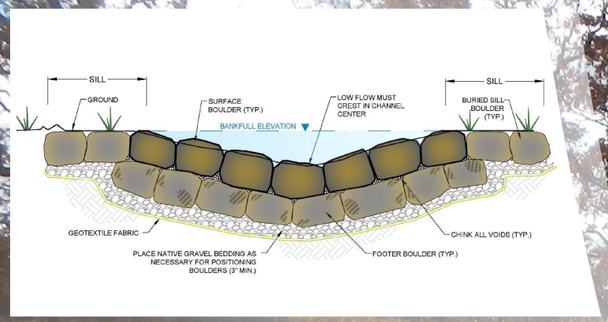

Matrix DESIGN GROUP

HK associates, inc

Monument Creek Watershed Restoration Master Plan

October 31, 2016

Submitted to:
Larry Small, Executive Director
Fountain Creek Watershed Flood Control and Greenway District
www.fountain-crk.org

Fountain Creek Watershed Flood Control & Greenway District

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Fountain Creek Watershed Flood Control and Greenway District

Monument Creek Watershed Restoration Master Plan

Final Report

Prepared for:

Larry Small, Executive Director

Fountain Creek Watershed Flood Control and Greenway District

Prepared by:

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Colorado Springs, CO 80920

719.575.0100

October 2016

Matrix Project No. 15.526.007

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Table of Contents

List of Tables

List of Figures

List of Appendices

1.0 Executive Summary

The Monument Creek Watershed Restoration Master Plan (Restoration Plan) was initiated by the Fountain Creek Watershed Flood Control and Greenway District (District) through a disaster recovery grant issued by the Colorado Department of Local Affairs (DOLA) under the Colorado Community Development Block Grant Program. The District was authorized in 2009 by Colorado Senate Bill 09-141 and an Amendment to Title 32 of the Colorado Revised Statues to oversee the resource management of the Fountain Creek Watershed in El Paso and Pueblo Counties.

The recent summer of floods occurring in 2013, coupled with the 2012 Waldo Canyon fire and the 2013 Black Forest fire have resulted in considerable transport of sediment and debris. The floods altered the creek bed, banks, floodplains and structures and have led to extensive flood damage including property and infrastructure damage, erosion and sedimentation that resulted in a net loss of flood capacity. To identify strategies that will mitigate the effects of fire and flood damage in the watershed, a holistic restoration planning effort was completed to provide effective and lasting protection of at-risk assets, as well as the health, safety and welfare of the public.

1.1 Goals

The Restoration Plan goals established a starting point and framework for the entire Monument Creek Watershed Restoration Master Plan. The planning philosophy for the Restoration Plan included providing an overall concept for establishing a relatively stable Monument Creek that is self-maintaining, cost effective and sustainable. This approach envisioned a stable watershed with healthy ecosystems that require minimal resources to maintain them. Achieving this vision required a balance in ecosystem health, social and political will to prioritize the watershed and a level of funding and financing to champion efforts to restore and conserve the watershed. Figure 1 illustrates the decision process used to guide the development of this plan.

1.1.1 Guiding Principles

Watershed management, as it relates to the natural environment, human activity and stormwater runoff, has been identified as a key component of several prior planning efforts within the watershed. These include City and County Comprehensive Plans, local ordinances, state and federal legislation, and previous watershed plans. Through an extensive assessment of guidance found in these documents, and various stormwater management documents being employed around the county, a set of guiding principles were compiled in the City of Colorado Springs Drainage Criteria Manual (DCM), adopted in May of 2014. The DCM not only provides a set of principles guiding watershed management but a solid technical foundation on which to develop and implement management plans. The most relevant of these principles are briefly described below and are more fully described in the General Stewardship Recommendations section.

Regional Solutions Work Best – Stormwater management is a regional phenomenon that transcends the boundaries between governmental jurisdictions or between properties.

Development Alters Runoff - Developmental activity may greatly alter the amount and character of runoff resulting in significant impacts to man-made or natural systems.

Space is Limited - Handling runoff properly is largely a space allocation problem.

Multi-Objective Projects use Available Resources more Effectively - Resources to implement drainage plans and improvements are limited. Drainage systems should be a multi-objective and multi-means effort.

Natural Systems are Valuable and Vulnerable - Natural systems possess a number of beneficial features that should be preserved and incorporated into the planning and design of the drainage system.

Understanding the Entire Hydrologic Cycle is Important - Natural drainage systems respond to and are dependent upon the full range of hydrologic conditions and sources of water including, snowmelt, groundwater, and the full range of rainfall events.

Maintenance Matters - Poorly maintained systems may not function properly, reducing their effectiveness and reducing the benefits from the economic investment required to construct them.

Floodplains can be Hazardous - Floodplains, both regulated and unregulated, are areas of potential hazard due to high rates of runoff.

Altering Stormwater Runoff has Legal Implications - Drainage law places certain obligations on those who cause or oversee modifications to the natural effects of the hydrologic cycle and the conveyance of runoff overland.

Our understanding of how best to fulfill the ideals expressed in these principals continues to evolve. The development of the Restoration Plan was conceived with a commitment to these guiding principles, but also with an ongoing evaluation of "what works".

1.2 Planning Area

The Monument Creek Watershed includes 236.8 square miles of forest, shrubland, and upland grass lands that culminate into a vast network of streams and riparian corridors. The mountains meet the plains at the center of the watershed on the United States Air Force Academy (USAFA). The watershed is predominantly north of Colorado Springs and includes the communities of Monument and Palmer Lake. With a diversity of public and private ownerships, the watershed is a major regional tourist and recreation destination as well as home for a large percentage of El Paso County and Colorado Springs residents. The watershed is characterized by extremes in temperature and precipitation, large elevation changes, steep gradients, and diverse ecosystems, rich with plant life and wildlife.

1.2.1 Watershed Map

Figure 2 below depicts the extents of the Monument Creek Watershed and highlights some of its essential characteristics. The footprints of major urban areas, such as Colorado Springs and Monument, can be seen nestled up against the USAFA boundary highlighted in blue. Burn scars from the recent wildfires flank the watershed; the Waldo Canyon Fire impacting the western side, and the Black Forest Fire affecting the east.

1.2.2 Watershed Context

Monument Creek Watershed is located in northwestern El Paso County, Colorado (County). The minimum elevation within the watershed is approximately 6,000 feet and the maximum is 9,727 feet at the top of Ormes Peak in the Rampart Range. The Monument Creek Watershed is the primary tributary to the greater Fountain Creek Watershed, ultimately a part of the Arkansas River drainage basin, Colorado's largest river basin draining 24,904 square miles of land area (Colorado State University 2001).

The extensive network of streams and riparian corridors provide a suite of functions from supporting the region's most diverse ecosystems to conveying surface runoff and reducing flood risk. Restoring and maintaining the functions of these natural assets is a vital component of watershed management.

The watershed is characterized by a complex land ownership pattern, representing a myriad of potential uses and relationships. The land ownership breakdown is as follows (CDOW 1998b):

- Private (which includes land managed by local government) - 58%
- Forest Service - 29%
- Department of Defense (USAFA) - 12%
- State of Colorado - 1%
- Bureau of Land Management - < 1%

The watershed is comprised of three predominant natural vegetation groups that are strongly correlated to elevation, precipitation, and soils: mixed coniferous forest, shrublands, and grasslands. Regional vegetation is less regulated by long-term ecological processes than anthropogenic effects. As a result, natural disturbance regimes have been altered due to land use change, fire exclusion, the spread of invasive and exotic species and other impacts.

Climate is complex in the project area, largely dependent on elevation and topography. The mountainous portions of the watershed receive over 25 inches of precipitation per year, while lower elevations within the watershed receive less precipitation, averaging just over 16 inches per year (Colorado State University 2000).

The watershed is highly urbanized. The Colorado Springs metropolitan area dominates the southern portion of the watershed. Other watershed communities include Monument, Palmer Lake and Black Forest.

The economic base of the County has changed dramatically over the last 100 years. Founded as a resort town and once driven by resource extraction and support for mining and timber industries, the region's economy is now dominated by federal installations, a burgeoning high tech sector, and higher education.

1.3 Use of Restoration Plan Document

The concurrent use and consideration of each element outlined in this report will guide the stakeholder group as it works towards the development and implementation of improvements that restore the Monument Creek Watershed. The primary vehicle guiding these restoration efforts is the actionable list of projects provided in Figure 3 and Table 1, and reiterated in other sections of the Restoration Plan. A list of supporting elements presented in the Restoration Plan can be found below. Section 6.1 further describes the intended use of each element included the Restoration Plan document.

- Conceptual Plan Mapbooks
- The Decision Making Matrix
- General Stewardship Recommendations
- Conceptual Design Toolbox
- Monitoring Strategies
- Partnering and Funding
- Background and Technical Information
- Design Concepts

1.3.1 Actionable List of Projects

As outlined in detail in the Plan Development section of this document, an actionable list of forty-two (42) prioritized projects has been identified through extensive technical evaluation and stakeholder input. The cost of completion of these projects is estimated to exceed $45.7 million dollars. The actionable list of projects that have been identified through the Restoration Plan can be found in Figure 3 and Table 1.

1.3.2 General Recommendations

There are a number of key recommendations and references outlined in the Restoration Plan that provide guidance for achieving the Restoration Plan goals. Paramount to this objective is the recommendation that the conservation of natural areas, currently functioning and providing valuable ecosystem services, should take priority over the restoration of impaired areas. Conservation efforts should address the following:

1. Conserve and protect wildlands.
2. Manage forests for the mitigation of wildfire.
3. Conserve riparian buffer zones.
4. Maintain and prevent encroachment upon the 100-year floodplain.
5. Value the watershed as an environmental resource.

It is recommended that any work that is done within the watershed will be in accordance with the City of Colorado Springs Drainage Criteria Manual and the forthcoming guidance published in the Fountain Creek Watershed Flood Control and Greenway District's Design Manual. The forthcoming manual will have a clearly defined development review process for which future projects should adhere to. Development and Re-Development projects should be encouraged to reduce runoff volume via Low Impact Development (LID) techniques to the maximum extent possible. Findings from the hydrologic analyses completed for this Restoration Plan indicated the need for a re-evaluation of the 24-hour design storm. A recommendation for updating the design storm will be included in the District's Design Manual. Moreover, the stream flows and 100-year target release rates calculated and reported in this Restoration Plan should supersede those published in existing outdated and largely obsolete Drainage Basin Planning Studies. Further discussion

regarding the general stewardship recommendations for the Monument Creek Watershed landscape has been provided in Section 4.0 of this document.

1.4 Fountain Creek Watershed Flood Control and Greenway District's Role

Following this planning effort, the stakeholder working group has agreed to continue to meet to implement the strategies and projects proposed by the Restoration Plan. The Fountain Creek Watershed Flood Control and Greenway District will host and facilitate the on-going stakeholder working group meetings.

1.4.1 Working Group / Coalition

The stakeholder working group for the Monument Creek Watershed Restoration Master Plan will continue to meet to set strategic objectives for the management of the watershed and continue to coordinate their individual efforts to take full advantage of forthcoming opportunities. This group will oversee the implementation of the Plan and make updates to the phasing, priorities, and schedule presented in this plan as necessitated by changing conditions within the watershed.

1.5 Summary of Key Projects

Key alternative projects identified by the public and stakeholder group, as well as those found thorough technical evaluation and field reconnaissance were grouped into categories representing similar project characteristics as discussed in Section 1.5.2. These projects and their affiliated alternative ranking are represented in the tables and maps presented in this section.

1.5.1 Project Overview Map

Figure 3 illustrates the rank and general location of the actionable list of projects developed in the plan development process. A list of these projects immediately follows this map. Maps and tables outlining each of the alternative projects identified by the Restoration Plan can be found in Section 3.0 of the report.

1.5.2 Number, Cost, Type of Projects

More than 250 projects were identified in the watershed during the initial phases of the Plan Development process. These projects varied significantly in their size, costs, and objectives. Projects with similar characteristics and objectives were lumped into nine different categories, listed below.

1. Immediate Action
2. Stream Reach Restoration
3. Detention and Water Quality Facilities
4. Flood Risk Reduction
5. Aquatic and Terrestrial Habitat
6. Local Erosion
7. Riparian Buffer Restoration
8. Trails and Open Space
9. Programmed Capital Improvements Projects

Through the alternatives analysis and prioritization processes, outlined in detail in the plan development section of the report, the initial list of more than 250 projects was reduced to an actionable list of 42 prioritized projects. Priority projects were selected from the highest ranking alternatives in each category. Along with their variety of objectives, the projects vary in their estimated costs, ranging from thousands to millions of dollars.

Context Statement

The Monument Creek Watershed includes 236.8 square miles of forest and upland grass lands. The mountains meet the plains within the watershed which is why the United States Air Force Academy is located at the center of the watershed. The watershed is predominantly north of Colorado Springs and includes the communities of Monument and Palmer Lake. With a diversity of public and private ownerships, the watershed is a major regional tourist and recreation destination as well as home for a large percentage of El Paso County and Colorado Springs residents.

The watershed is characterized by extremes in temperature and precipitation, large elevation changes, steep gradients and diverse ecosystems rich with plant life and wildlife.

The recent summer of 2013 floods, coupled with the 2012 Waldo Canyon fire and the 2013 Black Forest fire, have resulted in considerable transport of sediment and debris. The floods altered the creek bed, banks, floodplains and structures and have led to extensive flood damage including property and infrastructure damage, erosion and sedimentation that resulted in a net loss of flood capacity. To identify strategies that will mitigate the effects of fire damage and flood damage in the watershed, a holistic restoration planning effort will provide effective and lasting protection of at risk assets, as well as the health, safety and welfare of the public.

Core Values	Critical Issues from Stakeholders	Evaluation Criteria
Safety	• Reduce potential forest fire risk • Reduce potential flood risk • Address public health • Minimize actions in the upper watershed effecting the lower watershed • Protect property and public safety • Emergency access	1. Reduces flood risk to the public and residents by providing long term solutions that increase resiliency? 2. Avoids transfer of risks that create impacts downstream to infrastructure, channel and storm water systems? 3. Number of people protected?
Resiliency	• Reduce future flood damage risk • Provide smarter infrastructure solutions • Repair / replace failing infrastructure • Improve creek stability • Reduce risk to critical infrastructure	4. Physical area of watershed mitigated? 5. Critical Infrastructure at risk?
Constructability/Costs	• Find funding for future implementation • Includes fiscally responsible costs • Support regional criteria, implementation and enforcement • Long-term maintenance funding needed • Minimize maintenance requirements and costs • Understand the impact of T&E species on constructability	6. Creates infrastructure investments that are reasonable to construct and provides the best value for their lifecycle, function and purpose? 7. Meets or exceeds industry and local design standards? 8. Minimizes the effort required to maintain and repair the options? 9. Compatible with forest fire mitigation?
Environment	• Reduce future sediment loading and hydrological impacts to the creek due to 2012 and 2013 forest fires • Enhance sediment / debris capture and control • Provide detention • Reduce sediment generation / enhance soil stewardship • Improve water quality including turbidity, E. Coli and debris • Improve wildlife habitat (banking opportunities) • Increased channel capacity to accommodate future flooding • Manage increased storm water discharge due to development • Work with natural systems • Consistency with MS-4 requirements • Presence of endangered species • Include consideration of the introduction of new flow to the creek/volume change • Consider the impact of detention ponds built to out dated design criteria	10. Protects or improves the habitat, water quality and geomorphology of Monument Creek? 11 Incorporates locally available materials and environmentally friendly processes? 12. Quantity of sediment reduced? 13. Consistent with MS-4 requirements? 14. Does it meet CWCB criteria for multi-objectives program elements?
Community	• Protect infrastructure, tourism and the economy • Improve appearance and/or enhance the community • Distribute projects within the watershed • Be mindful of increased flood insurance costs • Consider greenway and open space opportunities • Communication with the residents • Are the historic CCC structures of value or a risk to future flooding • Need for better flood monitoring • Collaboration between agencies and communities • Consistent with land use regulations and management • Do not impact on aesthetics (historical element of USAFA) • Minimize development impact • Minimize economic injustice • Minimize impact to cultural and historic features	15. Provides access, connectivity and protects opportunities for enhancements to tourist destinations, community facilities, features and neighborhoods? 16. Provides funding, partnering and collaboration opportunities by meeting multiple stakeholder objectives? 17. Can be supported by current land use regulations or revised land use regulations? 18. Impacts to water rights?
Schedule	• Prioritize strategies as critical, necessary or desired	

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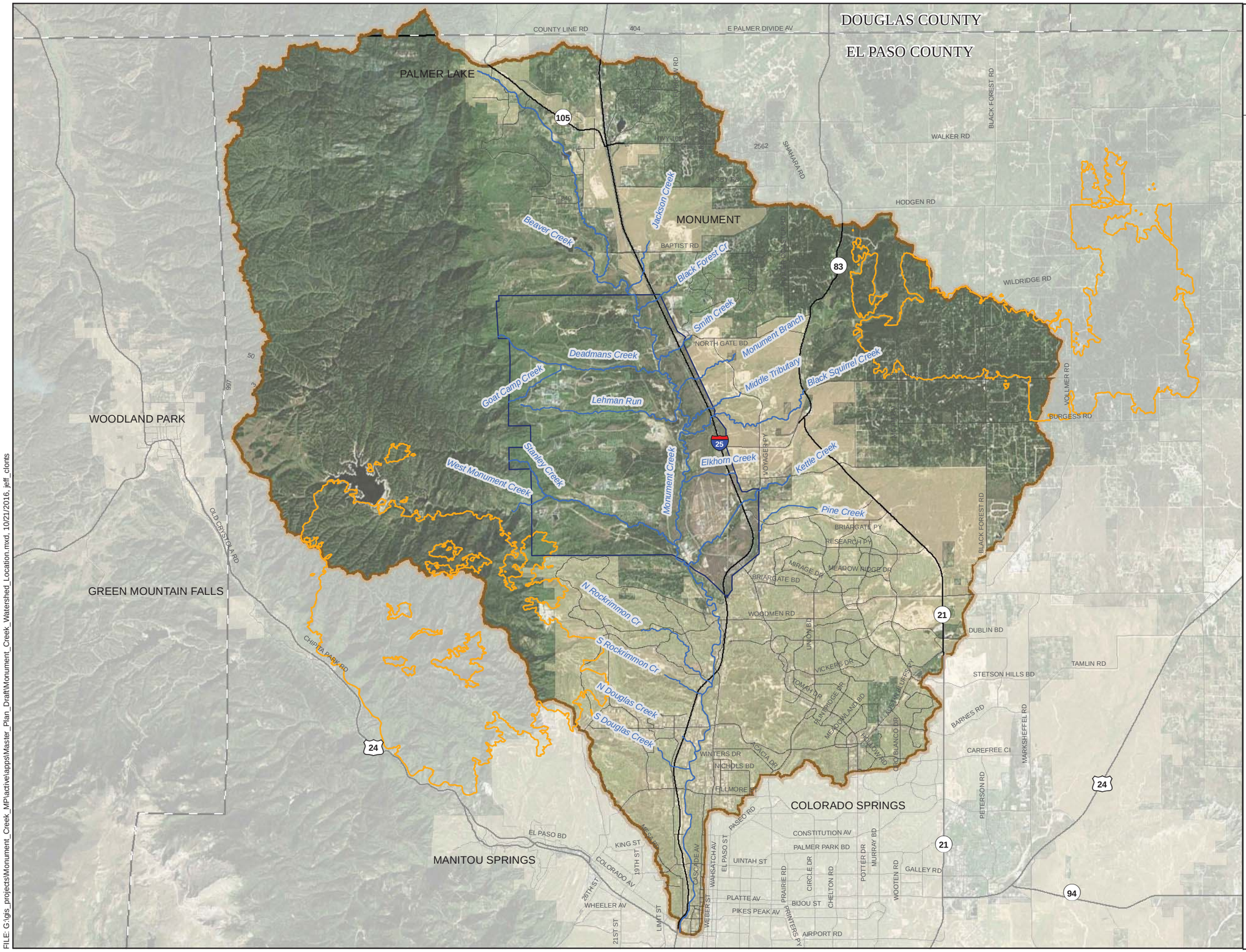
Figure 1. Monument Creek Decision Making Process



Watershed Location

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

Legend

- USAFA Boundary
- Fire Perimeter
- Monument Ceek Watershed
- County Boundary
- City
- Stream
- Highway
- Major Road

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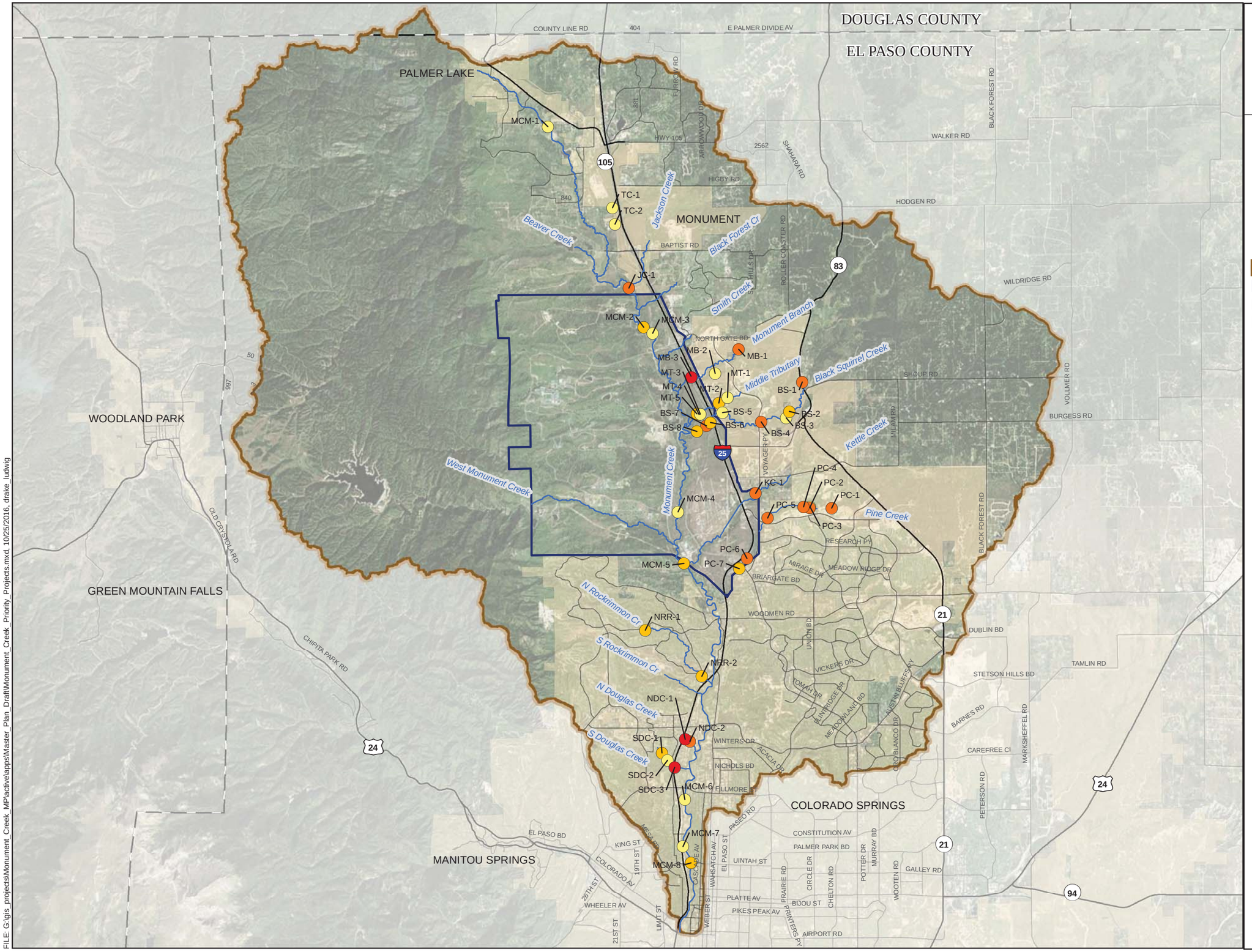
Figure 2. Monument Creek Watershed Location



Prioritized Projects

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

Legend

Project Priority

- Immediate
- High
- Moderate
- Low

- Monument Ceek Watershed
- USAFA Boundary
- County Boundary
- City
- Stream
- Highway
- Major Road

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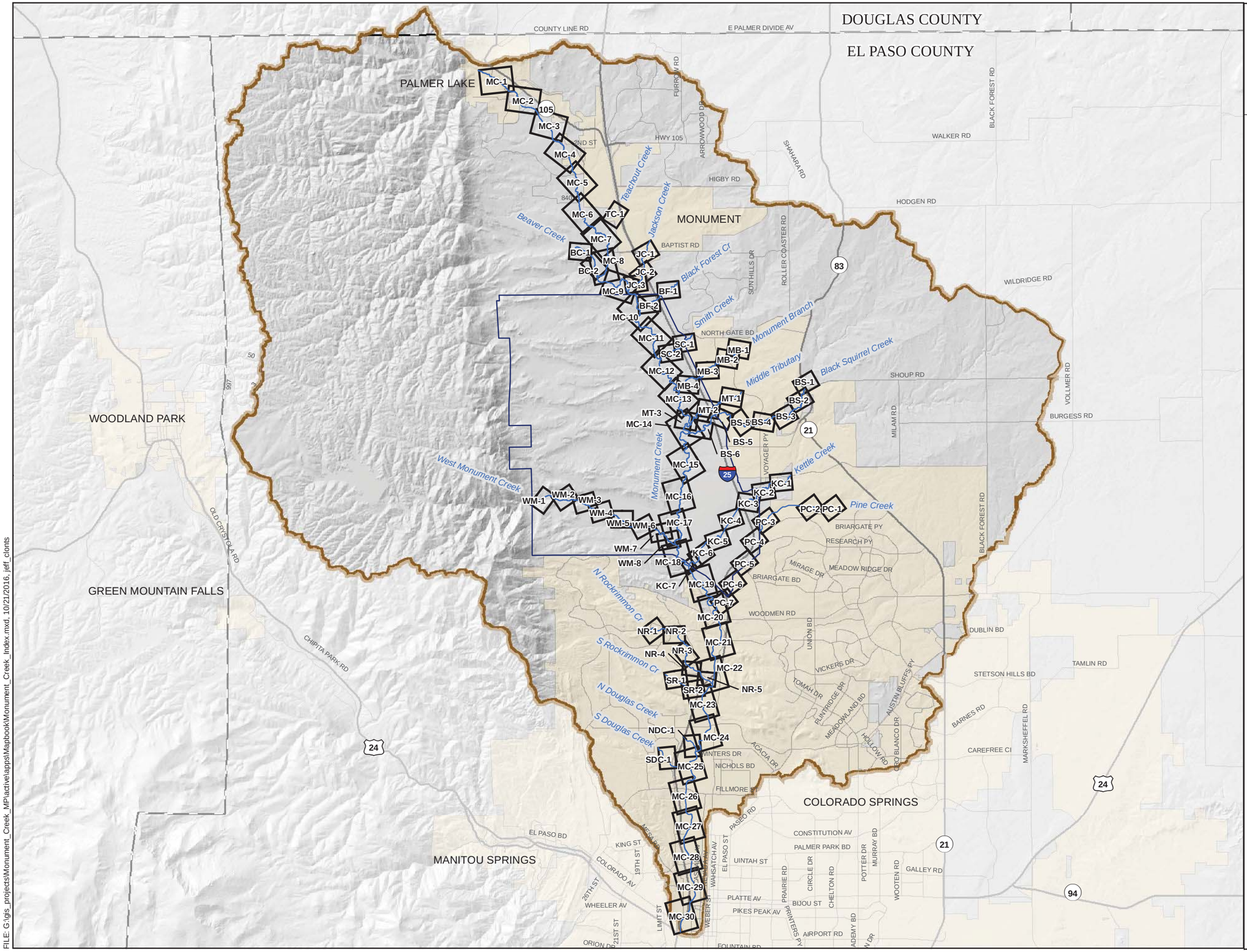
Figure 3. Monument Creek Watershed Prioritized Projects

Table 1. Monument Creek Watershed Restoration Master Plan: Priority of High and Immediate Ranking Projects

Monument Creek Watershed Restoration Master Plan: Priority of High and Immediate Ranking Projects					
Prioritization Map Project ID	**Project Description**	**Project Leadership**	**Alternative Category**	**Priority**	**Detailed Cost**
BS-1	Black Squirrel Conceptual Detention Upstream of Hwy 83	El Paso County	Detention and Water Quality Facility	High	$5,181,000
BS-2	Black Squirrel Conceptual Detention Near Silver Creek Dr.	The City of Colorado Springs	Detention and Water Quality Facility	Moderate	$1,129,000
BS-3	Black Squirrel Riparian Restoration North of Interquest Pkwy.	The City of Colorado Springs	Riparian Buffer Restoration	Low	$1,309,000
BS-4	Black Squirrel Detention Retrofit Upstream of Voyager Pkwy.	The City of Colorado Springs	Detention and Water Quality Facility	High	$897,000
BS-5	Black Squirrel Detention Retrofit Upstream of USAFA Property Boundary	The City of Colorado Springs	Detention and Water Quality Facility	Low	$1,218,000
BS-6	Stabilize Headcutting on Black Squirrel Downstream of I-25	United States Air Force Academy	Local Erosion	Moderate	$646,000
BS-7	Black Squirrel Small Drop Structures West of I-25	United States Air Force Academy	Stream Channel Restoration	High	$2,475,000
BS-8	Black Squirrel Natural Channel Design East of Monument Creek Confluence	United States Air Force Academy	Stream Channel Restoration	Moderate	$342,000
JC-1	Jackson Creek Small Drop Structures East of Monument Creek Confluence	El Paso County	Stream Channel Restoration	High	$1,227,000
KC-1	Kettle Creek Natural Channel Design East of I-25	United States Air Force Academy	Stream Channel Restoration	High	$2,235,000
MB-1	Monument Branch Detention Retrofit at Flying Horse	The City of Colorado Springs	Detention and Water Quality Facility	High	$1,721,000
MB-2	Monument Branch Detention at the Classical Academy	The City of Colorado Springs	Detention and Water Quality Facility	Low	$2,981,000
MB-3	Monument Branch Tributary Erosion between Northbound and Southbound I-25	Colorado Department of Transportation	Immediate Action	Immediate	$610,000
MCM-1	Monument Creek Riparian Restoration at Oxbridge Rd.	El Paso County	Riparian Buffer Restoration	Low	$182,000
MCM-2	Monument Creek Small Drop Structures Near Railroad Crossing at North Airfield	United States Air Force Academy	Stream Channel Restoration	Moderate	$1,337,000
MCM-3	Monument Creek Riparian Restoration Upstream of North Gate Blvd.	United States Air Force Academy	Riparian Buffer Restoration	Low	$242,000
MCM-4	Stabilize Headcutting on Monument Creek West of USAFA Airfield	United States Air Force Academy	Local Erosion	Low	$260,000
MCM-5	Stabilize Headcutting on Monument Creek near Thunderbird Ln.	United States Air Force Academy	Local Erosion	Moderate	$329,000
MCM-6	Flood Risk Reduction at W. Polk Rd. Bridge at Monument Creek	The City of Colorado Springs	Flood Risk Reduction	Low	$2,555,000
MCM-7	Mesa Creek Outfall	The City of Colorado Springs	Trails and Open Space	Low	$549,000
MCM-8	Uintah Bridge Bank Stabilization	The City of Colorado Springs	Trails and Open Space	Moderate	$511,000
MT-1	Stabilize Headcutting on Middle Tributary South of Middle Creek Pkwy.	The City of Colorado Springs	Local Erosion	Low	$1,354,000
MT-2	Middle Tributary Detention Retrofit Upstream of USAFA Property Boundary	The City of Colorado Springs	Detention and Water Quality Facility	Moderate	$944,000
MT-3	Stabilize Headcutting on Middle Tributary Downstream of I-25	United States Air Force Academy	Local Erosion	Low	$375,000
MT-4	Middle Tributary Small Drop Structures West of I-25	United States Air Force Academy	Stream Channel Restoration	Moderate	$711,000
MT-5	Middle Tributary Natural Channel Design East of Monument Creek Confluence	United States Air Force Academy	Stream Channel Restoration	Moderate	$158,000
NDC-1	North Douglas I-25 Downstream Failed Wingwall and Erosion	The City of Colorado Springs	Immediate Action	Immediate	$594,000
NDC-2	North Douglas Small Drop Structures East of I-25	The City of Colorado Springs	Stream Channel Restoration	High	$1,429,000
NRR-1	Culvert Replacement at War Eagle Dr. North	The City of Colorado Springs	Flood Risk Reduction	Moderate	$598,000
NRR-2	Levee Installation at S. Rockrimmon Blvd. Downstream of Pro Rodeo Dr.	The City of Colorado Springs	Flood Risk Reduction	Moderate	$243,000
PC-1	Pine Creek Detention Retrofit Upstream of Stoneglen Dr.	The City of Colorado Springs	Detention and Water Quality Facility	High	$743,000
PC-2	Pine Creek Conceptual Detention Downstream of Briargate Blvd.	The City of Colorado Springs	Detention and Water Quality Facility	High	$4,151,000
PC-3	Pine Creek Open Space	The City of Colorado Springs	Trails and Open Space	Low	$1,748,000
PC-4	Stabilize Headcutting on Pine Creek at Golf Course Trail Crossing	The City of Colorado Springs	Local Erosion	High	$178,000
PC-5	Stabilize Headcutting on Pine Creek Upstream of Briargate Blvd.	The City of Colorado Springs	Local Erosion	High	$236,000
PC-6	Pine Creek Natural Channel Design East of I-25	United States Air Force Academy	Stream Channel Restoration	High	$584,000
PC-7	Pine Creek Small Drop Structures East of I-25 and Downstream of Academy Blvd.	United States Air Force Academy	Stream Channel Restoration	Moderate	$1,430,000
SDC-1	South Douglas Small Drop Structures Downstream of Holland Park Blvd.	The City of Colorado Springs	Stream Channel Restoration	Moderate	$323,000
SDC-2	Sinton Trail	The City of Colorado Springs	Trails and Open Space	Low	$1,123,000
SDC-3	South Douglas I-25 Downstream Failed Wingwall and Erosion	The City of Colorado Springs	Immediate Action	Immediate	$112,000
TC-1	Culvert Replacement at Northern Teachout Creek Tributary and Old Denver Hwy.	El Paso County	Flood Risk Reduction	Low	$504,000
TC-2	Culvert Replacement at Teachout Creek and Old Denver Hwy.	El Paso County	Flood Risk Reduction	Low	$277,000

2.0 Monument Creek Watershed Conceptual Plan Mapbooks

The location and the priority of each of the actionable, prioritized projects listed above are shown again on the mapbooks provided in the following section of this report. The watershed conceptual plan mapbooks also illustrate the modeled and regulatory floodplain, per FEMA Preliminary Maps (July 2015), of the 100 year storm along with other critical infrastructure information such as utilities, culverts, and bridges that are affected by flooding.



Map Index

Conceptual Plan
El Paso County, CO

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Legend

- Map Index
- Monument Ceek Watershed
- USAFA Boundary
- County Boundary
- City
- Highway
- Major Road
- Stream

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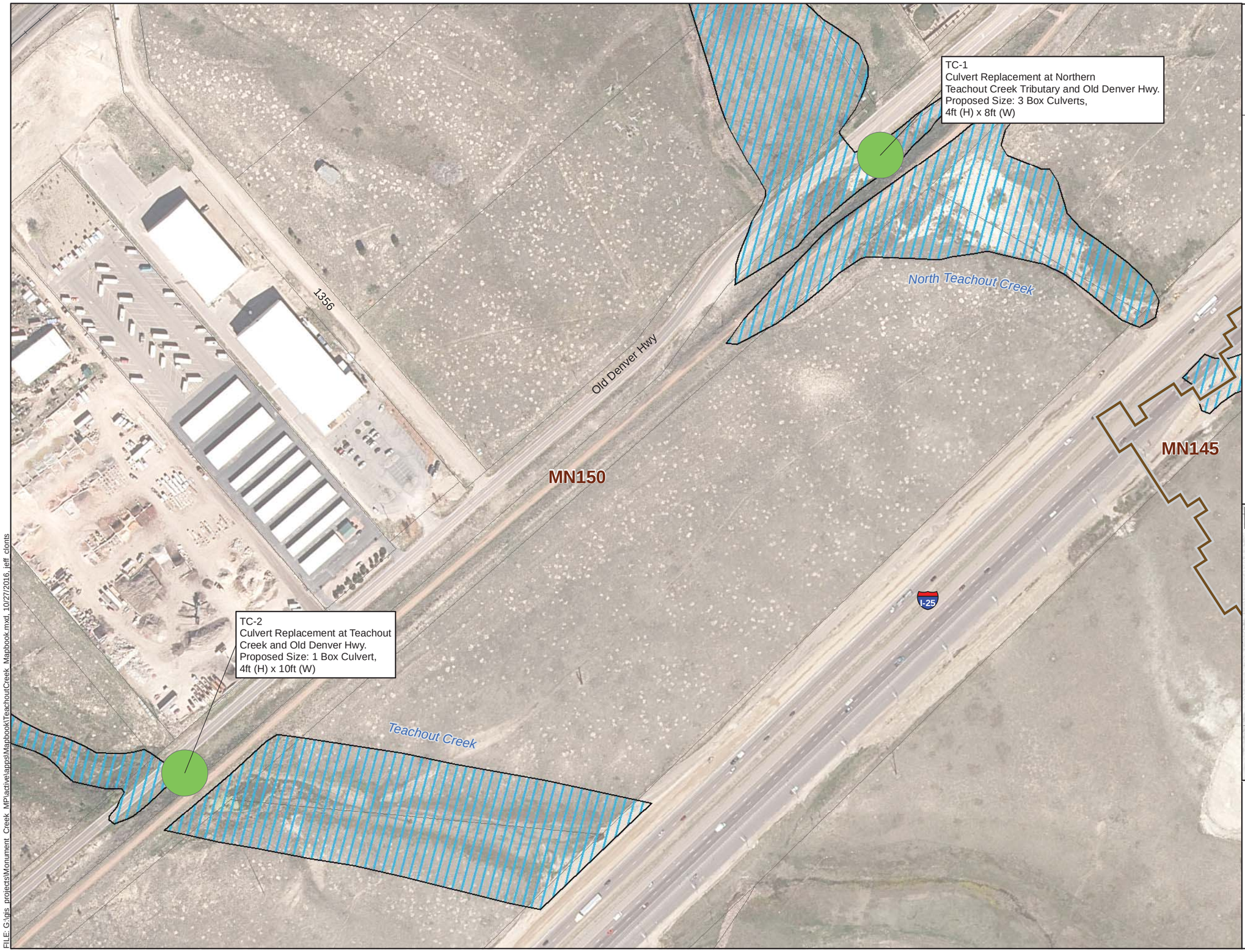

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TC-1

Teachout Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

- DFIRM 100-Year
- Subbasin
- CityParcels
- Railroads

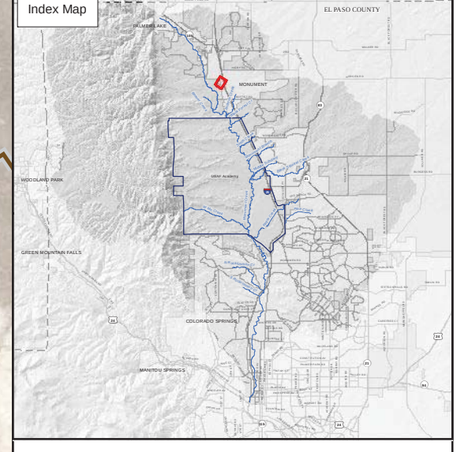
Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Flood Risk Reduction, Low

Index Map



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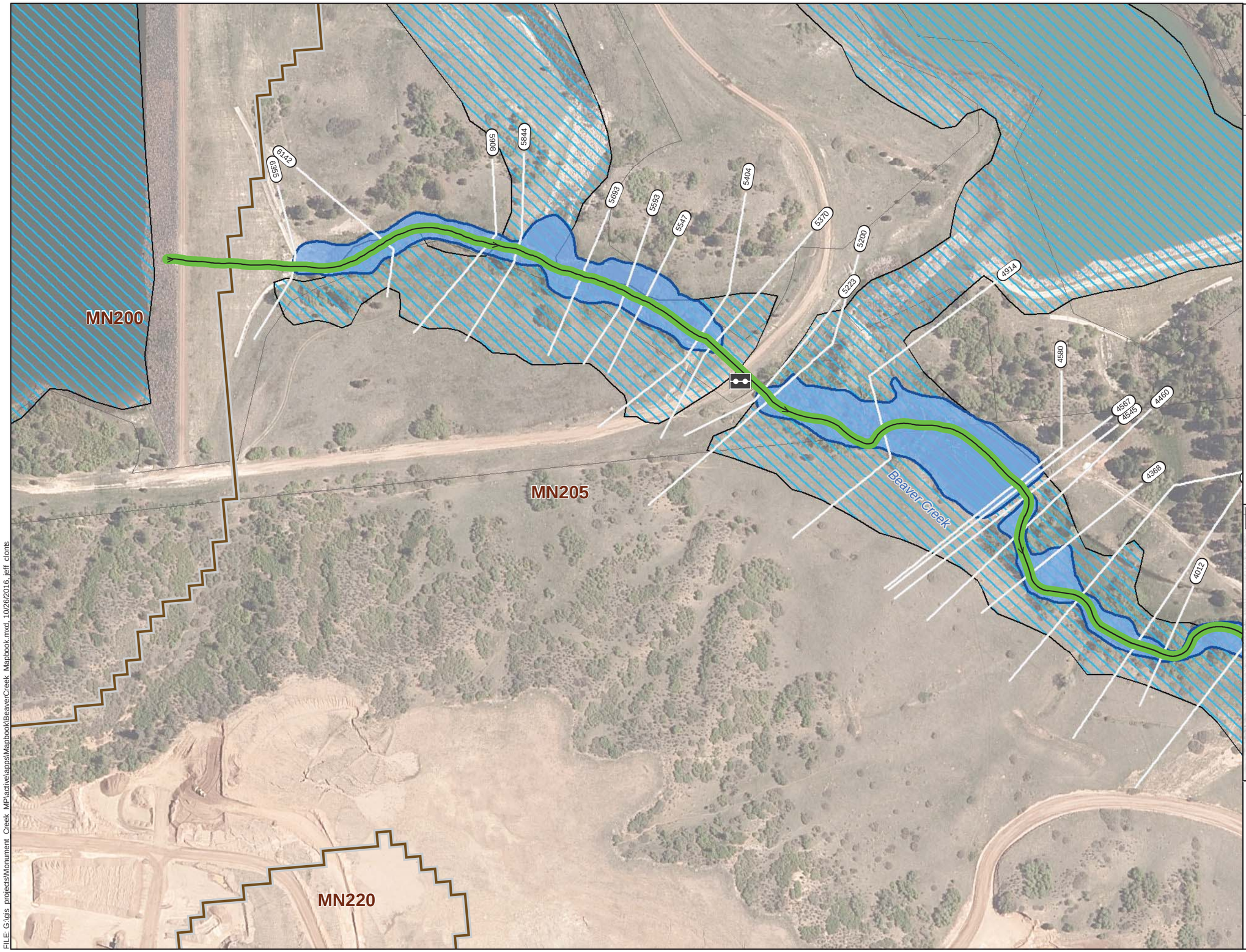


BC-1

Beaver Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

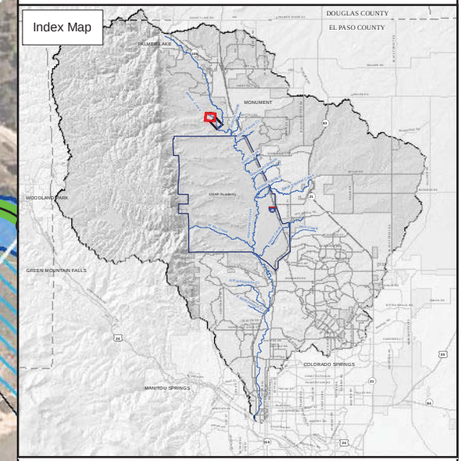
Legend

- Culvert
- Centerline
- Cross Section
- Fllodplain
- DFIRM 100-Year
- Subbasin
- Railroads
- CityParcels

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map



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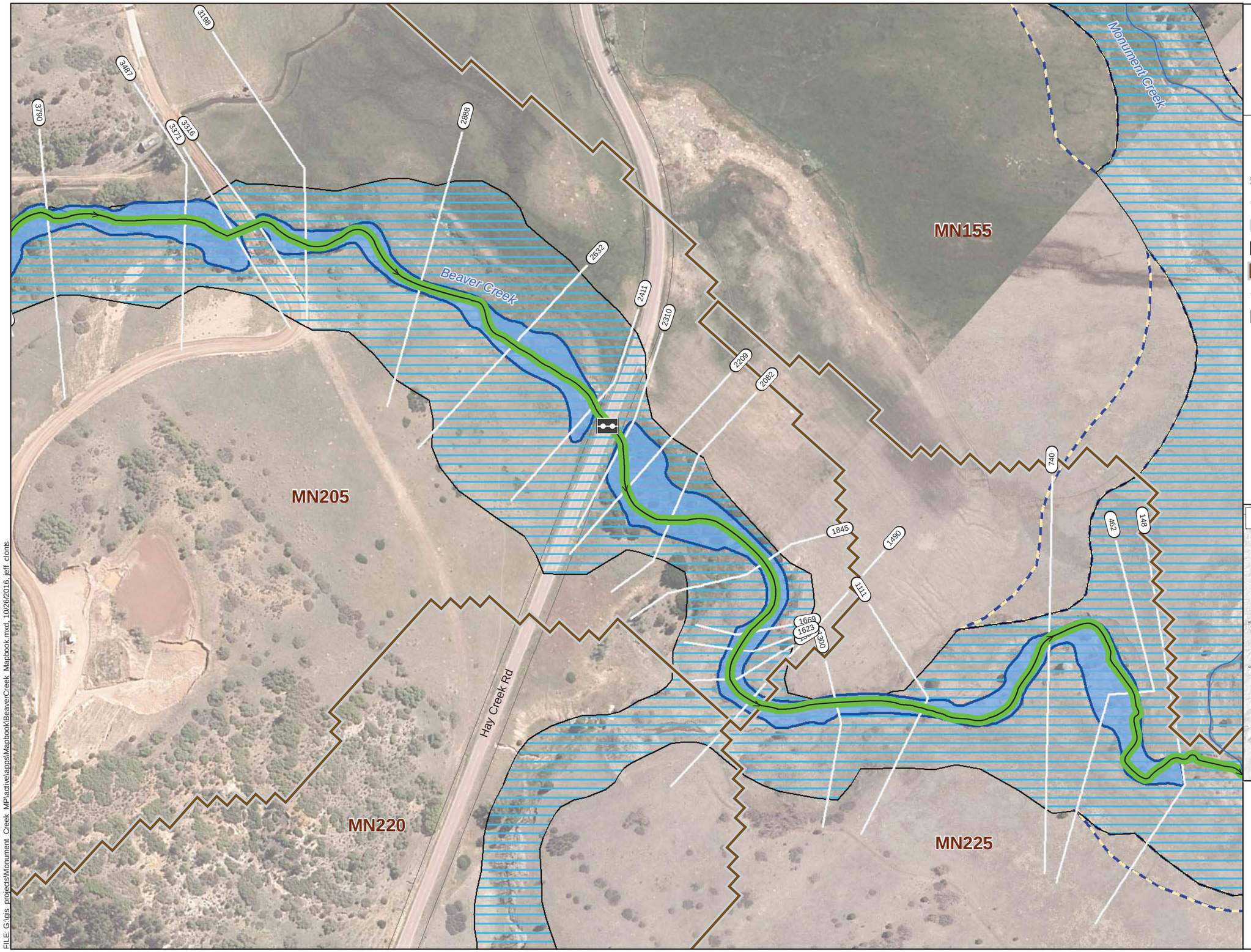


BC-2

Beaver Creek
Conceptual Plan
El Paso County, CO

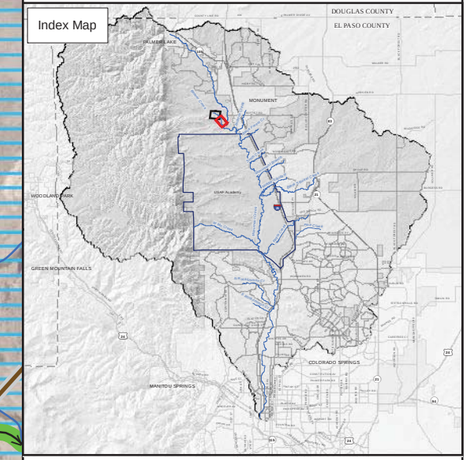
0 100 200
Feet

Legend

- Culvert
- Centerline
- Cross Section
- Fllodplain
- DFIRM 100-Year
- Subbasin
- Railroads
- CityParcels

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs Utilities

El Paso County Colorado

Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\BeaverCreek_Mapbook.mxd, 10/26/2016, jeff_clonts

JC-1

Jackson Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

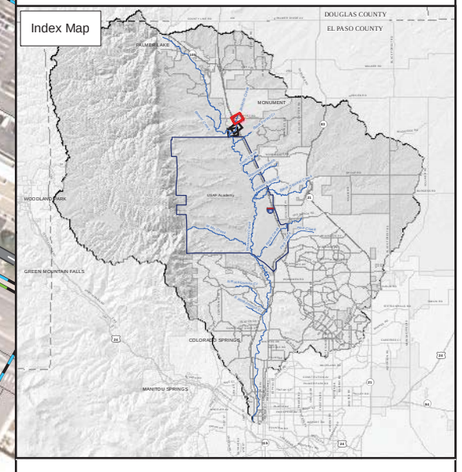
Legend

- Bridge
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- Subbasin
- CityParcels
- Railroads
- Water
- Manhole
- Storm Drain Pipe
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map



Matrix DESIGN GROUP

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\MapbookJacksonCreek_Mapbook.mxd, 10/26/2016, jeff_clonts

JC-2

Jackson Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

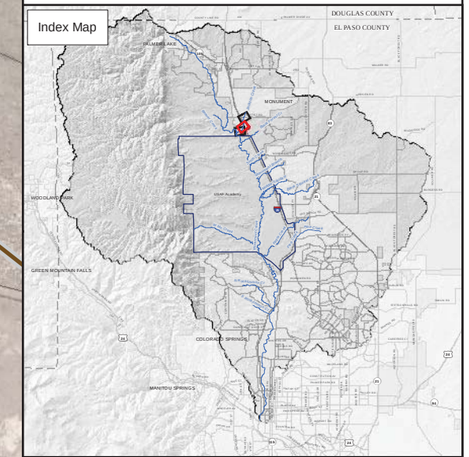
Legend

- Bridge
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- Subbasin
- CityParcels
- Railroads
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map



MN225
MN235
MN240
Struthers Rd
Jackson Creek
I-25
4695
4391
4111
4032
3901
3855
3463
3653
3798
3017
3200
2703
2562
2587
2083
2345
2519
2608

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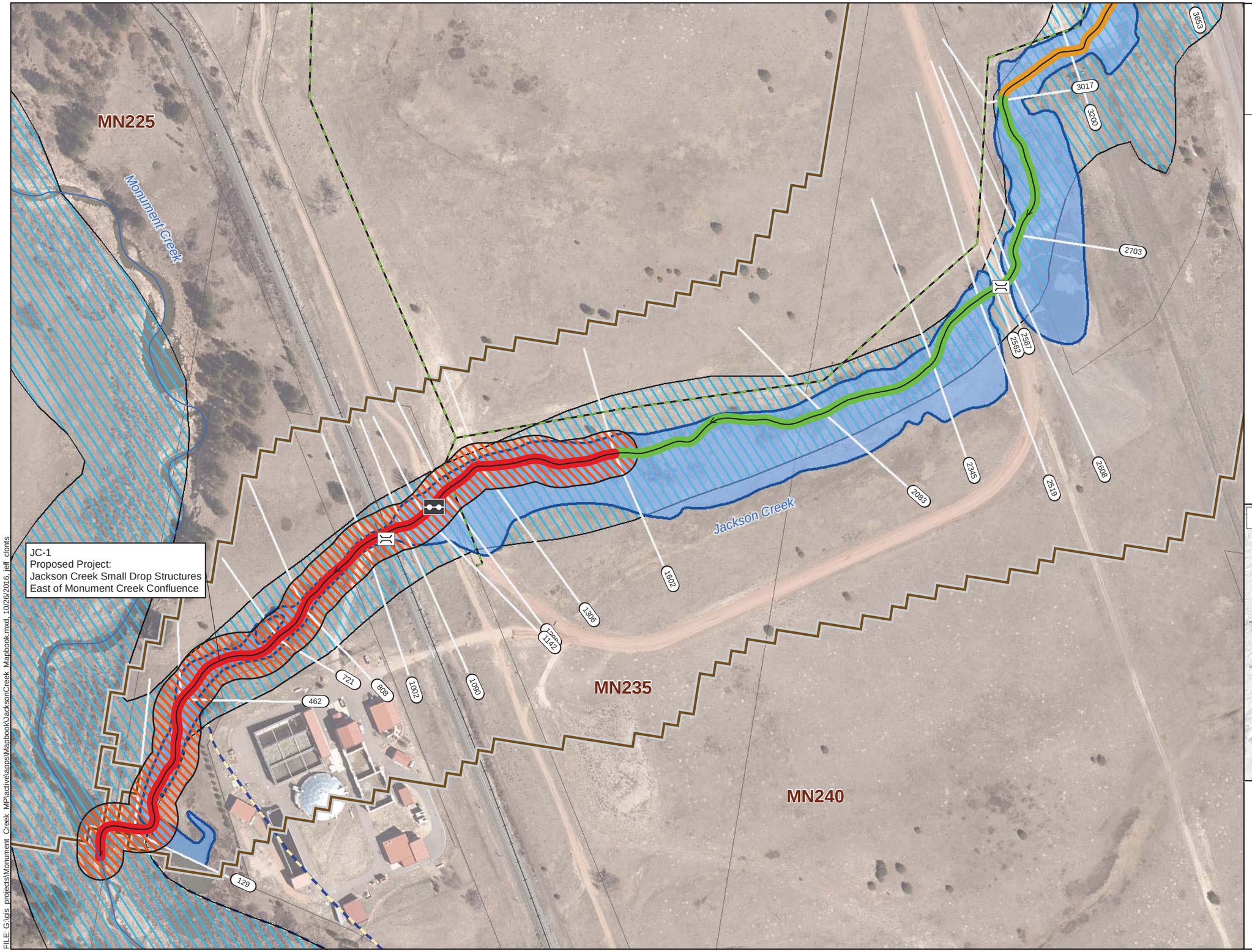


JC-3

Jackson Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

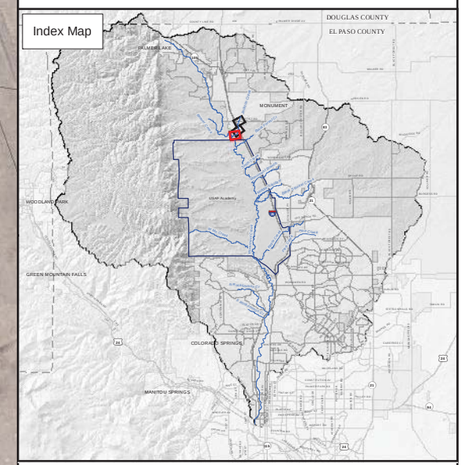
- Culvert
- Bridge
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- CityParcels
- Railroads
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Reach, High



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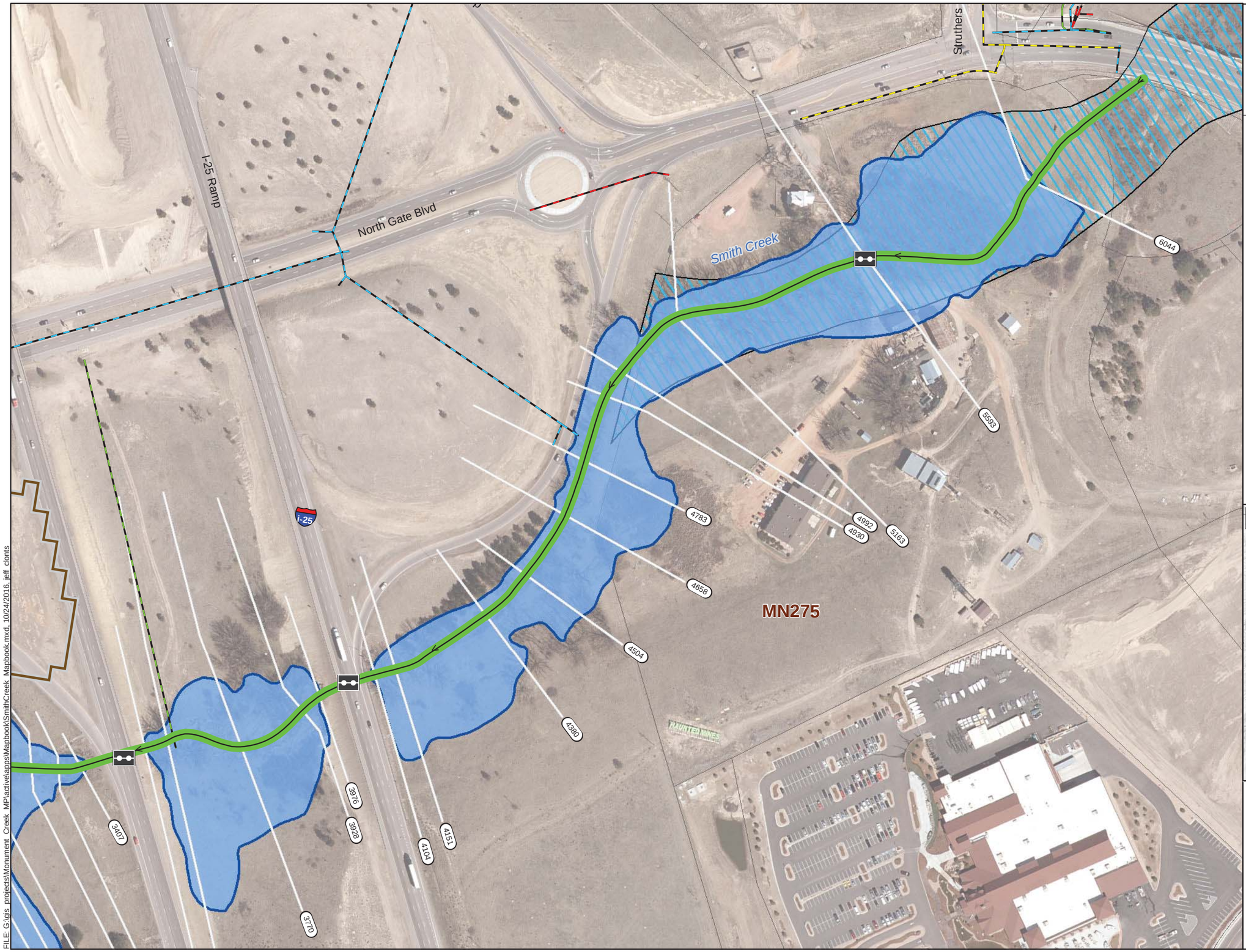


SC-1

Smith Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

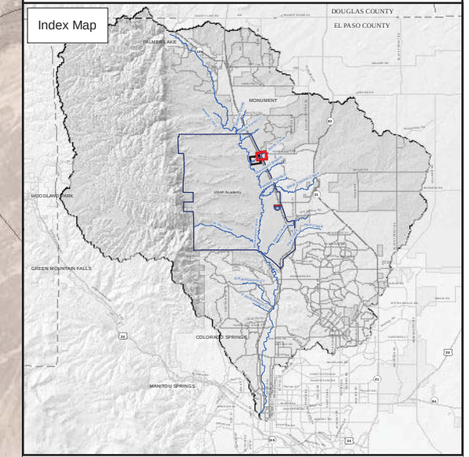
Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map



Colorado Springs
Colorado Springs Utilities
DOLA
El Paso County Colorado
Matrix Design Group

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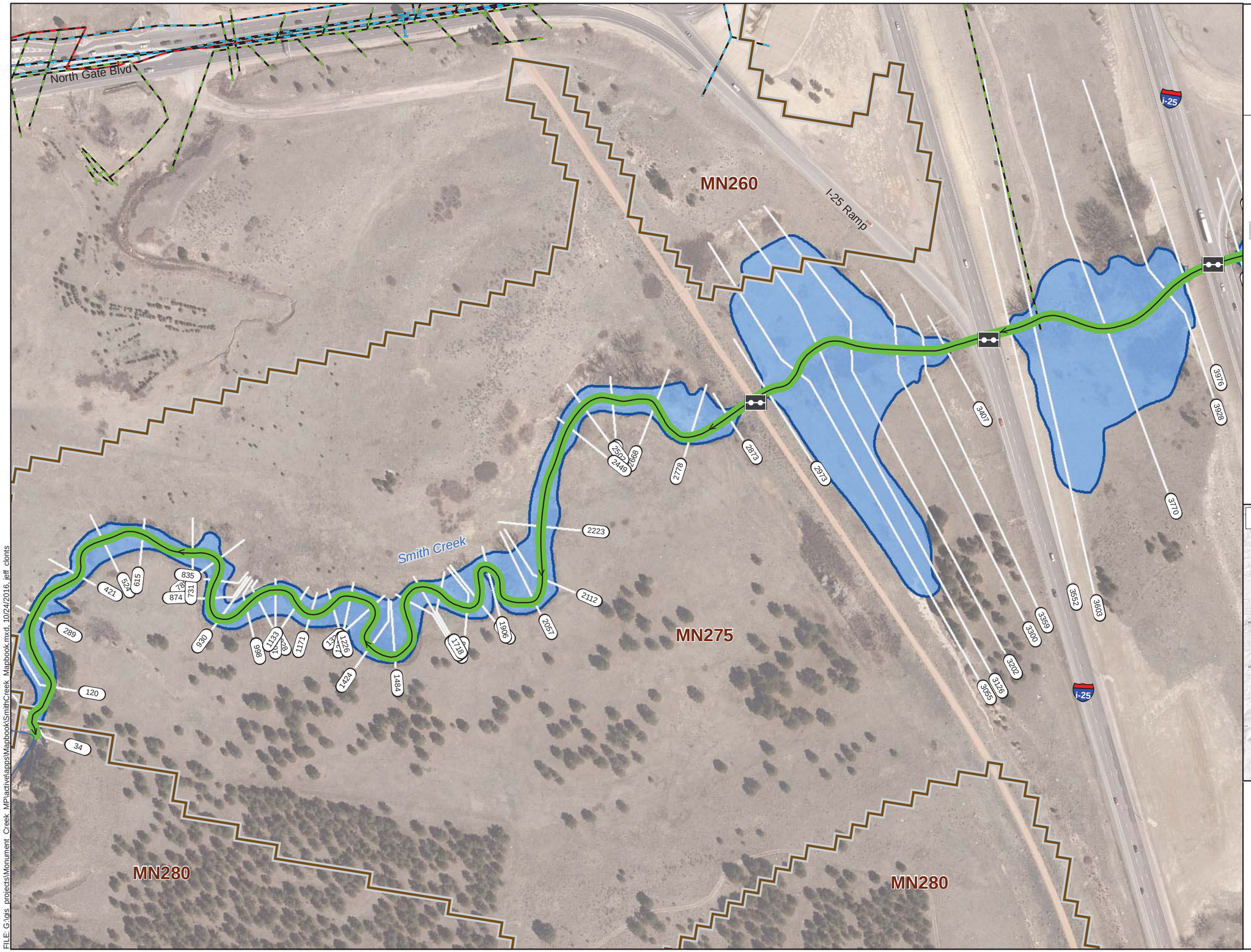


SC-2

Smith Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

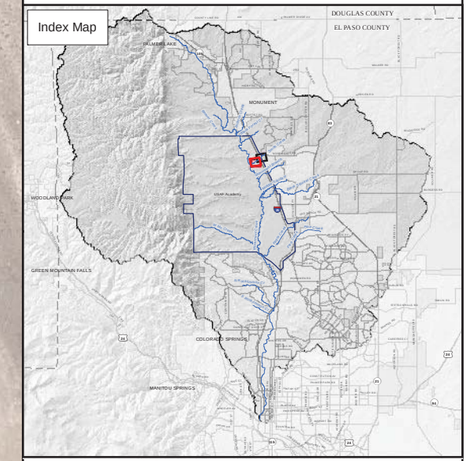
Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- Subbasin
- Railroads
- CityParcels

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map



Colorado Springs
Colorado Springs Utilities
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El Paso County Colorado
Matrix Design Group

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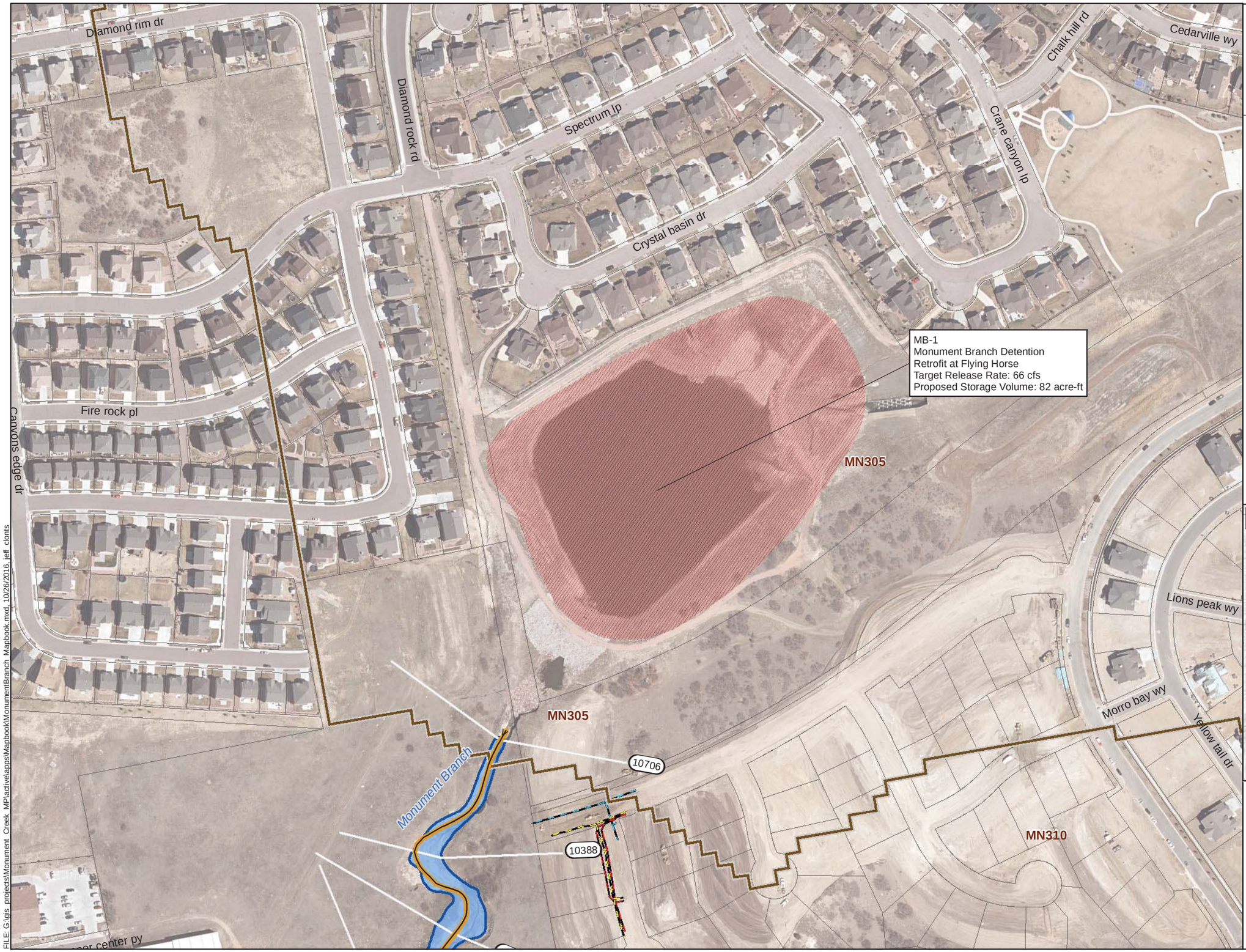


MB-1

Monument Branch
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

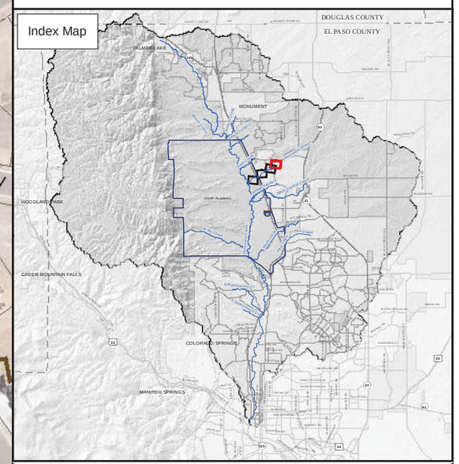
- Centerline
- Cross Section
- Floodplain
- Subbasin
- CityParcels
- Gas
- Underground Electric
- Water
- Railroads

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Detention, High



Colorado Springs Utilities
El Paso County Colorado
Matrix Design Group

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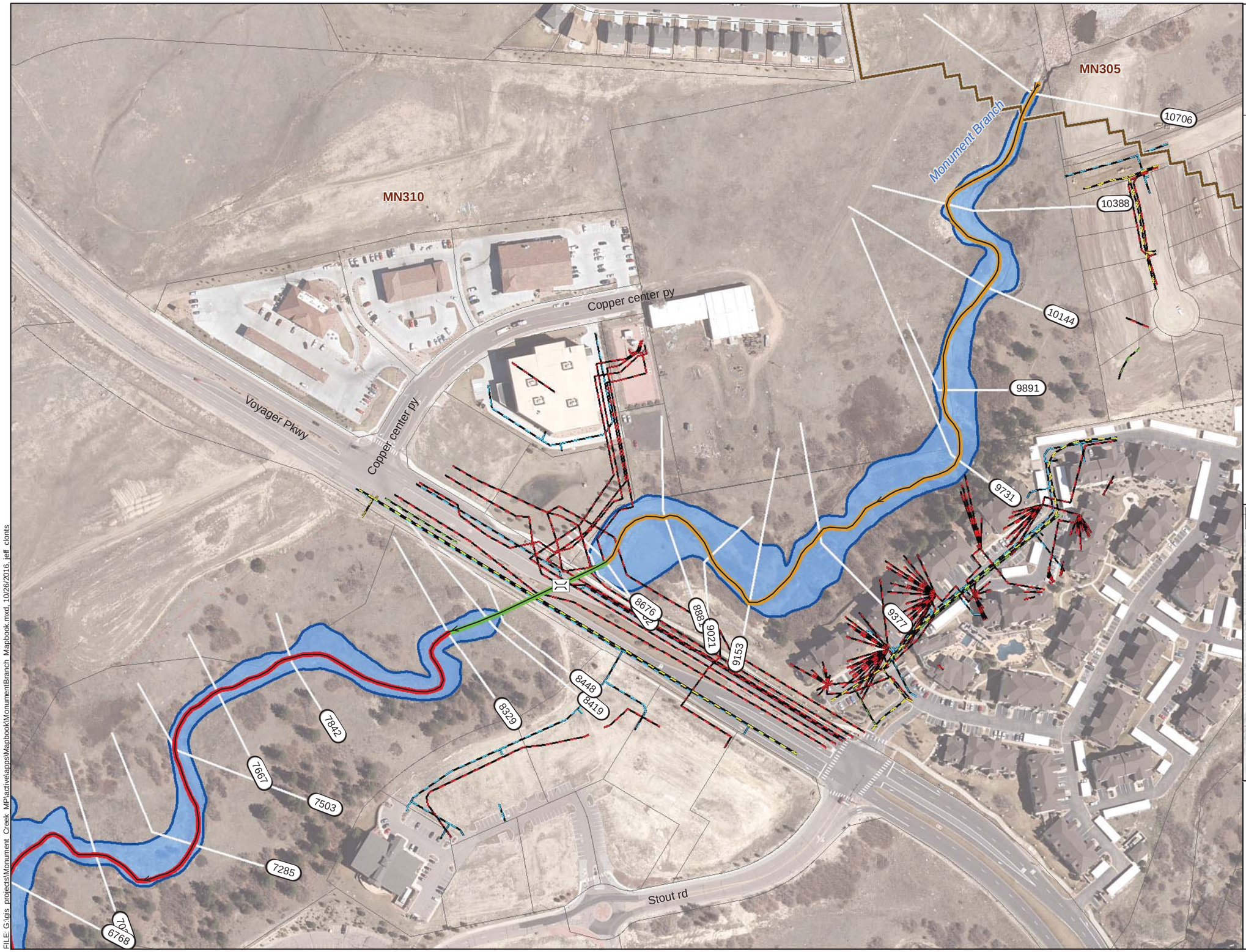


MB-2

Monument Branch
Conceptual Plan
El Paso County, CO

0 100 200
Feet

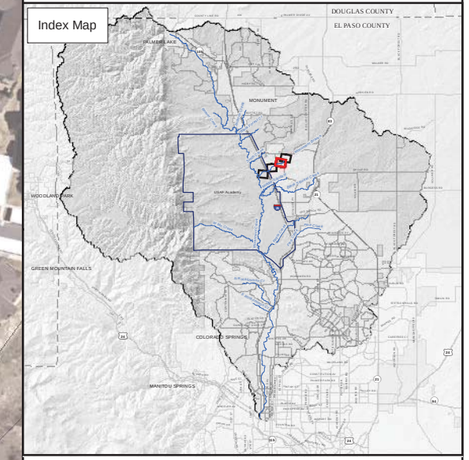
Legend

- Bridge
- Centerline
- Cross Section
- Floodplain
- Subbasin
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater
- Railroads

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map



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El Paso County Colorado

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FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\MonumentBranch_Mapbook.mxd, 10/26/2016, jeff_clonts

MB-3

Monument Branch
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

- Centerline
- Cross Section
- Floodplain
- Subbasin
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater
- Wastewater
- Railroads

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Detention, Low

Monument Branch

MB-2
Monument Branch Detention
Retrofit at the Classical Academy
Target Release Rate: 90 cfs
Proposed Storage Volume: 100 acre-ft

7023
6382
6087
5443
5643
5263
4787
4496
4059
3777
3683
3443
3372

Index Map

DOUGLAS COUNTY
EL PASO COUNTY

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\MapbookMonumentBranch_Mapbook.mxd, 10/26/2016, jeff_clonts

MB-3
Stabilize Monument Branch Tributary Erosion between Northbound and Southbound I-25

Monument Branch

Monument Creek

2590
2774
2484
2894
3168
3223
3363
3372
2285
2365
2213
2148
1995
1879
1935
1766
1635
1475
1287
1184
1099
986
938
755
651
521
404
233

I-25

MB-4

Monument Branch
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

- Culvert
- Bridge
- Centerline
- Cross Section
- Floodplain
- Subbasin
- CityParcels
- Railroads

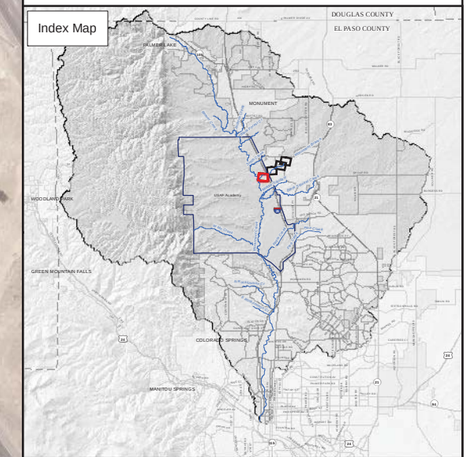
Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Immediate Action Project

Index Map



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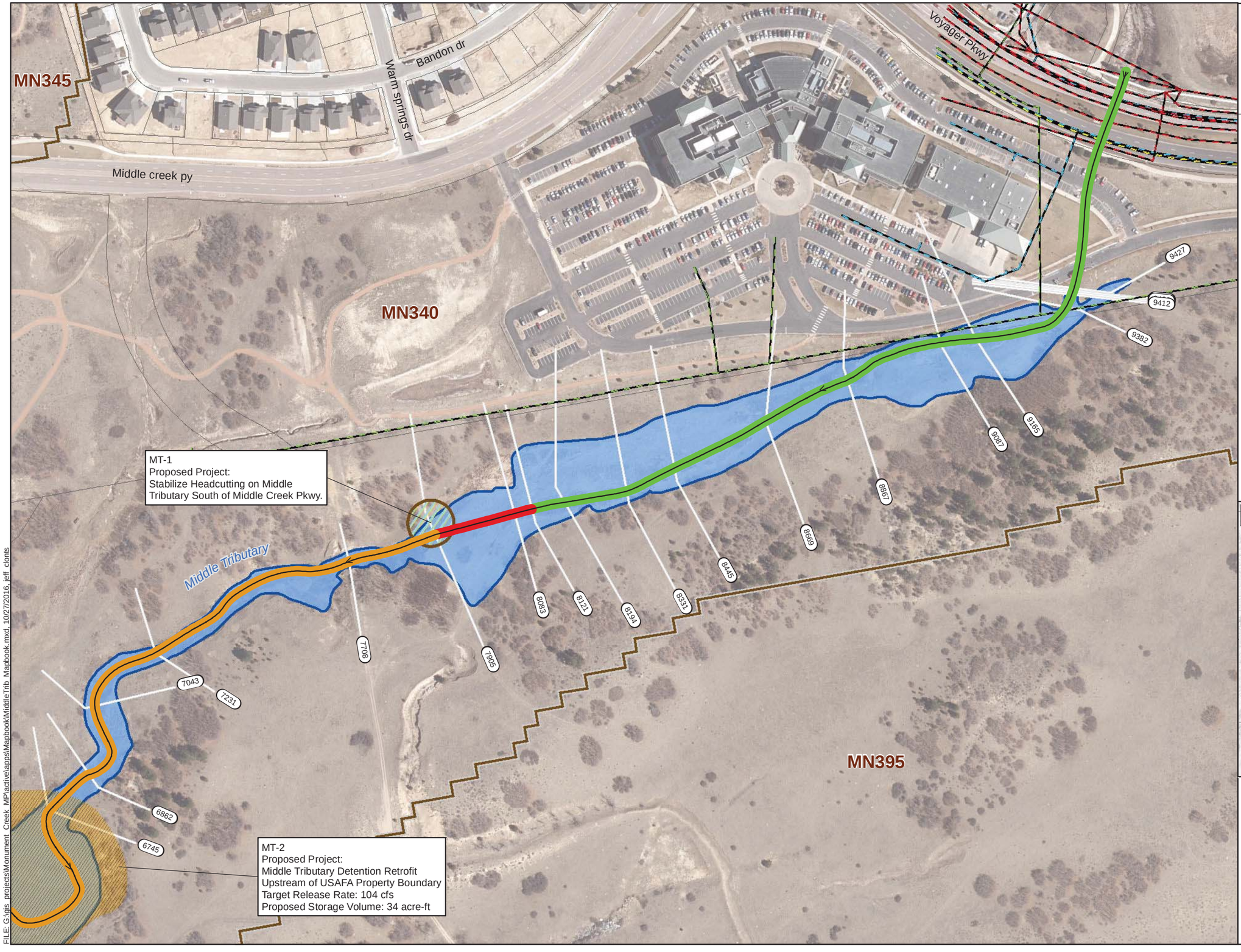


MT-1

Middle Tributary
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

- Centerline
- Cross Section
- Floodplain
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

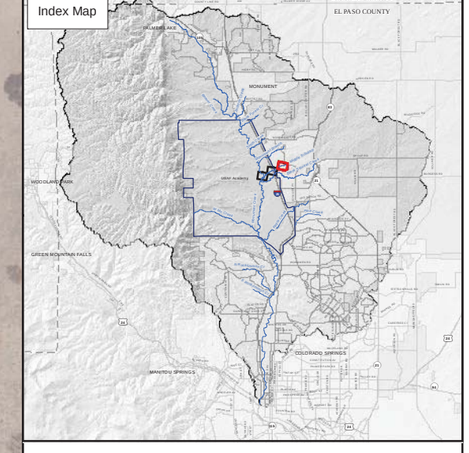
Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Stability, Low
- Detention, Moderate

Index Map



COLORADO SPRINGS
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EL PASO COUNTY
COLORADO
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FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\MiddleTrib_Mapbook.mxd, 10/27/2016, jeff_clonts

MT-2

Middle Tributary
Conceptual Plan
El Paso County, CO

0 100 200
Feet

MT-2
Proposed Project:
Middle Tributary Detention Retrofit
Upstream of USAFA Property Boundary
Target Release Rate: 104 cfs
Proposed Storage Volume: 34 acre-ft

MT-5
Proposed Project:
Middle Tributary Natural Channel
Design East of Monument Creek Confluence

MT-3
Proposed Project:
Stabilize Headcutting on Middle
Tributary Downstream of I-25

MT-4
Proposed Project:
Middle Tributary Small
Drop Structures West of I-25

MN335
MN345
MN340
MN395
Middle Tributary
I-25

Legend

- Culvert
- Bridge
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Wastewater

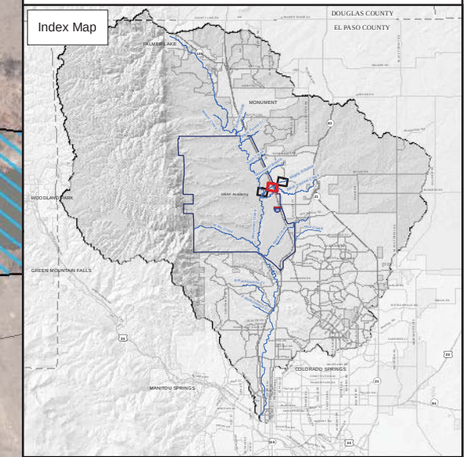
Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Reach, Moderate
- Stability, Low
- Detention, Moderate

Index Map



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El Paso County
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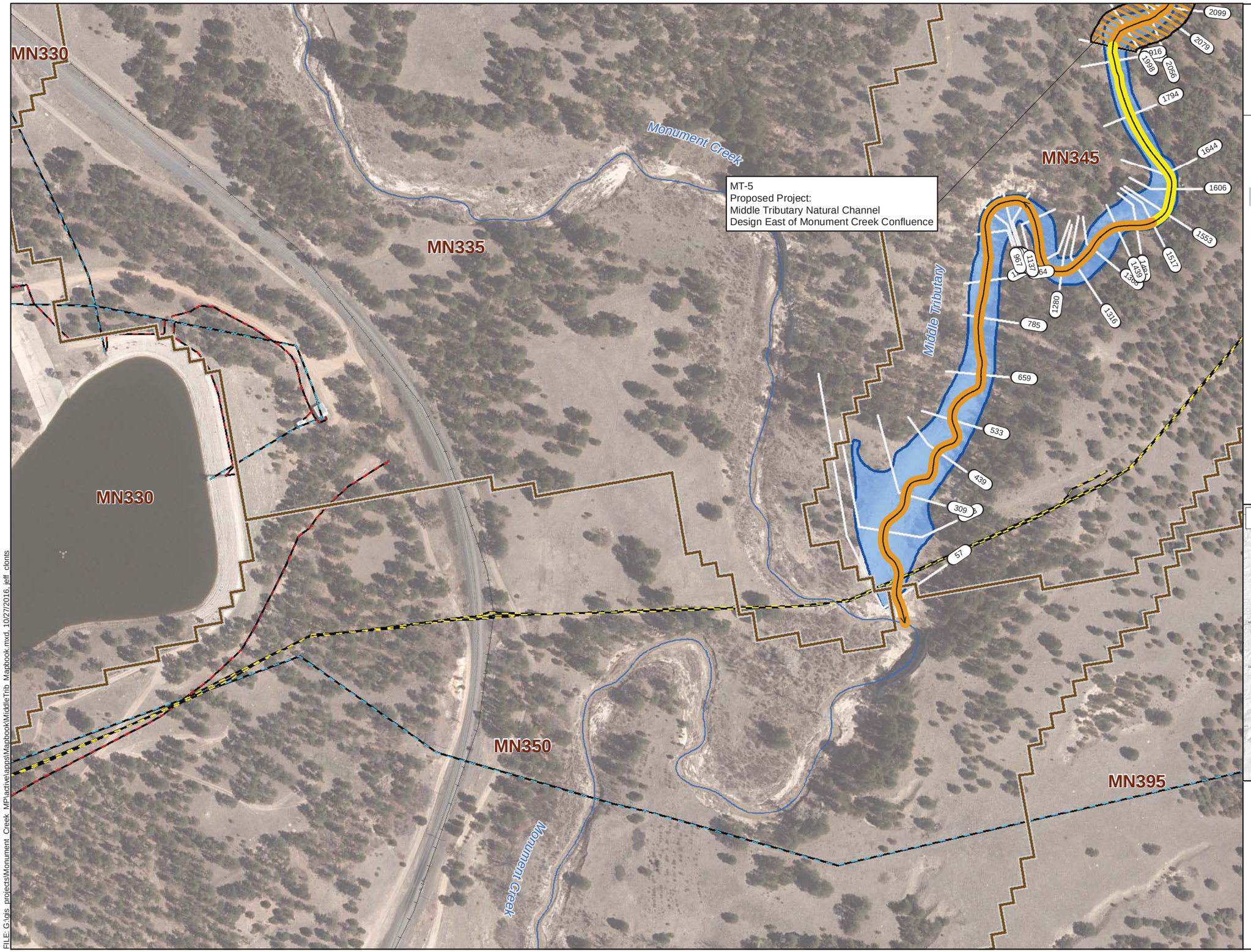
FILE: G:\gis_projects\Monument_Creek_MP\activeApps\MapbookMiddleTrib_Mapbook.mxd, 10/27/2016, jeff_clonts



MT-3

Middle Tributary
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

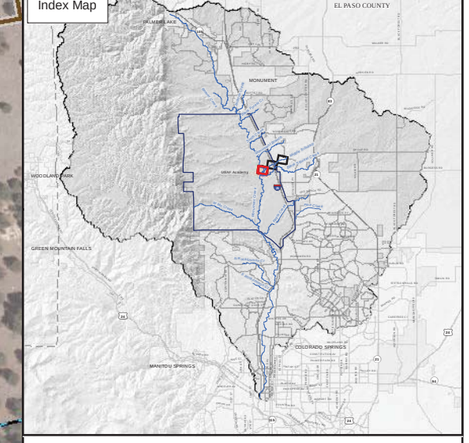
- Centerline
- Cross Section
- Floodplain
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Reach, Moderate



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El Paso County Colorado
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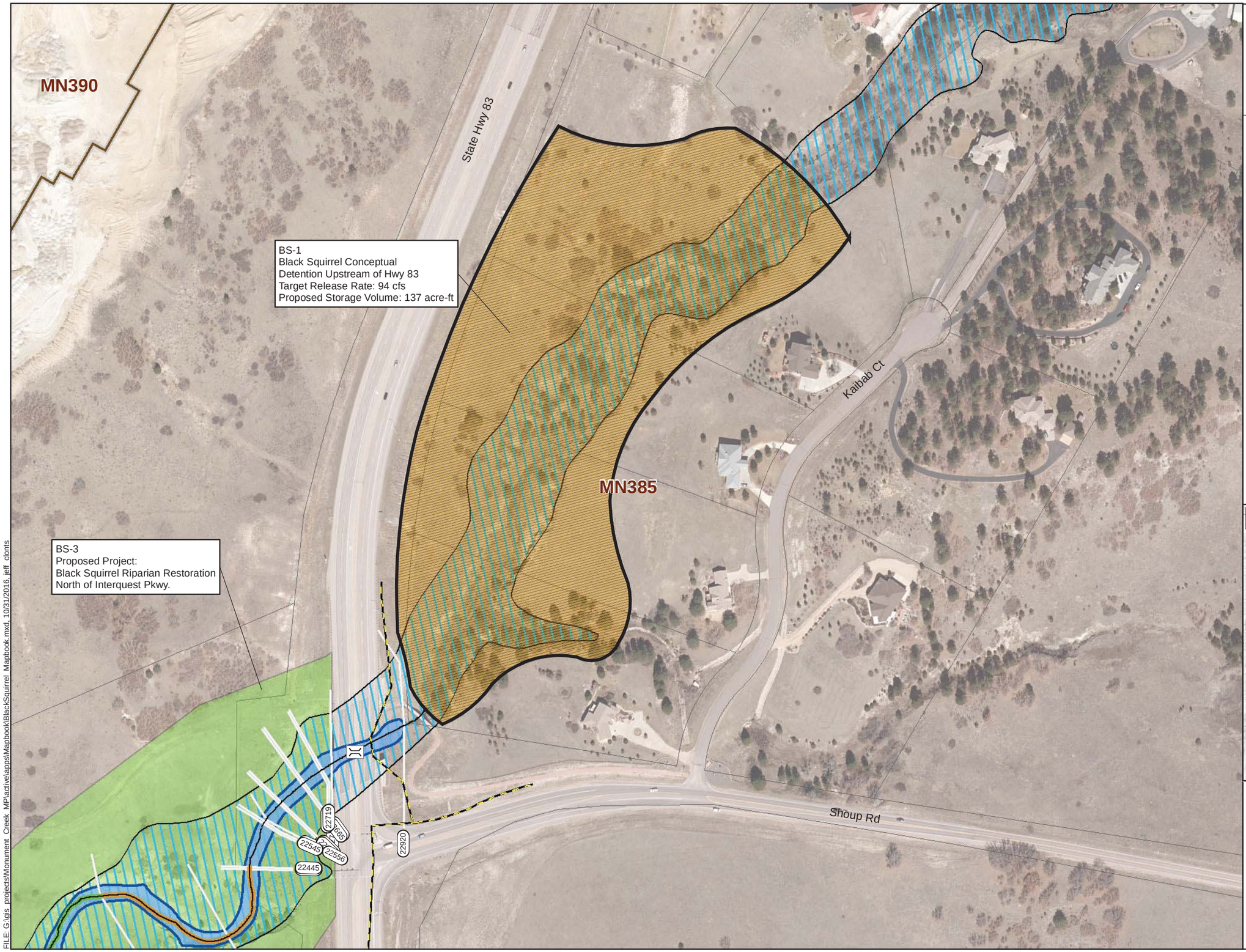


BS-1

Black Squirrel Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

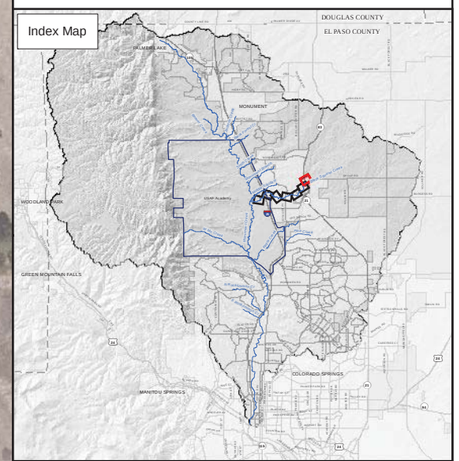
- Bridge
- Centerline
- XSCutLines
- Floodplain
- DFIRM 100-Year
- Subbasin
- CityParcels
- Railroads
- Gas

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Detention, High
- Riparian, Low



Colorado Springs Utilities

El Paso County Colorado

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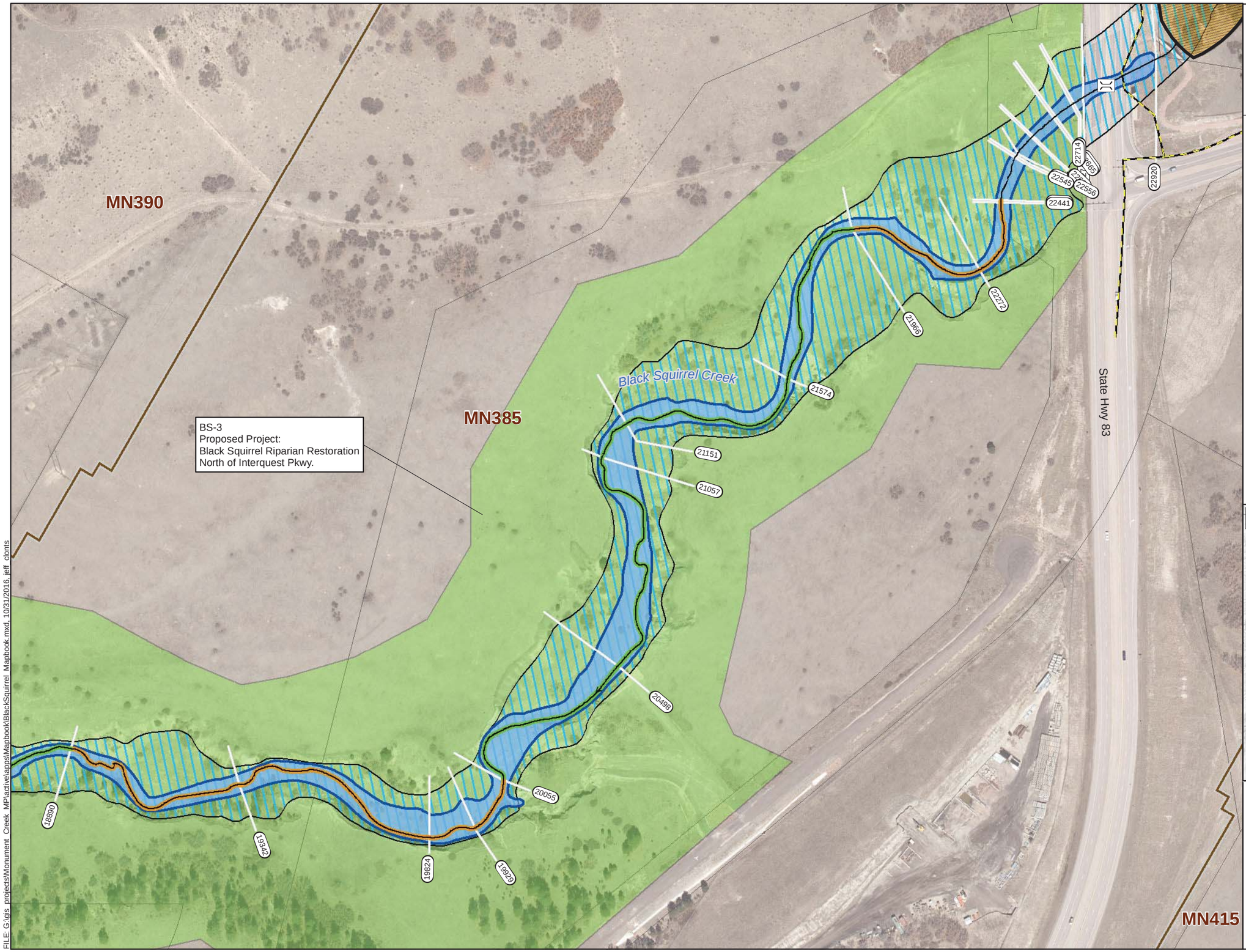

BS-2

Black Squirrel Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

- Bridge
- Centerline
- XSCutLines
- Floodplain
- DFIRM 100-Year
- Subbasin
- CityParcels
- Railroads
- Gas

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Detention, High
- Riparian, Low

Colorado Springs Utilities
El Paso County Colorado
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FILE: G:\gis_projects\Monument_Creek_MP\activeApps\MapbookBlackSquirrel_Mapbook.mxd, 10/31/2016, jeff_clonts

BS-3

Black Squirrel Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

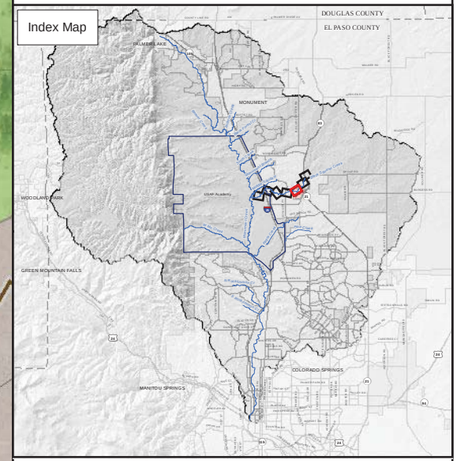
- Centerline
- XSCutLines
- Floodplain
- DFIRM 100-Year
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Overhead Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Detention, Moderate
- Riparian, Low



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El Paso County
Matrix Design Group

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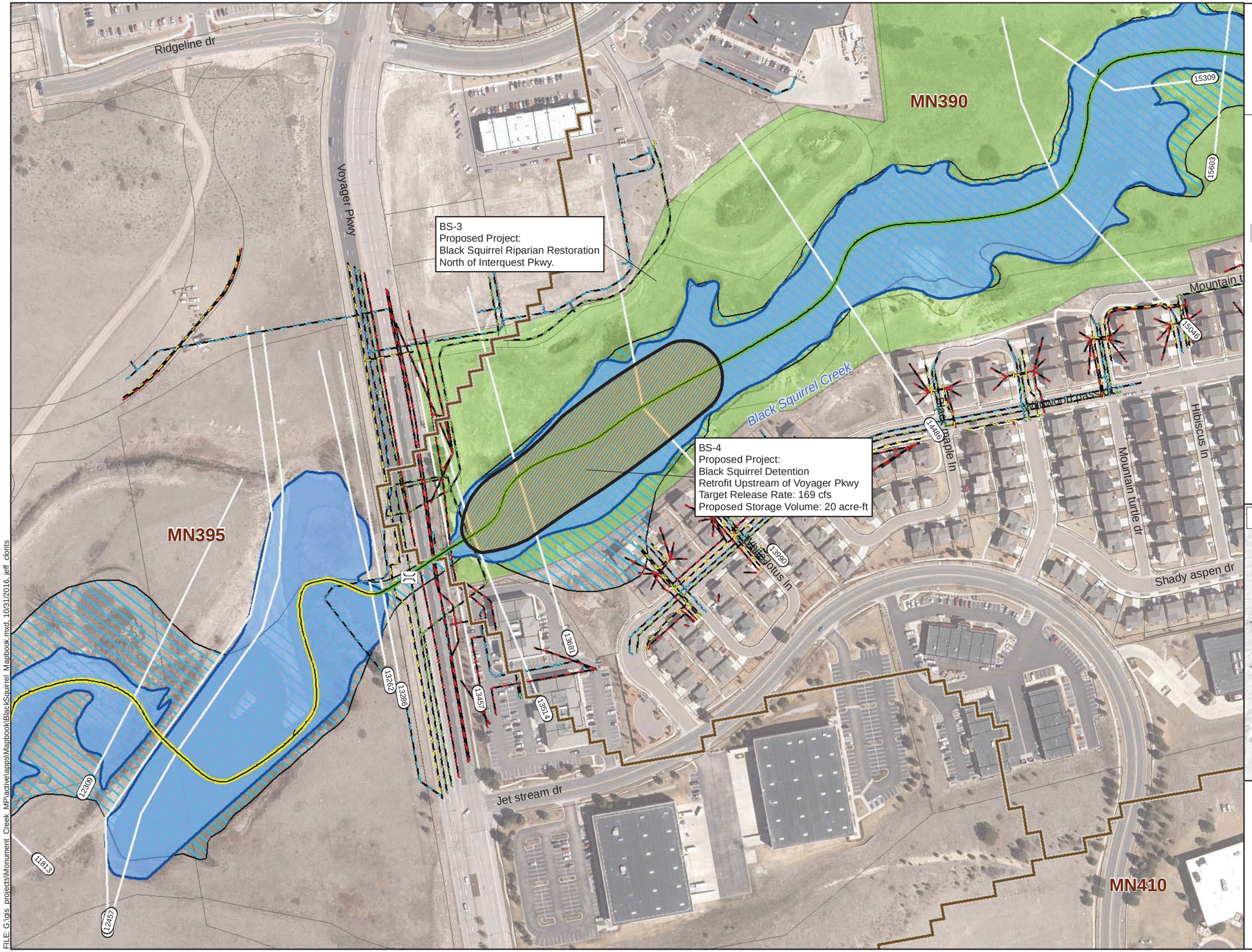


BS-4

Black Squirrel Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

- Bridge
- Centerline
- XSCutLines
- Floodplain
- DFIRM 100-Year
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Water
- Wastewater

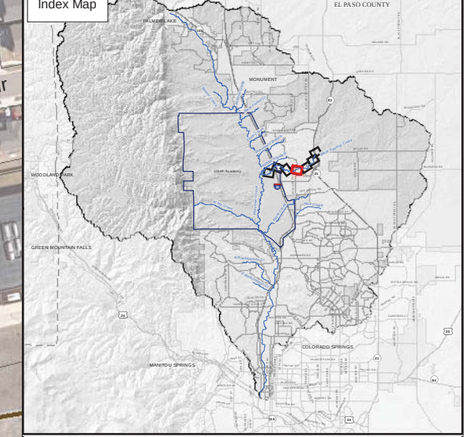
Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Detention, High
- Riparian, Low

Index Map



Colorado Springs
Colorado Springs Utilities
El Paso County
Colorado
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FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\BlackSquirrel_Mapbook.mxd, 10/31/2016, jeff_clonts

BS-5

Black Squirrel Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

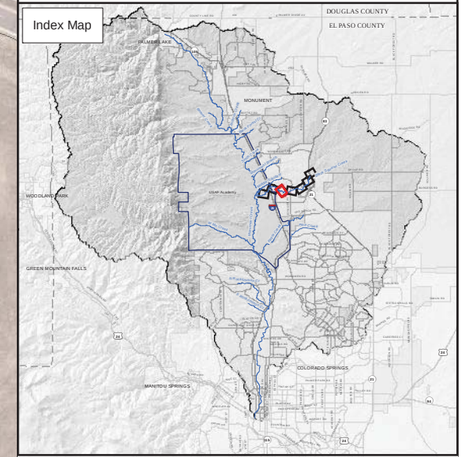
Legend

- Culvert
- Centerline
- XSCutLines
- Floodplain
- DFIRM 100-Year
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map



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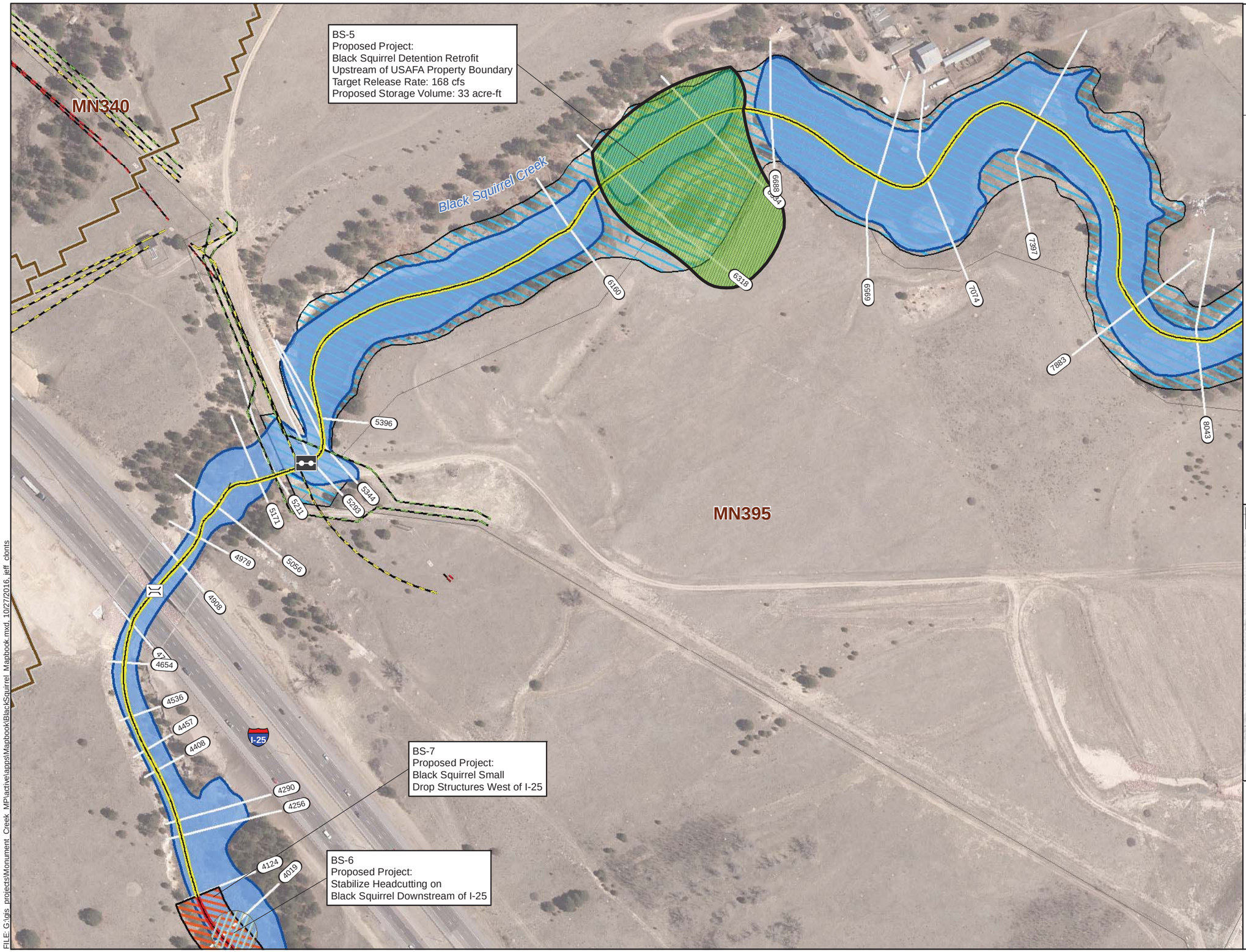


BS-6

Black Squirrel Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

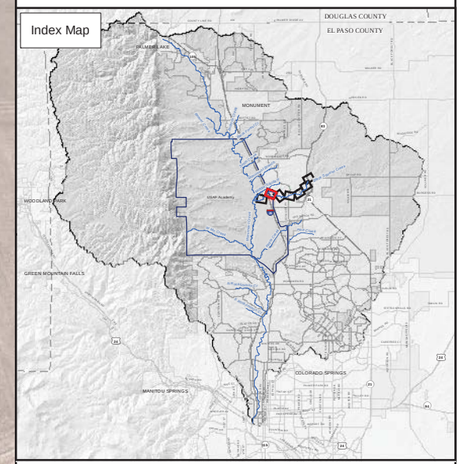
- Culvert
- Bridge
- Centerline
- XSCutLines
- Floodplain
- DFIRM 100-Year
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Reach, High
- Stability, Moderate
- Detention, Low



Colorado Springs
Colorado Springs Utilities
El Paso County Colorado
DOLA
Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\BlackSquirrel_Mapbook.mxd, 10/27/2016, jeff_clonts

BS-6
Proposed Project:
Stabilize Headcutting on
Black Squirrel Downstream of I-25

BS-7
Proposed Project:
Black Squirrel Small
Drop Structures West of I-25

BS-8
Proposed Project:
Black Squirrel Natural Channel
Design East of Monument Creek Confluence

MN345

MN395

MN350

Black Squirrel Creek

3931
3844
3643
3489
3154
3049
2893
2751
2593
2456
3268
3368
2331
2176
2124
2054
1921
1993
1767
1628
1539
1390
1217
1065
855
771
710
642
463
330
95

BS-7

Black Squirrel Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

- Culvert
- Centerline
- XSCutLines
- Floodplain
- Subbasin
- CityParcels
- Railroads
- Gas
- Water

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Reach, High
- Reach, Moderate
- Stability, Moderate

Index Map

DOUGLAS COUNTY
EL PASO COUNTY
PALMER LAKE
MONUMENT
WOODLAND PARK
GREEN MOUNTAIN FALLS
COLORADO SPRINGS
MANITOU SPRINGS

Colorado Springs
Colorado Springs Utilities
El Paso County Colorado
DOLA
Matrix Design Group

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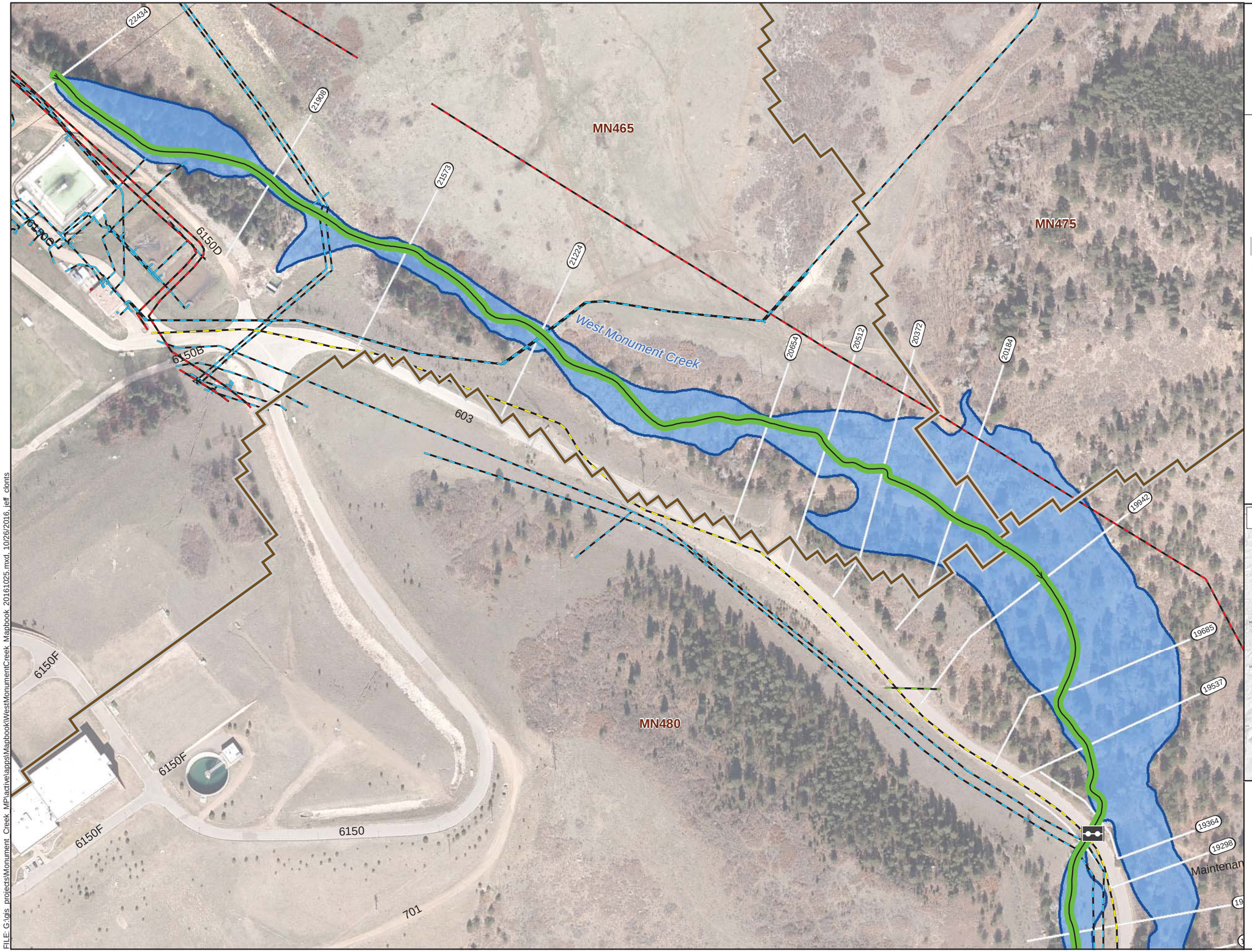


WM-1

West Monument Creek
Conceptual Plan
El Paso County, CO

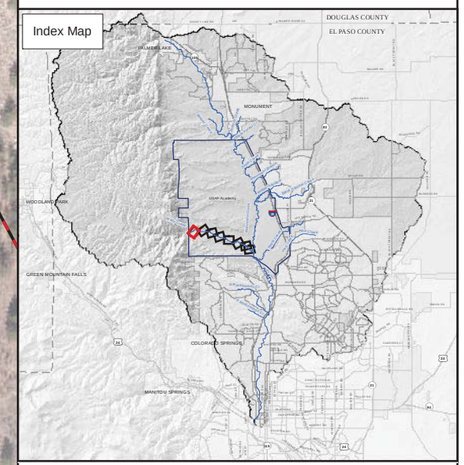
0 100 200
Feet

Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- Subbasin
- CityParcels
- Railroads
- Underground Electric
- Gas
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs Utilities

El Paso County Colorado

Matrix Design Group

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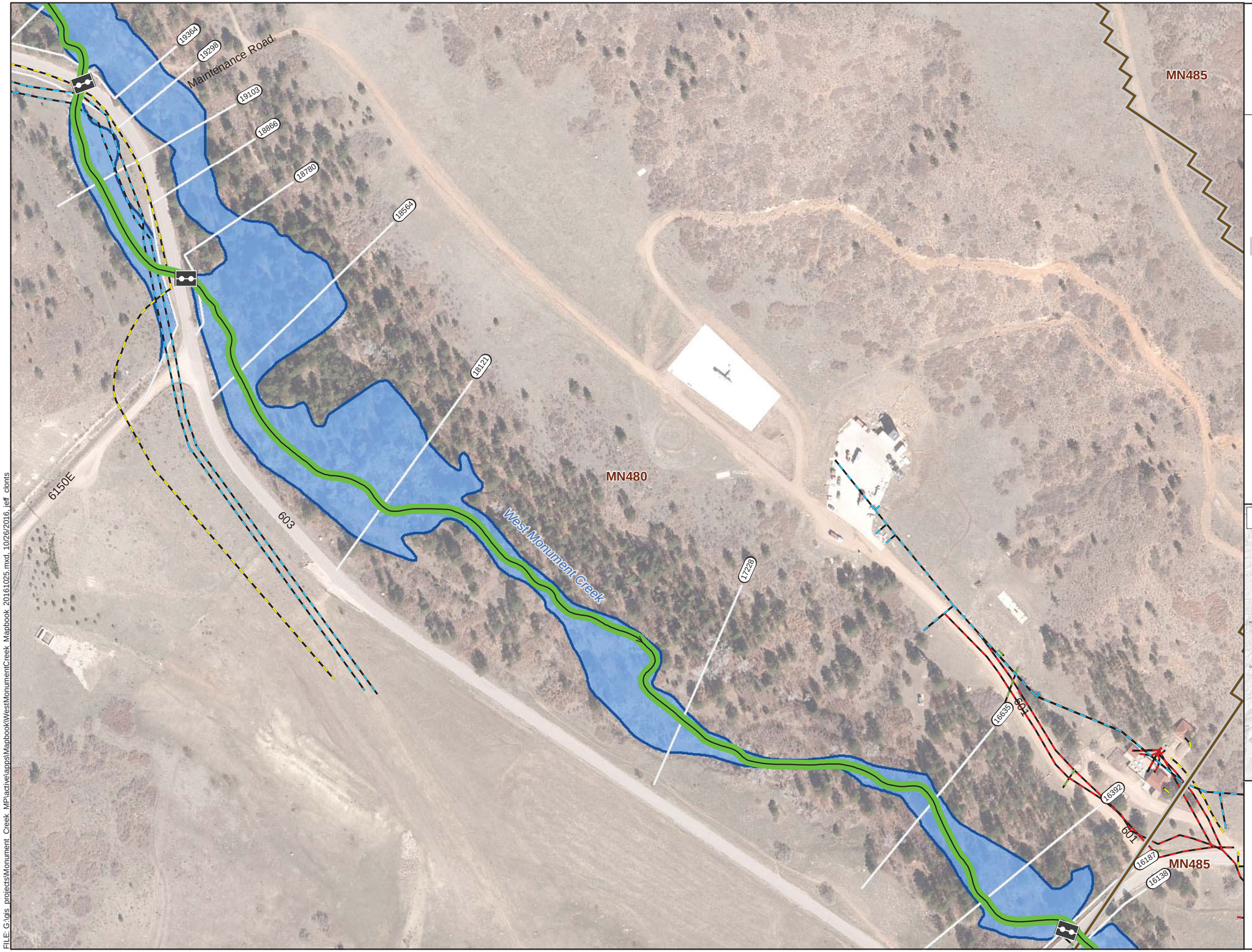


WM-2

West Monument Creek
Conceptual Plan
El Paso County, CO

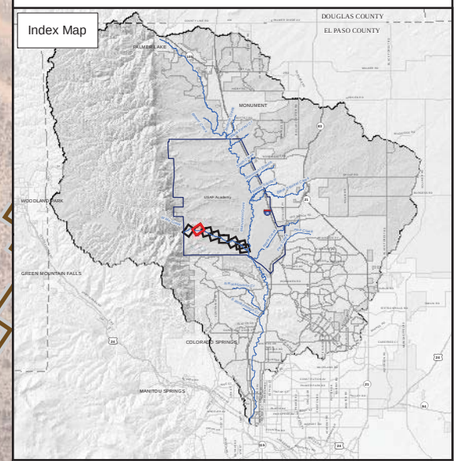
0 100 200
Feet

Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- Subbasin
- CityParcels
- Railroads
- Underground Electric
- Gas
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Matrix DESIGN GROUP

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WM-3

West Monument Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- Subbasin
- CityParcels
- Railroads
- Underground Electric
- Gas
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map

Colorado Springs Utilities

El Paso County

Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\MapbookWestMonumentCreek_Mapbook_20161025.mxd, 10/26/2016, jeff_clonts

WM-4

West Monument Creek
Conceptual Plan
El Paso County, CO

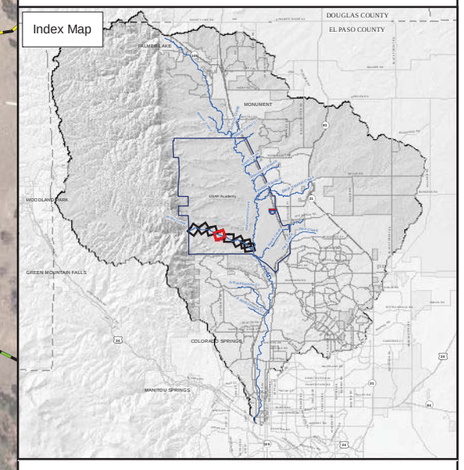
0 100 200
Feet

Legend

- Centerline
- Cross Section
- Floodplain
- Subbasin
- CityParcels
- Railroads
- Underground Electric
- Gas
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs
Colorado Springs Utilities
DOLA
El Paso County Colorado
Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\WestMonumentCreek_Mapbook_20161025.mxd, 10/26/2016, jeff_clonts

WM-5

West Monument Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

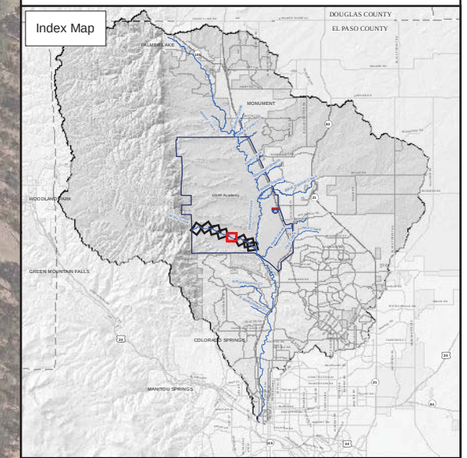
Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- Subbasin
- CityParcels
- Railroads
- Underground Electric
- Gas
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map



Colorado Springs Utilities

El Paso County Colorado

Matrix Design Group

MN425
MN485
W COLUMBINE DR
W DOGWOOD DR
COTTONWOOD DR
10827
10367
10091
9704
9506
9348
9163
8899
8529
8029
706A
Maintenance Road
West Monument Creek

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\WestMonumentCreek_Mapbook_20161025.mxd, 10/26/2016, jeff_clonts

WM-6

West Monument Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

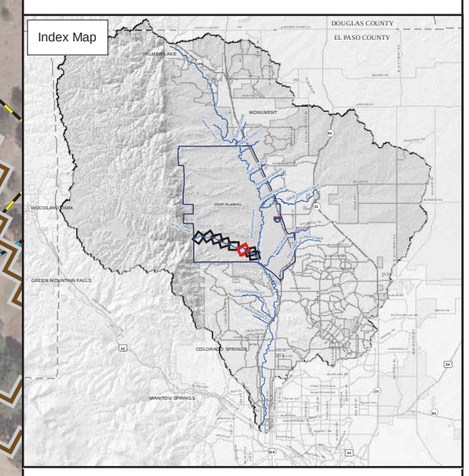
Legend

- Centerline
- Cross Section
- Floodplain
- Subbasin
- CityParcels
- Railroads
- Underground Electric
- Gas
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map



Colorado Springs Utilities

El Paso County Colorado

Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\WestMonumentCreek_Mapbook_20161025.mxd, 10/26/2016, jeff_clonts

WM-7

West Monument Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

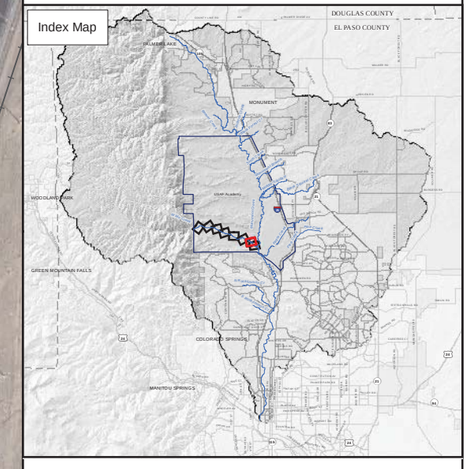
Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- Subbasin
- CityParcels
- Railroads
- Underground Electric
- Gas
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map



Colorado Springs Utilities

El Paso County
Colorado

Matrix Design Group

Maintenance Road
West Monument Creek
MN425
MN495
MN500
701
4657
4195
695A
3831
3577
3379
2629
2757
3256
2321
2108
1867
1734
1555
1428
1207
915
813
718
667
527

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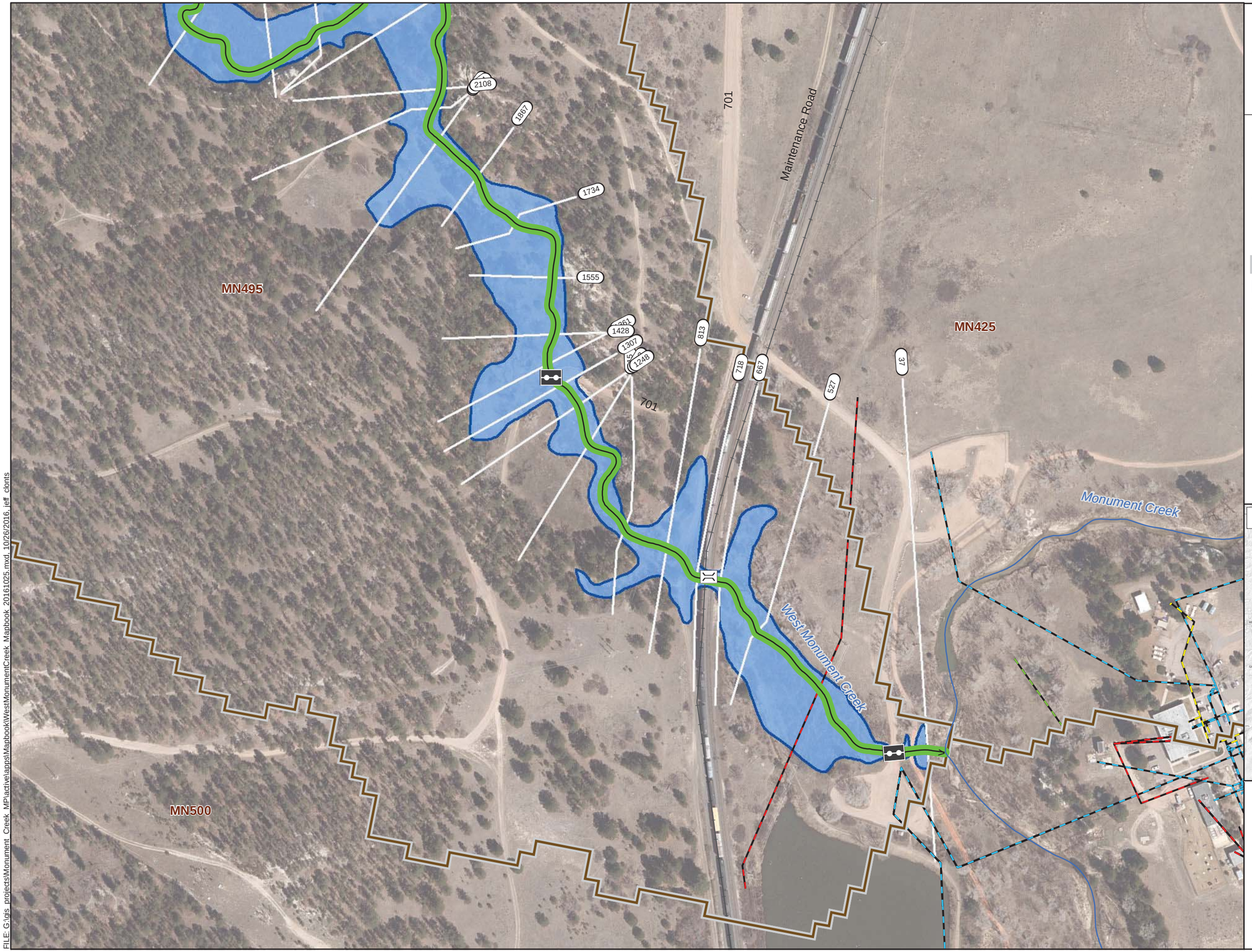


WM-8

West Monument Creek
Conceptual Plan
El Paso County, CO

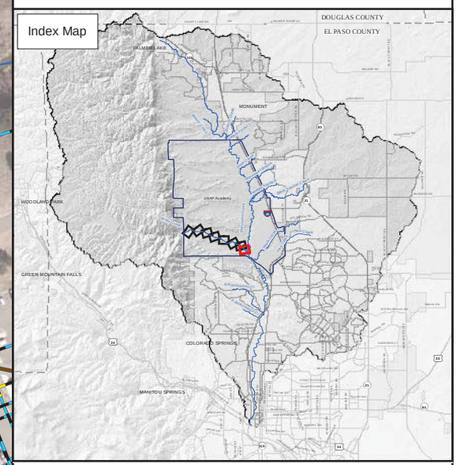
0 100 200
Feet

Legend

- Culvert
- Bridge
- Centerline
- Cross Section
- Floodplain
- Subbasin
- CityParcels
- Railroads
- Underground Electric
- Gas
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



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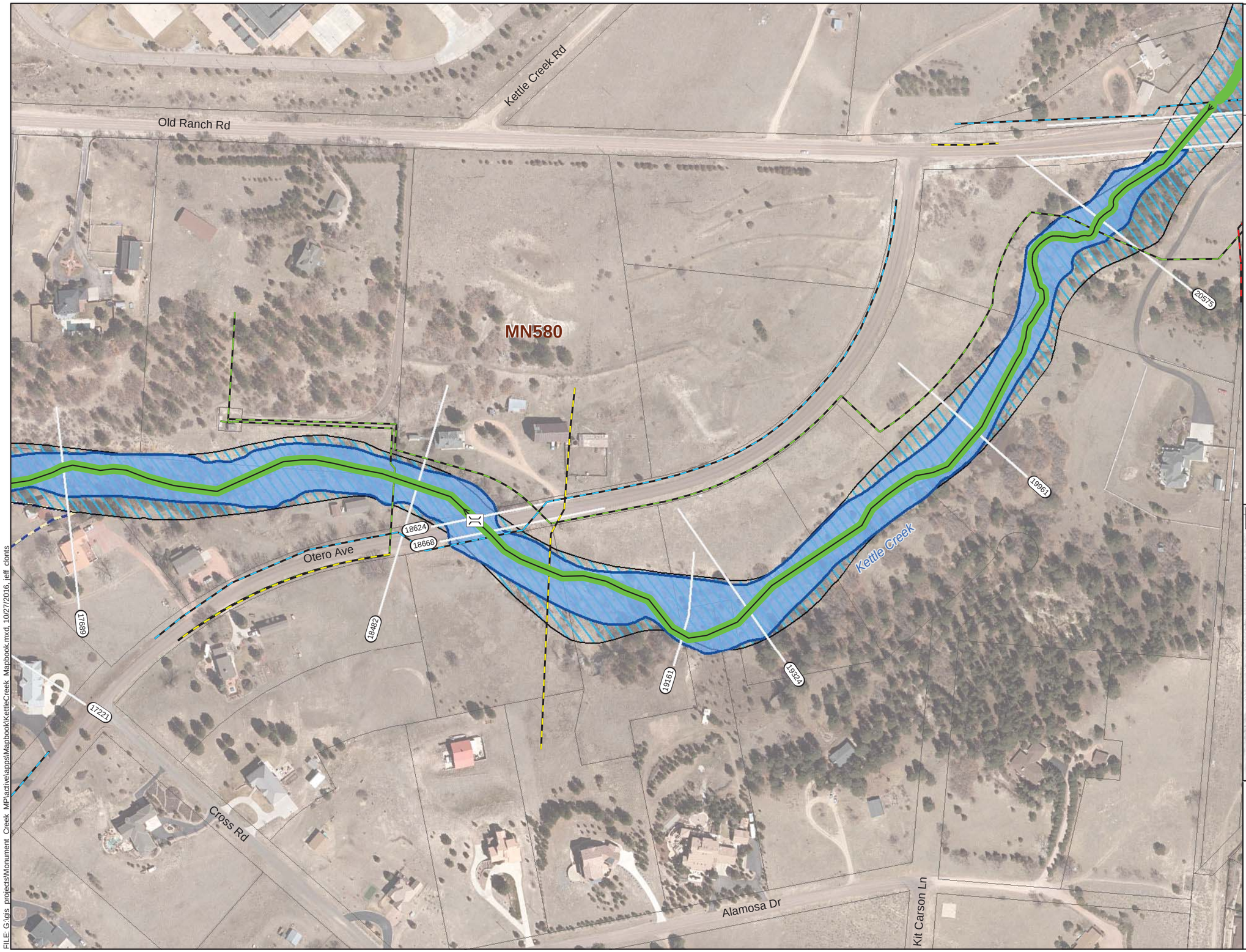

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KC-1

Kettle Creek
Conceptual Plan
El Paso County, CO

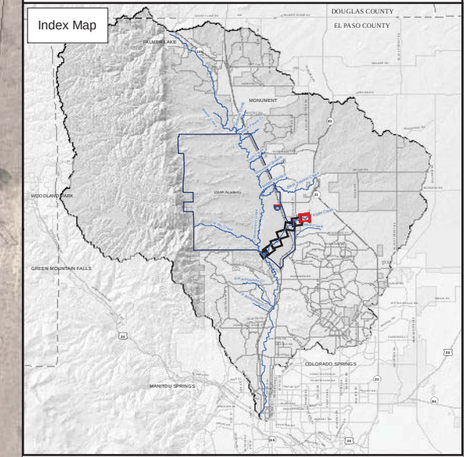
0 75 150
Feet

Legend

- Bridge
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs Utilities
El Paso County Colorado
Matrix Design Group

KC-2

Kettle Creek
Conceptual Plan
El Paso County, CO

0 75 150
Feet

KC-1
Kettle Creek Natural
Channel Design East of I-25

Montezuma Rd

Kettle Creek

MN580

MN615

Delta Rd

Otero Ave

Alamosa Dr

State Hwy 83

15402
15450
15552
15614
14811
14330
13782
13981
16763
17221
17689

Legend

- Bridge
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Water
- Wastewater

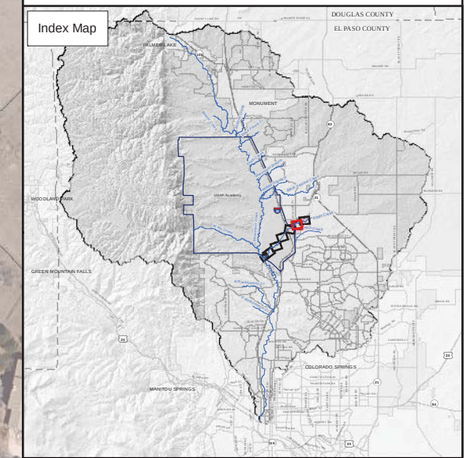
Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Reach, High

Index Map



Colorado Springs Utilities

El Paso County
Colorado

Matrix DESIGN GROUP

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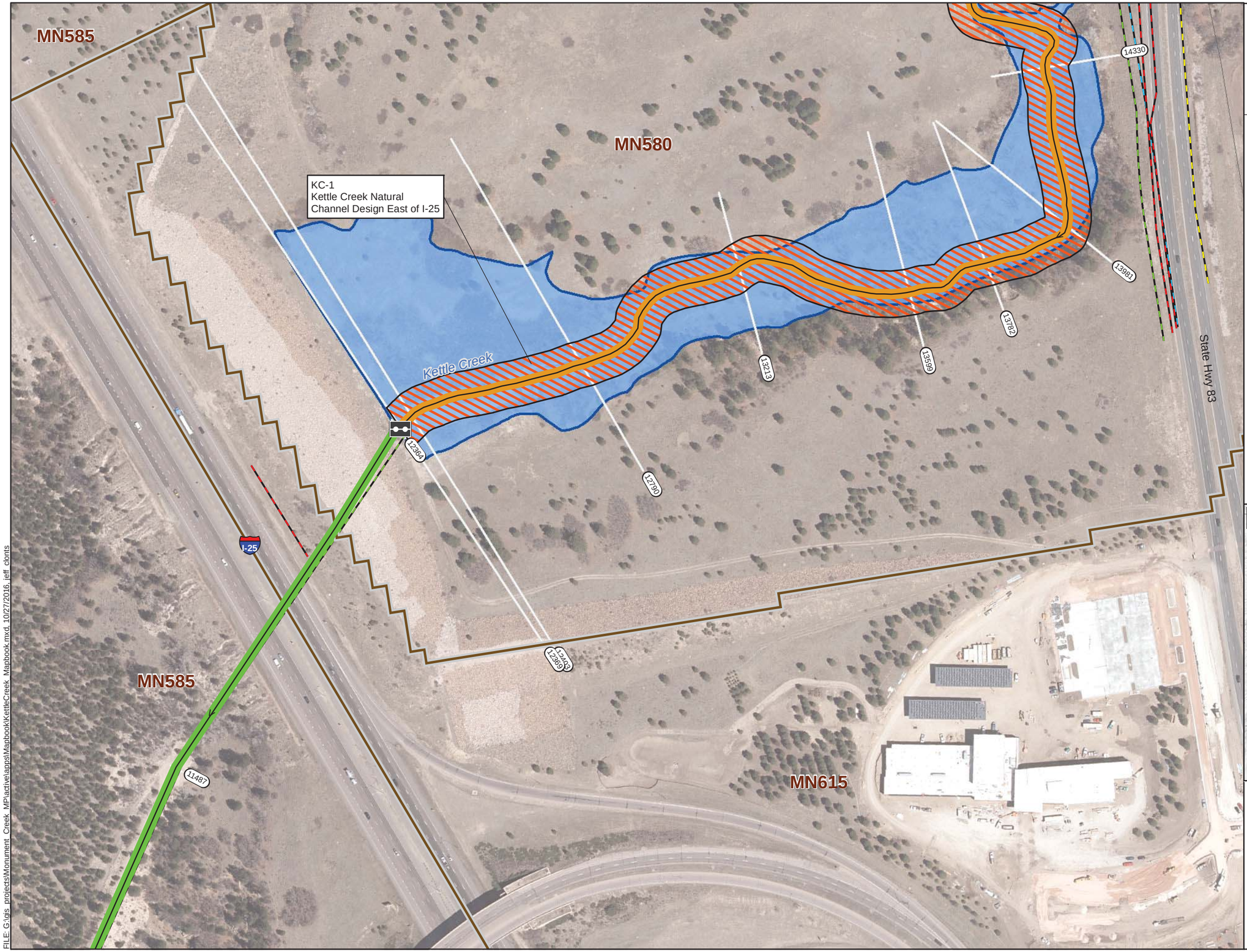


KC-3

Kettle Creek
Conceptual Plan
El Paso County, CO

0 75 150
Feet

Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Water
- Wastewater

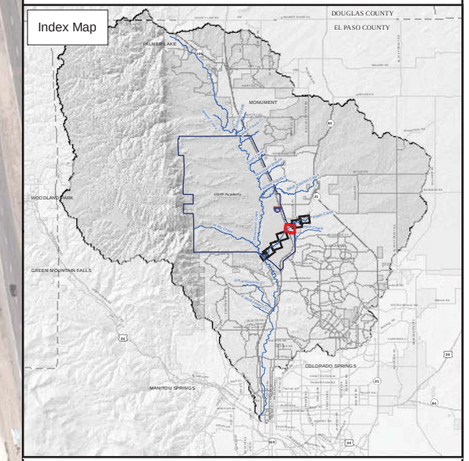
Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Reach, High

Index Map



Colorado Springs Utilities

El Paso County Colorado

Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\activeApps\MapbookKettleCreek_Mapbook.mxd, 10/27/2016, jeff_clonts

KC-4

Kettle Creek
Conceptual Plan
El Paso County, CO

0 75 150
Feet

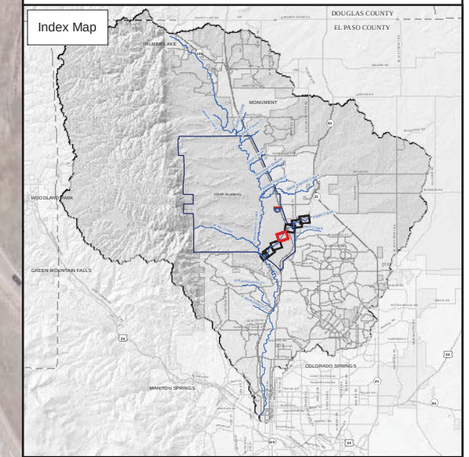
Legend

- Centerline
- Cross Section
- Floodplain
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map



Colorado Springs Utilities

El Paso County
Colorado

Matrix Design Group

TBD
Airfield Dr
Kettle Creek
MN585
Briargate Pkwy
MN595
Maintenance Road
904B
N/A
8476
8374
8308
8269
8248
8116

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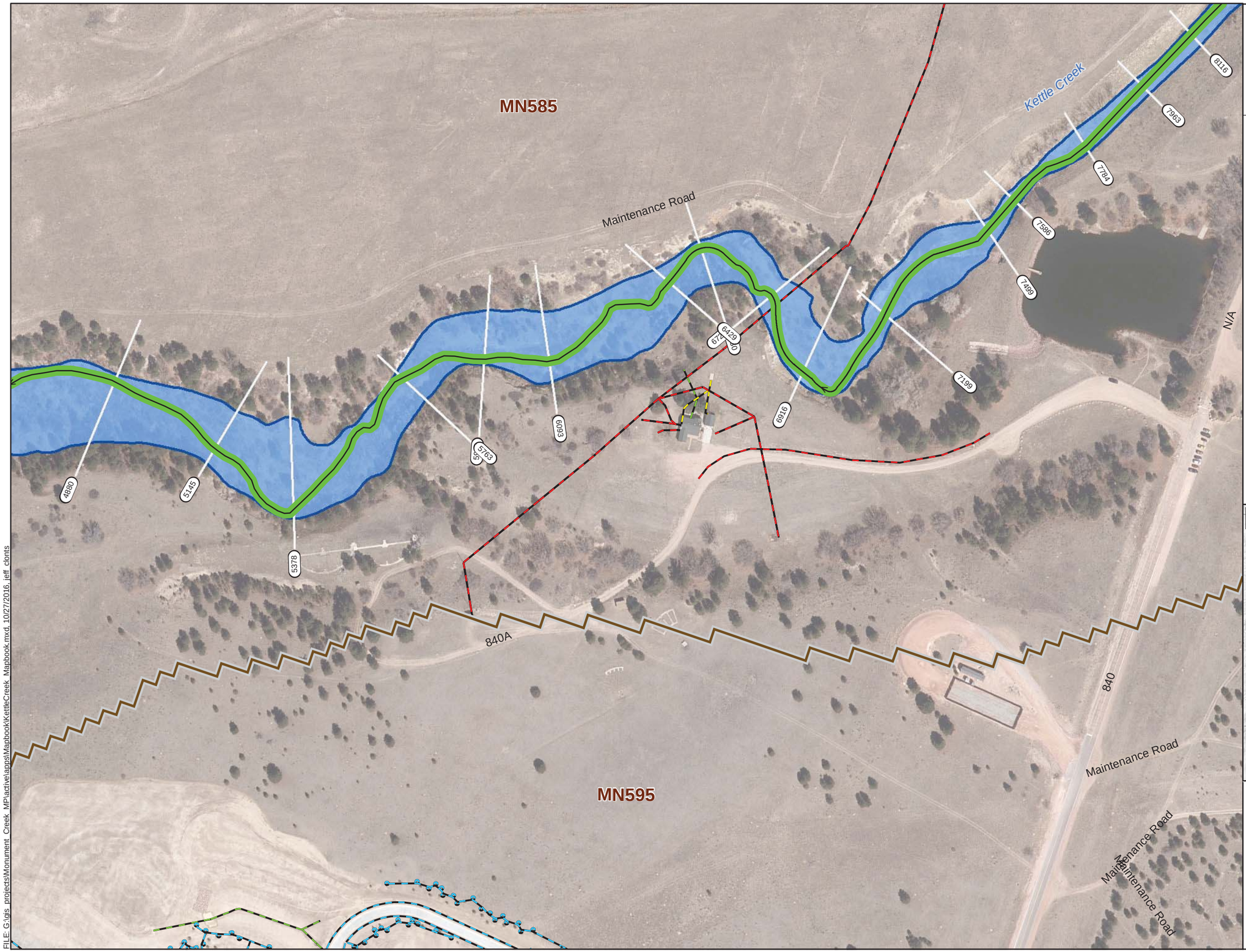


KC-5

Kettle Creek
Conceptual Plan
El Paso County, CO

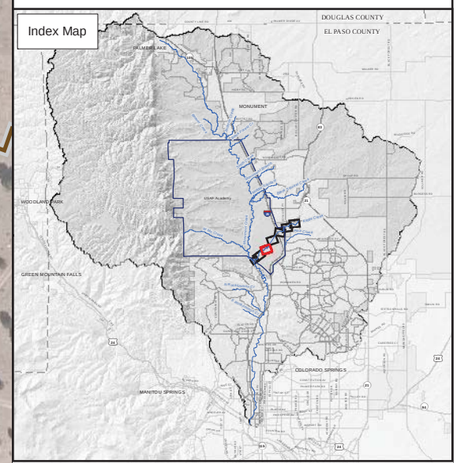
0 75 150
Feet

Legend

- Centerline
- Cross Section
- Floodplain
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



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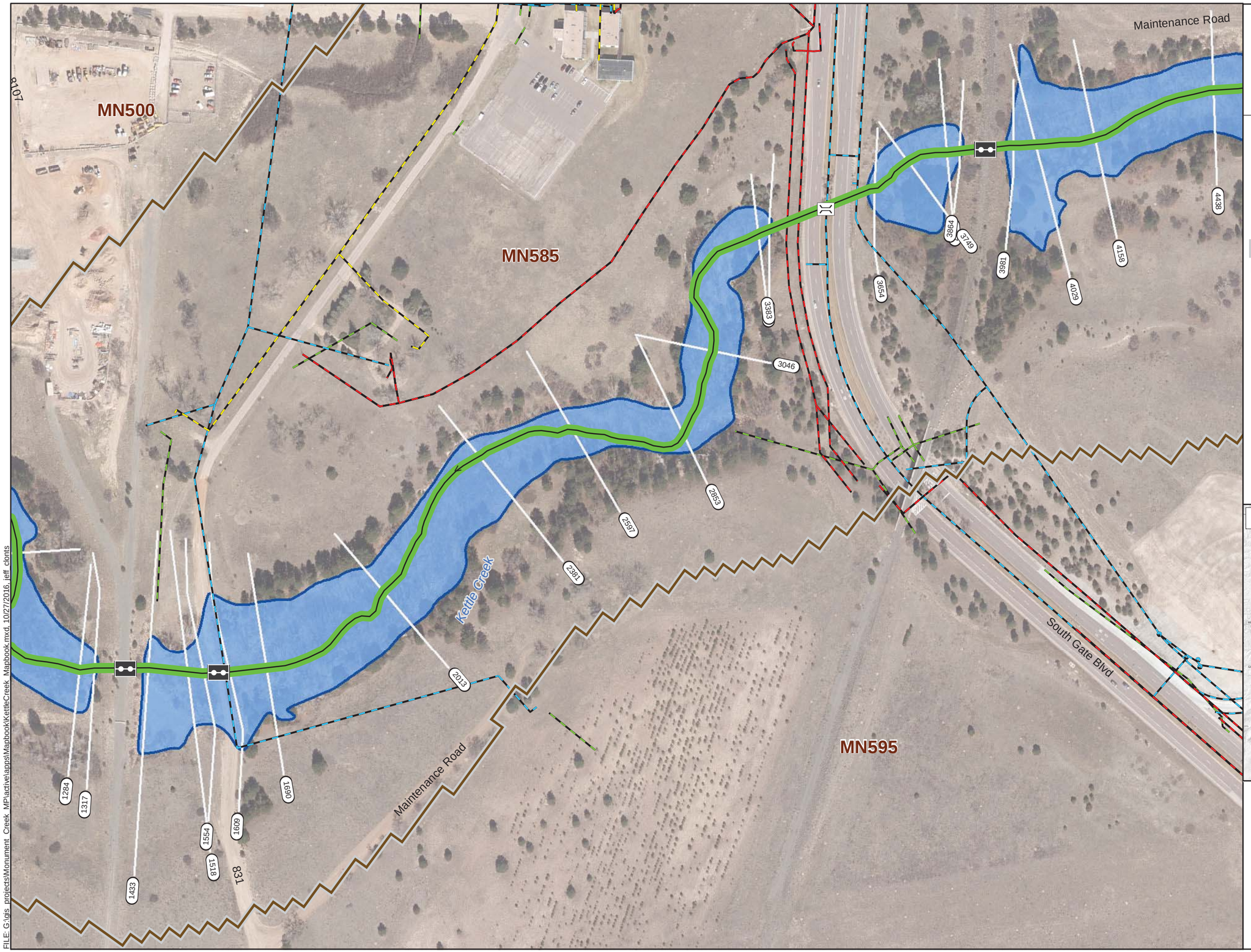


KC-6

Kettle Creek
Conceptual Plan
El Paso County, CO

0 75 150
Feet

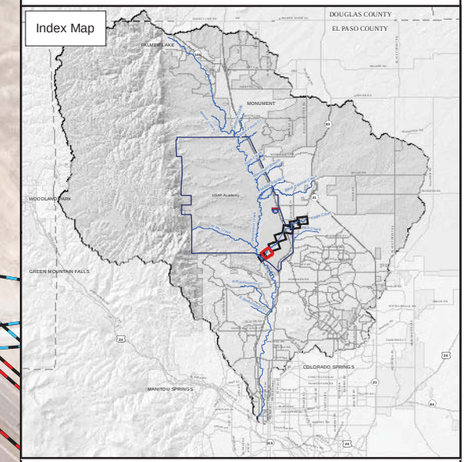
Legend

- Culvert
- Bridge
- Centerline
- Cross Section
- Floodplain
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map



Colorado Springs Utilities

El Paso County Colorado

Matrix Design Group

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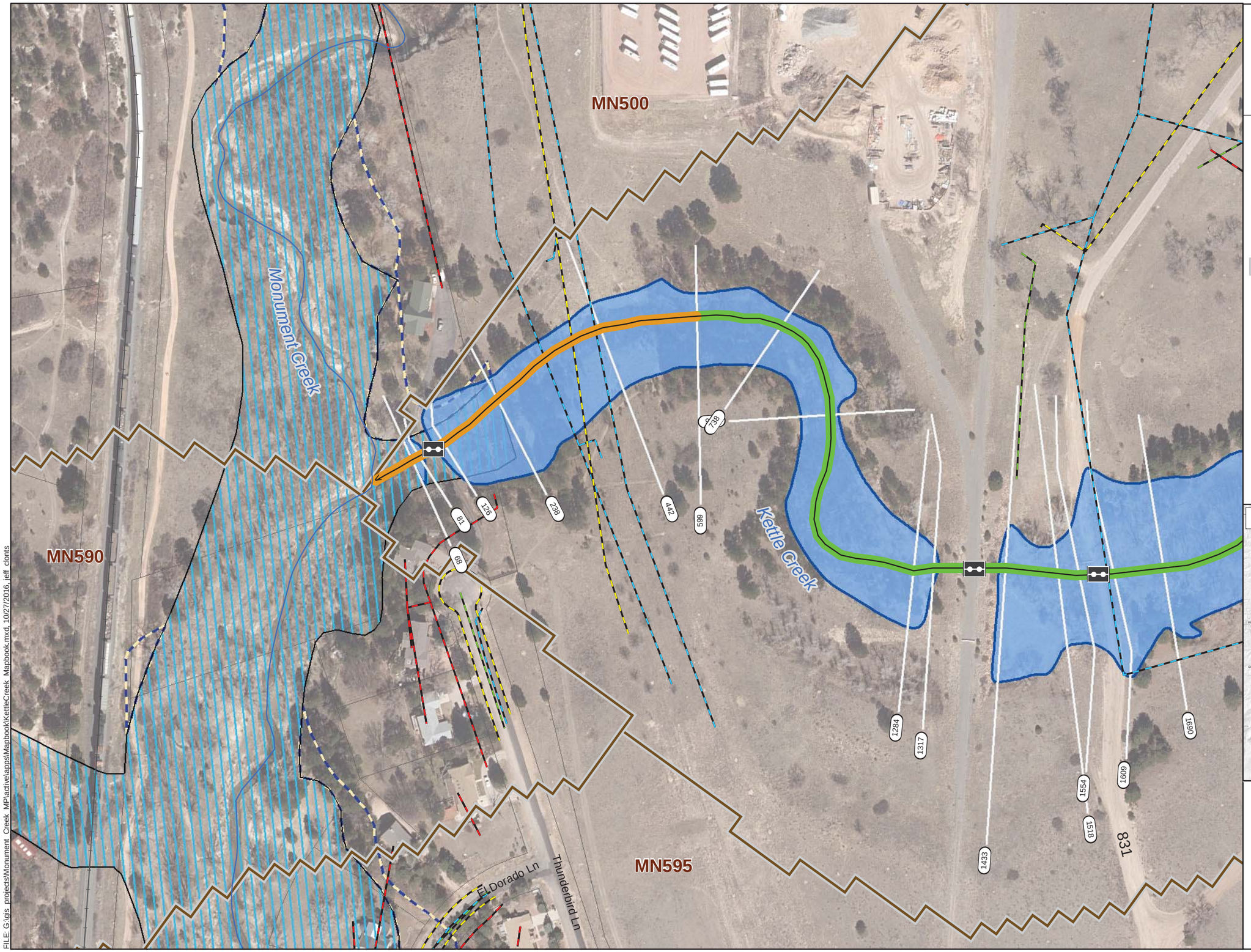


KC-7

Kettle Creek
Conceptual Plan
El Paso County, CO

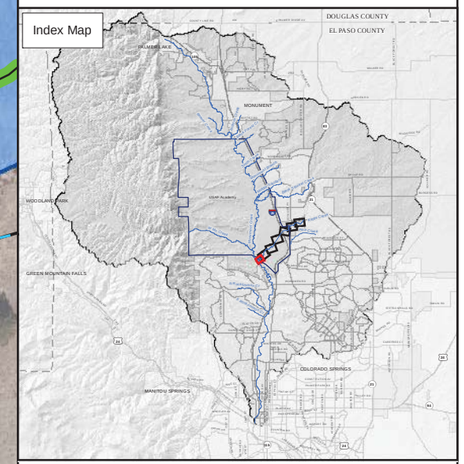
0 75 150
Feet

Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs Utilities
El Paso County Colorado
Matrix Design Group

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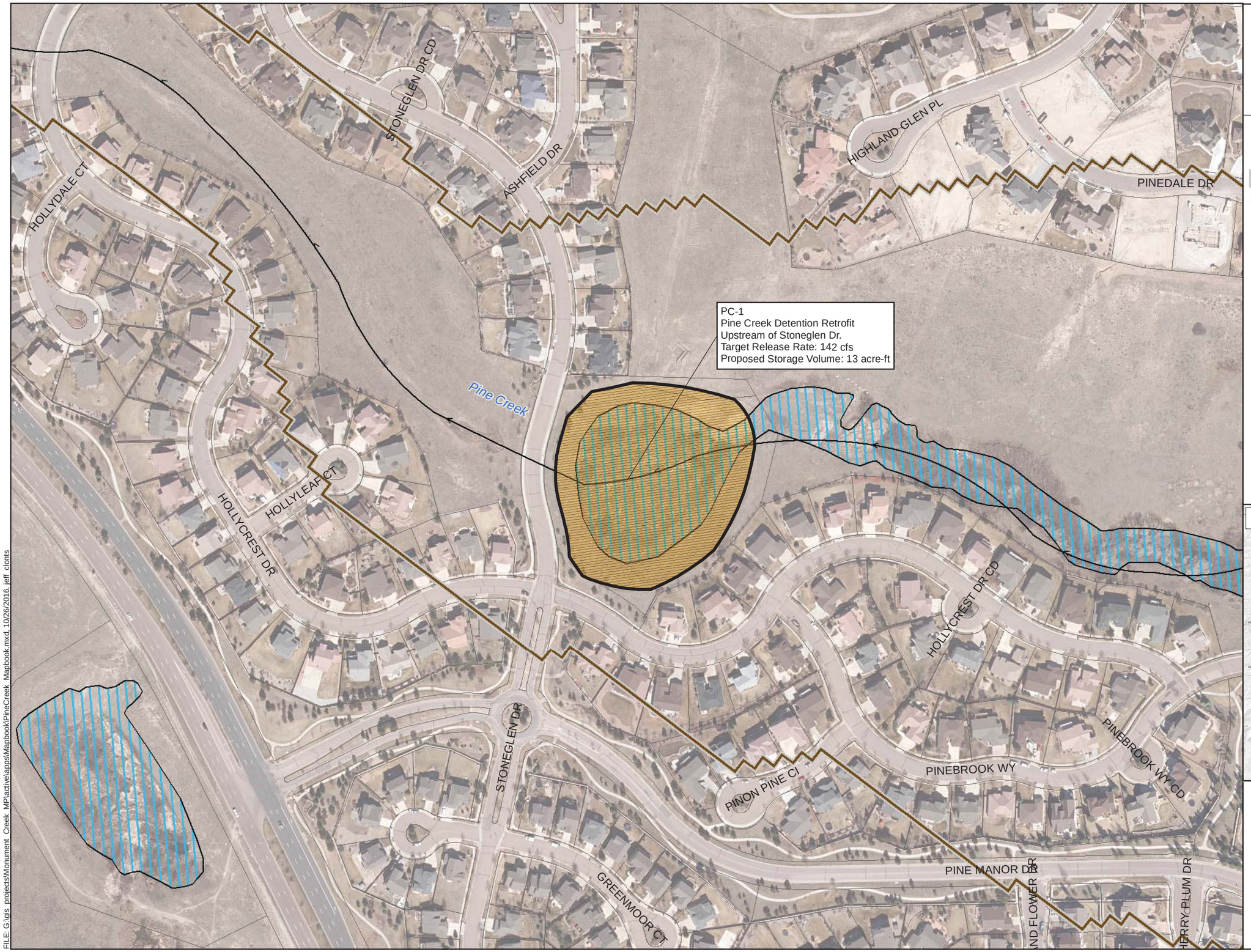


PC-1

Pine Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

- Centerline
- DFIRM 100-Year
- Subbasin
- CityParcels
- Railroads

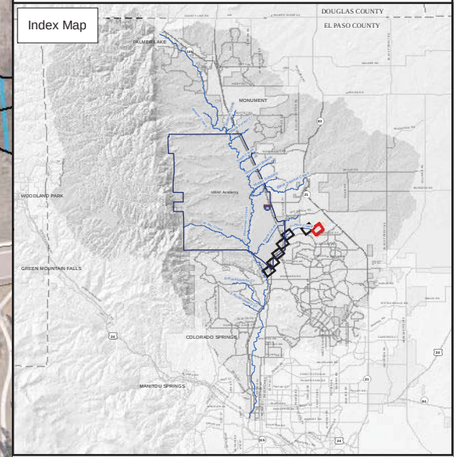
Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Detention, High

Index Map



Colorado Springs
Colorado Springs Utilities
DOLA
El Paso County Colorado
Matrix Design Group

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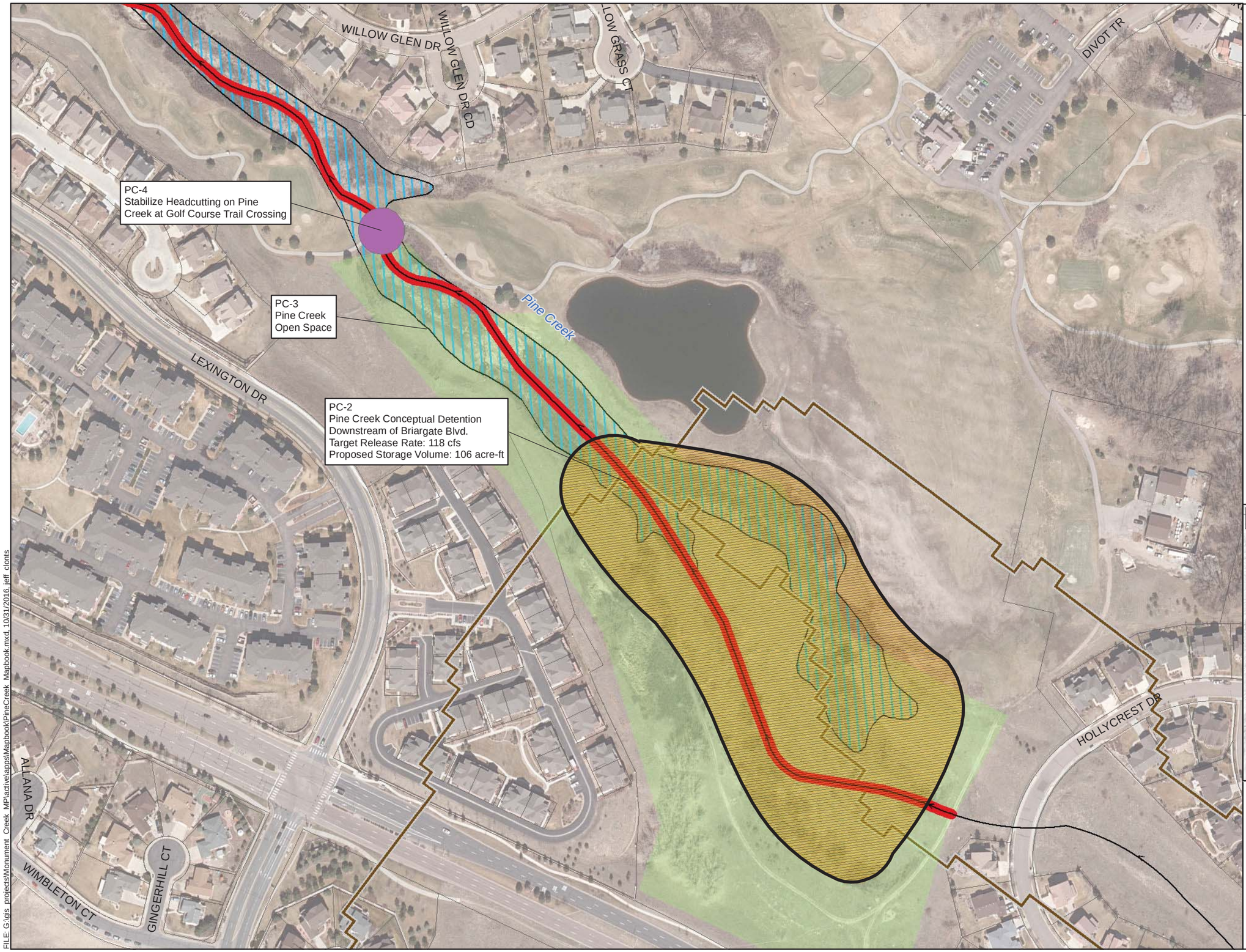


PC-2

Pine Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

- Centerline
- DFIRM 100-Year
- Subbasin
- CityParcels
- Railroads

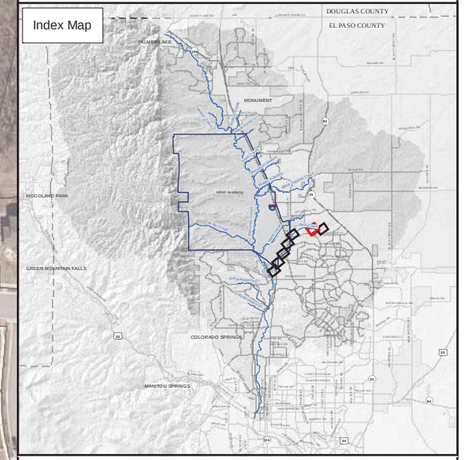
Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Detention, High
- Recreation, Low
- Stability, High

Index Map



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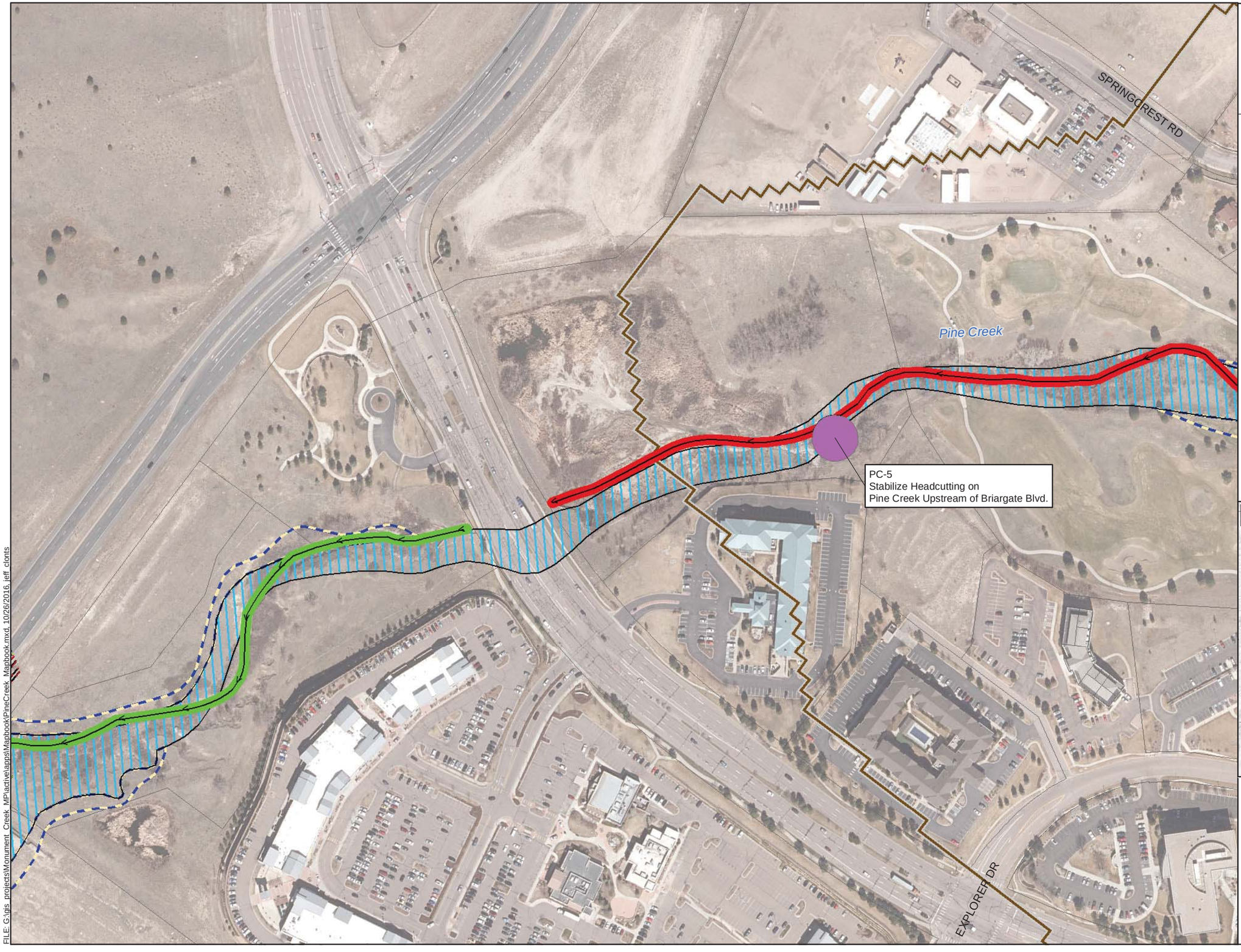


PC-3

Pine Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

- Centerline
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Water
- Wastewater

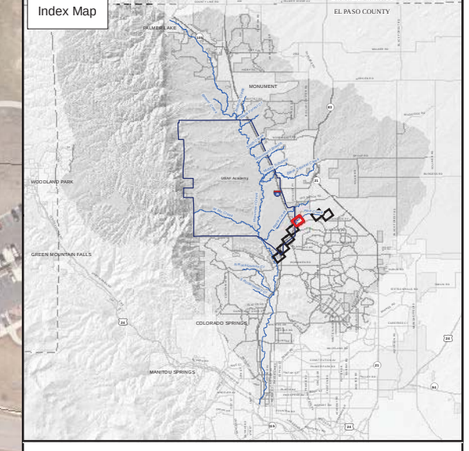
Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Stability, High

Index Map



Colorado Springs Utilities

El Paso County Colorado

Matrix Design Group

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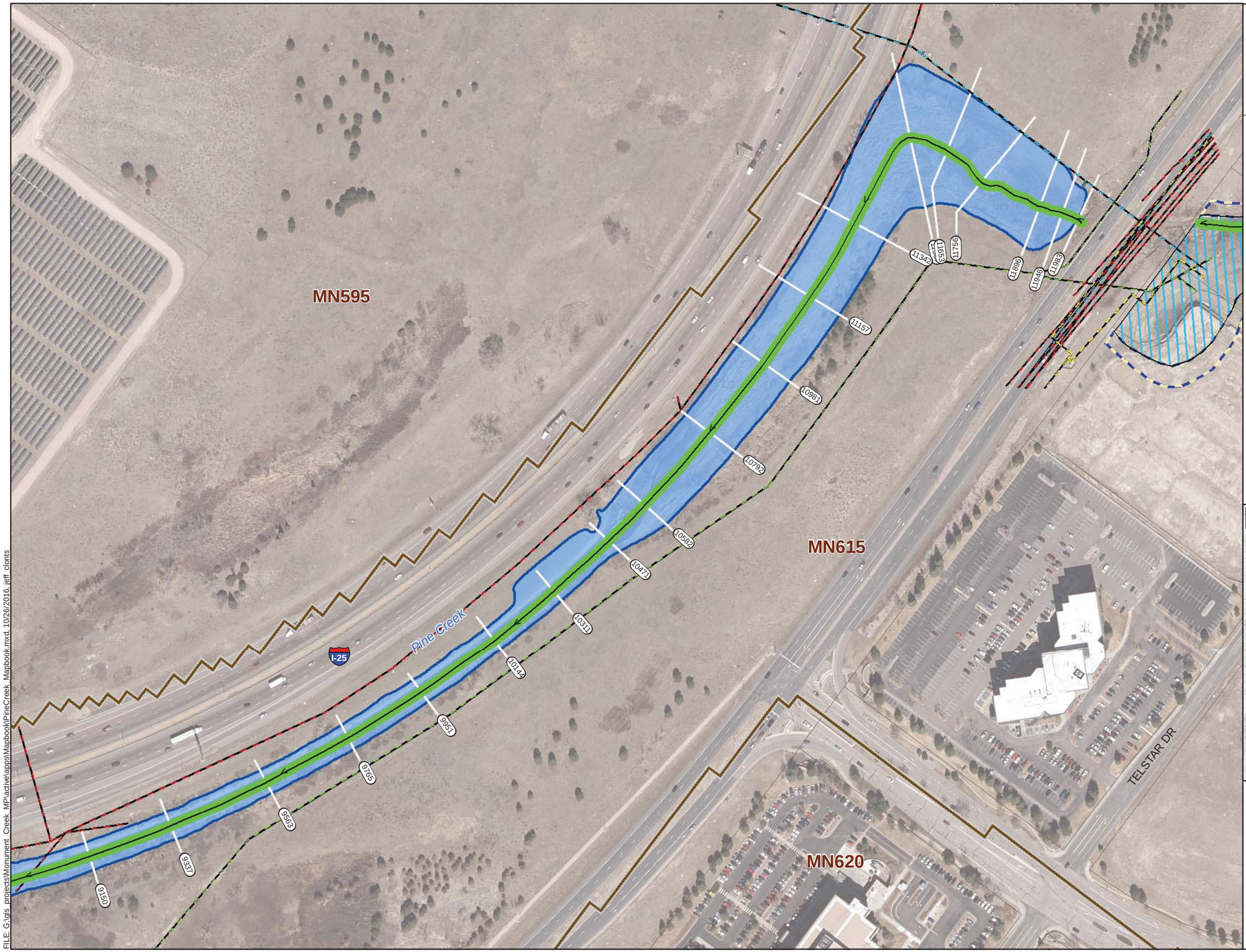


PC-4

Pine Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

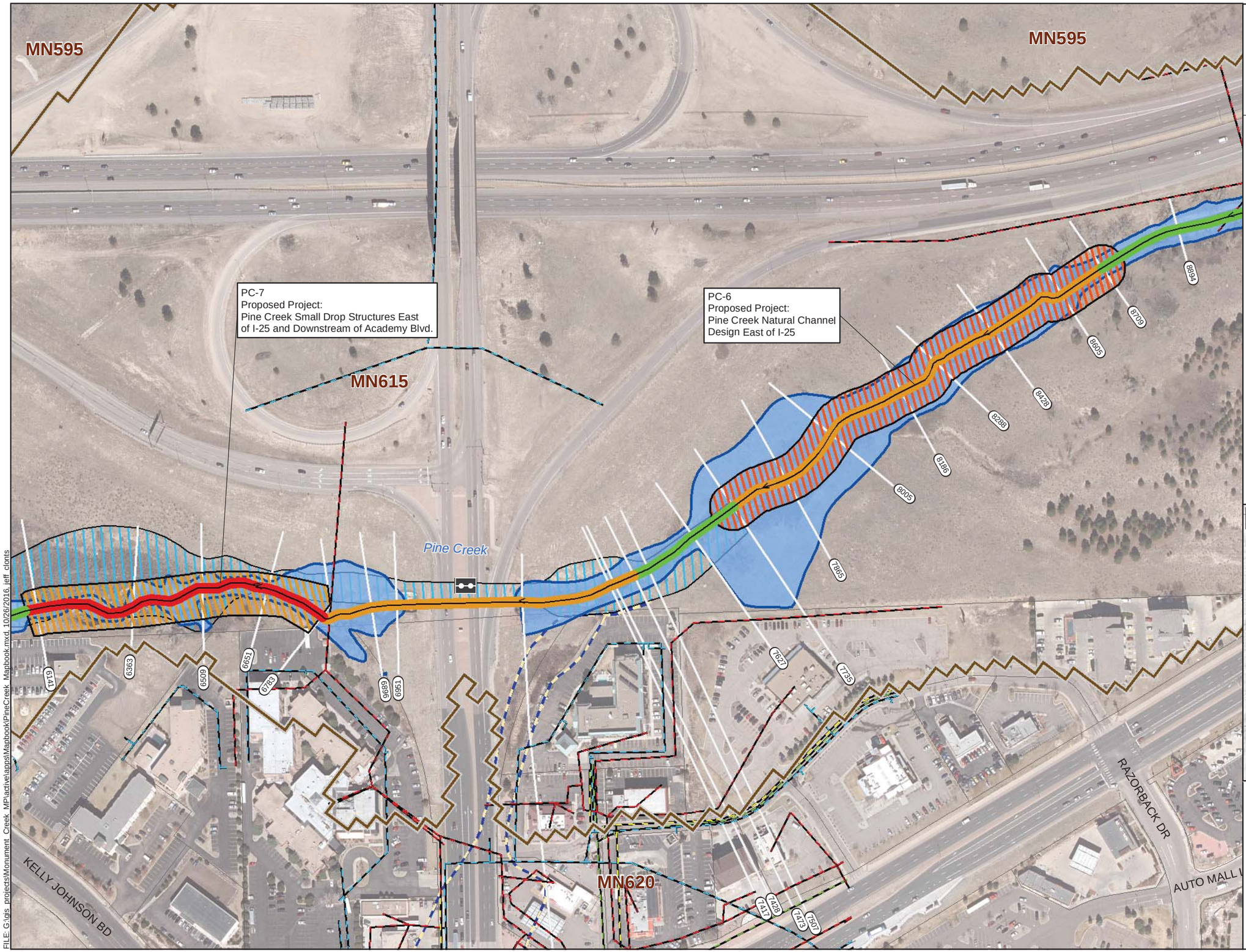
- Centerline
- XSCutLines
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Colorado Springs
Colorado Springs Utilities
DOLA
El Paso County Colorado
Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\PineCreek_Mapbook.mxd, 10/26/2016, jeff_clonts



PC-5

Pine Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

- Culvert
- Centerline
- XSCutLines
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Water
- Wastewater

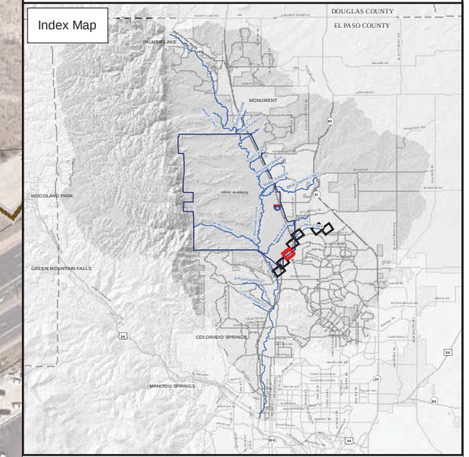
Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

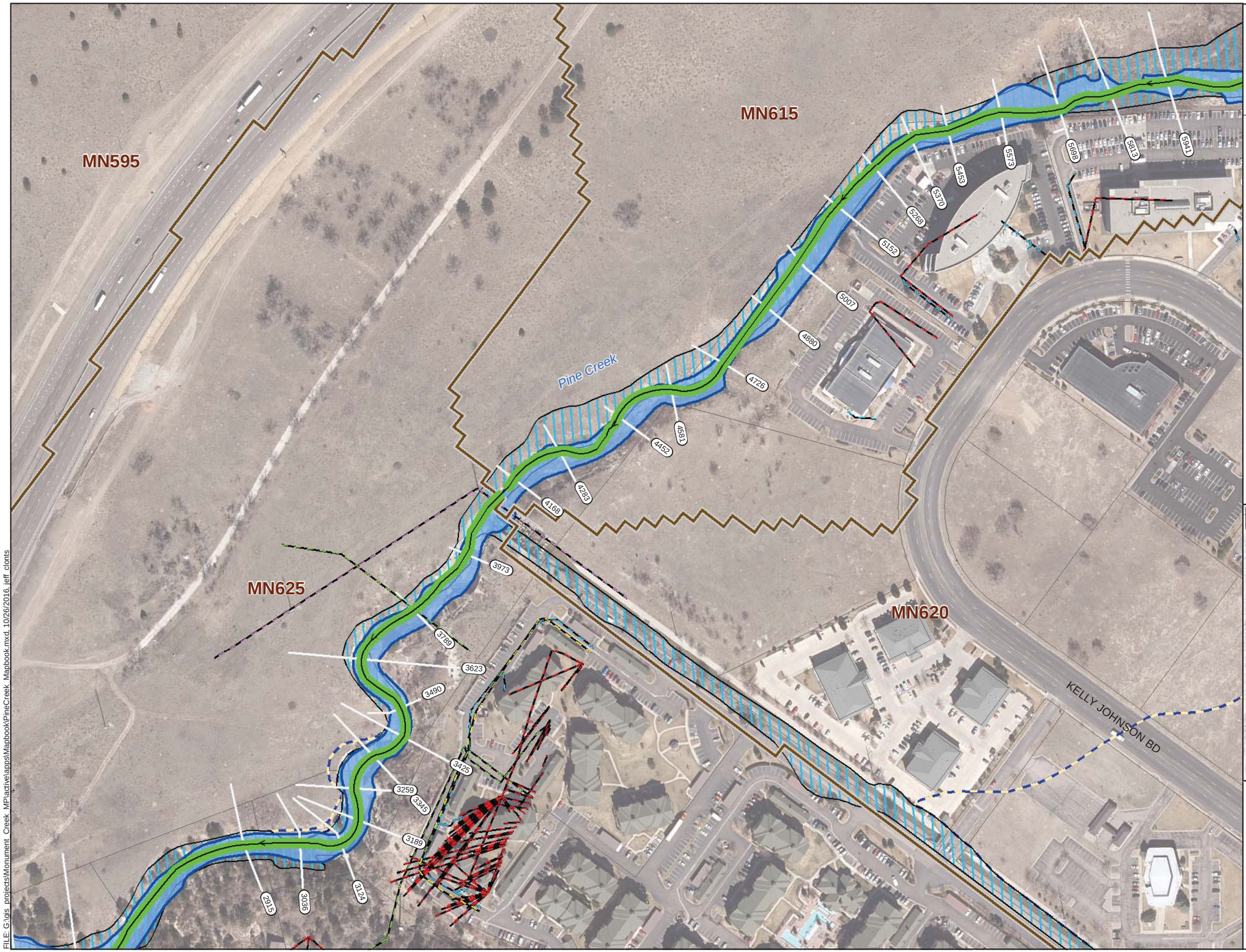
- Reach, High
- Reach, Moderate

Index Map



Colorado Springs Utilities
Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\MapbookPineCreek_Mapbook.mxd, 10/26/2016, jeff_clonts



PC-6

Pine Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

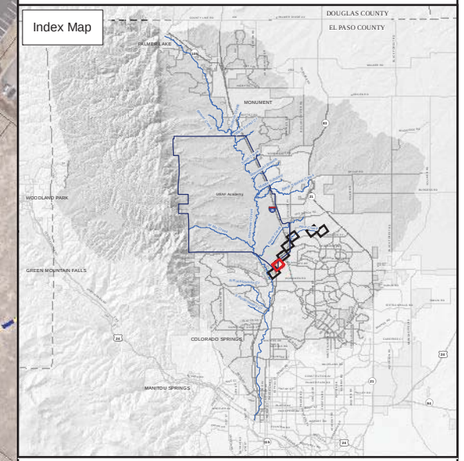
Legend

- Centerline
- XSCutLines
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Overhead Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map



Colorado Springs Utilities

Matrix DESIGN GROUP

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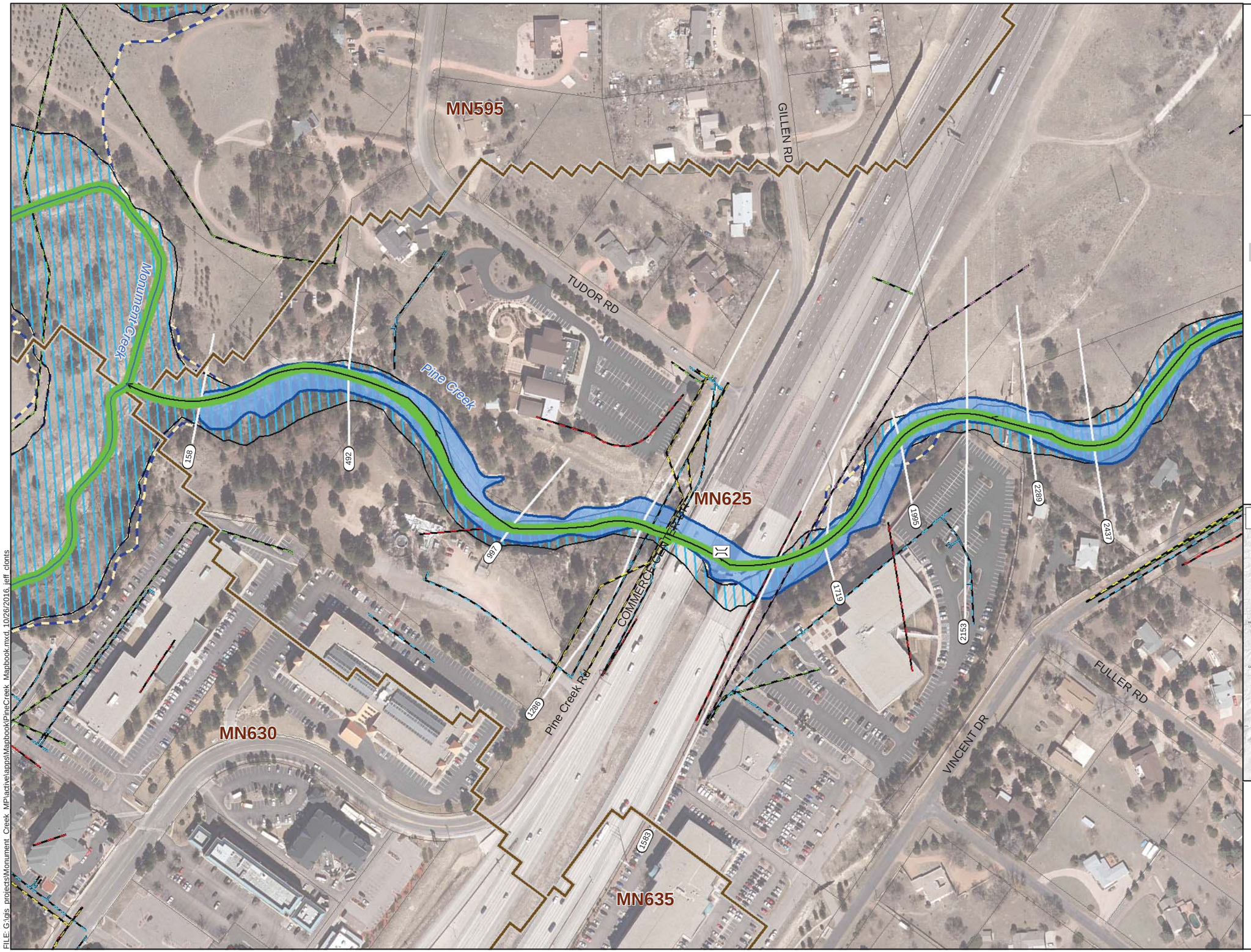


PC-7

Pine Creek
Conceptual Plan
El Paso County, CO

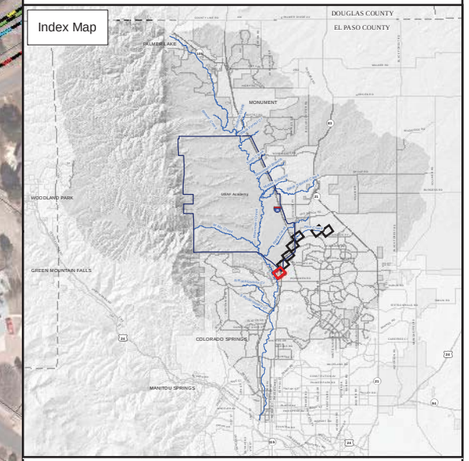
0 100 200
Feet

Legend

- Bridge
- Centerline
- XSCutLines
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Overhead Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs
Colorado Springs Utilities
DOLA
El Paso County Colorado
Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\PineCreek_Mapbook.mxd, 10/26/2016, jeff_clonts

NR-1

North Rockrimmon Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

NRR-1
Proposed Project:
Culvert Replacement
at War Eagle Dr. North
Proposed Size: 4 Box
Culverts, 6ft (H) x 10ft (W)

MN660

MN665

OAK HILLS DR
DARK HORSE DR
WINTER HAWK CI
Allegheny Dr
BLACKHAWK DR
BLACKHAWK CDS DR
WAR EAGLE DR
WAR EAGLE CI
WAR EAGLE CD DR
FLYING EAGLE PL
GREY EAGLE LN
HASTINGS DR
GREY EAGLE CI
E FALCON CT
North Rockrimmon

Legend

- Culvert
- Bridge
- Centerline
- Cross Section
- DFIRM 100-Year
- Subbasin
- Floodplain
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Rank

- Flood Risk Reduction, Moderate

Index Map

Matrix DESIGN GROUP

FILE: G:\gis_projects\Monument_Creek_MP\activeApps\MapbookNN_Rockrimmon_Manbook.mxd, 10/27/2016, jeff_clonts

NR-2

North Rockrimmon Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

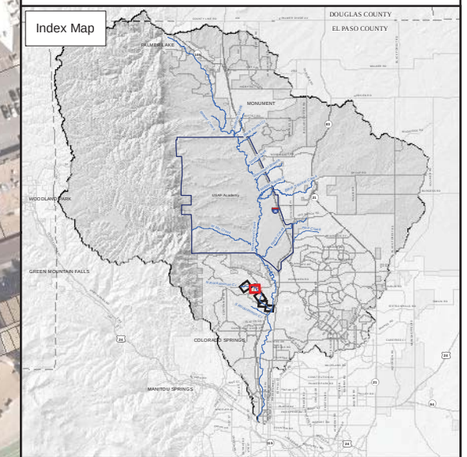
Legend

- Culvert
- Bridge
- Centerline
- Cross Section
- DFIRM 100-Year
- Subbasin
- Floodplain
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map



Matrix DESIGN GROUP

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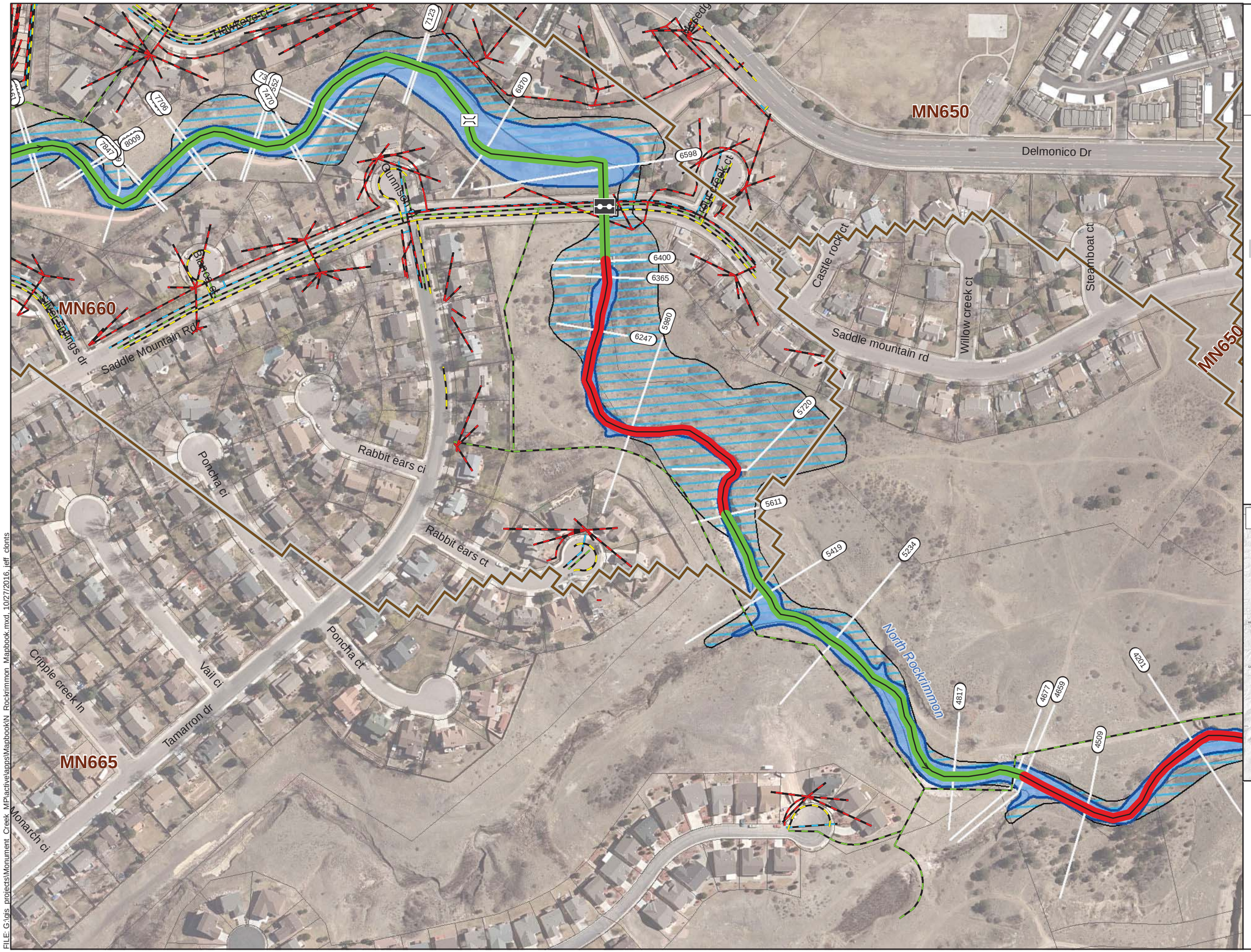


NR-3

North Rockrimmon Creek
Conceptual Plan
El Paso County, CO

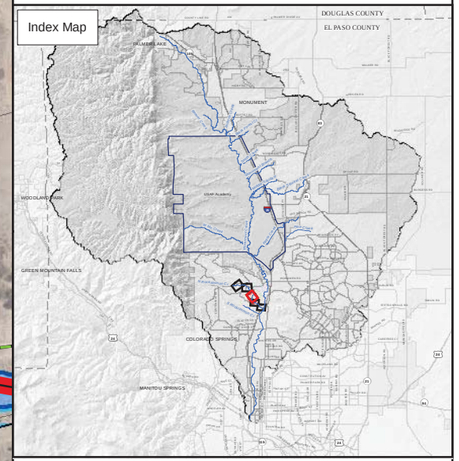
0 100 200
Feet

Legend

- Culvert
- Bridge
- Centerline
- Cross Section
- DFIRM 100-Year
- Subbasin
- Floodplain
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs Utilities
El Paso County
Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\activeApps\MapbookNR_Rockrimmon_Mapbook.mxd, 10/27/2016, jeff_clonts

NR-4

North Rockrimmon Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

- Culvert
- Centerline
- Cross Section
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Floodplain
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

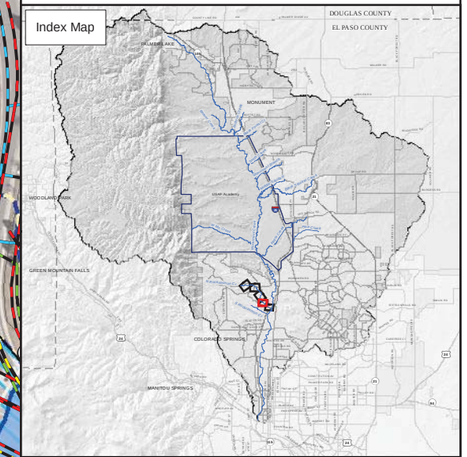
Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Rank

- Flood Risk Reduction, Moderate

Index Map



MN650
MN665
MN675
North Rockrimmon
Rockrimmon Blvd S
Delmonico Dr
Pro Rodeo Dr
4817
4677
4659
4509
4201
3971
3725
3478
2996
2746
2079

NRR-2
Proposed Project:
Levee Installation at S. Rockrimmon Blvd.
Downstream of Pro Rodeo Dr.
Proposed Levee Length: 400LF
Proposed Levee Height: 4LF

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\MapbookIN_Rockrimmon_Mapbook.mxd, 10/27/2016, jeff_clonts

NR-5

North Rockrimmon Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

- Culvert
- Bridge
- Centerline
- Cross Section
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Floodplain
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Rank

- Flood Risk Reduction, Moderate

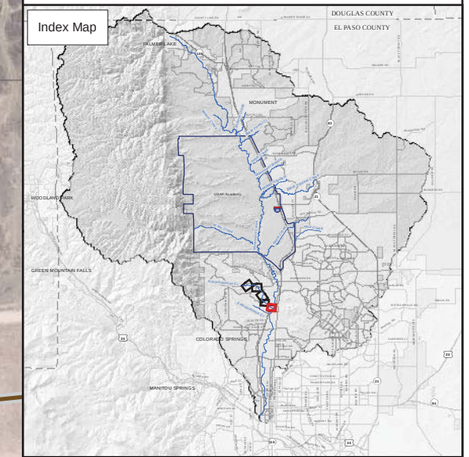
NRR-2
Proposed Project:
Levee Installation at S. Rockrimmon Blvd.
Downstream of Pro Rodeo Dr.
Proposed Levee Length: 400LF
Proposed Levee Height: 4LF

MN655
MN665
MN670
MN675

Rockrimmon Blvd
Pro Rodeo Dr
N Rockrimmon Cr
Monument Creek
I-25

2079
1856
1678
1373
1316
1077
1051
598
580
2021

Index Map



Colorado Springs
Colorado Springs Utilities
DOLA
El Paso County Colorado
Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\N_Rockrimmon_Mapbook.mxd, 10/27/2016, jeff_clonts

SR-1

South Rockrimmon Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

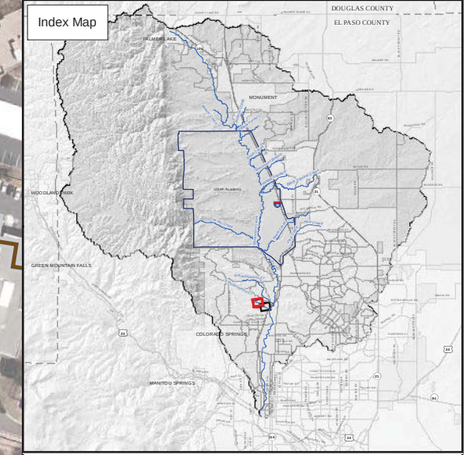
Legend

- Centerline
- Cross Section
- Floodplain
- Subbasin
- Railroads
- CityParcels
- Underground Electric
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map



Colorado Springs Utilities

El Paso County
Colorado

Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\MapbookKS_Rockrimmon_Mapbook.mxd, 10/26/2016, jeff_clonts

SR-2

South Rockrimmon Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

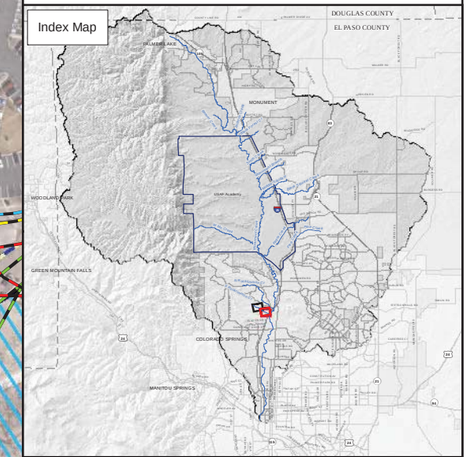
Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Index Map



Colorado Springs Utilities

El Paso County Colorado

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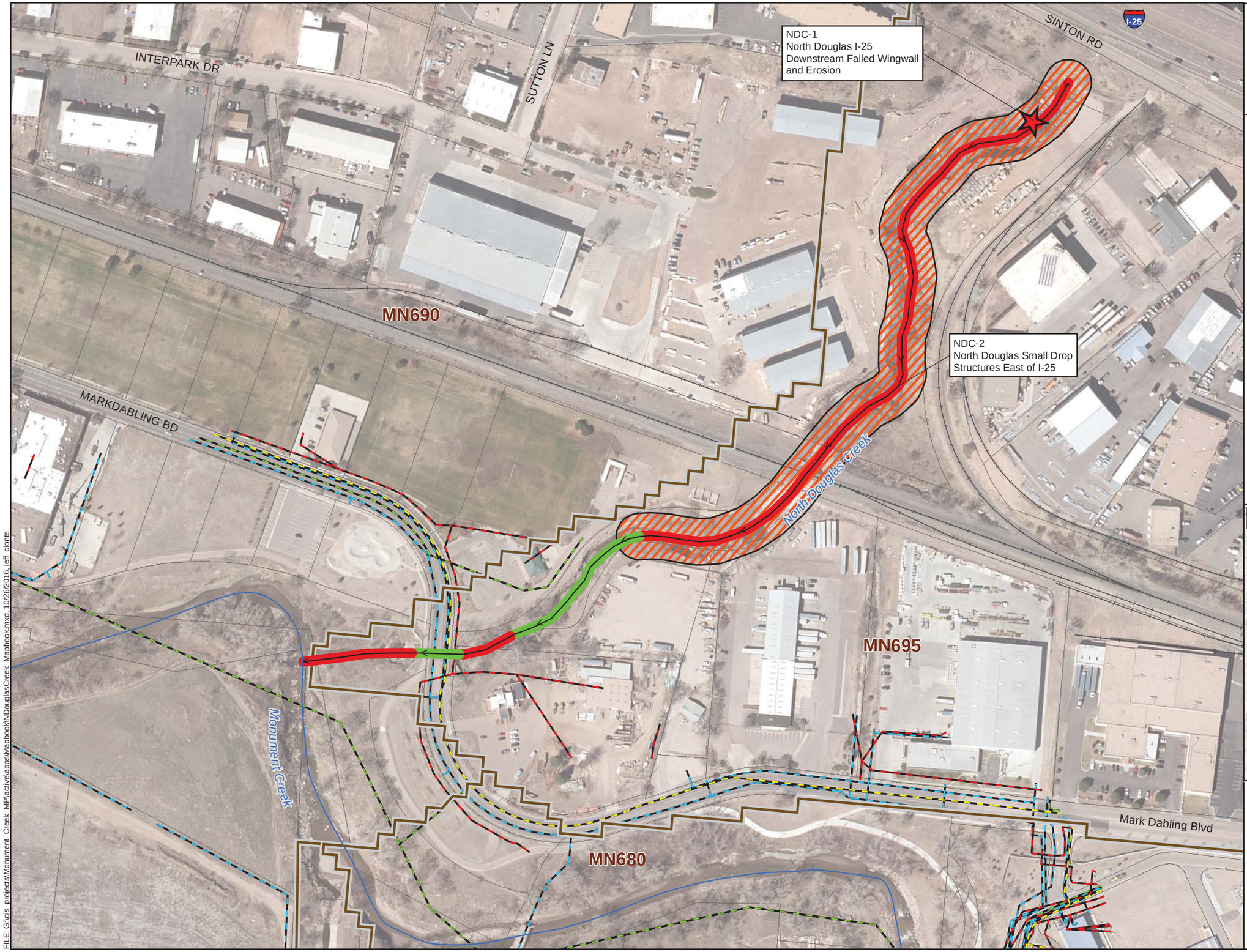


NDC-1

North Douglas Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

- Centerline
- Subbasin
- CityParcels
- Railroads
- Gas
- Underground Electric
- Water
- Wastewater

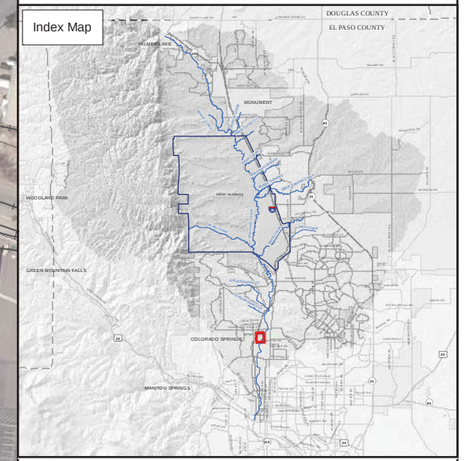
Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Reach, High
- Immediate Action Project

Index Map



Colorado Springs Utilities

El Paso County Colorado

Matrix Design Group

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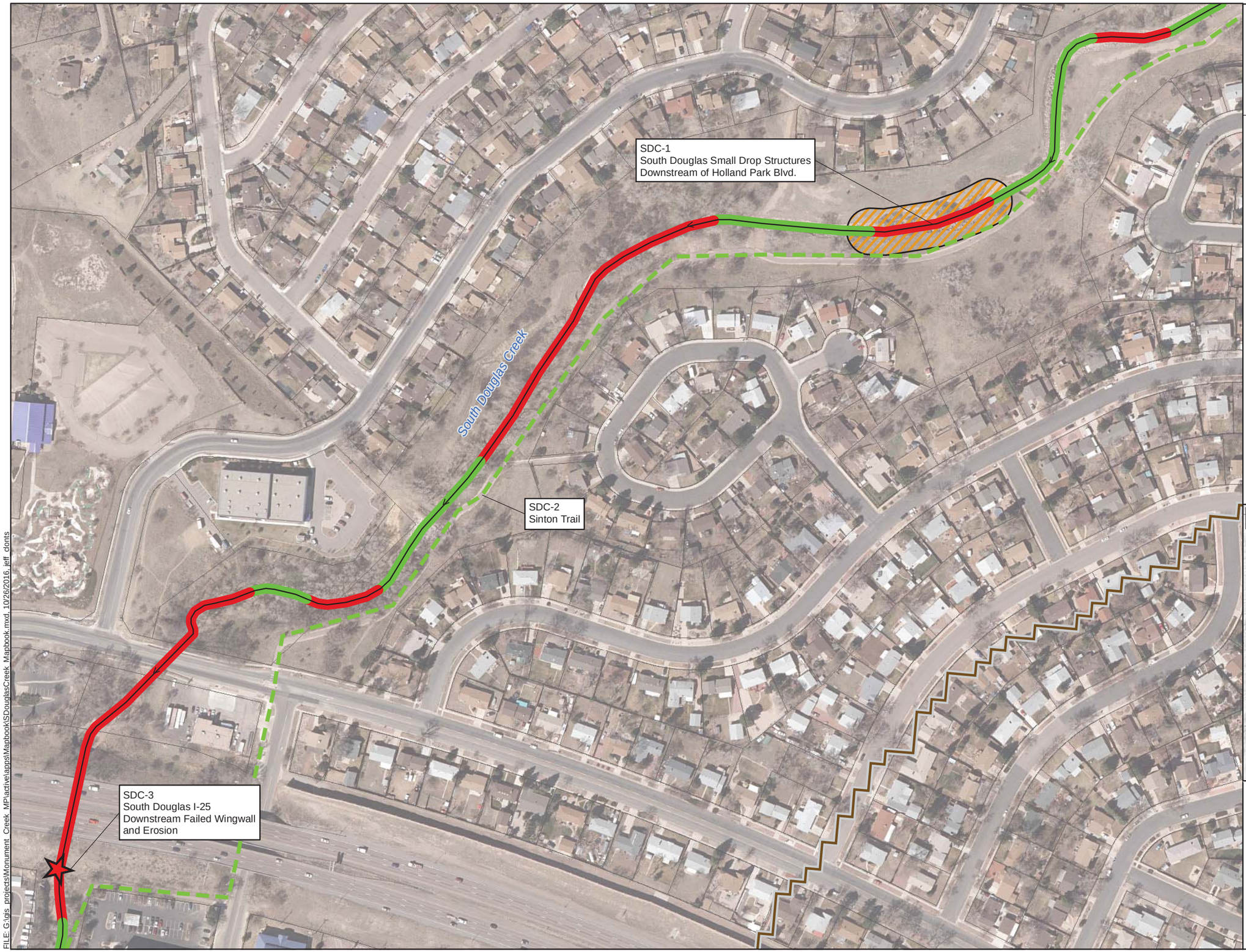


SDC-1

North Douglas Creek
Conceptual Plan
El Paso County, CO

0 100 200
Feet

Legend

- Centerline
- Subbasin
- CityParcels
- Railroads

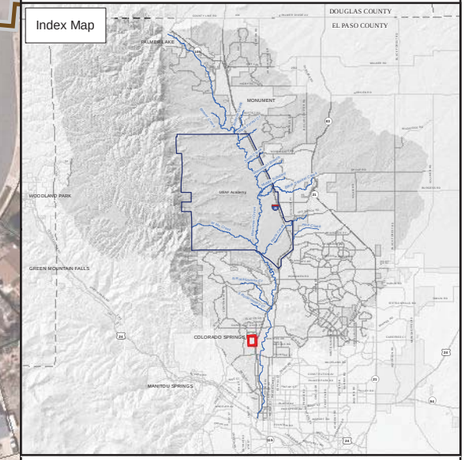
Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Rank

- Reach, Moderate
- Recreation, Low
- Immediate Action Project

Index Map



Matrix DESIGN GROUP

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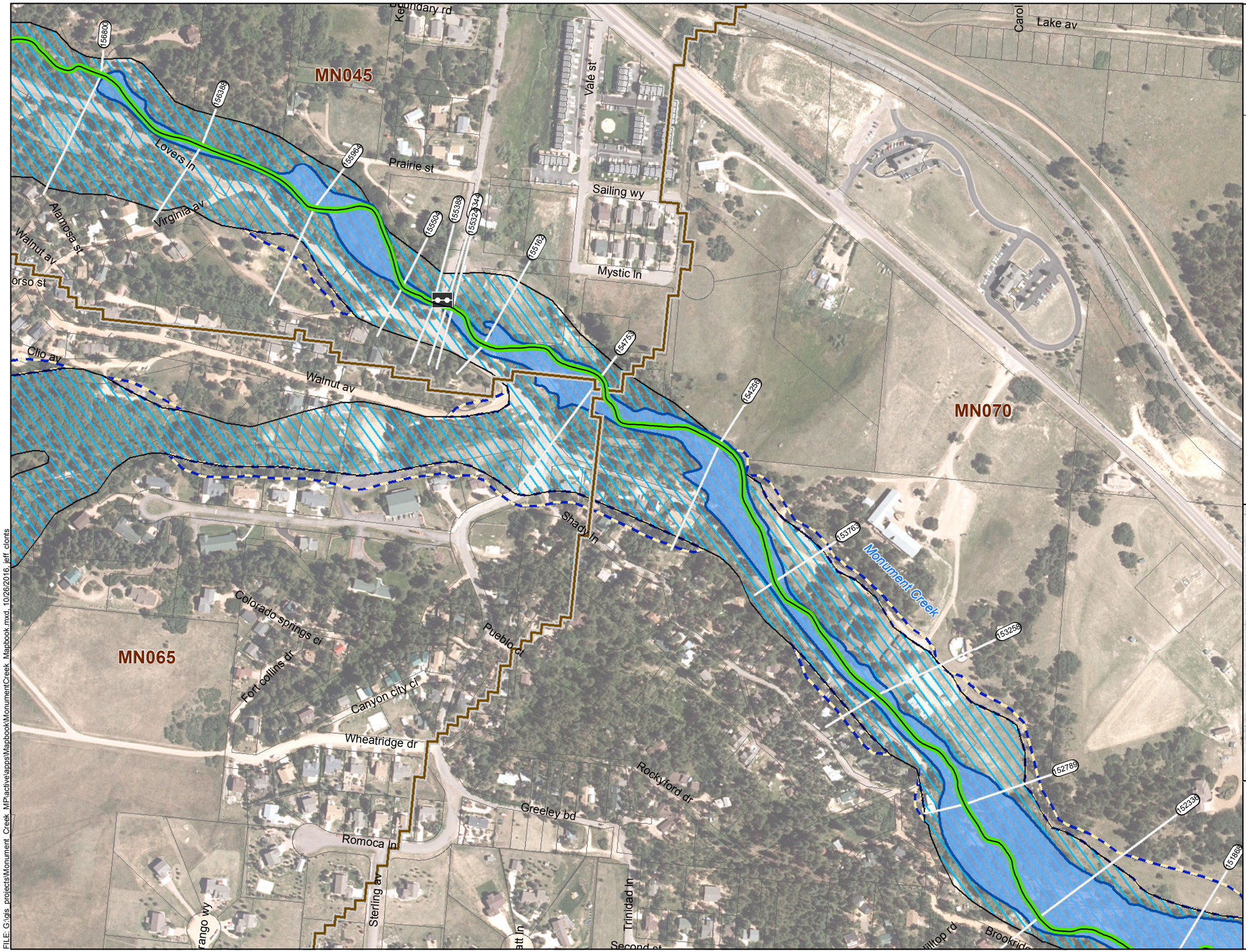


MC-1

Monument Creek
Conceptual Plan
El Paso County, CO

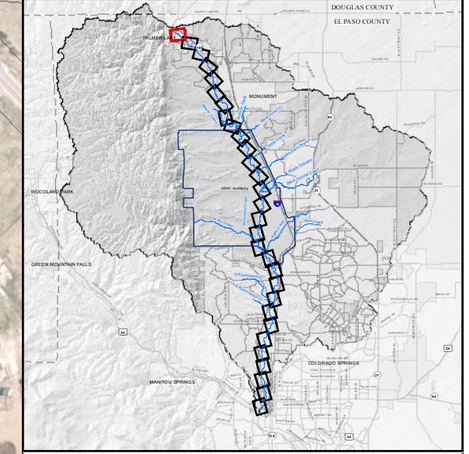
0 150 300
Feet

Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs Utilities
El Paso County Colorado
Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\MonumentCreek_Mapbook.mxd 10/26/2016 jeff clonts

MC-2

Monument Creek
Conceptual Plan
El Paso County, CO

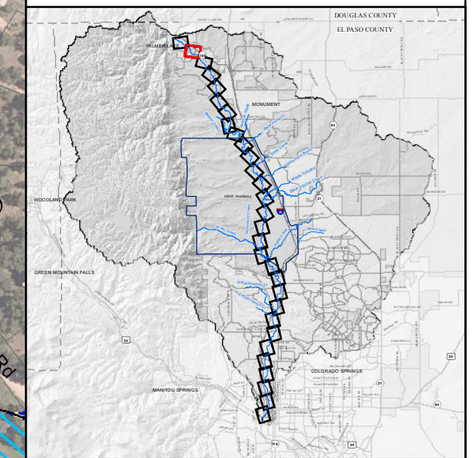
0 150 300
Feet

Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs Utilities
It's how we're all connected

El Paso County Colorado

Matrix Design Group

MN075

MN070

Monument Creek

Red Rock Ranch Dr

Rockbrook Rd

Forest View Rd

Douglas Ave

Forest view wy

El Rancho Way

163

152336 151863 151385 151025 150723 150304 149883 149590 149466 149169 148948 148789 148413 148198 147870 147509

FILE: G:\gis_projects\Monument_Creek_MPactive\apps\Mapbook\MonumentCreek_Mapbook.mxd, 10/26/2016, jeff_clonts

MC-3

Monument Creek
Conceptual Plan
El Paso County, CO

0 150 300
Feet

Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Riparian, Low

MN080
MN095
MN075
MN085
Monument Creek
MCM-1
Proposed Project:
Monument Creek Riparian
Restoration at Oxbridge Rd.
Westward ln
Meadow ln
Peakview bd
Range view rd
Vista view dr
Mesa verde rd
Summertime ct
Sunburst dr
Sunstar ct
163
431
1284
147075
146700
146243
145836
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144479
143996
143887
143860
143802
143616
143776
143165
142668
142178

FILE: G:\gis_projects\Monument_Creek_MP\activeApps\Mapbook\MonumentCreek_Mapbook.mxd 10/26/2016 jeff clonts

MC-4

Monument Creek
Conceptual Plan
El Paso County, CO

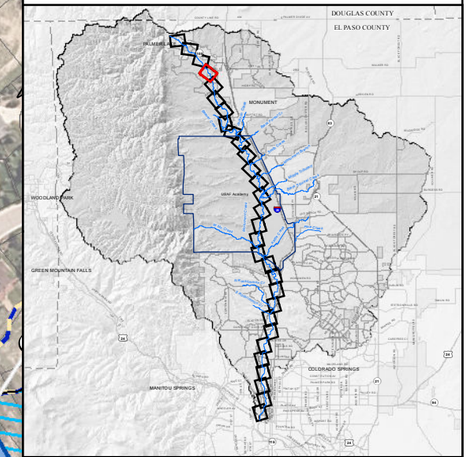
0 150 300
Feet

Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs Utilities

El Paso County
Colorado

Matrix Design Group

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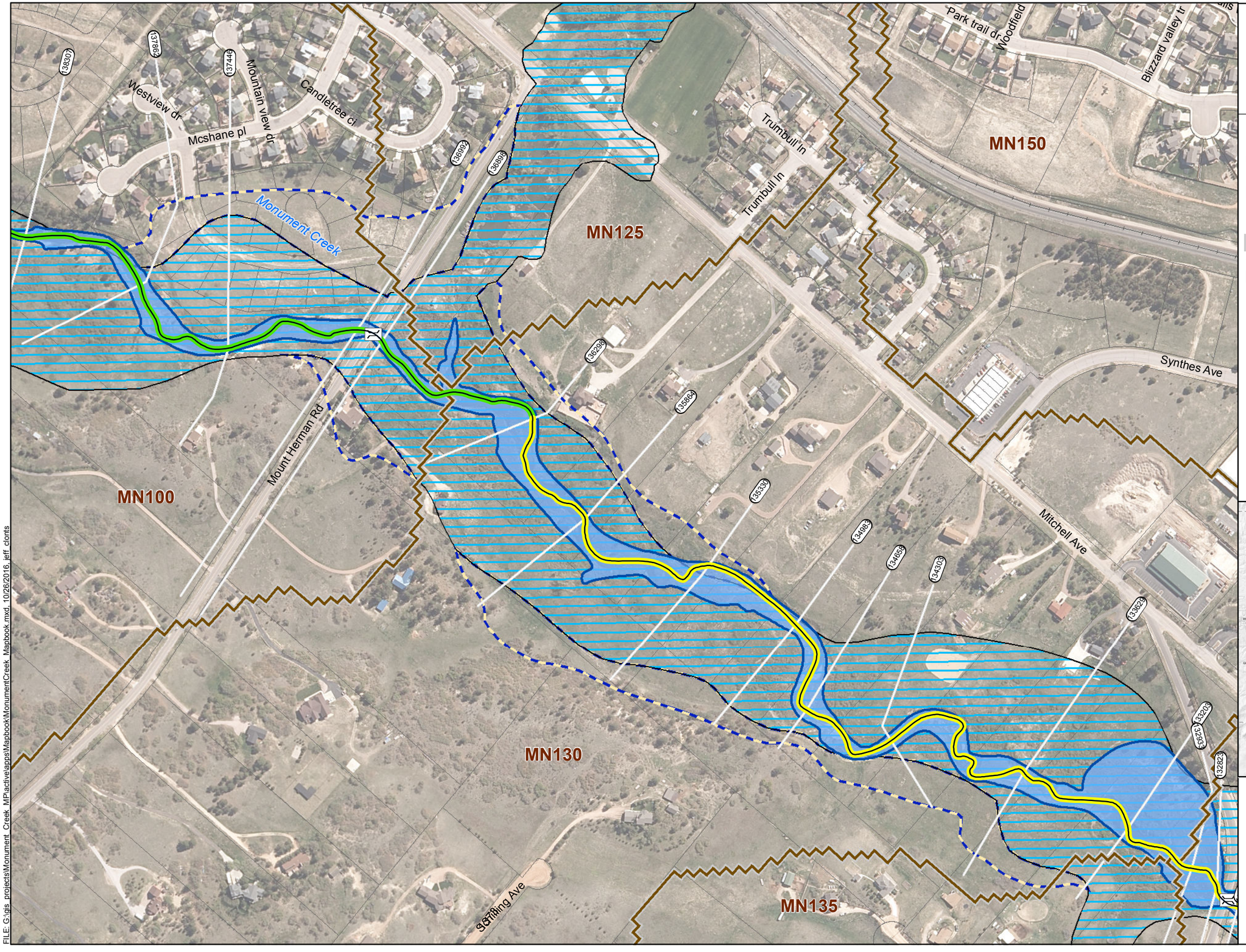

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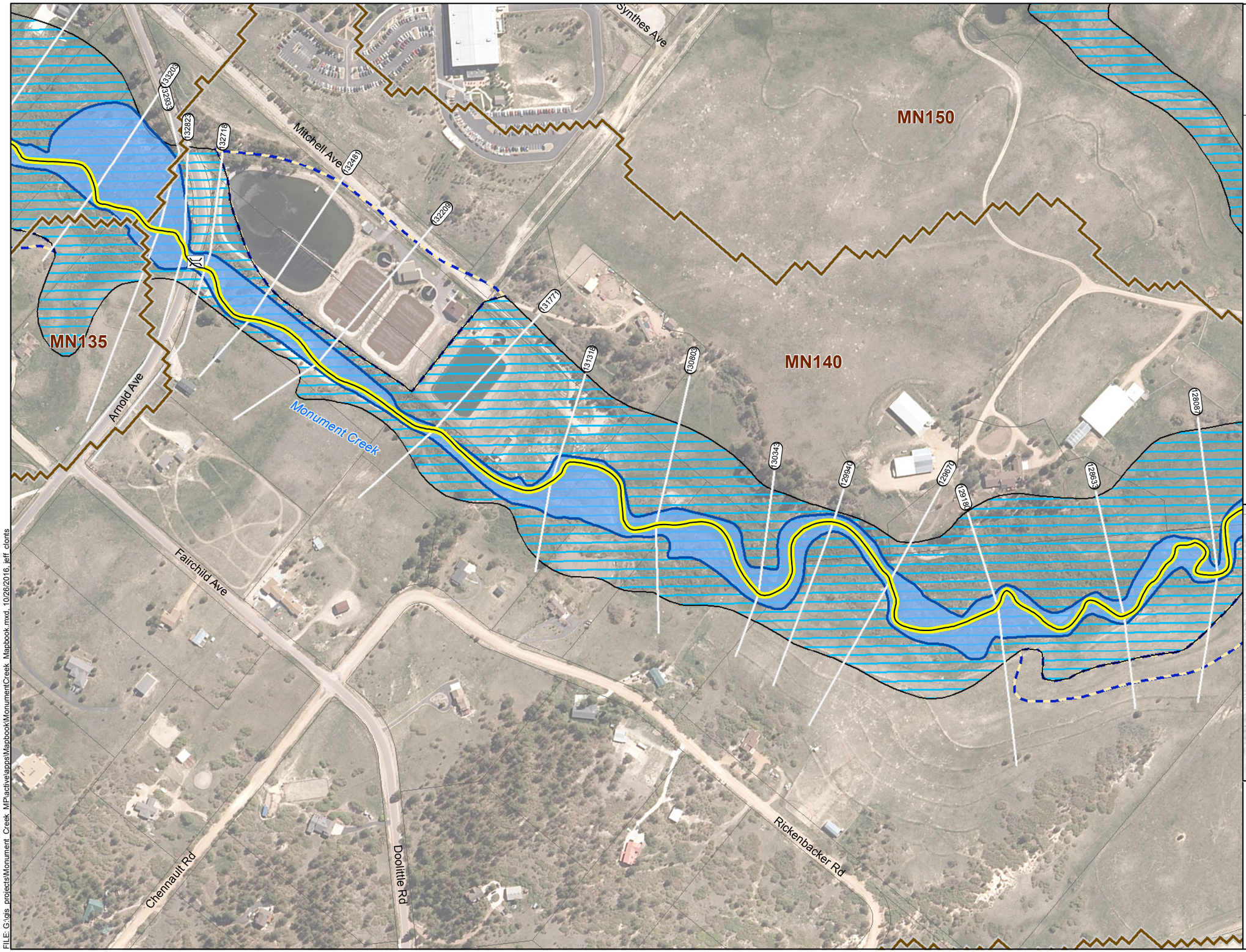


MC-6

Monument Creek
Conceptual Plan
El Paso County, CO

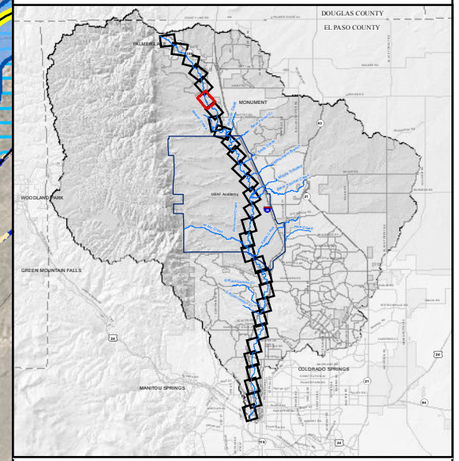
0 150 300
Feet

Legend

- Bridge
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs Utilities
El Paso County
Matrix Design Group

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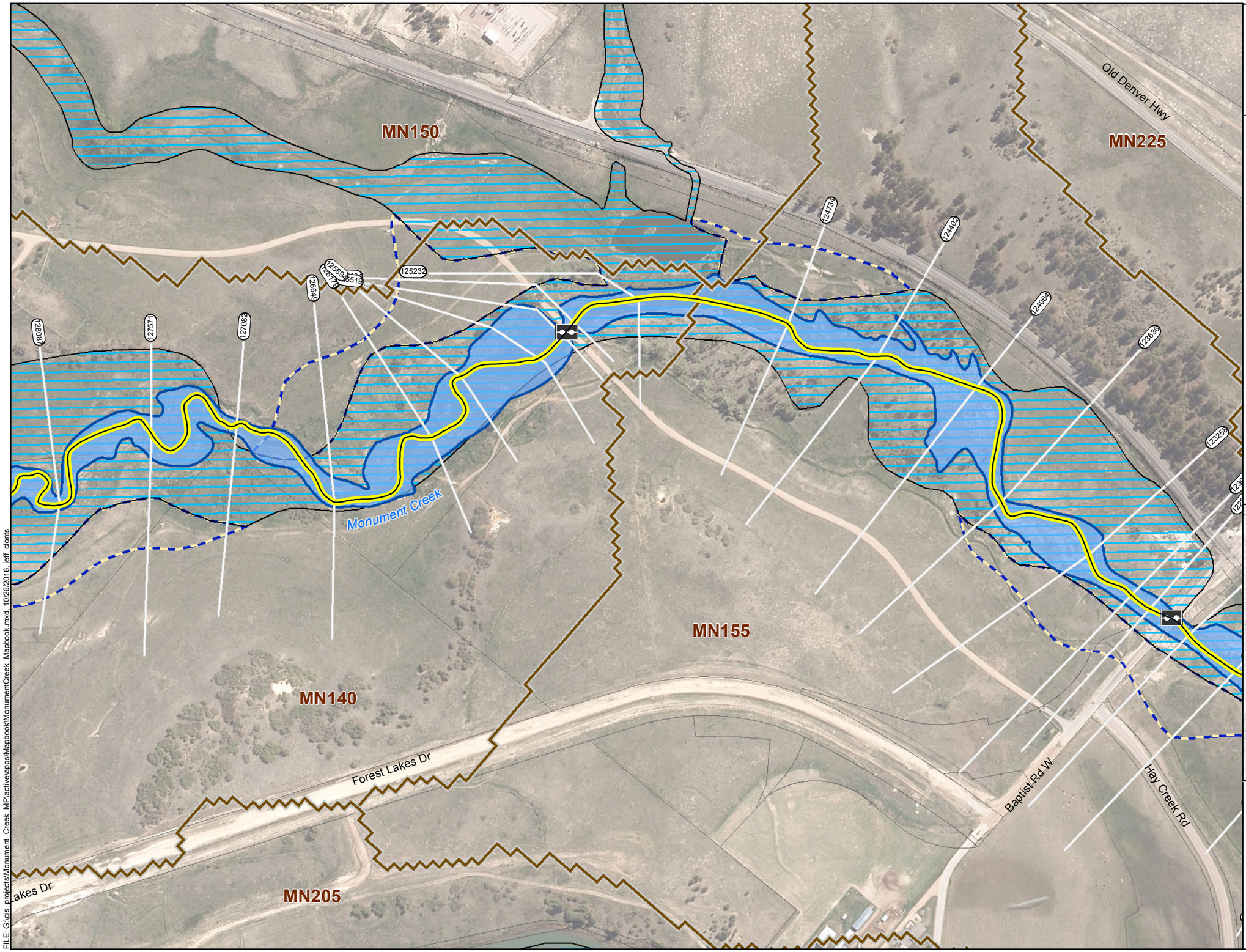


MC-7

Monument Creek
Conceptual Plan
El Paso County, CO

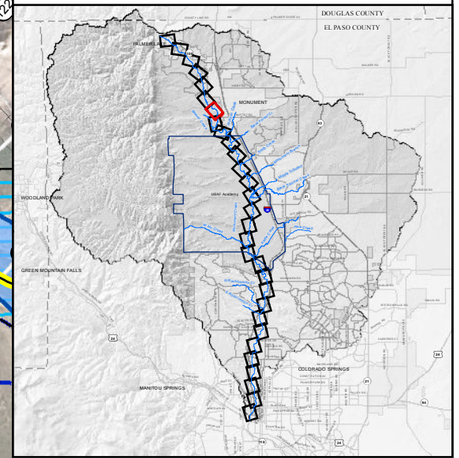
0 150 300
Feet

Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs Utilities
El Paso County
Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\activeApps\Mapbook\MonumentCreek_Mapbook.mxd 10/26/2016 jeff clonts

MC-8

Monument Creek
Conceptual Plan
El Paso County, CO

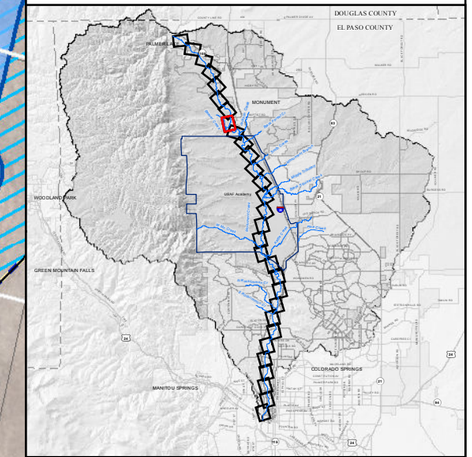
0 150 300
Feet

Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

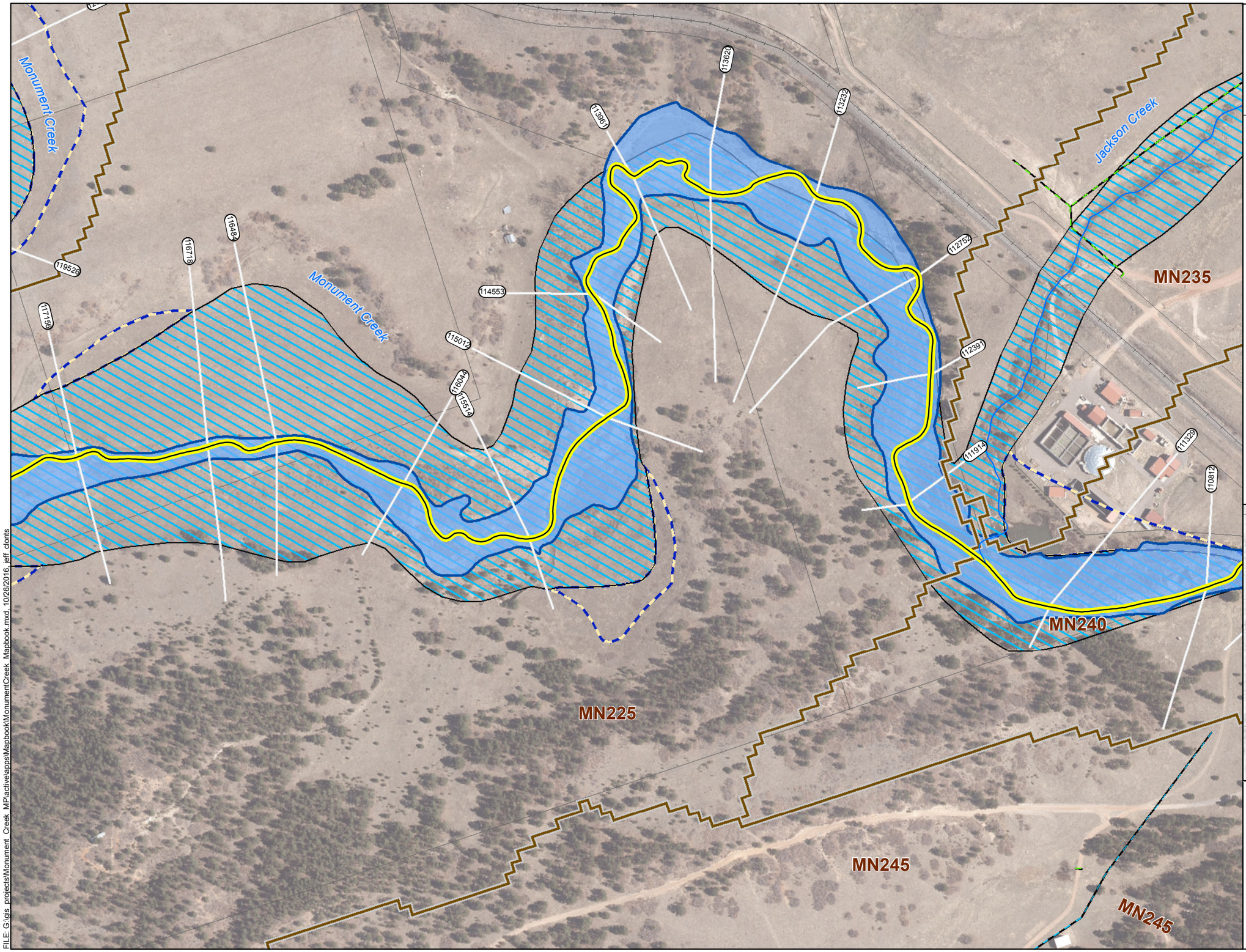


Colorado Springs Utilities

El Paso County
Colorado

Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\MonumentCreek_Mapbook.mxd 10/26/2016 jeff_clonts



MC-9

Monument Creek
Conceptual Plan
El Paso County, CO

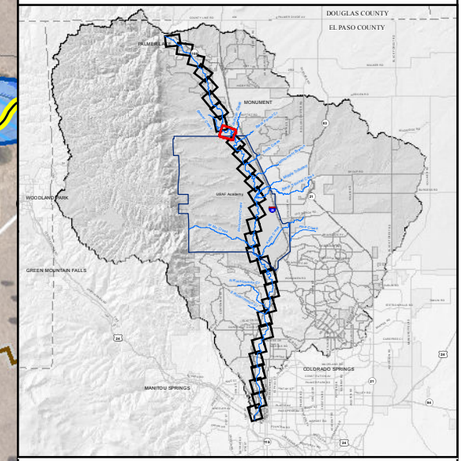
0 150 300
Feet

Legend

- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs Utilities

El Paso County
Colorado

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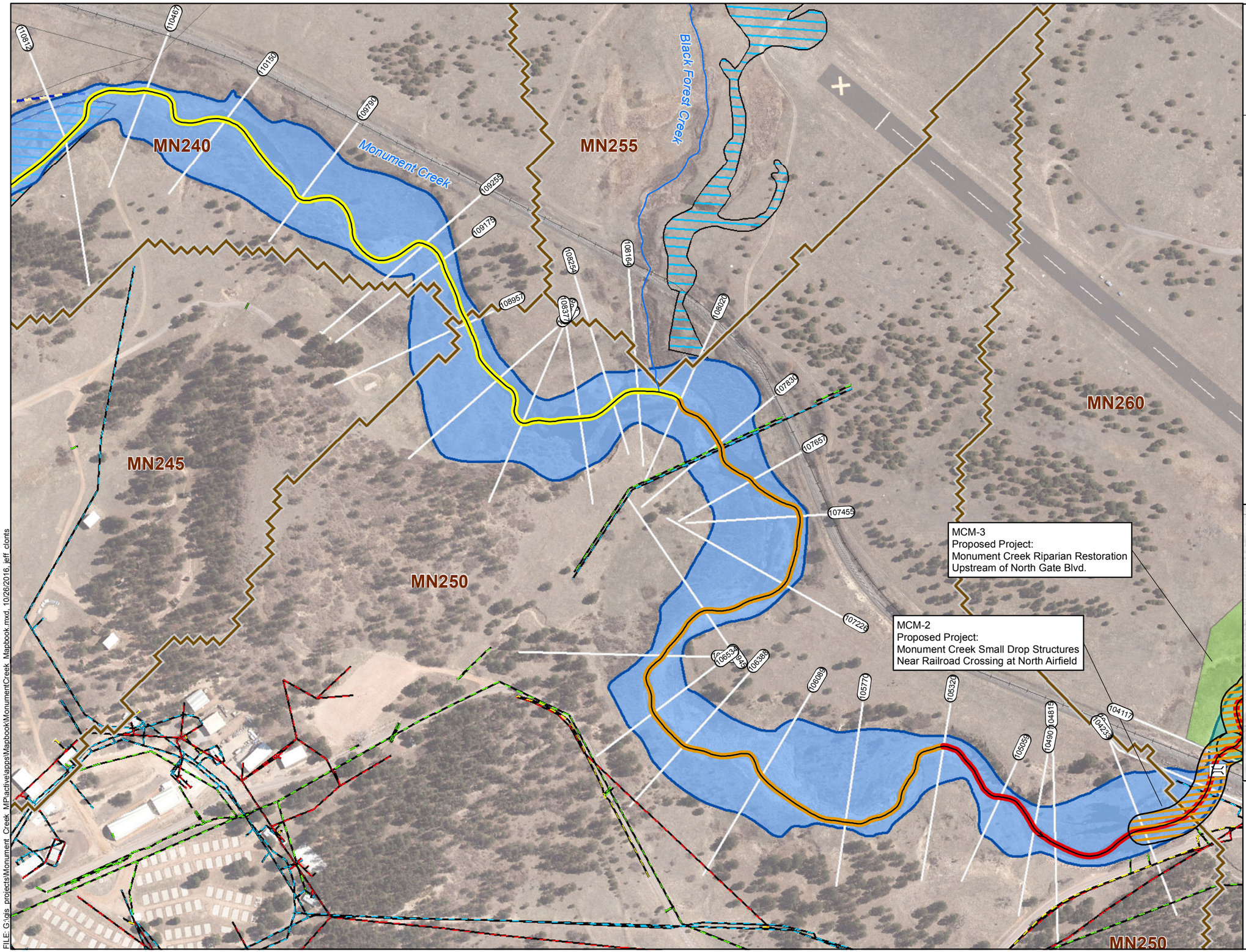
FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\MonumentCreek_Mapbook.mxd 10/26/2016 jeff_clonts



MC-10

Monument Creek
Conceptual Plan
El Paso County, CO

0 150 300
Feet

Legend

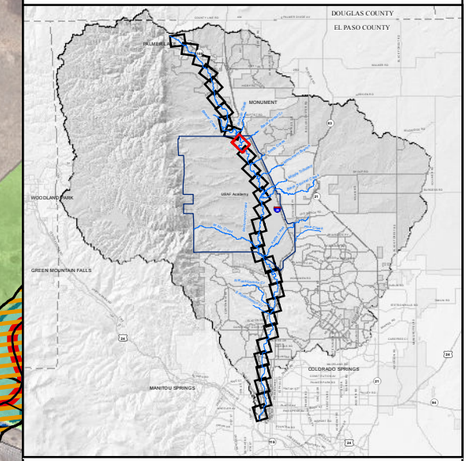
- Bridge
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Riparian, Low
- Reach, Moderate



Colorado Springs Utilities

El Paso County Colorado

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FILE: G:\gis_projects\Monument_Creek_MP\activeApps\Mapbook\MonumentCreek_Mapbook.mxd, 10/26/2016, jeff_clonts

MCM-3
Proposed Project:
Monument Creek Riparian Restoration
Upstream of North Gate Blvd.

MCM-2
Proposed Project:
Monument Creek Small Drop Structures
Near Railroad Crossing at North Airfield

MN260

MN250

Monument Creek

NORTH GATE BLVD

16334

900RW

103682
104117
104198
103353
103103
102853
101988
101733
102643
101466
100880
100474
100207
100039
99764
99635
99523
99367
99165
98838

MC-11

Monument Creek
Conceptual Plan
El Paso County, CO

0 150 300
Feet

Legend

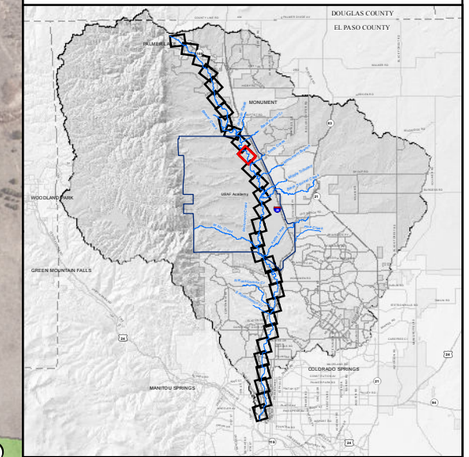
- Bridge
- Centerline
- Cross Section
- Floodplain
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Riparian, Low
- Reach, Moderate



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El Paso County
Colorado

Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\activeApps\Mapbook\MonumentCreek_Mapbook.mxd 10/31/2016 jeff_clonts

MC-12

Monument Creek
Conceptual Plan
El Paso County, CO

0 150 300
Feet

Legend

- Centerline
- Cross Section
- Floodplain
- Subbasin
- Railroads
- CityParcels
- Underground Electric
- Water
- Wastewater

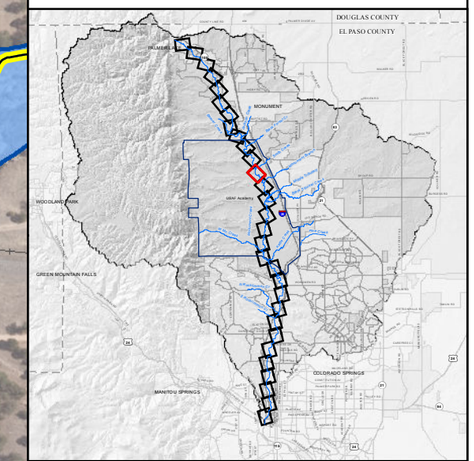
Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Riparian, Low

MCM-3
Proposed Project:
Monument Creek Riparian Restoration
Upstream of North Gate Blvd.



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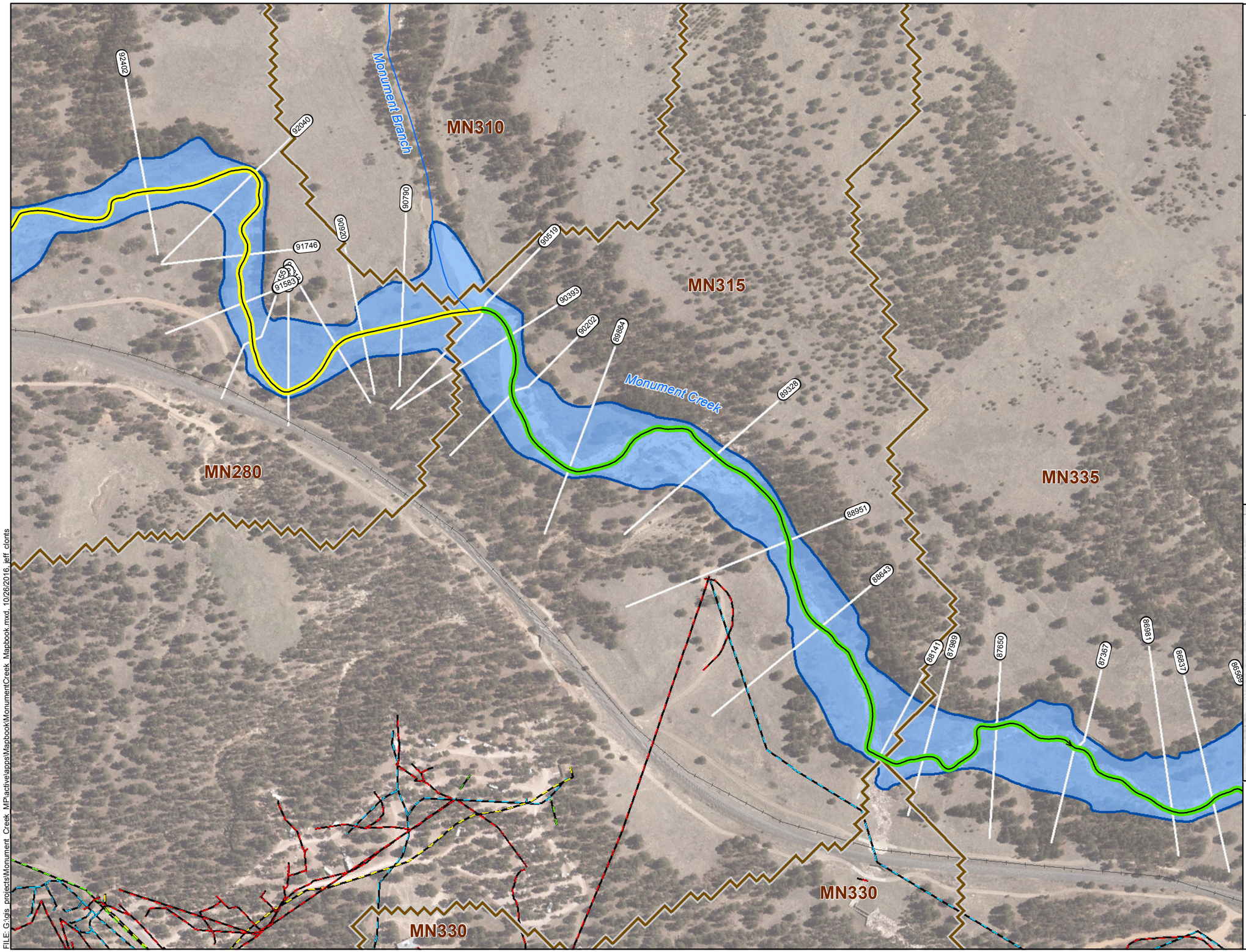


MC-13

Monument Creek
Conceptual Plan
El Paso County, CO

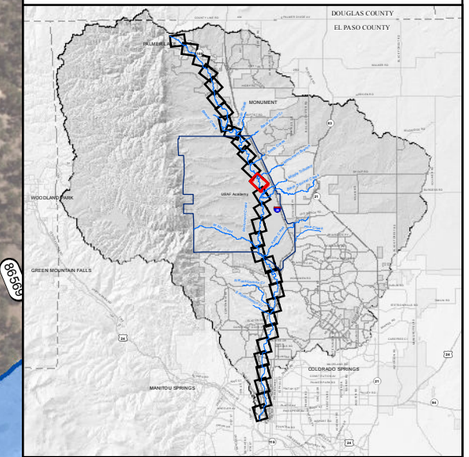
0 150 300
Feet

Legend

- Centerline
- Cross Section
- Floodplain
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



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El Paso County
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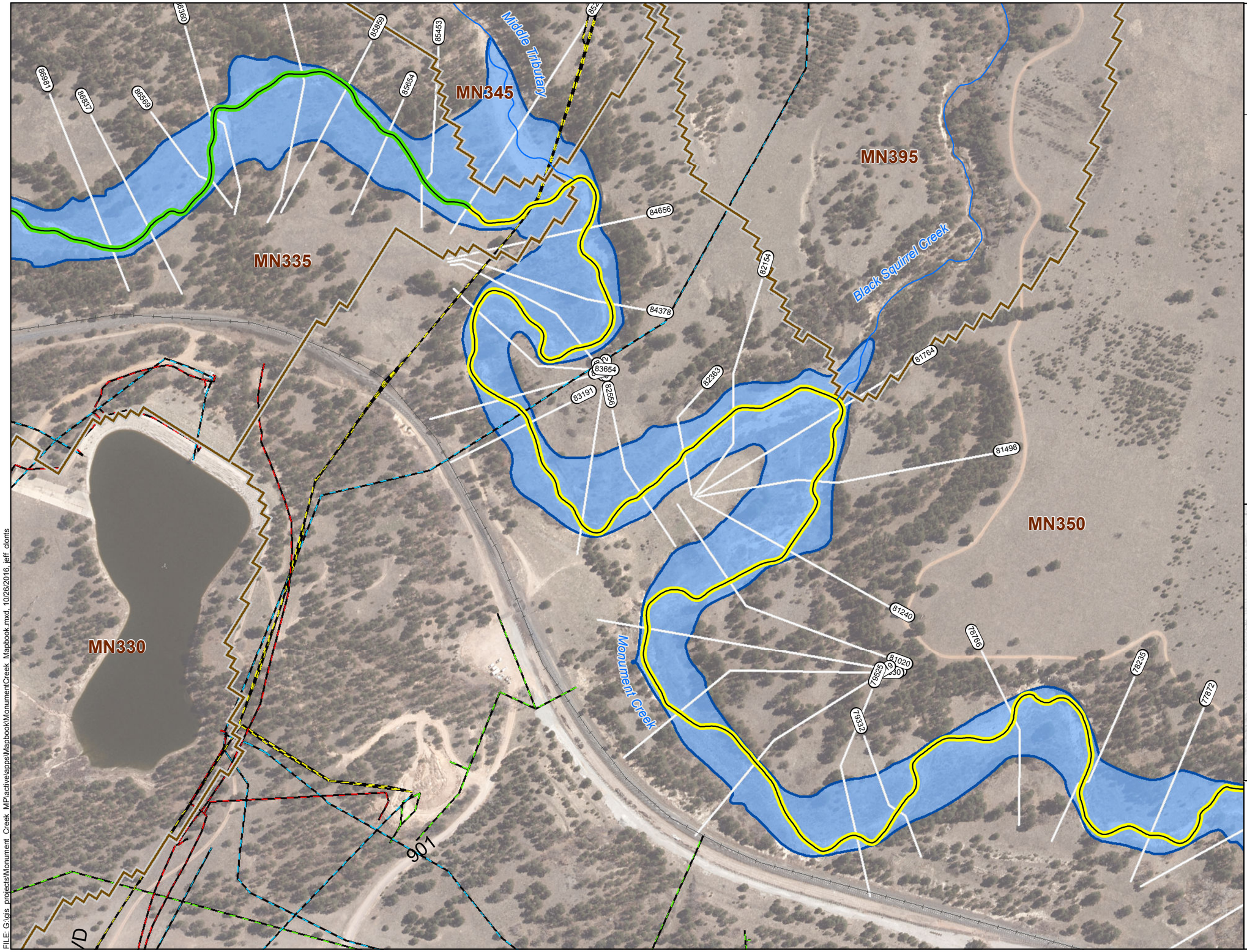
FILE: G:\gis_projects\Monument_Creek_MP\activeApps\MapbookMonumentCreek_Mapbook.mxd 10/26/2016 jeff_clonts



MC-14

Monument Creek
Conceptual Plan
El Paso County, CO

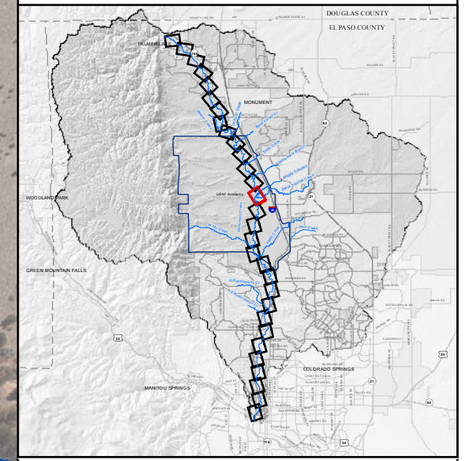
0 150 300
Feet

Legend

- Centerline
- Cross Section
- Floodplain
- Subbasin
- Railroads
- CityParcels
- Gas
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



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El Paso County
Colorado

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MC-15

Monument Creek
Conceptual Plan
El Paso County, CO

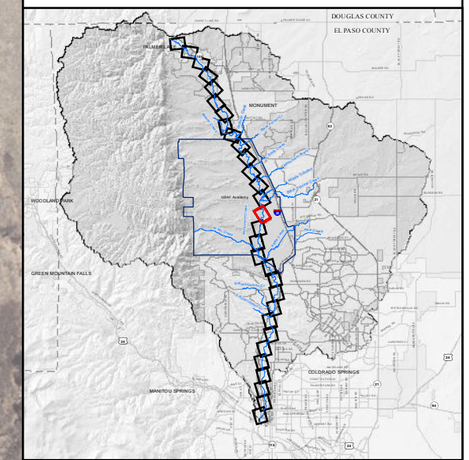
0 150 300
Feet

Legend

- Culvert
- Centerline
- Cross Section
- Floodplain
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



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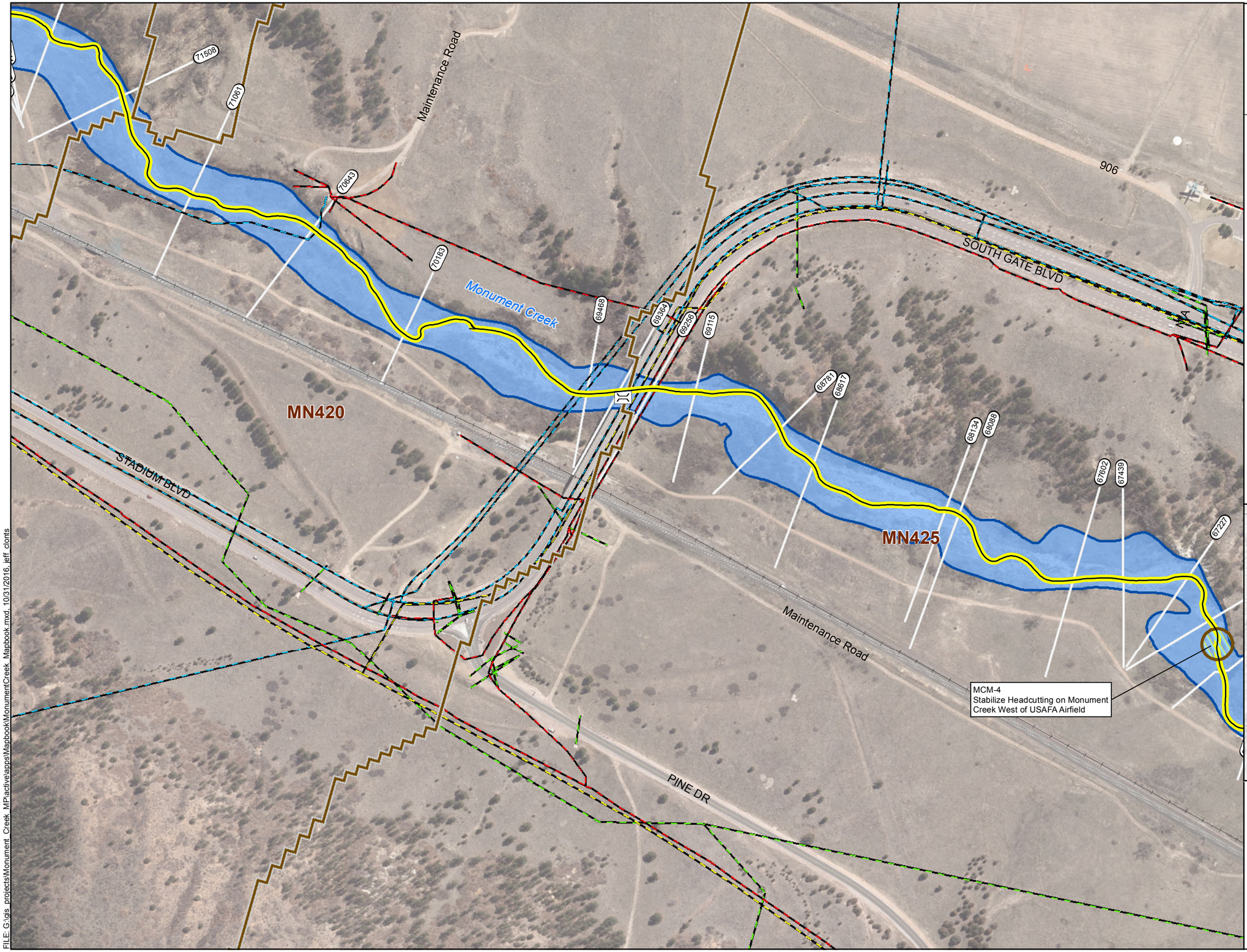
FILE: G:\gis_projects\Monument_Creek_MP\activeApps\Mapbook\MonumentCreek_Mapbook.mxd 10/26/2016 jeff_clonts



MC-16

Monument Creek
Conceptual Plan
El Paso County, CO

0 150 300
Feet

Legend

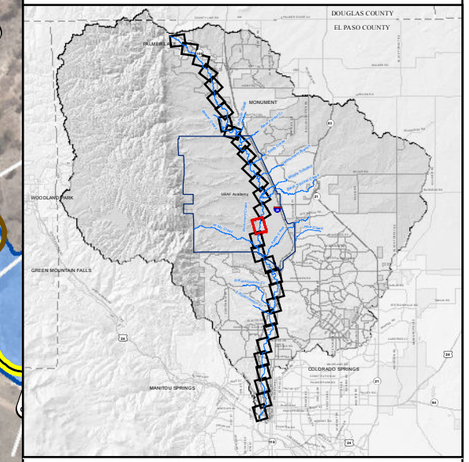
- Bridge
- Centerline
- Cross Section
- Floodplain
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Stability, Low



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FILE: G:\gis_projects\Monument_Creek_MP\activeApps\Mapbook\MonumentCreek_Mapbook.mxd, 10/31/2016, jeff_clonts

MCM-4
Stabilize Headcutting on Monument Creek West of USAFA Airfield

SOUTH GATE BLVD

SAGE BRUSH DR

EDGERTON DR

INDUSTRIAL DR

Monument Creek

Maintenance Road

701

Maintenance Road

West Monument Creek

MN500

MN425

MN495

MN49

67227 67054 66900 66824 66877 66151 65893 65685 65440 65254 65054 64611 63885 63302 63101 62761 62534 62294 62092 61906 61715 61365

81A 83 83A 85

MC-17

Monument Creek
Conceptual Plan
El Paso County, CO

0 150 300
Feet

Legend

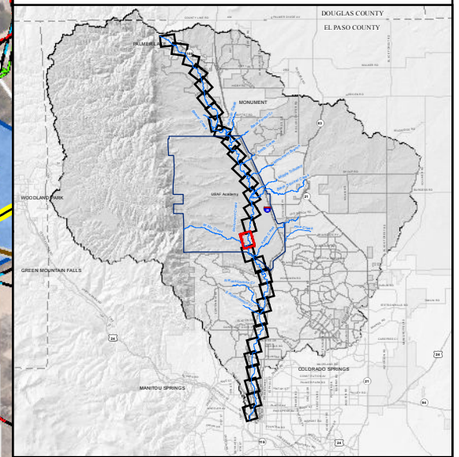
- Centerline
- Cross Section
- Floodplain
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Stability, Low



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El Paso County
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FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\MonumentCreek_Mapbook.mxd, 10/27/2016, jeff_clonts

MC-18

Monument Creek
Conceptual Plan
El Paso County, CO

0 150 300
Feet

Legend

- Bridge
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

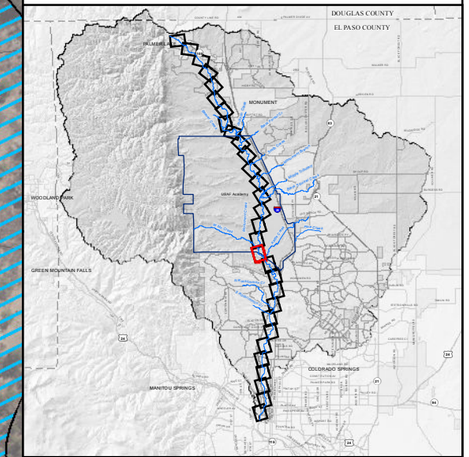
- Stability, Moderate

MCM-5
Proposed Project:
Stabilize Headcutting on Monument Creek near Thunderbird Ln.

MN585
MN590
MN500
MN495

Kettl Creek
Monument Creek

RAMP DR



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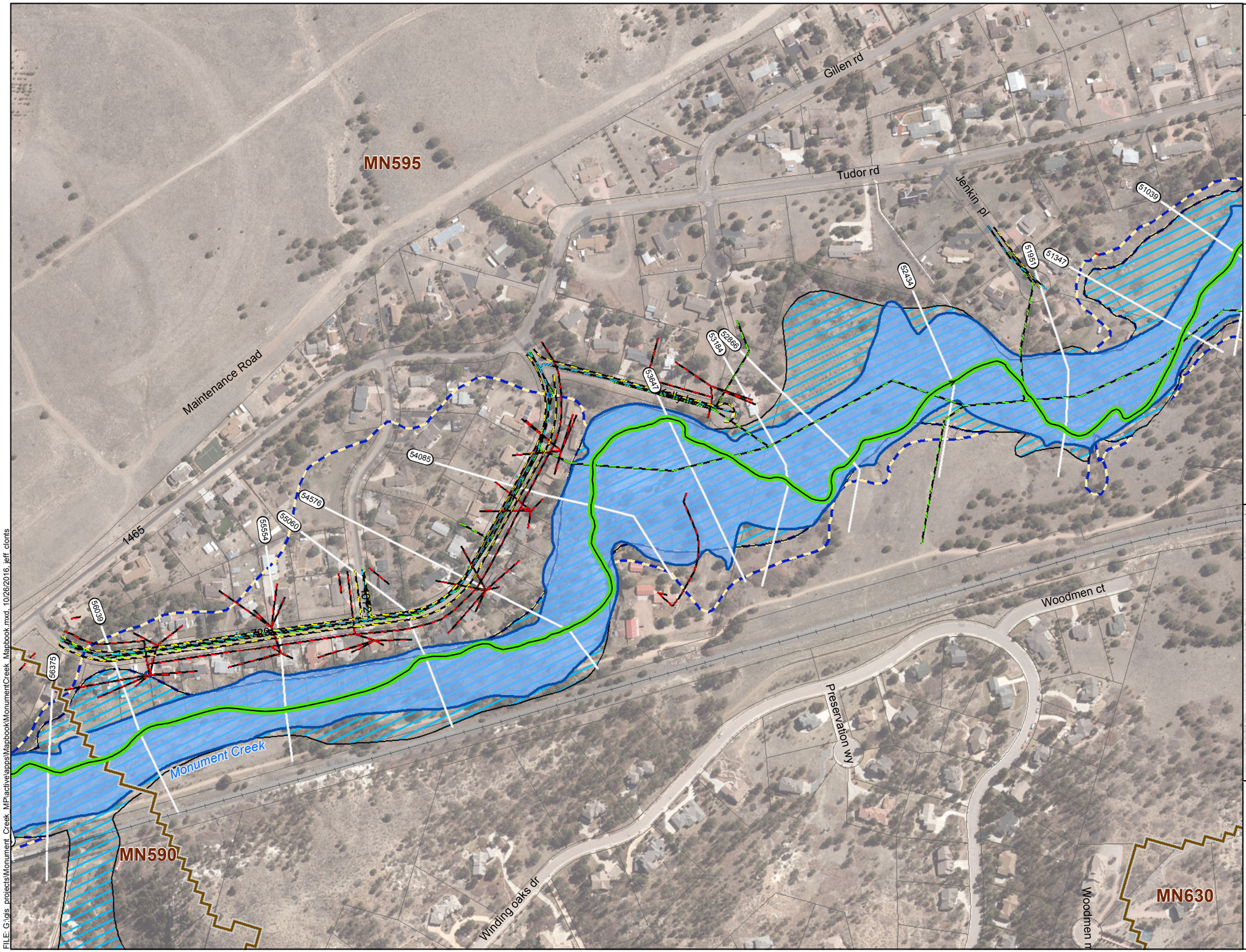


MC-19

Monument Creek
Conceptual Plan
El Paso County, CO

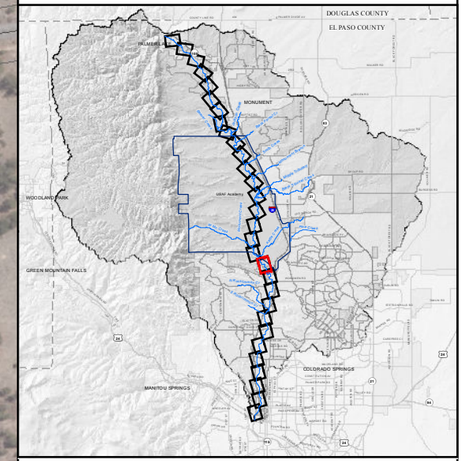
0 150 300
Feet

Legend

- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs Utilities

El Paso County
Colorado

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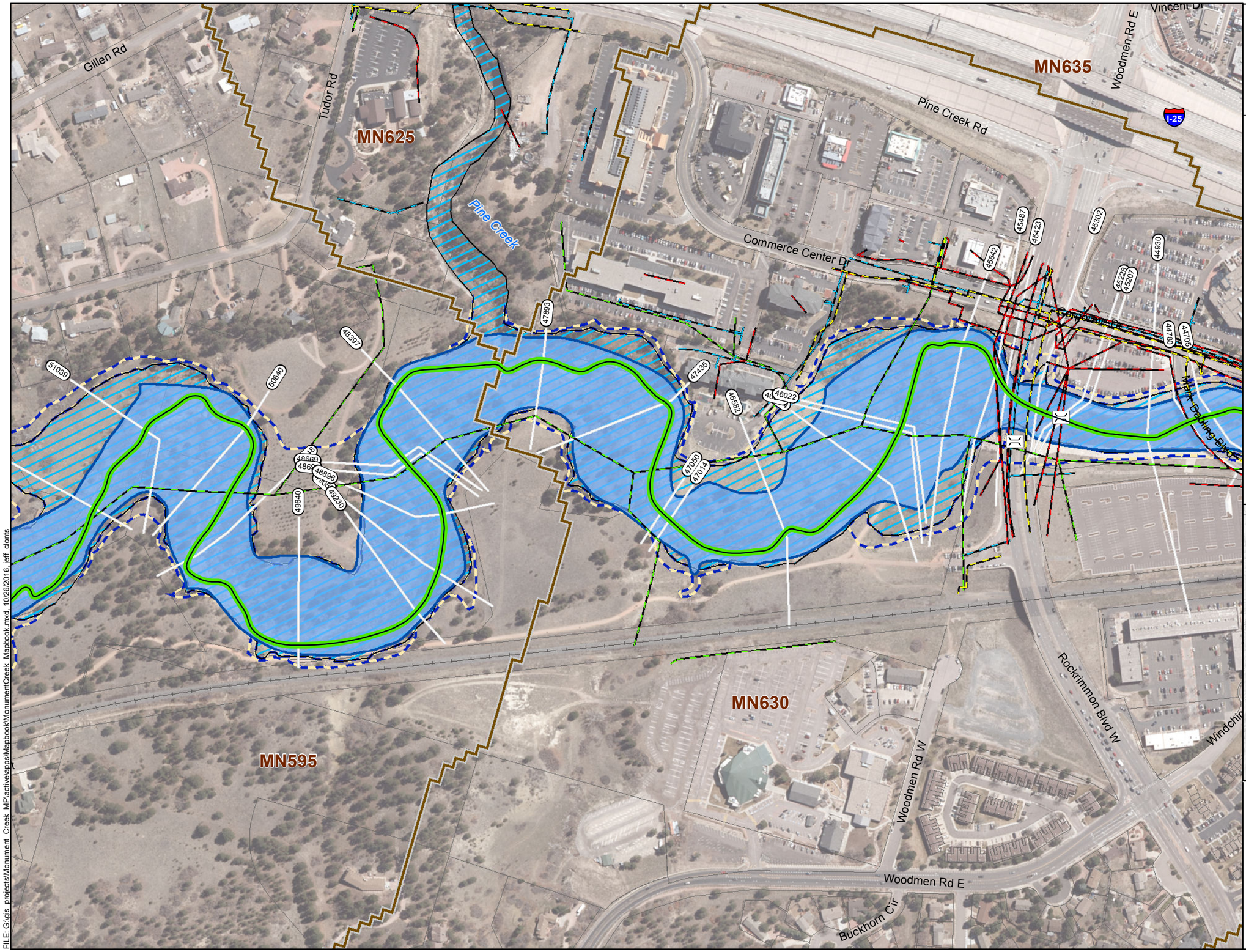

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MC-20

Monument Creek
Conceptual Plan
El Paso County, CO

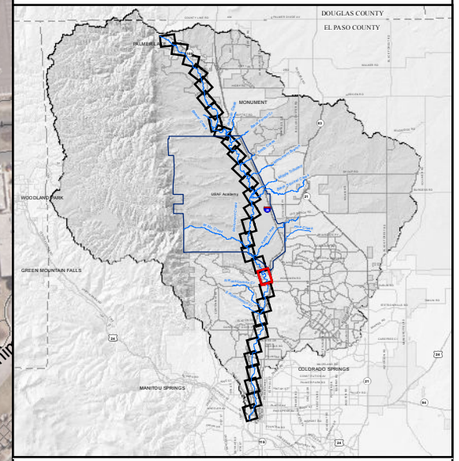
0 150 300
Feet

Legend

- Bridge
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



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El Paso County Colorado

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MC-21

Monument Creek
Conceptual Plan
El Paso County, CO

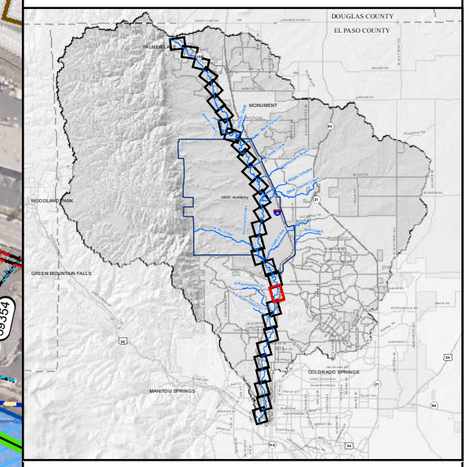
0 150 300
Feet

Legend

- Bridge
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



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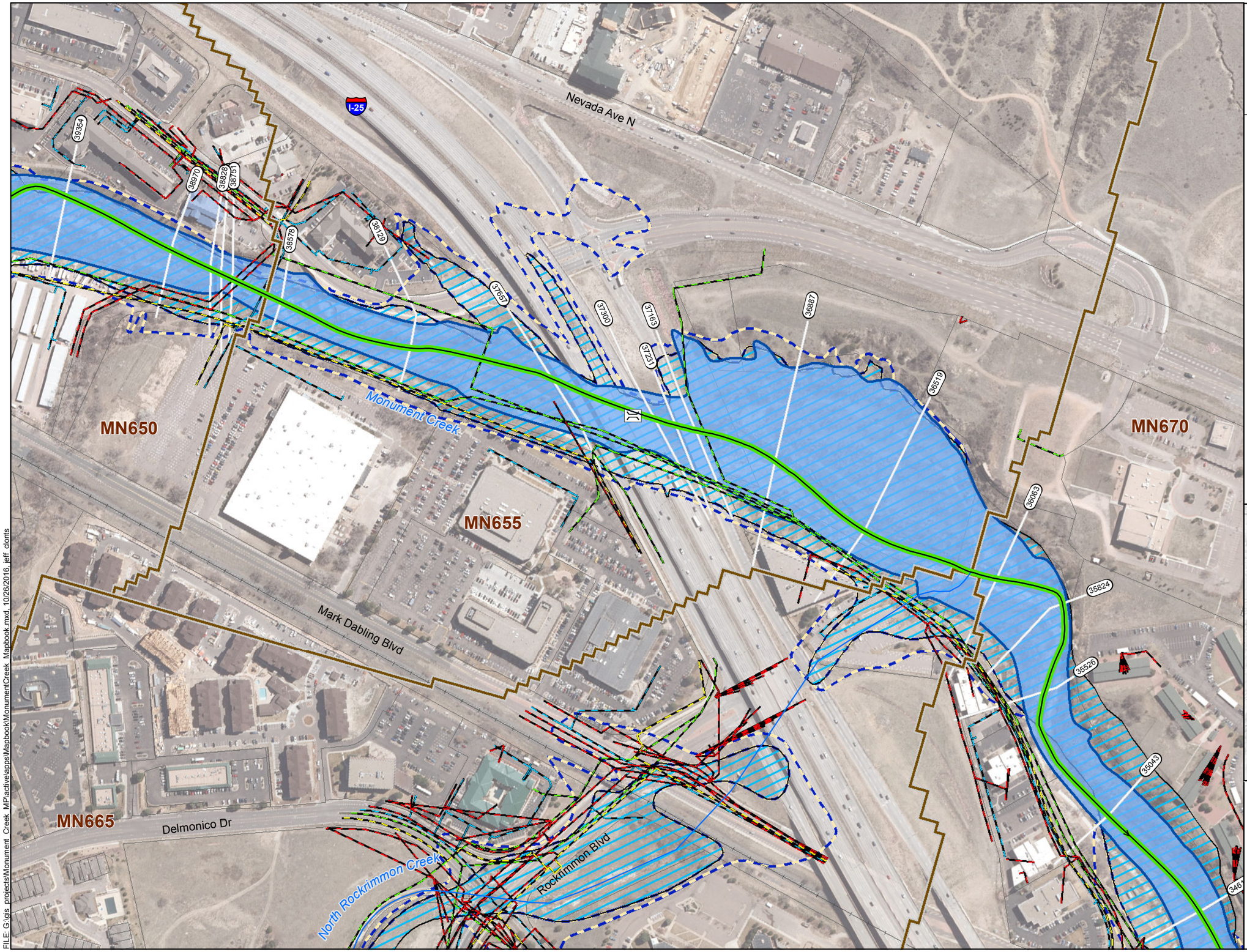
FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\MonumentCreek_Mapbook.mxd, 10/26/2016, jeff_clonts



MC-22

Monument Creek
Conceptual Plan
El Paso County, CO

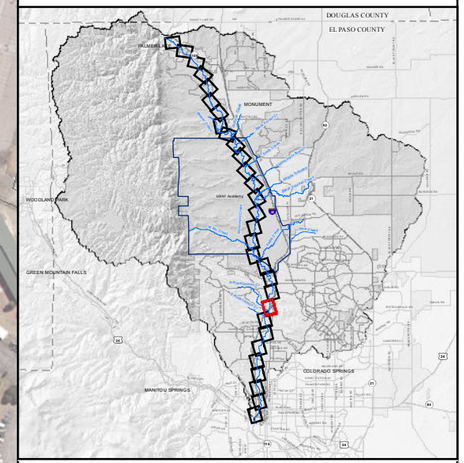
0 150 300
Feet

Legend

- Bridge
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



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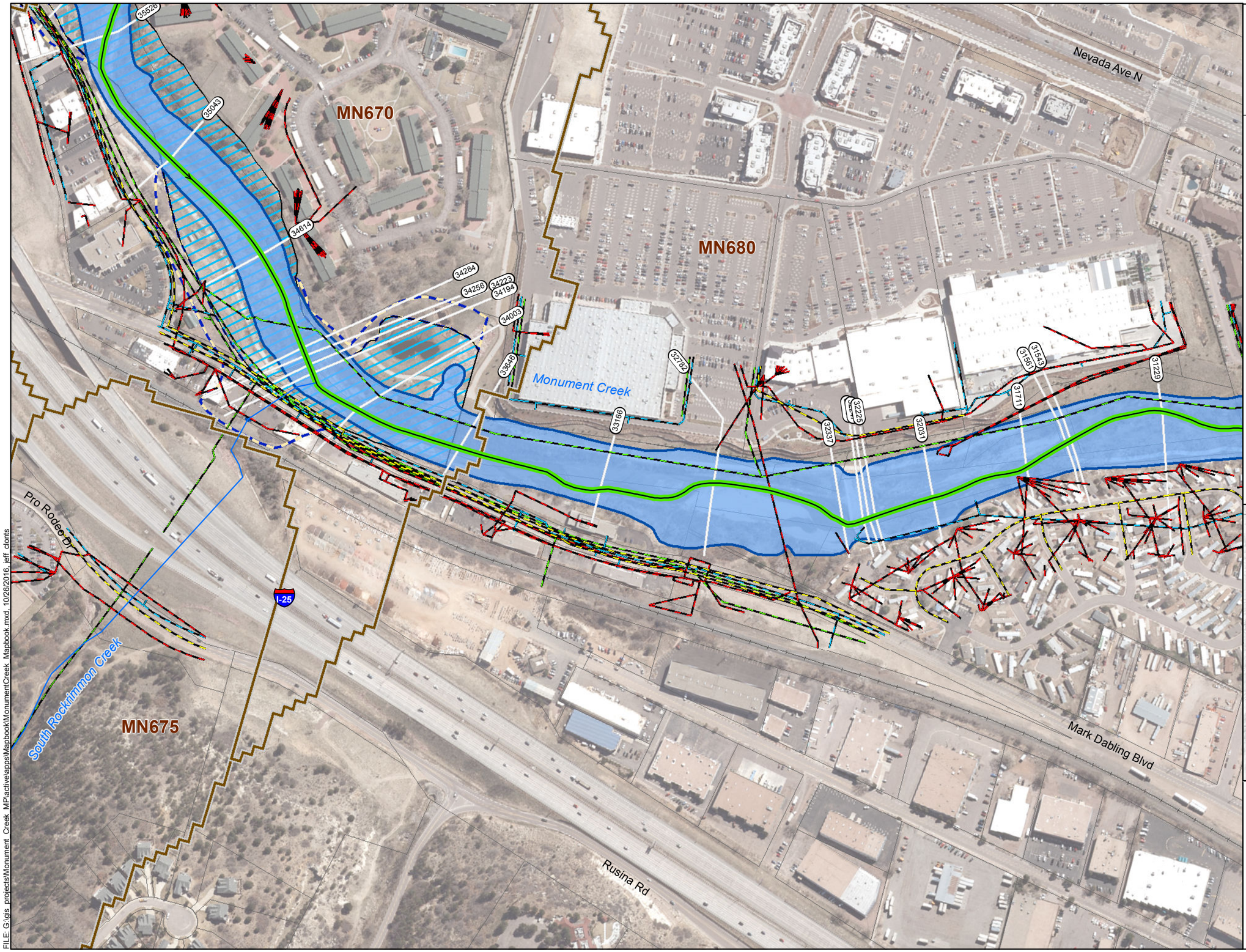


MC-23

Monument Creek
Conceptual Plan
El Paso County, CO

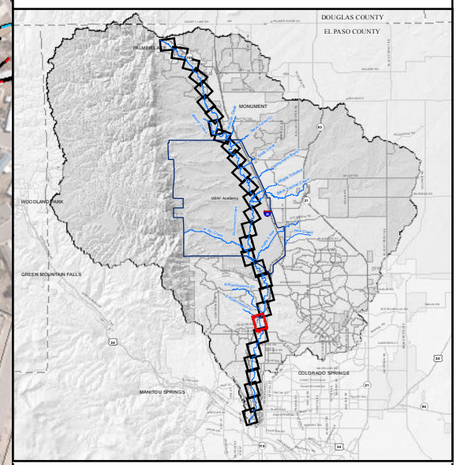
0 150 300
Feet

Legend

- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs Utilities

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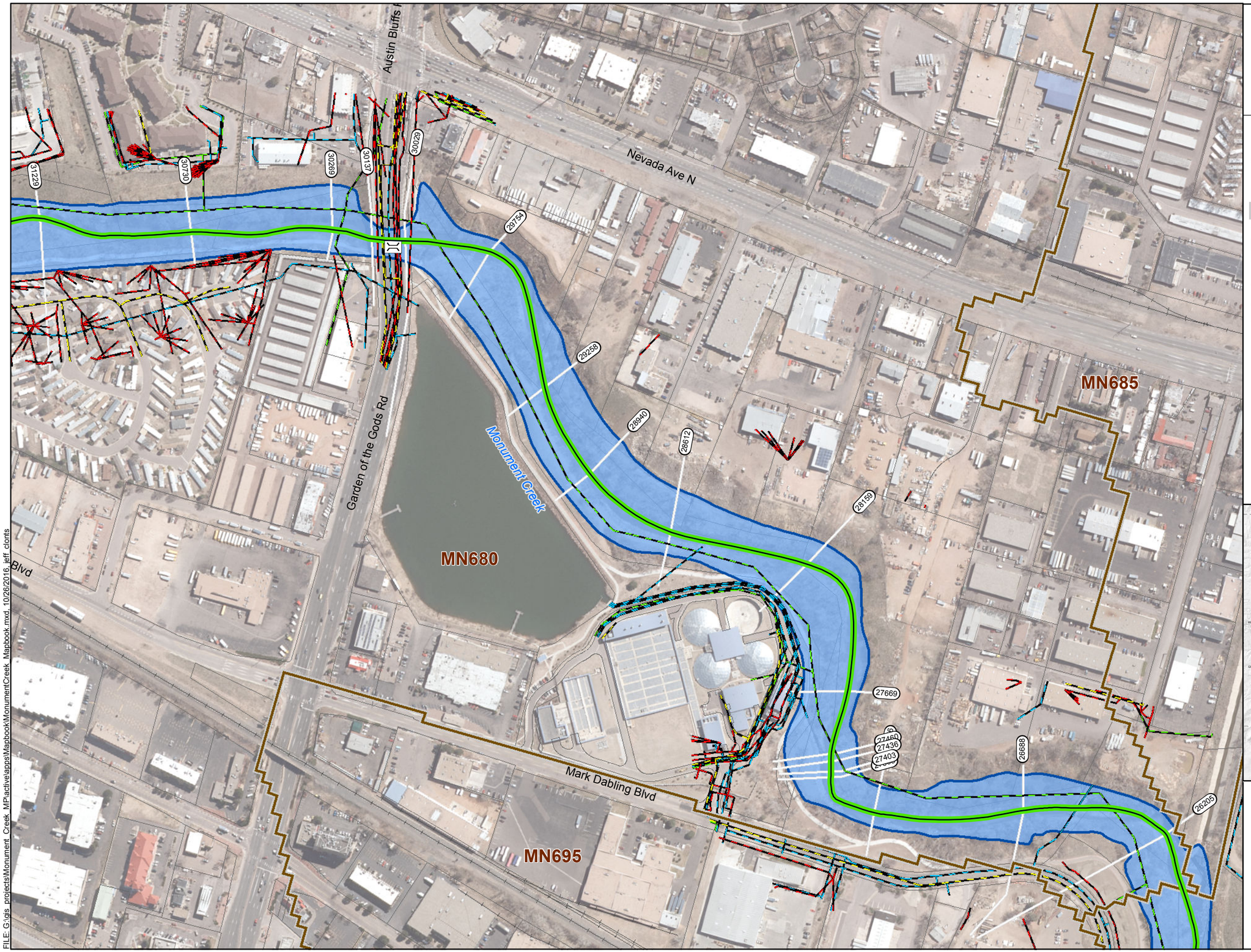


MC-24

Monument Creek
Conceptual Plan
El Paso County, CO

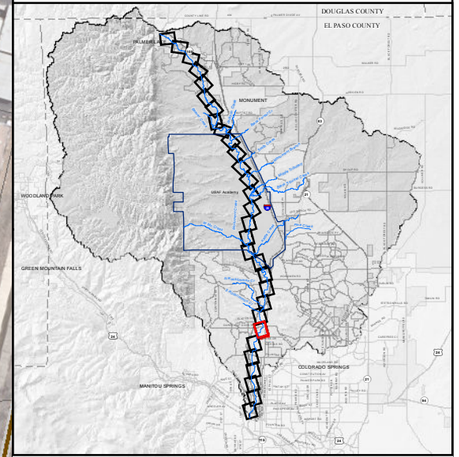
0 150 300
Feet

Legend

- Bridge
- Centerline
- Cross Section
- Floodplain
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



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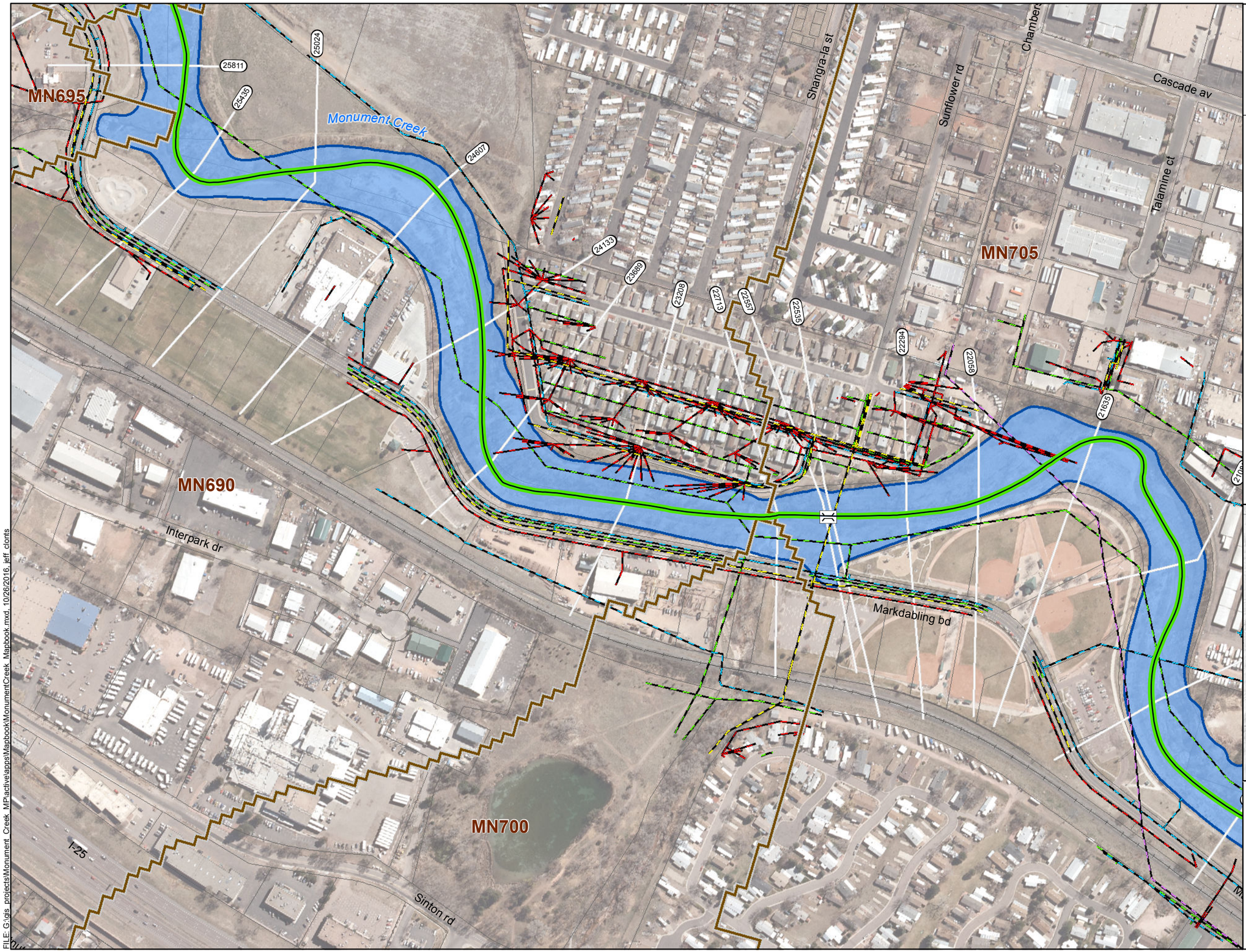
FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\MonumentCreek_Mapbook.mxd, 10/26/2016, jeff_clonts



MC-25

Monument Creek
Conceptual Plan
El Paso County, CO

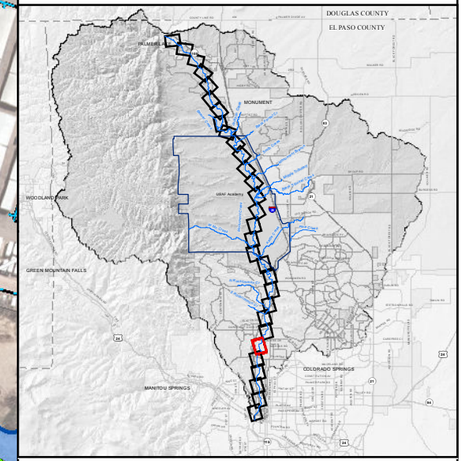
0 150 300
Feet

Legend

- Bridge
- Centerline
- Cross Section
- Floodplain
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Overhead Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs Utilities

El Paso County
Colorado

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FILE: G:\gis_projects\Monument_Creek_MP\activeApps\Mapbook\MonumentCreek_Mapbook.mxd 10/26/2016 jeff_clonts

MC-26

Monument Creek
Conceptual Plan
El Paso County, CO

0 150 300
Feet

Legend

- Bridge
- Centerline
- Cross Section
- Floodplain
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Overhead Electric
- Water
- Wastewater

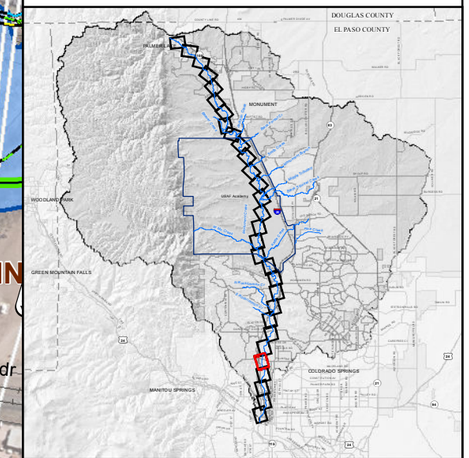
Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Flood Risk Reduction, Low

MCM-6
Proposed Project:
Flood Risk Reduction at W Polk Rd.
Bridge at Monument Creek
Proposed Low Chord: 6087.15 ft
Proposed Deck Span: 120 LF



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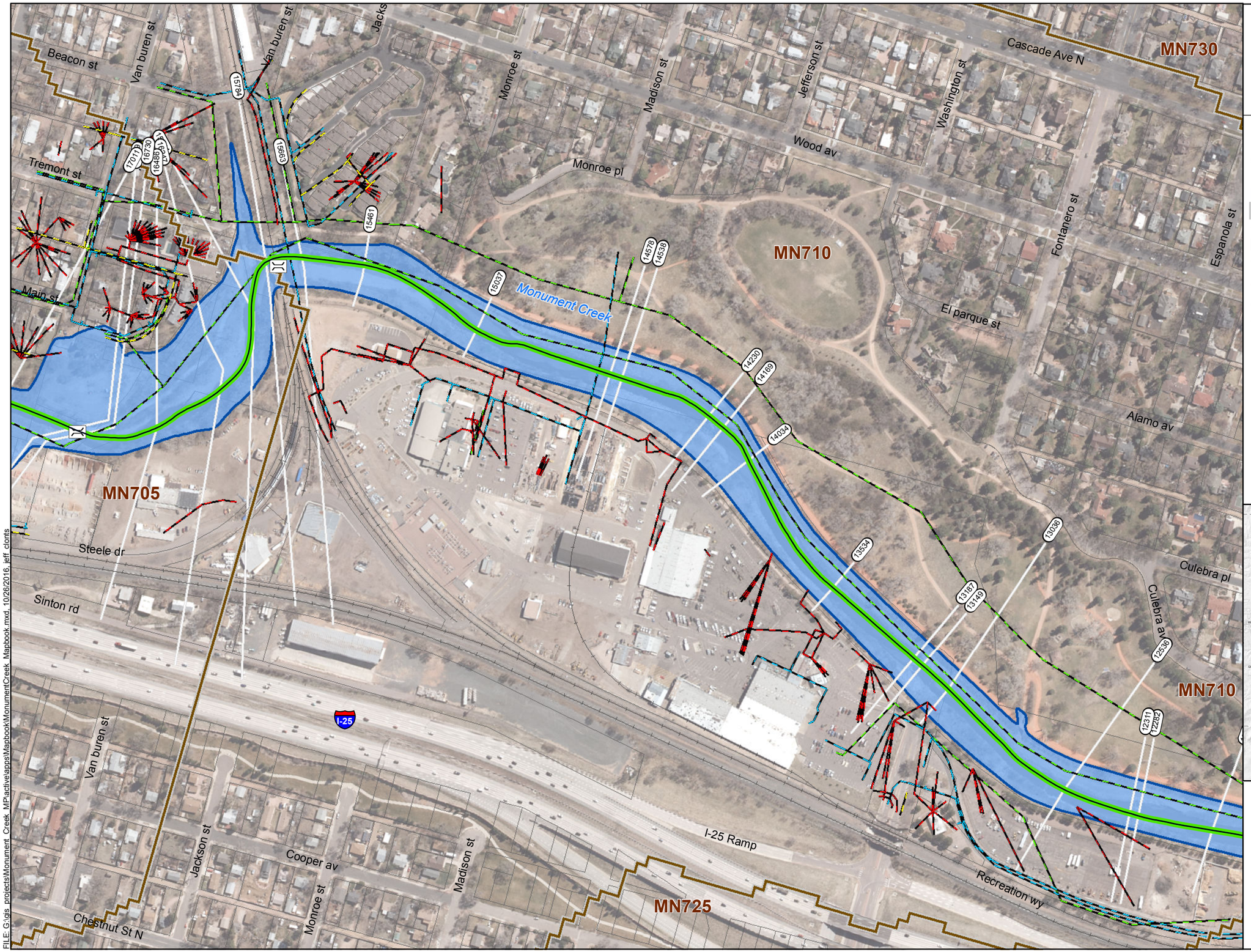


MC-27

Monument Creek
Conceptual Plan
El Paso County, CO

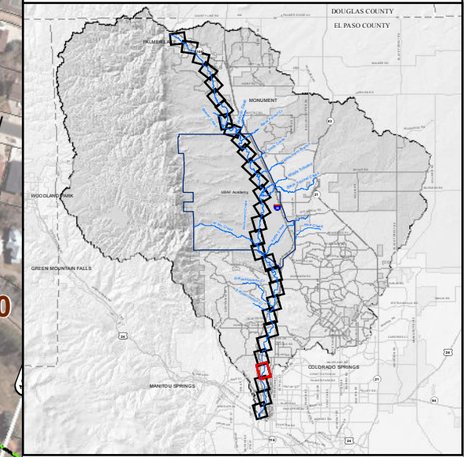
0 150 300
Feet

Legend

- Bridge
- Centerline
- Cross Section
- Floodplain
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs Utilities
El Paso County Colorado
Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MPactive\apps\MapbookMonumentCreek_Mapbook.mxd, 10/26/2016, jeff_clonts

MC-28

Monument Creek
Conceptual Plan
El Paso County, CO

0 150 300
Feet

Legend

- Centerline
- Cross Section
- Floodplain
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection

Project Type / Priority

- Recreation, Low
- Recreation, Moderate

MN730
MN710
MN725
MCM-8
Proposed Project:
Uintah Bridge Bank Stabilization
MCM-7
Proposed Project:
Mesa Creek Outfall
Monument Creek
Alamo av
Culebra pl
Culebra av
Del norte st
Caramillo st
Buena ventura st
Columbia st
Columbia St W
San miguel st
Wood av
Uintah St W
Cascade Ave N
Glen ay
Recreation wy
Walnut st
Walnut St N
Cooper av
Cooper Ave
Chestnut St N
Chestnut st
San rafael st
I-25
12536
12311
12282
12039
11751
11707
11592
11085
10777
10726
10629
10231
9574
9383
9243
9045
8547

FILE: G:\gis_projects\Monument_Creek_MP\activeapps\Mapbook\MonumentCreek_Mapbook.mxd, 10/31/2016, jeff_clonts

Colorado Springs Utilities
El Paso County
Matrix Design Group

MC-29

Monument Creek
Conceptual Plan
El Paso County, CO

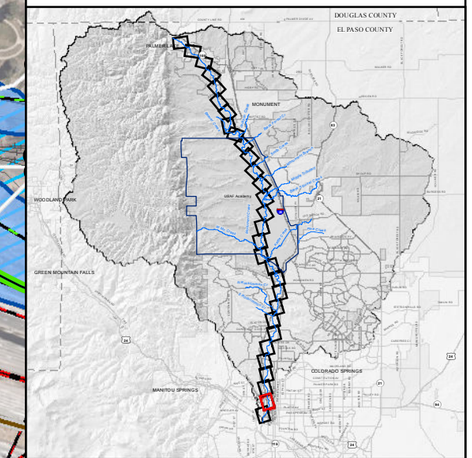
0 150 300
Feet

Legend

- Bridge
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



Colorado Springs Utilities
It's how we're all connected

El Paso County
Colorado

Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MPactive\apps\Mapbook\MonumentCreek_Mapbook.mxd, 10/26/2016, jeff_clonts

MC-30

Monument Creek
Conceptual Plan
El Paso County, CO

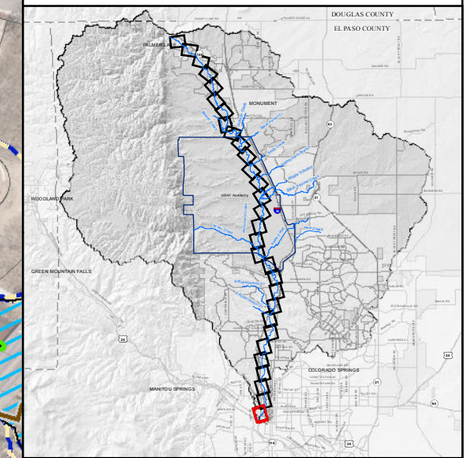
0 150 300
Feet

Legend

- Bridge
- Centerline
- Cross Section
- Floodplain
- DFIRM 100-Year
- DFIRM 500-Year
- Subbasin
- Railroads
- CityParcels
- Gas
- Underground Electric
- Water
- Wastewater

Reach Alternatives

- Natural Channel Design
- Protect In Place
- Protect In Place and Monitor
- Small Drop Structures w/ Toe Protection



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El Paso County
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FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Mapbook\MonumentCreek_Mapbook.mxd, 10/26/2016, jeff_clonts

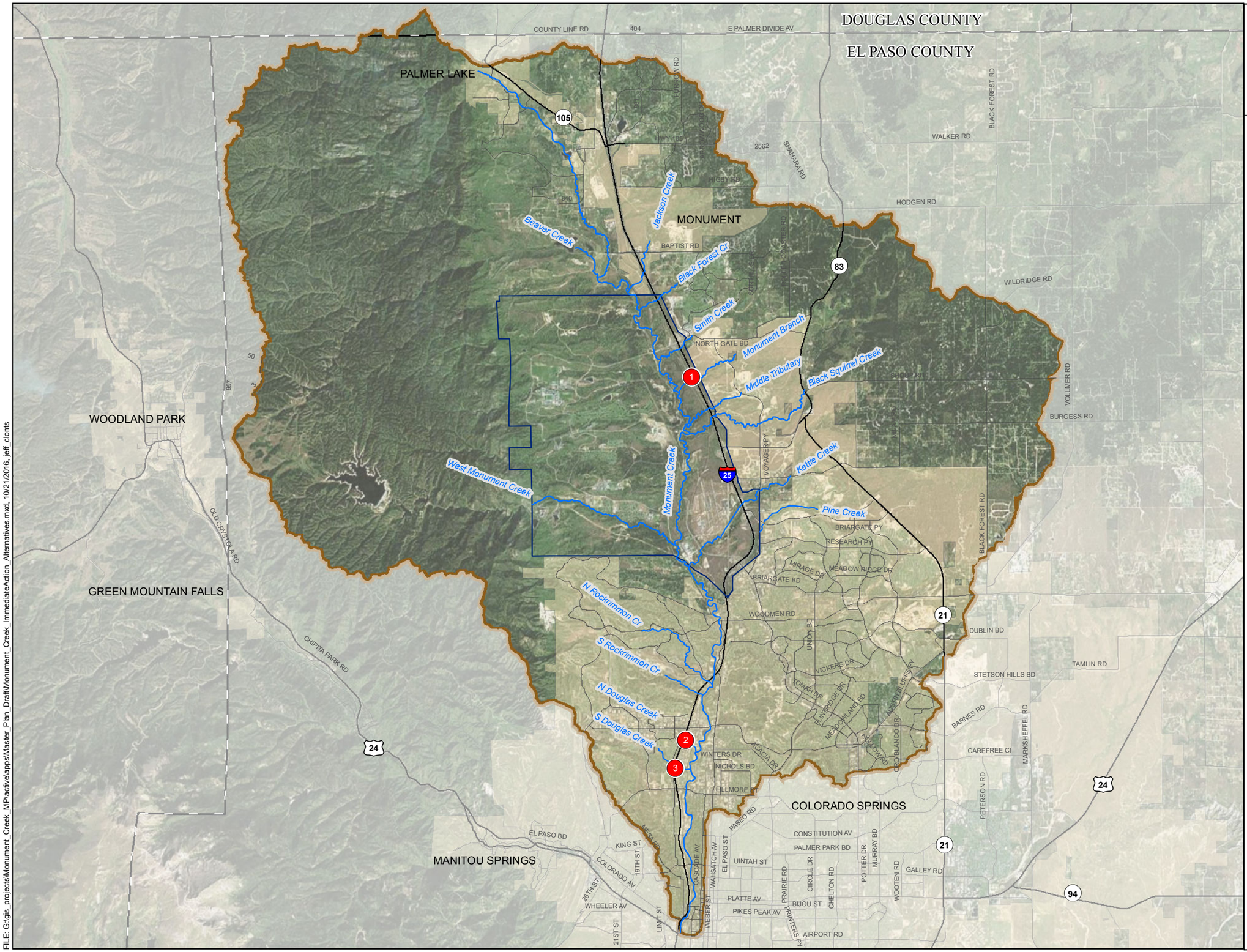
3.0 Final Project List

A major goal of the Restoration Plan was to identify potential capital improvement projects and areas of needed restoration and improvement. Our project team employed advanced hydraulic and hydrologic modeling, technical screening, and stakeholder input to identify these recommended projects. Methods also included geomorphic assessment through extensive field reconnaissance, bank evaluation, and erosion rate calculations, as well as the collection and review of stakeholder capital improvement project lists, stakeholder interviews, and collection and review of community input.

The project identification process yielded a number of different project types including stream restoration, improvements and the additions of detention and water quality facilities, flood risk reduction, riparian buffer restoration, trails and open space, aquatic and terrestrial habitat restoration, and general local erosion concerns. Existing project lists were also considered in this process.

Each project was ranked from "Low" to "Immediate" according to engineering analysis, technical evaluation, and screening. The following maps and tables show all of the identified projects by category. The number designation labeled on each of the projects identified on the map corresponds to the 'Alternative Map Project ID' value listed in the table under their respective alternative categories.

High ranking projects were evaluated further using the Decision Making Matrix, Table 3, as described in the Project Prioritization section of this report. The prioritized list of actionable projects resulting from the Decision Making Matrix evaluation, are shown in Table 1 included in the first section of this report. Immediate and high ranking, prioritized projects are also shown in the mapbooks along with their priority. For further explanation and details regarding the ranking and prioritization processes, refer to the Plan Development section of this report.



Immediate Action Alternatives

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

Legend

- Immediate Action Alternatives
- Monument Ceek Watershed
- USAFA Boundary
- County Boundary
- City
- Stream
- Highway
- Major Road

FILE: G:\gis_projects\Monument_Creek_MPactive\apps\Master_Plan_Draft\Monument_Creek_ImmediateAction_Alternatives.mxd, 10/21/2016, jeff_clonts

Figure 4. Monument Creek Watershed Immediate Action Alternatives

Stream Reach Restoration Alternatives

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

Legend

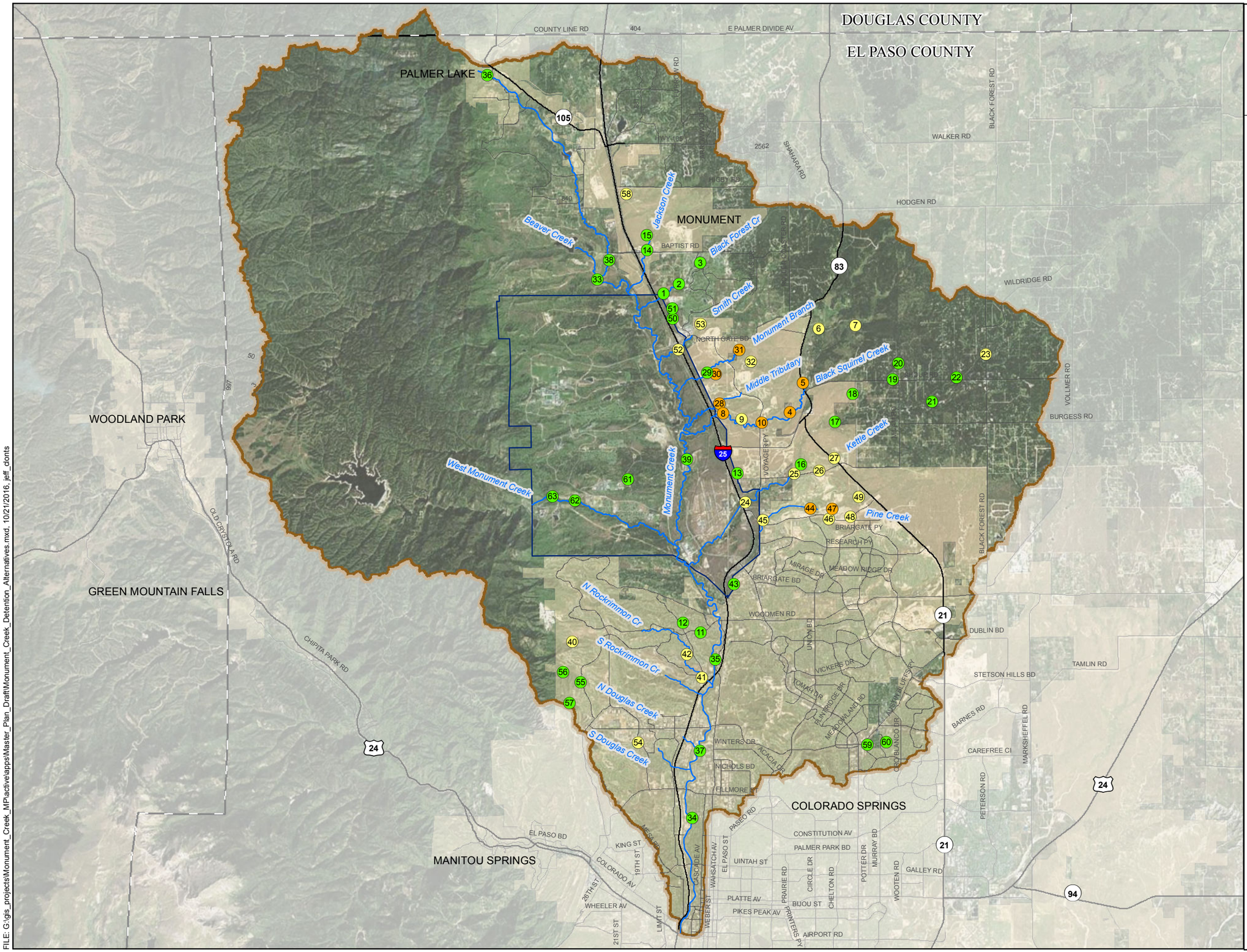
Reach Alternatives
- High
- Moderate
- Low

- Monument Ceek Watershed
- USAFA Boundary
- County Boundary
- City
- Stream
- Highway
- Major Road

Colorado Springs Utilities

Matrix Design Group

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Master_Plan_Draft\Monument_Creek_Stream_Reach_Alternatives.mxd, 10/21/2016, jeff_clonts



Detention and Water Quality Facilities Alternatives

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

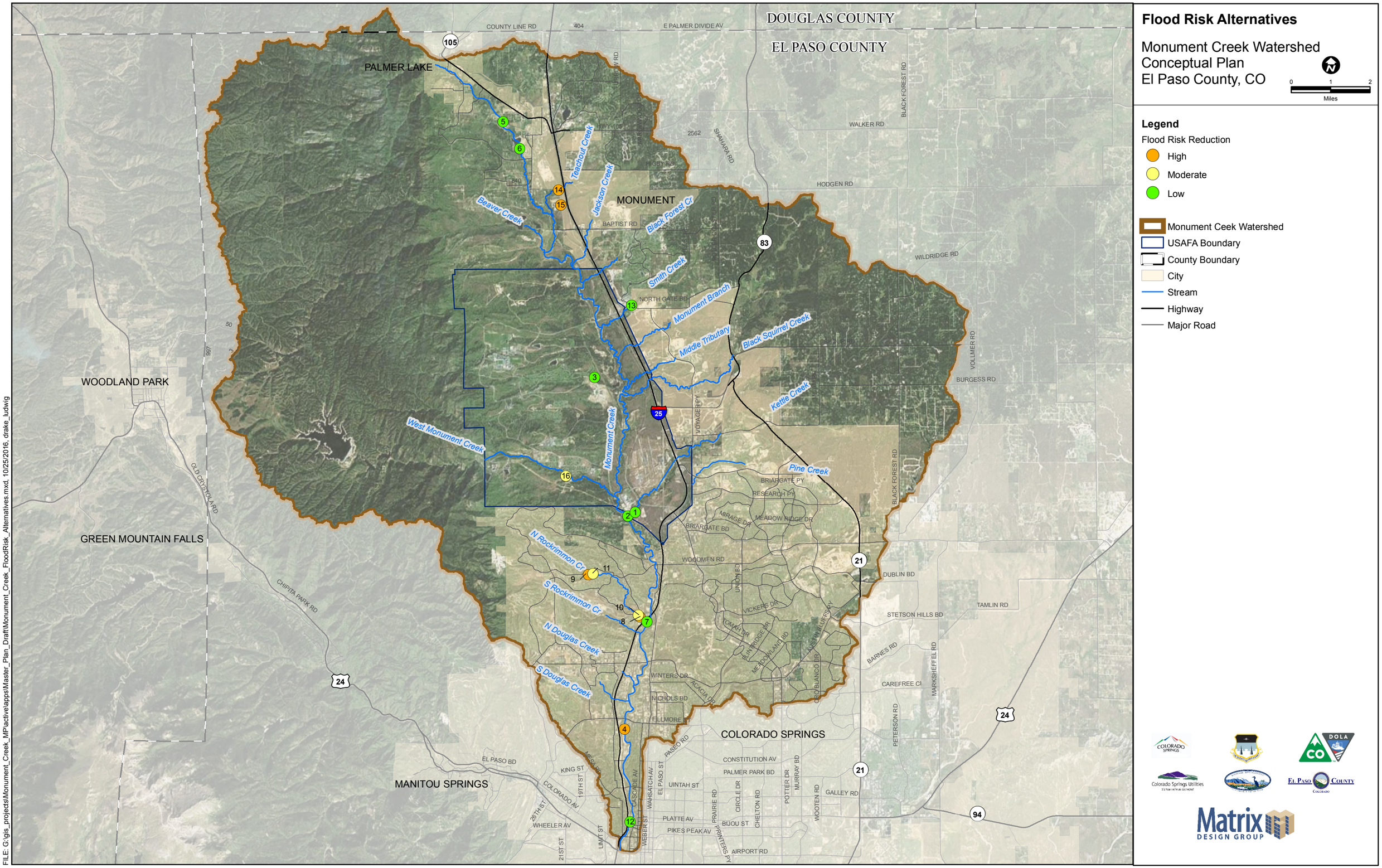
Legend

Detention Alternatives
- High
- Moderate
- Low

- Monument Ceek Watershed
- USAFA Boundary
- County Boundary
- City
- Stream
- Highway
- Major Road

FILE: G:\gis_projects\Monument_Creek_MPlactive\apps\Master_Plan_Draft\Monument_Creek_Detention_Alternatives.mxd, 10/21/2016, jeff_clonts

Figure 6. Detention and Water Quality Facilities Alternatives



FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Master_Plan_Draft\Monument_Creek_FloodRisk_Alternatives.mxd, 10/25/2016, drake_ludwig

Aquatic and Terrestrial Habitat Alternatives

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

Legend

Aquatic Alternatives

- Moderate

- Monument Ceek Watershed
- USAFA Boundary
- County Boundary
- City
- Stream
- Highway
- Major Road

DOUGLAS COUNTY

EL PASO COUNTY

PALMER LAKE

MONUMENT

WOODLAND PARK

GREEN MOUNTAIN FALLS

MANITOU SPRINGS

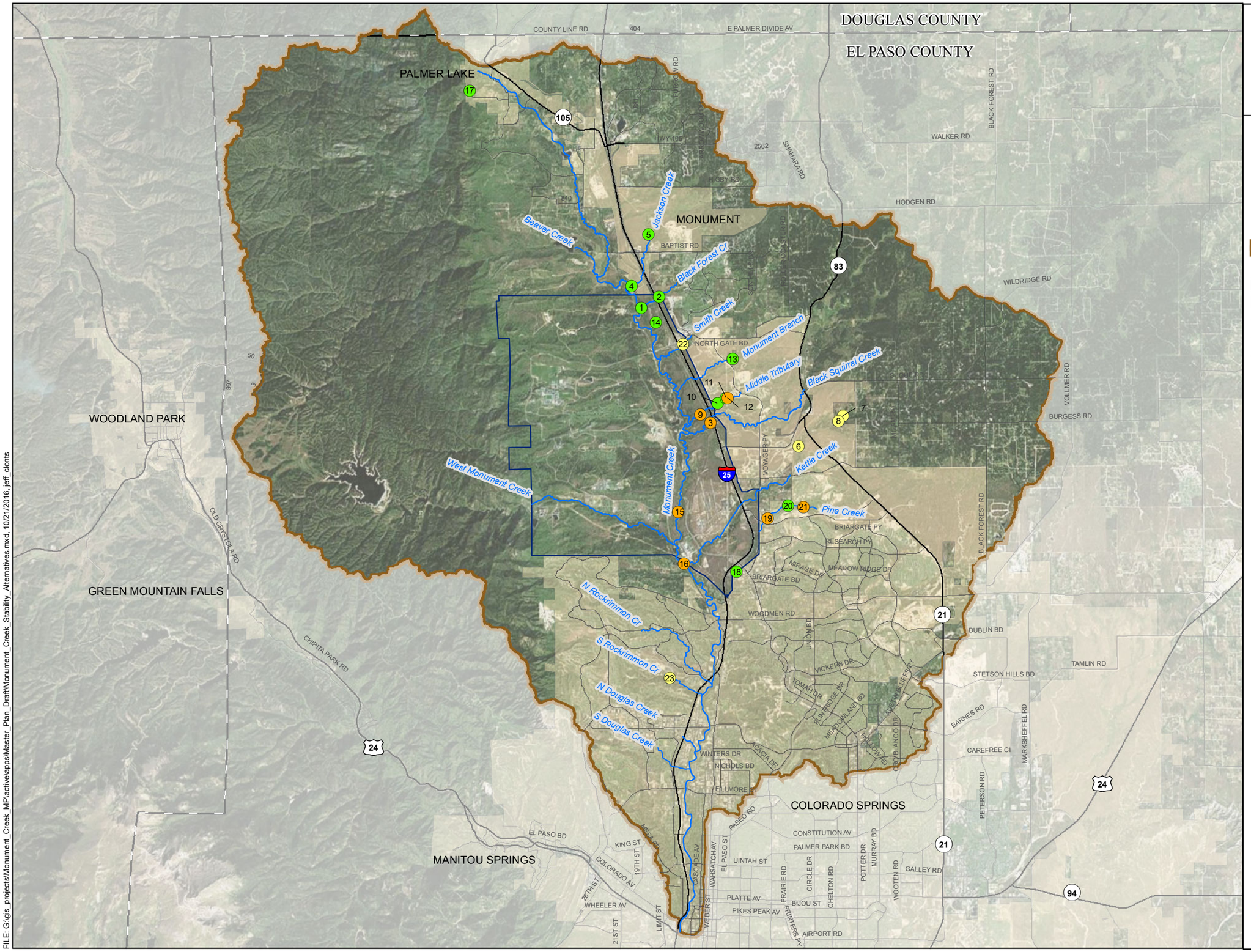
COLORADO SPRINGS

Jackson Creek
Beaver Creek
Black Forest Cr
Smith Creek
Monument Branch
Middle Tributary
Black Squirrel Creek
Kettle Creek
Pine Creek
Monument Creek
West Monument Creek
N Rockrimmon Cr
S Rockrimmon Cr
N Douglas Creek
S Douglas Creek

COUNTY LINE RD
E PALMER DIVIDE AV
HIGBY RD
WALKER RD
HODGEN RD
BAPTIST RD
NORTH GATE BD
WILDRIDGE RD
BURGESS RD
BRIARGATE PY
RESEARCH PY
BRIARGATE BD
MIRAGE DR
MEADOW RIDGE DR
WOODMEN RD
DUBLIN BD
STETSON HILLS BD
TAMLIN RD
BARNES RD
CAREFREE CI
WINTERS DR
NICHOLS BD
FILLMORE ST
PASEO RD
CONSTITUTION AV
PALMER PARK BD
UINTAH ST
GALLEY RD
EL PASO BD
KING ST
COLORADO AV
WHEELER AV
PLATTE AV
BIJOU ST
PIKES PEAK AV
AIRPORT RD
CHIPITA PARK RD
OLD CRYSTOLA RD

FILE: G:\gis_projects\Monument_Creek_MPlactive\apps\Master_Plan_Draft\Monument_Creek_Aquatic_Alternatives.mxd, 10/21/2016, jeff_clonts

Figure 8. Monument Creek Watershed Aquatic and Terrestrial Habitat Alternatives



Local Erosion Alternatives

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

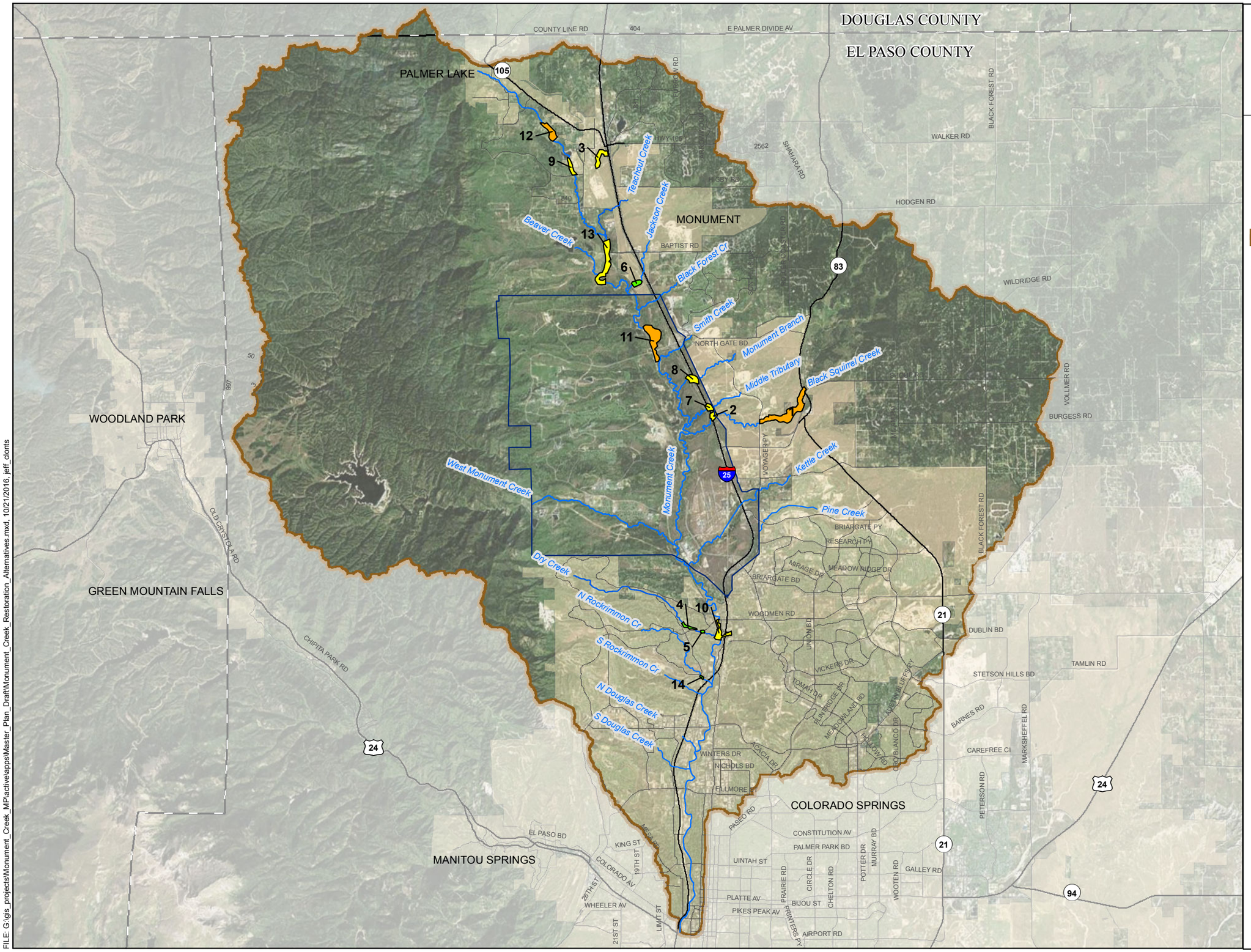
0 1 2
Miles

Legend

Rank
- High
- Moderate
- Low

- Monument Ceek Watershed
- USAFA Boundary
- County Boundary
- City
- Stream
- Highway
- Major Road

FILE: G:\gis_projects\Monument_Creek_MPactive\apps\Master_Plan_Draft\Monument_Creek_Stability_Alternatives.mxd. 10/21/2016. jeff_clonts



Riparian Buffer Restoration Alternatives

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

Legend

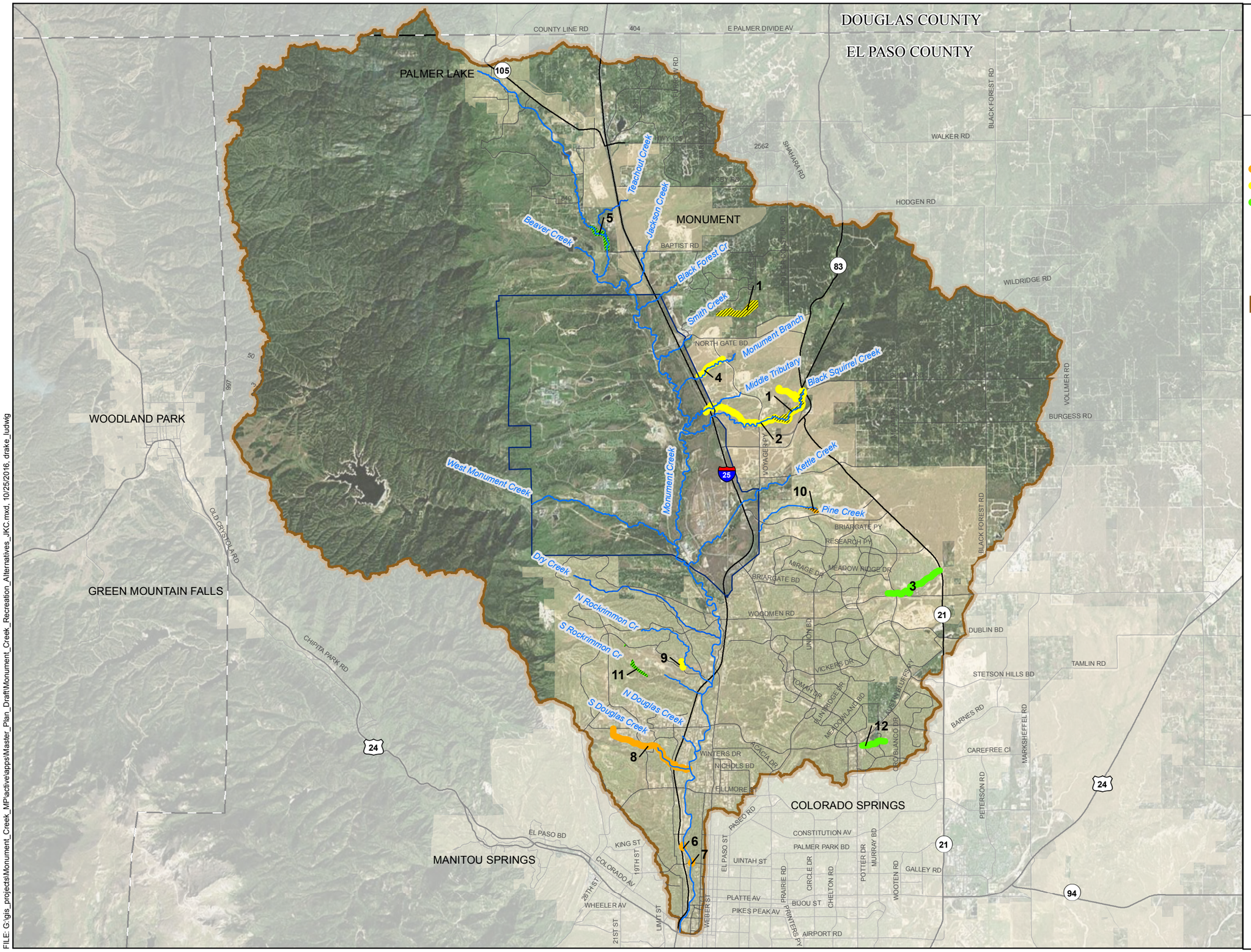
Riparian Restoration Alternatives

- High
- Moderate
- Low

- Monument Ceek Watershed
- USAFA Boundary
- County Boundary
- City
- Stream
- Highway
- Major Road

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Master_Plan_Draft\Monument_Creek_Restoration_Alternatives.mxd, 10/21/2016, jeff_clonts

Figure 10. Monument Creek Watershed Riparian Buffer Restoration Alternatives



Trails and Open Space Alternatives

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

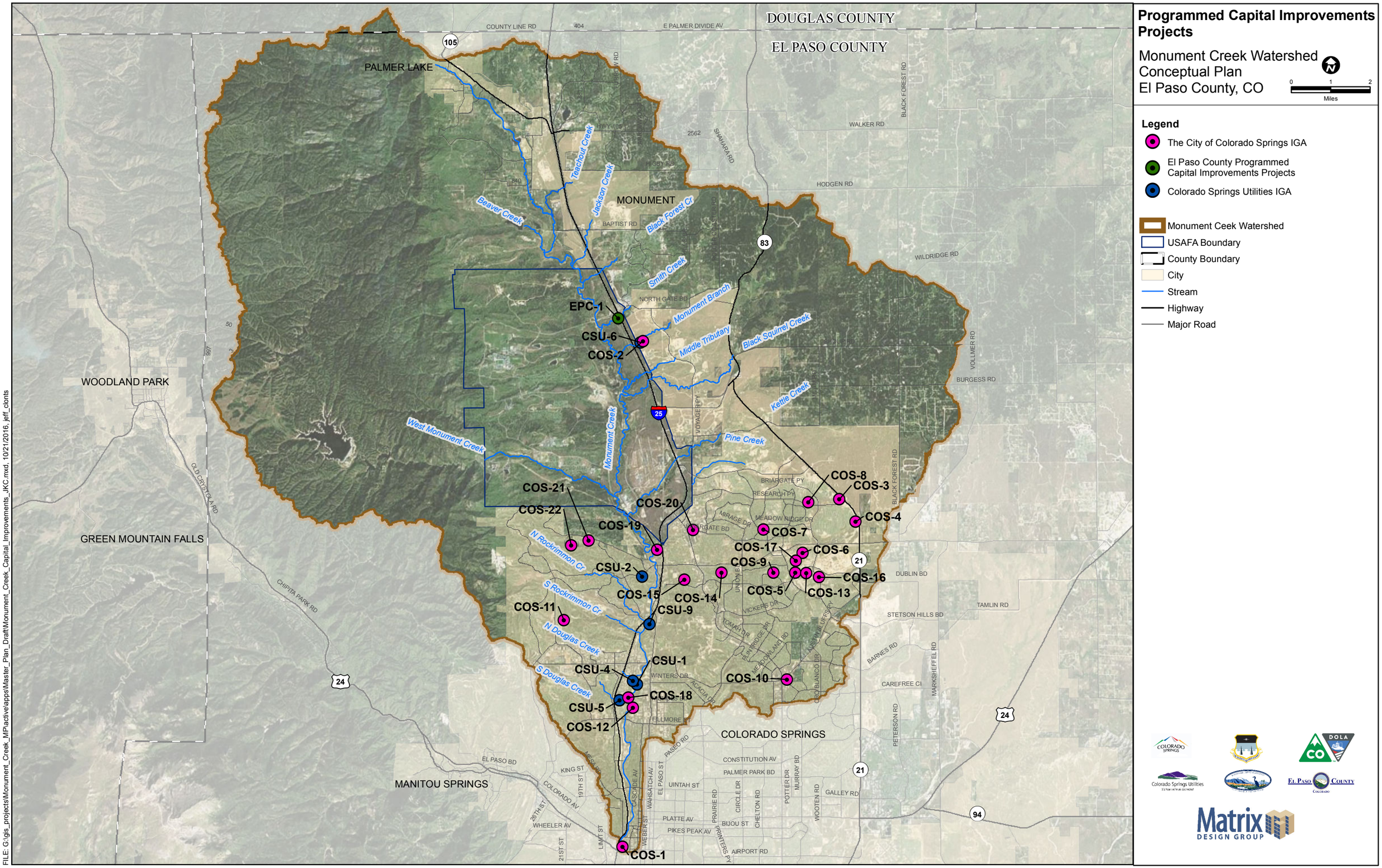
Legend

Trail Ranking
- High
- Moderate
- Low

Open Space Ranking
- High
- Moderate
- Low

- Monument Ceek Watershed
- USAFA Boundary
- County Boundary
- City
- Stream
- Highway
- Major Road

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Master_Plan_Draft\Monument_Creek_Recreation_Alternatives_JKC.mxd, 10/25/2016, drake_ludwig



Programmed Capital Improvements Projects

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

Legend

- The City of Colorado Springs IGA
- El Paso County Programmed Capital Improvements Projects
- Colorado Springs Utilities IGA
- Monument Ceek Watershed
- USAFA Boundary
- County Boundary
- City
- Stream
- Highway
- Major Road

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Master_Plan_Draft\Monument_Creek_Capital_Improvements_JKC.mxd, 10/21/2016, jeff_clonts

Figure 12. Monument Creek Watershed Programmed Capital Improvements Projects

Table 2. Monument Creek Project List and Alternative Ranking

Monument Creek Watershed Restoration Master Plan: Project List and Alternative Ranking				
Alternative Map Project ID	**Tributary / Location**	**Project Type**	**Ranking**	**Approximate Cost**
Alternative: Immediate Action				
1	Monument Branch	Headcut	Immediate	$100,000
2	North Douglas Creek	Failed Wingwalls	Immediate	$150,000
3	South Douglas Creek	Failed Wingwalls	Immediate	$150,000
Alternative: Stream Channel Restoration				
1	Black Forest	Natural Channel Design	Low	$240,000
2	Black Squirrel Creek	Small Drop Structures w/ Toe Protection	High	$2,515,000
3	Black Squirrel Creek	Natural Channel Design	High	$289,000
4	Black Squirrel Creek	Natural Channel Design	Moderate	$629,000
5	Black Squirrel Creek	Natural Channel Design	Low	$259,000
6	Black Squirrel Creek	Natural Channel Design	Low	$410,000
7	Black Squirrel Creek	Natural Channel Design	Low	$158,000
8	Jackson Creek	Small Drop Structures w/ Toe Protection	High	$1,231,000
9	Jackson Creek	Small Drop Structures w/ Toe Protection	Low	$559,000
10	Jackson Creek	Natural Channel Design	Low	$343,000
11	Kettle Creek	Natural Channel Design	High	$2,373,000
12	Kettle Creek	Natural Channel Design	Moderate	$244,000
13	Kettle Creek	Natural Channel Design	Moderate	$2,258,000
14	Kettle Creek	Natural Channel Design	Moderate	$98,000
15	Kettle Creek	Natural Channel Design	Moderate	$1,165,000
16	Kettle Creek	Natural Channel Design	Low	$131,000
17	Kettle Creek	Natural Channel Design	Low	$287,000
18	Kettle Creek	Natural Channel Design	Low	$293,000
19	Kettle Creek	Natural Channel Design	Low	$154,000
20	Kettle Creek	Natural Channel Design	Low	$233,000
21	Middle Tributary	Natural Channel Design	High	$168,000
22	Middle Tributary	Small Drop Structures w/ Toe Protection	High	$948,000
23	Middle Tributary	Natural Channel Design	Moderate	$917,000
24	Middle Tributary	Natural Channel Design	Low	$463,000
25	Middle Tributary	Natural Channel Design	Low	$520,000
26	Middle Tributary	Natural Channel Design	Low	$220,000
27	Middle Tributary	Natural Channel Design	Low	$325,000
28	Middle Tributary	Small Drop Structures w/ Toe Protection	Low	$239,000
29	Monument Branch	Small Drop Structures w/ Toe Protection	High	$1,231,000
30	Monument Branch	Natural Channel Design	Moderate	$853,000
31	Monument Branch	Natural Channel Design	Moderate	$329,000
32	Monument Branch	Natural Channel Design	Low	$1,367,000
33	Monument Branch	Natural Channel Design	Low	$1,897,000
34	Monument Branch	Small Drop Structures w/ Toe Protection	Low	$321,000
35	Monument Branch	Small Drop Structures w/ Toe Protection	Low	$859,000
36	Monument Branch	Natural Channel Design	Low	$607,000
37	Monument Creek Main Stem	Small Drop Structures w/ Toe Protection	High	$848,000
38	Monument Creek Main Stem	Small Drop Structures w/ Toe Protection	Moderate	$1,548,000
39	Monument Creek Main Stem	Natural Channel Design	Moderate	$1,121,000

Table 2. Monument Creek Project List and Alternative Ranking

Monument Creek Watershed Restoration Master Plan: Project List and Alternative Ranking				
Alternative Map Project ID	**Tributary / Location**	**Project Type**	**Ranking**	**Approximate Cost**
40	Monument Creek Main Stem	Natural Channel Design	Low	$865,000
41	Monument Creek Main Stem	Small Drop Structures w/ Toe Protection	Low	$7,337,000
42	North Douglas Creek	Small Drop Structures w/ Toe Protection	Moderate	$1,389,000
43	North Douglas Creek	Small Drop Structures w/ Toe Protection	Low	$212,000
44	North Douglas Creek	Small Drop Structures w/ Toe Protection	Low	$108,000
45	North Rockrimmon Creek	Small Drop Structures w/ Toe Protection	Moderate	$836,000
46	North Rockrimmon Creek	Small Drop Structures w/ Toe Protection	Low	$959,000
47	Pine Creek	Small Drop Structures w/ Toe Protection	High	$447,000
48	Pine Creek	Small Drop Structures w/ Toe Protection	High	$333,000
49	Pine Creek	Natural Channel Design	High	$526,000
50	Pine Creek	Natural Channel Design	Moderate	$373,000
51	Pine Creek	Small Drop Structures w/ Toe Protection	Low	$6,844,000
52	South Douglas Creek	Small Drop Structures w/ Toe Protection	High	$242,000
53	South Douglas Creek	Small Drop Structures w/ Toe Protection	Moderate	$324,000
54	South Douglas Creek	Small Drop Structures w/ Toe Protection	Moderate	$241,000
55	South Douglas Creek	Small Drop Structures w/ Toe Protection	Moderate	$143,000
56	South Douglas Creek	Small Drop Structures w/ Toe Protection	Moderate	$1,292,000
57	South Douglas Creek	Small Drop Structures w/ Toe Protection	Moderate	$514,000
58	South Douglas Creek	Small Drop Structures w/ Toe Protection	Moderate	$147,000
59	South Douglas Creek	Small Drop Structures w/ Toe Protection	Low	$117,000
60	South Douglas Creek	Small Drop Structures w/ Toe Protection	Low	$813,000
61	South Douglas Creek	Small Drop Structures w/ Toe Protection	Low	$146,000
Alternative: Detention and Water Quality Facilities				
1	Black Forest	Concept Detention	Low	$1,410,000
2	Black Forest	Detention Retrofit	Low	$30,000
3	Black Forest	Detention Retrofit	Low	$30,000
4	Black Squirrel Creek	Concept Detention	High	$4,390,000
5	Black Squirrel Creek	Concept Detention	High	$3,980,000
6	Black Squirrel Creek	Concept Detention	Moderate	$1,150,000
7	Black Squirrel Creek	Concept Detention	Moderate	$1,870,000
8	Black Squirrel Creek	Detention Retrofit	High	$3,940,000
9	Black Squirrel Creek	Detention Retrofit	Moderate	$750,000
10	Black Squirrel Creek	Detention Retrofit	High	$3,950,000
11	Dry Creek	Concept Detention	Low	$4,050,000
12	Dry Creek	Detention Retrofit	Low	$30,000
13	Elkhorn	Detention Retrofit	Low	$30,000
14	Jackson Creek	Concept Detention	Low	$980,000
15	Jackson Creek	Detention Retrofit	Low	$30,000
16	Kettle Creek	Concept Detention	Low	$17,320,000
17	Kettle Creek	Concept Detention	Low	$13,570,000
18	Kettle Creek	Concept Detention	Low	$2,260,000
19	Kettle Creek	Concept Detention	Low	$810,000
20	Kettle Creek	Concept Detention	Low	$810,000
21	Kettle Creek	Concept Detention	Low	$9,670,000

Table 2. Monument Creek Project List and Alternative Ranking

Monument Creek Watershed Restoration Master Plan: Project List and Alternative Ranking				
Alternative Map Project ID	**Tributary / Location**	**Project Type**	**Ranking**	**Approximate Cost**
22	Kettle Creek	Concept Detention	Low	$7,170,000
23	Kettle Creek	Concept Detention	Moderate	$3,230,000
24	Kettle Creek	Detention Retrofit	Moderate	$30,000
25	Kettle Creek	Detention Retrofit	Moderate	$30,000
26	Kettle Creek	Detention Retrofit	Moderate	$1,520,000
27	Kettle Creek	Detention Retrofit	Moderate	$1,850,000
28	Middle Tributary	Detention Retrofit	High	$1,330,000
29	Monument Branch	Concept Detention	Low	$7,040,000
30	Monument Branch	Detention Retrofit	High	$2,920,000
31	Monument Branch	Detention Retrofit	High	$2,090,000
32	Monument Branch	Detention Retrofit	Moderate	$2,920,000
33	Monument Creek Main Stem	Concept Detention	Low	$16,320,000
34	Monument Creek Main Stem	Concept Detention	Low	$45,190,000
35	Monument Creek Main Stem	Concept Detention	Low	$44,290,000
36	Monument Creek Main Stem	Concept Detention	Low	$4,560,000
37	Monument Creek Main Stem	Concept Detention	Moderate	$2,290,000
38	Monument Creek Main Stem	Concept Detention	Low	$5,920,000
39	Monument Creek Main Stem	Concept Detention	Low	$40,680,000
40	North Douglas Creek	Detention Retrofit	Moderate	$640,000
41	North Rockrimmon Creek	Concept Detention	Moderate	$1,190,000
42	North Rockrimmon Creek	Concept Detention	Moderate	$2,670,000
43	Pine Creek	Concept Detention	Low	$13,780,000
44	Pine Creek	Concept Detention	High	$4,080,000
45	Pine Creek	Detention Retrofit	Moderate	$30,000
46	Pine Creek	Detention Retrofit	Moderate	$2,690,000
47	Pine Creek	Detention Retrofit	High	$1,050,000
48	Pine Creek	Detention Retrofit	Moderate	$2,690,000
49	Pine Creek	Detention Retrofit	Moderate	$1,050,000
50	Smith Creek	Detention Retrofit	Low	$30,000
51	Smith Creek	Detention Retrofit	Low	$30,000
52	Smith Creek	Concept Detention	Moderate	$4,030,000
53	Smith Creek	Detention Retrofit	Moderate	$30,000
54	South Douglas Creek	Concept Detention	Moderate	$1,110,000
55	South Douglas Creek	Concept Detention	Low	$470,000
56	South Douglas Creek	Concept Detention	Low	$380,000
57	South Douglas Creek	Detention Retrofit	Low	$250,000
58	Teachout Creek	Concept Detention	Moderate	$1,390,000
59	Templeton Gap	Concept Detention	Low	$1,390,000
60	Templeton Gap	Concept Detention	Low	$1,660,000
61	USAFA	Detention Retrofit	Low	$30,000
62	West Monument Creek	Concept Detention	Low	$14,280,000
63	West Monument Creek	Concept Detention	Low	$14,740,000
Alternative: Flood Risk Reduction				
1	Kettle Creek	Culvert	Low	$14,000

Table 2. Monument Creek Project List and Alternative Ranking

Monument Creek Watershed Restoration Master Plan: Project List and Alternative Ranking				
Alternative Map Project ID	**Tributary / Location**	**Project Type**	**Ranking**	**Approximate Cost**
2	Kettle Creek	Culvert	Low	$27,000
3	Lehman Run	Culvert	Low	$51,000
4	Monument Creek	Bridge	High	$1,397,000
5	Monument Creek	Culvert	Low	$26,000
6	Monument Creek	Bridge	Low	$2,430,000
7	Monument Creek	Culvert	Low	$486,000
8	North Rockrimmon	Concept Levee	High	$178,000
9	North Rockrimmon	Culvert	High	$729,000
10	North Rockrimmon	Box Culvert	Moderate	$2,530,000
11	North Rockrimmon	Concept Levee	Moderate	$72,000
12	North Rockrimmon	Box Culvert	Low	$2,442,000
13	Smith Creek	Bridge	Low	$5,400,000
14	Teachout Creek	Culvert	High	$220,000
15	Teachout Creek	Culvert	High	$220,000
16	West Monument	Concept Levee	Moderate	$153,000
Alternative: Aquatic and Terrestrial Habitat				
1	Kettle Creek	Retrofit Structure for Fish Passage	Moderate	$180,000
2	Monument Creek Main Stem	Retrofit Structure for Fish Passage	Moderate	$400,000
3	Monument Creek Main Stem	Retrofit Structure for Fish Passage	Moderate	$340,000
4	Monument Creek Main Stem	Retrofit Structure for Fish Passage	Moderate	$800,000
5	Monument Creek Main Stem	Retrofit Structure for Fish Passage	Moderate	$320,000
6	Monument Creek Main Stem	Retrofit Structure for Fish Passage	Moderate	$360,000
7	Monument Creek Main Stem	Retrofit Structure for Fish Passage	Moderate	$200,000
8	Monument Creek Main Stem	Retrofit Structure for Fish Passage	Moderate	$560,000
9	Monument Creek Main Stem	Retrofit Structure for Fish Passage	Moderate	$320,000
10	West Monument Creek	Retrofit Structure for Fish Passage	Moderate	$100,000
11	West Monument Creek	Retrofit Structure for Fish Passage	Moderate	$200,000
Alternative: Local Erosion				
1	Black Forest	Headcutting	Low	$200,000
2	Black Forest	Channel Improvements	Low	$500,000
3	Black Squirrel Creek	Headcutting	High	$700,000
4	Jackson Creek	Headcutting	Low	$300,000
5	Jackson Creek	Headcutting	Low	$200,000
6	Kettle Creek	Headcutting	Moderate	$300,000
7	Kettle Creek	Headcutting	Moderate	$200,000
8	Kettle Creek	Headcutting	Moderate	$180,000
9	Middle Tributary	Headcutting	High	$400,000
10	Middle Tributary	Utility	Low	$300,000
11	Middle Tributary	Utility	Low	$300,000
12	Middle Tributary	Headcutting	High	$1,400,000
13	Monument Branch	Utility	Low	$300,000
14	Monument Creek Main Stem	Drainage Improvements	Low	$200,000
15	Monument Creek Main Stem	Headcutting	High	$200,000
16	Monument Creek Main Stem	Headcutting	High	$200,000

Table 2. Monument Creek Project List and Alternative Ranking

Monument Creek Watershed Restoration Master Plan: Project List and Alternative Ranking				
Alternative Map Project ID	**Tributary / Location**	**Project Type**	**Ranking**	**Approximate Cost**
17	Palmer Lake	Drainage Improvements	Low	$800,000
18	Pine Creek	Utility	Low	$300,000
19	Pine Creek	Headcutting	High	$300,000
20	Pine Creek	Utility	Low	$300,000
21	Pine Creek	Headcutting	High	$200,000
22	Smith Creek	Headcutting	Moderate	$400,000
23	South Rockrimmon Creek	Headcutting	Moderate	$500,000
Alternative: Riparian Buffer Restoration				
1	Black Squirrel Creek	Riparian Restoration	High	$1,238,000
2	Black Squirrel Creek	Riparian Restoration	Moderate	$134,000
3	Dirty Woman Creek	Riparian Restoration	Moderate	$459,000
4	Dry Creek	Riparian Restoration	Low	$229,000
5	Dry Creek	Riparian Restoration	Low	$60,000
6	Jackson Creek	Riparian Restoration	Low	$168,000
7	Middle Tributary	Riparian Restoration	Moderate	$121,000
8	Monument Branch	Riparian Restoration	Moderate	$213,000
9	Monument Creek Main Stem	Riparian Restoration	Moderate	$315,000
10	Monument Creek Main Stem	Riparian Restoration	Moderate	$357,000
11	Monument Creek Main Stem	Riparian Restoration	High	$832,000
12	Monument Creek Main Stem	Riparian Restoration	High	$357,000
13	Monument Creek Main Stem	Riparian Restoration	Moderate	$943,000
14	North Rockrimmon Creek	Riparian Restoration	Low	$78,000
Alternative: Trails and Open Space				
1	Black Squirrel / Smith Creek	Open Space	Moderate	$5,822,000
2	Black Squirrel Creek	Trail	Moderate	$256,000
3	Cottonwood Creek	Trail	Low	$90,000
4	Monument Branch	Trail	Moderate	$81,000
5	Monument Creek Main Stem	Open Space	Low	$4,673,000
6	Monument Creek Main Stem	Trail	High	$300,000
7	Monument Creek Main Stem	Trail	High	$450,000
8	North Douglas Creek	Trail	High	$134,000
9	North Rockrimmon Creek	Trail	Moderate	$61,000
10	Pine Creek	Open Space	High	$1,456,000
11	South Rockrimmon Creek	Trail	Low	$61,000
12	Templeton Gap	Park and Trail	Low	$34,000
Alternative: Programmed Capital Improvements Projects				
COS-1	Monument Creek Main Stem	Concept Detention	N/A	$2,500,000
COS-2	USAFA	Drainage Improvements	N/A	$2,000,000
COS-3	Fairfax	Concept Detention	N/A	$398,000
COS-4	Cottonwood Creek	Concept Detention	N/A	$2,740,000
COS-5	Rangewood Tributary	Concept Detention	N/A	$750,000
COS-6	Cottonwood Creek	Concept Detention	N/A	$1,591,000
COS-7	South Pine Creek	Concept Detention	N/A	$461,000
COS-8	Austin Bluffs Tributary	Concept Detention	N/A	$754,000

Table 2. Monument Creek Project List and Alternative Ranking

Monument Creek Watershed Restoration Master Plan: Project List and Alternative Ranking				
Alternative Map Project ID	**Tributary / Location**	**Project Type**	**Ranking**	**Approximate Cost**
COS-9	Cottonwood Creek	Concept Detention	N/A	$3,768,000
COS-10	Park Vista	Low Water Crossing	N/A	$3,750,000
COS-11	North Douglas Creek	Natural Channel Design	N/A	$3,500,000
COS-12	Monument Creek Main Stem	Drainage Improvements	N/A	$1,778,000
COS-13	Gold Medal Point Channel	Channel Improvements	N/A	$750,000
COS-14	Cottonwood Creek	Channel Improvements	N/A	$5,840,000
COS-15	Cottonwood Creek	Channel Improvements	N/A	$13,232,000
COS-16	Cottonwood Creek	Channel Improvements	N/A	$5,066,000
COS-17	Cottonwood Creek	Channel Improvements	N/A	$3,768,000
COS-18	Monument Creek Main Stem	Drainage Improvements	N/A	$478,000
COS-19	Pine Creek	Drainage Improvements	N/A	$1,250,000
COS-20	Pine Creek	Drainage Improvements	N/A	$1,641,000
COS-21	Dry Creek	Channel Improvements	N/A	$1,386,000
COS-22	Dry Creek	Drainage Improvements	N/A	$515,000
CSU-1	Monument Creek Main Stem	Channel Improvements	N/A	$820,000
CSU-2	Dry Creek	Channel Improvements	N/A	$510,000
CSU-4	North Douglas Creek	Channel Improvements	N/A	$251,000
CSU-5	South Douglas Creek	Channel Improvements	N/A	$176,000
CSU-6	Monument Branch	Channel Improvements	N/A	$1,100,000
CSU-9	Monument Creek Main Stem	Channel Improvements	N/A	$500,000
EPC-1	Smith Creek	Concept Detention	N/A	N/A

Table 3. Monument Creek Watershed Project Decision Matrix Results

ID	Criteria	Options Ranking (Fair / Better / Best)				
		BS-1 - Black Squirrel Conceptual Detention Upstream of Hwy 83	**BS-2 - Black Squirrel Conceptual Detention Near Silver Creek Dr.**	**BS-3 - Black Squirrel Riparian Restoration North of Interquest Pkwy.**	**BS-4 - Black Squirrel Detention Retrofit Upstream of Voyager Pkwy.**	**BS-5 - Black Squirrel Detention Retrofit Upstream of USAFA Property Boundary**
Evaluation Criteria						
1	Reduces flood risk to the public and residents by providing long term solutions that increase resiliency?	Reduces flood risk, no public safety risk, improves multi-objective resiliency, close to source	Reduces flood risk, no public safety risk, improves multi-objective resiliency	Does little for flood risk but increases resiliency	Reduces flood risk, no public safety risk, improves multi-objective resiliency	Reduces flood risk, no public safety risk, improves multi-objective resiliency, far from source
2	Avoids transfer of risks that create impacts downstream to infrastructure, channel and storm water systems?	Attenuate Flows, close to source	Attenuate Flows	No risk reduction	Attenuate Flows	Attenuate Flows
3	Number of people protected?	No people in vicinity	No people in vicinity	No people in vicinity	No people in vicinity	No people in vicinity
4	Physical area of watershed mitigated?	Large	Medium	Medium	Medium	Medium
5	Critical Infrastructure at risk?	Gas Utility Crossing Downstream	No	No	Gas, Underground Electric, Water, Wastewater Utility Crossing Downstream	No
6	Creates infrastructure investments that are reasonable to construct and provides the best value for their lifecycle, function and purpose?	Moderate, requires significant earthwork	Moderate, requires significant earthwork	Lower costs, provides environmental enhancement	Moderate, requires some earthwork	Moderate, requires significant earthwork
7	Meets or exceeds industry and local design standards?	Not a differentiator				
8	Minimizes the effort required to maintain and repair the options?	Moderate	Moderate	Lowest	Moderate	Moderate
9	Compatible with forest fire mitigation?	Mitigates flows from fire affected area	Mitigates flows from fire affected area	No significant relationship to forest fire mitigation	Mitigates flows from fire affected area	Mitigates flows from fire affected area
10	Protects or improves the habitat, water quality and geomorphology of Monument Creek and tributaries?	Improves Water Quality	Improves Water Quality	Improves habitat	Improves Water Quality	Improves Water Quality
11	Incorporates locally available materials and environmentally friendly processes?	Predominantly Earthwork with some concrete and rock structures	Predominantly Earthwork with some concrete and rock structures	Local plant materials, minimally invasive	Predominantly Earthwork with some concrete and rock structures	Predominantly Earthwork with some concrete and rock structures
12	Quantity of sediment reduced?	Moderate	Moderate	Low	Moderate	Moderate
13	Contributes to achieving MS-4 requirements?	No	Yes	No	Yes	Yes, but lower in the watershed
14	Does it meet CWCB criteria for multi-objective program elements?	Flow Attenuation, flood risk reduction, water quality, improves the success and resiliency of future projects	Flow Attenuation, flood risk reduction, water quality, improves the success and resiliency of future projects	Improves habitat and recreation	Flow Attenuation, flood risk reduction, water quality, improves the success and resiliency of future projects	Flow Attenuation, flood risk reduction, water quality, improves the success and resiliency of future projects
15	Provides access, connectivity and protects opportunities for enhancements to tourist destinations, community facilities, features and neighborhoods?	No	No	No	No	No
16	Provides funding, partnering and collaboration opportunities by meeting multiple stakeholder objectives?	Benefits the most partners	Benefits multiple partners	Benefits multiple partners	Benefits multiple partners	Benefits multiple partners
17	Can be supported by current land use regulations or revised land use regulations?	Not a differentiator				
18	Impacts to water rights?	Potential water rights coordination	Potential water rights coordination	No	Potential water rights coordination	Potential water rights coordination

Table 3. Monument Creek Watershed Project Decision Matrix Results

Fair | Better | Best

ID	Criteria	Options Ranking				
		BS-6 - Stabilize Headcutting on Black Squirrel Downstream of I-25	BS-7 - Black Squirrel Small Drop Structures West of I-25	BS-8 - Black Squirrel Natural Channel Design East of Monument Creek Confluence	JC-1 - Jackson Creek Small Drop Structures East of Monument Creek Confluence	KC-1 - Kettle Creek Natural Channel Design East of I-25
Evaluation Criteria						
1	Reduces flood risk to the public and residents by providing long term solutions that increase resiliency?	No flood risk reduction, downstream benefits, preventative measure to increase resiliency	Does little for flood risk but increases resiliency	Does little for flood risk but increases resiliency	Does little for flood risk but increases resiliency	Does little for flood risk but increases resiliency
2	Avoids transfer of risks that create impacts downstream to infrastructure, channel and storm water systems?	No risk reduction.	No risk reduction.	No risk reduction.	No risk reduction	No risk reduction.
3	Number of people protected?	No people in vicinity	No people in vicinity	No people in vicinity	No people in vicinity	No people in vicinity
4	Physical area of watershed mitigated?	Low	Medium	Medium	Medium	Medium
5	Critical Infrastructure at risk?	Santa Fe Trail in Vicinity. I-25 upstream of headcut.	Santa Fe Trail in Vicinity	No	Yes, Protects Railroad and Wastewater Crossing Downstream	Gas, Underground Electric, Water, Wastewater Utility Crossings and Highway 83 Upstream
6	Creates infrastructure investments that are reasonable to construct and provides the best value for their lifecycle, function and purpose?	Low cost, high return	Higher cost but foundational	Moderate cost, but foundational	Higher cost but foundational	Moderate cost, but foundational
7	Meets or exceeds industry and local design standards?	Not a differentiator				
8	Minimizes the effort required to maintain and repair the options?	Highest	Moderate	Moderate	Lowest	Moderate
9	Compatible with forest fire mitigation?	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation
10	Protects or improves the habitat, water quality and geomorphology of Monument Creek and tributaries?	Improves habitat, water quality, and geomorphology	Improves habitat, water quality, and geomorphology	Improves habitat, water quality, and geomorphology	Improves habitat, water quality, and geomorphology	Improves habitat, water quality, and geomorphology
11	Incorporates locally available materials and environmentally friendly processes?	Minimally invasive, can use local materials	Predominantly Earthwork with some concrete and rock structures	Predominantly Earthwork with minimal import material and some rock and log structures	Predominantly Earthwork with rock structures	Predominantly Earthwork with minimal import material and some rock and log structures
12	Quantity of sediment reduced?	Moderate	High	High	High	High
13	Contributes to achieving MS-4 requirements?	Yes, but preventative only	Yes	Yes	Yes	Yes
14	Does it meet CWCB criteria for multi-objective program elements?	Protects habitat and infrastructure	Habitat, water quality and protecting infrastructure	Both terrestrial and aquatic habitat, water quality and protecting infrastructure	Habitat, water quality and protecting infrastructure	Both terrestrial and aquatic habitat, water quality and protecting infrastructure
15	Provides access, connectivity and protects opportunities for enhancements to tourist destinations, community facilities, features and neighborhoods?	No	No	No	No	No
16	Provides funding, partnering and collaboration opportunities by meeting multiple stakeholder objectives?	Potential to benefit multiple partners.	Potential to benefit multiple partners.	Single beneficiary	Potential to benefit multiple partners.	Potential to benefit multiple partners.
17	Can be supported by current land use regulations or revised land use regulations?	Not a differentiator				
18	Impacts to water rights?	No	No	No	No	No

Table 3. Monument Creek Watershed Project Decision Matrix Results

Fair | Better | Best

ID	Criteria	Options Ranking				
		MB-1 - Monument Branch Detention Retrofit at Flying Horse	MB-2 - Monument Branch Detention at the Classical Academy	MCM-1 - Monument Creek Riparian Restoration at Oxbridge Rd.	MCM-2 - Monument Creek Small Drop Structures Near Railroad Crossing at North Airfield	MCM-3 - Monument Creek Riparian Restoration Upstream of North Gate Blvd.
Evaluation Criteria						
1	Reduces flood risk to the public and residents by providing long term solutions that increase resiliency?	Reduces flood risk, no public safety risk, improves multi-objective resiliency, close to source	Reduces flood risk, no public safety risk, improves multi-objective resiliency	Does little for flood risk but increases resiliency	Does little for flood risk but increases resiliency	Does little for flood risk but increases resiliency
2	Avoids transfer of risks that create impacts downstream to infrastructure, channel and storm water systems?	Attenuate Flows, close to source	Attenuate Flows	No risk reduction	No risk reduction.	No risk reduction.
3	Number of people protected?	No people in vicinity	No people in vicinity	No people in vicinity	No people in vicinity	No people in vicinity
4	Physical area of watershed mitigated?	Large	Medium	Medium	Medium	Medium
5	Critical Infrastructure at risk?	No	No	No	Railroad in vicinity - has been stabilized with sheet pile.	No
6	Creates infrastructure investments that are reasonable to construct and provides the best value for their lifecycle, function and purpose?	Moderate, requires no earthwork	Moderate, requires significant earthwork	Lower costs, provides environmental enhancement	Higher cost but foundational	Lower costs, provides environmental enhancement
7	Meets or exceeds industry and local design standards?	Not a differentiator				
8	Minimizes the effort required to maintain and repair the options?	Moderate	Moderate	Lowest	Moderate	Lowest
9	Compatible with forest fire mitigation?	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation
10	Protects or improves the habitat, water quality and geomorphology of Monument Creek and tributaries?	Improves Water Quality	Improves Water Quality	Improves habitat	Improves habitat, water quality, and geomorphology	Improves habitat.
11	Incorporates locally available materials and environmentally friendly processes?	Predominantly Earthwork with some concrete and rock structures	Predominantly Earthwork with some concrete and rock structures	Local plant materials, minimally invasive	Predominantly Earthwork with some concrete and rock structures	Local plant materials, minimally invasive
12	Quantity of sediment reduced?	Moderate	Moderate	Low	High	Low
13	Contributes to achieving MS-4 requirements?	Yes	Yes, but lower in the watershed	No	Yes	No
14	Does it meet CWCB criteria for multi-objective program elements?	Flow Attenuation, flood risk reduction, water quality, improves the success and resiliency of ongoing projects	Flow Attenuation, flood risk reduction, water quality, improves the success and resiliency of ongoing projects	Singular Objective	Improves habitat and water quality	Improves habitat and recreation
15	Provides access, connectivity and protects opportunities for enhancements to tourist destinations, community facilities, features and neighborhoods?	No	No	No	No	No
16	Provides funding, partnering and collaboration opportunities by meeting multiple stakeholder objectives?	Benefits multiple partners	Benefits multiple partners	Single beneficiary, Private Property	Potential to benefit multiple partners.	Single beneficiary
17	Can be supported by current land use regulations or revised land use regulations?	Not a differentiator				
18	Impacts to water rights?	Potential water rights coordination	Potential water rights coordination	No	No	No

Table 3. Monument Creek Watershed Project Decision Matrix Results

ID	Criteria	Options Ranking (Fair / Better / Best)				
		MCM-4 - Stabilize Headcutting on Monument Creek West of USAFA Airfield	MCM-5 - Stabilize Headcutting on Monument Creek near Thunderbird Ln.	MCM-6 -Flood risk Reduction at W. Polk Rd. Bridge at Monument Creek	MCM-7 - Mesa Creek Outfall	MCM-8 - Uintah Bridge Bank Stabilization
Evaluation Criteria						
1	Reduces flood risk to the public and residents by providing long term solutions that increase resiliency?	No flood risk reduction, downstream benefits, preventative measure to increase resiliency	No flood risk reduction, downstream benefits, preventative measure to increase resiliency	Provide flood risk reduction, public safety, and resiliency	No flood risk reduction, no downstream benefits, minimal effect on resiliency.	Minimal flood risk reduction, no downstream benefits, provides resiliency
2	Avoids transfer of risks that create impacts downstream to infrastructure, channel and storm water systems?	No risk reduction.	No risk reduction.	No risk reduction.	No risk reduction.	No risk reduction.
3	Number of people protected?	No people in vicinity	No people in vicinity.	Heavily traveled road	Trail users	Trail users
4	Physical area of watershed mitigated?	Low	Low	Low	Low	Low
5	Critical Infrastructure at risk?	No	No	Yes, Protects collector. Water, Wastewater, Gas Utility Crossing	Underground Electric, Wastewater Utilities in Vicinity	Bridge foundation exposed. Gas, Underground Electric, Water, Wastewater Utilities present.
6	Creates infrastructure investments that are reasonable to construct and provides the best value for their lifecycle, function and purpose?	Low cost, high return	Low cost, high return	Very high cost, high return	Low cost, minimal return	Low cost, minimal return
7	Meets or exceeds industry and local design standards?	Not a differentiator				
8	Minimizes the effort required to maintain and repair the options?	Highest	Highest	Highest	Highest	Highest
9	Compatible with forest fire mitigation?	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation
10	Protects or improves the habitat, water quality and geomorphology of Monument Creek and tributaries?	Improves habitat, water quality, and geomorphology	Improves habitat, water quality, and geomorphology	No improvement	No improvement	No improvement
11	Incorporates locally available materials and environmentally friendly processes?	Minimally invasive, can use local materials	Minimally invasive, can use local materials	Man-made infrastructure	Man-made infrastructure	Man-made infrastructure
12	Quantity of sediment reduced?	Moderate	Moderate	Low	Low	Low
13	Contributes to achieving MS-4 requirements?	Yes, but preventative only	Yes, but preventative only	No	No	No
14	Does it meet CWCB criteria for multi-objective program elements?	Singular objective	Habitat, water quality and protecting infrastructure	Singular Objective	Singular Objective	Stabilization, protects infrastructure, enhances recreation
15	Provides access, connectivity and protects opportunities for enhancements to tourist destinations, community facilities, features and neighborhoods?	No	No	No	Provides new trail route along Monument Creek	Provides new trail access along Monument Creek
16	Provides funding, partnering and collaboration opportunities by meeting multiple stakeholder objectives?	Single beneficiary	Benefits multiple partners	Benefits multiple partners	Benefits the most partners	Benefits the most partners
17	Can be supported by current land use regulations or revised land use regulations?	Not a differentiator				
18	Impacts to water rights?	No	No	No	No	No

Table 3. Monument Creek Watershed Project Decision Matrix Results

ID	Criteria	Options Ranking (Fair / Better / Best)				
		MT-1 - Stabilize Headcutting on Middle Tributary South of Middle Creek Pkwy.	MT-2 - Middle Tributary Detention Retrofit Upstream of USAFA Property Boundary	MT-3 - Stabilize Headcutting on Middle Tributary Downstream of I-25	MT-4 - Middle Tributary Small Drop Structures West of I-25	MT-5 - Middle Tributary Natural Channel Design East of Monument Creek Confluence
Evaluation Criteria						
1	Reduces flood risk to the public and residents by providing long term solutions that increase resiliency?	No flood risk reduction, downstream benefits, preventative measure to increase resiliency	Reduces flood risk, no public safety risk, improves multi-objective resiliency	No flood risk reduction, downstream benefits, preventative measure to increase resiliency	Does little for flood risk but increases resiliency	Does little for flood risk but increases resiliency
2	Avoids transfer of risks that create impacts downstream to infrastructure, channel and storm water systems?	No risk reduction	Attenuate Flows	No risk reduction.	No risk reduction.	No risk reduction.
3	Number of people protected?	No people in vicinity	No people in vicinity	No people in vicinity	No people in vicinity	No people in vicinity
4	Physical area of watershed mitigated?	Low	Medium	Low	Medium	Medium
5	Critical Infrastructure at risk?	No	Gas, Wastewater, Underground Electric utility crossings downstream	No	No	No
6	Creates infrastructure investments that are reasonable to construct and provides the best value for their lifecycle, function and purpose?	Low cost, high return	Moderate, requires less earthwork	Low cost, high return	Higher cost but foundational	Moderate cost, but foundational
7	Meets or exceeds industry and local design standards?	Not a differentiator				
8	Minimizes the effort required to maintain and repair the options?	Highest	Moderate	Highest	Moderate	Moderate
9	Compatible with forest fire mitigation?	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation
10	Protects or improves the habitat, water quality and geomorphology of Monument Creek and tributaries?	Improves habitat, water quality, and geomorphology	Improves Water Quality	Improves habitat, water quality, and geomorphology	Improves habitat, water quality, and geomorphology	Improves habitat, water quality, and geomorphology
11	Incorporates locally available materials and environmentally friendly processes?	Minimally invasive, can use local materials	Predominantly Earthwork with some concrete and rock structures	Minimally invasive, can use local materials	Predominantly Earthwork with some concrete and rock structures	Predominantly Earthwork with minimal import material.
12	Quantity of sediment reduced?	Moderate	Moderate	Moderate	High	High
13	Contributes to achieving MS-4 requirements?	Yes, but preventative only	Yes	Yes, but preventative only	Yes	Yes
14	Does it meet CWCB criteria for multi-objective program elements?	Singular Objective	Flow Attenuation, flood risk reduction, water quality, improves the success and resiliency of future projects	Singular objective	Improves habitat and water quality	Improves habitat and water quality
15	Provides access, connectivity and protects opportunities for enhancements to tourist destinations, community facilities, features and neighborhoods?	No	No	No	No	No
16	Provides funding, partnering and collaboration opportunities by meeting multiple stakeholder objectives?	Single beneficiary	Benefits multiple partners	Single beneficiary	Single beneficiary	Single beneficiary
17	Can be supported by current land use regulations or revised land use regulations?	Not a differentiator				
18	Impacts to water rights?	No	Potential water rights coordination	No	No	No

Table 3. Monument Creek Watershed Project Decision Matrix Results

ID	Criteria	Options Ranking				
		NDC-1 - North Douglas Small Drop Structures East of I-25	NRR-1 - Culvert Replacement at War Eagle Dr. North	NRR-2 - Levee Installation at S. Rockrimmon Blvd. Downstream of Pro Rodeo Dr.	PC-1 - Pine Creek Detention Retrofit Upstream of Stoneglen Dr.	PC-2 - Pine Creek Conceptual Detention Downstream of Briargate Blvd.
Evaluation Criteria						
1	Reduces flood risk to the public and residents by providing long term solutions that increase resiliency?	Does little for flood risk but increases resiliency	Provide flood risk reduction, public safety, and resiliency	Provide flood risk reduction, public safety, minimal effect on resiliency.	Reduces flood risk, no public safety risk, improves multi objective resiliency, close to source	Reduces flood risk, no public safety risk, improves multi objective resiliency, close to source
2	Avoids transfer of risks that create impacts downstream to infrastructure, channel and storm water systems?	No risk reduction.	No risk reduction	No risk reduction	Attenuate Flows, close to source	Attenuate Flows, close to source
3	Number of people protected?	No people in vicinity.	Neighborhood access.	Heavily traveled road	No people in vicinity	No people in vicinity
4	Physical area of watershed mitigated?	Medium	Low	Low	Large	Large
5	Critical Infrastructure at risk?	I-25 Upstream, Railroad downstream	Yes, Protects residential street. Gas, Water, Underground Electric crossing in vicinity	Yes, Protects major arterial. Gas, Underground Electric, Wastewater in vicinity	No	Golf course at risk
6	Creates infrastructure investments that are reasonable to construct and provides the best value for their lifecycle, function and purpose?	Higher cost but foundational	Low cost, high return.	Low cost, high return.	Moderate, requires some earthwork	Moderate, requires significant earthwork
7	Meets or exceeds industry and local design standards?	Not a differentiator				
8	Minimizes the effort required to maintain and repair the options?	Moderate	Highest	Highest	Moderate	Moderate
9	Compatible with forest fire mitigation?	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation
10	Protects or improves the habitat, water quality and geomorphology of Monument Creek and tributaries?	Improves habitat, water quality, and geomorphology	No improvement	No improvement	Improves Water Quality	Improves Water Quality
11	Incorporates locally available materials and environmentally friendly processes?	Predominantly Earthwork with rock structures	Man-made infrastructure	Minimally invasive, can use local materials	Predominantly Earthwork with some concrete and rock structures	Predominantly Earthwork with some concrete and rock structures
12	Quantity of sediment reduced?	High	Low	Low	Moderate	Moderate
13	Contributes to achieving MS-4 requirements?	Yes	No	No	Yes	Yes
14	Does it meet CWCB criteria for multi-objective program elements?	Habitat, water quality and protecting infrastructure	Singular Objective	Singular Objective	Flow Attenuation, flood risk reduction, water quality, improves the success and resiliency of future projects	Flow Attenuation, flood risk reduction, water quality, improves the success and resiliency of future projects
15	Provides access, connectivity and protects opportunities for enhancements to tourist destinations, community facilities, features and neighborhoods?	No	No	No	No	No
16	Provides funding, partnering and collaboration opportunities by meeting multiple stakeholder objectives?	Single beneficiary	Benefits multiple partners	Single beneficiary	Benefits multiple partners	Benefits multiple partners
17	Can be supported by current land use regulations or revised land use regulations?	Not a differentiator				
18	Impacts to water rights?	No	No	No	Potential water rights coordination	Potential water rights coordination

Fair | Better | Best

Table 3. Monument Creek Watershed Project Decision Matrix Results

ID	Criteria	Options Ranking				Fair / Better / Best
		PC-3 - Pine Creek Open Space	PC-4 - Stabilize Headcutting on Pine Creek at Golf Course Trail Crossing	PC-5 - Stabilize Headcutting on Pine Creek Upstream of Briargate Blvd.	PC-6 - Pine Creek Natural Channel Design East of I-25	PC-7 - Pine Creek Small Drop Structures East of I-25 and Downstream of Academy Blvd.
Evaluation Criteria						
1	Reduces flood risk to the public and residents by providing long term solutions that increase resiliency?	No flood risk reduction, no downstream benefits, minimal effect on resiliency.	No flood risk reduction, downstream benefits, preventative measure to increase resiliency	No flood risk reduction, downstream benefits, preventative measure to increase resiliency	Does little for flood risk but increases resiliency	Does little for flood risk but increases resiliency
2	Avoids transfer of risks that create impacts downstream to infrastructure, channel and storm water systems?	No risk reduction	No risk reduction	No risk reduction	No risk reduction.	No risk reduction.
3	Number of people protected?	No people in vicinity	Golf course users	Golf course users	No people in vicinity	No people in vicinity
4	Physical area of watershed mitigated?	Low	Low	Low	Medium	Medium
5	Critical Infrastructure at risk?	No	Golf course at risk	Golf course at risk	Threatens upstream lined channel.	Business complex in vicinity, threatens parking lots. Underground Electric Crossing Upstream.
6	Creates infrastructure investments that are reasonable to construct and provides the best value for their lifecycle, function and purpose?	Low cost, minimal return	Low cost, high return	Low cost, high return	Moderate cost, but foundational	Higher cost but foundational
7	Meets or exceeds industry and local design standards?	Not a differentiator				
8	Minimizes the effort required to maintain and repair the options?	Highest	Highest	Highest	Moderate	Moderate
9	Compatible with forest fire mitigation?	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation
10	Protects or improves the habitat, water quality and geomorphology of Monument Creek and tributaries?	Protects habitat	Improves habitat, water quality, and geomorphology	Improves habitat, water quality, and geomorphology	Improves habitat, water quality, and geomorphology	Improves habitat, water quality, and geomorphology
11	Incorporates locally available materials and environmentally friendly processes?	Minimally invasive, no construction required	Minimally invasive, can use local materials	Minimally invasive, can use local materials	Predominantly Earthwork with minimal import material.	Predominantly Earthwork with some concrete and rock structures
12	Quantity of sediment reduced?	Low	Moderate	Moderate	High	High
13	Contributes to achieving MS-4 requirements?	No	Yes, but preventative only	Yes, but preventative only	Yes	Yes
14	Does it meet CWCB criteria for multi-objective program elements?	Singular Objective	Habitat, water quality and protecting infrastructure	Habitat, water quality and protecting infrastructure	Both terrestrial and aquatic habitat, water quality and protecting infrastructure	Improves habitat and water quality
15	Provides access, connectivity and protects opportunities for enhancements to tourist destinations, community facilities, features and neighborhoods?	Provides open space feature	No	No	No	No
16	Provides funding, partnering and collaboration opportunities by meeting multiple stakeholder objectives?	Benefits multiple partners	Benefits multiple partners	Benefits multiple partners	Potential to benefit multiple partners.	Potential to benefit multiple partners.
17	Can be supported by current land use regulations or revised land use regulations?	Not a differentiator				
18	Impacts to water rights?	No	No	No	No	No

Table 3. Monument Creek Watershed Project Decision Matrix Results

ID	Criteria	Options Ranking			
					Fair / Better / Best
		SDC-1 - South Douglas Small drop Structures Downstream of Holland Park Blvd.	**SDC-2 - Sinton Trail**	**TC-1 - Culvert Replacement at Northern Teachout Creek Tributary and Old Denver Hwy.**	**TC-2 - Culvert Replacement at Teachout Creek and Old Denver Hwy.**
Evaluation Criteria					
1	Reduces flood risk to the public and residents by providing long term solutions that increase resiliency?	Does little for flood risk but increases resiliency	No flood risk reduction, no downstream benefits, minimal effect on resiliency.	Provide flood risk reduction, public safety, and resiliency	Provide flood risk reduction, public safety, and resiliency
2	Avoids transfer of risks that create impacts downstream to infrastructure, channel and storm water systems?	No risk reduction	No risk reduction	No risk reduction	No risk reduction
3	Number of people protected?	Trail users	Trail users	Heavily traveled road	Heavily traveled road
4	Physical area of watershed mitigated?	Medium	Low	Low	Low
5	Critical Infrastructure at risk?	No	No	Yes, Protects collector	Yes, Protects collector
6	Creates infrastructure investments that are reasonable to construct and provides the best value for their lifecycle, function and purpose?	Higher cost but foundational	Low cost, minimal return	Low cost, high return	Low cost, high return
7	Meets or exceeds industry and local design standards?	Not a differentiator			
8	Minimizes the effort required to maintain and repair the options?	Lowest	Moderate	Highest	Highest
9	Compatible with forest fire mitigation?	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation	No significant relationship to forest fire mitigation
10	Protects or improves the habitat, water quality and geomorphology of Monument Creek and tributaries?	Improves habitat, water quality, and geomorphology	No improvement	No improvement	No improvement
11	Incorporates locally available materials and environmentally friendly processes?	Predominantly Earthwork with rock structures	Man made infrastructure	Man made infrastructure	Man made infrastructure
12	Quantity of sediment reduced?	High	Low	Low	Low
13	Contributes to achieving MS-4 requirements?	Yes	No	No	No
14	Does it meet CWCB criteria for multi-objective program elements?	Habitat, water quality and protecting infrastructure	Singular Objective	Singular Objective	Singular Objective
15	Provides access, connectivity and protects opportunities for enhancements to tourist destinations, community facilities, features and neighborhoods?	No	Enhances existing	No	No
16	Provides funding, partnering and collaboration opportunities by meeting multiple stakeholder objectives?	Single beneficiary	Benefits multiple partners	Single beneficiary	Single beneficiary
17	Can be supported by current land use regulations or revised land use regulations?	Not a differentiator			
18	Impacts to water rights?	No	No	No	No

3.1 Prioritized Master List

Projects were identified throughout the Monument Creek Watershed via field investigation, technical analysis, and input from the community and stakeholders, as described in Section 1.5. After an initial project list was created, identified projects were considered amongst the project team and the coalition of engineers, planners, stakeholders, and local citizens for their importance and potential risks to infrastructure, development, and impact downstream and upstream of the project location. After the projects were identified, the results were presented to the community in public forums and to the stakeholders in several meetings for input, planning, and impact. Depending on the nature of the project, severity, and potential of other problems occurring if not addressed, a prioritization list was established, and the highest priority projects were deliberated on amongst the stakeholders and project team. This process was used to select specific projects of high priority on which to focus the Restoration Plan's attention.

After the initial projects were identified, the project list was presented to the stakeholders for input regarding the importance of each potential project and its impact on the surrounding area. Other issues that may be resolved when addressing individual projects were considered: potential flood reduction, impact to surrounding development, impact and conservation of important habitat and wildlife, the potential of additional damages if not addressed, and other factors that would allow for input regarding the projects priority.

Projects involving infrastructure, critical access roadways, bridges and culvert crossings, and heavily populated areas were designated to be addressed immediately. This designation is intended to ensure public safety in the surrounding areas, and to reduce the risk of creating additional critical problems.

3.1.1 Cost Estimates

Cost estimates were developed for each of the identified project sites. Initial cost estimates provided a metric for the overall feasibility of a given alternative; these costs are displayed as a part of Table 2 shown above. After the alternatives analysis and prioritization processes were completed, the individual cost estimates for the immediate and high ranking projects were refined further to include itemized costs. These refined cost estimates are included, with a brief project description, in the following section. All the costs published in this report are done so using current (2016) unit prices and are not projected for future implementation. Actual project costs will be dependent upon planning and construction methods. Background information used to develop these cost estimates are provided in Appendix E.

3.2 Immediate Action Projects

Utilizing several methods and procedures to identify recommended projects, the project team ranked each project according to the methodology described above. A description of all the projects that were ranked as immediate or high priority for the Monument Creek Watershed can be found below. Detailed cost estimates have been prepared for each of the listed immediate or high priority projects and are provided after each project description. Immediate Action Projects were identified by their elevated threat to public health and major infrastructure.

NDC-2: North Douglas I-25 Downstream Failed Wingwall and Erosion

This project has been identified as a potential risk to Interstate 25 and pedestrians who may access this area from the Interstate and nearby commercial properties. The proposed improvements provide repairs to the I-25 culvert in addition to a grouted boulder structure for grade control and bank stabilization measures. To further stabilize this reach of North Douglas Creek, consider the opportunity to couple this project with the small drop structure priority project, NDC-1.

Figure 13. NDC-2: North Douglas I-25 Downstream Failed Wingwall and Erosion

Table 4. NDC-2: North Douglas I-25 Downstream Failed Wingwall and Erosion

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 30,000.00	LS	$ 30,000.00
Dewatering	1	$ 30,000.00	LS	$ 30,000.00
Sediment and Erosion Control	1	$ 20,000.00	LS	$ 20,000.00
General Earthwork	0	$ 20.00	CY	$ -
Excavation and Export	0	$ 40.00	CY	$ -
Structural Conc.	20	$ 650.00	CY	$ 13,000.00
Import Fill	1100	$ 40.00	CY	$ 44,000.00
Grouted Boulder	450	$ 600.00	SY	$ 270,000.00
Riprap Mat (Soil Riprap Type VH)	130	$ 160.00	CY	$ 20,800.00
Fence	580	$ 15.00	LF	$ 8,700.00
Reveg (Seed, stakes, plugs)	2300	$ 1.20	SF	$ 2,800.00
Subtotal				$ 440,000.00
Engineering	15%			$ 66,000.00
Contingency	20%			$ 88,000.00
Total				$ 594,000.00

SDC-3: South Douglas I-25 Downstream Failed Wingwall and Erosion

This project has been identified as a potential risk to Interstate 25 and pedestrians who may access this area from the Interstate and nearby recreational trails and commercial properties. The proposed improvements provide repairs to the I-25 culvert, bank stabilization measures, and signage to recreation users of Sinton Trail.

Figure 14. SDC-3: South Douglas I-25 Downstream Failed Wingwall and Erosion

Table 5. SDC-3: South Douglas I-25 Downstream Failed Wingwall and Erosion

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 10,000.00	LS	$ 10,000.00
Dewatering	1	$ 10,000.00	LS	$ 10,000.00
Sediment and Erosion Control	1	$ 10,000.00	LS	$ 10,000.00
General Earthwork	100	$ 20.00	CY	$ 2,000.00
Excavation and Export	0	$ 40.00	CY	$ -
Structural Conc.	20	$ 650.00	CY	$ 13,000.00
Import Fill	260	$ 40.00	CY	$ 10,400.00
Grouted Boulder	0	$ 600.00	SY	$ -
Riprap Mat (Soil Riprap Type VH)	120	$ 160.00	CY	$ 19,200.00
Fence	350	$ 15.00	LF	$ 5,300.00
Reveg (Seed, stakes, plugs)	1000	$ 1.20	SF	$ 1,200.00
Subtotal				$ 82,000.00
Engineering	15%			$ 13,000.00
Contingency	20%			$ 17,000.00
Total				$ 112,000.00

MB-3: Monument Branch Tributary Erosion between Northbound and Southbound I-25

This project has been identified as Immediate Action for its direct threat to Interstate 25. The site consists of an incised tributary and large headcut. The proposed restoration work involves stabilizing the site and piping the drainage into Monument Branch.

Figure 15. MB-3: Monument Branch Tributary Erosion between Northbound and Southbound I-25

Table 6. MB-3: Monument Branch Tributary Erosion between Northbound and Southbound I-25

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 40,000.00	LS	$ 40,000.00
Dewatering	1	$ 40,000.00	LS	$ 40,000.00
Sediment and Erosion Control	1	$ 20,000.00	LS	$ 20,000.00
Inlet	1	$6,000	EA	$ 6,000.00
60" Manhole	5	$5,000	EA	$ 25,000.00
48" RCP	900	$200	LF	$ 180,000.00
Import Fill	2100	$ 40.00	CY	$ 84,000.00
FES	10	$2,700	EA	$ 27,000.00
Riprap Mat (Soil Riprap Type VH)	150	$ 160.00	CY	$ 24,000.00
Reveg (Seed, stakes, plugs)	5000	$ 1.20	SF	$ 6,000.00
Subtotal				$ 452,000.00
Engineering	15%			$ 68,000.00
Contingency	20%			$ 90,000.00
Total				$ 610,000.00

3.3 High Priority Projects

Critical projects that did not pose an elevated threat to public health and major infrastructure were given a high ranking in the alternatives analysis. The following section provides a brief discussion and a detailed cost estimate for each of these projects. As discussed in the plan development section of the Restoration Plan, these projects were carried forward and prioritized further via the decision making matrix and were included in the prioritized list of actionable projects, Table 1.

BS-1: Black Squirrel Conceptual Detention Upstream of Highway 83

This conceptual detention facility upstream of the Highway 83 crossing would help attenuate peak flows generated high in the Black Squirrel subwatershed.

Figure 16. BS-1: Black Squirrel Conceptual Detention Upstream of Highway 83

Table 7. BS-1: Black Squirrel Conceptual Detention Upstream of Highway 83

Item	QTY	Unit Cost	Unit	Total
Excavation/Embankment (onsite)	54333	$14.00	CY	$760,662.00
Excavation (haul)	0	$30.00	CY	$0.00
Embankment (haul)	24225	$30.00	CY	$726,750.00
Inlet/Forebay (8" conc. bottom)	1721	$300.00	CY	$516,210.00
Forebay Riprap (Type L) w/bedding	228	$70.00	CY	$15,988.00
Grouted 2' Dia Boulder Rundown	101	$216.00	SY	$21,708.00
6' Conc. Trickle Channel (6" thick, 6" deep)	375	$44.00	LF	$16,500.00
Outlet Pipe, RCP	50	$91.00	LF	$4,550.00
Outlet Pipe Protection - FES w/riprap	1	$1,230.00	EA	$1,230.00
Outlet Structure - 8" walls	8	$761.00	CY	$5,775.99
Outlet Structure trash rack, screen and railing	1	$5,000.00	LS	$5,000.00
Emergency Spillway (Type M riprap)	1280	$76.00	CY	$97,280.00
Concrete Crest Wall, 12" thick	154	$761.00	CY	$117,498.40
Access Road (12' wide, 8" Class 6 gravel)	700	$9.00	LF	$6,300.00
Stockpile Topsoil -	18419	$10.00	CY	$184,189.00
Place Topsoil -	18419	$12.00	CY	$221,026.80
Seeding, native	34	$620.00	AC	$21,266.00
Erosion Control Blanket	41443	$8.00	SY	$331,540.00
Mulching	34	$600.00	AC	$20,550.00
Land Requirement	15	$50,000.00	AC	$762,500.00
Subtotal				$3,836,524.19
Engineering	15%			$576,000.00
Contingency	20%			$768,000.00
Total				$5,181,000.00

BS-2: Black Squirrel Conceptual Detention near Silver Creek Drive

This conceptual detention facility just east of Silver Creek Drive would help attenuate peak flows generated high in the Black Squirrel subwatershed. There is an opportunity to couple the objectives of this project with that of BS-3.

Figure 17. BS-2: Black Squirrel Conceptual Detention near Silver Creek Drive

Table 8. BS-2: Black Squirrel Conceptual Detention near Silver Creek Drive

Item	QTY	Unit Cost	Unit	Total
Excavation/Embankment (onsite)	11116	$14.00	CY	$155,624.00
Excavation (haul)	4942	$30.00	CY	$148,260.00
Embankment (haul)		$30.00	CY	$0.00
Inlet/Forebay (8" conc. bottom)	258	$300.00	CY	$77,400.00
Forebay Riprap (Type L) w/bedding	85	$70.00	CY	$5,950.00
Grouted 2' Dia Boulder Rundown	119	$216.00	SY	$25,790.40
6' Conc. Trickle Channel (6" thick, 6" deep)	375	$44.00	LF	$16,500.00
Outlet Pipe, RCP	50	$91.00	LF	$4,550.00
Outlet Pipe Protection - FES w/riprap	1	$1,230.00	EA	$1,230.00
Outlet Structure - 8" walls	8	$761.00	CY	$5,775.99
Outlet Structure trash rack, screen and railing	1	$5,000.00	LS	$5,000.00
Emergency Spillway (Type M riprap)	1341	$76.00	CY	$101,893.20
Concrete Crest Wall, 12" thick	77	$761.00	CY	$58,216.50
Access Road (12' wide, 8" Class 6 gravel)	700	$9.00	LF	$6,300.00
Stockpile Topsoil -	2554	$10.00	CY	$25,544.00
Place Topsoil -	2554	$12.00	CY	$30,652.80
Seeding, native	5	$620.00	AC	$2,976.00
Erosion Control Blanket	5748	$8.00	SY	$45,980.00
Mulching	5	$600.00	AC	$2,850.00
Land Requirement	2	$50,000.00	AC	$115,000.00
Subtotal				$835,492.89
Engineering	15%			$126,000.00
Contingency	20%			$168,000.00
Total				$1,129,000.00

BS-3: Black Squirrel Riparian Restoration North of Interquest Parkway

These improvements span from the Black Squirrel crossing at Voyager Parkway upstream to Highway 83. Establishing a healthy riparian corridor through this reach will provide environmental and aesthetic benefits. There is an opportunity to couple the objectives of this project with that of BS-2.

Figure 18. BS-3: Black Squirrel Riparian Restoration North of Interquest Parkway

Table 9. BS-3: Black Squirrel Riparian Restoration North of Interquest Parkway

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 33,628	LS	$ 34,000
Site Preparation	1	$ 150,000	LS	$ 150,000
Seeding	1	$ 85,000	LS	$ 85,000
Live Planting	1	$ 250,000	LS	$ 250,000
Erosion Control	1	$ 450,000	LS	$ 450,000
Subtotal				$ 969,000
Engineering	15%			$ 146,000
Contingency	20%			$ 194,000
Total				$ 1,309,000

BS-4 Black Squirrel Detention Retrofit Upstream of Voyager Parkway

This is a detention retrofit project immediately east of Voyager Parkway. Adding a full spectrum outlet structure and increasing the capacity of the existing pond will improve upon its current function.

Figure 19. BS-4: Black Squirrel Detention Retrofit Upstream of Voyager Parkway

Table 10. BS-4 Black Squirrel Detention Retrofit Upstream of Voyager Parkway

Item	QTY	Unit Cost	Unit	Total
Excavation/Embankment (onsite)	8763	$14.00	CY	$122,682.00
Excavation (haul)		$30.00	CY	$0.00
Embankment (haul)	3319	$30.00	CY	$99,570.00
Inlet/Forebay (8" conc. bottom)	271	$300.00	CY	$81,240.00
Forebay Riprap (Type L) w/bedding	87	$70.00	CY	$6,111.00
Grouted 2' Dia Boulder Rundown	159	$216.00	SY	$34,430.40
6' Conc. Trickle Channel (6" thick, 6" deep)	375	$44.00	LF	$16,500.00
Outlet Pipe, RCP	50	$91.00	LF	$4,550.00
Outlet Pipe Protection - FES w/riprap	1	$1,230.00	EA	$1,230.00
Outlet Structure - 8" walls	8	$761.00	CY	$5,775.99
Outlet Structure trash rack, screen and railing	1	$5,000.00	LS	$5,000.00
Emergency Spillway (Type M riprap)	1396	$76.00	CY	$106,065.60
Concrete Crest Wall, 12" thick	80	$761.00	CY	$60,803.90
Access Road (12' wide, 8" Class 6 gravel)	700	$9.00	LF	$6,300.00
Stockpile Topsoil -	2689	$10.00	CY	$26,889.00
Place Topsoil -	2689	$12.00	CY	$32,266.80
Seeding, native	5	$620.00	AC	$3,100.00
Erosion Control Blanket	6050	$8.00	SY	$48,400.00
Mulching	5	$600.00	AC	$3,000.00
Land Requirement		$50,000.00	AC	$0.00
Subtotal				$663,914.69
Engineering	15%			$100,000.00
Contingency	20%			$133,000.00
Total				$897,000.00

BS -5: Black Squirrel Detention Retrofit Upstream of USAFA Property Boundary

This is a detention retrofit project near the Alison Valley Ranch ponds. Adding a full spectrum outlet structure and increasing the capacity of the existing depression adjacent to the second pond will improve upon its current function. The Farm development (formerly Alison Valley Ranch) has a commitment to upgrade the dams and stabilize Black Squirrel Creek as a component of their Prebles Meadow Jumping Mouse mitigation effort.

Figure 20. BS-5: Black Squirrel Detention Retrofit Upstream of USAFA Boundary

Table 11. BS -5: Black Squirrel Detention Retrofit Upstream of USAFA Property Boundary

Item	QTY	Unit Cost	Unit	Total
Excavation/Embankment (onsite)	19095	$14.00	CY	$267,330.00
Excavation (haul)		$30.00	CY	$0.00
Embankment (haul)	2044	$30.00	CY	$61,320.00
Inlet/Forebay (8" conc. bottom)	435	$300.00	CY	$130,560.00
Forebay Riprap (Type L) w/bedding	112	$70.00	CY	$7,847.00
Grouted 2' Dia Boulder Rundown	159	$216.00	SY	$34,279.20
6' Conc. Trickle Channel (6" thick, 6" deep)	375	$44.00	LF	$16,500.00
Outlet Pipe, RCP	50	$91.00	LF	$4,550.00
Outlet Pipe Protection - FES w/riprap	1	$1,230.00	EA	$1,230.00
Outlet Structure - 8" walls	8	$761.00	CY	$5,775.99
Outlet Structure trash rack, screen and railing	1	$5,000.00	LS	$5,000.00
Emergency Spillway (Type M riprap)	1384	$76.00	CY	$105,161.20
Concrete Crest Wall, 12" thick	88	$761.00	CY	$67,120.20
Access Road (12' wide, 8" Class 6 gravel)	700	$9.00	LF	$6,300.00
Stockpile Topsoil -	4437	$10.00	CY	$44,367.00
Place Topsoil -	4437	$12.00	CY	$53,240.40
Seeding, native	8	$620.00	AC	$5,146.00
Erosion Control Blanket	9983	$8.00	SY	$79,860.00
Mulching	8	$600.00	AC	$4,950.00
Land Requirement		$50,000.00	AC	$0.00
Subtotal				$900,536.99
Engineering	15%			$136,000.00
Contingency	20%			$181,000.00
Total				$1,218,000.00

BS-6: Stabilize Headcutting on Black Squirrel Downstream of I-25

A ten foot headcut was identified on Black Squirrel immediately downstream of I-25. Stabilizing this portion of reach with boulder structures and riprap is critical in maintaining stability upstream.

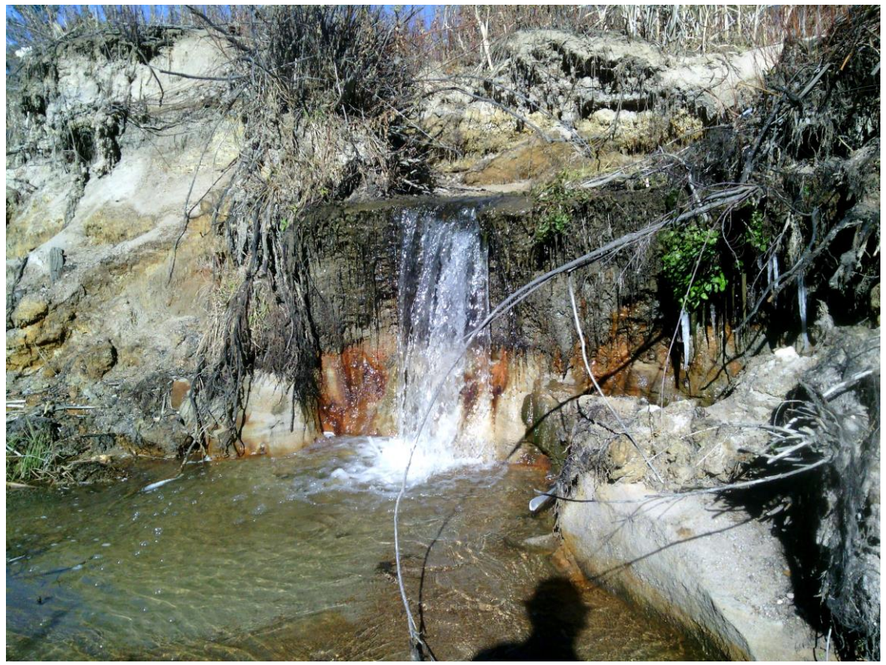


Figure 21. BS-6: Stabilize Headcutting on Black Squirrel Downstream of I-25

Table 12. BS-6: Stabilize Headcutting on Black Squirrel Downstream of I-25

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 25,000.00	LS	$ 25,000.00
Dewatering	1	$ 25,000.00	LS	$ 25,000.00
Sediment and Erosion Control	1	$ 18,000.00	LS	$ 18,000.00
General Earthwork	250	$ 20.00	CY	$ 5,000.00
Excavation and Export	190	$ 40.00	CY	$ 7,600.00
Boulder Drop Structure (48")	630	$ 300.00	SY	$ 189,000.00
Riprap Mat (Soil Riprap Type VH)	1110	$ 160.00	CY	$ 177,600.00
Reveg (Seed, Stakes, and Plugs)	25000	$ 1.20	SF	$ 30,000.00
Subtotal				$ 478,000.00
Engineering	15%			$ 72,000.00
Contingency	20%			$ 96,000.00
Total				$ 646,000.00

BS-7: Black Squirrel Small Drop Structures West of I-25

This reach is located on the Air Force Academy just west of Interstate 25 and extends approximately 1000-ft southwest of the New Santa Fe Regional Trail. This stretch of creek has experienced significant downcutting and bank erosion, and also includes several headcuts that are migrating upstream. Unstable slopes and unfavorable conditions indicate that small drop structures with toe protection would be a viable approach in this channel.

Figure 22. BS-7: Black Squirrel Small Drop Structures West of I-25

Table 13. BS-7: Black Squirrel Small Drop Structures West of I-25

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 120,000.00	LS	$ 120,000.00
Dewatering	1	$ 120,000.00	LS	$ 120,000.00
Sediment and Erosion Control	1	$ 90,000.00	LS	$ 90,000.00
General Earthwork	1600	$ 20.00	CY	$ 32,000.00
Excavation and Export	2240	$ 40.00	CY	$ 89,600.00
Import Fill	0	$ 20.00	CY	$ -
Grouted Boulder Drop Structure (48")	2450	$ 300.00	SY	$ 735,000.00
Ungrouted Boulder (36")	0	$ 200.00	CY	$ -
Riprap Mat (Soil Riprap Type VH)	3580	$ 160.00	CY	$ 572,800.00
Reveg (Seed, Stakes, and Plugs)	61200	$ 1.20	SF	$ 73,500.00
Subtotal				$ 1,833,000.00
Engineering	15%			$ 275,000.00
Contingency	20%			$ 367,000.00
Total				$ 2,475,000.00

BS-8: Black Squirrel Natural Channel Design East the Monument Creek Confluence

This reach is located approximately 650' downstream of BS-7 and therefore has the potential of being grouped with that reach as a combined project. However, results from the reach analysis in addition to valley and stream characteristics indicate that natural channel design would be appropriate for this reach. A hybrid approach would likely be feasible if this project were to be grouped with BS-6.

Figure 23. BS-8: Black Squirrel Natural Channel Design East of Monument Creek Confluence

Table 14. BS-8: Black Squirrel Natural Channel Design East the Monument Creek Confluence

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 20,000.00	LS	$ 20,000.00
Dewatering	1	$ 20,000.00	LS	$ 20,000.00
Sediment and Erosion Control	1	$ 10,000.00	LS	$ 10,000.00
General Earthwork	100	$ 20.00	CY	$ 2,000.00
Excavation and Export	930	$ 40.00	CY	$ 37,200.00
Import Fill	0	$ 20.00	CY	$ -
Grouted Boulder Drop Structure (48")	0	$ 300.00	SY	$ -
Ungrouted Boulder (36")	240	$ 200.00	CY	$ 48,000.00
Riprap Mat (Soil Riprap Type VH)	600	$ 160.00	CY	$ 96,000.00
Reveg (Seed, Stakes, and Plugs)	15900	$ 1.20	SF	$ 19,100.00
Subtotal				$ 253,000.00
Engineering	15%			$ 38,000.00
Contingency	20%			$ 51,000.00
Total				$ 342,000.00

JC-1: Jackson Creek Small Drop Structures East of the Monument Creek Confluence

This reach begins just northeast of the Upper Monument Creek Regional Wastewater Treatment Facility and extends to the confluence with Monument Creek. Multiple headcuts are present on this reach in addition to significant erosion. Small drop structures with toe protection are the recommended design approach on this reach.

Figure 24. JC-1: Jackson Creek Small Drop Structures East of the Monument Creek Confluence

Table 15. JC-1: Jackson Creek Small Drop Structures East of the Monument Creek Confluence

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$90,000.00	LS	$ 90,000.00
Dewatering	1	$90,000.00	LS	$ 90,000.00
Sediment and Erosion Control	1	$60,000.00	LS	$ 60,000.00
General Earthwork	100	$ 20.00	CY	$ 2,000.00
Excavation and Export	0	$ 40.00	CY	$ -
Import Fill	570	$ 20.00	CY	$ 11,400.00
Grouted Boulder Drop Structure (48")	1340	$ 300.00	SY	$ 402,000.00
Ungrouted Boulder (36")	0	$ 200.00	CY	$ -
Riprap Mat (Soil Riprap Type VH)	1400	$ 160.00	CY	$ 224,000.00
Reveg (Seed, Stakes, and Plugs)	23500	$ 1.20	SF	$ 28,200.00
Subtotal				$ 908,000.00
Engineering	15%			$ 137,000.00
Contingency	20%			$ 182,000.00
Total				$ 1,227,000.00

KC-1: Kettle Creek Natural Channel Design East of I-25

This nearly mile long stretch of Kettle Creek, which experiences high sediment loads and erosion rates, begins east of Voyager Parkway and extends to the dam adjacent to Interstate 25. As the reach has suitable available width and relatively low slopes, a natural channel design would be more appropriate and less costly than small drop structures with toe protection.

Figure 25. KC-1: Kettle Creek Natural Channel Design East of I-25

Table 16. KC-1: Kettle Creek Natural Channel Design East of I-25

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 110,000.00	LS	$ 110,000.00
Dewatering	1	$ 110,000.00	LS	$ 110,000.00
Sediment and Erosion Control	1	$ 80,000.00	LS	$ 80,000.00
General Earthwork	4900	$ 20.00	CY	$ 98,000.00
Excavation and Export	2900	$ 40.00	CY	$ 116,000.00
Import Fill	0	$ 20.00	CY	$ -
Grouted Boulder Drop Structure (48")	0	$ 300.00	SY	$ -
Ungrouted Boulder (36")	1110	$ 200.00	CY	$ 222,000.00
Riprap Mat (Soil Riprap Type VH)	4640	$ 160.00	CY	$ 742,400.00
Reveg (Seed, Stakes, and Plugs)	146600	$ 1.20	SF	$ 176,000.00
Subtotal				$ 1,655,000.00
Engineering	15%			$ 249,000.00
Contingency	20%			$ 331,000.00
Total				$ 2,235,000.00

MB-1: Monument Branch Detention at Flying Horse

This is a detention retrofit project downstream of the Flying Horse development, just south of Crystal Basin Drive. Retrofitting the outlet structure and increasing the capacity of this facility will improve upon its current function.

Figure 26. MB-1: Monument Branch Detention at Flying Horse

Table 17. MB-1: Monument Branch Detention at Flying Horse

Item	QTY	Unit Cost	Unit	Total
Excavation/Embankment (onsite)	13528	$14.00	CY	$189,392.00
Excavation (haul)	2774	$30.00	CY	$83,220.00
Embankment (haul)		$30.00	CY	$0.00
Inlet/Forebay (8" conc. bottom)	1044	$300.00	CY	$313,320.00
Forebay Riprap (Type L) w/bedding	177	$70.00	CY	$12,369.00
Grouted 2' Dia Boulder Rundown	79	$216.00	SY	$16,956.00
6' Conc. Trickle Channel (6" thick, 6" deep)	375	$44.00	LF	$16,500.00
Outlet Pipe, RCP	50	$91.00	LF	$4,550.00
Outlet Pipe Protection - FES w/riprap	1	$1,230.00	EA	$1,230.00
Outlet Structure - 8" walls	8	$761.00	CY	$5,775.99
Outlet Structure trash rack, screen and railing	1	$5,000.00	LS	$5,000.00
Emergency Spillway (Type M riprap)	997	$76.00	CY	$75,772.00
Concrete Crest Wall, 12" thick	103	$761.00	CY	$78,002.50
Access Road (12' wide, 8" Class 6 gravel)	700	$9.00	LF	$6,300.00
Stockpile Topsoil -	11024	$10.00	CY	$110,244.00
Place Topsoil -	11024	$12.00	CY	$132,292.80
Seeding, native	21	$620.00	AC	$12,710.00
Erosion Control Blanket	24805	$8.00	SY	$198,440.00
Mulching	21	$600.00	AC	$12,300.00
Land Requirement		$50,000.00	AC	$0.00
Subtotal				$1,274,374.29
Engineering	15%			$192,000.00
Contingency	20%			$255,000.00
Total				$1,721,000.00

MB-2: Monument Branch Detention Retrofit at the Classical Academy

This is a detention retrofit project immediately downstream of the Classical Academy. Retrofitting the outlet structure and increasing the capacity of this facility will improve upon its current function.

Figure 27. MB-2: Monument Branch Detention Retrofit at the Classical Academy

Table 18. MB-2: Monument Branch Detention Retrofit at the Classical Academy

Item	QTY	Unit Cost	Unit	Total
Excavation/Embankment (onsite)	6671	$14.00	CY	$93,398.67
Excavation (haul)	87970	$30.00	CY	$2,639,100.00
Embankment (haul)		$30.00	CY	$0.00
Inlet/Forebay (8" conc. bottom)	1266	$300.00	CY	$379,890.00
Forebay Riprap (Type L) w/bedding	195	$70.00	CY	$13,657.00
Grouted 2' Dia Boulder Rundown	97	$216.00	SY	$20,865.60
6' Conc. Trickle Channel (6" thick, 6" deep)	375	$44.00	LF	$16,500.00
Outlet Pipe, RCP	50	$91.00	LF	$4,550.00
Outlet Pipe Protection - FES w/riprap	1	$1,230.00	EA	$1,230.00
Outlet Structure - 8" walls	8	$761.00	CY	$5,775.99
Outlet Structure trash rack, screen and railing	1	$5,000.00	LS	$5,000.00
Emergency Spillway (Type M riprap)	1021	$76.00	CY	$77,573.20
Concrete Crest Wall, 12" thick	116	$761.00	CY	$88,276.00
Access Road (12' wide, 8" Class 6 gravel)	700	$9.00	LF	$6,300.00
Stockpile Topsoil -	13444	$10.00	CY	$134,444.00
Place Topsoil -	13444	$12.00	CY	$161,332.80
Seeding, native	25	$620.00	AC	$15,500.00
Erosion Control Blanket	30250	$8.00	SY	$242,000.00
Mulching	25	$600.00	AC	$15,000.00
Subtotal				$3,920,393.26
Engineering	15%			$589,000.00
Contingency	20%			$785,000.00
Total				$5,294,000.00

MCM-1: Monument Creek Riparian Restoration at Oxbridge Road

These improvements span from the Monument Creek crossing at Oxbridge Road upstream until the creek is in line with Peakview Boulevard. Restoring a healthy riparian corridor through this reach will provide environmental and aesthetic benefits.

Figure 28. MCM-1: Monument Creek Riparian Restoration at Oxbridge Road

Table 19. MCM-1: Monument Creek Riparian Restoration at Oxbridge Road

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 21,405	LS	$ 22,000
Site Preparation	1	$ 35,000	LS	$ 35,000
Seeding	1	$ 20,000	LS	$ 20,000
Live Planting	1	$ 25,000	LS	$ 25,000
Erosion Control	1	$ 32,000	LS	$ 32,000
Subtotal				$ 134,000
Engineering	15%			$ 21,000
Contingency	20%			$ 27,000
Total				$ 182,000

MCM-2: Monument Creek Small Drop Structures near Railroad Crossing at North Airfield

This stretch of channel is located on the main stem of Monument Creek just east of Jacks Valley Road and runs underneath the railroad. This reach experiences significant erosion and headcutting. Due to stream and valley characteristics, a small drop structure with toe protection approach would be appropriate for this reach. There is an opportunity to couple the objectives of this project with that of MCM-3.

Figure 29. MCM-2: Monument Creek Small Drop Structures near Railroad Crossing at North Airfield

Table 20. MCM-2: Monument Creek Small Drop Structures near Railroad Crossing at North Airfield

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 90,000.00	LS	$ 90,000.00
Dewatering	1	$ 90,000.00	LS	$ 90,000.00
Sediment and Erosion Control	1	$ 60,000.00	LS	$ 60,000.00
General Earthwork	900	$ 20.00	CY	$ 18,000.00
Excavation and Export	2960	$ 40.00	CY	$ 118,400.00
Import Fill	0	$ 20.00	CY	$ -
Grouted Boulder Drop Structure (48")	1560	$ 300.00	SY	$ 468,000.00
Ungrouted Boulder (36")	0	$ 200.00	CY	$ -
Riprap Mat (Soil Riprap Type VH)	500	$ 160.00	CY	$ 80,000.00
Reveg (Seed, Stakes, and Plugs)	54300	$ 1.20	SF	$ 65,200.00
Subtotal				$ 990,000.00
Engineering	15%			$ 149,000.00
Contingency	20%			$ 198,000.00
Total				$ 1,337,000.00

MCM-3: Monument Creek Riparian Restoration Upstream of North Gate Boulevard

These improvements span from the Monument Creek confluence of Smith Creek upstream to the railroad crossing. Establishing a healthy riparian corridor through this reach will provide environmental and aesthetic benefits. There is an opportunity to couple the objectives of this project with that of MCM-2.

Figure 30. MCM-3: Monument Creek Riparian Restoration Upstream of North Gate Boulevard

Table 21. MCM-3: Monument Creek Riparian Restoration Upstream of North Gate Boulevard

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 25,209	LS	$ 26,000
Site Preparation	1	$ 37,500	LS	$ 38,000
Seeding	1	$ 27,000	LS	$ 27,000
Live Planting	1	$ 42,500	LS	$ 43,000
Erosion Control	1	$ 45,000	LS	$ 45,000
Subtotal				$ 179,000
Engineering	15%			$ 27,000
Contingency	20%			$ 36,000
Total				$ 242,000

MCM-4: Stabilize Headcutting on Monument Creek West of USAFA Airfield

A headcut on the Monument Creek main stem, west of the Air Force Academy Airfield, was identified by the stakeholder group. Stabilizing this portion of reach with boulder structures and riprap is critical in maintaining stability upstream.

Figure 31. MCM-4: Stabilize Headcutting on Monument Creek West of USAFA Airfield

Table 22. MCM-4: Stabilize Headcutting on Monument Creek West of USAFA Airfield

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 10,000.00	LS	$ 10,000.00
Dewatering	1	$ 10,000.00	LS	$ 10,000.00
Sediment and Erosion Control	1	$ 7,000.00	LS	$ 7,000.00
General Earthwork	100	$ 20.00	CY	$ 2,000.00
Excavation and Export	80	$ 40.00	CY	$ 3,200.00
Boulder Drop Structure (48")	250	$ 300.00	SY	$ 75,000.00
Riprap Mat (Soil Riprap Type VH)	450	$ 160.00	CY	$ 72,000.00
Reveg (Seed, Stakes, and Plugs)	10000	$ 1.20	SF	$ 12,000.00
Subtotal				$ 192,000.00
Engineering	15%			$ 29,000.00
Contingency	20%			$ 39,000.00
Total				$ 260,000.00

MCM-5: Stabilize Headcutting on Monument Creek near Thunderbird Lane

A headcut on the Monument Creek main stem, east of the Thunderbird Lane, was identified by the stakeholder group. Stabilizing this portion of reach with boulder structures and riprap is critical in maintaining stability upstream.

Figure 32. MCM-5: Stabilize Headcutting on Monument Creek near Thunderbird Lane

Table 23. MCM-5: Stabilize Headcutting on Monument Creek near Thunderbird Lane

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 13,000.00	LS	$ 13,000.00
Dewatering	1	$ 13,000.00	LS	$ 13,000.00
Sediment and Erosion Control	1	$ 9,000.00	LS	$ 9,000.00
General Earthwork	130	$ 20.00	CY	$ 2,600.00
Excavation and Export	100	$ 40.00	CY	$ 4,000.00
Boulder Drop Structure (48")	320	$ 300.00	SY	$ 96,000.00
Riprap Mat (Soil Riprap Type VH)	560	$ 160.00	CY	$ 89,600.00
Reveg (Seed, Stakes, and Plugs)	12500	$ 1.20	SF	$ 15,000.00
Subtotal				$ 243,000.00
Engineering	15%			$ 37,000.00
Contingency	20%			$ 49,000.00
Total				$ 329,000.00

MCM-6: Flood Risk Reduction at West Polk Road Bridge at Monument Creek

Modeling results of Polk Bridge over Monument Creek show overtopping in the 50-yr and 100-yr return periods. As this crossing is undersized for these flows, an upsized replacement bridge is recommended that can meet or exceed the required capacity.

Figure 33. MCM-6: Flood Risk Reduction at West Polk Road Bridge at Monument Creek

Table 24. MCM-6: Flood Risk Reduction at West Polk Road Bridge at Monument Creek

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 90,000.00	LS	$ 90,000.00
Dewatering	1	$ 70,000.00	LS	$ 70,000.00
Sediment and Erosion Control	1	$ 40,000.00	LS	$ 40,000.00
Demo	1	$ 202,000.00	LS	$ 202,000.00
Bridge Replacement	6000	$ 220.00	SF	$ 1,320,000.00
Asphalt	300	$ 380.00	SF	$ 114,000.00
Curb and Gutter	640	$ 50.00	LF	$ 32,000.00
General Earthwork	1185	$ 20.00	CY	$ 24,000.00
Subtotal				$ 1,892,000.00
Engineering	15%			$ 284,000.00
Contingency	20%			$ 379,000.00
Total				$ 2,555,000.00

MCM-7: Mesa Creek Outfall

The Mesa Creek Outfall project requires the extension of the Mesa Creek culvert at the Monument Creek confluence and the realignment the Pikes Peak Greenway Trail to improve trail connectivity through downtown Colorado Springs.

Figure 34. MCM-7: Mesa Creek Outfall

Table 25. MCM-7: Mesa Creek Outfall

Item	QTY	Unit Cost	Unit	Total
Clear and Grub	1	$ 25,000	LS	$ 25,000
Tree Removal	1	$ 15,000	LS	$ 15,000
Earthwork	8570	$ 12	CY	$ 103,000
Concrete	368	$ 650	CY	$ 240,000
Wing Walls	1	$ 20,000	EA	$ 20,000
Grouted Rip Rap	20	$ 150	CY	$ 3,000
Subtotal				$ 406,000
Engineering	15%			$ 61,000
Contingency	20%			$ 82,000
Total				$ 549,000

MCM-8: Uintah Bridge Bank Stabilization

The Uintah Bridge Stabilization project reinforces the stability of the bridge at the Monument Creek and Uintah Street crossing while improving pedestrian access to Monument Creek.

Figure 35. MCM-8: Uintah Bridge Bank Stabilization

Table 26. MCM-8: Uintah Bridge Bank Stabilization

Item	QTY	Unit Cost	Unit	Total
Sheet Pile	8000	$ 18	FF	$ 144,000
Dewatering	1	$ 20,000	LS	$ 20,000
Rip Rap Base	1334	$ 70	CY	$ 94,000
Concrete Jetties	6000	$ 20	SF	$ 120,000
Subtotal				$ 378,000
Engineering	15%			$ 57,000
Contingency	20%			$ 76,000
Total				$ 511,000

MT-1: Stabilize Headcutting on Middle Tributary South of Middle Creek Parkway

A fifteen foot headcut was identified on Middle Tributary just south of Middle Creek Parkway. Stabilizing this portion of reach with boulder structures and riprap is critical in maintaining stability upstream.

Figure 36. MT-1: Stabilize Headcutting on Middle Tributary South of Middle Creek Parkway

Table 27. MT-1: Stabilize Headcutting on Middle Tributary South of Middle Creek Parkway

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 53,000.00	LS	$ 53,000.00
Dewatering	1	$ 53,000.00	LS	$ 53,000.00
Sediment and Erosion Control	1	$ 37,000.00	LS	$ 37,000.00
General Earthwork	530	$ 20.00	CY	$ 10,600.00
Excavation and Export	400	$ 40.00	CY	$ 16,000.00
Boulder Drop Structure (48")	1320	$ 300.00	SY	$ 396,000.00
Riprap Mat (Soil Riprap Type VH)	2330	$ 160.00	CY	$ 372,800.00
Reveg (Seed, Stakes, and Plugs)	52500	$ 1.20	SF	$ 63,000.00
Subtotal				$ 1,002,000.00
Engineering	15%			$ 151,000.00
Contingency	20%			$ 201,000.00
Total				$ 1,354,000.00

MT-2: Middle Tributary Detention Retrofit Upstream of USAFA Property Boundary

This is a detention retrofit project along Middle Tributary, south of Middle Creek Parkway. Adding a full spectrum outlet structure and increasing the capacity of the existing pond will improve upon its current function.

Figure 37. MT-2: Middle Tributary Detention Retrofit Upstream of USAFA Property Boundary

Table 28. MT-2: Middle Tributary Detention Retrofit Upstream of USAFA Property Boundary

Item	QTY	Unit Cost	Unit	Total
Excavation/Embankment (onsite)	901	$14.00	CY	$12,618.67
Excavation (haul)	5796	$30.00	CY	$173,870.00
Embankment (haul)		$30.00	CY	$0.00
Inlet/Forebay (8" conc. bottom)	448	$300.00	CY	$134,340.00
Forebay Riprap (Type L) w/bedding	114	$70.00	CY	$7,966.00
Grouted 2' Dia Boulder Rundown	108	$216.00	SY	$23,414.40
6' Conc. Trickle Channel (6" thick, 6" deep)	375	$44.00	LF	$16,500.00
Outlet Pipe, RCP	50	$91.00	LF	$4,550.00
Outlet Pipe Protection - FES w/riprap	1	$1,230.00	EA	$1,230.00
Outlet Structure - 8" walls	8	$761.00	CY	$5,775.99
Outlet Structure trash rack, screen and railing	1	$5,000.00	LS	$5,000.00
Emergency Spillway (Type M riprap)	990	$76.00	CY	$75,209.60
Concrete Crest Wall, 12" thick	69	$761.00	CY	$52,661.20
Access Road (12' wide, 8" Class 6 gravel)	700	$9.00	LF	$6,300.00
Stockpile Topsoil -	4571	$10.00	CY	$45,711.00
Place Topsoil -	4571	$12.00	CY	$54,853.20
Seeding, native	9	$620.00	AC	$5,270.00
Erosion Control Blanket	10285	$8.00	SY	$82,280.00
Mulching	9	$600.00	AC	$5,100.00
Subtotal				$712,650.06
Engineering	15%			$107,000.00
Contingency	20%			$143,000.00
Total				$963,000.00

MT-3: Stabilize Headcutting on Middle Tributary Downstream of I-25

A six foot headcut was identified on Middle Tributary immediately downstream of I-25. Stabilizing this portion of reach with boulder structures and riprap is critical in maintaining stability upstream. Combining this project with MT-4 and MT-5 would provide a hybrid approach to the restoration of Middle Tributary.

Figure 38. MT-3: Stabilize Headcutting on Middle Tributary Downstream of I-25

Table 29. MT-3: Stabilize Headcutting on Middle Tributary Downstream of I-25

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 15,000.00	LS	$ 15,000.00
Dewatering	1	$ 15,000.00	LS	$ 15,000.00
Sediment and Erosion Control	1	$ 11,000.00	LS	$ 11,000.00
General Earthwork	150	$ 20.00	CY	$ 3,000.00
Excavation and Export	110	$ 40.00	CY	$ 4,400.00
Boulder Drop Structure (48")	360	$ 300.00	SY	$ 108,000.00
Riprap Mat (Soil Riprap Type VH)	640	$ 160.00	CY	$ 102,400.00
Reveg (Seed, Stakes, and Plugs)	14400	$ 1.20	SF	$ 17,300.00
Subtotal				$ 277,000.00
Engineering	15%			$ 42,000.00
Contingency	20%			$ 56,000.00
Total				$ 375,000.00

MT-4: Middle Tributary Small Drop Structures West of I-25

This stretch of Middle Tributary is located immediately upstream of MT-5, and therefor has the potential of being grouped with that project when addressed. However, hydraulic analysis and geomorphic evaluation indicate that a natural channel design approach would be the most appropriate design application for this reach. If coupled with MT-5, this project would likely result in a hybrid approach to address different issues unique to each reach. Combining this project with MT-3 and MT-5 would provide a hybrid approach to the restoration of Middle Tributary.

Figure 39. MT-4: Middle Tributary Small Drop Structures West of I-25

Table 30. MT-4: Middle Tributary Small Drop Structures West of I-25

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 50,000.00	LS	$ 50,000.00
Dewatering	1	$ 50,000.00	LS	$ 50,000.00
Sediment and Erosion Control	1	$ 40,000.00	LS	$ 40,000.00
General Earthwork	500	$ 20.00	CY	$ 10,000.00
Excavation and Export	0	$ 40.00	CY	$ -
Import Fill	0	$ 20.00	CY	$ -
Grouted Boulder Drop Structure (48")	800	$ 300.00	SY	$ 240,000.00
Ungrouted Boulder (36")	0	$ 200.00	CY	$ -
Riprap Mat (Soil Riprap Type VH)	750	$ 160.00	CY	$ 120,000.00
Reveg (Seed, Stakes, and Plugs)	13100	$ 1.20	SF	$ 15,800.00
Subtotal				$ 526,000.00
Engineering	15%			$ 79,000.00
Contingency	20%			$ 106,000.00
Total				$ 711,000.00

MT-5: Middle Tributary Natural Channel Design East of the Monument Creek Confluence

This reach of Middle Tributary on the Air Force Academy west of Interstate 25 consists of previously installed channel stabilization structures which have failed in recent years. Natural channel design is a suitable means of channel stabilization in this reach as there is plenty of available belt width and reasonable bed slopes to work with. Combining this project with MT-3 and MT-4 would provide a hybrid approach to the restoration of Middle Tributary.

Figure 40. MT-5: Middle Tributary Natural Channel Design East of the Monument Creek Confluence

Table 31. MT-5: Middle Tributary Natural Channel Design East of the Monument Creek Confluence

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 10,000.00	LS	$ 10,000.00
Dewatering	1	$ 10,000.00	LS	$ 10,000.00
Sediment and Erosion Control	1	$ 10,000.00	LS	$ 10,000.00
General Earthwork	100	$ 20.00	CY	$ 2,000.00
Excavation and Export	0	$ 40.00	CY	$ -
Import Fill	380	$ 20.00	CY	$ 7,600.00
Grouted Boulder Drop Structure (48")	0	$ 300.00	SY	$ -
Ungrouted Boulder (36")	110	$ 200.00	CY	$ 22,000.00
Riprap Mat (Soil Riprap Type VH)	300	$ 160.00	CY	$ 48,000.00
Reveg (Seed, Stakes, and Plugs)	5300	$ 1.20	SF	$ 6,400.00
Subtotal				$ 116,000.00
Engineering	15%			$ 18,000.00
Contingency	20%			$ 24,000.00
Total				$ 158,000.00

NDC-1: North Douglas Small Drop Structures East of I-25

This reach of North Douglas Creek begins immediately east of Interstate 25 and extends approximate 1600' downstream. This reach has experienced significant degradation and erosion. Due to available width constraints, a small drop structure with toe protection approach would be most appropriate for this reach.

Figure 41. NDC-1: North Douglas Small Drop Structures East of I-25

Table 32. NDC-1: North Douglas Small Drop Structures East of I-25

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 80,000.00	LS	$ 80,000.00
Dewatering	1	$ 80,000.00	LS	$ 80,000.00
Sediment and Erosion Control	1	$ 50,000.00	LS	$ 50,000.00
General Earthwork	700	$ 20.00	CY	$ 14,000.00
Excavation and Export	0	$ 40.00	CY	$ -
Import Fill	270	$ 20.00	CY	$ 5,400.00
Grouted Boulder Drop Structure (48")	1200	$ 300.00	SY	$ 360,000.00
Ungrouted Boulder (36")	0	$ 200.00	CY	$ -
Riprap Mat (Soil Riprap Type VH)	2590	$ 160.00	CY	$ 414,400.00
Reveg (Seed, Stakes, and Plugs)	44600	$ 1.20	SF	$ 53,600.00
Subtotal				$ 1,058,000.00
Engineering	15%			$ 159,000.00
Contingency	20%			$ 212,000.00
Total				$ 1,429,000.00

NRR-1: Culvert Replacement at War Eagle Lane

Hydraulic modeling of this culvert resulted in overtopping of War Eagle Lane in every event modeled.. This roadway provides important access to War Eagle Ct. and War Eagle Dr. North. The recommended upsizing of this culvert to meet capacity includes 4-10x6 concrete box culverts

Figure 42. NRR-1: Culvert Replacement at War Eagle Lane

Table 33. NRR-1: Culvert Replacement at War Eagle Lane

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 52,000.00	LS	$ 52,000.00
Dewatering	1	$ 40,000.00	LS	$ 40,000.00
Sediment and Erosion Control	1	$ 24,000.00	LS	$ 24,000.00
Demo	1	$ 46,000.00	LS	$ 46,000.00
Culvert (4-8x6 Cell CBC)	150	$ 1,500.00	LF	$ 225,000.00
Asphalt	80	$ 380.00	SF	$ 30,400.00
General Earthwork	1200	$ 20.00	CY	$ 24,000.00
Subtotal				$ 442,000.00
Engineering	15%			$ 67,000.00
Contingency	20%			$ 89,000.00
Total				$ 598,000.00

NRR-2: Levee Installation at South Rockrimmon Boulevard Downstream of Pro Rodeo Drive

Hydraulic modeling and inundation mapping revealed that backwater caused by the limited capacity of the culvert which runs underneath the railroad to inundate South Rockrimmon Boulevard in the 100-yr return period. A proposed levee installation alongside of South Rockrimmon Boulevard would alleviate this flooding and would avoid right of way and easement issues associated with replacing the culvert underneath the railroad.

Figure 43. NRR-2: Levee Installation at South Rockrimmon Boulevard Downstream of Pro Rodeo Drive

Table 34. NRR-2: Levee Installation at South Rockrimmon Boulevard Downstream of Pro Rodeo Drive

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 8,000.00	LS	$ 8,000.00
Dewatering	1	$ 8,000.00	LS	$ 8,000.00
Sediment and Erosion Control	1	$ 4,000.00	LS	$ 4,000.00
General Earthwork	130	$ 20.00	LS	$ 2,700.00
Riprap Type VL	1304	$ 120.00	LF	$ 156,500.00
Subtotal				$ 180,000.00
Engineering	15%			$ 27,000.00
Contingency	20%			$ 36,000.00
Total				$ 243,000.00

PC-1: Pine Creek Detention Retrofit Upstream of Stoneglen Drive

This is a detention retrofit project immediately upstream of Stoneglen Drive. Retrofitting the outlet structure and increasing the capacity of this facility will improve upon its current function. Attention should be given to the outfall of this facility which is located just upstream of the Pine Creek Golf Course, North of Briargate Boulevard. Pending further analyses, this outfall may also require a retrofit.

Figure 44. PC-1: Pine Creek Detention Retrofit Upstream of Stoneglen Drive

Table 35. PC-1: Pine Creek Detention Retrofit Upstream of Stoneglen Drive

Item	QTY	Unit Cost	Unit	Total
Excavation/Embankment (onsite)	1333	$14.00	CY	$18,666.67
Excavation (haul)	3642	$30.00	CY	$109,260.00
Embankment (haul)		$30.00	CY	$0.00
Inlet/Forebay (8" conc. bottom)	181	$300.00	CY	$54,270.00
Forebay Riprap (Type L) w/bedding	70	$70.00	CY	$4,921.00
Grouted 2' Dia Boulder Rundown	138	$216.00	SY	$29,851.20
6' Conc. Trickle Channel (6" thick, 6" deep)	375	$44.00	LF	$16,500.00
Outlet Pipe, RCP	50	$91.00	LF	$4,550.00
Outlet Pipe Protection - FES w/riprap	1	$1,230.00	EA	$1,230.00
Outlet Structure - 8" walls	8	$761.00	CY	$5,775.99
Outlet Structure trash rack, screen and railing	1	$5,000.00	LS	$5,000.00
Emergency Spillway (Type M riprap)	707	$76.00	CY	$53,709.20
Concrete Crest Wall, 12" thick	41	$761.00	CY	$30,972.70
Access Road (12' wide, 8" Class 6 gravel)	700	$9.00	LF	$6,300.00
Stockpile Topsoil -	1748	$10.00	CY	$17,478.00
Place Topsoil -	1748	$12.00	CY	$20,973.60
Seeding, native	3	$620.00	AC	$2,046.00
Erosion Control Blanket	3933	$8.00	SY	$31,460.00
Mulching	3	$600.00	AC	$1,950.00
Subtotal				$414,914.36
Engineering	15%			$63,000.00
Contingency	20%			$83,000.00
Total				$561,000.00

PC-2: Pine Creek Conceptual Detention Downstream of Briargate Boulevard

This conceptual detention facility just downstream Briargate Boulevard would help attenuate peak flows generated high in the Black Squirrel subwatershed.

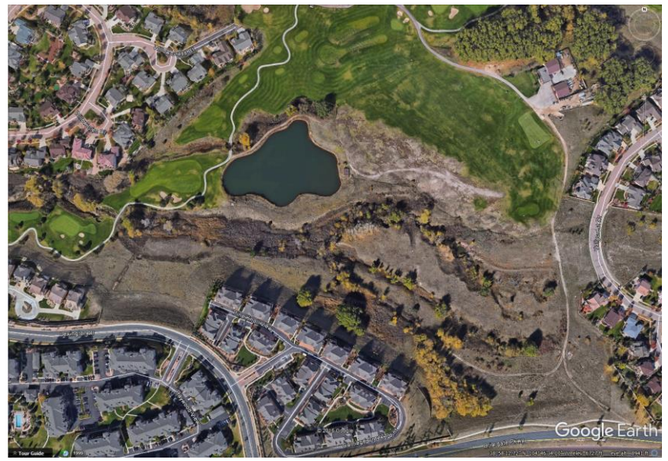


Figure 45. PC-2: Pine Creek Conceptual Detention Downstream of Briargate Parkway

Table 36. PC-2: Pine Creek Conceptual Detention Downstream of Briargate Boulevard

Item	QTY	Unit Cost	Unit	Total
Excavation/Embankment (onsite)	10667	$14.00	CY	$149,338.00
Excavation (haul)	145926	$30.00	CY	$4,377,780.00
Embankment (haul)		$30.00	CY	$0.00
Inlet/Forebay (8" conc. bottom)	1340	$300.00	CY	$402,030.00
Forebay Riprap (Type L) w/bedding	201	$70.00	CY	$14,063.00
Grouted 2' Dia Boulder Rundown	138	$216.00	SY	$29,851.20
6' Conc. Trickle Channel (6" thick, 6" deep)	375	$44.00	LF	$16,500.00
Outlet Pipe, RCP	50	$91.00	LF	$4,550.00
Outlet Pipe Protection - FES w/riprap	1	$1,230.00	EA	$1,230.00
Outlet Structure - 8" walls	8	$761.00	CY	$5,775.99
Outlet Structure trash rack, screen and railing	1	$5,000.00	LS	$5,000.00
Emergency Spillway (Type M riprap)	1870	$76.00	CY	$142,089.60
Concrete Crest Wall, 12" thick	163	$761.00	CY	$123,662.50
Access Road (12' wide, 8" Class 6 gravel)	700	$9.00	LF	$6,300.00
Stockpile Topsoil -	14251	$10.00	CY	$142,511.00
Place Topsoil -	14251	$12.00	CY	$171,013.20
Seeding, native	27	$620.00	AC	$16,430.00
Erosion Control Blanket	32065	$8.00	SY	$256,520.00
Mulching	27	$600.00	AC	$15,900.00
Subtotal				$5,880,544.49
Engineering	15%			$883,000.00
Contingency	20%			$1,177,000.00
Total				$7,941,000.00

PC-3: Pine Creek Open Space

Creating a designated open space along Pine Creek would not only provide environmental benefits but would also create a public amenity. This project can be coupled with PC-2 to provide a multi-functional facility.

Figure 46. PC-3: Pine Creek Open Space

Table 37. PC-3: Pine Creek Open Space

Item	QTY	Unit Cost	Unit	Total
Open Space Land Purchase	19	$ 76,602	AC	$ 1,456,000
Subtotal				$ 1,456,000
Contingency	20%			$ 292,000
Total				$ 1,748,000

PC-4: Stabilize Headcutting on Pine Creek Golf Course at Trail Crossing

A four foot headcut was identified on the Pine Creek Golf Course near a cart crossing. Stabilizing this portion of reach with boulder structures and riprap is critical in maintaining the stability of the cart path and upstream trail.

Figure 47. PC-4: Stabilize Headcutting on Pine Creek Golf Course at Trail Crossing

Table 38. PC-4: Stabilize Headcutting on Pine Creek Golf Course at Trail Crossing

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 10,000.00	LS	$ 10,000.00
Dewatering	1	$ 10,000.00	LS	$ 10,000.00
Sediment and Erosion Control	1	$ 5,000.00	LS	$ 5,000.00
General Earthwork	70	$ 20.00	CY	$ 1,400.00
Excavation and Export	50	$ 40.00	CY	$ 2,000.00
Boulder Drop Structure (48")	160	$ 300.00	SY	$ 48,000.00
Riprap Mat (Soil Riprap Type VH)	290	$ 160.00	CY	$ 46,400.00
Reveg (Seed, Stakes, and Plugs)	6400	$ 1.20	SF	$ 7,700.00
Subtotal				$ 131,000.00
Engineering	15%			$ 20,000.00
Contingency	20%			$ 27,000.00
Total				$ 178,000.00

PC-5: Stabilize Headcutting on Pine Creek Upstream of Briargate Boulevard

A five foot headcut was identified on Pine Creek upstream of Briargate Boulevard. Stabilizing this portion of reach with boulder structures and riprap is critical in maintaining stability upstream.

Figure 48. PC-5: Stabilize Headcutting on Pine Creek Upstream of Briargate Boulevard

Table 39. PC-5: Stabilize Headcutting on Pine Creek Upstream of Briargate Boulevard

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 9,000.00	LS	$ 9,000.00
Dewatering	1	$ 9,000.00	LS	$ 9,000.00
Sediment and Erosion Control	1	$ 7,000.00	LS	$ 7,000.00
General Earthwork	90	$ 20.00	CY	$ 1,800.00
Excavation and Export	70	$ 40.00	CY	$ 2,800.00
Boulder Drop Structure (48")	230	$ 300.00	SY	$ 69,000.00
Riprap Mat (Soil Riprap Type VH)	400	$ 160.00	CY	$ 64,000.00
Reveg (Seed, Stakes, and Plugs)	9000	$ 1.20	SF	$ 10,800.00
Subtotal				$ 174,000.00
Engineering	15%			$ 27,000.00
Contingency	20%			$ 35,000.00
Total				$ 236,000.00

PC-6: Pine Creek Natural Channel Design East of I-25

This stretch of Pine Creek is located just upstream of Academy Boulevard and east of Interstate 25. The reach has grade control on the upstream end in the form of a trapezoidal concrete channel, and has a drop structure downstream that appears to have some undermining. Valley characteristics and available width make this reach suitable for a natural channel design approach.

Figure 49. PC-6: Pine Creek Natural Channel Design East of I-25

Table 40. PC-6: Pine Creek Natural Channel Design East of I-25

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$30,000.00	LS	$ 30,000.00
Dewatering	1	$30,000.00	LS	$ 30,000.00
Sediment and Erosion Control	1	$20,000.00	LS	$ 20,000.00
General Earthwork	400	$ 20.00	CY	$ 8,000.00
Excavation and Export	1080	$ 40.00	CY	$ 43,200.00
Import Fill	0	$ 20.00	CY	$ -
Grouted Boulder Drop Structure (48")	0	$ 300.00	SY	$ -
Ungrouted Boulder (36")	0	$ 200.00	CY	$ -
Riprap Mat (Soil Riprap Type VH)	1670	$ 160.00	CY	$267,200.00
Reveg (Seed, Stakes, and Plugs)	27800	$ 1.20	SF	$ 33,400.00
Subtotal				$432,000.00
Engineering	15%			$ 65,000.00
Contingency	20%			$ 87,000.00
Total				$584,000.00

PC-7: Pine Creek Small Drop Structures East of I-25 and Downstream of Academy Boulevard

This highly incised reach on Pine Creek is just south of the North Academy Boulevard and Interstate 25 interchange. This stretch of creek has substantially eroded and ranks the worst overall in condition in the geomorphic assessment when evaluated by erosion rate in tons/ft./year. The reach is confined laterally by the nearly vertical banks and would require stabilization through means of small drop structures with toe protection to prevent further erosion and downcutting.

Figure 50. PC-7: Pine Creek Small Drop Structures East of I-25 and Downstream of Academy Boulevard

Table 41. PC-7: Pine Creek Small Drop Structures East of I-25 and Downstream of Academy Boulevard

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$50,000.00	LS	$ 50,000.00
Dewatering	1	$50,000.00	LS	$ 50,000.00
Sediment and Erosion Control	1	$40,000.00	LS	$ 40,000.00
General Earthwork	1300	$ 20.00	CY	$ 26,000.00
Excavation and Export	1920	$ 40.00	CY	$ 77,000.00
Import Fill	0	$ 20.00	CY	$ -
Grouted Boulder Drop Structure (48")	850	$ 300.00	SY	$ 255,000.00
Ungrouted Boulder (36")	0	$ 200.00	CY	$ -
Riprap Mat (Soil Riprap Type VH)	550	$ 160.00	CY	$ 88,000.00
Reveg (Seed, Stakes, and Plugs)	18300	$ 1.20	SF	$ 22,000.00
Subtotal				$ 608,000.00
Engineering	15%			$ 91,000.00
Contingency	20%			$ 122,000.00
Total				$ 1,430,000.00

SDC-1: South Douglas Small Drop Structures Downstream of Holland Park Boulevard

This relatively short reach runs alongside of Sinton trail and is located northwest of Ellston Place. This stretch of South Douglas Creek experiences high erosion rates. Due to space limitations from confinement of adjacent neighborhoods, a small drop structure with toe protection approach would be most feasible in this reach. Additionally, this project has the potential of being extended upstream and/or downstream to address additional reaches with moderate erosion rates.

Figure 51. SDC-1: South Douglas Small Drop Structures Downstream of Holland Park Boulevard

Table 42. SDC-1: South Douglas Small Drop Structures Downstream of Holland Park Boulevard

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 20,000.00	LS	$ 20,000.00
Dewatering	1	$ 20,000.00	LS	$ 20,000.00
Sediment and Erosion Control	1	$ 20,000.00	LS	$ 20,000.00
General Earthwork	100	$ 20.00	CY	$ 2,000.00
Excavation and Export	270	$ 40.00	CY	$ 10,800.00
Import Fill	0	$ 20.00	CY	$ -
Grouted Boulder Drop Structure (48")	270	$ 300.00	SY	$ 81,000.00
Ungrouted Boulder (36")	0	$ 200.00	CY	$ -
Riprap Mat (Soil Riprap Type VH)	450	$ 160.00	CY	$ 72,000.00
Reveg (Seed, Stakes, and Plugs)	10200	$ 1.20	SF	$ 12,300.00
Subtotal				$ 239,000.00
Engineering	15%			$ 36,000.00
Contingency	20%			$ 48,000.00
Total				$ 323,000.00

SDC-2: Sinton Trail

This project entails drainage improvements and general repairs to Sinton Trail from Garden of the Gods Road to the Pikes Peak Greenway Trail along Monument Creek.

Figure 52. SDC-2: Sinton Trail

Table 43. SDC-2: Sinton Trail

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 21,779	LS	$ 22,000
Site Preparation	1	$ 40,000	LS	$ 40,000
Seeding	1	$ 30,000	LS	$ 30,000
12' Wide Concrete Trail	16017	$ 43	CY	$ 689,000
Erosion Control	1	$ 50,000	LS	$ 50,000
Subtotal				$ 831,000
Engineering	15%			$ 125,000
Contingency	20%			$ 167,000
Total				$ 1,123,000

TC-1: Culvert Replacement at Northern Teachout Creek Tributary and Old Denver Highway

This culvert was stakeholder identified as overtopping in minor events. After evaluation of flows associated with this tributary at this design point, a recommended upsizing of the culvert to 3-8x4 concrete box culverts would provide enough capacity to pass the 100-yr return period event.

Figure 53. TC-1: Culvert Replacement at Northern Teachout Creek Tributary and Old Denver Highway

Table 44. TC-1: Culvert Replacement at Northern Teachout Creek Tributary and Old Denver Highway

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 25,000.00	LS	$ 25,000.00
Dewatering	1	$ 25,000.00	LS	$ 25,000.00
Sediment and Erosion Control	1	$ 16,000.00	LS	$ 16,000.00
Demo	1	$ 81,000.00	LS	$ 81,000.00
Culvert (3-8x4 Cell CBC)	150	$ 1,100.00	LF	$ 165,000.00
Asphalt	150	$ 380.00	SF	$ 57,000.00
General Earthwork	200	$ 20.00	CY	$ 4,000.00
Subtotal				$ 373,000.00
Engineering	15%			$ 56,000.00
Contingency	20%			$ 75,000.00
Total				$ 504,000.00

TC-2: Culvert Replacement at Teachout Creek and Old Denver Highway

This culvert was stakeholder identified as overtopping in minor events. After evaluation of flows associated with this tributary at this design point, a recommended upsizing of the culvert to a 10x4 concrete box culvert would provide enough capacity to pass the 100-yr return period event.

Figure 54. TC-2: Culvert Replacement at Teachout Creek and Old Denver Highway

Table 45. TC-2: Culvert Replacement at Teachout Creek and Old Denver Highway

Item	QTY	Unit Cost	Unit	Total
Mobilization	1	$ 14,000.00	LS	$ 14,000.00
Dewatering	1	$ 14,000.00	LS	$ 14,000.00
Sediment and Erosion Control	1	$ 10,000.00	LS	$ 10,000.00
Demo	1	$ 39,000.00	LS	$ 39,000.00
Culvert (10x4 CBC)	60	$ 1,600.00	LF	$ 96,000.00
Asphalt	80	$ 380.00	SF	$ 30,400.00
General Earthwork	70	$ 20.00	CY	$ 1,400.00
Subtotal				$ 205,000.00
Engineering	15%			$ 31,000.00
Contingency	20%			$ 41,000.00
Total				$ 277,000.00

4.0 General Stewardship Recommendations

To compliment the actionable list of projects presented in this plan, general stewardship recommendations for the Monument Creek Watershed landscape are provided in the sections below. Proper management of the watershed will not only preserve its existing condition but also restore those areas that are currently degraded. The health, safety and welfare of the surrounding communities will also improve with appropriate management of adjacent drainage ways. A comprehensive, multi-faceted approach to watershed management must be taken to restore the watershed to a healthy, stable, and resilient state. Previous studies have thoroughly discussed concepts of stewardship for the greater Fountain Creek Watershed; references to those studies are also included in the following sections.

4.1 The City of Colorado Springs Drainage Criteria Manual

The City of Colorado Springs adopted its Drainage Criteria Manual in May of 2014. The first chapters in Volume 1 provide general provisions and principles that were considered for the development of this plan and should be applied to all future projects within the watershed. Principles cohesively guide the planning, design, and implementation of drainage facilities to improve the overall health of the watershed. For a more detailed discussion regarding these principles, reference the document itself.

4.2 Fountain Creek Watershed Flood Control and Greenway District Design Manual

The Fountain Creek Watershed and Flood Control District has been proactive in addressing issues within the greater Fountain Creek Watershed, undertaking an effort to create a District Design Manual. Among other topics, the criteria manual will address updates to a 24-hour design storm applicable to the region and provide guidelines for the development review process. Where applicable, this manual in concert with the City of Colorado Springs Drainage Criteria Manual will be essential references in the implementation of the Restoration Plan.

4.3 U.S. Army Corps of Engineers Watershed Management Plan

The U.S. Army Corps of Engineers developed a set of general recommendations for the Fountain Creek Watershed related to development, rehabilitation/preservation, modeling/project design, and administration through discussions with project sponsors and stakeholders and analysis of the baseline conditions data and modeling. The development and rehabilitation/preservation recommendations continue to be relevant today and are reiterated below. Additional recommendations can be found in the U.S. Army Corps of Engineers Watershed Management Plan published in January, 2009 as a capstone to the comprehensive watershed study.

<u>Development</u>

- Review and modify development policies as necessary to include appropriate consideration of open space needs in development (focus on more habitat development within traditional parks).
- Limit sediment sources during construction by minimizing overlot grading.
- Review and modify development policies and landscape ordinances as necessary to include appropriate low impact development techniques (lowimpactdevelopment.org) such as those put forth by organizations such as the Center for Watershed Protection (cwp.org).
- Review and modify development policies as necessary to require post development hydrographs match predevelopment hydrographs for peak, volume, and timing to the extent practicable.
- Review and modify development policies as necessary to require post development sediment transport matches pre-development sediment transport to the extent practicable.
- Review and modify development policies as necessary to require assessment of upstream/downstream impacts (particularly the impacts due to small frequently occurring storm events such as the 2-yr event).
- Review and modify development policies as necessary to ensure involvement by regulatory agencies and stakeholders as soon as possible in the development process.
- Entities must follow through with review of development plans, adherence to approved plans through the construction process, and inspection/maintenance of completed projects.

<u>Rehabilitation/Preservation</u>

- Rehabilitate riparian areas to a healthy, functioning condition where opportunities exist to the extent practicable.
- Preserve existing wetlands and create additional wetlands where opportunities exist to the extent practicable.
- Entities constructing remedial projects in the watershed should develop a consistent approach and methodology for project design and construction while considering site-specific conditions and latest design methodologies.

4.4 Fountain Creek Vision Task Force Strategic Plan

In March 2009, the Fountain Creek Vision Task Force published a strategic plan for the watershed that included goals, objectives, and strategies for Flooding and Stormwater Management, Water Quality and Sedimentation, and Land Use Planning and Development among nine topic areas.

These plans have been adopted by the District Board as guiding documents and are germane to the Monument Creek Watershed. As such, the combined direction from these two plans were compiled into a goals and recommendations matrix and adopted by the District Board in 2010. The matrix identifies responsibility for accomplishing the goal or recommendation and associated commentary.

4.5 Fountain Creek District Policy Evaluation Report

In June 2012, the Fountain Creek Watershed Flood Control and Greenway District completed a policy evaluation report. The following list of recommendations was developed based on a review of the information contained in the report in conjunction with the District's Technical Advisory Committee and Community Advisory Group.

1. Adoption of the new City of Colorado Springs Drainage Criteria Manual as appropriate to each jurisdiction within the watershed.

2. Advancement of stormwater management "spin-off" projects proposed by the City of Colorado Springs from the Drainage Criteria Manual through an intergovernmental agreement. A Scope of Work to address these projects was developed and tasks include:

    a. Integration of site planning to accomplish Better Site Design and LID objectives in both development and redevelopment projects

    b. Addition of watershed wide considerations including:
        i. Hydrology/rainfall
        ii. Vegetation/soils
        iii. Steep slopes

    c. Review of floodplain administration policies such as improved definition of floodplain management policy & criteria

    d. Evaluation and incorporation of financial or other incentives to encourage the application of LID

3. Section 404 and 401 permits should be reviewed for consistency with Fountain Creek Watershed Vision Task Force Strategic Plan, the U.S. Army Corps of Engineers Watershed Management Plan recommendations and drainage criteria to determine potential impacts to streams, critical riparian and wetland areas, and the potential to cause erosion and sedimentation problems.

4. To advise local governments where impacts on water quality will be minimized and/or controllable and where areas of high erosion, sedimentation, and degraded water quality exist.

5. Remove regulatory barriers and provide selective incentives for LID, sustainable design, and green building to improve water quality and compliance with water quality standards.

6. The integration of site planning and plan approval with an efficient and effective enforcement program is needed to accomplish the goals and objectives of the Fountain Creek Watershed Vision Task Force Strategic Plan and the U.S. Army Corps of Engineers Watershed Management Plan.

7. Continued education of elected officials, senior leadership, planners, engineers, stakeholders in both the private and public sector of the need and benefit for promoting watershed health and improving land use and drainage policies and criteria.

4.6 Resource Management

The Monument Creek Watershed is rich with natural resources and ecological systems. Figure 55 shows the primary ecological systems of the Upper Monument Creek landscape (Upper Monument Creek Landscape Restoration Initiative, 2014). Proper management techniques are critical in ensuring the preservation of these resources. The following sections provide recommendations and useful references regarding the management of forests and other natural resources.

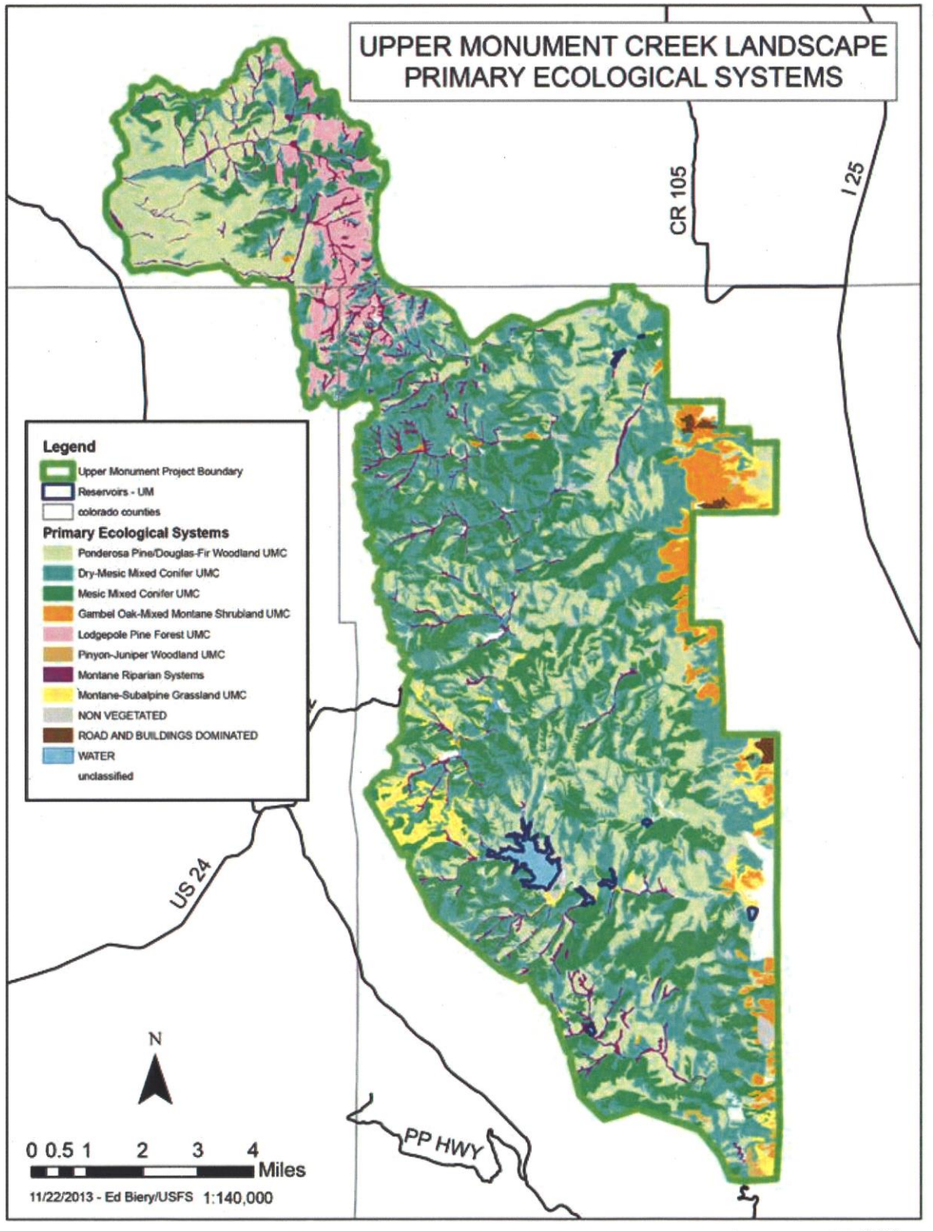


Figure 55. Upper Monument Creek Primary Ecological Systems (Upper Creek Landscape Restoration Initiative)

4.6.1 Forest Management: Upper Monument Creek Landscape Restoration Initiative

The Upper Monument Creek Landscape Restoration Initiative proposes fire mitigation management strategies. These strategies are illustrated with primary ecological systems and the document provides direction on fire mitigation based on the different landscape types. The map on the following page, from the Upper Monument Creek Landscape Restoration Initiative, shows the Upper Monument Creek Landscape Primary Ecological Systems.

Fire mitigation in different landscape types is divided into five (5) categories including:

- Ponderosa Pine-Douglas Fir-Woodlands
- Dry Mixed-Conifer Forests
- Mesic Mixed-Conifer Forests
- Gambel Oak-Mixed Montane Shrublands
- Lodgepole Pine Forests

Ponderosa Pine-Douglas Fir- Woodlands

Fire mitigation focuses on reducing stand densities and restoring special structure. Residual basal areas should be highly variable. Ponderosa Pine should be the dominant species, with Douglas Fir present in areas with higher moisture. Aspen and old trees should be retained and enhance. Untreated pockets should be left to provide wildlife cover

Figure 56. Ponderosa Pine-Douglas Fir-Woodlands

Dry Mixed-Conifer Forests

Treatment approach for the Dry Mixed-Conifer Forests is similar to the Ponderosa Pine-Douglas Fir-Woodlands approach. A higher proportion of Douglas Fir and other conifers should be present. Groupings may contain single or multiple species. Old trees, snags and coarse woody debris are important structural components that should remain.

Figure 57. Dry Mixed-Conifer Forests

Mesic Mixed-Conifer Forests

Mesic Mixed-Conifer Forests should be treated by reducing densities of older stands. Density reduction should focus on the removal of small-diameter trees, ladder and surface fuels. Reduction should enhance structural and age-class diversity between stands. Avoid uniform shapes and spacing between openings and base reduction of the local context.

Figure 58. Mesic Mixed-Conifer Forests

Gambel Oak-Mixed Montane Shrublands

In the Gambel Oak-Mixed Montane Shrublands, focus on reducing fuels, increasing structural diversity and breaking canopy continuity. Ponderosa Pines should be protected during the removal of Gambel Oak, other brush and smaller trees. Large, old Oak trees should be maintained. Consider wildlife objectives during the removal process. Priority should be given to treatments along roadsides and at private land interfaces.

Figure 59. Gambel Oak-Mixed Montane Shrublands

Lodgepole Pine Forests

Location may warrant a fuels-based treatment approach in the Lodgepole Pine Forests. Fuel reduction increases the likelihood of being able to use prescribed fire in downslope Ponderosa Pine-Douglas Fir-Woodlands and Dry Mixed-Conifer Forests. Mitigation should reduce surface and aerial fuel loads. Opening should be created to slow the rate of spread and break the direction of an active crown fire. Avoid creating homogenous patterns and place stands in areas with low risk of wind throw.

Figure 60. Lodgepole Pine Forests

4.6.2 Waldo Canyon and Black Forest Fire Mitigation

The 2012 Waldo Canyon Fire and the 2013 Black Forest Fire have resulted in widespread ecosystem impacts within the burned area as well as downstream instability and subsequent transport of sediment and debris. It is strongly recommended that on-going post-fire mitigation efforts continue in order to reduce adverse impacts to the Watershed. Continued coordination efforts are critical in achieving recovery of burned areas.

Waldo Canyon Fire recovery efforts are coordinated through the El Paso County Watershed Collaborative. Mitigation projects are being completed by the City of Colorado Springs, El Paso County, Colorado Springs Utilities, and the Coalition for the Upper South Platte. There are a number of projects that are actively in design including City of Colorado Springs restoration on North Douglas Creek and the nearby Chuckwagon Property. It is recommended that follow-up maintenance projects are also executed, including repairs to the project on the Alpine Tributary to South Douglas Creek. Cleanable sediment basins in the area should also be monitored and maintained, these include those on North Douglas, Chuckwagon property, Alpine Tributary, Blodgett Gulch, and at the Pine Valley Diversion. Finally, it is recommended that ongoing monitoring and candidate projects along unstable reaches on fire-affected tributaries including those on Upper North Douglas Creek.

Black Forest Together, Inc. continues to coordinate the Black Forest fire recovery efforts. As the majority of the fire affected private lands, landowners are encouraged to participate in fire mitigation programs. Mitigation funding and resources are available through Black Forest Together, Inc. and the Natural Resources Conservation Service.

4.6.3 Fountain Creek Corridor Restoration Master Plan

The Fountain Creek Corridor Restoration Master Plan is a great additional resource for projects in the Monument Creek Watershed. Because the Monument Creek Watershed is within the larger Fountain Creek Watershed, much of the information in the Fountain Creek Master Plan is applicable to the Monument Creek Watershed.

The Fountain Creek Corridor Master Plan establishes a revitalization concept vision for the reach of Fountain Creek between the southern Colorado Springs City limit line and the confluence with the Arkansas River in Pueblo.

The Fountain Creek Corridor Master Plan defines the elements that are included in a relatively stable reach of the creek as opposed to an unstable reach of the creek. The plan establishes a series of restoration techniques, including conservation, that are intended to be the tool box of techniques used as a part of revitalizing Fountain Creek.

A reader of the Fountain Creek Corridor Master Plan should view the Master Plan vision as a concept for applying these techniques. Specific demonstration projects were planned, designed, and constructed using these restoration techniques. The Fountain Creek Corridor Restoration Master Plan focused on project implementation along Fountain Creek, highlighting project approaches as well as partnering and funding opportunities.

Many of the demonstration projects use new technology or are demonstrating new design concepts. Performance information collected will be continually provided to stakeholders located in the corridor. The Master Plan directs readers to the source of this information for use in future Fountain Creek projects, not only within the Master Plan project limits, but throughout the Fountain Creek Watershed, including the Monument Creek Watershed.

Additionally, the Master Plan is intended to be used as a planning tool to help identify priorities, potential partners, potential funding, restoration techniques, implementation strategies and resources.

The shared revitalization vision for Fountain Creek is the beginning of an unprecedented regional partnership to save the Fountain Creek Watershed by reducing the danger of flooding, reducing erosion and sedimentation, improving water quality, improving wildlife habitat, opening pathways to eco-tourism, recreation, environmental sustainability and balanced economic prosperity.

4.7 Access, Visibility and Education

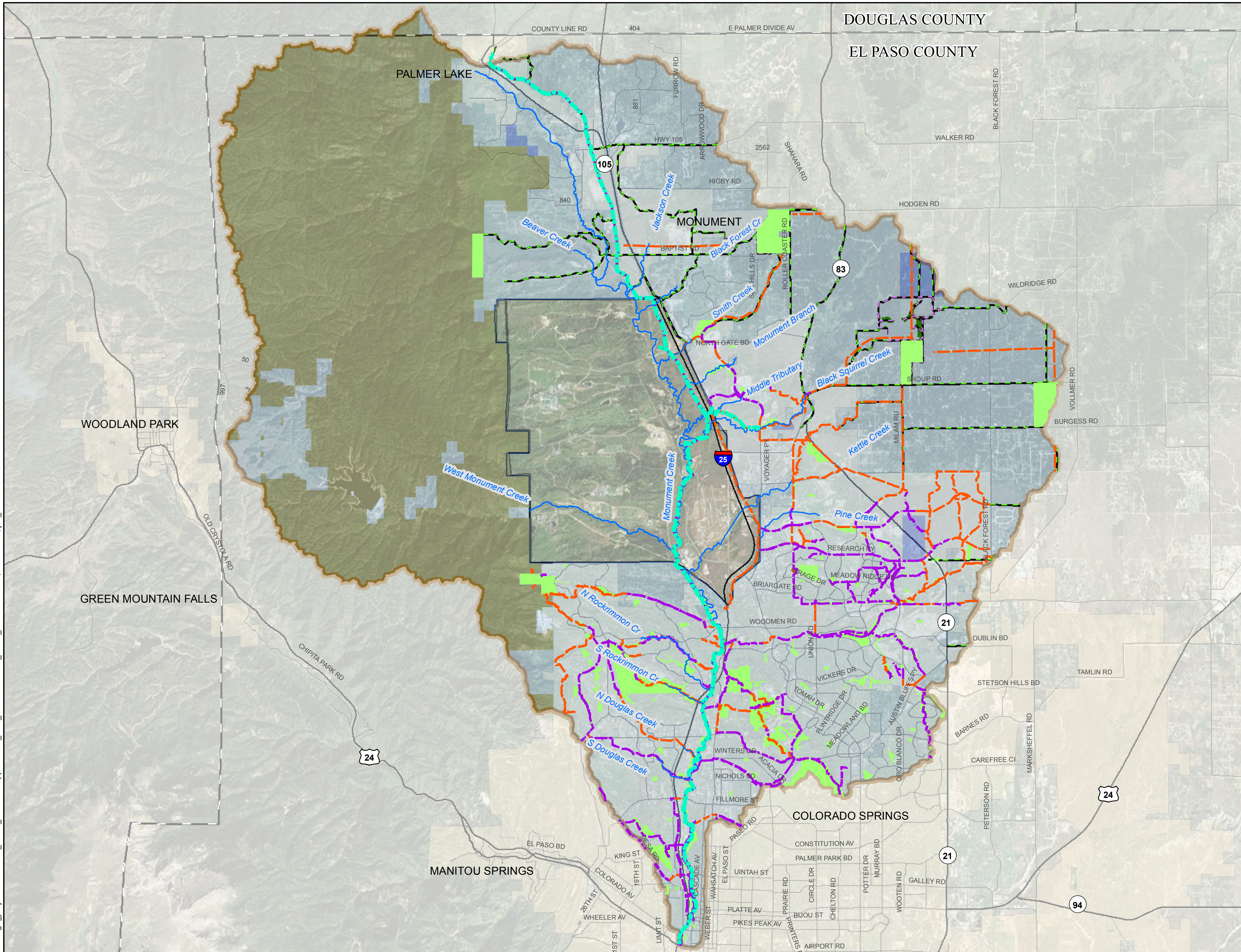
Access and visibility is a very important restoration technique. In order for the community to value Monument Creek and its tributaries as something that is beautiful and worth saving, the community has to be able to experience it. Right now the biggest issue in protecting the Monument Creek Watershed and motivating the community to use resources to restore the creek is the fact that the community, in general, views the creek as a liability, as an ugly drainage ditch with dirty water, eroding banks and the danger of flash flooding. Many have this misconception because the community currently has very limited access to the creek except in very

unbalanced, unstable reaches. However, within the watershed there are some pristine and relatively stable reaches of creek. Therefore, to instill responsibility in the community for the health of Monument Creek and its tributaries, the community must be provided access to these invaluable areas so that they will want to protect the creek and contribute to creating a community asset. When providing public access, however, measures should be taken to ensure the landscape is preserved and that the newly developed access does not have a detrimental effect on the natural resource. The most supportive and successful projects include access and visibility to the creek as a part of the overall goals of the project. It is the recommendation of this Restoration Plan to make community access and visibility a priority of every project.

It was public access to the South Platte River through Denver that helped bring public attention to the horrible conditions that existed along the South Platte River in the late 1970's. Once public attention was focused on the river, it only took 10 to 15 years for the South Platte River Greenway Foundation to become the model for greenways throughout the United States. Momentum, partnerships and funding are building to improve the river corridor to an even higher vision. This dramatic example and model in our own state makes it clear that access and visibility is key to the restoration of the Monument Creek Watershed.

This Master Plan places a high priority on projects that meet multiple objectives, including recreational needs. Figure 61 includes information from both the El Paso County and the City of Colorado Springs Trails and Open Space Master Plans. While this Master Plan includes a number of trails and open space projects identified by the project stakeholders' committee, there are additional trail and open space project opportunities in the Watershed that can be accomplished in combination with drainage corridor projects. As drainage corridor projects are planned, the Trails and Open Space Master Plans should also be reviewed to see if there is a partnership opportunity to include trail and open space improvements. Trails can often provide both a recreational and maintenance access function. Acquiring public open space for recreational use is one of the main tools to be used when conserving healthy drainage corridors.

Additionally, as drainage projects are considered, trail and open space opportunities may present themselves, even if not captured in the El Paso County or the Colorado Springs Trails and Open Space Master Plans. The Trail and Open Space Master Plans identify major Trail and Open Space Objectives. Often, shorter internal neighborhood trail connections and smaller neighborhood open space opportunities can be developed along with drainage corridor improvements. With every drainage corridor project developed, project stakeholders should always discuss and look for trail and open space opportunities.



Trails and Open Space Context Map

Monument Creek Watershed Conceptual Plan
El Paso County, CO

0 1 2
Miles

Legend

- Front Range Trail
- COS Proposed Trail
- COS Completed Trail
- COS Parks
- EPC Completed Trail
- EPC Proposed Trail
- EPC Parks

Land Owner

- BLM
- State
- DOD
- USFS
- Private

- Monument Ceek Watershed
- USAFA Boundary
- County Boundary
- City
- Stream
- Highway
- Major Road

FILE: G:\gis_projects\Monument_Creek_MP\active\apps\Master_Plan_Draft\Monument_Creek_Recreation.mxd, 10/26/2016, jeff_clonts

5.0 Conceptual Design Toolbox

References, plantings and typical design drawings have been compiled and presented in the following sections. These tools, in conjunction with the information provided for each of the projects, will illustrate some of the key design concepts that should be integrated into the identified projects.

5.1 The City of Colorado Springs Drainage Criteria Manual

Mentioned previously, the City of Colorado Springs Drainage Criteria Manual provides design guidance for a variety of drainage facilities including; culverts and bridges, open channels, and detention facilities. In the implementation of the Monument Creek Watershed Restoration Master Plan, the guidance provided in the Drainage Criteria Manual should be complemented with the results and information presented in Appendix B of this Restoration Plan.

Preliminary project design was completed for all of the prioritized projects included in the Restoration Plan. A summary of the design characteristics have been included in Appendix B for the immediate action, stream channel restoration, detention and water quality, and flood risk reduction projects. Using the concepts presented in this toolbox, design guidance from the Colorado Springs DCM, and preliminary design parameters outlined in Appendix B, the actionable list of priority projects can easily be implemented.

5.2 Fountain Creek Watershed Flood Control and Greenway District Design Manual

As mentioned previously, the District's Design Manual will provide design guidance that should be used in conjunction with the City of Colorado Springs Manual. The hydrologic analyses completed as a component of this Restoration Plan identified deficiencies in the current 24-hour storm methodologies, as discussed further in the Plan Development section of this document. The forthcoming District Design Manual will provide specific guidance on the implementation of a region-appropriate 24-hour design storm that addresses the deficiencies in the old methodologies. Where applicable, designers should use the new hydrologic methodologies in implementing this plan along with the other recommendations outlined in both Drainage Criteria Manuals.

5.3 Colorado Water Conservation Board Design Guidelines for Project Development

The Design Guidelines for Project Development published by the Colorado Water Conservation Board were used to guide the development of the alternatives presented in the Restoration Plan. A summary of some of the key elements of the guiding list is provided below:

- Project Design
    - Typical channel dimensions
    - Channel and floodplain alignment
    - Channel profile
    - Identification of project limits
    - Provisions for in stream structures, as applicable
    - Provisions for aquatic species, as applicable
    - Other elements identified within the project goals and objectives, as applicable
    - Preliminary engineering typical drawings
- Opinion of Probable Cost
    - Itemized cost breakdown
- Draft Planting Plan, as applicable
    - Identify existing on-site species
    - Identify revegetation needs with estimate quantities

5.4 Waldo Canyon Fire WARSSS

The hydrologic effects of the Waldo Canyon Fire were analyzed in 2013 as part of the Waldo Canyon Fire Watershed Assessment for River Stability and Sediment Supply (WARSSS) report. As summarized in the report, "The WARSSS study is a cumulative watershed effects analysis that quantifies changes in water yield, hillslope erosional processes, and stream channel impacts, including streambank erosion due to (fire) disturbance." Additionally, the study presented restoration scenarios for individual erosional processes. The scenarios were used as a benchmark in developing reach design approaches in this Restoration Plan. Parameters such as proposed reach sinuosity were referenced from the Waldo Canyon WARSSS evaluation. The figure below referenced from the report, shows a few of the natural stream channel succession scenarios.

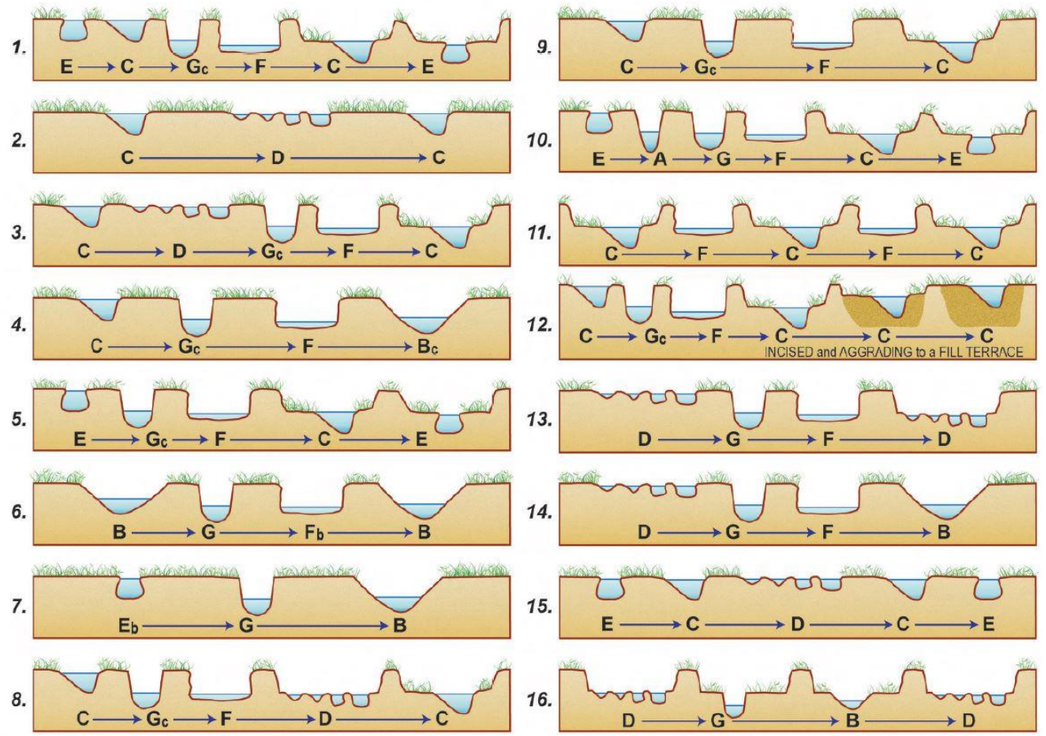


Figure 62. Natural Stream Succession Scenarios (Waldo Canyon Fire WARSSS)

5.5 Geomorphological Approach to Restoration of Incised Rivers

The technical paper, *"A Geomorphological Approach to Restoration of Incised Rivers"* by David Rosgen provides a methodology for stream classification and restoration priority. As a component of the technical evaluation of the watershed, the project team studied the geomorphology of a number of reaches along Monument Creek and its tributaries and followed this methodology to classify each reach based upon information gathered from the field. The stream classification, coupled with the results of the hydraulic modeling, provided a project specific restoration priority for unstable streams. The theory and techniques behind each restoration priority is discussed at length in this text. The flow chart below provides a guide to stream classification as presented in this technical paper.

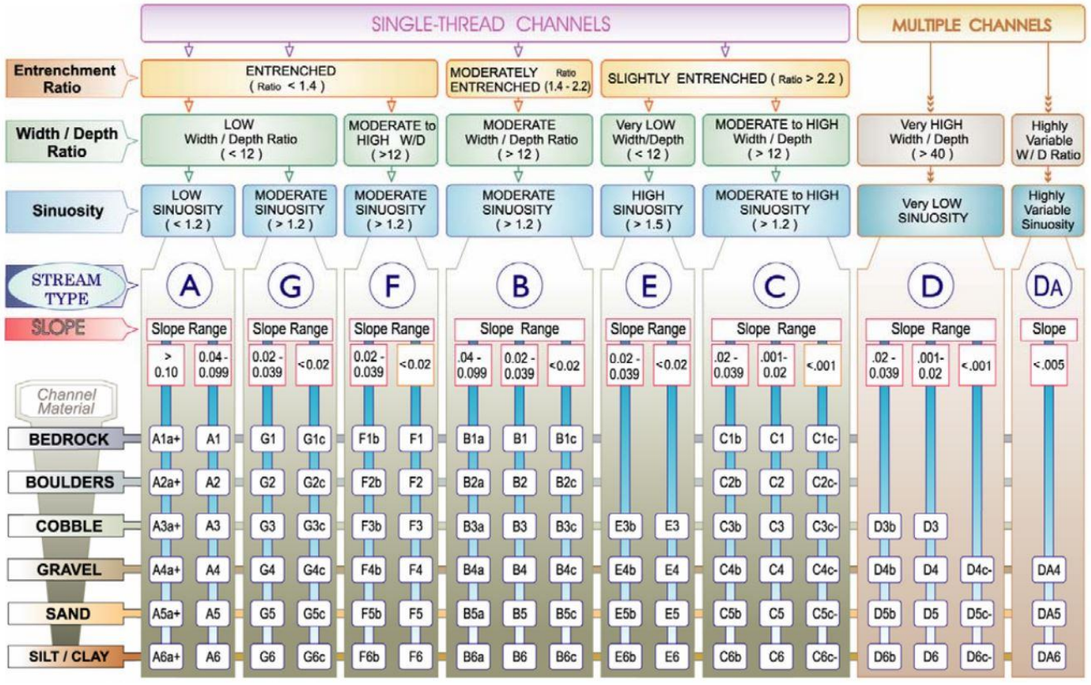


Figure 63. Rosgen Classification of Natural Rivers

5.6 Natural Resources Conservation Service Colorado Stream Restoration Guide

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Colorado published a technical note, "Guidance for Stream Restoration" in 2014 to provide guidance for stream restoration projects. This document provides a summary of and references to technical references for stream restoration projects organized by technical need. Beginning with site assessment, the technical note provides guidance for each step in the restoration process, providing potentially useful references in each section.

5.7 Plantings

Plant lists appropriate for each landscape position and ecosystem are provided in the following section. The Fountain Creek Restoration Master Plan identified ecosystems and appropriate plant palette for each ecosystem and is a useful reference for plantings in the Monument Creek Watershed.

Healthy ecosystems will support an abundance of plant and animal life. In the Monument Creek corridor, typical ecosystems include:

- The Creek (Open Water Channel) Ecosystem
- Sandbar / Gravel Creek Bank Ecosystems
- Riparian Woodland / Fringe Wetland
- Marsh Riparian Ecosystem
- Pond Ecosystem
- Cottonwood Gallery Ecosystem
- Shrub/Grassland Ecosystem

All of the ecosystems are prone to invasive species. Invasive species that are prevalent in every ecosystem except the Shrub/Grassland Ecosystem include:

- Salt Cedar (Tamarix ssp.)
- Cattails
- Reed Canary Grass
- Russian Olive

5.7.1 The Creek (Open Water Channel) Ecosystem

This is the area where open water flows. The open water channel can be narrow and deep, or wide with meandering channels.

5.7.2 Sandbar/Gravel Creek Bank Ecosystem

These are alluvial areas comprised of sand, gravel and rock benches that capture debris along the Creek. These areas have little or no organic matter and are free draining. They exist at, or just above, the Creek flow elevation (0-12" above the Creek). This ecosystem has limited vegetation including willow shrubs, native grasses and herbaceous plants. Primary species include:

- Narrowleaf Cottonwood
- Willow (Salix ssp.) species

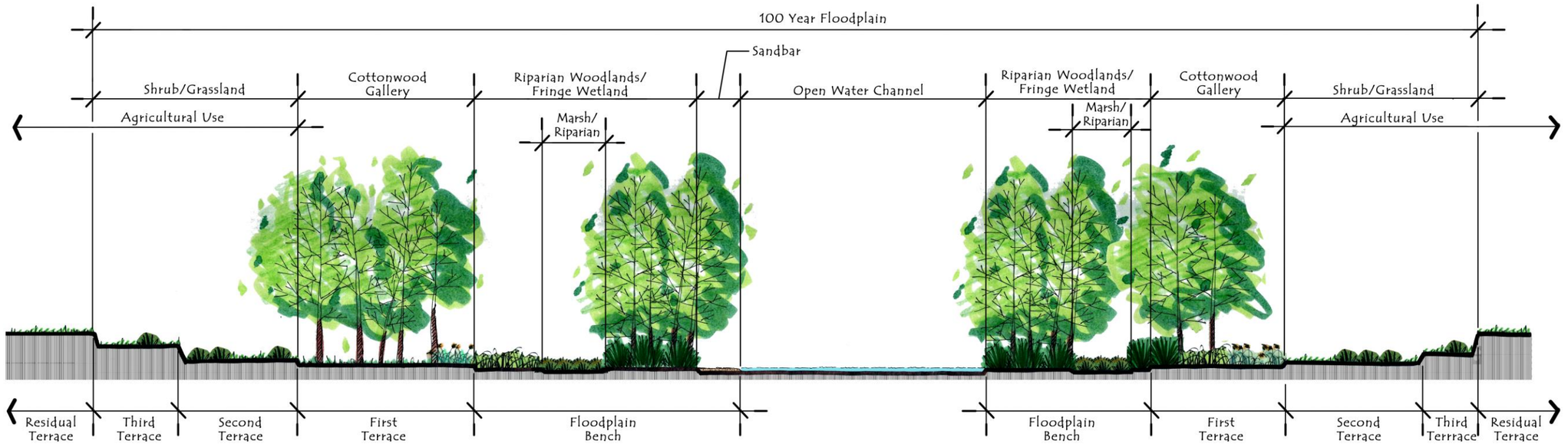


Figure 64. Typical Ecosystems for Use in Stream Restoration

5.7.3 Riparian Woodland/Fringe Wetland Ecosystem

This is the most prolific ecosystem due to its proximity to the water table. Generally occurring from 12"-24" above the Creek, this area is immediately adjacent to the Creek and is one of the "greenest" ecosystems. It includes trees, shrubs, grasses, rushes and sedges. Invasive species are prevalent and cover large areas. Because of this, they are difficult to control. Primary species include:

- Narrowleaf Cottonwood
- Willow (Salix ssp.)
- Plum / Chokecherry (Prunus ssp.)

90-95% of the Herbaceous Plants found in the corridor are Rush and Sedge species (Juncus ssp. and Carex ssp. respectively). These Herbaceous Plants are found in submerged, emergent and Aquatic Fringe locations within the ecosystem. Additional species include:

- Spikerush (Eleocharis ssp.)
- Bulrush (Scirpus ssp.)

5.7.4 Marsh Riparian Ecosystem

The Marsh Riparian Ecosystem includes the transitional areas that are at or below the normal flow elevations of the creek. The biodiversity of this area is large and contains a diverse array of plant species including shrubs, grasses, rushes and sedges. Soils are moist and open water is present at certain times of the year. Plant species are tolerant to submerged conditions due to seasonal flooding. Primary plant species include:

- Cottonwood (Populus ssp.)
- Willow (Salix ssp.)
- Plum/Chokecherry (Prunus ssp.)

While the majority of Herbaceous Plants found in the corridor are primarily Rush and Sedge species (Juncus ssp. and Carex ssp. respectively), other grasses exist including:

- Wildflowers (Sunflower, Cardinal Flower, Monkeyflower, Verbena)
- Grasses (Sloughgrass, Wheatgrass, Mannagrass, Needlegrass, Bluegrass)

5.7.5 Pond Ecosystems

Ponds along the corridor primarily serve or have served as agricultural uses and are usually void of vegetation except for grasses adjacent to the pond's edge. When ponds no longer serve agricultural uses, pond biodiversity should be expanded with riparian plantings to attract wildlife and provide other uses. The Riparian Woodlands and Marsh Riparian plant pallets should assist with pond revegetation.

5.7.6 Cottonwood Gallery Ecosystems

Cottonwood Galleries can be found paralleling each side of the creek. While some areas are dense, some areas tend to be more sporadic. The cause of this vanishing Cottonwood Gallery is due, in part, to development and agricultural uses adjacent to the creek changing the creek hydrology and stream geomorphology. The Cottonwood Galleries have a dense understory of shrubs and native grasses. The gallery protects the creek from erosion and provides wildlife habitat. Primary plant species include:

- Plains Cottonwood
- Peachleaf Willow and Crack willow
- Woody Shrubs (Snowberry, Rose, Currant, Buckbrush, Sage Brush)
- Grass/Cover Crops (Wheatgrass, Switchgrass, Indian Grass, Big Bluestem, Grama, Needle and Thread)

5.7.7 Shrub/Grassland Ecosystems

This ecosystem lies furthest from the open water in both horizontal and vertical distance. It is above the available water table, typically at least 24"above the creek bed. This ecosystem is rich with trees, shrubs and upland grasses and may contain the Cottonwood Gallery. Plants within this ecosystem are generally referred to as upland plants. It typically is the ecosystem that adjoins agricultural/private property along the Creek. Species are wildly varying and can include:

- Upland Trees (Cottonwood, Ash, Hackberry, Locust, Plum, Ponderosa Pine, Gambel Oak, fir/spruce)
- Woody Shrubs (Snowberry, Rose, Currant, Buckbrush, Sage Brush, Rabbitbrush, Yucca, Cholla)
- Grass/Cover Crop (Wheatgrass, Switchgrass, Indian Grass, Big Bluestem, Grama, Needle and Thread)

Invasive species in this ecosystem are primarily Canadian Thistle and Bindweed.

For a comprehensive list and additional description of ecosystems and plant palettes, refer to the Fountain Creek Restoration Master Plan.

5.8 Typicals

When approaching the restoration of identified projects or sections of channel throughout the Monument Creek Watershed, there are various design applications and techniques that can be applied based upon the unique characteristics of the reach. Depending on the planning alternative developed for each reach, a specific restoration plan can be applied to a length of channel to repair the identified deficiencies while also increasing the stability throughout the length of channel. For each alternative, various design applications can be utilized to manage the identified projects. For the reach planning alternatives, there are two major approaches to restoration; natural channel design and drop structures. Though there are differences in techniques and approaches between these two categories, the two approaches are not always mutually exclusive. A hybrid approach between drop structures and natural channel design is often appropriate for channel restoration. The reach alternatives analysis is explained in greater detail in Section 7.5.

The goal of the Natural Channel Design Alternative is to use natural form and materials to restore stream function and establish a low flow channel which provides access to the adjacent floodplain, allowing for overflow across the floodplain in larger events. This can be achieved through the implementation of a desirable stream type coupled with various grade control and bank protection measures to aid in returning the channel to a naturally stable cross section, slope, and pattern suitable for the stream and valley characteristics. Detailed guidance for natural channel design scenarios is provided in the documents mentioned earlier in this section of the report. Restoration scenarios are based on converting an impaired stream reach from its existing stream type to a proposed, or potential, stream type, based on stable reference reach data in the region. Existing and proposed stream types for Monument Creek and its studied tributaries can be found in Appendix C of this report. A typical cross section of a natural channel design is illustrated in the figure below.

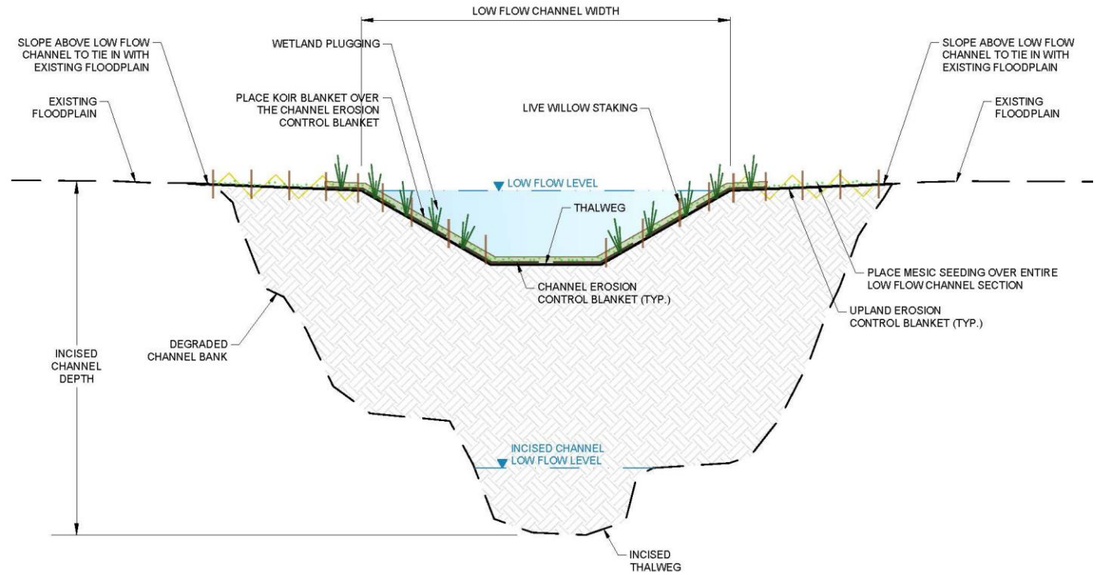
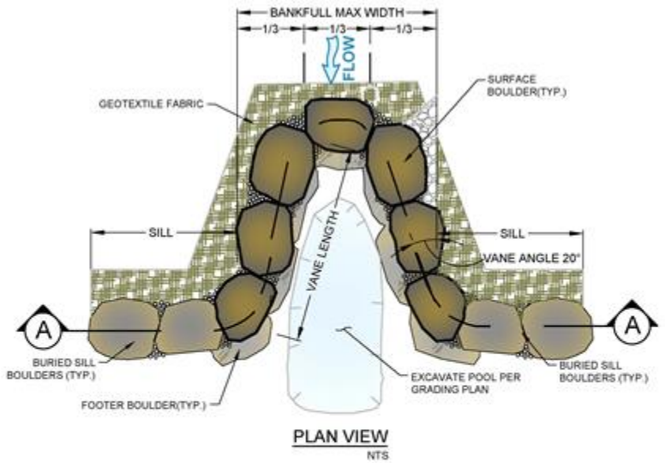


Figure 65. Typical Natural Channel Design Cross Section

Structures such as rock cross vanes, constructed riffles, and log rollers allow for grade control and energy dissipation, while ensuring the channel will attain a stable slope between structures. Typical concept design drawings and constructed examples of rock vanes and riffle structures are shown in Figures 66-69.



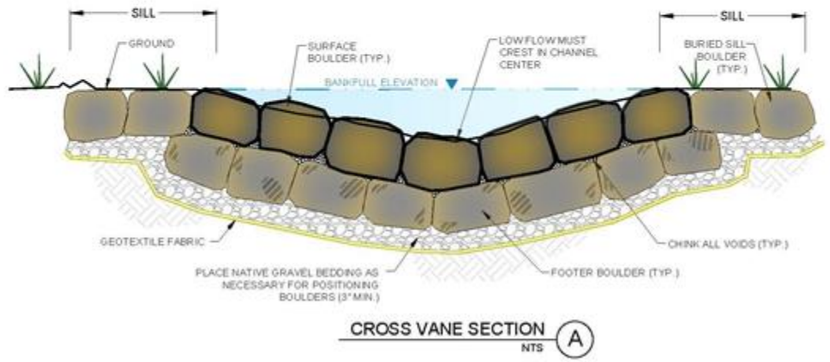


Figure 66. Typical Rock Vane Details

Figure 67. Constructed Rock Vane on North Douglas Creek

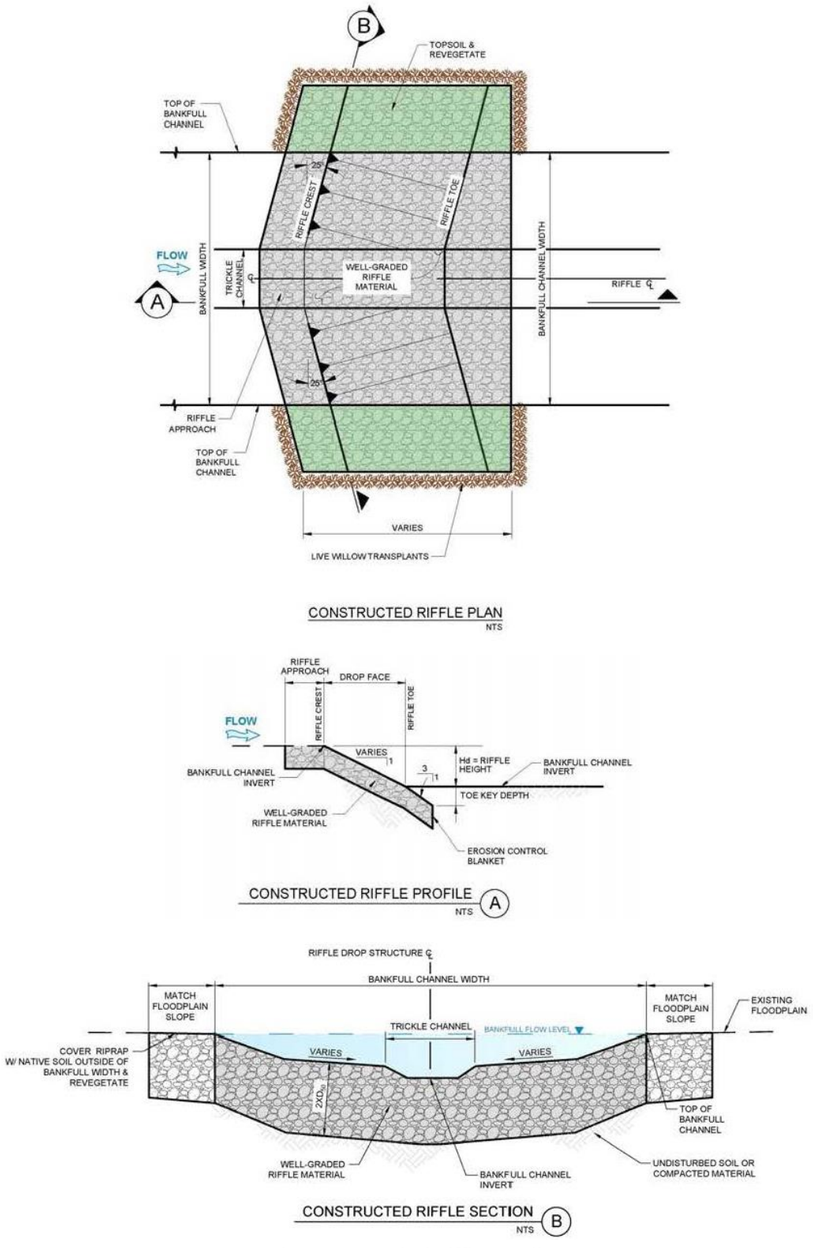


Figure 68. Typical Riffle Details

Figure 69. Constructed Riffle on Fountain Creek

The Small Drop Structures with Toe Protection Alternative utilizes drop structures with reinforced side slope toes throughout the channel. This alternative is necessary when narrow available channel and valley widths, high shear stresses, or unstable slopes do not readily allow for a natural channel design applications. The small drop alternative is discussed in greater detail in the Alternative Analysis section. Figure 70 illustrates a typical small drop structure detail in plan, profile, and section view. An example photograph of a constructed small drop structure and side slope toe protection can also be seen in Figure 71, on the following page.

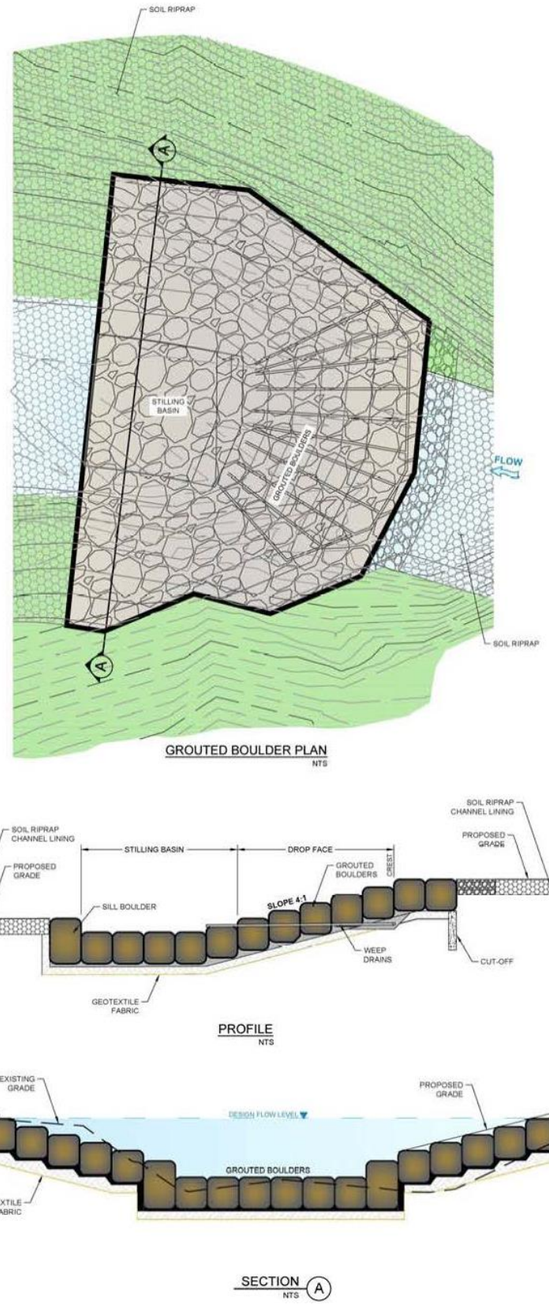


Figure 70. Typical Boulder Drop Structure Details

Figure 71. Constructed Boulder Drop Structure on Monument Creek

Attenuation of flood flows and the reduction of sediment delivery can be achieved through the construction of detention facilities. Detention facilities serve as a tool for mitigating downstream flooding and restoring the natural flow regime of downstream channels. Detention facilities can be installed in-line or off-line, depending on the hydrology of the project stream and availability of land in the project area. A conceptual plan of an off-line detention facility is shown in Figure 72. As shown, attenuation only occurs when the flows in the adjacent channel are large enough to overflow the lateral weir and activate the side detention basin.

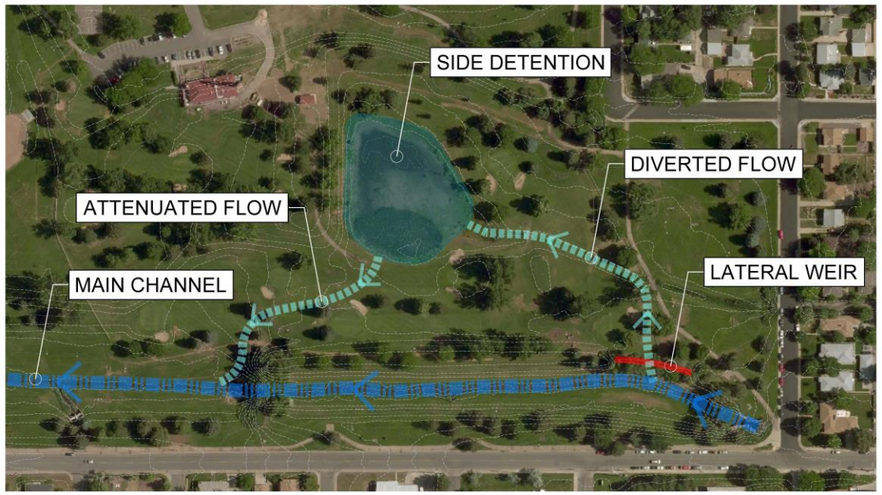


Figure 72. Conceptual Plan of an Offline Detention Facility

As with off-line detention facilities, the primary function of full-spectrum facilities is to reduce stream impacts and flooding downstream by attenuating peak flows. Full-spectrum detention facilities control flow for a wide range (spectrum) of rainfall-runoff events. As shown in Figure 73, there are typically three zones in a full spectrum detention pond; the Water Quality Capture Volume (WQCV), the Excess Urban Runoff Volume (EURV), and the 100-year Volume. Frequent urban runoff events typically transport the most sediment and can have significant impacts on the receiving waters. The slow release design of the WQCV and EURV mitigates these potential damages and promotes the stability and resiliency of downstream reaches and riparian corridors while also providing water quality benefits.

Traditionally, detention facilities have attenuated peak flows by removing the peak of the outflow hydrograph without the preservation of the shape of the pre-development hydrograph. Full spectrum detention facilities are intended to maintain the pre-development shape of the outflow hydrograph while attenuating increased peak flows. The 100-year volume, along with the WQCV and EURV, is then designed to ensure that the facility reduces the 100-year peak discharge to pre-developed conditions. Where and when possible, the installation of full spectrum is recommended throughout the watershed.

Target release rates for flood control volumes have been attached in Appendix C of the Restoration Plan. These release rates were calculated using parameters that were characteristic of undeveloped conditions throughout the watershed as discussed further in the Plan Development section. It is recommended that these target release rates be used in the design of sub-regional and regional detention facilities as described in the City of Colorado Springs DCM.

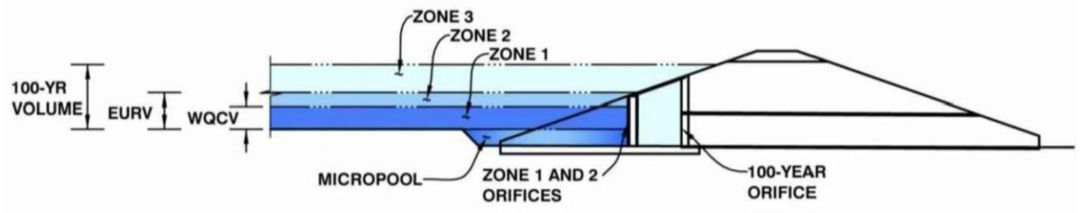


Figure 73. Typical Concept for Full Spectrum Detention (UDFCD Urban Storm Drainage Criteria Manual Volume 2)

Figure 74. Existing Full spectrum Detention Facility at Interquest Parkway and I-25

6.0 Project Implementation Guidelines

General guidelines for implementing the projects identified in this plan are provided in the following sections. These guidelines include recommendations for plan implementation, project phasing, permitting, monitoring, partnering and funding, and procedures for updating project priorities.

6.1 Use of Plan Documents

Project stakeholders can use all the elements provided in the Restoration Plan to develop a plan of action for the development and implementation of improvements that restore the Monument Creek Watershed. Specific direction for use of the main elements of the Restoration Plan is provided below:

- *Mapbooks* – The Mapbooks presented in the first portion of this report provide the location of and essential information for high and immediate ranking projects. Reach alternatives, bridge and culvert locations, model and regulatory floodplains, hydraulic model cross-sections, hydrologic subbasins, and adjacent utility locations are also shown on the mapbooks.
- *Design Toolbox* – The design toolbox and typical design drawings provide a reference for implementing the various approaches discussed earlier in the Restoration Plan. Along with the typical drawings and design approaches, valuable reference documents are also provided in the Conceptual Design Toolbox section of the report.
- *General Stewardship Recommendations* – In addition to referencing existing plans that discuss stewardship in great detail, the General Stewardship and Recommendations section of the report outlines general recommendations concerning watershed upland and forest management and fire mitigation as well as access, visibility, and education.
- *Design Concepts* – Developed for Immediate Action and High Ranking projects. Concepts for each of these projects are attached in Appendix B.
- *The Decision Making Matrix* – The Decision Making Matrix describes and prioritizes each of the high ranking project alternatives based on evaluation criteria developed by the stakeholder group. This matrix can be used and adjusted for future re-evaluation of the project prioritization.
- *Partnering and Funding* – The partnering and funding section of the Restoration Plan provides guidance for funding and leveraging additional funds through partnerships. A list of potential partners is also provided in this section.
- *Background and Technical Information* – All of the technical analyses and evaluation completed as part of this planning process is described in this portion of the report.
- *Monitoring Strategies* – Strategies for monitoring the health of the watershed and the progress of this plan are outlined in this section of the Plan.

6.1.1 Applying Provided Technical Information

Technical information has been extensively generated and compiled throughout this report regarding findings and recommendations provided by the project team. The team has provided these recommendations, along with conceptual designs and costs, for the implementation of the identified priority projects. These concepts and estimates are intended to give guidance in the initial phases of design when addressing an identified project. Project specific design concepts can be found in Appendix B for the high ranking projects identified in this plan. These design concepts outline essential design parameters such as target rating curves for the proposed detention facility improvements. As site conditions often change, sometimes rapidly, these recommendations will need to be reevaluated to ensure that they still apply to the issues and projects identified in this Restoration Plan.

6.1.2 Updating Priorities

As conditions change in the Monument Creek Watershed, identified projects will likely be completed and new problem areas may present themselves. If and when these changes necessitate updating the prioritized list of projects, all of the tools needed to do so are provided within this Restoration Plan. It is recommended that the stakeholder working group collectively work together to evaluate new potential projects using the evaluation criteria developed for this Restoration Plan. A flow chart representing the evaluation criteria developed by the stakeholder group has been included in the Guiding Principles section of the report. As discussed in the Plan Development section, the evaluation criteria was used to prioritize high ranking projects throughout the watershed using the Decision Making Matrix. Using the Decision Making Matrix, shown in Table 3, the stakeholder group can systematically prioritize the updated list of potential projects.

6.2 Phasing Approach & Timeline

Project ranking and priority should be considered in Restoration Plan implementation. High and immediate ranking projects are recommended to be completed first. The priority assigned to the high ranking projects should also be considered as high priority projects are typically designated as "high priority" by meeting multiple objectives and being aligned with the evaluation criteria set forth by the stakeholder group. It should also be noted that detention projects provide downstream benefits, such as flow attenuation, that may reduce the costs and needs of projects downstream. The evaluation of reach alternatives was completed under the assumption that upstream detention was not in place. Where possible, it is recommended that upstream detention projects precede improvements made downstream. It is important to note that the conceptual design parameters generated for the detention projects were done so under the assumption that the upstream detention projects had already been implemented. If upstream improvements are made, it is recommended that the plan model be run with these improvements in place in order to design downstream reach and detention improvements, and to evaluate flooding potential. Ultimately, the re-evaluation of the plan model will be the responsibility of the entity implementing the Restoration Plan.

6.3 Downstream Impacts

Improvements made as part of the implementation of this Restoration Plan will have downstream impacts. As previously mentioned, detention projects provide downstream benefits by attenuating peak flows. Other project types provide similar benefits. For example, reach restoration projects increase channel stability thus reducing downstream sediment transport. The implementation of this Restoration Plan will increase the overall health, stability, and resiliency of the watershed and protect downstream communities and drainage infrastructure from flooding damages.

6.4 Permitting

The following list represents a selection of federal and state environmental laws and regulations. Some of these regulatory issues are discussed by project type, but all have the potential to affect the proposed projects.

Federal

1. *Clean Water Act (CWA)* - Waters of the US (WUS), including wetlands, may require a Section 404 permit from the US Army Corps of Engineers (USACE).
2. *Endangered Species Act (ESA)* - Designated Critical Habitat for the Preble's Meadow Jumping Mouse (PMJM) occurs within the watershed, and suitable habitat is present in riparian areas; therefore these projects may require substantial consultation with the United States Fish and Wildlife Service (USFWS).
3. *National Historic Preservation Act (NHPA)* - For every project with a federal nexus, cultural and historic resources need to be evaluated and protected if needed. These consultations will occur between the federal agency and the State Historic Preservation Officer (SHPO).
4. *Migratory Bird Treaty Act (MBTA)* - The majority of birds that occur throughout North America are protected by the MBTA. Projects that are proposed during the breeding season (May through August) have the potential to affect a wide variety of bird species. Protections and mitigation for birds, their nests, and eggs need to be in place to comply with the MBTA.
5. *Bald and Golden Eagle Protection Act. (BGEPA)* - Eagles have protections in addition to those provided by the MBTA. If eagles are disturbed to the point that a nest fails or a pair fails to reproduce in a particular year, the cause of the disturbance (any of the proposed projects) would violate BGEPA.
6. *National Flood Insurance Act (NFIA)* - A Floodplain Development Permit may be required for modification and improvements to existing structures and the construction of new structures. Projects that propose to alter the current floodplain in an area need to work with the local Floodplain Administrator to permit the activity.

State

1. *Senate Bill 40 (SB40) Wildlife Certification* -SB 40 certification is required when a project with state agency involvement (typically the Colorado Department of Transportation) impacts wildlife or aquatic resources in Colorado streams. State listed Threatened and Endangered species with potential to occur are also evaluated during the certification process. The certification is issued by CPW.
2. *CWA Section 401 Water Quality Certification* - This certification is regulated through the Colorado Department of Health and Human Resources (CDPHE). The Colorado Water Quality Control Division (WQCD) reviews and issues Water Quality Certifications under Section 401 of the federal CWA for projects or actions that are applicable to the provisions of the Colorado 401 Certification Regulation. A CWA 401 Water Quality Certification is required for any federal license or permit that is issued to construct or operate a facility, which may result in any fill or discharge into WUS.

6.5 Monitoring

The technical evaluation of the Watershed identified some reaches as 'Protect-In-Place and Monitor' through a process described in detail in the Plan Development section of this report. These reaches can be seen in the mapbooks provided earlier in the report and are also shown on the overall watershed map on the following page. Protect-In-Place and Monitor reaches are currently stable but are at risk of future instability. It is recommended that each jurisdiction monitor their identified reaches on a routine basis to prevent future instability and degradation.

There are a number of different approaches to monitoring, each with their own level of efficacy and required effort. One of the easiest ways to monitor identified reaches is through the comparison of current and historic aerial photography. Using a platform like Google Earth, major changes in the reach condition can be identified and addressed as needed. Similarly, the jurisdiction can develop profiles for each reach and update them with new topographic information (LiDAR) as it becomes available. Both of these methods require the generation of a new dataset.

Making routine field visits to each of these identified areas would allow for a relatively quick identification of a possible point of instability. Detailed field notes and photographs should be recorded and compared between visits to the various sites. References to specific monitoring procedures can be found in the Reporting and Monitoring section of the previously mentioned Natural Resources Service Colorado Stream Restoration Guide.

Monitoring projects throughout the design, construction, and post-construction phases is also critical in ensuring that all of the outlined goals and objectives are being met for that project. Following the monitoring procedures outlined, the success of an implemented project can be evaluated.

Protect-In-Place and Monitor Reaches

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

Legend

- Protect in Place and Monitor
- Monument Ceek Watershed
- Stream
- County Boundary
- City
- Highway
- Major Road

DOUGLAS COUNTY

EL PASO COUNTY

PALMER LAKE

MONUMENT

WOODLAND PARK

GREEN MOUNTAIN FALLS

MANITOU SPRINGS

COLORADO SPRINGS

Beaver Creek
Jackson Creek
Black Forest Cr
Smith Creek
Monument Branch
Middle Tributary
Black Squirrel Creek
West Monument Creek
Monument Creek
Kettle Creek
Pine Creek
N Rockrimmon Cr
S Rockrimmon Cr
N Douglas Creek
S Douglas Creek

COUNTY LINE RD
E PALMER DIVIDE AV
HIGBY RD
WALKER RD
HODGEN RD
BAPTIST RD
WILDRIDGE RD
NORTH GATE BD
BURGESS RD
VOLLMER RD
BRIARGATE PY
RESEARCH PY
MIRAGE DR
MEADOW RIDGE DR
BRIARGATE BD
WOODMEN RD
DUBLIN BD
STETSON HILLS BD
TAMLIN RD
BARNES RD
CAREFREE CI
WINTERS DR
NICHOLS BD
FILLMORE ST
PASEO RD
CONSTITUTION AV
PALMER PARK BD
UINTAH ST
GALLEY RD
EL PASO BD
KING ST
COLORADO AV
WHEELER AV
PLATTE AV
BIJOU ST
PIKES PEAK AV
AIRPORT RD
CHIPITA PARK RD
OLD CRYSTOLA RD

105
83
25
21
24
94

6.6 Funding and Partnering

As funding becomes available for projects identified in the Restoration Plan, opportunities for leveraging available funds should always be considered. There are many organizations, including government agencies and non-profit organizations, which should be considered as potential sources for additional funding, man-power and other non-financial resources. Often, multiple sources can be considered because funding organizations are proportionally more interested as the number of partners increase. More partners usually results in a greater interest. The following are lists of potential funding partners, organized by areas of interest, and identified by the goals and missions of their organization:

Conservation Easements

- Colorado Open Lands
- Trust for Public Lands
- Natural Resources Conservation Services (NRCS)
- Colorado Division of Wildlife (CDOW)

River Stabilization, Flood Control and Water Quality

- City and County Public Works Departments
- Environmental Protection Agency (EPA)
- United States Geological Survey (USGS)
- Colorado Water Conservation Board (CWCB)
- Colorado Department of Public Health and Environment (CDPHE)
- U.S. Army Corps of Engineers
- U.S. Air Force Academy (USAFA)
- U.S. Department of Interior-Bureau of Reclamation
- Colorado Department of Transportation (CDOT)

Wildlife Habitat and Conservation

- Colorado Division of Wildlife (CDOW)
- Colorado Water Conservation Board (CWCB)
- U.S. Fish and Wildlife Service
- The National Fish and Wildlife Foundation
- U.S. Department of Interior
- Trout Unlimited
- Ducks Unlimited
- U.S. Army Corp. of Engineers
- Colorado State University
- United States Geological Survey (USGS)

Trails and Recreation

- Great Outdoors Colorado (GOCO)
- Colorado State Parks
- Colorado Division of Wildlife (CDOW)
- Local Parks and Recreation Districts
- City and County Parks and Recreation Departments
- El Pomar Foundation
- Fountain Creek Foundation

Environmental Education

- Environmental Protection Agency (EPA)
- National Fish and Wildlife Foundation
- Anschutz Family Foundation
- Cornell Douglas Foundation
- The Lauren Townsend Memorial Wildlife Fund
- Smart World Corporation
- The Colorado Health Foundation
- Great Outdoors Colorado (GOCO)
- Colorado State University
- The Catamount Institute
- The Fountain Creek Foundation
- The El Pomar Foundation
- Colorado Department of Public Health and Environment (CDPHE)
- Colorado Division of Wildlife (CDOW)

6.7 Volunteer Opportunities

Opportunities to involve non-coalition partners and volunteers may improve the implementation of certain projects, especially those with a high public profile or interdisciplinary nature.

7.0 Plan Development

The path to a comprehensive management plan involving the input of stakeholders, technical experts and citizens at large begins with defining the goals and structure of the plan. The following tasks were developed to define common goals and establish a level of service that could be achieved with such a master plan.

- *Problem Identification* – Identified what the stakeholders wanted to be addressed by the plan and what types of projects will be addressed. Defines the geographic extents of the study areas.
- *Technical Analysis* – Identified what data and analyses were required to evaluate the problems and project needs. Identified the appropriate tools and methods to evaluate the results.
- *Alternatives Selection* – Identified the options available to address the problems. This task developed a set of alternatives and restoration techniques to achieve the goals of the stakeholder group in an efficient and effective manner.
- *Plan Development* – Developed a decision making process to organize, manage, and prioritize projects. This task connected the identified problems and solutions into a comprehensive comparison that can help stakeholders and resource managers evaluate their needs with respect to regional needs and objectives.

In order to develop an actionable plan with stakeholder involvement integrated into the project prioritization, the team developed a detailed stakeholder decision making process to facilitate comparisons between numerous similarly ranked projects. The decision making process was used to establish the appropriate projects and criteria to include in each Decision Matrix. The decision making process defines the context of the restoration goals and objectives, the core values, critical issues, and evaluation criteria intended to be over and above the technical analysis and ranking. A diagram of the decision making process can be found in Figure 1.

7.1 Acknowledgements

A number of stakeholders, agency personnel, county and municipal staff, consultants, and private interests contributed to the planning effort. Contributors to this document are listed in the following sections.

7.1.1 Sponsors

Overseen by Mr. Larry Small, Executive Director of the District, the Fountain Creek Watershed Flood Control and Greenway District was the primary sponsor and project manager of the Monument Creek Watershed Restoration Master Plan. The Colorado Department of Local Affairs (DOLA) was the primary grant agency of the planning effort. Project sponsors also include; the City of Colorado Springs, Colorado Springs Utilities, El Paso County, and the United States Air Force Academy.

7.1.2 Stakeholders

Individual members of the working stakeholder group include:

Alison Plute, Colorado Springs Utilities
Allyn Kratz, Cheyenne Mountain Chapter of Trout Unlimited
Angela Essing, Pikes Peak Area Council of Governments
Ben Dumakowski, Pine Creek Golf Course
Bill Alspach, City of Woodland Park
Bob Miner, Town of Palmer Lake
Brian Kelley, City of Colorado Springs
Brian Mihlbachler, United States Air Force Academy
Brian Potts, Pikes Peak Area Council of Governments
Carol Ekatius, Coalition of the Upper South Platte
Cathy Green, Town of Palmer Lake
Chris Lieber, City of Colorado Springs
Chris Sturm, Colorado Water Conservation Board
David Deitemeyer, City of Colorado Springs
David Watt, Colorado Department of Transportation
Elaine Kleckner, El Paso County
Frederick Williams, United States Air Force Academy
Gary Barber, Greenway Fund
Jara Johnson, Coalition of the Upper South Platte
Jason Wells, City of Manitou Springs
Jeff Rice, El Paso County
Jennifer Irvine, El Paso County
Jerry Cordova, City of Colorado Springs
John Chavez, El Paso County
John Fooks, Cheyenne Mountain Chapter of Trout Unlimited
Karen Berchtold, City of Manitou Springs
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Keith Curtis, Pikes Peak Regional Building Department
Kenneth Clark, Black Forest Together
Kip Peterson, Donala Water and Sanitation District
Larry Bagley, City of Colorado Springs
Larry McCulloch, La Foret Conference and Retreat Center
Lesley Mace, Colorado Department of Transportation
Lisa Patton, Coalition of the Upper South Platte
Mark Shea, Colorado Springs Utilities
Mary Menz, Teller County
Michael Cullinane, Town of Green Mountain Falls
Nancy Trosper, Black Forest Together
Oscar Martinez, United States Forest Service
Pete Galusky, Pikes Peak Area Council of Governments
Pete Vujcich, El Paso County
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Sarah Hartley, City of Manitou Springs

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Tim Mitros, City of Colorado Springs
Waverly Klaw, Colorado Department of Local Affairs

7.1.3 Project Team

Engineering and planning consultation was provided by Matrix Design Group, Inc. and its team that included planning expertise provided by THK Associates, Inc., geomorphology expertise provided by Wildland Hydrology Inc. and Blue Mountain Consultants, LLC, and environmental expertise provided by Smith Environmental and Engineering.

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7.2 Guiding Principles

Watershed management, as it relates to the natural environment and human activity and stormwater runoff, has been identified as a key component of prior planning efforts, including City and County Comprehensive Plans, which identify land use patterns, local ordinances and state legislation. The guiding principles that help to direct stormwater management were codified in the City of Colorado Springs Drainage Criteria Manual (2013). This document is a compilation of guidance found in various stormwater management documents currently being employed around the county, especially in the Front Range, and of the extensive years of experience of the project team that assembled the document. It provides a solid fountain on which to develop and implement management plans for the watershed. However, our understanding of how best to fulfill the ideals expressed in these principals continues to evolve. The development of the Restoration Plan was conceived with a commitment to these guiding principles, but also with an ongoing evaluation of "what works".

These principles were consulted and incorporated into the planning process for the watershed to inform the process and the decisions represented in the proposed plan. These principles are restated below:

1. **Drainage is a regional phenomenon that does not respect the boundaries between governmental jurisdictions or between properties.** Systems that are planned and designed without considering regional implications may be ineffective and costly. Therefore, it is necessary to formulate programs that include public, private and multi-jurisdictional involvement. The governmental agencies involved must provide coordination, consistent standards, master planning, and possibly, joint-funding for key projects to achieve optimum results.

2. **The drainage system is a subsystem of the total urban infrastructure system.** Developing a drainage system independent of considering how it relates to other infrastructure systems limits the potential for compatible integration and increases the probability of conflicts between the functions of different types of infrastructure. Drainage system planning and design must be compatible with local and regional comprehensive plans and must be coordinated with planning and designs for land uses, open space, utilities, wildlife, recreation, transportation corridors and other infrastructure.

3. **Development activity may greatly alter the amount and character of runoff resulting in significant impacts to man-made or natural systems.** Land development activities and supporting infrastructure (buildings, roads, schools, parking, etc.) have the potential to introduce significant changes to hydrology and water quality, including increased peak flow rates, runoff volumes and pollutant loadings that may cause negative impacts such as flooding, water quality degradation, erosion and sedimentation. These changes have the potential to damage man-made improvements as well as natural systems. Increased flow rates and runoff volumes typically result from increased runoff from impervious areas. Water quality degradation may result from the mixing of runoff with pollutants associated with human activity, from increased sediment loads and/or from hydromodification effects of increased runoff on streams. Generally, the effects of development are most pronounced for runoff from the more frequent storm events, including those that may not have produced runoff prior to development. The increased frequency and volume of runoff from these events may significantly alter the hydrologic conditions in a watershed. Implementation of water quality features, channel stabilization measures and flood control detention are typically necessary to mitigate the adverse hydrologic and water quality effects of urbanization.

4. **Every urban area has a minor and a major drainage system, whether or not they are actually planned and designed**. The minor drainage system is designed to provide public convenience and to accommodate low to moderate, frequently occurring flows. The major system carries more water less frequently and operates when runoff exceeds the capacity of the minor system. To provide for orderly urban growth, reduce costs to future generations, and limit the loss of life, property damage and environmental impacts, both systems must be properly planned, designed and constructed.

5. **Handling runoff properly is largely a space allocation problem.** The volume of water present at a given point in time in an urban region cannot be compressed or diminished. Natural processes possess a prescriptive easement for intermittent occupancy by runoff. Encroachments into this easement may adversely affect adjacent properties and natural systems during inevitable periods of natural easement occupancy. If adequate space is not provided, stormwater runoff may conflict with other land uses,

increasing the potential for damages, environmental impacts and disruption of the functioning of other urban systems.

6. **The diversion of storm runoff from one watershed or basin to another may introduce significant capacity and legal problems.** Drainage problems should not be transferred from one watershed or basin to another. Diversions should be avoided unless specific and prudent reasons justify and dictate such a transfer, and downstream damages are sufficiently mitigated.

7. **Resources to implement drainage plans and improvements are limited. Drainage systems should be a multi-objective and multi-means effort.** The many competing demands placed upon space and resources require a management strategy that meets multiple objectives, including the preservation of ecological systems, water quality enhancement, groundwater recharge, recreation, wetland preservation, enhancement and creation, protection of landmarks/amenities, control of erosion and sediment deposition, and creation of open spaces.

8. **Natural systems possess a number of beneficial features that should be preserved and incorporated into the design of the drainage system.** Good designs incorporate the effectiveness of the natural systems rather than negate, replace or ignore them. Existing features such as natural drainageways, depressions, wetlands, floodplains, permeable soils, habitat, and vegetation provide for infiltration, help control the volume and rate of runoff, extend the travel time, prevent erosion, filter sediments and other pollutants, and recycle nutrients and support the ecology.

9. **Natural drainage systems respond to and are dependent upon the full range of hydrologic conditions and sources of water, including snowmelt, groundwater and the full range of rainfall events.** To be effective, the planning and design of drainage systems must address all of these potential sources of water and the full range of potential rates of flow and volumes and how they may be altered by development activity. By "mimicking" pre-development runoff as a result of implementing development techniques and/or runoff control measures downstream impacts can be reduced. Mimicking pre-development runoff is achieved by approximating the rate, volume and timing of storm-caused runoff into the receiving system.

10. **The drainage system must be designed, beginning with the outlet or point of outflow from the project, giving full consideration to potential impacts and the effects of off-site flows entering the system.** The design of the drainage management system shall take into account runoff from upstream sites and shall evaluate the downstream conveyance system to ensure that it has sufficient capacity to accept design discharges without adverse backwater or downstream impacts such as flooding, stream bank erosion, channel degradation, and sediment deposition. An assessment of potential downstream impacts should be based on quantifiable measures that relate to basin conditions immediately after project completion and with regard to future development and its timing.

11. **Poorly maintained systems may not function properly, reducing their effectiveness and reducing the benefits from the economic investment required to construct them.** Operation and maintenance procedures and activities must be developed and documented with the facility design, including the identification and acquisition of rights of access. Clear assignment of maintenance responsibilities must be identified and assigned to an established entity with the resources and understanding required to ensure proper ongoing maintenance.

12. **Floodplains, both regulated and unregulated, are areas of potential hazard due to high rates of runoff.** Modification of floodplains requires large investments in resources, and risks may increase when they are not properly managed. Flooding potential exists throughout the drainage system and is not limited to "regulatory" floodplains. In addition, flooding potential is not limited to regulatory flows (flows used to define regulatory floodplains), and flow estimates may not accurately represent risk. Multiple times each year estimated rainfalls and/or flood flows are normally exceeded somewhere in Colorado or the Fountain Creek watershed. It is not a question of *if* estimated flood flows (regulatory or non-regulatory) will be exceeded, but *when and where* they will be exceeded. The preservation of floodplains serves to reduce flood flows by providing temporary "storage" in the overbank areas. Floodplain preservation also, minimize hazards, preserve habitat and open space, improve water quality, create a more livable environment, and protect the public health, safety, and welfare.

13. **Drainage law places certain obligations on those who cause or oversee modifications to the natural effects of the hydrologic cycle and the conveyance of runoff overland.** It is incumbent on individuals and agencies to safeguard the right of those potentially impacted by modifications to stormwater runoff to reduce the potential for impacts to public health, safety and welfare and to maintain the orderly development of human-made systems.

In summary, these principles identify the need to actively manage the actual and potential impacts to natural systems related to changes in stormwater runoff due to human activity so that we protect and preserve these valuable assets and so that the interest of the public with regard to health safety and welfare are secured.

These guiding principles have also been identified by other efforts that relate to planning for the watershed. These efforts include:

- Fountain Creek Corridor Restoration Master Plan (Matrix/THK, 2011)
- Watershed Management Plan (USACE, 2009)
- Fountain Creek Vision Task Force Strategic Plan (FCVTF, 2009)

With the goal of implementing these principles a number of policies are described in the DCM and have been adopted by the City of Colorado Springs. The most relevant of these policies are summarized as follows:

- Planning and Design will be: early, comprehensive, multi-purpose, developed through master plans and implemented through efficient site design.
- Changes to Runoff will be mitigated through: Best Management Practices (BMPs), "natural" channel design and detention facilities.
- Floodplains will be delineated based on the 100-year peak flood flow and should remain undisturbed and within flood easements.
- Permits will be acquired from Local, State and Federal agencies to address environmental and legal concerns.

7.2.1 Context Statement from Decision Process

The stakeholder coalition worked over a series of three meetings to define the desired future of the Monument Creek Watershed. This future vision was captured in a project "Context Statement" that provided guidance for future strategy development. The following is the "Context Statement" as developed by the stakeholder coalition.

> *The Monument Creek Watershed includes 236.8 square miles of forest and upland grass lands. The mountains meet the plains within the watershed which is why the United Air Force Academy is located at the center of the watershed. The watershed is predominantly north of Colorado Springs and includes the communities of Monument and Palmer Lake. With a diversity of public and private ownerships, the watershed is a major regional tourist and recreation destination as well as home for a large percentage of El Paso and Colorado Springs residents.*
>
> *The watershed is characterized by extremes in temperature and precipitation, large elevation changes, steep gradients and diverse ecosystems rich with plant life and wildlife.*
>
> *The recent summer of 2013 floods, coupled with the 2012 Waldo Canyon fire and the 2013 Black Forest fire have resulted in considerable transport of sediment and debris. The floods altered the creek bed, banks, floodplains and structures and have led to extensive flood damage including property and infrastructure damage, erosion and sedimentation that resulted in a net loss of flood capacity. To identify strategies that will mitigate the effects of fire damage and flood damage in the watershed, a holistic restoration planning effort will provide effective and lasting protection of at risk assets as well as the health, safety and welfare of the public.*

7.2.2 Core Values from Decision Process

In addition to developing the "Context Statement" in the stakeholder coalition meetings, stakeholders identified critical issues and their "Core Values". The issues and "Core Values" included engineering, environmental and physical issues along with social and political issues.

Core Values		Definitions
Safety	-	Freedom from danger, injury or damage
Resiliency	-	Recovering strength, the ability to bounce back into shape
Constructability	-	The ability to build by fitting parts or elements together systematically and efficiently
Environment	-	All the connections, circumstances and influences surrounding and effecting the development of an organism or group of organisms
Community	-	The condition of living with others, a friendly association
Schedule	-	A timed plan for a procedure or project

Once all the issues and "Core Values" were identified, the "Evaluation Criteria" were developed to include all the stakeholder issues and "Core Values". The criteria used for prioritizing stormwater capital projects as part of the 'Intergovernmental Agreement between Pueblo County and the City of Colorado Springs and its Utilities Enterprise' (IGA) were integrated into the critical issues of the decision process to provide consistency between the prioritization criteria used as a component of the IGA and the "Evaluation Criteria" employed by this Restoration Plan. The IGA prioritization criteria are listed below:

- Protect property and public safety
- Repair/replace failing infrastructure
- Improve appearance and/or enhance the community
- Distribute projects within the City
- Enhance sediment/debris capture and control
- Reduce sediment generation/enhance soil stewardship
- Improve water quality
- Provide detention

The "Evaluation Criteria" developed for the Restoration Plan was used to help prioritize the projects. It was important that the "Evaluation Criteria" were developed early in the process to avoid any biases toward a particular alternative, strategy or project. Figure 1 shows a diagram of the Monument Creek Watershed Restoration Master Plan Decision Making Process.

The Restoration Plan was rooted in the idea that ecosystem health, along and within Monument Creek and its tributaries, is dependent on the following physical characteristics of the Creek including:

- Water quality
- Water quantity
- A level of natural stability

The Creek and its tributaries are constantly seeking a balance of these characteristics. The concepts proposed in this Restoration Plan are intended to help the Monument Creek and its tributaries jump start their natural ability to find this balance. See Section 5.0 of this plan for a discussion of conservation and restoration concepts. As this balance is achieved, flora and fauna will thrive. The wellness of these ecosystems in critical, according to the U.S.G.S. Northern Prairie Wildlife Research Center, wetlands and riparian areas comprise < 1% of the land area in the western United States, yet they support a tremendous diversity and abundance of wildlife. For example, in Arizona and New Mexico at least 80% of all animals use riparian areas at some stage of their lives. In the interior Columbine River basin 64% of nontropical migratory land birds depend on riparian vegetation during the breeding season. This habitat may harbor from 2 to 10 times as many individual birds as does adjacent, non-riparian vegetation. (U.S.G.S., 2006 Birds as Indicators of Riparian Vegetation Conditions in the Western United States). Also, in the Journal of Soil and Water Conservation, it was reported that stream and riparian ecosystem areas compose only 0.5% – 1.0% of the overall western landscape, a disproportionately large percentage (70%-80%) of all desert, shrub, grassland plants and animals depend on them. (A.J. Belsky, A. Matzke, S. Uselman, 1999 Survey of Livestock Influences on Stream and Riparian Ecosystems in the Western United States). Finally, although they represent only a small fraction of the surface area of western area lands, riparian zones are critically important to over 75% of terrestrial species. (E. Channey, W. Elmore, W.S. Platts, 1993 Livestock Grazing on Western Riparian Areas).

Therefore, it was critical that the Monument Creek Watershed Restoration Master Plan provided the direction to accomplish the following objectives:

- Improve health, safety, and quality of life
- Improve water quality
- Improve wildlife habitats
- Improve stream bed and bank stability
- Improve fisheries
- Improve general creek health
- Reduce flooding magnitude and incidents
- Reduce sedimentation
- Improve access and visibility

These objectives are accomplished by first understanding the difference between an unstable and relatively stable Monument Creek. This plan recommends a course of action for making unstable portions of the Creek relatively stable.

The Restoration Plan utilizes the following strategies to address water quality, sedimentation, flooding and stabilization concerns:

1. Slowing down the creek in to reduce its erosion and sediment carrying capacity by:
    a) Increasing the curves (sinuosity) of the creek, effectively lengthening the creek.
    b) Reducing the amount of water in the creek during a flood by diverting water into wetlands and side detention areas.
    c) Protecting the wide natural floodplain from further infringement.
2. Naturally filtering runoff and thus improving water quality in the creek, improving existing wetlands and adding new wetlands.
3. Stabilizing eroding banks along the creek that contribute large quantities of sediment downstream.
4. Narrowing the creek channel in areas where sediment is deposited so that the sediment can be carried out.
5. Adding additional sustainable riparian vegetation to help stabilize the creek.
6. Through development of new stormwater management and land use regulations to reduce peak flows and runoff volumes that result from development within the watershed.

When successfully applied, these strategies improve wildlife habitat, protect productive ecosystems and improve recreational opportunities.

7.2.3 Conservation

Conservation can involve property rights acquisition with the primary intent being to preserve and protect the floodplain and adjacent lands. This can be accomplished through direct property purchases and placing the purchased lands in public ownership to be managed as open space, through the purchase of conservation easements on private property that mandates management as open space or agricultural use, or through land grants.

As a rule, it can be generally stated that the more property that can be managed as an open space conservation area, the healthier the Creek corridor. Conservation areas allow the natural functions of the Creek to continue uninterrupted. Generally, one of the strategies of this Restoration Plan is to manage all the 100 year floodplain as a conservation area, allowing no encroachment. Areas being managed as conservation areas will:

- Preserve floodplain connectivity
- Preserve many existing cultural heritage sites
- Preserve relatively stable, sustainable creek segments
- Maintain pervious land and the natural infiltration process
- Reduce and slow storm runoff
- Improve water quality
- Improve creek stability
- Preserve terrestrial and aquatic wildlife habitat
- Provide a buffer between development and the creek
- Increase recreation and education opportunities (provide a community and regional amenity)

7.2.4 Riparian Buffer Zones

Riparian buffer zones, when maintained, reduce land use encroachment and fill or structures being located too close to the creek. Providing riparian buffers are often an option when easement or acquisition of lands for conservation is not possible. Generally, the riparian buffer zones provide most of the same positive attributes as land conservation but since they are narrower, the full benefit is reduced proportionally to width reduction. Areas being managed as riparian buffer zones will:

- Maintain pervious land and the natural filtration processes
- Reduce and slow storm runoff
- Improve water quality
- Improve creek stability
- Preserve terrestrial and aquatic wildlife habitat
- Provide a buffer between development and the creek
- Increase recreation and education opportunities (provide a community and regional amenity)

7.2.5 Floodplain

Maximizing floodplain increases flood storage, reduces flood depth and the shear stress that damages the creek corridor. This can be achieved many different ways including; excavating side detention areas, reconnecting to disconnected historical floodplain remnants, avoiding channelization of the creek and avoiding land use and infrastructure encroachment. Maximizing the floodplain wherever possible will:

- Improve connectivity of the creek to its floodplain in urban and suburban settings to reduce flood depth and velocity
- Increase flood storage and slow the flood wave

- Increase vegetation and wildlife habitat
- Increase floodplain capacity using a practical combination of construction techniques

7.2.6 Colorado Water Conservation Board Design Guidelines for Plan Development

The Design Guidelines for Project Development published by the Colorado Water Conservation Board listed design guidelines for a preferred alternative. These guidelines are as follows:

- Project Goals Statement
  - Clear definition of project goals and objectives
- Watershed and Site Assessment
  - Review of existing watershed processes and conditions
  - Photo documentation
  - Basemap development including: property boundaries, infrastructure and utility information, topographic information, etc. , as applicable
- Hydrology and Hydraulics
  - Watershed hydrology – evaluated for pertinent stage / duration flows as necessitated by the design goals.
  - Hydraulic model development – water surface elevation, stream velocity, shear stress and other parameter for each stage and discharge through the reach. Developed for existing conditions and , as applicable, for proposed conditions using non-proprietary software for future use.
- Geomorphology
  - Identification of existing and proposed stream style or type, bedform, planform, and channel evolution stage
  - Discussion of geomorphological processes and cause of instability

7.3 Public Involvement

In an effort to provide the most comprehensive plan possible, the public and stakeholder group were involved throughout the plan development process. Their input complemented the technical evaluation to create a common sense plan that addressed a wide variety of issues throughout the watershed. Figure 76 illustrates how public outreach was continued throughout all stages of the plan development.

7.3.1 Stakeholder

The stakeholder group met on a monthly basis throughout the development of the Restoration Plan to review progress, maintain program goals and objectives, and address topics of concern. Continuous involvement of the stakeholder group ensured that the Restoration Plan not only addresses the key issues in the watershed but is actionable. The stakeholder group will continue to meet to implement and update the plan, as necessitated by changing conditions within the watershed, as discussed earlier in this report.

7.3.2 Community

The public outreach process involved a number of public meetings held throughout the planning process. Meeting locations were strategically chosen to involve communities from multiple geographies throughout the watershed. The public outreach process not only educated and informed community members of the issues present in the watershed, but gave them the opportunity to provide input and identify specific locations and issues of concerns within the planning area. Their questions and comments were recorded and addressed in the Plan.

7.4 Technical Analysis Methods and Results

Projects throughout the watershed were identified by public and stakeholder input, field reconnaissance, and technical evaluation. The methods, procedures, and results of the environmental, geomorphological, hydrologic, and hydraulic analyses done during the development of this Plan are discussed in detail in the following sections.

7.4.1 Data Collection

Compiling and processing the most recent data and information within the watershed was essential in creating an actionable Restoration Plan. Data from previous studies and up-to-date information provided by local entities were used concurrently in the plan development process to identify projects throughout the Monument Creek Watershed and aide in the decision making process. Existing watershed and sub-watershed extents, stream centerlines, and other basin characteristics were used as a basis for further technical evaluation. Updated aerial, land-use, burn severity and topographic information helped build the foundation of the hydrologic and hydraulics models and subsequent analyses. Field reconnaissance provided channel information necessary for the geomorphic assessment of the watershed. Photographs and dimensions of new or recently improved crossings were also surveyed in the field. Information regarding the habitat of terrestrial and aquatic species, including endangered species, throughout the watershed was used in developing the environmental context behind the Restoration Plan.

7.4.2 Existing Conditions

The Monument Creek Watershed consists of a mosaic of forest, shrubland, and upland grass lands. Elevation changes, steep gradients and diverse ecosystems present natural contrasts throughout the watershed landscape. A variety of land uses, ranging from the Pike National Forest to the dense urban areas of Colorado Springs, contribute to the assortment of features found within the 236.8 square mile watershed. Extremes in temperature and precipitation are also characteristic of the Monument Creek Watershed. These conditions culminate into a diverse set of hydrologic and hydraulic conditions, requiring an equally diverse set of management policies and solutions to holistically restore and preserve the watershed. Environmental, geomorphological, hydrologic, and hydraulic evaluations were all completed during the development of this Restoration Plan.

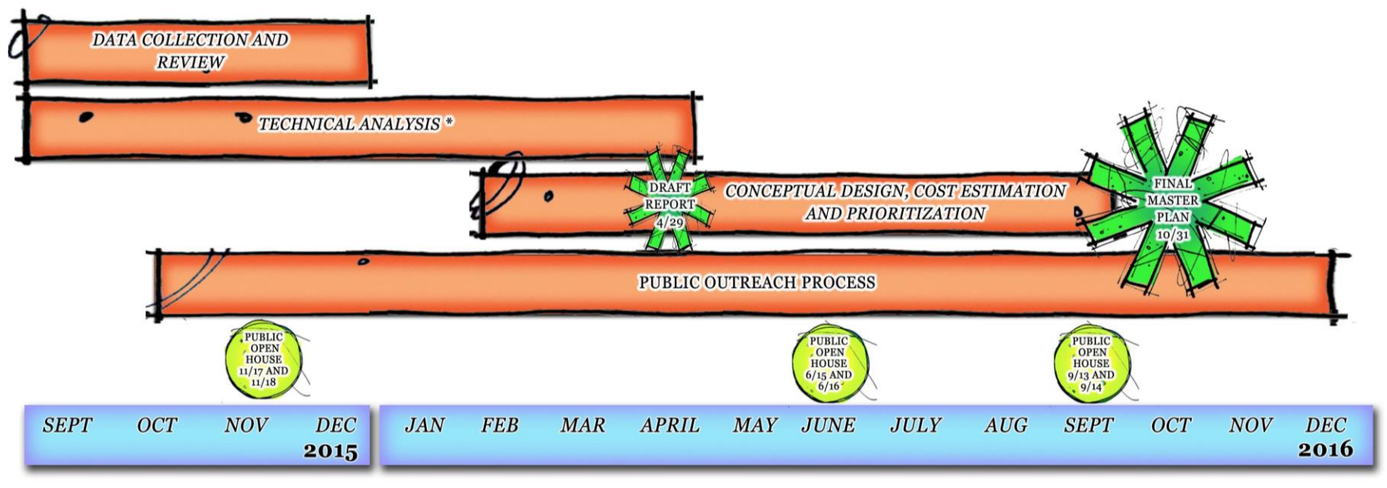


Figure 76. Monument Creek Organizational timeline and Public Process

7.4.3 Environmental Baseline and Water Quality

The US Fish and Wildlife Service (USFWS) has designated Critical Habitat for two Threatened and Endangered species protected under the Endangered Species Act (ESA): the Preble's meadow jumping mouse (PMJM) and the Mexican Spotted Owl (Strix occidentalis lucida). Projects occurring in Critical Habitat must consider the potential to adversely modify its habitat. However, even if an area is not designated as Critical Habitat, it does not mean habitat is absent. For example, all riparian habitat should be evaluated for PMJM, and all forested or cliff areas should be evaluated for the Mexican Spotted Owl. The exception to this guideline occurs in the south part of the main stem of Monument Creek, which has been block-cleared for the PMJM, meaning that projects do not need to consider impacts to the mouse in those areas. Figure 77 illustrates the limits of these critical habitat areas.

Big game winter ranges, production areas, and concentration areas are important to maintain, because the health of the following populations depends on the integrity of these areas. Bighorn sheep (Ovis canadensis) and elk (Cervus canadensis) are the most sensitive to changes regarding these areas, and provide significant hunting and wildlife viewing value to the public. Other species, including white-tailed deer (Odocoileus virginianus) and mule deer (Odocoileus hemionus), can be included as well, but their ranges are broader and they are less dependent on seasonal migrations. The extents of the aforementioned ranges are also included in Figure 77.

The Arkansas darter (Etheostoma cragini) is a Candidate for listing under the ESA and is a Colorado State Threatened Species. The main stem of Monument Creek throughout the watershed is considered potential habitat by Colorado Parks and Wildlife (CPW). When planning on the watershed scale, projects should consider impacts to aquatic habitats not only for the darter, but to maintain other stream functions that contribute to ecosystem health.

Barriers to fish movement can have significant impacts on aquatic habitats. Projects that plan to modify, maintain, or add structures to any stream channel, need to ensure that they are appropriate for fish passage. The extents of the Arkansas darter habitat is shown in Figure 78 along with existing fish barriers.

The vegetation at a given location is a function of several factors, including the soil conditions, elevation, annual precipitation, and historical use of the area. The vegetative composition and structure in turn affects the use of the area by wildlife. Figure 79 illustrates the diversity and extents of the vegetative cover throughout the Monument Creek Watershed.

Wetlands and riparian areas, in addition to being protected by the Clean Water Act (CWA), also provide excellent habitat for wildlife, especially in developed areas where riparian corridors provide wildlife with protected movement through a patchwork of landscapes. The USFWS provides wetland data through the National Wetland Inventory (NWI). Although, these data sets are older and digitized from hard copy maps, the wetland polygons in the watershed are valuable when identifying wetland resources and determining

preliminary impacts. In addition to the USFWS data, the Colorado Division of Wildlife (now Colorado Parks and Wildlife) provides data on the extent of the riparian areas within the watershed. Wetland areas, along with Potential Conservation Area (PCAs), mentioned below, are shown on Figure 80.

The Colorado Natural Heritage Program (CNHP) has identified PCAs throughout the state, including eight within the watershed. These areas focus on capturing the ecological processes that are necessary to support the continued existence of a particular element, suite of elements, or other significant features. There is no regulatory or legal protection provided to PCAs. However, if a project is proposed in one of these areas, an investigation should be performed to determine what unique features may occur. CNHP maintains reports on each PCA.

To achieve and maintain water quality throughout the watershed, the Pikes Peak Area Council of Governments (PPACG) developed a Water Quality Management (208) Plan in 2010. The Water Quality Management Plan outlines regulatory water quality standards and provides information regarding water quality issues and concerns in the greater Pikes Peak region. The document also mentions source water assessment and protection. Sourcewater protection is promoted via the priority projects listed in the Restoration Plan.

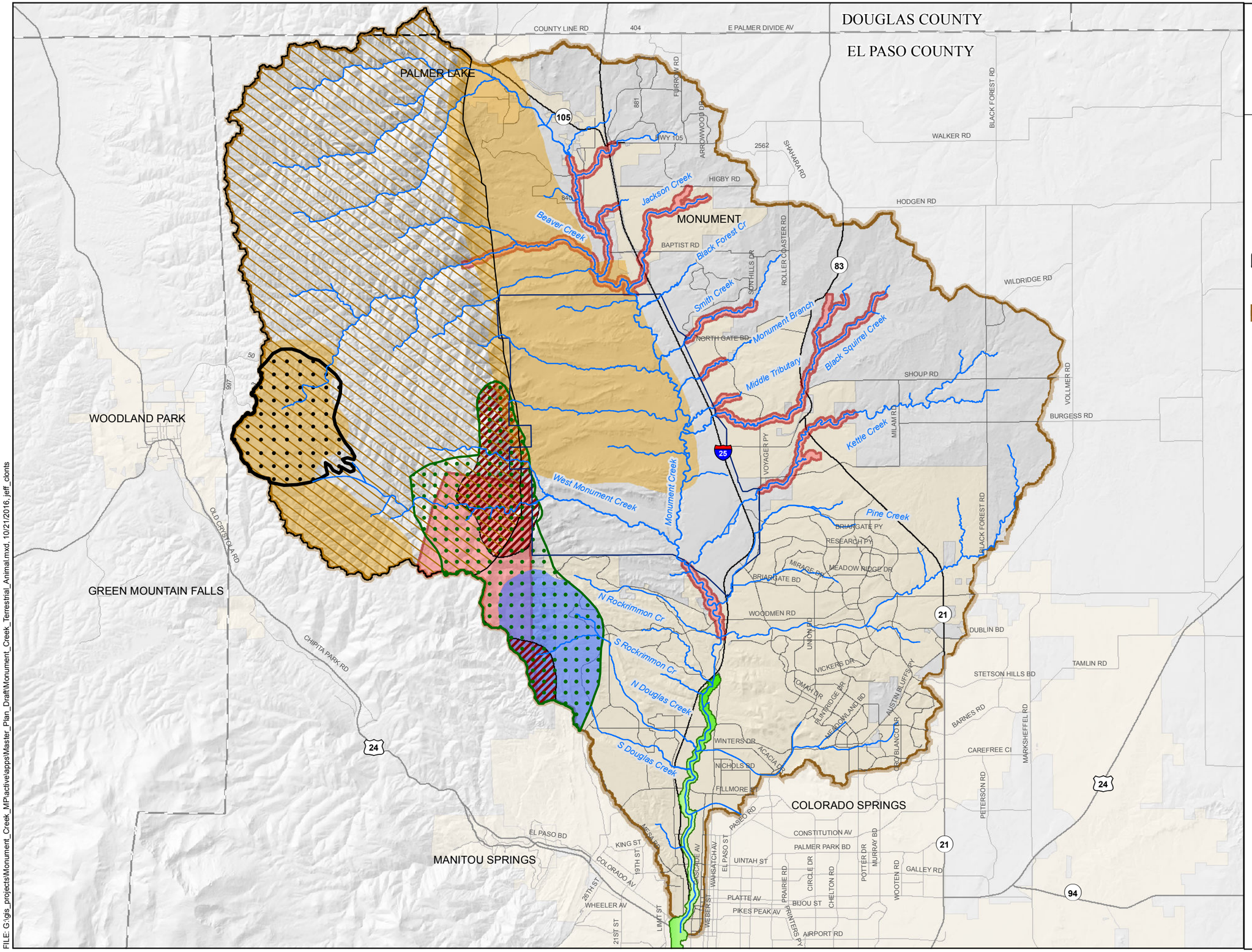
Regional water quality stakeholders, along with the Pikes Peak Area Council of Governments (PPACG), have also formed the Arkansas/Fountain Coalition for Urban Rivers Evaluation (AF CURE), to collaboratively participate in water quality regulatory issues on Monument Creek, Fountain Creek in whole, and parts of the Lower Arkansas River. Currently AF CURE is active on water quality issues including regulatory changes for nutrients criteria, establishment of appropriate temperature criteria throughout the Fountain Creek watershed, and an effort to distinguish between the multiple streams tributaries to Monument Creek and Fountain Creek to allow for more appropriate water quality criteria to be applied to them. AF CURE also participate in the Colorado Monitoring Framework and the Colorado Data Sharing Network, statewide water quality forums that focus on related data gathering and sharing. AFCURE, along with PPACG, is also leading a stakeholder effort to develop a watershed plan to address the E. coli impairments on Monument Creek and Fountain Creek.

Section 303(d) of the Federal Clean Water Act requires each state to submit a list of waters, within their jurisdiction, that do not or may not meet water quality standards to the Environmental Protection Agency (EPA). Included on the 303(d) list of impaired waters was the Monument Creek main stem for Escherichia coli (E. Coli), temperature and provisional aquatic life, West Monument Creek for provisional aquatic life, and all other tributaries outside of the National Forest and USAFA for E. Coli.

A Municipal Separate Storm Sewer System (MS4) Permit has been issued within the Monument Creek Watershed. All projects outlined in the Restoration Plan should be implemented in compliance with the permit. Figure 81, below, further illustrates the extents of water quality issues and hazards.

To plan for potential risks to watershed health and the subsequent impacts to water quality, supply, and operations, Colorado Springs Utilities initiated a watershed management planning effort in 2010. The North Slope Watershed Management Plan, developed as part of their planning effort in 2013, is a useful guidance document for source water protection. Key objectives to source water protection are outlined as part of the plan. They include:

- Protect raw water supplies
- Prevent the release of a contaminant into source waters
- Raise public awareness about water quality and its protection



Terrestrial Animal Habitats

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

Legend

- Critical Habitat
- Bighorn Winter Range
- Bighorn Summer Range
- Bighorn Production Area
- Elk Winter Range
- Elk Summer Range
- Elk Summer Concentration Area
- PMJM Block Clearance Zone
- Monument Ceek Watershed
- USAFA Boundary
- County Boundary
- City
- Highway
- Major Road
- Stream

Matrix DESIGN GROUP

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Figure 77. Monument Creek Watershed Terrestrial Animal Habitats

Aquatic Animal Habitats

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

Legend

- Fish Barriers
- AK Darter Potential Habitat
- Monument Ceek Watershed
- USAFA Boundary
- County Boundary
- City
- Highway
- Major Road
- Stream

DOUGLAS COUNTY

EL PASO COUNTY

PALMER LAKE

WOODLAND PARK

GREEN MOUNTAIN FALLS

MANITOU SPRINGS

MONUMENT

COLORADO SPRINGS

Jackson Creek
Beaver Creek
Black Forest Cr
Smith Creek
Monument Branch
Middle Tributary
Black Squirrel Creek
Kettle Creek
Monument Creek
West Monument Creek
Pine Creek
N Rockrimmon Cr
S Rockrimmon Cr
N Douglas Creek
S Douglas Creek

COUNTY LINE RD
E PALMER DIVIDE AV
HWY 105
HIGBY RD
BAPTIST RD
NORTH GATE RD
WALKER RD
HODGEN RD
WILDRIDGE RD
SHOUP RD
BURGESS RD
OLD CRYSTOLA RD
CHIPITA PARK RD
WOODMEN RD
BRIARGATE BD
MEADOW RIDGE DR
MIRAGE PK
RESEARCH PY
BRIARGATE PY
DUBLIN BD
STETSON HILLS BD
TAMLIN RD
BARNES RD
CAREFREE CI
WINTERS DR
NICHOLS BD
FILLMORE ST
EL PASO BD
CONSTITUTION AV
PALMER PARK BD
UINTAH ST
PLATTE AV
BIJOU ST
PIKES PEAK AV
AIRPORT RD
GALLEY RD
KING ST
WHEELER AV
LIMIT ST
21ST ST
26TH ST
19TH ST
COLORADO AV
PASEO RD
WINTERS DR
VICKERS DR
TOMAH DR
FLINTRIDGE DR
MEADOWLAND BD
AUSTIN BLUFFS PY
CROOBLANCO DR
ACACIA DR

105
83
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21
94

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Vegetation Type

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

Legend

Vegetation Type
- Montane Forest; Montane Forest/Shrubland
- Montane Shrubland
- Montane Grassland
- Grassland
- Riparian; Riparian Woodland
- Open Water
- Agriculture
- Urban/Built-Up

- Monument Ceek Watershed
- USAFA Boundary
- County Boundary
- City
- Highway
- Major Road
- Stream

Colorado Springs Utilities
El Paso County Colorado
Matrix Design Group

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Figure 79. Monument Creek Watershed Vegetation Type

Vegetative Communities

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

Legend

- Wetlands and Associated Riparian Areas

Potential Conservation Areas

- B2: Very High Biodiversity Significance
- B3: High Biodiversity Significance
- B4: Moderate Biodiversity Significance
- B5: General Biodiversity Interest

- Monument Ceek Watershed
- USAFA Boundary
- County Boundary
- City
- Highway
- Major Road
- Stream

Colorado Springs Utilities
It's how we're all connected

El Paso County
Colorado

Matrix Design Group

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Water Quality and Hazardous Materials

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

Legend

Streams Requiring TMDLs

Phase 1 Issues

- CERCLIS
- CORRACT
- Landfill
- Open LUST
- Open LUST, CORRACT
- VCUP

- Monument Ceek Watershed
- USAFA Boundary
- County Boundary
- City
- Highway
- Major Road
- Stream

DOUGLAS COUNTY

EL PASO COUNTY

PALMER LAKE

MONUMENT

WOODLAND PARK

GREEN MOUNTAIN FALLS

MANITOU SPRINGS

COLORADO SPRINGS

Jackson Creek

Beaver Creek

Black Forest Cr

Smith Creek

Monument Branch

Middle Tributary

Black Squirrel Creek

Kettle Creek

Pine Creek

West Monument Creek

Monument Creek

N Rockrimmon Cr

S Rockrimmon Cr

N Douglas Creek

S Douglas Creek

COUNTY LINE RD

E PALMER DIVIDE AV

HWY 105

BAPTIST RD

NORTH GATE BD

WALKER RD

HODGEN RD

WILDRIDGE RD

SHOUP RD

BURGESS RD

MEADOW RIDGE DR

WOODMEN RD

DUBLIN BD

STETSON HILLS BD

TAMLIN RD

BARNES RD

CAREFREE CI

WINTERS DR

NICHOLS

FILLMORE ST

PASEO RD

CONSTITUTION AV

PALMER PARK BD

UINTAH ST

GALLEY RD

PLATTE AV

BIJOU ST

PIKES PEAK AV

AIRPORT RD

EL PASO BD

KING ST

19TH ST

26TH ST

WHEELER AV

21ST ST

OLD CRYSTOLA RD

CHIPITA PARK RD

105

83

25

24

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Figure 81. Monument Creek Watershed Water Quality and Hazardous Materials

7.4.4 Hydrology and Hydraulics

An understanding of the hydrologic and hydraulic processes active in the Monument Creek watershed is essential in identifying areas of risk and possible improvement. Hydrologic and hydraulic computer models provide valuable insight into these complex processes.

The technical hydrologic analysis done for this study is a continuation of the investigations and evaluations developed in the past 12 years to determine the conditions of the watershed. This update builds on the Fountain Creek Watershed Study (FCWS) and the recent sedimentation mitigation project conducted by the United States Geological Survey (USGS) on behalf of the District. Figure 82 illustrates the extents of the hydrologic and hydraulic modeling updated for this study.

Hydrology

The Monument Creek hydrology model was updated to more accurately estimate the amount of anticipated runoff and the time it takes for that runoff to accumulate within the drainage network. The analyses incorporated updated design rainfall depths, improved hydrologic soil information, updated land use information, including burn areas, and results from other recent hydrologic studies within the Monument Creek Watershed.

The detailed hydrologic modeling consisted of the following steps:

1. Delineate and sub-divide the Monument Creek Watershed into topographic subbasins with similar hydrologic characteristics while considering the use of discharge estimates at specific design points. Using the delineation, define the flow paths and relative locations of overland flow, shallow concentrated flow, and channel flow for each subbasin.
2. Update the Watershed's soil parameters to reflect updates to the Hydrologic Soil Group (HSG) designations in the updated City of Colorado Spring's Drainage Criteria Manual.
3. Identify and incorporate areas of land use changes within the Watershed.
4. Estimate pre-fire Curve Number (CN) values for each subbasin with respect to soil types, land use and antecedent runoff condition (ARC).
5. Adjust the pre-fire CN values for burned areas based on Soil Burn Severity (SBS) mapped via Burned Area Reflectance Classification (BARC) process to create the post-fire HEC-HMS model.
6. Identify and implement major detention facilities within the watershed.
7. Identify and implement the most appropriate rainfall event into the hydrologic model.

Matrix acquired high resolution topographic data from El Paso County and used the Geographic Information System (GIS) tools, 3-D Analyst, HEC-GeoHMS and ArcHydro, to define the extents of the model subbasins. These subbasins were strategically delineated such that design flows at specific project locations could be easily referenced.

The existing and future Curve Number coverages were updated from the FCWS to reflect the Waldo Canyon and Black Forest Fire burn scars as well as changes in land use and hydrologic soil group (HSG) designations. These updates were based upon the antecedent runoff conditions (ARC) mandated by the Colorado Springs Drainage Criteria Manual. Figure 83 shows the updated existing coverage.

In addition to the existing and future coverages, Matrix created a Curve Number coverage to represent historical, pre-development flows. The Curve Numbers for this coverage were generated based upon the typical vegetative cover of the underlying soil. Modeling the pre-development conditions not only provided a benchmark for historical stream flows throughout the Watershed but a target release rate for detention facilities. The results of the pre-development conditions model are attached in Appendix C.

The stakeholder group was tasked with providing information on their existing detention facilities within the Watershed for implementation into the hydrologic model. Though it was not feasible to model every detention facility in the Watershed, the information the stakeholders provided allowed for many more of these facilities to be captured within this model as opposed to those created in the FCWS.

Per the revised DCM, Matrix selected the 2-hour design storm to represent 2-year, 5-year, 10-year, 50-year, and 100-year rainfall distributions. This synthetic storm applies 112% of a 1-hour rainfall depth over 2 hours, with 100% of the rainfall depth applied in the first 60 minutes and the remaining 12% applied over the latter hour. To account for orographic effects, the 1-hour rainfall depths were obtained at the centroid of each subbasin from the 2013 National Oceanographic and Atmospheric Administration (NOAA) Rainfall Atlas 14.

The 24-hour, Type II, design storm was also modeled in the development of this plan but deficiencies in the methodology were quickly identified by the project team. Using the latest rainfall data, NOAA Rainfall Atlas 14, in conjunction with the 24-hour Type II distribution produced runoff results throughout the drainage basin that were inconsistent with the gathered stream gage data. As stated in Chapter 4 of the Natural Resource Conservation Service (NRCS) National Engineering Handbook (NEH) September 2015 draft, "To use a Type II or other legacy rainfall distribution with the updated NOAA Atlas 14 data could introduce errors by application of inaccurate rainfall intensities during the storm." Thus, the 2-hour event was used in the hydrologic analyses and development of this plan.

Per the requirements of the DCM, the Initial Abstraction (Ia) ratio was initially set to 0.1 for preliminary model runs. However, upon calibration to observed data collected from a number of stream gages throughout the watershed, this ratio was adjusted to meet historical recorded flows at a range of frequencies, from the 2-year to the 100-year event. A summary of the calibration and the updated hydrology results are reported in Table 46 and Table 47 respectively.

Table 46. Hydrology Gage Analysis Comparison

	2-Year, 2-Hour		*100-Year, 2-Hour*	
	Gage Analysis (cfs)	Existing Calibrated Model Results (cfs)	Gage Analysis (cfs)	Existing Calibrated Model Results (cfs)
Monument Creek at Palmer Lake	60	32	800	1400
Monument Creek below Monument Lake near Monument	60	30	400	610
Monument Creek above North Gate Boulevard at U.S. Air Force Academy	180	460	1700	3500
Monument Creek above Woodmen Road at Colorado Springs	1300	980	5000	9700
Monument Creek at Pikeview	1400	1400	9900	9900
Monument Creek at Bijou Street at Colorado Springs	5600	2700	11000	26000

Table 47. Hydrology Results

Location	Existing Stream Flows (cfs)				
	100-yr	50-yr	10-yr	5-yr	2-yr
Beaver Creek at Bristlecone Reservoir	110	69	66	66	66
Beaver Creek at Hay Creek Road	230	170	76	59	58
Black Forest Tributary at Interstate 25	240	170	52	25	6
Black Squirrel Creek at Highway 83	820	580	210	120	43
Black Squirrel Creek at Voyager Parkway	880	610	210	120	44
Dirty Woman Creek at Lake Woodmoor Drive	570	400	120	52	11
Dirty Woman Creek at Highway 105	680	480	150	69	21
Dry Creek at Pebble Way	1500	1100	530	360	210
Dry Creek at Mark Dabling Boulevard	1700	1300	620	430	250
Jackson Creek at Baptist Road	280	180	33	8	0
Kettle Creek at Milam Road	2600	2000	910	610	340
Kettle Creek at North Powers Boulevard	3100	2300	1100	680	370
Kettle Creek at Interstate 25	3600	2700	1200	740	390
Kettle Creek at Thunderbird Lane	1700	1600	1000	640	330
Middle Tributary at Interstate 25	430	330	160	110	56
Monument Branch at Flying Horse Detention	630	490	240	170	96
Monument Branch at Interstate 25	1200	910	450	320	190
Monument Creek at Red Rock Ranch Drive	1100	710	220	110	28
Monument Creek at Monument Lake	2600	1900	690	370	140
Monument Creek at Mt. Herman Road	610	220	73	62	30
Monument Creek at Arnold Avenue	1300	860	280	150	49
Monument Creek at West Baptist Road	2100	1400	410	210	60
Monument Creek at USAFA Railroad Crossing	3000	2000	570	290	120
Monument Creek at North Gate Boulevard	3200	2100	590	300	120
Monument Creek at South Gate Boulevard	6200	4100	1200	550	290
Monument Creek at Thunderbird Lane	8900	6300	2400	1500	730
Monument Creek at East Woodmen Boulevard	9200	6500	2500	1600	750
Monument Creek at Interstate 25	11000	8100	3700	2500	1400
Monument Creek at Garden of the Gods Road	14000	10000	4400	2900	1600
Monument Creek at Fillmore Street	24000	18000	7600	4900	2500
Monument Creek at West Polk Street	24000	18000	7700	4900	2600
Monument Creek at East Uintah Street	25000	19000	8200	5200	2700
Monument Creek at West Bijou Street	26000	19000	8300	5300	2700
North Rockrimmon at Saddlemountain Road	910	710	360	240	140
North Rockrimmon at Mark Dabling Boulevard	1900	1500	680	450	240
Pine Creek at Golf Course	1300	950	470	330	200
Pine Creek at Briargate Boulevard	1800	1400	670	460	270
Pine Creek at Interstate 25	3500	2700	1300	900	520
Smith Creek at Pleier Drive	580	420	150	84	34
Smith Creek at Interstate 25	990	720	280	160	64
South Rockrimmon at Interstate 25	1100	850	420	290	160
Teachout Creek at Interstate 25	530	390	150	77	26
West Monument Creek at West Monument Creek Road	1800	1300	550	350	190
West Monument Creek at Railroad Crossing	2100	1500	610	380	190

Hydraulics

The hydraulic models developed for the USAFA Floodplain Revisions in 2003 and the USACE FCWS in 2006 were updated using new topography and structures information to model the hydraulic response to the newly developed hydrology. Additionally, Matrix created hydraulic models for the North and South Rockrimmon tributaries for this study. The hydraulic models were developed and updated using the USACE Hydrologic Engineering Center's River Analysis System (HEC-RAS) version 4.1. Figure 85 shows each cross section used in the development of the hydraulic models following the aforementioned Curve Number.

Existing models were updated using the most recent available LiDAR provided by El Paso County. The new North and South Rockrimmon models were also constructed with this information, supplemented by field survey.

Hydraulic model results were used to develop the inundation maps and floodplain maps for the 100-year event. The resulting inundation area are shown on the mapbooks provided in Section 2.0 of this Restoration Plan. It is important to note that the these inundation areas do not represent the shown Flood Insurance Rate Maps (FIRMs) used for flood hazard insurance as directed by the National Flood Insurance Program (NFIP) and administered by FEMA.

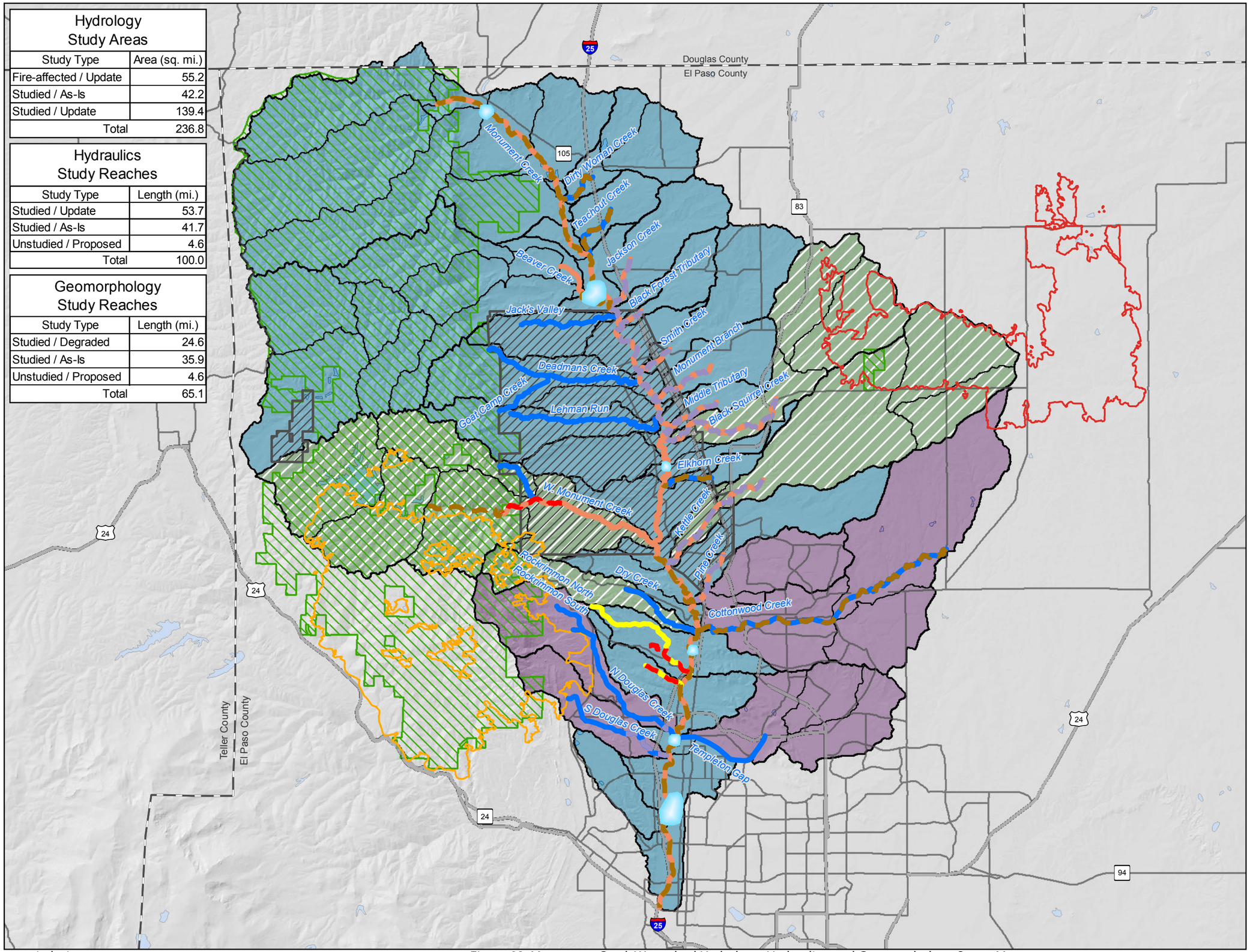
Hydraulic model results were also applied to the Alternatives Analysis to determine the range of effects that could put the channels, banks, and floodplains at risk. The risk to the stability and ecology of these features and engineered structures varies as runoff increases and the appropriate mitigation measure must accommodate a range of conditions including low flow, frequent events and less frequent, flood events.

Ultimately, the hydrologic and hydraulic modeling efforts provide a mechanism by which the watershed can be studied holistically to identify areas that are at risk as well as opportunities for improvement. For more information on the methodology and results of the hydrologic and hydraulic analyses, refer to the technical memorandum found in Appendix C of this report.

Hydrology Study Areas	
Study Type	Area (sq. mi.)
Fire-affected / Update	55.2
Studied / As-Is	42.2
Studied / Update	139.4
Total	236.8

Hydraulics Study Reaches	
Study Type	Length (mi.)
Studied / Update	53.7
Studied / As-Is	41.7
Unstudied / Proposed	4.6
Total	100.0

Geomorphology Study Reaches	
Study Type	Length (mi.)
Studied / Degraded	24.6
Studied / As-Is	35.9
Unstudied / Proposed	4.6
Total	65.1



Monument Creek Watershed Restoration Master Plan

Study Scope Map

Legend

- County Boundary
- Subbasin
- USFS Lands
- USAFA Boundary
- Fire-affected Basin
- Black Forest Burn Perimeter
- Waldo Canyon Burn Perimeter
- USGS Proposed Detention (6)
- Water Body

Basin Type

- Fire-affected / Update
- Studied / As-Is
- Studied / Update

Hydraulics

- Studied / As-Is
- Studied / Update
- Unstudied / Proposed

Geomorphology / Sediment

- Studied / As-Is
- Studied / Degraded; Update
- Unstudied / Proposed

0 1.5 3 Miles

Matrix Design Group

Figure 82. Monument Creek Watershed Hydrology, Hydraulics, and Geomorphology Scope Map

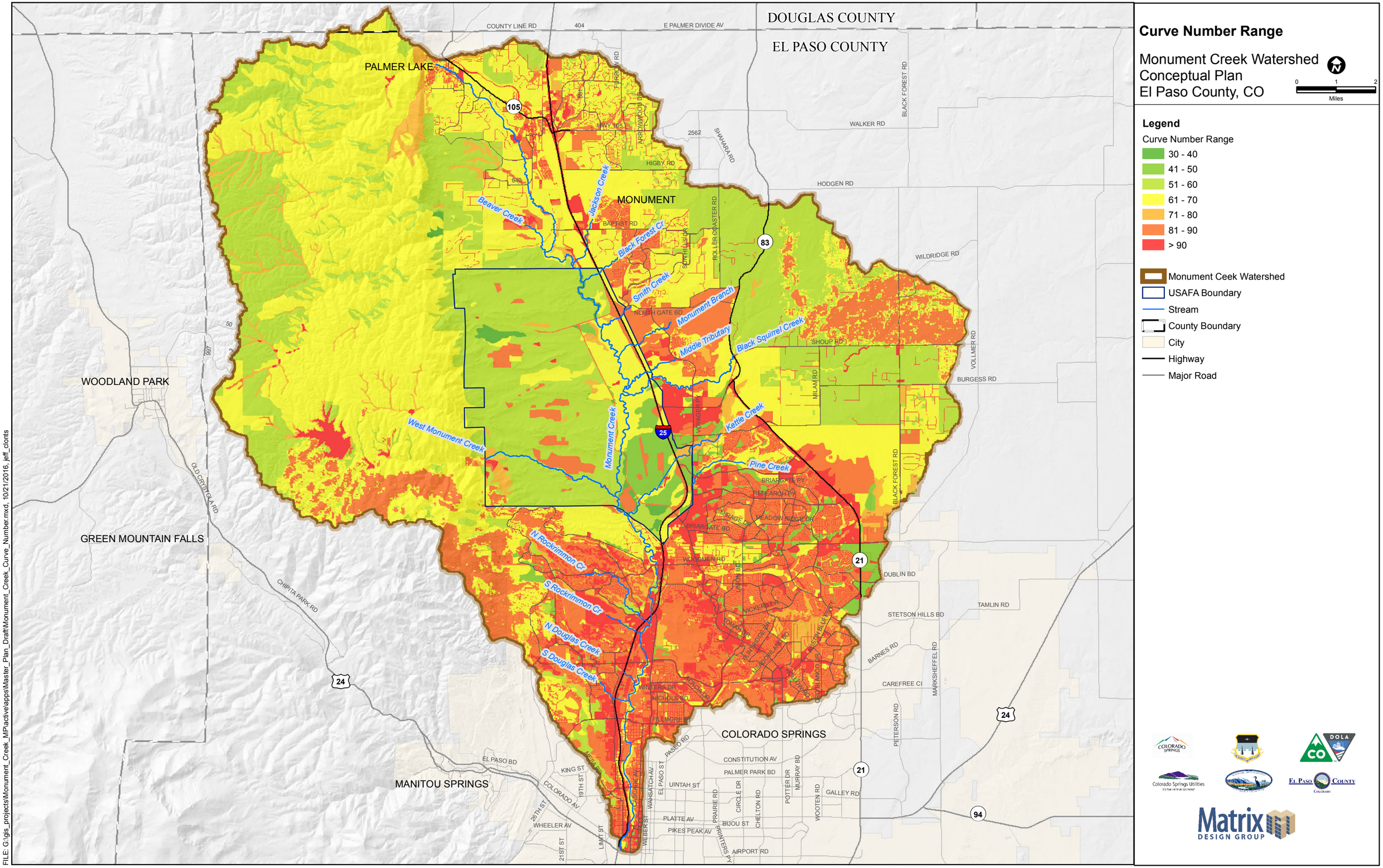


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Figure 83. Monument Creek Watershed Curve Number Range

Existing Hydrology Results

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

Legend

- Subbasins
- Adopt by Reference
- Monument Ceek Watershed
- Fire Perimeter
- USAFA Boundary
- County Boundary
- City
- Stream
- Highway
- Major Road

Subbasin: 2 yr cfs | 100 yr cfs

Junction #

DOUGLAS COUNTY
EL PASO COUNTY
PALMER LAKE
MONUMENT
WOODLAND PARK
GREEN MOUNTAIN FALLS
MANITOU SPRINGS
COLORADO SPRINGS
COUNTY LINE RD
E PALMER DIVIDE AV
WALKER RD
HODGEN RD
BAPTIST RD
NORTH GATE BD
WILDRIDGE RD
BURGESS RD
BLACK FOREST RD
VOLLMER RD
VOYAGER PY
SHAMARA RD
OLD CRYSTOLA RD
CHIPITA PARK RD
BRIARGATE BD
MESA RIDGE PY
MEADOW RIDGE DR
MIRAGE DR
WESTMENT BD
UNION BL
NICKENS DR
DUBLIN BD
STETSON HILLS BD
TAMLIN RD
BARNES RD
CAREFREE CI
MARKSHEFFEL RD
PETERSON RD
EL PASO BD
KING ST
19TH ST
26TH ST
COLORADO AV
WHEELER AV
21ST ST
LIMIT ST
CASCADE AV
WAHSATCH AV
WEBER ST
EL PASO ST
PASEO RD
PRAIRIE RD
PRINTERS PY
CIRCLE DR
CHELTON RD
POTTER DR
MURRAY BD
WOOTEN RD
CONSTITUTION AV
PALMER PARK BD
UINTAH ST
PLATTE AV
PIKES PEAK AV
BIJOU ST
AIRPORT RD
GALLEY RD
FILLMORE ST
NICHOLS BL
WOODMEN RD
Beaver Creek
Jackson Creek
Black Forest Cr
Smith Creek
Monument Branch
Middle Tributary
Black Squirrel Creek
Kettle Creek
Pine Creek
Monument Creek
West Monument Creek
N Rockrimmon Cr
S Rockrimmon Cr
N Douglas Creek
S Douglas Creek
25
24
21
94
2562

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Model Cross Sections

Monument Creek Watershed
Conceptual Plan
El Paso County, CO

0 1 2
Miles

Legend

- Cross Section
- Subbasin
- USAFA Boundary
- Fire Perimeter
- Monument Ceek Watershed
- County Boundary
- City
- Stream
- Highway
- Major Road

DOUGLAS COUNTY

EL PASO COUNTY

PALMER LAKE

MONUMENT

WOODLAND PARK

GREEN MOUNTAIN FALLS

MANITOU SPRINGS

COLORADO SPRINGS

Jackson Creek
Beaver Creek
Black Forest Cr
Smith Creek
Monument Branch
Middle Tributary
Black Squirrel Creek
West Monument Creek
Monument Creek
Kettle Creek
Pine Creek
N Rockrimmon Cr
S Rockrimmon Cr
N Douglas Creek
S Douglas Creek

COUNTY LINE RD
E PALMER DIVIDE AV
WALKER RD
HODGEN RD
BAPTIST RD
NORTH GATE BD
WILDRIDGE RD
BURGESS RD
VOLLMER RD
BLACK FOREST RD
SHAMARA RD
HIGBY RD
HWY 105
BRIARGATE PY
RESEARCH PY
MIRAGE DR
MEADOW RIDGE DR
BRIARGATE BD
WOODMEN RD
DUBLIN BD
TAMLIN RD
STETSON HILLS BD
BARNES RD
CAREFREE CI
MARKSHEFFEL RD
PETERSON RD
VOYAGER PY
UNION BD
VICKERS DR
TEMPLETON GAP RD
ELINRIDGE DR
MEADOWLAND BD
AUSTIN BLUFFS PY
CROWBLANCO DR
HOLLOW RD
WINTERS DR
NICHOLS RD
FILLMORE ST
ACACIA DR
PASEO RD
CONSTITUTION AV
PALMER PARK BD
UINTAH ST
EL PASO ST
WAHSATCH AV
TEJON ST
CIRCLE DR
POTTER DR
MURRAY BD
GALLEY RD
WOOTEN RD
PRAIRIE RD
CHELTON RD
PRINTERS PY
PLATTE AV
BIJOU ST
PIKES PEAK AV
AIRPORT RD
WEBER ST
LIMIT ST
WHEELER AV
COLORADO AV
EL PASO BD
KING ST
19TH ST
21ST ST
28TH ST
OLD CRYSTOLA RD
CHIPITA PARK RD

105
83
25
24
21
94
404
2562
957
50

Colorado Springs Utilities
El Paso County Colorado
DOLA
Matrix Design Group

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Figure 85. Monument Creek Watershed Model Cross Sections

7.4.5 Geomorphology

The purpose of the geomorphic assessment was to classify existing stream and valley types, evaluate the degree and magnitude of in-stream erosion and deposition rates, identify immediate action items and features of concern such as headcuts and infrastructure at risk, map current stream centerlines, and establish restoration potential and priorities for the selected reaches of Monument Creek and 13 major tributaries based on the magnitude and potential of adverse consequences of continued instability and downstream sediment supply.

The Matrix team, including subconsultants Wildland Hydrology, Inc. and Blue Mountain Consultants, LLC performed a detailed bank and channel stability assessment to evaluate the geomorphic condition of the selected reaches of Monument Creek and 13 major tributaries in the areas identified by stakeholders as primary sources of erosion and excess sediment. These reaches are identified in the Scope Map displayed in the previous section.

Field work was completed in November and December of 2015 and included walking the selected reaches of Monument Creek and tributaries. Additionally, the team mapped existing stream types and condition, valley types, and other relevant parameters to determine existing bank erosion rates. The table below lists the reaches and stream lengths as mapped in the field. Mapped miles included only areas where stream banks potentially contribute sediment; stable reaches, wetlands, concrete channels, and road underpasses (e.g. culvert) were not included in the stream length totals.

Table 48. Reaches and Stream Lengths Included in the Geomorphic Assessment

Stream	Mapped Miles
Black Forest Tributary	0.26
Black Squirrel Creek	1.95
Jackson Creek	1.39
Kettle Creek	6.32
Middle Tributary	1.29
Monument Branch	2.06
Monument Creek	5.62
North Douglas	0.44
North Rockrimmon	0.85
Pine Creek	2.70
Smith Creek	0.30
South Douglas	1.18
South Rockrimmon[1]	0
West Monument	1.33
Grand Total	25.69

[1]South Rockrimmon was walked and photographed but the entire reach rated as either Good or Fair Condition. No restoration priorities exist on this stream and the stream channel was not mapped.

The team then developed river restoration priorities using average annual bank erosion rate (tons/ft/year) and objectively stratified reaches from "Low" to "High" rank. Finally, the team proposed stream type conversion and restoration potential for all reaches. Sediment savings as a function of stream type conversion (reduction in sediment supply from bank erosion), was calculated for each reach.

Field reconnaissance was completed to map the project reaches of the Monument Creek and tributaries and classify the existing stream type and condition. The project reaches were classified into five (5) Rosgen stream types shown in Figure 86 on the following page.

Included in the evaluation of stream morphology were conditional criteria that reflect the potential local erosion rates, which were estimated as a function of stream condition, designated as "poor", "poor-fair", "fair", and "good". These classifications were based on conditions regarding stream stability as observed and documented in the field. A reach under" poor" condition will supply significantly more sediment than a similar reach classified as "fair" or "good" condition. The result of the bank condition evaluation for sediment supply reaches is shown in Figure 87 on the following page.

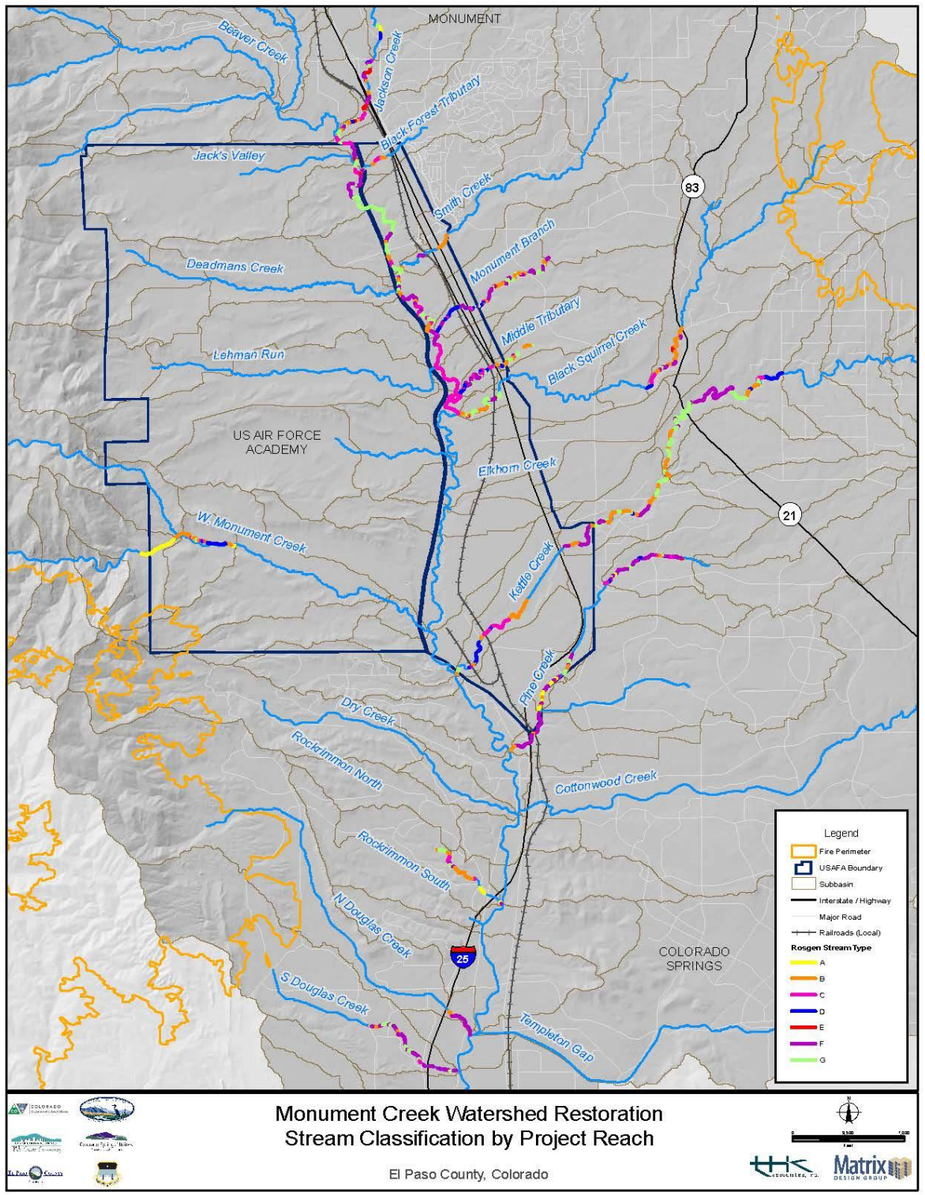

Figure 86. Stream Classification by Project Reach

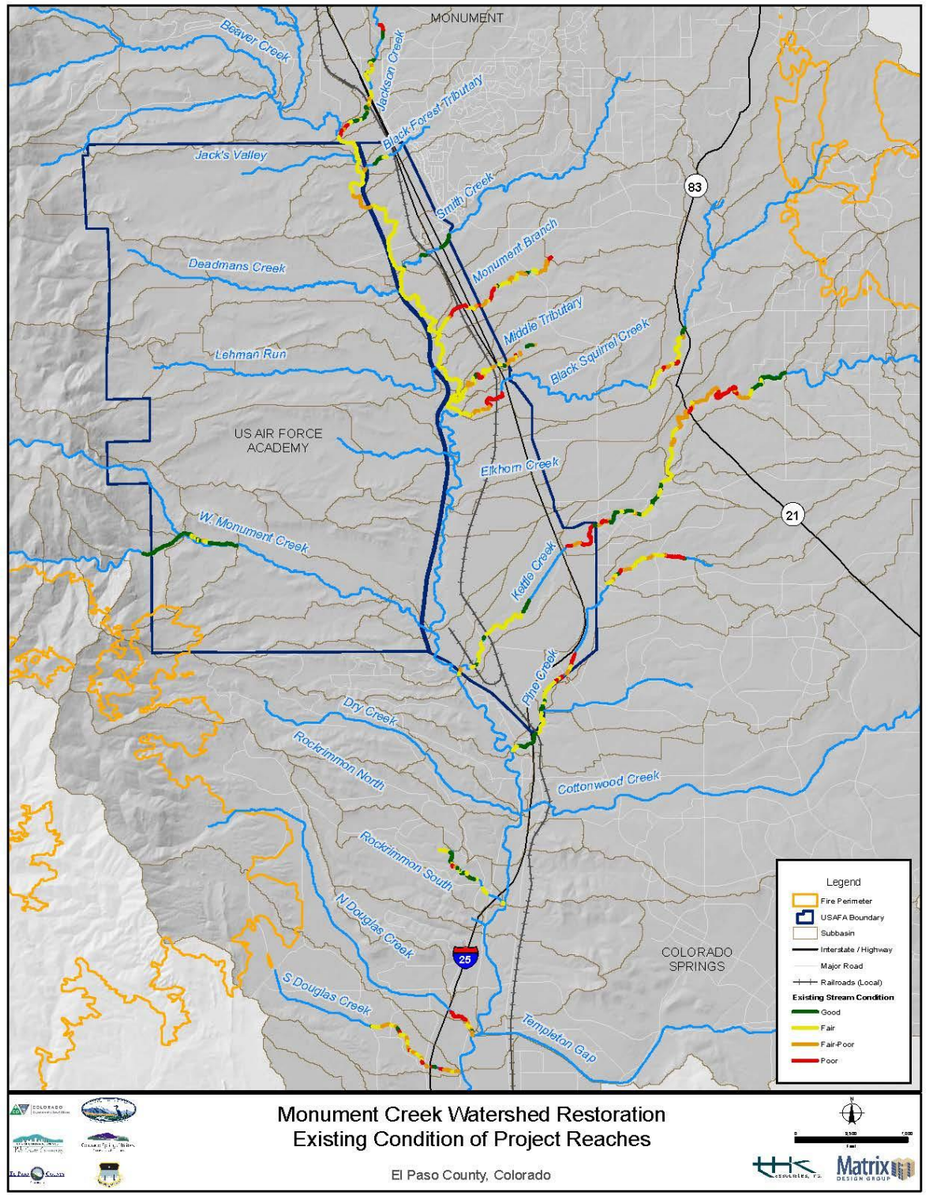

Figure 87. Stream Conditions Found in the Monument Creek Watershed

In addition to assessing the existing condition and associated total erosion rates, our team made recommendations to restore respective reaches in the corridor to stable stream types that would reduce sediment supply and function as stable reaches based on data from reference reaches in the area. Table 49 identifies the amount of erosion reduction that could be reasonably achieved by restoring eroding reaches, and effectively reducing the supply to the Monument Creek mainstem and ultimately downstream to Fountain Creek. The potential for erosion reduction also provides a metric for establishing restoration priority.

Table 49. Proposed Restoration and Potential Erosion Reduction

Stream Type	Parameters	Black Forest Tributary	Black Squirrel Creek	Jackson Creek	Kettle Creek	Middle Tributary	Monument Branch	Monument Creek	North Douglas	North Rockrimmon	Pine Creek	Smith Creek	South Douglas	West Monument	Grand Total
A	Stream Length Mapped (ft)			410						617	1707			2707	**5440**
	Erosion - Current (Tons/yr)			38						4	39			24	**104**
B	Stream Length Mapped (ft)	540	4381	978	9990	1293	1906	2307	361	1989	1376	1221	448	2325	**29116**
	Erosion - Current (Tons/yr)	6.3	165.6	56.4	228.5	47.0	87.2	122.2	82.7	37.3	54.7	2.7	23.8	25.8	**940**
C	Stream Length Mapped (ft)	576	894	1463	2484	1148	494	11315		586	504		138	280	**19882**
	Erosion - Current (Tons/yr)	0.2	4.2	7.1	14.8	12.9	15.2	200.8		0.8	64.3		34.0	7.8	**362**
D	Stream Length Mapped (ft)		390	1017	3552	1349	1167				170			1502	**9147**
	Erosion - Current (Tons/yr)		0.0	0.0	19.1	0.0	0.0				0.3			0.2	**20**
Da	Stream Length Mapped (ft)					175	1008				241				**1424**
	Erosion - Current (Tons/yr)					0.0	0.0				2.5				**2**
E	Stream Length Mapped (ft)		268	1160			39	482			80				**2029**
	Erosion - Current (Tons/yr)		3.5	9.2			0.1	9.4			0.2				**23**
F	Stream Length Mapped (ft)	183	1976	1205	8277	1659	4346	6694	1961	423	8984	365	4355		**40428**
	Erosion - Current (Tons/yr)	82.4	1421.7	522.1	8410.0	1373.2	3504.4	647.0	1363.7	116.0	5038.6	9.3	2077.8		**24566**
G	Stream Length Mapped (ft)	88	2393	1086	9051	1201	1913	8869		897	1173		1297	227	**28196**
	Erosion - Current (Tons/yr)	34.1	2266.7	1064.2	4473.8	517.4	759.5	3117.0		404.8	653.5		529.8	69.8	**13891**
Total	**Stream Length Mapped (ft)**	**1388**	**10303**	**7319**	**33354**	**6826**	**10872**	**29667**	**2322**	**4511**	**14235**	**1586**	**6237**	**7042**	**135662**
	Erosion - Current (Tons/yr)	**123**	**3862**	**1697**	**13146**	**1951**	**4366**	**4096**	**1446**	**563**	**5853**	**12**	**2665**	**128**	**39908**
	Erosion Rate - Current (Tons/ft/yr)	**0.09**	**0.37**	**0.23**	**0.39**	**0.29**	**0.40**	**0.14**	**0.62**	**0.12**	**0.41**	**0.01**	**0.43**	**0.02**	**0.29**
	Erosion - Post Construction (Tons/yr)	**0.8**	**16.4**	**9.1**	**64.7**	**9.7**	**17.2**	**41.6**	**3.8**	**12.8**	**55.4**	**2.8**	**10.5**	**32.8**	**278**

For more information on the methodology and results of the geomorphic analyses, refer to the technical memo found in Appendix C of this report.

7.5 Alternatives Analysis Methods and Results

A holistic and comprehensive approach was used to evaluate potential projects throughout the Monument Creek Watershed. The project team and stakeholders defined nine categories to systematically consider hundreds of projects throughout the Watershed to achieve a multifaceted Restoration Plan. Projects were identified and ranked through the Alternatives Analysis process and then prioritized through technical analyses and stakeholder involvement. The Alternatives Analysis process and the Project Prioritization process are summarized in the following flow chart.

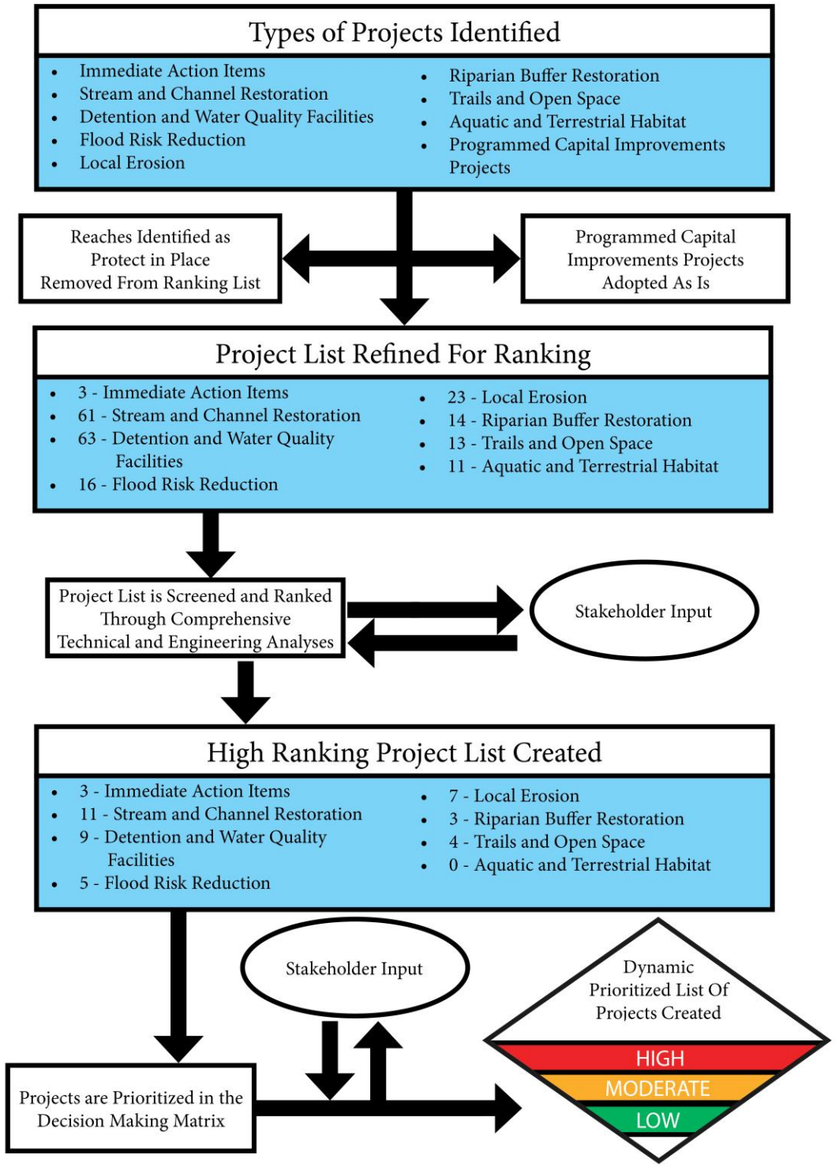

Figure 88. Alternatives Analysis and Project Prioritization Flow Chart

7.5.1 Reach Alternatives Analysis

Reaches throughout the Monument Creek Watershed require various levels of intervention and management to ensure long-term stability and to minimize the risks of flooding and the associated damages. Because Monument Creek and each of its tributaries have unique characteristics and experience distinctive flows, the selection of potential improvement projects required a comprehensive analysis of several variables and parameters present in the streams. The overall methodology used in the planning reach alternatives was consistent throughout the Monument Creek Watershed; however, some of the parameters were adjusted based on the unique geomorphology of each creek. The screening parameters and associated reference materials are provided in Appendix D. The evaluation process is also illustrated in Figure 89.

Evaluation of Reach Alternatives

Alternatives for each of the planning reaches were evaluated using the 2-year, 2-hour and 100-year, 2-hour peak flows, as detailed in the Hydrology Section. The result of this process was a recommended planning alternative to be used when addressing each project outlined in the Final Project List Section. These alternatives are intended to provide a methodology to be used in repairing the identified projects while also creating a stable reach in hopes of minimizing similar potential problem areas in future flooding. The process for arriving at the suggested planning alternatives for each reach using the established screening parameters is shown in Figure 89. A total of six different reach alternatives were considered in the screening process and are described below.

Protect In Place

There are several pristine sections of channel throughout the Monument Creek Watershed that are currently in a stable condition. These reaches typically consist of a small low-flow channel that is connected to a very wide floodplain which allows for the effective conveyance of all flood flows by dissipating erosive energy over the entire floodplain area. These sections also provide water quality benefit due to the amount of surface area available for infiltration. Preserving these reaches does not require a direct channel improvement cost. However, detention improvements may be required depending on the location of the reach and upstream changes in hydrology. Reaches that met the following criteria are included in this category:

- The reach is currently in stable condition
- The reach was not considered to be at risk of potential future hydromodification.

Protect In Place and Monitor

Reaches were observed in the Monument Creek Watershed that did not appear to require intervention, but did not fall under the Protect In Place alternative. These reaches, therefore, require monitoring and may require intervention at a later date. Reaches had to meet the following criteria in order to be included in this category:

- The reach is currently in stable condition.
- The reach was considered to be at risk of future potential hydromodification.

Natural Channel Design

The goal of this reach alternative is to restore the low-flow channel and connect it to the adjacent floodplain. This alternative allows for channel shear stresses to be reduced by allowing flood flows to access the floodplain where the erosive energy is dissipated over the entire floodplain area. This reach alternative can be used where mild longitudinal slopes exist and where floodplain shear stresses are within a range that can be withstood by vegetation. This reach alternative has tremendous water quality benefit due to the amount of surface area available for infiltration and because they channel erosion is limited. The target slope and channel section for this alternative would be maintained through grade control structures. Reaches had to meet the following criteria in order to be included in this category:

- Existing slope of less than or equal to the average slope in channel sections that are currently classified as stable.
- The required available width for Natural Channel Design is achievable. (Available width is measured in the field or through aerial photography. Required width is a dependent on the calculated low flow width, determined by hydraulic and hydrologic variables).
- The average shear stress in channel sections is currently stable. Calculated using the 2-yr flood stage from the Hydrology Section of this report within the existing channel section

Small Drop Structures with Toe Protection

This reach alternative involves hardening the lower portion of the side slopes of the channel cross-section while relying on smaller (< 3 ft) drop structures to maintain a target longitudinal slope. Reaches had to meet the following criteria in order to be included in this category:

- Spacing between drop structure greater than or equal to 100 feet. Spacing between drop structures less than 100 feet in Monument Creek would result in too many drop structures in a reach.

Large Drop Structures with Toe Protection

This reach alternative involves hardening the lower portion of the side slopes of the channel cross-section while relying on larger (6 ft > drop height > 3 ft) drop structures to maintain the stable longitudinal slope. Large drop structures were only used if the spacing required for small drop structures was less than 100 ft.

Fully-Lined Channel

This reach alternative involves lining the channel cross-section with riprap for the full length of the reach. Riprap should be sized to handle the projected shear stress for the 100-year flood event with limited or no grade control structures. Fully lined channels are only required where it is determined that large drop structures are not suitable due to spacing or width constraints. Fully-lined channels were not required anywhere in the Monument Creek Watershed.

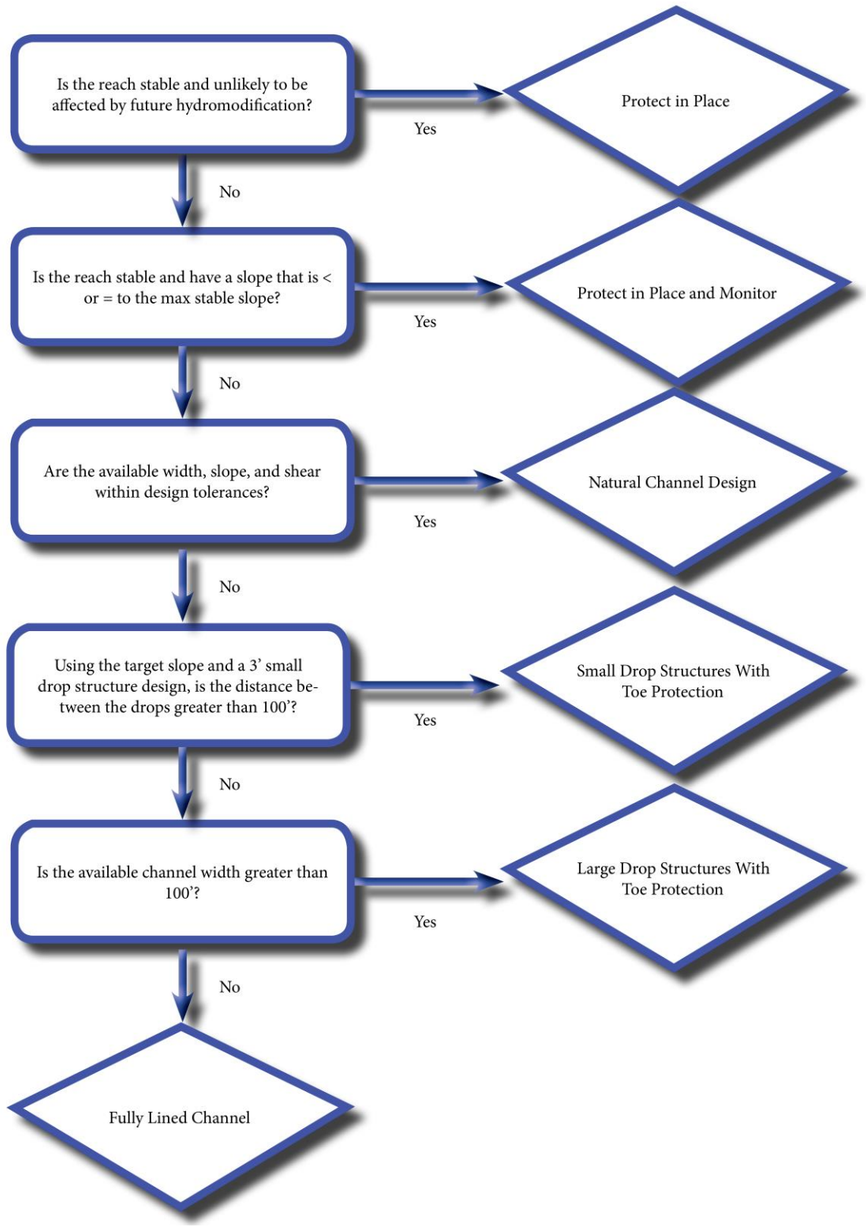

Figure 89. Alternatives Analysis Screening Flow Chart

7.5.2 Flood Risk Reduction

The hydraulic analysis identified areas where crossings were undersized. Additionally, the hydraulics modeling provided floodplain extents and identified areas where infrastructure was inundated in a flood event. These crossings and areas at risk, along with others identified by the stakeholder group, were considered for flood risk reduction improvement projects. Each flood risk reduction alternative was evaluated by the severity of potential flooding and the importance of the crossing being protected.

7.5.3 Detention and Water Quality Alternatives

A number of detention and water quality sites were identified throughout the watershed that to provide downstream water quality and flow reduction benefits. Some of these sites only require improvements to existing detention facilities where others would require the construction of a new facility. As done with other types of projects, these project locations were ranked based upon a number of technical criteria; including approximate existing Hydromodification, potential future Hydromodification, proposed downstream reach improvements, environmental benefits, flood risk reduction benefits, and overall practicality.

Hydrologic model results provided the existing and target flows downstream of each location. Using this information, an approximate facility size was estimated via methodology described in Chapter 6 of the NRCS Technical Release 55 (TR-55) guidance document. The initial approximation of the required detention facility size provided insight into the overall practicality of the project location. Projects that required over 100 acre-feet of storage were deemed less practical in this evaluation due to the magnitude of project costs. High ranking detention and water quality alternatives were refined to meet the aforementioned target release rates using HEC-HMS and the Urban Drainage and Flood Control District's Detention Design spreadsheet software.

7.5.4 Project Lists

The results of the Alternatives Analysis are provided in Section 3.0.

7.6 Prioritization Methods and Results

The projects that received a technical ranking of high in the alternatives evaluation were prioritized under the "Evaluation Criteria" developed as part of the Decision Making Process.. The prioritization process considered not only the technical need for the projects, but also their ability to be funded, the capability to meet multiple objectives of multiple stakeholders, cost effectiveness, ease of access, visibility and the need for, or ease of, right-of-way acquisition. The prioritization process was the key to establishing a realistic implementation plan that identified motivated partners and obtainable funding opportunities. Implementation steps were then developed from the prioritization process.

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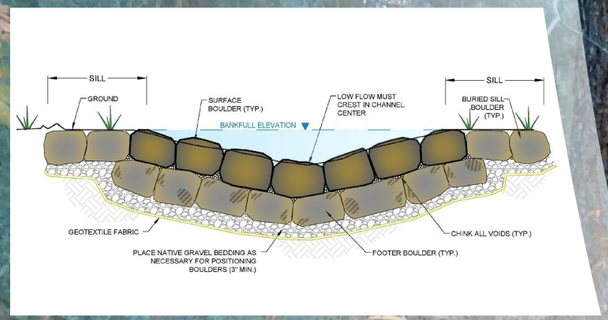

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