PRELIMINARY HYDRAULICS REPORT
STRUCTURE I-15-AO REPLACEMENT
As a part of the
REGION TWO BRIDGE BUNDLE PACKAGE
TELLER COUNTY, COLORADO

A Part of Section 6, Township 13 South, Range 70 West of the 6th P.M.,
County of Teller, Colorado

February 12, 2021

Prepared for:

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TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1 Background and Purpose

The CDOT Region 2 Bridge Bundle Design Build Project consists of the replacement of a total of nineteen (19) structures bundled together as a single project. These structures are rural bridges on essential highway corridors (US 350, US 24, CO 239 and CO 9) in southeastern and central Colorado. These key corridors provide rural mobility, intra- and interstate commerce, movement of agricultural products and supplies, and access to tourist destinations. The design build project consists of seventeen (17) bridges and two (2) Additionally Requested Elements (AREs) structures.

The fourteen (14) of the structures in this design build project are jointly funded by the USDOT FHWA Competitive Highway Bridge Program grant and the Colorado Bridge Enterprise (Project No. 23558). The remaining five (5) structures are funded solely by the Colorado Bridge Enterprise (Project No. 23559). These projects are combined to form one design-build project. The two ARE structures are part of the five bridges funded by the Colorado Bridge Enterprise.

The nineteen bridges identified to be included in the 'Region 2 Bridge Bundle' were selected based on similarities in the bridge conditions, risk factors, site characteristics, and probable replacement type, with the goal of achieving economy of scale. Seventeen of the bridges being replaced are at least 80 years old. Five of the bridges are Load Restricted, limiting trucking routes through major sections of the US 24 and US 350 corridors. The bundle is comprised of nine timber bridges, four concrete box culverts, one corrugated metal pipe (CMP), four concrete I-beam bridges, and one I-beam bridge with corrugated metal deck.

1.2 Site Description

The purpose of this report is to document the preliminary hydraulic analysis and design for the replacement of Structure I-15-AO as a part of the CDOT Region 2 Bridge Bundle Design Build. The project is located within Teller County at Mile Post 271.90 along US 24 between Florissant and Divide. Structure I-15-AO crosses over a seasonal wash. Figure 1 below illustrates the project location. The project is located in Section 6, Township 13 South, Range 70 West of the 6th P.M., County of Teller, Colorado. **Figure 1** shows the project limits.

The report will document preliminary hydrology, hydraulic, and scour analysis/outlet protection to support the proposed structure replacement design.

The Federal Emergency Management Agency (FEMA) has designated the project site as a FEMA Zone X, as determined by the Flood Insurance Rate Maps (FIRM) 08119C0160D effective date September 25, 2009, as shown in **Appendix A**. FEMA Zone X is an area of minimal flood hazard risk. Since Structure I-15-AO is not in a Special Flood Hazard Area (SFHA), this project will meet CDOT and state requirements. For rural, two-lane highways, the design flow for bridges and culverts is the 25-year storm event. However, the CDOT DDM requires all non-jurisdictional flood areas to follow Colorado Water Conservation Board's guidelines, which state that any development or construction should not raise the 100-year flood event WSEs more than 0.5'. While this is not a statewide requirement, best practice is to follow these guidelines. Structure I-15-AO falls into this category, but because the existing structure passes the 100-year flows, the proposed structures must be sized accordingly.

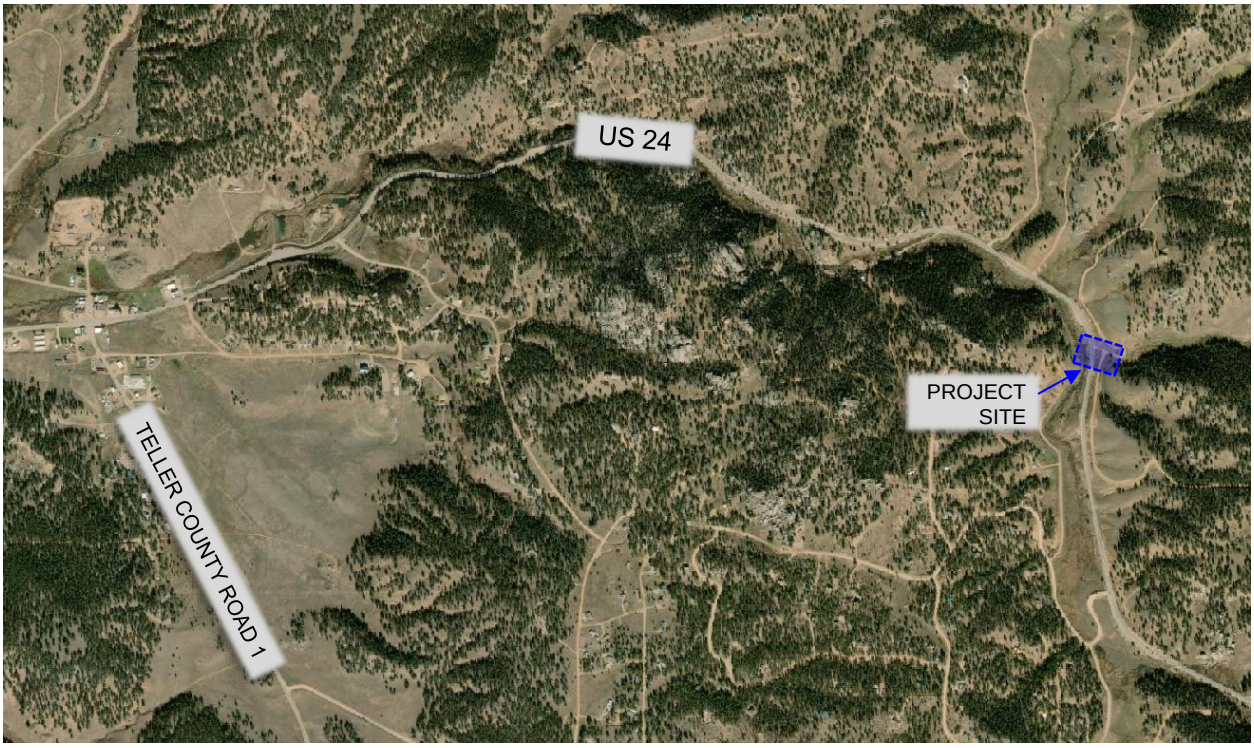


Figure 1: Vicinity Map

2. HYDROLOGY

Preliminary hydrology for the watershed tributary to this structure was provided by CDOT. A memorandum provided by CDOT has been provided that summarizes basin areas, runoff methodology and approximate flowrates derived from the preliminary analysis. **Table 1** is a summary of the approximate flowrates provided by CDOT for structure I-15-AO.

Twin Creek runs parallel to US 24 on the downstream side. Structure I-15-AO flows combine with Twin Creek just downstream of the existing structure. Flows for Twin Creek were not provided by CDOT, and no published hydrology study was readily available. The drainage area of the Twin Creek basin is 11.9 square miles. A USGS StreamStats analysis was completed for Twin Creek. The flows produced by this analysis are much lower than the hydrology study for I-15-AO produced. Further analysis will be required to more accurately depict the tailwater effect on structure I-15-AO in the final design.

Table 1: Summary of Peak Discharge for Bridge I-15-AO

River Location	Design Storm	100-year (cfs)	200-year (cfs)	500-year (cfs)
Upstream of Bridge	100-year	1,597	1,992	2,604
Twin Creek	100-year	153	174	212

3. EXISTING CONDITIONS

3.1 Existing Structure

The existing structure is a two-cell 10'x8' concrete box culvert. It was built in 1937. The box culvert's superstructure, substructure, and deck are in need of repair. No utilities were found attached to the bridge.

3.2 Watershed Overview

The seasonal wash is a channel that flows from the east to the west toward Twin Creek. The watershed tributary to the structure is approximately 5.29 square miles in area. The watershed generally slopes to the west. The stream bed does have a small base flow.

The stream flows at an approximate angle of attack of 90 degrees to the structure. The area surrounding the bridge is rural with undeveloped land to both upstream and downstream sides of the bridge. There is an existing 72-inch diameter CMP culvert under an existing dirt drive approximately 70 feet upstream of the existing RCBC. The stream combines with Twin Creek just downstream of US 24.

3.3 Site Investigation

A site investigation by Stanley Consultants in August 2020 was performed to gain an understanding of the key hydraulic and geomorphic features of the stream at the project site and of the overall watershed. This investigation found obvious concrete deterioration along the top and base of the box culverts. Site photos are included in **Appendix C**.

4. HYDRAULIC ANALYSIS

A two-dimensional (2D) hydraulic model was developed using the Sediment and River Hydraulics 2D model (SRH-2D) software developed by the USBR in 2008. A 2D model was chosen to represent this area due to the complexity of the stream. The Surface Water Modeling System (SMS) was used to develop the inputs for the SRH-2D Version 13.0 model, as well as post-process the results. For this analysis, three models were developed:

- Existing Conditions
- Proposed Conditions: Bridge Replacement
- Proposed Conditions: Box Culvert Replacement

4.1 Debris potential

The potential for debris production and delivery is estimated to be low (minimal) based on guidance from Federal Highway Administration (FHWA) Hydraulic Engineering Circular (HEC) No. 20. The flowchart for potential debris production is presented in Figure 2. The channel banks and bottom near the bridge are vegetated with tall grasses and shrubs, and no trees are present, as confirmed with the site visit in August 2020. Aerial imagery of the watershed near the bridge is shown in **Appendix C**.

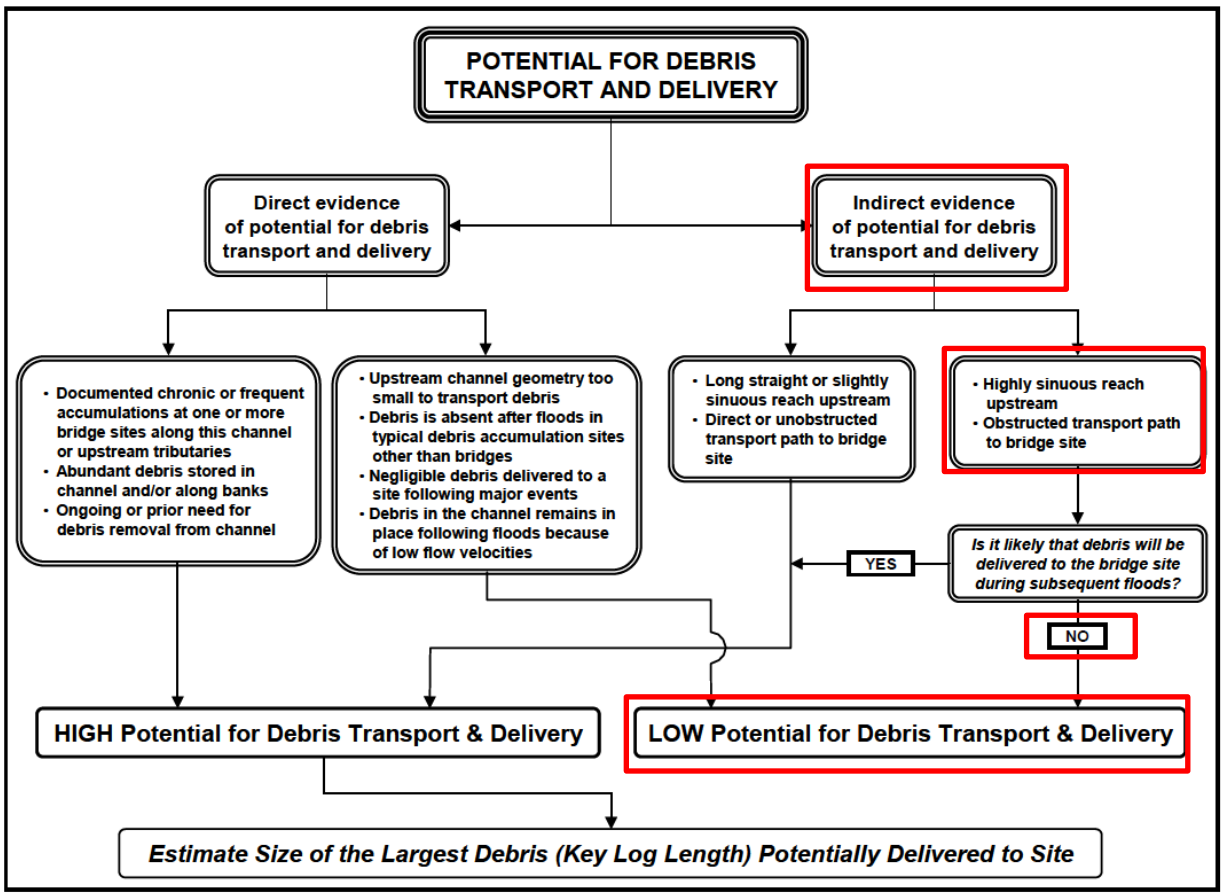


Figure 2: Flow Chart for Potential Debris Production (FHWA, HEC 20)

4.2 Freeboard

The CDOT Drainage Design Manual (2019) specifies freeboard requirements for all bridges. Freeboard is the minimum clearance between the design approach WSE and the low chord of the bridge. It is a factor of safety that acts as a buffer to account for unknown factors that could increase the height of the calculated WSE. Streams classified as high debris streams shall have a minimum of 4 feet of freeboard. Low-to-moderated streams CDOT highly encourages 2 feet be provided, where practical. The elevation of the water surface 50 to 100 feet upstream of the face of the bridge shall be the elevation to which the freeboard is added to get the bottom or low-girder elevation of the bridge.

The channel was not identified as having a high potential for debris production. Therefore, if a bridge is selected for the proposed conveyance structure, 2 feet of freeboard would typically be required. The existing 100-year water surface elevation hits the existing box culvert above the top of the box. The proposed design has a wider opening; therefore, the proposed bridge option provides 2.5-ft of freeboard and the proposed culvert has a 1.5-ft opening between the water surface and the top of the box.

4.3 Modeling Parameters

4.3.1 Elevation Data

Existing conditions survey for the bridge and channel cross sections was performed by CDOT in June 2020. LiDAR was acquired by CDOT in June 2020. These two data sources were combined for the modeling elevation surface.

A local, custom projection was used for the data collection in the existing conditions survey. The survey was converted into NAD 1983 Colorado State Plane Central US Survey Feet for the hydraulic modeling. All elevations are referenced to NAVD 88 (feet).

4.3.2 Computational Mesh

The computational mesh is an unstructured mesh, which allows for the use of triangles and quadrilaterals, with variable element sizes. Roadways used quadrilaterals, with the face lined up perpendicular to flow. Triangles were typically used in the floodplain. The total number of mesh elements is 16,979 and the mesh extends approximately 970 feet upstream of the structure and 1,040 feet downstream of the structure.

4.3.3 Surface Roughness

Surface roughness, represented by the Manning's roughness coefficient, is presented in **Table 2**. A Manning's n-value was assigned to each land use based on aerial imagery, topography, a site visit in August 2020, and engineering judgment. Photos from the site visit used to confirm the n-values selected are shown in **Appendix C**, and a map showing existing conditions materials coverages is shown in **Appendix D**.

Table 2: Manning's n-values

Land Use	n-value
Channel	0.035
Dense Vegetation	0.070
Light Vegetation	0.050
Open Space	0.055
Paved Road	0.016
Dirt Road	0.020

4.3.4 Boundary Conditions

The boundary conditions include a steady state inflow and a normal depth calculated outflow.

The peak flows developed in **Table 1** were used to develop a steady-state inflow boundary condition. The inflow boundary condition extends the full length of the inundation boundary in the upstream portion of the project location. The model was set to a dry initial condition.

A second inflow boundary condition was included for Twin Creek, which runs north to south in this location parallel with US 24. The flows from I-15-AO combine with flows from Twin Creek just downstream of the structure.

For the downstream boundary condition, the subcritical outflow option was selected. This outflow condition uses the inputs of anticipated flow, Manning's n-value, channel slope, and terrain data to determine the outflow constant water surface elevation. **Table 3** presents the boundary condition values.

Table 3: Model Boundary Condition Inputs

Frequency Storm	Inflow at Twin Creek (cfs)	Inflow at I-15-AO (cfs)	Outflow Constant WSE (ft)
100-Year	153	1,597	8,436.40

4.3.5 Hydraulic Structures

The modeled existing culvert geometry is based on the survey completed in August 2020. The survey data included shots detailing the structure. The inlet elevation of the culvert is 8468.81 and the outlet elevation of the culvert is 8466.94.

4.3.6 Simulation Control

The hydraulic simulations are run with a 1.0 second time step for 0.5 hours when a steady state solution is met. The parabolic turbulence method is used with a coefficient of 0.7.

4.4 Model Results

4.4.1 Existing Conditions

The range of depths experienced in the channel at the bridge during the 100-year event is from 5.68 feet to 10.18 feet. The results demonstrate that the existing 72" culvert cannot convey flows through it, and flow overtop the roadway at the dirt driveway just north of the crossing during the 100-year event. The results also show that flows pond behind the embankment both north and south of the existing box culvert as well. Existing conditions 100-year depths of flow are shown in **Appendix D**.

4.4.2 Alternatives Analysis

An alternatives/risk analysis was completed in the preliminary design process to determine the most feasible options for the hydraulic conveyance structure. Both a bridge and reinforced concrete box culvert (RCBC) option were analyzed. Many factors were taken into consideration when determining the preferred alternative for this preliminary analysis. These factors included cost, constructability, effects on the stream hydraulics, environmental impacts, among others.

<u>Proposed RCBC</u>

This option was modeled using the same SRH-2D model as was used for the existing conditions. Modifications to the model included channel re-grading to flatten the bottom of the culvert. The proposed model has 20,227 mesh elements. The use of HY-8 to model this culvert is acceptable due to the direction of flow being perpendicular to the roadway.

Because the existing condition overtops the road, a similar opening size was used for the box culverts to keep the WSEs the same or lower than existing conditions. The preliminary model shows the roadway embankment sloping at 3:1, and the proposed culvert being 57.5 feet in length. The RCBC option for this structure required a 2 cell 10-foot wide by 10-foot tall structure. This structure size was determined to prevent roadway overtopping which would result in lower WSEs of the channel.

Depths and velocity grids for the proposed RCBC show depths from 5.22 to 9.11 feet and velocities from 7.44 to 18.05 ft/s. See **Appendix E** for 100-year depths and velocities graphics for this option.

Proposed Bridge

This option was modeled using the same SRH-2D model as was used for the existing conditions. Modifications to the model included slightly widening the channel bottom to establish vertical abutments outside of the existing structure. The proposed model has 20,277 mesh elements. The proposed model has a 30-foot span width, no piers, the low chord of the bridge upstream is at 8480.08 and downstream is 8478.43 elevation, and the high chord didn't change from the existing condition. Roadway embankments were graded at 4:1.

Depths and velocity grids for the proposed RCBC show depths from 3.25 to 5.39 feet and velocities from 11.98 to 15.81 ft/s. See **Appendix F** for 100-year depths and velocities graphics for this option.

5. WATER SURFACE ELEVATION ANALYSIS

FEMA has designated the project site as a Zone X, as determined by the FIRM #08119C0160D effective date September 25, 2009, as shown in **Appendix A**.

FEMA Zone X is not a special flood hazard area inundated by the 100-year flood.

Proposed RCBC

Based on modeling results, the proposed RCBC will decrease the WSE by more than 1 foot. Because the opening of the proposed RCBC is larger than the existing opening and the culvert is longer, a lower WSE is expected.

In order to perform a comparison between the existing and proposed WSE, 8 cross sections were cut across the 2D hydraulic model results both upstream and downstream of the proposed bridge. The average WSE was determined for both existing and the proposed RCBC option, as shown in **Appendix G**. The WSE comparison at these sections is shown in Table 4. There is some flow that backs up into the creek for about 300 feet south of the crossing for an approximate depth of 0.50 ft, tailwater data was provided from StreamStats which was included in the model as an additional input condition for Twin Creek.

Table 4: Comparison of Existing and Proposed RCBC WSE at I-15-AO

Cross Section	Location Relative to Proposed RCBC	Existing WSE (ft)	Proposed WSE (ft)	Proposed vs. Existing
1	Upstream	8490.83	8490.83	0.00
2	Upstream	8481.87	8481.87	0.00

3	Upstream	8480.11	8480.14	0.03
4	Upstream	8479.65	8477.43	-2.22
5	Downstream	8472.87	8471.15	-1.72
6	Downstream	8470.96	8469.01	-1.95
7	Downstream	8466.80	8466.69	-0.11
8	Downstream	8464.57	8464.57	0.00

Proposed Bridge

Similarly, the model for the proposed bridge will decrease the WSE by more than 1 foot. The bridge opening for this option is similar to the existing structure but has a flatter channel bottom. Therefore, the WSE is expected to decrease.

For the proposed bridge, upstream of Bridge I-15-AO (Cross Sections 1-4), the WSE decreases between 0.05 feet and 1.77 feet between existing and proposed. Downstream of Bridge I-15-AO (Cross Sections 5-8), the WSE decreases a maximum of 2.01 feet between existing and proposed. The creek just downstream of the crossing flows from south to north. There is some flow that backs up into the creek for about 300 feet south of the crossing for an approximate depth of 0.50 ft, tailwater data was provided from StreamStats which was included in the model as an additional input condition for Twin Creek.

Appendix G shows the cross sections used for the proposed bridge option as well as the floodplain limit changes between existing and proposed for this scenario. Table 5 also shows a WSE comparison at each section for the proposed bridge option.

Table 5: Comparison of Existing and Proposed Bridge WSE at I-15-AO

Cross Section	Location Relative to Proposed Bridge	Existing WSE (ft)	Proposed WSE (ft)	Proposed vs. Existing
1	Upstream	8490.83	8490.83	0.00
2	Upstream	8481.87	8481.87	0.00
3	Upstream	8480.11	8480.16	0.05
4	Upstream	8479.65	8477.88	-1.77
5	Downstream	8472.87	8470.86	-2.01
6	Downstream	8470.96	8469.02	-1.94
7	Downstream	8466.80	8466.70	-0.10
8	Downstream	8464.57	8464.57	0.00

6. RCBC OUTLET ENERGY DISSIPATION

The design procedure recommended in section 11.4 of the DDM was followed for outlet protection and energy dissipation at the outlet of the box culvert. All hydraulic data from the proposed culvert was gathered including height, width, length, slope, etc. The culvert control was determined to be outlet controlled, and outlet depth, velocity and Froude number was

determined. To determine tailwater data, the downstream channel information was gathered from the survey data, field inspection, and the SRH-2D model.

Allowable scour estimation was completed using HY-8. Soil parameters of the downstream channel were extracted from the soils reports, and geotechnical investigation. The estimated scour hole was then determined using HY-8. Due to large scour hole estimates, energy dissipation was then considered.

The energy dissipation alternative selected for this RCBC outlet is a riprap apron based on the Froude number of 1.0 which is less than 3. See results from HY-8 energy dissipation analysis in **Appendix H**.

7. CONCLUSIONS

This report presents preliminary analysis and results from the hydrologic and hydraulic study for the Region 2 Bridge Bundle Design Build – Bridge I-15-AO. This report documents preliminary analysis in determining costs for proposed structure replacement at this location. It also includes preliminary FEMA floodplain analysis and scour analysis.

A two-dimensional model was developed to analyze the flows through the existing bridge and compare the WSEs and velocities to the proposed design. This model was utilized to optimize the proposed solution to replacement of the existing bridge.

Based on the hydraulic analysis, the proposed replacement for this structure is a 2 cell, 10-ft by 10-ft tall concrete box culvert. The 100-year water surface elevation is lowered and no longer overtops the roadway with this option. The headwater elevation at the culvert entrance is 7.17 ft and the Headwater to Depth (HW/D) ratio is 0.72 which meets CDOT requirements of 1.5 for this culvert.

8. REFERENCES

1. "Colorado Department of Transportation Drainage Design Manual", Colorado Department of Transportation, 2019.
2. Mile High Flood District, Urban Storm Drainage Criteria Manual (USDCM), Volumes I, II, and III, August 2018.
3. "Hydraulic Engineering Circular No. 18 – Evaluating Scour at Bridges Fifth Edition". U.S. Department of Transportation Federal Highway Administration, April 2012.
4. "Hydraulic Engineering Circular No. 20 – Stream Stability at Highway Structures". U.S. Department of Transportation Federal Highway Administration, April 2012.
5. "Hydraulic Engineering Circular No. 23 – Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance – Third Edition," U.S. Department of Transportation, Federal Highway Administration, September 2009.
6. CDOT Region 2 2D Quick Check Hydrology Summary Report and Matrix, Colorado Department of Transportation, 2020.

APPENDIX A FEMA FIRM 08119C0160D

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988 (NAVD88). These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-2, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at http://www.ngs.noaa.gov/.

Base Map information shown on this FIRM was provided in digital format by Teller County. These data are current as of 2007.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study Report (which contains authoritative hydraulic data)* may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study Report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

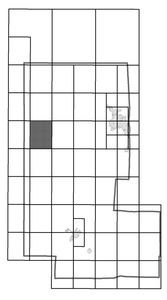
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA Map (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/.

Teller County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)
East Fork Fountain Creek	4.2
East Fork Paint Pony	4.2
Fountain Creek	4.2
Lovell Gulch	4.2
Loy Gulch	4.2
Paint Pony	4.2
Trout Creek	4.2

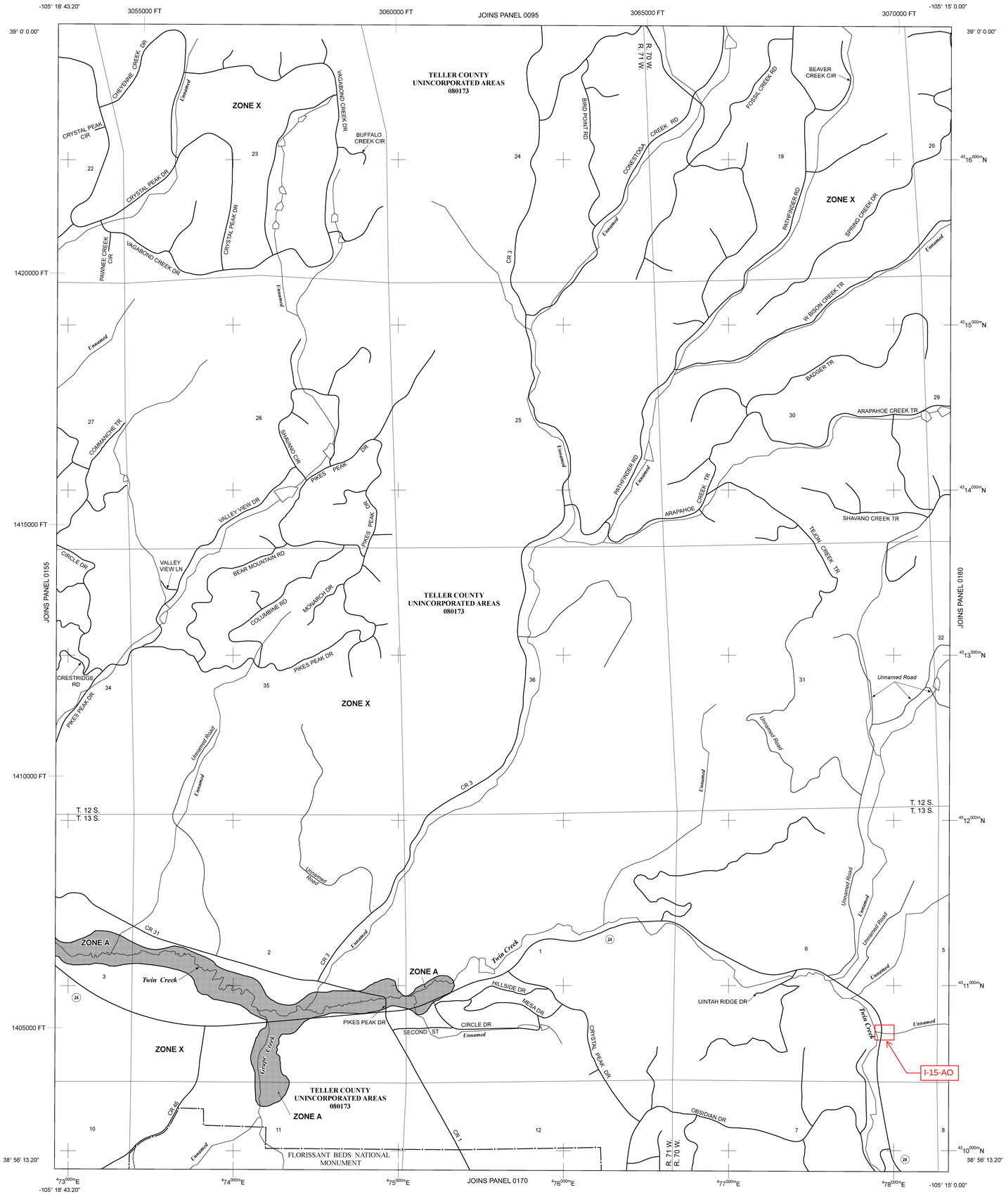
Example: To convert Fountain Creek elevations to NAVD 88, 4.2 feet were added to the NGVD 29 elevations.

Panel Location Map



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- Floodplain boundary
- Floodway boundary
- Zone D Boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- A — A — Cross section line
- 23 — 23 — Transect line
- 97° 07' 30.00" / 32° 22' 30.00" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 4275000mN — 1000-meter Universal Transverse Mercator grid ticks, zone 13
- 6000000 FT — 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic projection
- DX5510 × — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
September 30, 1988

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
SEPTEMBER 25, 2009 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

PANEL 0160D

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

TELLER COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 0160 OF 0415

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS

COMMUNITY	NUMBER	PANEL	SUFFIX
TELLER COUNTY	080173	0160	D

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
08119C0160D

MAP REVISED
SEPTEMBER 25, 2009

Federal Emergency Management Agency

APPENDIX B NRCS SOIL SURVEY

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Teller-Park Area, Colorado, Parts of Park and Teller Counties

November 17, 2020

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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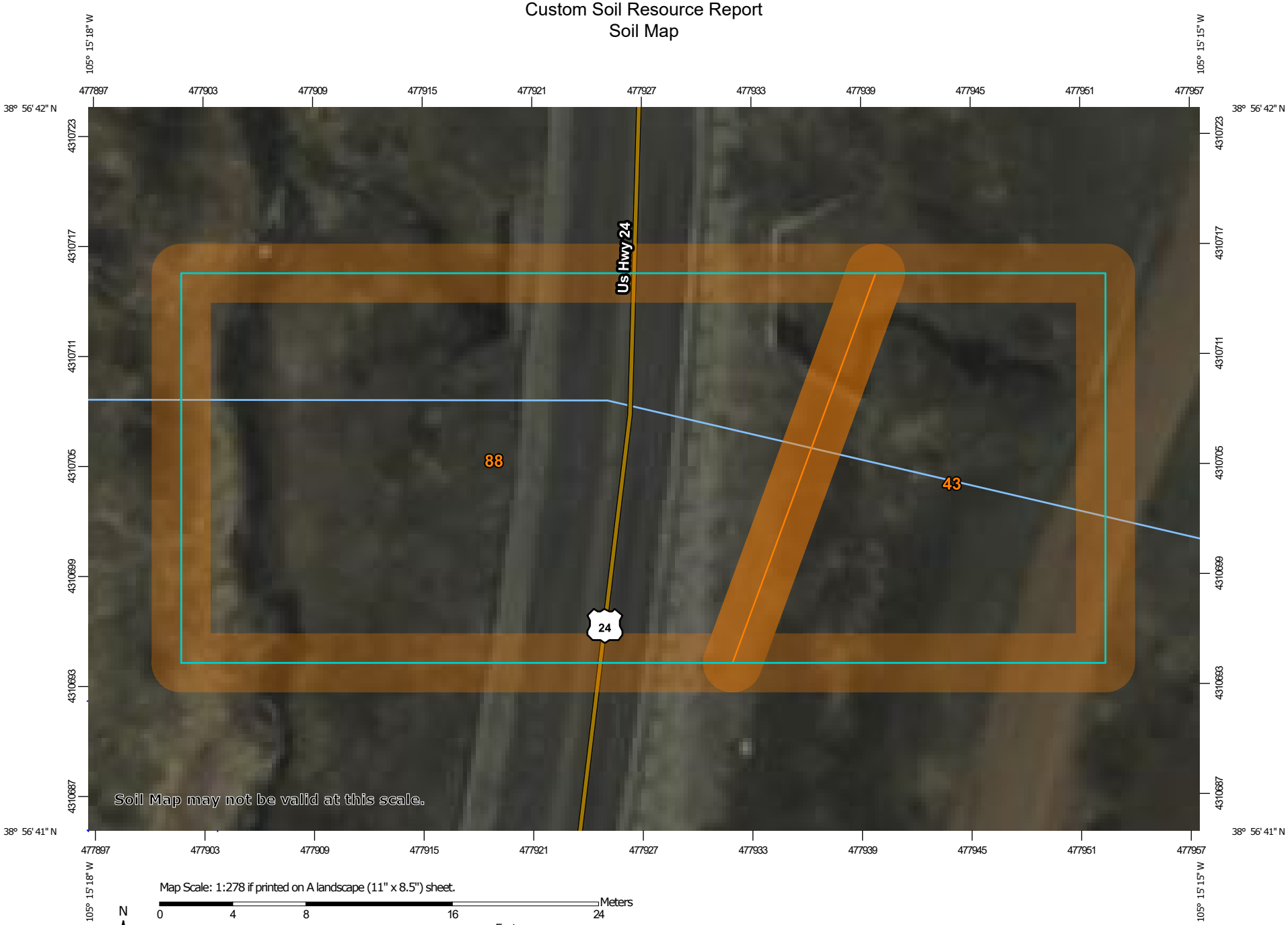
Contents

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Teller-Park Area, Colorado, Parts of Park and Teller Counties
Survey Area Data: Version 12, Jun 5, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 18, 2020—May 21, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
43	Guffey-Rofork association, 5 to 50 percent slopes	0.1	32.6%
88	Rofork very gravelly sandy loam, 5 to 55 percent slopes	0.2	67.4%
Totals for Area of Interest		**0.3**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however,

onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Teller-Park Area, Colorado, Parts of Park and Teller Counties

43—Guffey-Rofork association, 5 to 50 percent slopes

Map Unit Setting

National map unit symbol: 2n84h
Elevation: 8,300 to 9,500 feet
Mean annual precipitation: 14 to 20 inches
Mean annual air temperature: 38 to 40 degrees F
Frost-free period: 50 to 80 days
Farmland classification: Not prime farmland

Map Unit Composition

Guffey and similar soils: 50 percent
Rofork and similar soils: 25 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Guffey

Setting

Landform: Mountains
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium over residuum weathered from granite

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
E1 - 1 to 8 inches: very gravelly coarse sandy loam
E2 - 8 to 13 inches: very gravelly coarse sandy loam
Bt - 13 to 27 inches: very gravelly clay loam
Cr - 27 to 60 inches: bedrock

Properties and qualities

Slope: 5 to 50 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water capacity: Very low (about 1.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Other vegetative classification: Douglas-fir/kinnikinnick-common juniper (PSME/ARUV-JUCO6) (C1219)
Hydric soil rating: No

Description of Rofork

Setting

Landform: Mountains
Landform position (three-dimensional): Mountaintop, mountainflank
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium derived from granite and gneiss over residuum weathered from granite and gneiss

Typical profile

A1 - 0 to 5 inches: very gravelly sandy loam
A2 - 5 to 9 inches: extremely gravelly sandy loam
AC - 9 to 14 inches: extremely gravelly coarse sand
Cr - 14 to 24 inches: bedrock

Properties and qualities

Slope: 5 to 50 percent
Depth to restrictive feature: 10 to 20 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 0.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: R048AY240CO
Other vegetative classification: Ponderosa pine/Arizona fescue (PIPO/FEAR2) (C1109), Mountain muhly - Arizona fescue (MUMO-FEAR2) (G2602)
Hydric soil rating: No

Minor Components

Typic haplustolls

Percent of map unit: 10 percent
Landform: Mountains
Ecological site: R048AY222CO
Hydric soil rating: No

Rock outcrop

Percent of map unit: 5 percent
Landform: Knobs, hills
Landform position (three-dimensional): Crest, nose slope
Hydric soil rating: No

Adderton

Percent of map unit: 5 percent
Landform: Flood plains
Ecological site: R048AY222CO
Hydric soil rating: No

Catamount

Percent of map unit: 5 percent
Landform: Mountains
Hydric soil rating: No

88—Rofork very gravelly sandy loam, 5 to 55 percent slopes

Map Unit Setting

National map unit symbol: 2n84f
Elevation: 8,100 to 10,000 feet
Mean annual precipitation: 14 to 24 inches
Mean annual air temperature: 36 to 41 degrees F
Frost-free period: 50 to 80 days
Farmland classification: Not prime farmland

Map Unit Composition

Rofork and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rofork

Setting

Landform: Mountains
Landform position (three-dimensional): Mountaintop, mountainflank
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium derived from granite and gneiss over residuum weathered from granite and gneiss

Typical profile

A1 - 0 to 5 inches: very gravelly sandy loam
A2 - 5 to 9 inches: extremely gravelly sandy loam
AC - 9 to 14 inches: extremely gravelly coarse sand
Cr - 14 to 24 inches: bedrock

Properties and qualities

Slope: 5 to 55 percent
Depth to restrictive feature: 10 to 20 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 0.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: R048AY240CO
Other vegetative classification: Ponderosa pine/Arizona fescue (PIPO/FEAR2) (C1109), Mountain muhly - Arizona fescue (MUMO-FEAR2) (G2602)
Hydric soil rating: No

Minor Components

Typic haplustolls

Percent of map unit: 5 percent
Landform: Mountains
Ecological site: R048AY222CO
Hydric soil rating: No

Adderton

Percent of map unit: 3 percent
Landform: Flood plains
Ecological site: R048AY222CO
Hydric soil rating: No

Rock outcrop

Percent of map unit: 2 percent
Landform: Hills, knobs
Landform position (three-dimensional): Crest, nose slope
Hydric soil rating: No

APPENDIX C AERIAL IMAGERY AND PHOTOS

AERIAL IMAGERY AND PHOTOS

STRUCTURE I-15-AO

FIGURE 1

AERIAL IMAGERY AND PHOTOS

STRUCTURE I-15-AO

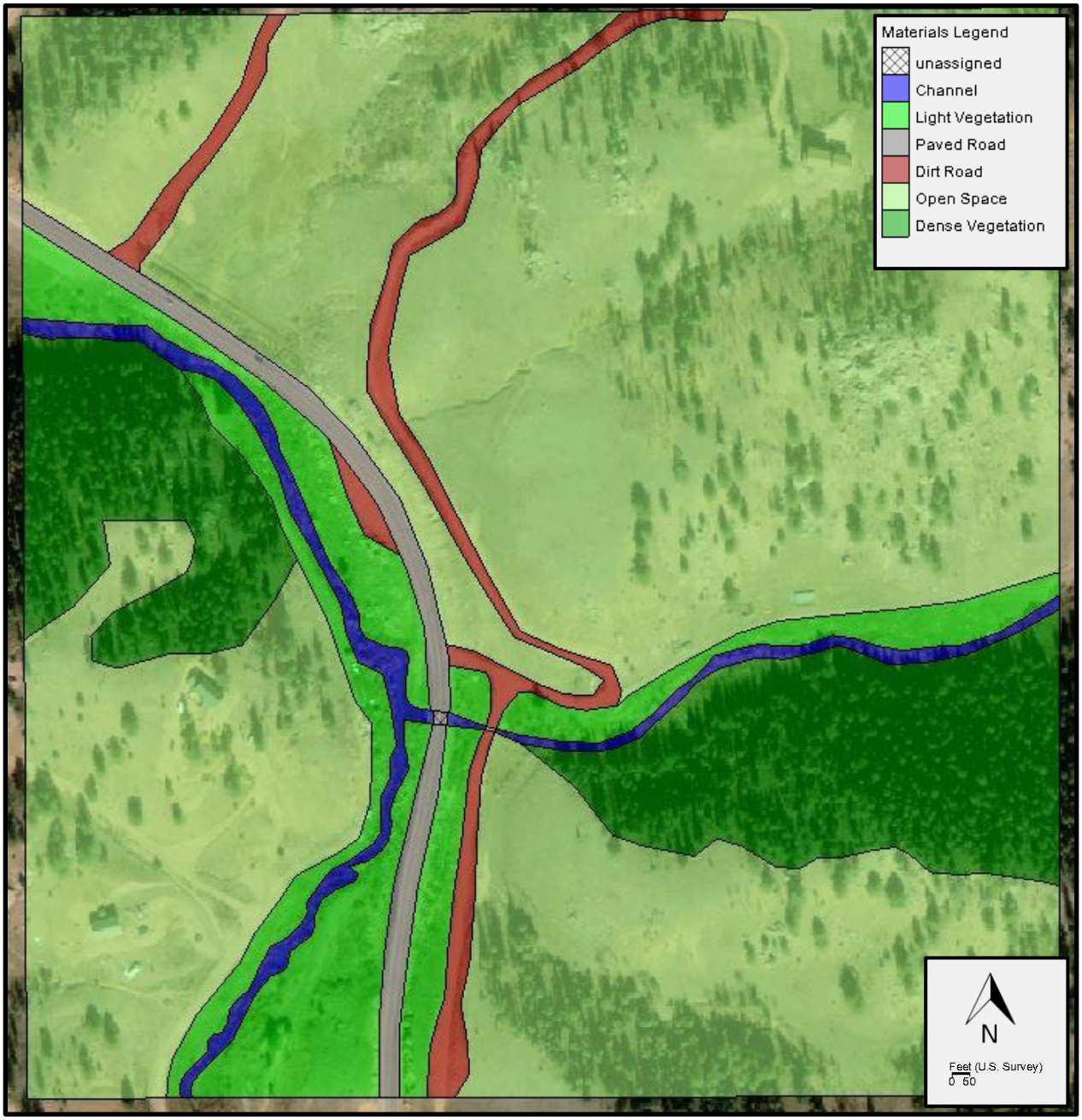
FIGURE 2

AERIAL IMAGERY AND PHOTOS
STRUCTURE I-15-AO
FIGURE 3

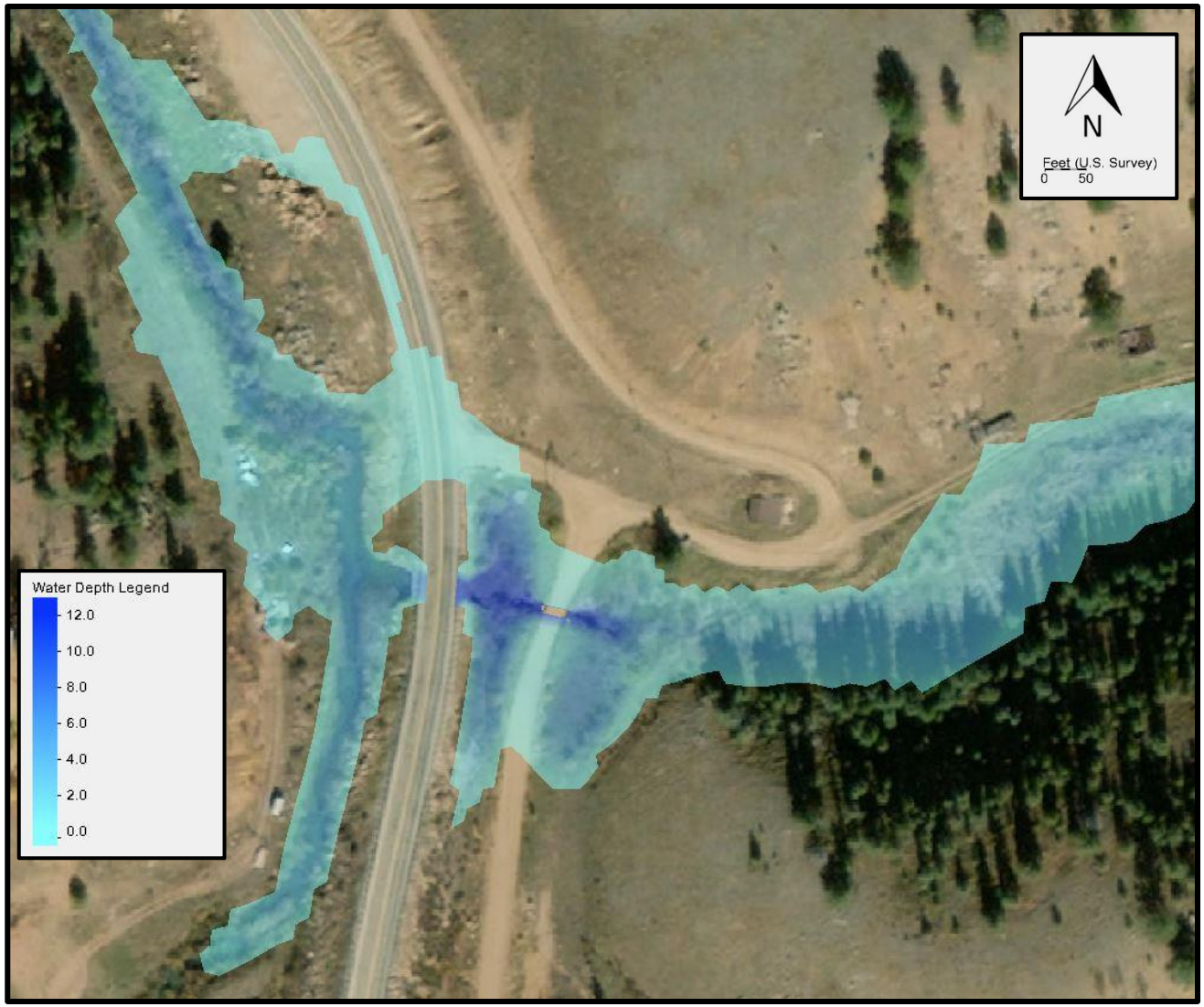
AERIAL IMAGERY AND PHOTOS
STRUCTURE I-15-AO
FIGURE 4

AERIAL IMAGERY AND PHOTOS
STRUCTURE I-15-AO
FIGURE 5

APPENDIX D EXISTING CONDITIONS MODEL GRAPHICS



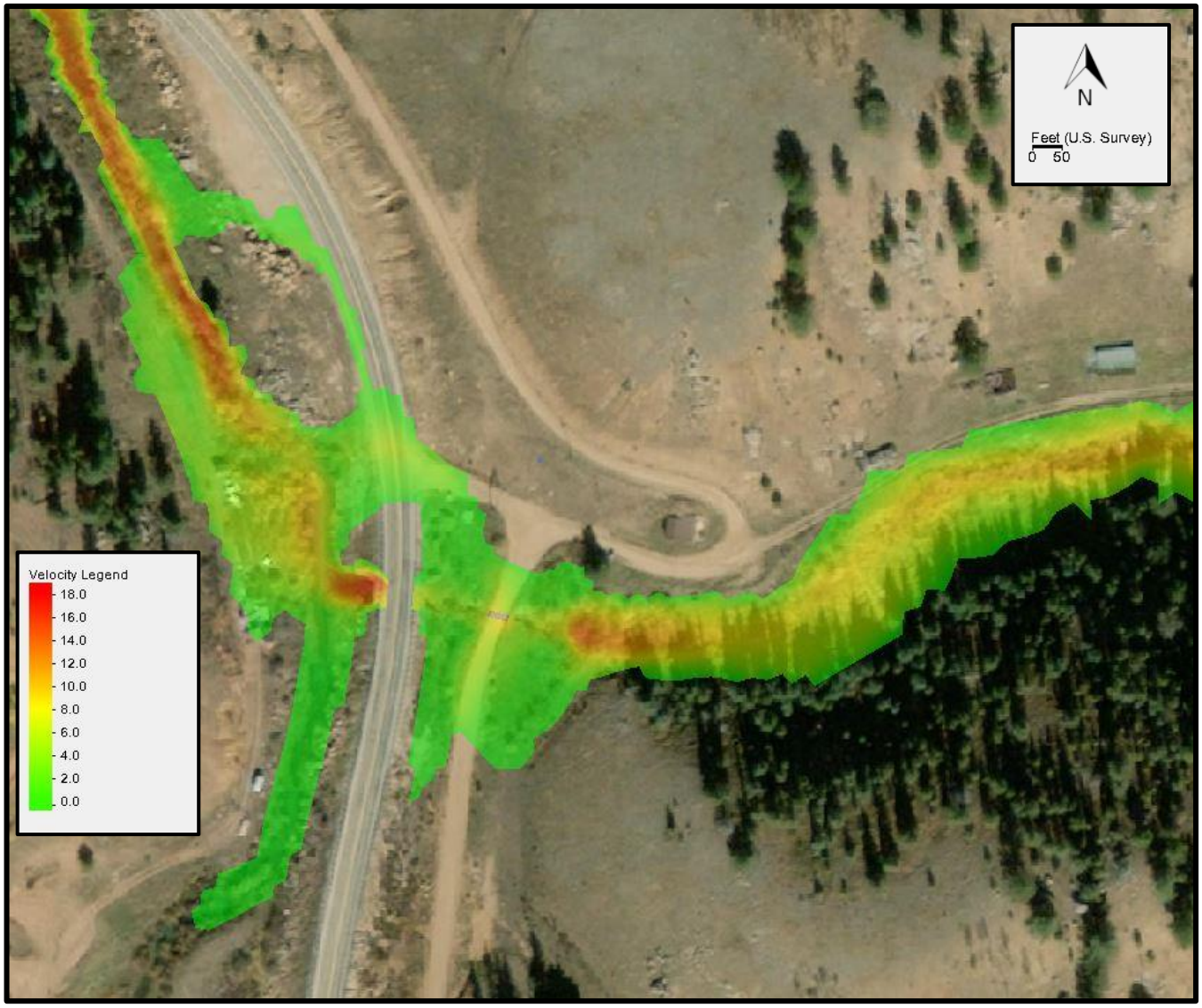
MATERIALS COVERAGE
STRUCTURE I-15-AO
FIGURE 1



EXISTING CONDITIONS – WATER DEPTH

STRUCTURE I-15-AO

FIGURE 2

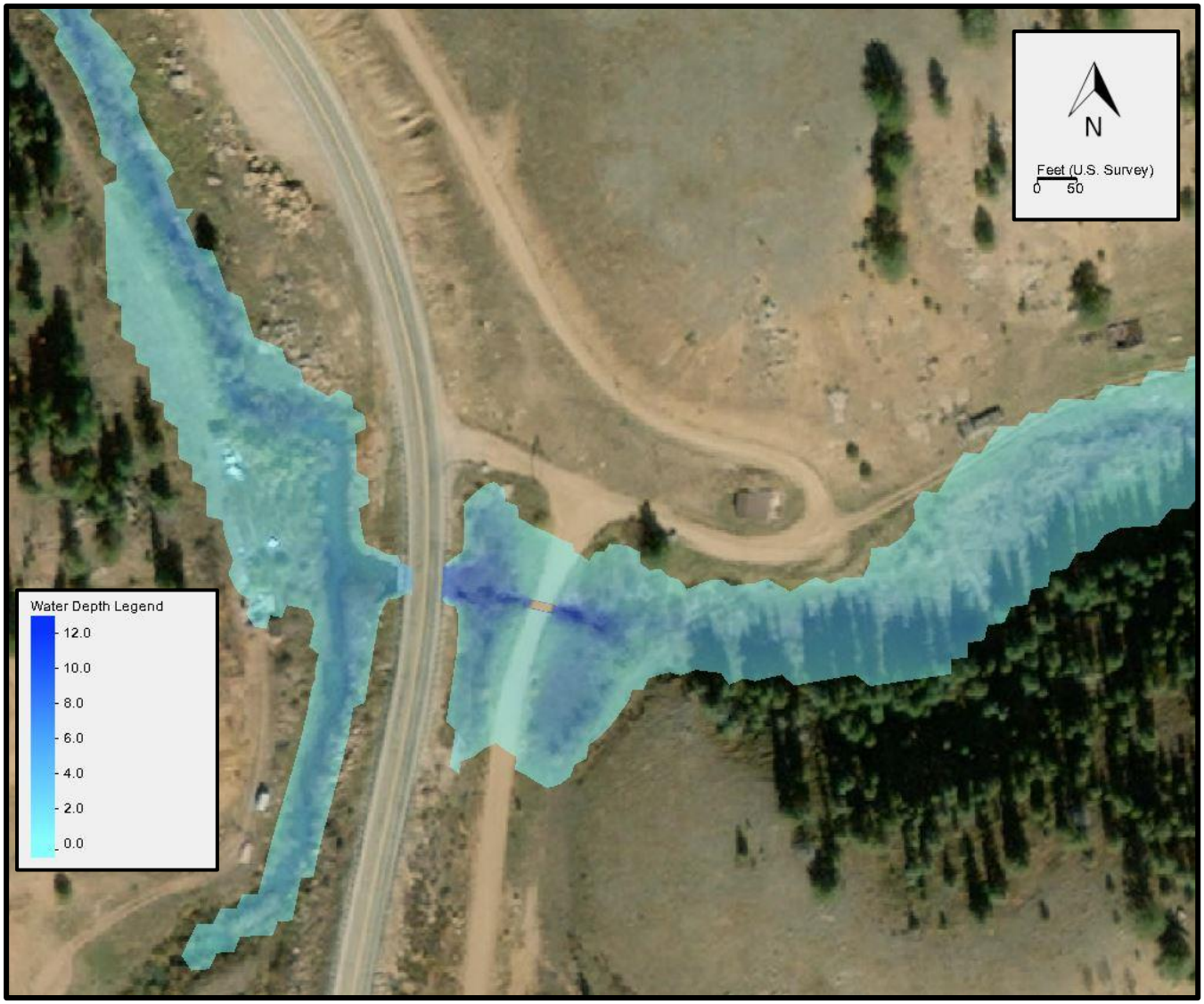


EXISTING CONDITIONS – VELOCITY

STRUCTURE I-15-AO

FIGURE 3

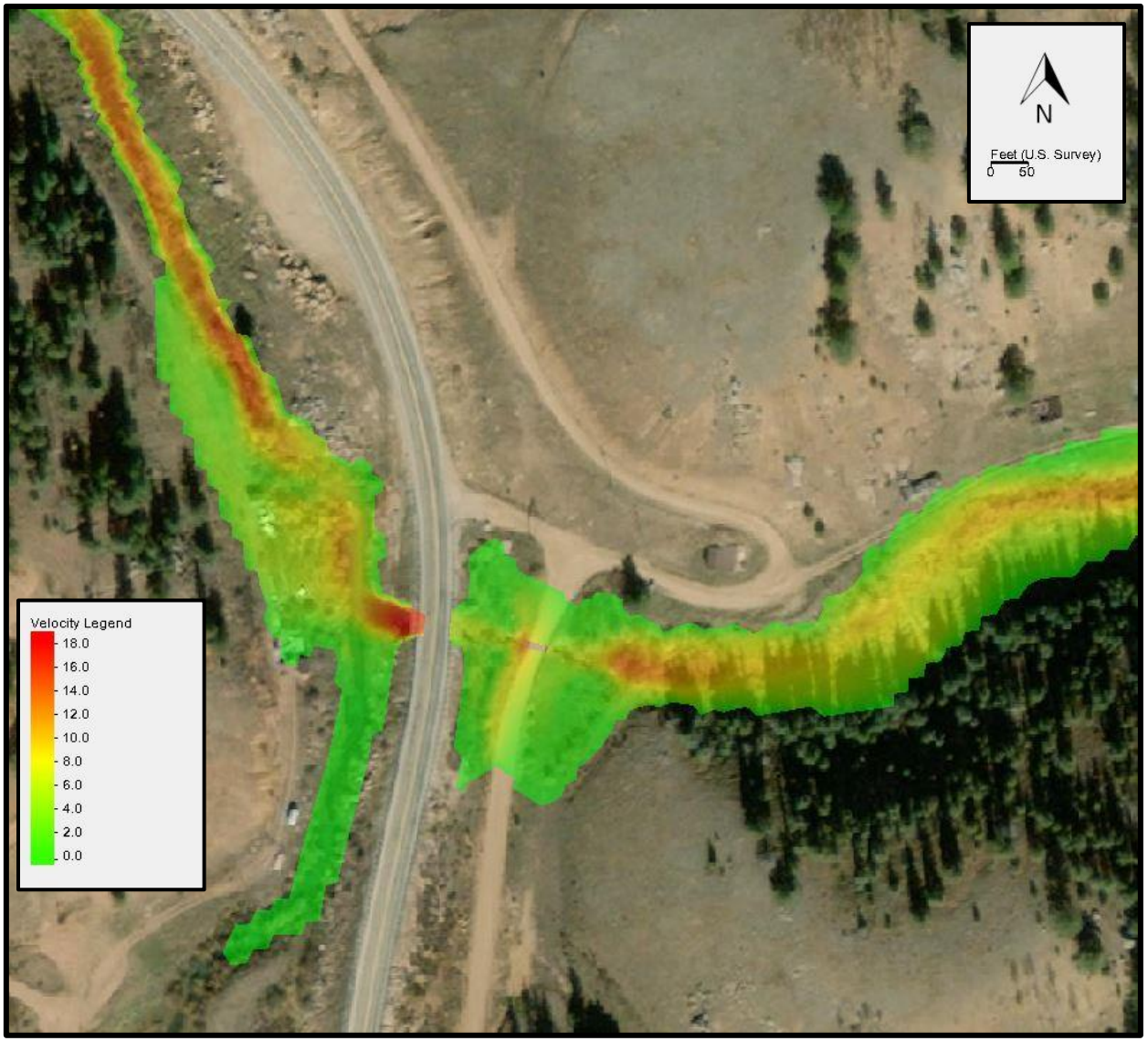
APPENDIX E PROPOSED RCBC ALTERNATIVE MODEL GRAPHICS



PROPOSED CONDITIONS – WATER DEPTH

RCBC AT STRCUTURE I-15-AO

FIGURE 1

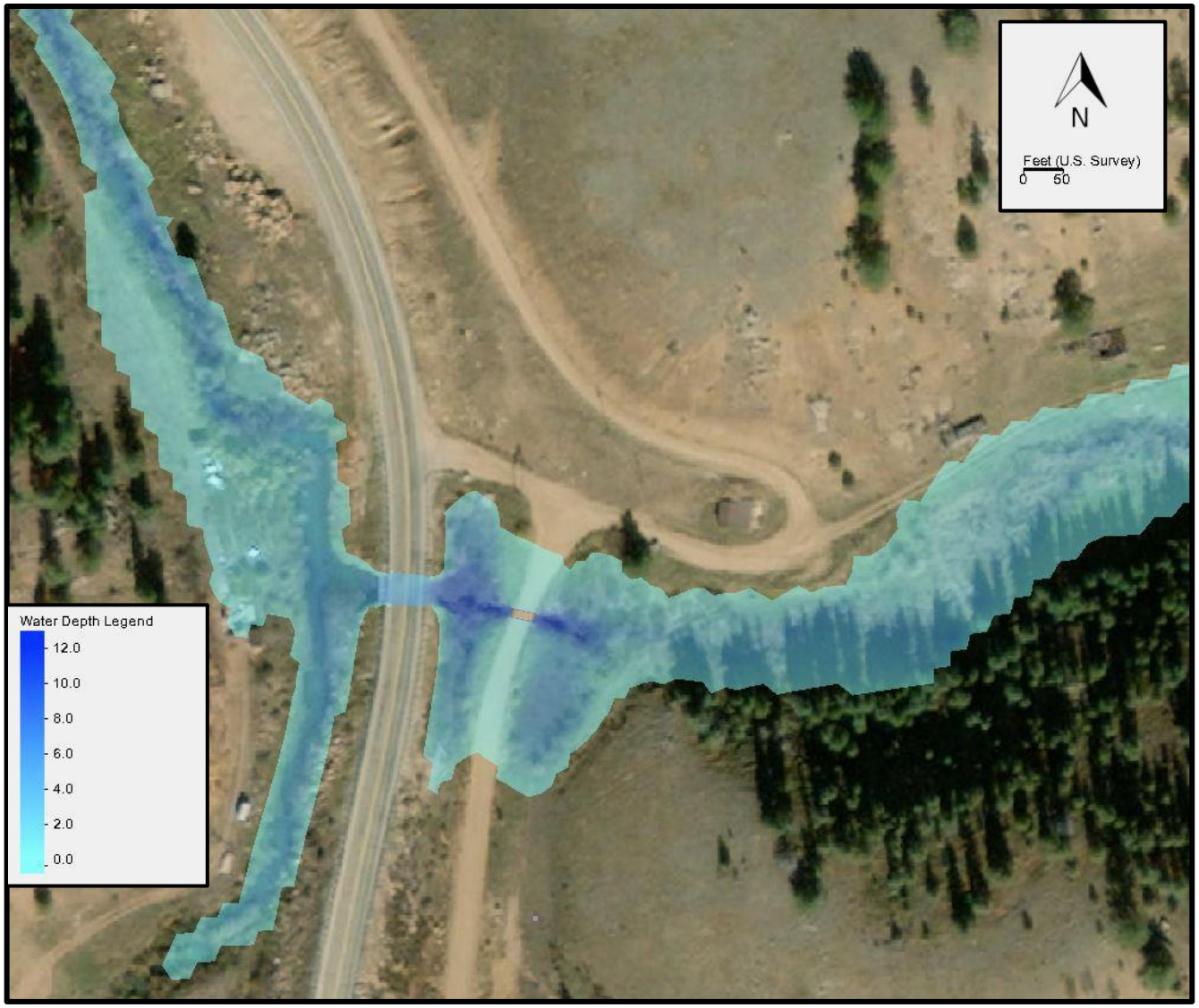


PROPOSED CONDITIONS – VELOCITY

RCBC AT STRUCTURE G-12-C

FIGURE 2

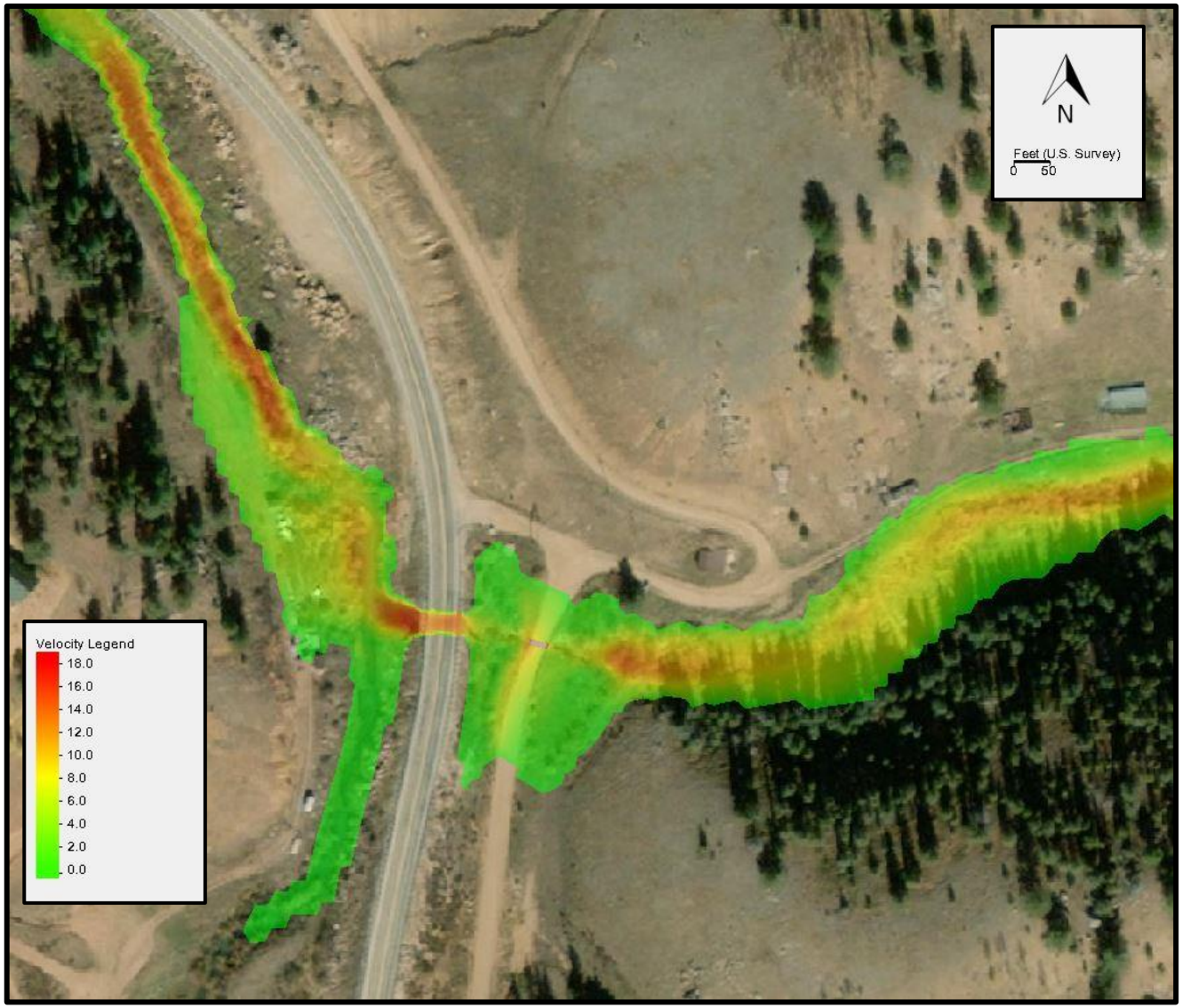
APPENDIX F PROPOSED BRIDGE ALTERNATIVE MODEL GRAPHICS



PROPOSED CONDITIONS – WATER DEPTH

BRIDGE AT STRUCTURE I-15-AO

FIGURE 1



PROPOSED CONDITIONS – VELOCITY

BRIDGE AT STRUCTURE I-15-AO

FIGURE 2

APPENDIX G WATER SURFACE ELEVATION COMPARISON GRAPHICS

WATER SURFACE ELEVATION COMPARISON – RCBC OPTION

STRUCTURE I-15-AO

FIGURE 1

WATER SURFACE ELEVATION COMPARISON – BRIDGE OPTION

STRUCTURE I-15-AO

FIGURE 2

APPENDIX H ENERGY DISSIPATION ANALYSIS

HY-8 Energy Dissipation Report

Scour Hole Geometry

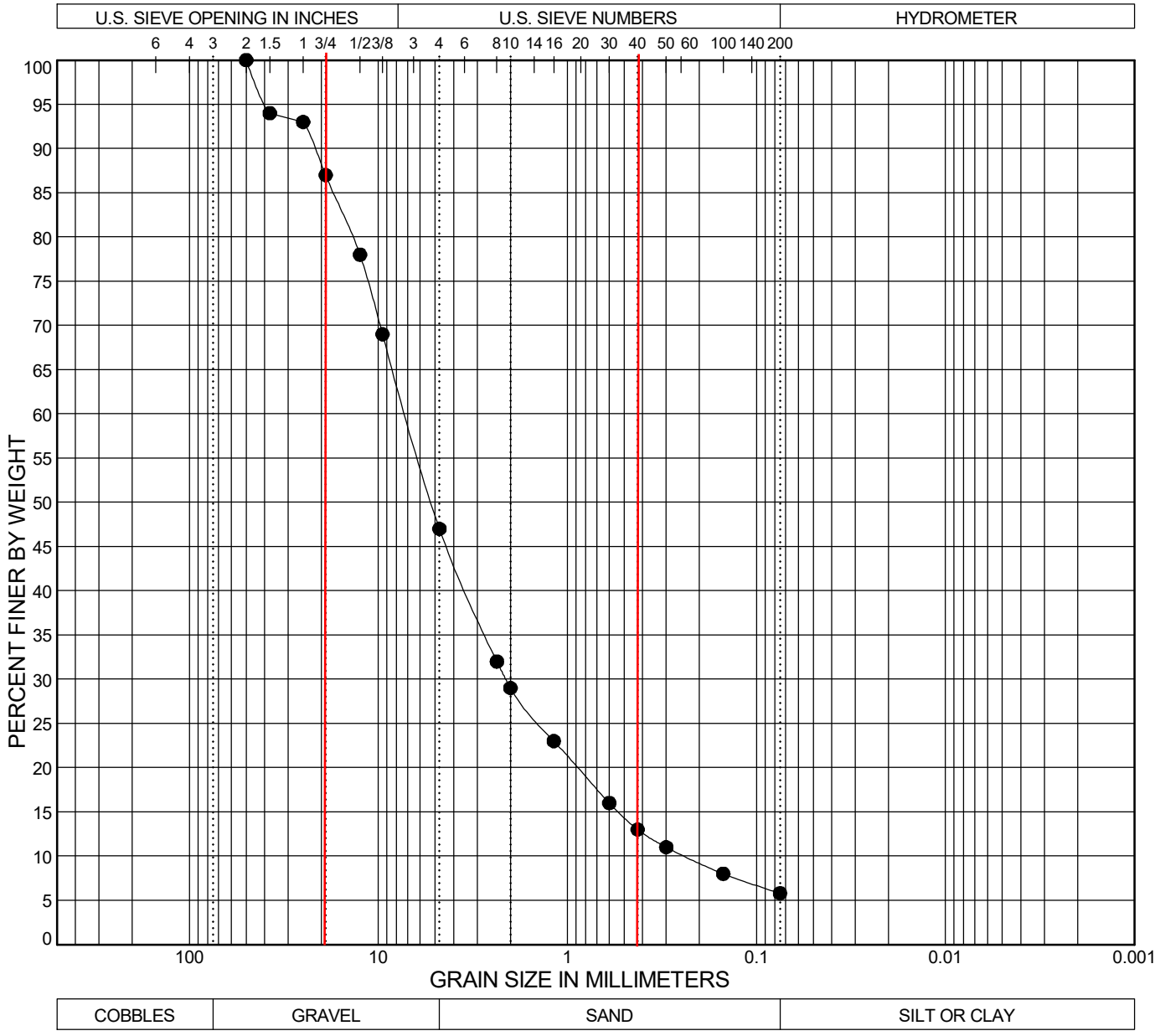
Parameter	Value	Units
Select Culvert and Flow		
Crossing	Proposed	
Culvert	Proposed Culvert	
Flow	1597.00	cfs
Culvert Data		
Culvert Width (including multiple barrels)	20.0	ft
Culvert Height	10.0	ft
Outlet Depth	5.83	ft
Outlet Velocity	13.70	ft/s
Froude Number	1.00	
Tailwater Depth	5.48	ft
Tailwater Velocity	6.95	ft/s
Tailwater Slope (SO)	0.0000	
Scour Data		
Time to Peak		
Note:	if Time to Peak is unknown, enter 30 min	
Time to Peak	30.00	min
Cohesion	Noncohesive	
D16 Value	0.42	mm
D84 Value	18.00	mm
Tailwater Flow Depth after Culvert Outlet	Normal Depth	
Results		
Assumptions		
Soil Sigma	6.55	
Scour Hole Dimensions		
Length	-1.#IO	ft
Width	-1.#IO	ft
Depth	-1.#IO	ft
Volume	-1.#IO	ft^3
DS at .4(LS)	-1.#IO	ft
Tailwater Depth (TW)	5.480	ft
Velocity with TW and WS	-1.#IO	ft/s

HY-8 Energy Dissipation Report

External Energy Dissipator

Parameter	Value	Units
Select Culvert and Flow		
Crossing	Proposed	
Culvert	Proposed Culvert	
Flow	1597.00	cfs
Culvert Data		
Culvert Width (including multiple barrels)	20.0	ft
Culvert Height	10.0	ft
Outlet Depth	5.83	ft
Outlet Velocity	13.70	ft/s
Froude Number	1.00	
Tailwater Depth	5.48	ft
Tailwater Velocity	6.95	ft/s
Tailwater Slope (SO)	0.0000	
External Dissipator Data		
External Dissipator Category	Streambed Level Structures	
External Dissipator Type	Riprap Basin	
Restrictions		
Froude Number	<3	
Input Data		
Condition to be used to Compute Basin Outlet Velocity	Best Fit Curve	
D50 of the Riprap Mixture		
Note:	Minimum HS/D50 = 2 is Obtained if D50 = 0.596 ft	
D50 of the Riprap Mixture	0.596	ft
DMax of the Riprap Mixture	1.500	ft
Results		
Brink Depth	5.589	ft
Brink Velocity	14.287	ft/s
Depth (YE)	5.589	ft
Riprap Thickness	2.250	ft
Riprap Foreslope	3.0000	ft
Check HS/D50		
Note:	OK if HS/D50 > 2.0	
HS/D50	2.015	
HS/D50 Check	HS/D50 is OK	
Check D50/YE		
Note:	OK if 0.1 < D50/YE < 0.7	
Check D50/YE	0.107	
D50/YE Check	D50/YE is OK	
Basin Length (LB)	80.000	ft
Basin Width	73.333	ft
Apron Length	20.000	ft
Pool Length	60.000	ft
Pool Depth (HS)	1.201	ft
TW/YE	0.980	
Tailwater Depth (TW)	5.480	ft
Average Velocity with TW	3.457	ft/s
Critical Depth (Yc)	2.397	ft
Average Velocity with Yc	8.526	ft/s
Downstream Riprap for High TW		
Distance: 1 LB		
Velocity	10.906	ft/s
Size	0.775	ft
Distance: 2 LB		
Velocity	6.328	ft/s
Size	0.261	ft
Distance: 3 LB		
Velocity	4.207	ft/s
Size	0.115	ft
Distance: 4 LB		
Velocity	3.148	ft/s
Size	0.065	ft

APPENDIX I GEOTECHNICAL INFORMATION



BOREHOLE	DEPTH (ft)	AASHTO Classification	USCS Classification	LL	PL	PI	%Gravel	%Sand	%Fines	
									%Silt	%Clay
● **I-15-AO Scour**	**0.0**	**A-1-a (0)**	**GW-GM**	**NV**	**NP**	**NP**	**53.0**	**41.2**	**5.8**	

Yeh and Associates, Inc.
Geotechnical • Geological • Construction Services

SIEVE ANALYSIS

FIGURE

S- 2

Project No. 220-063 Date: 11-24-2020
Report By: D. Gruenwald Yeh Lab: Colorado Springs
Checked By: J. McCall

CDOT Region 2 Bridge Bundle
Scour Test Results
Structure I-15-AO

03 GRAIN SIZE YEH 220-063 R2 BRIDGE BUNDLE.GPJ 2019 YEH COLORADO TEMPLATE.GDT 2019 YEH COLORADO LIBRARY.GLB 11/24/20