Project Effectiveness Evaluation

Summary of Findings

Prepared for:

Prepared by:

Matrix
Excellence by Design

2435 Research Pkwy, Suite 300
Colorado Springs, CO 80920
719-575-0100

Contact: Tori Mack, PE

February 1, 2024

Table of Contents

List of Figures

List of Tables

Appendix

Introduction

In order to evaluate the success of previous projects, the Fountain Creek Watershed, Flood Control, and Greenway District (District) contracted Matrix Design Group (Matrix) to assess the success of selected, previously completed projects. Projects selected for evaluation are listed in Table 1, from north to south. A map of the project areas is included in Figure 1.

Table 1. Key Project Data

Project	Start – End Dates	Construction Costs ($)
Masciantonio Trust Bank and Young Hollow	2016-2018	$2.0 million
Overton Road Bank Restoration	2019-2020	$1.0 million
Pinon Bridge	2018-2019	$2.3 million
Barr Farm, Phase 2	2019-2020	$10.2 million
Barr Farm, Phase 1	2018-2019	(District: $4.5 million; CDOT: $1.5 million)
Highway 47 Bank Restoration	2017-2018	$6.0 million
13th Street Channel Restoration	2018-2021	$2.6 million

The 2017 Fountain Creek Watershed Assessment of River Stability and Sediment Supply (WARSSS) Report provides an evaluation of pre-project conditions for each project area with additional analysis conducted as part of the 2019 Floodplain Management Opportunities (FMO) Study. The priorities identified in the WARSSS and the FMO Study have been used to determine which projects were advanced to the design and construction phases.

Project summaries and objectives are provided in this report, and full project backgrounds are provided in each project's Alternatives Analysis and/or Technical Memorandum. The Alternatives Analyses include detailed discussion of the evolution of Fountain Creek over time, a departure analysis to quantify the impairment within the project area, and an overview of the design alternatives evaluated. The Technical Memorandums were not completed for every project. Where available, these documents cover design decisions and project supporting materials including geotechnical reports.

Discussion of Project Goals

The seven projects selected for evaluation were constructed with the intent of contributing to the District's authorization to manage, administer, and fund the capital improvements necessary in the Fountain Creek Watershed to:

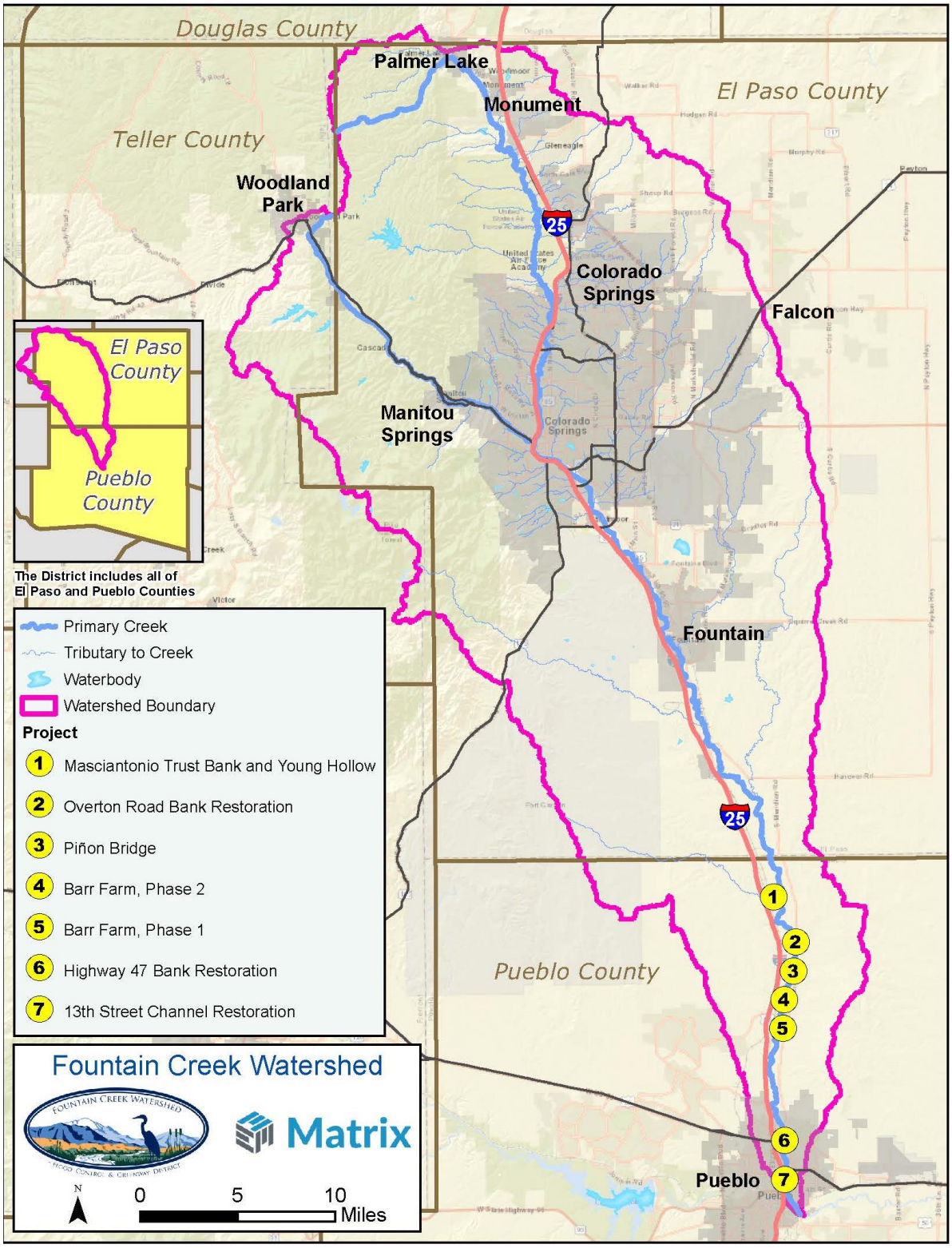
- Mitigate flooding, erosion, and sedimentation;
- Address water quality issues;
- Improve drainage;
- Protect open space;
- Develop public recreational opportunities including open space.

(District, 2023)

The completion of bank stabilization projects directly reduces the quantity of erosion within the Fountain Creek Corridor, reducing sedimentation in the watershed. Through the reduction of sediment introduced into the system, nutrient contributions, including phosphorus, can be reduced. Restoration of riparian

vegetation and natural stream function has been shown to increase water quality and reduce concentrations of nitrogen and other nutrients (WE&RF, 2016).

Figure 1. Fountain Creek Watershed Map



2023 Flooding

Historic flooding occurred in June of 2023, generating the first flood flows many of these projects have been exposed to. Figure 2 shows the hydrograph for the USGS gage at Highway 50 with the design hydrology used on the Highway 47 project noted in Table 2. The grey dashed line shown in the figure is the average flow from previous years. Within this period, there were at least 2-3 bankfull events, a 2-year event, and a 10-year event. The provisional peak flow of 20,000 CFS (+/-) recorded on June 22, 2023 corresponds, approximately, to a 20-year flood event. These high-water levels in Fountain Creek likely increased stresses on banks throughout the watershed. Flows of 200 CFS are noted and are above the baseflow condition throughout Fountain Creek; at this level, it is unsafe to enter the creek.

Figure 2. USGS Gage at Highway 50 with Highway 47 return intervals noted.

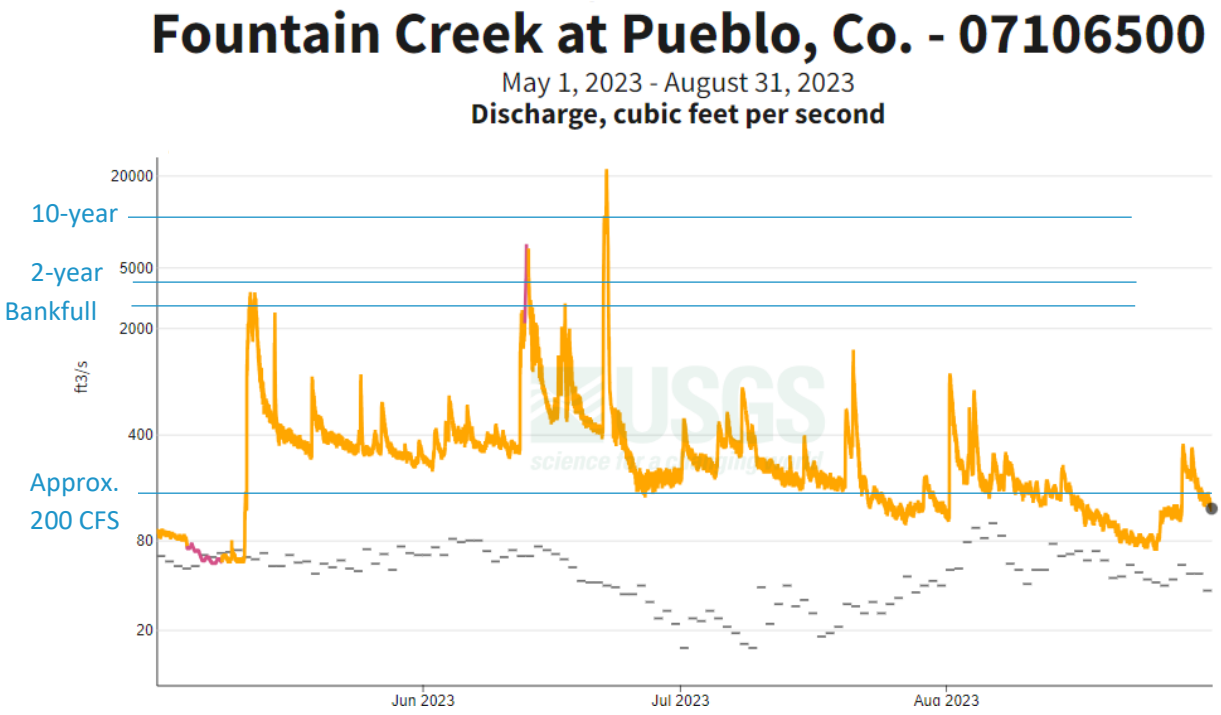


Table 2. Hydrology at the Highway 47 Project.

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

Evaluation Methodology

Each of the six project sites were visited in the summer of 2023 for assessment of site conditions. All site visits occurred after the major flood event of June 2023. Overall site conditions for each project area are described and the Bank Assessment for Non-point Source Consequences of Sediment (BANCS) methodology was used to estimate sediment supply from eroding banks (Rosgen, 2006). Vegetation assessments were completed at each site during the field visits or estimates were made via desktop and field photo analysis after field visits were completed. Vegetation conditions were evaluated by assessing nativity (native, non-native, or noxious) and growth form (graminoid, forb, woody), along with estimates of percent cover and survival rates for the planted woody species.

The BANCS methodology uses the Bank Hazard Erosion Index (BEHI) and Near Bank Stress (NBS) measurements of a bank to estimate sediment load. The Colorado US Department of Agriculture Forest Service (1989) data for sediment estimates was used to convert the BANCS data into sediment contributions from the eroding banks (Rosgen, 2006). The 2017 WARSSS report quantified the sediment contribution from each of the eroding banks identified in the report based on the assumption of 1 ton of sediment per foot of bank per year (WARSSS, 2017). This generalized assumption was made due to the scale of the study and was used to establish general relationships between bank erosion contributions and to identify high priority banks.

Five of the high priority banks identified in the WARSSS report received a more precise sediment assessment in 2016 using the BANCS assessment. Where this data is available, these more precise estimates will be noted. Overall, these estimates are smaller than those presented in the WARSSS report due to greater precision in erosion rate estimates.

Site maps showing improvements are shown in Appendix A.

Project Assessments

Masciantonio Trust Bank and Young Hollow

The project is located in northern Pueblo County and includes 1,500 feet of Fountain Creek.

Project Background

Lateral migration within the creek corridor created a sharp bend, Bank PC003, resulting in the loss of agricultural lands and excessive sediment contribution to Fountain Creek (WARSSS,2017). While the identification of the project pre-dates the WARSSS study, it is identified as a high priority project within the report. A series of bendway weirs were installed along the cutbank to direct flow away from the compromised area. Grading was completed to create a bankfull bench in front of the cutbank.

Site Assessment

Site assessment was completed and included the Masciantonio project area, completed in 2018, and the Young Hollow drainage project, completed in 2020. In the Masciantonio project area, dense vegetation and a multi-threaded channel was observed. The mainstem of Fountain Creek has established to the east of the eroding bank and is shown in Figure 3. Observations noted heavy riparian vegetation on the banks and on the islands. Large debris piles, 5 to 6 feet high, were located throughout the area, likely a result of recent floods.

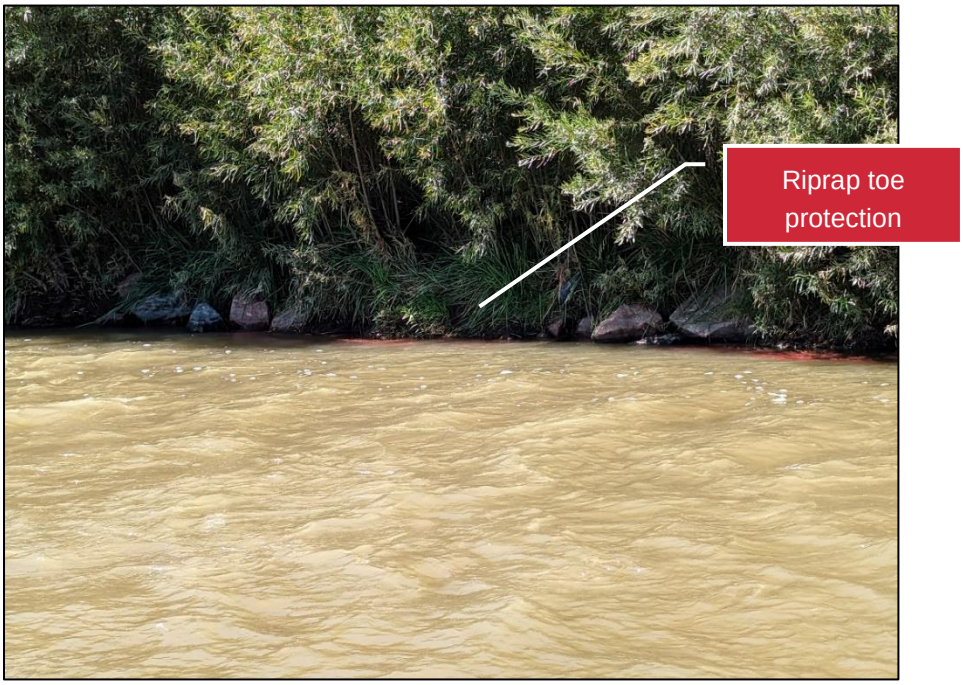
Figure 3. Mainstem of Fountain Creek through the Masciantonio project area.

Along the historic mainstem where the bendway weirs were installed, significant sediment deposition has occurred, increasing the channel bed elevation to at least the top of the weirs. Only one of the structures could be seen on site, shown in Figure 4. This structure is providing minor grade control and trapping aggraded sediment behind it.

Figure 4. Buried bendway weir.

The longitudinal toe protection installed at the two most downstream bendway weirs is visible and appears intact with large willows present throughout (Figure 5).

Figure 5. Longitudinal riprap toe.



The cut bank, Bank PC003, is sparsely vegetated along the slope with heavy vegetation on the bankfull bench protecting it from high velocity flow. Field observations noted evidence of flood flows extending across the bankfull bench and nearly to the toe of this slope.

Figure 6. Bank PC003, Summer 2023.

Stabilization at Young Hollow consisted of work to convert a culvert throttling flow at a low water crossing along a farm road to a more open channel form. Riprap was buried in the low water crossing to provide

resiliency in large flow events. Figure 7 shows the crossing in Summer 2023. Some rock is exposed and there is evidence of large flows in the area.

A large pool has is located downstream of the crossing, which was formed prior to crossing improvements. Site observations suggest that riprap held the elevation of the road crossing, but the crossing appears to have functioned as a drop structure, causing excessive downstream forces; this scour pool is shown in Figure 8. Steep banks are present at the pool, but, as the drainage transitions back into Fountain Creek, vegetation has been established, increasing the stability of the confluence area (Figure 9).

Figure 7. Young Hollow crossing.

Figure 8. Young Hollow looking upstream at scour pool.

Figure 9. Low water crossing, looking downstream.

Sediment Contributions

Sediment contributions for the major cut bank stabilized as part of this project, Bank PC003, were estimated to be 13,653 tons/year in the WARSSS report (WARSSS, 2017). Based on the 2023 site assessment, the remnant bank is not exposed to flows and, therefore, is not providing any significant sediment contribution to the Fountain Creek system. Site observations did not note any newly eroding

banks on the project site. Conversations with the lessee farmer indicate that during the 2023 floods, the project area was heavily inundated, and he noted little to no damage on the project site.

Based on the buried condition of the bendway weirs, it is likely that this area has been serving as a site for sediment deposition in past years, holding large amounts of sediment that would otherwise have flowed downstream.

Vegetation

Based on ocular estimates, vegetation cover within the Masciantonio project area is between 80 and 90 percent with approximately 20 percent grass and forb cover, 60 percent shrub cover, and five percent tree cover. Dominant species within the riparian corridor include narrowleaf willow (*Salix exigua;* native), broadleaf cattails (*Typha latifolia*; native), and plains cottonwood (*Populus deltoides* ssp. *monilifera*; native), while the upland areas are dominated by common sunflower (*Helianthus annuus*; native), kochia (*Bassia scoparia*; nonnative), and western wheat (*Pascopyrum smithii*; native). The project area consists of 60 to 70 percent native vegetation cover, while 10 to 20 percent is nonnative.

During construction, 6,446 narrowleaf willow cuttings, and 72 plains and narrowleaf cottonwood (*Populus angustifolia*; native) poles were installed throughout the project area. Based on ocular estimates, planted cottonwood poles and willow stakes had over 90 percent survival rate. Narrowleaf willows made up more than 50 percent of the total cover throughout the project area.

Although native vegetation is establishing well, small populations of Russian olive (*Elaeagnus angustifolia*; List B) and salt cedar (*Tamarix* sp.; List B) have established throughout the project area. To ensure continued revegetation success, vegetation management is recommended for a minimum of two years to control Russian olive, salt cedar, and other small populations of noxious weeds. Control of these species will likely require a combination of mechanical and chemical treatments appropriately timed to maximize effectiveness. Controlling these species will reduce vegetative competition and increase native vegetation establishment and cover. Areas disturbed by noxious weed control efforts should be reseeded with a native seed mix appropriate for the site.

Summary

The Masciantonio site is functioning as designed. The bendway weirs have provided protection to the Bank PC003 bank and vegetation has established to protect the re-graded bank. The weirs have become buried by sediment deposited in high flow events. Though the main channel is now located further east than its original alignment when the project was completed, the new braided pattern is not threatening infrastructure and is supporting dense riparian vegetation.

A combination of mechanical and chemical noxious weed control is recommended to address Russian olive and salt cedar, in addition to other small populations of noxious weeds, for the next two years, prior to the vegetation establishment reassessment. This control will ensure that revegetation requirements are continuously met throughout the site.

Overton Road Bank Restoration

This project is located in northern Pueblo County at the old Pinon Bridge site, approximately 11 miles north of Pueblo. The Project reach includes about 1,500 feet of Fountain Creek starting 300 feet upstream of the old Pinon Road bridge opening.

Project Background

The two primary objectives of this project were the removal of the abutments from the old Pinon Road bridge and addressing a large cutbank on the eastern bank of Fountain Creek. The Pinon Road bridge was decommissioned in 2005, but the abutments remained, creating an artificial constriction in the floodplain. After the 2013 and 2015 floods, Fountain Creek migrated to the east, eventually undercutting Overton Road, requiring the road to be rerouted and creating a significant cut bank, identified as Bank PC070 in the WARSSS report (WARSSS, 2017).

Project work included the restoration of two bends along the Fountain Creek mainstem. Two sections of riprap bend protection were installed to maintain the planform. The old bridge abutments associated with Pinon Road were removed. Site grading and revegetation were completed throughout the project site.

Site Assessment

An assessment of the high priority bank was conducted with a general site assessment to identify risks to the project site. Figure 10 shows the Overton site over time with photos taken near the old Overton Road bridge embankments, looking downstream. These photos have not been taken from the same location, but landmarks such as the building and several distinct trees can be used for comparison.

Initial post-construction site visits in 2021 (Figure 10b) showed good vegetation establishment post-construction. The channel has been moved away from the Bank PC070 bank, resulting in a complete reduction of sediment contribution from this bank. In the 2023 image (Figure 10c), the channel remains in its designed alignment and the bank, Bank PC070, is vegetated and protected. The site assessment showed no indications that flows reached this bank during the June flooding.

Figure 10. Overton Project site looking downstream.

(a) Pre-Project Site conditions, Spring 2019.

(b) Post-Project, Summer 2021.

(c) Post-Project, Summer 2023.

Significant sediment deposition on the outside of the downstream bend has occurred, burying the riprap bank protection and vegetation. In this condition Matrix was unable to assess the condition of the riprap. Figure 11 shows the bank protection, looking downstream, that was visible during the site visit, extending south into the sediment deposit.

Figure 11. Riprap bank protection buried by sediment.

The upstream side of this bank protection has been damaged by a buildup of debris, causing water to flank the protection. This is an area of concern that should be monitored. Note that flows on the date this photo was taken are greater than baseflow and therefore, water levels are higher than normal in this area.

Figure 12. Upstream tie-in of riprap bank protection

The inside of this lower bend showed some bank erosion. This area is best shown in Figure 13, which includes additional annotation. This erosion could not be evaluated more closely due to high water

conditions on the day of the site visit. At this time, this is not an area of concern due to the heavy vegetation still present along the bank and no evidence that forces in the thalweg of the channel are pointed at the bank under normal flow conditions.

The final area of analysis is the upstream bend. Bend protection is located on the west side of Fountain Creek which could not be accessed at the time of the site visit. This area is shown in Figure 14. The riprap bank protection appeared to be in good condition.

Figure 13. Overview of the downstream bend

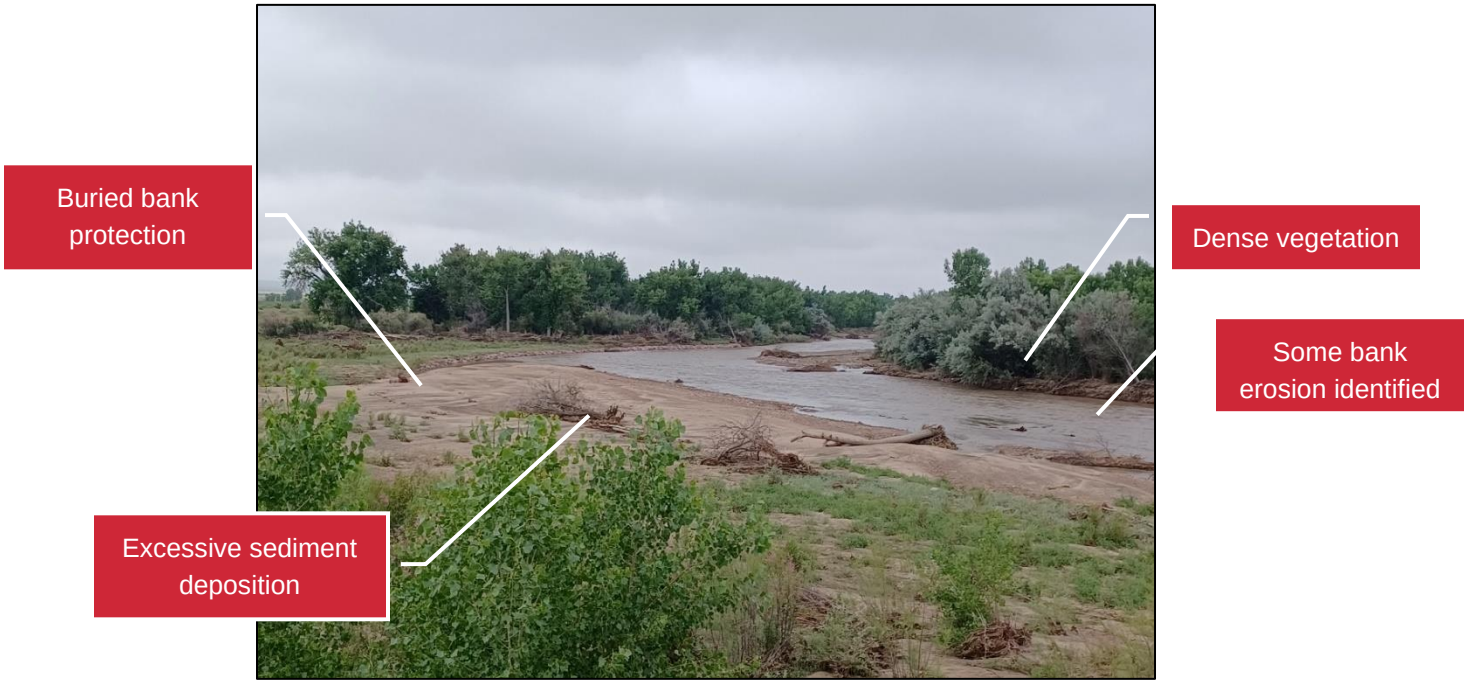


Figure 14. West bank of project area

Sediment Contributions

The 2017 WARSSS assessment identified four priority banks within the Overton Road project area; Bank PC070 was ranked as a high priority (WARSSS 2017). The banks, their estimated erosion rates and lengths are listed below in Table 3.

Table 3. Overton Rd Priority Banks (WARSSS, 2017)

Bank ID	Estimated Erosion Rate (tons/year)	Bank Length (ft)
PC012	3,015	201
PC013	1,554	518
PC069	3,546	1,182
PC070	16,225	1,014
Totals	**24,340**	**2,915**

Bank PC070 is the only high priority bank on the project site and, as noted, is fully protected by the Overton project. In its current, stabilized condition, this bank is not contributing sediment to the Fountain Creek system. Other banks were eliminated through grading and planfom improvements on the project site. In the project's current state, there are sediment contributions from the bank on the inside of the lower bend and by any ongoing erosion on the upstream side of the bank protection, but these contributions could not be measured at the time of site observation due to unsafe site conditions.

Vegetation

Vegetation establishment within the Overton project area has been heavily influenced by recent storm events that resulted in extremely high flows and sedimentation within the project area. Established vegetation within some areas has been covered with sediment. Based on ocular estimates, vegetation cover throughout the project area is between 30 and 40 percent cover with approximately 20 percent grass/forb cover, 15 percent shrub cover, and no tree cover. Dominant species within the riparian corridor include thickspike wheatgrass (*Elymus lanceolatus*; native), western wheat, slender wheatgrass (*Elymus trachycaulus*; native), narrowleaf willow, and plains cottonwood. Upland areas are dominated by blue grama (*Bouteloua gracilis*; native), kochia, and sand dropseed (*Sporobolus cryptandrus*; native). The project area consists of 20 to 30 percent native vegetation cover, while 10 percent is nonnative.

During construction, 26,257 willow cuttings and 340 cottonwood poles were installed throughout the project area. In areas that were affected by sedimentation, approximately 20 percent of all planted willow stakes and approximately 5 to 10 percent of all cottonwood poles were still visible, while the rest had been buried or carried away by storm flows. If soils continue to stay wet, willows are expected to recover over time. Due to sedimentation, survivorship of willows and cottonwood poles was not estimated; however, both species will likely resprout through accumulated sediment. While the site has experienced high levels of sedimentation, we recommend monitoring vegetation establishment over the next two growing seasons to understand how buried vegetation rebounds within the site. If vegetation has not reached a desirable level with at least 50 to 60 percent cover, replanting and reseeding may be necessary.

Although the site has gone through major landscape changes over the past growing season, native vegetation is establishing well. Small populations of salt cedar are present and make up approximately 2 to 5 percent of the total cover throughout the project area. Vegetation management is recommended for a

minimum of two years to control salt cedar and other small populations of noxious and non-native weeds. Control of these species will likely require a combination of mechanical and chemical treatments appropriately timed to maximize effectiveness. Controlling these species will reduce vegetative competition and increase native vegetation establishment and cover. Areas disturbed by noxious weed control efforts should be reseeded with a native seed mix appropriate for the site.

Summary

Ongoing monitoring is recommended for the Overton Road site. At this time, the project is functioning, but the potential flanking noted at the lower bend protection is the area of highest risk for the project site. Sediment contributions from areas of the project site are noted but these are likely lower than pre-project conditions.

A combination of mechanical and chemical noxious and non-native weed control is recommended for the next two years to limit competition with establishing native vegetation. In addition, vegetation establishment monitoring is recommended over the next two growing seasons to determine if replanting or reseeding is necessary to stabilize the project area.

Pinon Bridge

The Project is located on Fountain Creek immediately upstream of the Pinon Bridge in northern Pueblo County, approximately 10 miles north of Pueblo, and approximately 0.6 miles east of the northbound lanes of I-25.

Project Background

The primary objective of this project was to address migration of the Fountain Creek channel which was directing flows into the guide bank at the western bridge abutment. This redirection of flows created bank erosion on the western bank of Fountain Creek, causing the project to be ranked as a high priority in the WARSSS report (WARSSS, 2017).

This project restored 4 bends along the mainstem of Fountain Creek, stabilizing each with riprap bend protection. Site grading was completed to address the cut bank and revegetation was completed across the project site.

Site Assessment

The Pinon Bridge site could not be accessed due to ongoing high water in the Summer of 2023. Visual assessment from the Pinon Rd bridge was conducted. Figure 15 shows the riprap bank protection upstream of the Pinon Rd bridge. This protection has been damaged by flooding on the downstream end and a backwater area has been scoured behind the riprap as noted in the image. Please note that this photo was taken at above average water levels that are greater than baseflow.

A follow-up photo of the bank protection was taken in September 2023, showing sediment deposition between the end of the bank protection and the downstream point bar, shown in Figure 16. It appears that sediment is backfilling the area behind and downstream of the point bar, reestablishing the design pattern.

Figure 15. Riprap bank protection upstream of the Pinon Rd bridge, August 2023.

Figure 16. Riprap bank protection upstream of the Pinon Rd bridge, September 2023.

Significant erosion on the eastern bank, outside of the project area, was noted and is shown in Figure 17. Based on site reconnaissance and aerial images, it appears a pond, located to the northeast of the project area, may be causing this new side channel to be cut into the floodplain. Though there is significant erosion on the floodplain, site observations showed the riprap bend protection remained intact. In a follow-up visit, this area appeared dry, reducing site concerns.

Figure 17. Floodplain impacts (a) Looking east. (b) Looking west.

(a) (b)

Downstream of the bridge, the project area shows evidence of minor erosion downstream of the bend protection (Figure 18). Based on the flow path, this was likely caused by the flooding on the eastern bank of the channel. At this time, the erosion does not appear to be threatening the upstream bend protection or project as a whole. During the September visit, it appears a point bar is reforming in the bend of the channel.

Downstream of the project area, the bank shown in Figure 19 is actively eroding, retreating multiple feet during the recent flood events, according to the landowner. This bank was identified in the WARSSS report as Bank PC077 (WARSSS, 2017). If the retreat of this bank continues, it may put the Pinon Bridge project at risk.

Figure 18. Project area downstream of the Pinon Rd bridge, September 2023.

Figure 19. Eroding bank downstream of the project area.

Sediment Contributions

The WARSSS report identified Bank PC017 as a high priority bank, contributing 9,242 tons/year to the system (WARSSS, 2017). The detailed BANCS assessment completed for the project area refined this estimate to 6,887 tons/year. Bank PC017 is called out in Figure 20. This bank has been stabilized and vegetated by the project and is no longer contributing sediment to the system.

Figure 20. Area of Bank PC017.

Vegetation

Vegetation establishment within the Pinon Bridge project area was estimated from the bridge due to high flows at the time of the site visit. Due to storm events that caused extremely high flows, flooding, and sedimentation within the project area, some sediment has been deposited along the western edge of Fountain Creek and has likely buried existing vegetation. Based on ocular estimates, vegetation cover throughout the project area is between approximately 10 and 30 percent. Because we could not access the project area, species specific information is not available.

During construction, 15,767 narrowleaf willows, 48 narrowleaf cottonwoods, and 100 plains cottonwoods were installed throughout the project area. It is estimated that approximately 10 percent of the plantings have survived on the west side of the project area and approximately 30 percent have survived on the east side of the project area. Narrowleaf willows appeared to have the highest survival rate across the project area.

Small populations of noxious weeds, primarily made up of salt cedar, were also observed. To ensure continued revegetation success, vegetation management is recommended for a minimum of two years to control salt cedar and other small populations of noxious and non-native weeds. Control of these species will likely require a combination of mechanical and chemical treatments appropriately timed to maximize effectiveness. Controlling these species will reduce vegetative competition and increase native vegetation establishment and cover. Areas disturbed by noxious weed control efforts should be reseeded with a native seed mix appropriate for the site.

Summary

This project site should be monitored for changes to site conditions that may put the site at risk. The backwater area near the upstream bend protection appears to be backfilling with sediment, so no action is recommended. Grading on Bank PC017 has stabilized the area from further erosion.

A combination of mechanical and chemical noxious weed control is recommended for the next two years. In addition, it is recommended that the project site be monitored over the next two growing seasons to determine if existing vegetation will emerge through the accumulated sediment or if additional seeding and plantings are necessary to stabilize the project site.

Barr Farm, Phase 2

The Project consists of a segment of Fountain Creek with a total length of approximately 6,200 feet, located, approximately, 1.5 miles south of the Pinon Road bridge and approximately 0.2 to 0.4 miles west of Overton Road.

Project Objectives

The primary project objective was to address the high priority cut banks along this section of Fountain Creek, Banks PC078, PC079, and PC080. The WARSSS study ranked these banks as high priority banks (WARSSS, 2017). There is an additional medium priority bank, Bank PC022, on the site.

The channel was realigned to a planform consistent with Fountain Creek reference reach parameters and toe wood and soil lift bank protection was placed throughout the project site. Site grading was completed to smooth the cut banks and revegetation was completed throughout the project site.

Site Assessment

Site visits in 2021, after project completion, showed good bank stability provided by the toe wood, soil lifts and vegetative success in willow plantings, especially towards the middle and end of the project area. Figure 21 shows the bank protection at a low flow condition.

Figure 21. Bank Protection at Barr II, August 2021

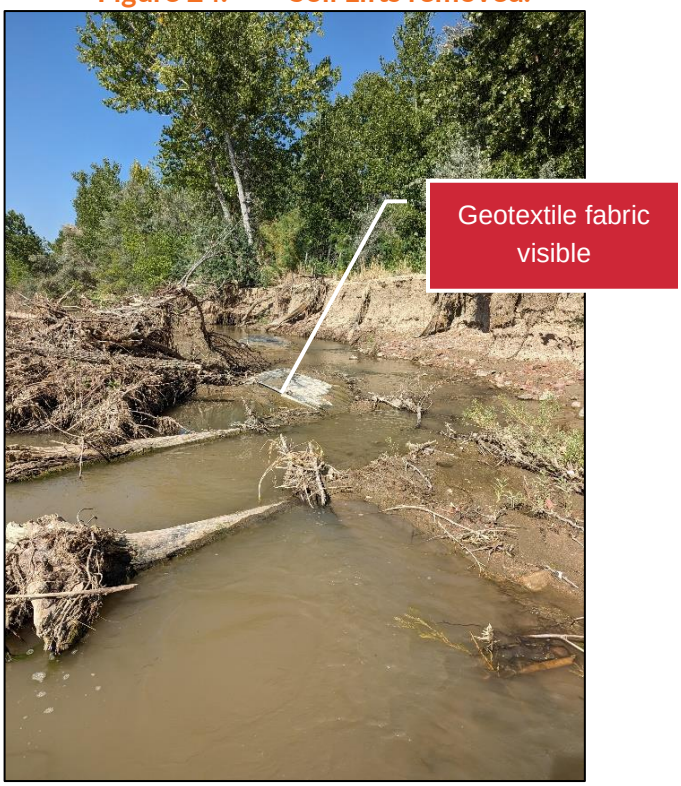
Figure 22 shows how Bank PC078 was graded to a stable slope and the mainstem of Fountain Creek was moved to protect the agricultural fields to the east.

Figure 22. Bank PC078, post-construction, August 2021

The floods in 2023 were the first test for the project site. Major damage to the bank protection was experienced and is shown in Figure 23 and Figure 24.

Figure 23. Damaged Toe Wood

Figure 24. Soil Lifts removed.



Discussions of the mechanism of failure have been conducted and two potential causes have been identified. The first theory is that the soil lifts above the toe wood may have been undermined as rising water used the reduced permeability of the geotextile fabric placed between the logs and soil lifts to infiltrate the structure and exert a buoyant force on the soil lifts, resulting in their removal by flooding flows. The second theory is that rising water and turbulence around the root wads, and debris caught on the root wads, damaged the front face on the soil lifts and progressively caused the removal of the overburden soil above and behind the toe wood structure. Regardless of the actual mechanism, this loss of the soil lifts exposed the underlying toe wood structure to damage from high velocity flows and debris. Some areas of the site lost the soil lifts but retained the toe wood structure, as shown in Figure 24. These logs are exposed to additional damage and are at risk of future failure.

Not all areas of toe wood are at risk. Sections of the bank protection remain, as shown in Figure 25. These areas are typically along the upstream end of bends where the hydraulic forces were lowest.

Figure 25. Intact toe wood sections.

Conversations with the property owner noted risks associated with the loss of toe protection near the middle of the project area. Significant migration of this bank may eventually threaten the pivot irrigation system for the nearby fields.

Sediment Contributions

The 2017 WARSSS report quantified the project area sediment contribution for the four banks as shown in Table 4. Due to the high priority of the project site, a more detailed BANCS analysis was completed on bank PC078 in 2017, estimating the sediment contribution for this bank to be 25,025 tons/year.

Table 4. Barr Phase II Priority Banks (WARSSS, 2017)

Bank ID	Estimated Erosion Rate (tons/year)	Bank Length (ft)
PC021	2,525	631
PC078	27,284	1,299
PC079	19,758	1,976
PC080	5,156	645
Total	**54,732**	**4,551**

Due to the size of the project site, a representative section of the project reach was evaluated using the BANCS methodology and a unit erosion rate for the project site of 0.19 tons/yr/ft was developed. For the full project length of 7,084 ft, it is estimated that 1,371 tons of sediment per year is being added to the system. Even with the recent bank protection failures, the project is demonstrating a significant reduction in sediment contribution.

Vegetation

Vegetation establishment within the Barr Phase 2 project area has been heavily influenced by recent storm events that resulted in extremely high flows, erosion, and sedimentation within the project area. The western edge of the channel experienced the highest amount of sedimentation while portions of the eastern project area support healthy populations of wetland and riparian vegetation. Based on ocular estimates, vegetation cover throughout the project area is between 60 and 70 percent with approximately 30 percent grass and forb cover, 30 percent shrub cover, and 5 percent tree cover. Dominant species within the riparian corridor include common threesquare (*Schoenoplectus pungens*; native), Indian ricegrass (*Achnatherum hymenoides*; native), narrowleaf willow, and plains cottonwood. Upland areas are dominated by blue grama, kochia, slender wheatgrass, and sand dropseed. The project area consists of 40 to 50 percent native vegetation cover, while 20 percent is nonnative.

During construction, 156,754 narrowleaf willow stakes were installed including 26,924 installed vertically, 4,736 installed in willow trenches, and 125,094 installed as part of soil lifts both horizontally and vertically. Additionally, 913 plains cottonwood poles were installed within the project site. Based on ocular estimates, 20 percent of the plantings have survived on the west side of the project area and 50 percent have survived on the east side of the project area. Most willow and cottonwood plantings were covered by sediment on the west side or washed away due to the scour; however, both species will likely resprout through accumulated sediment.

Small populations of salt cedar have established in various locations within the project area. To ensure continued revegetation success, vegetation management is recommended for a minimum of two years to control salt cedar and other small populations of noxious weeds. Control of these species will likely require a combination of mechanical and chemical treatments appropriately timed to maximize effectiveness. Controlling these species will reduce vegetative competition and increase native vegetation establishment and cover. Areas disturbed by noxious weed control efforts should be reseeded with a native seed mix appropriate for the site.

We recommend monitoring vegetation establishment throughout the project area over the next two growing seasons to understand how buried vegetation rebounds within the site and to assess the stability of other portions of the site. If vegetation has not reached at least 50 to 60 percent cover in the next two years, replanting and reseeding may be necessary.

Summary

A combination of mechanical and chemical noxious and non-native weed control is recommended for the next two years to limit undesirable competition with establishing native vegetation. The project area should be monitored over the next two growing seasons to determine if additional adaptive management such as reseeding or replanting is necessary to provide additional soil stability. The project area should also be monitored for additional bank erosion which may result in threats to the adjacent agricultural assets.

Barr Farm, Phase 1

The Project consists of the southern segment of the Barr Farm project area on Fountain Creek with a total length of approximately 5,200 feet located approximately 2.6 miles south of the Pinion Road bridge and west of Overton Road.

Project Objectives

Primary objectives of this project were to address the severe cut banks along this section of Fountain Creek that were encroaching onto adjacent agricultural land and threatening agricultural assets. The WARSSS study ranked this area as a high priority project (WARSSS, 2017). Secondary objectives were the protection of overhead utility lines that the eroding bank had put at risk.

The channel was realigned to a planform consistent with Fountain Creek reference reach parameters. Riprap bank protection was placed on three bends, and toe wood with soil lifts was placed on one bend. Site grading was completed to smooth the cut banks as much as possible, accounting for site limitations, and revegetation was completed throughout the project site.

Site Assessment

The site was assessed downstream to upstream. The downstream tie-in of the project site was well established in the design pattern and a stable bar on the inside of the bend has been established. This area is shown in Figure 26. The top of the historic cut bank is still visible at the downstream tie in. Heavy wetland vegetation was found in this area due to good groundwater connection in the area, shown in Figure 27. At the upstream tie in of this bank protection, the soil lifts installed above the riprap are still intact with some loose fabric visible in Figure 28.

Figure 26. Lower tie-in bend with remnant cut bank.

Figure 27. Heavy vegetation establishment on floodplain.

Figure 28. Riprap bend protection and soil lifts

The next bend upstream was the trial area for toe wood with soil lift bank protection that would later be built on Phase 2 of this project. In this area, most of the installed toe wood structure has remained intact but the soil lifts installed above have been compromised. This is shown in Figure 29 along with discarded geotextile fabric still present in the area of the structure.

During the site visit, it was noted that fine sediment was depositing behind and between the toe wood, backfilling the area. It appears that this bank protection was not exposed to the quantity of debris and stresses that impacted the upstream toe wood structures. Observations noted that the toe wood was directing flows away from the bank and maintaining the designed channel thalweg. On the downstream end of the toe wood, a large debris pile has protected the soil lifts. An example of this area is shown in Figure 30. Some of the material has been removed from the soil lift, but the fabric is intact and vegetation remains.

Figure 29. Remaining toewood structure.

Figure 30. Soil lift over toe wood.

The next bend upstream returns to a riprap bend protection approach. A large debris pile is located at the upstream end of the bend and sediment has aggraded along the point bar, creating a narrow and confined channel along the bank protection as shown in Figure 31 and Figure 32. There was no evidence of the riprap becoming undermined due to this confinement and it appeared that flows were able to overtop the riprap bend protection and flood into the adjacent cottonwood gallery.

Figure 31. Large debris pile.

Figure 32. Aggraded point bar.

The final, most upstream bend of the project is protected by riprap bank protection. No significant damage was noted to this area. The downstream end of the protection shows evidence of scour behind the riprap, shown in Figure 33. This is similar to what was noted at the Pinon Road project and sediment has begun to backfill the area as well.

Figure 33. Upstream bend protection.

Sediment Contributions

The WARSSS report identified two high priority banks and one medium priority bank on this project site. The bank information is summarized in Table 5. Due to the high priority of the project site, a more detailed BANCS analysis was completed in 2017 for Bank PC082, estimating the sediment contribution to be 18,581 tons/year.

Table 5. Barr Phase I Priority Banks (WARSSS, 2017)

Bank ID	Estimated Erosion Rate (tons/year)	Bank Length (ft)
PC022	1,199	599
PC081	28,427	836
PC082	25,189	787
Totals	**54,814**	**2,223**

Due to the size of the project site, a representative section of the project reach was evaluated using the BANCS methodology and a unit erosion rate for the project site of 0.06 tons/yr/ft was developed. For the full project length of 5,200 ft, it is estimated that 312 tons of sediment per year is being added to the system.

Vegetation

Vegetation establishment within the Barr Phase 1 project area has been heavily influenced by recent storm events that resulted in extremely high flows, erosion, and sedimentation within the project area. Based on ocular estimates, vegetation cover throughout the project area is between 50 and 60 percent; however, there are large areas with bare sediment due to aggradation. The western edge of the project area experienced moderate to high levels of erosion that exposed toe wood structures and geotextile fabric used during construction. The erosion, along with the fabric, has caused obvious impacts to established vegetation. The project area contains approximately 30 percent grass and forb cover, 30

percent shrub cover, and 5 percent tree cover. The dominant species within the riparian corridor include common threesquare, broadleaf cattail, prairie cordgrass (*Spartina pectinata*; native), reed canarygrass (*Phalaris arundinacea*; native), narrowleaf willow, and plains cottonwood, while the upland areas are dominated by little bluestem (*Schizachyrium scoparium*; native), switchgrass (*Panicum virgatum*; native), western wheatgrass, and kochia. The project area consists of 30 and 40 percent native vegetation cover, while 15 percent is nonnative.

During construction, 66,465 narrowleaf willow stakes were installed including 39,449 installed vertically and 27,016 installed as part of brush layering. Additionally, 64 plains cottonwood poles were installed within the project site. Due to damages incurred by storm events, most willow stakes and cottonwood poles on the west side of the project area were either buried or washed away with an estimated survival rate of 5 to 10 percent. Approximately 50 percent of willow stakes and plains cottonwood poles have survived on the eastern side of the project area.

Overall, native vegetation is establishing well along the eastern edge of the project area; however, small populations of salt cedar and other noxious weeds have established in various locations within the project area. Vegetation management is recommended for a minimum of two years to control salt cedar and other small populations of noxious weeds. Control of these species will likely require a combination of mechanical and chemical treatments appropriately timed to maximize effectiveness. Controlling these species will reduce competition and increase native vegetation establishment and cover. Areas disturbed by noxious weed control efforts should be reseeded with a native seed mix appropriate for the site.

We recommend monitoring vegetation establishment throughout the project area over the next two growing seasons to understand how buried vegetation rebounds within the site and to assess the stability of other portions of the site. If vegetation has not reached at least 50 to 60 percent cover in the next two years, replanting and reseeding may be necessary.

Summary

Overall, this site is performing as designed with the exception of the areas noted. It is anticipated that portions of the toe wood with soil lift sections and section of flanked riprap bend protection will aggrade with sediment but should be monitored for further degradation. The section of the project that is overly confined by the point bar aggradation, is not currently threatened by the confinement.

A combination of mechanical and chemical noxious and non-native weed control is also recommended for the next two years. The project area should be monitored over the next two growing seasons to determine if additional adaptive management such as reseeding or replanting is necessary to provide additional soil stability.

Highway 47 Bank Restoration

This project extends 3,800 feet upstream of the Highway 47 bridge on the north side of Pueblo. This project was completed in partnership with the Colorado Department of Transportation to protect their bridge asset.

Project Objectives

The primary project objective was the protection of the Highway 47 bridge that was being threatened by a realignment of Fountain Creek's main channel to the east and against the bridge abutment. Secondary objectives were to reduce sediment contributions from eroding banks within the project area.

The channel was realigned consistent with Fountain Creek reference reach parameters. Three bends along Fountain Creek were stabilized with riprap bend protection. A guide bank was installed at the Highway 47 bridge, site grading, and revegetation was completed throughout the project site.

Site Assessment

The site assessment identified significant channel migration and erosion in the area of the upstream project tie-in. Discussion and photo documentation is provided in the August 2023 memorandum "Conditions Assessment – Highway 47 Bank Restoration Project." That assessment noted that the upstream protective waterline bollards contributed significantly to the channel migration through the project reach. Additional discussion of changes to the project reach is provided in the August 2023 memorandum.

The primary objective of the project, protection of the Highway 47 bridge, has been achieved by the project. During the site assessment, no current threats to the bridge were identified.

During the site assessment, it was noted that much of the previously established vegetation was buried by the fine sediment deposited throughout the floodplain. Despite this, willows bent over by the flooding but unburied appeared to be alive and will likely survive. Cottonwood poles planted as part of the revegetation effort remain within the floodplain and are largely unaffected by the flooding. An example of the vegetation remaining on the floodplain and sediment deposition closer to the creek is shown in Figure 34.

Figure 34. Vegetation in the floodplain.

Sediment Contributions

The 2017 WARSSS report identified Bank PC109, ranked as a high priority bank, contributing 3,255 tons/year and that a total of 7 priority banks were located within the project area. Because this was a high priority area, field reconnaissance of the site was completed to provide a more precises sediment

estimate for Bank PC109. The field assessment calculated a sediment contribution of 3,250 tons/year. Bank PC109 and additional priority banks on the project site are summarized in Table 6.

A BANCS survey was completed to establish sediment contribution of the exposed banks within the project site. Four banks were surveyed within the project site resulting in a sediment contribution of 4,442 tons/year of sediment contribution.

Table 6. Highway 47 Priority Banks (WARSSS, 2017)

Bank ID	Estimated Erosion Rate (tons/year)	Bank Length (ft)
PC044	6,422	714
PC045	2,686	298
PC046	4,149	461
PC106	7,633	1,908
PC107	742	186
PC108	5,582	698
PC109	3,255	250
Totals	**30,468**	**4,515**

Vegetation

At the time of the site visit, large areas of established vegetation along the channel were covered in sediment and signs of storm flows were evident throughout the floodplain. Based on ocular estimates, vegetation cover throughout the project area is between 25 and 40 percent with approximately 15 to 20 percent grass and forb cover, 10 percent shrub cover, and less than 5 percent tree cover. Dominant species within the riparian corridor include common reed (*Phragmites australis*, Watch List), narrowleaf willow, sand dropseed, and kochia. There are large portions of the project area dominated by kochia with very little native vegetation present and phragmites lines most of the channel.

During construction, 44,291 narrowleaf willow, 140 plains cottonwood, and 154 narrowleaf cottonwood cuttings were installed throughout the project area. Based on ocular estimates 60 percent of the plantings have survived on the west side of the project area and 80 percent have survived on the east side of the project area; however, it is likely that some cuttings have been covered by sediment which are expected to resprout in the next few years.

Small populations of salt cedar have established in various locations within the project area. To ensure continued revegetation success, vegetation management is recommended for a minimum of two years to control salt cedar and other small populations of noxious weeds. Control of these species will likely require a combination of mechanical and chemical treatments appropriately timed to maximize effectiveness. Controlling these species will reduce vegetative competition and increase native vegetation establishment and cover. Areas disturbed by noxious weed control efforts should be reseeded with a native seed mix appropriate for the site. Areas dominated by kochia should be interseeded with an appropriate native seed mix and mechanical control using mowers or weed whackers should be employed to prevent kochia and other non-native annuals from producing seeds for a minimum of two years while native vegetation establishes.

We recommend monitoring vegetation establishment throughout the project area over the next two growing seasons to understand how buried vegetation rebounds and reseeded areas establish within the site and to assess the stability of other portions of the site. If vegetation has not reached at least 50 to 60 percent cover in the next two years, replanting and reseeding may be necessary.

Summary

Avenues for maintenance/restoration funding are currently being explored and work in this area is expected in 2024. Despite the condition of the site, the overall sediment contributions to the site has been reduced, from 30,468 tons/year to 4,442 tons/year. The major eroding bank, Bank PC109, has been protected by completion of the project.

A combination of mechanical and chemical noxious and non-native weed control is also recommended for the next two years. The project area should be monitored over the next two growing seasons to determine if additional adaptive management such as reseeding or replanting is necessary to provide additional soil stability. Additionally, areas dominated by kochia should be interseeded with a native seed mix and mechanical control should be employed to prevent kochia from producing seeds.

13th Street Channel Restoration

The project reach includes approximately 2,900 feet of Fountain Creek from south of 8th Street to north 13th Street in Pueblo, Colorado.

Project Objectives

The primary objective of this project was to reduce the sediment contribution by numerous eroding banks that were identified and ranked high in the WARSSS study. These eroding banks threatened the adjacent levee and railroad tracks.

The channel was realigned, consistent with the Fountain Creek reference reach parameters. Four bends were protected with riprap bank protection. Due to the urban nature of the site, a variety of additional stormwater and drainage improvements were completed within the project site.

Site Assessment

Over time, the thalweg of Fountain Creek within this project area has followed a straighter alignment than is expected on Fountain Creek and not consistent with the project design. Due to this, there has been sediment deposition within the boundaries of the bankfull channel. Erosion on the project site was noted to be exclusively on these sediment deposition areas as is shown in Figure 35. Flood flows appear to have been mostly contained within the bankfull corridor.

On site vegetation has been largely buried by fine sediment within the flooding extents. Shown in Figure 36, brush layering on site has successfully established.

Figure 35. Bank erosion, typical to the site.

Figure 36. On-site brush layering.

Sediment Contributions

The 2017 WARSSS report identifies seven banks on the 13th Street project area, outlined in Table 7.

Table 7. 13th Street Priority Banks (WARSSS, 2017)

Bank ID	Estimated Erosion Rate (tons/year)	Bank Length (ft)
PC053	2,273	284
PC054	1,714	428
PC055	3,778	1,259
PC115	3,072	768
PC116	4,637	927
Totals	**15,474**	**3,667**

The 2023 BANCS measurements resulted in a unit erosion rate of 0.19 tons/yr/ft, applied to the 2,800 ft project length, resulting in a sediment estimate of 532 tons/yr.

Vegetation

Overall, vegetation establishment within the 13th Street project area is very low with portions of the site impacted by sedimentation which has buried previously established vegetation. Based on ocular estimates, vegetation cover throughout the project area is between 30 and 40 percent with approximately 15 percent grass and forb cover, 20 percent shrub cover, and five percent tree cover. Dominant species observed include phragmites, sand dropseed, little bluestem, kochia, and narrowleaf willows. Outside of willow planting areas, much of the site is dominated by non-native and noxious weeds, primarily kochia and phragmites, while small pockets of the site have well established native grass populations.

During site construction, 33,183 narrowleaf willow stakes and 638 cottonwood poles were installed throughout the project area. Based on ocular estimates, 85 percent of the plantings have survived which represents the largest revegetation success for the project. However, understory grass and forb cover within willow and cottonwood planting areas is extremely low as these areas were not seeded and relied solely on establishment of woody plant material. For future projects we recommend seeding areas where willows and/or cottonwoods will be planted to improve soil stability and prevent non-native or noxious species from dominating the understory. We recommend these areas be interseeded during the 2024 growing season to improve native understory cover.

Small populations of salt cedar, Russian olive, and other noxious weeds have established in various locations within the project area. Vegetation management is recommended for a minimum of two years to control noxious and non-native weeds. Control of these species will likely require a combination of mechanical and chemical treatments appropriately timed to maximize effectiveness. Controlling these species will reduce vegetative competition and increase native vegetation establishment and cover. Areas disturbed by noxious weed control efforts should be reseeded with a native seed mix appropriate for the site. Areas dominated by kochia and areas with low overall vegetation should be interseeded with an appropriate native seed mix and mechanical control using mowers or weed whackers should be employed to prevent kochia and other non-native annuals from producing seeds for a minimum of two years while native vegetation establishes.

We recommend monitoring vegetation establishment throughout the project area over the next two growing seasons to understand how buried vegetation rebounds and reseeded areas establish within the

site. If vegetation cover has not reached at least 50 to 60 percent in the next two years, additional reseeding may be necessary.

Summary

Prior to completion of this evaluation, the 13th Street project had been identified for maintenance work as part of the 2-year warranty period and environmental permit requirements. Remediation of the revegetation on the project is underway in 2024 and ongoing maintenance requirements are being considered. The findings of this study support this previous assessment.

The current site conditions demonstrate a significant reduction in the sediment loading compared to the pre-project site conditions. The previously threatened railroad and levees are no longer at risk. The 8th Street bridge does not appear to be at risk from this project.

As noted, areas dominated by non-native weeds and areas with low overall vegetation cover should be interseeded in spring 2024 to improve vegetation establishment and overall site stability. A combination of mechanical and chemical noxious and non-native weed control is also recommended for the next two years. The project area should be monitored over the next two growing seasons to determine if additional adaptive management such as reseeding is necessary to provide additional soil stability.

Conclusions

This evaluation assessed seven District projects for effectiveness of sediment reduction, project function, and vegetative success. Recommendations for further action at each site is summarized in Table 8. Each of the seven projects shows a reduction in the sediment contribution from pre-project conditions to post-project conditions and no infrastructure is currently considered at-risk, satisfying key District objectives. A summary table of the pre- and post-project sediment contributions discussed in this report is available in Appendix B.

Repair or remediation is recommended at Highway 47 Bank Restoration and at 13th Street Channel Restoration. Highway 47 Bank Restoration experienced significant damage and is recommended for repair to its original designed alignment once the upstream bollards are removed. 13th Street Channel Restoration is not currently meeting the requirements of the USACE 404 permit, and exploration of remedial action is recommended. Monitoring in 2024 is recommended for many of the project sites impacted by the 2023 flooding. From there, it is anticipated an annual or biannual monitoring period may be recommended. In the case of Masciantonio, no additional monitoring is recommended as it was found that the project is well established with property and stream function protected.

Weed control is recommended at each of the seven projects to control noxious and non-native weeds to prevent undesirable competition with native vegetation. Vegetation monitoring for at least two years is recommended at five of the projects to determine how vegetation rebounds following sedimentation from Summer 2023 storm flows and if additional adaptive management such as seeding or replanting is necessary to improve site stability. Interseeding areas with low overall cover or low native cover is recommended for two of the projects to increase native vegetation cover and increase site stability.

Table 8. Summary Recommendations.

Project Site	Recommendation
Masciantonio Trust Bank and Young Hollow	Weed control for minimum of two years with focus on salt cedar and Russian olive.
Overton Road Bank Restoration	Monitoring of post-flood conditions in 2024. Weed control for minimum of two years with focus on salt cedar.
Pinon Bridge	Monitoring of post-flood conditions in 2024. Vegetation monitoring and weed control for minimum of two years.
Barr Farm, Phase 2	Monitoring of bend migration in 2024 and annually. Vegetation monitoring and weed control for minimum of two years.
Barr Farm, Phase 1	Monitoring of toe wood bend and confined area in 2024. Vegetation monitoring and weed control for minimum of two years.
Highway 47 Bank Restoration	Additional action recommended. In discussion. Vegetation monitoring and weed control for minimum of two years. Interseeding areas with low native cover.
13th Street Channel Restoration	Additional action recommended. In discussion. Vegetation monitoring and weed control for minimum of two years. Interseeding areas with low native cover.

Lessons Learned

Approaches to bank stabilization projects along Fountain Creek have changed over the years from bendway weirs to riprap bend protection to toe wood bend protection. As demonstrated by the Highway 47 site, rock and boulder bank protection is not resilient to excessive forces which can damage the integrity of hardened riprap and boulder structures.

Efforts to reduce the cost and increase the ecological value of projects lead to the introduction of toewood structures, first piloted on Barr Farm, Phase 1. Analysis of Barr Farm Phase 1 and 2, shows the toe wood's greatest vulnerability is the soil lifts constructed above the structure. Looking forward, methods for the reinforcement and protection of the soil lifts is being explored to increase the resiliency of the bend protection.

Vegetative success is the key to the long-term stability of these channel projects. Recommendataions have been made for the monitoring and maintenance of vegetation on previously completed project sites to control invasive and nonnative species. Moving forward, Matrix and the District are developing specifications and contractor qualifications to support vegetative management and to increase success.

References

(Anderson, Michelle. 2006). Salix exigua. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: https://www.fs.usda.gov/database/feis/plants/shrub/salexi/all.html [2023, November 14].

(District, 2023). Overview. Fountain Creek Watershed, Flood Control, and Greenway District. https://www.fountain-crk.org/overview.

(FMO, 2019) *Fountain Creek Corridor Floodplain Management Opportunities Study*. December 2019. Fountain Creek Watershed, Flood Control & Greenway District.

(Matrix, 2023) *Conditions Assessment – Highway 47 Bank Restoration Project* [Memorandum]. Matrix Design Group to Fountain Creek District. August 2023.

(Rosgen, 2006) *Watershed Assessment of River Stability and Sediment Supply*. Dave Rosgen. Second Edition. 2006. Wildland Hydrology.

(USACE, 2020a) U.S. Army Corps of Engineers. 2020. Colorado Stream Quantification Tool (CSQT) User Manual and Spreadsheets. Version 1.0. U.S. Army Corps of Engineers, Albuquerque District, Pueblo Regulatory Office.

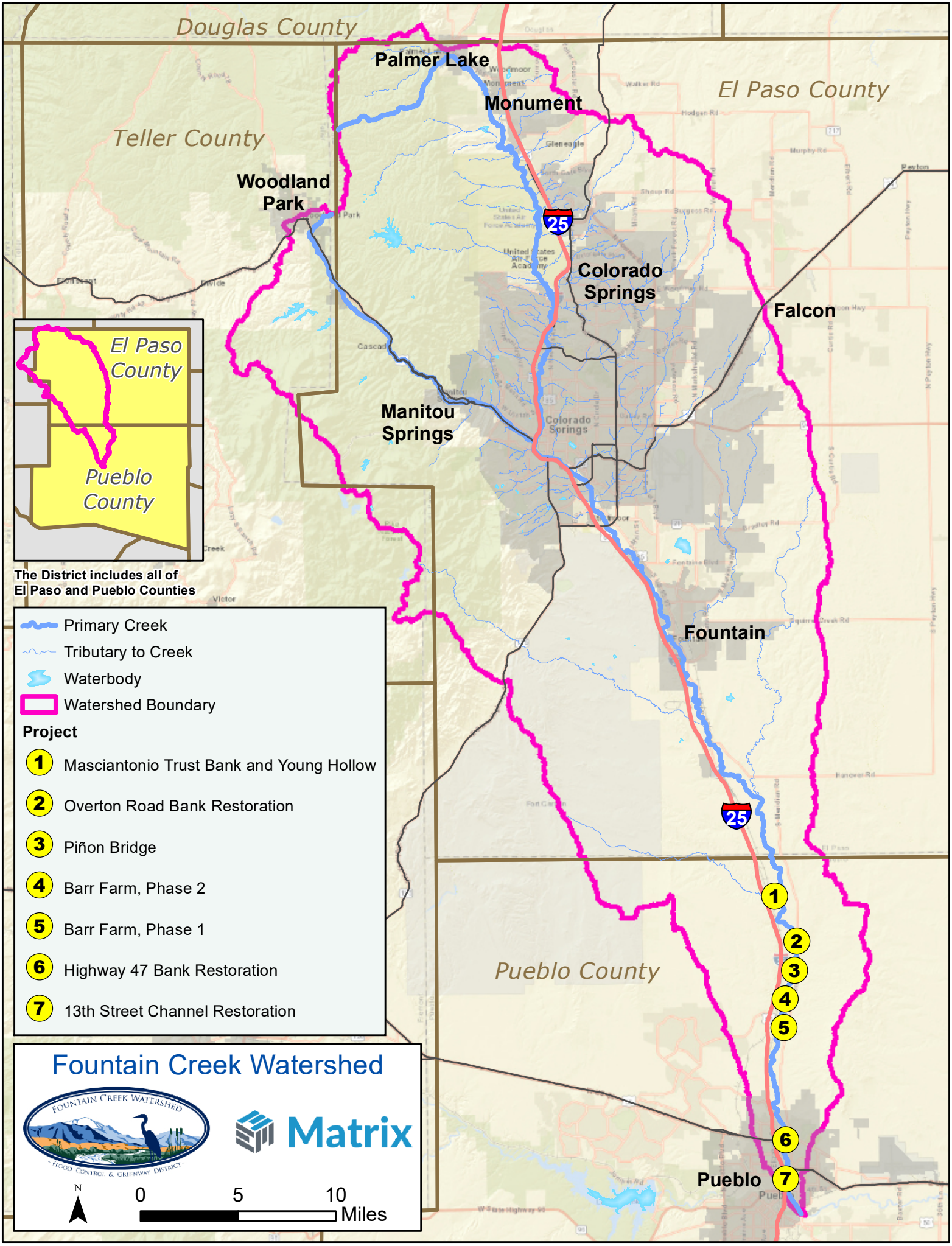
(USACE, 2020b) U.S. Army Corps of Engineers. 2020. Scientific Support for the Colorado Stream Quantification Tool. Version 1.0. U.S. Army Corps of Engineers, Albuquerque District, Pueblo Regulatory Office.

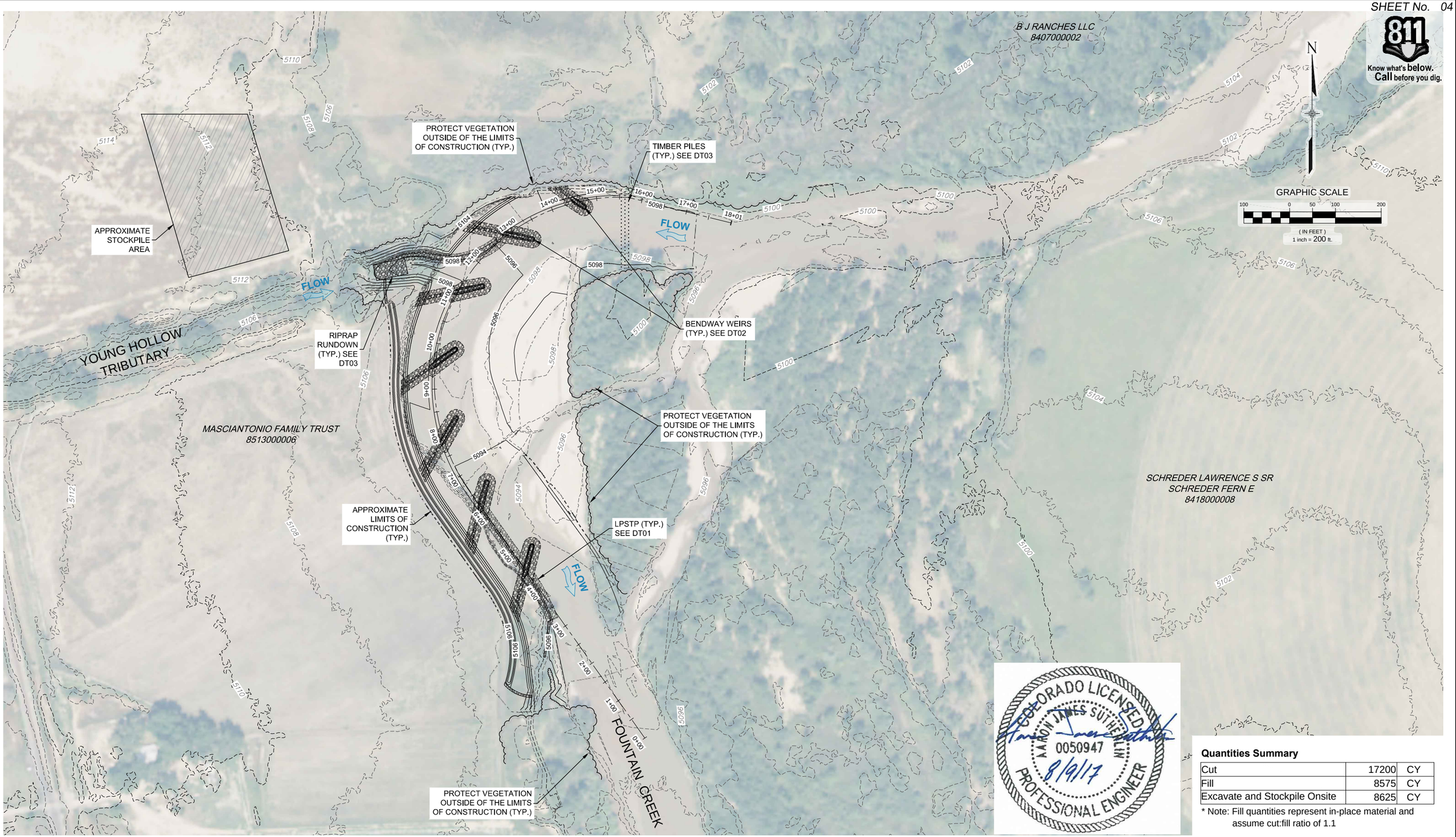
(WARSSS, 2017) *Fountain Creek Corridor WARSSS Study*. March 2017. Fountain Creek Watershed, Flood Control & Greenway District.

(WE&RF, 2016) Stream Restoration as a BMP: Crediting Guidance. 2016. Water Environment & Reuse Foundation.

APPENDIX A

PROJECT SITE MAPS


Douglas County
Palmer Lake
Monument
El Paso County
Teller County
Woodland Park
25
Colorado Springs
Falcon
El Paso County
Pueblo County
Manitou Springs
The District includes all of El Paso and Pueblo Counties
Primary Creek
Tributary to Creek
Waterbody
Watershed Boundary
Project
1 Masciantonio Trust Bank and Young Hollow
2 Overton Road Bank Restoration
3 Piñon Bridge
4 Barr Farm, Phase 2
5 Barr Farm, Phase 1
6 Highway 47 Bank Restoration
7 13th Street Channel Restoration
Fountain
Pueblo County
Pueblo
Fountain Creek Watershed
Matrix
N
0
5
10
Miles



Quantities Summary

Cut	17200	CY
Fill	8575	CY
Excavate and Stockpile Onsite	8625	CY

* Note: Fill quantities represent in-place material and assume cut:fill ratio of 1.1

REFERENCE DRAWINGS

X-526-MDG22x34
X-526-PR-GRAD
X-526-EX-TOPO
X-526-EX-IMAGE

No.	DATE	DESCRIPTION	BY

REVISIONS

COMPUTER FILE MANAGEMENT

FILE NAME: S:\16.526.009 Fountain Creek Enterprise Masciantonio Trust Bank\Dwg\Design Plan\526-DR01.dwg
CTB FILE: Matrix(black).ctb
PLOT DATE: 8/9/2017 2:36 PM
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE.

FINAL DESIGN PLANS

FOUNTAIN CREEK WATERSHED - FLOOD CONTROL & GREENWAY DISTRICT -

PREPARED BY: Matrix DESIGN GROUP AN EMPLOYEE-OWNED COMPANY

SEAL

NOTICE:
FINAL DESIGN PLANS
APPROVED FOR CONSTRUCTION

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 16.526.009

FOUNTAIN CREEK WATERSHED, FLOOD CONTROL & GREENWAY DISTRICT

MASCIANTONIO TRUST BANK RESTORATION PROJECT
FINAL DESIGN PLANS

OVERALL DRAINAGE PLAN

DESIGNED BY:	AJS	SCALE		DATE ISSUED:	August 2017
DRAWN BY:	RAF	HORIZ.	1" = 200'	SHEET	04 OF 18
CHECKED BY:	GWT	VERT.	N/A	DRAWING No.	DR01

Know what's below. Call before you dig. 811

REMOVE ROAD EMBANKMENT TO MATCH ADJACENT FLOODPLAIN. DISTURBED AREAS TO BE TREATED AS UPLAND SEEDING AREAS (SEE RV02 FOR DETAILS ON SEED, SOIL CONDITIONER, AND EROSION CONTROL BLANKET).

EXISTING RIPRAP. TO BE REUSED IN BANK PROTECTION

EXISTING CMP. DO NOT DISTRUB

OLD PINON ROAD

REMOVE EXIST. 72" CMP

APPROXIMATE LIMIT OF ROAD REMOVAL. FINAL EXTENT TO BE DETERMINED IN FIELD BY FIELD ENGINEER

GRAPHIC SCALE
150 0 75 150 300
(IN FEET)
1 inch = 300 ft.

OLD PINON ROAD INSET

EXIST. 72" CMP INV.= 5009.84'

EXIST. 72" CMP INV.= 5011.47'

EXIST. 72" CMP INV.= 5008.83' TO BE REMOVED

EXIST. 72" CMP INV.= 5011.14' TO BE REMOVED

OLD PINON ROAD

PROPOSED REMOVAL OF ABUTMENT, RIPRAP, AND APPROX. 450 LF OF EMBANKMENT ROAD. ADDITIONAL ROAD REMOVAL SHOWN IN INSET (THIS PAGE).

MASCIANTONIO FAMILY TRUST 8430000017

PUEBLO SPRINGS LLC AN ARIZONA LLC 8400000089

EXIST. BRIDGE ABUTMENT

EXIST. RIPRAP (TYP.) TO BE REUSED IN BANK PROTECTION

PROPOSED RIPRAP KEY-IN. SEE DT03.

PROPOSED RIPRAP BEND PROTECTION (TYP.) SEE DT03.

FOUNTAIN CREEK

PROPOSED CHANNEL ALIGNMENT

SURVEYED EXIST. THALWEG (TYP.)

APPROXIMATE LIMITS OF DISTURBANCE (TYP.)

PROPOSED RIPRAP BEND PROTECTION (TYP.) SEE DT03.

PUEBLO SPRINGS LLC PUEBLO SPRINGS RANCH LLC 8431000012

PUEBLO SPRINGS LLC PUEBLO SPRINGS RANCH LLC 8431000012

EXIST. RIPRAP (TYP.) TO BE REUSED IN BANK PROTECTION

EXIST. WELL HOUSE STRUCTURE

EXIST. OVERHEAD ELECTRIC AND FIBER OPTIC

FINAL GRADE TO BE DETERMINED BASED ON AVAILABILITY OF MATERIAL

EXIST. UNDERGROUND FIBER OPTIC

EXIST. OVERHEAD ELECTRIC

EXIST. BRIDGE ABUTMENT

EXIST. RIPRAP (TYP.)

TAFOYA SHIRLEY TAFOYA GARY 8430000010

EXIST. BARBWIRE FENCE (TYP.)

EXIST. STRUCTURE (TYP.)

EXIST. BARBWIRE FENCE (TYP.)

TAFOYA SHIRLEY TAFOYA GARY 8430000016

PUEBLO SPRINGS LLC PUEBLO SPRINGS RANCH LLC 8400000082

PUEBLO SPRINGS LLC PUEBLO SPRINGS RANCH LLC 8400000083

OVERTON ROAD

GRAPHIC SCALE
100 0 50 100 200
(IN FEET)
1 inch = 200 ft.

NOTE: THE EXISTING RIPRAP WITHIN THE PROJECT AREA SHOULD BE REUSED IN THE DESIGN BANK PROTECTION. ALL RIPRAP USED IN THE BANK PROTECTION MUST STILL MEET TYPE VH GRADATION, WHICH COULD REQUIRE BLENDING EXISTING RIPRAP WITH IMPORTED RIPRAP. THE CONTRACTOR SHALL WORK WITH THE FIELD ENGINEER TO ENSURE REUSE OF RIPRAP MEETS DESIGN SPECIFICATIONS.

Earthwork - Cut/Fill Onsite	22,099	CY

NOTE: 1. ANY EXCESS CUT MATERIAL SHALL BE PLACED AS DIRECTED BY THE DISTRICT.
2. EARTHWORK ESTIMATE DOES NOT INCLUDE ADDITIONAL ROAD REMOVAL SHOWN ON INSET.

REFERENCE DRAWINGS

X-526-MDG22x34
X-526-EX-IMAGE
X-526-PR-GRAD
X-526-EX-TOPO
X-526-EX-PARCELS

No.	DATE	DESCRIPTION	BY

REVISIONS

COMPUTER FILE MANAGEMENT

FILE NAME: S:\19.526.018 Overton Road Bank Restoration\Dwg\Design Plans\526-DR01.dwg
CTB FILE: Matrix(black).ctb
PLOT DATE: 1/8/2020 4:57 PM
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE.

100% DESIGN PLANS

FOUNTAIN CREEK WATERSHED - FLOOD CONTROL & GREENWAY DISTRICT -

PREPARED BY: Matrix Excellence by Design

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 19.526.018

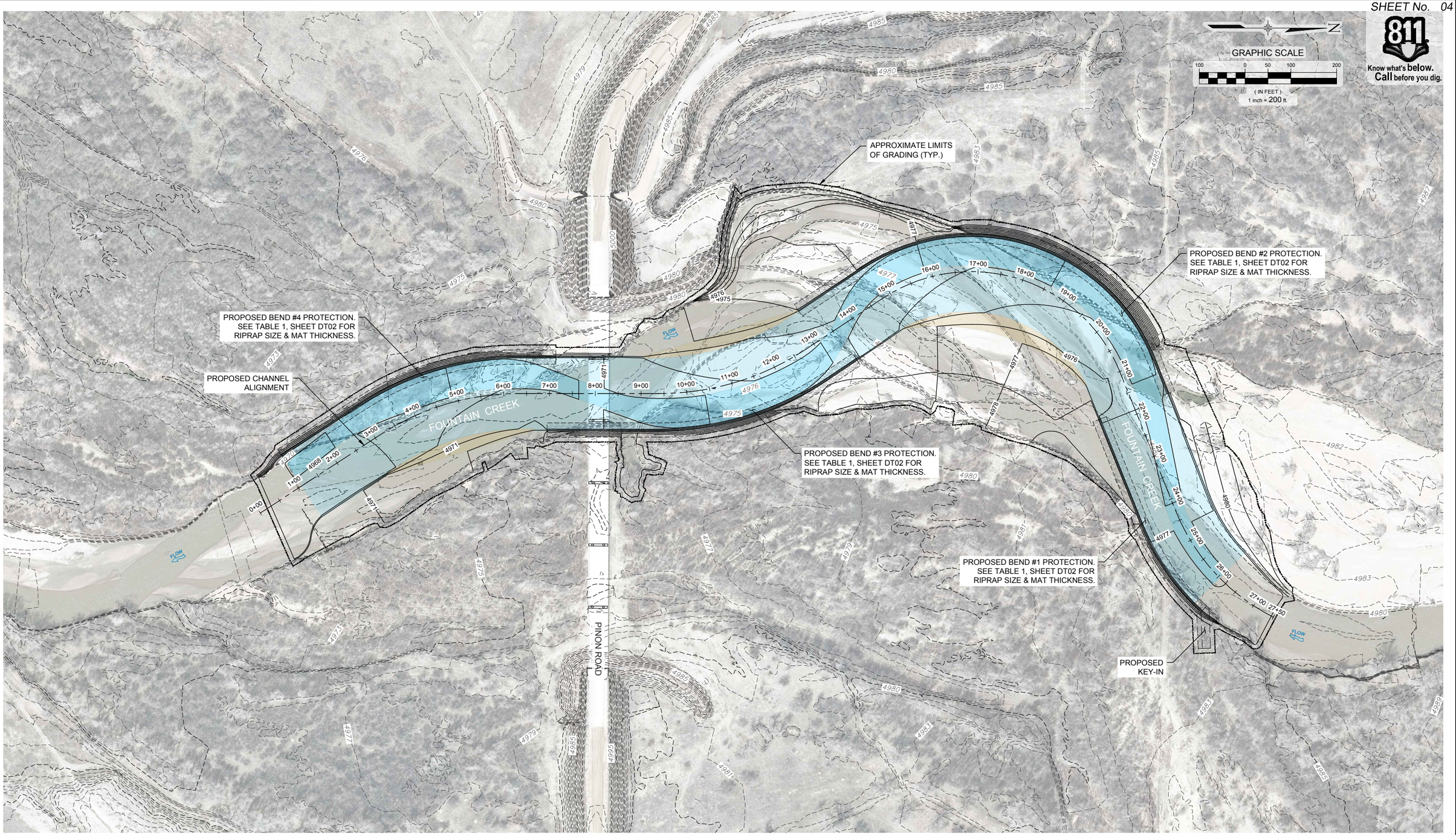
SEAL

FOUNTAIN CREEK WATERSHED, FLOOD CONTROL & GREENWAY DISTRICT

OVERTON ROAD BANK RESTORATION PROJECT
100% DESIGN PLANS

OVERALL DRAINAGE PLAN

DESIGNED BY:	JAB	SCALE	DATE ISSUED:	January 2020	DRAWING No.
DRAWN BY:	JTB	HORIZ. 1" = 200'			
CHECKED BY:	AJS	VERT. N/A	SHEET	04 OF 23	DR01



REFERENCE DRAWINGS

X-526-EX-IMAGE
X-526-MDG22x34
X-526-PR-GRAD

No.	DATE	DESCRIPTION	BY

REVISIONS

100% DESIGN PLANS

COMPUTER FILE MANAGEMENT

FILE NAME: S:\18.526.015 pinon bridge\Dwg\design plans\526-DR01.dwg
CTB FILE: Matrix(black).ctb
PLOT DATE: 12/20/2018 11:04 AM
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE.

FOUNTAIN CREEK WATERSHED - FLOOD CONTROL & GREENWAY DISTRICT -

PREPARED BY: Matrix DESIGN GROUP AN EMPLOYEE-OWNED COMPANY

SEAL

NOTICE:
100% DESIGN PLANS
APPROVED FOR CONSTRUCTION
SUBJECT TO REVISION DURING FINAL DESIGN REVIEW.

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 18.526.015

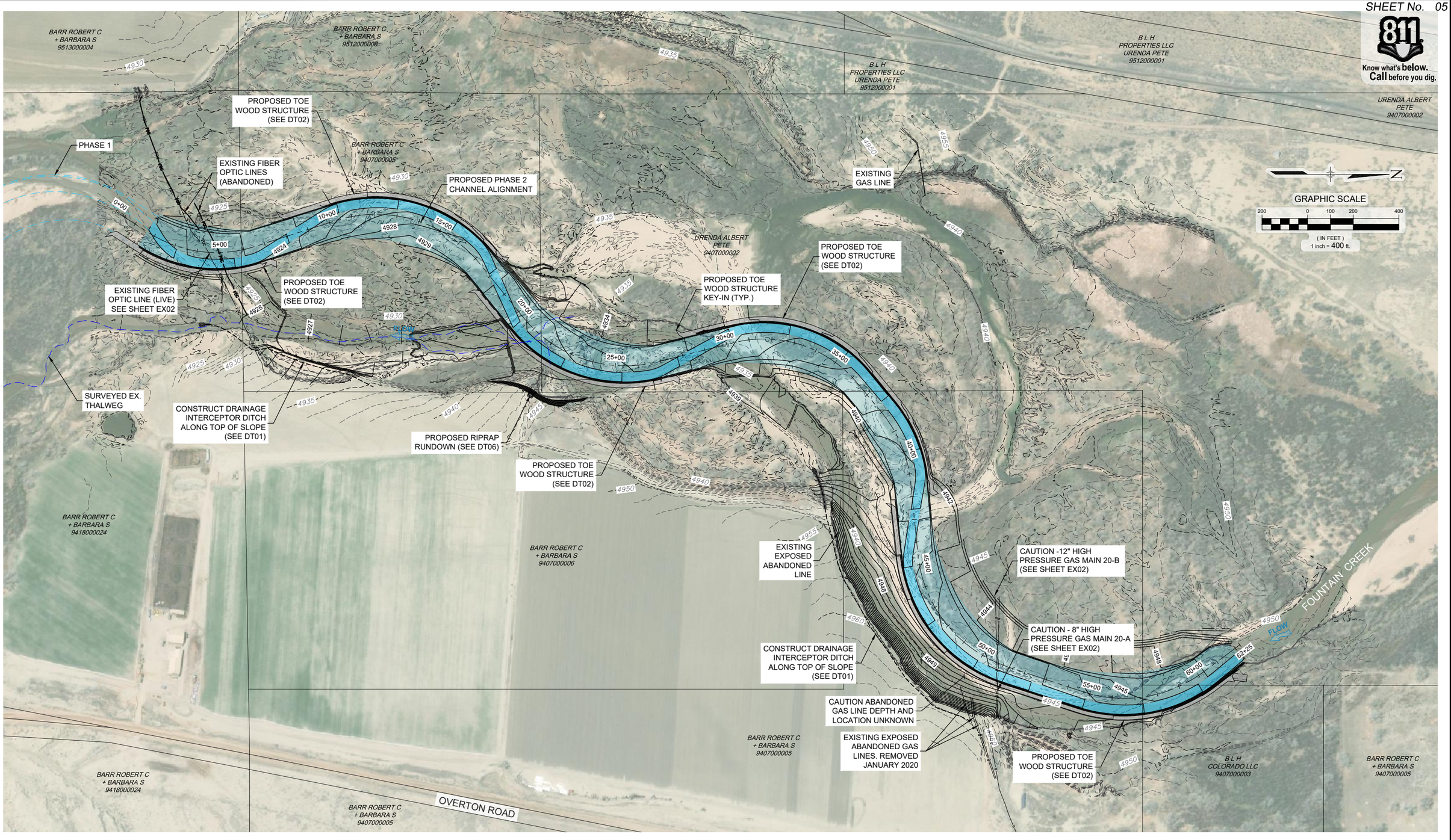
FOUNTAIN CREEK WATERSHED, FLOOD CONTROL & GREENWAY DISTRICT

PINON BRIDGE BANK STABILIZATION PROJECT
100% DESIGN PLANS

OVERALL DRAINAGE PLAN

DESIGNED BY:	AJS	SCALE		DATE ISSUED: December 2018	DRAWING No.
DRAWN BY:	RAF	HORIZ.	1" = 200'		
CHECKED BY:	DRT	VERT.	N/A	SHEET 04 OF 23	DR01

811 Know what's below. Call before you dig.



REFERENCE DRAWINGS

X-526-EX-IMAGE
X-526-MDG22x34
X-526-EX-TOPO
X-526-PR-GRAD

No.	DATE	DESCRIPTION	BY
02	02/27/2020	GAS LINE FIELD VERIFIED - POTHOLING INFORMATION ADDED	JTB

REVISIONS

COMPUTER FILE MANAGEMENT

FILE NAME: S:\19.526.019 Barr Farm Phase 2\Dwg\Design Plans\526-DR01.dwg
CTB FILE: Matrix(black).ctb
PLOT DATE: 3/3/2020 8:44 AM
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE.

100% DESIGN PLANS

FOUNTAIN CREEK WATERSHED - FLOOD CONTROL & GREENWAY DISTRICT -

PREPARED BY: Matrix Excellence by Design

SEAL

NOTICE:
100% DESIGN PLANS
APPROVED FOR CONSTRUCTION

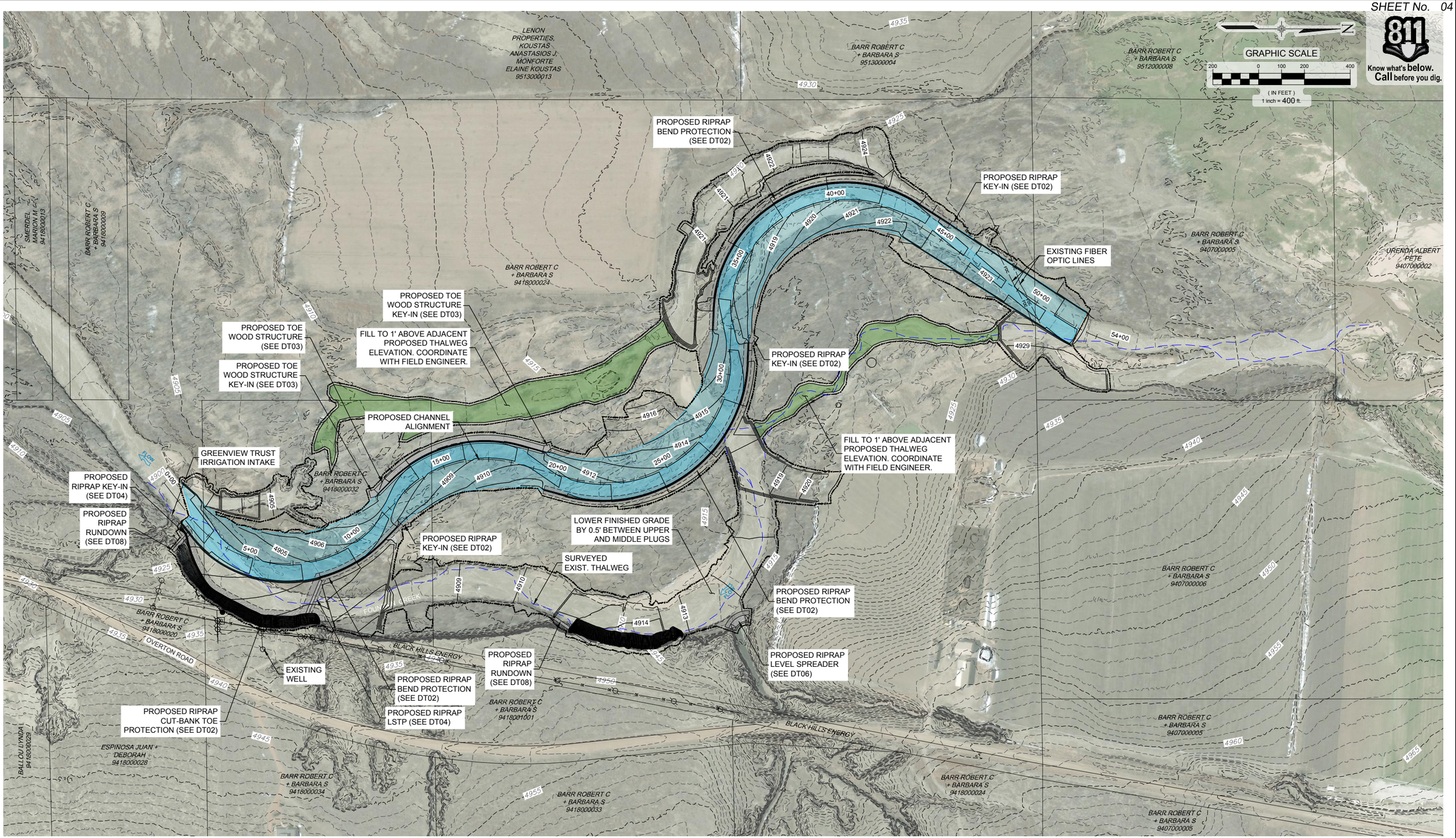
FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 19.526.019

FOUNTAIN CREEK WATERSHED WATER ACTIVITY ENTERPRISE

BARR FARM PHASE 2 CHANNEL RESTORATION PROJECT
100% DESIGN PLANS

OVERALL DRAINAGE PLAN

DESIGNED BY:	DWB	SCALE		DATE ISSUED:	November 2019
DRAWN BY:	RAF	HORIZ.	1" = 400'	SHEET	05 OF 43
CHECKED BY:	JAB	VERT.	N/A	DRAWING No.	DR01



REFERENCE DRAWINGS

X-526-EX-IMAGE
X-526-MDG22x34
X-526-EX-TOPO
X-526-PR-GRAD

No.	DATE	DESCRIPTION	BY
1	04 / 23 / 2019	REVISED DOWNSTREAM GRADING AND RIPRAP.	RAF

REVISIONS

COMPUTER FILE MANAGEMENT

FILE NAME: S:\18.526.014 Barr Farm\Dwg\Design Plans\526-DR01.dwg
CTB FILE: Matrix(black).ctb
PLOT DATE: 4/24/2019 8:35 AM
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE.

100% DESIGN PLANS

FOUNTAIN CREEK WATERSHED - FLOOD CONTROL & GREENWAY DISTRICT -

PREPARED BY:
Matrix DESIGN GROUP
AN EMPLOYEE-OWNED COMPANY

SEAL

NOTICE:
100% DESIGN PLANS
APPROVED FOR CONSTRUCTION

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 18.526.014

FOUNTAIN CREEK WATERSHED, FLOOD CONTROL & GREENWAY DISTRICT

BARR FARM CHANNEL RESTORATION PROJECT
100% DESIGN PLANS

OVERALL DRAINAGE PLAN

DESIGNED BY:	DWB	SCALE		DATE ISSUED:	December 2018
DRAWN BY:	RAF	HORIZ.	1" = 400'	SHEET	04 OF 44
CHECKED BY:	JAB	VERT.	N/A	DRAWING No.	DR01

Know what's **below.** **Call** before you dig.

GRADING:

EARTHWORK (CUT & FILL MATERIAL) = 83,512 CY
EARTHWORK (EXCESS CUT) = 7,182 CY
EARTHWORK-GUIDE BANK (CUT & FILL MATERIAL) = 6,149 CY

DEPARTMENT OF TRANSPORTATION 418000031
DILLON DR.
PERKINS GINA A 418000045
DILLON DRIVE ASSOCIATES LLC 418000040
HIGHWAY 47
GENTEMANN AMY H + HOWARD J 418000042
DILLON DRIVE ASSOCIATES LLC 418000033
CITY OF PUEBLO 418000021
CITY OF PUEBLO 418000013
CITY OF PUEBLO 418000006
CITY OF PUEBLO 418000018
CITY OF PUEBLO 418000020
CITY OF PUEBLO 418000041
DEPARTMENT OF TRANSPORTATION 418000008
CITY OF PUEBLO 418000009
SUBURBAN LAND CO 418000014
CITY OF PUEBLO 418000027
CITY OF PUEBLO 418000002
JERRY MURPHY RD.
FOUNTAIN CREEK

PROPOSED RIPRAP ABUTMENT PROTECTION
PROPOSED RIPRAP BANK PROTECTION
PROPOSED RIPRAP BEND PROTECTION (TYP.)
MAINTAIN ACCESS ROAD AT LIMITS OF DISTURBANCE
PROPOSED UPPER TERRACE TOE PROTECTION (TYP.)
APPROXIMATE DEBRIS FIELD
EXCAVATE CHANNEL TO PROVIDE POSITIVE DRAINAGE FROM CULVERT. EXACT DIMENSION AND LOCATION TO BE FIELD DETERMINED.
REFER TO FOUNTAIN CREEK BANK STABILIZATION AT SIDE DETENTION FACILITY DESIGN PLANS DATED SEPTEMBER 2016
PROPOSED GUIDE BANK
RESTORE ≈200 LF OF 8' WIDE BIKE TRAIL
RIPRAP PROTECTION AT OUTFALL
APPROXIMATE LIMITS OF DISTURBANCE (TYP.)
EXISTING WETLAND AREA TO REMAIN
PROTECT EXISTING TREE ISLAND
PROPOSED RIPRAP BEND PROTECTION (TYP.)
PROPOSED RIPRAP BEND PROTECTION (TYP.)

FLOW
6+50
10+00
15+00
20+00
25+00
30+00
35+00
40+00
45+00
49+76

GRAPHIC SCALE
150 0 75 150 300
(IN FEET)
1 inch = 300 ft.

REFERENCE DRAWINGS
X-526-MDG22x34
X-526-EX-IMAGE
X-526-EX-PARCELS
X-526-PR-GRAD
X-526-EX-WETLAND

No.	DATE	DESCRIPTION	BY
2	05 / 22 / 2018	REVISE D/S GRADING, REVISE ABUTMENT PROTECTION & GUIDE BANK, ADD RIPRAP RUNDOWN.	RAF
1	04 / 09 / 2018	REVISE D/S GRADING, ADD D/S UPPER TERRACE TOE PROTECTION.	RAF

REVISIONS

COMPUTER FILE MANAGEMENT
FILE NAME: S:\17.526.012 Fountain Creek Enterprise Hwy 47 Bank Restoration\Dwg\Design Plan\526-DR01.dwg
CTB FILE: Matrix(black).ctb
PLOT DATE: 5/22/2018 2:21 PM
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE.

100% DESIGN PLANS

FOUNTAIN CREEK WATERSHED - FLOOD CONTROL & GREENWAY DISTRICT -

PREPARED BY: Matrix DESIGN GROUP AN EMPLOYEE-OWNED COMPANY

SEAL

NOTICE:
100% DESIGN PLANS
APPROVED FOR CONSTRUCTION
SUBJECT TO REVISION DURING FINAL DESIGN REVIEW.

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 17.526.012

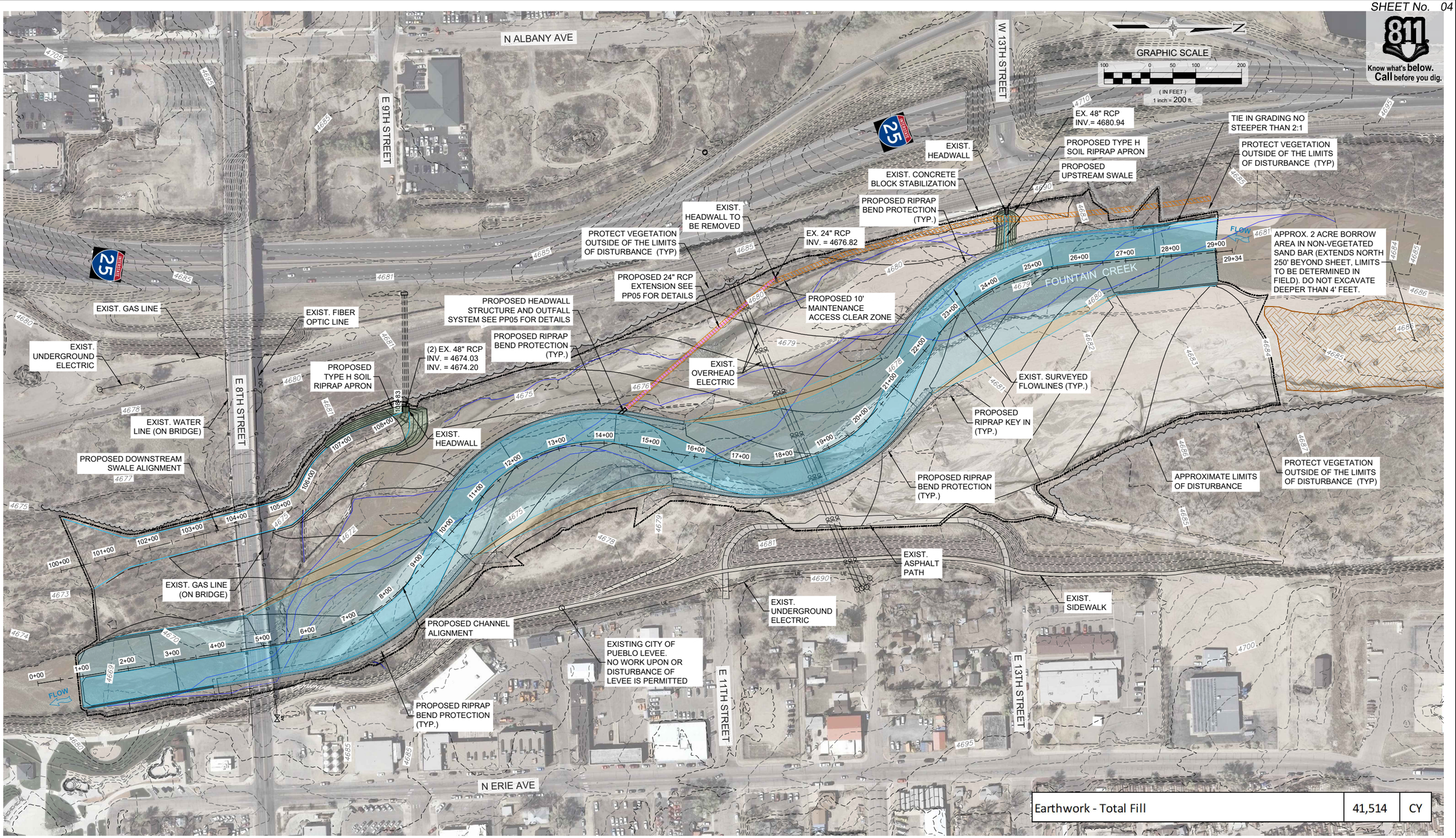
FOUNTAIN CREEK WATERSHED, FLOOD CONTROL & GREENWAY DISTRICT

HIGHWAY 47 BANK RESTORATION PROJECT
100% DESIGN PLANS

OVERALL DRAINAGE PLAN

DESIGNED BY:	AJS	SCALE	
DRAWN BY:	RAF	HORIZ. 1" = 300'	DATE ISSUED: May 2018
CHECKED BY:	GWT	VERT. N/A	SHEET 04 OF 26

DRAWING No. DR01



Earthwork - Total Fill	41,514	CY

REFERENCE DRAWINGS

X-526-MDG22x34
X-526-EX-PARCELS
X-526-EX-IMAGE
X-526-EX-UTIL
X-526-PR-GRAD

No.	DATE	DESCRIPTION	BY

REVISIONS

COMPUTER FILE MANAGEMENT

FILE NAME: S:\18.526.017 Fountain Creek Channel Restoration at 13th St\Dwg\Design Plans\526-DR01.dwg
CTB FILE: Matrix(black).ctb
PLOT DATE: 10/7/2020 11:37 AM
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE.

100% DESIGN PLANS

FOUNTAIN CREEK WATERSHED - FLOOD CONTROL & GREENWAY DISTRICT -

PREPARED BY: Matrix Excellence by Design

SEAL

NOTICE:
100% DESIGN PLANS
APPROVED FOR CONSTRUCTION

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 18.526.017

FOUNTAIN CREEK WATERSHED, WATER ACTIVITY ENTERPRISE

FOUNTAIN CREEK CHANNEL RESTORATION IN PUEBLO AT 13TH STREET - 100% DESIGN PLANS

OVERALL DRAINAGE PLAN

DESIGNED BY:	AJS	SCALE		DATE ISSUED:	JULY 2020
DRAWN BY:	JTB	HORIZ.	1" = 200'	SHEET	04 OF 32
CHECKED BY:	DWB	VERT.	N/A		

DRAWING No. DR01

APPENDIX B

SUMMARY OF SEDIMENT CONTRIBUTIONS

Bank Erosion Findings
Summary Table

Project	Bank ID	Pre-Project Estimated Erosion Rate (tons/year)	Detailed Estimate (tons/year)	Priority	Post-Project Estimated Erosion Rate (tons/year)	Reduction (tons/year)
Masciantonio Trust Bank and Young Hollow	PC003	13,653		High	Negligible	As much as 20,822
	PC056	7,169		Medium-High		
Overton Road Bank Restoration	PC012	3,015		Medium	PC070 Removed*	
	PC013	1,554		Low		
	PC069	3,546		Low		
	PC070	16,225		High		
Pinon Bridge	PC017	9,242		High	PC017 Removed*	
	PC018	2,002		Low		
Barr Farm, Phase 2	PC021	2,525		Medium	7,084	47,639
	PC078	27,284	25,025	High		
	PC079	19,758		High		
	PC080	5,156		High		
Barr Farm, Phase 1	PC022	1,199		Medium	312	54,502
	PC081	28,427		High		
	PC082	25,189	18,581	High		
Highway 47 Bank Restoration	PC044	6,422		Medium-High	4,442	26,026
	PC045	2,686		Medium-High		
	PC046	4,149		Medium-Low		
	PC106	7,633		Medium		
	PC107	742		Medium-Low		
	PC108	5,582		Medium-Low		
	PC109	3,255	3,250	High		
13th Street Channel Restoration	PC053	2,273		High	2,800	12,674
	PC054	1,714		Medium-High		
	PC055	3,778		Medium		
	PC115	3,072		Medium-High		
	PC116	4,637		Medium		

* Further site assessement could ne be completed due to high flow conditions.