)
12
14
16
18
20

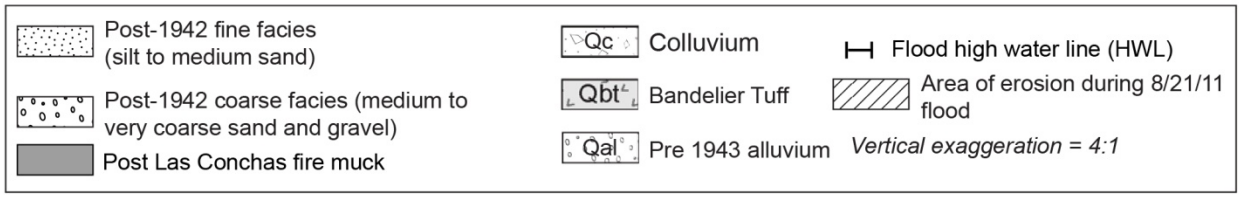

Post-1942 fine facies (silt to medium sand)
Post-1942 coarse facies (medium to very coarse sand and gravel)
Post Las Conchas fire muck (8/3/11 flood)
Qc
Colluvium
Qbt
Bandelier Tuff
Qal
Pre 1943 alluvium
Flood high water line (HWL)
Area of erosion during 8/21/11 flood
Vertical exaggeration = 4:1

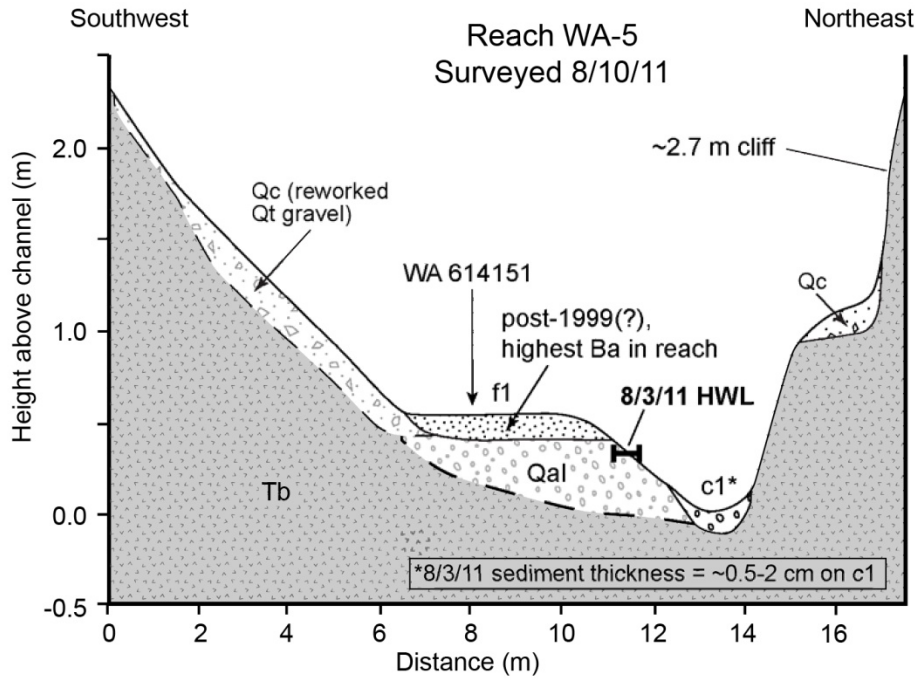

Reach WA-4, Cross section #1
Surveyed 8/10/11
8/3/11 flood event overflowed upstream, flowed down road and re-entered channel at WA-4 cross section #1 location, resulting in flood deposits on f1 that are above the 8/3/11 HWL observed in the main channel
Southwest
Northeast
WA-613154 & WAT-001
Ponderosa ca. 1930 A.D.
19 cm burial
WA-613156 & WAT-002
Ponderosa ca. 1933 A.D.
25 cm burial
WA4-s8 (projected)
pre-1943 ponderosa
9 cm burial
WA-613155
pre-1943 (?) juniper
26 cm burial
8/3/11 HWL
(main channel)
Qt
f1
f1*
c1*
c2*
Qal
Qc
Tb
post-1942?
post-1999?
*8/3/11 muck thickness <0.1 cm on c1, approx. 4 cm on c2, 2 to 3 cm on f1N
Height above channel (m)
Distance (m)
Surveyed 6/27/12
8/21/11 HWL (projected from ~10 m southwest of section)
Ashy vfs-fs
(8/21/12)
Height above 8/10/11 channel (m)
*8/21/11 deposits: 5 cm (?) gravel + cobbles on c1, c2 partially or entirely stripped, f1 partially stripped + 0-2 cm ashy vfs, 2-5 cm ashy vfs on Qt and Qc
Post-1942 fine facies (silt to medium sand)
Post-1942 coarse facies (medium to very coarse sand and gravel)
Post Las Conchas fire muck (8/3 and 8/21/11 flood deposits)
Colluvium
Bandelier Tuff
Pre 1943 alluvium
Flood high water line (HWL)
Area of erosion during 8/21/11 flood
Vertical exaggeration = 4:1

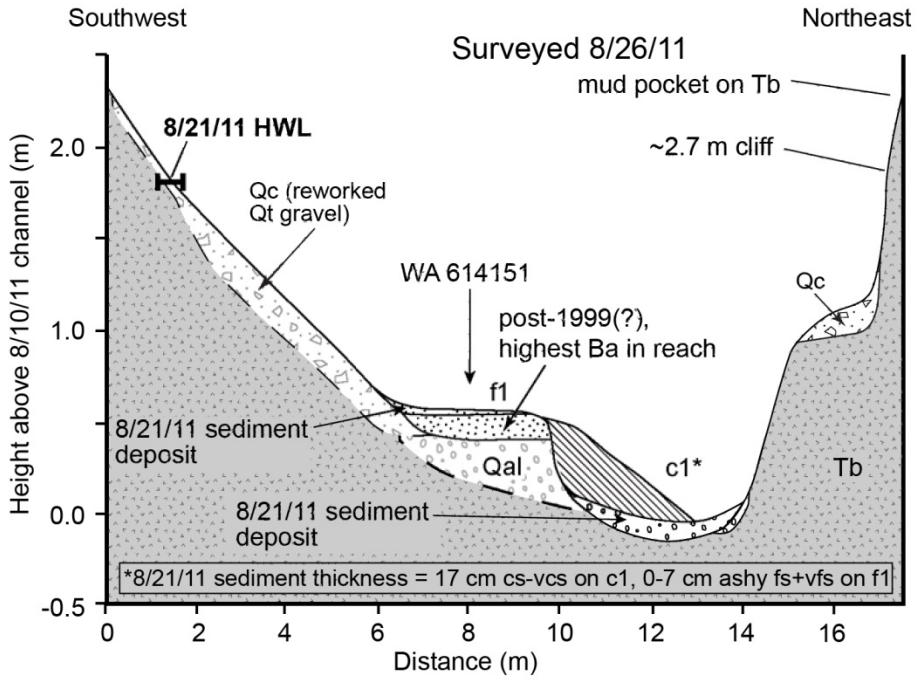

Southwest
Northeast
Reach WA-4, Cross section #2
Surveyed 8/11/11
Height above channel (m)
2.0
1.0
0.0
8/3/11 HWL
WA-10032
(projected)
WA-10031
(projected)
post-1999
Qty
Qto
f1
c2
pre-2000
c1*
pre-2000, highest Ba in reach
Qal
Tb
Tb
*8/3/11 muck thickness ~0.1 cm on c1
0
2
4
6
8
10
12
14
16
18
20
22
Distance (m)
Southwest
Northeast
Surveyed 6/27/12
8/21/11 HWL
(on slope SW of section)
Height above 8/11/11 channel (m)
2.0
1.0
0.0
Qto
Ashy vfs + woody
debris/pine needles
8/21/11
Ashy vfs
(8/21/11)
vfs
(8/21/11)
post-1999
Qty
f1
c2
pre-2000
c1*
pre-2000, highest Ba in reach
Qal
Tb
Tb
*8/21/11 deposits: 0 cm on c1 (stripped),
c2 partially scoured, 4 cm ashy vfs on
f1, 4 cm vfs on Qty, 13 cm ashy vfs + 9
cm pine needles/woody debris on Qto
0
2
4
6
8
10
12
14
16
18
20
22
Distance (m)
Post-1942 fine facies
(silt to medium sand)
Post-1942 coarse facies (medium to
very coarse sand and gravel)
Post Las Conchas fire muck (8/21/11 flood)
Qc
Colluvium
Qbt
Bandelier Tuff
Qal
Pre 1943 alluvium
Flood high water line (HWL)
Area of erosion during 8/21/11
flood
Vertical exaggeration = 4:1

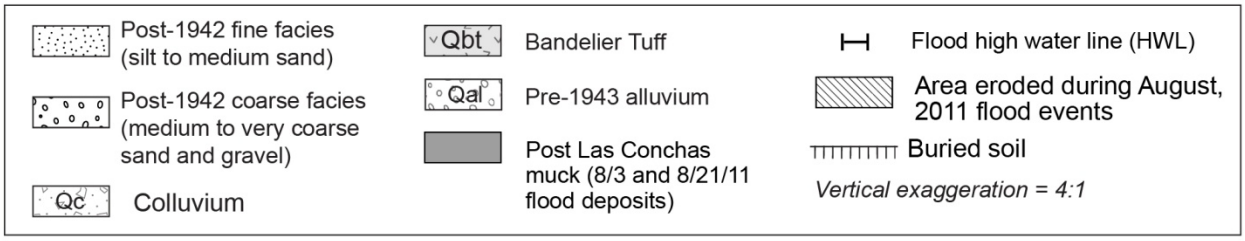

Southwest
WA-4W
Surveyed 8/10/11
Northeast
Qt
WA-614134,
WA-614133
(projected)
8/3/11 HWL
f1*
f1*
post-1999
post-1999 c2*
post-1976? pre-2000, highest Ba in reach
c1*
post-1942, pre-1977, highest Ag in reach
post-1976,
pre 2000
Qal
post-1999
*8/3/11 muck thickness <0.1 cm
on c1, 2-3 cm on c2, 2-6 cm on f1
Height above channel (m)
2.0
1.0
0.0
-1.0
0
2
4
6
8
10
12
Distance (m)


Southwest
WA-4W
Surveyed 8/10/11
Northeast
8/21/11 HWL
Qt
WA-614134,
WA-614133
(projected)
f1*
f1*
c2*
post-1999
post-1999
post-1976? pre-2000, highest Ba in reach
c1*
post-1942, pre-1977, highest Ag in reach
post-1976,
pre 2000
Qal
*8/21/11 deposits: 0 (scoured) to
>13 cm fs-ms + some cs on f1, c1
scoured + 11 cm ashy cs+g, 11
cm ashy fs-ms+pumice gravel
Height above 8/10/11 channel (m)
2.0
1.0
0.0
-1.0
0
2
4
6
8
10
12
Distance (m)


Post-1942 fine facies
(silt to medium sand)
Post-1942 coarse facies (medium to
very coarse sand and gravel)
Post Las Conchas fire muck
Qc
Colluvium
Qbt
Bandelier Tuff
Qal
Pre 1943 alluvium
Flood high water line (HWL)
Area of erosion during 8/21/11
flood
Vertical exaggeration = 4:1


Southwest
Northeast
Reach WA-5
Surveyed 8/10/11
Height above channel (m)
2.0
1.0
0.0
-0.5
~2.7 m cliff
Qc (reworked
Qt gravel)
WA 614151
post-1999(?),
highest Ba in reach
Qc
f1
8/3/11 HWL
Qal
Tb
c1*
*8/3/11 sediment thickness = ~0.5-2 cm on c1
0
2
4
6
8
10
12
14
16
Distance (m)


Southwest
Northeast
Surveyed 8/26/11
mud pocket on Tb
8/21/11 HWL
~2.7 m cliff
Height above 8/10/11 channel (m)
2.0
1.0
0.0
-0.5
Qc (reworked
Qt gravel)
WA 614151
post-1999(?),
highest Ba in reach
Qc
f1
8/21/11 sediment
deposit
Qal
c1*
Tb
8/21/11 sediment
deposit
*8/21/11 sediment thickness = 17 cm cs-vcs on c1, 0-7 cm ashy fs+vfs on f1
0
2
4
6
8
10
12
14
16
Distance (m)


Post-1942 fine facies
(silt to medium sand)
Post-1942 coarse facies
(medium to very coarse
sand and gravel)
Qc
Colluvium
Qbt
Bandelier Tuff
Qal
Pre-1943 alluvium
Post Las Conchas
muck (8/3 and 8/21/11
flood deposits)
Flood high water line (HWL)
Area eroded during August,
2011 flood events
Buried soil
Vertical exaggeration = 4:1

Appendix D

Photographs



Log jam in reach CDV-1C



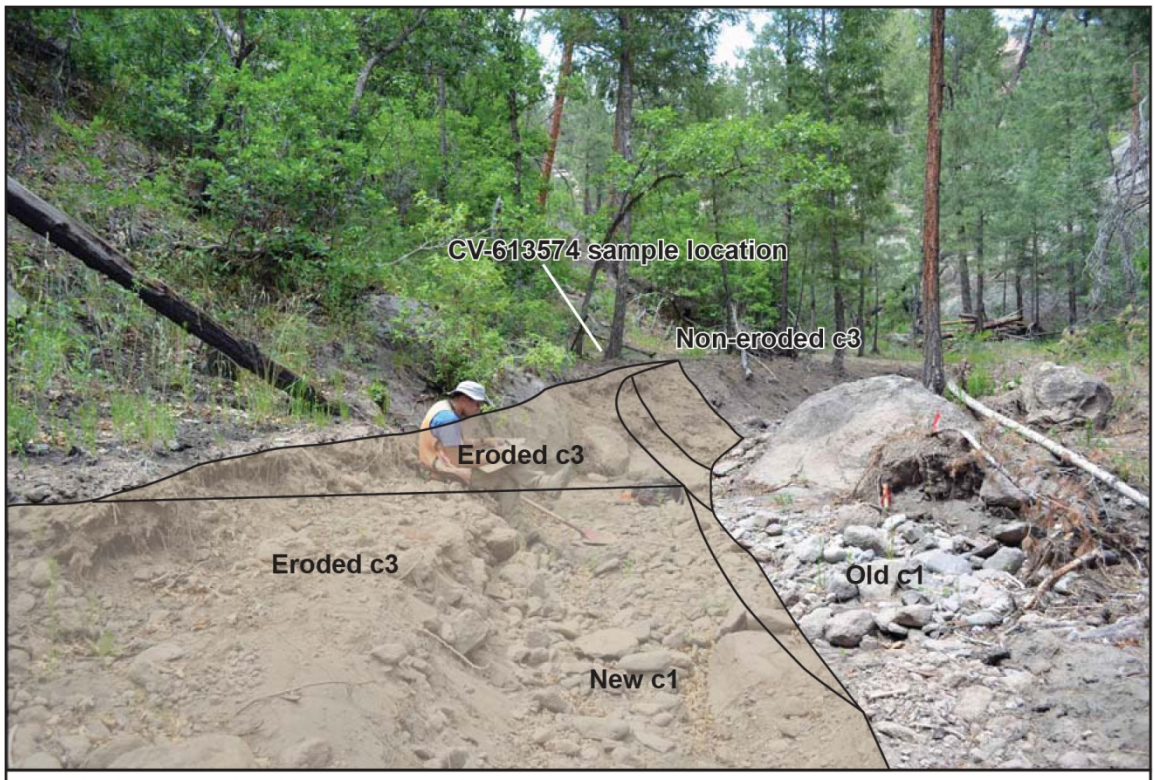
Cobble to boulder gravel deposit upstream of log jam in reach CDV-1C



Post-Las Conchas muck layer in reach CDV-2W



Measuring cross section #2 in reach CDV-3 with a tape measure, hand level, and stadia rod.



Partially eroded c3 in reach CDV-3



Former c1 surface, scoured to bedrock by 8/21/11 flood in reach CDV-3. Dashed line and coloration change on bedrock surface shows pre-flood sediment thickness.



Erosion of f1 to expose Qal in reach WA-2. Cobbles/boulders in channel were deposited during 8/21/11 flood event.



Eroded channel at cross section location, reach CDVS-1



Log jam in reach WA-3



Coarse sediment deposited in the 8/21/11 flood in reach WA-3 upstream of log jam



Thin (3 cm) post-Las Conchas fine sediment deposit on intact pre-fire f1 surface in reach WA-4. Note that sample stake and visquene emplaced during pre-fire sampling event are both intact.



Thin (6 cm) post-Las Conchas fine sediment (ashy, silty vfs + organic matter) overlying pre-Las Conchas fine sediment on f1 surface at (intact) sample location WA-614136 in reach WA-4W. In WA-4W f1 is commonly overlain by up to 20 cm of post-Las Conchas fine- to coarse-grained sand and small gravel.