



MEMORANDUM

Date: September 27, 2023 (rev. October 31,2023)

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

District

From: Dan Bare, PE, Spencer Wells, PE, and Justin Apfel, WPIT, Matrix Design Group Inc. (Matrix)

RE: Evaluation of Alternatives for Highway 47 Project Repairs and the Eagleridge Project

BACKGROUND

The impacts to the Highway 47 improvements project, due to a series of flood flows in the Spring and Summer of 2023, have been previously documented in a memorandum by Matrix, dated August 8, 2023. Recent flood flows in Fountain creek reached as high as 20,000 cfs (approximately a 20-year event), per provisional USGS gage data. Due to the presence of abandoned protective waterline bollards and the poor upstream transition into the Highway47 project flows were directed at project improvements in a manner inconsistent with the design causing an upper portion of the improvements to be dislodged and realignment of the channel. A primary goal of the Highway 47 project was the protection of the Highway 47 bridge, which was not threatened or disturbed by the recent flood flows. The August 8th memorandum stated that repairs could include; removal of the upstream waterline bollards, reestablishing design grades; replacement of displaced riprap bank protection and revegetation of disturbed areas. The cost of the repairs was estimated to be \$1,345,000 to \$1,943,000. It was noted that the cost of the repairs would depend on whether the work is done as an independent project or in conjunction with the planned upstream Eagleridge project.

This memorandum provides a further assessment of the post-flood conditions and evaluates alternatives for addressing site conditions, including in concert with completion of the Eagleridge project. Figure 1 shows the general location of subject reach on Fountain Creek.



Figure 1. Project Location



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SUMMARY

An evaluation of an existing conditions/no action alternative and four action alternatives was completed to provide a range of options for the District to address impacts to the Highway 47 project and to the Eagleridge project. The assessment of the initial four action alternatives was described in the September 27, 2023 version of this memorandum. Subsequently it was requested that a fifth action alternative (Alternative 6) be considered and it is included in this memorandum. Therefore, all of the alternatives evaluated included:

Alternative 1 – Existing Conditions/No Action

Alternative 2 – Bollard Removal Only

Alternative 3 – Revise Highway 47 Design

Alternative 4 – Restore Highway 47 Design

Alternative 5 – Complete Eagleridge with Highway 47 Alternative 4

Alternative 6 – Complete Eagleridge without Highway 47 Restoration

Alternatives 1 through 5 were evaluated for hydraulic conditions using 2-Dimensional HEC-RAS models for bankfull and 100-year flows. These models show the anticipated flow path and velocities under the various site conditions. An estimate of construction cost to implement each of the action alternatives was also completed. The cost of completing repairs within the Highway 47 project reach will be affected if they are completed as part of the Eagleridge project construction. There will be cost efficiencies if the repairs are combined with the Eagleridge project work.

Note that each of the action alternatives would include removal of the abandoned waterline bollards. Their removal would allow the creek to seek a more natural alignment and avoid imposing flow directions dictated by the bollards. The estimated bollard removal cost could be improved with input from a contractor. In addition to removal of the waterline bollards an abandoned waterline remains in the creek bed that will need to be considered as part of the bollard removal.

In addition to requiring design plans, implementing some of the action alternatives could require a Clean Water Act Section 404 and, possibly, a Floodplain Development Permit. A Letter of Map Revision request was received by FEMA on September 21st. This floodplain analysis included documentation of impacts due to the Pueblo Levee, 13thStreet and Highway 47 projects. The level of permitting required will vary depending on which alternative is selected.

The hydraulic analyses showed that the presence of the bollards has had a significant impact on the direction of the creek migration and it is likely that migration will continue to occur. Being the least expensive alternative and providing the opportunity for the creek to establish a more natural alignment it appears that Alternative 2 could be an acceptable option, however, without some level of restoration and/or channel and bank improvements future migration can be expected. Table 1 summarizes the results of the evaluations.



Table 1. Alternatives Comparison Table

Alternative	Hydraulics	Permitting	Infrastructure Impacts	Cost ^A	Schedule
1 – Existing Conditions/No Action	Most uncertain ongoing channel migration	None	Some potential infrastructure damage	\$5,000	NA
2 – Bollard Removal Only	Less potential ongoing channel migration	Nationwide Permit likely	Some potential infrastructure damage, abandoned waterline removals	\$65,000+?	2 months to contract and month to complete removal
3 Revise Highway 47 Design	Some stabilization of potential migration, uncertain upstream transition	Individual or Regional General Permit likely, potential FDP revisions	Some potential infrastructure damage	\$1,442,000	2 to 3 months design, 3 months construction
4 – Restore Highway 47 Design	Improved stabilization, uncertain upstream transition	Nationwide Permit likely	Some potential infrastructure damage	\$2,922,000	2 to 3 months design, 3 months construction
5 – Complete Eagleridge Project with Highway 47 Alt 4 ^B	Most reliable stabilization, least ongoing channel migration	Nationwide Permit likely, revise FDP application	Least potential infrastructure damage	\$7,008,000 (\$5,440,000) ^c	3 to 4 months design, 4 to 5 months construction
6 – Complete Eagleridge Project without Highway 47 Restoration	Leaves Highway 47 in current condition with ongoing migration and most reliable stabilization upstream	Nationwide Permit in- place, revise FDP application	Some potential infrastructure damage	\$5,882,000	3 months design, 4 months construction

- A) Cost includes 15% construction contingency and 10% for engineering, construction administration and permitting.
- B) Alternatives 5 and 6 depend on landowner agreements.
- C) Previous construction cost estimate (excluding 15% continency and 10% engineering) was \$4,290,000, up to \$6,640,000 with inflation.

ALTERNATIVES

Five alternatives were evaluated for hydraulic conditions for bankfull and 100-year flows, requirements for construction and construction cost, engineering and permitting, for potential impacts to adjacent infrastructure and for impacts to project schedules. Alternative 6 was not evaluated for hydraulic conditions, but would result in very similar results as Alternative 5 within the Eagleridge project reach and similar results as Alternative 3 downstream.

Alternative 1 - Existing Conditions/No Action

Under post-flood conditions there has been significant migration of the creek causing erosion of the banks, especially the easterly bank at the abandoned waterline bollards, and into the downstream Highway 47 improvements. Photo 1 shows the debris deposited against the waterline bollards and erosion of the easterly creek bank.



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Photo 2 shows that the creek has migrated to the east upstream of the Highway 47 project and has intersected the Highway 47 improvements in the upstream portion of the design alignment, causing a breach in the rock bank protection and realigning a portion of the creek. However, the designed alignment has been rejoined as the creek continues to flow toward and under the Highway 47 bridge.



Photo 1 - Creek Conditions at Waterline Bollards

Photo 2 shows the overall creek alignment based on the most recently collected aerial photography.



Photo 2 - Current Creek Alignment

(source: Nearmap)

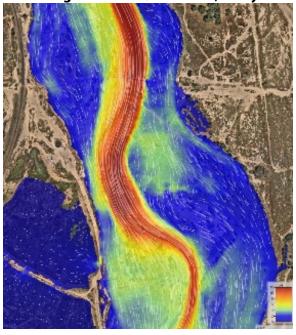


The flow velocities and pattern of flow based on the 2-Dimensional model analysis for the bankfull flow rate is shown in Figure 2, and the pattern of flow for the 100-year flow rate is shown in Figure 3. Flow velocities are represented by colors; blue indicating lower velocities and red indicating higher velocities. The direction of flow is indicated by the light flow lines.

xisting Conditions/No Action; Bankf

Figure 2 – Alternative 1: Existing Conditions/No Action; Bankfull Velocity & Flow Pattern

Figure 3 – Alternative 1: Existing Conditions/No Action; 100-year Velocity & Flow Pattern



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Permitting

Section 404 - The Highway 47 project was authorized under Nationwide Permit (NWP) 27 and authorization did not include monitoring requirements, therefore no further permit compliance action would be required under this alternative.

Floodplain Development Permit – The completed hydraulic analysis and LOMR documents for the Highway 47 improvements represent post-project conditions for the Highway 47 project. Under this alternative the previously completed floodplain analysis is expected to be valid.

Infrastructure - Infrastructure in the area includes major overhead power lines, a water transmission line, two abandoned water lines, and the Highway 47 bridge. Allowing the creek to establish a long-term pattern is less predictable without any further work or removal of the waterline bollards. There is some potential for impacts to existing infrastructure due to continued migration of the creek over time, including additional damage to the Highway 47 bank protection. However, no significant, impending impacts have been identified.

Schedule – As there is no action required scheduling for this alternative is not an issue.

Cost - Obviously, the No Action alternative does not involve additional design, or construction costs. So only follow up on the status of permitting may be necessary and is estimated to be \$5,000.

The consequences of this alternative are summarized as follows:

- Unpredictable continued creek migration
- Implementation of the Eagleridge design would be rendered ineffective without a transition to downstream conditions
- Potential continued damage to Highway 47 bank stabilization improvements
- Permit requirements need to be considered
- Potential long-term encroachment at Highway 47 bridge is unlikely

Alternative 2 - Bollard Removal Only

Removal of the waterline bollards is considered the minimum effort required to mitigate impacts to creek flows. The current conditions are clearly impacting flow velocities and flow patterns in the creek and future realignment of the creek can be expected, however, the extent of future migration is uncertain. Based on the design plans provided by Pueblo Water Works, the project that lowered the waterline under the creek left two abandoned waterlines in the creek bed. These waterlines are just beneath the creek bed and will also likely provide an impediment to creek flows and movement of the creek bed. The results of the hydraulic analysis are shown in Figures 4 and 5. Removal of the waterline bollards will allow the creek to establish a more natural configuration and somewhat reduce the potential for future migration.



Figure 4 - Alternative 2: Bollard Removal Only; Bankfull Velocities and Flow Pattern

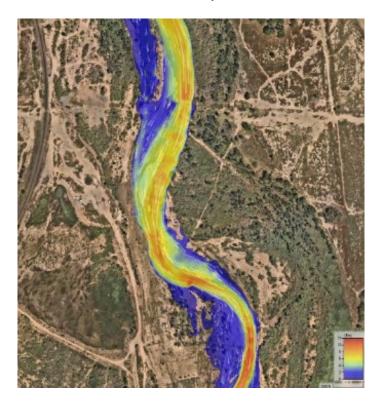
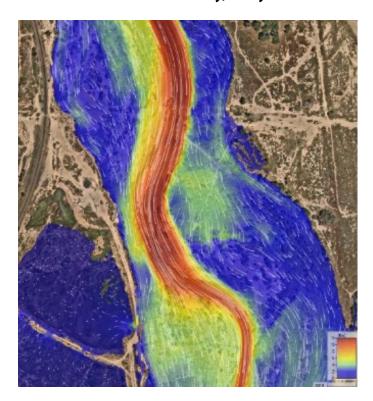


Figure 5 – Alternative 2: Bollard Removal Only; 100-year Velocities & Flow Pattern



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Permitting

Section 404 - It is likely that Alternative 3 would be authorized under a NWP because the disturbance footprint will only include the area immediately adjacent to the bollards. Because removal of the bollards would restore this section of Fountain Creek to a more natural conditions, this activity would likely be permitted using NWP 27.

Floodplain Development Permit – The completed hydraulic analysis and LOMR documents for the Highway 47 improvements represent post-project conditions for the Highway 47 project. Under this alternative the previously completed floodplain analysis is expected to be valid.

Infrastructure – There is some potential for impacts to existing infrastructure due to continued migration of the creek over time, including additional damage to the Highway 47 bank protection. However, no significant, impending impacts have been identified. Removal of the bollard barrier should provide less potential for creek migration.

Cost -The cost associated with this alternative is related to removal of the waterline bollards and any permitting required and is estimated to be \$65,000. However, removal of the abandoned waterlines could increase the cost of this alternative if it is determined that their presence will influence creek flows.

Schedule - Follow up to refine alternative costs and contract for removal of the obstructions and potential impacts to the permits could be completed in the next couple of months.

The consequences of this alternative are summarized as follows:

- This alternative provides a limited action to reduce migration caused by future flood flows
- Unpredictable continued creek migration will remain
- Potential for continued damage to Highway 47 improvements
- Section 404 permit would be required for removal of waterline bollards
- Potential long-term encroachment at Highway 47 bridge is unlikely

Alternative 3 – Revise Highway 47 Design

This alternative does not include the restoration of the original Highway 47, but includes stabilization of the creek in its current alignment, adjustments to the Highway 47 design and removal of the waterline bollards. Removal of some of the Highway 47 bank protection would be necessary to provide a transition into the relocated creek. This approach would reduce project construction and engineering costs, however, the pattern of flow would be uncertain without regrading in the area of the waterline bollards upstream and the transition to the less disturbed improvements downstream.

The results of the hydraulic analyses are shown in Figures 6 and 7. Removal of the waterline bollards will allow the creek to establish a more natural configuration and reduce the potential for future migration. Stabilization of the impacted Highway 47 improvements should reduce the potential for additional damage.



Figure 6 - Alternative 3: Revise Highway 47 Design; Bankfull Velocities and Flow Pattern

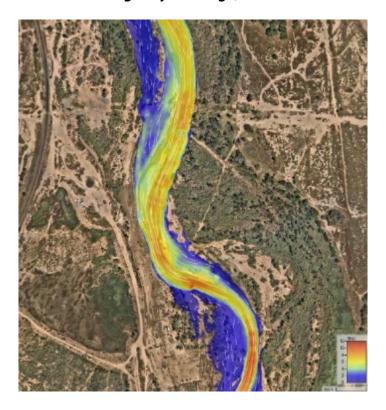
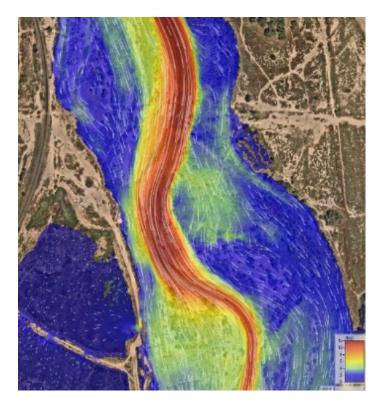


Figure 7 – Alternative 3: Revise Highway 47 Design; 100-year Velocities & Flow Pattern



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Permitting

Section 404 - The Section 404 permitting approach will ultimately depend on design and impacts to Waters of the US (WOTUS); however, this alternative would not likely be authorized under NWP 3 for Maintenance as it would include deviations from the original design. If the revised design impacts less than 1,000 linear feet along the bank, does not exceed 0.5 acre of permanent wetland loss, and does not exceed two cubic yards of fill per running foot below the ordinary high-water mark, it would likely be authorized under Regional General Permit (RGP) 37 for Stream Stabilization. If the revised design exceeds thresholds outlined in RGP 37, it would likely require an Individual Permit (IP).

Floodplain Development Permit – The completed hydraulic analysis, and LOMR documents, for the Highway 47 improvements represent post-project conditions for the Highway 47 project. Under this alternative the creek conditions will differ from those represented in the completed LOMR hydraulic analysis and could require revisions to that analysis and a resubmittal of the LOMR documentation. It will be necessary to discuss the situation with the Pueblo Floodplain Administrator, and maybe FEMA, to determine how to address impacts to the regulatory floodplain.

Infrastructure – There is some potential for impacts to existing infrastructure due to continued migration of the creek over time, however this alternative should reduce the potential for additional damage to the Highway 47 bank protection. ,No significant, impending impacts have been identified. Removal of the bollard barrier should provide less potential for creek migration.

Cost - Initiating revisions to the Highway 47 improvements apart from the Eagleridge project improvements will require certain costs; such as mobilization/demobilization, permitting and materials to be higher. The estimated cost for construction of this alternative is \$2,922,000; including a 15% construction contingency and 10% for engineering, contract administration and permitting. Engineering costs for this alternative will be limited and will not require extensive modifications to the design plans, but will include bid documents, construction administration and post-construction monitoring.

Schedule - To prepare permitting and construction bid documents will require approximately two months and construction could be completed within in a three month period, once permitting and bidding is completed.

The consequences of this alternative are summarized as follows:

- Less potential for continued creek migration due to future flood flows
- Unpredictable continued creek migration will remain upstream
- Potential for continued damage to Highway 47 improvements will be reduced
- 404 permit requirements need to be evaluated
- Potential long-term encroachment at Highway 47 bridge is unlikely

Alternative 4 – Restore Highway 47 Design

This alternative includes the restoration of the original design for the Highway 47 improvements and removal of the waterline bollards without completing the Eagleridge project improvements. However, some transition at the upstream limits of the project will be necessary. Without some



improvements in the Eagleridge reach and with the removal of the bollards the potential for channel migration into the improved section will remain. The results of the hydraulic analysis are shown in Figures 8 and 9. Removal of the waterline bollards will allow the creek to establish a more natural configuration and reduce the potential for future migration. Restoration of the impacted Highway 47 improvements will provide more stability and reduce the potential for additional damage. Completing this work as a separate project will increase costs due to construction mobilization, reduced quantities and other fixed costs.

Permitting

Section 404 - It is likely that Alternative 4 would be authorized under a NWP 3 for Maintenance because the improvements will be consistent with the previously approved design and will not require significant deviations from the original design.

Floodplain Development Permit - The recently completed floodplain analysis and LOMR submittal includes hydraulic modeling for the post-project Highway 47 improvements based on the original design. If the project is restored to the original design the completed analysis should still be applicable.

Infrastructure – There is some potential for impacts to existing infrastructure due to continued migration of the creek over time, including additional damage to the Highway 47 bank protection. However, no significant, impending impacts have been identified. Removal of the bollard barrier should provide less potential for creek migration.

Cost - Initiating restoration of the Highway 47 improvements apart from the Eagleridge project improvements will require certain costs; such as mobilization/demobilization, permitting and materials to be higher. The estimated cost for construction of this alternative is \$2,922,000; including a 15% construction contingency and 10% for engineering, contract administration and permitting. Engineering costs for this alternative will include modifications to the design plans to recognize changes to existing conditions, to limit the area of improvements, bid documents, construction administration and post-construction monitoring.

Schedule - To prepare permitting and construction bid documents will require approximately two months and construction could be completed in a three-month period, once bidding and permitting is completed.

The consequences of this alternative are summarized as follows:

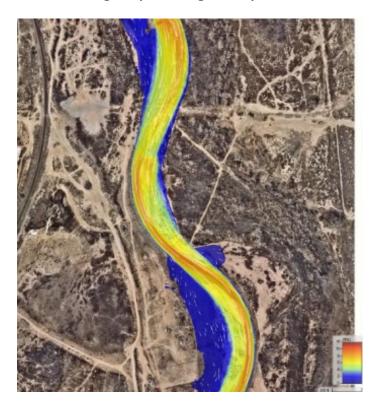
- Less potential for continued creek migration due to future flood flows
- Unpredictable continued creek migration will remain upstream
- Reduced potential continued damage to Highway 47 improvements
- 404 permit requirements should be more predictable
- Potential long-term encroachment at Highway 47 bridge is unlikely



Figure 8 - Alternative 4: Restore Highway 47 Design; Bankfull Velocities and Flow Pattern



Figure 9 – Alternative 4: Restore Highway 47 Design; 100-year Velocities & Flow Pattern



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Alternative 5 - Complete Eagleridge with Highway 47 Alternative 4 Restoration

This alternative restores the original Highway 47 design, removes the waterline bollards and adjusts the Eagleridge design to account for the realignment of the creek and to reinforce the typical bank protection design section. This alternative provides the most stable approach to the creek improvements and provides the least potential for future creek migration. The results of the hydraulic analysis are shown in Figures 10 and 11. Restoration of the impacted Highway 47 improvements will provide more stability and reduce the potential for additional damage. Completing this work as a combined project with Highway 47 project restoration and Eagleridge project improvements will decrease costs for the Highway 47 restoration work due to efficiencies in construction mobilization, lower unit costs and other fixed costs.

Permitting

Section 404 – The Eagleridge project has been authorized under NWP 27; however, it is likely that Alternative 5 would require the same level of permitting as Alternative 4 for the Highway 47 repairs and would be authorized under NWP 3 for Maintenance, if it does not require significant deviations from the original design. It will be necessary to engage the US Army Corps of Engineers (USACE) early in the process to ensure the project would be authorized under NWP 3 to avoid delays in the permitting process.

Floodplain Development Permit – a No-rise Certification was previously submitted for the Eagleridge project based on Highway 47 post-project downstream conditions and the proposed alignment and grading. That process was interrupted due to a requirement by the Pueblo Floodplain Administrator that Letter of Map Revision documentation be prepared for previously completed projects at Highway 47, 13th Street and the Pueblo Levee. Those LOMR documents have been completed and submitted to Pueblo and FEMA for processing. Therefore, we anticipate that the FDP process can be resumed for the Eagleridge project and this alternative. The documentation for the Eagleridge project FDP will need to be updated to include the Highway 47 floodplain analysis submitted with the LOMR documentation. We anticipate that this updated documentation will allow the project to be approved under a No-rise certification with a LOMR to be submitted upon project completion.

Infrastructure – This alternative provides the least potential for creek migration over time and the most protection for Highway 47 improvements and adjacent infrastructure.

Cost - The cost of constructing this alternative was updated to include the downstream improvements assuming that the Highway 47 project would be restored to its original design alignment with associated grading, bank protection and revegetation. A revision to the proposed Eagleridge project design will also impact the cost of construction. Therefore, the cost of this alternative is estimated to be \$7,008,000; including a 15% construction contingency and 10% for engineering, construction contract administration and permitting.

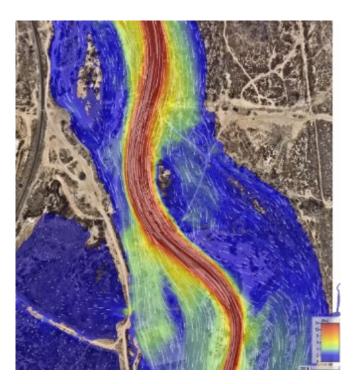
Schedule - To prepare permitting and construction bid documents will require approximately three months and construction could be completed in a five-month period once bidding and permitting is completed. Implementation of this alternative moves the anticipated construction start date from October, 2023 to Early, 2024. This schedule depends on an expedited permitting process.



Figure 10 - Alternative 5: Complete Eagleridge w/ Highway 47 Alternative 4; Bankfull Velocities and Flow Pattern



Figure 11 – Alternative 5: Complete Eagleridge w/ Highway 47 Alternative 4; 100-year Velocities and Flow Pattern



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The consequences of this alternative are summarized as follows:

- Lowest potential for continued migration due to future flood flows
- Lowest potential for continued damaged to Highway 47 improvements
- Implementation of Eagleridge design would be rendered ineffective and/or significantly altered.
- Potential continued removal of Highway 47 improvements
- 404 permit requirements are in place and should be retained
- Floodplain development permit will be updated
- Potential long-term encroachment at Highway 47 bridge is unlikely

Alternative 6 - Complete Eagleridge without Highway 47 Restoration

This alternative provides a transition into the original Highway 47 design, removes the waterline bollards and adjusts the Eagleridge design to account for the realignment of the creek and to reinforce the typical bank protection design section. However, restoration of the original Highway 47 improvements would not be completed. This alternative provides a stable approach to the creek improvements upstream of the Highway 47 improvements, but leaves the breach of the bank protection within the upstream bend of the Highway 47 improvements unrepaired. This allows for ongoing potential for future creek migration downstream of the Eagleridge improvements.

The results of the hydraulic analysis shown in Figures 10 and 11 represent the flow patterns that would be expected in the Eagleridge portion of the improvements. Downstream of the Eagleridge improvements the hydraulic analysis results would be similar to those shown in Figures 6 and 7.

Permitting

Section 404 – The Eagleridge project has been authorized under NWP 27 and it is anticipated that the revisions to the design under this alternative would continue to be covered by the NWP 27. However, it will be necessary to engage the US Army Corps of Engineers (USACE) early in the design process to ensure that the project will continue to be authorized under NWP 27 and avoid delays in the project schedule.

Floodplain Development Permit – A No-rise Certification was previously submitted for the Eagleridge project based on Highway 47 post-project downstream conditions and the proposed alignment and grading. That process was interrupted due to a requirement by the Pueblo Floodplain Administrator that Letter of Map Revision documentation be prepared for previously completed projects at Highway 47, 13th Street and the Pueblo Levee. Those LOMR documents have been completed and submitted to Pueblo and FEMA for processing. Therefore, we anticipate that the FDP process can be resumed for the Eagleridge project and this alternative. The documentation for the Eagleridge project FDP will need to be updated to include the Highway 47 floodplain analysis submitted with the LOMR documentation. We anticipate that this updated documentation will allow the project to be approved under a No-rise certification with a LOMR to be submitted upon project completion.

Infrastructure – This alternative allows for some ongoing potential for creek migration over time and reduces the protection for Highway 47 improvements and adjacent infrastructure.



Cost - The cost of constructing this alternative was updated to include a revision to the proposed Eagleridge project design due to the changed creek alignment and a hardened bank protection. Therefore, the cost of this alternative is estimated to be \$5,882,000, including a 15% construction contingency and 10% for engineering, construction contract administration and permitting.

Schedule - To prepare permitting and construction bid documents will require approximately three months and construction could be completed in a four-month period once bidding and permitting is completed. Implementation of this alternative moves the anticipated construction start date from October, 2023 to Early, 2024. This schedule depends on an expedited permitting process.

The consequences of this alternative are summarized as follows:

- Significantly reduced potential for continued migration due to future flood flows within the Eagleridge project reach
- Continued potential for damage to Highway 47 improvements
- Implementation of Eagleridge design would be revised to account for channel migration due to floods
- 404 permit requirements are in place and should be retained
- Floodplain development permit will be updated
- Potential long-term encroachment at Highway 47 bridge is unlikely

CONCLUSION

A summary of the evaluation of Alternatives 1 through 5 described in this memorandum was presented to the Monetary Mitigation Fund committee at a September 20, 2023 meeting of the committee. Alternative 5 was selected as the preferred alternative. However, due to possible funding limitations Alternative 6 was added at the request of the District. Implementing Alternative 6 could provide significant benefits to this reach of Fountain Creek even without restoration of downstream Highway 47 improvements.

ATTACHMENTS

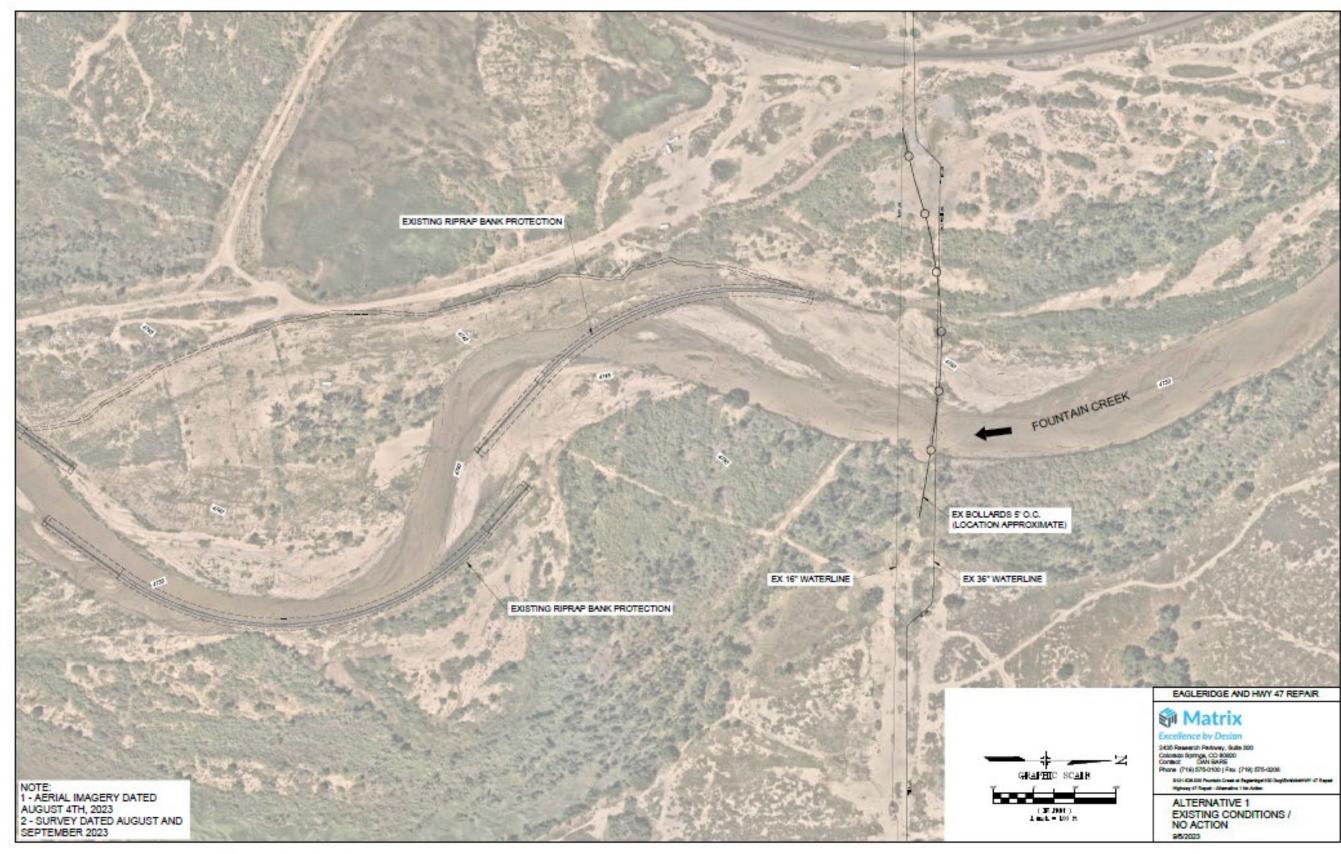
- A. Alternative 1 Existing Conditions/No Action Exhibit
- B. Alternative 2 Remove Bollards Only Exhibit
- C. Alternative 3 Redesign Highway 47 Exhibit
- D. Alternative 4 Restore Highway 47 Exhibit
- E. Alternative 5 Complete Eagleridge with Highway 47 Alternative 4 Exhibit
- F. Alternative 6 Complete Eagleridge without Highway 47 Restoration Exhibit



Attachment A

Alternative 1 – Existing Conditions / No Action Exhibit





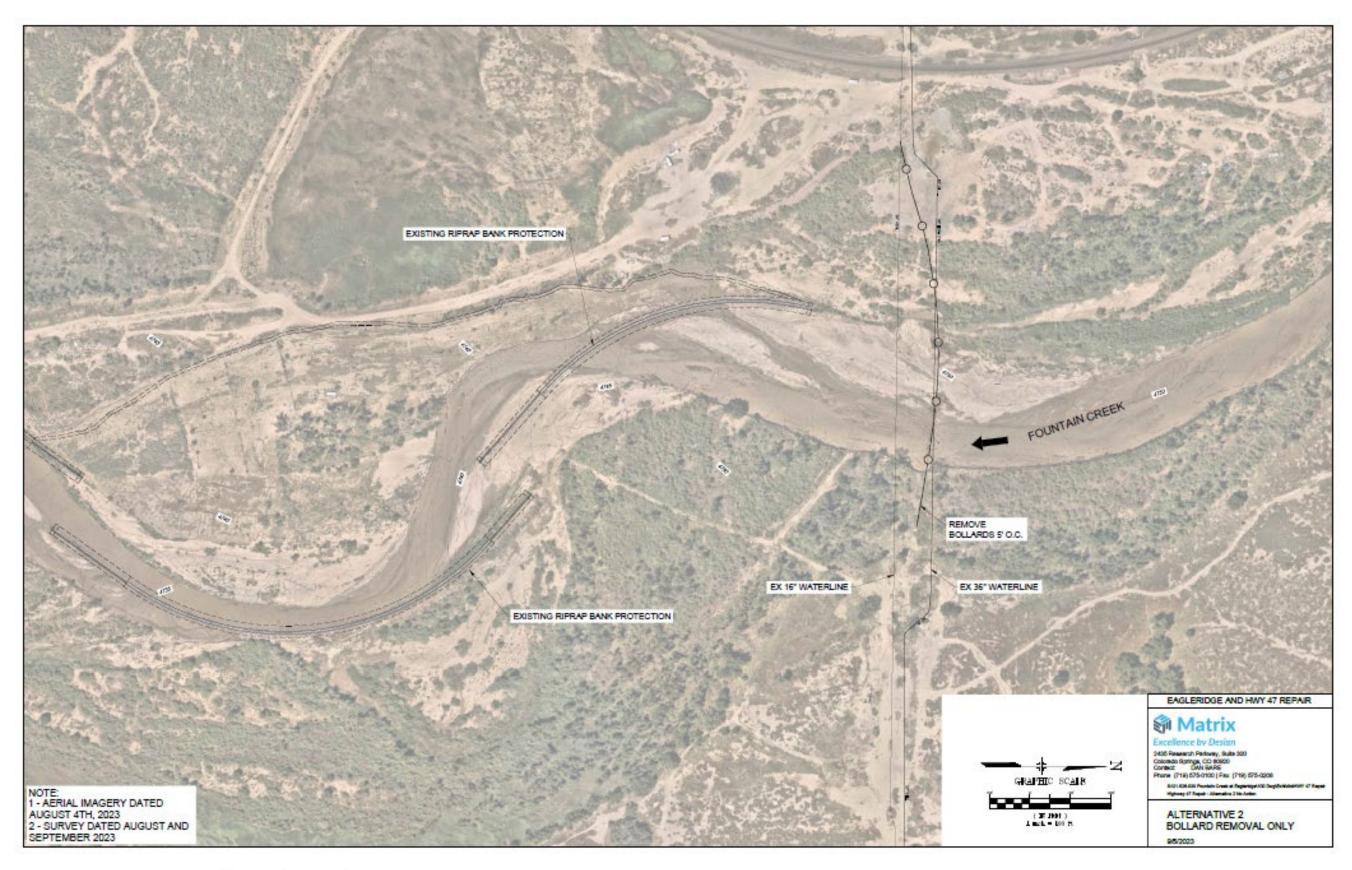
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Attachment B

Alternative 2 – Remove Bollards Only Exhibit





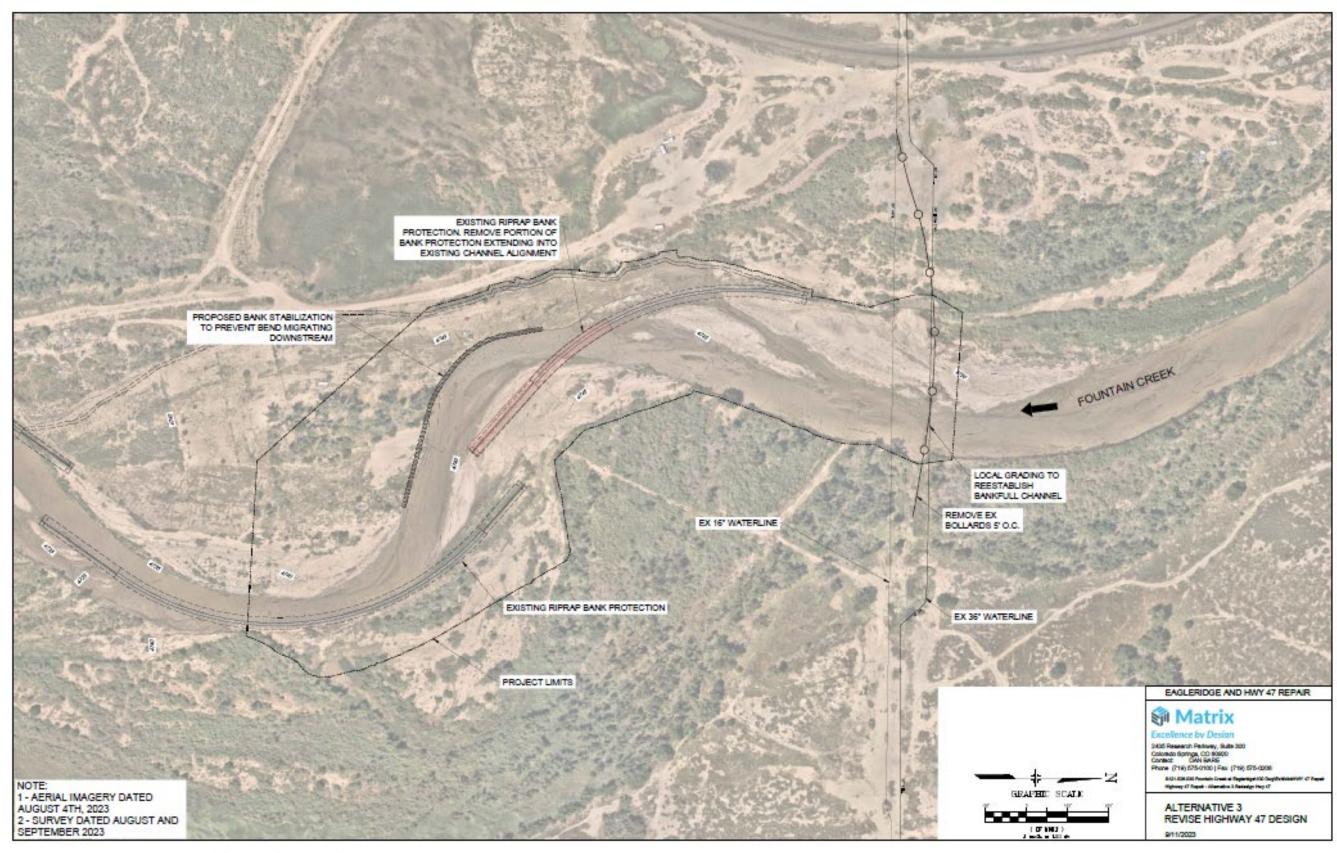
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Attachment C

Alternative 3 – Revise Highway 47 Design Exhibit





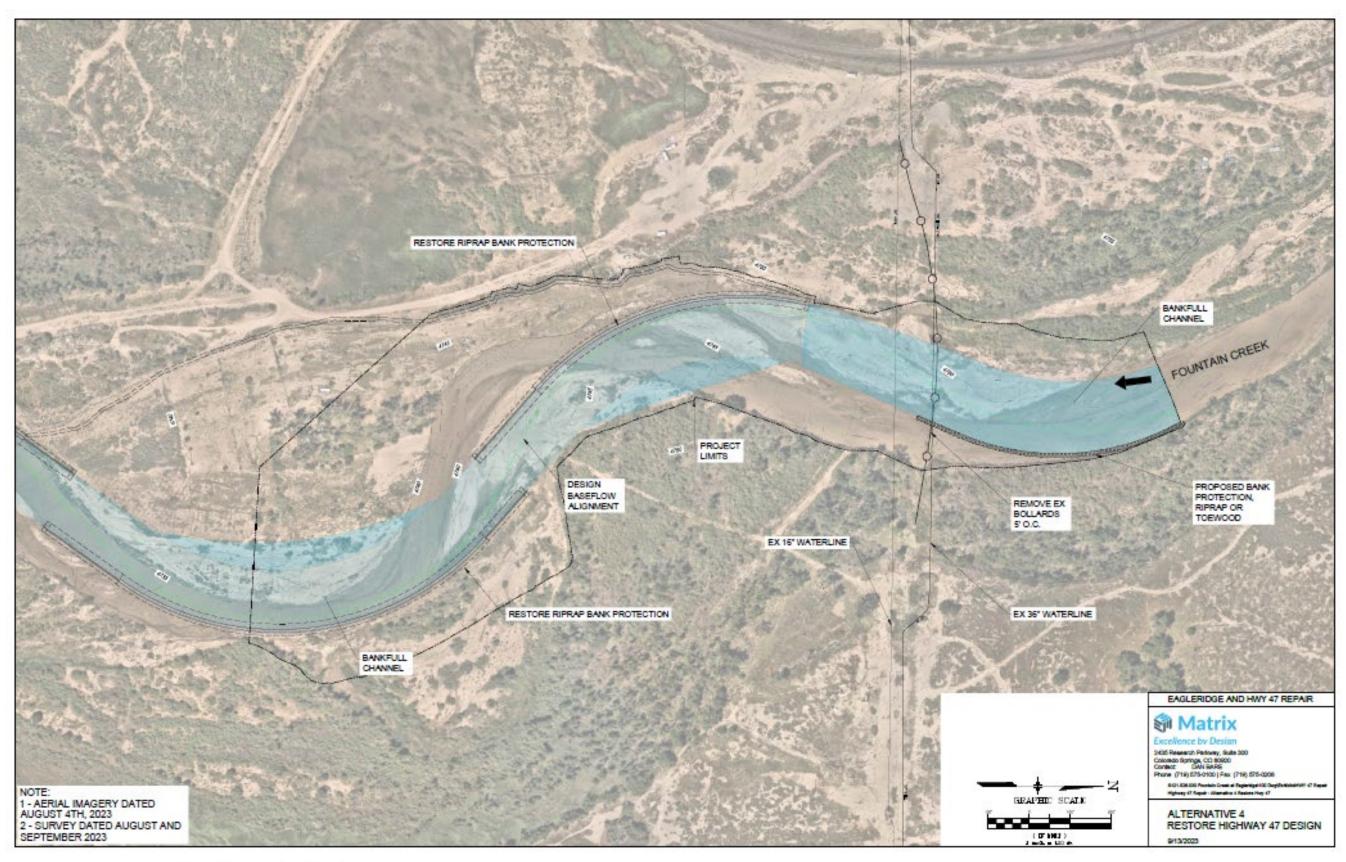
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Attachment D

Alternative 4 – Restore Highway 47 Exhibit





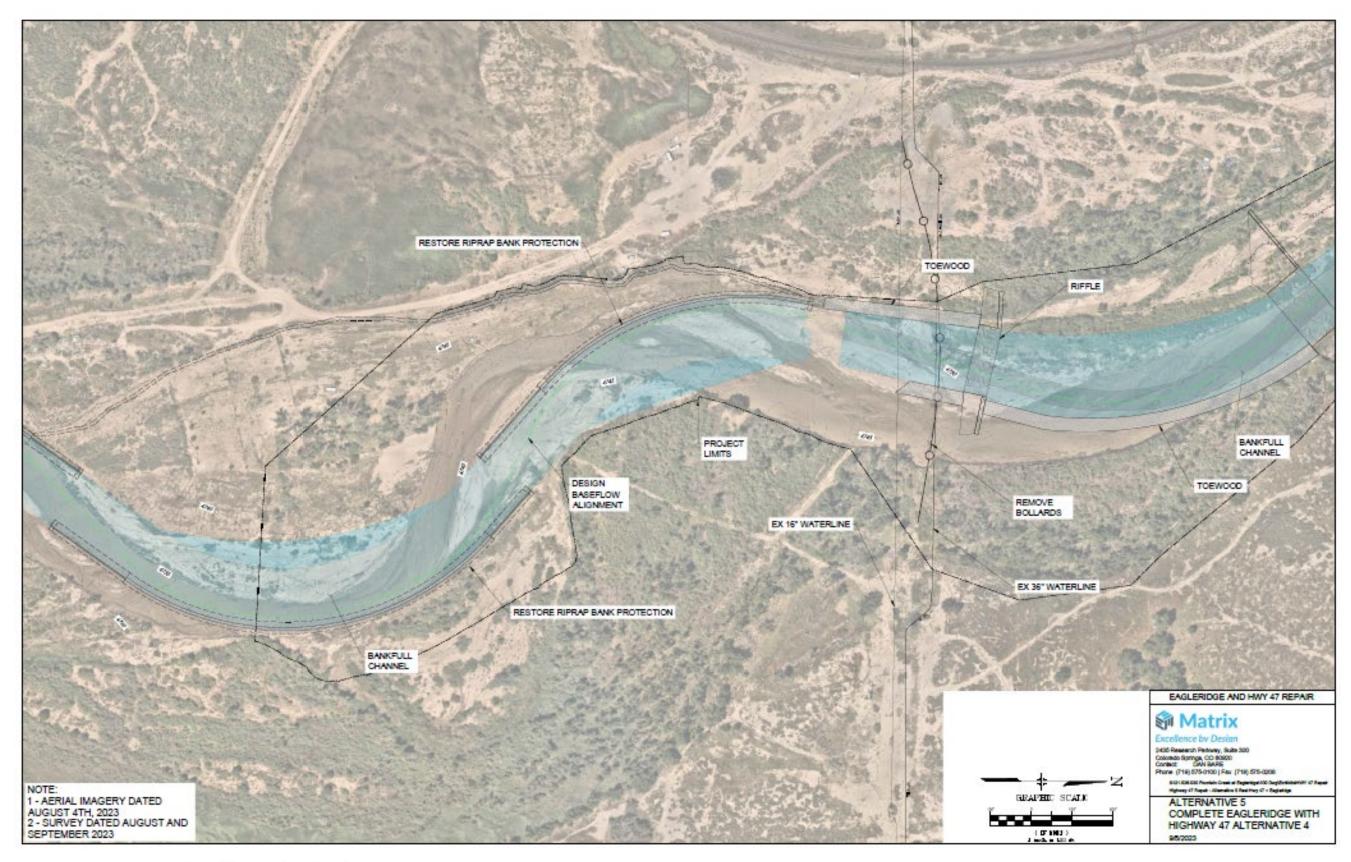
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Attachment E

Alternative 5 - Complete Eagleridge with Highway 47 Alternative 4 Exhibit





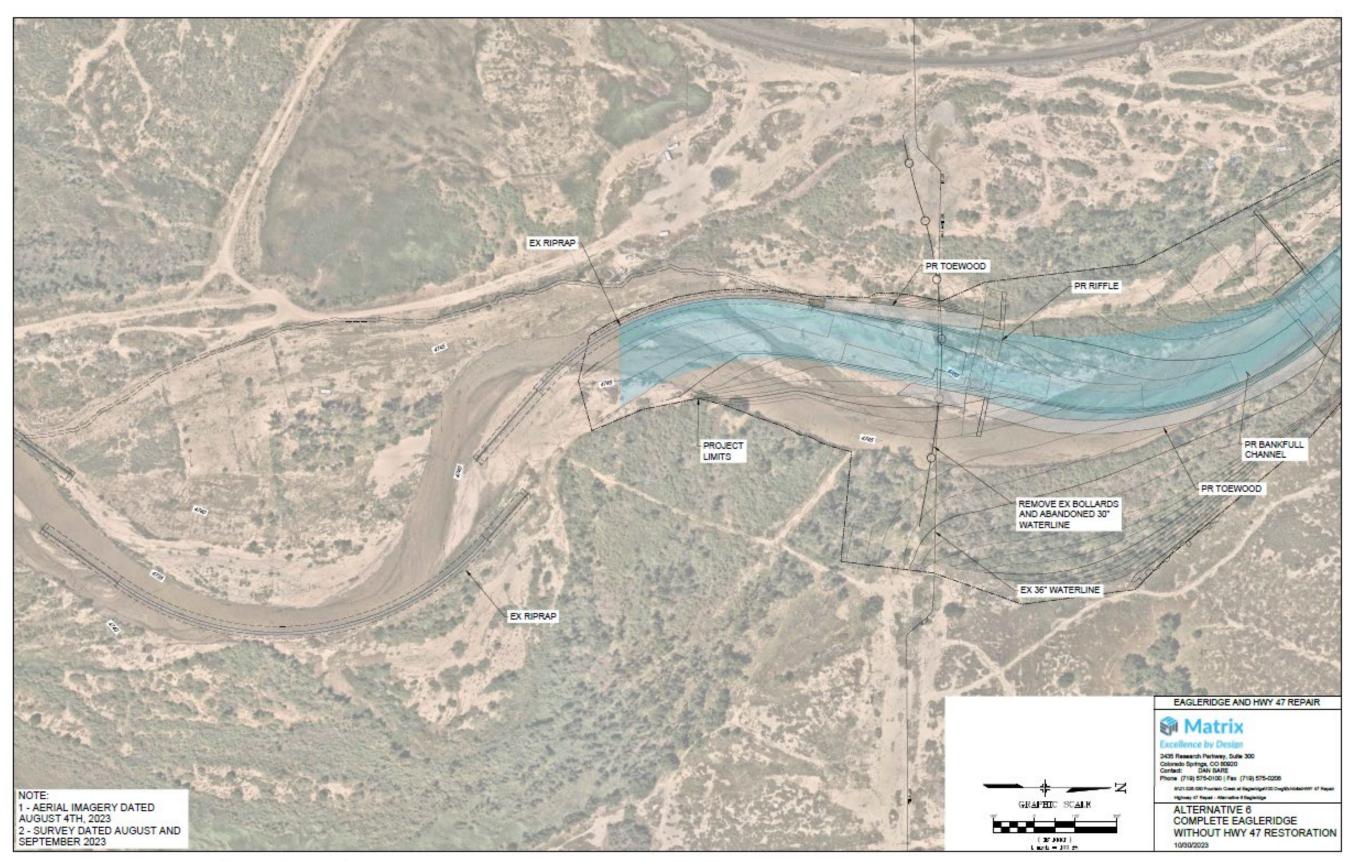
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Attachment F

Alternative 6 -Complete Eagleridge without Highway 47 Restoration





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