

MEMORANDUM

Date: August 8, 2023

To: Alli Schuch, Executive Director
Fountain Creek Watershed Flood Control and Greenway District

From: Dan Bare, P.E.; Tori Mack, P.E.; Drew Beck, P.E.

RE: Preliminary Conditions Assessment - Highway 47 Bank Restoration Project

Purpose

The purpose of this memorandum is to provide an assessment of the Highway 47 Bank Restoration Project (Project) conditions following relatively high runoff events in the Spring and Summer of 2023. On-site investigations have been conducted, an aerial survey has been completed and USGS stream gage data has been assessed to evaluate current Project conditions, possible remediation efforts and possible repair costs for the project site.

Background

The Project is located on Fountain Creek on the north side of Pueblo. The Project is a 3,800-foot reach of Fountain Creek extending north of the Highway 47 bridge to the northern limit of the Pueblo Side Detention Facility. The location of the project is shown in Figure 1 below.



Figure 1. Project Vicinity Map

Fountain Creek migrated significantly over time as it approached the Highway 47 bridge crossing (see Figure 2). The June 2015 flood, with a peak flow of about 18,000 cfs, caused a

realignment of Fountain Creek. Approximately 2,000 linear feet of Fountain Creek migrated to the east toward the bridge abutment, creating a sharp bend off the historic thalweg alignment of the creek. This realignment is shown by the 2016 thalweg location in Figure 2. To protect the bridge abutment, Colorado Department of Transportation (CDOT) performed an emergency creek relocation project in March 2017 to move the creek away from the Highway 47 bridge.

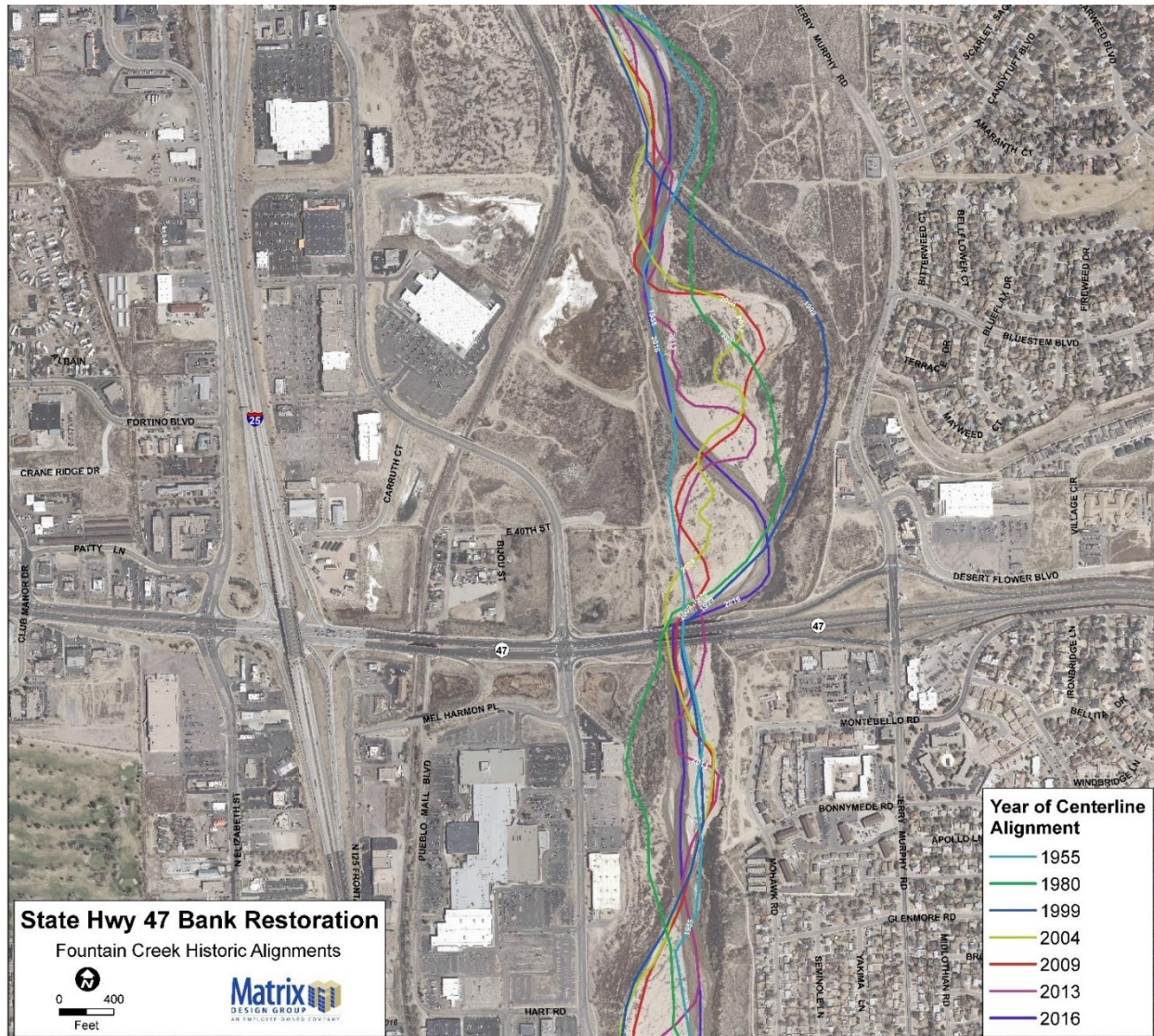


Figure 2. Fountain Creek at Highway 47 Historic Alignments of Thalweg

The Fountain Creek Watershed, Flood Control and Greenway District (District), in conjunction with CDOT, initiated a project to evaluate methods to mitigate the risk of future damage to the Highway 47 bridge and to restore Fountain Creek to more natural stream characteristics.

In 2018, construction and revegetation efforts were completed consistent with the design plan. Figure 3 below shows the project following construction in August 2018.

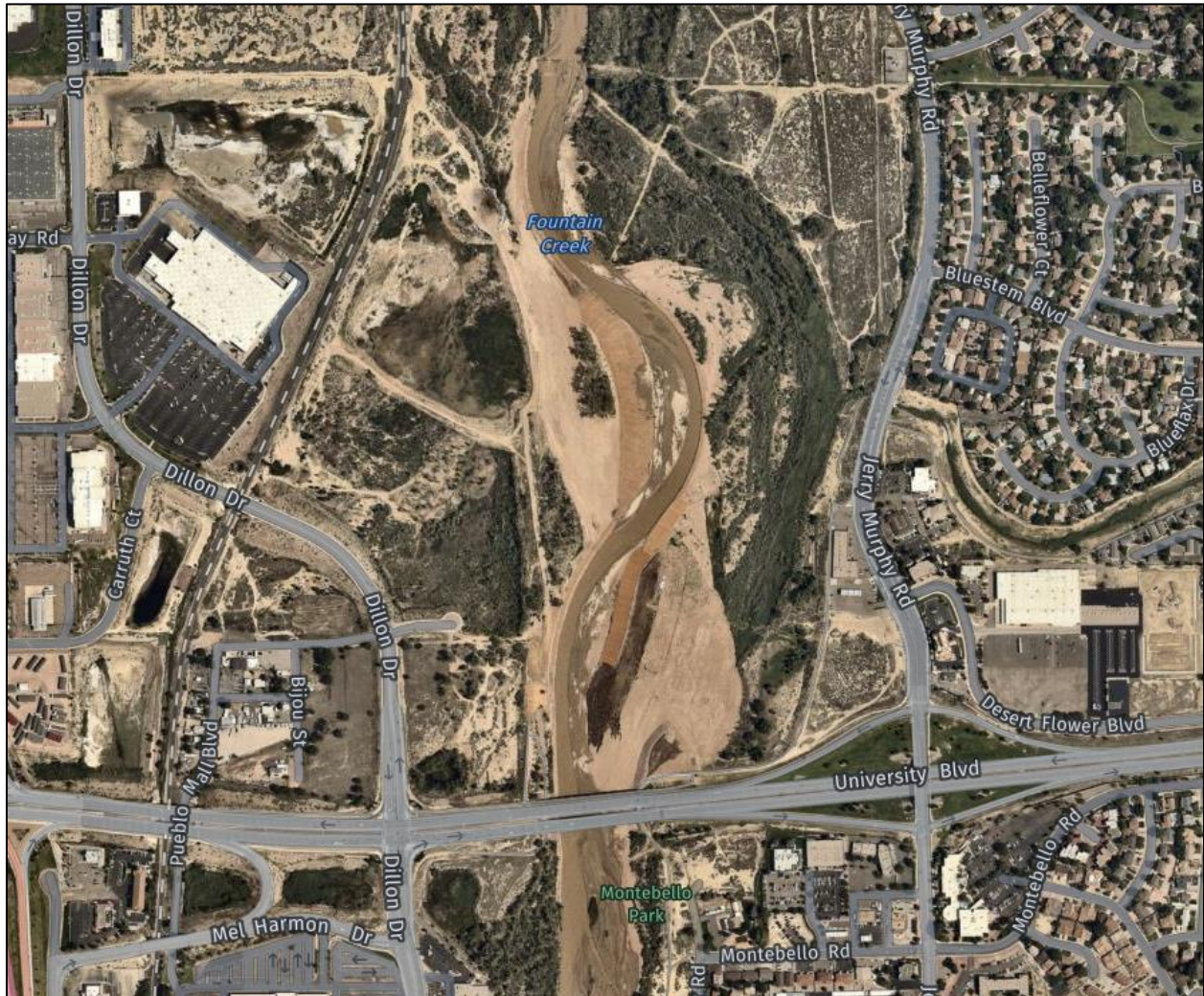


Figure 3. Post-Construction Project Condition.

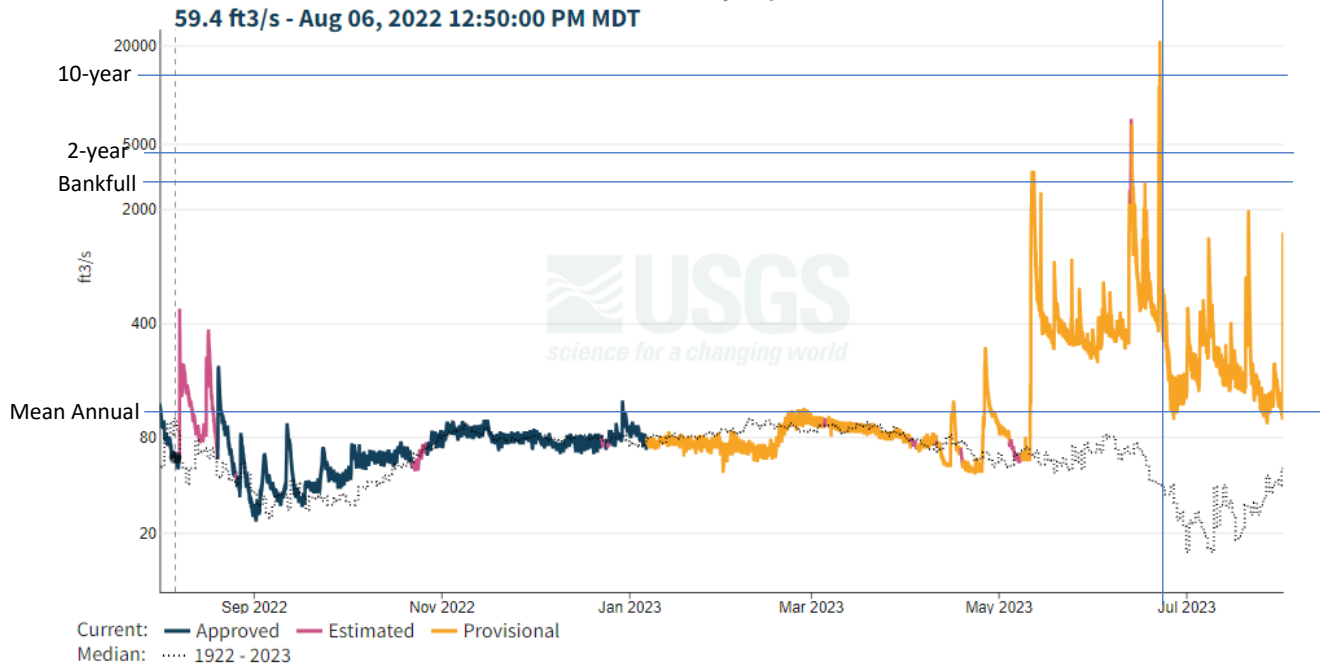
Project improvements were truncated at the upstream end of Bend 3 because bollards protecting Pueblo Board of Water Works (PBWW) water transmission lines were crossing the creek upstream. Since completion of the Project the water transmission lines have been relocated well below the stream bed and the bollards are no longer needed. Removal of the bollards and providing a stable transition into the Project are proposed as part of the Eagleridge project, scheduled to begin construction later in 2023.

In recent months, peak flows in Fountain Creek have exceeded any other peak flows that have occurred since Project completion in 2018. Ongoing high flows in June and July have consistently exceeded the mean annual flow for the reach and have far exceeded the seasonal average flow. Figure 4 shows the provisional USGS gage data for this period with the design hydrology selected for the Project. Bankfull discharge occurred at least three times, the 2-year event occurred twice, and the 10-year event was exceeded once between May and June 2023.

Fountain Creek at Pueblo, Co. - 07106500

August 1, 2022 - August 1, 2023

Streamflow, ft³/s ⓘ



Recurrence Interval	Mean Annual Flow	Bankfull Flow	2-Year	5-Year	10-Year	June 16, 2015 Event	50-Year	100-Year	500-Year
Discharge (ft ³ /s)	158 ¹	2,990 ²	4,600 ³	9,500 ³	14,400 ³	18,500 ³	30,200 ³	39,600 ³	70,000 ³

¹ Average annual flow from USGS data from 1980-2016

² USACE *Fountain Creek Watershed Study*

³ FEMA Hydrology Report for Fountain Creek, El Paso County, CO

Figure 4. USGS Flow Data for Fountain Creek at Pueblo, CO and Design Hydrology.

Figure 5 shows the results of a flow-frequency analysis for the USGS Pueblo gage completed by Michael Baker Jr. in April 2010. The provisional peak flow of 20,000 cfs (+/-) of June 22, 2023 corresponds, approximately, to a 20-year flood event.

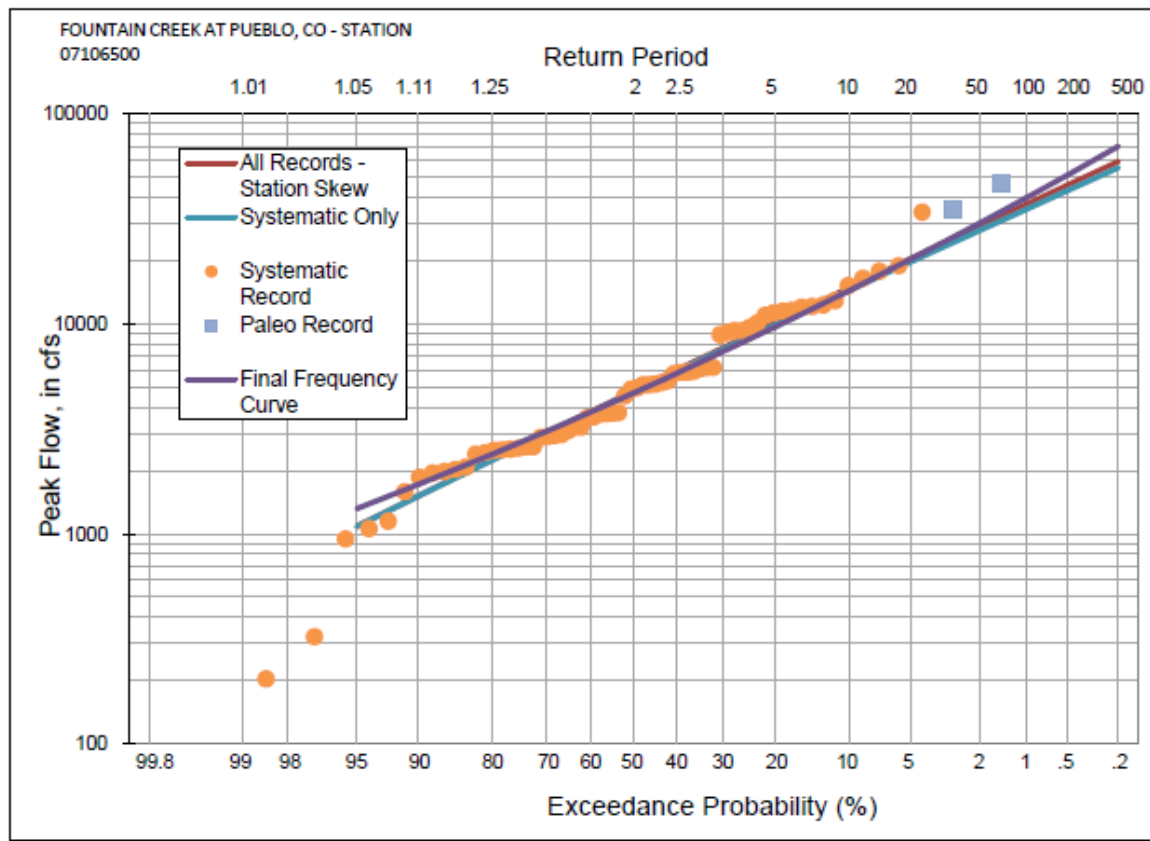


Figure 5. USGS Gage Analysis, Michael Baker Jr, April 2010

Post-Project Assessment

In 2023, Matrix Design Group, Inc. (Matrix) was contracted by the District to assess a selection of previously completed projects and to provide a summary of each project's effectiveness in meeting design objectives. As part of this effort, Matrix assessed conditions at the Project in June 2023 to compare them to the initial design (Figure 5) and post-construction condition (Figure 3).

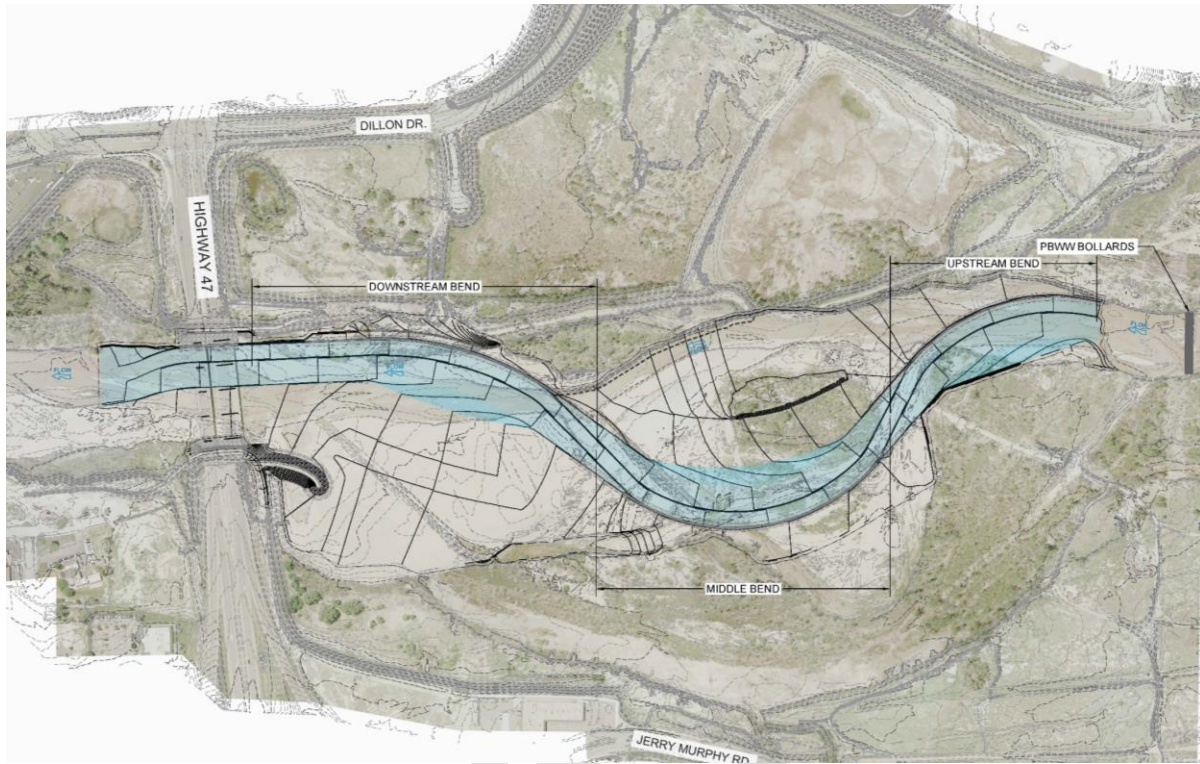


Figure 5. Project Design - Plan View

During the June assessment, Matrix observed significant channel migration and erosion in the area adjacent to and downstream of the PBWW bollards (noted in Figure 5) at the upstream end of the project. The following photo log provides documentation and discussion of site conditions during the June 2023 site assessment.

A sketch map of site conditions and photo locations is provided as an attachment to this memo.


Waterline Bollards Looking Downstream

Photo 1

Photo 1 shows the exposed bollards with debris stacked along the bollards to the left. To the right, large woody debris and associated sediment settlement have deposited, encouraging flows to the left side of the photo. This flow is outside the Project flow path.

The exposed bollards immediately adjacent to the upstream end of the Project were observed to be catching debris and acting as a baffle causing disruptions to flow as it entered the upstream end of the Project. At the low flow conditions of the site visit the bollards caused flow to spread as it entered the upstream end of the Project. In high flow conditions, it is believed that the bollards and associated debris acted as a significant flow impediment.



Waterline Bollards Looking East	
Photo 2	
<p>Debris was observed to be piled along the bollards causing obstruction to the channel flow. The eroding bank where high flows flanked the bollards is visible in the background of the photo. The main channel has been pushed to the east of its previous position.</p> <p>At low flow, a deep pool was observed on the upstream side of the bollards and the main flow path followed the exposed cut bank in the center of this photo.</p>	

Upstream Bend Looking Upstream

Photo 3

Photo 3 shows erosion and lateral migration of the upstream meander bend. Note the riprap bend protection at the upstream end of the Bend 3.

Downstream of the bollards, flow has been redirected from its designed path and is approaching the upstream bend, nearly perpendicular to the channel. Annotative arrows have been added to Photo 3 to show the flow path observed during the site visit. This path caused excessive stress, likely beyond the design parameters, to be placed on the riprap bank protection. Riprap has been displaced in this bend and material has eroded behind much of the bank protection, resulting in a lateral migration of the bend downstream of the design location.



Middle Bend Looking Downstream


Photo 4

Excessive sediment deposition was observed on the inside of Bend 2. Matrix estimated the height of the point bar to be similar to the height of the top of the riprap bend protection located on the outside of the bend. This sediment was generally coarse gravel to cobble sized material that may have come from the upstream eroded bank.

The height of the point bar along the middle bend caused the main channel to become entrenched through the bend, likely exacerbating erosional processes.



Middle Bend Looking Upstream	
Photo 5	
<p>A breach in the riprap bend protection is located one-half to two-thirds of the way down the bend protection of Bend 2. In the top left of this photo, the elevation of the point bar can be seen. This breach may have been caused by the increased entrenchment causing increased forces to be exerted on the riprap bend protection.</p> <p>The location of this breach is noted in the attached sketch map. Desktop analysis of flooding flow paths noted this breach is within a straight-line path downstream from the post-flooding bend.</p>	

Downstream Bend Looking West	
Photo 6	
<p>The downstream bend was observed to be functioning as intended, with some deposition observed on the inside of Bend 1. This deposition is likely a result of the upstream erosion described above. Riparian plantings were assessed and there was evidence that many had been buried under fine sediments on the floodplain.</p> <p>Matrix did not observe any degradation of the riprap guide bank or immediate risks to the Highway 47 bridge due to the upstream site concerns.</p>	

Approach to Repairs

Matrix's initial proposal for remedial action includes:

1. Remove upstream waterline bollards
2. Reestablish design grades across the site where degradation or deposition has occurred
3. Replace the riprap bank protection that was flanked in the upper bend (Bend 3)
4. Replace the riprap bank protection that was breached in the middle bend (Bend 2)
5. Revegetate areas where regrading is needed.

These actions could occur separately or as part of the Eagleridge project which is anticipated to begin later in 2023.

At this time, no impacts to the Highway 47 Bridge have occurred and no action is recommended in this area.

Preliminary Estimated Repair Costs

The following cost estimate outlines anticipated costs for a repair of the Project. Unknowns associated with this cost estimate include mobilization, site access, water control and dewatering. This estimate assumes that the Project will be completed separately. If work on the Project can be done in coordination with, or as part of, the Eagleridge project, immediately upstream, efficiency of scale may be achieved to reduce these costs.

Table 1. Highway 47 Emergency Repair Cost Estimate.

Base Construction Cost Estimate	\$1,500,000
AACE Class 4 Low Estimate (-10%)	\$1,345,000
AACE Class 4 Upper Estimate (+30%)	\$1,943,000

Typically, construction in and around Fountain Creek occurs during periods of low flow and when flood events are less common, after September. Therefore, repair efforts could be coordinated with the schedule for the Eagleridge project, providing the benefit of unit prices resulting from the bidding process and the appropriate timing for construction activity.

Additional cost will be incurred for engineering and contracting should the project be done separately or in conjunction with the Eagleridge project.

The project was completed under a Floodplain Development Permit issued by the City of Pueblo and a Section 404 permit issued by the Corps of Engineers. It will be necessary to assess any permitting requirements and their associated cost.

DRONE SURVEY, JULY 2023

