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DEPARTMENT OF ENERGY

Environmental Management Los Alamos Field Office (EM-LA)
Los Alamos, New Mexico 87544

April 6, 2020

EMLA-2020-1290-02-001

Mr. Kevin Pierard
Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6313

Subject: Submittal of the 2019 Monitoring Report for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project

Dear Mr. Pierard:

Enclosed please find two hard copies with electronic files of the "2019 Monitoring Report for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project." This annual monitoring report assesses overall performance of the mitigation efforts installed in the Los Alamos and Pueblo watershed since 2007. Evaluations of precipitation, storm water discharge, and constituent concentrations obtained in 2019 were used to determine the effects of mitigations installed over the years. The "2018 Monitoring Report for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project" was approved with minor comments by the New Mexico Environment Department (NMED) on July 11, 2019.

Pursuant to Section XXIII.C of the Compliance Order on Consent, a pre-submission review meeting was held with the U.S. Department of Energy Environmental Management Los Alamos Field Office (EM-LA); Newport News Nuclear BWXT-Los Alamos, LLC (N3B); and NMED on December 17, 2019, to discuss changes in monitoring requirements for 2020.

If you have any questions, please contact Amanda White at (505) 309-1366 (amanda.white@em-la.doe.gov) or Cheryl Rodriguez at (505) 257-7941 (cheryl.rodriguez@em.doe.gov).

Sincerely,

For: Stephen C. Hoffman

Arturo Q. Duran
Compliance and Permitting Manager
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1. Two hard copies with electronic files – 2019 Monitoring Report for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project (EM2020-0019)

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March 2020
EM2020-0019

2019 Monitoring Report for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project

N3B Los Alamos

March 2020
EM2020-0019

2019 Monitoring Report for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project

March 2020

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EXECUTIVE SUMMARY

This tenth annual monitoring report provides a summary of analytical data, discharge measurements, geomorphic changes, and precipitation data associated with storm water samples collected from the Los Alamos/Pueblo (LA/P) watershed from June to November 2019. Monitoring objectives include collecting data to evaluate the effect of watershed mitigations installed in the LA/P watershed on stream flow and sediment and contaminant transport. Watershed mitigations evaluated include the Delta Prime (DP) Canyon grade-control structure (GCS) and associated floodplains; the Pueblo Canyon drop structure, willow planting, wetland, and GCS; the Los Alamos Canyon low-head weir and associated sediment detention basins; and the storm water detention basins and vegetative buffer below the Solid Waste Management Unit 01-001(f) drainage in Los Alamos Canyon. Pursuant to Section VII of the 2005 Compliance Order on Consent (Consent Order), Los Alamos National Laboratory (the Laboratory) had implemented interim measures to reduce the migration of contaminants within the LA/P watershed. These mitigations have been implemented with the overall goals of minimizing the potentially erosive nature of storm water runoff, enhancing deposition of sediment, and reducing access of contaminated sediments to storm water. Appendix B of the 2016 Consent Order requires the submission of this annual monitoring report to the New Mexico Environment Department.

Gaging station and sampling locations within the LA/P watershed monitor the hydrology and sediment transport, including stations that bound the mitigation sites. Stage height/discharge is monitored at 5-min intervals at a series of gaging stations. Precipitation data are collected across the Laboratory by means of 5 meteorological towers and an extended network of 14 precipitation gages. Sampling for analytical suites specific to each reach of the watershed is conducted using portable automated samplers. Sampling equipment and the extended rain gage network are deactivated during the winter months (December to April) and reactivated in the spring.

Attenuation of flow and associated sediment transport are primary goals of the sediment transport mitigation activities. Decreasing flow velocity allows for increased infiltration, thus reducing peak discharge, reducing the distance the flood bore travels downstream, and reducing the distance sediment and associated contaminants entrained in the storm water travel downstream. In DP Canyon, the GCS and associated floodplains between gaging stations E038 and E039.1 facilitated a significant reduction in the suspended sediment being transported downstream. In Pueblo Canyon, the wetland, willows, drop structure, and GCS between gaging stations E059.5 and E060.1 facilitated such a reduction in peak discharge that storm water runoff at E060.1 was not large enough to sample. In Los Alamos Canyon, a reduction in peak discharge, runoff volume, and sediment yield transmission downstream between E042.1 and E050.1 was due to the low-head weir and associated sediment detention basins between the two gaging stations. The 2019 monitoring data in the LA/P watershed indicate that, in general, the mitigations are performing as designed.

Geomorphic changes are monitored at one background area, five sediment transport mitigation sites, and two sediment detention basin areas that have been established in the LA/P watershed. The bank and thalweg surveys and repeat photographs support the conclusion of overall stability of the banks and channels in Pueblo, DP, and Los Alamos Canyons and establish the geomorphic change between 2018 and 2019 as minor, indicating that the watershed mitigations are performing as designed.

Based on the correlations between concentrations of metals, radioisotopes, and polychlorinated biphenyls (PCBs) in unfiltered storm water and suspended sediment concentration presented in the “2015 Monitoring Report for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project,” in 2016 the Laboratory removed certain constituents from storm water monitoring at Los Alamos and Pueblo watershed gaging stations E026, E030, E038, E039.1, E040, E042.1, E055, E055.5, E056, E059.5, and E059.8. Unfiltered target analyte list metals (as well as isotopic uranium, gross beta, and radium-226/228) at E050.1 and

E060.1 continue to be monitored in response to the 2017 memorandum of understanding between the U.S. Department of Energy and the Buckman Direct Diversion Board. Dissolved metals, total selenium, total mercury, and total recoverable aluminum (after filtration using a 10-µm pore size filter) continue to be monitored because these dissolved and total metals have numeric criteria applicable to achieving designated and attainable uses given in 20.6.4 New Mexico Administrative Code. Silver in unfiltered storm water in Acid and Pueblo Canyons and total PCBs and certain isotopic radionuclides in unfiltered storm water will continue to be monitored.

Continued monitoring in 2020 is expected to confirm the sediment transport mitigations in the LA/P watershed are performing as designed.

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1.0 INTRODUCTION

Los Alamos National Laboratory (LANL or the Laboratory) is a multidisciplinary research facility owned by the U.S. Department of Energy (DOE) and managed by Triad National Security, LLC. The Laboratory is located in north-central New Mexico approximately 60 mi northeast of Albuquerque and 20 mi northwest of Santa Fe. The Laboratory site comprises an area of approximately 36 mi^2, mostly on the Pajarito Plateau, which consists of a series of mesas separated by eastward-draining canyons. It also includes part of White Rock Canyon along the Rio Grande to the east.

This tenth annual monitoring report summarizes analytical data, discharge measurements, and precipitation data associated with storm water collected from the Los Alamos and Pueblo (LA/P) watershed from June to November 2019; reports on geomorphic changes during 2019 at the sediment transport mitigation sites in the LA/P watershed; and documents watershed mitigation inspections in 2019. Appendix A includes acronyms and abbreviations. Appendix B addresses geomorphic and wetland changes in 2019, and Appendix C provides photographic documentation of watershed mitigation inspections. Appendix D (on CD included with this document) presents analytical results for 2019, along with gaging station stage and discharge data. This monitoring was initially stipulated by the New Mexico Environment Department (NMED) approval with direction for the “Los Alamos and Pueblo Canyons Supplemental Investigation Report,” which states that “The Permittees must install surface water monitoring stations below each newly-installed weir and develop a monitoring plan to evaluate each weir’s effectiveness” (NMED 2007, 098284). Subsequent proposed mitigation and monitoring efforts were identified and implemented per the approved “Interim Measure Work Plan to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons” (hereafter, the IMWP) (LANL 2008, 101714; NMED 2008, 103007) and the approved “Supplemental Interim Measures Work Plan to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons” (hereafter, the SIMWP) (LANL 2008, 105716; NMED 2009, 105014). Monitoring in 2019 was performed in accordance with the “2019 Monitoring Plan for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project” (N3B 2019, 700418).

Monitoring objectives include collecting data to evaluate the effect of watershed mitigations installed in the LA/P watershed on stream flow and sediment and on contaminant transport. The discussion of flow and analytical results for suspended sediment and constituent concentrations focuses on an evaluation of the overall performance of the watershed, with specific emphasis on the effects of the mitigations implemented per the IMWP and SIMWP. The discussion in Appendix B of geomorphic stability focuses on sediment stability and mobility in the watershed as a measure of the overall stability of the watershed and the performance of the sediment-mitigation structures.

The NMED approval with modifications for the 2013 monitoring plan for sediment transport mitigation (LANL 2013, 243432; NMED 2013, 523106) also directed the Laboratory to monitor storm water above and below the detention basins below the Solid Waste Management Unit (SWMU) 01-001(f) drainage in upper Los Alamos Canyon. Watershed mitigations evaluated in this report include the Delta Prime (DP) Canyon grade-control structure (GCS) and associated floodplains; the Pueblo Canyon drop structure, willow plantings, wetland, and GCS; the Los Alamos Canyon low-head weir and associated sediment detention basins; and the storm water detention basins and associated vegetative buffer below the SWMU 01-001(f) drainage in Los Alamos Canyon.

Work began in 2014 to rehabilitate and mitigate damage to the Pueblo Canyon wetlands, GCS, and gaging station E060.1 from the September 2013 flooding. Work accomplished in 2014 included planting willows below the wetlands; planting canary reed grass; installing piezometer transects to record water levels and willow performance; stabilizing the local banks; and undertaking Phase I post-flooding mitigation activities at gaging station E060.1, including armoring of the north bank directly downstream of the flume and stabilizing select banks. Work accomplished in 2015 included installing a drop structure at the Pueblo Canyon wetland headcut; installing gaging station E059.8 equipped with a v-notch flume; undertaking Phase II of gaging station E060.1 post-flooding mitigations, including redirecting the channel; installing spurs for bank protection; contouring the area around the gaging station; installing erosion protection measures at the downstream side of both the existing Pueblo Canyon GCS and gaging station E060.1; and constructing an access road.

Key constituents of concern in the watershed addressed in this monitoring report include radionuclides. Corrective actions at the Laboratory are subject to the 2016 Compliance Order on Consent (Consent Order). Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to NMED in accordance with DOE policy.

1.1 Project Goals and Methods

The mitigations specified in the IMWP and SIMWP have been implemented with the overall goal of minimizing the potentially erosive nature of storm water runoff to enhance deposition of sediment and to reduce or eliminate the susceptibility of contaminated sediments to flood erosion. Figures 1.1-1 and 1.1-2 show the locations of the mitigation and monitoring stations, including stream gaging stations, in the LA/P watershed. Mitigation/rehabilitation measures performed in 2014 and 2015 in response to the September 2013 floods are discussed in this report because these measures have become integral to the LA/P watershed monitoring. In the Pueblo Canyon watershed, the central focus of the mitigations is to maintain a physically, hydrologically, and biologically functioning wetland that can reduce peak flows and trap suspended sediment because of the presence of thick wetland vegetation. Stabilization and enhancement of the wetland were partially addressed with the installation of a GCS designed to inhibit headcutting below the terminus of the wetland and to promote the establishment of additional riparian or wetland vegetation beyond the current terminus of the wetland. Mitigations in upper portions of Pueblo Canyon above the wetland are designed primarily to reduce the flood peaks and to enhance channel/floodplain interaction before floods reach the wetland. Gaging stations are situated within the watershed to monitor the overall hydrology and sediment transport along the length of the watershed, including stations that bound the wetland.

In DP and Los Alamos Canyons, mitigations included stabilizing and partially burying the channel and adjacent floodplains in upper DP Canyon, which is a source of contaminants entrained in frequent floods that originate from a portion of the Los Alamos townsite. A GCS was installed with a height that encourages channel aggradation, thus reducing the potential for erosion of contaminated sediment deposits in adjacent banks during floods. Channel aggradation should also encourage the spreading of floodwaters, thereby reducing peak discharge because of transmission loss within the reach and thus enhancing sediment deposition. Lower flood peaks should also reduce the erosion of contaminated sediment deposits downcanyon of the DP GCS. Mitigations in Los Alamos Canyon several kilometers below the DP Canyon confluence involve removing accumulated sediment behind the Los Alamos Canyon low-head weir to increase the residence time of floodwaters and to enhance settling of suspended sediment and associated contaminants. (Sediment removal in Los Alamos Canyon was performed in April 2014 but not in 2015, 2016, 2017, 2018, or 2019 because not enough sediment had accumulated to warrant its removal.)

Additional mitigations were implemented in Los Alamos Canyon under a separate administrative requirement (LANL 2008, 104020; NMED 2009, 105858) to address polychlorinated biphenyl (PCB) contamination associated with SWMU 01-001(f). The mitigation actions at that location involved removing contaminated sediment from the hillslope and constructing detention basins and a willow-planted vegetation buffer at the bottom of the associated hillside drainage to promote the settling of PCB-contaminated sediments in runoff from the upgradient PCB-contaminated hillslope drainage. In addition, a pipeline was installed in 2015 under the National Pollutant Discharge Elimination System (NPDES) Permit NM0030759 (the Individual Permit) to divert townsite runoff around SWMU 01-001(f).

Inspections of all watershed mitigations are performed on a routine basis and after significant flow events (greater than 50 cubic feet per second [cfs] at locations with gaging stations or greater than 0.5 in. in 30 min at locations without gaging stations). These inspections are completed to ensure the watershed mitigations are functioning properly and to identify if maintenance may be required. Appendix C contains photographs and descriptions of each inspection and associated information.

2.0 MONITORING IN THE LA/P WATERSHED

2.1 Discharge and Precipitation Measurements and Sampling Activities

Discharge was measured and surface water sampling was attempted at 13 gaging stations in the LA/P watershed in 2019. Gaging stations with concrete, trapezoidal, supercritical-flow flumes are designated Los Alamos below Low Head Weir (E050.1), Pueblo below Grade Control Structure (E060.1), DP below Grade Control Structure (E039.1), and Los Alamos above Low Head Weir (E042.1). Nine other gaging stations that complete the monitoring network in the LA/P watershed are designated as Pueblo above Acid (E055), South Fork Acid Canyon (E055.5), Acid above Pueblo (E056), Los Alamos below Ice Rink (E026), Los Alamos above DP Canyon (E030), DP above TA-21 (E038), E059.5 Pueblo below LAC WWTF (E059.5), E059.8 Pueblo below Wetlands (E059.8), and DP above Los Alamos Canyon (E040). Figure 1.1-2 shows the locations of stream gaging stations and watershed mitigations within the Laboratory's property boundary and on adjacent land owned by the County of Los Alamos.

Stage height was monitored at each LA/P gaging station at 5-min intervals in the LA/P watershed. Sutron 9210 data loggers stored each recorded stage-height measurement as it was made. Discharge was computed for each 5-min stage measurement using rating curves for each individual gaging station. Log check dams in Acid Canyon just below E055.5 installed in 2017 caused the channel bed to fluctuate significantly through 2017. In March 2018, the gage station at E055.5 was relocated 35 feet upstream to a more stable location (Figure 2.1-1). At the beginning of the 2019 sampling season one cross-section at the new gage station's sensor location and the channel slope were surveyed before any flows in order to calculate a stage height for the sampling trip level. The survey data were used to calculate multiple discharge measurements at different stage heights using the Manning's formula to create a rating curve.

$$V = \frac{1}{n}\, s^{1/2}\, R^{2/3} \qquad \textbf{Equation 1}$$

Where *V* = the mean velocity of the flow,

s = the slope of the channel,

R = the hydraulic radius of the cross-section of the channel, and

n = the roughness coefficient.

Though this is a proper method to create a rating curve, it is not as robust as surveying multiple cross-sections and using the survey data in a Hydrologic Engineering Center River Analysis System (HEC-RAS) model from the U.S. Army Corps of Engineers (USACE 2008, 109517; USACE 2008, 109518), which was the method used for all other stations. A more robust survey and rating curve will be created in 2020. Shaft-encoder float sensors installed in stilling wells were used to measure water levels at E042.1, E050.1, and E060.1. Self-contained bubbler pressure sensors (Sutron Accubar) were used to measure water levels at E059.5 and E059.8, and at E055 and E056 for part of the year, and to provide backup sensing at E042.1, E050.1, and E060.1. Radar sensors were used to measure water levels at

E026, E030, E038, E039.1, E040, and E055.5; and at E055 and E056, where the radar sensors replaced the bubbler pressure sensors partway through the monitoring season; and to provide backup sensing at E042.1, E050.1, and E060.1.

A complete record of 5-min stage-height measurements for the monitoring period from June 1, 2019, to October 31, 2019, exists at E026, E030, E038, E039.1, E040, E042.1, E050.1, E055, E055.5, E056, E059.5, E059.8, and E060.1. Appendix D contains the 5-min gaging station stage and discharge data for the LA/P watershed.

Programs that monitor storm water at the Laboratory use precipitation data collected at the Laboratory's meteorological towers. Figure 2.1-2 shows total precipitation for each month from 2013 to 2019 averaged over Laboratory sites; annual heterogeneity and increase in precipitation occurs during the summer monsoon. In addition, a seasonal, extended rain gage network is deployed from April to November to coincide with storm water monitoring periods. Storm water monitoring stations are assigned to individual rain gages by means of a geographic information system (GIS) using the method of Thiessen polygons. Rain gages, meteorological towers, Thiessen polygons and the drainage area for each stream gaging station associated with the LA/P watershed are presented in Figure 2.1-3.

Sampling was conducted using ISCO 3700 portable automated samplers. Two ISCO samplers were installed at each of the following locations: E038, E039.1, E042.1, E050.1, E059.5, E059.8, and E060.1. At locations where two samplers were installed, one sampler was configured with a 24-bottle carousel to monitor primarily suspended sediment, and the second sampler was configured with a 12-bottle carousel to monitor inorganic and organic chemicals and radionuclides. At locations where a single sampler was installed, the sampler was configured with a 12-bottle carousel to monitor suspended sediment, inorganic and organic chemicals, and radionuclides. Sampler intake lines were set above the bottom of the channel or flume and were placed perpendicularly to the direction of flow. Trip levels (in discharge) and the dates during which the trip levels were active are presented in Table 2.1-1.

Sampling equipment at gaging stations in the LA/P watershed was shut down during the winter months and reactivated in the spring. Automated samplers and equipment at gaging stations were inspected at least monthly for all of 2019. Gaging station equipment at E050.1 and E060.1 was inspected weekly throughout the year. Equipment found to be damaged or malfunctioning was repaired within 4 business days after the problem was discovered, with the exception of E056. The bubbler pressure sensor malfunctioned but the problem was not immediately diagnosed. The bubbler pressure sensor was replaced with a radar sensor 27 working days after it malfunctioned. Equipment at the 13 LA/P gaging stations was connected via telemetry to a base station, allowing real-time access to discharge measurements and battery state of charge. Inspectors reviewed telemetry daily to ensure gaging stations were functioning correctly, and gaging stations and samplers were inspected in the field when telemetry readings indicated discharge had occurred or equipment problems existed. Additionally, flumes at E039.1, E042.1, E050.1, and E060.1 were inspected for sedimentation after each discharge event and cleaned within 5 workdays after sedimentation was noted.

2.2 Sampling at the Detention Basins below the SWMU 01-001(f) Drainage

In 2019, samples were collected during two storm water sampling events with an automated sampler above two constructed detention basins below the SWMU 01-001(f) drainage at location CO111041. No samples were collected downgradient of the detention basins at the culvert at the terminus of the vegetative buffer below the lower basin (CO101038) because the detention basins would have to be near capacity to collect a sample. Sampling locations and storm water control features at the detention basins below the SWMU 01-001(f) drainage are identified in Figure 2.2-1. No physical evidence of storm water flow across the lower basin spillway was observed during post-storm inspections in 2019.

2.3 Sampling at the Gaging Stations in the LA/P Watershed

During the 2019 monitoring period (June 1 to approximately October 31), the sample-triggering discharge (5 cfs above base flow at E026, E050.1, E059.5, E059.8, E060.1; 100 cfs at E038; and 50 cfs at the other gaging stations) was exceeded during 5 storm events occurring on 6 days as presented in Table 2.3-1. No precipitation events exceeding a sample-triggering discharge occurred before June 1 or after October 31. A total of 13 sampling events occurred during the monitoring period at LA/P gaging stations. A sampling event is defined as the collection of 1 or more samples from a specific gaging station during a specific runoff event. Maximum daily discharge at all gaging stations on days when the sample-triggering discharge is exceeded is presented in Table 2.3-1. Table 2.3-1 also summarizes the runoff events sampled at each gaging station. Reasons that storm water was not collected during particular storm events are categorized and presented in Table 2.3-2. Deviations from the monitoring plan are explained more fully in section 2.5.

2.4 Samples Collected in the LA/P Watershed

Sample suites presented in the monitoring plan vary according to the monitoring location and are based on key indicator constituents, as well as requirements stipulated by NMED and per the 2017 memorandum of understanding between DOE and the Buckman Direct Diversion Board (BDDB) (DOE and BDD Board 2017, 602995) for a given portion of the watershed. Analyses obtained from storm water collected at sampling locations are presented in Table 2.4-1. In cases where insufficient water was collected to perform all planned analyses, analyses were prioritized in the order presented in Table 2.4-1. Up to 24 samples per event were collected for suspended sediment analysis from a single ISCO sampler containing a 24-bottle carousel at the lower gaging stations (E042.1, E050.1, E059.5, and E060.1) and upper DP Canyon gaging stations (E038 and E039.1) (Figures 1.1-2 and 2.1-3). Suspended sediment analyses at all other locations were obtained from the first and last sample in an ISCO sampler containing a 12-bottle carousel. Suspended sediment analyses were conducted using American Society for Testing and Materials (ASTM) method D3977-97, from an entire sample, and reported using the designation Suspended Sediment Concentration (SSC).

The U.S. Environmental Protection Agency (EPA) target analyte list (TAL) dissolved metals were analyzed in filtered samples at all locations. Total mercury, selenium, and uranium were analyzed in unfiltered samples at all locations. Other required analyses were conducted from unfiltered samples. Sample collection times were recorded for each individual sample bottle filled, which allowed more precise estimation of discharge and SSCs at the time samples were collected.

Analyses were conducted using the analytical methods presented in Table 2.4-2. Table 2.4-1 presents the prioritization matrix that was used to guide the submission of analyses during 2019. Except at E050.1 and E060.1, where all events are monitored for all parameters, if four runoff events have been sampled at a gaging station during the monitoring year, subsequent events with discharge less than the largest discharge of the sampled storm events will not be analyzed.

Analyses planned and analyses performed differ during the year for several reasons including the following:

1. Incomplete sample volumes were collected.
    a. Minimum volumes are required to obtain specified detection limits. If the volumes were insufficient, select analyses were not performed.
    b. Lowest-priority analyses are omitted when incomplete volumes are collected.

2. Samples are collected in glass or polyethylene bottles.
    a. Organic chemical analyses are conducted on samples collected in glass bottles and if glass bottles did not fill, analyses were not performed.
    b. Boron was analyzed as an addition to the TAL metal suite, and samples were collected in polyethylene bottles. If sufficient volume was not collected in polyethylene bottles, then boron analyses were not ordered.

2.5 Deviations from Monitoring Plan

The 2019 monitoring plan calls for samples to be retrieved from the field within 1 business day of sample collection (LANL 2018, 603015). The interval between sample collection and sample retrieval is documented in Table 2.5-1. In cases where samples are not retrieved on the first business day after sample collection, the following priority order is used to collect samples:

- BDDB-related gaging stations E050.1 and E060.1: In 2019, three of three sampling events were collected within 1 business day.
- Gaging stations bounding watershed mitigations at E038, E039.1, E042.1, E059.5, and E059.8: In 2019, five of six sampling events were collected within 1 business day.
- Other gaging stations at E026, E030, E040, E055, E055.5, E056, CO101038, and CO111041: In 2019, four of four sampling events were collected within 1 business day.

In 2019, 13 sample sets were collected, retrieved, and analyzed from gaging stations and from the sampler at CO111041. Samples were collected 12 times within the first business day.

If the stage or discharge could not be correctly measured because of damage or silting that occurred, these instances are documented in Table 2.5-2.

Battery voltage, stage height, and sensor function at each active gaging station were remotely monitored daily. An on-site inspection was performed if any malfunction or sample collection event was observed. Samplers and monitoring equipment were physically inspected initially in May and at least monthly between June 1, 2019, and November 2019

In 2019, Newport News Nuclear BWXT-Los Alamos, LLC (N3B) planned to analyze samples collected from gaging stations E050.1 and E060.1 for TAL metals in the sample-sediment fraction on a dry-weight basis. Sediment concentrations in samples from these gaging stations in 2019 were insufficient for this analysis.

3.0 WATERSHED HYDROLOGY

The topography, geology, geomorphology, and meteorology of the LA/P watershed are quite complex and include mesas, canyons, and large-elevation gradients; alluvium, volcanic tuff, pumice, and basalt; ephemeral streams, evolving stream networks (both laterally and vertically), and sediment-laden stream discharge; winter snowfall that can create spring snowmelt; intense summer monsoonal rainfall and occasional late-summer to fall tropical storm activity; and severe spatial variability of rainfall. Consequently, monitoring of the LA/P watershed runoff is also complex and challenging.

3.1 Drainage Areas and Impervious Surfaces

The drainage area specific to each gaging station (i.e., not nested) was developed using the ArcHydro Data Model in ArcGIS, and these drainage areas are presented in Figure 2.1-3. Model inputs were developed using an elevation grid created from 1-ft light detecting and ranging (LiDAR) images (a digital elevation model from 2014) and manual site-specific controls based on field assessments. Each drainage area defines the area that drains to the particular gaging station from either the next upstream gaging station or the headwaters of the watershed.

The impervious surface area was derived from the Los Alamos County's roads and structures GIS layers. Roads, parking lots, and structures were considered impervious, and the total impervious area was computed for each watershed. The total impervious area was then divided by the total area of each watershed to compute the percent impervious surface area. The following assumptions were made in determining the percent impervious surface area: (1) the roads/parking lots and structures GIS layers were developed in 2009, and thus newer impervious surfaces will not be captured; (2) other impervious surfaces such as sidewalks and rock outcroppings may not have been included in the calculations. A significant factor in the frequency of discharge at each gaging station is the ratio of pervious to impervious surface area discharging to the gaging station or within the canyon drainage (Table 3.1-1).

3.2 Water and Sediment Transmission

Figure 3.2-1 is a flow diagram of the LA/P watershed showing each gaging station and the location of sediment transport mitigation sites. Figure 3.2-2 shows box-and-whisker plots of SSC for DP, Los Alamos, and Pueblo/Acid Canyons from up- to downstream over the past 7 yr of monitoring. As expected, Los Alamos Canyon had high concentrations of suspended sediment in 2013 as a result of the Las Conchas fire in 2011 and because there is less impervious area contributing to Los Alamos Canyon, thus making more sediment available for erosion. Large post-fire runoff events have tapered off since the fire and SSC magnitudes have returned to pre-fire levels. Sampled SSC levels in 2019 are higher than in recent years and similar to post-fire levels, but that is most likely due to SSC sampling from only the largest runoff events. The sampling trip levels at most gage stations in Los Alamos, DP, and Pueblo Canyons were significantly increased in 2019 to insure only the largest runoff events were sampled. SSC in DP and Pueblo/Acid Canyons is significantly less than in Los Alamos Canyon. Historical observations show that SSC in Los Alamos Canyon generally decreases from E026 to E050.1, particularly after flowing through the lower Los Alamos Canyon sediment detention basins and low-head weir (between E042.1 and E050.1). SSC then increases greatly after the Guaje Canyon confluence (E099), and decreases slightly at E109.9. Gaging station E109.9 was decommissioned after the September 2013 flood, and sampling has not been performed at E099 since 2014 because Guaje Canyon watershed is not impacted by the Laboratory; thus, sampling is not required as part of the LA/P monitoring efforts. In DP Canyon, SSC generally decreases from E038 to E039.1. This is most likely because of the large percentage of impervious area in the E038 watershed, causing high-velocity, high-erodibility flows that scour the channel between the townsite and E038; then the DP Canyon floodplains area and GCS decrease the flow velocity before it reaches E039.1, removing sediment. In 2019, SSC was collected at E038 and E039.1 on July 26 and August 7. SSC was not collected at E040 in 2019 because the sampler clogged with sediment when it attempted to sample both these flow events. July 26 and August 7 were the only flow events large enough to sample at E040. Both these flow events were sampled for SSC at E042.1 and E050.1. Gaging station E050.1 collected SSC during one more flow event on July 8. With large storm events, DP Canyon flows join Los Alamos Canyon to increase the flow velocity and SSC measured at E042.1, and the lower Los Alamos sediment detention basins and low-head weir remove sediment, reducing the SSC at E050.1.

In Acid Canyon, SSC decreases slightly from E055.5 to E056, most likely because of the largely impervious area associated with E055.5 and the largely pervious area associated with E056. In 2019, flow was not large enough to sample at E055.5, and E056 did not have any samples. Although the sensor at E056 was not functioning for part of the season, field measurements of high water marks indicate that no flow events were greater than 50 cfs. Acid Canyon joins Pueblo Canyon just below E056 in Acid Canyon and E055 in Pueblo Canyon. Historically, SSC has been slightly higher at E055 in Pueblo Canyon above this confluence then at E056. In 2019, there was only one flow event large enough to be sampled by E055, and it was not sampled. Gaging station E059.5 is located in lower Pueblo Canyon below this confluence with Acid Canyon and after other inputs from many other tributaries. In 2019, discharge at E059.5 exceeded the trip level of 5 cfs three times and was sampled once. From E059.8 to below the GCS at E060.1, SSC increased significantly in 2015; however, in the last 8 years, 2015 was the only year E060.1 experienced flow large enough to sample. In 2019, flow was not great enough to sample at E059.8 or E060.1.

For runoff events exceeding sampling triggers in 2019, Figure 3.2-3 shows hydrographs for Los Alamos, DP, and Acid/Pueblo Canyons from upstream to downstream. Table 3.2-1 summarizes the flood bore transmission downstream across the major sediment transport mitigations, including travel time of flood bore from the upstream to the downstream gaging station, peak discharges of the flood bore at the gaging station, and the percent reduction in peak discharge between the stations for every sampled runoff event in 2019. The flood bore is defined as the leading edge of the storm hydrograph as it transmits downcanyon, and peak discharge is the maximum 5-min instantaneous flow rate measured during a flood. The focus was on peak discharge because it is related to stream power, and in ephemeral streams in semiarid climates, the greater the stream power, the greater the erosive force, and hence the greater the sediment transport (Bagnold 1977, 111753; Graf 1983, 111754; Lane et al. 1994, 111757). As flood bores move from up- to downstream, peak discharge can either increase by means of alluvial groundwater and/or tributary contributions or decrease because of transmission losses (infiltration). During the August 7 runoff event, the peak discharge exceeded the rating curve for E038. A best-fit equation of the rating curve was used to calculate the peak discharge value. During the July 26 and August 8 runoff events the peak discharge decreased between E038 and E039.1, and historically this is the case; however, with the estimated peak discharge value for the August 7 flow event at E038, the peak discharge increased between the two stations. It is possible that the peak discharge value is underestimated.

Figure 3.2-4 shows the hydrograph and sedigraph for gaging stations E038, E039.1, E042.1, E050.1, and E059.5, which sampled through all or most of the duration of a runoff event plotted as time after the peak. Typically, SSC decreases through the hydrograph as energy dissipates and is highly correlated with discharge. At the end of the hydrograph and sedigraph for gaging station E038 during the August 7 runoff event, the SSC increases significantly while the discharge decreases. One likely explanation is that sediment deposition during the falling limb of the hydrograph raised the channel bed up to the opening of the sampler intake tube and potentially buried it, causing the sampler to pull sediment straight off the channel bed.

Figure 3.2-5 shows the linear relationship between sediment yield and runoff volume for the stations where SSC was measured throughout the runoff event over the past 7 yr of monitoring; Table 3.2-2 presents the 2013 through 2019 values shown in Figure 3.2-5. Although SSC and instantaneous discharge are not always highly correlated as a result of localized precipitation, sediment availability, or antecedent conditions, the linear relationship between sediment yield and runoff volume is well established (Onodera et al. 1993, 111759; Nichols 2006, 111758; Mingguo et al. 2007, 111756).

The runoff volume for each event was computed as follows:

$$V = \sum_{i=0}^{n} Q(t_i)(t_{i+1} - t_i) \quad , \qquad \textbf{Equation 2}$$

Where n = the number of instantaneous discharge measurements taken throughout the runoff event,

t_i = the time at which an instantaneous discharge measurement is taken, and

$Q(t_i)$ = the discharge (ft^3/s) at time t_i (multiplied by 60 to convert from ft^3/s to ft^3/min).

The mass of sediment for each runoff event was computed by

$$M = \sum_{j=0}^{m} Q(t_j)(t_{j+1} - t_j)\,SSC(t_j) \quad , \qquad \textbf{Equation 3}$$

Where m = the number of SSC samples taken throughout the storm event,

t_j = the time, j, at which an SSC sample is taken,

$Q(t_j)$ = the discharge (ft^3/s) at time t_j interpolated from the instantaneous discharge measurements taken at time t_j (multiplied by 60 to convert from ft^3/s to ft^3/min), and

$SSC(t_j)$ = SSC (mg/L) at time t_j (multiplied by 28.3×10^{-6} to convert from mg/L to kg/ft^3).

Figure 3.2-6 shows the linear relationship between sediment yield and peak discharge, which is not as robust as the relationship between sediment yield and runoff volume during the past 7 yr, shown in Figure 3.2-5.

3.3 Geomorphic Changes and Vegetation Health

Geomorphic changes that occurred from 2011 to 2019 at sediment transport mitigation sites in the LA/P watershed were evaluated and are discussed in Appendix B.

In 2019, new aerial survey techniques replaced previously implemented ground-based global positioning system (GPS) survey methods. Tetra Tech was contracted to survey Los Alamos, DP, and Pueblo Canyon areas of interest using airborne hyperspectral and LiDAR equipment to collect geomorphic and vegetation data. A baseline LiDAR aerial survey was performed in 2018, during which points were measured at a density at least equivalent to the 2016 LiDAR data set (18–24 points per m^2). The LiDAR surveys provided a detailed digital elevation model (DEM) of the entire active channel within the wetland area, allowing comparison with historic ground-based geomorphic survey data.

Vegetation features were surveyed using an AISA EAGLE II visible and near-infrared (VNIR) hyperspectral imaging sensor system affixed to a Cessna 172 Skyhawk. A total of 128 spectral bands for the VNIR were collected, producing a ground sampling distance of 0.5 m. Location and altitude data were collected by an Oxford Technical Solutions, Ltd., 2+ second-generation GPS.

Upon completion of airborne survey efforts, ground truthing was performed to identify reed canary grass, willow, and cattail. These data were used to develop a classification algorithm for the analysis of the hyperspectral data. Analysis resulted in seven target vegetation classes: reed canary grass, willow, cattail, mixed reed canary grass and willow, other vegetation, surface water, and non-vegetated.

3.4 Impact and Efficiency of Watershed Mitigations

Below is a discussion of each watershed mitigation and the impact and efficiency of that system.

DP Canyon: Sampling was performed in DP Canyon on August 7 above the GCS and upstream wetland (at E038); sampling below the GCS and upstream wetland (at E039.1) was performed on July 26 and August 7 (Table 2.3-1). SSC analyses performed from samples collected during these runoff events allow direct evaluation of the effect of the GCS and upstream wetland on flow and sediment transport (Figures 3.4-1 and 3.4-2). Sample collection began within 5 min of the flow volume exceeding the trip level: 100 cfs for E038 and 50 cfs for E039.1. On July 26 at E039.1 the runoff event had a calculated sediment yield of 5.5 yd^3 (E038 did not sample on July 26), and for E038 and E039.1, respectively, the calculated sediment yield is 30.5 yd^3 and 12.2 yd^3 on August 7 (Table 3.2-2). The sediment yield was reduced by 60% between these two stations, or from above to below the GCS/wetland, for the August 7 event.

Statistics over the past 7 yr of monitoring are also useful in assessing performance. Figure 3.4-1 shows box-and-whisker plots for E038 and E039.1 for SSC and peak discharge. These plots show major reductions in SSC and slight reduction (depending on the year) in mean peak discharge (i.e., erosive force) over the 7 yr, which are consistent with the goals of the sediment transport mitigation activities. In 2019, most peak discharge values from runoff events in DP Canyon were lower than in prior years, but the sampled SSC values were higher than in recent years. This is most likely due to the increased trip levels, which ensured that only the runoff events with high peak discharge and therefore increased erosive force and stream power to carry more sediment were sampled (Figure 3.4-1). Another potential contributor to the increased sediment is heavy construction at the head of the DP watershed.

Decreasing storm water velocity allows for increased infiltration, thus reducing peak discharge, reducing the distance the flood bore travels downstream, and reducing the distance that sediment and associated contaminants entrained in the storm water travel downstream. Increasing infiltration reduces peak discharge but can also decrease the total volume of storm water. In 2019, the peak discharge decreased in three of five measureable runoff events between E038 and E039.1, with an average decrease of 49% relative percent difference (RPD), and increased in two of five runoff events, with an increase of 52% RPD (Table 3.2-1).

Pueblo Canyon: In 2019, SSC analyses were performed on the August 7 runoff event in Pueblo Canyon above the drop structure (E059.5). This runoff event at E059.5 had a calculated sediment yield of 4.0 yd^3 (Table 3.2-2). However, no SSC data were collected below the drop structure (E059.8), or below the wetland and GCS (E060.1) (Table 2.3-1). Therefore, statistics over the past 7 yr of monitoring must be used to assess performance. Figure 3.4-1 shows box-and-whisker plots for E059.5, E059.8, and E060.1 for SSC and peak discharge. As these plots indicate, mean peak discharge was effectively attenuated through the Pueblo Canyon wetland, resulting in little to no transport from the upper Pueblo watershed into lower Los Alamos Canyon. This is consistent with the goals of the sediment transport mitigation activities. In 2019, the peak discharge decreased in five of five measurable runoff events between E059.5 to E059.8 with an average decrease of 100% RPD. The peak discharge between E059.8 and E060.1 increased in one of one measurable runoff events with an increase of 100% RPD (Table 3.2-1).

The discharge magnitude is being reduced through this area, which is a primary goal of the mitigation actions. Indeed, discharge is being reduced so much that no samples were collected at E060.1 in 2012, 2013, 2016, 2017, 2018, or 2019; SSC was not analyzed for the one sample collected in 2014; and only two samples were collected in 2015. In addition, SSC magnitude was reduced through the mitigation structures in 2015.

Los Alamos Canyon: Sampling was performed in Los Alamos Canyon on July 26 and August 7 above (E042.1) and below (E050.1) the lower Los Alamos sediment detention basins and low-head weir (Table 2.3-1). Sample collection began within 5 min of the flow volume exceeding the trip level: 50 cfs for E042.1 and 5 cfs for E050.1. The calculated sediment yield at E042.1 and E050.1, respectively, is 36.1 yd^3 and 14.7 yd^3 on July 26, and 36.9 yd^3 and 16.0 yd^3 on August 7 (Figure 3.4-3 and Table 3.2-2). The sediment yield between above (E042.1) and below (E050.1) the lower Los Alamos sediment detention basins and low-head weir was reduced 59% in the July 26 runoff event and 57% in the August 7 runoff event. In 2019, peak discharge decreased in three of five measureable runoff events between E042.1 and E050.1, with an average decrease of 41% RPD. The peak discharge between E042.1 and E050.1 increased in one of five measurable runoff events with an increase of 40% RPD (Table 3.2-1). Sediment trapping efficiency is expected to be higher in smaller events and events early in the season before the detention basins have filled with water. Flow is reduced through the weir and the upstream sediment detention basins, allowing sediment to settle out of suspension; thus, this mitigation feature is performing as designed.

In addition to examining coinciding sampling events, performance of the weir and upstream sediment detention basins can be assessed by examining statistics over the past 7 yr of monitoring. Figure 3.4-1 shows box-and-whisker plots for E042.1 and E050.1 for SSC and peak discharge. These plots show major reductions in SSC, particularly in the post–Las Conchas fire years of 2012 and 2013; thus, the weir is performing as designed. The SSC values in 2019 were around the values seen in the post-fire years. This is most likely due to sampling only the largest runoff events. Minor reductions in peak discharge occurred from 2011 to 2013 and 2016, 2018, and 2019; minor increases in peak discharge occurred in 2010, 2014, 2015, and 2017.

3.5 Los Alamos Canyon Snowmelt and Otowi Well #2 Discharge

From the beginning of March 2019 through May 2019, there was constant flow through all of Upper Los Alamos Canyon—from E026 down to E050.1—as shown in Figure 3.5-1. The runoff at E026 is from snowmelt from the mountains discharging through the Los Alamos Reservoir. Since E030, E042.1, and E050.1 have very similar flow volumes for the majority of the flow duration, it is safe to say that most of the flow through Los Alamos Canyon was snowmelt runoff. During this time, Los Alamos County was discharging water into the Los Alamos Canyon from a municipal well, Otowi Well #2, which the County was developing and testing. Table 3.5-1 shows the dates and flow rates of the discharge from the well into Los Alamos County. Otowi Well #2 is located downstream of E030 and upstream of E042.1. Though there was contribution from the well to E042.1 and E050.1, the majority of the water was from snowmelt.

4.0 ANALYTICAL RESULTS

Appendix D (on CD included with the document) contains the analytical results for the LA/P watershed. Appendix B of the 2016 Consent Order requires the submission of this annual monitoring report to NMED.

4.1 Analytes Exceeding Comparison Values

The watershed mitigations in the LA/P watershed have been constructed to mitigate the transport of contaminated sediments, and the analytical results from monitoring are presented and evaluated within this context. The mitigation actions were not undertaken with the objective of reducing concentrations of water-borne contaminants to specific levels, and the analytical results are therefore not compared with water-quality standards or other criteria for that purpose or for the purpose of evaluating compliance with regulatory requirements. For this report, monitoring results are compared with water-quality standards at the request of NMED.

The New Mexico Water Quality Control Commission Standards for Interstate and Intrastate Surface Waters (20.6.4 New Mexico Administrative Code [NMAC]) establish surface water criteria. Surface waters within DP Canyon at E038, Pueblo, and Acid Canyons are unclassified, non-perennial waters of the state under 20.6.4.98 NMAC, with segment-specific designated uses of livestock watering, wildlife habitat, marginal warm-water aquatic life, and primary contact. The criteria applicable to the marginal warm-water aquatic life designation include both acute and chronic aquatic life criteria and the human health–organism only (HH-OO) criteria. Surface waters within Los Alamos Canyon and DP Canyon at E039.1 are classified as ephemeral and intermittent waters of the state under 20.6.4.128 NMAC, with segment-specific designated uses of livestock watering, wildlife habitat, limited aquatic life, and secondary contact. The criteria applicable to the limited aquatic life designation include the acute aquatic life criteria and the HH-OO only criteria but do not include the chronic aquatic life criteria.

Water-quality criteria for total and total recoverable pollutants are compared with unfiltered surface water sample concentrations. The water-quality criterion for total recoverable aluminum is for filtered storm water samples using a 10-µm pore size. NMED's Surface Water Quality Bureau suggested that a 10-µm filter size is too large (NMED 2016, 602301); however this report presents exceedances of the 10-µm pore size following current guidance (NMED 2012, 700224). Other water-quality criteria are for dissolved concentrations of pollutants, which are compared with filtered storm water samples using a 0.45-µm pore size. Acute and chronic aquatic life criteria for dissolved cadmium, chromium, copper, lead, manganese, nickel, and zinc, and acute aquatic life criteria for dissolved silver, are calculated based on the hardness of each sample. Concurrent hardness values in the LA/P watershed range between 7.89 mg/L and 43.3 mg/L (average value is 27.7 mg/L) calcium carbonate ($CaCO_3$) calculated from calcium and magnesium values from storm water collected in 2019. Hardness-dependent metals criteria are strongly influenced by the hardness value used in the calculation, i.e., a low hardness value results in a low metals criterion and a high hardness value results in a high metals criterion. The water-quality criteria for dioxins are the sum of the dioxin toxicity equivalents expressed as 2,3,7,8 tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). Table 4.1-1 presents the comparison of detected analytical results from 2019 with the water-quality criteria.

The Los Alamos County townsite routes most of its storm water and entrained pollutants into Los Alamos and Pueblo Canyons. Storm water pollutant loading to receiving waters is derived from the decay of buildings, parking lots, roads, and automobile traffic emissions that occurs in a developed urban landscape and is common to urban developed landscapes throughout the developed world (Tsihrintzis and Hamid 1997, 602314; Göbel et al. 2007, 252959). Many of the structures and impervious surfaces within the Los Alamos County townsite are older and have weathered over the years and continue to shed metals and organic compounds to Los Alamos and Pueblo Canyons adjacent to the townsite. In addition, pollutants have accumulated in sediments in canyon bottoms over time and are mobilized during storm flow events in canyon bottoms and are commonly detected throughout the gage network adjacent to and downstream of the Los Alamos townsite.

A large portion of townsite runoff is routed to DP canyon, the south fork of Acid Canyon, and upper Pueblo Canyon. Most of the exceedances observed in 2019 are metals and PCBs detected at gage stations located directly downstream from these routing pathways.

In 2019, there were 12 aluminum exceedances of NMED's hardness-dependent acute and chronic aquatic life screening criteria in storm water ranging from 474 to 18,200 µg/L; the average value of all twelve 10-µm filtered aluminum results is 8202 µg/L. Hardness-dependent water-quality criteria range from 106 to 1101 µg/L. Until December 2018, the national acute aquatic life criteria was 750 µg/L and the chronic aquatic life criteria was 87 µg/L. In December 2018, EPA updated its recommended criteria for aluminum in fresh water to reflect aluminum's bioavailability to living organisms like fish and invertebrate species. The bioavailability and associated toxicity of aluminum are calculated using a multiple linear regression model using pH, dissolved organic carbon, and total hardness (EPA 2018, 700247).

Because hardness in storm water runoff is typically very low, the corresponding calculated aluminum water-quality criteria is low, resulting in a greater number of exceedances. Aluminum in storm water is representative of the natural background composition of the Bandelier Tuff (LANL 2013, 239557). On the Pajarito Plateau, much of the sediment-bound aluminum is associated with poorly crystalline silica-rich glass of Bandelier Tuff. As the tuff weathers, the glass particles and associated aluminum form sediment that accumulates, is entrained, and is then transported by storm water runoff. In addition, aluminum is generally not an issue or problematic in runoff from developed urban landscapes on a national scale and is not associated with current or historical industrial processes within the Los Alamos County townsite.

Copper exceedances in 2019 range from 1.82 to 4.62 µg/L; the average value of all 12 detections of dissolved copper is 2.50 µg/L. The corresponding acute and chronic aquatic life screening criteria range between 1.23 and 6.16 µg/L. To put this into perspective, the copper acute aquatic life criteria threshold in the NPDES Individual Permit (NM0030759) is 4.3 µg/L calculated with a hardness of 30 mg/L $CaCO_3$. Copper is a component of brake pads and roofing materials and is a common constituent in storm water emanating from urban environments in both dissolved and colloidal form (TCD Environmental 2004, 602305). Consequently, copper exceedances are most likely due to runoff from the impervious developed landscape within the Los Alamos townsite.

The one lead exceedance in 2019 was 1.08 µg/L from the E059.5 sample on August 7, 2019. The average value of all seven detections of dissolved lead is 0.778 µg/L. The hardness-dependent aquatic life screening criteria range between 0.56 and 24.6 µg/L. Lead is a common component of house paint, building siding, and automobiles and is commonly found in storm water runoff from urban landscapes on a national scale (Davis and Burns 1999, 602303; Göbel et al. 2007, 252959), such as the Los Alamos County townsite. Because of the low solubility in the neutral pH range, lead is usually present in particulate form entrained in urban storm water.

Twelve gross alpha radioactivity concentrations were observed above the 15-pCi/L screening level threshold in 2019. The exceedances range from a minimum of 15.2 pCi/L to a maximum radioactivity concentration of 464 pCi/L; the average value of all 12 detected gross alpha results is 138 pCi/L. Gross alpha is strongly correlated with SSC and is associated with the decay of naturally occurring uranium and thorium in the Bandelier Tuff (LANL 2013, 239557). Although there have been discharges of legacy radionuclide pollutants in the past at select locations within the Laboratory, the alpha activity of those constituents when measured by alpha spectroscopy contributes an insignificant amount of activity to the gross alpha activity values (McNaughton et al. 2012, 254666).

Four selenium concentrations were observed above the New Mexico wildlife habitat screening criteria of 5.0 µg/L in 2019. The exceedances range from a minimum of 5.8 µg/L to a maximum concentration of 7.34 µg/L; the average value of all nine detected selenium results is 4.79 µg/L.

No zinc concentration exceedances of the NMED water-quality standards were observed in samples from 2019.

PCBs are the most common compound that exceeded water-quality criteria in 2019. Total PCB concentrations range from 0.00562 to 8.06 µg/L and most often exceed the most sensitive screening level (HH-OO threshold of 0.00064 µg/L). The average overall exceedance concentration observed in 2019 is 1.02 µg/L and is heavily weighted by PCB concentrations observed at CO111041 (upper Los Alamos detention basins). Without the upper Los Alamos detention basin results (see section 4.4), the average PCB concentration is 0.19 µg/L, which is greater than the urban runoff PCB median value of 0.012 µg/L reported in the 2012 PCB report presenting PCB concentrations in Los Alamos County storm water runoff

(LANL 2012, 219767). In addition to electrical transformer cooling fluids, PCBs were commonly used as a stabilizing agent for paints, caulking, oils, hydraulic fluid, road paint, pigments, plastics, and a host of other industrial materials. The ubiquitous distribution of PCBs in an urban setting in addition to atmospheric deposition and very low screening levels accounts for the relatively high number of detections and exceedances in surface and storm water emanating from developed urban landscapes in Los Alamos County (LANL 2012, 219767). In addition, PCBs have been archived in sediment and organic material that is occasionally released from the terrestrial inventory and transported in storm water flow events to canyon bottoms.

The method detection limits (MDLs) reported for analyses of nondetected 2,3,7,8 TCDD, cadmium, silver, and thallium exceeded the screening levels for those compounds. Cadmium MDLs were 0.37 to 1.59 times larger than the hardness-dependent acute screening levels and 1.75 times larger than the hardness-dependent chronic screening levels. Silver MDLs are 0.39 to 7.39 times larger than the hardness-dependent acute screening levels. The thallium MDL of 0.6 µg/L is 1.3 times the human health screening level of 0.47 µg/L. MDLs for 2,3,7,8-TCDD range from 3.76 pg/L to 3.97 pg/L, which are approximately 70–80 times the human health screening level of 0.051 pg/L. More sensitive analytical methods are not available for these compounds.

In summary, exceedances in storm water are associated with pollutant loadings emanating from Los Alamos County and are mainly associated with the developed urban landscape and day-to-day activities associated with the weathering of roads, parking lots, and structures that are in various stages of decay and with vehicle traffic. The chemical signature of storm water runoff is representative of many urban landscapes on a national scale.

4.2 Relationships between Discharge and SSC

Discharge was calculated from stage height using a rating curve, which is the relationship between discharge in cubic feet per second and height of the water in feet, developed for each individual gaging station. Stage height was measured at 5-min intervals and logged continuously during each sampled storm event. SSC and particle size were measured during each storm in conjunction with inorganic and organic chemicals and radionuclides.

SSC and instantaneous discharge estimates were calculated for each sample using a linear relationship between the two corresponding analytically determined SSCs or the two corresponding physically measured discharges, as follows:

$$y = mx + b$$ **Equation 4**

Where y = the calculated SSC or discharge at the time of sample collection,

m = the slope of the line,

x = the time differential in minutes between SSC sample collection or discharge measurements, and

b = the concentration of analytically determined SSC before sample analyses or corresponding physically determined discharge.

The slope is determined by dividing the difference in SSC or discharge by the difference in time, in minutes, between SSC sample collection or discharge measurements before and after analytical sample collection. This equation was used to calculate SSC and instantaneous discharge for samples collected. Where analytical results are not bounded by sediment results, the concentration of the nearest sediment result is used as an estimate of the sediment concentration at the time the sample was collected. If SSC was not measured during a storm, an estimate was not produced. The calculated SSCs and instantaneous discharges are presented in Table 4.2-1.

4.3 Relationship between SSC and Concentrations of Constituents

The projected total metal values for each sample with measured SSC analyses were planned to be calculated using equations presented in the "2015 Monitoring Report for Los Alamos/Pueblo Watershed" (LANL 2016, 601433). SSC-estimated concentrations for each metal and isotopic uranium are presented in Table 4.3-1.

4.4 Storm Water Sampling below SWMU 01-001(f)

Results in 2019 for the storm water samples analyzed for total PCBs collected at the inlet to the upper detention basin below the SWMU 01-001(f) drainage are 3.14 µg/L and 8.06 µg/L. These total PCB results are within the range of results for samples collected from 2011 to 2018. The results continue to indicate the hillslope is a source of PCBs, even after sediment and rock were removed during corrective action at SWMU 01-001(f) in 2010.

5.0 CHANGES FROM THE 2018 REPORT

Based on changes that occurred in 2019, this report has been updated from the 2018 report. The changes are summarized below:

- In 2019, sediment concentrations in samples collected at E050.1 were insufficient for the analysis of TAL metals in the sediment fraction on a dry-weight basis. No samples were collected from E060.1 in 2019.
- Appendix A contains acronyms and abbreviations.
- Geomorphic changes and vegetation monitoring discussions are combined in Appendix B (Previously Appendixes A and C, respectively).
- Watershed mitigation inspection discussion and photo documentation are now in Appendix C.
- Appendix D (on CD included with this document) contains the analytical data and the gaging station stage and discharge data.

6.0 CONCLUSIONS

Attenuation of flow and associated sediment transport are primary goals of the sediment transport mitigation activities. Decreasing flow velocity allows for increased infiltration, thus reducing peak discharge, reducing the distance the flood bore travels downstream, and reducing the distance sediment and associated contaminants entrained in the storm water travel downstream. In DP Canyon, the GCS and associated floodplains between gaging stations E038 and E039.1 facilitated a significant reduction in the suspended sediment being transported downstream. In Pueblo Canyon, the wetland, willows, drop structure, and GCS between gaging stations E059.5 and E060.1 facilitated such a reduction in peak discharge that storm water runoff at E060.1 was not large enough to sample. In Los Alamos Canyon, a reduction in peak discharge, runoff volume, and sediment yield transmission downstream between E042.1 and E050.1 was due to the low-head weir and associated sediment detention basins between the two gaging stations. The 2019 monitoring data in the LA/P watershed indicate that, in general, the mitigations are performing as designed.

Geomorphic changes are monitored at one background area, five sediment transport mitigation sites, and two sediment retention basin areas that have been established in the LA/P watershed. The bank and thalweg surveys and repeat photographs support the conclusion of overall stability of the banks and channels in Pueblo, DP, and Los Alamos Canyons and establish the geomorphic change between 2018 and 2019 as minor, indicating that the watershed mitigations are performing as designed.

Based on the correlations between concentrations of metals, radioisotopes, and PCBs in unfiltered storm water and suspended sediment concentration presented in the "2015 Monitoring Report for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project" (LANL 2016, 601433), in 2016 the Laboratory discontinued certain constituents from storm water monitoring at Los Alamos and Pueblo watershed gaging stations E026, E030, E038, E039.1, E040, E042.1, E055, E055.5, E056, E059.5, and E059.8. Unfiltered TAL metals (as well as isotopic uranium, gross beta, and radium-226/228) at E050.1 and E060.1 continue to be monitored in response to the 2017 memorandum of understanding between DOE and the BDDB (DOE and BDD Board 2017, 602995). Dissolved metals, total selenium, total mercury, and total recoverable aluminum (after filtration using a 10-µm pore size filter) continue to be monitored because these dissolved and total metals have numeric criteria applicable to achieving designated and attainable uses given in 20.6.4 NMAC. Silver in unfiltered storm water in Acid and Pueblo Canyons and total PCBs and certain isotopic radionuclides in unfiltered storm water will continue to be monitored.

Continued monitoring in 2020 is expected to confirm the sediment transport mitigations in the LA/P watershed are performing as designed.

7.0 REFERENCES AND MAP DATA SOURCES

7.1 References

The following reference list includes documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. This information is also included in text citations. ERIDs were assigned by the Laboratory's Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above). IDs are used to locate documents in N3B's Records Management System and in the Master Reference Set. The NMED Hazardous Waste Bureau and N3B maintain copies of the Master Reference Set. The set ensures that NMED has the references to review documents. The set is updated when new references are cited in documents.

Bagnold, R.A., April 1977. "Bed Load Transport by Natural Rivers," *Water Resources Research,* Vol. 13, No. 2, pp. 303–312. (Bagnold 1977, 111753)

Davis, A.P., and M. Burns, 1999. "Evaluation of Lead Concentration in Runoff from Painted Structures," *Water Resources,* Vol. 33, No. 13, pp. 2949-2958. (Davis and Burns 1999, 602303)

DOE and BDD Board (U.S. Department of Energy and Buckman Direct Diversion Board), November 2017. "Memorandum of Understanding between the U.S. Department of Energy and the Buckman Direct Diversion Board Regarding Water Quality Monitoring," Santa Fe, New Mexico. (DOE and BDD Board 2017, 602995)

EPA (U.S. Environmental Protection Agency), December 2018. "Final Aquatic Life Ambient Water Quality Criteria for Aluminum 2018," EPA-822-R-18-001, Office of Water, Office of Science and Technology, Washington, D.C. (EPA 2018, 700247)

Göbel, P., C. Dierkes, and W.G. Coldewey, April 2007. "Storm Water Runoff Concentration Matrix for Urban Areas," *Journal of Contaminant Hydrology,* Vol. 91, No. 1–2, pp. 26–42. (Göbel et al. 2007, 252959)

Graf, W.L., September 1983. "Downstream Changes in Stream Power in the Henry Mountains, Utah," *Annals of the Association of American Geographers,* Vol. 73, No. 3, pp. 373–387. (Graf 1983, 111754)

Lane, L.J., M.H. Nichols, M. Hernandez, C. Manetsch, and W.R. Osterkamp, December 12–16, 1994. "Variability in Discharge, Stream Power, and Particle-Size Distributions in Ephemeral-Stream Channel Systems," in *Variability in Stream Erosion and Sediment Transport*, Proceedings of the Canberra Symposium, December 12–16, 1994, International Association of Hydrological Sciences publication no. 224, pp. 335–342. (Lane et al. 1994, 111757)

LANL (Los Alamos National Laboratory), February 2008. "Interim Measure Work Plan to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons," Los Alamos National Laboratory document LA-UR-08-1071, Los Alamos, New Mexico. (LANL 2008, 101714)

LANL (Los Alamos National Laboratory), October 2008. "Supplemental Interim Measures Work Plan to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons," Los Alamos National Laboratory document LA-UR-08-6588, Los Alamos, New Mexico. (LANL 2008, 105716)

LANL (Los Alamos National Laboratory), November 2008. "Los Alamos Site Monitoring Area 2 Interim Measure and Monitoring Plan," Los Alamos National Laboratory document LA-UR-08-6891, Los Alamos, New Mexico. (LANL 2008, 104020)

LANL (Los Alamos National Laboratory), May 2012. "Polychlorinated Biphenyls in Precipitation and Stormwater within the Upper Rio Grande Watershed," Los Alamos National Laboratory document LA-UR-12-1081, Los Alamos, New Mexico. (LANL 2012, 219767)

LANL (Los Alamos National Laboratory), April 2013. "Background Metals Concentrations and Radioactivity in Storm Water on the Pajarito Plateau, Northern New Mexico," Los Alamos National Laboratory document LA-UR-13-22841, Los Alamos, New Mexico. (LANL 2013, 239557)

LANL (Los Alamos National Laboratory), June 2013. "2013 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project, Revision 1," Los Alamos National Laboratory document LA-UR-13-24419, Los Alamos, New Mexico. (LANL 2013, 243432)

LANL (Los Alamos National Laboratory), April 2016. "2015 Monitoring Report for Los Alamos/ Pueblo Watershed Sediment Transport Mitigation Project," Los Alamos National Laboratory document LA-UR-16-22705, Los Alamos, New Mexico. (LANL 2016, 601433)

LANL (Los Alamos National Laboratory), April 2018. "2018 Monitoring Plan for Los Alamos/ Pueblo Watershed Sediment Transport Mitigation Project," Los Alamos National Laboratory document LA-UR-18-23238, Los Alamos, New Mexico. (LANL 2018, 603015)

McNaughton, M., W. Eisele, D. Englert, R. Ford-Schmid, and J. Whicker, 2012. “Natural Radioactivity in Northern New Mexico Water,” Los Alamos National Laboratory document LA-UR-12-26061, Los Alamos, New Mexico. (McNaughton et al. 2012, 254666)

Mingguo, Z., C. Qiangguo, and C. Hao, September 2007. “Effect of Vegetation on Runoff-Sediment Yield Relationship at Different Spatial Scales in Hilly Areas of the Loess Plateau, North China,” *Acta Ecologica Sinica,* Vol. 27, No. 9, pp. 3572–3581. (Mingguo et al. 2007, 111756)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), April 2019. “2019 Monitoring Plan for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project,” Newport News Nuclear BWXT-Los Alamos, LLC, document EM2019-0132, Los Alamos, New Mexico. (N3B 2019, 700418)

Nichols, M.H., January 2006. “Measured Sediment Yield Rates from Semiarid Rangeland Watersheds,” *Rangeland Ecology and Management,* Vol. 59, No. 1, pp. 55–62. (Nichols 2006, 111758)

NMED (New Mexico Environment Department), August 30, 2007. “Approval with Direction, Los Alamos and Pueblo Canyons Supplemental Investigation Report,” New Mexico Environment Department letter to D. Gregory (DOE-LASO) and D. McInroy (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2007, 098284)

NMED (New Mexico Environment Department), July 18, 2008. “Approval with Modifications, Interim Measure Work Plan to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons,” New Mexico Environment Department letter to D. Gregory (DOE-LASO) and D. McInroy (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2008, 103007)

NMED (New Mexico Environment Department), February 20, 2009. “Approval with Modifications, Supplemental Interim Measure Work Plan (SIWP) to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons,” New Mexico Environment Department letter to D. Gregory (DOE-LASO) and D. McInroy (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2009, 105014)

NMED (New Mexico Environment Department), May 5, 2009. “Approval with Modifications, Los Alamos Site Monitoring Area 2 (LA-SMA-2) Interim Measure and Monitoring Plan to Mitigate Contaminated Sediment Transport in Los Alamos Canyon,” New Mexico Environment Department letter to D. Gregory (DOE-LASO) and D. McInroy (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2009, 105858)

NMED (New Mexico Environment Department), August 24, 2012. “Aluminum Filtration Study,” New Mexico Environment Department, Surface Water Quality Bureau. (NMED 2012, 700224)

NMED (New Mexico Environment Department), July 19, 2013. “Approval, 2013 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project, Revision 1,” New Mexico Environment Department letter to P. Maggiore (DOE-LASO) and J.D. Mousseau (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2013, 523106)

NMED (New Mexico Environment Department), November 29, 2016. “Preliminary Evaluations of LANS Aluminum Filter Study Data, Aluminum Bioavailability: Implications for Ambient Water Quality Criteria and Sampling,” New Mexico Environment Department, Surface Water Quality Bureau. (NMED 2016, 602301)

Onodera, S., J. Wakui, H. Morishita, and E. Matsumoto, July 1993. “Seasonal Variation of Sediment Yield on a Gentle Slope in Semi-Arid Region, Tanzania,” in *Sediment Problems: Strategies for Monitoring, Prediction and Control*, Proceedings of the Yokohama Symposium, July 1993, International Association of Hydrological Sciences publication no. 217, pp. 29–37. (Onodera et al. 1993, 111759)

TCD Environmental (TCD Environmental, LLC), November 2004. “Copper Sources in Urban Runoff and Shoreline Activities, Information Update.” (TCD Environmental 2004, 602305)

Tsihrintzis, V.A., and R. Hamid, 1997. “Modeling and Management of Urban Stormwater Runoff Quality: A Review,” *Water Resources Management,* Vol. 11, pp. 137-164. (Tsihrintzis and Hamid 1997, 602314)

USACE (U.S. Army Corps of Engineers), March 2008. “HEC-RAS River Analysis System, Hydraulic Reference Manual,” Computer Program Documentation No. CPD-69, Washington, D.C. (USACE 2008, 109517)

USACE (U.S. Army Corps of Engineers), March 2008. “HEC-RAS River Analysis System, User's Manual,” Version 4.0, Computer Program Documentation No. CPD-68, Washington, D.C. (USACE 2008, 109518)

7.2 Map Data Sources

GageStation; Los Alamos National Laboratory, ER-ES, As published, project folder 15-0013; \\slip\gis\GIS\Projects\15-Projects\15-0013\zip\2015_E059.8_GageStation.shp; 2015

Facility location; Los Alamos National Laboratory, ER-ES, As published, project folder 15-0013; \\slip\gis\GIS\Projects\15-Projects\15-0013\project_data.gdb;merge_sandia_features_AGAIN;2015

Erosion control structure; Los Alamos National Laboratory, ER-ES, As published, project folder 15-0013; \\slip\gis\GIS\Projects\15-Projects\15-0013\project_data.gdb;merge_sandia_features_AGAIN;2015

Sediment control structure; Los Alamos National Laboratory, ER-ES, As published, project folder 15-0013; \\slip\gis\GIS\Projects\15-Projects\15-0013\project_data.gdb;merge_sandia_features_AGAIN;2015

Willow planting area; Los Alamos National Laboratory, ER-ES, As published, project folder 14-0015; \\slip\gis\GIS\Projects\14-Projects\14-0015\shp\as_built_willow_banks.shp; 2015

Structures; County of Los Alamos, Information Services; as published 29 October 2007.

Drainage; County of Los Alamos, Information Services; as published 16 May 2006.

Los Alamos County Boundary; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; Unknown publication date.

Road Centerlines for the County of Los Alamos; County of Los Alamos, Information Services; as published 04 March 2009.

Watersheds; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; EP2006-0942; 1:2,500 Scale Data; 27 October 2006.

Contour, 4-ft interval; Los Alamos National Laboratory, ER-ES, As published, project folder 15-0013;\\slip\gis\Data\HYP\LiDAR\2014\Bare_Earth\BareEarth_DEM_Mosaic.gdb; 2015

Technical Area Boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Office; September 2007; as published 13 August 2010.

Sediment Geomorphology; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program, ER2002-0589; 1:1,200 Scale Data; 01 January 2002.

Monitoring area; Los Alamos National Laboratory, ER-ES, As published, project folder 15-0013; \\slip\gis\GIS\Projects\15-Projects\15-0013\zip\ZoomAreas.shp; 2015

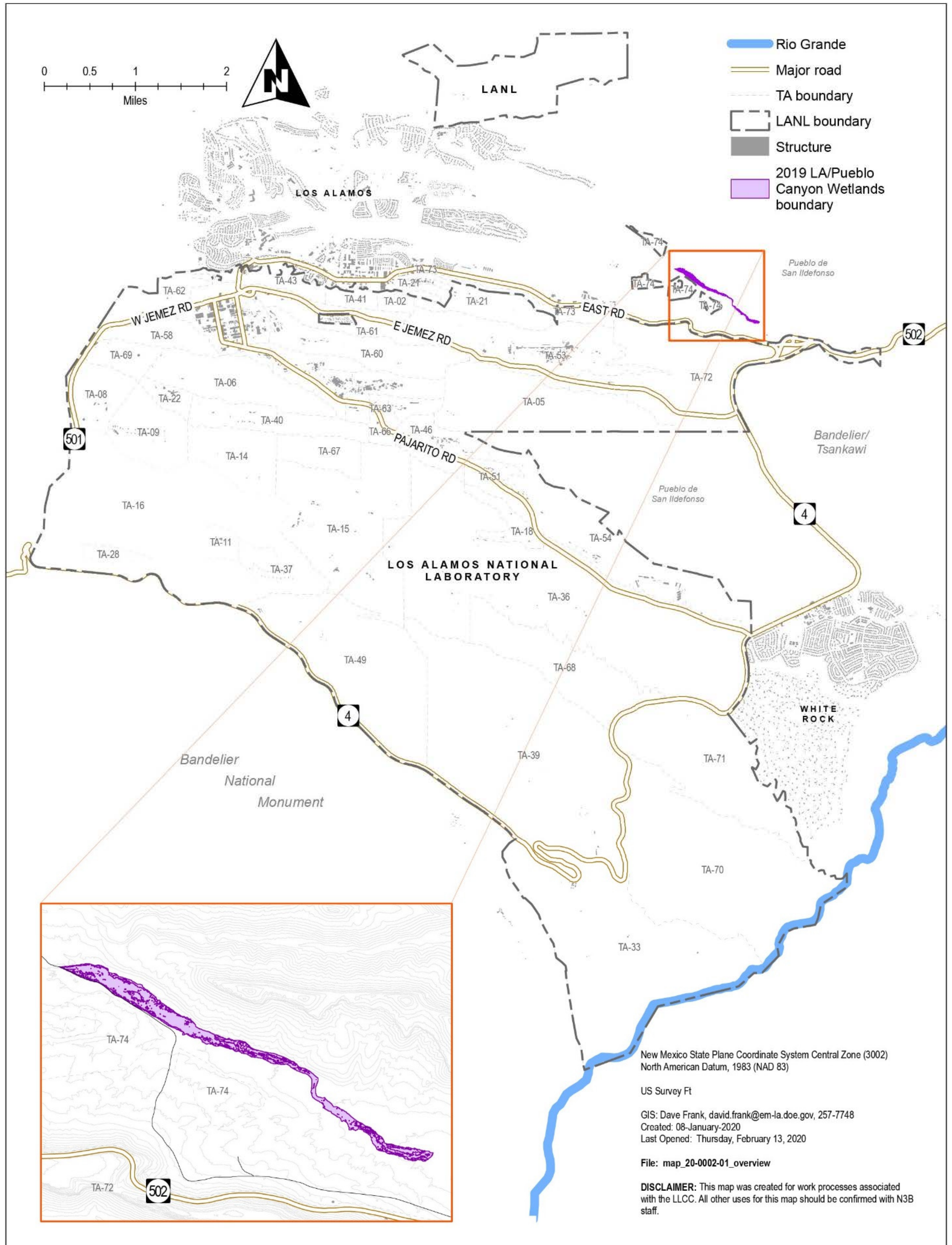


Figure 1.1-1 LA/P wetlands location in relation to Los Alamos National Laboratory property

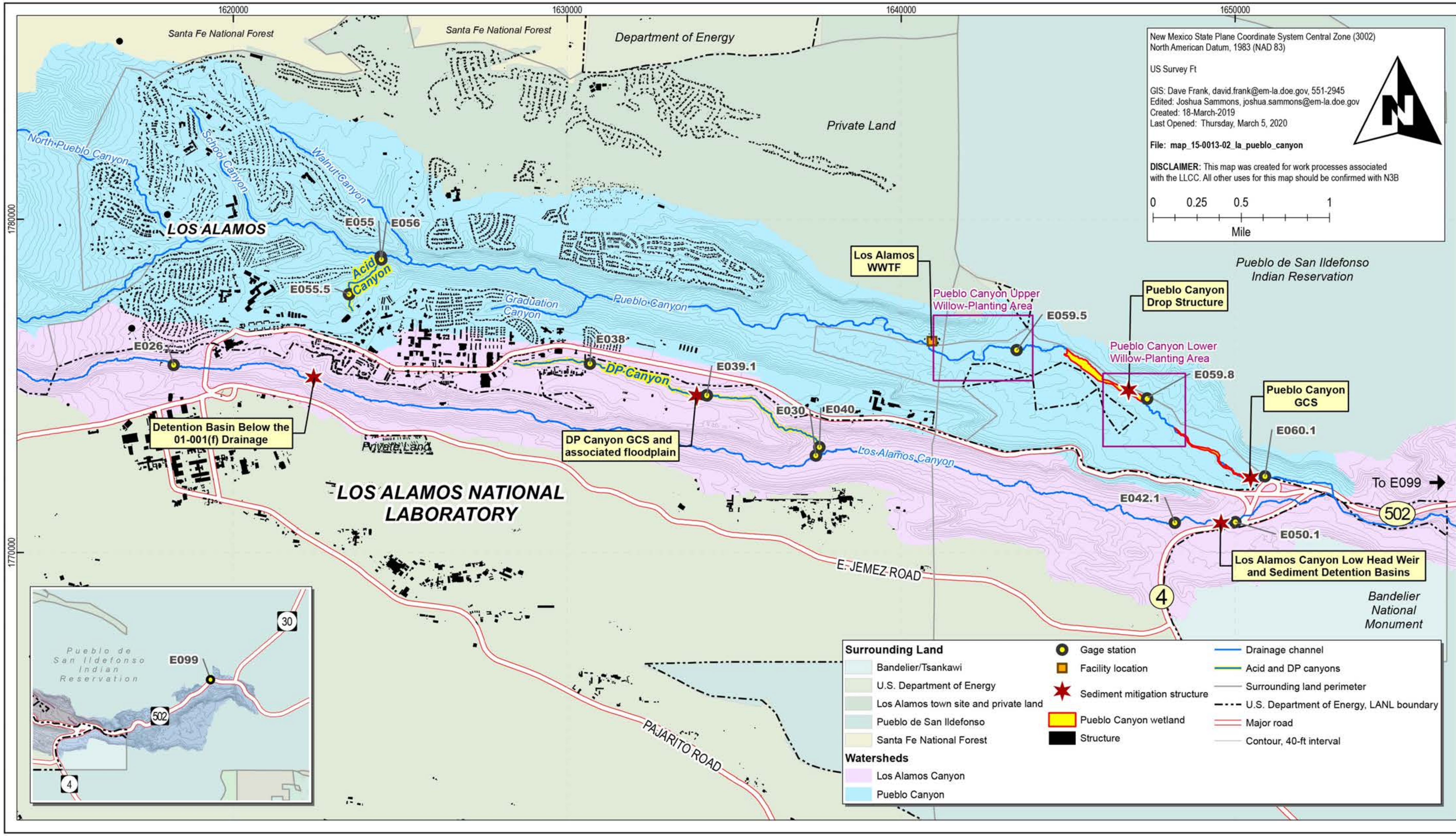


Figure 1.1-2 Los Alamos and Pueblo Canyons showing monitoring locations and sediment transport mitigation sites

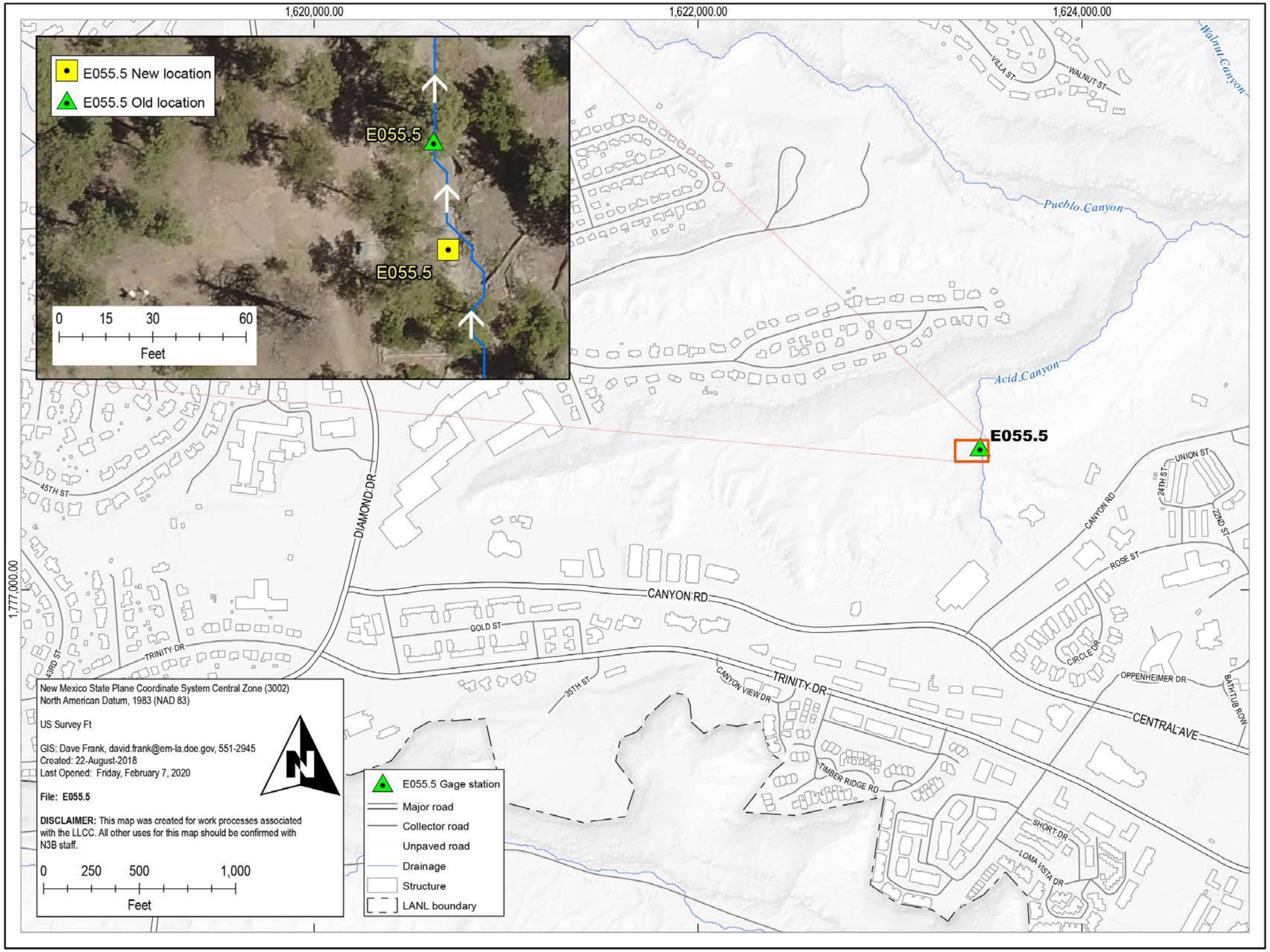


Figure 2.1-1 The new and old location of gaging station E055.5 in Acid Canyon. The new station is located 35 ft upstream of the old station's location.

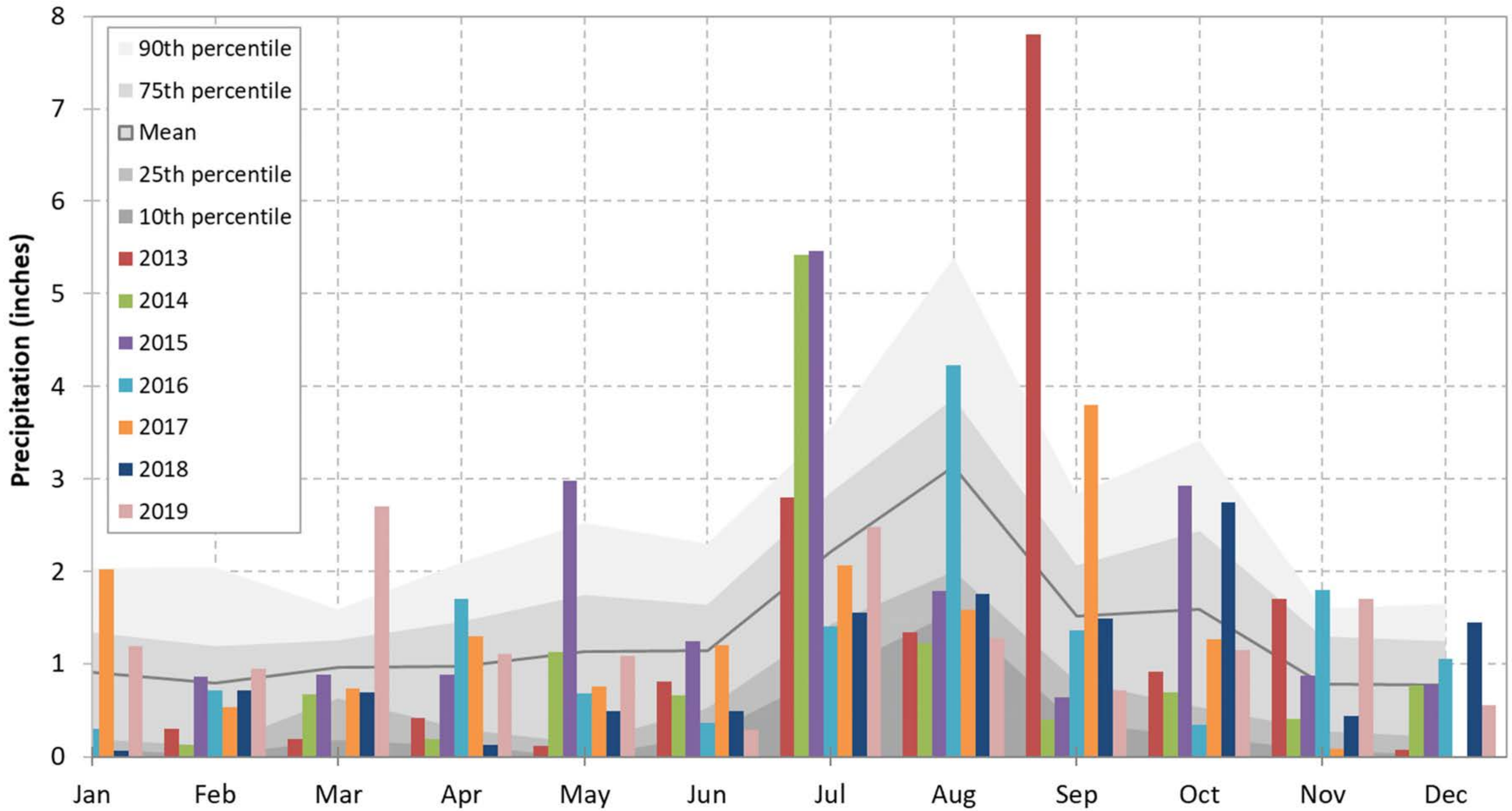


Figure 2.1-2 Total precipitation for each month between 2013 and 2019 based on meteorological tower data averaged across the Laboratory (mean and percentiles are based on data from 1992 to 2010)

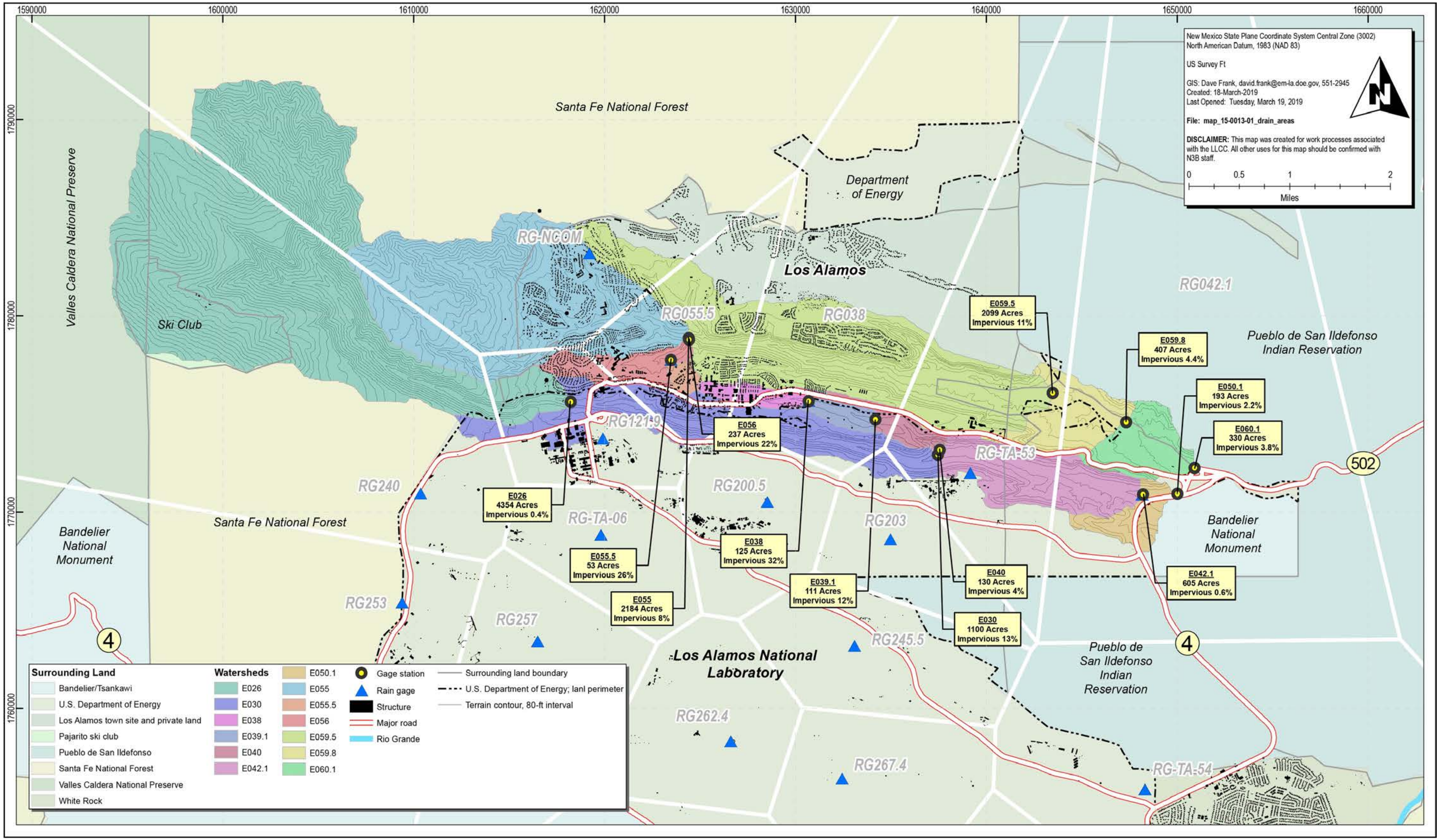


Figure 2.1-3 LA/P watershed showing drainage areas for each stream gaging station and associated rain gages and Thiessen polygons

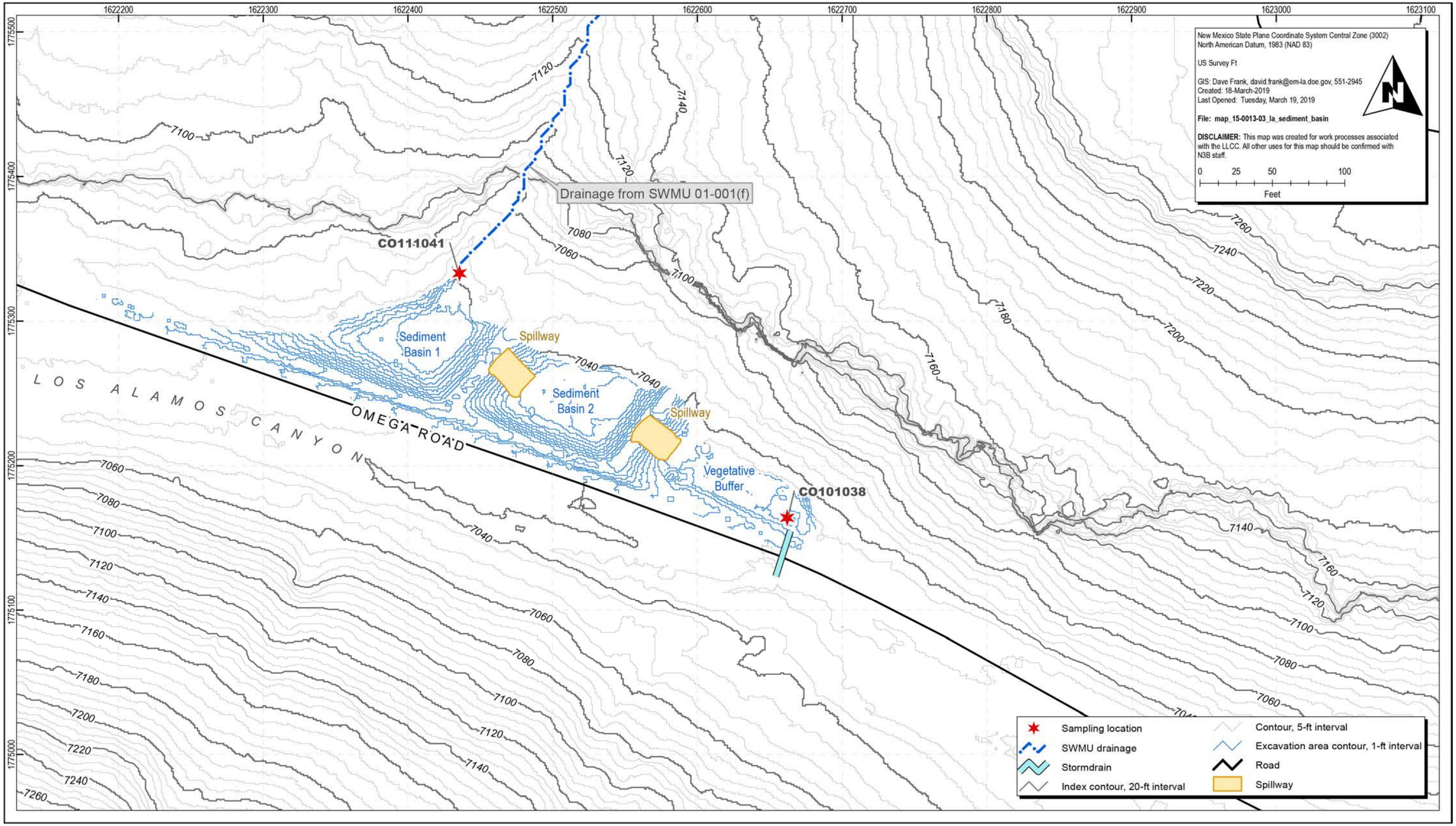


Figure 2.2-1 Upper Los Alamos Canyon sediment detention basins and sampling locations below the SWMU 01-001(f) drainage

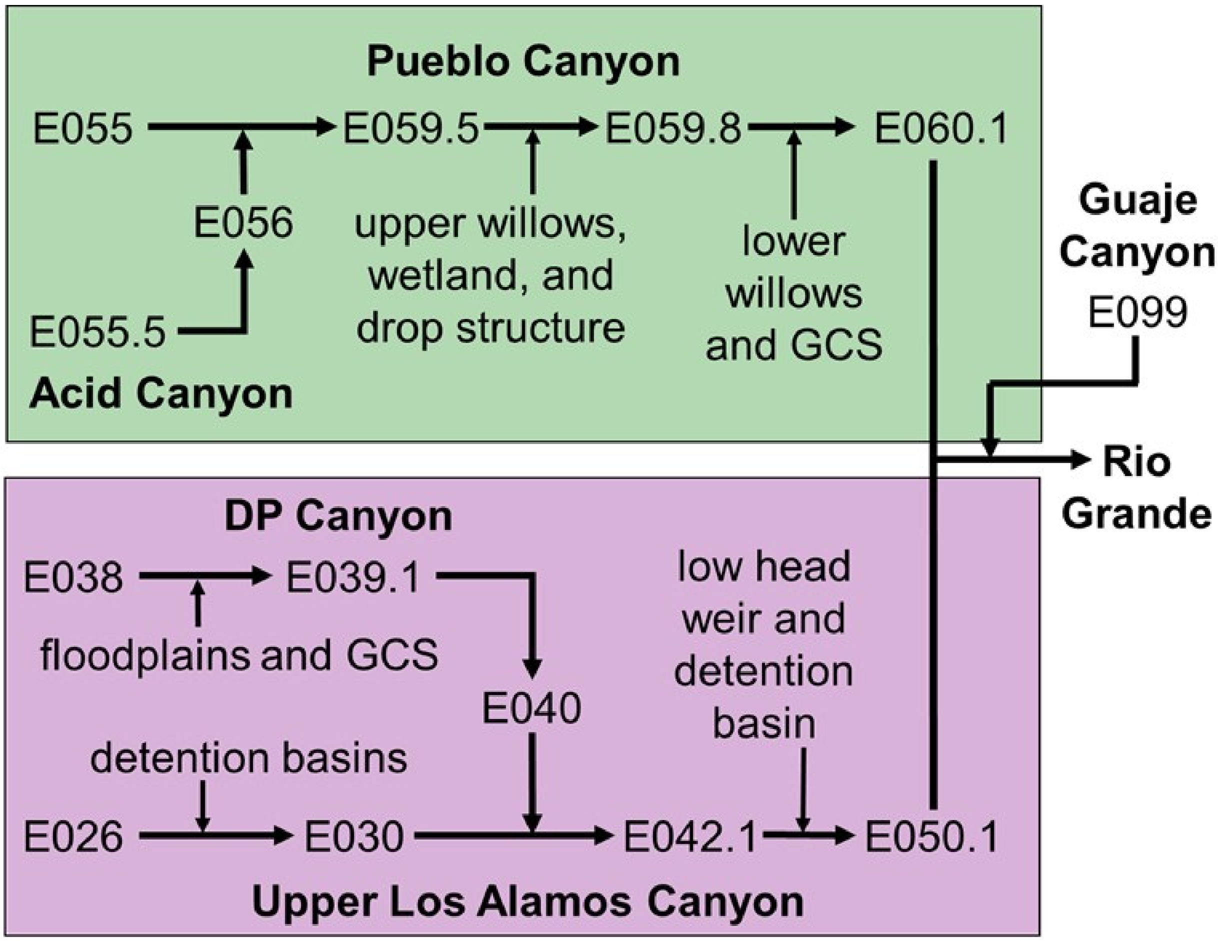


Figure 3.2-1 Flow diagram of gaging stations and sediment transport mitigation sites in the LA/P watershed

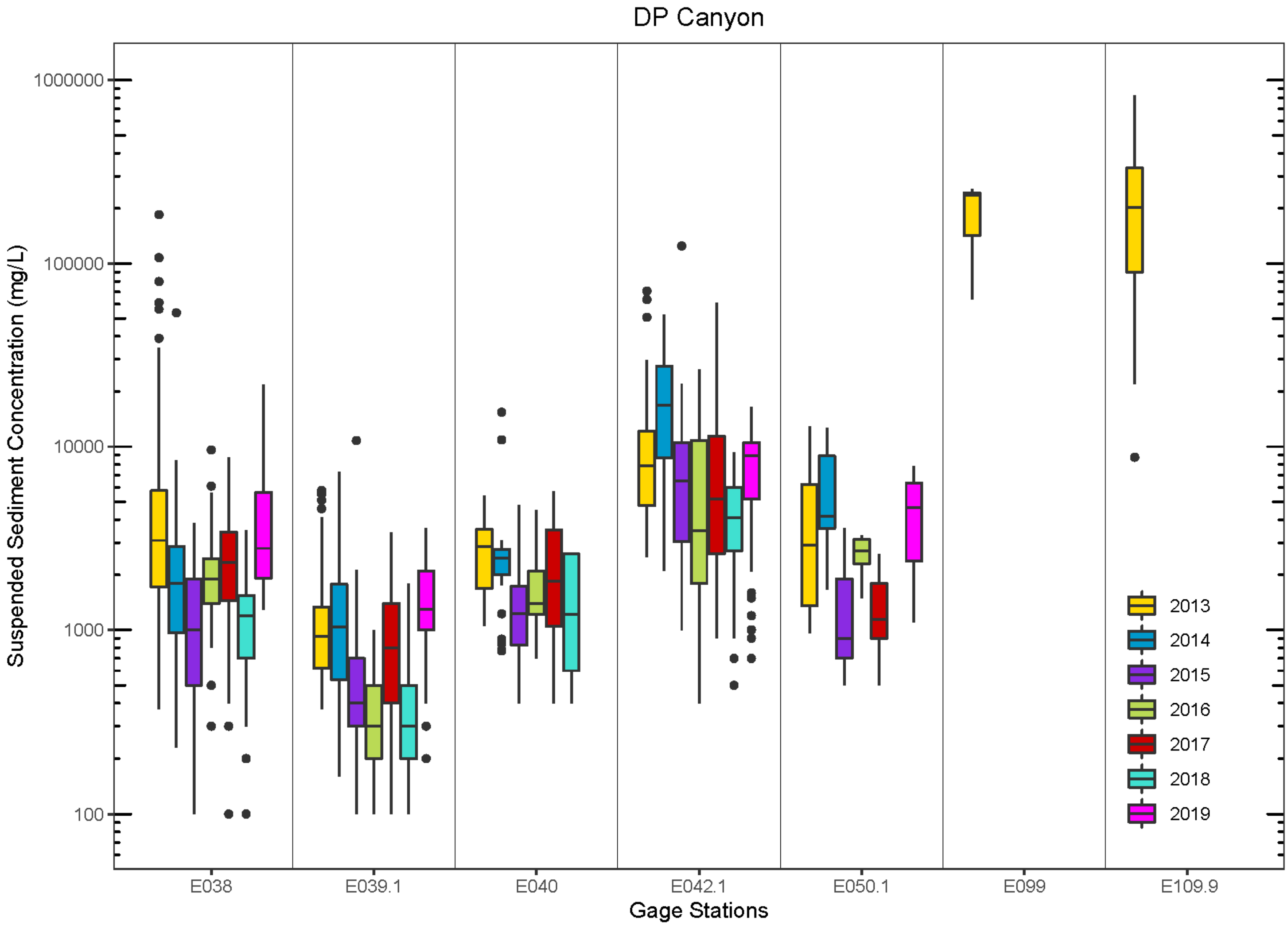


Figure 3.2-2 Box-and-whisker plots of SSC for all gaging stations in the LA/P watershed over the past 7 yr of monitoring. Black dots represent outliers.

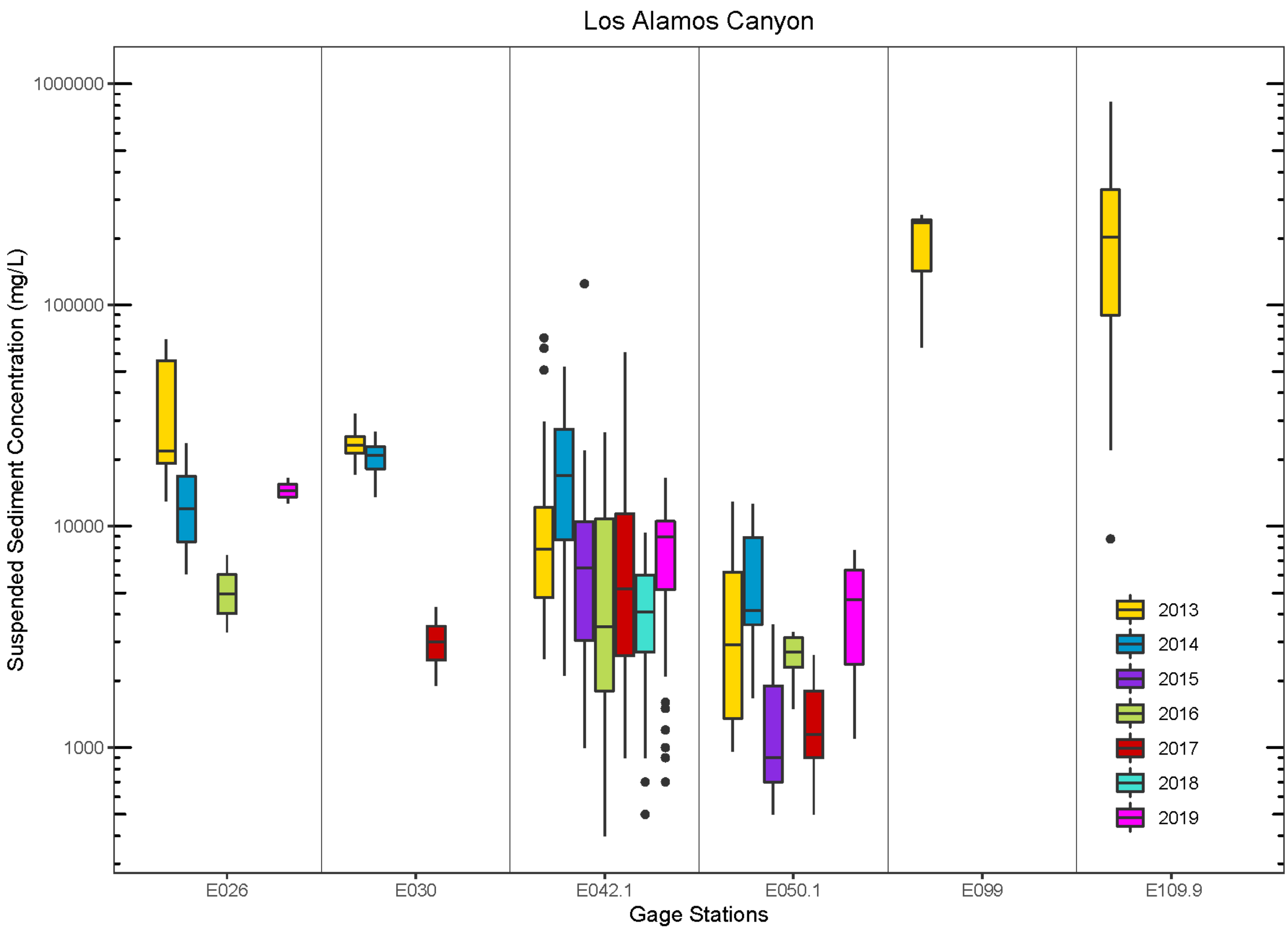


Figure 3.2-2 (continued) **Box-and-whisker plots of SSC for all gaging stations in the LA/P watershed over the past 7 yr of monitoring. Black dots represent outliers.**

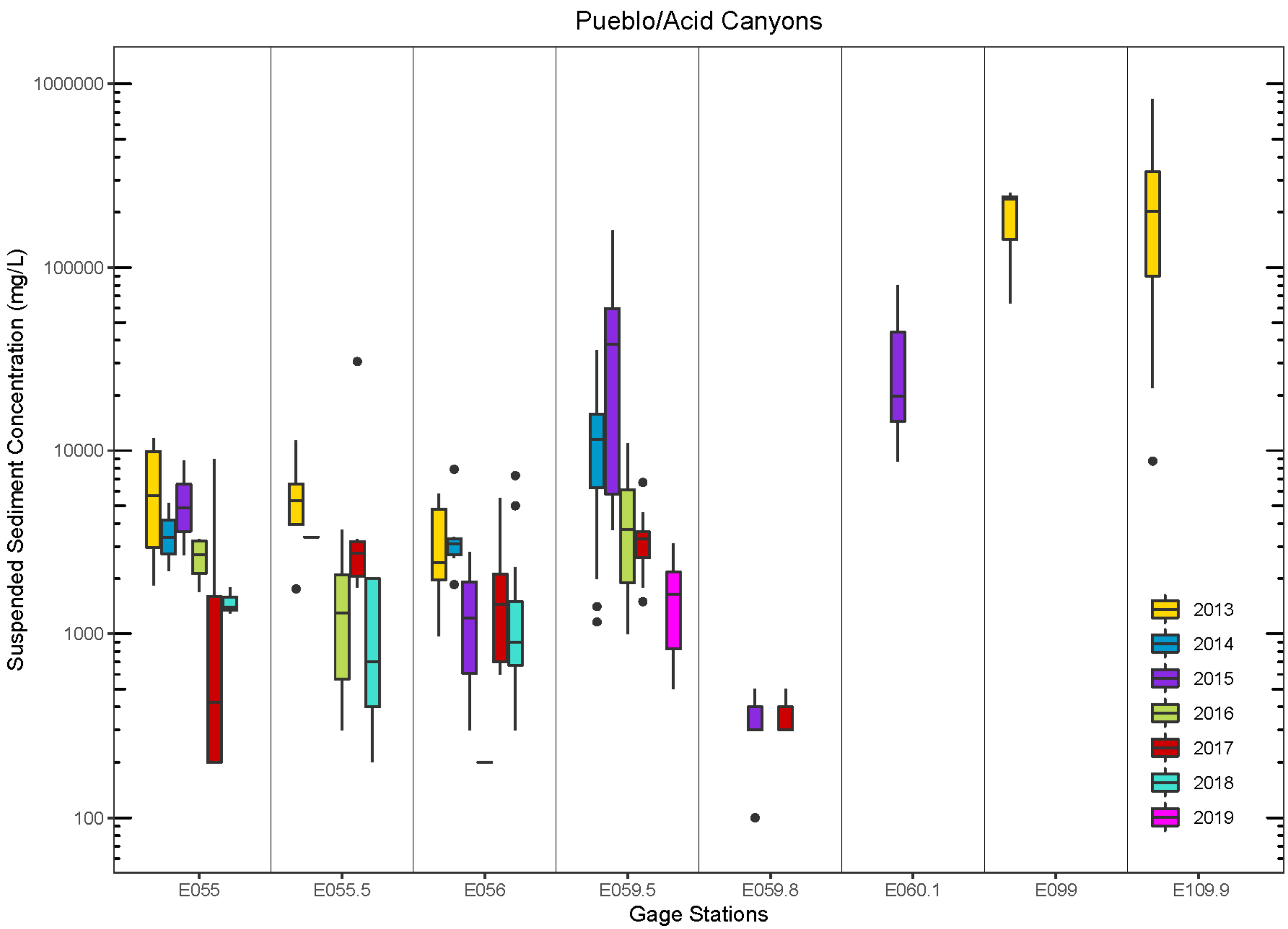
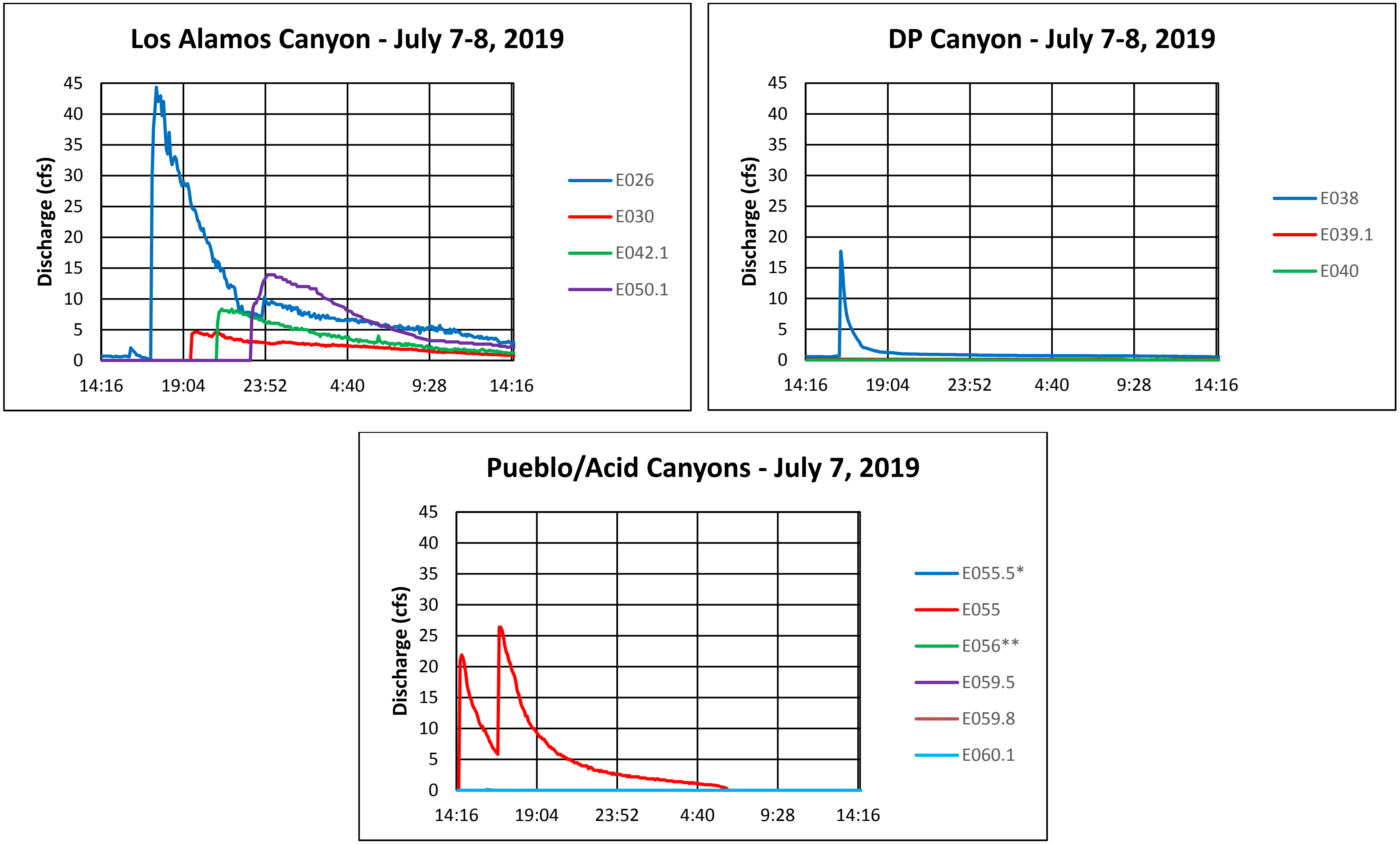


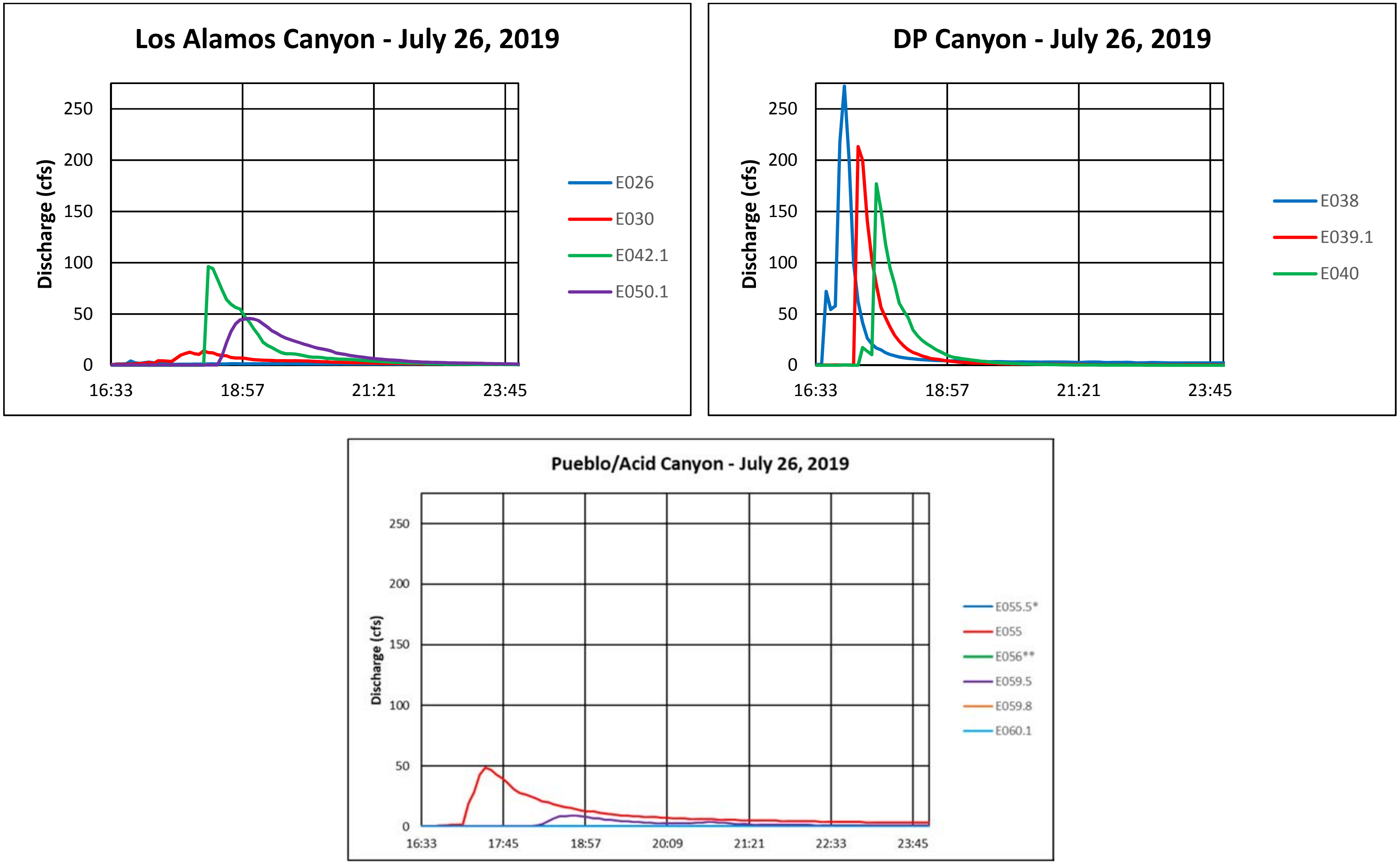
Figure 3.2-2 (continued) **Box-and-whisker plots of SSC for all gaging stations in the LA/P watershed over the past 7 yr of monitoring. Black dots represent outliers.**



* E055.5 discharge data calculated from a best-fit curve from a rating curve created from one channel cross-section.

** E056 sensor potentially was malfunctioning during this time.

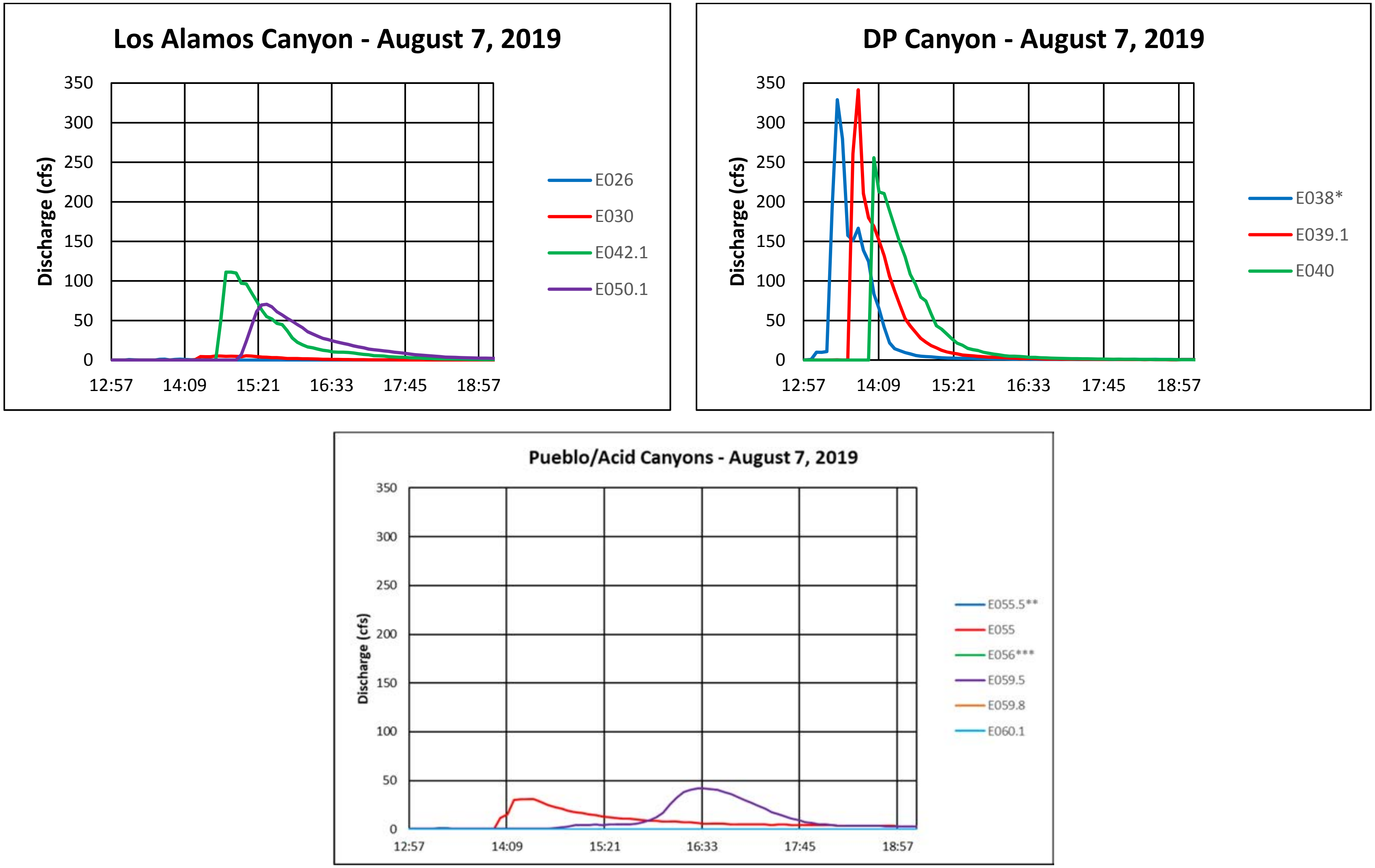
Figure 3.2-3 Hydrographs during each sample-triggering runoff event for each canyon from upstream to downstream reaches



* E055.5 discharge data calculated from a best-fit curve from a rating curve created from one channel cross-section.

** E056 sensor was malfunctioning during this time.

Figure 3.2-3 (continued) Hydrographs during each sample-triggering runoff event for each canyon from upstream to downstream reaches

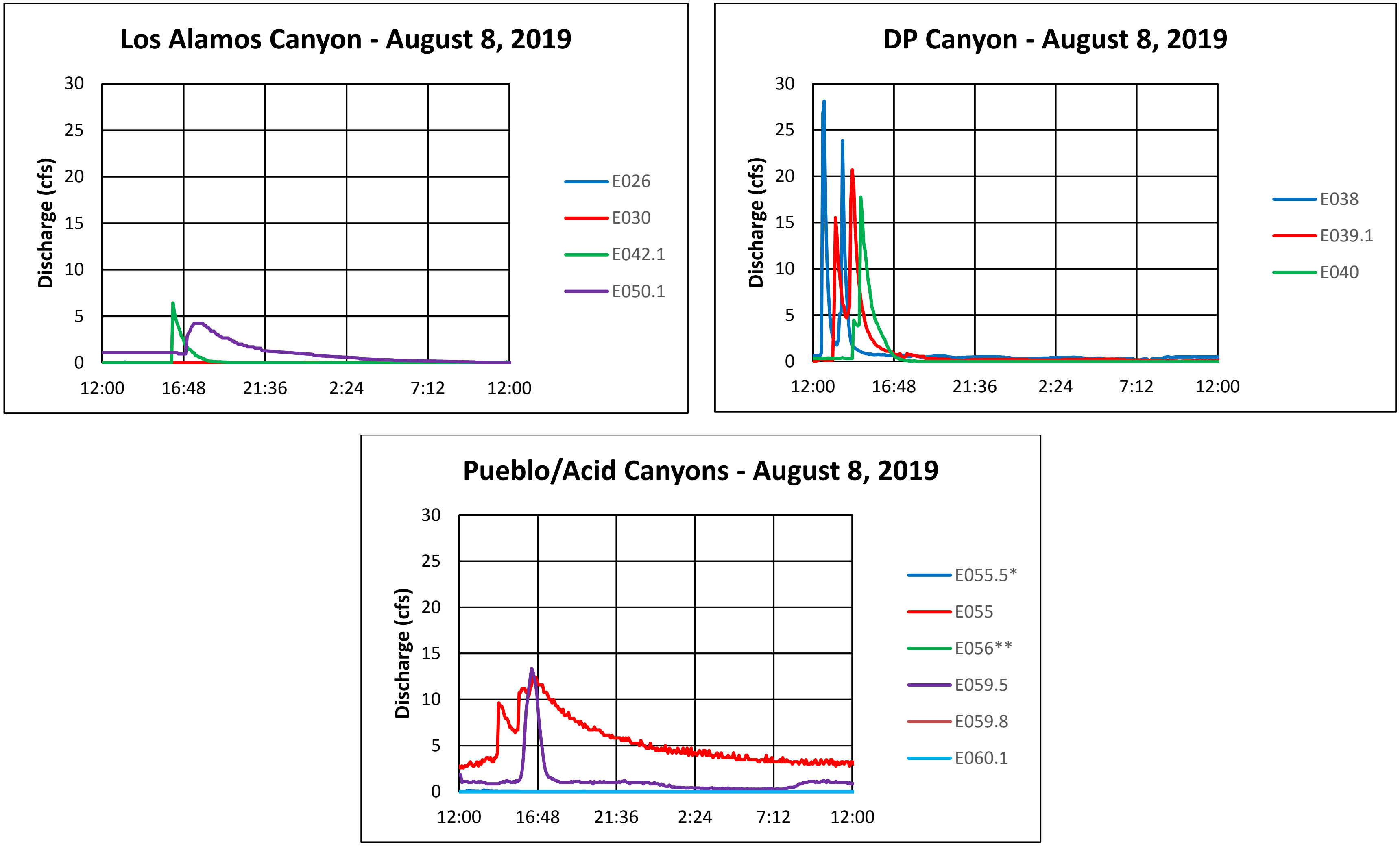


* E038 peak discharge exceeded rating curve, so peak discharge value estimated from a best-fit equation created from the rating curve, which is potentially underestimated.

** E055.5 discharge data calculated from a best-fit curve from a rating curve created from one channel cross-section.

*** E056 sensor was malfunctioning during this time.

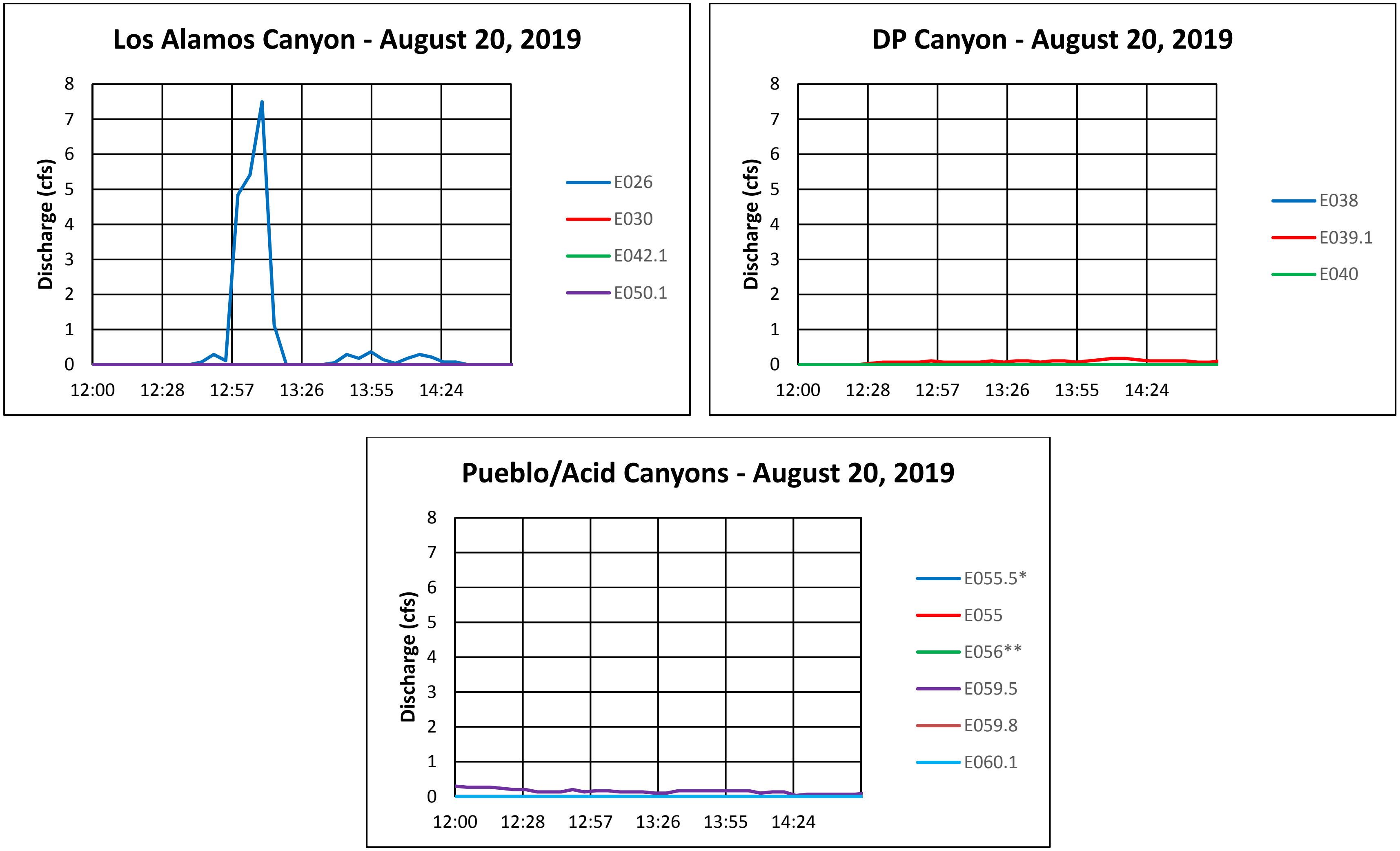
Figure 3.2-3 (continued) **Hydrographs during each sample-triggering runoff event for each canyon from upstream to downstream reaches**



* E055.5 discharge data calculated from a best-fit curve from a rating curve created from one channel cross-section.

** E056 sensor was malfunctioning during this time.

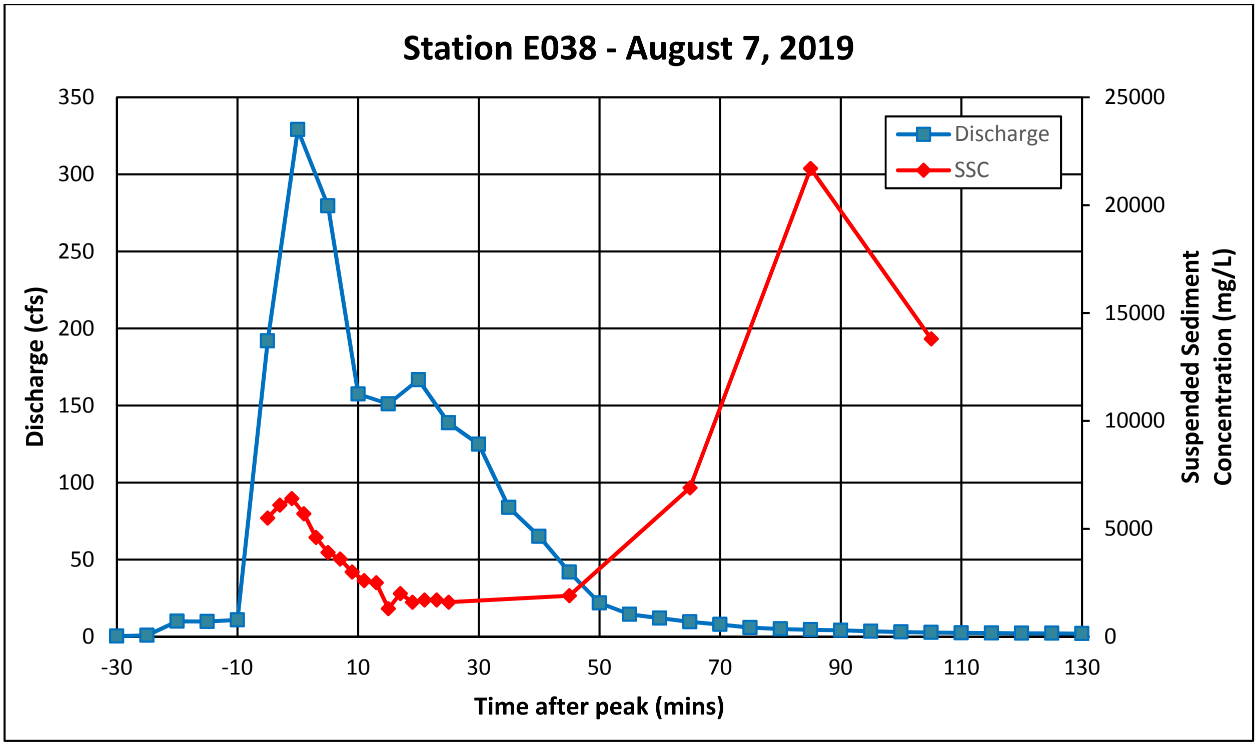
Figure 3.2-3 (continued) Hydrographs during each sample-triggering runoff event for each canyon from upstream to downstream reaches



* E055.5 discharge data calculated from a best-fit curve from a rating curve created from one channel cross-section.

** E056 sensor was malfunctioning during this time.

Figure 3.2-3 (continued) Hydrographs during each sample-triggering runoff event for each canyon from upstream to downstream reaches



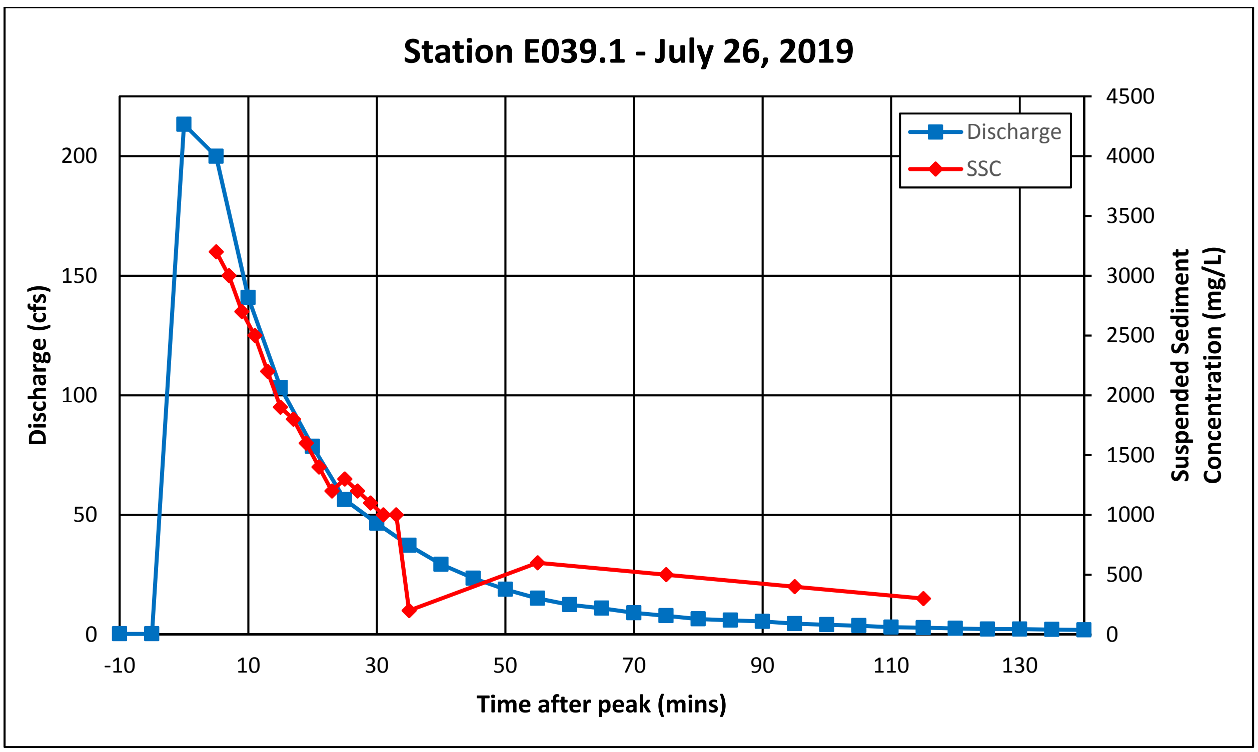
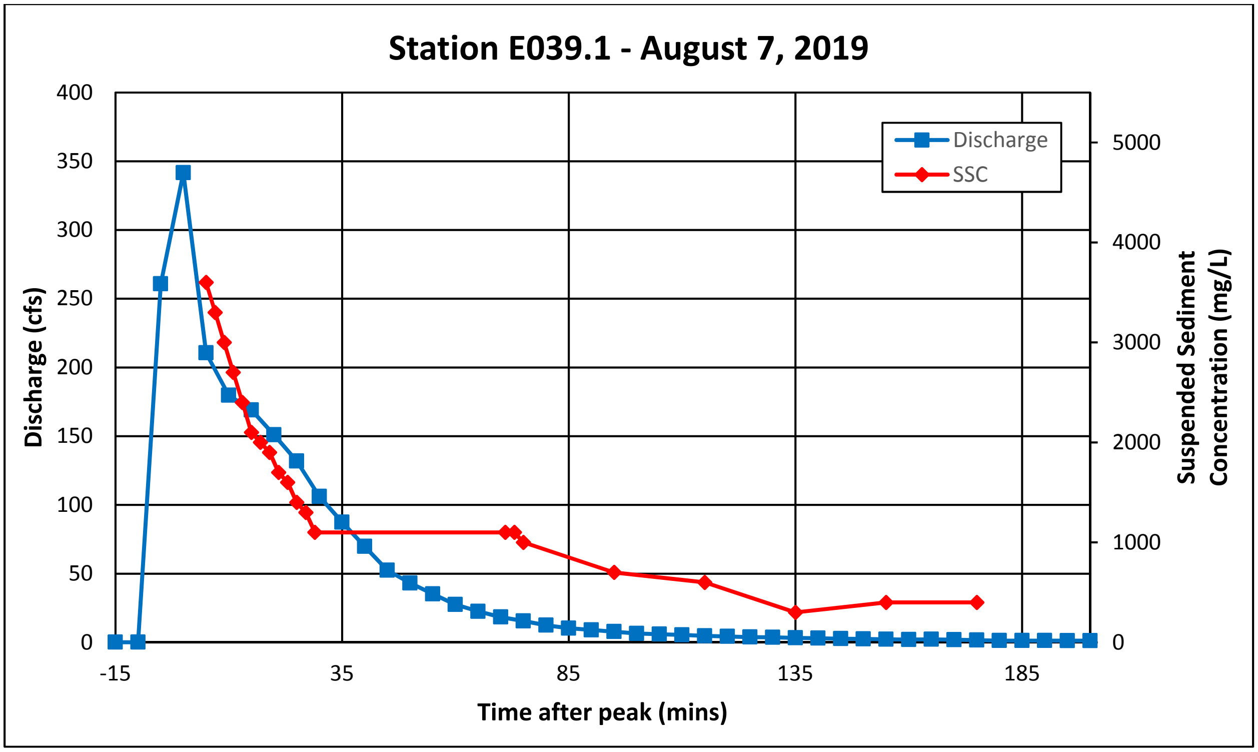


Figure 3.2-4 Measured discharge and measured SSC for events sampled at E038, E039.1, E042.1, E050.1, and E059.5



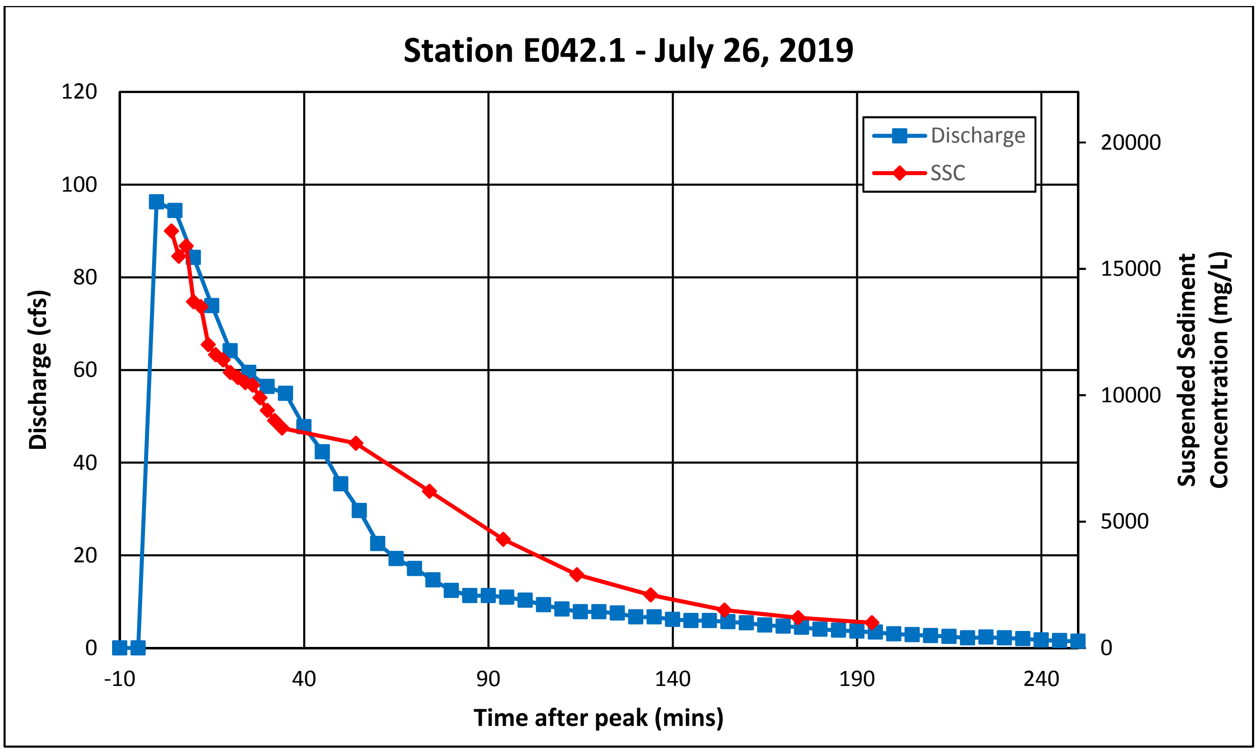
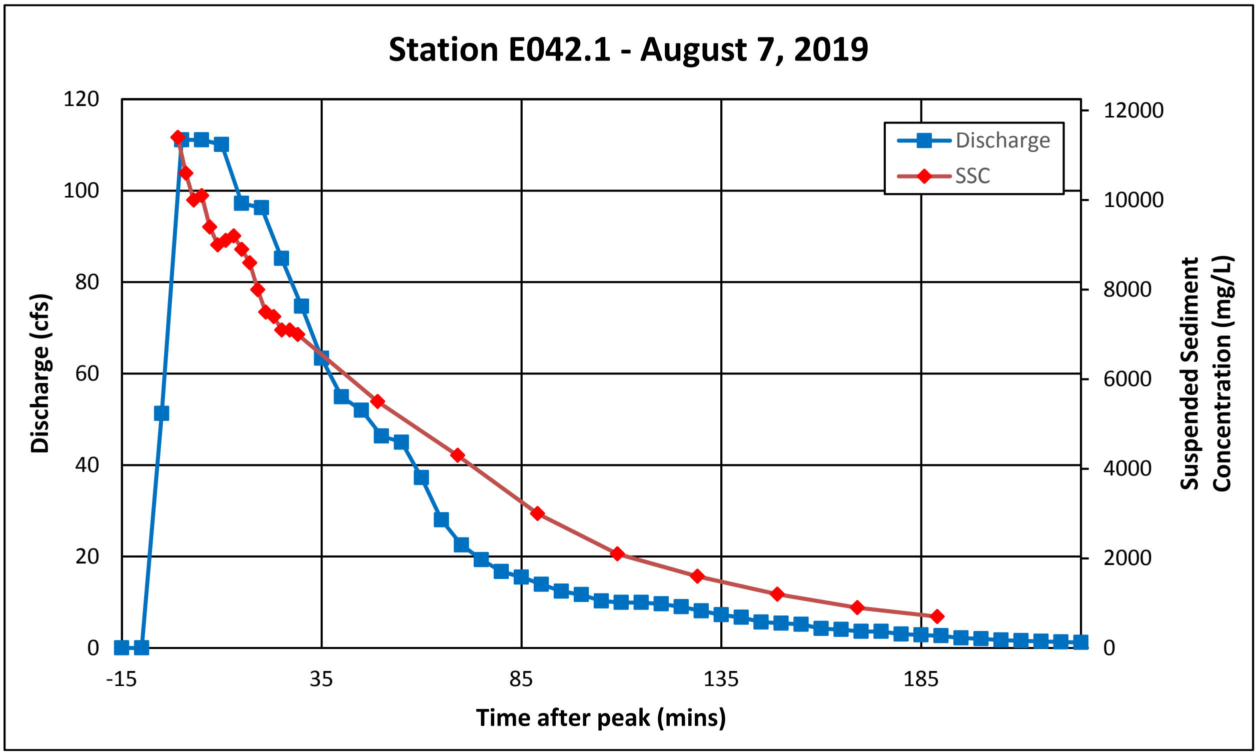


Figure 3.2-4 (continued) **Measured discharge and measured SSC for events sampled at E038, E039.1, E042.1, E050.1, and E059.5**



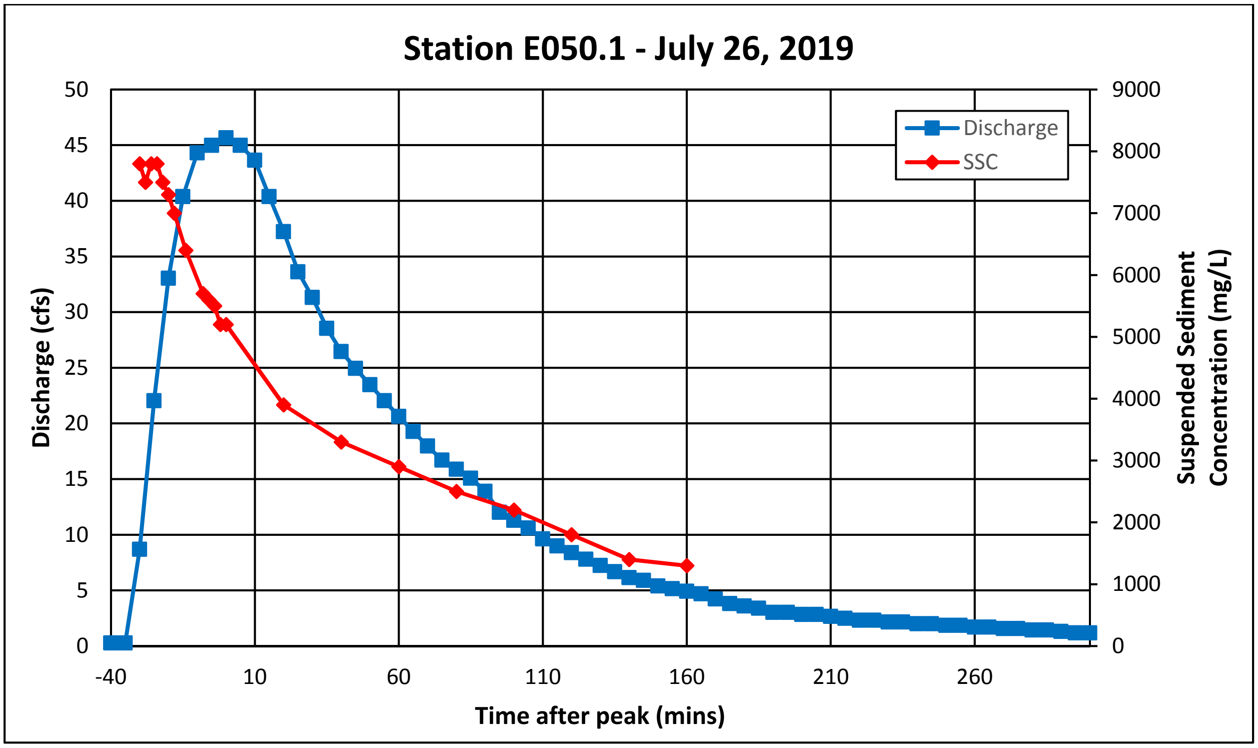
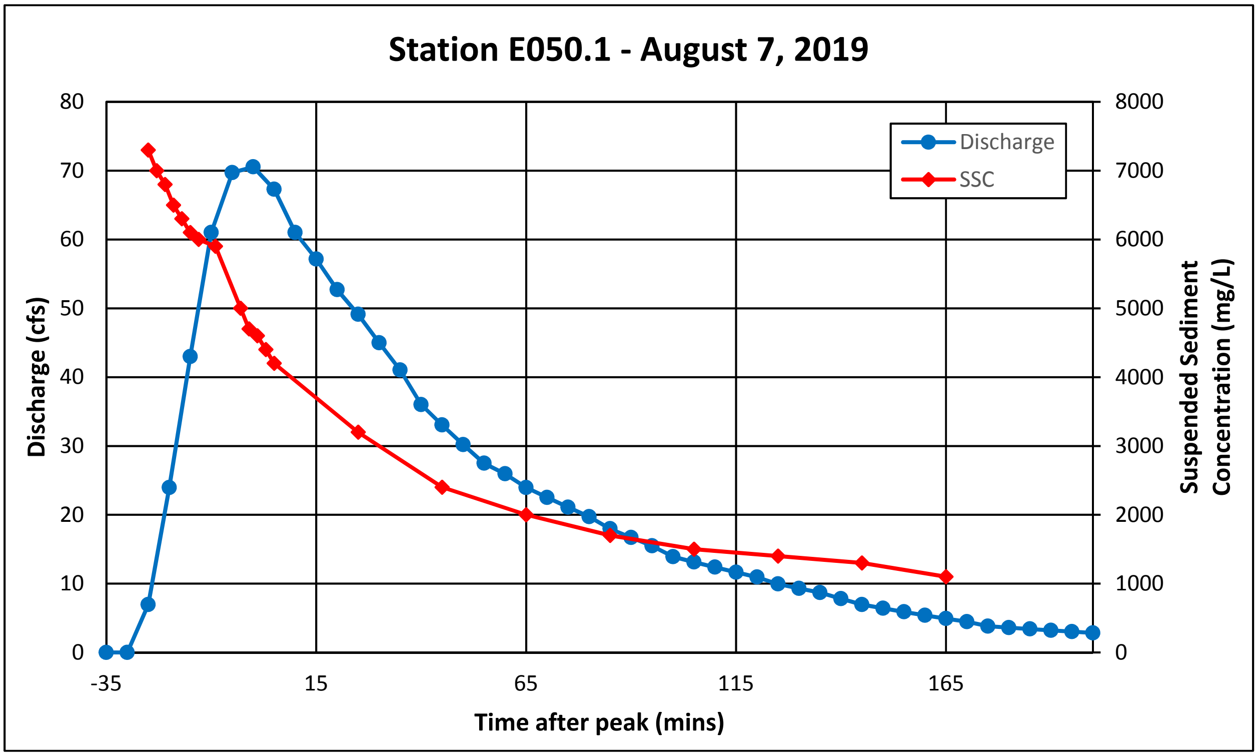


Figure 3.2-4 (continued) **Measured discharge and measured SSC for events sampled at E038, E039.1, E042.1, E050.1, and E059.5**



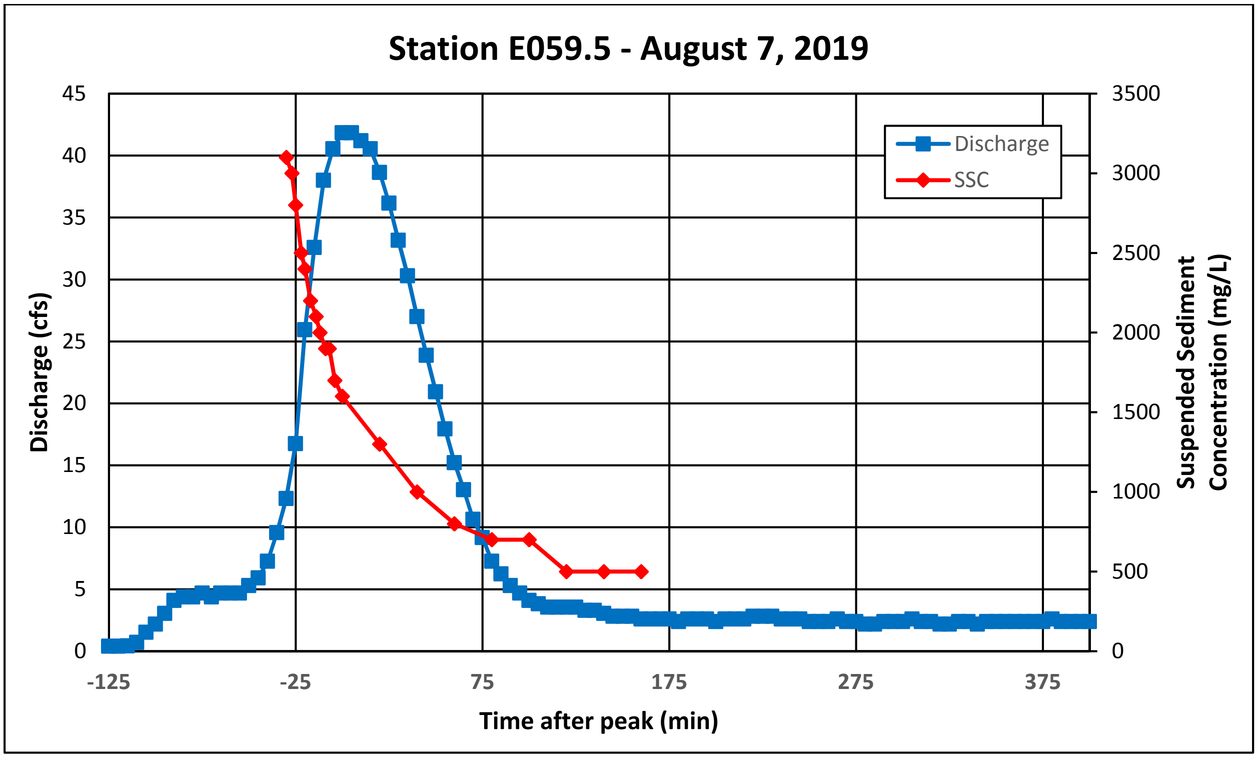


Figure 3.2-4 (continued) **Measured discharge and measured SSC for events sampled at E038, E039.1, E042.1, E050.1, and E059.5**

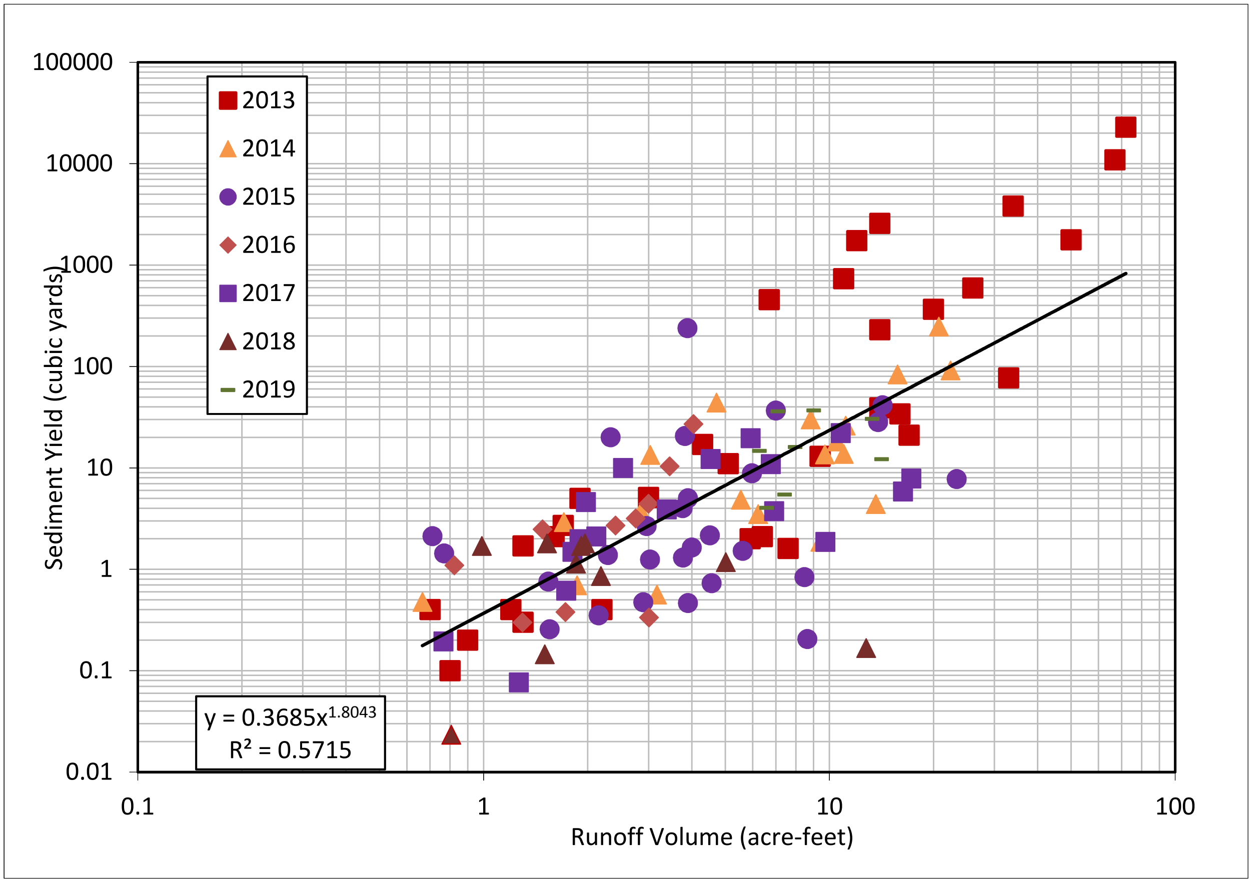


Figure 3.2-5 Relationship between SSC-based sediment yield and runoff volume over the past 7 yr of monitoring

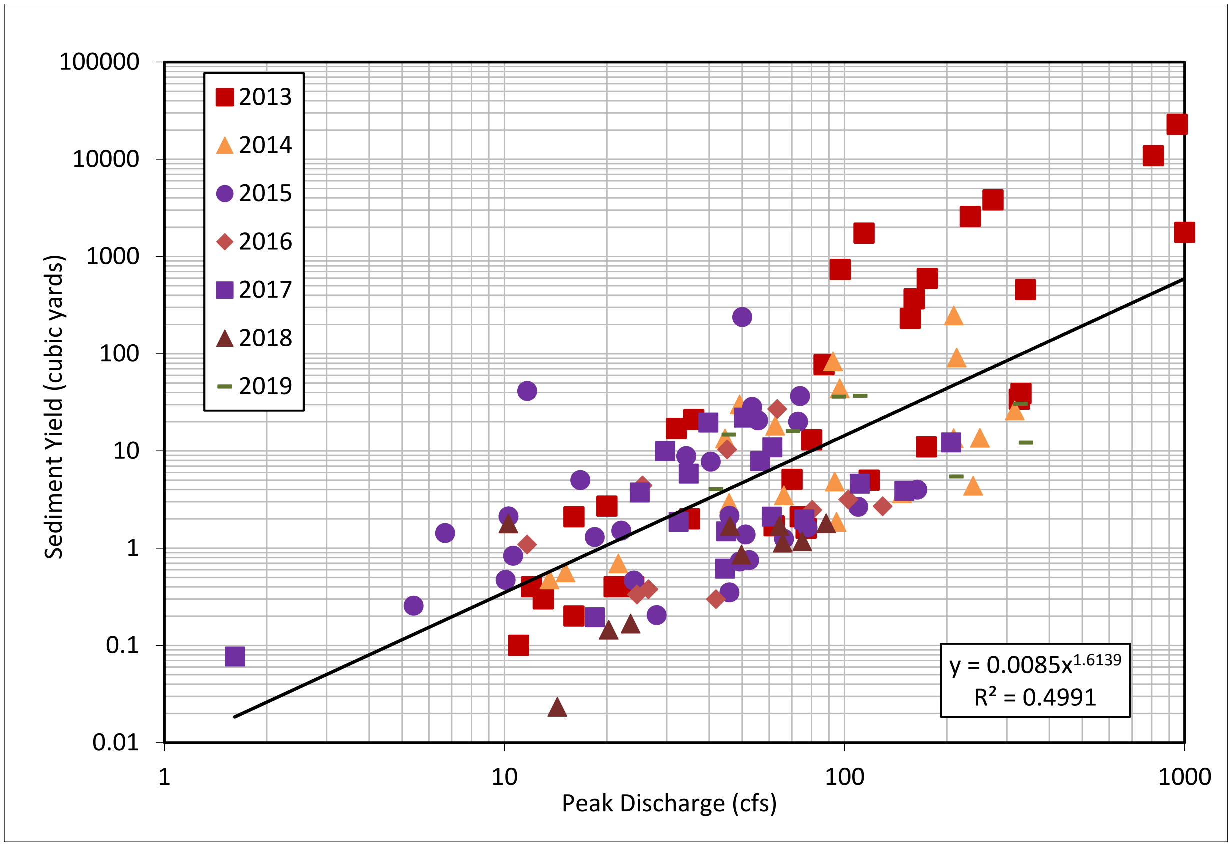


Figure 3.2-6 Linear relationship between SSC-based sediment yield and peak discharge over the past 7 yr of monitoring

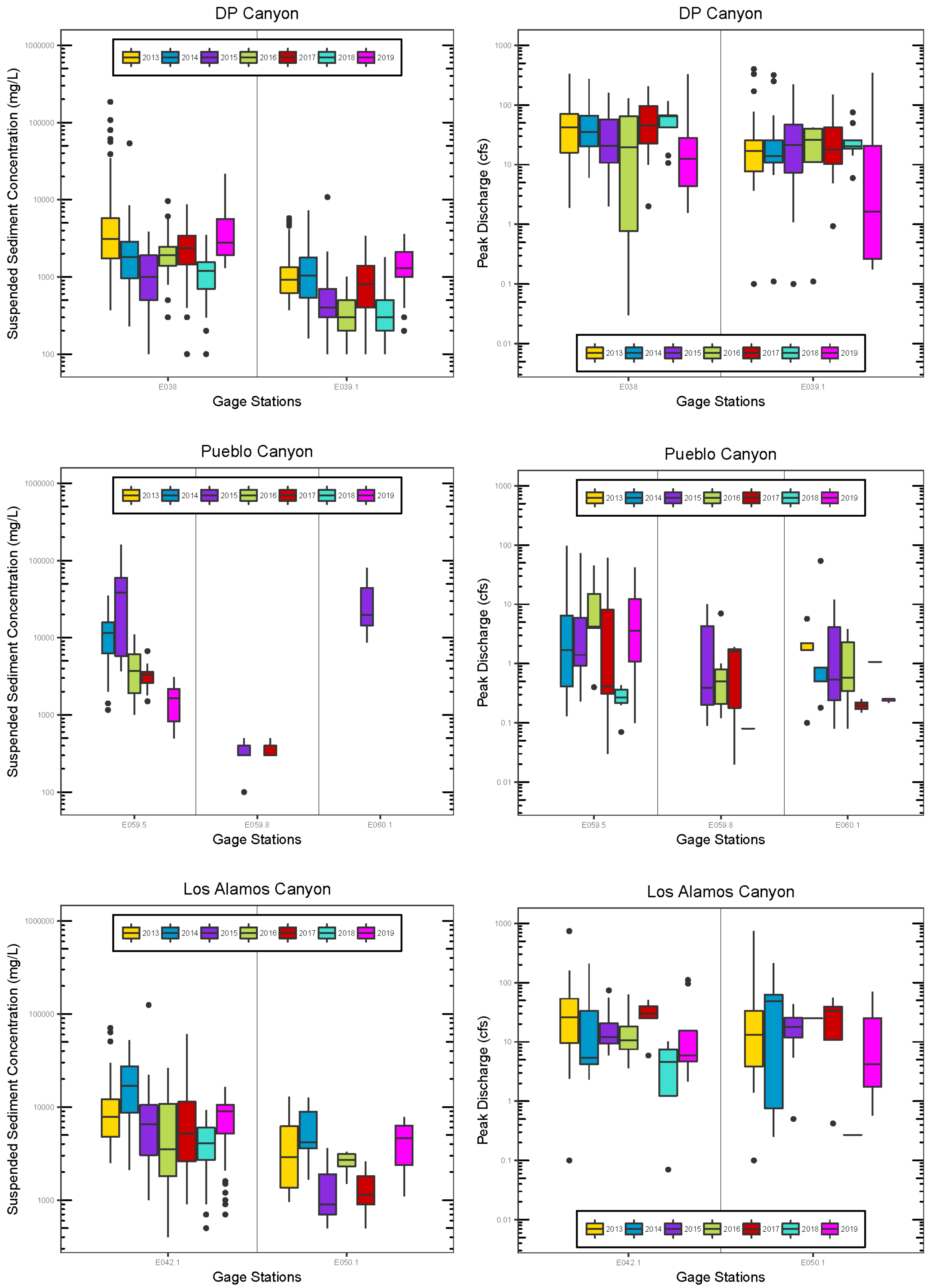


Figure 3.4-1 Box-and-whisker plots of SSC (left) and peak discharge (right) upstream and downstream of the watershed mitigations in DP (top), Pueblo (middle), and

Los Alamos (bottom) Canyons over the past 7 yr of monitoring. Black dots represent outliers.

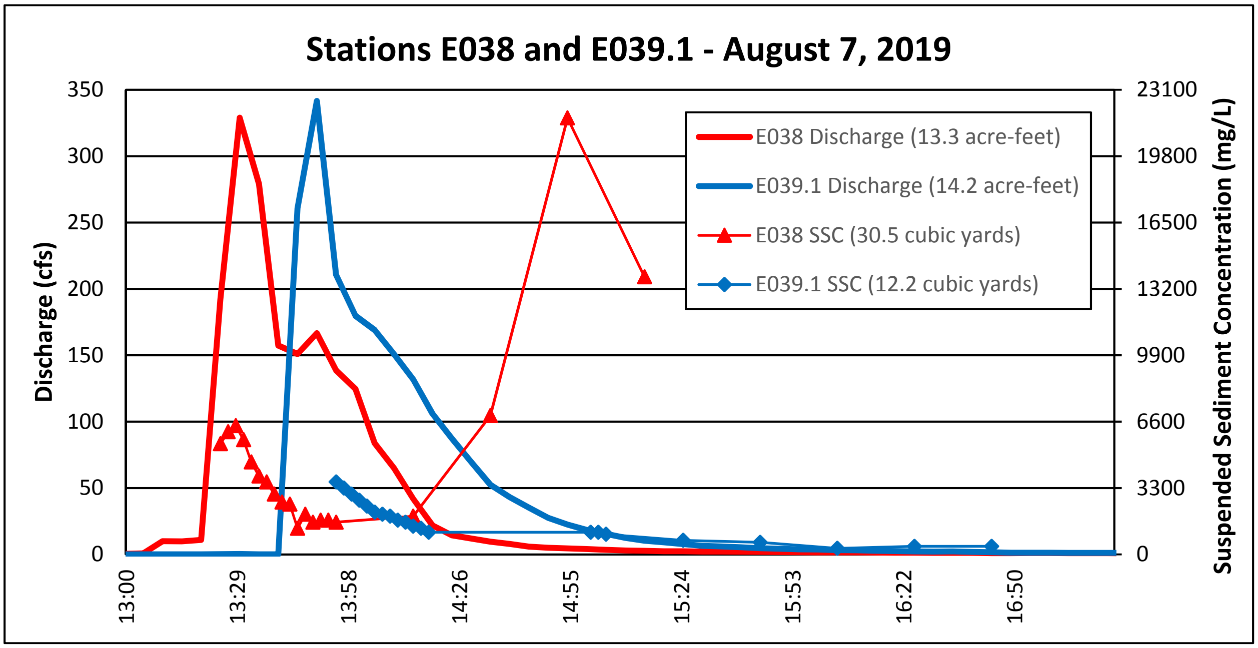
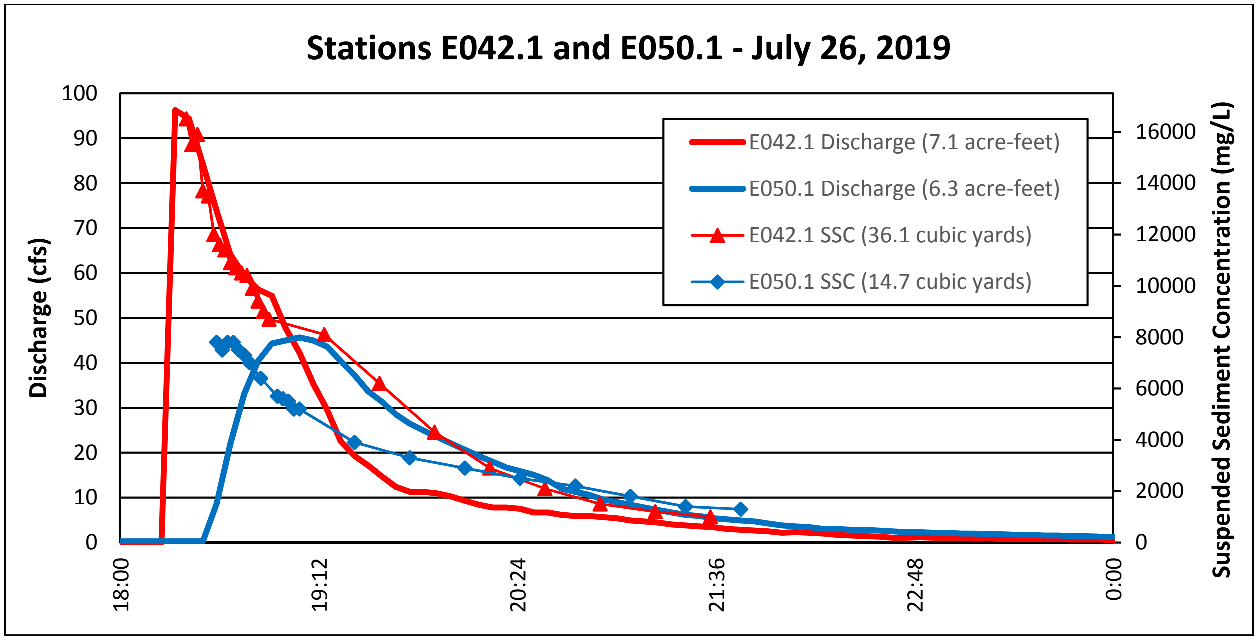


Figure 3.4-2 **Discharge and SSC at E038 and E039.1 in DP Canyon on days when sampling of the same runoff event occurred**



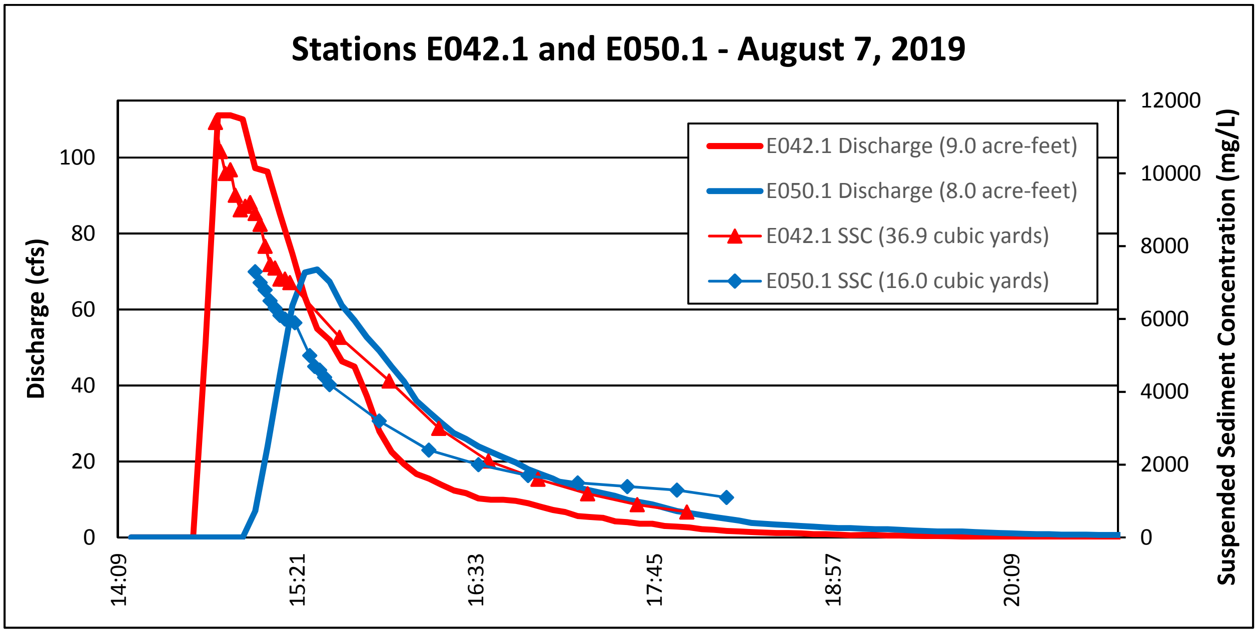


Figure 3.4-3 **Discharge and SSC at E042.1 and E050.1 in upper Los Alamos Canyon on days when sampling of the same runoff event occurred**

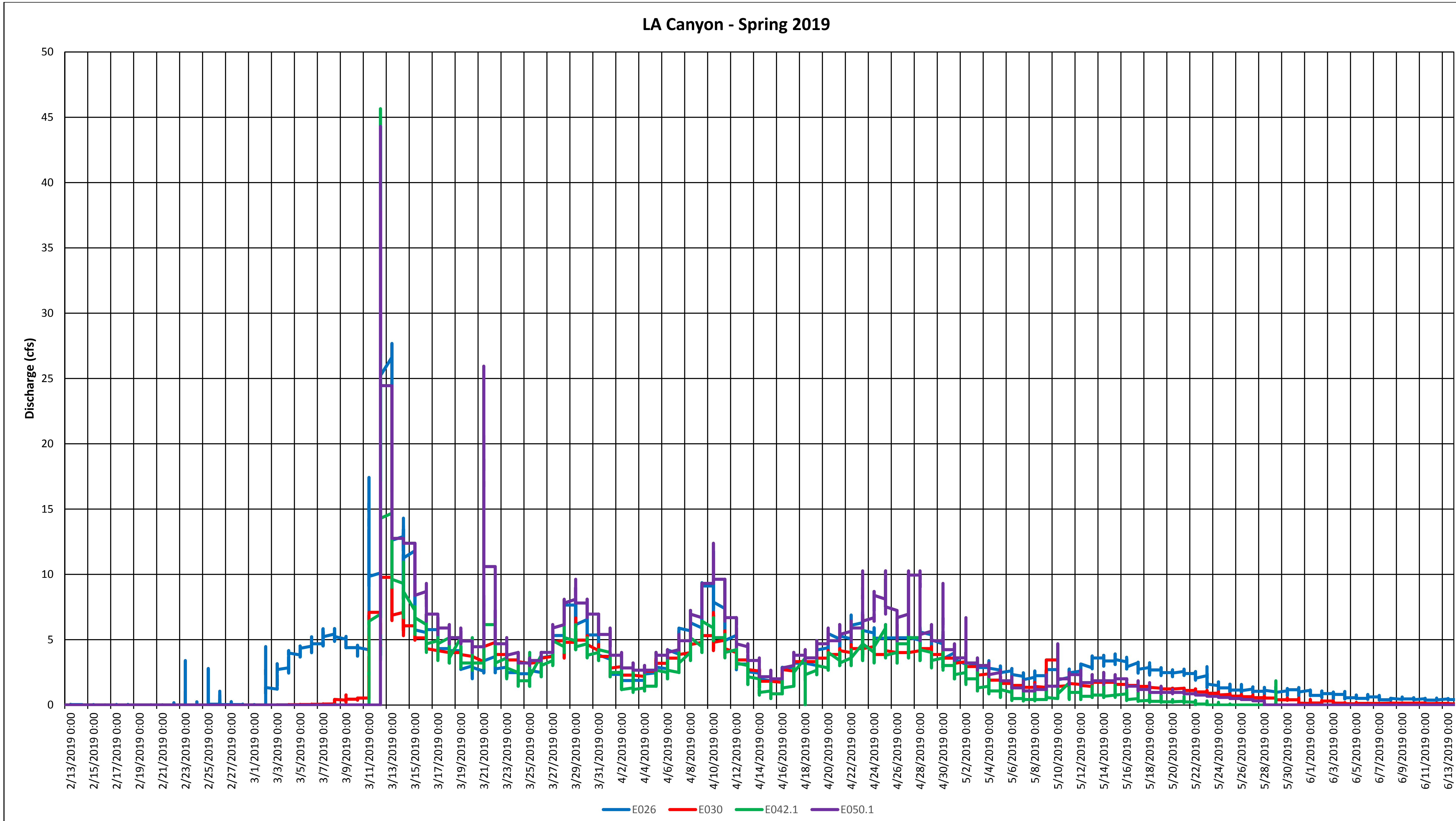


Figure 3.5-1 Discharge at E026, E030, E042.1, and E050.1 in upper Los Alamos Canyon from February 13, 2019, through June 6, 2019

Table 2.1-1
Equipment Configuration at LA/P Gaging Stations

Gaging Station	Stage Measurement Sensor	Communication Method with Data Logger	Sampler Trip Level (Discharge) (cfs)	Dates Sampler Trip Level Active
E026	Radar sensor	Radio telemetry	5	Monitoring season
E030	Radar sensor	Radio telemetry	50	Monitoring season
E038	Radar sensor	Radio telemetry	100	Monitoring season
E039.1	Radar sensor	Radio telemetry	50	Monitoring season
E040	Radar sensor	Radio telemetry	50	Monitoring season
E042.1	Encoder, bubbler, radar sensor	Radio telemetry	50	Monitoring season
E050.1	Encoder, bubbler, radar sensor	Radio telemetry	5	Monitoring season
E055	Bubbler	Radio telemetry	50	Until 8/29/2019
E055	Radar sensor	Radio telemetry	50	After 8/29/2019
E055.5	Radar sensor	Radio telemetry	50*	Monitoring season
E056	Bubbler	Radio telemetry	50	Until 8/28/2019
E056	Radar sensor	Radio telemetry	50	After 8/28/2019
E059.5	Bubbler	Radio telemetry	5	Monitoring season
E059.8	Bubbler	Radio telemetry	5	Monitoring season
E060.1	Encoder, bubbler, radar sensor	Radio telemetry	5	Monitoring season

* E055.5 sampler trip level determined by a rating curve created from one channel cross-section.

Table 2.3-1
Maximum Daily Discharge and Storm Water Sampling in the LA/P Watershed during 2019

Date	Los Alamos/Pueblo												
	DP Canyon			Los Alamos Canyon				Acid Canyon		Pueblo Canyon			
	E038	E039.1	E040	E026	E030	E042.1	E050.1	E055.5	E056	E055	E059.5	E059.8	E060.1
7/7-7/8/2019	18 BT[a]	0.18 BT	0 BT	44 S[b]	4.8 BT	8.4 BT	14 S	0.17 BT	0 BT	26 BT	0 BT	0 BT	0 BT
7/26/2019	272 NS[c]	213 S	177 S	4.2 BT	14 BT	96 S	46 S	1 BT	ND[d] BT	48 BT	9.2 NS	0 BT	0.25 BT
8/7/2019	329[e] S	342 S	255 NS	1.25 BT	5.5 BT	111 S	71 S	1.3 BT	ND BT	42 BT	42 S	0 BT	0 BT
8/8/2019	28 BT	21 BT	18 BT	0.09 BT	0.06 BT	6.4 BT	4.2 BT	0.22	ND BT	12 BT	13 NS	0 BT	0 BT
8/20/2019	0 BT	0.18 BT	0 BT	7.5 NS	0 BT	0 BT	0 BT	0.04	ND BT	ND	1 BT	0 BT	0 BT

Note: Units are cubic feet per second.

[a] BT = Below gage station triggering threshold, no sample collected.

[b] S = Sample was collected. These discharge levels are highlighted in yellow to emphasize those events for which discharge exceeded the trip level and samples were collected.

[c] NS = No sample was collected, but discharge was above gaging station trip level. These discharge levels are shaded in blue to highlight those events where discharge was above trip level, but no sample was collected.

[d] ND = No data. Site equipment malfunctioned and did not record flow. Field measurements of high water marks show flows below trip level.

[e] At E038 the peak stage during the 08/07/2019 flow event exceeded the rating curve. The peak discharge value was calculated using a best-fit equation for the rating curve.

Table 2.3-2
Sampling Operational Issues during the 2019 Monitoring Year

Gaging Station	Date	Peak Discharge (cfs)	Reason	Comment
E026	8/20/2019	7.5	Operator error	Sampler intake tubing set above the trip level.
E038	7/26/2019	272	Operator error	Sampler not left in inhibited state at previous site visit.
E040	8/7/2019	255	Site conditions	Intake clogged with sediment. No sample collected.
E059.5	7/26/2019	9.2	Operator error	Sampler not left in inhibited state at previous site visit.
E059.5	8/8/2019	13	Site conditions	Sample collection from previous storm on 8/7/2019 had not yet been retrieved because of a lightning stand-down on 8/8/2019. Field team was unable to access the site. Sampler was not inhibited to sample during 8/8/2019 storm event.

Table 2.4-1
Factors Contributing to Analytical Suite Prioritization

Gage	Priority	Analytical Suite	Glass Bottle	Polyethylene Bottle	Minimum Volume Required (L)
DP Canyon Gages					
E038, E039.1, E040	1	PCBs	Yes	No	1
	2	Gamma spectroscopy[a] and gross alpha	Yes	Yes	1
	3	Isotopic radionuclides	Yes	Yes	1
	4	Strontium-90	No	Yes	1
	5	Dioxins and furans	Yes	No	1
	6	TAL metals[b] (F[c]/UF[d])	Yes	Yes	0.25/0.25
	7	TOC[e], BLM suite[f]	Yes	No	1
	8	Particle size and SSC	Yes	Yes	1
Upper Los Alamos Canyon Gages					
E026, E030	1	PCBs	Yes	No	1
	2	Gamma spectroscopy and gross alpha	Yes	Yes	1
	3	Isotopic radionuclides	Yes	Yes	1
	4	Strontium-90	No	Yes	1
	5	Dioxins and furans	Yes	No	1
	6	TAL metals (F/UF)	Yes	Yes	0.25/0.25
	7	TOC, BLM suite	Yes	No	1
	8	Particle size and SSC	Yes	Yes	1

Table 2.4-1 (continued)

Gage	Priority	Analytical Suite	Glass Bottle	Polyethylene Bottle	Minimum Volume Required (L)
Upper Pueblo Canyon and Acid Canyon Gages					
E055, E055.5, E056	1	PCBs	Yes	No	1
	2	Gamma spectroscopy and gross alpha	Yes	Yes	1
	3	Isotopic radionuclides	Yes	Yes	1
	4	TAL metals (F/UF)	Yes	Yes	0.25/0.25
	5	TOC, BLM suite	Yes	No	1
	6	Particle size and SSC	Yes	Yes	1
Lower Los Alamos Canyon Gages					
E042.1	1	PCBs	Yes	No	1
	2	Gamma spectroscopy and gross alpha	Yes	Yes	1
	3	Isotopic radionuclides	Yes	Yes	1
	4	Strontium-90	Yes	Yes	1
	5	Dioxins/furans	Yes	No	1
	6	TAL metals (F/UF)	Yes	Yes	0.25/0.25
	7	TOC, BLM suite	Yes	No	1
	8	Particle size and SSC	Yes	Yes	1
E050.1	1	PCBs	Yes	No	1
	2	Gamma spectroscopy and gross alpha	Yes	Yes	1
	3	Isotopic radionuclides	Yes	Yes	1
	4	Dioxins/furans	Yes	No	1
	5	Strontium-90	Yes	Yes	1
	6	TAL metals (F/UF)	Yes	Yes	0.25/0.25
	7	TOC, BLM suite	Yes	No	1
	8	Gross beta	Yes	Yes	0.25
	9	Radium-226/radium-228	Yes	Yes	1
	10	Particle size and SSC	Yes	Yes	1
Lower Pueblo Canyon Gages					
E059.5, E059.8	1	PCBs	Yes	No	1
	2	Gamma spectroscopy and gross alpha	Yes	Yes	1
	3	Isotopic radionuclides	Yes	Yes	1
	4	Dioxins/furans	Yes	No	1
	5	Strontium-90	Yes	Yes	1
	6	TAL metals (F/UF)	Yes	Yes	0.25/0.25
	7	TOC, BLM suite	Yes	No	1
	8	Particle size and SSC	Yes	Yes	1

Table 2.4-1 (continued)

Gage	Priority	Analytical Suite	Glass Bottle	Polyethylene Bottle	Minimum Volume Required (L)
E060.1	1	PCBs	Yes	No	1
	2	Gamma spectroscopy and gross alpha	Yes	Yes	1
	3	Isotopic radionuclides	Yes	Yes	1
	4	Dioxins/furans	Yes	No	1
	5	Strontium-90	Yes	Yes	1
	6	TAL metals (F/UF)	Yes	Yes	0.25/0.25
	7	TOC, BLM suite	Yes	No	1
	8	Gross beta	Yes	Yes	0.25
	9	Radium-226/radium-228	Yes	Yes	1
	10	Particle size and SSC	Yes	Yes	1
Detention Basin and Vegetative Buffer below the SWMU 01-001(f) Drainage					
CO111041, CO101038	1	PCBs	Yes	No	1
	2	TAL metals (F/UF)	Yes	Yes	0.25/0.25
	3	TOC, BLM suite	Yes	No	1
	4	Gross alpha	Yes	Yes	1
	5	Particle size and SSC	Yes	Yes	1

[a] Gamma spectroscopy = Actinium-228, beryllium-7, bismuth-212, bismuth-214, cesium-134, cesium-137, cobalt-60, gross gamma, iodine-131, lead-212, lead-214, potassium-40, protactinium-234m, sodium-22, thallium-208, and thorium-234.

[b] TAL Metals = TAL metals are Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, and Zn; hardness is calculated from calcium and magnesium, components of the TAL list.

[c] F = Analyses of filtered sample.

[d] UF = Analyses unfiltered sample.

[e] TOC = Total organic carbon.

[f] Biotic ligand model (BLM) suite = Alkalinity, dissolved organic carbon, pH, and sulfate.

Table 2.4-2
Analytical Requirements for Storm Water Samples

Analytical Suite	Method	BDD[a] Monitoring	Detention Basins and Wetland Below the SWMU 01-001(f) Drainage	DP Canyon Gages	Fire-Affected Lower Watershed Gages	Lower Pueblo Canyon Gages	Upper Los Alamos Canyon Gages	Upper Pueblo Canyon and Acid Canyon Gages
Alkalinity	EPA:310.1	X	X[b]	X	X	X	X	X
Americium-241	HASL-300:AM-241	X	—[c]	—	X	X	—	X
Chloride	EPA:300.0	X	X	X	X	X	X	X
Dioxins/furans	EPA:1613B	X	—	—	X	X	X	—
Dissolved organic carbon	SW-846:9060	X	X	X	X	X	X	X
Gamma spectroscopy	EPA:901.1	X	—	X	X	X	X	X
Gross alpha	EPA:900	X	X	X	X	X	X	X
Gross beta	EPA:900	X	—	—	—	—	—	—
Hardness[d]	SM:A2340B	X	X	X	X	X	X	X
Isotopic plutonium	HASL-300:ISOPU	X	—	X	X	X	X	X
Isotopic uranium	HASL-300:ISOU	X	—	—	—	—	—	—
Mercury	EPA:245.2	X	X	X	X	X	X	X
Particle size	ASTM:C1070-01	X	X	X	X	X	X	X
PCBs	EPA:1668C	X	X	X	X	X	X	X
pH	EPA:150.1	X	X	X	X	X	X	X
Radium-226/radium-228	EPA:903.1/904	X	—	—	—	—	—	—
Silver	EPA:200.8	—	—	—	—	X	X[e]	X
SSC	ASTM:D3977-97	X	X	X	X	X	X	X
Strontium-90	EPA:905.0	X	—	X	X	X	X	—
Sulfate	EPA:300.0	X	X	X	X	X	X	X
Hg+Se+U	EPA:200.8	—	X	X	X	X	X	X
TAL metals	EPA:200.7/200.8	X	X	X	X	X	X	X
Total organic carbon	SW-846:9060	X	X	X	X	X	X	X

[a] BDD = Buckman Direct Diversion gaging stations E050.1 and E060.1.

[b] X = Monitoring planned.

[c] — = Monitoring not planned.

[d] Hardness is calculated from filtered calcium and magnesium, components of the TAL metals list.

[e] E030 only.

Table 2.5-1
Sample Collection and Sample Retrieval Working-Day Interval

Location Alias	Date Sample Collected	Date Sample Retrieved	Working Days between Collection and Retrieval	Comment
CO111041	7/26/2019	7/29/2019	1	No comment
CO111041	8/7/2019	8/8/2019	1	No comment
E040	7/26/2019	7/29/2019	1	No comment
E038	8/7/2019	8/8/2019	1	No comment
E039.1	7/26/2019	7/29/2019	1	No comment
E039.1	8/7/2019	8/8/2019	1	No comment
E059.5	8/7/2019	8/8/2019	1	No comment
E042.1	7/26/2019	7/29/2019	1	No comment
E042.1	8/7/2019	8/9/2019	2	Site visit attempted on 8/8/2019, but field teams were called in from field because of a lightning stand-down.
E026	7/7/2019	7/8/2019	1	No comment
E050.1	7/8/2019	7/8/2019	0	No comment
E050.1	7/26/2019	7/29/2019	1	No comment
E050.1	8/7/2019	8/8/2019	1	No comment

Table 2.5-2
Gaging Station Operational Issues during the 2019 Monitoring Year

Gaging Station	Reason	Issue Date	Repair Date	Working Days from Issue to Repair	Potential Missed Discharge above Trigger	Peak Discharge (cfs)
E026	Scouring because of snowmelt	4/30/2019	n/a[a]	n/a	1	7.5
E040	Silting	7/26/2019	7/30/2019	2	0	<1
	Silting	8/8/2019	8/9/2019	1	0	<1
	Silting	8/9/2019	8/16/2019	5	0	<1
	Silting	10/4/2019	10/8/2019	2	0	<1
E055	Radar sensor needs radar plate installed	9/12/2019	9/18/2019	4	0	0
E056	Bubbler sensor malfunction	7/20/2019	8/28/2019	27	0	27[b]

[a] n/a = Not applicable.

[b] Discharge estimated from high–water mark field measurements.

Table 3.1-1
Drainage Area and Impervious Surface Percentage in the Los Alamos Canyon Watersheds

Canyon	Gaging Station	Drainage Area (acres)	Impervious Surface (%)
Acid	E055.5	53	26
Acid*	E056	237	22
Acid	Acid Canyon above E056	290	23
Pueblo	E055	2184	8.0
Pueblo	E059.5	2099	11
Pueblo	E059.8	407	4.4
Pueblo*	E060.1	330	3.8
Pueblo	Pueblo Canyon above E060.1	5310	9.5
DP	E038	125	32
DP*	E039.1	111	12
DP*	E040	130	4.0
DP	DP Canyon above E039.1	236	23
DP	DP Canyon above E040	366	16
LA	E026	4354	0.4
LA*	E030	1100	13
LA*	E042.1	605	0.6
LA*	E050.1	193	2.2
LA*	E109.9 (including Guaje Canyon)	27,000	1.2
LA	Los Alamos Canyon above E050.1	6250	2.7
LA	Los Alamos, Pueblo, and Guaje Canyons above E109.9	37,760	2.6
LA*	Los Alamos Canyon between E050.1, E060.1, and E109.9	5240	2.4
Guaje	E099	21,000	0.9

Notes: Drainage areas marked by an asterisk do not extend to head of watershed above gaging station. The drainage areas without an asterisk extend from the gaging station to the head of the watershed.

Table 3.2-1
Travel Time of Flood Bore, Peak Discharge, Increase or Decrease in Peak Discharge, and Percent Change in Peak Discharge from Upstream to Downstream Gaging Stations for 2019 Runoff Events Exceeding Sampling Triggers across the Watershed Mitigations

Date (2019)	Travel Time from E038 to E039.1 (min)	Peak Discharge (cfs)		+/−[a]	%[a]	Travel Time from E042.1 to E050.1 (min)	Peak Discharge (cfs)		+/−[a]	%[a]
		E038	E039.1				E042.1	E050.1		
7/7–7/8	0	18	0.18	−	99	165	8.4	14	+	40
7/26	15	272	213	−	22	50	96	46	−	52
8/7	20	329[b]	342	+	5	45	111	71	−	36
8/8	105	28	21	−	25	80	6.4	4.2	−	34
8/20	—[c]	0	0.18	+	100	—	0	0	—	—
Min	0	0	0	—	5	45	0	0	—	34
Mean	35	129	115	—	50	85	44	27	—	41
Max	105	325	342	—	100	165	111	71	—	52
Date (2019)	**Travel Time from E059.5 to E059.8 (min)**	**Peak Discharge (cfs)**		**+/−[a]**	**%[a]**	**Travel Time from E059.8 to E060.1 (min)**	**Peak Discharge (cfs)**		**+/−[a]**	**%[a]**
		E059.5	**E059.8**				**E059.8**	**E060.1**		
7/7–7/8	—	0	0	—	—	—	0	0	—	—
7/26	—	9.2	0	−	100	—	0	0.25	+	100
8/7	—	42	0	−	100	—	0	0	—	—
8/8	—	13	0	−	100	—	0	0	—	—
8/20	—	1	0	−	100	—	0	0	—	—
Min	—	0	0	—	100	—	0	0	—	100
Mean	—	13	0	—	100	—	0	0	—	100
Max	—	42	0	—	100	—	0	0	—	100

[a] + = Increase; − = decrease; % = percent change in peak discharge.

[b] At E038 the peak stage during the 08/07/2019 flow event exceeded the rating curve. The peak discharge value was calculated using a best-fit equation for the rating curve.

[c] — = Result not applicable.

Table 3.2-2
SSC-Based Sediment Yield and Runoff Volume for Sampled 2013 to 2019 Runoff Events

Gaging Station	Date	Sediment Yield (tons)	Sediment Yield (yd^3)[a]	Runoff Volume (acre-ft)	Peak Discharge (cfs)
2013 Runoff Events					
E038	6/14/2013	11	5.1	3.0	70
E038	6/30/2013	11	5.0	1.9	120
E038	7/12/2013	87	39	14	330
E038	7/28/2013	4.7	2.1	1.6	74
E038	8/5/2013	25	11	5.1	170
E038	8/9/2013	3.8	1.7	1.3	62
E039.1	6/14/2013	0.6	0.3	1.3	13
E039.1	6/30/2013	0.3	0.1	0.8	11
E039.1	7/12/2013	75	34	16	330
E039.1	7/28/2013	0.8	0.4	1.2	24
E039.1	8/4/2013	0.8	0.4	0.7	12
E039.1	8/9/2013	0.5	0.2	0.9	16
E039.1	9/10/2013	4.4	2.0	5.9	35
E039.1	9/12/2013	3.6	1.6	7.6	77
E039.1	11/5/2013	0.9	0.4	2.2	21
E042.1	7/12/2013	817	366	20	160
E042.1	8/5/2013	29	13	9.4	80
E042.1	9/10/2013	48	21	17	36
E050.1	7/12/2013	39	17	4.3	32
E050.1	8/5/2013	6.1	2.7	1.7	20
E050.1	9/10/2013	4.6	2.1	6.4	11
E050.1	9/12/2013	171	77	33	87
E099	7/12/2013	5748	2574	14	230
E099	8/5/2013	1015	455	6.7	340
E109.9	7/8/2013	3880	1737	12	110
E109.9	7/12/2013[b]	1326	594	26	180
E109.9	7/20/2013[b]	24,305	10,883	67	810
E109.9	7/25/2013	1639	734	11	100
E109.9	7/26/2013[b]	515	230	14	160
E109.9	8/3/2013	51,060	22,862	72	950
E109.9	8/5/2013b	3955	1771	50	1000
E109.9	8/9/2013	8524	3816	34	270

Table 3.2-2 (continued)

Gaging Station	Date	Sediment Yield (tons)	Sediment Yield (yd^3)[a]	Runoff Volume (acre-ft)	Peak Discharge (cfs)
2014 Runoff Events					
E038	7/8/2014	6.5	2.9	1.7	46
E038	7/27/2014	7.9	3.5	2.9	148
E038	7/29/2014	11	4.8	5.5	94
E039.1	7/8/2014	1.1	0.5	0.7	14
E039.1	7/15/2014	1.3	0.6	3.2	15
E039.1	7/15/2014	58	26	11	317
E039.1	7/27/2014	1.6	0.7	1.9	22
E039.1	7/29/2014	7.8	3.5	6.2	66
E039.1	7/31/2014	31	14	11	250
E040	7/29/2014	4.2	1.9	9.4	95
E040	7/31/2014	9.8	4.4	14	239
E042.1	7/29/2014	186	83	16	92
E042.1	7/31/2014	551	247	21	210
E050.1	7/15/2014	67	30	8.8	49
E050.1	7/29/2014	41	18	11	63
E050.1	7/31/2014	204	91	22	214
E059.5	7/29/2014	30	13	3.0	44
E059.5	7/31/2014	98	44	4.7	97
2015 Runoff Events					
E038	06/26/2015	9.0	4.0	3.8	163
E038	07/20/2015	3.7	1.6	4.0	78
E038	07/31/2015	6.0	2.7	3.0	110
E038	08/08/2015	1.7	0.8	1.5	52
E039.1	05/21/2015	1.0	0.5	3.9	24
E039.1	06/26/2015[b]	2.8	1.3	3.0	66
E039.1	07/03/2015	3.1	1.4	2.3	51
E039.1	07/07/2015	4.8	2.2	4.5	46
E039.1	07/29/2015	1.6	0.7	4.6	49
E039.1	08/08/2015	0.8	0.4	2.1	46
E039.1	10/21/2015	0.5	0.2	8.6	28
E042.1	07/03/2015	4.7	2.1	0.7	10
E042.1	07/07/2015	63	28	14	53
E042.1	07/20/2015	46	21	3.8	56
E042.1	07/31/2015	82	37	7.0	74
E042.1	10/21/2015	11	5.0	3.9	17
E050.1	07/07/2015	17	7.8	23	40
E050.1	07/20/2015	20	8.9	6.0	34

Table 3.2-2 (continued)

Gaging Station	Date	Sediment Yield (tons)	Sediment Yield (yd^3)[a]	Runoff Volume (acre-ft)	Peak Discharge (cfs)
E050.1	07/29/2015	3.4	1.5	5.6	22
E050.1	08/08/2015	1.9	0.8	8.5	11
E050.1	10/21/2015	2.9	1.3	3.8	18
E050.1	10/23/2015[b]	0.6	0.3	1.6	5.4
E059.5	07/03/2015	533	239	3.9	50
E059.5	07/31/2015	44.8	20	2.3	73
E059.8	10/21/2015	1.1	0.5	2.9	10
E060.1	07/02/2015[b]	93	42	14	12
E060.1	07/20/2015	3.2	1.4	0.8	6.7
2016 Runoff Events					
E038	8/19/2016	5.5	2.5	1.5	80
E038	8/24/2016	6.0	2.7	2.4	129
E038	8/27/2016	7.1	3.2	2.8	103
E039.1	8/3/2016	0.8	0.4	1.7	27
E039.1	9/6/2016	0.7	0.3	1.3	42
E039.1	11/5/2016	0.7	0.3	3.0	25
E042.1	8/27/2016	60	27	4.0	63
E042.1	11/6/2016	2.4	1.1	0.8	12
E050.1	8/27/2016	9.9	4.4	3.0	25
E059.5	8/27/2016	23	10	3.5	45
2017 Runoff Events					
E038	7/8/2017	9327	4.6	2.0	110
E038	7/26/2017	24,828	12.3	4.5	205
E038	7/29/2017	3016	1.5	1.8	45
E038	8/7/2017	4013	2.0	1.9	76
E039.1	7/8/2017	4273	2.1	2.1	60
E039.1	7/26/2017	7881	3.9	3.4	150
E039.1	7/29/2017	1247	0.6	1.7	45
E039.1	8/7/2017	394	0.2	0.8	18
E042.1	7/26/2017	20,223	10.0	2.5	30
E042.1	9/27/2017	7583	3.7	6.9	25
E042.1	9/29/2017	44,574	22.0	10.8	51
E042.1	10/4/2017	39,745	19.6	5.9	40
E050.1	9/27/2017	3781	1.9	9.7	32
E050.1	9/29/2017	15,899	7.8	17.3	56
E050.1	10/4/2017	11,842	5.8	16.3	35
E059.5	9/29/2017	22,036	10.9	6.8	61
E059.8	10/5/2017[b]	156	0.1	1.3	1.6

Table 3.2-2 (continued)

Gaging Station	Date	Sediment Yield (tons)	Sediment Yield (yd^3)[a]	Runoff Volume (acre-ft)	Peak Discharge (cfs)
2018 Runoff Events					
E038	08/02/2018	2.5	1.1	1.8	66
E038	08/10/2018	4.0	1.8	2.0	88
E038	08/15/2018	3.8	1.7	1.9	64
E038	09/03/2018	3.8	1.7	1.0	46
E039.1	08/02/2018	0.4	0.2	13	24
E039.1	08/10/2018	1.9	0.9	2.2	50
E039.1	08/15/2018	0.3	0.1	1.5	20
E039.1	09/03/2018	0.1	0.0	0.8	14
E039.1	09/04/2018	2.6	1.2	5.0	75
E042.1	09/04/2018	4.0	1.8	1.5	10
2019 Runoff Events					
E038	08/07/2019	68.0	30.5	13.3	329[c]
E039.1	07/26/2019	12.2	5.5	7.4	213
E039.1	08/07/2019	27.2	12.2	14.2	342
E042.1	07/26/2019	80.7	36.1	7.1	96
E042.1	08/07/2019	82.5	36.9	9.0	111
E050.1	07/26/2019	32.9	14.7	6.3	46
E050.1	08/07/2019	35.8	16.0	8.0	71
E059.5	08/07/2019	9.0	4.0	6.6	42

Notes: Sediment yield and runoff volume were calculated only from sampled events with reliable hydrographs and sedigraphs. Thus, the September 12, 2013, sampling at E026 and E109.9 was excluded.

[a] Volumetric sediment yield was computed using a soil bulk density of 2650 kg/m^3 and volume = mass/density.

[b] Samples were not collected throughout the entire hydrograph (see Figures 3.2-3 and 3.2-4); thus, sediment yields may be underestimated.

[c] At E038 the peak stage during the 08/07/2019 flow event exceeded the rating curve. The peak discharge value was calculated using a best-fit equation for the rating curve.

Table 3.5-1
Otowi Well #2 Discharges during Development and Testing

Date	Average Flow Rate (GPM)	Duration (Min)	Activity
February 14−15, 2019	250	Varies	Well development
February 19−24, 2019	200	Varies	Well development
February 25, 2019	100	Varies	Well development
March 2-3, 2019	500	Varies	Well development
April 27,2019	895	60	Step drawdown test
April 27,2019	1002	60	Step drawdown test
April 27,2019	1102	60	Step drawdown test
April 27,2019	1194	60	Step drawdown test
April 27,2019	1302	60	Step drawdown test
April 27−28, 2019	1236	1350	Constant rate test

Table 4.1-1
Comparison of Detected Analytical Results from 2019 with the Water Quality Criteria

Gage	Sample Date	Analyte	Field Prep Code	Result	MDL/ MDA[b]	PQL[c]	Unit[d]	Hardness Used[e]	Exceedance Ratio[a]				
									LW[f]	WH	AAL	CAL	HH-OO
CO111041[g]	7/26/19	Aluminum	F10u[h]	1540	19.3	50.0	µg/L	12.9	—[i]	—	7.44×	—	—
CO111041	7/26/19	Antimony	F[j]	1.8	1.00	3.00	µg/L	—	—	—	—	—	0.00×
CO111041	7/26/19	Copper	F	3	0.300	2.00	µg/L	12.9	0.01×	—	1.54×	—	—
CO111041	7/26/19	Dioxin[k]	UF[l]	2.41E-04	—	—	µg/L	—	—	—	—	—	4720×
CO111041	7/26/19	Gross alpha	UF	28.8	1.59	—	pCi/L	—	1.92×	—	—	—	—
CO111041	7/26/19	Lead	F	0.618	0.500	2.00	µg/L	12.9	0.01×	—	0.09×	—	—
CO111041	7/26/19	Manganese	F	2.65	2.00	10.0	µg/L	12.9	—	—	0.00×	—	—
CO111041	7/26/19	Nickel	F	0.86	0.600	2.00	µg/L	12.9	—	—	0.01×	—	—
CO111041	7/26/19	Total PCB	UF	8.06	—	—	µg/L	—	—	576×	4.03×	576×	12,593×
CO111041	7/26/19	Vanadium	F	1.84	1.00	5.00	µg/L	—	0.02×	—	—	—	—
CO111041	7/26/19	Zinc	F	16.9	3.30	20.0	µg/L	12.9	0.00×	—	0.68×	—	0.00×
CO111041	8/7/19	Aluminum	F	176	19.3	50.0	µg/L	7.89	—	—	1.67×	—	—
CO111041	8/7/19	Aluminum	F10u	474	19.3	50.0	µg/L	7.89	—	—	4.49×	—	—
CO111041	8/7/19	Copper	F	1.82	0.300	2.00	µg/L	7.89	0.00×	—	1.48×	—	—
CO111041	8/7/19	Dioxin	UF	1.30E-05	—	—	µg/L	—	—	—	—	—	255×
CO111041	8/7/19	Gross alpha	UF	15.2	1.98	—	pCi/L	—	1.01×	—	—	—	—
CO111041	8/7/19	Manganese	F	5.08	2.00	10.0	µg/L	7.89	—	—	0.00×	—	—
CO111041	8/7/19	Total PCB	UF	3.14	—	—	µg/L	—	—	224×	1.57×	224×	4906×
E026	7/7/19	Aluminum	F10u	9300	19.3	50.0	µg/L	41.7	—	—	9.01×	—	—
E026	7/7/19	Copper	F	0.889	0.300	2.00	µg/L	41.7	0.00×	—	0.15×	—	—
E026	7/7/19	Dioxin	UF	2.72E-07	—	—	µg/L	—	—	—	—	—	5.33×
E026	7/7/19	Gross alpha	UF	16.9	2.45	—	pCi/L	—	1.13×	—	—	—	—
E026	7/7/19	Lead	F	0.562	0.500	2.00	µg/L	41.7	0.01×	—	0.02×	—	—
E026	7/7/19	Manganese	F	10.6	2.00	0.01	µg/L	41.7	—	—	0.00×	—	—

Table 4.1-1 (continued)

Gage	Sample Date	Analyte	Field Prep Code	Result	MDL/ MDA[b]	PQL[c]	Unit[d]	Hardness Used[e]	Exceedance Ratio[a]				
									LW[f]	WH	AAL	CAL	HH-OO
E026	7/7/19	Mercury	UF	0.292	0.067	0.200	µg/L	—	0.03×	0.38×	—	—	—
E026	7/7/19	Nickel	F	0.695	0.600	2.00	µg/L	41.7	—	—	0.00×	—	—
E026	7/7/19	Selenium	UF	6.52	2.00	5.00	µg/L	—	—	1.30×	0.33×	—	—
E026	7/7/19	Total PCB	UF	0.00562	—	—	µg/L	—	—	0.40×	0.00×	0.40×	8.78×
E026	7/7/19	Vanadium	F	1.66	1.00	5.00	µg/L	—	0.02×	—	—	—	—
E030	7/26/19	Dioxin	UF	1.16E-07	—	—	µg/L	—	—	—	—	—	2.28×
E030	7/26/19	Total PCB	UF	0.0669	—	—	µg/L	—	—	4.78×	0.03×	4.78×	105×
E038	8/7/19	Aluminum	F10u	4680	19.3	50.0	µg/L	13.7	—	—	20.82×	—	—
E038	8/7/19	Chromium	F	3.56	3.00	10.0	µg/L	—	0.00×	—	—	—	—
E038	8/7/19	Copper	F	2.06	0.300	2.00	µg/L	13.7	0.00×	—	1.00×	—	—
E038	8/7/19	Dioxin	UF	8.52E-08	—	—	µg/L	—	—	—	—	—	1.67×
E038	8/7/19	Gross alpha	UF	80.7	7.40	—	pCi/L	—	5.38×	—	—	—	—
E038	8/7/19	Lead	F	0.513	0.500	2.00	µg/L	13.7	0.01×	—	0.07×	—	—
E038	8/7/19	Manganese	F	4.64	2.00	10.0	µg/L	13.7	—	—	0.00×	—	—
E038	8/7/19	Selenium	UF	2.97	2.00	5.00	µg/L	—	—	0.59×	0.15×	—	—
E038	8/7/19	Total PCB	UF	0.0528	—	—	µg/L	—	—	3.77×	0.03×	3.77×	82.50×
E038	8/7/19	Vanadium	F	1.35	1.00	5.00	µg/L	—	0.01×	—	—	—	—
E038	8/7/19	Zinc	F	4.01	3.30	20.0	µg/L	13.7	0.00×	—	0.015×	—	0.00×
E039.1	7/26/19	Aluminum	F10u	6600	19.3	50.0	µg/L	26.8	—	—	11.71×	—	—
E039.1	7/26/19	Copper	F	4.3	0.300	2.00	µg/L	26.8	0.01×	—	1.11×	—	—
E039.1	7/26/19	Dioxin	UF	1.59E-07	—	—	µg/L	—	—	—	—	—	3.12×
E039.1	7/26/19	Gross alpha	UF	41.2	2.51	—	pCi/L	—	2.75×	—	—	—	—
E039.1	7/26/19	Lead	F	0.937	0.500	2.00	µg/L	26.8	0.01×	—	0.06×	—	—
E039.1	7/26/19	Manganese	F	5.89	2.00	10.0	µg/L	26.8	—	—	0.00×	—	—
E039.1	7/26/19	Nickel	F	1.09	0.600	2.00	µg/L	26.8	—	—	0.01×	—	—
E039.1	7/26/19	Total PCB	UF	0.0739	—	—	µg/L	—	—	5.28×	0.04×	5.28×	115×

Table 4.1-1 (continued)

Gage	Sample Date	Analyte	Field Prep Code	Result	MDL/ MDA[b]	PQL[c]	Unit[d]	Hardness Used[e]	Exceedance Ratio[a]				
									LW[f]	WH	AAL	CAL	HH-OO
E039.1	7/26/19	Vanadium	F	3.36	1.00	5.00	µg/L	—	0.03×	—	—	—	—
E039.1	7/26/19	Zinc	F	15.6	3.30	20.0	µg/L	26.8	0.00×	—	0.32×	—	0.00×
E039.1	8/7/19	Aluminum	F10u	7090	19.3	50.0	µg/L	18.9	—	—	20.30×	—	—
E039.1	8/7/19	Copper	F	2.25	0.300	2.00	µg/L	18.9	0.00×	—	0.80×	—	—
E039.1	8/7/19	Dioxin	UF	1.62E-07	—	—	µg/L	—	—	—	—	—	3.18×
E039.1	8/7/19	Gross alpha	UF	110	6.01	—	pCi/L	—	7.33×	—	—	—	—
E039.1	8/7/19	Lead	F	0.98	0.500	2.00	µg/L	18.9	0.01×	—	0.10×	—	—
E039.1	8/7/19	Manganese	F	6.18	2.00	10.0	µg/L	18.9	—	—	0.00×	—	—
E039.1	8/7/19	Nickel	F	0.863	0.600	2.00	µg/L	18.9	—	—	0.01×	—	—
E039.1	8/7/19	Selenium	UF	2.42	2.00	5.00	µg/L	—	—	0.48×	0.12×	—	—
E039.1	8/7/19	Total PCB	UF	0.0946	—	—	µg/L	—	—	6.76×	0.05×	6.76×	148×
E039.1	8/7/19	Vanadium	F	2.77	1.00	5.00	µg/L	—	0.03×	—	—	—	—
E042.1	7/26/19	Aluminum	F10u	11,000	19.3	50.0	µg/L	43.3	—	—	10.12×	—	—
E042.1	7/26/19	Boron	F	21.3	15.0	50.0	µg/L	—	0.00×	—	—	—	—
E042.1	7/26/19	Copper	F	2.6	0.300	2.00	µg/L	43.3	0.01×	—	0.43×	—	—
E042.1	7/26/19	Dioxin	UF	4.42E-05	—	—	µg/L	—	—	—	—	—	866×
E042.1	7/26/19	Gross alpha	UF	22.8	1.96	—	pCi/L	—	1.52×	—	—	—	—
E042.1	7/26/19	Manganese	F	304	2.00	10.0	µg/L	43.3	—	—	0.13×	—	—
E042.1	7/26/19	Mercury	UF	0.493	0.067	0.200	µg/L	—	0.05×	0.64×	—	—	—
E042.1	7/26/19	Nickel	F	1.03	0.600	2.00	µg/L	43.3	—	—	0.00×	—	—
E042.1	7/26/19	Selenium	UF	3.86	2.00	5.00	µg/L	—	—	0.77×	0.19×	—	—
E042.1	7/26/19	Total PCB	UF	0.58	—	—	µg/L	—	—	41.43×	0.29×	41.43×	906×
E042.1	7/26/19	Vanadium	F	2.33	1.00	5.00	µg/L	—	0.02×	—	—	—	—
E042.1	8/7/19	Aluminum	F10u	12,900	19.3	50.0	µg/L	35.8	—	—	15.40×	—	—
E042.1	8/7/19	Boron	F	16.1	15.0	50.0	µg/L	—	0.00×	—	—	—	—
E042.1	8/7/19	Copper	F	2	0.300	2.00	µg/L	35.8	0.00×	—	0.39×	—	—

Table 4.1-1 (continued)

Gage	Sample Date	Analyte	Field Prep Code	Result	MDL/ MDA[b]	PQL[c]	Unit[d]	Hardness Used[e]	Exceedance Ratio[a]				
									LW[f]	WH	AAL	CAL	HH-OO
E042.1	8/7/19	Dioxin	UF	5.01E-06	—	—	µg/L	—	—	—	—	—	98.32×
E042.1	8/7/19	Gross alpha	UF	284	18.6	—	pCi/L	—	18.93×	—	—	—	—
E042.1	8/7/19	Manganese	F	32.2	2.00	10.0	µg/L	35.8	—	—	0.02×	—	—
E042.1	8/7/19	Nickel	F	0.618	0.600	2.00	µg/L	35.8	—	—	0.00×	—	—
E042.1	8/7/19	Selenium	UF	5.8	2.00	5.00	µg/L	—	—	1.16×	0.29×	—	—
E042.1	8/7/19	Total PCB	UF	0.591	—	—	µg/L	—	—	42.21×	0.30×	42.21×	923×
E042.1	8/7/19	Vanadium	F	2.94	1.00	5.00	µg/L	—	0.03×	—	—	—	—
E042.1	8/7/19	Zinc	F	4.87	3.30	20.0	µg/L	35.8	0.00×	—	0.08×	—	0.00×
E050.1	7/8/19	Aluminum	F10u	18,200	19.3	50.0	µg/L	43.7	—	—	16.53×	—	—
E050.1	7/8/19	Copper	F	1.21	0.300	2.00	µg/L	43.7	0.00×	—	0.20×	—	—
E050.1	7/8/19	Dioxin	UF	6.20E-07	—	—	µg/L	—	—	—	—	—	12.16×
E050.1	7/8/19	Gross alpha	UF	209	16.2	—	pCi/L	—	13.93×	—	—	—	—
E050.1	7/8/19	Manganese	F	9.71	2.00	10.0	µg/L	43.7	—	—	0.00×	—	—
E050.1	7/8/19	Mercury	UF	0.15	0.067	0.200	µg/L	—	0.02×	0.19×	—	—	—
E050.1	7/8/19	Nickel	F	0.632	0.600	2.00	µg/L	43.7	—	—	0.00×	—	—
E050.1	7/8/19	Radium-226 and radium-228	UF	3.99	—	—	pCi/L	—	0.13×	—	—	—	—
E050.1	7/8/19	Selenium	UF	6.34	2.00	5.00	µg/L	—	—	1.27×	0.32×	—	—
E050.1	7/8/19	Total PCB	UF	0.0647	—	—	µg/L	—	—	4.62×	0.03×	4.62×	101×
E050.1	7/8/19	Vanadium	F	1.61	1.00	5.00	µg/L	—	0.02×	—	—	—	—
E050.1	7/8/19	Zinc	F	7.63	3.30	20.0	µg/L	43.7	0.00×	—	0.10×	—	0.00×
E050.1	7/26/19	Aluminum	F10u	9180	19.3	50.0	µg/L	34.7	—	—	11.44×	—	—
E050.1	7/26/19	Boron	F	20.3	15.0	50.0	µg/L	—	0.00×	—	—	—	—
E050.1	7/26/19	Cobalt	F	1.24	1.00	5.00	µg/L	—	0.00×	—	—	—	—
E050.1	7/26/19	Copper	F	3	0.300	2.00	µg/L	34.7	0.01×	—	0.61×	—	—
E050.1	7/26/19	Dioxin	UF	2.32E-06	—	—	µg/L	—	—	—	—	—	45.49×

Table 4.1-1 (continued)

Gage	Sample Date	Analyte	Field Prep Code	Result	MDL/ MDA[b]	PQL[c]	Unit[d]	Hardness Used[e]	Exceedance Ratio[a]				
									LW[f]	WH	AAL	CAL	HH-OO
E050.1	7/26/19	Gross alpha	UF	464	46.3	—	pCi/L	—	30.93×	—	—	—	—
E050.1	7/26/19	Lead	F	0.759	0.500	2.00	µg/L	34.7	0.01×	—	0.04×	—	—
E050.1	7/26/19	Manganese	F	20.5	2.00	10.0	µg/L	34.7	—	—	0.01×	—	—
E050.1	7/26/19	Mercury	UF	0.394	0.067	0.200	µg/L	—	0.04×	0.51×	—	—	—
E050.1	7/26/19	Nickel	F	1.15	0.600	2.00	µg/L	34.7	—	—	0.01×	—	—
E050.1	7/26/19	Radium-226 and radium-228	UF	7.19	—	—	pCi/L	—	0.24×	—	—	—	—
E050.1	7/26/19	Selenium	UF	4.48	2.00	5.00	µg/L	—	—	0.90×	0.22×	—	—
E050.1	7/26/19	Total PCB	UF	0.185	—	—	µg/L	—	—	13.21×	0.09×	13.21×	289×
E050.1	7/26/19	Vanadium	F	2.63	1.00	5.00	µg/L	—	0.03×	—	—	—	—
E050.1	8/7/19	Aluminum	F10u	11,600	19.3	50.0	µg/L	27.5	—	—	19.87×	—	—
E050.1	8/7/19	Copper	F	2.29	0.300	2.00	µg/L	27.5	0.00×	—	0.58×	—	—
E050.1	8/7/19	Dioxin	UF	1.60E-05	—	—	µg/L	—	—	—	—	—	313×
E050.1	8/7/19	Gross alpha	UF	336	17.5	—	pCi/L	—	22.40×	—	—	—	—
E050.1	8/7/19	Mercury	UF	0.285	0.067	0.200	µg/L	—	0.03×	0.37×	—	—	—
E050.1	8/7/19	Nickel	F	0.629	0.600	2.00	µg/L	27.5	—	—	0.00×	—	—
E050.1	8/7/19	Radium-226 and radium-228	UF	6.32	—	—	pCi/L	—	0.21×	—	—	—	—
E050.1	8/7/19	Selenium	UF	7.34	2.00	5.00	µg/L	—	—	1.47×	0.37×	—	—
E050.1	8/7/19	Total PCB	UF	0.304	—	—	µg/L	—	—	21.71×	0.15×	21.71×	475×
E050.1	8/7/19	Vanadium	F	1.89	1.00	5.00	µg/L	—	0.02×	—	—	—	—
E059.5	8/7/19	Aluminum	F10u	5860	19.3	50.0	µg/L	25.9	—	—	10.90×	27.20×	—
E059.5	8/7/19	Boron	F	68.6	15.0	50.0	µg/L	—	0.01×	—	—	—	—
E059.5	8/7/19	Copper	F	4.62	0.300	2.00	µg/L	25.9	0.01×	—	1.23×	1.64×	—
E059.5	8/7/19	Dioxin	UF	1.16E-07	—	—	µg/L	—	—	—	—	—	2.28×
E059.5	8/7/19	Gross alpha	UF	52.6	3.59	—	pCi/L	—	3.51×	—	—	—	—

Table 4.1-1 (continued)

Gage	Sample Date	Analyte	Field Prep Code	Result	MDL/ MDA[b]	PQL[c]	Unit[d]	Hardness Used[e]	Exceedance Ratio[a]				
									LW[f]	WH	AAL	CAL	HH-OO
E059.5	8/7/19	Lead	F	1.08	0.500	2.00	µg/L	25.9	0.01×	—	0.07×	1.92×	—
E059.5	8/7/19	Manganese	F	7.21	2.00	10.0	µg/L	25.9	—	—	0.00×	0.01×	—
E059.5	8/7/19	Nickel	F	2.05	0.600	2.00	µg/L	25.9	—	—	0.01×	0.12×	—
E059.5	8/7/19	Selenium	UF	3.36	2.00	5.00	µg/L	—	—	0.67×	0.17×	—	—
E059.5	8/7/19	Total PCB	UF	0.071	—	—	µg/L	—	—	5.07×	0.04×	5.07×	111×
E059.5	8/7/19	Vanadium	F	4.48	1.00	5.00	µg/L	—	0.04×	—	—	—	—
E059.5	8/7/19	Zinc	F	13.5	3.30	20.0	µg/L	25.9	0.00×	—	0.29×	0.38×	0.00×

[a] Analytical results are normalized by calculating an exceedance ratio. This ratio is defined as the analytical result divided by the applicable water-quality standard. Thus, results exceeding the standard will be greater than an exceedance ratio of 1.0.

[b] MDA = Minimum detectable activity.

[c] PQL = Practical quantitation limit or uncertainty.

[d] Unit applies to result, MDL, PQL, and screening level.

[e] The hardness measured during the storm event was used to calculate hardness-based screening levels.

[f] LW = livestock watering, WH = wildlife habitat, AAL = acute aquatic life, CAL = chronic aquatic life, HH-OO = human health-organism only.

[g] Above Upper Los Alamos Canyon detention ponds.

[h] F10u = Filtered to 10 µm.

[i] — = Not provided by the analytical laboratory or not applicable.

[j] F = Filtered to 0.45 µm.

[k] The dioxin criteria apply to the sum of the dioxin toxicity equivalents expressed as 2,3,7,8-TCDD dioxin.

[l] UF = Unfiltered.

Table 4.2-1
Calculated SSC and Instantaneous Discharge
Determined for Each Sample Collected during 2019 in the LA/P Watershed

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
CO111041	07/26/2019	16:39	WT_LAP-19-175236	UF[b]	SSC	2800	n/a[c]
CO111041	07/26/2019	16:41	WT_LAP-19-175344	UF	Estimated	2600	n/a
CO111041	07/26/2019	16:43	WT_LAP-19-176069	UF	Estimated	2500	n/a
CO111041	07/26/2019	16:43	WT_LAP-19-176405	F[d]	Estimated	2500	n/a
CO111041	07/26/2019	16:43	WT_LAP-19-176513	F	Estimated	2500	n/a
CO111041	07/26/2019	16:43	WT_LAP-19-176621	UF	Estimated	2500	n/a
CO111041	07/26/2019	16:47	WT_LAP-19-175829	F	Estimated	2200	n/a
CO111041	07/26/2019	16:47	WT_LAP-19-175961	F10u[e]	Estimated	2200	n/a
CO111041	07/26/2019	16:49	WT_LAP-19-176177	UF	Estimated	2000	n/a
CO111041	07/26/2019	16:51	WT_LAP-19-175798	UF	Estimated	1900	n/a
CO111041	07/26/2019	16:53	WT_LAP-19-176297	UF	SSC	1700	n/a
CO111041	08/07/2019	13:32	WT_LAP-19-175251	UF	SSC	400	n/a
CO111041	08/07/2019	13:36	WT_LAP-19-176094	UF	Estimated	300	n/a
CO111041	08/07/2019	13:36	WT_LAP-19-176430	F	Estimated	300	n/a
CO111041	08/07/2019	13:36	WT_LAP-19-176538	F	Estimated	300	n/a
CO111041	08/07/2019	13:36	WT_LAP-19-176646	UF	Estimated	300	n/a
CO111041	08/07/2019	13:40	WT_LAP-19-175854	F	Estimated	300	n/a
CO111041	08/07/2019	13:40	WT_LAP-19-175986	F10u	Estimated	300	n/a
CO111041	08/07/2019	13:42	WT_LAP-19-176202	UF	Estimated	300	n/a
CO111041	08/07/2019	13:44	WT_LAP-19-175359	UF	Estimated	200	n/a
CO111041	08/07/2019	13:44	WT_LAP-19-175799	UF	Estimated	200	n/a
CO111041	08/07/2019	13:46	WT_LAP-19-176322	UF	SSC	200	n/a

Table 4.2-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E026	07/07/2019	17:40	WT_LAP-19-175244	UF	SSC	16,500	42
E026	07/07/2019	17:42	WT_LAP-19-175352	UF	Estimated	16,100	43
E026	07/07/2019	17:44	WT_LAP-19-176077	UF	Estimated	15,700	43
E026	07/07/2019	17:44	WT_LAP-19-176413	F	Estimated	15,700	43
E026	07/07/2019	17:44	WT_LAP-19-176521	F	Estimated	15,700	43
E026	07/07/2019	17:44	WT_LAP-19-176629	UF	Estimated	15,700	43
E026	07/07/2019	17:48	WT_LAP-19-175837	F	Estimated	15,000	41
E026	07/07/2019	17:48	WT_LAP-19-175935	UF	Estimated	15,000	41
E026	07/07/2019	17:48	WT_LAP-19-175969	F10u	Estimated	15,000	41
E026	07/07/2019	17:50	WT_LAP-19-175511	UF	Estimated	14,600	40
E026	07/07/2019	17:54	WT_LAP-19-175717	UF	Estimated	13,800	42
E026	07/07/2019	17:56	WT_LAP-19-175549	UF	Estimated	13,500	41
E026	07/07/2019	17:58	WT_LAP-19-175666	UF	Estimated	13,100	40
E026	07/07/2019	18:00	WT_LAP-19-176305	UF	SSC	12,700	38
E038	08/07/2019	13:25	WT_LAP-19-176727	UF	SSC	5500	192
E038	08/07/2019	13:27	WT_LAP-19-176728	UF	SSC	6100	248
E038	08/07/2019	13:29	WT_LAP-19-176729	UF	SSC	6400	286
E038	08/07/2019	13:31	WT_LAP-19-176730	UF	SSC	5700	304
E038	08/07/2019	13:33	WT_LAP-19-176731	UF	SSC	4600	292
E038	08/07/2019	13:35	WT_LAP-19-176732	UF	SSC	3900	279
E038	08/07/2019	13:37	WT_LAP-19-176733	UF	SSC	3600	226
E038	08/07/2019	13:39	WT_LAP-19-176734	UF	SSC	3000	178
E038	08/07/2019	13:40	WT_LAP-19-175238	UF	SSC	2500	157

Table 4.2-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E038	08/07/2019	13:41	WT_LAP-19-176735	UF	SSC	2600	156
E038	08/07/2019	13:42	WT_LAP-19-175346	UF	Estimated	2600	155
E038	08/07/2019	13:43	WT_LAP-19-176736	UF	SSC	2500	154
E038	08/07/2019	13:44	WT_LAP-19-176623	UF	Estimated	1900	152
E038	08/07/2019	13:44	WT_LAP-19-176515	F	Estimated	1900	152
E038	08/07/2019	13:44	WT_LAP-19-176407	F	Estimated	1900	152
E038	08/07/2019	13:44	WT_LAP-19-176071	UF	Estimated	1900	152
E038	08/07/2019	13:45	WT_LAP-19-176737	UF	SSC	1300	151
E038	08/07/2019	13:47	WT_LAP-19-176738	UF	SSC	2000	157
E038	08/07/2019	13:48	WT_LAP-19-175963	F10u	Estimated	1800	160
E038	08/07/2019	13:48	WT_LAP-19-175831	F	Estimated	1800	160
E038	08/07/2019	13:49	WT_LAP-19-176739	UF	SSC	1600	163
E038	08/07/2019	13:50	WT_LAP-19-176179	UF	Estimated	1700	167
E038	08/07/2019	13:51	WT_LAP-19-176740	UF	SSC	1700	161
E038	08/07/2019	13:52	WT_LAP-19-175711	UF	Estimated	1700	155
E038	08/07/2019	13:53	WT_LAP-19-176741	UF	SSC	1700	150
E038	08/07/2019	13:55	WT_LAP-19-176742	UF	SSC	1600	139
E038	08/07/2019	13:58	WT_LAP-19-175543	UF	Estimated	1800	130
E038	08/07/2019	13:58	WT_LAP-19-175678	UF	Estimated	1800	130
E038	08/07/2019	14:02	WT_LAP-19-176299	UF	SSC	2000	107
E038	08/07/2019	14:15	WT_LAP-19-176743	UF	SSC	1900	42
E038	08/07/2019	14:35	WT_LAP-19-176744	UF	SSC	6900	10
E038	08/07/2019	14:55	WT_LAP-19-176745	UF	SSC	21700	4

Table 4.2-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E038	08/07/2019	15:15	WT_LAP-19-176746	UF	SSC	13,800	3
E039.1	07/26/2019	17:25	WT_LAP-19-176751	UF	SSC	3200	200
E039.1	07/26/2019	17:27	WT_LAP-19-176752	UF	SSC	3000	175
E039.1	07/26/2019	17:29	WT_LAP-19-176753	UF	SSC	2700	151
E039.1	07/26/2019	17:30	WT_LAP-19-175239	UF	SSC	2400	141
E039.1	07/26/2019	17:31	WT_LAP-19-176754	UF	SSC	2500	133
E039.1	07/26/2019	17:32	WT_LAP-19-175347	UF	Estimated	2400	126
E039.1	07/26/2019	17:33	WT_LAP-19-176755	UF	SSC	2200	118
E039.1	07/26/2019	17:34	WT_LAP-19-176624	UF	Estimated	2100	110
E039.1	07/26/2019	17:34	WT_LAP-19-176516	F	Estimated	2100	110
E039.1	07/26/2019	17:34	WT_LAP-19-176408	F	Estimated	2100	110
E039.1	07/26/2019	17:34	WT_LAP-19-176072	UF	Estimated	2100	110
E039.1	07/26/2019	17:35	WT_LAP-19-176756	UF	SSC	1900	103
E039.1	07/26/2019	17:37	WT_LAP-19-176757	UF	SSC	1800	93
E039.1	07/26/2019	17:38	WT_LAP-19-175964	F10u	Estimated	1700	88
E039.1	07/26/2019	17:38	WT_LAP-19-175832	F	Estimated	1700	88
E039.1	07/26/2019	17:39	WT_LAP-19-176758	UF	SSC	1600	84
E039.1	07/26/2019	17:40	WT_LAP-19-176180	UF	Estimated	1500	79
E039.1	07/26/2019	17:41	WT_LAP-19-176759	UF	SSC	1400	74
E039.1	07/26/2019	17:42	WT_LAP-19-175712	UF	Estimated	1300	69
E039.1	07/26/2019	17:43	WT_LAP-19-176760	UF	SSC	1200	64
E039.1	07/26/2019	17:44	WT_LAP-19-175544	UF	Estimated	1300	60
E039.1	07/26/2019	17:45	WT_LAP-19-176761	UF	SSC	1300	56

Table 4.2-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E039.1	07/26/2019	17:46	WT_LAP-19-175679	UF	Estimated	1300	54
E039.1	07/26/2019	17:47	WT_LAP-19-176762	UF	SSC	1200	52
E039.1	07/26/2019	17:48	WT_LAP-19-176300	UF	SSC	1100	50
E039.1	07/26/2019	17:49	WT_LAP-19-176763	UF	SSC	1100	48
E039.1	07/26/2019	17:51	WT_LAP-19-176764	UF	SSC	1000	45
E039.1	07/26/2019	17:53	WT_LAP-19-176765	UF	SSC	1000	41
E039.1	07/26/2019	17:55	WT_LAP-19-176766	UF	SSC	200	37
E039.1	07/26/2019	18:15	WT_LAP-19-176767	UF	SSC	600	15
E039.1	07/26/2019	18:35	WT_LAP-19-176768	UF	SSC	500	8
E039.1	07/26/2019	18:55	WT_LAP-19-176769	UF	SSC	400	5
E039.1	07/26/2019	19:15	WT_LAP-19-176770	UF	SSC	300	3
E039.1	08/07/2019	13:55	WT_LAP-19-177015	UF	SSC	3600	211
E039.1	08/07/2019	13:57	WT_LAP-19-177016	UF	SSC	3300	198
E039.1	08/07/2019	13:59	WT_LAP-19-177017	UF	SSC	3000	186
E039.1	08/07/2019	14:00	WT_LAP-19-175254	UF	SSC	2100	180
E039.1	08/07/2019	14:01	WT_LAP-19-177018	UF	SSC	2700	178
E039.1	08/07/2019	14:02	WT_LAP-19-175362	UF	Estimated	2600	175
E039.1	08/07/2019	14:03	WT_LAP-19-177019	UF	SSC	2400	173
E039.1	08/07/2019	14:04	WT_LAP-19-176091	UF	Estimated	2300	171
E039.1	08/07/2019	14:04	WT_LAP-19-176427	F	Estimated	2300	171
E039.1	08/07/2019	14:04	WT_LAP-19-176535	F	Estimated	2300	171
E039.1	08/07/2019	14:04	WT_LAP-19-176643	UF	Estimated	2300	171
E039.1	08/07/2019	14:05	WT_LAP-19-177020	UF	SSC	2100	169

Table 4.2-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E039.1	08/07/2019	14:07	WT_LAP-19-177021	UF	SSC	2000	161
E039.1	08/07/2019	14:08	WT_LAP-19-175851	F	Estimated	2000	158
E039.1	08/07/2019	14:08	WT_LAP-19-175983	F10u	Estimated	2000	158
E039.1	08/07/2019	14:09	WT_LAP-19-177022	UF	SSC	1900	154
E039.1	08/07/2019	14:10	WT_LAP-19-176199	UF	Estimated	1800	151
E039.1	08/07/2019	14:11	WT_LAP-19-177023	UF	SSC	1700	147
E039.1	08/07/2019	14:12	WT_LAP-19-175731	UF	Estimated	1700	143
E039.1	08/07/2019	14:13	WT_LAP-19-177024	UF	SSC	1600	139
E039.1	08/07/2019	14:14	WT_LAP-19-175563	UF	Estimated	1500	136
E039.1	08/07/2019	14:15	WT_LAP-19-177025	UF	SSC	1400	132
E039.1	08/07/2019	14:16	WT_LAP-19-175680	UF	Estimated	1400	127
E039.1	08/07/2019	14:17	WT_LAP-19-177026	UF	SSC	1300	122
E039.1	08/07/2019	14:18	WT_LAP-19-176319	UF	SSC	1100	116
E039.1	08/07/2019	14:19	WT_LAP-19-177027	UF	SSC	1100	111
E039.1	08/07/2019	15:01	WT_LAP-19-177028	UF	SSC	1100	18
E039.1	08/07/2019	15:03	WT_LAP-19-177029	UF	SSC	1100	17
E039.1	08/07/2019	15:05	WT_LAP-19-177030	UF	SSC	1000	16
E039.1	08/07/2019	15:25	WT_LAP-19-177031	UF	SSC	700	8
E039.1	08/07/2019	15:45	WT_LAP-19-177032	UF	SSC	600	5
E039.1	08/07/2019	16:05	WT_LAP-19-177033	UF	SSC	300	3
E039.1	08/07/2019	16:25	WT_LAP-19-177034	UF	SSC	400	2
E039.1	08/07/2019	16:45	WT_LAP-19-177035	UF	SSC	400	2
E040	07/26/2019	17:51	WT_LAP-19-175345	UF	Estimated	n/a	113

Table 4.2-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E042.1	07/26/2019	18:24	WT_LAP-19-176823	UF	SSC	16,500	95
E042.1	07/26/2019	18:26	WT_LAP-19-176824	UF	SSC	15,500	92
E042.1	07/26/2019	18:28	WT_LAP-19-176825	UF	SSC	15,900	88
E042.1	07/26/2019	18:29	WT_LAP-19-175243	UF	SSC	14,000	86
E042.1	07/26/2019	18:30	WT_LAP-19-176826	UF	SSC	13,700	84
E042.1	07/26/2019	18:31	WT_LAP-19-175351	UF	Estimated	13,600	82
E042.1	07/26/2019	18:32	WT_LAP-19-176827	UF	SSC	13,500	80
E042.1	07/26/2019	18:33	WT_LAP-19-176520	F	Estimated	12,800	78
E042.1	07/26/2019	18:33	WT_LAP-19-176628	UF	Estimated	12,800	78
E042.1	07/26/2019	18:33	WT_LAP-19-176076	UF	Estimated	12,800	78
E042.1	07/26/2019	18:33	WT_LAP-19-176412	F	Estimated	12,800	78
E042.1	07/26/2019	18:34	WT_LAP-19-176828	UF	SSC	12,000	76
E042.1	07/26/2019	18:36	WT_LAP-19-176829	UF	SSC	11,600	72
E042.1	07/26/2019	18:37	WT_LAP-19-175836	F	Estimated	11,500	70
E042.1	07/26/2019	18:37	WT_LAP-19-175968	F10u	Estimated	11,500	70
E042.1	07/26/2019	18:38	WT_LAP-19-176830	UF	SSC	11,400	68
E042.1	07/26/2019	18:39	WT_LAP-19-176184	UF	Estimated	11,200	66
E042.1	07/26/2019	18:40	WT_LAP-19-176831	UF	SSC	10,900	64
E042.1	07/26/2019	18:41	WT_LAP-19-175510	UF	Estimated	10,800	63
E042.1	07/26/2019	18:42	WT_LAP-19-176832	UF	SSC	10,700	62
E042.1	07/26/2019	18:43	WT_LAP-19-175716	UF	Estimated	10,600	61
E042.1	07/26/2019	18:44	WT_LAP-19-176833	UF	SSC	10,500	60
E042.1	07/26/2019	18:45	WT_LAP-19-175548	UF	Estimated	10,500	59

Table 4.2-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E042.1	07/26/2019	18:46	WT_LAP-19-176834	UF	SSC	10,400	59
E042.1	07/26/2019	18:48	WT_LAP-19-176835	UF	SSC	9900	58
E042.1	07/26/2019	18:49	WT_LAP-19-175629	UF	Estimated	9700	57
E042.1	07/26/2019	18:50	WT_LAP-19-176836	UF	SSC	9400	56
E042.1	07/26/2019	18:51	WT_LAP-19-176304	UF	SSC	9100	56
E042.1	07/26/2019	18:52	WT_LAP-19-176837	UF	SSC	9000	56
E042.1	07/26/2019	18:54	WT_LAP-19-176838	UF	SSC	8700	55
E042.1	07/26/2019	19:14	WT_LAP-19-176839	UF	SSC	8100	31
E042.1	07/26/2019	19:34	WT_LAP-19-176840	UF	SSC	6200	15
E042.1	07/26/2019	19:54	WT_LAP-19-176841	UF	SSC	4300	11
E042.1	07/26/2019	20:14	WT_LAP-19-176842	UF	SSC	2900	8
E042.1	07/26/2019	20:34	WT_LAP-19-176843	UF	SSC	2100	7
E042.1	07/26/2019	20:54	WT_LAP-19-176844	UF	SSC	1500	6
E042.1	07/26/2019	21:14	WT_LAP-19-176845	UF	SSC	1200	5
E042.1	07/26/2019	21:34	WT_LAP-19-176846	UF	SSC	1000	3
E042.1	08/07/2019	14:49	WT_LAP-19-176943	UF	SSC	11,400	97
E042.1	08/07/2019	14:51	WT_LAP-19-176944	UF	SSC	10,600	111
E042.1	08/07/2019	14:53	WT_LAP-19-176945	UF	SSC	10,000	111
E042.1	08/07/2019	14:55	WT_LAP-19-176946	UF	SSC	10,100	111
E042.1	08/07/2019	14:57	WT_LAP-19-176947	UF	SSC	9400	111
E042.1	08/07/2019	14:59	WT_LAP-19-175258	UF	SSC	9500	110
E042.1	08/07/2019	14:59	WT_LAP-19-176948	UF	SSC	9000	110
E042.1	08/07/2019	15:01	WT_LAP-19-175366	UF	Estimated	9100	107

Table 4.2-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E042.1	08/07/2019	15:01	WT_LAP-19-176949	UF	SSC	9100	107
E042.1	08/07/2019	15:03	WT_LAP-19-176950	UF	SSC	9200	102
E042.1	08/07/2019	15:03	WT_LAP-19-176087	UF	Estimated	9200	102
E042.1	08/07/2019	15:03	WT_LAP-19-176531	F	Estimated	9200	102
E042.1	08/07/2019	15:03	WT_LAP-19-176423	F	Estimated	9200	102
E042.1	08/07/2019	15:03	WT_LAP-19-176639	UF	Estimated	9200	102
E042.1	08/07/2019	15:05	WT_LAP-19-176951	UF	SSC	8900	97
E042.1	08/07/2019	15:07	WT_LAP-19-176952	UF	SSC	8600	97
E042.1	08/07/2019	15:07	WT_LAP-19-175847	F	Estimated	8600	97
E042.1	08/07/2019	15:07	WT_LAP-19-175979	F10u	Estimated	8600	97
E042.1	08/07/2019	15:09	WT_LAP-19-176953	UF	SSC	8000	96
E042.1	08/07/2019	15:09	WT_LAP-19-176195	UF	Estimated	8000	96
E042.1	08/07/2019	15:11	WT_LAP-19-175515	UF	Estimated	7500	94
E042.1	08/07/2019	15:11	WT_LAP-19-176954	UF	SSC	7500	94
E042.1	08/07/2019	15:13	WT_LAP-19-176955	UF	SSC	7400	90
E042.1	08/07/2019	15:13	WT_LAP-19-175727	UF	Estimated	7400	90
E042.1	08/07/2019	15:15	WT_LAP-19-175559	UF	Estimated	7100	85
E042.1	08/07/2019	15:15	WT_LAP-19-176956	UF	SSC	7100	85
E042.1	08/07/2019	15:17	WT_LAP-19-176957	UF	SSC	7100	81
E042.1	08/07/2019	15:19	WT_LAP-19-175630	UF	Estimated	7000	77
E042.1	08/07/2019	15:19	WT_LAP-19-176958	UF	SSC	7000	77
E042.1	08/07/2019	15:21	WT_LAP-19-176315	UF	SSC	7300	72
E042.1	08/07/2019	15:39	WT_LAP-19-176959	UF	SSC	5500	47

Table 4.2-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E042.1	08/07/2019	15:59	WT_LAP-19-176960	UF	SSC	4300	24
E042.1	08/07/2019	16:19	WT_LAP-19-176961	UF	SSC	3000	14
E042.1	08/07/2019	16:39	WT_LAP-19-176962	UF	SSC	2100	10
E042.1	08/07/2019	16:59	WT_LAP-19-176963	UF	SSC	1600	8
E042.1	08/07/2019	17:19	WT_LAP-19-176964	UF	SSC	1200	5
E042.1	08/07/2019	17:39	WT_LAP-19-176965	UF	SSC	900	4
E042.1	08/07/2019	17:59	WT_LAP-19-176966	UF	SSC	700	3
E050.1	07/07/2019	23:55	WT_LAP-19-178203	UF	Estimated	2300	14
E050.1	07/08/2019	00:10	WT_LAP-19-175245	UF	SSC	2300	14
E050.1	07/08/2019	00:12	WT_LAP-19-175353	UF	Estimated	2300	14
E050.1	07/08/2019	00:14	WT_LAP-19-176078	UF	Estimated	2300	14
E050.1	07/08/2019	00:14	WT_LAP-19-176414	F	Estimated	2300	14
E050.1	07/08/2019	00:14	WT_LAP-19-176522	F	Estimated	2300	14
E050.1	07/08/2019	00:14	WT_LAP-19-176630	UF	Estimated	2300	14
E050.1	07/08/2019	00:15	WT_LAP-19-178191	UF	Estimated	2300	14
E050.1	07/08/2019	00:18	WT_LAP-19-175838	F	Estimated	2300	14
E050.1	07/08/2019	00:18	WT_LAP-19-175970	F10u	Estimated	2300	14
E050.1	07/08/2019	00:20	WT_LAP-19-176186	UF	Estimated	2300	14
E050.1	07/08/2019	00:22	WT_LAP-19-175512	UF	Estimated	2300	14
E050.1	07/08/2019	00:24	WT_LAP-19-175718	UF	Estimated	2300	14
E050.1	07/08/2019	00:26	WT_LAP-19-175550	UF	Estimated	2300	14
E050.1	07/08/2019	00:28	WT_LAP-19-175695	UF	Estimated	2300	14
E050.1	07/08/2019	00:32	WT_LAP-19-176306	UF	SSC	2200	14

Table 4.2-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E050.1	07/26/2019	18:35	WT_LAP-19-176919	UF	SSC	7800	9
E050.1	07/26/2019	18:37	WT_LAP-19-176920	UF	SSC	7500	13
E050.1	07/26/2019	18:39	WT_LAP-19-176921	UF	SSC	7800	19
E050.1	07/26/2019	18:41	WT_LAP-19-176922	UF	SSC	7800	24
E050.1	07/26/2019	18:43	WT_LAP-19-176923	UF	SSC	7500	28
E050.1	07/26/2019	18:45	WT_LAP-19-176924	UF	SSC	7300	33
E050.1	07/26/2019	18:47	WT_LAP-19-176925	UF	SSC	7000	36
E050.1	07/26/2019	18:49	WT_LAP-19-178206	UF	Estimated	6700	39
E050.1	07/26/2019	18:51	WT_LAP-19-176926	UF	SSC	6400	41
E050.1	07/26/2019	18:53	WT_LAP-19-178194	UF	Estimated	6200	43
E050.1	07/26/2019	18:57	WT_LAP-19-176927	UF	SSC	5700	45
E050.1	07/26/2019	18:59	WT_LAP-19-176928	UF	SSC	5600	45
E050.1	07/26/2019	19:01	WT_LAP-19-176929	UF	SSC	5500	45
E050.1	07/26/2019	19:03	WT_LAP-19-176930	UF	SSC	5200	45
E050.1	07/26/2019	19:05	WT_LAP-19-176931	UF	SSC	5200	46
E050.1	07/26/2019	19:15	WT_LAP-19-175260	UF	SSC	5500	44
E050.1	07/26/2019	19:17	WT_LAP-19-175368	UF	Estimated	5200	42
E050.1	07/26/2019	19:19	WT_LAP-19-176637	UF	Estimated	4900	41
E050.1	07/26/2019	19:19	WT_LAP-19-176529	F	Estimated	4900	41
E050.1	07/26/2019	19:19	WT_LAP-19-176421	F	Estimated	4900	41
E050.1	07/26/2019	19:19	WT_LAP-19-176085	UF	Estimated	4900	41
E050.1	07/26/2019	19:23	WT_LAP-19-175977	F10u	Estimated	4200	38
E050.1	07/26/2019	19:23	WT_LAP-19-175845	F	Estimated	4200	38

Table 4.2-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E050.1	07/26/2019	19:25	WT_LAP-19-176193	UF	Estimated	3900	37
E050.1	07/26/2019	19:25	WT_LAP-19-176932	UF	SSC	3900	37
E050.1	07/26/2019	19:27	WT_LAP-19-175513	UF	Estimated	3800	36
E050.1	07/26/2019	19:29	WT_LAP-19-175725	UF	Estimated	3800	34
E050.1	07/26/2019	19:31	WT_LAP-19-175557	UF	Estimated	3700	33
E050.1	07/26/2019	19:33	WT_LAP-19-175698	UF	Estimated	3600	32
E050.1	07/26/2019	19:37	WT_LAP-19-176313	UF	SSC	3500	30
E050.1	07/26/2019	19:45	WT_LAP-19-176933	UF	SSC	3300	26
E050.1	07/26/2019	20:05	WT_LAP-19-176934	UF	SSC	2900	21
E050.1	07/26/2019	20:25	WT_LAP-19-176935	UF	SSC	2500	16
E050.1	07/26/2019	20:45	WT_LAP-19-176936	UF	SSC	2200	11
E050.1	07/26/2019	21:05	WT_LAP-19-176937	UF	SSC	1800	8
E050.1	07/26/2019	21:25	WT_LAP-19-176938	UF	SSC	1400	6
E050.1	07/26/2019	21:45	WT_LAP-19-176939	UF	SSC	1300	5
E050.1	08/07/2019	15:05	WT_LAP-19-177183	UF	SSC	7300	7
E050.1	08/07/2019	15:07	WT_LAP-19-177184	UF	SSC	7000	13
E050.1	08/07/2019	15:09	WT_LAP-19-177185	UF	SSC	6800	20
E050.1	08/07/2019	15:11	WT_LAP-19-177186	UF	SSC	6500	27
E050.1	08/07/2019	15:13	WT_LAP-19-177187	UF	SSC	6300	35
E050.1	08/07/2019	15:15	WT_LAP-19-177188	UF	SSC	6100	43
E050.1	08/07/2019	15:17	WT_LAP-19-177189	UF	SSC	6000	50
E050.1	08/07/2019	15:19	WT_LAP-19-178207	UF	Estimated	5900	57
E050.1	08/07/2019	15:21	WT_LAP-19-177190	UF	SSC	5900	63

Table 4.2-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E050.1	08/07/2019	15:23	WT_LAP-19-178195	UF	Estimated	5600	66
E050.1	08/07/2019	15:27	WT_LAP-19-177191	UF	SSC	5000	70
E050.1	08/07/2019	15:29	WT_LAP-19-177192	UF	SSC	4700	70
E050.1	08/07/2019	15:31	WT_LAP-19-177193	UF	SSC	4600	70
E050.1	08/07/2019	15:33	WT_LAP-19-177194	UF	SSC	4400	69
E050.1	08/07/2019	15:35	WT_LAP-19-177195	UF	SSC	4200	67
E050.1	08/07/2019	15:40	WT_LAP-19-175275	UF	SSC	3900	61
E050.1	08/07/2019	15:42	WT_LAP-19-175383	UF	Estimated	3800	59
E050.1	08/07/2019	15:44	WT_LAP-19-176552	F	Estimated	3700	58
E050.1	08/07/2019	15:44	WT_LAP-19-176660	UF	Estimated	3700	58
E050.1	08/07/2019	15:44	WT_LAP-19-176444	F	Estimated	3700	58
E050.1	08/07/2019	15:44	WT_LAP-19-176108	UF	Estimated	3700	58
E050.1	08/07/2019	15:48	WT_LAP-19-176000	F10u	Estimated	3500	54
E050.1	08/07/2019	15:48	WT_LAP-19-175868	F	Estimated	3500	54
E050.1	08/07/2019	15:50	WT_LAP-19-176216	UF	Estimated	3400	53
E050.1	08/07/2019	15:52	WT_LAP-19-175520	UF	Estimated	3300	51
E050.1	08/07/2019	15:54	WT_LAP-19-175748	UF	Estimated	3200	50
E050.1	08/07/2019	15:55	WT_LAP-19-177196	UF	SSC	3200	49
E050.1	08/07/2019	15:56	WT_LAP-19-175580	UF	Estimated	3100	48
E050.1	08/07/2019	15:58	WT_LAP-19-175699	UF	Estimated	3000	47
E050.1	08/07/2019	16:02	WT_LAP-19-176336	UF	SSC	2700	43
E050.1	08/07/2019	16:15	WT_LAP-19-177197	UF	SSC	2400	33
E050.1	08/07/2019	16:35	WT_LAP-19-177198	UF	SSC	2000	24

Table 4.2-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E050.1	08/07/2019	16:55	WT_LAP-19-177199	UF	SSC	1700	18
E050.1	08/07/2019	17:15	WT_LAP-19-177200	UF	SSC	1500	13
E050.1	08/07/2019	17:35	WT_LAP-19-177201	UF	SSC	1400	10
E050.1	08/07/2019	17:55	WT_LAP-19-177202	UF	SSC	1300	7
E050.1	08/07/2019	18:15	WT_LAP-19-177203	UF	SSC	1100	5
E059.5	08/07/2019	16:00	WT_LAP-19-176775	UF	SSC	3100	12
E059.5	08/07/2019	16:03	WT_LAP-19-176776	UF	SSC	3000	15
E059.5	08/07/2019	16:05	WT_LAP-19-176777	UF	SSC	2800	17
E059.5	08/07/2019	16:08	WT_LAP-19-176778	UF	SSC	2500	22
E059.5	08/07/2019	16:10	WT_LAP-19-176779	UF	SSC	2400	26
E059.5	08/07/2019	16:13	WT_LAP-19-176780	UF	SSC	2200	30
E059.5	08/07/2019	16:16	WT_LAP-19-176781	UF	SSC	2100	34
E059.5	08/07/2019	16:18	WT_LAP-19-176782	UF	SSC	2000	36
E059.5	08/07/2019	16:21	WT_LAP-19-176783	UF	SSC	1900	39
E059.5	08/07/2019	16:23	WT_LAP-19-176784	UF	SSC	1900	40
E059.5	08/07/2019	16:26	WT_LAP-19-176785	UF	SSC	1700	41
E059.5	08/07/2019	16:30	WT_LAP-19-176786	UF	SSC	1600	42
E059.5	08/07/2019	16:40	WT_LAP-19-175240	UF	SSC	1300	41
E059.5	08/07/2019	16:43	WT_LAP-19-175348	UF	Estimated	1300	41
E059.5	08/07/2019	16:45	WT_LAP-19-176625	UF	Estimated	1300	41
E059.5	08/07/2019	16:45	WT_LAP-19-176409	F	Estimated	1300	41
E059.5	08/07/2019	16:45	WT_LAP-19-176517	F	Estimated	1300	41
E059.5	08/07/2019	16:45	WT_LAP-19-176073	UF	Estimated	1300	41

Table 4.2-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E059.5	08/07/2019	16:50	WT_LAP-19-175965	F10u	Estimated	1300	39
E059.5	08/07/2019	16:50	WT_LAP-19-175833	F	Estimated	1300	39
E059.5	08/07/2019	16:50	WT_LAP-19-176787	UF	SSC	1300	39
E059.5	08/07/2019	16:53	WT_LAP-19-176283	UF	Estimated	1200	37
E059.5	08/07/2019	16:53	WT_LAP-19-176181	UF	Estimated	1200	37
E059.5	08/07/2019	16:55	WT_LAP-19-175713	UF	Estimated	1200	36
E059.5	08/07/2019	16:57	WT_LAP-19-175636	UF	Estimated	1100	35
E059.5	08/07/2019	17:00	WT_LAP-19-175545	UF	Estimated	1100	33
E059.5	08/07/2019	17:07	WT_LAP-19-176301	UF	SSC	900	29
E059.5	08/07/2019	17:10	WT_LAP-19-176788	UF	SSC	1000	27
E059.5	08/07/2019	17:30	WT_LAP-19-176789	UF	SSC	800	15
E059.5	08/07/2019	17:50	WT_LAP-19-176790	UF	SSC	700	7
E059.5	08/07/2019	18:10	WT_LAP-19-176791	UF	SSC	700	4
E059.5	08/07/2019	18:30	WT_LAP-19-176792	UF	SSC	500	4
E059.5	08/07/2019	18:50	WT_LAP-19-176793	UF	SSC	500	3
E059.5	08/07/2019	19:10	WT_LAP-19-176794	UF	SSC	500	3

[a] SSC measured using ASTM method D3977-97.

[b] UF = Unfiltered.

[c] n/a = Not applicable.

[d] F = Filtered.

[e] F10u = Filtered to 10 µm.

Table 4.3-1
Calculated Total Metal and Isotopic Uranium Concentrations Determined for each Sample Analyzed for SSC during 2019 in the LA/P Watershed

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Measured SSC (mg/L)	Estimated Total Recoverable Metals Concentrations and Unfiltered Isotopic Uranium Activities																			
					Ag (µg/L) 0.499 + 0.0000237[a] * SSC[b]	Al (µg/L) 19,895 + 3.59 * SSC	As (µg/L) 6.79 + 0.000663 * SSC	Ba (µg/L) −117 + 0.16 * SSC	Be (µg/L) 2.57 + 0.000673 * SSC	Cd (µg/L) 0.751 + 0.000254 * SSC	Cr (µg/L) 24 + 0.00255 * SSC	Cu (µg/L) 47.3 + 0.00322 * SSC	Fe (µg/L) 3489 + 5.99 * SSC	Hg (µg/L) 0.307 + 0.0000218 * SSC	Mn (µg/L) −12,962 + 2.51 * SSC	Ni (µg/L) 19.3 + 0.00344 * SSC	Pb (µg/L) 107 + 0.00864 * SSC	Se (µg/L) 4.66 + 0.000136 * SSC	Tl (µg/L) 0.621 + 0.000116 * SSC	U-234 (pCi/L) −0.856 + 0.00078[c] * SSC	U-235/236 (pCi/L) −0.131 + 0.0000474 * SSC	U-238 (pCi/L) −1.33 + 0.000802 * SSC	V (µg/L) 25.4 + 0.00739 * SSC	Zn (µg/L) −53.3 + 0.0788 * SSC
Sediment Background Value (mg/kg)					1	15,400	3.98	127	1.31	0.4	10.5	11.2	13,800	0.1	543	9.38	19.7	0.3	0.73	2.59	0.2	2.29	19.7	60.2
CO111041	07/26/2019	16:39	WT_LAP-19-175236	2800	0.565	29,947	8.65	331	4.45	1.462	31.1	56.3	20,261	0.368	−5934	28.93	131.2	5.04	0.946	1.33	0.00	0.92	46.1	167.3
CO111041	07/26/2019	16:53	WT_LAP-19-176297	1700	0.539	25,998	7.92	155	3.71	1.183	28.3	52.8	13,672	0.344	−8695	25.15	121.7	4.89	0.818	0.47	−0.05	0.03	38.0	80.7
CO111041	08/07/2019	13:32	WT_LAP-19-175251	400	0.508	21,331	7.06	−53	2.84	0.853	25.0	48.6	5885	0.316	−11,958	20.68	110.5	4.71	0.667	−0.54	−0.11	−1.01	28.4	−21.8
CO111041	08/07/2019	13:46	WT_LAP-19-176322	200	0.504	20,613	6.92	−85	2.70	0.802	24.5	47.9	4687	0.311	−12,460	19.99	108.7	4.69	0.644	−0.70	−0.12	−1.17	26.9	−37.5
E026	07/07/2019	17:40	WT_LAP-19-175244	16,500	0.890	79,130	17.73	2523	13.67	4.942	66.1	100.4	102,324	0.667	28,453	76.06	249.6	6.90	2.535	12.01	0.65	11.90	147.3	1246.9
E026	07/07/2019	18:00	WT_LAP-19-176305	12,700	0.800	65,488	15.21	1915	11.12	3.977	56.4	88.2	79,562	0.584	18,915	62.99	216.7	6.39	2.094	9.05	0.47	8.86	119.3	947.5
E038	08/07/2019	13:25	WT_LAP-19-176727	5500	0.629	39,640	10.44	763	6.27	2.148	38.0	65.0	36,434	0.427	843	38.22	154.5	5.41	1.259	3.43	0.13	3.08	66.0	380.1
E038	08/07/2019	13:27	WT_LAP-19-176728	6100	0.644	41,794	10.83	859	6.68	2.300	39.6	66.9	40,028	0.440	2349	40.28	159.7	5.49	1.329	3.90	0.16	3.56	70.5	427.4
E038	08/07/2019	13:29	WT_LAP-19-176729	6400	0.651	42,871	11.03	907	6.88	2.377	40.3	67.9	41,825	0.447	3102	41.32	162.3	5.53	1.363	4.14	0.17	3.80	72.7	451.0
E038	08/07/2019	13:31	WT_LAP-19-176730	5700	0.634	40,358	10.57	795	6.41	2.199	38.5	65.7	37,632	0.431	1345	38.91	156.2	5.44	1.282	3.59	0.14	3.24	67.5	395.9
E038	08/07/2019	13:33	WT_LAP-19-176731	4600	0.608	36,409	9.84	619	5.67	1.919	35.7	62.1	31,043	0.407	−1416	35.12	146.7	5.29	1.155	2.73	0.09	2.36	59.4	309.2
E038	08/07/2019	13:35	WT_LAP-19-176732	3900	0.591	33,896	9.38	507	5.19	1.742	33.9	59.9	26,850	0.392	−3173	32.72	140.7	5.19	1.073	2.19	0.05	1.80	54.2	254.0
E038	08/07/2019	13:37	WT_LAP-19-176733	3600	0.584	32,819	9.18	459	4.99	1.665	33.2	58.9	25,053	0.385	−3926	31.68	138.1	5.15	1.039	1.95	0.04	1.56	52.0	230.4
E038	08/07/2019	13:39	WT_LAP-19-176734	3000	0.570	30,665	8.78	363	4.59	1.513	31.7	57.0	21,459	0.372	−5432	29.62	132.9	5.07	0.969	1.48	0.01	1.08	47.6	183.1
E038	08/07/2019	13:40	WT_LAP-19-175238	2500	0.558	28,870	8.45	283	4.25	1.386	30.4	55.4	18,464	0.362	−6687	27.90	128.6	5.00	0.911	1.09	−0.01	0.68	43.9	143.7
E038	08/07/2019	13:41	WT_LAP-19-176735	2600	0.561	29,229	8.51	299	4.32	1.411	30.6	55.7	19,063	0.364	−6436	28.24	129.5	5.01	0.923	1.17	−0.01	0.76	44.6	151.6
E038	08/07/2019	13:43	WT_LAP-19-176736	2500	0.558	28,870	8.45	283	4.25	1.386	30.4	55.4	18,464	0.362	−6687	27.90	128.6	5.00	0.911	1.09	−0.01	0.68	43.9	143.7
E038	08/07/2019	13:45	WT_LAP-19-176737	1300	0.530	24,562	7.65	91	3.44	1.081	27.3	51.5	11,276	0.335	−9699	23.77	118.2	4.84	0.772	0.16	−0.07	−0.29	35.0	49.1
E038	08/07/2019	13:47	WT_LAP-19-176738	2000	0.546	27,075	8.12	203	3.92	1.259	29.1	53.7	15,469	0.351	−7942	26.18	124.3	4.93	0.853	0.70	−0.04	0.27	40.2	104.3
E038	08/07/2019	13:49	WT_LAP-19-176739	1600	0.537	25,639	7.85	139	3.65	1.157	28.1	52.5	13,073	0.342	−8946	24.80	120.8	4.88	0.807	0.39	−0.06	−0.05	37.2	72.8
E038	08/07/2019	13:51	WT_LAP-19-176740	1700	0.539	25,998	7.92	155	3.71	1.183	28.3	52.8	13,672	0.344	−8695	25.15	121.7	4.89	0.818	0.47	−0.05	0.03	38.0	80.7
E038	08/07/2019	13:53	WT_LAP-19-176741	1700	0.539	25,998	7.92	155	3.71	1.183	28.3	52.8	13,672	0.344	−8695	25.15	121.7	4.89	0.818	0.47	−0.05	0.03	38.0	80.7
E038	08/07/2019	13:55	WT_LAP-19-176742	1600	0.537	25,639	7.85	139	3.65	1.157	28.1	52.5	13,073	0.342	−8946	24.80	120.8	4.88	0.807	0.39	−0.06	−0.05	37.2	72.8

Table 4.3-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Measured SSC (mg/L)	Estimated Total Recoverable Metals Concentrations and Unfiltered Isotopic Uranium Activities																				
					Ag (µg/L) 0.499 + 0.0000237[a] * SSC[b]	Al (µg/L) 19,895 + 3.59 * SSC	As (µg/L) 6.79 + 0.000663 * SSC	Ba (µg/L) −117 + 0.16 * SSC	Be (µg/L) 2.57 + 0.000673 * SSC	Cd (µg/L) 0.751 + 0.000254 * SSC	Cr (µg/L) 24 + 0.00255 * SSC	Cu (µg/L) 47.3 + 0.00322 * SSC	Fe (µg/L) 3489 + 5.99 * SSC	Hg (µg/L) 0.307 + 0.0000218 * SSC	Mn (µg/L) −12,962 + 2.51 * SSC	Ni (µg/L) 19.3 + 0.00344 * SSC	Pb (µg/L) 107 + 0.00864 * SSC	Se (µg/L) 4.66 + 0.000136 * SSC	Tl (µg/L) 0.621 + 0.000116 * SSC	U-234 (pCi/L) −0.856 + 0.00078[c] * SSC	U-235/236 (pCi/L) −0.131 + 0.0000474 * SSC	U-238 (pCi/L) −1.33 + 0.000802 * SSC	V (µg/L) 25.4 + 0.00739 * SSC	Zn (µg/L) −53.3 + 0.0788 * SSC
Sediment Background Value (mg/kg)					1	15,400	3.98	127	1.31	0.4	10.5	11.2	13,800	0.1	543	9.38	19.7	0.3	0.73	2.59	0.2	2.29	19.7	60.2
E038	08/07/2019	14:02	WT_LAP-19-176299	2000	0.546	27,075	8.12	203	3.92	1.259	29.1	53.7	15,469	0.351	−7942	26.18	124.3	4.93	0.853	0.70	−0.04	0.27	40.2	104.3
E038	08/07/2019	14:15	WT_LAP-19-176743	1900	0.544	26,716	8.05	187	3.85	1.234	28.8	53.4	14,870	0.348	−8193	25.84	123.4	4.92	0.841	0.63	−0.04	0.19	39.4	96.4
E038	08/07/2019	14:35	WT_LAP-19-176744	6900	0.663	44,666	11.36	987	7.21	2.504	41.6	69.5	44,820	0.457	4357	43.04	166.6	5.60	1.421	4.53	0.20	4.20	76.4	490.4
E038	08/07/2019	14:55	WT_LAP-19-176745	21,700	1.013	97,798	21.18	3355	17.17	6.263	79.3	117.2	13,3472	0.780	41,505	93.95	294.5	7.61	3.138	16.07	0.90	16.07	185.8	1656.7
E038	08/07/2019	15:15	WT_LAP-19-176746	13,800	0.826	69,437	15.94	2091	11.86	4.256	59.2	91.7	86,151	0.608	21,676	66.77	226.2	6.54	2.222	9.91	0.52	9.74	127.4	1034.1
E039.1	07/26/2019	17:25	WT_LAP-19-176751	3200	0.575	31,383	8.91	395	4.72	1.564	32.2	57.6	22,657	0.377	−4930	30.31	134.6	5.10	0.992	1.64	0.02	1.24	49.0	198.9
E039.1	07/26/2019	17:27	WT_LAP-19-176752	3000	0.570	30,665	8.78	363	4.59	1.513	31.7	57.0	21,459	0.372	−5432	29.62	132.9	5.07	0.969	1.48	0.01	1.08	47.6	183.1
E039.1	07/26/2019	17:29	WT_LAP-19-176753	2700	0.563	29,588	8.58	315	4.39	1.437	30.9	56.0	19,662	0.366	−6185	28.59	130.3	5.03	0.934	1.25	0.00	0.84	45.4	159.5
E039.1	07/26/2019	17:30	WT_LAP-19-175239	2400	0.556	28,511	8.38	267	4.19	1.361	30.1	55.0	17,865	0.359	−6938	27.56	127.7	4.99	0.899	1.02	−0.02	0.59	43.1	135.8
E039.1	07/26/2019	17:31	WT_LAP-19-176754	2500	0.558	28,870	8.45	283	4.25	1.386	30.4	55.4	18,464	0.362	−6687	27.90	128.6	5.00	0.911	1.09	−0.01	0.68	43.9	143.7
E039.1	07/26/2019	17:33	WT_LAP-19-176755	2200	0.551	27,793	8.25	235	4.05	1.310	29.6	54.4	16,667	0.355	−7440	26.87	126.0	4.96	0.876	0.86	−0.03	0.43	41.7	120.1
E039.1	07/26/2019	17:35	WT_LAP-19-176756	1900	0.544	26,716	8.05	187	3.85	1.234	28.8	53.4	14,870	0.348	−8193	25.84	123.4	4.92	0.841	0.63	−0.04	0.19	39.4	96.4
E039.1	07/26/2019	17:37	WT_LAP-19-176757	1800	0.542	26,357	7.98	171	3.78	1.208	28.6	53.1	14,271	0.346	−8444	25.49	122.6	4.90	0.830	0.55	−0.05	0.11	38.7	88.5
E039.1	07/26/2019	17:39	WT_LAP-19-176758	1600	0.537	25,639	7.85	139	3.65	1.157	28.1	52.5	13,073	0.342	−8946	24.80	120.8	4.88	0.807	0.39	−0.06	−0.05	37.2	72.8
E039.1	07/26/2019	17:41	WT_LAP-19-176759	1400	0.532	24,921	7.72	107	3.51	1.107	27.6	51.8	11,875	0.338	−9448	24.12	119.1	4.85	0.783	0.24	−0.06	−0.21	35.7	57.0
E039.1	07/26/2019	17:43	WT_LAP-19-176760	1200	0.527	24,203	7.59	75	3.38	1.056	27.1	51.2	10,677	0.333	−9950	23.43	117.4	4.82	0.760	0.08	−0.07	−0.37	34.3	41.3
E039.1	07/26/2019	17:45	WT_LAP-19-176761	1300	0.530	24,562	7.65	91	3.44	1.081	27.3	51.5	11,276	0.335	−9699	23.77	118.2	4.84	0.772	0.16	−0.07	−0.29	35.0	49.1
E039.1	07/26/2019	17:47	WT_LAP-19-176762	1200	0.527	24,203	7.59	75	3.38	1.056	27.1	51.2	10,677	0.333	−9950	23.43	117.4	4.82	0.760	0.08	−0.07	−0.37	34.3	41.3
E039.1	07/26/2019	17:48	WT_LAP-19-176300	1100	0.525	23,844	7.52	59	3.31	1.030	26.8	50.8	10,078	0.331	−10,201	23.08	116.5	4.81	0.749	0.00	−0.08	−0.45	33.5	33.4
E039.1	07/26/2019	17:49	WT_LAP-19-176763	1100	0.525	23,844	7.52	59	3.31	1.030	26.8	50.8	10,078	0.331	−10,201	23.08	116.5	4.81	0.749	0.00	−0.08	−0.45	33.5	33.4
E039.1	07/26/2019	17:51	WT_LAP-19-176764	1000	0.523	23,485	7.45	43	3.24	1.005	26.6	50.5	9479	0.329	−10,452	22.74	115.6	4.80	0.737	−0.08	−0.08	−0.53	32.8	25.5
E039.1	07/26/2019	17:53	WT_LAP-19-176765	1000	0.523	23,485	7.45	43	3.24	1.005	26.6	50.5	9479	0.329	−10,452	22.74	115.6	4.80	0.737	−0.08	−0.08	−0.53	32.8	25.5
E039.1	07/26/2019	17:55	WT_LAP-19-176766	200	0.504	20,613	6.92	−85	2.70	0.802	24.5	47.9	4687	0.311	−12,460	19.99	108.7	4.69	0.644	−0.70	−0.12	−1.17	26.9	−37.5
E039.1	07/26/2019	18:15	WT_LAP-19-176767	600	0.513	22,049	7.19	−21	2.97	0.903	25.5	49.2	7083	0.320	−11,456	21.36	112.2	4.74	0.691	−0.39	−0.10	−0.85	29.8	−6.0
E039.1	07/26/2019	18:35	WT_LAP-19-176768	500	0.511	21,690	7.12	−37	2.91	0.878	25.3	48.9	6484	0.318	−11,707	21.02	111.3	4.73	0.679	−0.47	−0.11	−0.93	29.1	−13.9
E039.1	07/26/2019	18:55	WT_LAP-19-176769	400	0.508	21,331	7.06	−53	2.84	0.853	25.0	48.6	5885	0.316	−11,958	20.68	110.5	4.71	0.667	−0.54	−0.11	−1.01	28.4	−21.8
E039.1	07/26/2019	19:15	WT_LAP-19-176770	300	0.506	20,972	6.99	−69	2.77	0.827	24.8	48.3	5286	0.314	−12,209	20.33	109.6	4.70	0.656	−0.62	−0.12	−1.09	27.6	−29.7
E039.1	08/07/2019	13:55	WT_LAP-19-177015	3600	0.584	32,819	9.18	459	4.99	1.665	33.2	58.9	25,053	0.385	−3926	31.68	138.1	5.15	1.039	1.95	0.04	1.56	52.0	230.4
E039.1	08/07/2019	13:57	WT_LAP-19-177016	3300	0.577	31,742	8.98	411	4.79	1.589	32.4	57.9	23,256	0.379	−4679	30.65	135.5	5.11	1.004	1.72	0.03	1.32	49.8	206.7

Table 4.3-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Measured SSC (mg/L)	Estimated Total Recoverable Metals Concentrations and Unfiltered Isotopic Uranium Activities																			
					Ag (µg/L) 0.499 + 0.0000237[a] * SSC[b]	Al (µg/L) 19,895 + 3.59 * SSC	As (µg/L) 6.79 + 0.000663 * SSC	Ba (µg/L) −117 + 0.16 * SSC	Be (µg/L) 2.57 + 0.000673 * SSC	Cd (µg/L) 0.751 + 0.000254 * SSC	Cr (µg/L) 24 + 0.00255 * SSC	Cu (µg/L) 47.3 + 0.00322 * SSC	Fe (µg/L) 3489 + 5.99 * SSC	Hg (µg/L) 0.307 + 0.0000218 * SSC	Mn (µg/L) −12,962 + 2.51 * SSC	Ni (µg/L) 19.3 + 0.00344 * SSC	Pb (µg/L) 107 + 0.00864 * SSC	Se (µg/L) 4.66 + 0.000136 * SSC	Tl (µg/L) 0.621 + 0.000116 * SSC	U-234 (pCi/L) −0.856 + 0.00078[c] * SSC	U-235/236 (pCi/L) −0.131 + 0.0000474 * SSC	U-238 (pCi/L) −1.33 + 0.000802 * SSC	V (µg/L) 25.4 + 0.00739 * SSC	Zn (µg/L) −53.3 + 0.0788 * SSC
Sediment Background Value (mg/kg)					1	15,400	3.98	127	1.31	0.4	10.5	11.2	13,800	0.1	543	9.38	19.7	0.3	0.73	2.59	0.2	2.29	19.7	60.2
E039.1	08/07/2019	13:59	WT_LAP-19-177017	3000	0.570	30,665	8.78	363	4.59	1.513	31.7	57.0	21,459	0.372	−5432	29.62	132.9	5.07	0.969	1.48	0.01	1.08	47.6	183.1
E039.1	08/07/2019	14:00	WT_LAP-19-175254	2100	0.549	27,434	8.18	219	3.98	1.284	29.4	54.1	16,068	0.353	−7691	26.52	125.1	4.95	0.865	0.78	−0.03	0.35	40.9	112.2
E039.1	08/07/2019	14:01	WT_LAP-19-177018	2700	0.563	29,588	8.58	315	4.39	1.437	30.9	56.0	19,662	0.366	−6185	28.59	130.3	5.03	0.934	1.25	0.00	0.84	45.4	159.5
E039.1	08/07/2019	14:03	WT_LAP-19-177019	2400	0.556	28,511	8.38	267	4.19	1.361	30.1	55.0	17,865	0.359	−6938	27.56	127.7	4.99	0.899	1.02	−0.02	0.59	43.1	135.8
E039.1	08/07/2019	14:05	WT_LAP-19-177020	2100	0.549	27,434	8.18	219	3.98	1.284	29.4	54.1	16,068	0.353	−7691	26.52	125.1	4.95	0.865	0.78	−0.03	0.35	40.9	112.2
E039.1	08/07/2019	14:07	WT_LAP-19-177021	2000	0.546	27,075	8.12	203	3.92	1.259	29.1	53.7	15,469	0.351	−7942	26.18	124.3	4.93	0.853	0.70	−0.04	0.27	40.2	104.3
E039.1	08/07/2019	14:09	WT_LAP-19-177022	1900	0.544	26,716	8.05	187	3.85	1.234	28.8	53.4	14,870	0.348	−8193	25.84	123.4	4.92	0.841	0.63	−0.04	0.19	39.4	96.4
E039.1	08/07/2019	14:11	WT_LAP-19-177023	1700	0.539	25,998	7.92	155	3.71	1.183	28.3	52.8	13,672	0.344	−8695	25.15	121.7	4.89	0.818	0.47	−0.05	0.03	38.0	80.7
E039.1	08/07/2019	14:13	WT_LAP-19-177024	1600	0.537	25,639	7.85	139	3.65	1.157	28.1	52.5	13,073	0.342	−8946	24.80	120.8	4.88	0.807	0.39	−0.06	−0.05	37.2	72.8
E039.1	08/07/2019	14:15	WT_LAP-19-177025	1400	0.532	24,921	7.72	107	3.51	1.107	27.6	51.8	11,875	0.338	−9448	24.12	119.1	4.85	0.783	0.24	−0.06	−0.21	35.7	57.0
E039.1	08/07/2019	14:17	WT_LAP-19-177026	1300	0.530	24,562	7.65	91	3.44	1.081	27.3	51.5	11,276	0.335	−9699	23.77	118.2	4.84	0.772	0.16	−0.07	−0.29	35.0	49.1
E039.1	08/07/2019	14:18	WT_LAP-19-176319	1100	0.525	23,844	7.52	59	3.31	1.030	26.8	50.8	10,078	0.331	−10,201	23.08	116.5	4.81	0.749	0.00	−0.08	−0.45	33.5	33.4
E039.1	08/07/2019	14:19	WT_LAP-19-177027	1100	0.525	23,844	7.52	59	3.31	1.030	26.8	50.8	10,078	0.331	−10,201	23.08	116.5	4.81	0.749	0.00	−0.08	−0.45	33.5	33.4
E039.1	08/07/2019	15:01	WT_LAP-19-177028	1100	0.525	23,844	7.52	59	3.31	1.030	26.8	50.8	10,078	0.331	−10,201	23.08	116.5	4.81	0.749	0.00	−0.08	−0.45	33.5	33.4
E039.1	08/07/2019	15:03	WT_LAP-19-177029	1100	0.525	23,844	7.52	59	3.31	1.030	26.8	50.8	10,078	0.331	−10,201	23.08	116.5	4.81	0.749	0.00	−0.08	−0.45	33.5	33.4
E039.1	08/07/2019	15:05	WT_LAP-19-177030	1000	0.523	23,485	7.45	43	3.24	1.005	26.6	50.5	9479	0.329	−10,452	22.74	115.6	4.80	0.737	−0.08	−0.08	−0.53	32.8	25.5
E039.1	08/07/2019	15:25	WT_LAP-19-177031	700	0.516	22,408	7.25	−5	3.04	0.929	25.8	49.6	7682	0.322	−11,205	21.71	113.0	4.76	0.702	−0.31	−0.10	−0.77	30.6	1.9
E039.1	08/07/2019	15:45	WT_LAP-19-177032	600	0.513	22,049	7.19	−21	2.97	0.903	25.5	49.2	7083	0.320	−11,456	21.36	112.2	4.74	0.691	−0.39	−0.10	−0.85	29.8	−6.0
E039.1	08/07/2019	16:05	WT_LAP-19-177033	300	0.506	20,972	6.99	−69	2.77	0.827	24.8	48.3	5286	0.314	−12,209	20.33	109.6	4.70	0.656	−0.62	−0.12	−1.09	27.6	−29.7
E039.1	08/07/2019	16:25	WT_LAP-19-177034	400	0.508	21,331	7.06	−53	2.84	0.853	25.0	48.6	5885	0.316	−11,958	20.68	110.5	4.71	0.667	-0.54	−0.11	−1.01	28.4	−21.8
E039.1	08/07/2019	16:45	WT_LAP-19-177035	400	0.508	21,331	7.06	−53	2.84	0.853	25.0	48.6	5885	0.316	−11,958	20.68	110.5	4.71	0.667	−0.54	−0.11	−1.01	28.4	−21.8
E042.1	07/26/2019	18:24	WT_LAP-19-176823	16,500	0.890	79,130	17.73	2523	13.67	4.942	66.1	100.4	102,324	0.667	28,453	76.06	249.6	6.90	2.535	12.01	0.65	11.90	147.3	1246.9
E042.1	07/26/2019	18:26	WT_LAP-19-176824	15,500	0.866	75,540	17.07	2363	13.00	4.688	63.5	97.2	96,334	0.645	25,943	72.62	240.9	6.77	2.419	11.23	0.60	11.10	139.9	1168.1
E042.1	07/26/2019	18:28	WT_LAP-19-176825	15,900	0.876	76,976	17.33	2427	13.27	4.790	64.5	98.5	98,730	0.654	26,947	74.00	244.4	6.82	2.465	11.55	0.62	11.42	142.9	1199.6
E042.1	07/26/2019	18:29	WT_LAP-19-175243	14,000	0.831	70,155	16.07	2123	11.99	4.307	59.7	92.4	87,349	0.612	22,178	67.46	228.0	6.56	2.245	10.06	0.53	9.90	128.9	1049.9
E042.1	07/26/2019	18:30	WT_LAP-19-176826	13,700	0.824	69,078	15.87	2075	11.79	4.231	58.9	91.4	85,552	0.606	21,425	66.43	225.4	6.52	2.210	9.83	0.52	9.66	126.6	1026.3
E042.1	07/26/2019	18:32	WT_LAP-19-176827	13,500	0.819	68,360	15.74	2043	11.66	4.180	58.4	90.8	84,354	0.601	20,923	65.74	223.6	6.50	2.187	9.67	0.51	9.50	125.2	1010.5
E042.1	07/26/2019	18:34	WT_LAP-19-176828	12,000	0.783	62,975	14.75	1803	10.65	3.799	54.6	85.9	75,369	0.569	17,158	60.58	210.7	6.29	2.013	8.50	0.44	8.29	114.1	892.3
E042.1	07/26/2019	18:36	WT_LAP-19-176829	11,600	0.774	61,539	14.48	1739	10.38	3.697	53.6	84.7	72,973	0.560	16,154	59.20	207.2	6.24	1.967	8.19	0.42	7.97	111.1	860.8

Table 4.3-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Measured SSC (mg/L)	Estimated Total Recoverable Metals Concentrations and Unfiltered Isotopic Uranium Activities																				
					Ag (µg/L) 0.499 + 0.0000237[a] * SSC[b]	Al (µg/L) 19,895 + 3.59 * SSC	As (µg/L) 6.79 + 0.000663 * SSC	Ba (µg/L) −117 + 0.16 * SSC	Be (µg/L) 2.57 + 0.000673 * SSC	Cd (µg/L) 0.751 + 0.000254 * SSC	Cr (µg/L) 24 + 0.00255 * SSC	Cu (µg/L) 47.3 + 0.00322 * SSC	Fe (µg/L) 3489 + 5.99 * SSC	Hg (µg/L) 0.307 + 0.0000218 * SSC	Mn (µg/L) −12,962 + 2.51 * SSC	Ni (µg/L) 19.3 + 0.00344 * SSC	Pb (µg/L) 107 + 0.00864 * SSC	Se (µg/L) 4.66 + 0.000136 * SSC	Tl (µg/L) 0.621 + 0.000116 * SSC	U-234 (pCi/L) −0.856 + 0.00078[c] * SSC	U-235/236 (pCi/L) −0.131 + 0.0000474 * SSC	U-238 (pCi/L) −1.33 + 0.000802 * SSC	V (µg/L) 25.4 + 0.00739 * SSC	Zn (µg/L) −53.3 + 0.0788 * SSC
			Sediment Background Value (mg/kg)		1	15,400	3.98	127	1.31	0.4	10.5	11.2	13,800	0.1	543	9.38	19.7	0.3	0.73	2.59	0.2	2.29	19.7	60.2
E042.1	07/26/2019	18:38	WT_LAP-19-176830	11,400	0.769	60,821	14.35	1707	10.24	3.647	53.1	84.0	71,775	0.556	15,652	58.52	205.5	6.21	1.943	8.04	0.41	7.81	109.6	845.0
E042.1	07/26/2019	18:40	WT_LAP-19-176831	10,900	0.757	59,026	14.02	1627	9.91	3.520	51.8	82.4	68,780	0.545	14,397	56.80	201.2	6.14	1.885	7.65	0.39	7.41	106.0	805.6
E042.1	07/26/2019	18:42	WT_LAP-19-176832	10,700	0.753	58,308	13.88	1595	9.77	3.469	51.3	81.8	67,582	0.540	13,895	56.11	199.4	6.12	1.862	7.49	0.38	7.25	104.5	789.9
E042.1	07/26/2019	18:44	WT_LAP-19-176833	10,500	0.748	57,590	13.75	1563	9.64	3.418	50.8	81.1	66,384	0.536	13,393	55.42	197.7	6.09	1.839	7.33	0.37	7.09	103.0	774.1
E042.1	07/26/2019	18:46	WT_LAP-19-176834	10,400	0.745	57,231	13.69	1547	9.57	3.393	50.5	80.8	65,785	0.534	13,142	55.08	196.9	6.07	1.827	7.26	0.36	7.01	102.3	766.2
E042.1	07/26/2019	18:48	WT_LAP-19-176835	9900	0.734	55,436	13.35	1467	9.23	3.266	49.2	79.2	62,790	0.523	11,887	53.36	192.5	6.01	1.769	6.87	0.34	6.61	98.6	726.8
E042.1	07/26/2019	18:50	WT_LAP-19-176836	9400	0.722	53,641	13.02	1387	8.90	3.139	48.0	77.6	59,795	0.512	10,632	51.64	188.2	5.94	1.711	6.48	0.31	6.21	94.9	687.4
E042.1	07/26/2019	18:51	WT_LAP-19-176304	9100	0.715	52,564	12.82	1339	8.69	3.062	47.2	76.6	57,998	0.505	9879	50.60	185.6	5.90	1.677	6.24	0.30	5.97	92.6	663.8
E042.1	07/26/2019	18:52	WT_LAP-19-176837	9000	0.712	52,205	12.76	1323	8.63	3.037	47.0	76.3	57,399	0.503	9628	50.26	184.8	5.88	1.665	6.16	0.30	5.89	91.9	655.9
E042.1	07/26/2019	18:54	WT_LAP-19-176838	8700	0.705	51,128	12.56	1275	8.43	2.961	46.2	75.3	55,602	0.497	8875	49.23	182.2	5.84	1.630	5.93	0.28	5.65	89.7	632.3
E042.1	07/26/2019	19:14	WT_LAP-19-176839	8100	0.691	48,974	12.16	1179	8.02	2.808	44.7	73.4	52,008	0.484	7369	47.16	177.0	5.76	1.561	5.46	0.25	5.17	85.3	585.0
E042.1	07/26/2019	19:34	WT_LAP-19-176840	6200	0.646	42,153	10.90	875	6.74	2.326	39.8	67.3	40,627	0.442	2600	40.63	160.6	5.50	1.340	3.98	0.16	3.64	71.2	435.3
E042.1	07/26/2019	19:54	WT_LAP-19-176841	4300	0.601	35,332	9.64	571	5.46	1.843	35.0	61.1	29,246	0.401	−2169	34.09	144.2	5.24	1.120	2.50	0.07	2.12	57.2	285.5
E042.1	07/26/2019	20:14	WT_LAP-19-176842	2900	0.568	30,306	8.71	347	4.52	1.488	31.4	56.6	20,860	0.370	−5683	29.28	132.1	5.05	0.957	1.41	0.01	1.00	46.8	175.2
E042.1	07/26/2019	20:34	WT_LAP-19-176843	2100	0.549	27,434	8.18	219	3.98	1.284	29.4	54.1	16,068	0.353	−7691	26.52	125.1	4.95	0.865	0.78	−0.03	0.35	40.9	112.2
E042.1	07/26/2019	20:54	WT_LAP-19-176844	1500	0.535	25,280	7.78	123	3.58	1.132	27.8	52.1	12,474	0.340	−9197	24.46	120.0	4.86	0.795	0.31	−0.06	−0.13	36.5	64.9
E042.1	07/26/2019	21:14	WT_LAP-19-176845	1200	0.527	24,203	7.59	75	3.38	1.056	27.1	51.2	10,677	0.333	−9950	23.43	117.4	4.82	0.760	0.08	−0.07	−0.37	34.3	41.3
E042.1	07/26/2019	21:34	WT_LAP-19-176846	1000	0.523	23,485	7.45	43	3.24	1.005	26.6	50.5	9479	0.329	−10,452	22.74	115.6	4.80	0.737	−0.08	−0.08	−0.53	32.8	25.5
E042.1	08/07/2019	14:49	WT_LAP-19-176943	11,400	0.769	60,821	14.35	1707	10.24	3.647	53.1	84.0	71,775	0.556	15,652	58.52	205.5	6.21	1.943	8.04	0.41	7.81	109.6	845.0
E042.1	08/07/2019	14:51	WT_LAP-19-176944	10,600	0.750	57,949	13.82	1579	9.70	3.443	51.0	81.4	66,983	0.538	13,644	55.76	198.6	6.10	1.851	7.41	0.37	7.17	103.7	782.0
E042.1	08/07/2019	14:53	WT_LAP-19-176945	10,000	0.736	55,795	13.42	1483	9.30	3.291	49.5	79.5	63,389	0.525	12,138	53.70	193.4	6.02	1.781	6.94	0.34	6.69	99.3	734.7
E042.1	08/07/2019	14:55	WT_LAP-19-176946	10,100	0.738	56,154	13.49	1499	9.37	3.316	49.8	79.8	63,988	0.527	12,389	54.04	194.3	6.03	1.793	7.02	0.35	6.77	100.0	742.6
E042.1	08/07/2019	14:57	WT_LAP-19-176947	9400	0.722	53,641	13.02	1387	8.90	3.139	48.0	77.6	59,795	0.512	10,632	51.64	188.2	5.94	1.711	6.48	0.31	6.21	94.9	687.4
E042.1	08/07/2019	14:59	WT_LAP-19-175258	9500	0.724	54,000	13.09	1403	8.96	3.164	48.2	77.9	60,394	0.514	10,883	51.98	189.1	5.95	1.723	6.55	0.32	6.29	95.6	695.3
E042.1	08/07/2019	14:59	WT_LAP-19-176948	9000	0.712	52,205	12.76	1323	8.63	3.037	47.0	76.3	57,399	0.503	9628	50.26	184.8	5.88	1.665	6.16	0.30	5.89	91.9	655.9
E042.1	08/07/2019	15:01	WT_LAP-19-176949	9100	0.715	52,564	12.82	1339	8.69	3.062	47.2	76.6	57,998	0.505	9879	50.60	185.6	5.90	1.677	6.24	0.30	5.97	92.6	663.8
E042.1	08/07/2019	15:03	WT_LAP-19-176950	9200	0.717	52,923	12.89	1355	8.76	3.088	47.5	76.9	58,597	0.508	10,130	50.95	186.5	5.91	1.688	6.32	0.31	6.05	93.4	671.7
E042.1	08/07/2019	15:05	WT_LAP-19-176951	8900	0.710	51,846	12.69	1307	8.56	3.012	46.7	76.0	56,800	0.501	9377	49.92	183.9	5.87	1.653	6.09	0.29	5.81	91.2	648.0
E042.1	08/07/2019	15:07	WT_LAP-19-176952	8600	0.703	50,769	12.49	1259	8.36	2.935	45.9	75.0	55,003	0.494	8624	48.88	181.3	5.83	1.619	5.85	0.28	5.57	89.0	624.4

Table 4.3-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Measured SSC (mg/L)	Estimated Total Recoverable Metals Concentrations and Unfiltered Isotopic Uranium Activities																			
					Ag (µg/L) 0.499 + 0.0000237[a] * SSC[b]	Al (µg/L) 19,895 + 3.59 * SSC	As (µg/L) 6.79 + 0.000663 * SSC	Ba (µg/L) −117 + 0.16 * SSC	Be (µg/L) 2.57 + 0.000673 * SSC	Cd (µg/L) 0.751 + 0.000254 * SSC	Cr (µg/L) 24 + 0.00255 * SSC	Cu (µg/L) 47.3 + 0.00322 * SSC	Fe (µg/L) 3489 + 5.99 * SSC	Hg (µg/L) 0.307 + 0.0000218 * SSC	Mn (µg/L) −12,962 + 2.51 * SSC	Ni (µg/L) 19.3 + 0.00344 * SSC	Pb (µg/L) 107 + 0.00864 * SSC	Se (µg/L) 4.66 + 0.000136 * SSC	Tl (µg/L) 0.621 + 0.000116 * SSC	U-234 (pCi/L) −0.856 + 0.00078[c] * SSC	U-235/236 (pCi/L) −0.131 + 0.0000474 * SSC	U-238 (pCi/L) −1.33 + 0.000802 * SSC	V (µg/L) 25.4 + 0.00739 * SSC	Zn (µg/L) −53.3 + 0.0788 * SSC
Sediment Background Value (mg/kg)					1	15,400	3.98	127	1.31	0.4	10.5	11.2	13,800	0.1	543	9.38	19.7	0.3	0.73	2.59	0.2	2.29	19.7	60.2
E042.1	08/07/2019	15:09	WT_LAP-19-176953	8000	0.689	48,615	12.09	1163	7.95	2.783	44.4	73.1	51,409	0.481	7118	46.82	176.1	5.75	1.549	5.38	0.25	5.09	84.5	577.1
E042.1	08/07/2019	15:11	WT_LAP-19-176954	7500	0.677	46,820	11.76	1083	7.62	2.656	43.1	71.5	48,414	0.471	5863	45.10	171.8	5.68	1.491	4.99	0.22	4.69	80.8	537.7
E042.1	08/07/2019	15:13	WT_LAP-19-176955	7400	0.674	46,461	11.70	1067	7.55	2.631	42.9	71.1	47,815	0.468	5612	44.76	170.9	5.67	1.479	4.92	0.22	4.60	80.1	529.8
E042.1	08/07/2019	15:15	WT_LAP-19-176956	7100	0.667	45,384	11.50	1019	7.35	2.554	42.1	70.2	46,018	0.462	4859	43.72	168.3	5.63	1.445	4.68	0.21	4.36	77.9	506.2
E042.1	08/07/2019	15:17	WT_LAP-19-176957	7100	0.667	45,384	11.50	1019	7.35	2.554	42.1	70.2	46,018	0.462	4859	43.72	168.3	5.63	1.445	4.68	0.21	4.36	77.9	506.2
E042.1	08/07/2019	15:19	WT_LAP-19-176958	7000	0.665	45,025	11.43	1003	7.28	2.529	41.9	69.8	45,419	0.460	4608	43.38	167.5	5.61	1.433	4.60	0.20	4.28	77.1	498.3
E042.1	08/07/2019	15:21	WT_LAP-19-176315	7300	0.672	46,102	11.63	1051	7.48	2.605	42.6	70.8	47,216	0.466	5361	44.41	170.1	5.65	1.468	4.84	0.22	4.52	79.3	521.9
E042.1	08/07/2019	15:39	WT_LAP-19-176959	5500	0.629	39,640	10.44	763	6.27	2.148	38.0	65.0	36,434	0.427	843	38.22	154.5	5.41	1.259	3.43	0.13	3.08	66.0	380.1
E042.1	08/07/2019	15:59	WT_LAP-19-176960	4300	0.601	35,332	9.64	571	5.46	1.843	35.0	61.1	29,246	0.401	−2169	34.09	144.2	5.24	1.120	2.50	0.07	2.12	57.2	285.5
E042.1	08/07/2019	16:19	WT_LAP-19-176961	3000	0.570	30,665	8.78	363	4.59	1.513	31.7	57.0	21,459	0.372	−5432	29.62	132.9	5.07	0.969	1.48	0.01	1.08	47.6	183.1
E042.1	08/07/2019	16:39	WT_LAP-19-176962	2100	0.549	27,434	8.18	219	3.98	1.284	29.4	54.1	16,068	0.353	−7691	26.52	125.1	4.95	0.865	0.78	−0.03	0.35	40.9	112.2
E042.1	08/07/2019	16:59	WT_LAP-19-176963	1600	0.537	25,639	7.85	139	3.65	1.157	28.1	52.5	13,073	0.342	−8946	24.80	120.8	4.88	0.807	0.39	−0.06	−0.05	37.2	72.8
E042.1	08/07/2019	17:19	WT_LAP-19-176964	1200	0.527	24,203	7.59	75	3.38	1.056	27.1	51.2	10,677	0.333	−9950	23.43	117.4	4.82	0.760	0.08	−0.07	−0.37	34.3	41.3
E042.1	08/07/2019	17:39	WT_LAP-19-176965	900	0.520	23,126	7.39	27	3.18	0.980	26.3	50.2	8880	0.327	−10,703	22.40	114.8	4.78	0.725	−0.15	−0.09	−0.61	32.1	17.6
E042.1	08/07/2019	17:59	WT_LAP-19-176966	700	0.516	22,408	7.25	−5	3.04	0.929	25.8	49.6	7682	0.322	−11,205	21.71	113.0	4.76	0.702	−0.31	−0.10	−0.77	30.6	1.9
E050.1	07/08/2019	00:10	WT_LAP-19-175245	2300	0.554	28,152	8.31	251	4.12	1.335	29.9	54.7	17,266	0.357	−7189	27.21	126.9	4.97	0.888	0.94	−0.02	0.51	42.4	127.9
E050.1	07/08/2019	00:32	WT_LAP-19-176306	2200	0.551	27,793	8.25	235	4.05	1.310	29.6	54.4	16,667	0.355	−7440	26.87	126.0	4.96	0.876	0.86	−0.03	0.43	41.7	120.1
E050.1	07/26/2019	18:35	WT_LAP-19-176919	7800	0.684	47,897	11.96	1131	7.82	2.732	43.9	72.4	50,211	0.477	6616	46.13	174.4	5.72	1.526	5.23	0.24	4.93	83.0	561.3
E050.1	07/26/2019	18:37	WT_LAP-19-176920	7500	0.677	46,820	11.76	1083	7.62	2.656	43.1	71.5	48,414	0.471	5863	45.10	171.8	5.68	1.491	4.99	0.22	4.69	80.8	537.7
E050.1	07/26/2019	18:39	WT_LAP-19-176921	7800	0.684	47,897	11.96	1131	7.82	2.732	43.9	72.4	50,211	0.477	6616	46.13	174.4	5.72	1.526	5.23	0.24	4.93	83.0	561.3
E050.1	07/26/2019	18:41	WT_LAP-19-176922	7800	0.684	47,897	11.96	1131	7.82	2.732	43.9	72.4	50,211	0.477	6616	46.13	174.4	5.72	1.526	5.23	0.24	4.93	83.0	561.3
E050.1	07/26/2019	18:43	WT_LAP-19-176923	7500	0.677	46,820	11.76	1083	7.62	2.656	43.1	71.5	48,414	0.471	5863	45.10	171.8	5.68	1.491	4.99	0.22	4.69	80.8	537.7
E050.1	07/26/2019	18:45	WT_LAP-19-176924	7300	0.672	46,102	11.63	1051	7.48	2.605	42.6	70.8	47,216	0.466	5361	44.41	170.1	5.65	1.468	4.84	0.22	4.52	79.3	521.9
E050.1	07/26/2019	18:47	WT_LAP-19-176925	7000	0.665	45,025	11.43	1003	7.28	2.529	41.9	69.8	45,419	0.460	4608	43.38	167.5	5.61	1.433	4.60	0.20	4.28	77.1	498.3
E050.1	07/26/2019	18:51	WT_LAP-19-176926	6400	0.651	42,871	11.03	907	6.88	2.377	40.3	67.9	41,825	0.447	3102	41.32	162.3	5.53	1.363	4.14	0.17	3.80	72.7	451.0
E050.1	07/26/2019	18:57	WT_LAP-19-176927	5700	0.634	40,358	10.57	795	6.41	2.199	38.5	65.7	37,632	0.431	1345	38.91	156.2	5.44	1.282	3.59	0.14	3.24	67.5	395.9
E050.1	07/26/2019	18:59	WT_LAP-19-176928	5600	0.632	39,999	10.50	779	6.34	2.173	38.3	65.3	37,033	0.429	1094	38.56	155.4	5.42	1.271	3.51	0.13	3.16	66.8	388.0
E050.1	07/26/2019	19:01	WT_LAP-19-176929	5500	0.629	39,640	10.44	763	6.27	2.148	38.0	65.0	36,434	0.427	843	38.22	154.5	5.41	1.259	3.43	0.13	3.08	66.0	380.1
E050.1	07/26/2019	19:03	WT_LAP-19-176930	5200	0.622	38,563	10.24	715	6.07	2.072	37.3	64.0	34,637	0.420	90	37.19	151.9	5.37	1.224	3.20	0.12	2.84	63.8	356.5

Table 4.3-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Measured SSC (mg/L)	Estimated Total Recoverable Metals Concentrations and Unfiltered Isotopic Uranium Activities																			
					Ag (µg/L) 0.499 + 0.0000237[a] * SSC[b]	Al (µg/L) 19,895 + 3.59 * SSC	As (µg/L) 6.79 + 0.000663 * SSC	Ba (µg/L) −117 + 0.16 * SSC	Be (µg/L) 2.57 + 0.000673 * SSC	Cd (µg/L) 0.751 + 0.000254 * SSC	Cr (µg/L) 24 + 0.00255 * SSC	Cu (µg/L) 47.3 + 0.00322 * SSC	Fe (µg/L) 3489 + 5.99 * SSC	Hg (µg/L) 0.307 + 0.0000218 * SSC	Mn (µg/L) −12,962 + 2.51 * SSC	Ni (µg/L) 19.3 + 0.00344 * SSC	Pb (µg/L) 107 + 0.00864 * SSC	Se (µg/L) 4.66 + 0.000136 * SSC	Tl (µg/L) 0.621 + 0.000116 * SSC	U-234 (pCi/L) −0.856 + 0.00078[c] * SSC	U-235/236 (pCi/L) −0.131 + 0.0000474 * SSC	U-238 (pCi/L) −1.33 + 0.000802 * SSC	V (µg/L) 25.4 + 0.00739 * SSC	Zn (µg/L) −53.3 + 0.0788 * SSC
Sediment Background Value (mg/kg)					1	15,400	3.98	127	1.31	0.4	10.5	11.2	13,800	0.1	543	9.38	19.7	0.3	0.73	2.59	0.2	2.29	19.7	60.2
E050.1	07/26/2019	19:05	WT_LAP-19-176931	5200	0.622	38,563	10.24	715	6.07	2.072	37.3	64.0	34,637	0.420	90	37.19	151.9	5.37	1.224	3.20	0.12	2.84	63.8	356.5
E050.1	07/26/2019	19:15	WT_LAP-19-175260	5500	0.629	39,640	10.44	763	6.27	2.148	38.0	65.0	36,434	0.427	843	38.22	154.5	5.41	1.259	3.43	0.13	3.08	66.0	380.1
E050.1	07/26/2019	19:25	WT_LAP-19-176932	3900	0.591	33,896	9.38	507	5.19	1.742	33.9	59.9	26,850	0.392	−3173	32.72	140.7	5.19	1.073	2.19	0.05	1.80	54.2	254.0
E050.1	07/26/2019	19:37	WT_LAP-19-176313	3500	0.582	32,460	9.11	443	4.93	1.640	32.9	58.6	24,454	0.383	−4177	31.34	137.2	5.14	1.027	1.87	0.03	1.48	51.3	222.5
E050.1	07/26/2019	19:45	WT_LAP-19-176933	3300	0.577	31,742	8.98	411	4.79	1.589	32.4	57.9	23,256	0.379	−4679	30.65	135.5	5.11	1.004	1.72	0.03	1.32	49.8	206.7
E050.1	07/26/2019	20:05	WT_LAP-19-176934	2900	0.568	30,306	8.71	347	4.52	1.488	31.4	56.6	20,860	0.370	−5683	29.28	132.1	5.05	0.957	1.41	0.01	1.00	46.8	175.2
E050.1	07/26/2019	20:25	WT_LAP-19-176935	2500	0.558	28,870	8.45	283	4.25	1.386	30.4	55.4	18,464	0.362	−6687	27.90	128.6	5.00	0.911	1.09	−0.01	0.68	43.9	143.7
E050.1	07/26/2019	20:45	WT_LAP-19-176936	2200	0.551	27,793	8.25	235	4.05	1.310	29.6	54.4	16,667	0.355	−7440	26.87	126.0	4.96	0.876	0.86	−0.03	0.43	41.7	120.1
E050.1	07/26/2019	21:05	WT_LAP-19-176937	1800	0.542	26,357	7.98	171	3.78	1.208	28.6	53.1	14,271	0.346	−8444	25.49	122.6	4.90	0.830	0.55	−0.05	0.11	38.7	88.5
E050.1	07/26/2019	21:25	WT_LAP-19-176938	1400	0.532	24,921	7.72	107	3.51	1.107	27.6	51.8	11,875	0.338	−9448	24.12	119.1	4.85	0.783	0.24	−0.06	−0.21	35.7	57.0
E050.1	07/26/2019	21:45	WT_LAP-19-176939	1300	0.530	24,562	7.65	91	3.44	1.081	27.3	51.5	11,276	0.335	−9699	23.77	118.2	4.84	0.772	0.16	−0.07	−0.29	35.0	49.1
E050.1	08/07/2019	15:05	WT_LAP-19-177183	7300	0.672	46,102	11.63	1051	7.48	2.605	42.6	70.8	47,216	0.466	5361	44.41	170.1	5.65	1.468	4.84	0.22	4.52	79.3	521.9
E050.1	08/07/2019	15:07	WT_LAP-19-177184	7000	0.665	45,025	11.43	1003	7.28	2.529	41.9	69.8	45,419	0.460	4608	43.38	167.5	5.61	1.433	4.60	0.20	4.28	77.1	498.3
E050.1	08/07/2019	15:09	WT_LAP-19-177185	6800	0.660	44,307	11.30	971	7.15	2.478	41.3	69.2	44,221	0.455	4106	42.69	165.8	5.58	1.410	4.45	0.19	4.12	75.7	482.5
E050.1	08/07/2019	15:11	WT_LAP-19-177186	6500	0.653	43,230	11.10	923	6.94	2.402	40.6	68.2	42,424	0.449	3353	41.66	163.2	5.54	1.375	4.21	0.18	3.88	73.4	458.9
E050.1	08/07/2019	15:13	WT_LAP-19-177187	6300	0.648	42,512	10.97	891	6.81	2.351	40.1	67.6	41,226	0.444	2851	40.97	161.4	5.52	1.352	4.06	0.17	3.72	72.0	443.1
E050.1	08/07/2019	15:15	WT_LAP-19-177188	6100	0.644	41,794	10.83	859	6.68	2.300	39.6	66.9	40,028	0.440	2349	40.28	159.7	5.49	1.329	3.90	0.16	3.56	70.5	427.4
E050.1	08/07/2019	15:17	WT_LAP-19-177189	6000	0.641	41,435	10.77	843	6.61	2.275	39.3	66.6	39,429	0.438	2098	39.94	158.8	5.48	1.317	3.82	0.15	3.48	69.7	419.5
E050.1	08/07/2019	15:21	WT_LAP-19-177190	5900	0.639	41,076	10.70	827	6.54	2.250	39.0	66.3	38,830	0.436	1847	39.60	158.0	5.46	1.305	3.75	0.15	3.40	69.0	411.6
E050.1	08/07/2019	15:27	WT_LAP-19-177191	5000	0.618	37,845	10.11	683	5.94	2.021	36.8	63.4	33,439	0.416	−412	36.50	150.2	5.34	1.201	3.04	0.11	2.68	62.4	340.7
E050.1	08/07/2019	15:29	WT_LAP-19-177192	4700	0.610	36,768	9.91	635	5.73	1.945	36.0	62.4	31,642	0.409	−1165	35.47	147.6	5.30	1.166	2.81	0.09	2.44	60.1	317.1
E050.1	08/07/2019	15:31	WT_LAP-19-177193	4600	0.608	36,409	9.84	619	5.67	1.919	35.7	62.1	31,043	0.407	−1416	35.12	146.7	5.29	1.155	2.73	0.09	2.36	59.4	309.2
E050.1	08/07/2019	15:33	WT_LAP-19-177194	4400	0.603	35,691	9.71	587	5.53	1.869	35.2	61.5	29,845	0.403	−1918	34.44	145.0	5.26	1.131	2.58	0.08	2.20	57.9	293.4
E050.1	08/07/2019	15:35	WT_LAP-19-177195	4200	0.599	34,973	9.57	555	5.40	1.818	34.7	60.8	28,647	0.399	−2420	33.75	143.3	5.23	1.108	2.42	0.07	2.04	56.4	277.7
E050.1	08/07/2019	15:40	WT_LAP-19-175275	3900	0.591	33,896	9.38	507	5.19	1.742	33.9	59.9	26,850	0.392	−3173	32.72	140.7	5.19	1.073	2.19	0.05	1.80	54.2	254.0
E050.1	08/07/2019	15:55	WT_LAP-19-177196	3200	0.575	31,383	8.91	395	4.72	1.564	32.2	57.6	22,657	0.377	−4930	30.31	134.6	5.10	0.992	1.64	0.02	1.24	49.0	198.9
E050.1	08/07/2019	16:02	WT_LAP-19-176336	2700	0.563	29,588	8.58	315	4.39	1.437	30.9	56.0	19,662	0.366	−6185	28.59	130.3	5.03	0.934	1.25	0.00	0.84	45.4	159.5
E050.1	08/07/2019	16:15	WT_LAP-19-177197	2400	0.556	28,511	8.38	267	4.19	1.361	30.1	55.0	17,865	0.359	−6938	27.56	127.7	4.99	0.899	1.02	−0.02	0.59	43.1	135.8
E050.1	08/07/2019	16:35	WT_LAP-19-177198	2000	0.546	27,075	8.12	203	3.92	1.259	29.1	53.7	15,469	0.351	−7942	26.18	124.3	4.93	0.853	0.70	−0.04	0.27	40.2	104.3

Table 4.3-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Measured SSC (mg/L)	Estimated Total Recoverable Metals Concentrations and Unfiltered Isotopic Uranium Activities																			
					Ag (µg/L) 0.499 + 0.0000237[a] * SSC[b]	Al (µg/L) 19,895 + 3.59 * SSC	As (µg/L) 6.79 + 0.000663 * SSC	Ba (µg/L) −117 + 0.16 * SSC	Be (µg/L) 2.57 + 0.000673 * SSC	Cd (µg/L) 0.751 + 0.000254 * SSC	Cr (µg/L) 24 + 0.00255 * SSC	Cu (µg/L) 47.3 + 0.00322 * SSC	Fe (µg/L) 3489 + 5.99 * SSC	Hg (µg/L) 0.307 + 0.0000218 * SSC	Mn (µg/L) −12,962 + 2.51 * SSC	Ni (µg/L) 19.3 + 0.00344 * SSC	Pb (µg/L) 107 + 0.00864 * SSC	Se (µg/L) 4.66 + 0.000136 * SSC	Tl (µg/L) 0.621 + 0.000116 * SSC	U-234 (pCi/L) −0.856 + 0.00078[c] * SSC	U-235/236 (pCi/L) −0.131 + 0.0000474 * SSC	U-238 (pCi/L) −1.33 + 0.000802 * SSC	V (µg/L) 25.4 + 0.00739 * SSC	Zn (µg/L) −53.3 + 0.0788 * SSC
Sediment Background Value (mg/kg)					1	15,400	3.98	127	1.31	0.4	10.5	11.2	13,800	0.1	543	9.38	19.7	0.3	0.73	2.59	0.2	2.29	19.7	60.2
E050.1	08/07/2019	16:55	WT_LAP-19-177199	1700	0.539	25,998	7.92	155	3.71	1.183	28.3	52.8	13,672	0.344	−8695	25.15	121.7	4.89	0.818	0.47	−0.05	0.03	38.0	80.7
E050.1	08/07/2019	17:15	WT_LAP-19-177200	1500	0.535	25,280	7.78	123	3.58	1.132	27.8	52.1	12,474	0.340	−9197	24.46	120.0	4.86	0.795	0.31	−0.06	−0.13	36.5	64.9
E050.1	08/07/2019	17:35	WT_LAP-19-177201	1400	0.532	24,921	7.72	107	3.51	1.107	27.6	51.8	11,875	0.338	−9448	24.12	119.1	4.85	0.783	0.24	−0.06	−0.21	35.7	57.0
E050.1	08/07/2019	17:55	WT_LAP-19-177202	1300	0.530	24,562	7.65	91	3.44	1.081	27.3	51.5	11,276	0.335	−9699	23.77	118.2	4.84	0.772	0.16	−0.07	−0.29	35.0	49.1
E050.1	08/07/2019	18:15	WT_LAP-19-177203	1100	0.525	23,844	7.52	59	3.31	1.030	26.8	50.8	10,078	0.331	−10201	23.08	116.5	4.81	0.749	0.00	−0.08	−0.45	33.5	33.4
E059.5	08/07/2019	16:00	WT_LAP-19-176775	3100	0.572	31,024	8.85	379	4.66	1.538	31.9	57.3	22,058	0.375	−5181	29.96	133.8	5.08	0.981	1.56	0.02	1.16	48.3	191.0
E059.5	08/07/2019	16:03	WT_LAP-19-176776	3000	0.570	30,665	8.78	363	4.59	1.513	31.7	57.0	21,459	0.372	−5432	29.62	132.9	5.07	0.969	1.48	0.01	1.08	47.6	183.1
E059.5	08/07/2019	16:05	WT_LAP-19-176777	2800	0.565	29,947	8.65	331	4.45	1.462	31.1	56.3	20,261	0.368	−5934	28.93	131.2	5.04	0.946	1.33	0.00	0.92	46.1	167.3
E059.5	08/07/2019	16:08	WT_LAP-19-176778	2500	0.558	28,870	8.45	283	4.25	1.386	30.4	55.4	18,464	0.362	−6687	27.90	128.6	5.00	0.911	1.09	−0.01	0.68	43.9	143.7
E059.5	08/07/2019	16:10	WT_LAP-19-176779	2400	0.556	28,511	8.38	267	4.19	1.361	30.1	55.0	17,865	0.359	−6938	27.56	127.7	4.99	0.899	1.02	−0.02	0.59	43.1	135.8
E059.5	08/07/2019	16:13	WT_LAP-19-176780	2200	0.551	27,793	8.25	235	4.05	1.310	29.6	54.4	16,667	0.355	−7440	26.87	126.0	4.96	0.876	0.86	−0.03	0.43	41.7	120.1
E059.5	08/07/2019	16:16	WT_LAP-19-176781	2100	0.549	27,434	8.18	219	3.98	1.284	29.4	54.1	16,068	0.353	−7691	26.52	125.1	4.95	0.865	0.78	−0.03	0.35	40.9	112.2
E059.5	08/07/2019	16:18	WT_LAP-19-176782	2000	0.546	27,075	8.12	203	3.92	1.259	29.1	53.7	15,469	0.351	−7942	26.18	124.3	4.93	0.853	0.70	−0.04	0.27	40.2	104.3
E059.5	08/07/2019	16:21	WT_LAP-19-176783	1900	0.544	26,716	8.05	187	3.85	1.234	28.8	53.4	14,870	0.348	−8193	25.84	123.4	4.92	0.841	0.63	−0.04	0.19	39.4	96.4
E059.5	08/07/2019	16:23	WT_LAP-19-176784	1900	0.544	26,716	8.05	187	3.85	1.234	28.8	53.4	14,870	0.348	−8193	25.84	123.4	4.92	0.841	0.63	−0.04	0.19	39.4	96.4
E059.5	08/07/2019	16:26	WT_LAP-19-176785	1700	0.539	25,998	7.92	155	3.71	1.183	28.3	52.8	13,672	0.344	−8695	25.15	121.7	4.89	0.818	0.47	−0.05	0.03	38.0	80.7
E059.5	08/07/2019	16:30	WT_LAP-19-176786	1600	0.537	25,639	7.85	139	3.65	1.157	28.1	52.5	13,073	0.342	−8946	24.80	120.8	4.88	0.807	0.39	−0.06	−0.05	37.2	72.8
E059.5	08/07/2019	16:40	WT_LAP-19-175240	1300	0.530	24,562	7.65	91	3.44	1.081	27.3	51.5	11,276	0.335	−9699	23.77	118.2	4.84	0.772	0.16	−0.07	−0.29	35.0	49.1
E059.5	08/07/2019	16:50	WT_LAP-19-176787	1300	0.530	24,562	7.65	91	3.44	1.081	27.3	51.5	11,276	0.335	−9699	23.77	118.2	4.84	0.772	0.16	−0.07	−0.29	35.0	49.1
E059.5	08/07/2019	17:07	WT_LAP-19-176301	900	0.520	23,126	7.39	27	3.18	0.980	26.3	50.2	8880	0.327	−10,703	22.40	114.8	4.78	0.725	−0.15	−0.09	−0.61	32.1	17.6
E059.5	08/07/2019	17:10	WT_LAP-19-176788	1000	0.523	23,485	7.45	43	3.24	1.005	26.6	50.5	9479	0.329	−10,452	22.74	115.6	4.80	0.737	−0.08	−0.08	−0.53	32.8	25.5
E059.5	08/07/2019	17:30	WT_LAP-19-176789	800	0.518	22,767	7.32	11	3.11	0.954	26.0	49.9	8281	0.324	−10,954	22.05	113.9	4.77	0.714	−0.23	−0.09	−0.69	31.3	9.7

Table 4.3-1 (continued)

Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Measured SSC (mg/L)	Estimated Total Recoverable Metals Concentrations and Unfiltered Isotopic Uranium Activities																			
					Ag (µg/L) 0.499 + 0.0000237[a] * SSC[b]	Al (µg/L) 19,895 + 3.59 * SSC	As (µg/L) 6.79 + 0.000663 * SSC	Ba (µg/L) −117 + 0.16 * SSC	Be (µg/L) 2.57 + 0.000673 * SSC	Cd (µg/L) 0.751 + 0.000254 * SSC	Cr (µg/L) 24 + 0.00255 * SSC	Cu (µg/L) 47.3 + 0.00322 * SSC	Fe (µg/L) 3489 + 5.99 * SSC	Hg (µg/L) 0.307 + 0.0000218 * SSC	Mn (µg/L) −12,962 + 2.51 * SSC	Ni (µg/L) 19.3 + 0.00344 * SSC	Pb (µg/L) 107 + 0.00864 * SSC	Se (µg/L) 4.66 + 0.000136 * SSC	Tl (µg/L) 0.621 + 0.000116 * SSC	U-234 (pCi/L) −0.856 + 0.00078[c] * SSC	U-235/236 (pCi/L) −0.131 + 0.0000474 * SSC	U-238 (pCi/L) −1.33 + 0.000802 * SSC	V (µg/L) 25.4 + 0.00739 * SSC	Zn (µg/L) −53.3 + 0.0788 * SSC
Sediment Background Value (mg/kg)					**1**	**15,400**	**3.98**	**127**	**1.31**	**0.4**	**10.5**	**11.2**	**13,800**	**0.1**	**543**	**9.38**	**19.7**	**0.3**	**0.73**	**2.59**	**0.2**	**2.29**	**19.7**	**60.2**
E059.5	08/07/2019	17:50	WT_LAP-19-176790	700	0.516	22,408	7.25	−5	3.04	0.929	25.8	49.6	7682	0.322	−11,205	21.71	113.0	4.76	0.702	−0.31	−0.10	−0.77	30.6	1.9
E059.5	08/07/2019	18:10	WT_LAP-19-176791	700	0.516	22,408	7.25	−5	3.04	0.929	25.8	49.6	7682	0.322	−11,205	21.71	113.0	4.76	0.702	−0.31	-0.10	−0.77	30.6	1.9
E059.5	08/07/2019	18:30	WT_LAP-19-176792	500	0.511	21,690	7.12	−37	2.91	0.878	25.3	48.9	6484	0.318	−11,707	21.02	111.3	4.73	0.679	−0.47	-0.11	−0.93	29.1	−13.9
E059.5	08/07/2019	18:50	WT_LAP-19-176793	500	0.511	21,690	7.12	−37	2.91	0.878	25.3	48.9	6484	0.318	−11,707	21.02	111.3	4.73	0.679	−0.47	-0.11	−0.93	29.1	−13.9
E059.5	08/07/2019	19:10	WT_LAP-19-176794	500	0.511	21,690	7.12	−37	2.91	0.878	25.3	48.9	6484	0.318	−11,707	21.02	111.3	4.73	0.679	−0.47	-0.11	−0.93	29.1	−13.9

Note: Cells are shaded gray when SSC-estimated metals and isotopic uranium concentrations (µg/L or pCi/L) exceed background concentrations expected in sediment.

[a] Unit of inorganic slope is µg/L/mg/L.

[b] Unit of SSC measurement is mg/L.

[c] Unit of radioisotope slope is pCi/L/mg/L.

Appendix A

Acronyms and Abbreviations

A-1.0 ACRONYMS AND ABBREVIATIONS

AAL	acute aquatic life
ASTM	American Society for Testing and Materials
BDD	Buckman Direct Diversion
BDDB	Buckman Direct Diversion Board
BLM	biotic ligand model
CAL	chronic aquatic life
cfs	cubic foot per second
Consent Order	Compliance Order on Consent
DEM	digital elevation model
DOE	Department of Energy (U.S.)
DP	Delta Prime
EPA	Environmental Protection Agency (U.S.)
F	filtered
GCS	grade-control structure
GIS	geographic information system
GPS	global positioning system
HH-OO	human health–organism only
IMWP	Interim Measure Work Plan to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons
Individual Permit	National Pollutant Discharge Elimination System Permit No. NM0030759
Laboratory	Los Alamos National Laboratory
LANL	Los Alamos National Laboratory
LA/P	Los Alamos and Pueblo (watershed)
LiDAR	light detecting and ranging
LW	livestock watering
MDA	minimum detectable activity
MDL	method detection limit
N3B	Newport News Nuclear BWXT-Los Alamos, LLC
NDVI	normalized difference vegetation index
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System

PCB	polychlorinated biphenyl
PQL	practical quantitation limit
RPD	relative percent difference
Redox	oxidation reduction
SIMWP	Supplemental Interim Measures Work Plan to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons
SSC	suspended sediment concentration
SWMU	solid waste management unit
TA	technical area
TAL	target analyte list (EPA)
TCDD[2,3,7,8]	2,3,7,8 tetrachlorodibenzo-p-dioxin
TOC	total organic carbon
TRM	turf-reinforcement mat
UF	unfiltered
VNIR	visible and near-infrared
WH	wildlife habitat
WWTF	wastewater treatment facility

Appendix B

2019 Geomorphic and Wetland Vegetation Changes at Sediment Transport Mitigation Sites in the Los Alamos/Pueblo Watershed

B-1.0 INTRODUCTION

This appendix establishes new baseline data obtained through aerial methodology and evaluates geomorphic and wetland vegetation changes that occurred at sediment transport mitigation sites in the Los Alamos/Pueblo (LA/P) watershed during the 2019 monsoon season. Data was collected with the use of aerial hyperspectral imaging and light detection and ranging (LiDAR) imaging over the specified area of interest within the LA/P watershed, a new methodology outlined in the "2018 Monitoring Report for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project" (N3B 2019, 700419). The aerial-derived data sets for 2019, compared with previous survey data derived from the global positioning system (GPS) in 2018 and baseline data sets from 2013, depict seasonal variation and enhance evaluation of the stability of the LA/P sediment transport mitigation sites within Los Alamos National Laboratory (LANL or the Laboratory).

Vegetation surveys are performed to monitor health and success of willow plantings. Coyote willows (*Salix exigua*) were planted in Pueblo Canyon to aid in surface stabilization, reduce flow velocity, and encourage sediment accumulation (LANL 2016, 601433; LANL 2017, 602343). The vitality of wetland species is a good indicator of oxidation-reduction (redox) and saturation conditions over a spatial distribution that cannot be easily measured by other point data techniques such as alluvial well/piezometer monitoring. Specifically, the presence of obligate wetland vegetation implies persistent saturation.

Results from this aerial survey are presented in this appendix, representing geomorphic and vegetation change in the 2019 monsoon season and across the current and previous survey methodology.

B-2.0 AIRBORNE-BASED SURVEY METHODS OF THE LOS ALAMOS/PUEBLO WATERSHED

In 2019, new aerial survey techniques replaced previously implemented ground-based GPS survey methods. Tetra Tech was contracted to survey the LA/P sediment transport mitigation project area of interest using airborne hyperspectral and LiDAR equipment to collect geomorphic and vegetation data. A baseline LiDAR aerial survey was performed in 2018, during which points were measured at a density at least equivalent to the 2016 LiDAR data set (18–24 points per m^2). The LiDAR surveys provided a detailed digital elevation model (DEM) of the entire active channel within the wetland area, allowing comparison with historic ground-based geomorphic survey data.

Vegetation features were surveyed using an AISA EAGLE II visible and near-infrared (VNIR) hyperspectral imaging sensor system affixed to a Cessna 172 Skyhawk. A total of 128 spectral bands for the VNIR were collected, producing a ground sampling distance of 0.5m. Location and altitude data were collected by an Oxford Technical Solutions, Ltd., 2+ second-generation GPS.

Upon completion of airborne survey efforts, ground truthing was performed to identify reed canary grass, willow, and cattail. These data were used to develop a classification algorithm for the analysis of the hyperspectral data. Analysis resulted in seven target vegetation classes: reed canary grass, willow, cattail, mixed reed canary grass and willow, other vegetation, surface water, and non-vegetated (Figure B-2.0-1).

B-3.0 HYDROLOGIC EVENTS DURING THE 2019 MONSOON SEASON

Sample discharge events in 2019 was less frequent than the 2018 discharge events at all gage stations, primarily because of increased actuation levels. There were five sample-triggering storm events in 2019, with the largest runoff-producing event occurring on August 7 (see section 2.1 in the main text for more details).

B-4.0 MONITORING RESULTS

The monsoon season of 2019 resulted in minor annual changes to morphology of monitored features and caused no significant geomorphic changes within reach S-2. While minor changes occurred during the 2019 monsoon season, increased precision through new monitoring techniques will provide a more accurate and robust baseline data set for both geomorphic and vegetation data. Spatial data generated through new aerial methodology had a confidence level greater than 85%; exceeding the industry standard. Future data sets will be collected on a triennial survey basis.

B-4.1 Thalweg and Stream Bank

In 2018, the channel thalweg and stream bank top profile was surveyed by GPS in numerous segmented sections; a total length of 6491 ft and 9035 linear ft for the thalweg and banktop, respectively. In 2013 the entire thalweg and banktop were surveyed by GPS to establish baseline conditions; the total length was established at 7431 ft for the thalweg and 12,400 linear ft for the banktop.

LiDAR data were collected at the end of 2018 and used to produce a DEM. Data were not available for analysis for the 2018 report but were analyzed and used in this 2019 report. Analysis from the DEM contours in 2019 facilitated the determination of thalweg and banktop within the area of interest. The DEM identified the entire thalweg at 9981 ft, and the banktop at 14,524 ft; a 53 and 61 percent increase, respectively, in linear length identified from the 2018 methodology. The DEM contour proved advantageous in identifying both the thalweg and banktop; while the GPS survey was unable to identify a clear thalweg because of diffused flow or vegetation, the extent of the DEM-identified thalweg and banktop could be continued (Figures B-4.1-1, B-4.1-2, and B-4.1-3).

Both the 2013 and 2018 GPS-surveyed thalwegs aligned very accurately to the DEM thalweg profile. Polylines generated from high-density LiDAR-generated DEM show to be as accurate, if not more, accurate, in capturing the thalweg and banktop elevation profile, especially in areas of diffused flow, braided channels, and heavily vegetated areas.

B-4.2 Wetland Vegetation

There was ample variation between the 2017 GPS wetland survey and the 2019 VNIR survey data sets. Data from 2017 focused solely on willow and grouped vegetation into five communities based on plant height and spatial distribution, while the 2019 data set defines individual species and their distribution. Within the area of interest, the 2019 Tetra Tech survey identified two willow group species (willow and mix [willow mixed with reed canary grass]) along with vegetation in the other vegetation and non-vegetated classes.

Variation of willow vegetation determined from each survey method was significant (the 2017 survey quantified 1.89 acres; the 2019 survey identified 0.22 acres); variation is primarily a function of differences between survey methodology (Figure B-4.2-1, Table B-4.2-1). The 2019 data are not suggesting that willow abundance has decreased 89 percent between 2017 and 2019; rather, the detail and distribution of wetland species is much finer in the 2019 data set. The capability to extract non-riparian species or non-vegetated area is an excellent tool to prevent overestimation of wetland area and also to quantify potential triennial expansion or reduction in willow vegetation distribution within the watershed.

Further, with data collected in the 2019 survey, it was possible to generate a normalized difference vegetation index (NDVI) (Figure B-4.2-2), essentially a surface reflectance, for the vegetation in the LA/P watershed. These data are used to produce a wetland plant health matrix that can then be compared across triennial survey data, quantifying individual plant species vigor throughout the wetland.

Additional vegetation metrics of height and density were collected and used in the production and analysis of the species distribution algorithms and species distribution (Figures B-4.2-3 and B-4.2-4).

B-5.0 CONCLUSIONS AND RECOMMENDATIONS

In 2019, storm water peak discharge did not alter geomorphologic stability or willow distribution attributes with the LA/P watershed. Sample triggering discharge events were less frequent than 2018 events, but this is a function of increased trip levels for the 2019 monitoring season.

Comparison of data between 2018 survey methods and 2019 survey methods produces variation that is not attributable to hydrologic effects. Regardless, vegetative and geomorphic variation from 2018 to 2019 suggests that the LA/P watershed is stable and functioning properly.

The processed LiDAR data will be field verified to ensure that geomorphic changes shown in a DEM comparison represent actual geomorphic changes. Additional ground-truth efforts may occur to improve species distribution data sets and expand for potentially occurring additional riparian obligate species in the LA/P watershed complex.

If no large storm events occur, creating significant geomorphic change, aerial LiDAR surveys will be performed every third year, with the next survey scheduled for 2022. Additional ground-truthing efforts and data analysis will improve and refine the existing 2019 data set as well as the 2022 effort.

B-6.0 REFERENCES AND MAP DATA SOURCES

B-6.1 References

The following reference list includes documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. This information is also included in text citations. ERIDs were assigned by the Laboratory's Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by Newport News Nuclear BWXT-Los Alamos, LLC (N3B) (IDs 700000 and above). IDs are used to locate documents in N3B's Records Management System and in the Master Reference Set. The New Mexico Environment Department (NMED) Hazardous Waste Bureau and N3B maintain copies of the Master Reference Set. The set ensures that NMED has the references to review documents. The set is updated when new references are cited in documents.

LANL (Los Alamos National Laboratory), April 2016. "2015 Monitoring Report for Los Alamos/ Pueblo Watershed Sediment Transport Mitigation Project," Los Alamos National Laboratory document LA-UR-16-22705, Los Alamos, New Mexico. (LANL 2016, 601433)

LANL (Los Alamos National Laboratory), April 2017. "2016 Monitoring Report for Los Alamos/ Pueblo Watershed Sediment Transport Mitigation Project," Los Alamos National Laboratory document LA-UR-17-23308, Los Alamos, New Mexico. (LANL 2017, 602343)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), April 2019. "2018 Monitoring Report for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project," Newport News Nuclear BWXT-Los Alamos, LLC, document EM2019-0106, Los Alamos, New Mexico. (N3B 2019, 700419)

B-6.2 Map Data Sources

Paved Road; Los Alamos National Laboratory, FWO Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 29 November 2010.

Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 29 November 2010.

Fences; Los Alamos National Laboratory, IFPROG, As published, Oracle Spatial Database; GISPUBPRD1/PUB.Infrastructure/PUB.fences_arc, 2020.

Gage Stations: N3B/T2S, As published, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 15-0080; project_data.gdb; point feature dataset; gage_stations feature class; 2020

2018 Species Distribution; N3B/T2S, As published, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 19-0056; project_data.gdb; poly feature dataset; species_distribution_2018 feature class; 2020.

2019 Aerial Thalweg; N3B/T2S, As published, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 19-0056; project_data.gdb; line feature dataset; thalweg_2016_derived_data feature class; 2020.

Hillshade; N3B/T2S, As published, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) 2014; BareEarth; BareEarth_DEM_Mosaic_Overviews; BareEarth_DEM_Mosaic.gdb

Sandia Wetlands 2019 Boundary; Sandia 2019 Wetlands Vegetation Density; N3B/T2S, As published, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 19-0056; project_data.gdb; sandia_density raster dataset; 2020.

Sandia NDVI; N3B/T2S, As published, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 19-0056; project_data.gdb; sandia_NDVI_extract raster dtaset; 2020.

Contours, 20 and 2-ft interval; N3B/T2S, As published, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 19-0056; project_data.gdb; line feature dataset; site_contour feature class; 2020.

Sandia 2019 Wetlands Vegetation Density; N3B/T2S, As published, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 19-0056; project_data.gdb; sandia_density raster dataset; 2020.

Sandia 2019 Wetlands Vegetation Height; N3B/T2S, As published, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 19-0056; project_data.gdb; sandia_height_extract raster dataset; 2020.

2017 GPS Thalweg; N3B/T2S, As published, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 19-0056; project_data.gdb; line feature dataset; T2017_Sandia_Thalweg_ln feature class; 2020.

2019 Aerial plunge pool; N3B/T2S, As published, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) \LANL Hyperspectral Data\Species_Distribution\West_AOI\W_Surface_Water.shp 2020.

2019 Bank top; N3B/T2S, As published, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 19-0056; project_data.gdb; line feature dataset; T2018_Sandia_Canyon_BankTops_Line feature class; 2020.

2019 Plunge Pool; 3B/T2S, As published, GIS projects folder; Q:\LANL Hyperspectral Data\Species_Distribution\West_AOI\W_Surface_Water.shp 2020.

Surrounding Land: As published; N3B GIS project folder: Q:\16-Projects\16-0033\project_data.gdb\polygon\pline_lab_county; October 2019.

TA Boundary: As published; Triad SDE Spatial Geodatabase: GISPUBPRD1\PUB.Boundaries\PUB.Tecareas; October 2019.

Major Road: As published; Q:\16-Projects\16-0033\project_data.gdb\line\major_road; October 2019.

Drainage: As published; Q:\16-Projects\16-0033\project_data.gdb\line\drainage_features; October 2019.

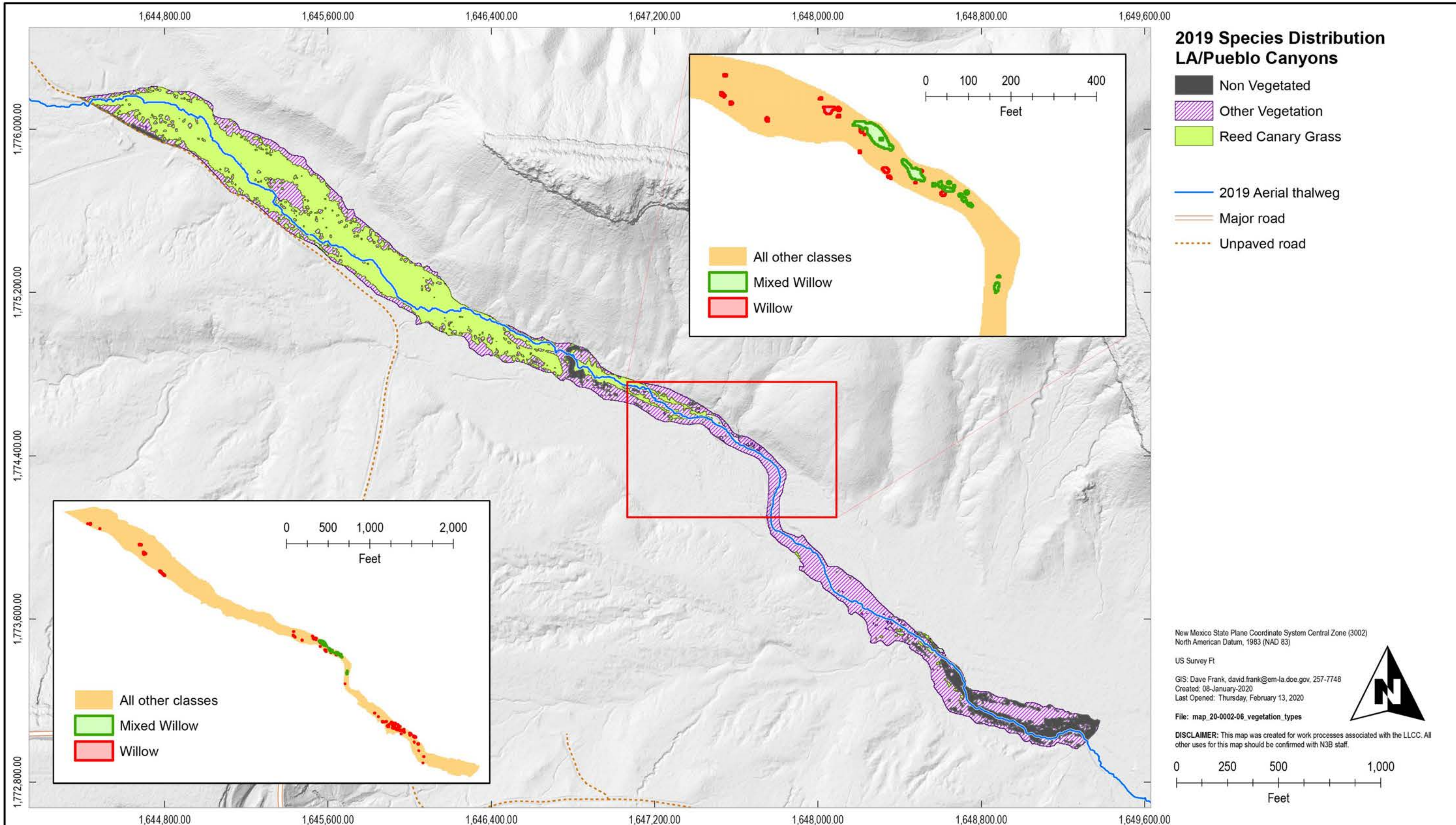


Figure B-2.0-1 LA/P 2019 species distribution, gage stations, and thalweg

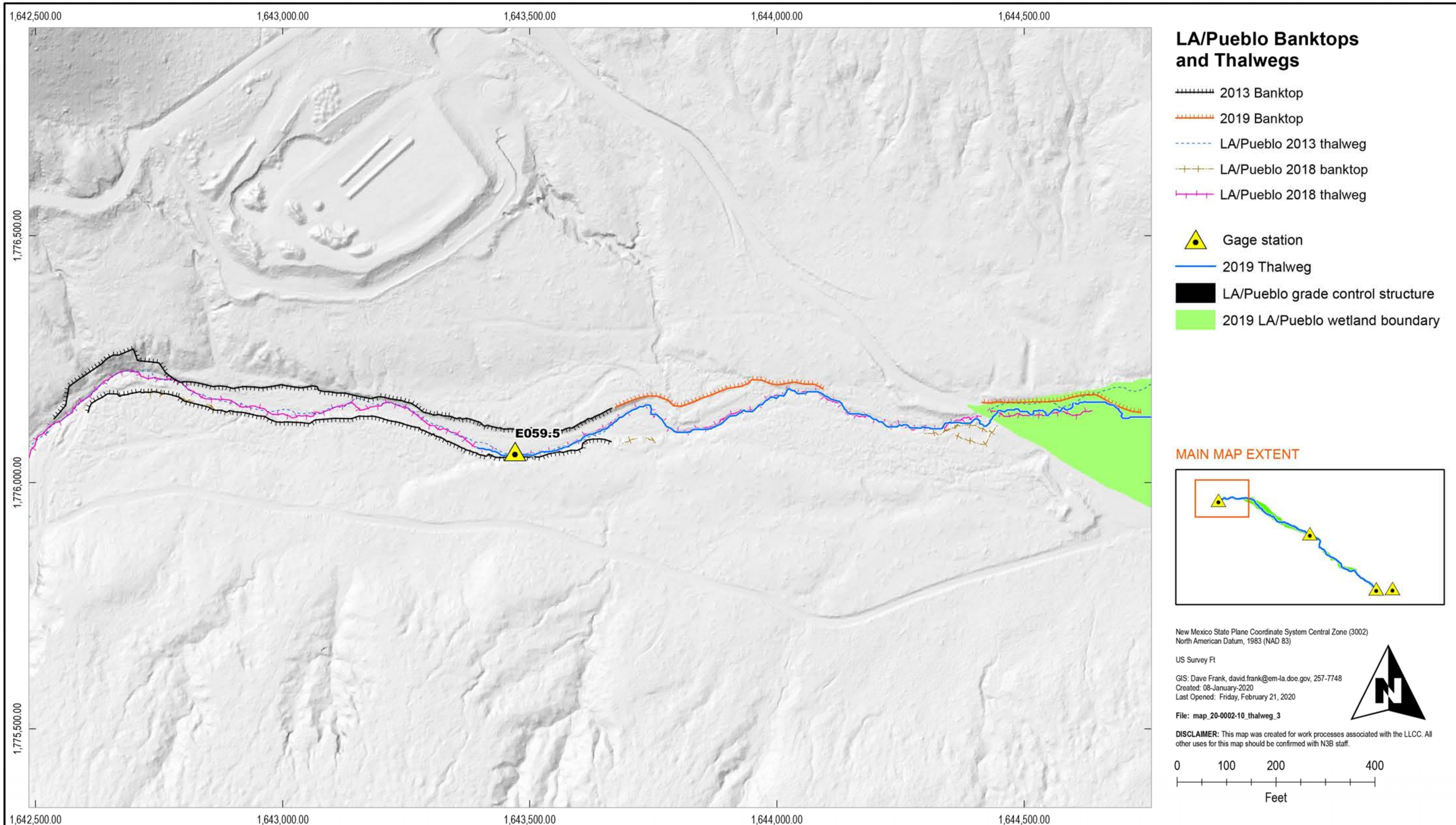


Figure B-4.1-1 Comparison of thalweg and banktop surveys near gage station E059.5

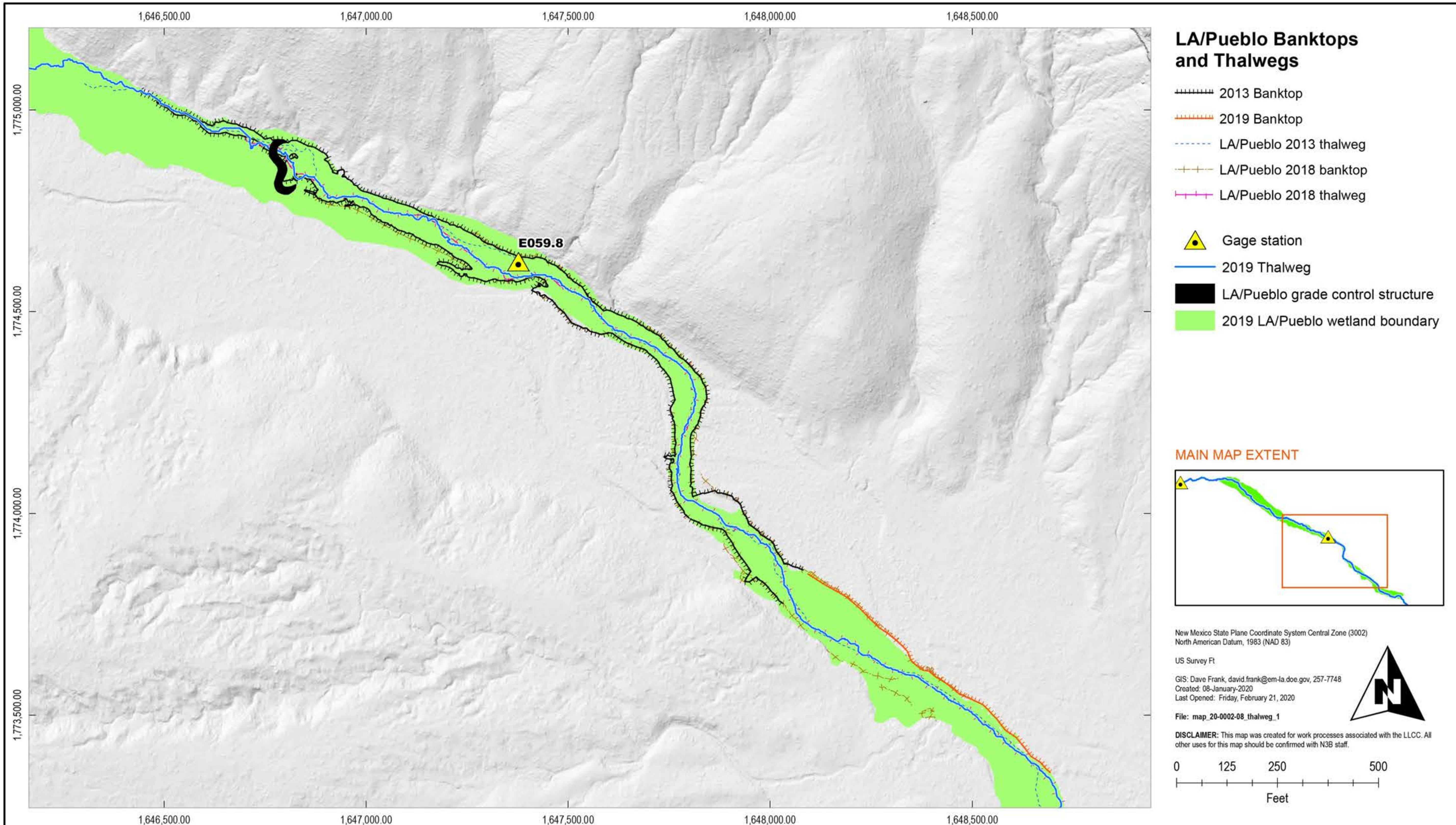


Figure B-4.1-2 Comparison of thalweg and banktop surveys near gage station E059.8

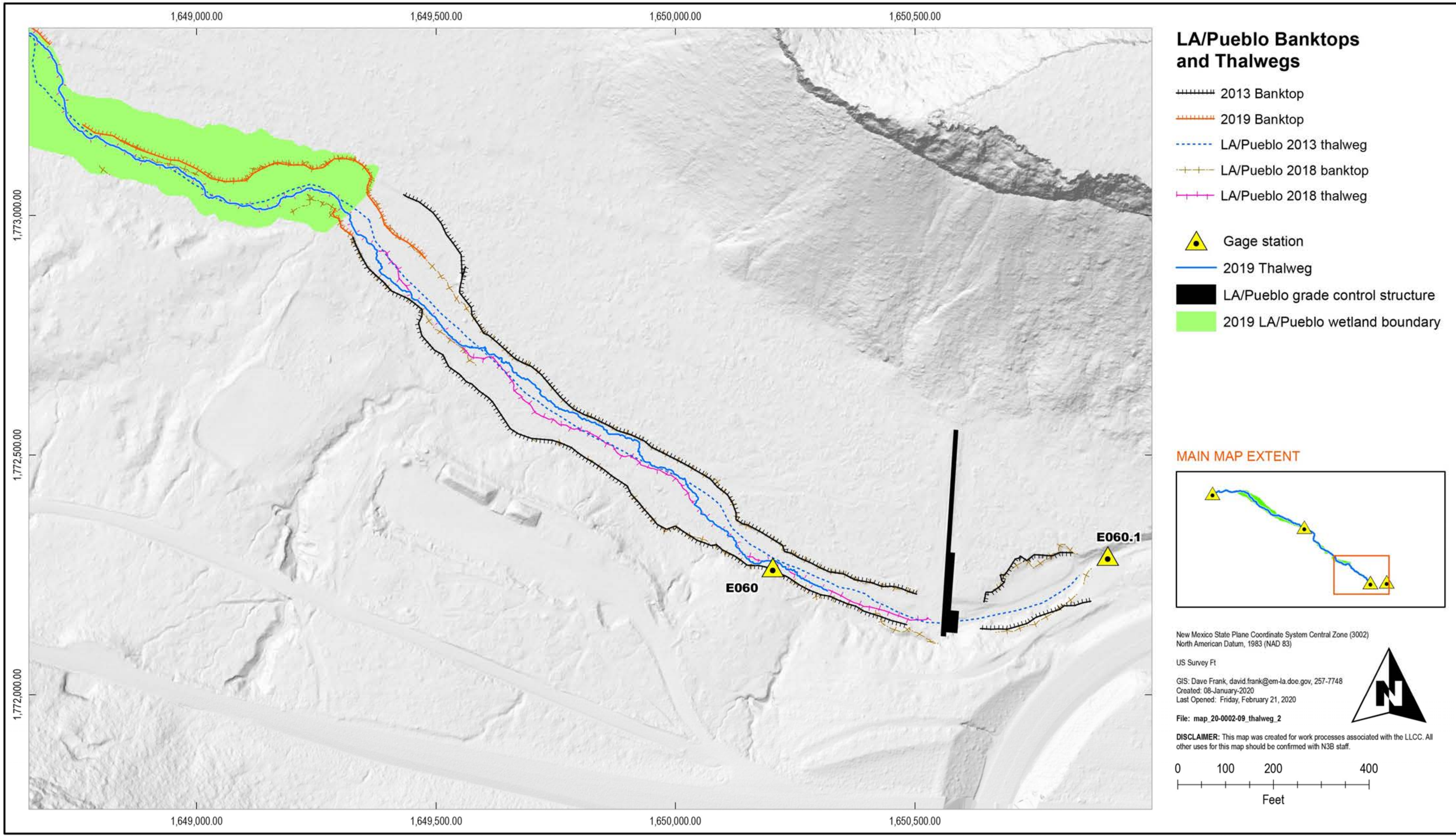


Figure B-4.1-3 Comparison of thalweg and bank top surveys near gage station E060.1

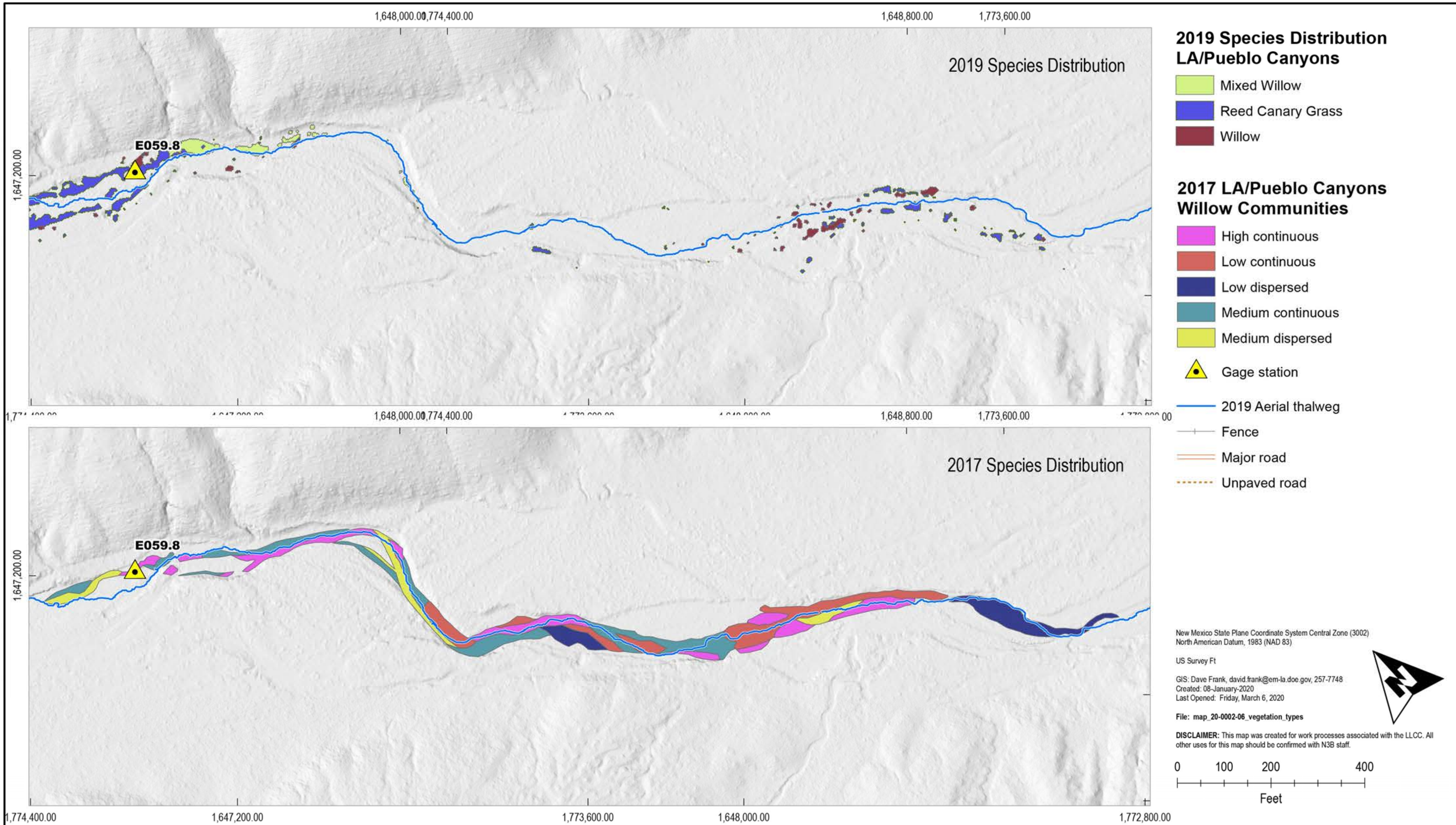


Figure B-4.2-1 Comparison of willow distribution across 2017 GPS survey and 2019 aerial survey methods in LA/P watershed

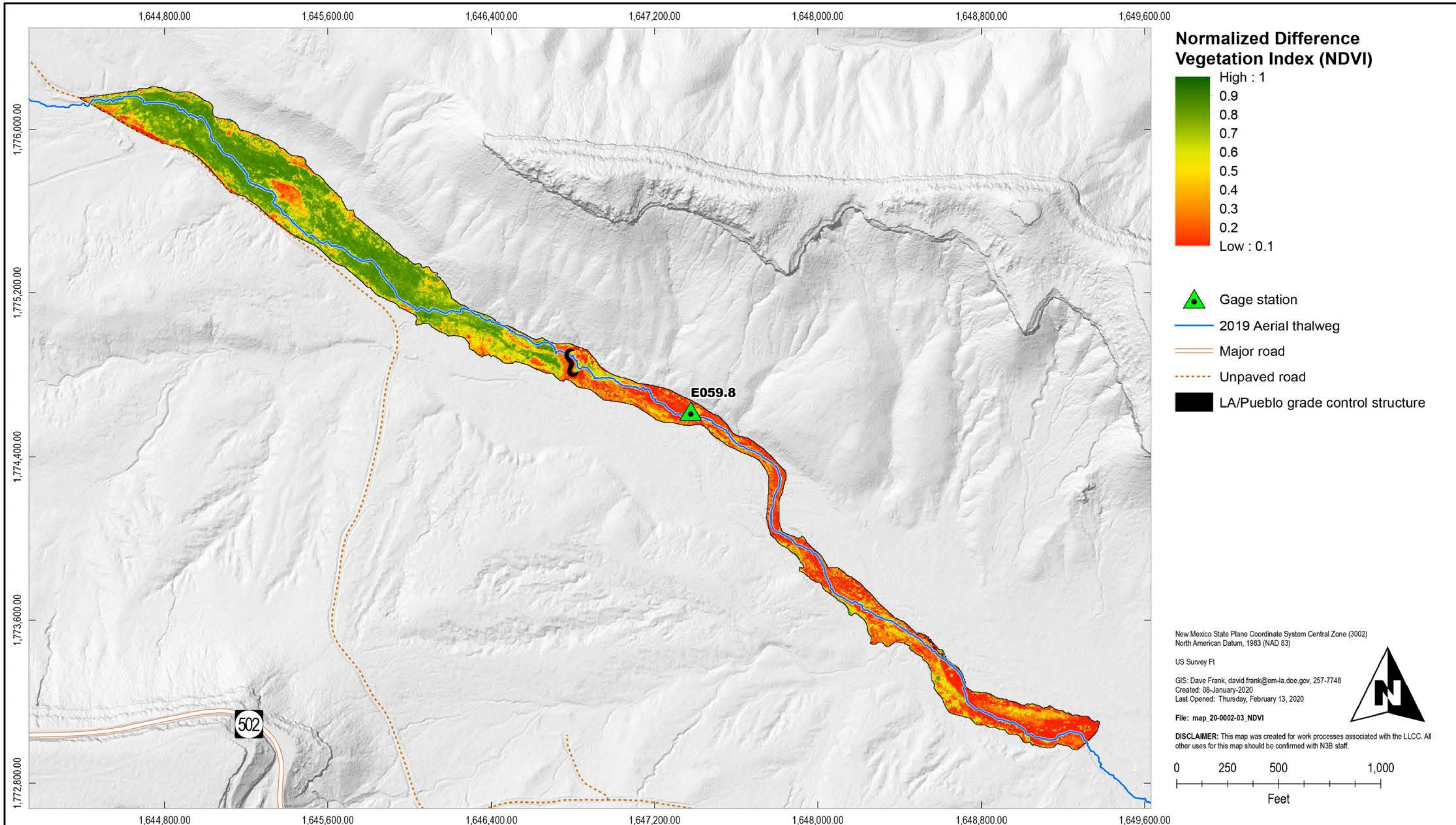


Figure B-4.2-2 2019 aerial-derived normalized difference vegetation index of LA/P watershed

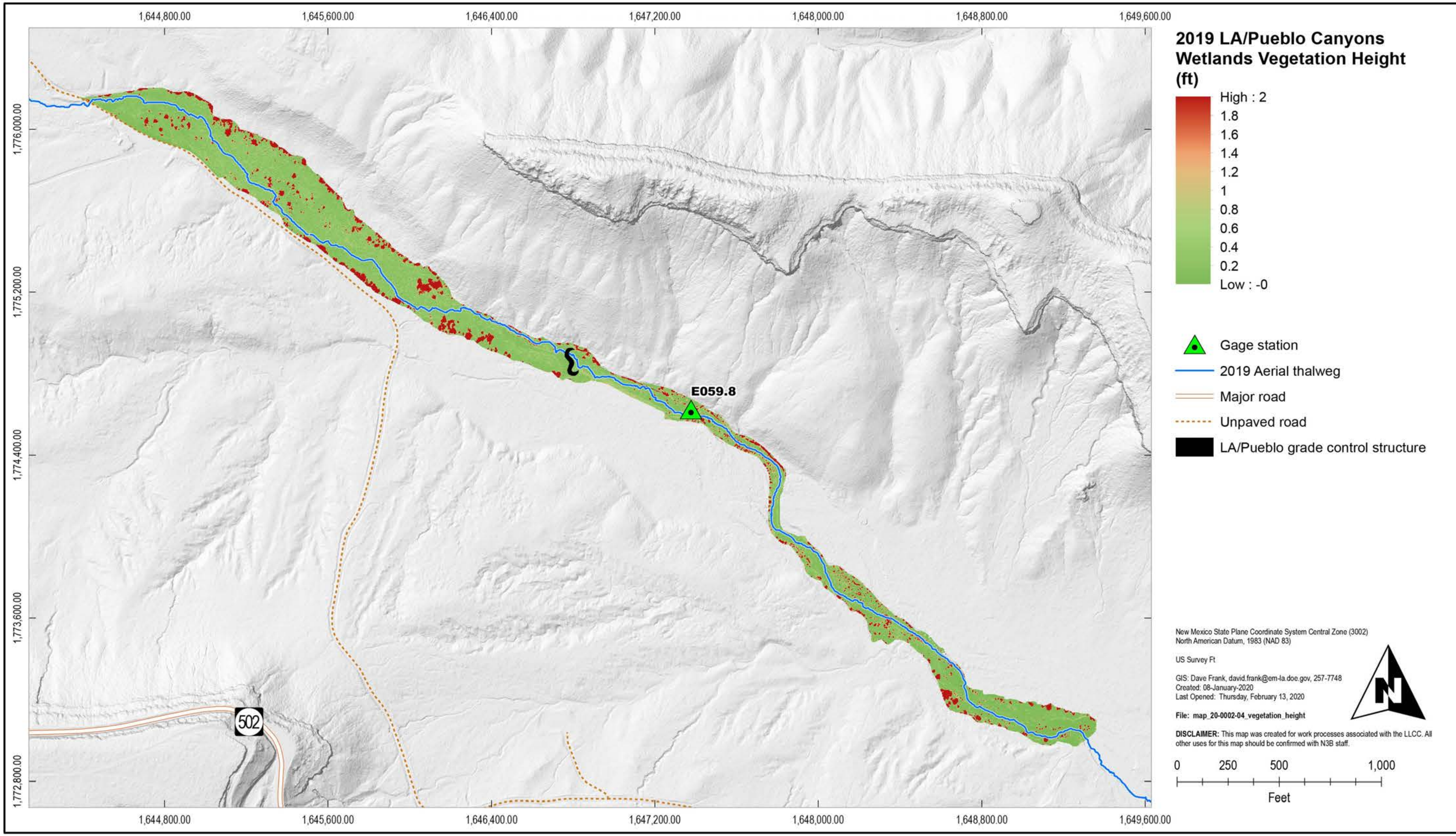


Figure B-4.2-3 2019 aerial-derived LA/P watershed vegetation height

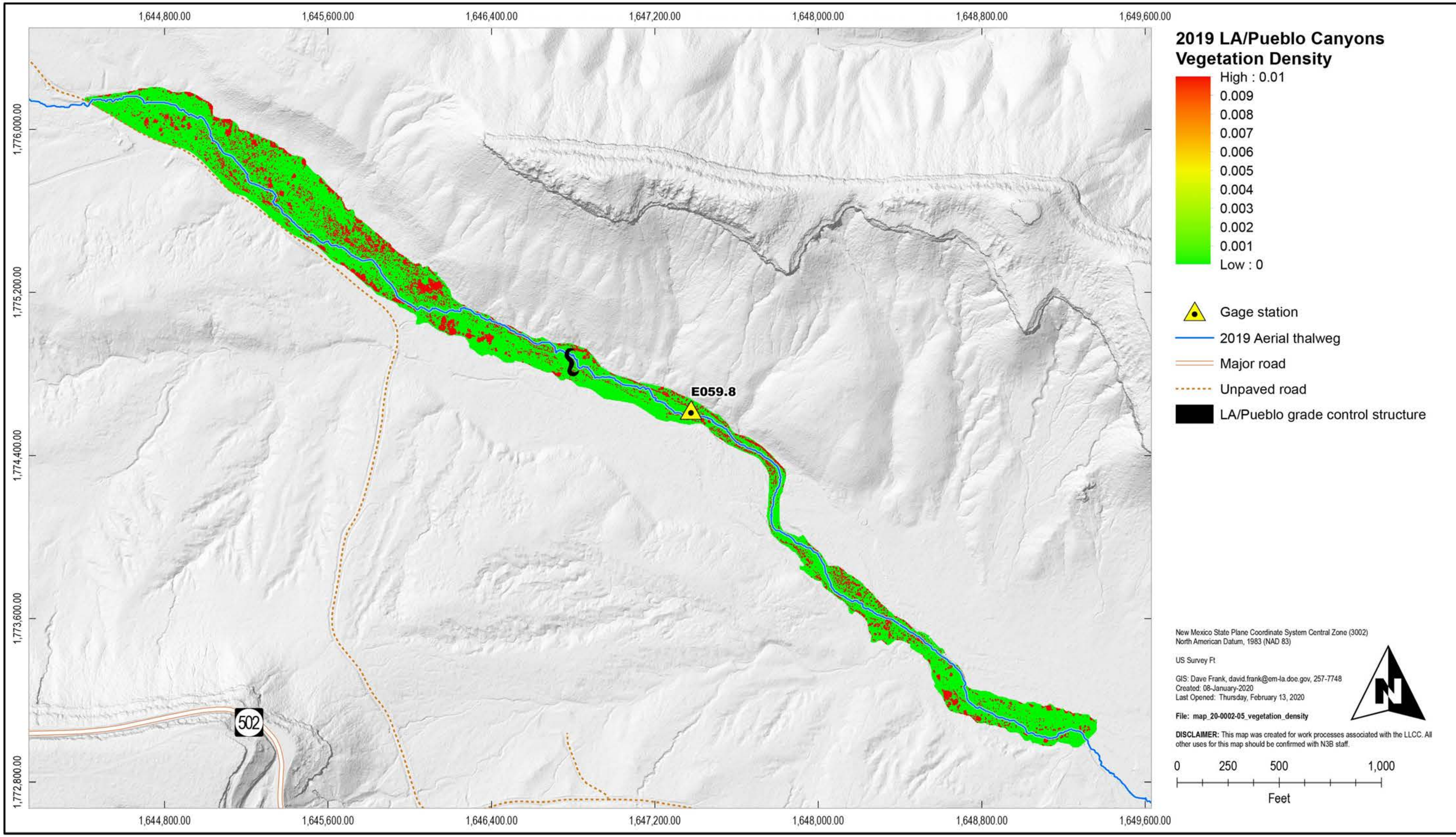


Figure B-4.2-4 2019 aerial-derived LA/P watershed vegetation density

Table B-4.2-1
Willow Distribution
from 2017 GPS Survey and 2019 Aerial Survey

Survey Year	Willow	Mixed Willow/Grass	Total Area
2017	82,425	n/a*	82,425
2019	5613	4317	9930

Note: Units are square feet.

* n/a = Not applicable.

Attachment B-1

2019 Geomorphic and Vegetation Changes
in LA/P Watershed Survey Data
(on CD included with this document)

Appendix C

2019 Watershed Mitigation Inspections

C-1.0 INTRODUCTION

Watershed storm water controls and grade-control structures (GCSs) are inspected on a routine basis and after significant flow events (greater than 50 cubic feet per second [cfs]). These inspections are completed to ensure the watershed mitigations are functioning properly and to identify if maintenance may be required. Examples of items evaluated during inspections include the following:

- Debris/sediment accumulation that could impede operation
- Water levels behind retention structures
- Physical damage of structure, or failure of structural components
- Undermining, piping, flanking, settling, movement, or breeching of structure
- Vegetation establishment and vegetation that may negatively impact structural components
- Rodent damage
- Vandalism
- Erosion

The photographs in this appendix depict annual or significant flow-event-driven storm water inspections of watershed mitigations in Los Alamos and Pueblo Canyons. Each group of photographs is associated with a specific feature (e.g., standpipe, weir, upstream, downstream, etc.) that has the potential to develop issues. The photographs are presented in chronological order and depict the feature in 2019. Photographs of features were taken to mirror previous inspection photographs as closely as possible. Inspections were conducted in May and October–November of 2019 and in response to the July 25–26 and August 7, 2019, storm events.

The May 2019 Los Alamos Canyon sediment pond inspection revealed degradation of the coating on the beam trolley wheels and gouging of the I-beams at the trolley pipe supports located above the Los Alamos Canyon sediment ponds. These observations resulted in a recommendation for further investigation. In response, two special inspections were conducted at the I-beam trolley pipe supports: a special inspection on June 19, 2019, to take measurements, and a follow-up on June 26, 2019, with the pipe support manufacturer and the pipe design-build contractor to discuss the measurements taken on June 19. The findings of these special inspections are described below.

On June 19, 2019, a special inspection occurred in the morning and afternoon to measure pipe temperature changes and measure pipe movement. During the inspection, a change in pipe temperature of 59.7ºF (51.6ºF to 111.3ºF) was observed. At the upper beam trolley pipe support, the pipe moved to the west by approximately 9.5 in. and at the lower beam trolley, the pipe moved 13.75 in.

During the June 26, 2019, inspection, the lower beam trolley support and the I-beam were observed to be out of plane. Level readings indicated twisting in the beam, which was attributed to horizontal forces acting on the trolley supports in the north/south direction because of pipe expansion and contraction caused by fluctuations in temperature. Measurements taken during the June 19 inspection at the I-beam pipe supports were discussed and noted as expected behavior. Degradation of the trolley wheels was noted as “normal wear and tear.” The pipe support manufacturer indicated that the beam supports could last another 80 yr, recommended a follow-up inspection to measure pipe movement, and suggested the wheel trolleys be replaced every 20 yr.

C-2.0 DP CANYON GRADE-CONTROL STRUCTURE

C-2.1 Embankment

Photo C-2.1-1 May 2019—Embankment is stable and operating as designed. Well-established vegetation with no erosion occurring from hillslope. Some trash and debris present.

Photo C-2.1-2 Flow event inspection for August 7, 2019, storm event—embankment. Vegetation is well established.

Photo C-2.1-3 November 2019—Embankment is stable and operating as designed. Well-established vegetation with no erosion occurring from hillslope. One rodent hole encountered. Recommend continued monitoring.

Photo C-2.1-4 May 2019—Erosion occurring at northeast corner of weir. Recommend filling hole with on-site round riprap.

Photo C-2.1-5 **Flow event inspection for July 25, 2019, storm event—Erosion occurring at northeast corner of weir was addressed. Area filled with on-site round riprap.**

C-2.2 Overflow Weir Structure

Photo C-2.2-1 **May 2019—upslope face of weir, looking east. Weir is functioning; no deteriorating joints or bulging gabion baskets.**

Photo C-2.2-2 Flow event inspection for July 25, 2019, storm event—upslope face of weir, looking east. Some trash/debris present.

Photo C-2.2-3 Flow event inspection for August 7, 2019, storm event—upslope face of weir, looking east. Some trash/debris present.

Photo C-2.2-4 November 2019—upstream face of weir. Floatable debris present. Recommend removal of debris.

C-2.3 Crest of Weir Structure

Photo C-2.3-1 May 2019—weir structure looking upstream. No deteriorated joints present on upslope side of weir. Gabion basket is structurally intact and in stable condition.

Photo C-2.3-2 November 2019—weir structure looking upstream. No significant change since last inspection.

C-2.4 Downstream Face of Overflow Weir Structure

Photo C-2.4-1 May 2019—downstream face of weir. Continue to monitor bulging gabion baskets. No evidence of cracking/spalling; area is clear of debris.

Photo C-2.4-2 November 2019—downstream face of weir. No significant change since last inspection.

C-2.5 GCS Standpipe

Photo C-2.5-1 May 2019—standpipe. Sediment level is approximately 1 ft below wood board stop. No significant change since last inspection. Will continue to monitor.

Photo C-2.5-2 May 2019—standpipe. Tire is present within standpipe. No action recommended.

Photo C-2.5-3 **Flow event inspection for July 25, 2019, storm event—standpipe. No change in sediment level since last inspection.**

Photo C-2.5-4 **Flow event inspection for August 7, 2019, storm event—standpipe. Sediment level at approximately 6 in. below top of wood board stop.**

Photo C-2.5-5 November 2019—standpipe. Sediment level is approximately 1 ft below wood board stop. Tire is present within standpipe. No action recommended.

C-2.6 GCS Spillway

Photo C-2.6-1 May 2019—spillway alignment. Spillway operating as designed. No sign of improper alignment or deterioration. Recommend removal of trash encountered.

Photo C-2.6-2 Flow event inspection for August 7, 2019, storm event—spillway. Sediment/debris deposition indicating flow over the spillway.

Photo C-2.6-3 **November 2019—spillway alignment. Spillway operating as designed. No sign of improper alignment, deterioration, or trash/debris.**

C-2.7 GCS Outlet

Photo C-2.7-1 May 2019—outlet. Evidence of corrosion noted in 2018. Pond level was at approximately 6 in. above the bottom of the outlet culvert at time of inspection. No evidence of undercutting, erosion, or excessive sediment deposition. Fallen trees are present downstream of GCS—one upstream of flow gage and one downstream of flow gage. Recommend removal of fallen trees. Sediment level to 6 in. above outlet culvert invert elevation. Will continue to monitor.

Photo C-2.7-2 Flow event inspection for July 25, 2019, storm event—outlet. Evidence of corrosion noted in 2018. Pond level was at approximately 6 in. above the bottom of the outlet culvert at time of inspection.

Photo C-2.7-3 **Flow event inspection for August 7, 2019, storm event—outlet. Pond level was at approximately 6 in. above the bottom of the outlet culvert at time of inspection.**

Photo C-2.7-4 **November 2019—outlet. Channel downgradient of pool is dry.**

C-3.0 UPPER LOS ALAMOS CANYON SEDIMENT DETENTION PONDS

C-3.1 Lower Basin Embankment and Pond

Photo C-3.1-1 May 2019—lower basin. No breaching/slides/cracks/sloughs present on embankment and pond. No erosion occurring on slope. No trash or debris present in control. Recommend pest control along south side of ponds for several rodent burrows.

Photo C-3.1-2 Flow event inspection for August 7, 2019, storm event—lower basin

Photo C-3.1-3 **November 2019—lower basin. Basin dry. Rodent burrows encountered on south side of basin. Will continue to monitor.**

C-3.2 Upper Basin Embankment and Pond

Photo C-3.2-1 **May 2019—upper basin. No breaching, slides, cracks, or sloughs present on embankment and pond. No erosion occurring on slope. No trash or debris present in control. Recommend pest control along south side of ponds for several rodent burrows. Recommend removal of fallen tree in pond.**

Photo C-3.2-2 **Flow event inspection for August 7, 2019, storm event—upper basin. Sloughs due to wildlife tracts upgradient of turf-reinforcement mat (TRM). Fallen tree in pond. Vegetation growth noted on basin maintenance access. Recommend to clean up vegetation growth on the maintenance access paths.**

Photo C-3.2-3 **November 2019—upper basin. Basin dry. No erosion occurring on slope. Sloughing on south side of basin, above where TRM was installed. Sides are retained by concrete jersey barrier at edge of road. Rodent burrows encountered on south side of basin, above where TRM was installed. Fallen tree in basin. Will continue to monitor.**

C-3.3 Lower Basin Spillway

Photo C-3.3-1 May 2019—lower basin spillway. No signs of erosion occurring on or near spillway. Spillway is maintaining alignment and stability.

Photo C-3.3-2 Flow event inspection for August 7, 2019, storm event—lower basin spillway. Needlecast and taller vegetation noted. Recommend cleanup of vegetation growth on the spillway.

Photo C-3.3-3 **November 2019—lower basin spillway. No signs of erosion occurring on or near spillway. Spillway is maintaining alignment and stability. Rodent burrows encountered. Will continue to monitor.**

C-3.4 Upper Basin Spillway

Photo C-3.4-1 May 2019—upper basin spillway. No signs of erosion occurring on or near spillway. Spillway is maintaining alignment and stability.

Photo C-3.4-2 Flow event inspection for August 7, 2019, storm event—upper basin spillway and wetland vegetation. Needlecast noted. Vegetation is well established.

Photo C-3.4-3 **November 2019—upper basin spillway and wetland vegetation. No change since last inspection.**

C-3.5 Wetland and Culvert

Photo C-3.5-1 **May 2019—wetland vegetation. Willows and wetland vegetation well established, stable, and clear of trash/debris. No seepage or piping occurring.**

Photo C-3.5-2 **May 2019—culvert inlet. Willows and wetland vegetation well established, stable, and clear of trash/debris. No seepage or piping occurring.**

Photo C-3.5-3 **Flow event inspection for August 7, 2019, storm event—Culvert inlet is covered with branches.**

Photo C-3.5-4 November 2019—wetland vegetation. Good coverage.

Photo C-3.5-5 November 2019—culvert inlet. Area covered by vegetation. Culvert blocked.

C-3.6 Upstream Pipeline and Appurtenances

Photo C-3.6-1 May 2019—pipeline headwall. Headwall functioning as designed. Needlecast is blocking portion of pipe inlet grate. Recommend maintenance to remove needlecast.

Photo C-3.6-2 Flow event inspection for August 7, 2019, storm event—pipeline headwall. Needlecast debris was removed.

Photo C-3.6-3 **November 2019—pipeline headwall. Needlecast debris at trash rack blocking inlet. Blockage removed. Recommend replacement of trash rack with one that is not in line with the pipe inlet.**

Photo C-3.6-4 **May 2019—pipeline headwall. Rebar sticking up on headwall is a tripping hazard. Recommend removal.**

Photo C-3.6-5 May 2019—Pipeline cable support is no longer skewed.

Photo C-3.6-6 May 2019—Trolley flanged wheels on beam trolley supports are gouging the I-beam supports. Noted deterioration of coating on trolley flanged wheels. Recommend further investigation.

Photo C-3.6-7 May 2019—fallen tree on pipeline. Recommend relocation of fallen tree.

Photo C-3.6-8 May 2019—pipeline outlet downstream of Los Alamos Canyon road

Photo C-3.6-9 Flow event inspection for August 7, 2019, storm event—Castor gouging due to skewed support on beam trolley support 15, south side. Continue to monitor.

Photo C-3.6-10 Flow event inspection for August 7, 2019, storm event—pipeline outlet downstream of Los Alamos Canyon road

Photo C-3.6-11 **Flow event inspection for August 7, 2019, storm event—discharge culvert north of Los Alamos Canyon road. Geotextile exposed. Recommend placement of riprap to cover geotextile.**

Photo C-3.6-12 **November 2019—Tree fell on pipeline. Removal recommended.**

Photo C-3.6-13 November 2019—discharge culvert inlet and riser pipe. Evidence of water level found at top of spillway (needlecast deposition).

C-3.7 Upstream Pipeline Vacuum Breaker

Photo C-3.7-1 May 2019—pipeline vacuum breaker. Control is operating as designed with no apparent issues to structure.

Photo C-3.7-2 **Flow event inspection for August 7, 2019, storm event—pipeline vacuum breaker. Control is operating as designed with no apparent issues to structure.**

Photo C-3.7-3 **November 2019—pipeline vacuum breaker. Control is operating as designed with no apparent issues to structure.**

C-3.8 Upstream Pipeline Bridge Structure

Photo C-3.8-1 May 2019—pipeline bridge structure. Control is operating as designed with no apparent issues to structure.

Photo C-3.8-2 Flow event inspection for August 7, 2019, storm event—pipeline bridge structure. Control is operating as designed with no apparent issues to structure.

Photo C-3.8-3 November 2019—pipeline bridge structure. Control is operating as designed with no apparent issues to structure.

C-3.9 Pipeline Outlet and Energy Dissipater

Photo C-3.9-1 May 2019—pipeline outlet, energy dissipater, and gabion overflow structure. Control is operating as designed with no apparent issues to structure.

Photo C-3.9-2 Flow event inspection for August 7, 2019, storm event—pipeline outlet, energy dissipater, and gabion overflow structure. Control is operating as designed with no apparent issues to structure.

Photo C-3.9-3 November 2019—pipeline outlet, energy dissipater, and gabion overflow structure. Control is operating as designed with no apparent issues to structure.

C-4.0 LOS ALAMOS CANYON WEIR AND DETENTION PONDS

C-4.1 Weir Embankment Upstream Slope

Photo C-4.1-1 May 2019—upstream northern embankment slope. Slope embankment is stable with established vegetation.

Photo C-4.1-2 Flow event inspection for July 26, 2019, storm event—upstream northern embankment slope. Slope embankment is stable with established vegetation.

Photo C-4.1-3 Flow event inspection for August 7, 2019, storm event—upstream northern embankment slope. Slope embankment is stable with established vegetation.

Photo C-4.1-4 November 2019—upstream northern embankment slope

C-4.2 Weir Embankment Abutment

Photo C-4.2-1 May 2019—abutment looking south. Sinkholes still present. Four to five areas of preferential flow. Will continue to monitor. Lower pond filled with approximately 2-3 ft water. Actively flowing. Minor amount of trash on upstream side against the abutment. Recommend collection and disposal of trash.

Photo C-4.2-2 November 2019—abutment looking south. No change since last inspection.

C-4.3 Weir Embankment Downstream Slope

Photo C-4.3-1 May 2019—downstream southern embankment slope. No deficiency found.

Photo C-4.3-2 **Flow event inspection for July 26, 2019, storm event—downstream southern embankment slope. Sediment deposited from runoff coming from dirt roads upgradient of the northside gabion embankment. Will continue to monitor.**

Photo C-4.3-3 **Flow event inspection for July 26, 2019, storm event—downstream northern embankment slope. Recommend wattle or gravel bag placement at top of gabion baskets.**

Photo C-4.3-4 **Flow event inspection for August 7, 2019, storm event—downstream northern embankment slope. Surface water collecting on the paths downstream of the weir causing deposition of course sediments on the north gabion embankment. Recommend placement of gravel bags or wattles at the top of the gabions and relocating sediments deposited to north of the gravel bags or wattles.**

Photo C-4.3-5 **November 2019—downstream northern embankment slope. Recommend wattle or gravel bag placement on top of gabion baskets.**

C-4.4 Upper Pond

Photo C-4.4-1 May 2019—Los Alamos Pond 1 (upper) looking downstream. Pond appears to have been breached. Pond has no capacity to retain sediment.

Photo C-4.4-2 November 2019—Los Alamos Pond 1 (upper) looking downstream. Pond has been breached and has no sediment capacity.

C-4.5 Middle Pond

Photo C-4.5-1 **May 2019—Los Alamos Pond 2 (middle) looking downstream. Pond appears to have been breached. Minor ponding on the south side of channel. Pond has no capacity to retain sediment.**

Photo C-4.5-2 **Flow event inspection for July 26, 2019, storm event—Los Alamos Pond 2 (middle) looking downstream. Pond has been breached. No sediment capacity at flow line. Deposition of medium gradation (approximately 0.25-in.-diameter) size sediments noted at flow line.**

Photo C-4.5-3 **Flow event inspection for August 7, 2019, storm event—Los Alamos Pond 2 (middle). Pond has been breached and has no sediment capacity.**

Photo C-4.5-4 **November 2019—Los Alamos Pond 2 (middle). Pond has been breached and has no sediment capacity.**

C-4.6 Lower Pond

Photo C-4.6-1 May 2019—Los Alamos Pond 3 (lower). Water level is 4–5 ft below the spillway crest.

Photo C-4.6-2 Flow event inspection for July 26, 2019, storm event—Los Alamos Pond 3 (lower). Pond level approximately 0.5-ft deep in lower pond. Tadpoles noted. Approximately 0.5 ft sediment deposition upstream of pond. High flows on north side of pond; low flows at south side of pond. Will continue to monitor.

Photo C-4.6-3 **Flow event inspection for August 7, 2019, storm event—Los Alamos Pond 3 (lower). Sediment deposition area extended approximately 3 ft to the east (downstream).**

Photo C-4.6-4 **Flow event inspection for August 7, 2019, storm event—Los Alamos Pond 3 (lower)**

Photo C-4.6-5 November 2019—Los Alamos Pond 3 (lower). No significant change since last inspection.

C-4.7 Upslope Face and Crest of Overflow Weir Structure

Photo C-4.7-1 May 2019—upstream weir face. Continue to monitor bulging gabion baskets.

Photo C-4.7-2 **May 2019—broken gabion wires on north end of weir crest. Recommend repair of holes in gabion basket.**

Photo C-4.7-3 **May 2019—broken gabions on south end of crest. Recommend repair of holes in gabion basket.**

Photo C-4.7-4 **Flow event inspection for July 26, 2019, storm event—broken gabion wires on north end of weir crest. Recommend repair.**

Photo C-4.7-5 **Flow event inspection for August 7, 2019, storm event—weir crest**

Photo C-4.7-6 **Flow event inspection for August 7, 2019, storm event—broken gabion wires on north end of weir crest. Recommend repair.**

Photo C-4.7-7 **November 2019—weir crest**

Photo C-4.7-8 November 2019—broken gabion wires on north end of weir crest. Recommend repair.

Photo C-4.7-9 November 2019—broken gabion wires on south end of weir crest. Recommend repair.

C-4.8 Downstream Face of Overflow Weir Structure

Photo C-4.8-1 May 2019—downstream weir face. Continue to monitor bulging baskets and joints.

C-4.9 Weir Standpipe

Photo C-4.9-1 May 2019—standpipe. Gage reads approximately 6 ft of sediment and debris. Approximately 3 ft of standpipe exposed. No deficiency found.

Photo C-4.9-2 **Flow event inspection for July 26, 2019, storm event—standpipe. Sediment is approximately 4 ft deep. Debris accumulation (branches, pinecones, plastic bottles) is approximately 2 ft above sediment level. Approximately 3 ft of standpipe exposed.**

Photo C-4.9-3 **Flow event inspection for August 7, 2019, storm event—standpipe. Sediment upstream of weir at 4.7-ft depth and debris at 6-ft depth. Approximately 3 ft of standpipe exposed. No significant change since last inspection.**

Photo C-4.9-4 **November 2019—standpipe. Sediment and debris level at 4.6 ft on gage.**

C-4.10 Weir Outlet

Photo C-4.10-1 **May 2019—weir outlet. Water flowing/seeping through gabions at various locations. Pipe has some flow. Continue to monitor erosion occurring 50–60 ft downstream of the weir. No sediment present. Highly vegetated.**

Photo C-4.10-2 **Flow event inspection for July 26, 2019, storm event—weir outlet. Vegetation well established in gabion basket at outlet and blocks channelization noted in previous inspections from view. Sounds of continuous low flow not heard. Will continue to monitor. Scour hole developed downstream of apron at outlet. No significant change since last inspection. Recommend replacement of riprap to cover exposed filter fabric and protect undercut bank downgradient of pond culvert outlet.**

Photo C-4.10-3 November 2019—weir outlet. Erosion occurring in sediments deposited on top of gabion mattress. Erosion is resolved before end of gabion mattress apron. Sediment deposits on top of gabion mattress apron are approximately 1 in. below bottom of outlet invert.

C-4.11 Borrow Pit Runoff Control Berm

Photo C-4.11-1 May 2019—borrow pit and berm. Minor erosion on upper end of borrow pit. Vegetation well established.

Photo C-4.11-2 May 2019—Berm and TRM damage (north end) occurred during nearby Los Alamos County well construction. If additional sediment is brought in, the recommendation is to increase the entire berm height.

Photo C-4.11-3 May 2019—Berm and TRM damage (north end) occurred during nearby Los Alamos County well construction. If additional sediment is brought in, the recommendation is to increase the entire berm height.

Photo C-4.11-4 Flow event inspection for July 26, 2019, storm event—borrow pit. Vegetation is 60% established. Minor rilling (1–2 areas) in the upper area where sediments from the Los Alamos weir were previously placed. Minor rilling ends within the upper third of the sediment placement area. No significant change in the large undercut area encountered upgradient of the area where sediments from the Los Alamos weir were previously placed (noted in previous inspections).

Photo C-4.11-5 **Flow event inspection for July 26, 2019, storm event—borrow pit. Channelization is stabilized upstream of a log in the large undercut area. Will continue to monitor. Berm and TRM damage noted at north end of the berm. Damage occurred during nearby Los Alamos County well construction. Recommend discussion with Los Alamos County to repair berm and TRM damage. Filter fabric exposed and detached downstream of the berm on the south end. Recommend filter fabric restapling and then covering with base course.**

Photo C-4.11-6 **Flow event inspection for August 7, 2019, storm event—borrow pit. Vegetation is well established.**

Photo C-4.11-7 **Flow event inspection for August 7, 2019, storm event—borrow pit. Herd of elk encountered at borrow pit. Berm and TRM damage on north end of berm due to Los Alamos County well construction. Recommend coordination of berm and TRM repair with Los Alamos County. If additional sediment is brought into the area, recommend increasing the height of the berm.**

Photo C-4.11-8 **Flow event inspection for August 7, 2019, storm event—borrow pit. Los Alamos County well construction materials left on-site downgradient of the berm. Recommend coordination of material removal/disposal with Los Alamos County.**

Photo C-4.11-9 November 2019—borrow pit and berm

Photo C-4.11-10 November 2019—borrow pit. Damage on north end is not resolved by Los Alamos County. Recommend notification to Los Alamos County to have berm and TRM damage repaired.

Photo C-4.11-11 November 2019—borrow pit. Construction materials from Los Alamos County well project. Recommend request be sent to Los Alamos County for removal of materials downstream of the borrow-pit berm.

Photo C-4.11-12 November 2019—borrow pit. Construction materials from Los Alamos County well project. Recommend request be sent to Los Alamos County for removal of materials downstream of the borrow-pit berm.

C-5.0 PUEBLO CANYON GRADE-CONTROL STRUCTURE

C-5.1 Upstream Embankment

Photo C-5.1-1 May 2019—south embankment, looking west. Well-established vegetation on embankment. No signs of erosion or undermining.

Photo C-5.1-2 October 2019—south embankment, looking west. Well-established vegetation on embankment. No signs of erosion or undermining.

C-5.2 Embankment Abutment

Photo C-5.2-1 May 2019—embankment abutment from north side of channel, looking south. Well-established vegetation surrounding control. No presence of trash/debris.

Photo C-5.2-2 October 2019—embankment abutment from north side of channel, looking south. Well-established vegetation surrounding control. No presence of trash/debris.

C-5.3 Downstream Embankment and Outlet

Photo C-5.3-1 May 2019—downstream south embankment and scour-stop, looking south. Control is operating as designed. No buckling of embankment occurring. Riprap functioning as designed. Vegetation established and no evidence of erosion. Minor rodent burrows. Will continue to monitor.

Photo C-5.3-2 May 2019—downstream north embankment and scour-stop, looking north. Control is operating as designed. No buckling of embankment occurring. Riprap functioning as designed. Vegetation established and no evidence of erosion. Minor rodent burrows. Will continue to monitor.

C-5.4 Crest of Overflow Weir Structure and Spillway

Photo C-5.4-1 May 2019—weir crest and flow-way, looking south. Cracks in concrete are apparent where overflow weir intersects the spillway (both corners of the spillway). Alignment is fine. There appears to be a twisting of the overflow concrete weir and spillway crests as a result of gabion movement/settling. Will continue to monitor.

Photo C-5.4-2 May 2019—weir crest and flow-way, looking north. A tree has fallen over the overflow weir structure. Recommend removal of the tree. Bulging gabions and minor cracks present. Gabion wiring has failed in one location and created a hole approximately 1 ft in diameter. Recommend repair.

Photo C-5.4-3 May 2019—weir spillway and flow-way, looking west. Minor spalling/chipping of concrete on downstream side of the spillway. Will continue to monitor.

Photo C-5.4-4 October 2019—weir crest and flow-way, looking south. Recommend relocation of fallen tree.

Photo C-5.4-5 October 2019—weir crest and flow-way, looking north

C-5.5 Downstream Face of Overflow Weir Structure Showing Outlet and Spurs

Photo C-5.5-1 May 2019—Redi-Rock spurs, looking east. Well-established vegetation along all hillslopes. No erosion apparent along slopes or near TRM. All structures functioning as designed.

Photo C-5.5-2 May 2019—Redi-Rock spurs, looking west. Medium size (12-in. nominal diameter) rocks deposited upstream of flow gage. Will continue to monitor.

Photo C-5.5-3 October 2019—Redi-Rock spurs, looking east

Photo C-5.5-4 October 2019—Redi-Rock spurs, looking west

C-6.0 PUEBLO CANYON WETLAND STABILIZATION STRUCTURE

C-6.1 Upper, Middle, and Lower Pueblo Wetland Structure

Photo C-6.1-1 May 2019—Redi-Rock block structure, looking north. Redi-Rock structure shows no evidence of displacement or settling. Vegetation well established.

Photo C-6.1-2 May 2019—Redi-Rock block structure, looking southeast. Redi-Rock structure shows no evidence of displacement or settling. Vegetation well established.

Photo C-6.1-3 May 2019—Redi-Rock block structure. Preferential flow path located mid-upper level. The crushed stone placed in the void space between block 13 and 14 (as counted from north end of structure) washed out. Will continue to monitor.

Photo C-6.1-4 October 2019—Redi-Rock block structure, looking north. No deficiency found.

Photo C-6.1-5 October 2019—Redi-Rock block structure, looking southeast. No deficiency found.

Photo C-6.1-6 **October 2019—Redi-Rock block structure. Note preferential flow path. Recommend fill of void with a large graduation gravel.**

C-6.2 Wetland North Bank

Photo C-6.2-1 May 2019—wetland north bank, looking northeast. Slope is stable with no evidence of erosion where riprap is located. Structure is functioning as designed with established vegetation.

Photo C-6.2-2 October 2019—wetland north bank, looking northeast. Slope is stable with no evidence of erosion where riprap is located. Structure is functioning as designed with established vegetation.

C-6.3 Wetland South Bank

Photo C-6.3-1 May 2019—south bank, looking southeast. Structure is functioning as designed with established vegetation.

Photo C-6.3-2 October 2019—south bank, looking southeast. Structure is functioning as designed with established vegetation.

C-6.4 Downstream South Bank

Photo C-6.4-1 **May 2019—south-bank berm, looking northeast. Berm is stable; no noted erosion or breaching/slides/cracks to berm.**

Photo C-6.4-2 **October 2019—south-bank berm, looking northeast. Berm is stable; no noted erosion or breaching/slides/cracks to berm.**

C-6.5 Upstream Area of Wetland

Photo C-6.5-1 May 2019—upstream pond, looking upstream. Water present in pond. There is capacity for additional sediment accumulation.

Photo C-6.5-2 October 2019—upstream pond, looking upstream. Pond is dry. TRM is covered with sediment. Pond has approximately 1-ft depth for accumulation of sediment.

Appendix D

Analytical Results and Instantaneous
(5-min) Gaging Station Stage and Discharge Data
for the Los Alamos/Pueblo Watershed
(on CD included with this document)