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

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NMED Hazardous
Waste Bureau

EMLA-2022-BF078-02-001

April 15, 2022

Mr. Rick Shean
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 2021 Monitoring Report and 2022 Monitoring Plan for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project

Dear Mr. Shean:

Enclosed please find two hard copies with electronic files of the "2021 Monitoring Report and 2022 Monitoring Plan for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project." Please note that the 2021 monitoring report and 2022 monitoring plan are combined in a single document for the 2022 submission. The annual monitoring report assesses overall performance of the mitigation efforts installed in the Los Alamos and Pueblo watershed since 2007. The evaluation of precipitation, storm water discharge, and constituent concentrations obtained in 2021 were used to determine the effects of mitigations installed.

The objective of the monitoring plan is to evaluate the effects of mitigation measures undertaken in the Los Alamos and Pueblo watershed under the New Mexico Environment Department– (NMED-) approved "Interim Work Plan to Mitigate Contaminated Sediment Transport in the Los Alamos and Pueblo Canyons."

NMED approved with comments the "2020 Monitoring Report for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project" and the "2021 Monitoring Plan for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project" on July 8, 2021.

Pursuant to Section XXIII.C of the Compliance Order on Consent, the U.S. Department of Energy Environmental Management Los Alamos Field Office (EM-LA); Newport News Nuclear BWXT-Los Alamos, LLC (N3B); and NMED met in a pre-submission review meeting on December 7, 2021, to discuss changes in monitoring requirements for 2022. EM-LA, N3B, and NMED met in a follow-up meeting on January 26, 2022. The changes discussed have been captured in the 2022 monitoring plan, section 6 of the enclosed document.

If you have any questions, please contact Amanda White at (505) 309-1366 (amanda.white@em-la.doe.gov) or Cheryl Rodriguez at (505) 414-0450 (cheryl.rodriguez@em.doe.gov).

Sincerely,

ARTURO DURAN

Digitally signed by ARTURO DURAN
Date: 2022.04.14 10:52:45 -06'00'

Arturo Q. Duran
Compliance and Permitting Manager
U.S. Department of Energy
Environmental Management
Los Alamos Field Office

Enclosures:

1. Two hard copies with electronic files – 2021 Monitoring Report and 2022 Monitoring Plan for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project (EM2022-0002)

cc (letter with hard-copy enclosure[s]):
Cheryl Rodriguez, EM-LA

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Raymond Martinez, San Ildefonso Pueblo, NM
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Steven Lynne, Los Alamos County, Los Alamos, NM (2 copies)
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PRS website

April 2022
EM2022-0002

2021 Monitoring Report and 2022 Monitoring Plan for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project

N3B Los Alamos

EM2022-0002

2021 Monitoring Report and 2022 Monitoring Plan for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project

April 2022

Responsible program director:

Printed Name	Signature	Title	Organization	Date
Steve Veenis	[signature]	Program Director	Water Program	4/8/22

Responsible N3B representative:

Printed Name	Signature	Title	Organization	Date
Troy Thomson	[signature]	Program Manager	N3B Environmental Remediation Program	4/8/22

Responsible DOE EM-LA representative:

Printed Name	Signature	Title	Organization	Date
Arturo Q. Duran	ARTURO DURAN Digitally signed by ARTURO DURAN Date: 2022.04.14 10:53:15 -06'00'	Compliance and Permitting Manager	Office of Quality and Regulatory Compliance	

EXECUTIVE SUMMARY

This twelfth 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 May to November 2021. 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. The submission of this annual report to the New Mexico Environment Department is in accordance with the 2016 Consent Order.

Gaging station and sampling locations within the LA/P watershed monitor the hydrology and sediment transport, including stations that bound the mitigation sites. Stage/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. The 2021 monitoring season is characterized by the United States Drought Monitor as a period that began in exceptional drought in the LA/P watershed and surrounding areas, decreasing in severity during the month of August, to extreme drought for the remainder of the year. Eight precipitation events generated sufficient flows above sampler trip levels to collect samples at gaging stations during the monitoring season. The 2021 monitoring data in the LA/P watershed indicate that, in general, the mitigations are performing as designed.

In 2018, triennial aerial-based surveys replaced biennial aerial-based surveys plus annual ground-based Global Positioning System survey methods. Therefore, a light detection and ranging (LiDAR) survey was performed over the LA/P watershed in 2021, 3 yr after the 2018 LiDAR survey. The 2018 and 2021 surveys were compared to analyze geomorphic change. The geomorphic change detected in Pueblo, DP, and Los Alamos Canyons between 2018 and 2021 was minor, indicating that the watershed mitigations are performing as designed.

Continued monitoring in 2022 is expected to confirm that 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 twelfth 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 May to November 2021; details geomorphic change between 2018 and 2021 at the sediment transport mitigation sites in the LA/P watershed; and documents watershed mitigation inspections in 2021. Section 6 of this report is the LA/P watershed monitoring plan for calendar year 2022. The LA/P monitoring plan has previously been a separate document. Appendix A includes acronyms and abbreviations. Appendix B addresses geomorphic change between 2018 and 2021, and Appendix C provides photographic documentation of watershed mitigation inspections. Appendix D (on CD included with this document) presents analytical results and gaging station stage and discharge data, and Appendix E includes requalified 2012 and 2015 polychlorinated biphenyl (PCB) congener 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" (LANL 2005, 091818; 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 2021 was performed in accordance with the "2021 Monitoring Plan for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project" (N3B 2021, 701361).

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 of 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 following:

- 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-flood 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-flood 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. Figure 1.1-1 shows the location of the LA/P watershed with respect to Laboratory property, and Figure 1.1-2 shows 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 flood 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 2015–2021 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 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 biannually 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 2021. Gaging stations with concrete, trapezoidal, supercritical-flow flumes are designated as follows:

- 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 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 measurement as it was made. Discharge was computed for each 5-min stage measurement using rating curves for each individual gaging station. Shaft-encoder float sensors installed in stilling wells were used to measure water levels at E050.1 and E060.1. Self-contained bubbler pressure sensors (Sutron Accubar) were used to measure water levels at E059.5 and to provide backup sensing for E050.1 and E060.1. Radar sensors were used to measure water levels at E026, E030, E038, E039.1, E040, E042.1, E055, E055.5, E056, and E059.8 and to provide backup sensing at E050.1 and E060.1.

A complete record of 5-min stage measurements for the monitoring period from June 1, 2021, to October 31, 2021, 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 (on CD included with this document) 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 2.1-1 shows total precipitation for each month from 2015 to 2021, and Figure 2.1-2 shows total precipitation for each month in 2021. Both figures depict total precipitation averaged over Laboratory sites and in relation to historic totals, annual heterogeneity, and increase in precipitation, which 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. Figure 2.1-3 presents rain gages, meteorological towers, Thiessen polygons, and the drainage area for each stream gaging station associated with the LA/P watershed.

Sampling was planned 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 May. Automated samplers were inspected at least monthly during the 2021 monitoring season while samplers were active. Gaging station equipment was inspected at least monthly in 2021.

For gaging station equipment at E050.1 and E060.1, inspection occurred weekly throughout the year. Equipment found to be damaged or malfunctioning was repaired within 11 business days after the problem was discovered. Equipment at the 13 LA/P gaging stations was connected via telemetry to a base station, allowing real-time access to stage 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.

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

In 2021, no samples were collected 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 2021.

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

During the 2021 monitoring period (May 1 to approximately October 31), sample-triggering discharge occurred eight times. Table 2.3-1 shows precipitation totals and maximum daily discharge for storms that triggered sample attempts during the season. Table 2.3-2 indicates operational issues with sampling during the 2021 monitoring year. Table 2.3-3 shows the number of storm events that exceeded trip levels in comparison with samples collected. Samples were collected for 100% of storm events with measured discharge above trip levels. As shown in Table 2.3-4, sediment from a flow event on August 26, 2021, at E059.8 interfered with the radar sensor and was repaired on August 30, 2021. Because of the sedimentation, the trip level could not be measured, and Table 2.3-5 shows the number of working days between sample collection time and sample retrieval time. All samples in 2021 were retrieved within one business day of sample collection.

No precipitation events exceeding a sample-triggering discharge occurred before May 1, 2021, or after October 31, 2021. A sampling event is defined as the collection of one or more samples from a specific gaging station during a specific runoff event. 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 on 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. Planned analyses were prioritized in the order presented in Table 2.4-1. Suspended sediment analyses were planned using American Society for Testing and Materials (ASTM) method D3977-97 from an entire sample, and were reported using the designation “suspended sediment concentration” (SSC). Analyses were planned 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 2021. 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 may 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. If insufficient volume was collected in glass bottles, analyses were not performed.
   b. Boron was analyzed as an addition to the target analyte list (TAL) metals suite, and samples were collected in polyethylene bottles. If insufficient volume was collected in polyethylene bottles, boron analyses were not ordered.

2.5 Deviations from Monitoring Plan

Because of an error in reading the rating table values, the sampler trip level at E038 was incorrectly set at activation to 2.8 ft (77 cfs) instead of 3.05 ft (100 cfs) as stated in the 2021 monitoring plan (N3B 2021, 701361). A sample was collected on June 27, 2021, with a peak discharge of 89 cfs and on July 31, 2021, with a peak discharge of 87 cfs. No storm water samples were missed because of this error in the trip level at E038, as the trip level was set lower than the required trip level. On August 15, 2021, at E059.5, the 24-bottle ISCO collected storm water but the 12-bottle ISCO appeared to have an equipment malfunction. The 24-bottle ISCO was used for the analytical suite. All analyses were fulfilled except PCBs, as PCB analysis requires a glass bottle and the 24-bottle ISCO contains only polyethylene bottles.

If the stage or discharge could not be correctly measured because of damage or silting that occurred, these instances are documented in Table 2.3-4.

Battery voltage, stage, 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 at least monthly during the year.

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 and intermittent 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 detection and ranging (LiDAR) images (a digital elevation model [DEM] 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 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 percentage of impervious surface area. The following assumptions were made in determining the percentage of impervious surface area: because the GIS layers for roads/parking lots and structures were developed in 2009, newer impervious surfaces will not have been captured, and 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, Acid, and Pueblo Canyons from up- to downstream over the 9 yr of monitoring from 2013 to 2021 (excluding 2020 when no samples were collected). As expected, Los Alamos Canyon had high concentrations of suspended sediment in 2013 as a result of the 2011 Las Conchas fire 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 2021 were slightly lower than in recent years and similar to pre-fire levels. The low magnitude of storm events in 2021 could also contribute to the diminished SSC values. Lower SSC levels are also evidence that the sediment transport mitigations are performing as designed to manage the magnitude of SSC. The sample trip levels at most gaging stations in Los Alamos, DP, and Pueblo Canyons were decreased in 2021 to ensure that samples were collected during ongoing drought conditions. SSC in Los Alamos Canyon and Pueblo/Acid Canyons was significantly less than in DP Canyon in 2021. 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. Therefore, 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, while downstream, the DP Canyon floodplain area and GCS decrease the flow velocity before it reaches E039.1, removing sediment. With large storm events, DP Canyon flows join Los Alamos Canyon to increase the flow velocity and SSC measured at E042.1, while the downstream lower Los Alamos sediment detention basins and low-head weir remove sediment, reducing the SSC at E050.1. In 2021, DP Canyon samples were collected at E038 on June 27 and July 31 and at E039.1 on July 31. A sample was collected at E040 on October 1, 2021. The June 27 and July 31 storm events did not result in sample collection at E040, whereas the October 1 storm event resulted in a sample collection at E040. There were no storm events sampled at E042.1 or any stations in Upper Los Alamos Canyon. On August 26, 2021, flows at E050.1 resulted in sample collection.

In Acid Canyon, SSC decreases slightly from E055.5 to E056, likely because of the largely impervious area associated with E055.5 and the largely pervious area associated with E056. In 2021, flow was not large enough to sample at E055, E055.5 or E056. Gaging station E059.5 is located in lower Pueblo Canyon below this confluence with Acid Canyon and after other inputs from other tributaries. In 2021, the trip level at E059.5 was adjusted throughout the season as base flow changed. Two samples were collected at E059.5 on August 15 and August 28, 2021. From E059.8 to below the GCS at E060.1, SSC increased significantly in 2015. Between 2016 and 2020, flows were not large enough to collect a sample at E060.1. In 2021, a sample was collected at E060.1 and E050.1 on August 26. In 2021, flow was not great enough to sample at E059.8.

Hydrographs for runoff events with flows that exceeded sample trip levels in 2021 are presented in Figure 3.2-3 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 mitigation structures, including travel time of flood bore from upstream to 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 2021. The flood bore is defined as the leading edge of the storm hydrograph as it transmits downstream, and peak discharge is the maximum 5-min instantaneous flow rate measured during a flood. Peak discharge 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).

Figure 3.2-4 shows the hydrograph and sedigraph for gaging stations E038, E039.1, E050.1, E059.5, and E060.1. Figure 3.2-5 shows the hydrograph and sedigraph for E038 and E039.1 when samples were collected from the same storm event. These figures are from events that 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. The E059.5 hydrograph and sedigraph during the August 15 and August 28 runoff events show that SSC did not significantly decrease on the trailing limb of the storm event. These were low-magnitude, long-duration storm events where sampling finished before peak flows had subsided.

Figure 3.2-6 shows the linear relationship between sediment yield and runoff volume for the stations where SSC was measured throughout the runoff event over the past 9 yr of monitoring, 2013 to 2021 (excluding 2020 when no samples were collected); Table 3.2-2 presents the 2013 through 2021 values shown in Figure 3.2-6. Although SSC and instantaneous discharge are not always highly correlated (because 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:

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

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

$$M = \sum_{j=0}^{m} Q(t_j)(t_{j+1} - t_j)\, SSC(t_j) \quad , \qquad \textbf{Equation 2}$$

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 3.2-7 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 9 yr of monitoring as shown in Figure 3.2-6. The relationship between discharge and SSC is further discussed in section 4.2 of this report.

3.3 Geomorphic Changes and Vegetation Health

Geomorphic changes that occurred from 2018 to 2021 at sediment transport mitigation sites in the LA/P watershed were evaluated and are discussed in Appendix B.

In 2018, surveys of the Los Alamos and Pueblo Canyon watersheds were performed using aerial LiDAR equipment to collect geomorphic data. In 2021, repeat LiDAR surveys of the watersheds were conducted. The LiDAR surveys provide a detailed representation of the land surface for the entire watershed, and geomorphic change was identified by comparing the 2018 and 2021 LiDAR survey data.

Aerial-based vegetation surveys were completed in September 2019 and are scheduled for August 2022, and results will be discussed in the 2022 annual report. The next aerial-based geomorphic survey is scheduled for fall 2025, to be conducted concurrently with the aerial-based vegetation survey in 2025.

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: In 2021, sampling was performed in DP Canyon on June 27 and July 31 above the GCS and upstream wetland (E038). Sampling below the GCS and upstream wetland (E039.1) was performed on July 31 (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 3.2-5). Sample collection began within 5 min of the flow exceeding the sample trip levels. Sample trip levels at each gaging station are presented in Table 2.1-1. On June 27, 2021, at E038, the runoff event had a calculated sediment yield of 2.7 yd^3 (E039.1 did not sample on June 27), and for E038 and E039.1, respectively, the calculated sediment yields on July 31, 2021, are 2.7 yd^3 and 0.5 yd^3 (Table 3.2-2). The sediment yield was reduced by 81% between these two stations, or from above to below the GCS/wetland, for the July 31 event.

Statistics over the past 9 yr of monitoring from 2013 to 2021 (excluding 2020 when no samples were collected) are also useful in assessing performance of sediment transport mitigations 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 9 yr, which is consistent with the goals of the sediment transport mitigation activities. Runoff events are defined as resultant flow of more than 1 cfs per sampling event at a particular gaging station when 24-hr total precipitation at the associated precipitation gage exceeds 0.1 in. (Figure 3.4-1). In 2021, the average peak discharge values from runoff events in DP Canyon were higher than prior years, and the sampled SSC values were slightly lower than recent years. Decreasing SSC values in 2021 indicate a stable system. Lowered sample trip levels in 2021 due to drought conditions may also have contributed to the decrease in SSC sampled storm events. Where sampled, storms were smaller in magnitude with below average erosive force and stream power to carry sediment.

Decreasing storm water velocity allows increased infiltration, thus reducing peak discharge, as well as the distance traveled downstream by the flood bore and by sediment and associated contaminants entrained in the storm water. Increasing infiltration reduces peak discharge but can also decrease the total volume of storm water. In 2021, the peak discharge decreased in four of six measureable runoff events between E038 and E039.1, with an average decrease of 69% relative percent difference (RPD), and increased in two of six runoff events, with an increase of 78% RPD (Table 3.2-1).

Pueblo Canyon: In 2021, SSC analysis was performed on the August 15 and 28 runoff events in Pueblo Canyon above the drop structure (E059.5). These runoff events on August 15 and 28 at E059.5 had calculated sediment yields of 0.2 yd^3 for both events (Table 3.2-2). SSC analysis was also performed on the August 26 runoff event below the wetland and GCS (E060.1). This runoff event on August 26 at E060.1 had a calculated sediment yield of 1.8 yd^3 (Table 3.2-2). Sample collection began within 5 min of the flow exceeding the sample trip levels except at E060.1 where a liquid-level actuator was used to trigger sample collection. Sample trip levels at each gaging station are presented in Table 2.1-1. However, no SSC data were collected below the drop structure (E059.8) at any of these events (Table 2.3-1). Therefore, statistics over the past 9 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. These plots indicate that 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 2021, the peak discharge decreased in three of three measurable runoff events between E059.5 and E059.8 with an average decrease of 100% RPD. The peak discharge between E059.8 and E060.1 did not qualify as a measurable runoff event between the two locations (Table 3.2-1).

The discharge magnitude is being reduced through this area, which is a primary goal of the mitigations. Discharge is being reduced so significantly that no samples were collected at E060.1 in 2013 or 2016 through 2020. One sample was collected in 2021 because a liquid-level actuator was used (versus a sample trip level of 5 cfs), and the storm water runoff was very localized and not representative of flow through the channel. In addition, SSC magnitude was reduced through the mitigation structures in 2015 and 2021.

Los Alamos Canyon: In 2021, sampling was performed in Los Alamos Canyon on August 26 below the lower Los Alamos sediment detention basins and low-head weir at E050.1 (Table 2.3-1). The calculated sediment yield at E050.1 was 0.01 yd^3 on August 26 (Table 3.2-2). Sample collection began within 5 min of the flow exceeding the sample trip levels except at E050.1 where a liquid-level actuator was used to trigger sample collection. Sample trip levels at each gaging station are presented in Table 2.1-1. However, no SSC data were collected above E042.1 (the lower Los Alamos sediment detention basins and low-head weir) during this event because of minimal flows at E042.1 (Table 2.3-1). Therefore, statistics over the past 9 yr of monitoring must be used to assess performance. Figure 3.4-1 shows box-and-whisker plots for SSC and peak discharge at E042.1 and E050.1. 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. In 2021, peak discharge decreased in two of three measureable runoff events between E042.1 and E050.1, with an average decrease of 100% RPD. In one of three measureable runoff events between E042.1 and E050.1, the peak discharge increased with an average increase of 93% 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.

The discharge magnitude is being reduced through this area, which is a primary goal of the mitigations. The SSC values in 2021 were less than the values seen in recent years. This is likely due to drought conditions where storms have been smaller and less frequent, as well as the lowering of sample trip levels in 2021. Minor reductions in peak discharge occurred from 2013 through 2016, and 2018, 2019, and 2021; while minor increases in peak discharge occurred in 2014, 2015, and 2017.

4.0 ANALYTICAL RESULTS

Appendix D (on CD included with this document) contains the analytical results for the LA/P watershed.

Analytical results meet the Newport News Nuclear BWXT-Los Alamos, LLC (N3B) minimum data quality objectives as outlined in N3B-PLN-SDM-1000: "Sample and Data Management Plan." N3B-PLN-SDM-1000 sets the validation frequency criteria at 100% Level 1 examination and Level 2 verification of data, and at 10% minimum Level 3 validation of data. A Level 1 examination assesses the completeness of the data as delivered from the analytical laboratory, identifies any reporting errors, and checks the usability of the data based on the analytical laboratory's evaluation of the data. A Level 2 verification evaluates the data to determine the extent to which the laboratory met the analytical method and the contract-specific quality control and reporting requirements. A Level 3 validation includes Levels 1 and 2 criteria and determines the effect of potential anomalies encountered during analysis and possible effects on data quality and usability. A Level 3 validation is performed manually with method-specific data validation procedures. Laboratory analytical data are validated by N3B personnel as outlined in N3B-PLN-SDM-1000; N3B-AP-SDM-3000, "General Guidelines for Data Validation"; N3B-AP-SDM-3014, "Examination and Verification of Analytical Data"; and additional method-specific analytical data validation procedures. All associated validation procedures have been developed, where applicable, from the U.S. Environmental Protection Agency (EPA) QA/G-8, "Guidance on Environmental Data Verification and Data Validation," the U.S. Department of Defense/Department of Energy "Consolidated Quality Systems Manual for Environmental Laboratories," the EPA "National Functional Guidelines for Data Validation," and the American National Standards Institute/American Nuclear Society 41.5, "Verification and Validation of Radiological Data."

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 waterborne contaminants to specific levels, and the analytical results are therefore not compared with water-quality standards or other criteria for that purpose, nor 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 Pueblo and Acid Canyons are unclassified, nonperennial 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 E038 and 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 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 storm water samples filtered with a 10-µm pore size. Other water-quality criteria are for dissolved concentrations of pollutants, which are compared with storm water samples filtered with 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 from 16.1 mg/L to 502 mg/L (averaging 97 mg/L) of calcium carbonate ($CaCO_3$) calculated from calcium and magnesium values for storm water collected in 2021. 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 criterion for dioxins is 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 2021 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, all of which occur in a developed urban landscape and are 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, continuing 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. They are commonly detected throughout the gaging station 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 2021 are metals and PCBs detected at gaging stations located directly downstream from these routing pathways.

In 2021, there were five aluminum exceedances of NMED's hardness-dependent acute and/or chronic aquatic life screening criteria in storm water with results ranging from 173 to 3760 µg/L; the average value of all eight 10-µm filtered aluminum results is 1668 µg/L. Hardness-dependent water-quality criteria range from 280 to 10,071 µg/L.

Because hardness in storm water runoff is typically very low, the corresponding calculated aluminum water-quality criterion 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 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.

The one copper exceedance in 2021 was 4.47 µg/L from the E039.1 sample on July 31, 2021. The average value of all eight dissolved copper results is 3.39 µg/L. The hardness-dependent aquatic life screening criteria range between 2.40 and 50 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 likely due to runoff from the impervious developed landscape within the Los Alamos townsite.

There were four dioxin exceedances out of seven samples in 2021. The New Mexico HH-OO criteria for dioxin is 5.1E-08 µg/L. The dioxin criteria apply to the sum of the dioxin toxicity equivalents expressed as 2,3,7,8-TCDD dioxin. The average value of the five detected dioxin results in 2021 is 1.54E-06 µg/L. For four of these detections the dioxin concentration is driven by PCBs, as certain PCB congeners are included in the sum of dioxin toxicity equivalents expressed as 2,3,7,8-TCDD dioxin. Dioxins and furans are measured only at E050.1 and E060.1.

Three gross-alpha concentrations were observed above the 15-pCi/L screening level threshold out of eight samples in 2021. The exceedances range from a minimum of 44.1 pCi/L to a maximum concentration of 146 pCi/L; the average value of all six detected gross-alpha results is 48.9 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).

There were no lead exceedances out of eight samples in 2021. The average value of all five detections of dissolved lead is 1.13 µg/L. The hardness-dependent aquatic life screening criteria range between 1.80 and 281 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 such as the Los Alamos County townsite on a national scale (Davis and Burns 1999, 602303; Göbel et al. 2007, 252959).

The one manganese exceedance out of eight samples in 2021 was 9890 µg/L from the E050.1 sample on August 26, 2021. The average value of all eight detections of dissolved manganese is 1279 µg/L. The hardness-dependent aquatic life screening criteria range between 1625 and 4738 µg/L.

The one mercury exceedance out of eight samples in 2021 was 1.38 µg/L from the E060.1 sample on August 26, 2021. The New Mexico wildlife habitat screening criteria for mercury is 0.77 µg/L. The average value of the two detected mercury results in 2021 is 0.74 µg/L.

The one exceedance of radium-226 and radium-228 out of two samples in 2021 was 42.7 pCi/L from the E050.1 sample on August 26, 2021. The New Mexico livestock watering screening criteria for radium-226 and radium-228 is 30 pCi/L. The average value of the two radium-226 and radium-228 results in 2021 is 32.7 pCi/L.

The one selenium exceedance out of eight samples in 2021 was 34.6 µg/L from the E060.1 sample on August 26, 2021. The New Mexico wildlife habitat screening criteria for selenium is 5.0 µg/L. The average value of all three detected selenium results is 14.2 µg/L.

There were no zinc exceedances out of eight samples in 2021. The average value of all eight dissolved zinc results is 88.3 µg/L.

PCBs are the most common compounds that exceeded water-quality criteria in 2021. Total PCB concentrations range from 0.00561 to 0.0394 µg/L and six of seven samples exceeded the most sensitive screening level (HH-OO threshold of 0.00064 µg/L). The average PCB concentration in 2021 is 0.024 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 stabilizing agents in 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 cadmium, silver, and thallium exceeded the screening levels for those compounds. Cadmium MDLs are 0.06 to 1.02 times larger than the hardness-dependent screening levels. Silver MDLs are 0.01 to 2.16 times larger than the hardness-dependent screening levels. The thallium MDL of 0.6 µg/L is 1.3 times the human health screening level of 0.47 µg/L. More sensitive analytical methods are not available for these compounds.

A summary of 2021 analytical data is shown in Figure 4.1-1. Analytical data for parameters with exceedances of water-quality criteria are presented in Figure 4.1-2 as exceedance ratios. 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.

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 vehicle traffic and with the weathering of roads, parking lots, and structures that are in various stages of decay. 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 using a rating curve, which is the relationship between discharge in ft^3 per second and height of the water in feet, developed for each individual gaging station. Stage 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:

$$y = mx + b \qquad \textbf{Equation 3}$$

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 collections 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 and interpolate the gaps between known data. 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 metals 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)

No storm water samples were collected at the inlet to the upper detention basin below SWMU 01-001 in 2020 or 2021. The results from 2010 through 2019 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.

4.5 Requalification of 2012 and 2015 PCB Congener Results

An error was identified in qualification of PCB congener results analyzed in 2012 and 2015 from seven samples collected from four locations in the LA/P watershed. The total PCB results were incorrectly qualified as nondetected because of method blank contamination. The appropriate qualification would have retained the total PCB results as detected. The associated data set and details of the changes are in Appendix E.

5.0 CHANGES FROM THE 2020 REPORT

Based on changes that occurred in 2021, this report has been updated from the 2020 report. The changes are summarized as follows:

- The 2022 monitoring plan has been merged with this report. This change introduces section 6.0, Table 6.1-1, Figure 6.3-1, and Tables 6.3-1 through 6.3-8.
- The following tables and figures were not included in the 2020 report, as no samples were collected, but have been added back to the 2021 report:
    - Table 4.1-1, Comparison of Detected Analytical results with NMED Water Quality Criteria
    - Table 4.2-1, Calculated SSC and Instantaneous Discharge Determined for each Sample Collected in the LA/P Watershed
    - Table 4.3-1, Calculated Total Metals and Isotopic Uranium Concentrations Determined for each Sample Analyzed for SSC in the LA/P Watershed
    - Figure 3.2-4, Measured discharge and measured SSC for events sampled at E038, E039.1, E050.1, E059.5, and E060.1
    - Figure 3.2-5, Discharge and SSC at E038 and E039.1 in DP Canyon on days when sampling of the same runoff event occurred

- Analytical data, including sediment data, are included in Appendix D (on CD included with this document).
- Table 2.3-3 has been added to show the number of storm events that exceeded trip levels in comparison with samples collected.
- Table 2.5-1 has been renamed 2.3-5 and discussion moved to section 2.3.
- Figures 4.1-1 and 4.1-2 have been added to visually present analytical exceedances.
- Appendix E, Requalification of 2012 and 2015 Polychlorinated Biphenyl Congener Data, has been added.

6.0 2022 MONITORING PLAN

This monitoring plan has been developed to satisfy the requirements of the NMED- approved “Interim Measure Work Plan to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons” (LANL 2008, 101714) and NMED’s “Approval with Modification, Interim Measure Work Plan to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons” (NMED 2008, 103007) and in response to NMED’s comments on previous monitoring plans (NMED 2010, 108444; NMED 2011, 203705; NMED 2013, 521854; NMED 2013, 523106; NMED 2015, 600507; NMED 2016, 601563; NMED 2017, 602504; NMED 2018, 700007; NMED 2019, 700461; NMED 2020, 700928; NMED 2021, 701517), as well as the 2016 Consent Order.

Monitoring proposed within this plan is designed to satisfy four purposes:

1. Monitoring is intended to evaluate the performance of the controls installed to mitigate sediment transport. Two types of monitoring that began in 2010 are designed to meet this objective:
    a. Monitoring geomorphic changes in the canyon bottom facilitates continued evaluation of sediment control mitigation measures.
    b. Collecting and analyzing storm water runoff samples supports assessment of the performance of sediment control measures.
2. Monitoring is intended to support the analyses requested by NMED to assess attainment of designated uses. Monitoring concentrations of dissolved metals and total recoverable metals and other pollutants, as requested by NMED in its approval of the 2010 monitoring plan (NMED 2010, 108444) and as adjusted via the annual monitoring plans, supports the determination of whether surface waters of the state are attaining designated uses.
3. Monitoring of contaminants in affected environmental media at DOE sites is required under DOE Order 458.1 Administrative Change 4, “Radiation Protection of the Public and the Environment,” and reporting is required under DOE Order 231.1B, “Environment, Safety, and Health Reporting.”
4. Monitoring is intended to satisfy requirements of the memorandum of understanding (MOU) between the DOE and the BDDB regarding water-quality monitoring (hereafter, the DOE-BDDB MOU) (DOE and BDD Board 2017, 602995). Analysis of gross beta, isotopic uranium, radium-226, and radium-228 at gaging stations E050.1 and E060.1 is being performed to support the DOE-BDDB MOU.

Storm water and geomorphic monitoring conducted under this 2022 monitoring plan will evaluate the potential impacts of any changes that occur in the watershed and the efficacy of the mitigations over time. Figures 1.1-2 and 2.2-1 show storm water monitoring locations and sediment control features. Before 2021, the annual monitoring plans were submitted separately from the annual report (LANL 2009, 107457; LANL 2011, 201578; LANL 2012, 222833; LANL 2013, 243432; LANL 2014, 256575; LANL 2016, 601434; LANL 2017, 602342; LANL 2018, 603015; N3B 2019, 700418; N3B 2020, 700841; N3B 2021, 701361).

6.1 Monitoring Geomorphic Changes

Aerial-based LiDAR surveying for monitoring geomorphic change is scheduled for 2025. A field visit will be scheduled in conjunction with NMED at the end of the monitoring year to observe whether geomorphic changes have occurred and what level of monitoring needs to be conducted in order to quantify the change. If storm water peak discharge at any gaging station in the LA/P watershed is greater than 50 ft^3 per second (cfs), the upgradient reach will be visually inspected at the end of the monsoonal period to document qualitative geomorphic changes. Biannual and greater-than-50 cfs inspections of the GCSs and detention basins will continue to be performed.

As of 2019, LiDAR surveys will be performed triennially to maintain a baseline and also after large disturbance events. Previously, ground-based bank, thalweg, and transect surveys were performed annually along with a field visit with NMED at the end of the monitoring year. The field visits were conducted to observe whether geomorphic changes occurred and what level of monitoring needed to be conducted in order to quantify the change, potentially including a new LiDAR survey. LiDAR surveys began in 2014 and repeat surveys were performed in 2015 and 2016. A new baseline was performed in 2018, a survey was conducted in 2021, and the next LiDAR survey is planned for 2025, unless a large disturbance event occurs, in which case visual or Global Positioning System– (GPS-) based ground surveys will be performed to determine if significant geomorphic change has occurred and a LiDAR survey will potentially be performed.

A large disturbance event has been defined for each canyon based on historical knowledge. Storm events where significant erosion or channel alterations occurred were examined, along with the associated discharge at the nearest gaging stations (Table 6.1-1). Based on this analysis, the discharge magnitude that has the potential to cause significant erosion was determined to be 300 cfs in Los Alamos Canyon, 250 cfs in Pueblo Canyon, and 350 cfs in DP Canyon. To simplify monitoring, a discharge of 200 cfs is used for all canyons. If discharge at one or more gaging station reaches this discharge value, it will be considered a large disturbance event that might warrant an aerial-based geomorphic and/or vegetation survey before the routine triennial survey. After a field visit is performed, if significant erosion or vegetation disturbance is observed, aerial surveys will be performed.

If events warrant, the plan for monitoring quantitative geomorphic changes via LiDAR survey is as follows. 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. The LiDAR surveys will provide a DEM of the entire active channel within each monitoring area so a comparison with the previous survey's DEM can show areas of geomorphic change. In addition, triangulated irregular networks will be developed and compared to identify areas of significant geomorphic change. If noteworthy features are identified in the LiDAR comparison, the features will be visually field-verified and additional ground-based survey methods may be implemented.

6.2 Monitoring Vegetation Changes

A baseline vegetation survey was performed in 2019, and vegetation surveys will be conducted triennially, with the next survey to be conducted in 2022. Airborne hyperspectral and LiDAR sensors will be used to classify vegetation species and determine vegetation density, stand height, and spatial extent. In addition, the normalized-difference vegetation index, which is an indicator of photosynthetic activity using the red and near-infrared bands, will be computed as a measure of the health of the Pueblo Canyon wetlands, including the historical upper and lower willow-planting areas.

6.3 Monitoring Storm Water Runoff

In 2022, storm water monitoring will be conducted at 13 gaging stations (Figure 1.1-2) and 2 ungaged stations (denoted as sampling locations in Figure 2.2-1) within the LA/P watershed. No changes to monitoring locations are planned from 2021 to 2022. Gaging stations are located where they will monitor sediment transport and performance of mitigations effectively throughout each watershed. Each gaging station automatically collects storm water runoff using ISCO samplers. Storm water analytical suites will be presented for each gaging station and are listed in Table 2.4-2.

The goal of the sampling is to collect data that

- represent spatial and temporal variations in potential contaminant concentrations and SSC in storm water;
- allow evaluation of short- and long-term trends in contaminant concentrations, SSC, and suspended sediment yield;
- provide data to support the determination of whether surface waters of the state are attaining designated uses; and
- meet requirements of the DOE-BDDB MOU.

The monitoring strategy described below was developed to achieve these goals.

6.3.1 2022 Storm Water Monitoring Locations Inspection, Maintenance, and Sample Retrieval Plan

Storm water monitoring at all locations proposed for 2022 will occur using ISCO-type automated pump samplers. Table 6.3-1 presents sampling locations and trip-level information. Two sampling locations, CO111041 and CO101038 in Figure 2.2-1, are not gaged and are located at the detention basins below SWMU 01-001(f). Monitoring requirements at these locations are listed in Table 6.3-2. These sampling locations will allow evaluation of how the sediment detention basins and associated vegetative buffer below the basins are performing. These monitoring locations will be inspected following a rain event exceeding 0.25 in. in a 30-min period as recorded at the rain gage at RG055.5.

All other storm water monitoring will occur at gaging stations. Gaging stations E050.1 and E060.1 will be activated by May 1 and all other gaging stations will be activated by June 1. Battery voltage, stage, and sensor function at each gaging station will be remotely monitored daily. Flow-measurement devices and telemetry at gaging stations E050.1 and E060.1 will be inspected at least weekly and after each flow event throughout the year. Automated samplers, flow-measurement devices, and telemetry at other gaging stations will be inspected following a discharge event with peak discharge greater than the trip level and on a rolling 30-day schedule following the sampler trip discharge event from June 1 to October 31. The rolling 30-day schedule will ensure that gaging stations are inspected at least monthly and after sampler-trip discharge storm events. Gaging station inspections will occur monthly from

November 1 to May 31. Equipment found to be damaged or malfunctioning will be repaired within 5 business days after the problem is identified. If the time to repair monitoring equipment at E050.1 and E060.1 is expected to exceed 48 hr, DOE will notify BDDB per the DOE-BDDB MOU.

Automated samplers at gaging stations will be deployed and operational on or before June 1. All sample retrievals will be attempted within 1 business day after collection. Table 2.3-5 presents the sample collection and sample retrieval working-day interval for 2021. However, sample retrieval within 1 business day of collection is not always feasible, such as with a sitewide storm event. If this is the case, sample retrieval will be performed using the following three-tiered priority order:

1. BDDB-related gaging stations E050.1 and E060.1;
2. Gaging stations bounding watershed mitigations at E038, E039.1, E042.1, E059.5, E059.8; and
3. Other gaging stations at E026, E030, E040, E055, E055.5, E056, CO101038, and CO111041.

Figure 6.3-1 illustrates this three-tiered approach to sample retrieval. Deviations from the planned inspection, maintenance, and sample collection objectives will be described in the 2022 Monitoring Report for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project.

6.3.2 Storm Water Sampling and Analysis Plan

Evaluation of the performance of sediment controls will be supported by repeat analyses of SSC through each sampled storm at gaging stations above and below each watershed mitigation. Storm water runoff sampling at E050.1, E060.1, CO101038, and CO111041 will be triggered by any detected streamflow. Because of ongoing drought conditions, trip levels for the remaining gaging stations will be set to a low value at the beginning of the season and raised after one sample has been collected (Table 6.3-1).

Four storm water samples are planned at each of the following gaging stations: E026, E050.1, E059.5, E059.8, and E060.1. Two storm water samples are planned at each of the following gaging stations: E030, E038, E039.1, E040, E042.1, E055, E055.5, and E056. The LA/P watershed system has been shown to be stable over the past 10 yr unless there is a large disturbance event, in which case the number of samples to be collected will be reconsidered. Storm water runoff sampling for chemical and radiochemical analyses at all gaging stations will be triggered 10 min after the maximum discharge exceeding the triggering discharge. Sampling at the detention basins below SWMU 01-001(f) will be triggered by liquid-level actuators detecting the presence of water above each sampler's intake. The chemical and radiochemical analyses will be bounded by analysis of SSC to calculate an estimate of the sediment content of each chemical and radiochemical analysis.

Analytical requirements for storm water samples collected to satisfy the four monitoring purposes are presented in Tables 6.3-2 through 6.3-7. Samples at gaging stations will be collected using automated storm water samplers that contain a carousel of twenty-four 1-L bottles and/or twelve 1-L bottles. Sample collection inlets will be placed a minimum of 0.33 ft above the bottom of natural stream channels and at 0.17 ft above the bottom of supercritical flumes. The sampling approach summarized above is intended to allow characterization of suspended sediment flux and contaminant concentrations from each portion of the hydrograph consisting of

1. rapidly rising limb,
2. short-duration peak,
3. rapidly receding limb following the peak, and
4. longer-duration recessional limb following the peak.

To characterize water quality entering and leaving the sediment detention basins and adjoining vegetative buffer below the SWMU 01-001(f) drainage, automated pump samplers will collect storm water from one location immediately upstream of sediment basin 1 and one location at the terminus of the vegetative buffer up to four times annually when storm water discharge is occurring (Figure 2.2-1).

Analytical suites vary according to monitoring groups and are based on key indicator contaminants, NMED requests, and the DOE-BDDB MOU for portions of each watershed. Gross beta, isotopic uranium, and radium 226/radium-228 are supplemental BDDB monitoring. Dissolved organic carbon, alkalinity, and pH are investigative monitoring. All other parameters are requirements of the Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project. Table 2.4-2 shows the analytical suite for each location. The results of SSC analyses will be used to calculate the total mass/activity transported during storm water runoff events at the gaging stations. Particle-size analyses conducted in conjunction with selected SSC analyses will support characterization of organic chemicals and radionuclides.

The list of analytical suites for each monitoring group is prioritized to guide what analyses will be conducted if the water volume collected from a storm event is not sufficient for all the planned suites (Table 2.4-1). The analytical method, expected MDL, and minimal detectable activity (MDA) (for radionuclides) are presented in Table 2.4-2. The sampling sequence for CO101038 and CO111041 is presented in Table 6.3-2. The sampling sequence for E026, E030, E055, E055.5, and E056 is presented in Table 6.3-3. Table 6.3-4 presents the sampling sequence at E038, E039.1, and E040. Table 6.3-5 presents the sampling sequence at E042.1. Table 6.3-6 presents the sampling sequence at E059.5 and E059.8. Table 6.3-7 presents the sampling sequence at E050.1 and E060.1. Additional samples beyond the required samples may potentially be submitted for chemical and radiochemical analyses at gaging stations E038, E059.5, E059.8, and E042.1 if samples are collected during an event at their paired downstream gaging stations (E039.1, E059.8, E060.1, and E050.1, respectively).

Total suspended sediment transport during a storm event is determined by sampling discharge periodically for SSC analysis throughout the hydrograph. Samples for SSC measurements will be collected at 2-min intervals for the first 30 min, then at 20-min intervals for the following 160 min if runoff is available. Repeat measurements will be taken above and below the DP Canyon GCS at E038 and E039.1, above and below the Los Alamos Canyon low-head weir at E042.1 and E050.1, and above and below the Pueblo Canyon drop structure and GCS at E059.5, E059.8, and E060.1 to better characterize the performance of the structures. At these stations, a second sampler is dedicated to collecting storm water for SSC analyses with the objective of representing most or all of the duration of runoff. Collecting SSC samples at 2-min intervals during the first 30 min allows characterization of the rapidly changing early part of the hydrograph.

6.3.3 Stage and Discharge Monitoring

Storm water runoff (in the form of stage and discharge) at each of the gaging stations listed in Table 2.4-2 and gaging station E099 will be monitored continuously throughout the year. Rating curves are used to convert stage to discharge. Rating curves for the gaging stations are updated following channel-forming flood events.

6.3.4 Inspections of Erosion and Sediment Control Structures

Erosion and sediment control structures and monitoring stations will be inspected after storm events exceeding 50 cfs or other channel-forming flood events. Repairs will be made as necessary to ensure such structures and other storm water mitigation features continue to function as intended.

6.3.5 Sediment Sampling and Analysis Plan

Sediment sampling is conducted annually within the LA/P watershed as part of monitoring conducted for the Annual Site Environmental Report (ASER). The results of the sediment sampling conducted in 2022 will be presented in the 2022 ASER.

6.4 Response to NMED Comments

The Permittees, in consultation with NMED, provided responses to NMEDs comments on the 2021 Monitoring Plan (NMED 2021, 701517)

6.5 2022 Monitoring Plan Changes

There are no changes in monitoring from 2021 to 2022.

6.6 Reporting

Monitoring conducted as part of this 2022 monitoring plan to determine whether waters of the state are attaining designated uses and to fulfill monitoring requirements in DOE Order 450.1A (superseded by 436.1) will be reported in the 2022 Monitoring Report and 2023 Monitoring Plan for Los Alamos/ Pueblo Watershed Sediment Transport Mitigation Project. Monitoring conducted as part of this 2022 monitoring plan solely to fulfill requirements of the DOE-BDDB MOU will be made available publically in Intellus New Mexico, available at http://www.intellusnm.com/. All analytical data, stream discharge measurements, and DEM measurements collected as a result of this plan will be provided in the 2022 Monitoring Report and 2023 Monitoring Plan for Los Alamos/Pueblo Watershed Sediment Transport Mitigation Project.

7.0 CONCLUSIONS

Attenuation of flow and associated sediment transport are primary goals of the sediment transport mitigation activities. Decreasing flow velocity allows increased infiltration, thus reducing peak discharge, reducing the distance the flood bore, 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, drop structure, and GCS between gaging stations E059.5 and E059.8 facilitated such a reduction in peak discharge that storm water runoff at E059.8 was not large enough to sample. One storm flow was high enough to trigger sample collection at E060.1. In Los Alamos Canyon, reductions in peak discharge, runoff volume, and sediment yield transmission downstream between E042.1 and E050.1 were attributed to the low-head weir and associated sediment detention basins between the two gaging stations. Monitoring data in the LA/P watershed indicate that, in general, the mitigations are performing as designed.

In 2018, triennial aerial-based LiDAR surveys replaced biennial aerial-based LiDAR surveys plus annual ground-based GPS surveys for monitoring of geomorphic change. In 2018 and 2021, LiDAR was flown over the LA/P watershed and the land surface data from the two surveys were compared to identify geomorphic change. The overall low magnitude of geomorphic change detected between the 2018 and 2021 LiDAR surveys provides evidence that the Los Alamos and Pueblo Canyon watershed is stable and that the sediment transport mitigations are functioning as designed.

Continued monitoring in 2022 is expected to confirm that the sediment transport mitigations in the LA/P watershed are performing as designed.

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8.2 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

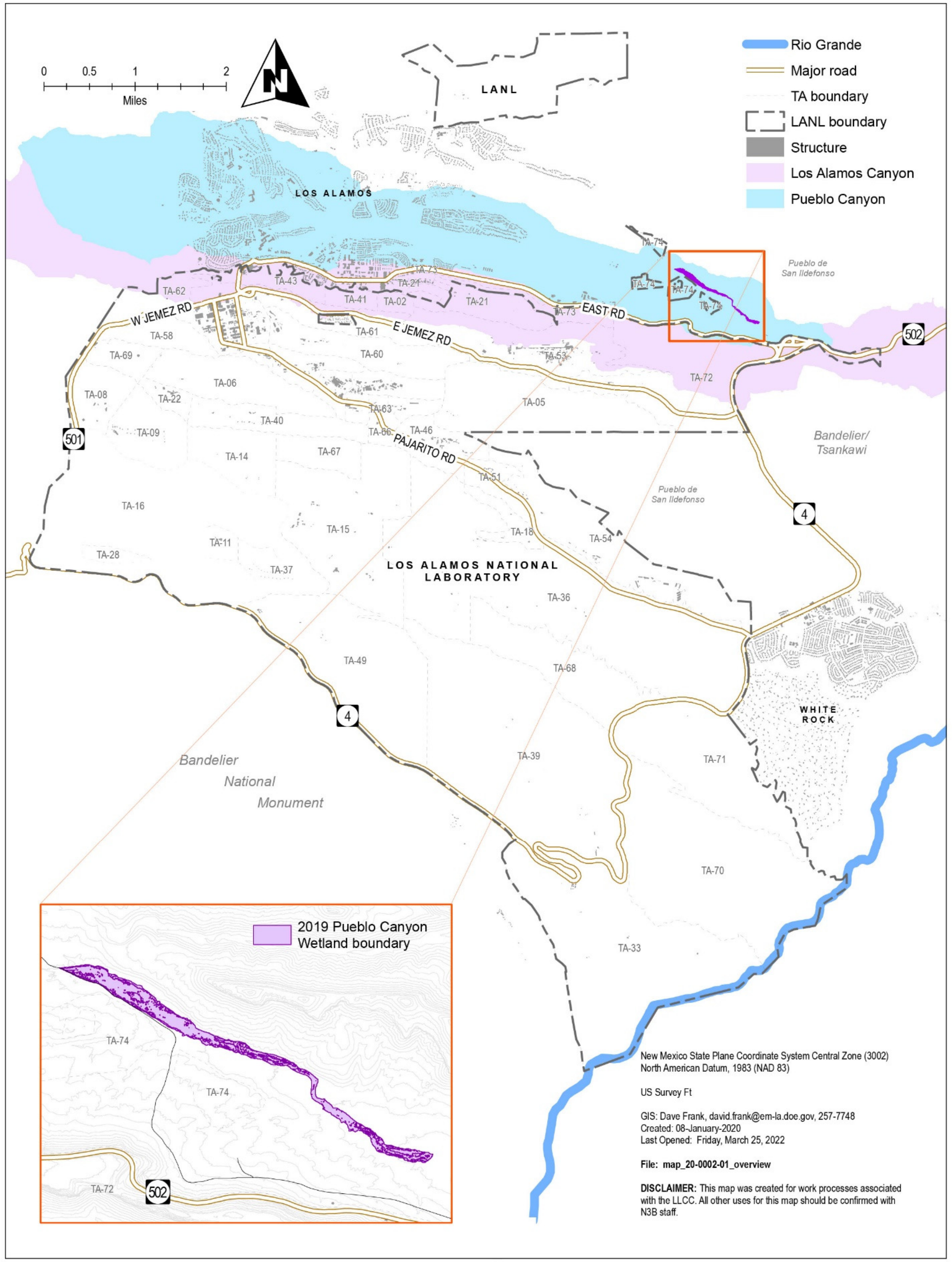


Figure 1.1-1 Los Alamos/Pueblo Canyon watershed and Pueblo Canyon wetland location in relation to Los Alamos National Laboratory property

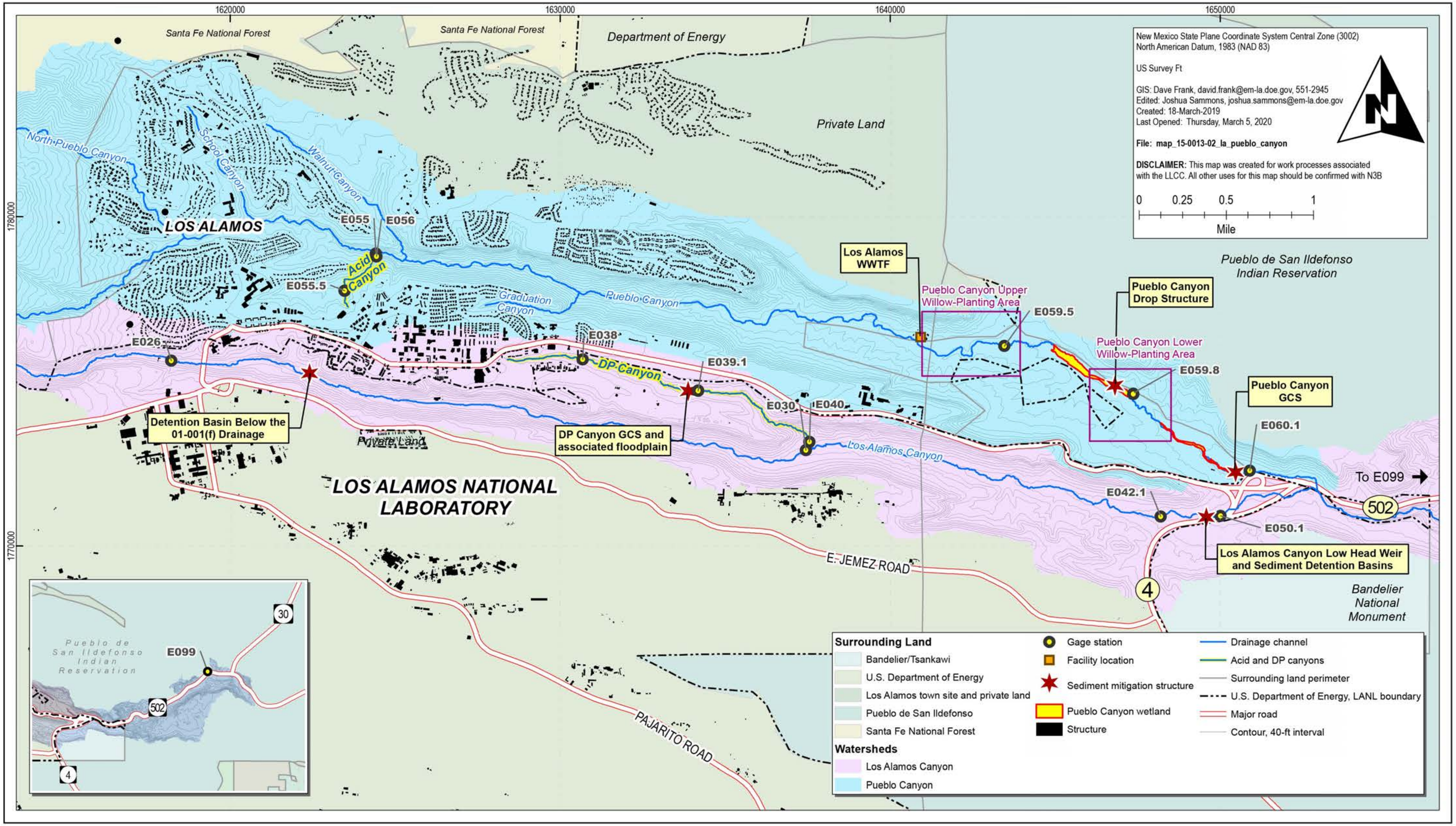
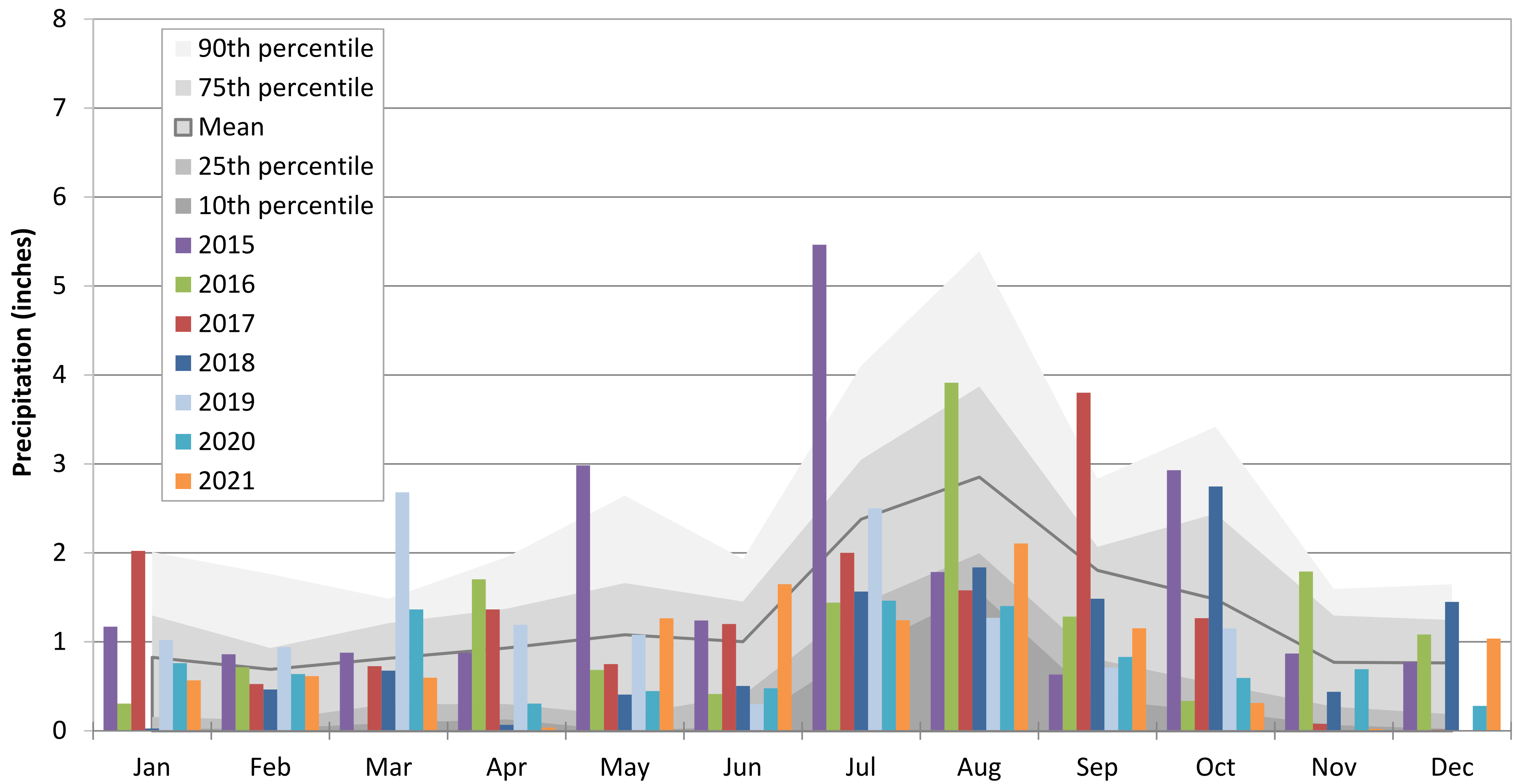
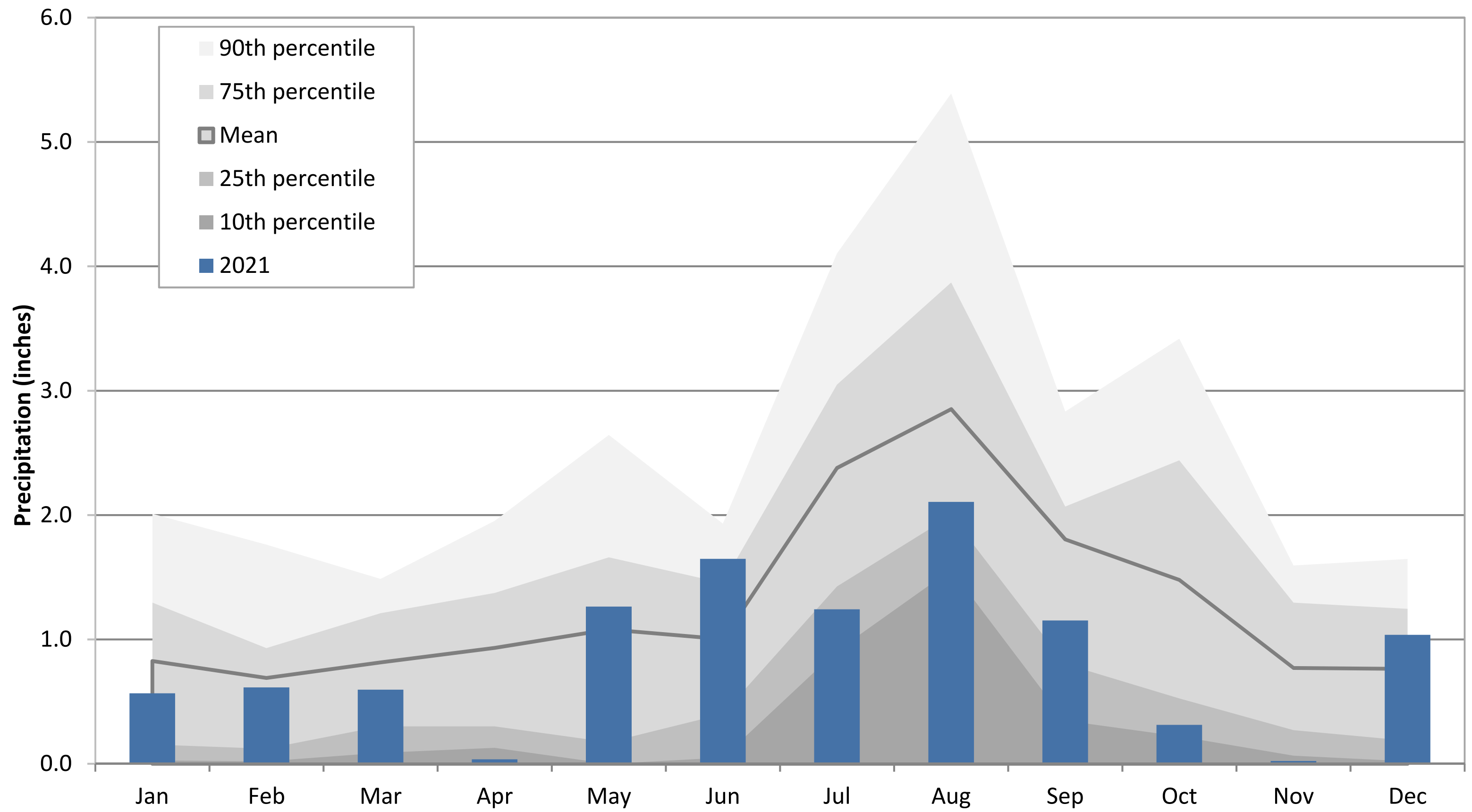


Figure 1.1-2 Los Alamos/Pueblo Canyon watershed showing monitoring locations and sediment transport mitigation sites



Note: Mean and percentiles are based on data from 1992 to 2010.

Figure 2.1-1 Total precipitation for each month between 2015 and 2021 based on meteorological tower data averaged across the Laboratory



Note: Mean and percentiles are based on data from 1992 to 2010.

Figure 2.1-2 Total precipitation for each month in 2021 based on meteorological tower data averaged across the Laboratory

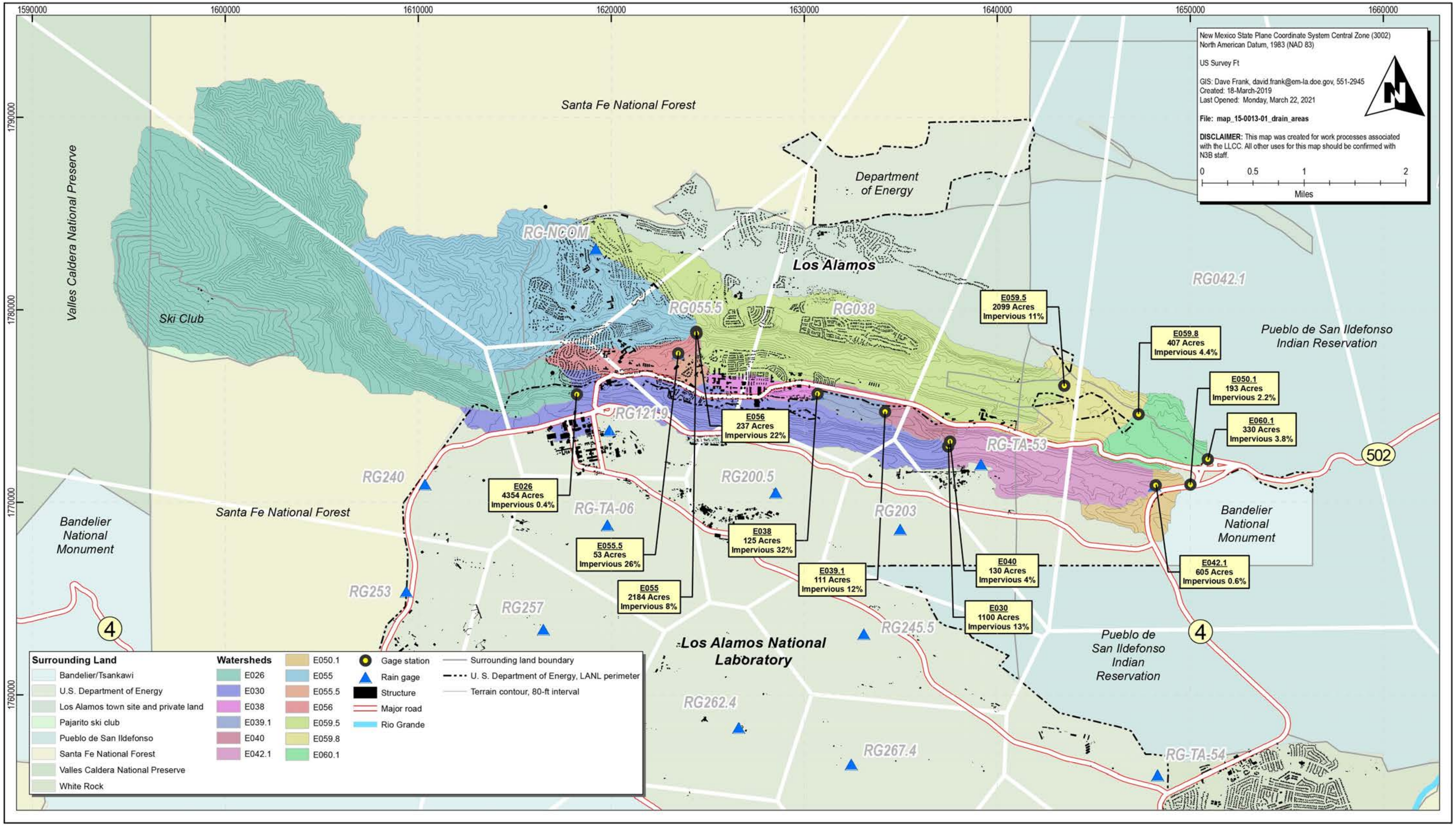


Figure 2.1-3 Los Alamos/Pueblo watershed showing drainage areas for each stream gaging station and associated rain gages and Thiessen polygons

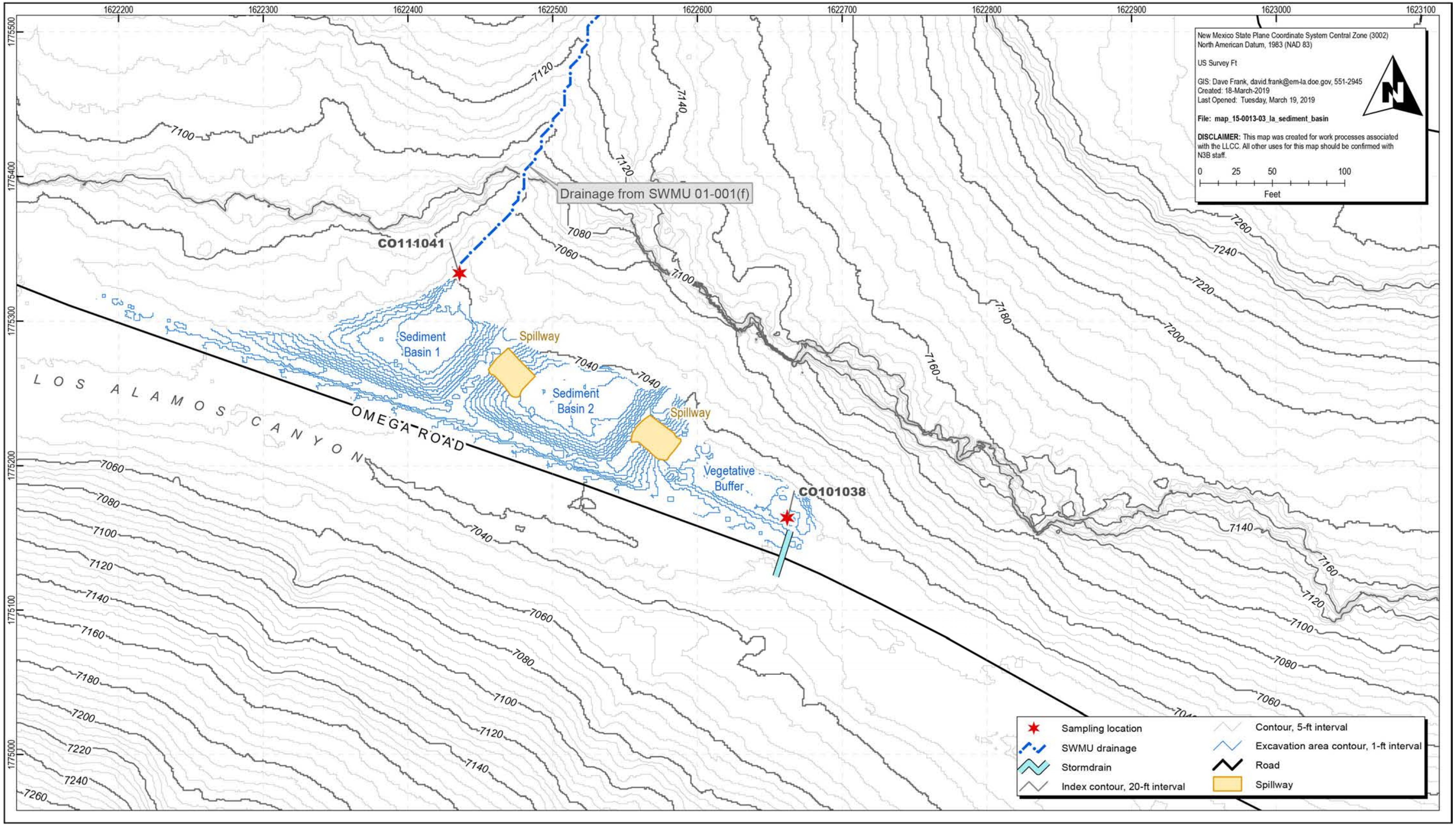


Figure 2.2-1 Upper Los Alamos Canyon sediment detention basins and sampling locations below the SWMU 01-001(f) drainage

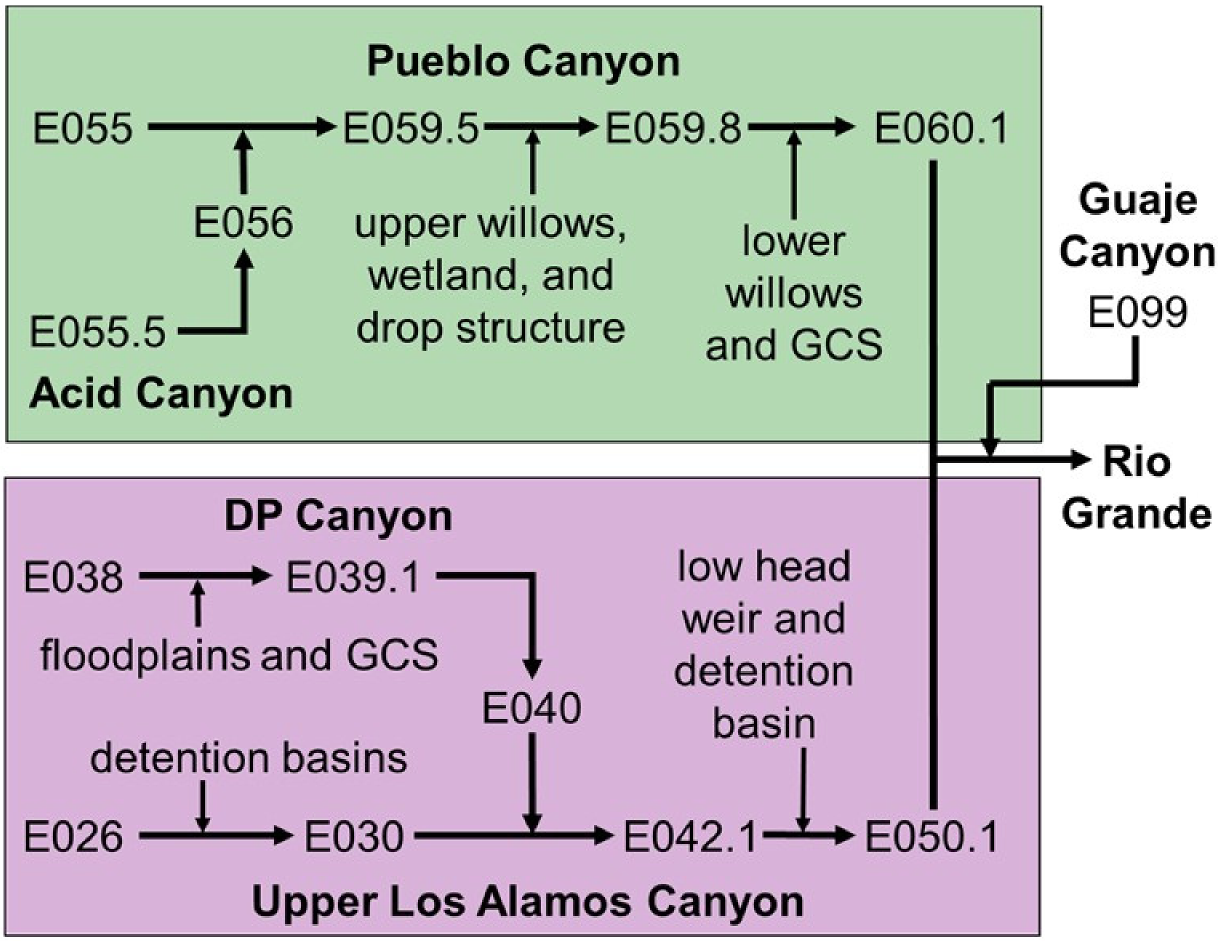
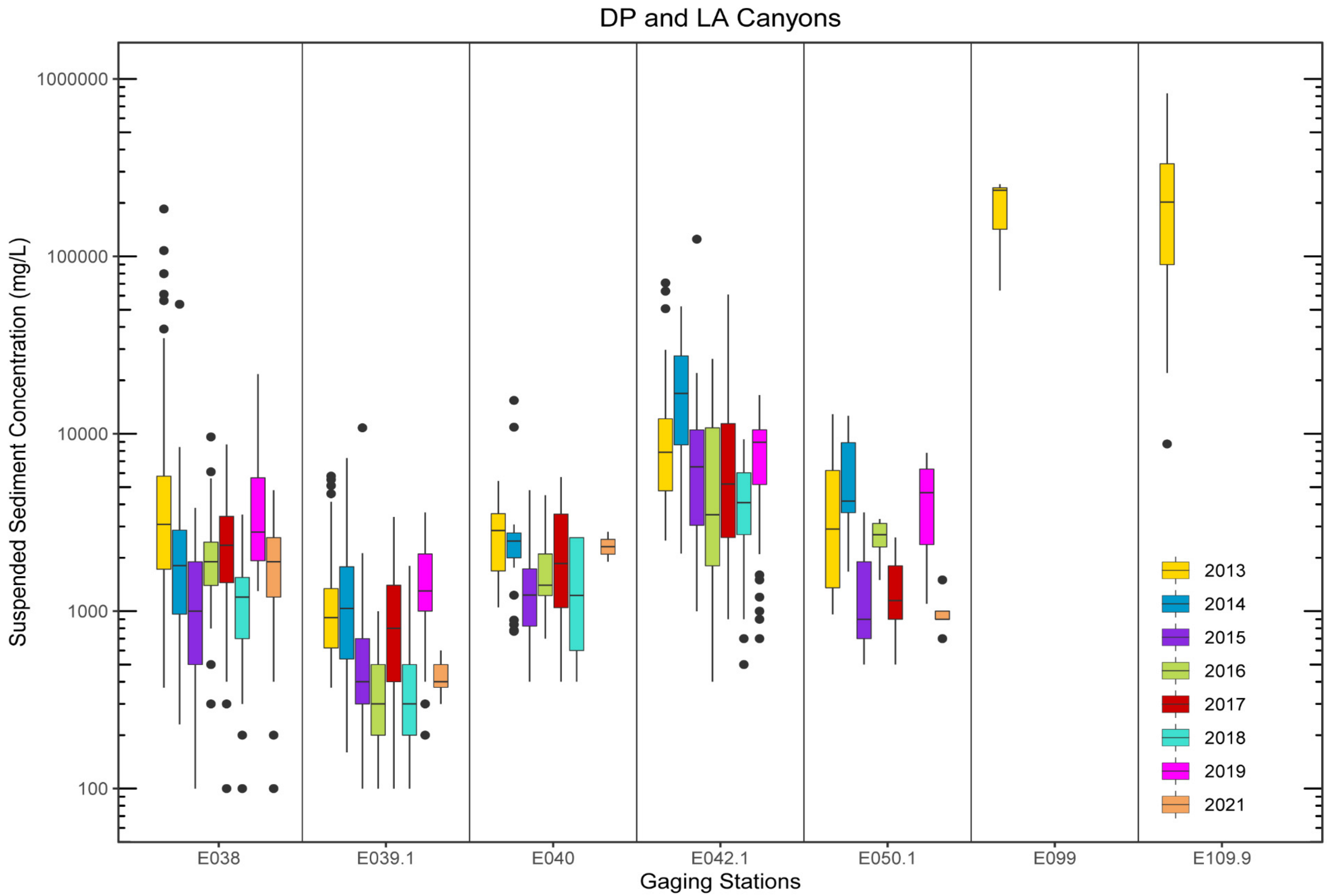
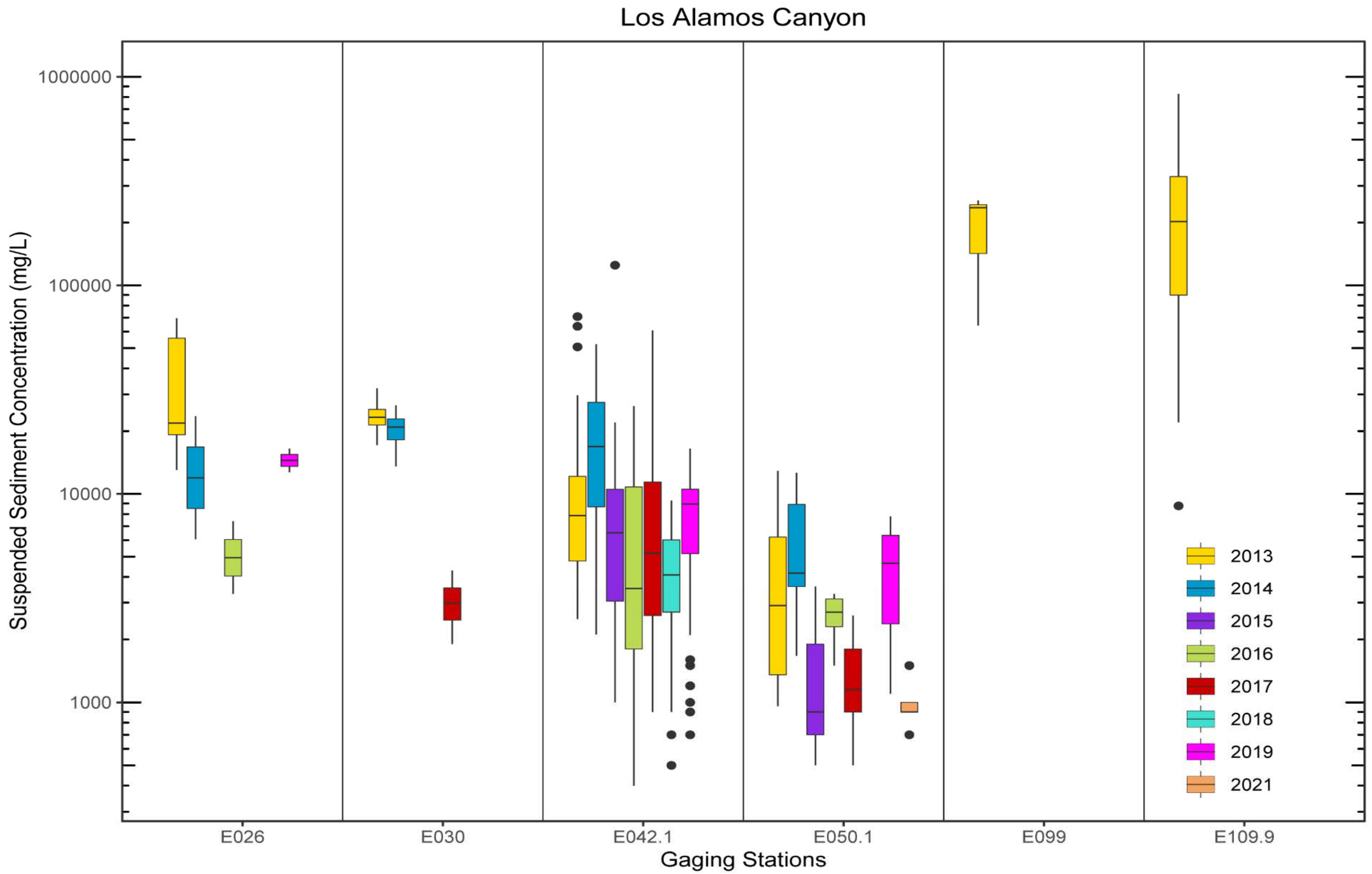


Figure 3.2-1 Flow diagram of gaging stations and sediment transport mitigation sites in the Los Alamos/Pueblo watershed



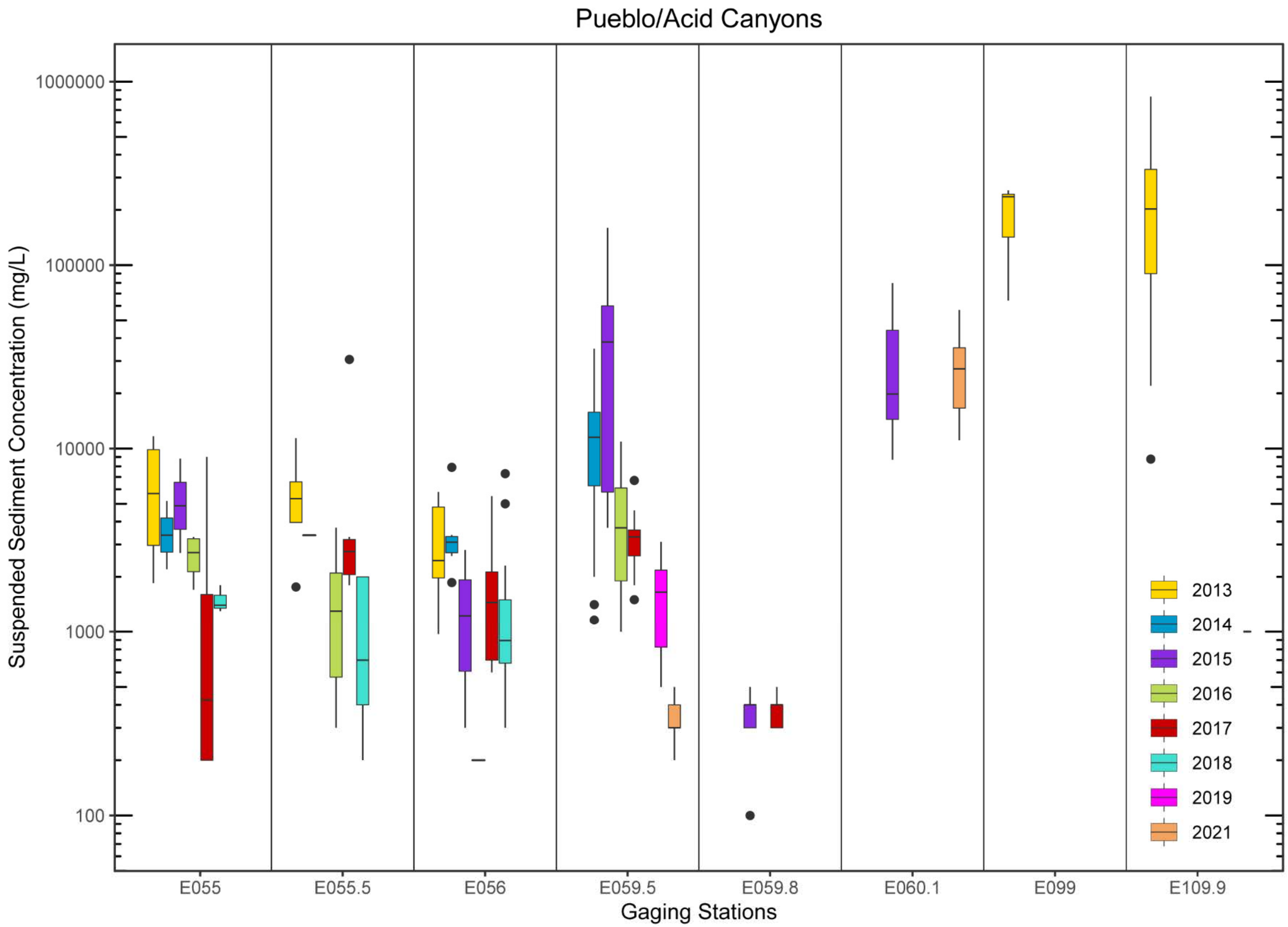
Note: Black dots represent outliers.

Figure 3.2-2 Box-and-whisker plots of SSC for all gaging stations in the Los Alamos/Pueblo watershed over the 9 yr of monitoring from 2013 to 2021 (excluding 2020 when no samples were collected)



Note: Black dots represent outliers.

Figure 3.2-2 (continued) Box-and-whisker plots of SSC for all gaging stations in the Los Alamos/Pueblo watershed over the 9 yr of monitoring from 2013 to 2021 (excluding 2020 when no samples were collected)



Note: Black dots represent outliers.

Figure 3.2-2 (continued) **Box-and-whisker plots of SSC for all gaging stations in the Los Alamos/Pueblo watershed over the 9 yr of monitoring from 2013 to 2021 (excluding 2020 when no samples were collected)**

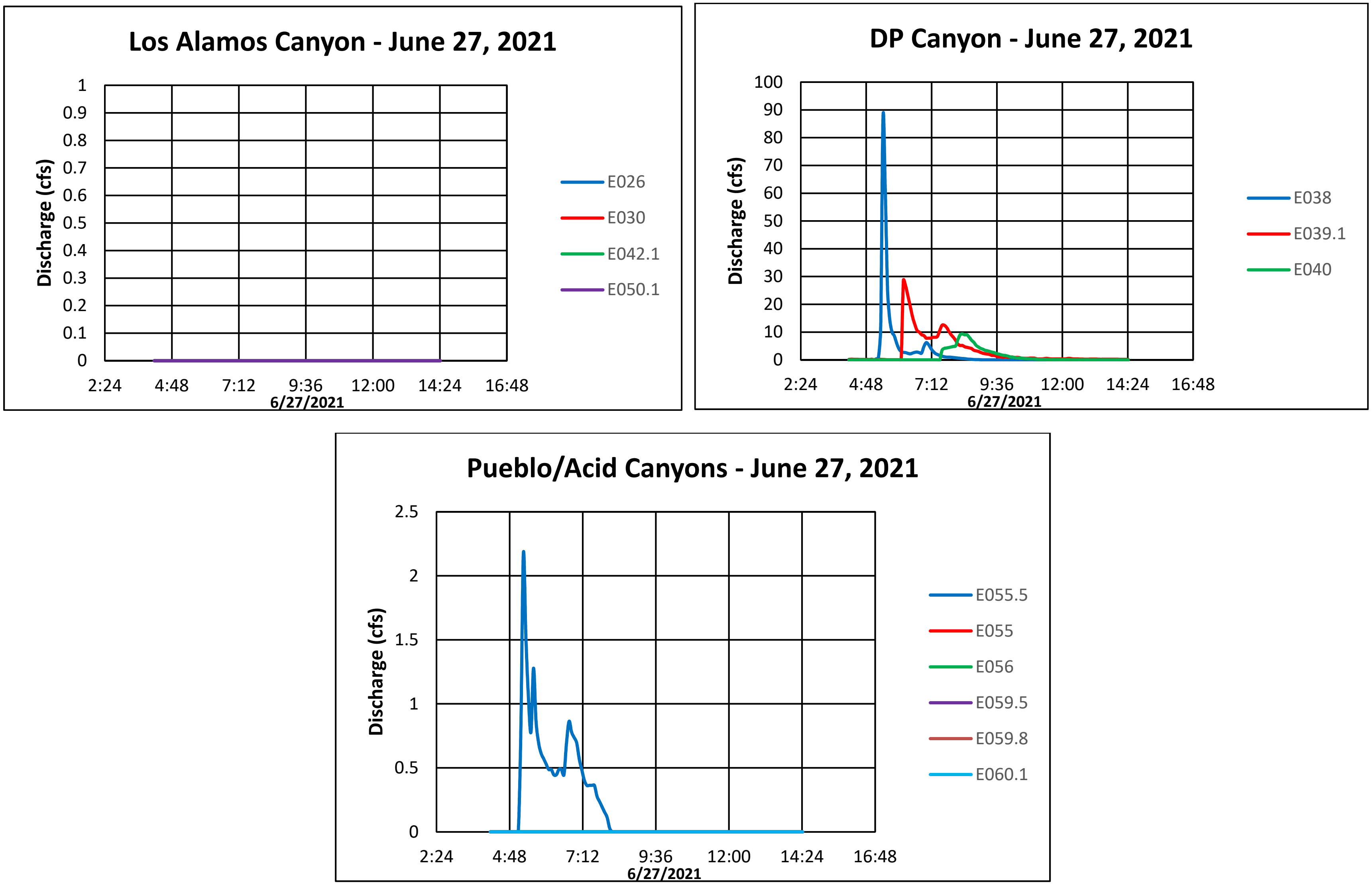


Figure 3.2-3 Hydrographs during each sample-triggering runoff event for each canyon from upstream to downstream reaches

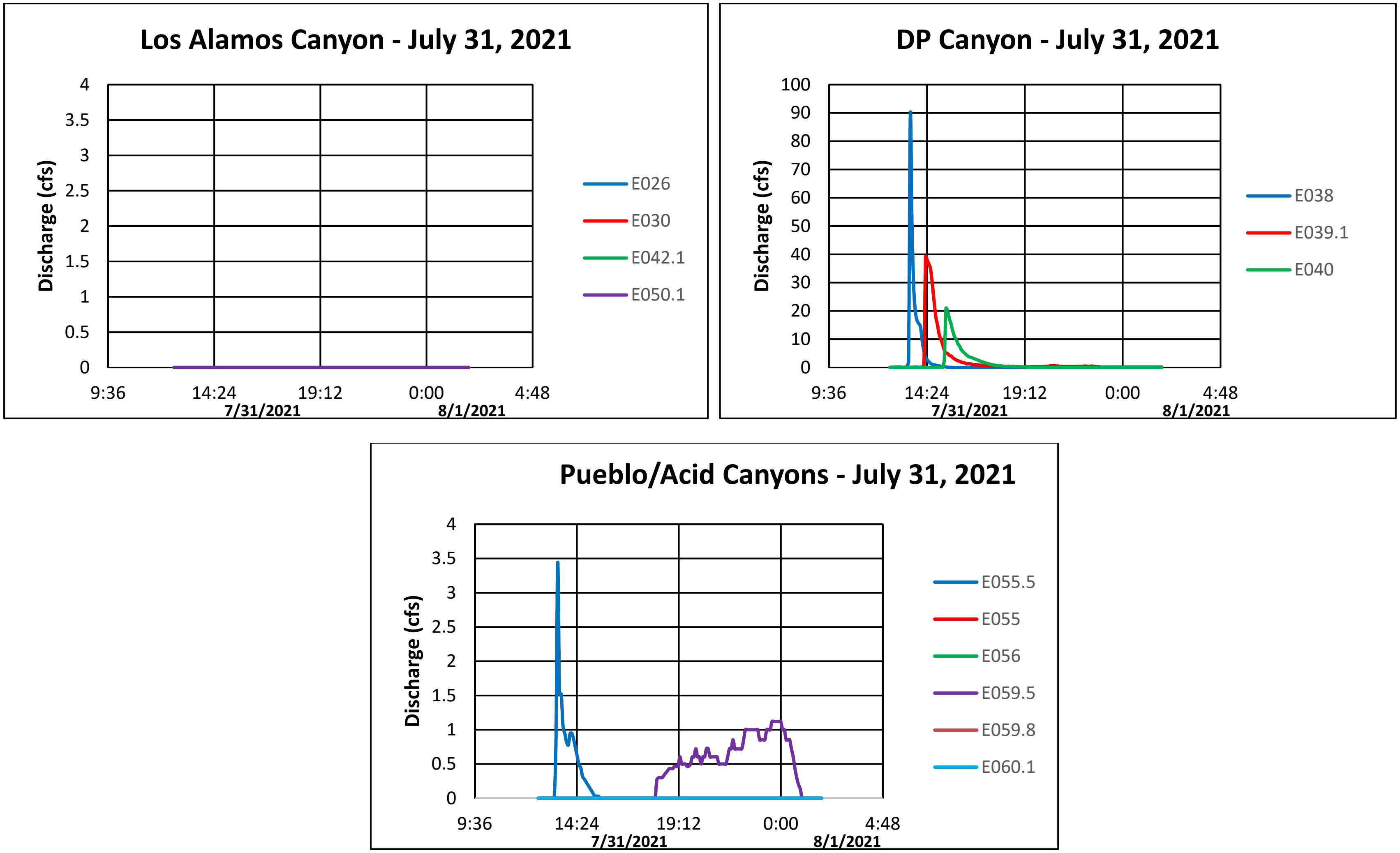


Figure 3.2-3 (continued) **Hydrographs during each sample-triggering runoff event for each canyon from upstream to downstream reaches**

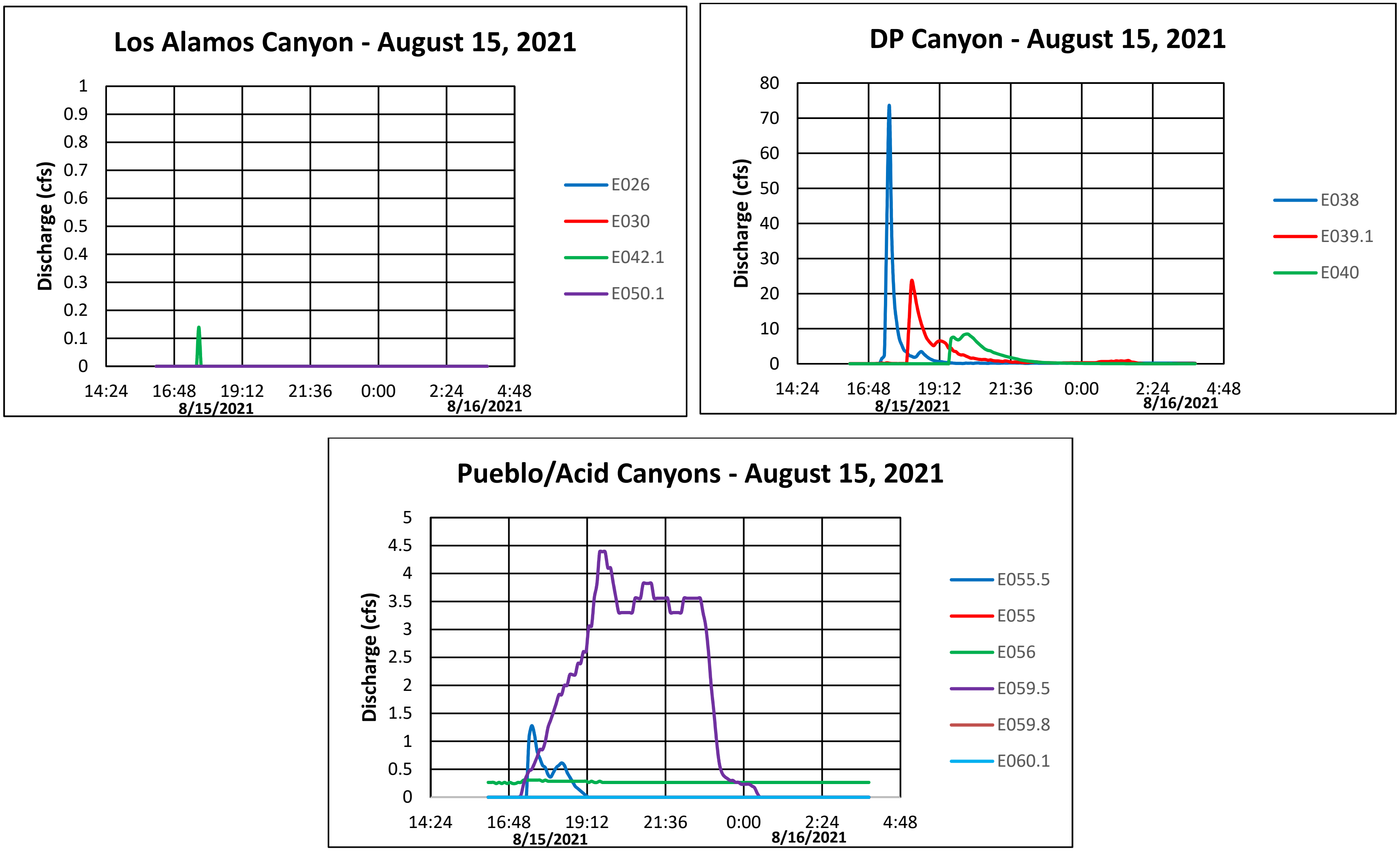
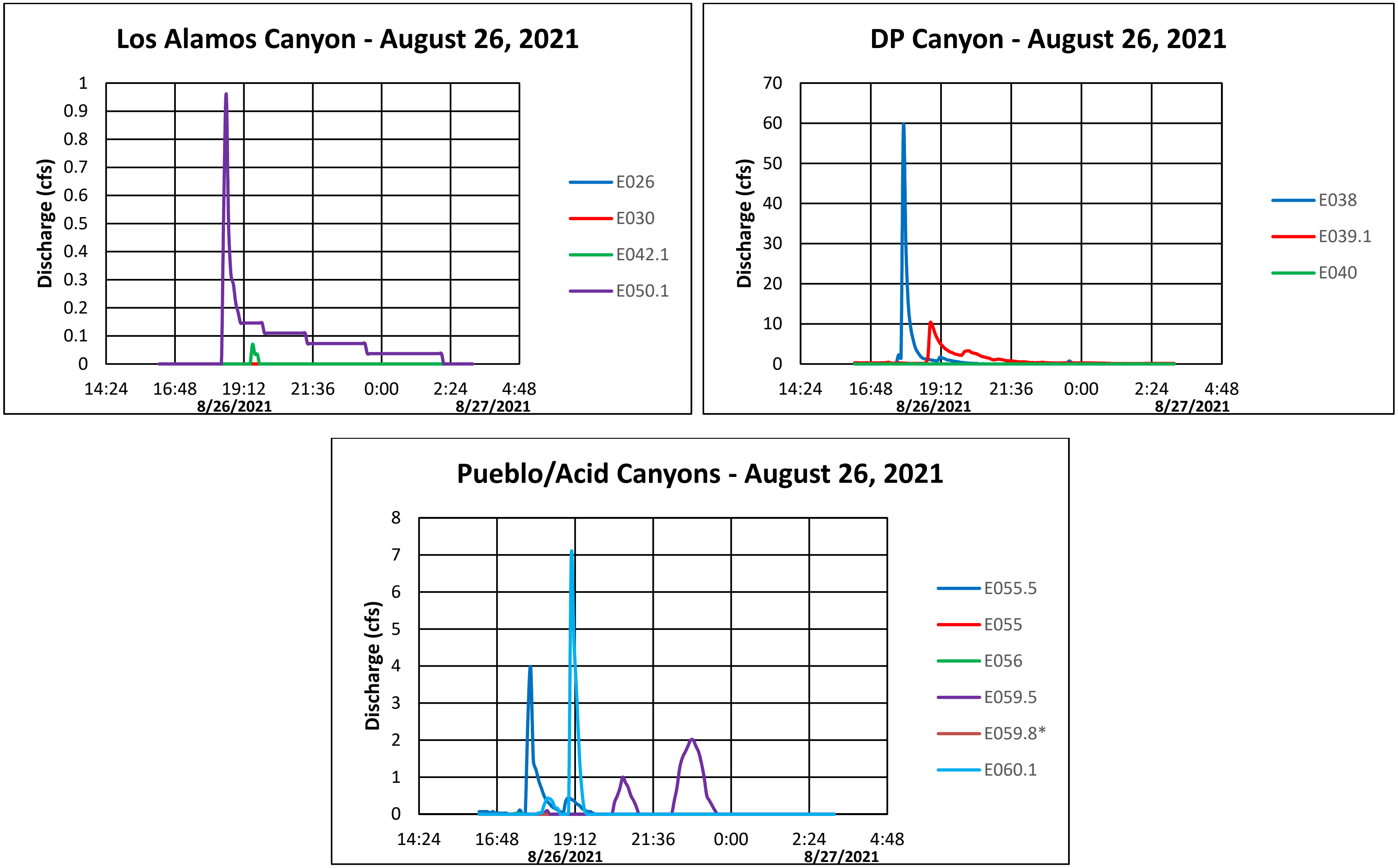
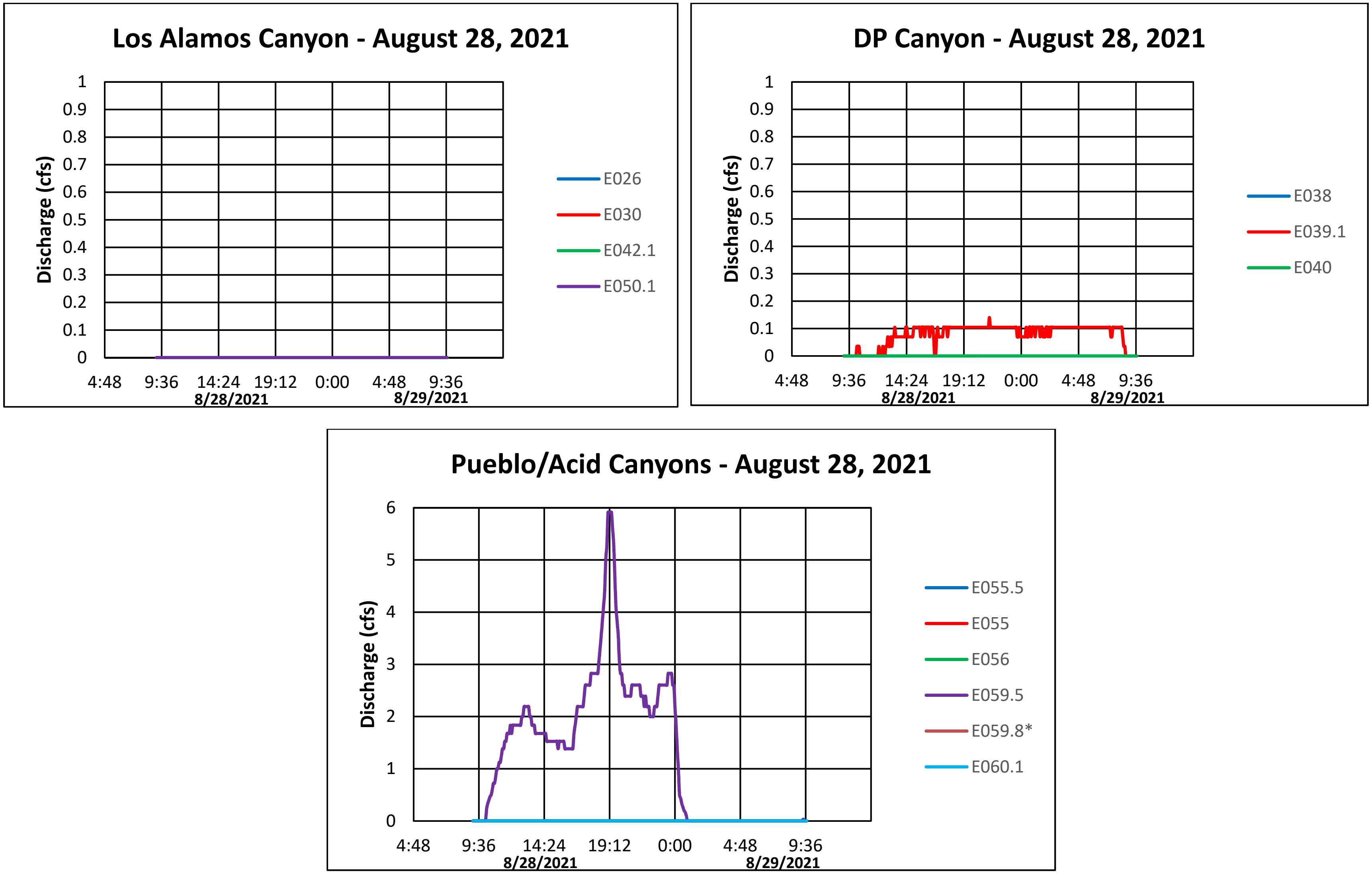


Figure 3.2-3 (continued) **Hydrographs during each sample-triggering runoff event for each canyon from upstream to downstream reaches**



* Potential sensor malfunction at E059.8 during this storm event

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



* Potential sensor malfunction at E059.8 during this storm event

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

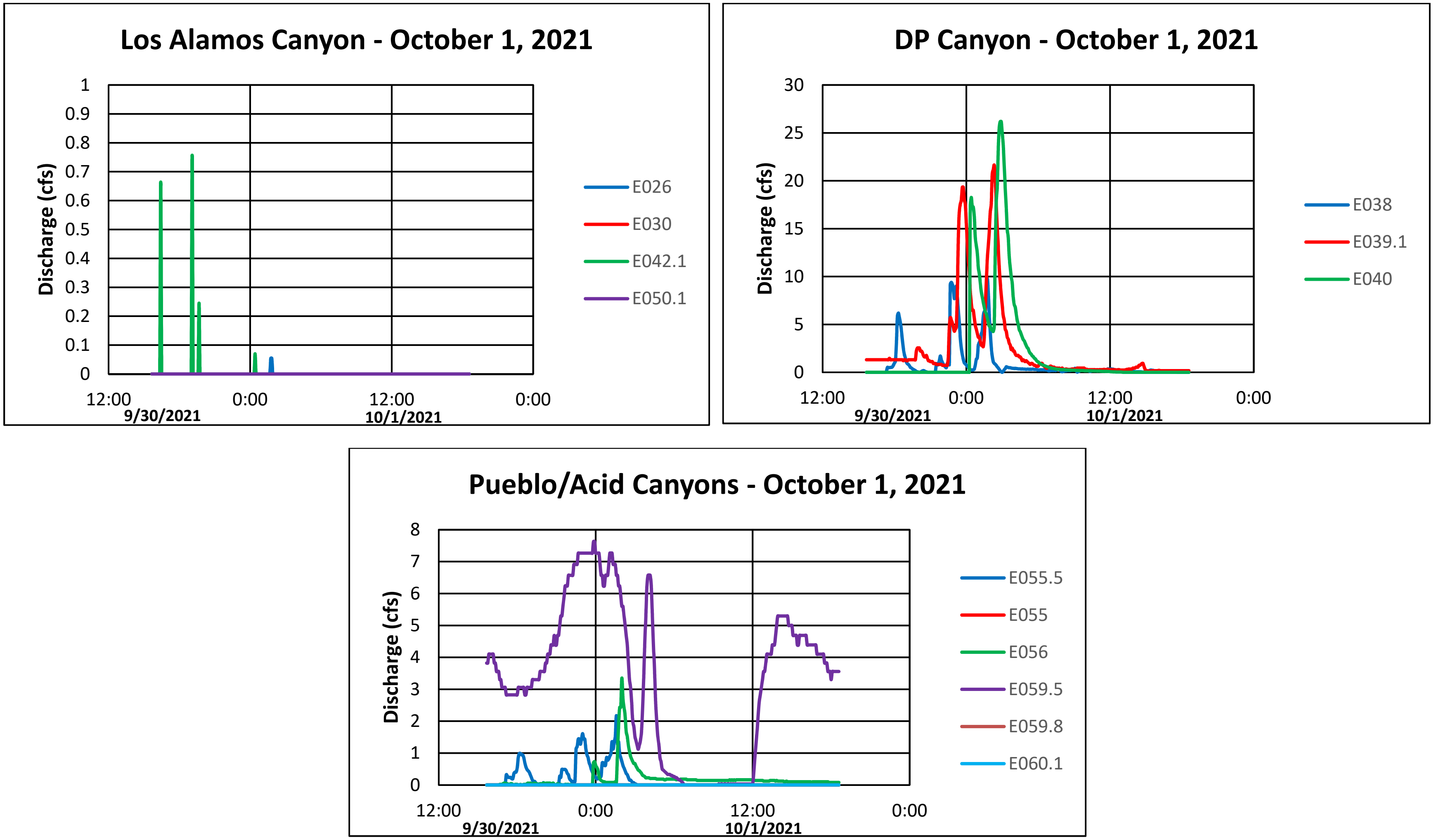


Figure 3.2-3 (continued) **Hydrographs during each sample-triggering runoff event for each canyon from upstream to downstream reaches**

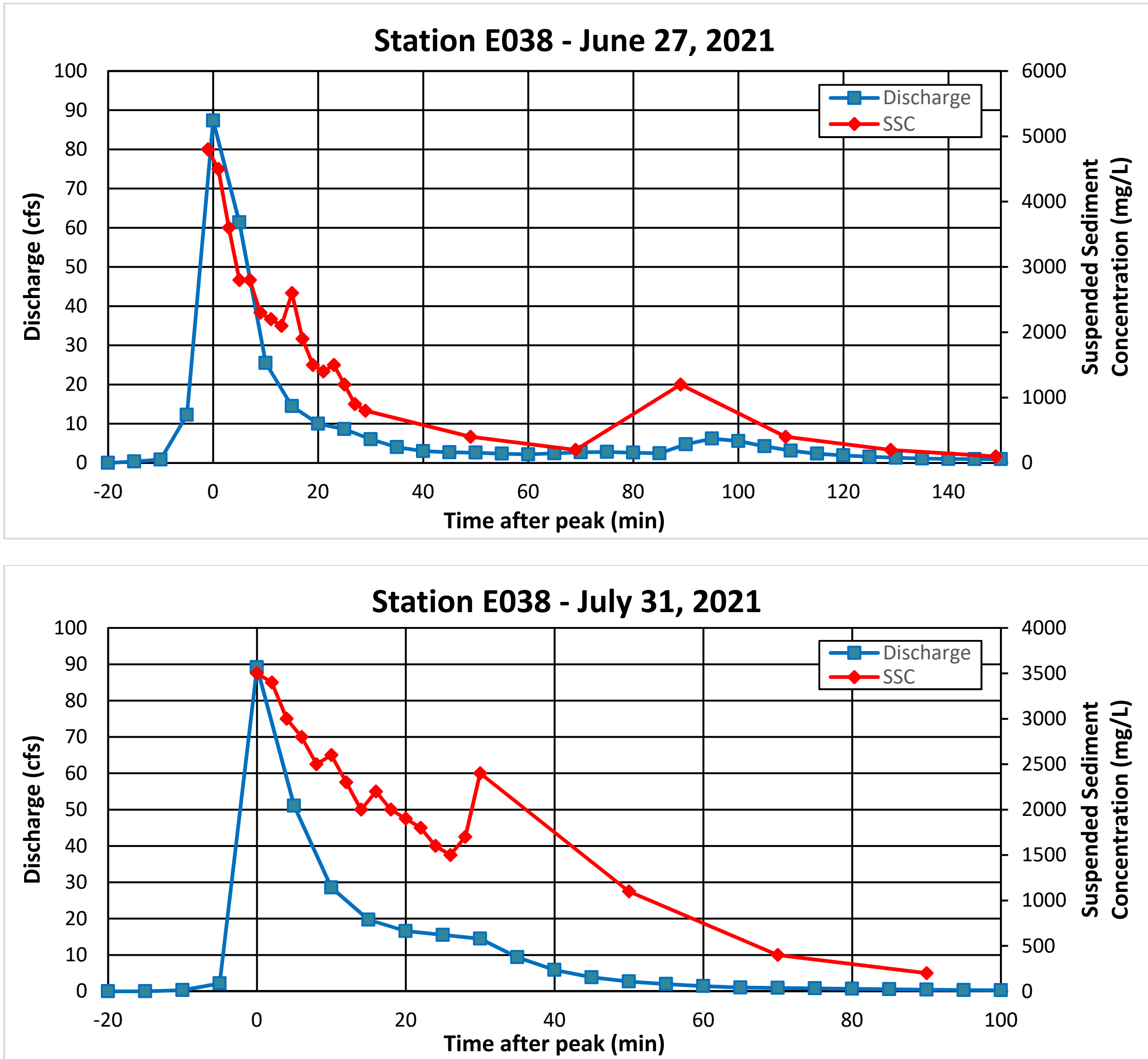
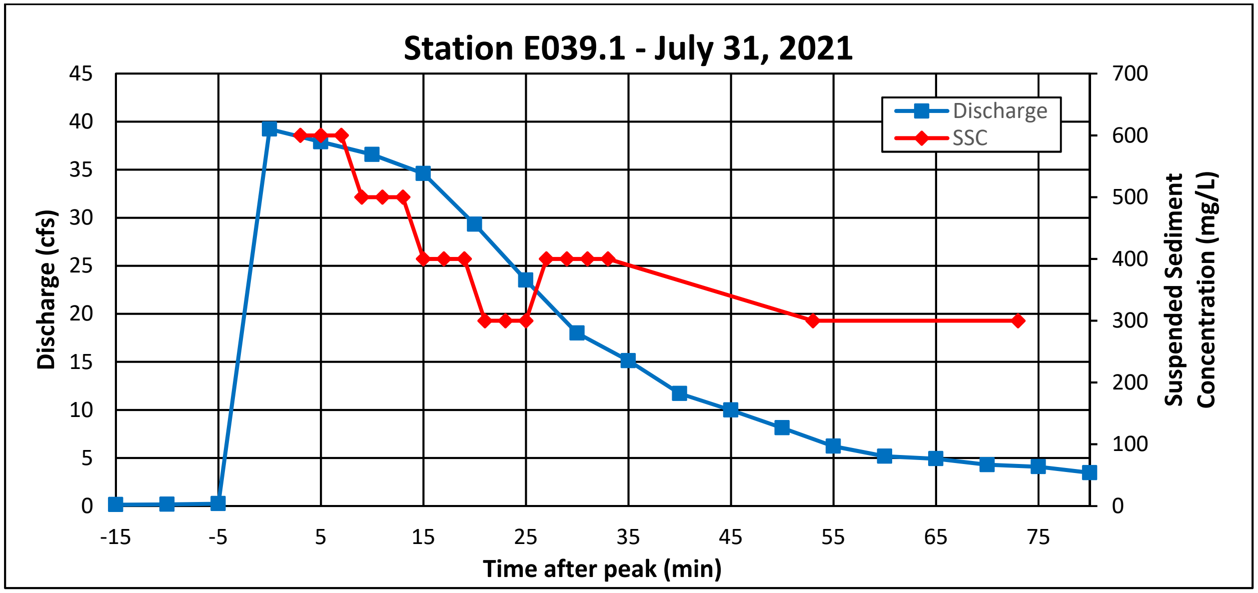


Figure 3.2-4 Measured discharge and measured SSC for events sampled at E038, E039.1, E050.1, E059.5, and E060.1



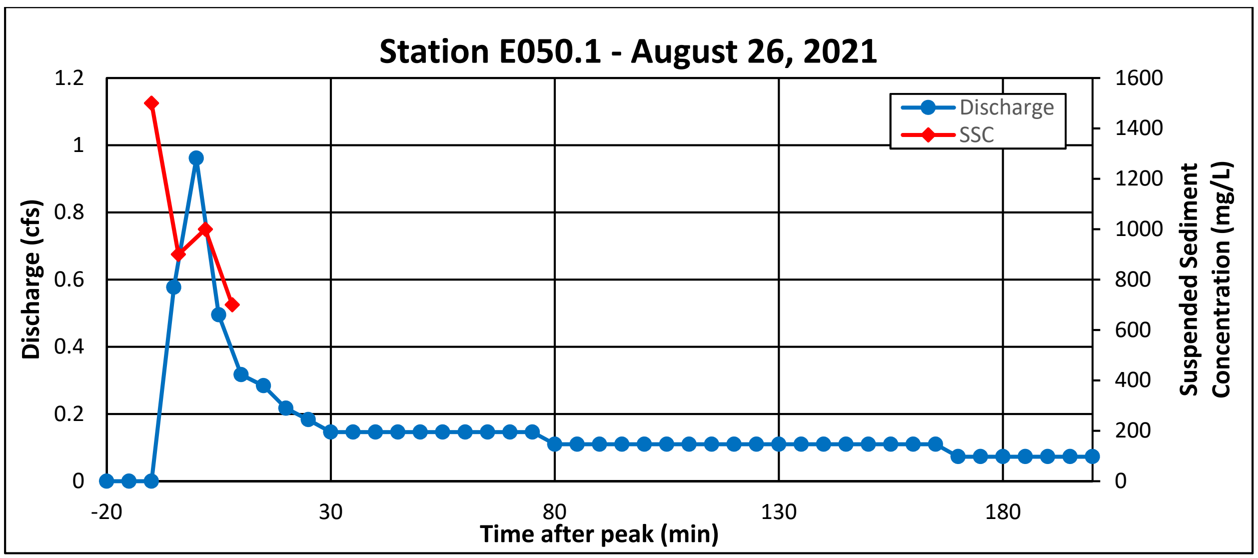
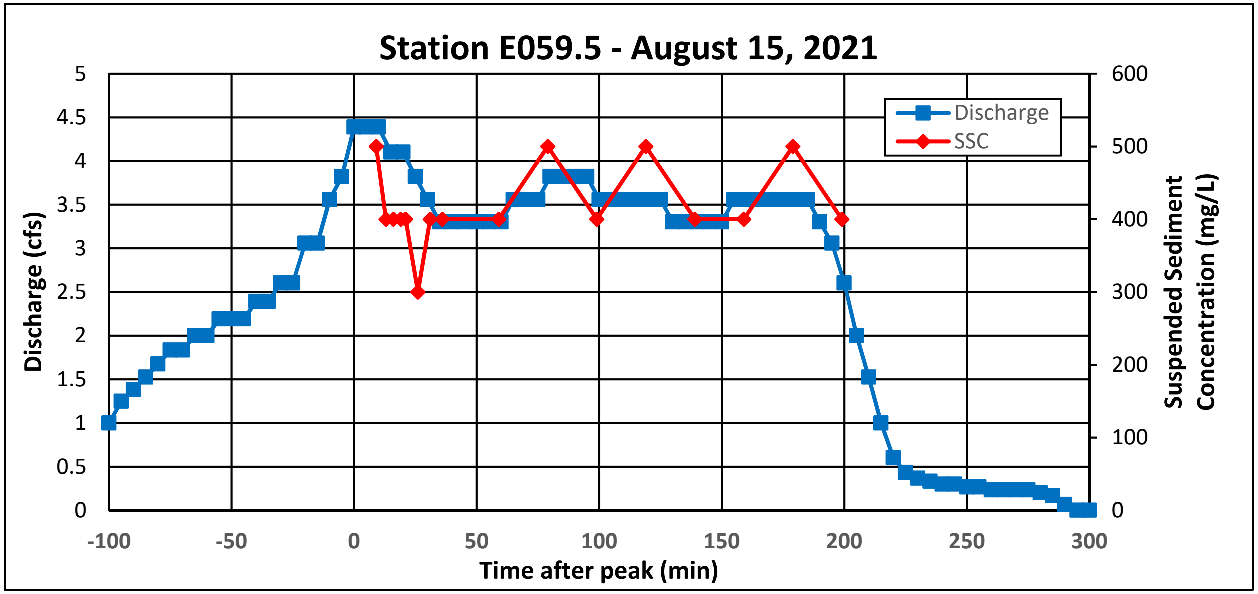


Figure 3.2-4 (continued) **Measured discharge and measured SSC for events sampled at E038, E039.1, E050.1, E059.5, and E060.1**



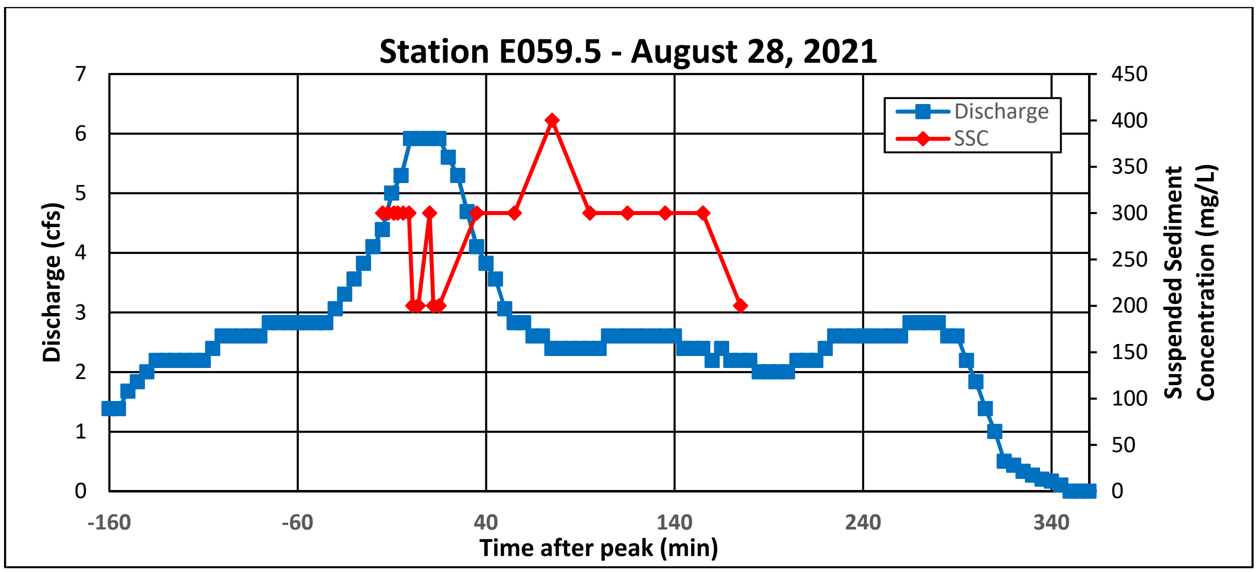


Figure 3.2-4 (continued) **Measured discharge and measured SSC for events sampled at E038, E039.1, E050.1, E059.5, and E060.1**

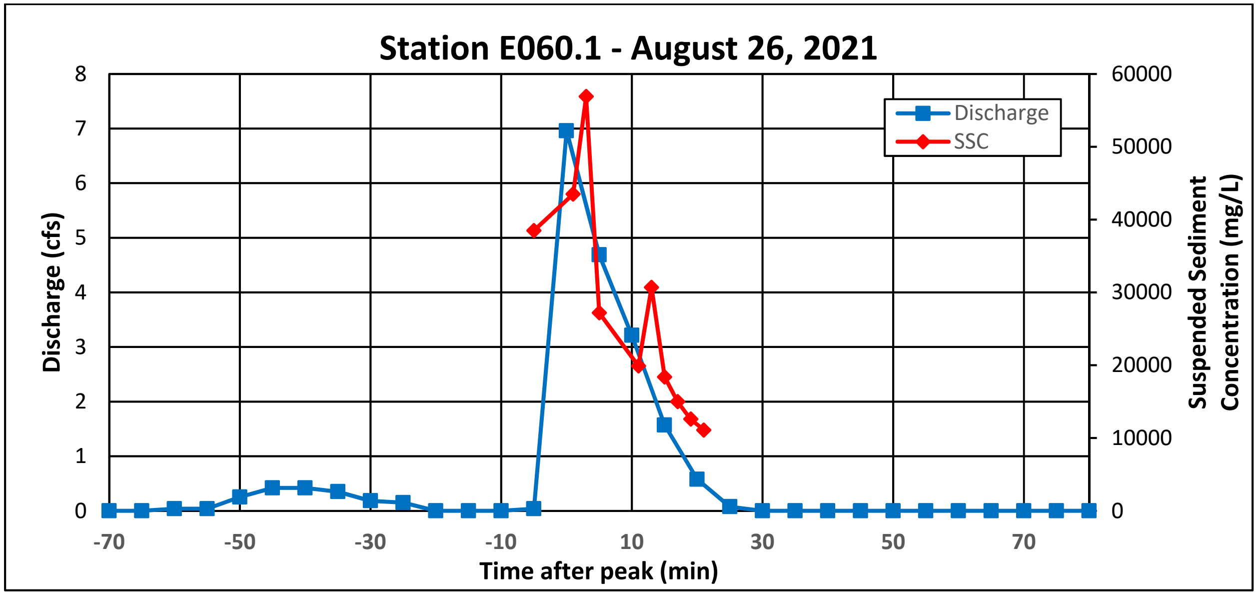


Figure 3.2-4 (continued) **Measured discharge and measured SSC for events sampled at E038, E039.1, E050.1, E059.5, and E060.1**

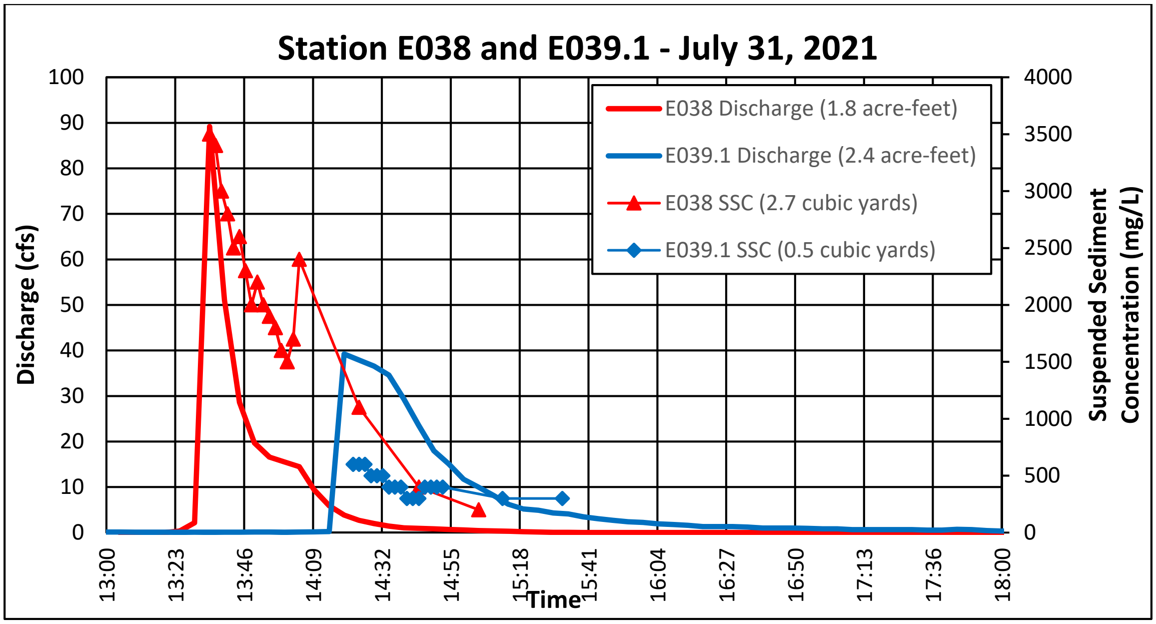


Figure 3.2-5 Discharge and SSC at E038 and E039.1 in DP Canyon on days when sampling of the same runoff event occurred

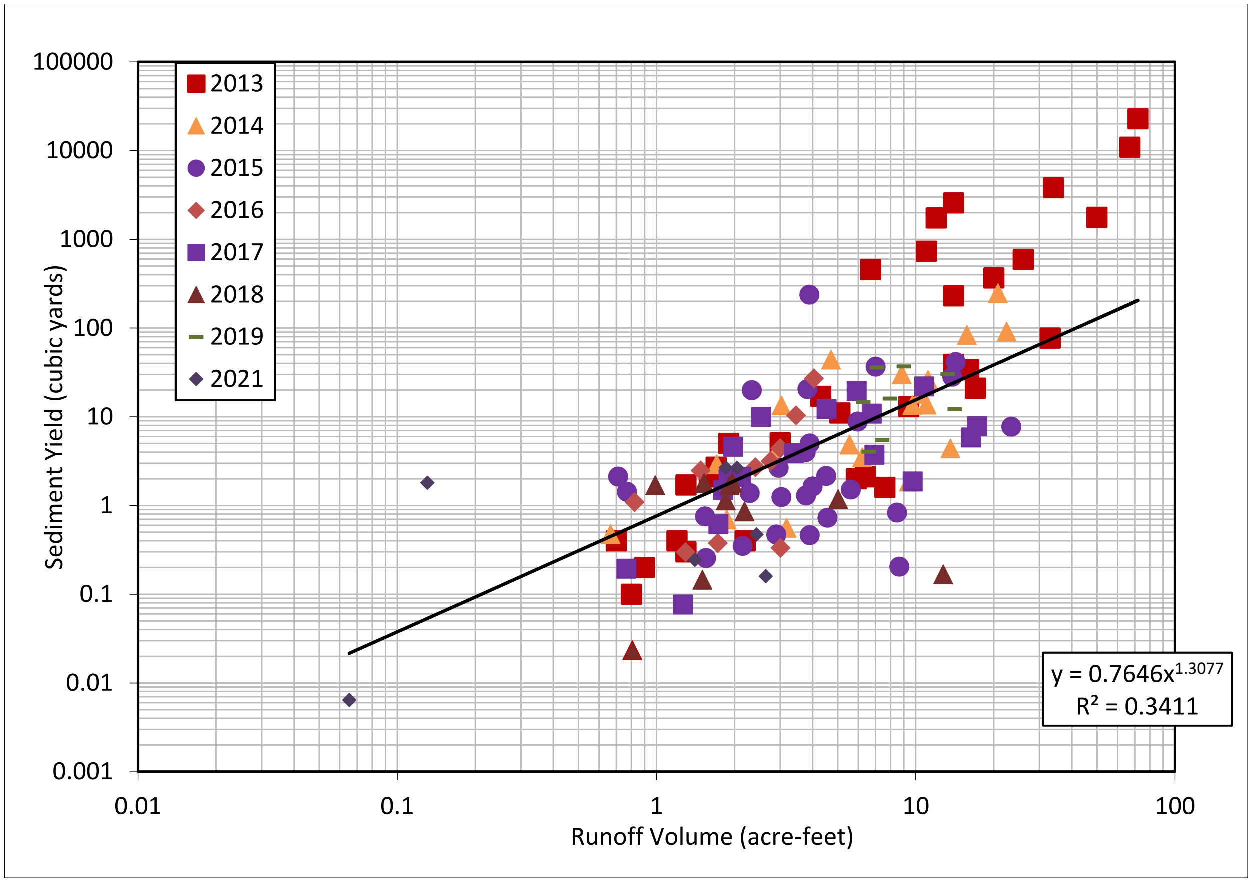


Figure 3.2-6 Relationship between SSC-based sediment yield and runoff volume over the 9 yr of monitoring from 2013 to 2021 (excluding 2020 when no samples were collected)

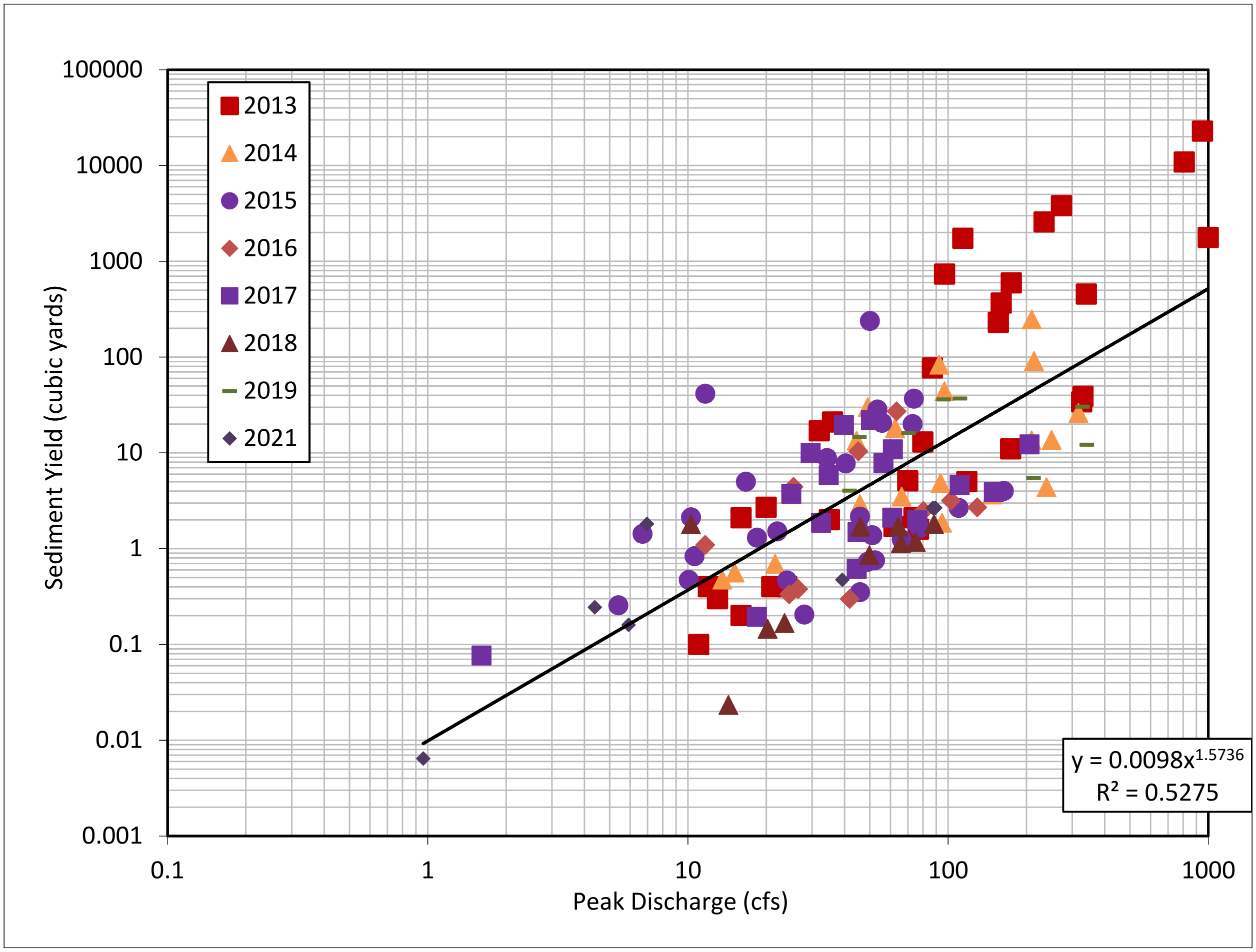
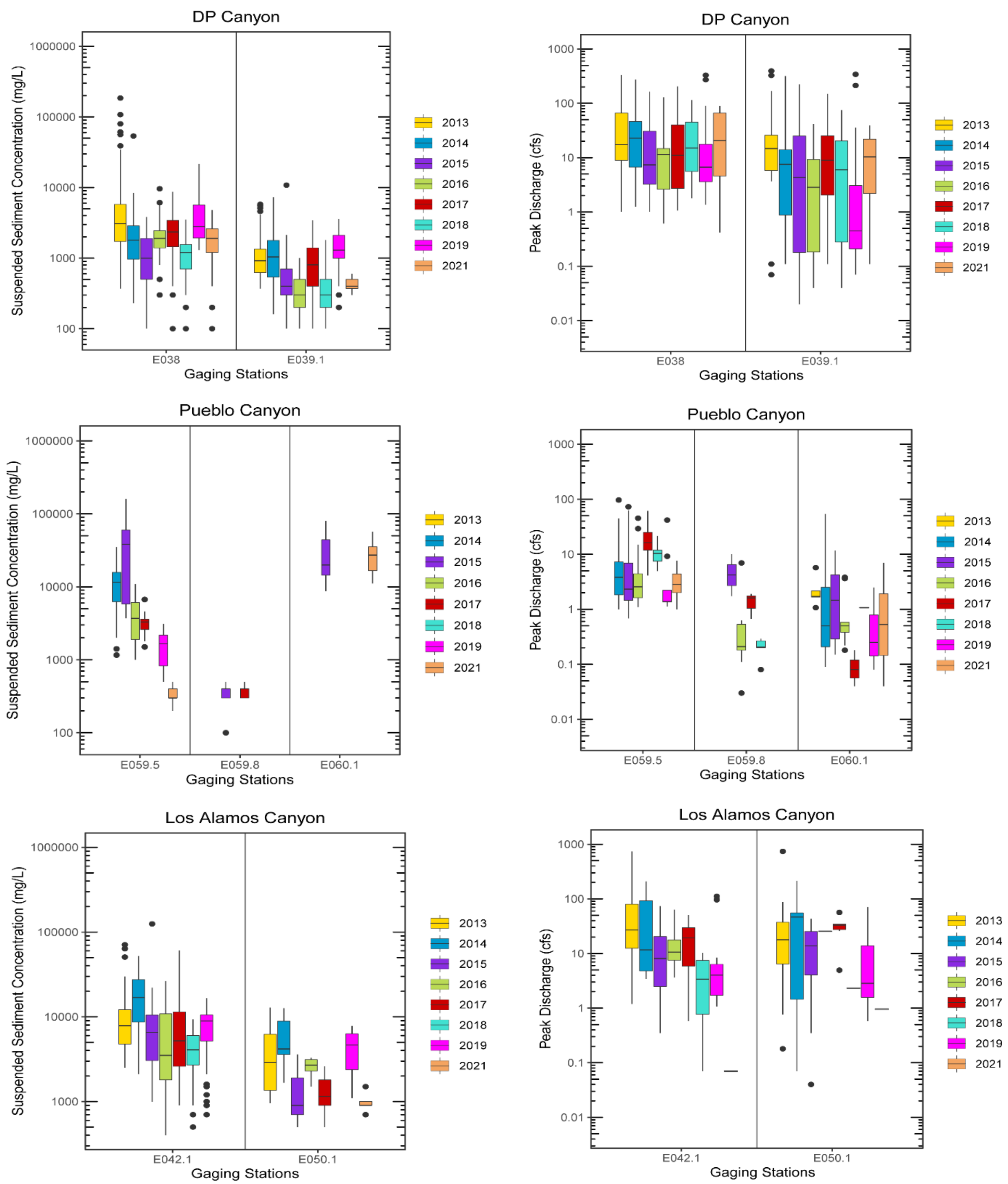


Figure 3.2-7 Linear relationship between SSC-based sediment yield and peak discharge over the 9 yr of monitoring from 2013 to 2021 (excluding 2020 when no samples were collected)



Note: Black dots represent outliers.

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 9 yr of monitoring from 2013 to 2021 (excluding 2020 when no samples were collected)

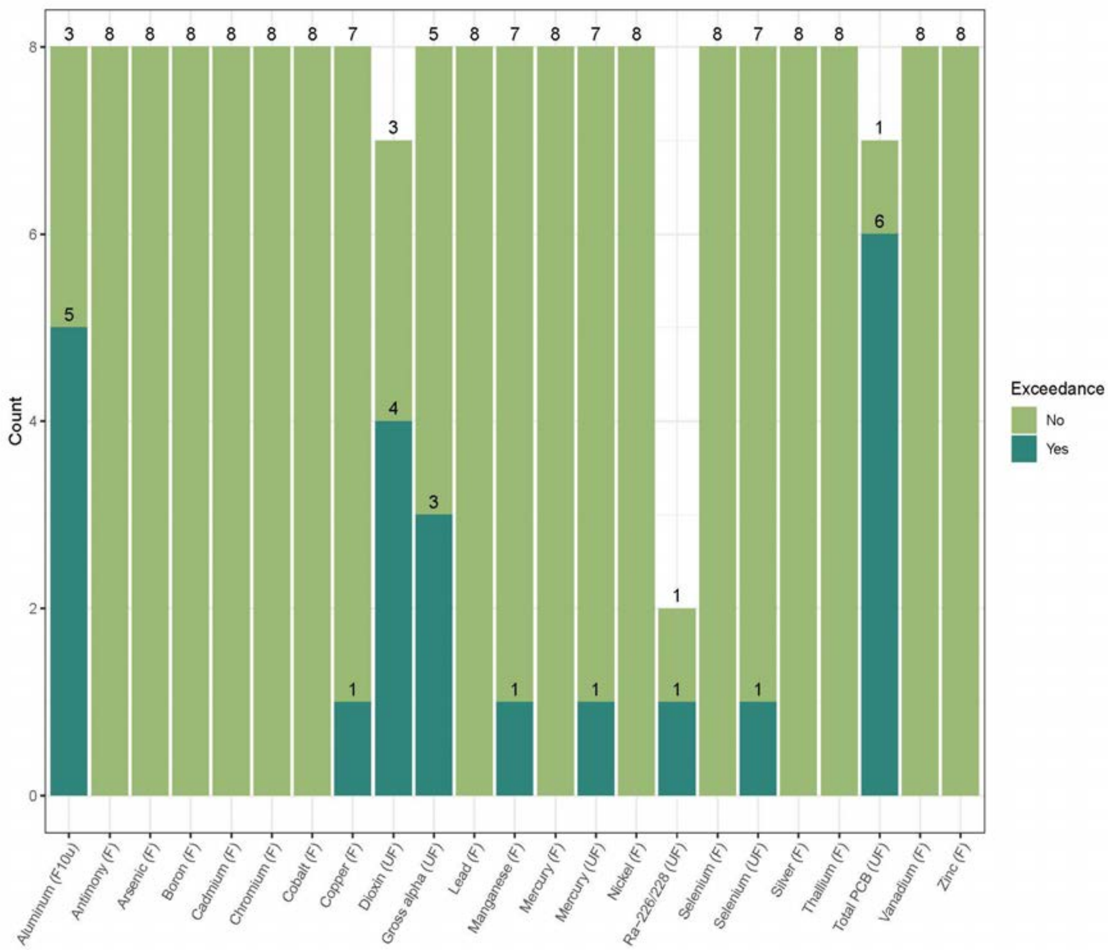
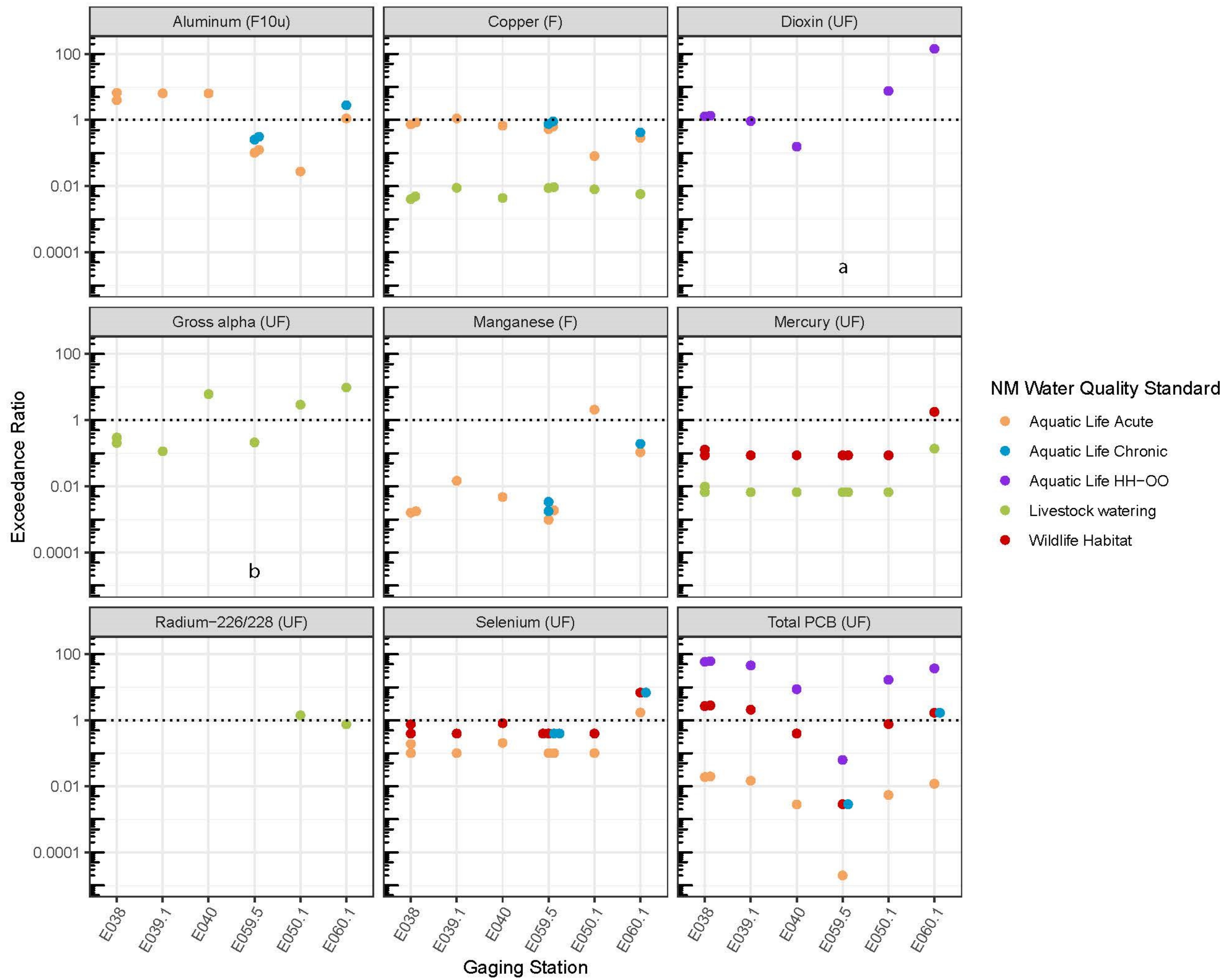


Figure 4.1-1 2021 Los Alamos/Pueblo storm water analytical result summary



Notes:
a = Dioxin result for E059.5 is 0 (nondetection) and cannot be displayed on log-scale.
b = Gross alpha result for the second sample at E059.5 is negative (nondetection) and cannot be displayed on log-scale.

Figure 4.1-2 2021 Los Alamos/Pueblo storm water analytical result exceedance ratios

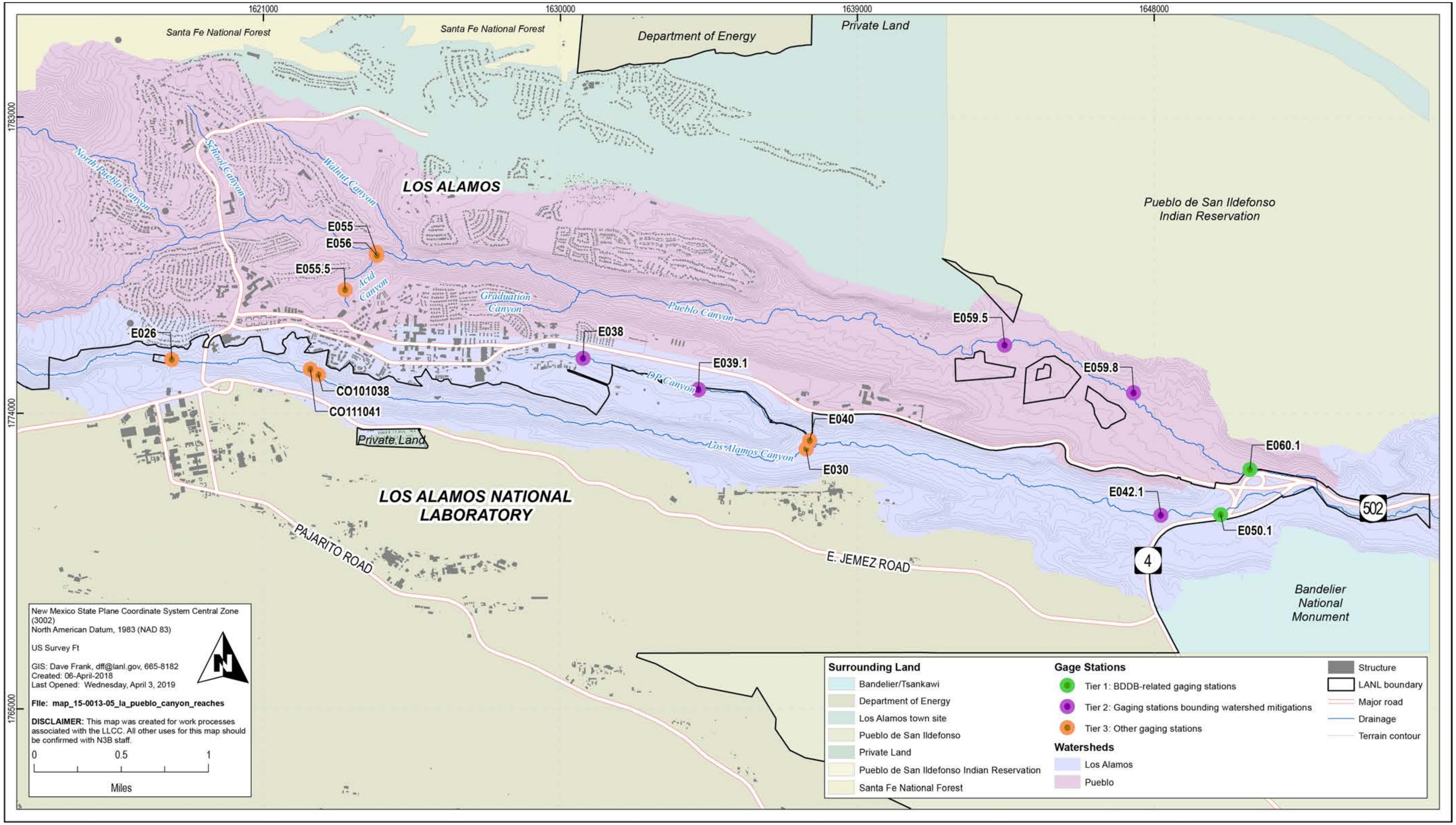


Figure 6.3-1 **Three-tiered approach to sample retrieval when 1 business day collection is not feasible**

Table 2.1-1
Equipment Configuration at Los Alamos/Pueblo 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	Activation to 7/28/2021
E026	Radar sensor	Radio telemetry	2	7/28/2021 to the end of the monitoring season
E030	Radar sensor	Radio telemetry	50	Activation to 7/28/2021
E030	Radar sensor	Radio telemetry	25	7/28/2021 to the end of the monitoring season
E038	Radar sensor	Radio telemetry	77	Monitoring season
E039.1	Radar sensor	Radio telemetry	50	Activation to 7/26/2021
E039.1	Radar sensor	Radio telemetry	25	7/26/2021 to the end of the monitoring season
E040	Radar sensor	Radio telemetry	50	Activation to 7/28/2021
E040	Radar sensor	Radio telemetry	25	7/28/2021 to the end of the monitoring season
E042.1	Radar sensor	Radio telemetry	50	Activation to 7/26/2021
E042.1	Radar sensor	Radio telemetry	25	7/26/2021 to the end of the monitoring season
E050.1	Encoder, bubble sensor, radar sensor	Radio telemetry	Liquid level actuator	Monitoring season
E055	Radar sensor	Radio telemetry	50	Activation to 7/28/2021
E055	Radar sensor	Radio telemetry	25	7/28/2021 to the end of the monitoring season
E055.5	Radar sensor	Radio telemetry	50	Activation to 7/27/2021
E055.5	Radar sensor	Radio telemetry	25	7/27/2021 to the end of the monitoring season
E056	Radar sensor	Radio telemetry	50	Activation to 7/28/2021
E056	Radar sensor	Radio telemetry	25	7/28/2021 to the end of the monitoring season
E059.5	Bubble sensor	Radio telemetry	5 cfs above base flow	Activation to 7/27/2021
E059.5	Bubble sensor	Radio telemetry	2 above base flow	7/27/2021 to 9/20/2021
E059.8	Radar sensor	Radio telemetry	5 cfs above base flow	Activation to 7/26/2021
E059.8	Radar sensor	Radio telemetry	2 cfs above base flow	7/26/2021 to the end of the monitoring season
E060.1	Encoder, bubble sensor, radar sensor	Radio telemetry	Liquid level actuator	Monitoring season

Table 2.3-1
Maximum Daily Discharge and Precipitation Totals for the Largest Storm Events in the Los Alamos/Pueblo Watershed during 2021

					Los Alamos/Pueblo											
	DP Canyon				Los Alamos Canyon					Acid Canyon			Pueblo Canyon			
Date	RG038 (in.)	E038 (cfs)	E039.1 (cfs)	E040 (cfs)	RG042.1 (in.)	E026 (cfs)	E030 (cfs)	E042.1 (cfs)	E050.1 (cfs)	RG055.5 (in.)	E055.5 (cfs)	E056 (cfs)	E055 (cfs)	E059.5 (cfs)	E059.8 (cfs)	E060.1 (cfs)
6/26–6/27/2021	0.99	87 S[a]	29 BT[b]	9.3 BT	0.50	0	0	0	0	0.64	2.2 BT	0	0	0	0	0
7/31/2021	0.56	89 S	39 S	20 BT	0.19	0	0	0	0	0.33	3.4 BT	0	0	1.1 BT	0	0
8/15/2021	0.49	74 BT	24 BT	8.4 BT	0.36	0	0	0.14 BT	0	0.29	1.3 BT	0.31 BT	0	4.4 S	0	0
8/26/2021	0.55	59 BT	10 BT	0	0.99	0	0	0.07 BT	0.96 S	0.43	3.9 BT	0.02 BT	0	2 BT	ND[c]	8.7 S
8/28/2021	0.04	0	0.14 BT	0.99 BT	0.06	0	0	0	0	0	0	0	0	5.9 S	ND	0
10/1/2021	0.35	9.8 BT	22 BT	26 S	0.32	0.05 BT	0	0 .07 BT	0	0.31	2.2 BT	3.3 BT	0	7.3 BT	0	0

Notes: Precipitation totals measured at precipitation gages RG038, RG042.1 and RG055.5 are in inches. Maximum daily discharge measured at the gaging stations is in cfs. Green shading denotes sample collected. Blue shading denotes streamflow below sampler trip level.

[a] S = Sample was collected.

[b] BT = Below gaging station triggering threshold; no sample collected.

[c] ND = No data; site equipment malfunctioned and did not record flow.

Table 2.3-2
Sampling Operational Issues during the 2021 Monitoring Year

Gaging Station	Date	Peak Discharge (cfs)	Reason	Comment
E059.5	8/15/2021	4.4	Equipment malfunction	The 24-bottle ISCO collected samples but the 12-bottle ISCO appeared to have an equipment malfunction.
E059.8	8/26/2021	ND*	Equipment malfunction	Sediment from a flow event on 8/26/2021 interfered with the radar sensor. Trip level was not measured, but possible flow above trip occurred.

*ND = no data available.

Table 2.3-3
Sample-Triggering Events and Percentage of Samples Collected during the 2021 Monitoring Year

Gaging Station	Trip Level (cfs)	Date Range in 2021	Storm Events which Exceeded Trip Level	Samples Collected	% Sampled Storms
E026	2	5/24–11/4	0	0	0
E030	50	5/20–7/27	0	0	0
	25	7/28–11/4	0	0	0
E038	77	5/13–11/5	2	2	100
E039.1	50	5/12–7/25	0	0	0
	25	7/26–11/2	1	1	100
E040	50	5/20–7/27	0	0	0
	25	7/28–11/4	1	1	100
E042.1	50	5/7–7/25	0	0	0
	25	7/26–11/1	0	0	0
E050.1	0.5	4/21–11/9	1	1	100
E055	50	5/21–7/27	0	0	0
	25	7/28–10/27	0	0	0
E055.5	50	5/19–7/26	0	0	0
	25	7/27–10/27	0	0	0
E056	50	5/21–7/27	0	0	0
	25	7/28–10/27	0	0	0
E059.5	8.38	5/1–7/26	0	0	0
	4.39	7/27–9/20	2	2	100
	8.27	9/21–10/12	0	0	0
	11.31	10/13–11/1	0	0	0
E059.8	5	5/5–7/25	0	0	0
	2	7/26–11/1	0	0	0
E060.1	5	4/21–11/9	1	1	100

Table 2.3-4
Gaging Station Operational Issues during the 2021 Monitoring Year

Gaging Station	Issue Description	Issue Date	Repair Date	Working Days from Issue to Repair	Potential Missed Discharge above Trigger	Peak Discharge (cfs)
E040	Silting	6/27/2021	7/2/2021	5	0	0.06
E040	Silting	8/16/2021	8/18/2021	2	0	0.11
E040	Silting	10/1/2021	10/18/2021	11	0	0.04
E056	Equipment malfunction. Loose cable connection.	7/26/2021	8/2/2021	5	0	0.35
E059.8	Silting interfering with radar sensor. Staff plate covered with sediment.	8/27/2021	8/30/2021	1	1	ND*

* ND = No discharge data recorded.

Table 2.3-5
Sample Collection and Sample Retrieval Working-Day Interval

Location Alias	Date Sample Collected	Date Sample Retrieved	Working Days between Collection and Retrieval	Comment
E038	6/27/2021	6/28/2021	1	Sample was retrieved the day after the storm event.
E038	7/31/2021	8/2/2021	1	Sample was collected on Saturday and was retrieved Monday.
E039.1	7/31/2021	8/2/2021	1	Sample was collected on Saturday and was retrieved on Monday.
E040	10/1/2021	10/1/2021	0	Sample was collected at 03:00 on 10/1/2021 and was retrieved at 10:00 on 10/1/2021.
E050.1	8/26/2021	8/27/2021	1	Sample was retrieved the day after the storm event.
E059.5	8/15/2021	8/16/2021	1	Sample was retrieved the day after the storm event.
E059.5	8/28/2021	8/30/2021	1	Sample was collected on Saturday and was retrieved on Monday.
E060.1	8/26/2021	8/27/2021	1	Sample was retrieved the day after the storm event.

Table 2.4-1
Analytical Suite Prioritization for each Gaging Station

Gaging Station	Priority	Analytical Suite	Glass Bottle	Polyethylene Bottle	Minimum Volume Required (L)
DP Canyon Gaging Stations					
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	BLM suite[e]	Yes	No	1
	8	Particle size and SSC[f]	Yes	Yes	1
Upper Los Alamos Canyon Gaging Stations					
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	BLM suite	Yes	No	1
	8	Particle size and SSC	Yes	Yes	1
Upper Pueblo Canyon and Acid Canyon Gaging Stations					
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	BLM suite	Yes	No	1
	6	Particle size and SSC	Yes	Yes	1
Lower Los Alamos Canyon Gaging Stations					
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	BLM suite	Yes	No	1
	8	Particle size and SSC	Yes	Yes	1

Table 2.4-1 (continued)

Gaging Station	Priority	Analytical Suite	Glass Bottle	Polyethylene Bottle	Minimum Volume Required (L)
Lower Los Alamos Canyon Gaging Stations (cont.)					
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	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 Gaging Stations					
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	BLM suite	Yes	No	1
	8	Particle size and SSC	Yes	Yes	1
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	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

Table 2.4-1 (continued)

Gaging Station	Priority	Analytical Suite	Glass Bottle	Polyethylene Bottle	Minimum Volume Required (L)
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	BLM suite	Yes	No	1
	4	Gross alpha	Yes	Yes	1
	5	Particle size and SSC	Yes	Yes	1

[a] Gamma spectroscopy = Ac-228, Be-7, Bi-212, Bi-214, Cs-134, Cs-137, Co-60, gross gamma, I-131, Pb-212, Pb-214, K-40, Pa-234, Na-22, Tl-208, and Th-234.

[b] Target analyte list (TAL) metals = 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 Ca and Mg, components of the TAL list.

[c] F = Analyses of filtered sample.

[d] UF = Analyses of unfiltered sample.

[e] BLM suite = Biotic ligand model suite: alkalinity, dissolved organic carbon, and pH.

[f] SSC = Suspended sediment concentration.

Table 2.4-2
Analytical Requirements for Storm Water Samples

Analytical Suite	Method	Contract-Required Reporting Limit	Typical Detection Limit in Storm Water[a]	Upper Los Alamos Canyon (E026, E030)	Upper Pueblo Canyon and Acid Canyon (E055, E056, E055.5)	DP Canyon (E038, E039.1, E040)	Lower Los Alamos Canyon (E042.1, E050.1)	Lower Pueblo Canyon (E059.5, E059.8, E060.1)	Supplemental BDDB Monitoring (E050.1, E060.1)	Detention Basins below the SWMU 01-001(f) Drainage
PCBs	EPA:1668C	n/a[b]	25 pg/L	X[c]	X	X	X	X	—[d]	X
Isotopic plutonium	HASL-300	0.075 pCi/L	0.5 pCi/L	X	X	X	X	X	—	—
Gamma spectroscopy[e]	EPA:901.1	8 pCi/L (Cs-137)	10 pCi/L (Cs-137)	X	X	X	X	X	—	—
Isotopic uranium	HASL-300	0.1 pCi/L	0.5 pCi/L	—	—	—	—	—	X	—
Americium-241	HASL-300	0.075 pCi/L	0.5 pCi/L	—	X	—	X	X	—	—
Strontium-90	EPA:905.0	0.5 pCi/L	0.5 pCi/L	X	—	X	X	X	—	—
TAL metals[f] + boron + uranium (total and dissolved)	EPA:200.7/200.8/245.2	Variable	Variable	X	X	X	X	X	—	X
Total recoverable aluminum	EPA:200.8	100 µg/L	20 µg/L	X	X	X	X	X	—	X
Dioxins and furans	EPA:1613B	10–50 ng/L	50 pg/L	X	—	—	X	X[g]	—	—
Gross alpha	EPA:900	3 pCi/L	10 pCi/L	X	X	X	X	X	—	X
Gross beta	EPA:900	3 pCi/L	10 pCi/L	—	—	—	—	—	X	—
Radium-226/Radium-228	EPA:903.1/EPA:904	1 pCi/L	0.5/0.5 pCi/L	—	—	—	—	—	X	—
SSC	ASTM: D3977-97	3 mg/L	10 mg/L	X	X	X	X	X	—	X
Particle size[h]	ASTM:C1070	n/a	0.01%	X	X	X	X	X	—	X

Table 2.4-2 (continued)

Analytical Suite	Method	Contract-Required Reporting Limit	Typical Detection Limit in Storm Water[a]	Upper Los Alamos Canyon (E026, E030)	Upper Pueblo Canyon and Acid Canyon (E055, E056, E055.5)	DP Canyon (E038, E039.1, E040)	Lower Los Alamos Canyon (E042.1, E050.1)	Lower Pueblo Canyon (E059.5, E059.8, E060.1)	Supplemental BDDB Monitoring (E050.1, E060.1)	Detention Basins below the SWMU 01-001(f) Drainage
Alkalinity[i]	EPA:310	n/a	n/a	X	X	X	X	X	—	X
pH[i]	EPA:150.1	n/a	n/a	X	X	X	X	X	—	X
Dissolved organic carbon[i]	EPA:415.1	n/a	0.5 mg/L	X	X	X	X	X	—	X

[a] Method detection limit or minimum detectable activity for radionuclides.

[b] n/a = Not applicable.

[c] X = Monitoring planned.

[d] — = Monitoring not planned.

[e] Gamma spectroscopy = Ac-228, Be-7, Bi-212, Bi-214, Cs-134, Cs-137, Co-60, gross gamma, I-131, Pb-212, Pb-214, K-40, Pa-234, Na-22, Tl-208, and Th-234.

[f] Target analyte list (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 CA and Mg, components of the TAL list.

[g] Dioxins and furans are measured at E060.1 only.

[h] These analytical suites are investigative monitoring.

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

* Drainage areas marked by an asterisk do not extend to the head of the watershed above the gaging station; unmarked drainage areas 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 2021 Runoff Events Exceeding Sampling Triggers across the Watershed Mitigations

Date	Travel Time from E038 to E039.1 (min)	Peak Discharge (cfs)		+/–[a]	%[b]	Travel Time from E042.1 to E050.1 (min)	Peak Discharge (cfs)		+/–[a]	%[b]
		E038	E039.1				E042.1	E050.1		
6/27	45	87	29	−	67	—[c]	0	0	—	—
7/31l	45	89	39	−	56	—	0	0	—	—
8/15	40	74	24	−	68	—	0.14	0	−	100
8/26	55	59	10	−	83	—	0.07	0.96	+	93
8/28	—	0	0.14	+	100	—	0	0	—	—
10/2	35	9.8	22	+	55	—	0.07	0	−	100
Min.	35	0	0.14	+	55	—	0	0	+	93
Mean	44	53	21	−	71.5	—	0.05	0.16	−	97.7
Max	55	89	39	+	100	—	0.14	0.96	−	100
Date	**Travel Time from E059.5 to E059.8 (min)**	**Peak Discharge (cfs)**		**+/–[a]**	**%[b]**	**Travel Time from E059.8 to E060.1 (min)**	**Peak Discharge (cfs)**		**+/–[a]**	**%[b]**
		E059.5	**E059.8**				**E059.8**	**E060.1**		
6/27	—	0	0	—	—	—	0	0	—	—
7/31	—	1.1	0	−	100	—	0	0	—	—
8/5	—	4.4	0	−	100	—	0	0	—	—
8/26	—	2	—	—	—	—	—	7.0	—	—
8/28	—	5.9	—	—	—	—	—	0	—	—
10/1	—	7.3	0	−	100	—	0	0	—	—
Min.	—	0	0	−	100	—	0	0	—	—
Mean	—	3.5	0	−	100	—	0	1.16	—	—
Max	—	7.3	0	−	100	—	0	7.0	—	—

[a] + = Increase; − = decrease

[b] % = Percent change in peak discharge.

[c] — = Result not applicable.

Table 3.2-2
SSC-Based Sediment Yield and Runoff Volume for Sampled 2013 to 2021 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	8/5/2013[b]	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)
2015 Runoff Events (cont.)					
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
2020 Runoff Events					
No samples were collected in 2020.					
2021 Runoff Events					
E038	6/27/2021	5.9	2.7	2.0	87.4
E038	7/31/2021	6.0	2.7	1.8	89.2
E039.1	7/31/2021	1.1	0.5	2.4	39.2
E050.1	8/26/2021[b]	0.0	0.0	0.1	1.0
E059.5	8/15/2021[b]	0.5	0.2	1.4	4.4
E059.5	8/28/2021[b]	0.4	0.2	2.5	5.9
E060.1	8/26/2021	4.0	1.8	0.1	7.0

Note: Sediment yield and runoff volume were calculated only from sampled events with reliable hydrographs and sedigraphs; hence, the 09/12/2013 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); hence, 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 4.1-1
Comparison of Detected Analytical Results from 2021 with NMED Water Quality Criteria

Gaging Station	Sample Date	Analyte	Field Prep Code	Result	MDL[b]/ MDA[c]	PQL[d]	Unit[e]	Hardness Used[f]	Exceedance Ratio[a]				
									LW[g]	WH	AAL	CAL	HH-OO
E038	6/27/2021	Aluminum	F10u[h]	1870	19.3	50.0	µg/L	16.1	—[i]	—	6.67	—	—
E038	6/27/2021	Copper	F[j]	2.03	0.300	2.00	µg/L	16.1	<0.01	—	0.84	—	—
E038	6/27/2021	Dioxin[k]	UF[l]	6.60E-08	—	—	µg/L	—	—	—	—	—	1.29
E038	6/27/2021	Gross alpha	UF	3.08	2.50	—	pCi/L	—	0.21	—	—	—	—
E038	6/27/2021	Lead	F	0.501	0.500	2.00	µg/L	16.1	0.01	—	0.06	—	—
E038	6/27/2021	Manganese	F	2.61	2.00	10.0	µg/L	16.1	—	—	<0.01	—	—
E038	6/27/2021	Nickel	F	0.633	0.600	2.00	µg/L	16.1	—	—	0.01	—	<0.01
E038	6/27/2021	Total PCB	UF	0.0379	—	—	µg/L	—	—	2.71	0.02	—	59.2
E038	6/27/2021	Vanadium	F	1.85	1.00	5.00	µg/L	—	0.02	—	—	—	—
E038	6/27/2021	Zinc	F	6.48	3.30	20.0	µg/L	16.1	<0.01	—	0.21	—	<0.01
E038	7/31/2021	Aluminum	F10u	1780	19.3	50.0	µg/L	22.6	—	—	3.99	—	—
E038	7/31/2021	Chromium	F	3.23	19.3	50.0	µg/L	—	<0.01	—	—	—	—
E038	7/31/2021	Copper	F	2.45	0.300	2.00	µg/L	22.6	<0.01	—	0.74	—	—
E038	7/31/2021	Dioxin	UF	6.91E-08	—	—	µg/L	—	—	—	—	—	1.35
E038	7/31/2021	Gross alpha	UF	4.49	1.86	—	pCi/L	—	0.30	—	—	—	—
E038	7/31/2021	Manganese	F	3.22	2.00	10.0	µg/L	22.6	—	—	<0.01	—	—
E038	7/31/2021	Mercury	UF	0.099	0.0670	0.200	µg/L	—	0.01	0.13	—	—	—
E038	7/31/2021	Nickel	F	0.774	0.600	2.00	µg/L	22.6	—	—	0.01	—	<0.01
E038	7/31/2021	Selenium	UF	3.82	2.00	5.00	µg/L	—	—	0.76	0.19	—	—
E038	7/31/2021	Total PCB	UF	0.0394	—	—	µg/L	—	—	2.81	0.02	—	61.6
E038	7/31/2021	Vanadium	F	2.24	1.00	5.00	µg/L	—	0.02	—	—	—	—
E038	7/31/2021	Zinc	F	7.89	3.30	20.0	µg/L	16.1	<0.01	—	0.19	—	<0.01
E039.1	7/31/2021	Aluminum	F10u	3760	19.3	50.0	µg/L	27.6	—	—	6.41	—	—
E039.1	7/31/2021	Boron	F	22	15.0	50.0	µg/L	—	<0.01	—	—	—	—

Table 4.1-1 (continued)

Gaging Station	Sample Date	Analyte	Field Prep Code	Result	MDL[b]/ MDA[c]	PQL[d]	Unit[e]	Hardness Used[f]	Exceedance Ratio[a]				
									LW[g]	WH	AAL	CAL	HH-OO
E039.1	7/31/2021	Cobalt	F	1.72	1.00	5.00	µg/L	—	<0.01	—	—	—	—
E039.1	7/31/2021	Copper	F	4.47	0.300	2.00	µg/L	27.6	0.01	—	1.12	—	—
E039.1	7/31/2021	Dioxin	UF	4.75E-08	—	—	µg/L	—	—	—	—	—	0.93
E039.1	7/31/2021	Lead	F	2.32	0.500	2.00	µg/L	27.6	0.02	—	0.15	—	—
E039.1	7/31/2021	Manganese	F	28.7	2.00	10.0	µg/L	27.6	—	—	0.01	—	—
E039.1	7/31/2021	Nickel	F	1.75	0.600	2.00	µg/L	27.6	—	—	0.01	—	<0.01
E039.1	7/31/2021	Total PCB	UF	0.0294	—	—	µg/L	—	—	2.10	0.01	—	45.9
E039.1	7/31/2021	Vanadium	F	4.33	1.00	5.00	µg/L	—	0.04	—	—	—	—
E039.1	7/31/2021	Zinc	F	21.5	3.30	20.0	µg/L	27.6	<0.01	—	0.43	—	<0.01
E040	10/1/2021	Aluminum	F10u	2780	19.3	50.0	µg/L	22.2	—	—	6.38	—	—
E040	10/1/2021	Antimony	F	1.67	1.00	3.00	µg/L	—	—	—	—	—	<0.01
E040	10/1/2021	Copper	F	2.2	0.300	2.00	µg/L	22.2	<0.01	—	0.68	—	—
E040	10/1/2021	Dioxin	UF	8.00E-09	—	—	µg/L	—	—	—	—	—	0.16
E040	10/1/2021	Gross alpha	UF	92.4	6.25	—	pCi/L	—	6.16	—	—	—	—
E040	10/1/2021	Lead	F	0.925	0.500	2.00	µg/L	22.2	0.01	—	0.08	—	—
E040	10/1/2021	Manganese	F	8.61	2.00	10.0	µg/L	22.2	—	—	<0.01	—	—
E040	10/1/2021	Nickel	F	0.784	0.600	2.00	µg/L	22.2	—	—	0.01	—	<0.01
E040	10/1/2021	Selenium	UF	4.12	2.00	5.00	µg/L	—	—	0.82	0.21	—	—
E040	10/1/2021	Total PCB	UF	0.00561	—	—	µg/L	—	—	0.40	<0.01	—	8.77
E040	10/1/2021	Vanadium	F	2.2	1.00	5.00	µg/L	—	0.02	—	—	—	—
E040	10/1/2021	Zinc	F	10.5	3.30	20.0	µg/L	22.2	<0.01	—	0.26	—	<0.01
E050.1	8/26/2021	Aluminum	F10u	280	19.3	50.0	µg/L	220[l]	—	—	0.03	—	—
E050.1	8/26/2021	Arsenic	F	2.24	2.00	5.00	µg/L	—	0.01	—	0.01	—	0.25
E050.1	8/26/2021	Boron	F	44	15.0	50.0	µg/L	—	0.01	—	—	—	—
E050.1	8/26/2021	Cobalt	F	80.9	1.00	5.00	µg/L	—	0.08	—	—	—	—
E050.1	8/26/2021	Copper	F	4.03	0.300	2.00	µg/L	400[m]	0.01	—	0.08	—	—

Table 4.1-1 (continued)

Gaging Station	Sample Date	Analyte	Field Prep Code	Result	MDL[b]/ MDA[c]	PQL[d]	Unit[e]	Hardness Used[f]	Exceedance Ratio[a]				
									LW[g]	WH	AAL	CAL	HH-OO
E050.1	8/26/2021	Dioxin	UF	3.86E-07	—[g]	—	µg/L	—	—	—	—	—	7.56
E050.1	8/26/2021	Gross alpha	UF	44.1	5.62	—	pCi/L	—	2.91	—	—	—	—
E050.1	8/26/2021	Lead	F	1.07	0.500	2.00	µg/L		<0.01	—	<0.01	—	—
E050.1	8/26/2021	Manganese	F	9890	2.00	10.0	µg/L	400[l]	—	—	2.09	—	—
E050.1	8/26/2021	Nickel	F	0.921	0.600	2.00	µg/L	400[l]	—	—	<0.01	—	<0.01
E050.1	8/26/2021	Radium-226 and radium-228	UF	42.7	—	—	pCi/L	—	1.42	—	—	—	—
E050.1	8/26/2021	Total PCB	UF	0.0108	—	—	µg/L	—	—	0.77	0.01	—	16.9
E050.1	8/26/2021	Vanadium	F	99	1.00	5.00	µg/L	—	0.99	—	—	—	—
E050.1	8/26/2021	Zinc	F	499	3.30	20.0	µg/L	400[l]	0.02	—	0.88	—	0.02
E059.5	8/15/2021	Aluminum	F10u	173	19.3	50.0	µg/L	59.6	—	—	0.10	0.26	—
E059.5	8/15/2021	Arsenic	F	2.76	2.00	5.00	µg/L	—	0.01	—	0.01	0.02	0.31
E059.5	8/15/2021	Boron	F	187	15.0	50.0	µg/L	—	0.04	—	—	—	—
E059.5	8/15/2021	Copper	F	4.39	0.300	2.00	µg/L	59.6	0.01	—	0.53	0.76	—
E059.5	8/15/2021	Gross alpha	UF	3.20	2.88	—	pCi/L	—	0.21	—	—	—	—
E059.5	8/15/2021	Manganese	F	2.47	2.00	10.0	µg/L	59.6	—	—	<0.01	<0.01	—
E059.5	8/15/2021	Nickel	F	1.37	0.600	2.00	µg/L	59.6	—	—	<0.01	0.04	<0.01
E059.5	8/15/2021	Vanadium	F	8.82	1.00	5.00	µg/L	—	0.09	—	—	—	—
E059.5	8/15/2021	Zinc	F	70.8	3.30	20.0	µg/L	59.6	<0.01	—	0.71	0.94	<0.01
E059.5	8/28/2021	Aluminum	F10u	177	19.3	50.0	µg/L	52.4	—	—	0.13	0.31	—
E059.5	8/28/2021	Arsenic	F	3.11	2.00	5.00	µg/L	—	0.02	—	0.01	0.02	0.35
E059.5	8/28/2021	Boron	F	182	15.0	50.0	µg/L	—	0.04	—	—	—	—
E059.5	8/28/2021	Copper	F	4.68	0.300	2.00	µg/L	52.4	0.01	—	0.64	0.91	—
E059.5	8/28/2021	Manganese	F	4.53	2.00	10.0	µg/L	52.4	—	—	<0.01	<0.01	—
E059.5	8/28/2021	Nickel	F	1.56	0.600	2.00	µg/L	52.4	—	—	0.01	0.05	<0.01
E059.5	8/28/2021	Vanadium	F	11.4	1.00	5.00	µg/L	—	0.11	—	—	—	—

Table 4.1-1 (continued)

Gaging Station	Sample Date	Analyte	Field Prep Code	Result	MDL[b]/ MDA[c]	PQL[d]	Unit[e]	Hardness Used[f]	Exceedance Ratio[a]				
									LW[g]	WH	AAL	CAL	HH-OO
E059.5	8/28/2021	Zinc	F	58.7	3.30	20.0	µg/L	52.4	<0.01	—	0.66	0.87	<0.01
E060.1	8/26/2021	Aluminum	F10u	2520	19.3	50.0	µg/L	73.6	—	—	1.12	2.80	—
E060.1	8/26/2021	Antimony	F	1.16	1.00	3.00	µg/L	—	—	—	—	—	<0.01
E060.1	8/26/2021	Arsenic	F	2.36	2.00	5.00	µg/L	—	0.01	—	0.01	0.02	0.26
E060.1	8/26/2021	Boron	F	20.1	15.0	50.0	µg/L	—	<0.01	—	—	—	—
E060.1	8/26/2021	Cobalt	F	2.41	1.00	5.00	µg/L	—	<0.01	—	—	—	—
E060.1	8/26/2021	Copper	F	2.90	0.300	2.00	µg/L	73.6	0.01	—	0.29	0.42	—
E060.1	8/26/2021	Dioxin	UF	7.20E-06	—	—	µg/L	—	—	—	—	—	141
E060.1	8/26/2021	Gross alpha	UF	146	9.54	—	pCi/L	—	9.73	—	—	—	—
E060.1	8/26/2021	Lead	F	0.849	0.500	2.00	µg/L	73.6	0.01	—	0.02	0.47	—
E060.1	8/26/2021	Manganese	F	288	2.00	10.0	µg/L	73.6	—	—	0.11	0.19	—
E060.1	8/26/2021	Mercury	UF	1.38	0.067	0.200	µg/L	—	0.14	1.79	—	—	—
E060.1	8/26/2021	Nickel	F	1.83	0.600	2.00	µg/L	73.6	—	—	0.01	0.05	<0.01

Table 4.1-1 (continued)

Gaging Station	Sample Date	Analyte	Field Prep Code	Result	MDL[b]/ MDA[c]	PQL[d]	Unit[e]	Hardness Used[f]	Exceedance Ratio[a]				
									LW[g]	WH	AAL	CAL	HH-OO
E060.1	8/26/2021	Radium-226 and radium-228	UF	22.7	—	—	pCi/L	—	0.76	—	—	—	—
E060.1	8/26/2021	Selenium	UF	34.6	2.00	5.00	µg/L	—	—	6.92	1.73	6.92	—
E060.1	8/26/2021	Total PCB	UF	0.0238	—	—	µg/L	—	—	1.70	0.01	1.70	37.2
E060.1	8/26/2021	Vanadium	F	9.59	1.00	5.00	µg/L	—	0.10	—	—	—	—
E060.1	8/26/2021	Zinc	F	31.2	3.30	20.0	µg/L	73.6	<0.01	—	0.26	0.34	<0.01

[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] MDL = Method detection limit.

[c] MDA = Minimum detectable activity.

[d] PQL = Practical quantitation limit or uncertainty.

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

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

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

[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.

[m] The hardness value for the sample collected from E050.1 on 8/26/2021 was 502 mg/L. Per 20.6.4 NMAC a maximum hardness of 220 mg/L is used for aluminum and 400 mg/L is used for all other hardness-dependent metals.

Table 4.2-1
Calculated SSC and Instantaneous Discharge
Determined for Each Sample Collected during 2021 in the Los Alamos/Pueblo Watershed

Gaging Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E038	06/27/2021	05:24	WT_LAP-21-224417	UF[b]	SSC	4800	65
E038	06/27/2021	05:26	WT_LAP-21-224418	UF	SSC	4500	82
E038	06/27/2021	05:28	WT_LAP-21-224419	UF	SSC	3600	71
E038	06/27/2021	05:30	WT_LAP-21-224420	UF	SSC	2800	61
E038	06/27/2021	05:32	WT_LAP-21-224421	UF	SSC	2800	45
E038	06/27/2021	05:34	WT_LAP-21-224422	UF	SSC	2300	31
E038	06/27/2021	05:35	WT_LAP-21-224774	UF	SSC	1900	26
E038	06/27/2021	05:36	WT_LAP-21-224423	UF	SSC	2200	23
E038	06/27/2021	05:37	WT_LAP-21-224657	UF	Estimated	2200	20
E038	06/27/2021	05:38	WT_LAP-21-224424	UF	SSC	2100	18
E038	06/27/2021	05:39	WT_LAP-21-224810	F[c]	Estimated	2400	16
E038	06/27/2021	05:39	WT_LAP-21-224828	UF	Estimated	2400	16
E038	06/27/2021	05:40	WT_LAP-21-224425	UF	SSC	2600	14
E038	06/27/2021	05:42	WT_LAP-21-224426	UF	SSC	1900	13
E038	06/27/2021	05:44	WT_LAP-21-224427	UF	SSC	1500	11
E038	06/27/2021	05:45	WT_LAP-21-224720	F	Estimated	1500	10
E038	06/27/2021	05:45	WT_LAP-21-224738	UF	Estimated	1500	10
E038	06/27/2021	05:45	WT_LAP-21-224756	F10u[d]	Estimated	1500	10
E038	06/27/2021	05:46	WT_LAP-21-224428	UF	SSC	1400	10
E038	06/27/2021	05:47	WT_LAP-21-224698	UF	Estimated	1500	9
E038	06/27/2021	05:48	WT_LAP-21-224429	UF	SSC	1500	9
E038	06/27/2021	05:49	WT_LAP-21-224673	UF	Estimated	1400	9

Table 4.2-1 (continued)

Gaging Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E038	06/27/2021	05:50	WT_LAP-21-224430	UF	SSC	1200	9
E038	06/27/2021	05:52	WT_LAP-21-224431	UF	SSC	900	8
E038	06/27/2021	05:54	WT_LAP-21-224432	UF	SSC	800	7
E038	06/27/2021	05:55	WT_LAP-21-224708	UF	Estimated	800	6
E038	06/27/2021	05:57	WT_LAP-21-224792	UF	SSC	900	5
E038	06/27/2021	06:14	WT_LAP-21-224433	UF	SSC	400	3
E038	06/27/2021	06:34	WT_LAP-21-224434	UF	SSC	200	3
E038	06/27/2021	06:54	WT_LAP-21-224435	UF	SSC	1200	4
E038	06/27/2021	07:14	WT_LAP-21-224436	UF	SSC	400	3
E038	06/27/2021	07:34	WT_LAP-21-224437	UF	SSC	200	1
E038	06/27/2021	07:54	WT_LAP-21-224438	UF	SSC	100	1
E038	07/31/2021	13:35	WT_LAP-21-225049	UF	SSC	3500	89
E038	07/31/2021	13:37	WT_LAP-21-225050	UF	SSC	3400	72
E038	07/31/2021	13:39	WT_LAP-21-225051	UF	SSC	3000	58
E038	07/31/2021	13:41	WT_LAP-21-225052	UF	SSC	2800	46
E038	07/31/2021	13:43	WT_LAP-21-225053	UF	SSC	2500	37
E038	07/31/2021	13:45	WT_LAP-21-224918	UF	SSC	2300	29
E038	07/31/2021	13:45	WT_LAP-21-225054	UF	SSC	2600	29
E038	07/31/2021	13:47	WT_LAP-21-225035	UF	Estimated	2300	25
E038	07/31/2021	13:47	WT_LAP-21-225055	UF	SSC	2300	25
E038	07/31/2021	13:49	WT_LAP-21-224864	UF	Estimated	2000	21
E038	07/31/2021	13:49	WT_LAP-21-224882	F	Estimated	2000	21
E038	07/31/2021	13:49	WT_LAP-21-225056	UF	SSC	2000	21
E038	07/31/2021	13:51	WT_LAP-21-225057	UF	SSC	2200	19
E038	07/31/2021	13:53	WT_LAP-21-224936	F10u	Estimated	2000	18

Table 4.2-1 (continued)

Gaging Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E038	07/31/2021	13:53	WT_LAP-21-224954	UF	Estimated	2000	18
E038	07/31/2021	13:53	WT_LAP-21-224972	F	Estimated	2000	18
E038	07/31/2021	13:53	WT_LAP-21-225058	UF	SSC	2000	18
E038	07/31/2021	13:55	WT_LAP-21-224996	UF	Estimated	1900	17
E038	07/31/2021	13:55	WT_LAP-21-225059	UF	SSC	1900	17
E038	07/31/2021	13:57	WT_LAP-21-225060	UF	SSC	1800	16
E038	07/31/2021	13:59	WT_LAP-21-225022	UF	Estimated	1600	16
E038	07/31/2021	13:59	WT_LAP-21-225061	UF	SSC	1600	16
E038	07/31/2021	14:01	WT_LAP-21-225062	UF	SSC	1500	15
E038	07/31/2021	14:03	WT_LAP-21-224991	UF	Estimated	1700	15
E038	07/31/2021	14:03	WT_LAP-21-225063	UF	SSC	1700	15
E038	07/31/2021	14:05	WT_LAP-21-225064	UF	SSC	2400	14
E038	07/31/2021	14:07	WT_LAP-21-224900	UF	SSC	3900	12
E038	07/31/2021	14:25	WT_LAP-21-225065	UF	SSC	1100	3
E038	07/31/2021	14:45	WT_LAP-21-225066	UF	SSC	400	1
E038	07/31/2021	15:05	WT_LAP-21-225067	UF	SSC	200	0
E039.1	07/31/2021	14:23	WT_LAP-21-224441	UF	SSC	600	38
E039.1	07/31/2021	14:25	WT_LAP-21-224442	UF	SSC	600	38
E039.1	07/31/2021	14:27	WT_LAP-21-224443	UF	SSC	600	37
E039.1	07/31/2021	14:28	WT_LAP-21-224775	UF	SSC	600	37
E039.1	07/31/2021	14:29	WT_LAP-21-224444	UF	SSC	500	37
E039.1	07/31/2021	14:30	WT_LAP-21-224658	UF	Estimated	500	37
E039.1	07/31/2021	14:31	WT_LAP-21-224445	UF	SSC	500	36
E039.1	07/31/2021	14:32	WT_LAP-21-224811	F	Estimated	500	36
E039.1	07/31/2021	14:32	WT_LAP-21-224829	UF	Estimated	500	36

Table 4.2-1 (continued)

Gaging 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	07/31/2021	14:33	WT_LAP-21-224446	UF	SSC	500	35
E039.1	07/31/2021	14:35	WT_LAP-21-224447	UF	SSC	400	35
E039.1	07/31/2021	14:36	WT_LAP-21-224721	F	Estimated	400	34
E039.1	07/31/2021	14:36	WT_LAP-21-224739	UF	Estimated	400	34
E039.1	07/31/2021	14:36	WT_LAP-21-224757	F10u	Estimated	400	34
E039.1	07/31/2021	14:37	WT_LAP-21-224448	UF	SSC	400	32
E039.1	07/31/2021	14:38	WT_LAP-21-224699	UF	Estimated	400	31
E039.1	07/31/2021	14:39	WT_LAP-21-224449	UF	SSC	400	30
E039.1	07/31/2021	14:41	WT_LAP-21-224450	UF	SSC	300	28
E039.1	07/31/2021	14:42	WT_LAP-21-224674	UF	Estimated	300	27
E039.1	07/31/2021	14:43	WT_LAP-21-224451	UF	SSC	300	26
E039.1	07/31/2021	14:45	WT_LAP-21-224452	UF	SSC	300	24
E039.1	07/31/2021	14:46	WT_LAP-21-224709	UF	Estimated	400	22
E039.1	07/31/2021	14:47	WT_LAP-21-224453	UF	SSC	400	21
E039.1	07/31/2021	14:49	WT_LAP-21-224454	UF	SSC	400	19
E039.1	07/31/2021	14:50	WT_LAP-21-224793	UF	SSC	400	18
E039.1	07/31/2021	14:51	WT_LAP-21-224455	UF	SSC	400	17
E039.1	07/31/2021	14:53	WT_LAP-21-224456	UF	SSC	400	16
E039.1	07/31/2021	15:13	WT_LAP-21-224457	UF	SSC	300	7
E039.1	07/31/2021	15:33	WT_LAP-21-224458	UF	SSC	300	4
E059.5	08/15/2021	19:44	WT_LAP-21-224465	UF	SSC	500	4
E059.5	08/15/2021	19:48	WT_LAP-21-224466	UF	SSC	400	4
E059.5	08/15/2021	19:51	WT_LAP-21-224467	UF	SSC	400	4
E059.5	08/15/2021	19:54	WT_LAP-21-224776	UF	SSC	400	4
E059.5	08/15/2021	19:56	WT_LAP-21-224468	UF	SSC	400	4

Table 4.2-1 (continued)

Gaging 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	08/15/2021	19:59	WT_LAP-21-224722	F	Estimated	300	4
E059.5	08/15/2021	19:59	WT_LAP-21-224740	UF	Estimated	300	4
E059.5	08/15/2021	19:59	WT_LAP-21-224758	F10u	Estimated	300	4
E059.5	08/15/2021	20:01	WT_LAP-21-224469	UF	SSC	300	4
E059.5	08/15/2021	20:04	WT_LAP-21-224700	UF	Estimated	400	4
E059.5	08/15/2021	20:06	WT_LAP-21-224470	UF	SSC	400	4
E059.5	08/15/2021	20:09	WT_LAP-21-224675	UF	Estimated	400	3
E059.5	08/15/2021	20:11	WT_LAP-21-224471	UF	SSC	400	3
E059.5	08/15/2021	20:14	WT_LAP-21-224692	UF	Estimated	400	3
E059.5	08/15/2021	20:34	WT_LAP-21-224472	UF	SSC	400	3
E059.5	08/15/2021	20:54	WT_LAP-21-224473	UF	SSC	500	4
E059.5	08/15/2021	21:14	WT_LAP-21-224474	UF	SSC	400	4
E059.5	08/15/2021	21:34	WT_LAP-21-224475	UF	SSC	500	4
E059.5	08/15/2021	21:54	WT_LAP-21-224476	UF	SSC	400	3
E059.5	08/15/2021	22:14	WT_LAP-21-224477	UF	SSC	400	4
E059.5	08/15/2021	22:34	WT_LAP-21-224478	UF	SSC	500	4
E059.5	08/15/2021	22:54	WT_LAP-21-224479	UF	SSC	400	3
E050.1	08/26/2021	18:25	WT_LAP-21-225169	UF	SSC	1500	0
E050.1	08/26/2021	18:27	WT_LAP-21-224943	F10u	Estimated	1100	0
E050.1	08/26/2021	18:27	WT_LAP-21-224961	UF	Estimated	1100	0
E050.1	08/26/2021	18:27	WT_LAP-21-224979	F	Estimated	1100	0
E050.1	08/26/2021	18:28	WT_LAP-21-224925	UF	SSC	900	0
E050.1	08/26/2021	18:29	WT_LAP-21-224988	UF	Estimated	900	1
E050.1	08/26/2021	18:30	WT_LAP-21-225042	UF	Estimated	900	1
E050.1	08/26/2021	18:31	WT_LAP-21-225170	UF	SSC	900	1

Table 4.2-1 (continued)

Gaging 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	08/26/2021	18:32	WT_LAP-21-225018	UF	Estimated	900	1
E050.1	08/26/2021	18:33	WT_LAP-21-225003	UF	Estimated	900	1
E050.1	08/26/2021	18:35	WT_LAP-21-225011	UF	Estimated	1000	1
E050.1	08/26/2021	18:37	WT_LAP-21-225171	UF	SSC	1000	1
E050.1	08/26/2021	18:39	WT_LAP-21-225013	UF	Estimated	900	0
E050.1	08/26/2021	18:41	WT_LAP-21-224871	UF	Estimated	800	0
E050.1	08/26/2021	18:41	WT_LAP-21-224889	F	Estimated	800	0
E050.1	08/26/2021	18:43	WT_LAP-21-225172	UF	SSC	700	0
E060.1	08/26/2021	18:59	WT_LAP-21-224783	UF	SSC	32,600	0
E060.1	08/26/2021	19:00	WT_LAP-21-224559	UF	SSC	38,500	0
E060.1	08/26/2021	19:01	WT_LAP-21-224666	UF	Estimated	39,300	0
E060.1	08/26/2021	19:02	WT_LAP-21-224713	UF	Estimated	40,200	1
E060.1	08/26/2021	19:03	WT_LAP-21-224819	F	Estimated	41,000	3
E060.1	08/26/2021	19:03	WT_LAP-21-224837	UF	Estimated	41,000	3
E060.1	08/26/2021	19:06	WT_LAP-21-224560	UF	SSC	43,500	6
E060.1	08/26/2021	19:07	WT_LAP-21-224729	F	Estimated	50,200	6
E060.1	08/26/2021	19:07	WT_LAP-21-224747	UF	Estimated	50,200	6
E060.1	08/26/2021	19:07	WT_LAP-21-224765	F10u	Estimated	50,200	6
E060.1	08/26/2021	19:08	WT_LAP-21-224561	UF	SSC	56,900	6
E060.1	08/26/2021	19:09	WT_LAP-21-224686	UF	Estimated	42,100	5
E060.1	08/26/2021	19:10	WT_LAP-21-224562	UF	SSC	27,200	5
E060.1	08/26/2021	19:12	WT_LAP-21-224688	UF	Estimated	24,800	4
E060.1	08/26/2021	19:13	WT_LAP-21-224706	UF	Estimated	23,600	4
E060.1	08/26/2021	19:15	WT_LAP-21-224690	UF	Estimated	21,100	3
E060.1	08/26/2021	19:16	WT_LAP-21-224563	UF	SSC	19,900	3

Table 4.2-1 (continued)

Gaging Station	Sample Collection Date	Sample Collection Time	Field Sample ID	Field Prep	SSC Source[a]	Calculated SSC (mg/L)	Calculated Instantaneous Discharge (cfs)
E060.1	08/26/2021	19:18	WT_LAP-21-224564	UF	SSC	30,700	2
E060.1	08/26/2021	19:20	WT_LAP-21-224565	UF	SSC	18,400	2
E060.1	08/26/2021	19:22	WT_LAP-21-224566	UF	SSC	15,000	1
E060.1	08/26/2021	19:24	WT_LAP-21-224567	UF	SSC	12,600	1
E060.1	08/26/2021	19:26	WT_LAP-21-224568	UF	SSC	11,100	0
E059.5	08/28/2021	18:50	WT_LAP-21-225097	UF	SSC	300	4
E059.5	08/28/2021	18:53	WT_LAP-21-225098	UF	SSC	300	5
E059.5	08/28/2021	18:56	WT_LAP-21-225099	UF	SSC	300	5
E059.5	08/28/2021	18:58	WT_LAP-21-225100	UF	SSC	300	5
E059.5	08/28/2021	19:01	WT_LAP-21-225101	UF	SSC	300	5
E059.5	08/28/2021	19:04	WT_LAP-21-225102	UF	SSC	300	6
E059.5	08/28/2021	19:06	WT_LAP-21-225103	UF	SSC	200	6
E059.5	08/28/2021	19:09	WT_LAP-21-225104	UF	SSC	200	6
E059.5	08/28/2021	19:15	WT_LAP-21-225106	UF	SSC	300	6
E059.5	08/28/2021	19:17	WT_LAP-21-225107	UF	SSC	200	6
E059.5	08/28/2021	19:20	WT_LAP-21-225108	UF	SSC	200	6
E059.5	08/28/2021	19:24	WT_LAP-21-224920	UF	SSC	300	6
E059.5	08/28/2021	19:27	WT_LAP-21-225037	UF	Estimated	300	5
E059.5	08/28/2021	19:30	WT_LAP-21-224866	UF	Estimated	300	5
E059.5	08/28/2021	19:30	WT_LAP-21-224884	F	Estimated	300	5
E059.5	08/28/2021	19:35	WT_LAP-21-224938	F10u	Estimated	300	5
E059.5	08/28/2021	19:35	WT_LAP-21-224956	UF	Estimated	300	5
E059.5	08/28/2021	19:35	WT_LAP-21-224974	F	Estimated	300	5
E059.5	08/28/2021	19:37	WT_LAP-21-224998	UF	Estimated	300	4
E059.5	08/28/2021	19:39	WT_LAP-21-225006	UF	Estimated	300	4

Table 4.2-1 (continued)

Gaging 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	08/28/2021	19:40	WT_LAP-21-225109	UF	SSC	300	4
E059.5	08/28/2021	19:42	WT_LAP-21-225024	UF	Estimated	300	4
E059.5	08/28/2021	19:47	WT_LAP-21-224902	UF	SSC	300	4
E059.5	08/28/2021	20:00	WT_LAP-21-225110	UF	SSC	300	3
E059.5	08/28/2021	20:20	WT_LAP-21-225111	UF	SSC	400	2
E059.5	08/28/2021	20:40	WT_LAP-21-225112	UF	SSC	300	2
E059.5	08/28/2021	21:00	WT_LAP-21-225113	UF	SSC	300	3
E059.5	08/28/2021	21:20	WT_LAP-21-225114	UF	SSC	300	3
E059.5	08/28/2021	21:40	WT_LAP-21-225115	UF	SSC	300	2
E059.5	08/28/2021	22:00	WT_LAP-21-225116	UF	SSC	200	2
E040	10/01/2021	02:59	WT_LAP-21-224773	UF	SSC	2800	25
E040	10/01/2021	03:01	WT_LAP-21-224656	UF	Estimated	2700	25
E040	10/01/2021	03:03	WT_LAP-21-224809	F	Estimated	2600	24
E040	10/01/2021	03:03	WT_LAP-21-224827	UF	Estimated	2600	24
E040	10/01/2021	03:07	WT_LAP-21-224719	F	Estimated	2400	23
E040	10/01/2021	03:07	WT_LAP-21-224737	UF	Estimated	2400	23
E040	10/01/2021	03:07	WT_LAP-21-224755	F10u	Estimated	2400	23
E040	10/01/2021	03:09	WT_LAP-21-224697	UF	Estimated	2300	22
E040	10/01/2021	03:11	WT_LAP-21-224672	UF	Estimated	2200	21
E040	10/01/2021	03:15	WT_LAP-21-224707	UF	Estimated	2000	19
E040	10/01/2021	03:17	WT_LAP-21-224791	UF	SSC	1900	18

[a] SSC = Measured using ASTM method D3977-97.

[b] UF = Unfiltered.

[c] F = Filtered.

[d] F10u = Filtered using 10 micron filter.

Table 4.3-1
Calculated Total Metals and Isotopic Uranium Concentrations Determined for each Sample Analyzed for SSC during 2021 in the Los Alamos/Pueblo Watershed

Gaging 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	06/27/2021	05:24	WT_LAP-21-224417	4800	0.613	37,127	9.97	651	5.80	1.970	36.2	62.8	32,241	0.412	-914	35.81	148.5	5.31	1.178	2.89	0.10	2.52	60.9	324.9
E038	06/27/2021	05:26	WT_LAP-21-224418	4500	0.606	36,050	9.77	603	5.60	1.894	35.5	61.8	30,444	0.405	-1667	34.78	145.9	5.27	1.143	2.65	0.08	2.28	58.7	301.3
E038	06/27/2021	05:28	WT_LAP-21-224419	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	06/27/2021	05:30	WT_LAP-21-224420	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
E038	06/27/2021	05:32	WT_LAP-21-224421	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
E038	06/27/2021	05:34	WT_LAP-21-224422	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
E038	06/27/2021	05:35	WT_LAP-21-224774	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	06/27/2021	05:36	WT_LAP-21-224423	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
E038	06/27/2021	05:38	WT_LAP-21-224424	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
E038	06/27/2021	05:40	WT_LAP-21-224425	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	06/27/2021	05:42	WT_LAP-21-224426	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	06/27/2021	05:44	WT_LAP-21-224427	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
E038	06/27/2021	05:46	WT_LAP-21-224428	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
E038	06/27/2021	05:48	WT_LAP-21-224429	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
E038	06/27/2021	05:50	WT_LAP-21-224430	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
E038	06/27/2021	05:52	WT_LAP-21-224431	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
E038	06/27/2021	05:54	WT_LAP-21-224432	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
E038	06/27/2021	05:57	WT_LAP-21-224792	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
E038	06/27/2021	06:14	WT_LAP-21-224433	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
E038	06/27/2021	06:34	WT_LAP-21-224434	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
E038	06/27/2021	06:54	WT_LAP-21-224435	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
E038	06/27/2021	07:14	WT_LAP-21-224436	400	0.508	21,331	7.06	-53	2.84	0.853	25.0	48.6	5885	0.316	-11958	20.68	110.5	4.71	0.667	-0.54	-0.11	-1.01	28.4	-21.8
E038	06/27/2021	07:34	WT_LAP-21-224437	200	0.504	20,613	6.92	-85	2.70	0.802	24.5	47.9	4687	0.311	-12460	19.99	108.7	4.69	0.644	-0.70	-0.12	-1.17	26.9	-37.5

Table 4.3-1 (continued)

Gaging 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	06/27/2021	07:54	WT_LAP-21-224438	100	0.501	20,254	6.86	-101	2.64	0.776	24.3	47.6	4088	0.309	-12711	19.64	107.9	4.67	0.633	-0.78	-0.13	-1.25	26.1	-45.4
E038	07/31/2021	13:35	WT_LAP-21-225049	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
E038	07/31/2021	13:37	WT_LAP-21-225050	3400	0.580	32,101	9.04	427	4.86	1.615	32.7	58.2	23,855	0.381	-4428	31.00	136.4	5.12	1.015	1.80	0.03	1.40	50.5	214.6
E038	07/31/2021	13:39	WT_LAP-21-225051	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	07/31/2021	13:41	WT_LAP-21-225052	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
E038	07/31/2021	13:43	WT_LAP-21-225053	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	07/31/2021	13:45	WT_LAP-21-224918	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
E038	07/31/2021	13:45	WT_LAP-21-225054	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	07/31/2021	13:47	WT_LAP-21-225055	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
E038	07/31/2021	13:49	WT_LAP-21-225056	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	07/31/2021	13:51	WT_LAP-21-225057	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
E038	07/31/2021	13:53	WT_LAP-21-225058	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	07/31/2021	13:55	WT_LAP-21-225059	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	07/31/2021	13:57	WT_LAP-21-225060	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
E038	07/31/2021	13:59	WT_LAP-21-225061	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	07/31/2021	14:01	WT_LAP-21-225062	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
E038	07/31/2021	14:03	WT_LAP-21-225063	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	07/31/2021	14:05	WT_LAP-21-225064	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
E038	07/31/2021	14:07	WT_LAP-21-224900	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	07/31/2021	14:25	WT_LAP-21-225065	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
E038	07/31/2021	14:45	WT_LAP-21-225066	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
E038	07/31/2021	15:05	WT_LAP-21-225067	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	07/31/2021	14:23	WT_LAP-21-224441	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	07/31/2021	14:25	WT_LAP-21-224442	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	07/31/2021	14:27	WT_LAP-21-224443	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	07/31/2021	14:28	WT_LAP-21-224775	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	07/31/2021	14:29	WT_LAP-21-224444	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	07/31/2021	14:31	WT_LAP-21-224445	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	07/31/2021	14:33	WT_LAP-21-224446	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	07/31/2021	14:35	WT_LAP-21-224447	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	07/31/2021	14:37	WT_LAP-21-224448	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

Table 4.3-1 (continued)

Gaging 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	07/31/2021	14:39	WT_LAP-21-224449	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	07/31/2021	14:41	WT_LAP-21-224450	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	07/31/2021	14:43	WT_LAP-21-224451	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	07/31/2021	14:45	WT_LAP-21-224452	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	07/31/2021	14:47	WT_LAP-21-224453	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	07/31/2021	14:49	WT_LAP-21-224454	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	07/31/2021	14:50	WT_LAP-21-224793	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	07/31/2021	14:51	WT_LAP-21-224455	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	07/31/2021	14:53	WT_LAP-21-224456	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	07/31/2021	15:13	WT_LAP-21-224457	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	07/31/2021	15:33	WT_LAP-21-224458	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
E040	10/01/2021	02:59	WT_LAP-21-224773	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
E040	10/01/2021	03:17	WT_LAP-21-224791	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
E050.1	08/26/2021	18:25	WT_LAP-21-225169	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	08/26/2021	18:28	WT_LAP-21-224925	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
E050.1	08/26/2021	18:31	WT_LAP-21-225170	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
E050.1	08/26/2021	18:37	WT_LAP-21-225171	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
E050.1	08/26/2021	18:43	WT_LAP-21-225172	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	08/15/2021	19:44	WT_LAP-21-224465	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	08/15/2021	19:48	WT_LAP-21-224466	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
E059.5	08/15/2021	19:51	WT_LAP-21-224467	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
E059.5	08/15/2021	19:54	WT_LAP-21-224776	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
E059.5	08/15/2021	19:56	WT_LAP-21-224468	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
E059.5	08/15/2021	20:01	WT_LAP-21-224469	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
E059.5	08/15/2021	20:06	WT_LAP-21-224470	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
E059.5	08/15/2021	20:11	WT_LAP-21-224471	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
E059.5	08/15/2021	20:34	WT_LAP-21-224472	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
E059.5	08/15/2021	20:54	WT_LAP-21-224473	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	08/15/2021	21:14	WT_LAP-21-224474	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
E059.5	08/15/2021	21:34	WT_LAP-21-224475	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	08/15/2021	21:54	WT_LAP-21-224476	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

Table 4.3-1 (continued)

Gaging 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	08/15/2021	22:14	WT_LAP-21-224477	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
E059.5	08/15/2021	22:34	WT_LAP-21-224478	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	08/15/2021	22:54	WT_LAP-21-224479	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
E059.5	08/28/2021	18:50	WT_LAP-21-225097	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
E059.5	08/28/2021	18:53	WT_LAP-21-225098	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
E059.5	08/28/2021	18:56	WT_LAP-21-225099	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
E059.5	08/28/2021	18:58	WT_LAP-21-225100	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
E059.5	08/28/2021	19:01	WT_LAP-21-225101	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
E059.5	08/28/2021	19:04	WT_LAP-21-225102	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
E059.5	08/28/2021	19:06	WT_LAP-21-225103	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
E059.5	08/28/2021	19:09	WT_LAP-21-225104	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
E059.5	08/28/2021	19:15	WT_LAP-21-225106	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
E059.5	08/28/2021	19:17	WT_LAP-21-225107	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
E059.5	08/28/2021	19:20	WT_LAP-21-225108	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
E059.5	08/28/2021	19:24	WT_LAP-21-224920	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
E059.5	08/28/2021	19:40	WT_LAP-21-225109	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
E059.5	08/28/2021	19:47	WT_LAP-21-224902	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
E059.5	08/28/2021	20:00	WT_LAP-21-225110	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
E059.5	08/28/2021	20:20	WT_LAP-21-225111	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
E059.5	08/28/2021	20:40	WT_LAP-21-225112	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
E059.5	08/28/2021	21:00	WT_LAP-21-225113	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
E059.5	08/28/2021	21:20	WT_LAP-21-225114	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
E059.5	08/28/2021	21:40	WT_LAP-21-225115	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
E059.5	08/28/2021	22:00	WT_LAP-21-225116	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
E060.1	08/26/2021	18:59	WT_LAP-21-224783	32,600	1.272	136,929	28.40	5099	24.51	9.031	107.1	152.3	198,763	1.018	68,864	131.44	388.7	9.09	4.403	24.57	1.41	24.82	266.3	2515.6
E060.1	08/26/2021	19:00	WT_LAP-21-224559	38,500	1.411	158,110	32.32	6043	28.48	10.530	122.2	171.3	234,104	1.146	83,673	151.74	439.6	9.90	5.087	29.17	1.69	29.55	309.9	2980.5
E060.1	08/26/2021	19:06	WT_LAP-21-224560	43,500	1.530	176,060	35.63	6843	31.85	11.800	134.9	187.4	264,054	1.255	96,223	168.94	482.8	10.58	5.667	33.07	1.93	33.56	346.9	3374.5
E060.1	08/26/2021	19:08	WT_LAP-21-224561	56,900	1.848	224,166	44.51	8987	40.86	15.204	169.1	230.5	344,320	1.547	129,857	215.04	598.6	12.40	7.221	43.53	2.57	44.30	445.9	4430.4
E060.1	08/26/2021	19:10	WT_LAP-21-224562	27,200	1.144	117,543	24.82	4235	20.88	7.660	93.4	134.9	166,417	0.900	55,310	112.87	342.0	8.36	3.776	20.36	1.16	20.48	226.4	2090.1
E060.1	08/26/2021	19:16	WT_LAP-21-224563	19,900	0.971	91,336	19.98	3067	15.96	5.806	74.7	111.4	122,690	0.741	36,987	87.76	278.9	7.37	2.929	14.67	0.81	14.63	172.5	1514.8
E060.1	08/26/2021	19:18	WT_LAP-21-224564	30,700	1.227	130,108	27.14	4795	23.23	8.549	102.3	146.2	187,382	0.976	64,095	124.91	372.2	8.84	4.182	23.09	1.32	23.29	252.3	2365.9

Table 4.3-1 (continued)

Gaging 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**
E060.1	08/26/2021	19:20	WT_LAP-21-224565	18,400	0.935	85,951	18.99	2827	14.95	5.425	70.9	106.5	113,705	0.708	33,222	82.60	266.0	7.16	2.755	13.50	0.74	13.43	161.4	1396.6
E060.1	08/26/2021	19:22	WT_LAP-21-224566	15,000	0.855	73,745	16.74	2283	12.67	4.561	62.3	95.6	93,339	0.634	24,688	70.90	236.6	6.70	2.361	10.84	0.58	10.70	136.3	1128.7
E060.1	08/26/2021	19:24	WT_LAP-21-224567	12,600	0.798	65,129	15.14	1899	11.05	3.951	56.1	87.9	78,963	0.582	18,664	62.64	215.9	6.37	2.083	8.97	0.47	8.78	118.5	939.6
E060.1	08/26/2021	19:26	WT_LAP-21-224568	11,100	0.762	59,744	14.15	1659	10.04	3.570	52.3	83.0	69,978	0.549	14,899	57.48	202.9	6.17	1.909	7.80	0.40	7.57	107.4	821.4

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.

Table 6.1-1
Significant Geomorphic Changes and Associated Peak Discharges

Date	Gaging Station	Peak Discharge (cfs)	Noted Erosion in Geomorphic Changes Section of the Corresponding Year's Annual Report
8/5/2010	E039.1	275	The DP Canyon GCS was not damaged during storms in 2010.
8/5/2010	E056	243	Three Pueblo Canyon cross-vane structures were extensively damaged.
8/16/2010	E039.1	306	The DP Canyon GCS was not damaged during storms in 2010.
8/16/2010	E056	256	Three Pueblo Canyon cross-vane structures were extensively damaged.
8/16/2010	E059	243	Three Pueblo Canyon cross-vane structures were extensively damaged.
8/19/2011	E039.1	267	No noted major erosion/stream-altering events
8/19/2011	E040	153	No noted major erosion/stream-altering events
8/19/2011	E038	181	No noted major erosion/stream-altering events
8/21/2011	E039.1	281	No noted major erosion/stream-altering events
8/21/2011	E038	229	No noted major erosion/stream-altering events
8/21/2011	E040	208	No noted major erosion/stream-altering events
8/22/2011	E042.1	171	No noted major erosion/stream-altering events
7/11/2012	E042.1	290	Net sediment deposition for 2012 in the DP Canyon GCS area is greater than that recorded in 2011; this sediment deposition includes both channel aggradation and overbank deposition.
7/11/2012	E050.1	117	Net sediment deposition for 2012 in the DP Canyon GCS area is greater than that recorded in 2011; this sediment deposition includes both channel aggradation and overbank deposition.
8/3/2012	E042.1	211	Net sediment deposition for 2012 in the DP Canyon GCS area is greater than that recorded in 2011; this sediment deposition includes both channel aggradation and overbank deposition.
8/3/2012	E050.1	168	Net sediment deposition for 2012 in the DP Canyon GCS area is greater than that recorded in 2011; this sediment deposition includes both channel aggradation and overbank deposition.
8/3/2012	E026	130	Net sediment deposition for 2012 in the DP Canyon GCS area is greater than that recorded in 2011; this sediment deposition includes both channel aggradation and overbank deposition.
7/12/2013	E038	330	The engineered structures in Los Alamos and DP Canyons appear to have enhanced sediment deposition in these areas.
7/12/2013	E039.1	330	The engineered structures in Los Alamos and DP Canyons appear to have enhanced sediment deposition in these areas.
7/12/2013	E040	260	The engineered structures in Los Alamos and DP Canyons appear to have enhanced sediment deposition in these areas.

Table 6.1-1 (continued)

Date	Station	Peak Discharge (cfs)	Noted Erosion in Geomorphic Changes Section of the Corresponding Year's Annual Report
9/12/2013	E026	400	Although the September 2013 flood event resulted in significant erosion in most surveyed areas in Pueblo Canyon, the magnitude of the erosion was likely reduced by the sediment mitigation structures and willow plantings.
9/12/2013	E056	260	Although the September 2013 flood event resulted in significant erosion in most surveyed areas in Pueblo Canyon, the magnitude of the erosion was likely reduced by the sediment mitigation structures and willow plantings.
7/15/2014	E038	270	The net deposition observed in Los Alamos and DP Canyons was likely enhanced by the sediment mitigation structures.
7/31/2014	E039.1	250	The net deposition observed in Los Alamos and DP Canyons was likely enhanced by the sediment mitigation structures.
7/31/2014	E040	240	The net deposition observed in Los Alamos and DP Canyons was likely enhanced by the sediment mitigation structures.
7/15/2014	E040	270	The net deposition observed in Los Alamos and DP Canyons was likely enhanced by the sediment mitigation structures.
7/31/2014	E042.1	210	The net deposition observed in Los Alamos and DP Canyons was likely enhanced by the sediment mitigation structures.
7/31/2014	E050.1	201	The net deposition observed in Los Alamos and DP Canyons was likely enhanced by the sediment mitigation structures.
7/31/2015	E040	240	Minor erosion noted
7/31/2015	E039.1	220	Minor erosion noted
7/8/2017	E038	205	The LA/P watershed underwent minor geomorphologic changes during the 2017 monsoon season.
7/8/2017	E039.1	150	The LA/P watershed underwent minor geomorphologic changes during the 2017 monsoon season.
7/8/2017	E040	101	The LA/P watershed underwent minor geomorphologic changes during the 2017 monsoon season.

Note: There were no large storm events in 2016 or 2018–2021.

Table 6.3-1
2022 Los Alamos/Pueblo Storm Water Sampling Locations and Trip Level Information

Gaging Station	EIM[a] Location ID	Sampler Trip Mechanism	Trip Discharge June 1, 2022 (cfs)	Trip Discharge After One Sample is Collected (cfs)
CO101038[b]	CO101038	Liquid-level actuator	n/a[c]	n/a
CO111041[b]	CO111041	Liquid-level actuator	n/a	n/a
E026	Los Alamos below Ice Rink	Gaging station discharge	2	5
E030	Los Alamos above DP Canyon	Gaging station discharge	25	50
E038	DP above TA-21	Gaging station discharge	50	100
E039.1	DP below grade ctrl structure	Gaging station discharge	25	50
E040	DP above Los Alamos Canyon	Gaging station discharge	25	50
E042.1	Los Alamos above low-head weir	Gaging station discharge	25	50
E050.1	Los Alamos below low-head weir	Liquid-level actuator	n/a	n/a
E055	Pueblo above Acid	Gaging station discharge	25	50
E055.5	South Fork of Acid Canyon	Gaging station discharge	25	50
E056	Acid above Pueblo	Gaging station discharge	25	50
E059.5	E059.5 Pueblo below LAC WWTF	Gaging station discharge	2 above base flow	5 above base flow
E059.8	E059.8 Pueblo Below Wetlands	Gaging station discharge	2	5
E060.1	Pueblo below GCS	Liquid-level actuator	n/a	n/a

[a] EIM = Environmental Information Management System.

[b] LA-2 ponds or upper LA detention basins.

[c] n/a = Not applicable.

Table 6.3-2
Sampling Sequence for Collection of Storm Water Samples at the Detention Basins and Vegetative Buffer below the SWMU 01-001(f) Drainage

Sample Bottle (1 L)	CO101038, CO111041	
	Start Time (min) 12-Bottle ISCO	Analytical Suite
1	Trigger	SSC particle size
2	Trigger +2	PCBs (UF[a]) Part 1[b]
3	Trigger +4	DOC[c] (F[d]), alkalinity + pH (UF)
4	Trigger +6	PCBs (UF) Part 2
5	Trigger +8	TAL metals[e] + boron + uranium + hardness (F/UF), total recoverable aluminum (F10µ[f])
6	Trigger +10	Gross alpha (UF)
7	Trigger +12	SSC
8	Trigger +14	Extra bottle
9	Trigger +16	Extra bottle
10	Trigger +18	Extra bottle
11	Trigger +20	Extra bottle
12	Trigger +22	Extra bottle

[a] UF = Unfiltered.

[b] Bottles 2 and 4 are to be sent to the lab together for one PCB analysis.

[c] DOC = Dissolved organic carbon.

[d] F = Filtered through a 0.45-µm membrane.

[e] 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 Ca and Mg, components of the TAL list.

[f] F10µ = Filtered through a 10-µm membrane.

Table 6.3-3
Sampling Sequence for Collection of Storm Water Samples at E026, E030, E055, E055.5, and E056

Sample Bottle (1 L)	Start Time (min) 12-Bottle ISCO	E026 and E030	Sample Bottle	Start Time (min) 12-Bottle ISCO	E055, E055.5, and E056
		Analytical Suites			Analytical Suites
1	Max+10	SSC particle size	1	Max+10	SSC; particle size
2	Max+12	PCBs (UF[a]) Part 1[b]	2	Max+12	PCBs (UF) Part 1
3	Max+14	DOC[c] (F[d]), alkalinity + pH (UF)	3	Max+14	DOC (F), alkalinity + pH (UF)
4	Max+16	PCBs (UF) Part 2	4	Max+16	PCBs (UF) Part 2
5	Max+18	TAL metals[e] + boron + uranium + hardness (F/UF), total recoverable aluminum (F10µ[f])	5	Max+18	TAL metals + boron + uranium + hardness (F/UF), total recoverable aluminum (F10µ)

Table 6.3-3 (continued)

Sample Bottle (1 L)	Start Time (min) 12-Bottle ISCO	E026 and E030 Analytical Suites	Sample Bottle	Start Time (min) 12-Bottle ISCO	E055, E055.5, and E056 Analytical Suites
6	Max+20	Dioxins and furans (UF)	6	Max+20	Americium-241 (UF), isotopic plutonium (UF)
7	Max+22		7	Max+22	Gamma spectroscopy (UF), gross alpha (UF)
8	Max+24	Strontium-90 (UF)	8	Max+24	
9	Max+26	Gamma spectroscopy[g] (UF), gross alpha (UF), isotopic plutonium (UF)	9	Max+26	SSC
10	Max+28		10	Max+28	Extra bottle
11	Max+30	SSC	11	Max+30	Extra bottle
12	Max+32	Extra bottle	12	Max+32	Extra bottle

[a] UF = Unfiltered.

[b] Bottles 2 and 4 are to be sent to the lab together for one PCB analysis.

[c] DOC = Dissolved organic carbon.

[d] F = Filtered through a 0.45-µm membrane.

[e] 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 Ca and Mg, components of the TAL list.

[f] F10µ = Filtered through a 10-µm membrane.

[g] Gamma spectroscopy = Ac-228, Be-7, Bi-212, Bi-214, Cs-134, Cs-137, Co-60, gross gamma, I-131, Pb-212, Pb-214, K-40, Pa-234, Na-22, Tl-208, and Th-234.

Table 6.3-4
Sampling Sequence for Collection of Storm Water Samples at E038, E039.1, and E040

Sample Bottle (1 L)	Start Time (min) 12-Bottle ISCO	E038, E039.1, and E040 Analytical Suites	E038 and E039.1 Start Time (min) 24-Bottle ISCO	E038 and E039.1 Analytical Suites 24-Bottle ISCO 1-L Poly Wedge
1	Max+10	SSC particle size	Trigger	SSC
2	Max+12	PCBs (UF[a]) Part 1[b]	Trigger+2	SSC
3	Max+14	DOC[c] (F[d]), alkalinity + pH (UF)	Trigger+4	SSC
4	Max+16	PCBs (UF) Part 2	Trigger+6	SSC
5	Max+18	TAL metals[e] + boron + uranium + hardness (F/UF), total recoverable aluminum (F10µ[f])	Trigger+8	SSC
6	Max+20	Strontium-90 (UF)	Trigger+10	SSC
7	Max+22	Gamma spectroscopy[g] (UF), gross alpha (UF), isotopic plutonium (UF)	Trigger+12	SSC
8	Max+24		Trigger+14	SSC
9	Max+26	SSC	Trigger+16	SSC
10	Max+28	Extra bottle	Trigger+18	SSC
11	Max+30	Extra bottle	Trigger+20	SSC
12	Max+32	Extra bottle	Trigger+22	SSC

Table 6.3-4 (continued)

Sample Bottle (1 L)	Start Time (min) 12-Bottle ISCO	E038, E039.1, and E040	E038 and E039.1	
		Analytical Suites	Start Time (min) 24-Bottle ISCO	Analytical Suites 24-Bottle ISCO 1-L Poly Wedge
13	n/a[h]	n/a	Trigger+24	SSC
14	n/a	n/a	Trigger+26	SSC
15	n/a	n/a	Trigger+28	SSC
16	n/a	n/a	Trigger+30	SSC
17	n/a	n/a	Trigger+50	SSC
18	n/a	n/a	Trigger+70	SSC
19	n/a	n/a	Trigger+90	SSC
20	n/a	n/a	Trigger+110	SSC
21	n/a	n/a	Trigger+130	SSC
22	n/a	n/a	Trigger+150	SSC
23	n/a	n/a	Trigger+170	SSC
24	n/a	n/a	Trigger+190	SSC

[a] UF = Unfiltered.

[b] Bottles 2 and 4 are to be sent to the lab together for one PCB analysis.

[c] DOC = Dissolved organic carbon.

[d] F = Filtered through a 0.45-µm membrane.

[e] 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 Ca and Mg, components of the TAL list.

[f] F10µ = Filtered through a 10-µm membrane.

[g] Gamma spectroscopy = Ac-228, Be-7, Bi-212, Bi-214, Cs-134, Cs-137, Co-60, gross gamma, I-131, Pb-212, Pb-214, K-40, Pa-234, Na-22, Tl-208, and Th-234.

[h] n/a = Not applicable.

Table 6.3-5
Sampling Sequence for Collection of Storm Water Samples at E042.1

Sample Bottle (1 L)	Start Time (min) 12-Bottle ISCO	Analytical Suites 12-Bottle ISCO	Start Time (min) 24-Bottle ISCO	Analytical Suites 24-Bottle ISCO 1-L Poly Wedge
1	Max+10	SSC particle size	Trigger	SSC
2	Max+12	PCBs (UF[a]) Part 1[b]	Trigger+2	SSC
3	Max+14	DOC[c] (F[d]), alkalinity + pH (UF)	Trigger+4	SSC
4	Max+16	PCBs (UF) Part 2	Trigger+6	SSC
5	Max+18	TAL metals[e] + boron + uranium + hardness (F/UF), total recoverable aluminum (F10µ[f])	Trigger+8	SSC
6	Max+20	Dioxins and furans (UF)	Trigger+10	SSC
7	Max+22	Strontium-90 (UF)	Trigger+12	SSC
8	Max+24	Gamma spectroscopy[g] (UF), gross alpha (UF)	Trigger+14	SSC
9	Max+26		Trigger+16	SSC
10	Max+28	Americium-241 (UF), isotopic plutonium (UF)	Trigger+18	SSC
11	Max+60	SSC	Trigger+20	SSC
12	Max+62	Extra bottle	Trigger+22	SSC
13	n/a[h]	n/a	Trigger+24	SSC
14	n/a	n/a	Trigger+26	SSC
15	n/a	n/a	Trigger+28	SSC
16	n/a	n/a	Trigger+30	SSC
17	n/a	n/a	Trigger+50	SSC
18	n/a	n/a	Trigger+70	SSC
19	n/a	n/a	Trigger+90	SSC
20	n/a	n/a	Trigger+110	SSC
21	n/a	n/a	Trigger+130	SSC
22	n/a	n/a	Trigger+150	SSC
23	n/a	n/a	Trigger+170	SSC
24	n/a	n/a	Trigger+190	SSC

[a] UF = Unfiltered.

[b] Bottles 2 and 4 are to be sent to the lab together for one PCB analysis.

[c] DOC = Dissolved organic carbon.

[d] F = Filtered through a 0.45-µm membrane.

[e] 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 Ca and Mg, components of the TAL list.

[f] F10µ = Filtered through a 10-µm membrane.

[g] Gamma spectroscopy = Ac-228, Be-7, Bi-212, Bi-214, Cs-134, Cs-137, Co-60, gross gamma, I-131, Pb-212, Pb-214, K-40, Pa-234, Na-22, Tl-208, and Th-234.

[h] n/a = Not applicable.

Table 6.3-6
Sampling Sequence for Collection of Storm Water Samples at E059.5 and E059.8

Sample Bottle (1 L)	Start Time (min) 12-Bottle ISCO	Analytical Suites 12-Bottle ISCO	Start Time (min) 24-Bottle ISCO	Analytical Suites 24-Bottle ISCO 1-L Poly Wedge
1	Max+10	SSC particle size	Trigger	SSC
2	Max+12	PCBs (UF[a]) Part 1[b]	Trigger+2	SSC
3	Max+14	DOC[c] (F[d]), alkalinity + pH (UF)	Trigger+4	SSC
4	Max+16	PCBs (UF) Part 2	Trigger+6	SSC
5	Max+18	TAL metals[e] + boron + uranium + hardness (F/UF), total recoverable aluminum (F10µ[f])	Trigger+8	SSC
6	Max+20	Strontium-90 (UF)	Trigger+10	SSC
7	Max+22	Americium-241 (UF), isotopic plutonium (UF)	Trigger+12	SSC
8	Max+24	Gamma spectroscopy[g] (UF), gross alpha (UF)	Trigger+14	SSC
9	Max+26		Trigger+16	SSC
10	Max+28	SSC	Trigger+18	SSC
11	Max+60	Extra bottle	Trigger+20	SSC
12	Max+62	Extra bottle	Trigger+22	SSC
13	n/a[h]	n/a	Trigger+24	SSC
14	n/a	n/a	Trigger+26	SSC
15	n/a	n/a	Trigger+28	SSC
16	n/a	n/a	Trigger+30	SSC
17	n/a	n/a	Trigger+50	SSC
18	n/a	n/a	Trigger+70	SSC
19	n/a	n/a	Trigger+90	SSC
20	n/a	n/a	Trigger+110	SSC
21	n/a	n/a	Trigger+130	SSC
22	n/a	n/a	Trigger+150	SSC
23	n/a	n/a	Trigger+170	SSC
24	n/a	n/a	Trigger+190	SSC

[a] UF = Unfiltered.

[b] Bottles 2 and 4 are to be sent to the lab together for one PCB analysis.

[c] DOC = Dissolved organic carbon.

[d] F = Filtered through a 0.45-µm membrane.

[e] 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 Ca and Mg, components of the TAL list.

[f] F10µ = Filtered through a 10-µm membrane.

[g] Gamma spectroscopy = Ac-228, Be-7, Bi-212, Bi-214, Cs-134, Cs-137, Co-60, gross gamma, I-131, Pb-212, Pb-214, K-40, Pa-234, Na-22, Tl-208, and Th-234.

[h] n/a = Not applicable.

Table 6.3-7
Sampling Sequence for Collection of Storm Water Samples at E050.1 and E060.1

Sample Bottle (1 L)	Start Time (min) 12-Bottle ISCO	Analytical Suites 12-Bottle ISCO	Start Time (min) 24-Bottle ISCO	Analytical Suites 24-Bottle ISCO 1-L Poly Wedge
1	Max+10	SSC particle size	Trigger	SSC
2	Max+12	PCBs (UF[a]) Part 1[b]	Trigger+2	SSC
3	Max+14	DOC[c] (F[d]), alkalinity + pH (UF)	Trigger+4	SSC
4	Max+16	PCBs (UF) Part 2	Trigger+6	SSC
5	Max+18	TAL metals[e] + boron + uranium + hardness (F/UF), total recoverable aluminum (F10µ[f])	Trigger+8	SSC
6	Max+20	Dioxins and furans (UF)	Trigger+12	SSC
7	Max+22		Trigger+14	SSC
8	Max+24	Strontium-90 (UF)	Trigger+16	Gross beta (UF)
9	Max+26	Gamma spectroscopy[g] (UF), gross alpha (UF)	Trigger+18	SSC
10	Max+28	Isotopic plutonium (UF), americium-241 (UF), isotopic uranium (UF)	Trigger+20	Radium-226/radium-228 (UF)
11	Max+60		Trigger+22	
12	Max+62	SSC	Trigger+24	SSC
13	n/a[h]	n/a	Trigger+26	Per this monitoring plan, section 3.6: TAL metals + boron + uranium + hardness (F/UF), solid phase TAL metals + boron + uranium, SSC
14	n/a	n/a	Trigger+28	
15	n/a	n/a	Trigger+30	SSC
16	n/a	n/a	Trigger+50	SSC
17	n/a	n/a	Trigger+70	SSC
18	n/a	n/a	Trigger+90	SSC
29	n/a	n/a	Trigger+110	SSC
20	n/a	n/a	Trigger+130	SSC
21	n/a	n/a	Trigger+150	SSC
21	n/a	n/a	Trigger+170	SSC
23	n/a	n/a	Trigger+190	SSC
24	n/a	n/a	Trigger+210	SSC

[a] UF = Unfiltered.

[b] Bottles 2 and 4 are to be sent to the lab together for one PCB analysis.

[c] DOC = Dissolved organic carbon.

[d] F = Filtered through a 0.45-µm membrane.

[e] 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 Ca and Mg, components of the TAL list.

[f] F10µ = Filtered through a 10-µm membrane.

[g] Gamma spectroscopy = Ac-228, Be-7, Bi-212, Bi-214, Cs-134, Cs-137, Co-60, gross gamma, I-131, Pb-212, Pb-214, K-40, Pa-234, Na-22, Tl-208, and Th-234.

[h] n/a = Not applicable.

Appendix A

Acronyms and Abbreviations

A-1.0 ACRONYMS AND ABBREVIATIONS

3-D	three-dimensional
AAL	acute aquatic life
ASER	Annual Site Environmental Report
ASTM	American Society for Testing and Materials
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
DOC	dissolved organic carbon
DOE	Department of Energy (U.S.)
DP	Delta Prime
EIM	Environmental Information Management System
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 detection and ranging
LW	livestock watering
MDA	minimum detectable activity
MDL	method detection limit
MOU	memorandum of understanding
N3B	Newport News Nuclear BWXT-Los Alamos, LLC

NAVD 88	North American Vertical Datum of 1988
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
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
T2S	Tech2 Solutions
TAL	target analyte list (EPA)
TCDD[2,3,7,8]	2,3,7,8 tetrachlorodibenzo-p-dioxin
TIN	triangular irregular network
UF	unfiltered
WH	wildlife habitat
WWTF	wastewater treatment facility

Appendix B

2021 Geomorphic Changes at
Sediment Transport Mitigation Sites in the
Los Alamos/Pueblo Canyon Watershed

B-1.0 INTRODUCTION

This appendix evaluates geomorphic change that occurred between 2018 and 2021 at sediment transport mitigation sites in the Los Alamos/Pueblo Canyon watershed within and near Los Alamos National Laboratory (LANL or the Laboratory). Geomorphic change was evaluated using aerial light detection and ranging (LiDAR) data collected in November 2018 and October 2021. Ground-based and aerial-based survey data in Los Alamos, Pueblo, and Delta Prime (DP) Canyons were reported previously (LANL 2011, 200902; LANL 2012, 218411; LANL 2015, 600439; LANL 2016, 601433; LANL 2017, 602343; LANL 2018, 603023; N3B 2019, 700419). Figure B-1.0-1 shows Los Alamos/Pueblo Canyon watershed sediment transport mitigation sites discussed in this appendix.

The current methodology, in which LiDAR surveys are planned to occur every 3 yr, was originally outlined in the “2019 Monitoring Plan for Los Alamos and Pueblo Watershed” (N3B 2019, 700418), and replaced the biennial aerial-based LiDAR surveys plus annual ground-based Global Positioning System (GPS) surveys. Aerial-derived data sets from 2018 and 2021 are compared to depict land surface variability aimed at evaluating the stability of the Los Alamos and Pueblo watershed.

Aerial-based vegetation surveys were completed in September 2019 and are scheduled for August 2022, and results will be discussed in the 2022 annual report. The next aerial-based geomorphic survey is scheduled for fall 2025, to be conducted concurrently with the aerial-based vegetation survey in 2025.

B-2.0 AERIAL LiDAR SURVEY METHODS OF THE LOS ALAMOS/PUEBLO CANYON WATERSHED

LiDAR surveying is a process by which lasers are directed at a surface and the resulting reflections are used to calculate the distance to the surface. Aerial LiDAR surveying involves mounting the LiDAR equipment on an airplane and flying a known course while directing lasers at the ground surface to generate a three-dimensional (3-D) point cloud of the surface.

Aerial LiDAR surveying is the most practical method to evaluate topographic change over large areas such as the watercourses of Los Alamos and Pueblo Canyons. Other survey techniques require extensive fieldwork, making the surveying cost prohibitive, and provide only estimates of the overall area of interest, resulting in large propagated error estimates of topographic change. While there are difficulties associated with accurately capturing the ground land surface over particular land covers (i.e., dense vegetation, steep elevation gradient, and water) with aerial-based LiDAR surveys compared with ground-based transect surveys, the accuracy of aerial-based surveys far outweighs these disadvantages. Also, the collection of vegetation data along with the geomorphic data and ground-truth surveying will help remedy these issues.

In 2018, surveys of the Los Alamos and Pueblo Canyon watersheds were performed using aerial LiDAR equipment to collect geomorphic data. In 2021, repeat LiDAR surveys of the watersheds were conducted. The LiDAR surveys provide a detailed representation of the land surface for the entire watershed, and geomorphic change was identified by comparing the 2018 and 2021 LiDAR survey data.

B-2.1 Aerial LiDAR Survey Data Collection and Processing

The 2018 LiDAR data were collected with a RIEGL 1560i LiDAR sensor and a Phase One digital frame camera mounted on a fixed-wing aircraft. LiDAR was acquired with a point density of 6 points per square meter. Figure B-2.1-1 presents the point density for this survey in the Los Alamos and Pueblo Canyon watershed. See Attachment B-1 (on CD included with this document) for a detailed description the LiDAR collection process in 2018. The 2021 LiDAR data were collected with a Galaxy T2000 LiDAR sensor mounted on a fixed-wing aircraft and the point density (points per square meter) in the Los Alamos and Pueblo Canyon watershed is presented in Figure B-2.1-2. The Galaxy T2000 scanner collects points at a density of 6.8 points per square meter and to ensure point density thresholds were met, double coverage was planned into the LiDAR flights (see Attachment B-2 [on CD included with this document] for a detailed description of coverage over the area of interest and the flight plan). Ground points were collected to accompany the aerial survey in 2021. Attachment B-2 provides details as to how the ground points were used to calibrate and quality-check the LiDAR flights. These ground survey points serve as calibration and check points, and the complete summary of the ground survey and the survey points is included as Attachment B-3 (on CD included with this document).

B-2.2 Digital Elevation Model Generation and Geomorphic Change Estimation Procedures

A raster-based change detection approach was performed for the 2018 and 2021 data sets. A digital elevation model (DEM) was created through DEM differencing by comparing elevations from 2018 and 2021. The change-detection DEM represents the vertical difference between the 2021 ground elevations and the 2018 ground elevations; further detail of the data processing is included in Attachment B-2. Negative values (2021 elevation is less than 2018 elevation) indicate areas of erosion or sediment loss; positive values (2021 elevation is greater than 2018 elevation) indicate areas of aggradation or sediment accumulation. Elevation changes from −0.5 foot to +0.5 foot are set to “transparent” as a threshold; otherwise every grid cell would show a value. These thresholds are based on the absolute vertical accuracy of LiDAR quality Level 1 data, which is approximately 10 cm. However, when change detection between two data sets is calculated, the vertical accuracy decreases to about 14 cm (or approximately 0.5 ft) because of error propagation.

A vector-based change detection approach was also performed for the 2018 and 2021 data sets as well. This approach used only the “ground” classified points from the LiDAR point cloud and implemented a vertical threshold of 1 ft of change and a point cluster size of 800 ft^2. The vertical and point size clusters were selected to avoid false positives from change that was related to either vertical or horizontal error. Additional details regarding the collection of LiDAR data, developments of surface and change-detection DEMs, and change-detection vector data can be found in the LiDAR data delivery report (Attachment B-2).

While aerial-based surveys are more accurate than ground-based transect surveys at detecting changes in the land surface, it is important to note the limitations of LiDAR analysis in densely vegetated areas or near steep cliffs, both of which are present in the Los Alamos and Pueblo watershed. In areas of dense vegetation (i.e., reed canary grass or dense tree canopy), the improper assignment of vegetation points as ground-classified points is more likely than in areas of sparse vegetation cover. When these “ground” (actually vegetation) points are used as part of the 3-D point cloud to generate the ground-surface DEM, they contribute to elevation-change anomalies. The change calculations will therefore identify some elevation changes that are from changes in vegetation height rather than from changes in the ground surface caused by either channel processes (e.g., sediment erosion or deposition) or other geomorphic processes occurring outside the channel itself. In 2022, an aerial vegetation survey will be conducted and the combination of the vegetation and geomorphic data (to be included in the 2022 annual report) will more accurately characterize change in densely vegetated areas.

The complication near steep elevation gradients arises because these areas are typically characterized by cliffs, steep embankments, and large boulders. These steep areas are not captured particularly well within the LiDAR data sets. Therefore, large amounts of elevation change may be observed though no real topographic change has occurred at the canyon edges. Ground-truth surveys to confirm change detection will be performed.

Finally, water is opaque to LiDAR; therefore, sediment erosion/deposition features that are submerged at the time of surveying are not captured. This can cause the change-detection algorithms to generate areas of significant change although no real change has occurred.

B-3.0 HYDROLOGIC EVENTS DURING 2021 MONSOON SEASON

Drought conditions persisted in 2021, resulting in low-magnitude and low-intensity storm events. Drought conditions in the years between the 2018 and 2021 LiDAR surveys are evident in the minimal change detected in the data. The largest storm water runoff events in 2021 at the sediment transport mitigation sites in the Los Alamos and Pueblo Canyon watershed occurred as follows (see section 3 of the report for additional details):

- Pueblo Canyon (gaging stations E055, E059.5, E059.8, and E060.1): August 15, August 26, August 28, and October 1;
- DP Canyon (gaging stations E038 and E039.1): June 27, July 31, August 15, August 26, and October 1; and
- Los Alamos Canyon (gaging stations E026, E030, E042.1 and E050.1): August 15 and August 26.

As demonstrated in Table B-3.0-1, the 2021 peak discharges were below average at all gaging stations, further indicating the persisting drought. Persistent drought conditions and low-magnitude, low-intensity storms resulted in minimal geomorphic change throughout the watershed.

B-4.0 RESULTS

The 2021 monsoonal season resulted in minor changes to geomorphology within the Los Alamos and Pueblo Canyon watershed. This was confirmed by both the change detection in LiDAR survey results between 2018 and 2021 and the biannual surveys of the grade control structures (GCSs) (see Appendix C for details of the survey findings). In addition, an annual walkdown of the sediment transport mitigation sites with the New Mexico Environment Department (NMED) was performed in 2021, and minimal change was identified.

B-4.1 Thalweg and Channel Banks

The LiDAR data were used to derive the thalweg from both the 2018 and 2021 DEMs extending from E059.5 to E060.1 (Figure B-4.1-1 and Figure B-4.1-2). The channel thalweg vertical profile, shown in Figure B-4.1-3, compares the 2018 and 2021 LiDAR-derived thalwegs. The greatest change in thalweg elevation was an apparent increase of 2-4 ft below the Pueblo Canyon drop structure and propagating downstream to the Pueblo Canyon GCS. This difference in elevation is due to lateral thalweg migration and vegetation impacts near the drop structure, not due to sediment deposition or streambed aggradation. The average amount of vertical change in the thalweg was 0.3-ft increase in elevation, with the median amount of vertical change being similar at 0.4 ft increase in elevation.

The thalwegs derived from the DEMs demonstrate that, on average, the thalweg migrated laterally approximately 22 ft in areas that did shift. Of the total thalweg length (9145 ft), 3720 ft (or 41% of the total length) showed a distinct change between 2018 and 2021, and 5425 ft (or 59% of the total length) did not show a distinct change between 2018 and 2021. Small lateral shifts in the thalweg are normal as the channel establishes preferential flow paths and new sediment erosion/deposition occurs. The greatest lateral shifts occurred in the dense wetland area upstream of the Pueblo Canyon drop structure, and historically this area has had a dynamic, nearly braided, preferential flow path; thus this behavior is expected. The overall minor average vertical and lateral change in the thalweg between 2018 and 2021 are indicative of a stable system. Areas of significant lateral or vertical thalweg shifts will be monitored for changing conditions.

Channel banks for 2018 and 2021 were derived using the DEMs for the respective years. Overall, the channel banks are stable and show mostly minor changes in bank position over the Pueblo Canyon monitoring area from 2018 to 2021 (Figure B-4.1-4). As another indicator of geomorphic stability, while the thalweg experienced minor lateral and vertical migration between 2018 and 2021, it remained within the channel banks as identified from the aerial imagery.

B-4.2 Pueblo Canyon Background Area above the Wastewater Treatment Facility

The Pueblo Canyon background area is the stream reach above the wastewater treatment facility (WWTF) (Figure B-1.0-1) and it serves as a reference reach to identify change in the upper Pueblo Canyon watershed that may result in additional sediment migration downstream.

The geomorphic elevation changes in this reach were minimal near the stream and its direct banks (Figure B-4.2-1). The majority of elevation changes were on the canyon bluffs' tops or along the steep inclined banks and ridge line; however, as stated previously, change can be exaggerated in areas with steep elevation gradients. Minimal changes in the background area are an indication of a stable system.

B-4.3 Pueblo Canyon E059.5 to WWTF (Upper Willow Planting Area)

The Pueblo Canyon reach identified as E059.5 to the WWTF includes the area previously identified as the upper willow planting area (Figure B-1.0-1). A large flood event in 2008 caused major erosion in this area and willows were planted in 2009 to stabilize the channel.

The comparison of geomorphic changes detected in the LiDAR surveys in 2018 and 2021 showed minimal elevation variations near the stream and channel banks (Figure B-4.3-1).

B-4.4 Pueblo Canyon E059.8 to E059.5 (Pueblo Canyon Drop Structure)

The Pueblo Canyon reach identified as E059.8 to E059.5 includes the area previously identified as the lower willow planting area, as well as the Pueblo Canyon drop structure (Figure B-1.0-1). A headcut in this area (near gaging station E059.8) propagated upstream during the very large flood event in 2013. In 2014 to 2015, the Pueblo Canyon drop structure was constructed to prevent further headcut propagation or erosion and willows were planted to stabilize the channel.

The comparison of geomorphic changes detected in the LiDAR surveys in 2018 and 2021 showed one significant area of change defined as greater than 1 ft vertical change over 800 ft^2. This area is upstream of the Pueblo Canyon drop structure on the river's left, looking downstream (Figure B-4.4-1). This change was a net loss in elevation between 2018 and 2021 (2021 elevation is less than 2018 elevation) attributed to standing water present during the 2018 LiDAR survey that was not present during the 2021 LiDAR survey because of exceptional drought conditions. The remainder of the reach showed minimal elevation variations near the stream and channel banks.

B-4.5 Pueblo Canyon E060.1 to E059.8 (Pueblo Canyon GCS)

The furthest downstream Pueblo Canyon reach extends from gaging station E059.8 to E060.1 and includes the Pueblo Canyon GCS (Figure B-1.0-1). A headcut in this area (near gaging station E060.1) propagated upstream during a large flood event in 2008. In 2009 to 2010, the Pueblo Canyon GCS was constructed to prevent further headcut propagation or erosion.

The comparison of geomorphic changes detected in the LiDAR surveys in 2018 and 2021 showed minimal elevation variations near the stream and channel banks (Figure B-4.5-1). Overall, the Pueblo Canyon GCS area has been geomorphically stable with only minor changes since 2018.

B-4.6 Upper Los Alamos Canyon Detention Basins

The Upper Los Alamos Canyon sediment detention basins are located at the base of the drainage below Solid Waste Management Unit 01-001(f) (also known as LA-SMA-2.1 or Hillside 140) and are shown in Figure B-1.0-1.

The comparison of geomorphic changes detected in the LiDAR surveys in 2018 and 2021 showed one significant area of elevation loss within the detention basins. The significant decrease of elevation that occurred within the detention basins is because of the presence of standing water in the 2018 LiDAR survey that was not present in the 2021 LiDAR survey (Figure B-4.6-1). Within the sediment detention basins, there was some evidence of sedimentation, which is expected in basins designed to capture and retain sediment. This is supported by the findings in the biannual GCS inspections (Appendix C). There were minor elevation variations along the stream and channel banks. Comparison of the 2018 and 2021 DEMs reveals areas of elevation change along the canyon walls, most likely because of soil/rock falls or exaggerated change in areas with steep elevation gradients. Overall, the Los Alamos Canyon detention basin area is geomorphically stable with only minor changes since 2018.

B-4.7 Los Alamos Canyon Low-Head Weir and Associated Basins

The Los Alamos Canyon low-head weir and the associated sediment detention basins are located upstream of the confluence of Los Alamos Canyon with Pueblo Canyon, near the intersection of NM 4 and Omega Road (Figure B-1.0-1). The three basins and weir were constructed after the Cerro Grande Fire in 2000 to detain sediment and to reduce the energy of storm water runoff, which may cause erosion downstream.

Between 2018 and 2021, there were two significant areas of change: sedimentation (elevation gain) in the upper and middle basins, and apparent erosion (elevation loss) in the lower basin (Figure B-4.7-1). Sediment accumulation occurred in the two upper sediment basins; thus these basins are performing as designed. The elevation loss in the lower basin is because of the presence of standing water during the 2018 LiDAR survey, but not during the 2021 LiDAR survey because of exceptional drought conditions. Changes in elevation below the weir were minimal and indicate the weir is functioning well with sediment accumulating upstream of the weir and minimal erosion occurring downstream of the weir.

B-4.7.1 Los Alamos Canyon Low-Head Weir Basins’ Stage/Storage Relationship

The available storage remaining in the sediment detention basins above the Los Alamos low-head weir was determined with a stage/storage table (Table B-4.7-1). The sediment detention basins’ stage/storage relationship was developed using the 2014 LiDAR data in North American Vertical Datum of 1988 (NAVD 88). The sediment detention basins were cleaned out in April 2014; therefore, the sediment storage volume from the 2014 LiDAR, collected in June 2014, is used as a baseline for total available sediment storage in the basins. The capacity of each basin was measured in ArcGIS using the 2014 LiDAR. Note that the middle basin is within the ponding area of the lower basin (Table B-4.7-2).

In Table B-4.7-2, the percent of sediment storage remaining (shown in Figure B-4.7-2), and percent of basin capacity (shown in Figure B-4.7-3) were calculated for the lower basin. This analysis assumed that the upper and middle basins are at capacity based on 2015 inspection notes. The staff plate readings were assigned an elevation based on the LiDAR elevation of the top of the low-head weir spillway, and level and rod readings were collected in the field.

The detention basins' available sediment storage volume was determined from the 2014, 2018, and 2021 LiDAR data in the NAVD 88 datum. Available sediment storage volumes were determined for each year by creating a triangular irregular network (TIN) surface from the point cloud LiDAR data in ArcGIS, then creating a top-of-basin polygon from the 6358.7-ft contour polyline. The low-head weir spillway elevation was verified to be 6358.7 ft for 2014, 2018, and 2021. The "Polygon Volume" tool was then used to determine the available sediment storage between the top-of-basin polygon and the TIN surface for each year.

The 2018 to 2021 change-detection vector data indicated that there was a total erosion volume of 2916 ft^3 and a total aggradation volume of 14,751 ft^3 in the basins. The erosion volume was determined to be from standing water, which translated to capacity being artificially added to the measured available sediment storage volume for 2018. The aggradation volume is close to the difference between the available sediment storage volume change between 2018 and 2021 of 10,794 ft^3. Table B-4.7-3 presents the volume of available storage, the percent storage remaining, and the percent of basin capacity.

The LiDAR change-detection analysis was performed in conjunction with field measurements collected during the biannual inspections (see Appendix C). Two measurements were collected at the Los Alamos low-head weir during the October 2021 inspection: (1) one measurement at the lowest point of the basins equaling a 1.69-ft staff plate reading, and (2) one measurement at the staff plate of 4.80 ft. The 1.69-ft staff plate reading correlates to an available storage volume remaining of 84%, and the 4.80-ft reading correlates to an available storage volume remaining of 61%. When these stage/storage results are compared with the 2021 LiDAR, the available storage analysis result of 52% volume remaining shows that the stage/storage analysis is underestimating the remaining capacity. This is likely because transported sediment is moving into the upper portion of the basin as opposed to the lower portion where the staff plate is located. The stage/storage relationship will be re-evaluated in 2022 to continue to refine the stage/storage table and field measurement protocol.

B-4.8 DP Canyon GCS and Upstream Wetland Area

The DP Canyon GCS area of interest includes the GCS itself, upstream to the upper end of the wetland area above the GCS (Figure B-1.0-1). The DP Canyon GCS was constructed in 2009 to 2010 to stabilize a headcut that formed after a large storm event in 2008.

The comparison of geomorphic changes detected in the LiDAR surveys in 2018 and 2021 showed minimal elevation variations near the stream and channel banks, showing minor erosion and deposition in the wetland area and minor erosion along the upstream end of the GCS (Figure B-4.8-1). All elevation changes near the stream were less than 1 ft of gain or loss. The elevation change occurring in the wetland area may be an artifact of the dense vegetation, showing vegetation growth and senescence versus actual change. The minor sediment deposition along the structure is most likely from streamflow overtopping the GCS. Overall, the DP Canyon GCS area has been geomorphically stable with only minor changes since 2018.

B-5.0 CONCLUSIONS AND RECOMMENDATIONS

Drought conditions persist in the Los Alamos and Pueblo Canyon watershed, as evidenced in the low-magnitude peak discharge during the 2021 monsoon season. In 2021, storm water runoff peak discharge did not exceed 100 cubic feet per second at any gaging station across the watershed.

Thalwegs derived from the 2018 and 2021 LiDAR data for Pueblo Canyon indicate few changes in the overall thalweg movement between the two surveys. Small areas of lateral and vertical thalweg migration were observed that are attributable to adjustments as the channel continues to evolve following the very large flood event in 2013. Channel banks derived from the 2018 and 2021 LiDAR data indicate there were minimal changes and provide further evidence of the stability of the system.

Two different change-detection methods were used to compare the 2018 and 2021 LiDAR surveys: (1) a raster method based on the difference between the 2018 and 2021 LiDAR point cloud–derived DEMs, and (2) a vector method based on the difference between the 2018 and 2021 LiDAR point cloud–derived TINs and constrained to detect significant change greater than 1 ft in the vertical and 800 ft^2 in the horizontal.

Three areas of significant change (greater than 1 ft vertical and 800 ft^2 horizontal) were identified: (1) upstream of the Pueblo Canyon drop structure (Figure B-4.4-1), (2) basin 1 of the upper Los Alamos detention basins (Figure B-4.6-1), and (3) the sediment detention basin associated with the Los Alamos low-head weir (Figure B-4.7-1). The presence of standing water in these three locations during the 2018 LiDAR survey resulted in artificial elevation loss; that is, the 2021 elevation is less than the 2018 elevation because water that was present in 2018 was not present in 2021. However, the overall low magnitude of geomorphic change detected between the 2018 and 2021 LiDAR surveys provides evidence that the Los Alamos and Pueblo Canyon watershed is stable and that the sediment transport mitigations are functioning as designed.

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 2025 (the geomorphology survey has been shifted one year to better align with the vegetation survey). The next vegetation survey is scheduled to occur in the summer of 2022, and beginning with the 2022 annual report, both the vegetation and geomorphic data will be presented together. This change will allow for a more comprehensive analysis of the stability of the Los Alamos and Pueblo Canyon watershed. The vegetation surveys assess the extent and species composition of wetland vegetation, as well as the overall health of the vegetation and vegetation height. The stability of wetland vegetation is tightly connected to geomorphic stability. Being able to display these data together will be especially helpful in interpreting the geomorphic change-detection results, as the presence of dense vegetation may impact the accuracy of the analysis.

B-6.0 REFERENCES AND MAP DATA SOURCES

B-6.1 References

The following reference list includes documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID.ERIDs were assigned by Los Alamos National Laboratory's (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).

LANL (Los Alamos National Laboratory), February 2011. "Baseline Geomorphic Conditions at Sediment Transport Mitigation Sites in the Los Alamos and Pueblo Canyon Watersheds, Revision 1," Los Alamos National Laboratory document LA-UR-11-0936, Los Alamos, New Mexico. (LANL 2011, 200902)

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LANL (Los Alamos National Laboratory), May 2015. "2014 Monitoring Report for Los Alamos/ Pueblo Watershed Sediment Transport Mitigation Project," Los Alamos National Laboratory document LA-UR-15-21413, Los Alamos, New Mexico. (LANL 2015, 600439)

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)

LANL (Los Alamos National Laboratory), April 2018. "2017 Monitoring Report for Los Alamos/ Pueblo Watershed Sediment Transport Mitigation Project," Los Alamos National Laboratory document LA-UR-18-23237, Los Alamos, New Mexico. (LANL 2018, 603023)

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)

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)

B-6.2 Map Data Sources

The following list provides data sources for maps included in this appendix.

Grade control structure: As published, N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) (Q: GIS DATA) Project: 12-Projects\12-0019\shp\dissolve_cad_export.shp; Information assumed to have originated from TPMC and was transferred to N3B/T2S sometime during the 2018 timeframe. Data as published, 2019.

Canyon Reaches: As published; Triad SDE Spatial Geodatabase: GISPUBPRD1\PUB.regulatory\PUB.canyon_reaches; February 2022.

Drainage features: As published; Triad SDE Spatial Geodatabase: GISPUBPRD1\PUB.Hydrology\PUB.EM_sw_watercourse; February 2022.

Cascade Pool: As published, N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) (Q: GIS DATA) Project: 14-0015\shp\sandia_wetlands\cascade_pool.shp; Information assumed to have originated from TPMC and was transferred to N3B/T2S sometime during the 2018 timeframe. Data as published, February 2022.

Culvert: As published, N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) (Q: GIS DATA) Project: 14-0015\shp\sandia_wetlands\site_culverts.shp; Data as published, February 2022.

Tech Areas: As published; Triad SDE Spatial Geodatabase: GISPUBPRD1\PUB.Boundaries\PUB.tecareas; December 2020.

Buildings: As published, County of Los Alamos GIS Server: (https://gis.losalamosnm.us/securegis/rest/services/basemaps/basemap/FeatureServer); February 2022.

Paved Road: As published; Triad SDE Spatial Geodatabase: GISPUBPRD1\PUB.Infrastructure\PUB.paved_rds_arc; February 2022.

Unpaved Road: As published; Triad SDE Spatial Geodatabase: GISPUBPRD1\PUB.Infrastructure\PUB.paved_rds_arc, February 2022.

Former Los Alamos County landfill: As published, N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) (Q: GIS DATA) Project: 14-0015; project_data.gdb; former_LA_landfill; February 2022.

Fences: As published; Triad SDE Spatial Geodatabase: GISPUBPRD1\PUB.Infrastructure\PUB.fences_arc; December 2020.

Index and Terrain Contours (All Intervals): As published, N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) (Q: GIS DATA) Project: 20-0002; project_data.gdb; line feature dataset; site_contour; All contours generated from the 2021 Geotiff data as collected and processed by TetraTech's Geoinformatics Group; N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) Q:\GIS Drive\Lidar_2021\2021\03_DEM (change detection area)\NAVD88\GeoTIFF\. February 2022.

Detention basin 1-ft contour: As published, N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) (Q: GIS DATA) Project: 22-0002; project_data.gdb; line feature dataset; clip_upper_LA_basin_2021_dem, February 2022.

2018 2021 change detection in elevation: As published, N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) (Q: GIS DATA) Lidar_2021\2021\04_Change_Detection\dz_difference. Data as collected and processed by TetraTech's Geoinformatics Group, February 2022.

2018 2021 change detection (vector representation): As published, N3B/T2S, GIS projects folder; \\N3B fs01\N3B-shares) (Q: GIS DATA) Lidar_2021\2021\04_Change_Detection\shapefile/change_detection.shp. Data as collected and processed by TetraTech's Geoinformatics Group, February 2022.

Gaging stations (point features): As published; EIM data pull, February 2022.

Pueblo wetlands boundary: As published, N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) (Q: GIS DATA) Project: 22-0002; project_data.gdb; poly feature dataset; dissolve_la_pueblo; Information assumed to have originated from TPMC and was transferred to N3B/T2S sometime during the 2018 timeframe. Data as published, February 2022.

Thalweg 2018: As published, N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) (Q: GIS DATA) Project: 20-0002; project_data.gdb; line feature dataset; pueblo_2018_thalweg; Information assumed field collected/verified by handheld GPS sometime during or before 2018. As published, February 2022.

Thalweg 2021: As published, N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) (Q: GIS DATA) Project: 20-0002; project_data.gdb; line feature dataset; pueblo_2021_thalweg; Information assumed field collected/verified by handheld GPS sometime during or before 2018. As published, February 2022.

2017 Thalweg GPS: As published, N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) (Q: GIS DATA) Project: 20-0002; project_data.gdb; point feature dataset; gps_trace_2017_thalweg; Information assumed field collected/verified by handheld GPS sometime during or before 2018. As published, February 2022.

2016 Thalweg 2016 GPS: As published, N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) (Q: GIS DATA) Project: 20-0002; project_data.gdb; point feature dataset; gps_trace_2016_thalweg; Information assumed field collected/verified by handheld GPS sometime during or before 2018. As published, February 2022.

2015 Thalweg 2015 GPS: As published, N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) (Q: GIS DATA) Project: 20-0002; project_data.gdb; point feature dataset; gps_trace_2015_thalweg; Information assumed field collected/verified by handheld GPS sometime during or before 2018. As published, February 2022.

Banktops 2018: As published, N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) (Q: GIS DATA) Project: 20-0002; project_data.gdb; line feature dataset; banktop_digitize_2018; As published, February 2022.

Banktops 2021: As published, N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) (Q: GIS DATA) Project: 20-0002; project_data.gdb; line feature dataset; banktop_digitize_2021; As published, February 2022.

LiDAR AOI: As published, N3B/T2S, GIS projects folder; \\N3B-fs01\N3B-shares) (Q: GIS DATA) Project: 20-0002; project_data.gdb; poly_feature_dataset; new_aoi; February 2022.

Regional area: As published; Triad SDE Spatial Geodatabase: GISPUBPRD1\PUB.Boundaries\PUB.regional_area; February 2022.

Watershed: As published; Triad SDE Spatial Geodatabase: GISPUBPRD1\PUB.Hydrology\PUB.Watersheds, February 2022.

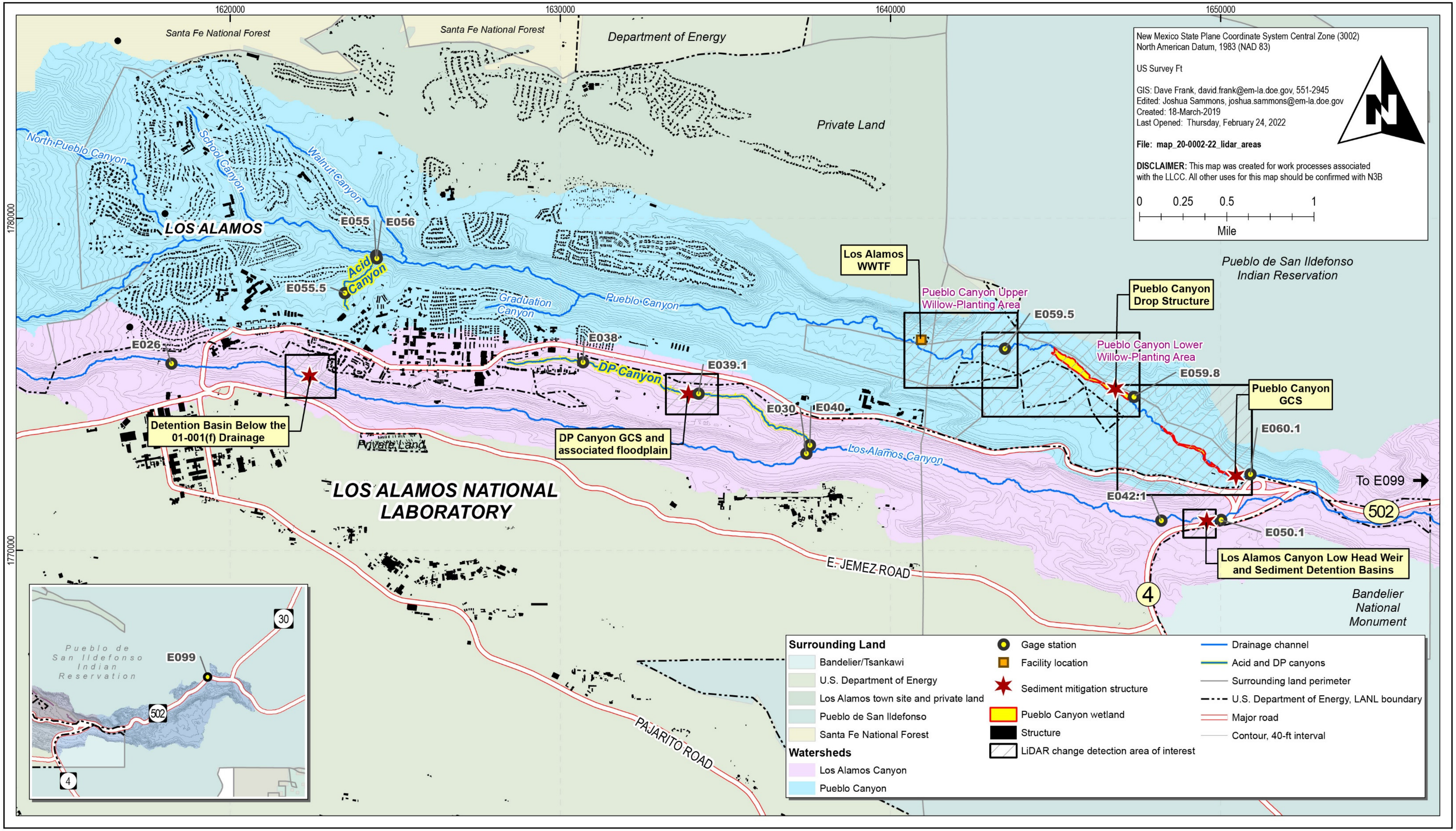

Figure B-1.0-1 Los Alamos/Pueblo Canyon watershed sediment transport mitigation sites and associated areas of interest

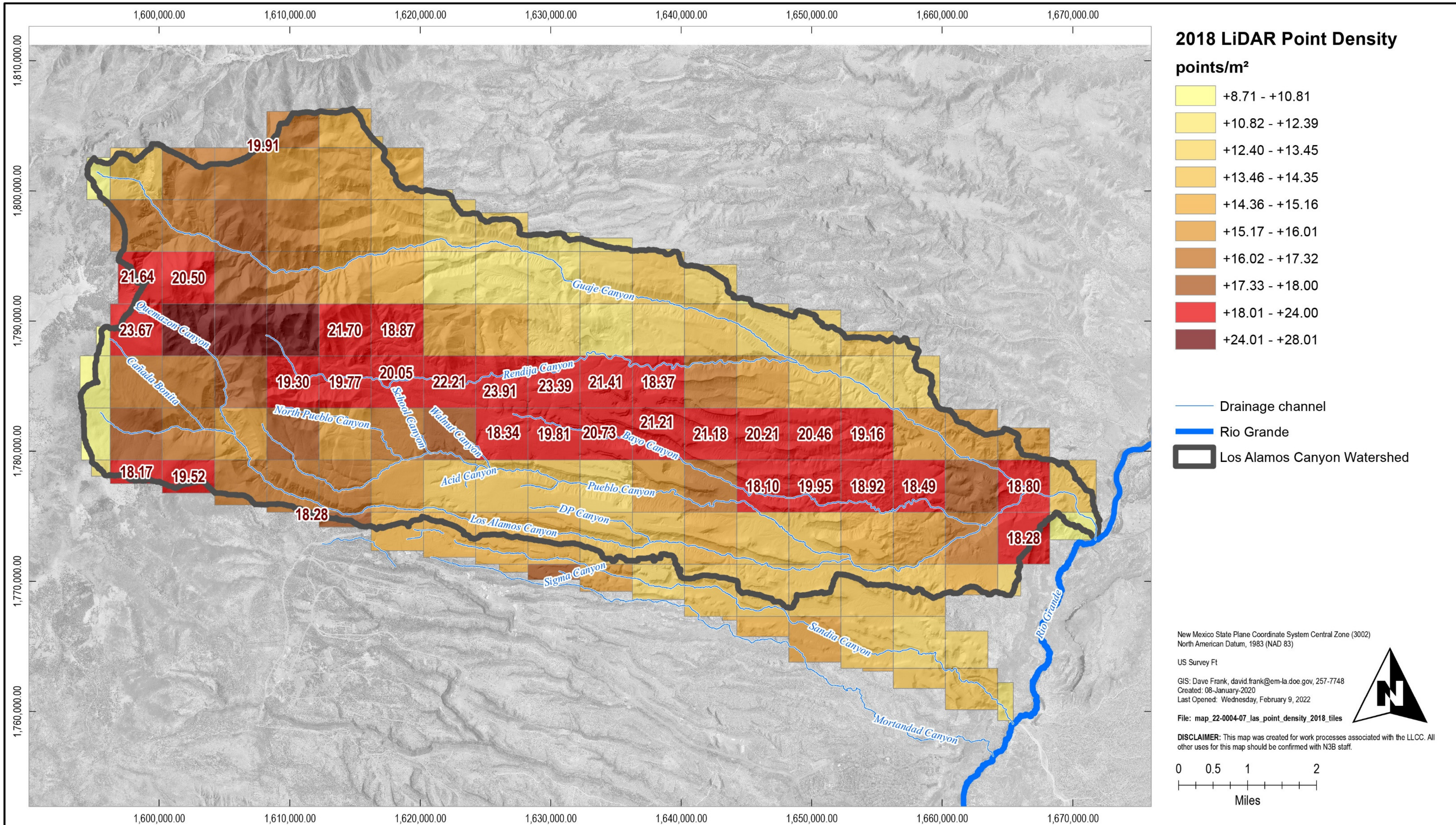

Figure B-2.1-1 2018 LiDAR point density in the Los Alamos and Pueblo Canyon watershed

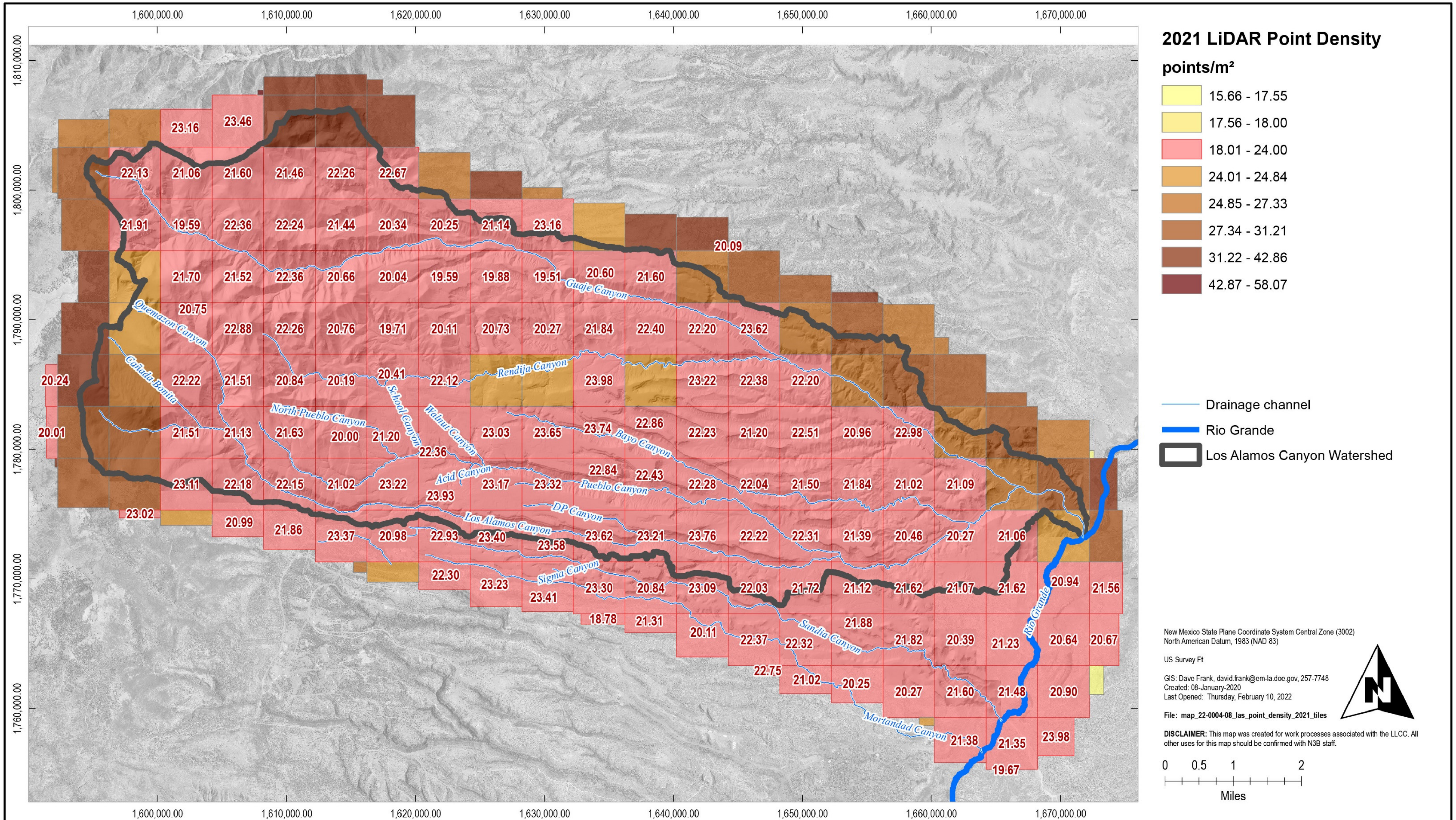

Figure B-2.1-2 2021 LiDAR point density in the Los Alamos and Pueblo Canyon watershed

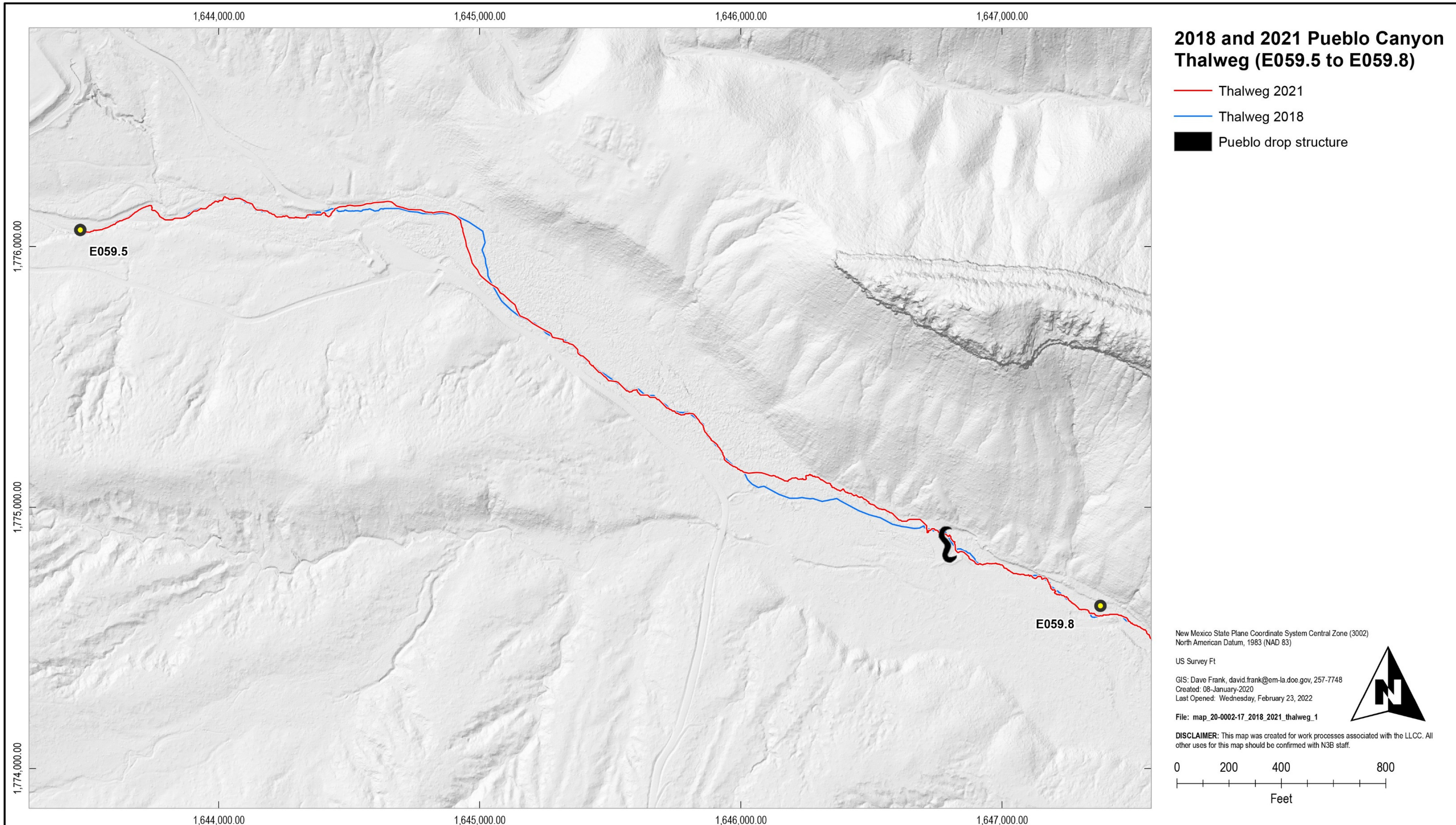

Figure B-4.1-1 2018 to 2021 aerial thalweg comparison for Pueblo Canyon (E059.5 to E059.8)

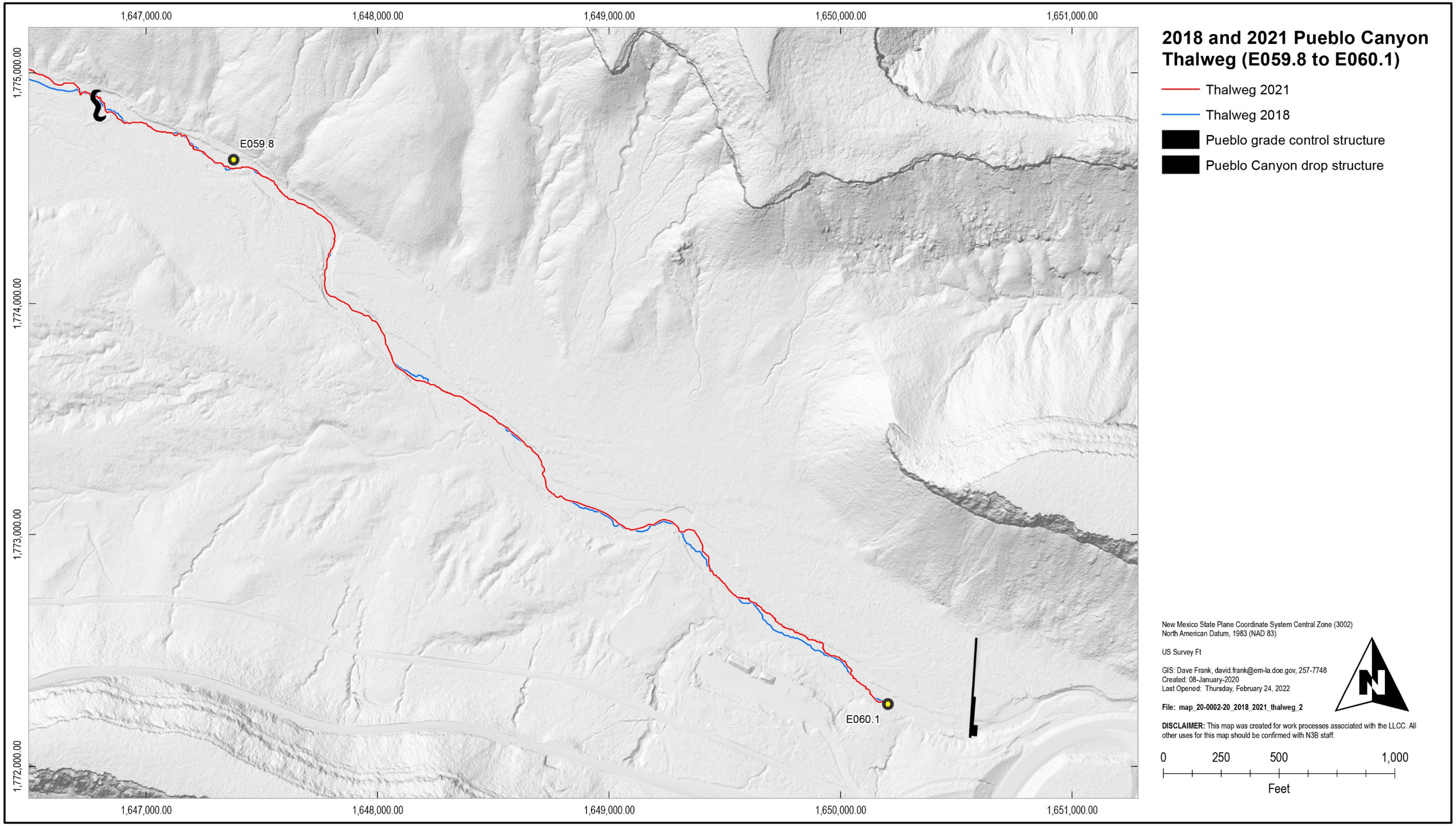

Figure B-4.1-2 2018 to 2021 aerial thalweg comparison for Pueblo Canyon (E059.8 to E060.1)

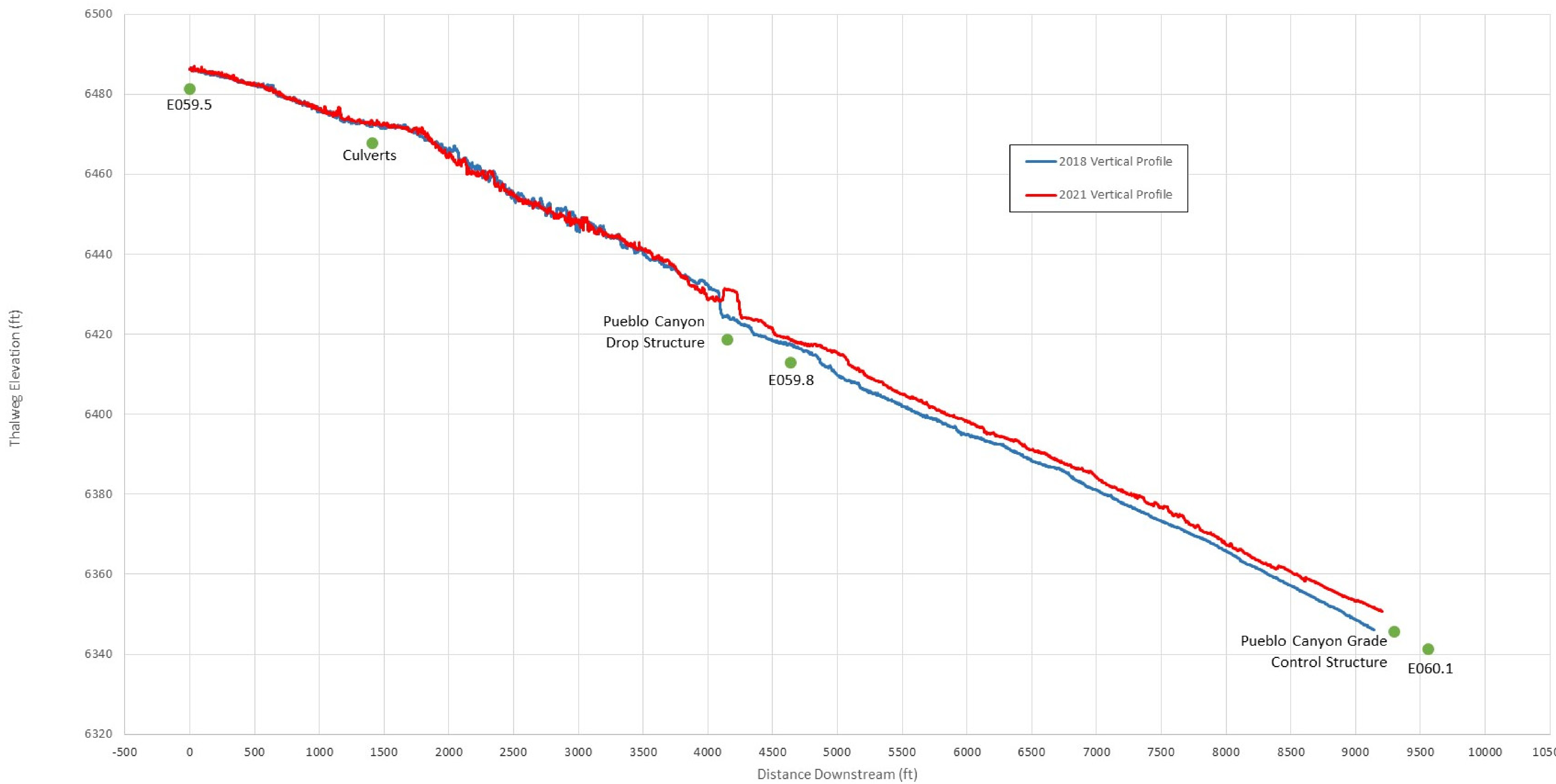

Figure B-4.1-3 2018 to 2021 aerial thalweg vertical profile comparison for Pueblo Canyon (E059.5 to E060.1)

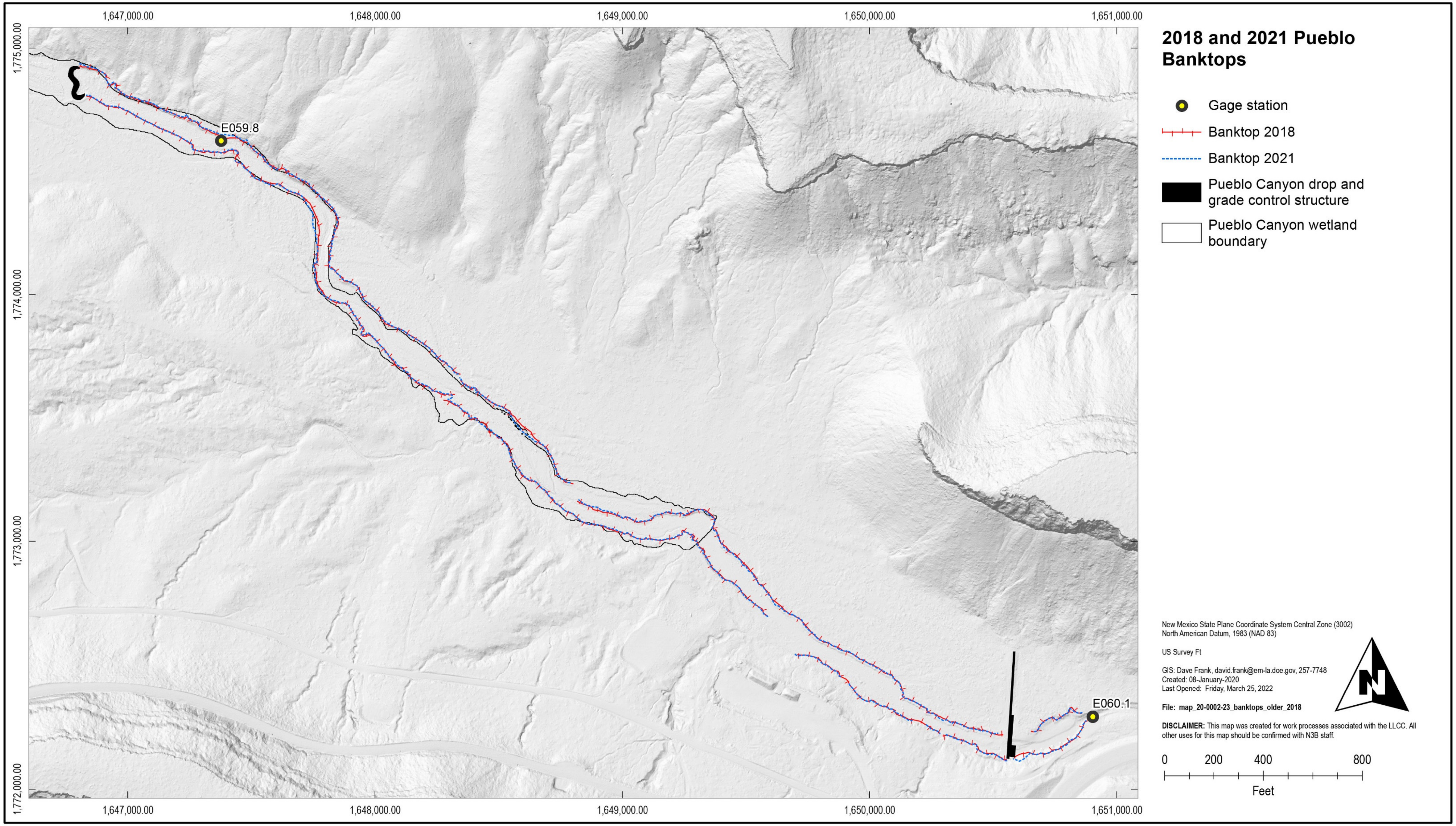

Figure B-4.1-4 2018 to 2021 channel bank comparison for Pueblo Canyon

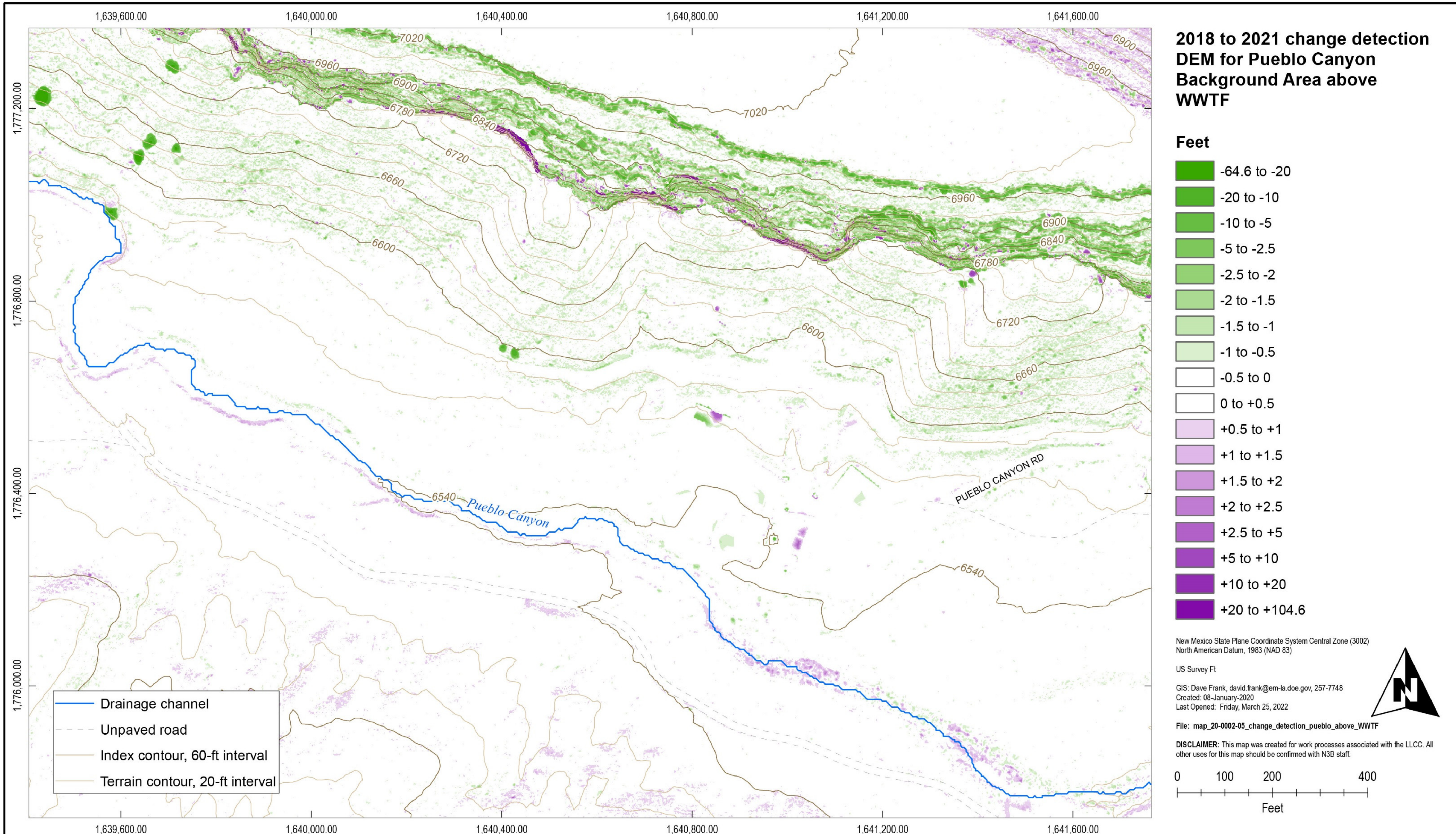

Figure B-4.2-1 2018 to 2021 DEM change detection for Pueblo Canyon background area above the WWTF

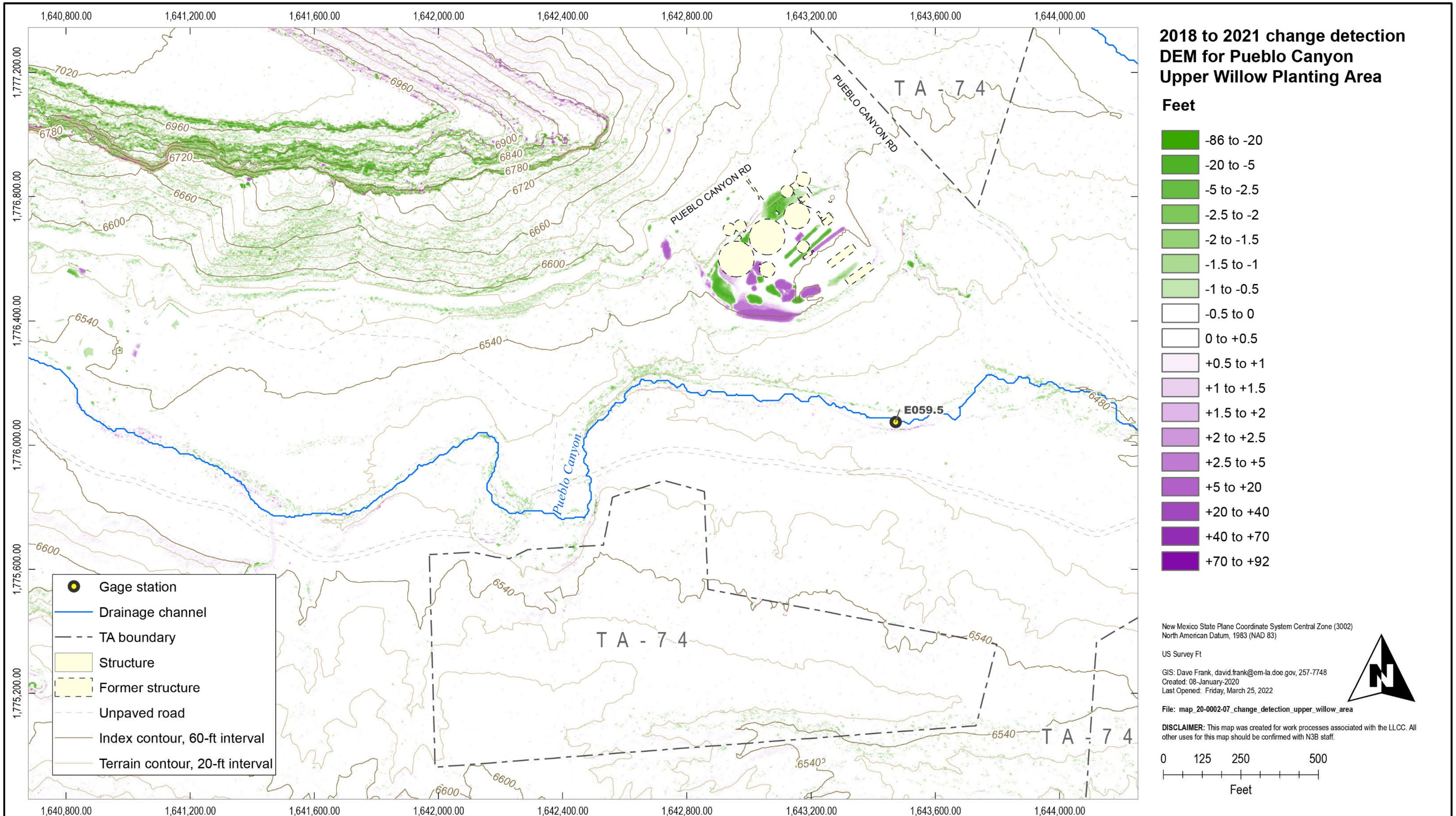

Figure B-4.3-1 2018 to 2021 DEM change detection for Pueblo Canyon from E059.5 to WWTF near the upper willow planting area

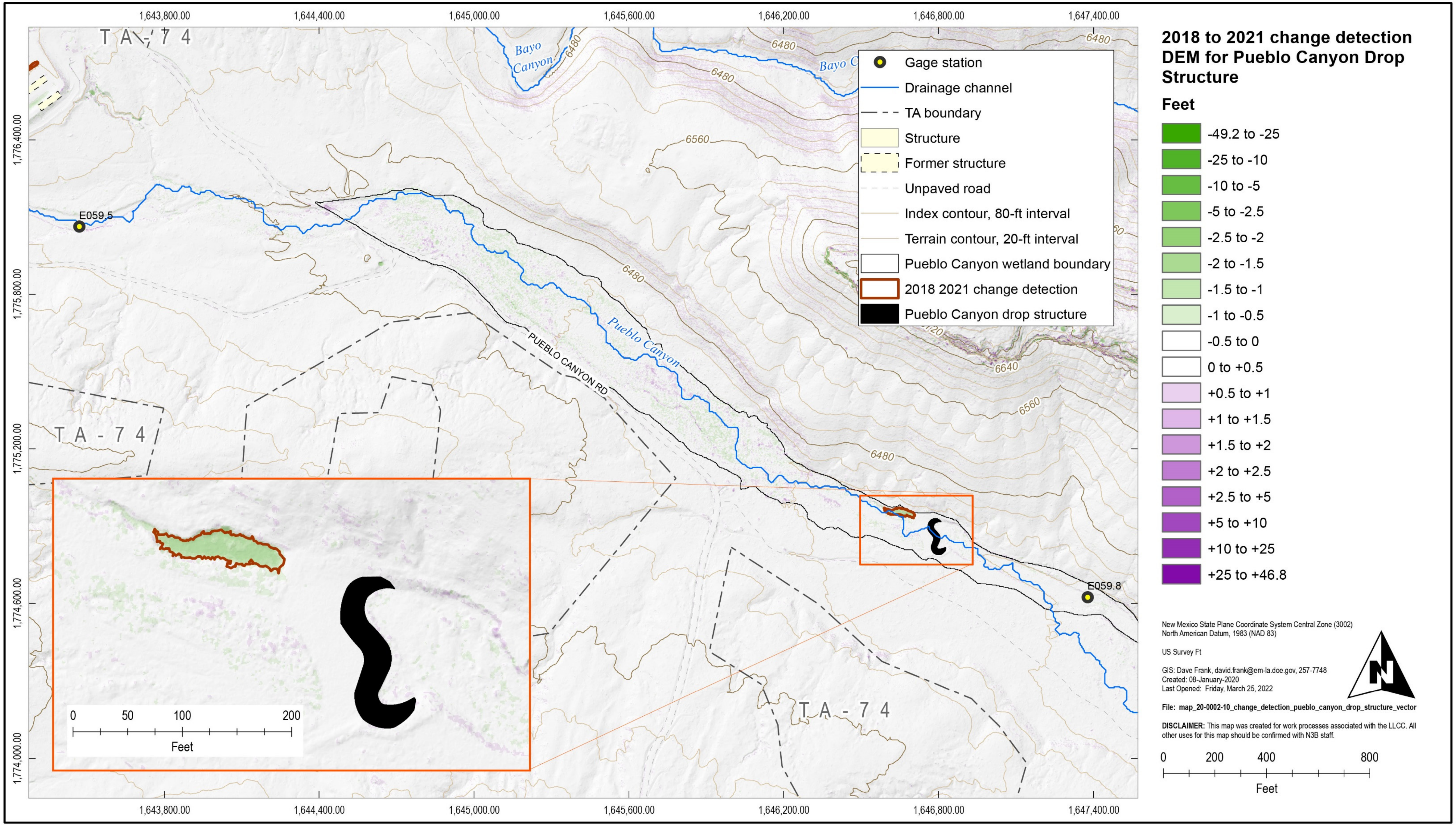

Figure B-4.4-1 2018 to 2021 LiDAR change detection in Pueblo Canyon from E059.8 to E059.5 near Pueblo Canyon drop structure

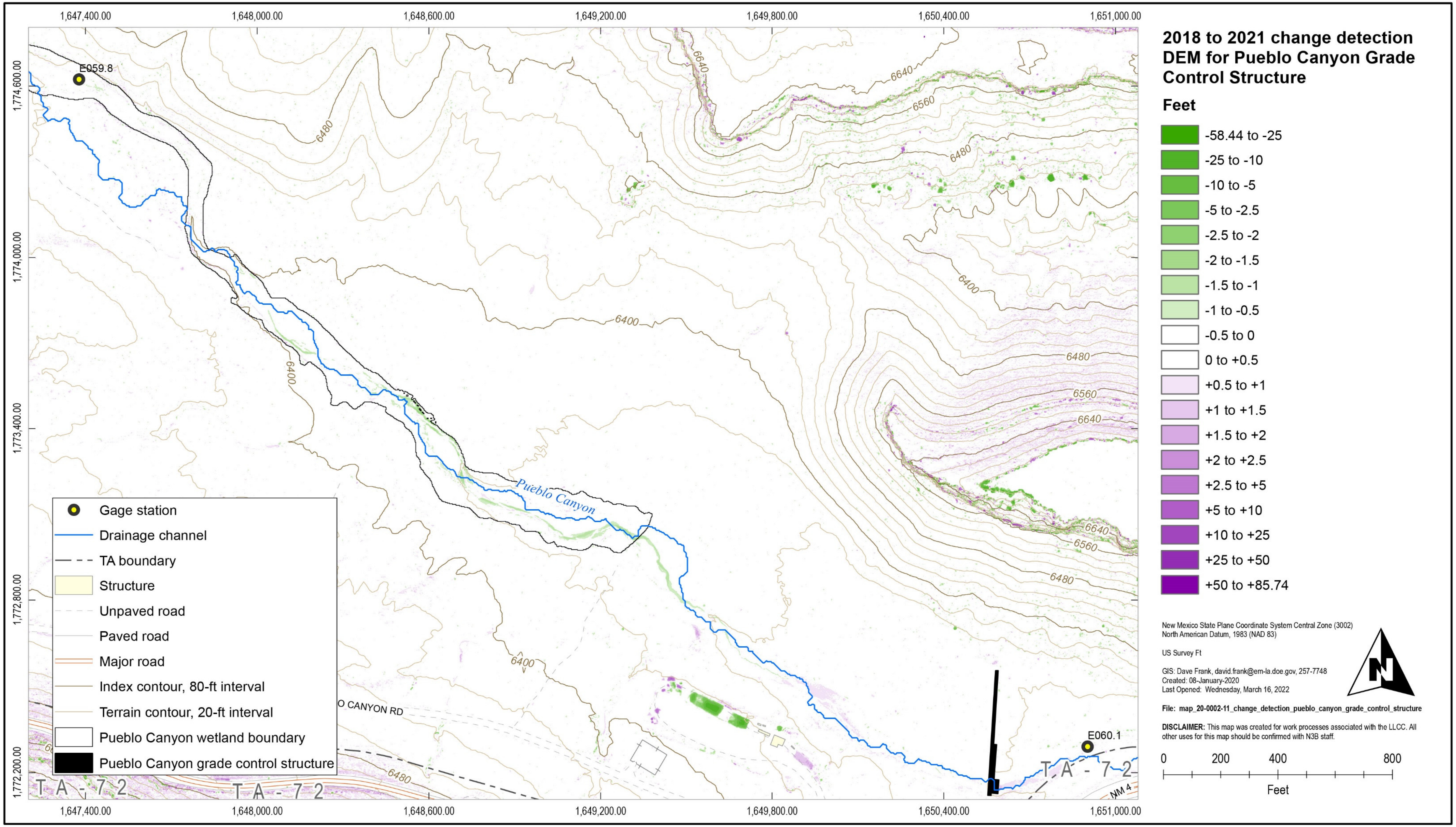

Figure B-4.5-1 2018 to 2021 DEM change for Pueblo Canyon from E060.1 to E059.8 near the Pueblo Canyon GCS

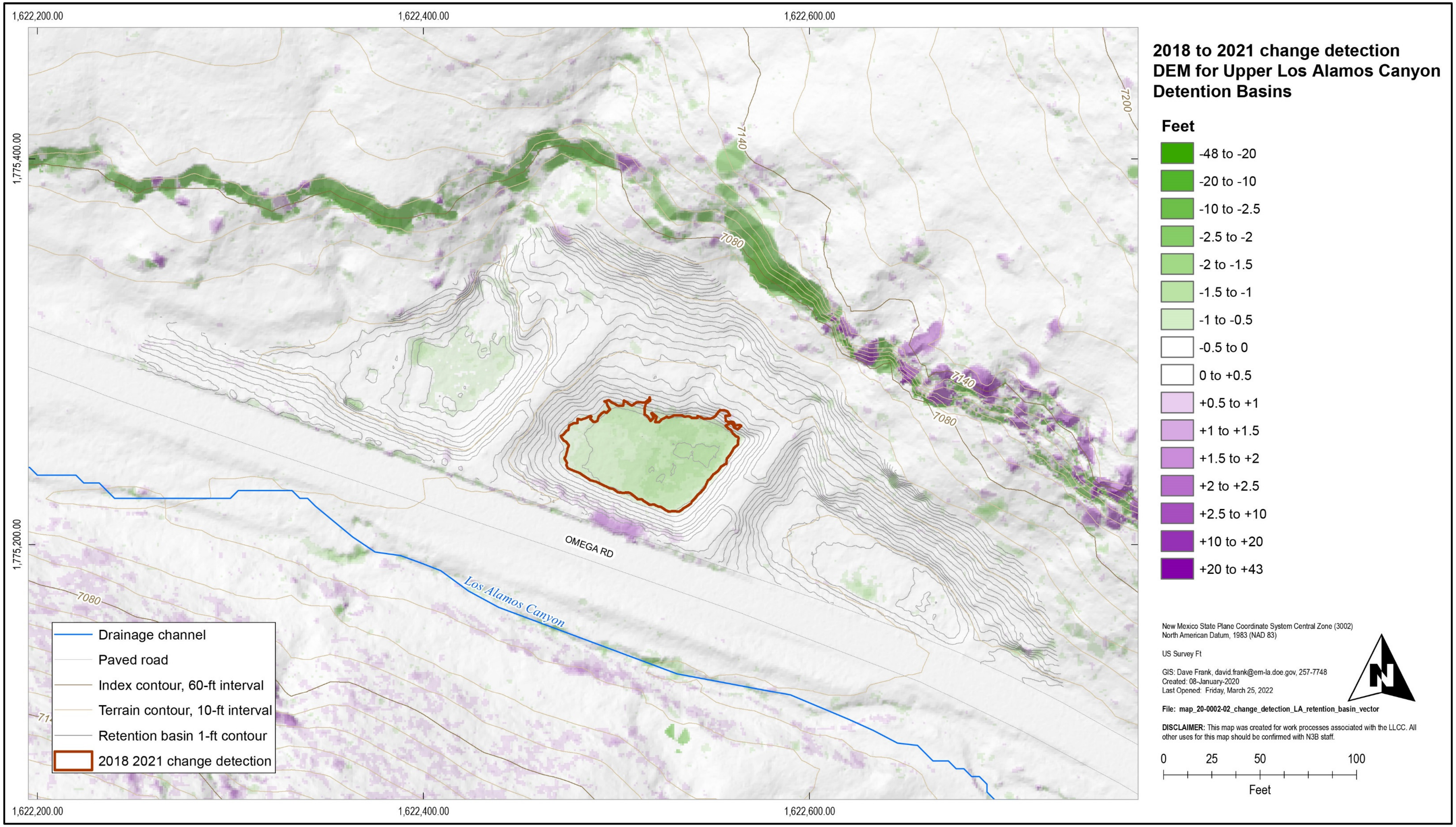

Figure B-4.6-1 2018 to 2021 LiDAR change detection in the upper Los Alamos detention basins near LA-SMA-2.1

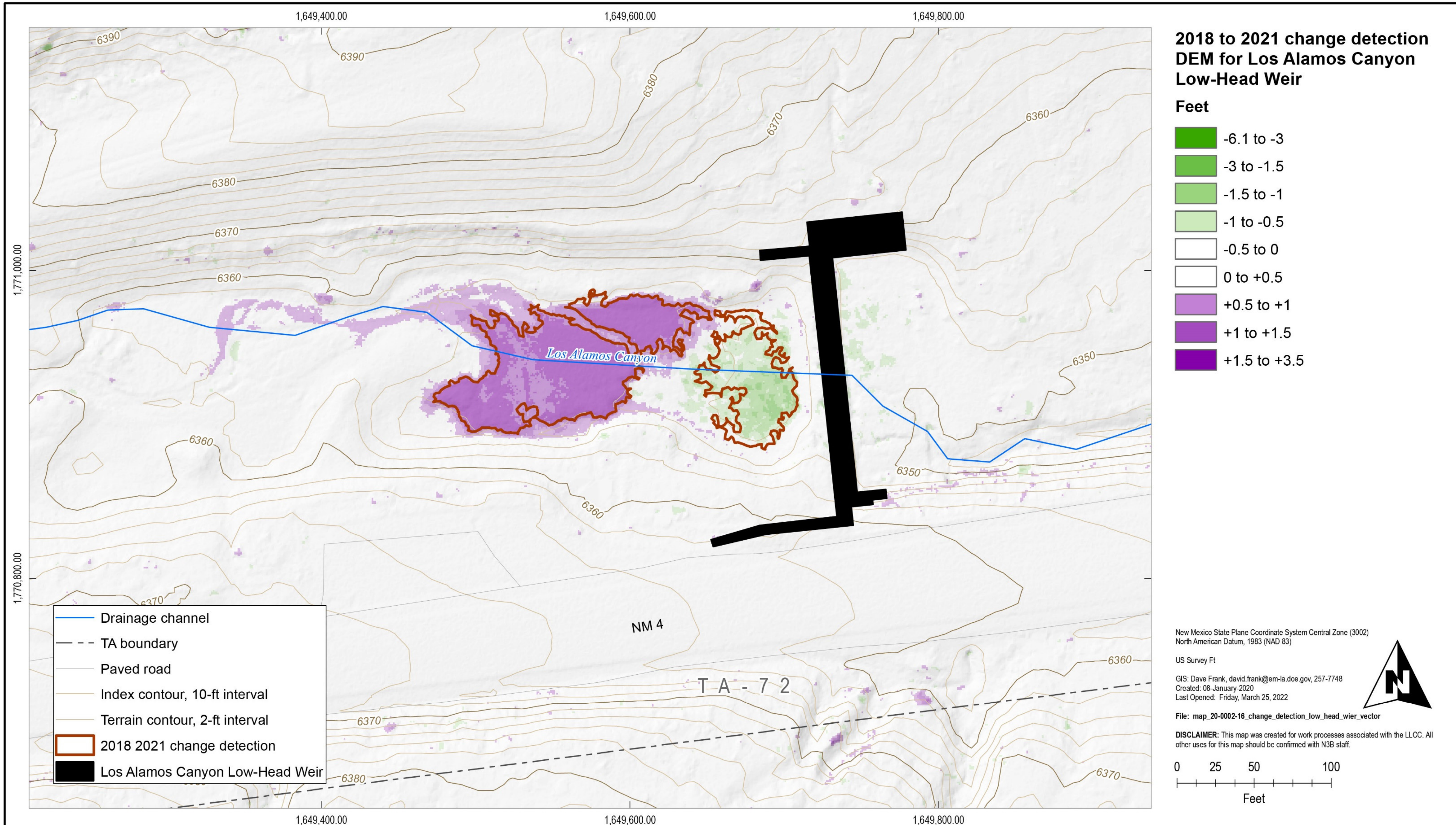

Figure B-4.7-1 2018 to 2021 LiDAR change detection near the Los Alamos Canyon low-head weir and associated sediment detention basins

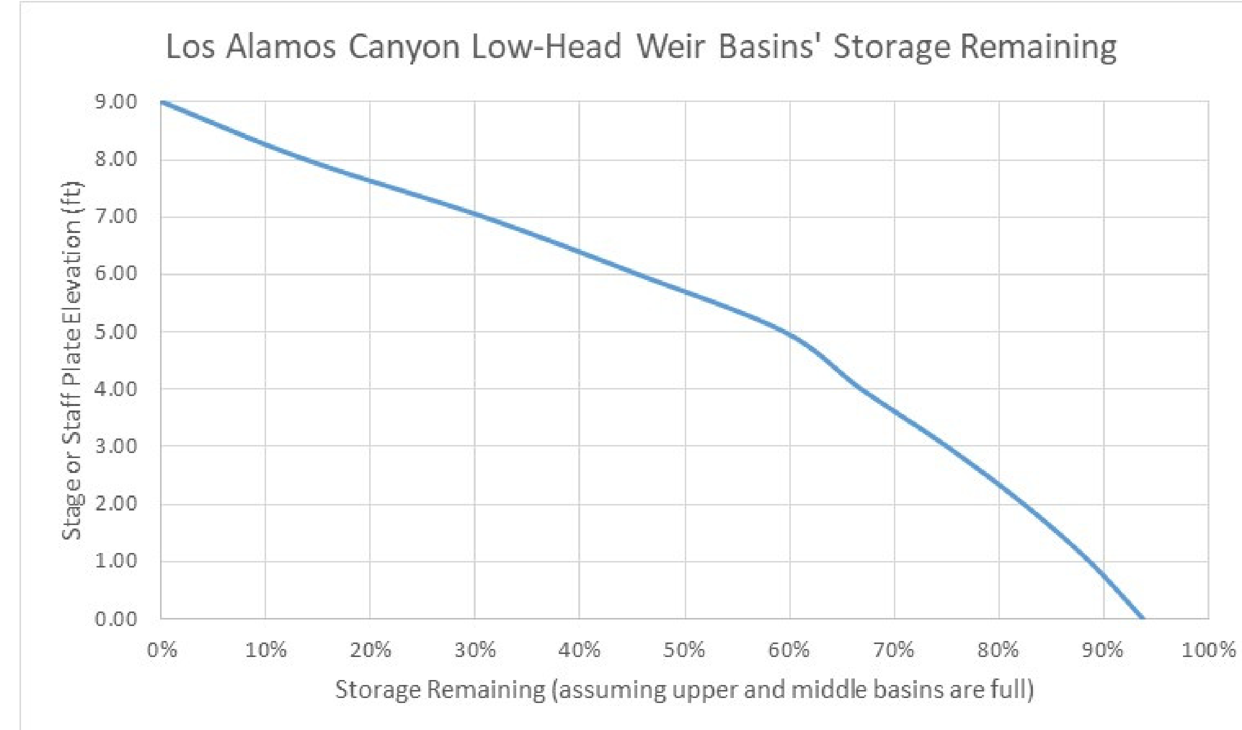

Figure B-4.7-2 Stage/storage relationship for Los Alamos low-head weir basins' percent storage remaining

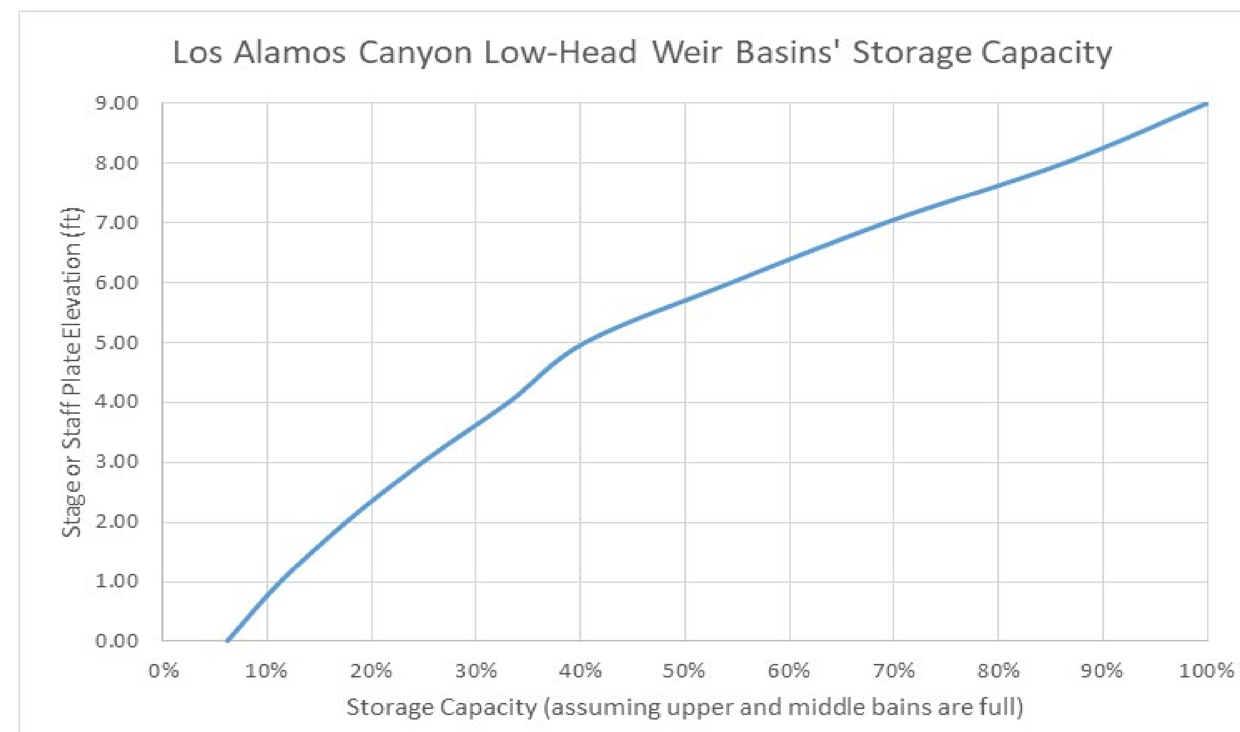

Figure B-4.7-3 Stage/storage relationship for Los Alamos Canyon low-head weir basins' percent storage capacity

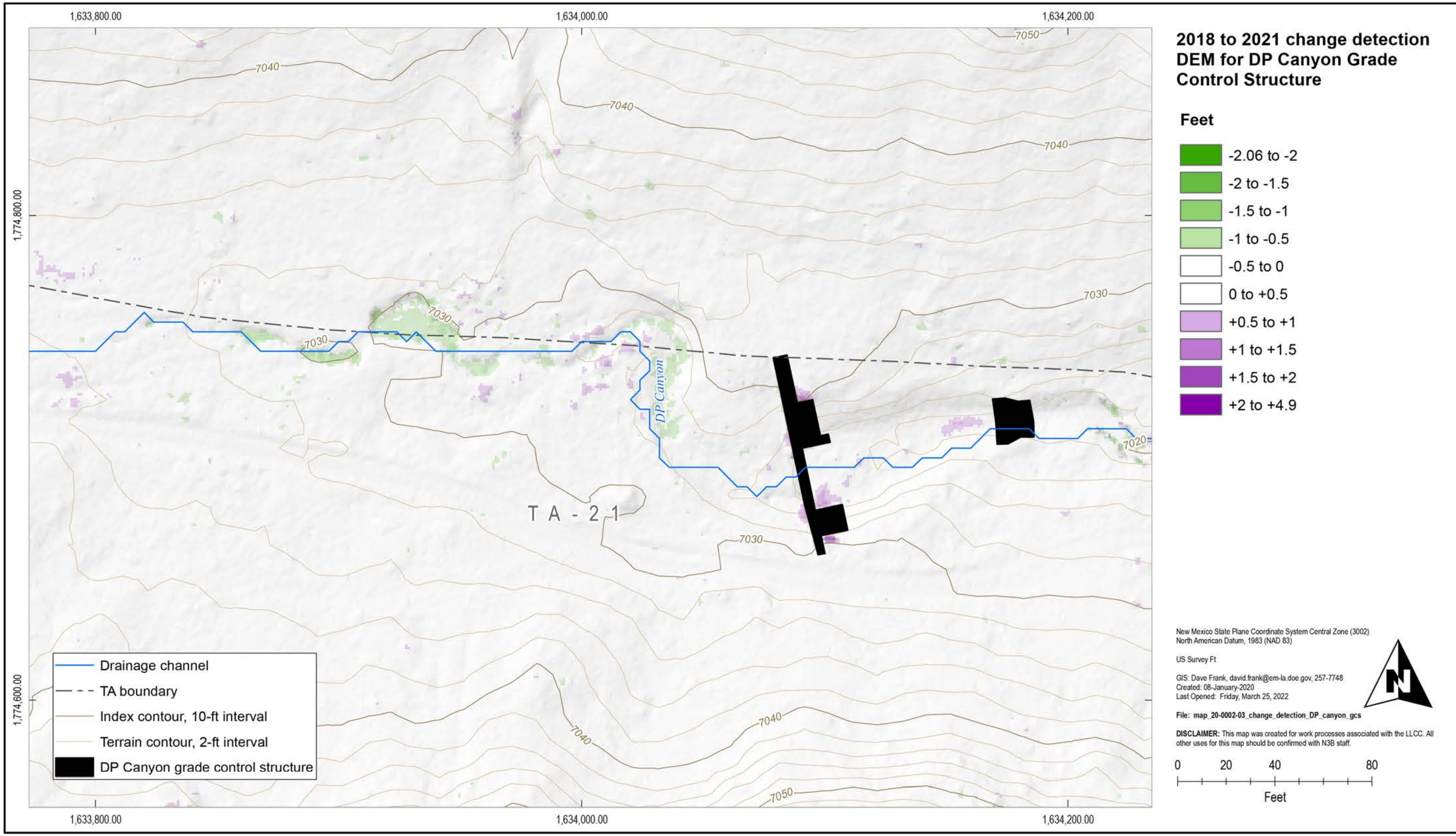

Figure B-4.8-1 2018 to 2021 DEM change near the DP Canyon GCS

Table B-3.0-1
Peak Discharge at Los Alamos/Pueblo Gaging Stations

	Los Alamos/Pueblo												
	DP Canyon			Los Alamos Canyon				Acid Canyon		Pueblo Canyon			
Year	E038	E039.1	E040	E026	E030	E042.1	E050.1	E055.5	E056	E055	E059.5	E059.8	E060.1
2012	79	97	46	130	130	290	170	0	27	13	N/A*	N/A	0
2013	330	400	830	850	450	740	740	47	820	80	N/A	N/A	1400
2014	270	320	270	54	290	210	210	16	45	70	97	N/A	54
2015	160	220	240	66	15	74	43	47	31	53	73	10	12
2016	130	42	75	56	9.8	63	25	35	17	18	45	6.9	3.8
2017	205	150	101	3.4	12	51	56	2.31	24	33	61	1.9	0.25
2018	115	75	78	2.2	0	10	2.3	0.92	4.6	14	0.43	0.08	1.1
2019	329	342	255	44	14	111	71	1.3	0	48	42	0	0.25
2020	38	3.25	0.06	0.52	40	0.07	0	6	0.16	0	1.2	0	0.22
2021	89	39	26	0.05	0	0.14	0.96	3.9	3.3	0	7.3	0	8.7
Mean	175	169	192	121	96	155	132	16	97	33	41	3	148

* N/A = Not Available.

Table B-4.7-1
Storage Capacity of Los Alamos Low-Head Weir Sediment Detention Basins

Basin	Storage (ft^3)	Storage (acre-ft)	Percent of Total Capacity
Lower Basin	276,570	6.35	95.9%
Middle Basin	4969	0.11	1.7%
Upper Basin	7016	0.16	2.4%
Total Capacity	288,555	6.62	100%

Table B-4.7-2
Stage/Storage Values for Los Alamos Canyon
Low-Head Weir Lower Sediment Detention Basin

Lower Basin Stage (ft)	Staff Plate (ft)	Storage (ft^3)	Storage (acre-ft)	% of Sediment Storage Remaining	% of Basin Capacity
6358.7	9.00	276,570	6.35	0%	100%
6357.7	8.00	237,090	5.44	14%	86%
6356.7	7.00	187,914	4.31	31%	69%
6355.7	6.00	145,378	3.34	45%	55%
6354.7	5.00	104,996	2.41	59%	41%
6353.7	4.00	83,730	1.92	67%	33%
6352.7	3.00	60,027	1.38	75%	25%
6351.7	2.00	38,955	0.89	82%	18%
6350.7	1.00	20,792	0.48	89%	11%
6349.7	0.00	6050	0.14	94%	6%

Table B-4.7-3
Sediment Accumulation in Los Alamos Canyon
Low-Head Weir Sediment Detention Basins in 2014, 2018, and 2021

Year	Volume of Available Sediment Storage (cu-ft)	% of Sediment Storage Remaining	% of Basin Capacity
2014	288,555	100%	0%
2018	159,779	55%	45%
2021	148,985	52%	48%

Attachment B-1

Los Alamos National Laboratory
LiDAR Mapping Project 2018 Collection
(on CD included with this document)

Attachment B-2

Los Alamos National Laboratory
LiDAR Mapping Project Data Delivery Report
(on CD included with this document)

Attachment B-3

Survey Report Summary for
35 Check Point LiDAR Support Project
(on CD included with this document)

Appendix C

2021 Watershed Mitigation Inspections

C-1.0 INTRODUCTION

Watershed storm water controls and grade-control structures (GCSs) are inspected biannually and after significant flow events (greater than 50 cubic feet per second). These inspections are completed to ensure the watershed mitigations are functioning properly and to identify needed maintenance. Examples of items evaluated during inspections include the following:

- Debris/sediment accumulation that could impede operation
- Water levels behind retention structures
- Physical damage to 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 biannual inspections of watershed mitigations in Los Alamos and Pueblo Canyons. Each group of photographs is associated with a specific feature (e.g., standpipe or weir) that has the potential to develop issues. The photographs are presented in chronological order and depict the feature in 2021. Photographs of features were taken to mirror previous inspection photographs as closely as possible. Pre-monsoon spring inspections were conducted in May 2021 and post-monsoon fall inspections were completed in October 2021. Recommended and completed maintenance is listed in the table below with photographs at the end of each watershed mitigation section.

Table C-1.0-1
Los Alamos and Pueblo Watershed Controls Maintenance

Maintenance	Date Recommended	Date Completed
C-2.0 DP Canyon Grade Control Structure		
Fill holes from piping located upstream of weir	10/22/2020	5/18/2021
Trash pickup during spring 2021 inspection	10/22/2020	5/18/2021
C-3.0 Upper Los Alamos Canyon Sediment Detention Ponds		
Removal of vegetation on pond bank (determined not to be needed)	10/15/2020	n/a*
Removal of protruding rebar from headwall	10/15/2020	5/14/2021
Maintain pedestrian bridge over pipeline	10/15/2020	5/14/2021
Trash pickup	10/26/2021	Pending
C-4.0 Los Alamos Canyon Weir		
Repair holes in gabion	10/07/2020	5/12/2021
Recommend placement of gravel bags at top of north bank downstream of the weir (determined not to be needed)	10/07/2020	n/a
Trash pickup during spring 2021 inspection	n/a	5/12/2021
C-5.0 Pueblo Canyon Grade Control Structure		
Remove fallen tree from top of weir	10/14/2020	5/25/2021
Remove vegetation from spillway	10/14/2020	5/25/2021
Trash pickup	n/a	5/25/2021
Repair concrete spalling on spillway (determined not to be required; continue monitoring)	5/25/2021	n/a
Repair broken wire in gabion baskets	10/14/2021	Pending
C-6.0 Pueblo Wetland Stabilization Structure		
Placement of erosion control mitigation on downstream south bank exhibiting erosion (determined that removal of feral cows from canyon is appropriate mitigation)	10/14/2020	n/a
Trash pickup during spring 2021 inspection	n/a	5/25/2021

* n/a = Not applicable.

C-2.0 DP CANYON GRADE CONTROL STRUCTURE

C-2.1 Embankments

Photo C-2.1-1 May 2021—South embankment, upstream of GCS, looking west/upstream

Photo C-2.1-2 October 2021—South embankment and GCS, looking west/upstream

C-2.2 Overflow Weir Structure

Photo C-2.2-1 May 2021—Upstream face of GCS, looking east/downstream

Photo C-2.2-2 October 2021—Upstream face of GCS, looking east/downstream

Photo C-2.2-3 May 2021—Crest of GCS, looking north

Photo C-2.2-4 October 2021—Crest of GCS, looking north

C-2.3 Standpipe

Photo C-2.3-1 May 2021—Standpipe. Sediment level is approximately 1 ft below wood stop board. No significant change since last inspection. Continue to monitor.

Photo C-2.3-2 October 2021—Standpipe. Sediment level is approximately 1 ft below wood stop board. No significant change since last inspection. Continue to monitor.

C-2.4 Spillway

Photo C-2.4-1 May 2021—GCS spillway and flow-way, looking south

Photo C-2.4-2 October 2021—GCS spillway and flow-way, looking south

C-2.5 Outlet

Photo C-2.5-1 May 2021—Outlet. Pond level was above the bottom of the culvert invert at time of inspection.

Photo C-2.5-2 October 2021—Outlet. Pond level was above the bottom of the culvert invert at time of inspection.

C-2.6 Maintenance

Photo C-2.6-1 May 2021—Removed tire from standpipe and picked up trash.

Photo C-2.6-2 May 2021—Filled piping hole with riprap.

C-3.0 UPPER LOS ALAMOS CANYON SEDIMENT DETENTION PONDS

C-3.1 Basin Embankment and Ponds

Photo C-3.1-1 May 2021—Lower basin, looking east

Photo C-3.1-2 October 2021—Lower basin, looking east

Photo C-3.1-3 May 2021—Upper basin, looking north

Photo C-3.1-4 October 2021—Upper basin, looking southwest at gabion overflow structure

C-3.2 Basin Spillways

Photo C-3.2-1 May 2021—Lower basin spillway, looking north

Photo C-3.2-2 October 2021—Lower basin spillway, looking north

Photo C-3.2-3 May 2021—Upper basin spillway, looking north

Photo C-3.2-4 October 2021—Upper basin spillway, looking south

C-3.3 Wetland and Culvert

Photo C-3.3-1 May 2021—Wetland from lower basin spillway, looking east

Photo C-3.3-2 October 2021—Wetland, looking west

Photo C-3.3-3 May 2021—Wetland culvert inlet

Photo C-3.3-4 October 2021—Wetland culvert inlet

Photo C-3.3-5 May 2021—Wetland culvert outlet

Photo C-3.3-6 October 2021—Wetland culvert outlet

C-3.4 Upstream Pipeline and Appurtenances

Photo C-3.4-1 May 2021—Pipeline headwall. Needlecast blockage removed.

Photo C-3.4-2 October 2021—Pipeline headwall

Photo C-3.4-3 May 2021—Pipeline cable support

Photo C-3.4-4 October 2021—Pipeline cable support

Photo C-3.4-5 May 2021—Pipeline beam supports

Photo C-3.4-6 October 2021—Pipeline beam supports

Photo C-3.4-7 May 2021—Pipeline cleanout

Photo C-3.4-8 October 2021— Pipeline cleanout

Photo C-3.4-9 May 2021—Pipeline vacuum breaker

Photo C-3.4-10 October 2021—Pipeline vacuum breaker

Photo C-3.4-11 May 2021—Pipeline bridge structure

Photo C-3.4-12 October 2021—Pipeline bridge structure

Photo C-3.4-13 May 2021—Pipeline outlet, energy dissipater, and gabion overflow structure

Photo C-3.4-14 October 2021—Pipeline outlet, energy dissipater, and gabion overflow structure

Photo C-3.4-15 May 2021—Pipeline energy dissipater

Photo C-3.4-16 October 2021—Pipeline energy dissipater

Photo C-3.4-17 May 2021—Discharge culvert inlets and trash racks

Photo C-3.4-18 October 2021—Discharge culvert inlets and trash racks

Photo C-3.4-19 May 2021—Discharge culvert outlets and bank protection

Photo C-3.4-20 October 2021—Discharge culvert outlets and bank protection

C-3.5 Maintenance

Photo C-3.5-1 May 2021—Rebar noted in earlier inspections has been removed.

Photo C-3.5-2 October 2021—Recommend trash removal during spring 2022 inspection.

C-4.0 LOS ALAMOS CANYON LOW-HEAD WEIR AND ASSOCIATED DETENTION BASINS

C-4.1 Embankments

Photo C-4.1-1 May 2021—Upstream southern embankment, looking east/downstream

Photo C-4.1-2 October 2021—Upstream southern embankment, looking west/upstream

Photo C-4.1-3 May 2021—Downstream southern embankment and abutment, looking west/upstream

Photo C-4.1-4 October 2021—Downstream southern embankment and abutment, looking east/downstream

Photo C-4.1-5 May 2021—Downstream northern embankment, looking east/downstream. Sediment deposited from runoff coming from dirt roads upgradient of the embankment. No action recommended.

Photo C-4.1-6 October 2021—Downstream northern embankment, looking east/downstream. Sediment deposited from runoff coming from dirt roads upgradient of the embankment. No action recommended.

C-4.2 Sediment Detention Basins

Photo C-4.2-1 May 2021—Upper basin, looking west/upstream. Upper basin has no remaining sediment capacity; the lower basin has significant capacity remaining.

Photo C-4.2-2 October 2021—Upper basin, looking west/upstream. Upper basin has no remaining sediment capacity; the lower basin has significant capacity remaining.

Photo C-4.2-3 May 2021—Middle basin, looking east/downstream. Middle basin has no remaining sediment capacity; the lower basin has significant capacity remaining.

Photo C-4.2-4 October 2021—Middle basin, looking east/downstream. Middle basin has no remaining sediment capacity; the lower basin has significant capacity remaining.

Photo C-4.2-5 May 2021—Lower basin, looking east/downstream. Erosion has occurred and vegetation has been impacted by feral cows. Continue to monitor.

Photo C-4.2-6 October 2021—Lower basin, looking east/downstream. Erosion has occurred and vegetation has been impacted by feral cows. A number of feral cows have been removed from the canyon. Continue to monitor.

C-4.3 Overflow Weir Structure

Photo C-4.3-1 May 2021—Upstream face of weir, looking south

Photo C-4.3-2 October 2021—Upstream face of weir, looking south

Photo C-4.3-3 May 2021—Weir crest, looking north

Photo C-4.3-4 October 2021—Weir crest, looking north

Photo C-4.3-5 May 2021—Downstream face of weir, looking north

Photo C-4.3-6 October 2021—Downstream face of weir, looking south

C-4.4 Standpipe

Photo C-4.4-1 May 2021—Standpipe. Debris and sediment is at staff plate height 5.4 ft. No significant change since last inspection.

Photo C-4.4-2 October 2021—Standpipe. Debris is at staff plate height 5.4 ft and sediment is at 4.8 ft; this correlates to 61% of storage capacity remaining. No significant change since last inspection.

C-4.5 Weir Outlet

Photo C-4.5-1 May 2021—Weir outlet

Photo C-4.5-2 October 2021—Weir outlet

Photo C-4.5-3 October 2021—Headcut at edge of gabion mattress, downstream of weir outlet, looking east/downstream. Continue to monitor.

Photo C-4.5-4 October 2021—Headcut at edge of gabion mattress, downstream of weir outlet, looking west/upstream. Continue to monitor.

C-4.6 Borrow Pit

Photo C-4.6-1 May 2021—Borrow pit, looking east. Vegetation has been impacted by feral cows. Continue to monitor.

Photo C-4.6-2 October 2021—Borrow pit, looking east. Vegetation has been impacted by feral cows and additional rilling has been noted. Feral cows were removed from the canyon. Continue to monitor.

Photo C-4.6-3 May 2021—Borrow pit runoff retention berm. Berm has been impacted by recent Los Alamos County well construction activities. Berm is still functioning and stable, no action recommended. Continue to monitor.

Photo C-4.6-4 October 2021—Borrow pit runoff retention berm. Berm has been impacted by recent Los Alamos County well construction activities. Berm is still functioning and stable, no action recommended. Continue to monitor.

C-4.7 Maintenance

Photo C-4.7-1 May 2021—Repair of holes in gabion baskets noted in earlier inspections. Trash was also picked up from weir ponding area.

C-5.0 PUEBLO CANYON GRADE CONTROL STRUCTURE

C-5.1 Embankments

Photo C-5.1-1 May 2021—South bank abutment, looking south

Photo C-5.1-2 October 2021—South bank abutment, looking south.

Photo C-5.1-3 May 2021—North bank abutment, looking south

Photo C-5.1-4 October 2021—North bank abutment, looking south

Photo C-5.1-5 May 2021—Downstream south embankment, looking west/upstream

Photo C-5.1-6 October 2021—Downstream south embankment and weir, looking east/downstream

Photo C-5.1-7 May 2021—Downstream north embankment, looking north

Photo C-5.1-8 October 2021—Downstream north embankment and weir, looking north

C-5.2 Overflow Weir Structure and Spillway

Photo C-5.2-1 May 2021—Weir crest and flow-ways, looking south

Photo C-5.2-2 October 2021—Weir crest and north flow-way, looking north

Photo C-5.2-3 May 2021—Downstream face of weir, looking west/upstream

Photo C-5.2-4 October 2021—Downstream face of weir, looking west/upstream

Photo C-5.2-5 May 2021—Spalling on concrete weir spillway. No action recommended, continue to monitor.

Photo C-5.2-6 October 2021—Spalling on concrete weir spillway. No action recommended, continue to monitor.

C-5.3 Outlet

Photo C-5.3-1 October 2021—Outlet culvert standpipe. Outlet is approximately two-thirds belowgrade and remains functional.

C-5.4 Spurs

Photo C-5.4-1 May 2021—Redi-rock spurs, looking west/upstream

Photo C-5.4-2 October 2021—Redi-rock spurs, looking west/upstream

C-5.5 Maintenance

Photo C-5.5-1 October 2021—Identified broken wire in gabions at weir. Maintenance will be done during spring 2022 inspection.

C-6.0 PUEBLO WETLAND STABILIZATION STRUCTURE

C-6.1 Wetland Stabilization Structures

Photo C-6.1-1 May 2021—Redi-Rock block structure, looking west/upstream

Photo C-6.1-2 October 2021—Redi-Rock block structure, looking west/upstream

Photo C-6.1-3 May 2021—Redi-Rock block structure, looking east/downstream

Photo C-6.1-4 October 2021—Redi-Rock block structure, looking southeast

C-6.2 Banks

Photo C-6.2-1 May 2021—Downstream north bank abutment, looking north

Photo C-6.2-2 October 2021—Downstream north bank abutment, looking north

Photo C-6.2-3 May 2021—Downstream south bank abutment, looking south

Photo C-6.2-4 October 2021—Downstream south bank abutment, looking south

Photo C-6.2-5 May 2021— Downstream banks, looking east/downstream. Banks and vegetation have been impacted by feral cows. Continue monitoring.

Photo C-6.2-6 October 2021— Downstream banks, looking east/downstream. Banks and vegetation have been impacted by feral cows. A number of cows have been removed from the canyon. Continue monitoring.

C-6.3 Upstream Area

Photo C-6.3-1 May 2021—Upstream wetland, looking west/upstream

Photo C-6.3-2 October 2021—Upstream wetland, looking west/upstream

Photo C-6.3-3 May 2021—Upstream ponded area, looking west/upstream

Photo C-6.3-4 October 2021—Upstream ponded area, looking west/upstream

C-6.4 Maintenance

Photo C-6.4-1 May 2021—Tire and debris removed from channel

Appendix D

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

Appendix E

Requalification of 2012 and
2015 Polychlorinated Biphenyl Congener Results
(on CD included with this document)

E-1.0 REQUALIFICATION OF 2012 AND 2015 POLYCHLORINATED BIPHENYL CONGENER RESULTS

An error was identified in qualification of polychlorinated biphenyl (PCB) congener results analyzed in 2012 and 2015 from seven samples collected from four locations in the Los Alamos and Pueblo Canyon watershed. The total PCB results were incorrectly qualified as nondetected because of method blank contamination. The appropriate qualification would have retained the total PCB results as detected. The requalified 2012 and 2015 PCB congener data is included on CD with this document, and Table E-1 defines the abbreviations used in the data set.

Table E-1
Abbreviations Used in the Appendix E Spreadsheet

Abbreviation	Description
Y	The analyte is detected.
N	The analyte is not detected.
J	The analyte is classified as detected but the reported concentration value is expected to be more uncertain than usual
J+	The analyte is classified as detected but the reported concentration value is expected to be more uncertain than usual with a potential positive bias.
NQ	No validation qualifier flag is associated with this result, and the analyte is classified as detected.
U	The analyte is classified as not detected.
CB4	The detected sample result is less than 5 times the detected concentration of the same analyte in the method blank.
CB4a	The detected sample result is greater than or equal to 5 times and less than 100 times the detected concentration of the same analyte in the method blank.
J_LAB	The analytical laboratory qualified the detected result as estimated (J) because the result was less the PQL but greater than the MDL.
NQ	The analytical laboratory did not qualify the analyte as not detected and/or any other standard qualifier. The analyte is detected in the sample.
U_LAB	The analytical laboratory qualified the analyte as not detected.
nc	No change to the originally reported detect flag, validation qualifier, or validation reason code.