Boulder Creek Restoration Master Plan

December 2015

Urban Drainage and Flood Control District
Boulder County, City of Boulder, City of Longmont



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December 11, 2015

Ms. Shea Thomas, P.E.
Urban Drainage and Flood Control District
Senior Project Engineer, Master Planning Program
2480 W. 26th Avenue, Suite 156B
Denver, Colorado 80211-5304

RE: Boulder Creek Restoration Master Plan – Master Plan Report

Dear Ms. Thomas:

ICON Engineering, Inc. is pleased to submit this Restoration Master Plan Report for Boulder Creek. This plan can be used as a guide for future stream restoration activities and drainage improvements along Boulder Creek. This submittal incorporates the comments received on the DRAFT Conceptual Design Report from the project sponsors and stakeholders.

We would like to acknowledge the projects team's assistance in the preparation of this study. This report could not have been prepared without input from yourself, Boulder County, the Cities Boulder and Longmont, and other stakeholders to this project.

We appreciate the opportunity to work with the District on this important study and look forward to working with you on future projects.

Sincerely,
ICON ENGINEERING, Inc.



Craig D. Jacobson, P.E., CFM
Principal, Project Manager



Brian J. LeDoux, P.E., CFM
Project Engineer



Jeremy K. Deischer, EI
Project Engineer

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ES EXECUTIVE SUMMARY

ES.1 Purpose and Objective

The purpose of this master plan is to provide planning guidance to improve resiliency along Boulder Creek from the confluence with Fourmile Creek, in Boulder Canyon, to the confluence with the Saint Vrain Creek in the City of Longmont. This plan provides general guidance for stream and ecological restoration among other multiple objectives including:

- Identification of immediate project needs;
- Provide general guidance for stream restoration;
- Identify ecological needs and benefits;
- Identify floodplain management strategies;
- Identify transportation improvements at Boulder Creek stream crossings;
- Identify concurrent recreation and open space access planning;
- Identify an improvement prioritization plan;
- Develop cost estimates for financial planning.

It is important to note that this master plan provides general guidance for restoration efforts, but it does not re-evaluate the current 100-year floodplain limits regulated by FEMA. Although the implementation of some proposed projects presented in this master plan will also improve the regulatory floodplain, the focus of this master plan is to provide a planning tool for stream and ecological restoration.

Within the City of Boulder, Boulder Creek resembles an urban stream corridor. This master plan does not comprehensively evaluate Boulder Creek through the City limits. Instead, the plan addresses specific areas of concern identified by the city staff and other interested parties. General guidance for Boulder Creek is also presented by the City's Greenway's Master Plan and Open Space and Mauntain Parks' Grassland Ecosystem Management Plan [Reference 4, 64].

ES.2 Planning Process

Planning for this report began in December 2014. The consultant team collected information related to stream characteristics and existing infrastructure, as well as observations related to 2013 flood event. Data was collected from multiple sources, including the Federal Emergency Management Agency (FEMA), the Colorado Water Conservation Board (CWCB), the Urban Drainage and Flood Control District (UDFCD), and the Colorado Department of Transportation (CDOT), and local counties and municipalities.

Once background information was obtained, the consultant team identified focal areas, and prepared geomorphic and riparian field assessments. This information was presented to the project team and interested stakeholders at monthly progress meetings.

Public awareness of the master planning effort was developed through a combination of direct mailings to adjacent property owners and the development of a project website. The project website included interactive features allowing individuals to subscribe to a mailing list or to leave site specific comments through an interactive comment map.

The project team was able to gather input from the public at four separate public meetings and workshops over the course of the project:

- March 10, 2015: Boulder Creek MDP Public Meeting held in the City of Boulder
- March 18, 2015: Boulder Creek MDP Public Meeting held in Weld County
- September 16, 2015: FEMA Boulder Creek PMR Public Workshop
- September 29, 2015: Boulder Creek MDP Public Meeting held in the City of Boulder

The minutes for all project meetings along with all public comments received can be found in APPENDIX B

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Table ES- 1: Project Participants

Name	Representing
Craig D. Jacobson	ICON Engineering, Inc., Project Manager
Brian LeDoux	ICON Engineering, Inc., Project Engineer
Jeremy Deischer	ICON Engineering, Inc., Project Engineer
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Julie McKay	Boulder County Creek Recovery & Restoration Program Manager
Diane Malone	Boulder County IT Project Manager
Kristine Obendorf	Boulder County Transporation Engineer
Varda Blum	Boulder County Floodplain Manager
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Jesse Rounds	Boulder County Parks and Open Space Planner
Claire DeLeo	Boulder County Parks and Open Space Senior Resource Specialist
Katie Knapp	City of Boulder
Annie Noble	City of Boulder
Marianne Giolitto	City of Boulder Open Space and Mountain Parks
Dan Wolford	City of Longmont
Jonathan Akins	University of Colorado
Naren Tayal	FEMA
Dan Marcucci	Colorado Department of Transportation
Scott Holwick	Lyons Gaddis - Attorneys & Counselors
Diana Aungst	Weld County
Steve Stanish	Town of Frederick

ES.3 Project Area Description

The Boulder Creek watershed has a drainage area of approximately 440 square miles, and is located within Boulder and Weld Counties. The majority of the watershed is located within Boulder County. The watershed is bounded to the west by the continental divide, to the north by the Saint Vrain Creek watershed, and to the south by the Clear Creek watershed. This study focuses on the main stem of Boulder Creek from the confluence with Fourmile Creek, approximately 2 miles west of the City of Boulder, to the confluence with Saint Vrain Creek, located within the City of Longmont. The study encumbers over 24 miles of channel length along Boulder Creek.

Boulder Creek is a perennial stream which generally flows from west to northeast. The study area generally lies within the South Central Semi-Arid Prairie ecoregion of the Great Plains; while a small portion of the upstream project reach occurs within the Northwestern Forested Mountain ecoregion of the Southern Rockies. The topographic elevation ranges from approximately 5,700 feet above mean sea level (AMSL) at the confluence with Fourmile Creek to approximately 4,800 feet AMSL at the downstream end of the project area.

West of the City of Boulder, Boulder Creek is confined within the steep canyon terrain of Boulder Canyon. Boulder Canyon generally shares the stream corridor with State Highway 119. East of Boulder Canyon, Boulder Creek enters the City of Boulder, where the stream reflects more of an urban waterway and greenway than a natural stream system. Although, through this reach, Boulder Creek does incorporate some degree of natural landscapes, the encroachment from urban development has occurred over many years. The channel is more confined and numerous bridges, diversions, and stabilization structures exist along its path. East of the city, within Boulder and Weld Counties and the City of Longmont, Boulder Creek resembles a plains stream with a broad floodplain. Although this stretch has fewer bridges than within the urban areas of the City of Boulder, over time, the stream also has experienced significant channel modifications as a result of farming, diversions, sand and gravel ponds, and aggregate mining. As a result, in many areas sinuosity has decreased and the stream lacks natural meanders and bends.

The predominant land cover type within the study area is cultivated cropland, which includes grazing, alfalfa and other crop production. As noted above, aggregate mining of sand and gravel since the mid 1950's has visibly shaped the project area landscape as open water ponds are scattered within the floodplain. Natural vegetation cover exists within the riparian zone and a variety of wetland habitats also exist. However, riparian and wetland habitat only occupies a small percentage of the project area. Other land uses include high and low density development within the City of Boulder, roadways and transportation infrastructure.

The Boulder Creek corridor contains a variety of wildlife, threatened or endangered species, and aquatic habitat. Both the City of Boulder Open Space and Mountain Parks and Boulder County Parks and Open Space maintain land restrictions or seasonal closures throughout the project area.

Finally, the floodplain areas along Boulder Creek are regulated by local floodplain administrators and the Federal Emergency Management Agency (FEMA) over the entirety of the study reach. Regulatory floodplain areas include a variety of flood zones for riverine and shallow flooding locations. Base Flood Elevations (BFEs), and shaded Zone X designating the 0.2%-annual-chance, or 500-year floodplain area has been identified within Boulder County. A regulatory floodway has also been designated along a portion of Boulder Creek from Valmont Road through 61st Street. Boulder County regulates floodway along Boulder Creek although a floodway designation is not shown on the FIRM. Within Weld County the regulatory floodplain consists of an approximate study designation. It should be noted that the City of Boulder is undergoing a floodplain remapping effort for the reach of Boulder Creek and Boulder Slough through the city limits. Although the City is still awaiting the formal adoption of the study on the FEMA FIRM maps, concurrence from FEMA has been given to the technical data, and these changes have therefore been considered with this master plan where applicable.

A map of the study area can be found in Figure ES- 1: Watershed Map.

ES.3.2 Project Area Hydrology

Hydrologic information for the Boulder Creek Watershed has been documented from a variety of sources, initiating with the initial U.S. Army Corps of Engineers (COE) Floodplain Information Report in 1969 [Reference 17, U.S. Army Corps of Engineers], updates by the COE in 1977, more recent Flood Hazard Area Delineation (FHAD) reports [References 18 & 19, Muller Engineering Company] for the City of Boulder and Boulder County, and current FEMA Flood Insurance Studies (FIS) [Reference 20, FEMA]. In general, the current regulatory discharges are based on the 1977 COE findings.

In 2009, the City of Boulder initiated an update to the FEMA flood maps. As part of this study, an evaluation was completed to review and confirm previous hydrologic values [Reference 21, Anderson Consulting Engineers, Inc.]. This evaluation concluded that the regulatory discharges are reasonable.

For the purposes of this master plan, the current FEMA regulatory discharges were maintained for evaluating flood control aspects of each project alternative. These discharges are presented in Table 3-1, below. It should be noted that the regulatory discharges presented were confirmed within the referenced regulatory flood studies at each location.

Table ES- 2: Peak Flow Summary

Location	Drainage Area (sq. mi.)	10-Year (cfs)	25-Year (cfs)	50-Year (cfs)	100-Year (cfs)	500-Year (cfs)
Fourmile Creek Mouth[2]	129	2,050	--[1]	7,960	11,660	21,180
Boulder Creek Canyon Mouth[2]	130	2,050	--[1]	7,960	11,660	21,180
6th Street[3]	130 [5]	2,200	5,830	8,100	12,150	22,100
55th Street[3]	155 [5]	3,600	7,070	9,300	13,050	22,056
75th Street[4]	305	3,350	--[1]	9,600	13,800	28,800
U.S. Highway 287[4]	331	2,800	--[1]	8,600	12,700	27,600
County Line Road[4]	431	2,850	--[1]	9,150	13,750	31,700
County Road 16.5[6]	443	--[1]	--[1]	--[1]	13,750	--[1]
County Road 20.5[7]	446	--[1]	--[1]	--[1]	12,250	--[1]

[1] Data Not Avaliable

[2] Floodplain Information Report, Upper Boulder Creek & Fourmile Creek, Gingery Associates, 1981

[3] Boulder Creek Floodplain Mapping Study, Anderson Consulting Engineers, Inc., 2013

[4] Flood Hazard Area Delineation, Lower Boulder Creek, Muller Engineering Company, Inc. 1983

[5] Flood Hazard Area Delineation, Boulder Creek, Muller Engineering Company, Inc. 1983

[6] Letter of Map Revision 12-08-0198P at 16.5 Road, Weld County

[6] Letter of Map Revision 12-08-1047P at 20.5 Road, Weld County

December 2015

Figure ES-1

Boulder Creek Master Plan

Project Overview

0 1 2 3 4 mi

N

LONGMONT

BOULDER

ERIE

Downstream Limit of Study

Upstream Limit of Study

Legend

- Open Space
- County Boundaries
- Flood Hazard Area
- Boulder Creek
- HUC Basins

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ES.3.3 Project Area Hydraulics

The focus of this study is stream restoration and ecological enhancement along Boulder Creek. The study does not re-evaluate the current 100-year floodplain limits as regulated by FEMA. For those reasons, a comprehensive floodplain model has not been generated for this study. However, hydraulic information was collected from a variety of sources.

ES.4 Alternative Analysis

The majority of the developed alternatives were a part of four main alternative categories:

- Sediment Maintenance: Although restoration activities recommended with this master plan will alleviate several of these routine problem areas over time, ongoing maintenance, particularly with existing trail underpasses is still needed. Maintenance activities generally include removal of sediment on an annual basis.
- Natural Stream / Channel Restoration: In order to allow Boulder Creek to return to a more natural state, channel restoration projects have been proposed along Boulder Creek. These projects consist of providing an appropriate channel width, bank full depth, stream sinuosity, overbank floodplain connection, and ecological / habitat enhancements. Alternatives presented apply the stream restoration principles at locations with immediate restoration needs and a higher likelihood of implementation in the future. These projects are generally focused in areas where property has already been acquired, such as public lands, or locations where changes to private infrastructure could be more easily implemented. However, the geomorphic and ecological principles presented can be applied uniformly for Boulder Creek, as property and funding become available.
- Roadway Crossing Improvements: It is typical for roadway crossings of Boulder Creek, particularly east of the City of Boulder, to experience overtopping while the bridge structure, itself, remains perched over the main channel. In accordance to Boulder and Weld County criteria, new bridges are required to be elevated above the 100-year flood level. Per discussions with Boulder County transportation staff, it was determined that all bridges over Boulder Creek would meet this criteria, at a minimum. Overtopping is allowed elsewhere along the roadway. Boulder County also requested that additional alternatives be evaluated for 61st Street, 75th Street, 95th Street, and East County Line Road, to convey the 100-year event without overtopping in order to provide emergency services during flooding. A summary of major roadway crossings along Boulder Creek is presented in Table 9-2: Bridge Information and Replacement Locations. This table compares the existing bridge elevations and estimated bridge deck thicknesses with FEMA's regulatory 100-year water surface elevations along Boulder Creek to determine if a bridge currently meets criteria. Bridges outside of criteria were selected to be replaced by this master plan. Bridge replacement recommendations can be found in Table 11-3: Recommended Bridge Replacement.
- Stream Stabilization and Ditch Diversions: Numerous water diversion points exist in Boulder Creek. Currently very few of the existing diversions structures also accommodate fish passage or macro-invertebrates common to the region. Improvements are recommended to retro-fit or rebuild diversions to satisfy this multi-objective need. Specifically these systems are proposed to be replaced with sloped drop faces and fish passage measures. Each diversion point would still be required to also maintain adequate depth to satisfy the decreed discharge for water diversion. These conversions will allow the adjacent channel to exist in a more natural state while also providing the long term ability to divert water at the diversion point. Plans to modify any diversion structure may only proceed pursuant to agreement with the owner of the diversion structure. The diversion structures proposed to be modified to allow for aquatic and habitat passage while maintaining the efficiency to divert water to the water rights holder can be found in Table 9-1: Alternative Ditch Diversion Structures. Drop structures, and other existing stabilization measures, which present obstruction to fish passage or macro-invertebrate habitat, have also been proposed to be replaced in a similar manner.

ES.5 Master Plan

The Conceptual Design for this master plan generally follows the alternatives proposed in the recommended plan with exception of three areas noted by sponsors in the Selected Plan Letter.

At the confluence with the St. Vrain Creek, Boulder Creek has breached along the north bank at a different location since the Alternative Analysis was submittal. The project plan would reflect maintaining the current stream alignment with the Boulder Creek / St. Vrain Creek confluence remaining at its existing location. Given the stream segment and breach occurs on City of Longmont Open Space, improvements in this area will be more related to maintenance of the existing stream configuration and ecological enhancements.

Flooding events have become more common at 95th Street. At the request of Boulder County, an interim improvement was developed to help prevent overtopping of the roadway during these more frequent storms, while still maintain the current bridge configurations and relation to downstream private property. This interim plan proposes changes to the roadway and integrates with stream restoration needs upstream of 95th Street on City of Boulder Open Space property. Although the interim condition is presented with the conceptual design, the master plan improvements and cost estimate reflect a more long term solution.

At Cordry Court, improvements to the Boulder Creek Trail and grading between the trail and the Cordry Court residences have been added as a recommended improvement to eliminate the high hazard on the residences. In accordance with City greenway's objectives, property acquisition in this area could be considered as a means to eliminate high flood hazard and improve overall public safety.

ES.5.1 Reach 1 – Confluence with St. Vrain Creek to approximately 3,300 ft. upstream of the City of Longmont

Beginning at the confluence with the Saint Vrain Creek, Reach 1 extends upstream along Boulder Creek for just over a mile of channel length. All of Reach 1 is contained within Weld County and within City of Longmont Open Space towards the downstream end. There are no channel crossings within this reach with the exception to a gravel pit conveyor crossing and several non-formalized low-water crossings for vehicles. This reach includes gravel pit ponds on either side of Boulder Creek that currently hold water. The riparian area within Reach 1 is approximately 700 feet wide near the confluence with Saint Vrain Creek and narrows to approximately 250 feet at the upstream end. Beyond the riparian area the floodplain overbanks generally consist of active and fallow farm lands. Sporadic residential and farm structures are also present within the overbanks along with several petroleum well pads.

During the 2013 flood, the Saint Vrain Creek breached its banks, avulsing through nearby gravel pit ponds. A further breach of the pond bank between the Saint Vrain Creek and Boulder Creek redefined the confluence location of the

two streams, moving it approximately 1,300 feet upstream of the original location. In 2015, following spring runoff, Boulder Creek also breached the same pond bank further west. This again modified the confluence. The streams continue to change over time. The master plan recommendations reflect maintaining the creek in-place and providing additional ecological enhancements along the original stream alignment as seen in Figure 11-9. Gravel pond spillways have also been recommended for ponds adjacent to Boulder Creek.

ES.5.2 Reach 2 – From approximately 3,300 ft. upstream of the City of Longmont to CR 16 ½

Reach 2 is approximately three miles long and includes bridge crossings at Weld County Roads 20½ and 16½. Although Reach 2 is located in Weld County, upstream locations are also co-managed through Boulder County Conservation Easements. Two major diversion structures to Rural Ditch and Idaho Creek are located within this reach. The diversion structure at the confluence of Idaho Creek diverts water from Boulder Creek which is conveyed in Idaho Creek for diversion by: Delehant Ditch, Houck No. 2 Ditch, Carr & Tyler Ditch, Smith & Emmons Ditch, and Godding Ditch. The structure at Idaho Creek diverting water from Boulder Creek for these five ditches is referred to as Idaho Creek Diversion throughout this report.

Disturbances from historic land use practices and channel alterations are widespread. Similarly, floodplain overbanks throughout Reach 2 generally consist of sand and gravel ponds, and aggregate mining operations. The channel within Reach 2 is relatively straight as a result of encroachment on both banks.

Master plan improvements through this reach include: replacement of the bridge crossing at Weld County Roads 20½ and 16½ with 180 foot span bridges compatible with baseline geomorphic conditions; retro-fit of the two ditch diversion structures to accommodate aquatic and habitat passage; modification of a grade control structure for aquatic and habitat passage; and the installation of gravel pond spillways to reduce the chance of failure during flood events. Downstream of CO Rd. 16 ½, general stream restoration is also recommended to repair bank erosion and revitalize Boulder Creek and the surrounding environment as seen in Figure 11-10. Through this reach Boulder Creek is more confined by adjacent land uses; therefore a more confined approach to stream restoration would be anticipated.

ES.5.3 Reach 3 – From CR 16 ½ to approximately 5,800 ft. upstream

Reach 3 is located completely within Weld County with the majority of the property managed through Boulder County Open Space Conservation Easements. This is a short reach with a stream length of only 5,800 ft., spanning a distance of approximately 3,900 ft. The most significant, and ongoing, problem within Reach 3 occurs upstream of Weld County Road 16.5, where a breach in the Bryant Pond diverts flow from Boulder Creek east into the Williams Reservoir No. 1. This has led to overtopping of 16.5 Road well east of the bridge and has led to the continued cut through the south bank of Idaho Creek downstream of the Idaho Creek diversion structure thus bypassing the controlled diversion element at the confluence of Boulder Creek and Idaho Creek.

Master plan improvements in this reach focus on stream restoration and protection of the gravel pit pond from further failure. Stream restoration improvements propose a new alignment of Boulder Creek further west than its current location, reestablishing more historic stream alignment and providing additional buffer between the creek and reservoir as seen in Figure 11-10. Installation of gravel pond spillways will reduce the opportunity for failure of the reservoir embankment.

ES.5.4 Reach 4 – From approximately 5,800 ft. upstream of CR 16 ½ to U.S. 287

Reach 4 is the longest reach with a stream length of 4.5 miles. Reach 4 is located in both Weld County and Boulder County with portions of the land owned or managed by Boulder County Parks and Open Space. The downstream most section is flanked by past aggregate mining activities; the Town of Erie's sanitary and Re-use facility; and areas under active gravel operations. The remaining overbanks include active and fallow farm lands and minimal residential development. There are six stream crossings that span Boulder Creek through Reach 4, some of which have capacity exceeding the 100-year event. Others are more limited in size, dilapidated, or un-usable. Several irrigation diversions also exist within Reach 4. Finally, downstream of 109th Street, Boulder County is pursuing a stream restoration project with the U.S. Army Corps of Engineers. This project extends from 109th Street to Kenosha Road.

Several different improvements are recommended through Reach 4 including: modifications to ditch diversions; improvements at roadway crossings; and stream restoration. At the downstream limits, an existing project is underway to stabilize channel banks adjacent to the Town of Erie's Re-use facility. Downstream of East County Line Road the conceptual design proposes to modify the Godding A. and D. Plumb Ditch to accommodate aquatic and habitat passage, in addition to installing gravel pond spillways at adjacent reservoirs. The East County Line Road Bridge is proposed to be improved to a 220 ft. span bridge, improving the crossing to a 100-year conveyance level consistent with the upstream Mineral Road Bridge. Bridge improvements at East County Line Road should also address stream restoration needs immediately downstream where concrete rubble has been used to stabilize stream banks. No improvements are proposed for the Mineral Road crossing as the existing crossing already meets the 100-year conveyance criteria.

Upstream of Mineral Road, stream restoration is proposed throughout the Wheeler Ranch property. Although a more unimpacted approach restoration can be performed in this area, the final restoration plan should consider constraints defined by the land owner and needs for the confluence with Coal Creek as seen in Figure 11-11. An unimpacted stream corridor for all of Boulder Creek can be found in APPENDIX B.

Upstream of the Wheeler Ranch property, channel banks have eroded and exposed the pipe outlet from the Bailey-Kenosha Pond. Stabilization is proposed along the east bank of Boulder Creek in this area. Upstream of the Bailey-Kenosha Pond, additional stream restoration is recommended downstream to the proposed U.S. Army Corps of Engineers project limits located upstream of Kenosha Road. The existing Howell Ditch Diversion, as well as local grade control, are also proposed to be modified for aquatic and habitat passage. Several gravel pond spillways have been proposed to reduce the chance of failure during flood events. At Kenosha Road and 109th Street, 180 ft. span bridges are proposed to increase the conveyance capacity and accommodate geomorphic channel conditions. The Kenosha Road bridge should be evaluated to determine whether the structure could be removed in the future based on the transportation needs in the area before improving the roadway crossing.

Alternate stream alignments for restoration between U.S. 287 and 109th Street should be considered during final design to best balance the historic stream alignment, with current land uses and transition to the downstream U.S. Army Corps of Engineers project.

ES.5.5 Reach 5 – From U.S. 287 to approximately 4,200 ft. upstream of 95th St.

This reach is located completely within Boulder County and has a stream length of approximately 3 miles. Within Reach 5, Boulder Creek crosses 95th Street, which washed out during the September 2013 flood event and nearly again in 2015. Diversion structures feed the Boulder and Weld County Ditch and the Lower Boulder Ditch. The overbanks generally consist of inactive gravel pit ponds and both active and fallow farm fields. A vast majority of this reach follows Boulder County Parks and Open Space, including the Alexander Dawson Open Space, or conservation easements. Past stabilization efforts have been implemented in this reach, although damage was extensive following recent floods.

Master plan improvements for Reach 5 consist of stream restoration, modifications to ditch diversions, and improving the roadway crossing at 95th Street. No improvements are proposed to the roadway crossing at U.S. 287 as the bridge crossing already exceeds the 100-year conveyance capacity.

Upstream of U.S. 287, stream restoration is proposed through Alexander Dawson Open Space, with aquatic and habitat passage improvements at the Boulder and Weld County Ditch diversion and upstream grade control. A more unimpacted approach to restoration is recommended through this area given the open space designation. An unimpacted stream corridor for all of Boulder Creek can be found in APPENDIX B.

Upstream and downstream of 95th Street, stream restoration has been proposed to reestablish geomorphic channel geometry and improve riparian habitat. Similar to between U.S. 287 and 109th Street, several options for restoration may exist, including changes to both public and private property. Costs for the master plan improvements at this location generally reflect the restoration of Boulder Creek to the north of the current alignment, including: reestablishment of Boulder Creek through the 95th Street Pond (City of Boulder Open Space), new 100-year crossing of 95th Street at the roadway low point; construction of a new channel and easements across the Boulder Valley Farms property; and diversion to the current Lower Boulder Ditch at its current location. The master plan improvements represent a long term solution for the area.

Given the many entities involved and challenges of implementation for the long term solution, Boulder County requested that an interim solution be developed to address more frequent flooding problems at 95th Street. The interim solution will maintain the existing bridge, raise the roadway elevation to prevent frequent overtopping, and provide conveyance from the pond to the bridge through a vegetated spillway. This interim solution is depicted in Figure 11-13.

ES.5.6 Reach 6 – From approximately 4,200 ft. upstream of 95th St. to 75th St.

Reach 6 is approximately 4.5 miles long and is completely contained within Boulder County. The stream corridor itself is located on land managed by the City of Boulder's Open Space and Mountain Parks Division. This reach appears to remain in a natural state with little encroachments on either overbank. Gravel mining operations on the south side of the creek have left several small gravel ponds in the floodplain. Hydraulic drop structures exist both upstream and downstream of 75th Street and the diversion structure for the Leggett Ditch is centrally located.

Master plan improvements for this reach include modifying Leggett Ditch for aquatic and habitat passage and improving the 75th Street crossing to a 220 ft. span bridge. Similar to the Kenosha Road bridge, the roadway crossing at 75th Street should be evaluated at a future time to determine whether the structure can be removed based on the transportation needs in the area.

ES.5.7 Reach 7 – From 75th St. to Valmont Rd.

This reach is approximately 3.5 miles in length and covers areas of both City of Boulder Open Space and Mountain Parks and Boulder County Parks and Open Space properties. Through this reach, the channel is nearly completely flanked by sand and gravel ponds, and mining operations. Most of these operations are no longer active and the excavated ponds remain full of water. The City of Boulder wastewater treatment plant is located just south of the creek, upstream of 75th Street. The wastewater treatment plant is protected from flooding by a ring levee. Private stream crossings, minor arterial (61st Street), bike path, and a major arterial (Valmont Road) crossings, are all located within Reach 7. The confluence of South Boulder Creek and Boulder Creek is located within Reach 7.

Projects within Reach 7 include the installation of gravel pond spillways, protection of the City of Boulder's sanitary sewer trunk line, improved roadway crossings, stream restoration, and modification of existing diversion structures. Seven gravel pit spillways are proposed to protect Walden Ponds near the downstream limit of Reach 7. Several gravel pond spillways are proposed within the Walden Ponds Wildlife Habitat area and along private ponds within Reach 7. Stream stabilization and bank protection is proposed to provide additional protection from erosion and degradation in the vicinity of the City of Boulder's central sanitary interceptor. These locations will be protected using grade control structures and bank stabilization.

The master plan improvements do not include stream restoration downstream of 61st Street, as this reach is currently being addressed by ongoing City of Boulder Open Space and Mountain Parks improvements; however general restoration guidance for this area is provided. Master plan improvement through this reach do, however, include modifying the two irrigation ditch diversion structures to accommodate aquatic and habitat passage.

The existing 61st Street bridge is proposed to be replaced with a 220 ft. span bridge to accommodate the 100-year event. Upstream of 61st Street to Valmont Road, stream restoration has been proposed to reestablish baseline geomorphic conditions, increase channel sinuosity, and improve overall riparian vegetation and habitat. This reach is also currently being evaluated by City of Boulder Open Space and Mountain Parks.

The existing trail crossing of Boulder Creek at Old Valmont Road is currently undersized. During the 2013 flood, the crossing was an obstruction to flow and a significant amount of blockage developed from debris and other items. This bridge is proposed to be replaced with a 180 ft. span pedestrian bridge to better convey flood flow, debris, and accommodate geomorphic channel conditions and habitat.

Finally, improvements through Reach 7 include improving the Butte Mill Ditch Crossing across South Boulder Creek. For this ditch, which originates from Boulder Creek, modifications include siphoning the canal flows underneath South Boulder Creek in a 54" RCP.

ES.5.8 Reach 8 – From Valmont Rd. to 30th St.

This reach is approximately 2.3 miles in length and primarily located within the City of Boulder. The channel characteristics generally include a combination of riparian habitat, roadway, and trail crossings. Wonderland and Goose Creeks enter Boulder Creek within Reach 8, and several small ponds are located adjacent to the stream. For Boulder Creek, Reach 8 reflects the transition to an urban flood channel and for the most part, Boulder Creek has

been locked in place through urbanization. The Burlington Northern and Santa Fe (BNSF) railroad embankment presents a significant obstacle for Boulder Creek and its connectivity with upstream and downstream floodplain areas. The BNSF crossing also has significantly less conveyance capacity than the larger span bridges within Boulder.

Master plan improvements within Reach 8 are comprised of stream restoration, improving the railroad crossing conveyance capacity, access to the Boulder Community Health Hospital, and management of accumulated sediment. Stream restoration is proposed from the downstream limit of Reach 8 at Valmont Road through Foothills Parkway. As described above, the BNSF railroad is a significant obstacle for Boulder Creek. The crossing is proposed to be increased to a 180 ft. span bridge to better convey flood flows and accommodate geomorphic channel conditions.

To ensure safe access to the hospital during major floods, up to the 500-year event, an alternate access point from 48th Street has been recommended. This access point would only serve emergency vehicles and would not provide routine access as seen in Figure 11-14.

Frequent sediment deposition has been observed throughout Reach 8 along Boulder Creek and pedestrian trail crossings. This sediment is believed to be conveyed downstream from into the City from Boulder Canyon where the manmade obstructions cause the sediment to collect around infrastructure. Maintenance level sediment removal projects (up to 200 cubic yards per year) have been incorporated into the master plan at various crossing locations.

ES.5.9 Reach 9 – From 30th St. to City of Boulder Limits

Reach 9 extends through the City of Boulder from 30th St. to upstream of Arapahoe Avenue. This reach also includes the University of Colorado (CU) Campus, between 17th Street and Folsom. Many roadway crossings exist through this reach as well as Boulder Creek trail bridges. The Boulder Creek trail also follows the creek for the entire reach. Many buildings are located within the Boulder Creek floodplain. The City of Boulder has designated additional regulatory zones to manage existing development and redevelopment. Strategic plans, including CU's North of Boulder Creek study have also been developed to identify management strategies to reduce overall flood risk. Similarly, the City of Boulder is currently in the process of planning for redevelopment surrounding the Civic Center area, and is evaluating this plan with respect to flood management.

Master plan improvements within Reach 9 include mitigating flood hazards, improving access near Boulder Creek, modifying diversions, and sediment maintenance. Downstream of 28th Street, along Cordry Court, realignment of the Boulder Creek Trail is proposed to increase conveyance and mitigate the high hazard conditions near residences. In accordance with City greenway's objectives, property acquisition in this area should be considered as a means to eliminate high hazard designation and improve overall public safety. Near the CU campus, two new pedestrian bridges are proposed to improve access to the North of Boulder Creek campus. These bridges, or walkways, will provide emergency access to areas otherwise susceptible to isolation during flood events.

To mitigate flood hazards along the Boulder Slough, an overflow diversion structure is proposed at 14th Street. This diversion system will divert flows in excess of the conveyance capacity of the ditch back into Boulder Creek, reducing flood risk to adjacent properties and can be seen in Figure 11-14.

Changes to the diversion structure at Broadway are also proposed to accommodate aquatic and habitat passage. The conceptual rendering of a typical diversion structure can be seen in Figure 11-17.

Similar to other locations, six areas have been identified for annual sediment removal (up to 200 cubic yards per year) in Reach 9.

No new alternatives have been developed for the Civic Center area in this master plan study; however changes to Boulder Creek at this location should consider implementing recommendations discussed in 9.3 Improvement Alternative Categories.

ES.5.10 Reach 10 – From City of Boulder Limits to Fourmile Creek

Reach 10 reflects the reach of Boulder Canyon between the City of Boulder and the confluence with Fourmile Creek. This reach has much steeper overbank slopes and narrower cross section than the reaches to the east. The reach length is approximately 2 miles and the riparian zone is narrow at less than 100 feet wide. Through the canyon, State Highway 119 parallels the creek, crossing it twice. The Boulder Creek trail also parallels Boulder Creek along the opposite bank of the highway. In general, the stream banks are steep and stable, and have been armored with cobble, rock, and riprap. Boulder County is currently in process of repairing sections of the Boulder Creek trail and extending the path up to Fourmile Creek.

Reach 10 improvements consist of modifying the Farmers' Ditch diversion for aquatic and habitat passage. Restoration of Boulder Creek has also been proposed in areas of disrepair following the 2013 flood event. Restoration locations have been depicted by the project conceptual design renderings as seen in Figure 11-15.

ES.5.11 Master Plan Prioritization

In general, projects presented by this master plan are isolated in nature and can be implemented in any order without affecting adjacent projects upstream and downstream. Stream restoration and ecological enhancement will be most affected when Boulder Creek has been restored in a consistent manner across the entirety of the study length.

Since many of the alternatives in this study are not directly comparable, each recommended alternative has been grouped into a distinguishing category for prioritization. The four categories reflect: stream and Ecological Restoration, Bridge Replacement & Emergency Access; Public Safety; and Stream Maintenance. Within each category, projects were ranked in terms of a high, medium, or low priority. Top priority was given to project which serviced an immediate need; high level of stakeholder interest or collaboration; and presented higher levels of feasibility for implementation. Lower priority was assigned to locations posing less immediate threat to public safety, or integrated more long term planning goals.

Table ES- 3: Prioritization Summary

Reach	ID	Prioritization by Project	Project Type	Jurisdiction	Priority
		HIGH PRIORITY PROJECTS			
2	E	CO Rd. 16.5 - Replace Bridge with 180 ft. Span Bridge	Bridge Replacement	Weld County	High
2	G	Stream Restoration Downstream of CO Rd. 16.5	Stream Restoration	Weld County	High
3	A	Stream Restoration Upstream of CO Rd. 16.5	Stream Restoration	Weld County	High
3	B	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Public Safety	Weld County	High
4	B	East County Line Road - 100-yr Option: Replace Bridge with 220 ft. Span Bridge	Bridge Replacement	Boulder County	High
4	F	Stream Restoration Through Doniphan, Wittemeyer Ponds, Bailey-Kenosha Ponds, and Open Space	Stream Restoration	Boulder County	High
4	G	Stabilize Howell Ditch Diversion System, Modify Diversion for Aquatic and Habitat Passage	Stream Restoration	Boulder County	High
4	H	Kenosha Rd. - Replace Bridge with 180 ft. Span Bridge	Bridge Replacement	Boulder County	High
4	J	109th St. - Replace Bridge with 180 ft. Span Bridge; Restore Adjacent Channel	Bridge Replacement	Boulder County	High
4	K	Stream Restoration Through Wheeler Ranch	Stream Restoration	Boulder County	High
7	E	61st Street - 100-yr Option: Replace Bridge with 220 ft. Span Bridge	Bridge Replacement	Boulder County	High
7	F	Replace Old Valmont Pedestrian Crossing with 180 ft. Span Bridge	Bridge Replacement	Boulder County	High
7	H	Protect Sanitary Interceptor Sewer	Public Safety	Boulder County	High
7	I	Stream Restoration from Valmont Rd to 61st Street	Stream Restoration	City of Boulder	High
8	C	BNSF Railroad - Replace Bridge with 180 ft. Span Bridge	Bridge Replacement	City of Boulder	High
8	F	Sediment Maintenance along Boulder Creek Path	Maintenance	City of Boulder	High
9	C	North of Boulder Creek Access Improvements	Bridge Replacement	City of Boulder	High
9	D	Boulder Slough Mitigation	Public Safety	City of Boulder	High
9	F	Sediment Maintenance along Boulder Creek Path	Maintenance	City of Boulder	High
		MEDIUM PRIORITY PROJECTS			
1	B	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Public Safety	City of Longmont / Weld County	Medium
2	A	CO Rd. 20.5 - Replace Bridge with 180 ft. Span Bridge	Bridge Replacement	Weld County	Medium
2	F	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Public Safety	Town of Frederick / Weld County	Medium
4	C	Protect Gravel Ponds / Town of Erie Reuse Pond / Wittemeyer Ponds Inlet & Outlet During Storm Flows, Typical.	Public Safety	Town of Erie / Weld County / Boulder County	Medium
4	D	Stabilize Bank at Bailey-Kenosha Pond Outlet	Stream Restoration	Boulder County	Medium
5	C	Protect Boulder Valley Ponds Inlet & Outlet During Storm Flows, Typical.	Public Safety	Boulder County	Medium
5	F	Stream Restoration Downstream of 95th Street	Stream Restoration	Boulder County	Medium
5	G	95th St. - 100-yr Option: Replace Bridge with 220 ft. Span Bridge	Bridge Replacement	Boulder County	Medium
5	H	Stream Restoration from Upstream of 95th St. to White Rocks Trail	Stream Restoration	City of Boulder	Medium
6	B	75th Street - 100-yr Option: Replace Bridge with 220 ft. Span Bridge	Bridge Replacement	Boulder County	Medium
7	A	Protect Walden Ponds Inlet & Outlet During Storm Flows, Typical	Public Safety	Boulder County	Medium
7	B	Protect Ponds Inlet & Outlet During Storm Flows, Typical	Public Safety	Boulder County	Medium
7	G	Modify Butte Mill Ditch Crossing on South Boulder Creek	Maintenance	Boulder County	Medium
8	D	Stream Restoration from Foothills Pkwy to BNSF RR	Stream Restoration	City of Boulder	Medium

Reach	ID	Prioritization by Project	Project Type	Jurisdiction	Priority
		LOW PRIORITY PROJECTS			
1	A	Stream Maintenance and Ecological Enhancements City of Longmont Open Space	Stream Restoration	City of Longmont / Weld County	Low
2	B	Replace Existing Grade Control for Aquatic and Habitat Passage	Stream Restoration	Weld County	Low
2	C	Modify Rural Ditch for Aquatic and Habitat Passage	Stream Restoration	Town of Frederick / Weld County	Low
2	D	Modify Idaho Creek Diversion for Aquatic and Habitat Passage	Stream Restoration	Weld County	Low
4	A	Modify Godding A. and D. Plumb Ditch for Aquatic and Habitat Passage	Stream Restoration	Weld County	Low
4	E	DS of Kenosha Rd. - Remove Washed Out Bridge	Maintenance	Boulder County	Low
4	I	Replace Grade Control for Aquatic and Habitat Passage	Stream Restoration	Boulder County	Low
5	A	Stream Restoration at Alexander Dawson Open Space	Stream Restoration	Boulder County	Low
5	B	Modify Boulder and Weld County Ditch for Aquatic and Habitat Passage	Stream Restoration	Boulder County	Low
5	D	Modify Grade Control Structures for Aquatic and Habitat Passage	Stream Restoration	Boulder County	Low
5	E	Modify Lower Boulder Ditch for Aquatic and Habitat Passage	Stream Restoration	Boulder County	Low
6	A	Modify Leggett Ditch for Aquatic and Habitat Passage	Stream Restoration	Boulder County	Low
7	C	Modify Diversion for Aquatic and Habitat Passage	Stream Restoration	Boulder County	Low
7	D	Modify Green Ditch Diversion for Aquatic and Habitat Passage	Stream Restoration	Boulder County	Low
8	A	Stream Restoration from 55th St. to Valmont Drive	Stream Restoration	City of Boulder	Low
8	B	Stream Restoration from BNSF RR to 55th St.	Stream Restoration	City of Boulder	Low
8	E	Hospital Access Improvements for 500-yr Event	Public Safety	City of Boulder	Low
9	A	Cordry Ct, High Hazard & Flood Mitigation	Public Safety	City of Boulder	Low
9	E	Modify Boulder Ditches Diversion for Aquatic and Habitat Passage	Stream Restoration	City of Boulder	Low
10	A	Modify Farmers' Ditch for Aquatic and Habitat Passage	Stream Restoration	Boulder County	Low
10	B	Boulder Canyon Stream Restoration	Stream Restoration	Boulder County	Low

* Although located in Boulder County this project is City of Boulder Open Space and Mountain Park managed land and has classified as City of Boulder jurisdiction

Table ES- 4: Cost Estimate Summary (Reach 1-6)

Reach	ID	Description	Jurisdiction	Reach Length (mi)	Capital	Eng / Admin / Legal	Contingency	Total Capital Cost	50-yr O&M Cost
1	A	Stream Maintenance and Ecological Enhancements City of Longmont Open Space	City of Longmont / Weld County	0.13	$ 39,146	$ 11,744	$ 9,787	$ 60,677	$ 9,800
	B	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	City of Longmont / Weld County	--	$ 261,000	$ 78,300	$ 65,250	$ 404,550	$ 1,085
		Reach 1 Total		**0.83**	**$ 300,146**	**$ 90,044**	**$ 75,037**	**$ 465,227**	**$ 10,885**
2	A	CO Rd. 20.5 - Replace Bridge with 180 ft. Span Bridge	Weld County	--	$ 1,792,200	$ 537,660	$ 448,050	$ 2,777,910	$ 35,420
	B	Replace Existing Grade Control for Aquatic and Habitat Passage	Weld County	--	$ 237,800	$ 71,340	$ 59,450	$ 368,590	$ 4,270
	C	Modify Rural Ditch for Aquatic and Habitat Passage	Town of Frederick / Weld County	--	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	D	Modify Idaho Creek Diversion for Aquatic and Habitat Passage	Weld County	--	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	E	CO Rd. 16.5 - Replace Bridge with 180 ft. Span Bridge	Weld County	--	$ 1,792,200	$ 537,660	$ 448,050	$ 2,777,910	$ 35,420
	F	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Town of Frederick / Weld County	--	$ 5,481,000	$ 1,644,300	$ 1,370,250	$ 8,495,550	$ 22,435
	G	Stream Restoration Downstream of CO Rd. 16.5	Weld County	0.38	$ 1,054,200	$ 316,260	$ 263,550	$ 1,634,010	$ 28,000
		Reach 2 Total		**3.14**	**$ 10,937,400**	**$ 3,281,220**	**$ 2,734,350**	**$ 16,952,970**	**$ 134,085**
3	A	Stream Restoration Upstream of CO Rd. 16.5	Weld County	0.38	$ 1,058,840	$ 317,652	$ 264,710	$ 1,641,202	$ 28,000
	B	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Weld County	--	$ 261,000	$ 78,300	$ 65,250	$ 404,550	$ 1,085
		Reach 3 Total		**1.03**	**$ 1,319,840**	**$ 395,952**	**$ 329,960**	**$ 2,045,752**	**$ 29,085**
4	A	Modify Godding A. and D. Plumb Ditch for Aquatic and Habitat Passage	Weld County	--	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	B	East County Line Road - 100-yr Option: Replace Bridge with 220 ft. Span Bridge	Boulder County	--	$ 3,655,197	$ 1,096,560	$ 913,799	$ 5,665,556	$ 28,560
	C	Protect Gravel Ponds / Town of Erie Reuse Pond / Wittemeyer Ponds Inlet & Outlet During Strom Flows, Typical.	Town of Erie / Weld County / Boulder County	--	$ 3,915,000	$ 1,174,500	$ 978,750	$ 6,068,250	$ 16,030
	D	Stabilize Bank at Bailey-Kenosha Pond Outlet	Boulder County		$ 17,089	$ 5,126	$ 4,272	$ 26,487	$ 3,220
	E	DS of Kenosha Rd. - Remove Washed Out Bridge		--	$ 69,600	$ 20,880	$ 17,400	$ 107,880	$ -
	F	Stream Restoration Through Doniphan, Wittemeyer Ponds, Bailey-Kenosha Ponds, and Open Space			$ 4,477,600	$ 1,343,280	$ 1,119,400	$ 6,940,280	$ 118,999
	G	Stabilize Howell Ditch Diversion System, Modify Diversion for Aquatic and Habitat Passage		--	$ 399,308	$ 119,792	$ 99,827	$ 618,927	$ 7,490
	H	Kenosha Rd. - Replace Bridge with 180 ft. Span Bridge		--	$ 2,296,800	$ 689,040	$ 574,200	$ 3,560,040	$ 28,560
	I	Replace Grade Control for Aquatic and Habitat Passage		--	$ 237,800	$ 71,340	$ 59,450	$ 368,590	$ 4,270
	J	109th St. - Replace Bridge with 180 ft. Span Bridge; Restore Adjacent Channel		--	$ 2,834,752	$ 850,426	$ 708,688	$ 4,393,866	$ 28,420
	K	Stream Restoration Through Wheeler Ranch		0.87	$ 2,424,657	$ 727,398	$ 606,164	$ 3,758,219	$ 64,399
		Reach 4 Total		**4.59**	**$ 20,617,803**	**$ 6,185,342**	**$ 5,154,450**	**$ 31,957,595**	**$ 304,218**
5	A	Stream Restoration at Alexander Dawson Open Space	Boulder County	0.85	$ 2,378,000	$ 713,400	$ 594,500	$ 3,685,900	$ 62,999
	B	Modify Boulder and Weld County Ditch for Aquatic and Habitat Passage		--	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	C	Protect Boulder Valley Ponds Inlet & Outlet During Storm Flows, Typical.		--	$ 1,305,000	$ 391,500	$ 326,250	$ 2,022,750	$ 5,355
	D	Modify Grade Control Structures for Aquatic and Habitat Passage		--	$ 237,800	$ 71,340	$ 59,450	$ 368,590	$ 4,270
	E	Modify Lower Boulder Ditch for Aquatic and Habitat Passage		--	$ 475,600	$ 142,680	$ 118,900	$ 737,180	$ 8,540
	F	Stream Restoration Downstream of 95th Street		0.38	$ 1,054,200	$ 316,260	$ 263,550	$ 1,647,495	$ 28,000
	G	95th St. - 100-yr Option: Replace Bridge with 220 ft. Span Bridge		--	$ 3,778,680	$ 1,133,604	$ 944,670	$ 5,856,954	$ 28,560
	H	Stream Restoration from Upstream of 95th St. to White Rocks Trail	City of Boulder	0.85	$ 2,371,947	$ 711,584	$ 592,987	$ 3,676,518	$ 62,999
		Reach 5 Total		**2.83**	**$ 11,891,227**	**$ 3,567,368**	**$ 2,972,807**	**$ 18,444,887**	**$ 204,993**
6	A	Modify Leggett Ditch for Aquatic and Habitat Passage	Boulder County	--	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	B	75th Street - 100-yr Option: Replace Bridge with 220 ft. Span Bridge		--	$ 3,097,220	$ 929,166	$ 774,305	$ 4,800,691	$ 28,560
		Reach 6 Total		**2.53**	**$ 3,387,220**	**$ 1,016,166**	**$ 846,805**	**$ 5,250,191**	**$ 32,830**

Table ES- 5: Cost Estimate Summary (Reach 7-10)

Reach	ID	Description	Jurisdiction	Reach Length (mi)	Capital	Eng / Admin / Legal	Contingency	Total Capital Cost	50-yr O&M Cost
7	A	Protect Walden Ponds Inlet & Outlet During Storm Flows, Typical	Boulder County	--	$ 1,827,000	$ 548,100	$ 456,750	$ 2,831,850	$ 7,490
	B	Protect Ponds Inlet & Outlet During Storm Flows, Typical		--	$ 1,827,000	$ 548,100	$ 456,750	$ 2,831,850	$ 7,490
	C	Modify Diversion for Aquatic and Habitat Passage		--	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	D	Modify Green Ditch Diversion for Aquatic and Habitat Passage		--	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	E	61st Street - 100-yr Option: Replace Bridge with 220 ft. Span Bridge		--	$ 2,843,416	$ 853,025	$ 710,854	$ 4,407,295	$ 28,420
	F	Replace Old Valmont Pedestrain Crossing with 180 ft. Span Bridge		--	$ 1,117,813	$ 335,344	$ 279,453	$ 1,732,610	$ 28,210
	G	Modify Butte Mill Ditch Crossing on South Boulder Creek		--	$ 235,238	$ 70,572	$ 58,810	$ 364,620	$ 4,200
	H	Protect Sanitary Interceptor Sewer		--	$ 511,010	$ 153,304	$ 127,753	$ 792,067	$ 8,540
	I	Stream Restoration from Valmont Rd to 61st Street	City of Boulder	1.18	$ 1,546,781	$ 464,034	$ 386,695	$ 2,397,510	$ 87,499
		Reach 7 Total		**3.51**	**$ 10,488,258**	**$ 3,146,479**	**$ 2,622,065**	**$ 16,256,802**	**$ 180,389**
8	A	Stream Restoration from 55th St. to Valmont Drive	City of Boulder	0.32	$ 429,200	$ 128,760	$ 107,300	$ 665,260	$ 23,800
	B	Stream Restoration from BNSF RR to 55th St.		0.91	$ 1,194,800	$ 358,440	$ 298,700	$ 1,851,940	$ 67,199
	C	BNSF Railroad - Replace Bridge with 180 ft. Span Bridge		--	$ 2,697,000	$ 809,100	$ 674,250	$ 4,180,350	$ 28,280
	D	Stream Restoration from Foothills Pkwy to BNSF RR		0.49	$ 638,000	$ 191,400	$ 159,500	$ 988,900	$ 36,400
	E	Hospital Access Improvements for 500-yr Event		--	$ 46,932	$ 14,080	$ 11,733	$ 72,745	$ -
	F	Sediment Maintenance along Boulder Creek Path		--	$ -	$ -	$ -	$ -	$ 839,993
		Reach 8 Total		**2.3**	**$ 5,005,932**	**$ 1,501,780**	**$ 1,251,483**	**$ 7,759,195**	**$ 995,672**
9	A	Cordry Ct, High Hazard & Flood Mitigation	City of Boulder	0.06	$ 65,589	$ 19,676	$ 16,397	$ 266,662	$ 13,650
	C	North of Boulder Creek Access Improvements		--	$ 3,496,000	$ 1,048,800	$ 874,000	$ 5,418,800	$ 69,999
	D	Boulder Slough Mitigation		--	$ 486,385	$ 145,916	$ 121,596	$ 753,897	$ 10,815
	E	Modify Boulder Ditches Diversion for Aquatic and Habitat Passage		--	$ 406,000	$ 121,800	$ 101,500	$ 629,300	$ 4,270
	F	Sediment Maintenance along Boulder Creek Path		--	$ -	$ -	$ -	$ -	$ 1,259,989
		Reach 9 Total		**2.87**	**$ 4,453,974**	**$ 1,336,192**	**$ 1,113,493**	**$ 7,068,659**	**$ 1,358,723**
10	A	Modify Farmers' Ditch for Aquatic and Habitat Passage	Boulder County	--	$ 300,000	$ 90,000	$ 75,000	$ 465,000	$ 4,270
	B	Boulder Canyon Stream Restoration		0.91	$ 696,000	$ 208,800	$ 174,000	$ 1,078,800	$ 67,199
		Reach 10 Total		**1.64**	**$ 996,000**	**$ 298,800**	**$ 249,000**	**$ 1,543,800**	**$ 71,469**
			Total Costs	**25.27**	**$ 69,397,800**	**$ 20,819,343**	**$ 17,349,450**	**$ 107,745,078**	**$ 3,322,349**

Boulder Creek Master Plan
Conceptual Design Interactive Map

Open detailed sheets in new window:

Conceptual Design Alternatives	Reach 1 - 3
Stream Restoration Alternatives	Reach 4
Bridge Replacement Alternatives	Reach 5 - 6
Public Safety Alternatives	Reach 7 - 8
Maintenance Alternatives	Reach 9 - 10

City Boundaries - ON or OFF

100-yr Floodplain - ON or OFF

Open Space - ON or OFF

This drawing is for master planning purposes and represents preliminary and conceptual engineering. Alternatives will be considered by local agencies and the Urban Drainage and Flood Control District provided the alternative offers an equivalent intent of the plan, including hydraulic capacity, water quality, stream stability, and natural waterway features. The alternative must comply with all requirements of the local jurisdiction and the Urban Drainage and Flood Control District. In addition, there may be State and Federal requirements that will need to be considered and met. This drawing does not provide a final design and shall not be used for construction purposes.

Many activities that occur in or affect ditches, drainages, creeks, ponds or wetlands require a Section 404 Permit Authorization from the US Army Corps of Engineers. During preliminary design, and prior to final design or starting work, contact the Corps' Denver Regulatory Office at 303-979-4120 for appropriate permit authority to avoid compromising and delaying the completion of the project.

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0 — 1.25 — 2.5 — 5 Miles

Legend

- Sediment Alternatives
- Gravel Pit Spillway
- Walden Pond
- Hydraulic Features
- Reach 1
- Reach 2
- Reach 3
- Reach 4
- Reach 5
- Reach 6
- Reach 7
- Reach 8
- Reach 9
- Reach 10
- High Priority
- Medium Priority
- Low Priority
- County Border
- City Boundaries
- 100-yr Floodplain
- Open Space

LONGMONT

BOULDER

ERIE

Boulder County

Weld County

Upstream Limit of Study

Downstream Limit of Study

Coordinate with Civic Center Plan (by others)

Reach 4- Bank Stabilization at Re-Use Facility (By Others)

Reach 4- Corps of Engineers Restoration Project (By Others)

1.0 INTRODUCTION

1.1 Funding and Authorization

Funding for this master plan effort has been provided by the Urban Drainage and Flood Control District (UDFCD), Boulder County, the City of Boulder, and the City of Longmont in addition to a Colorado Watershed Restoration Grant from the Colorado Water Conservation Board. ICON Engineering, Inc. (ICON) and their project team, including Ecological Resource Company (ERC) and DHM Design (DHM) were chosen by the funding partners complete this study through a competitive selection process. ICON's team includes engineers, GIS specialists, scientists, ecologists, planners, and landscape architects with diverse and extensive backgrounds. ICON's contract with the UDFCD was formalized in Agreement No. 14-09.07 on December 16, 2014 to begin work on this project.

1.2 Background

Between September 9 and September 15, 2013, a large rainfall event resulted in widespread flooding along the Colorado Front Range. Boulder Creek experienced peak flows during this event ranging from 4,956 cubic feet per second (cfs) within the City of Boulder at Broadway, to over 9,000 cfs downstream of US Highway 287 [Reference 1, CH2MHill]. This equated to around a 25-year and 50-year regulatory flood event peak discharge for Boulder Creek, at each location respectively. Within the City of Boulder, damages from the flood within the Boulder Creek drainage basin alone, were estimated to have exceeded $41 million [Reference 2, City of Boulder] and were largely attributed to high groundwater and sewer backups as compared to damages from surface water flooding. Significant damage was also prevalent within City of Boulder open space, unincorporated Boulder County, Weld County and the City of Longmont. Banks overtopped at adjacent open space ponds and former aggregate pit excavations. Roadway embankments, including 95th and 109th Streets, breached. In other locations, stream diversion systems were impaired. Structural damage was more evident in the vicinity of Kenosha Road and 115th Street, where several residential homes experienced flood damage. Finally, the flood left portions of Boulder Creek in a state of disrepair, highlighting the need for this master plan study.

It is important to recognize that the September 2013 flood was not the only significant flooding event on Boulder Creek. Since 1864, six other notable floods have occurred, including the flood of 1894 that had peak flow rates exceeding the September 2013 event. Peak flow rates from 1864 were estimated at 12,000 to 13,600 cfs near 4th Street in Boulder [Reference 3, Sherry Oaks].

1.3 Purpose, Scope, Limitations

The purpose of this master plan is to provide planning guidance to improve resiliency along Boulder Creek from the confluence with Fourmile Creek, in Boulder Canyon, to the confluence with the Saint Vrain Creek in the City of Longmont. This plan provides general guidance for stream and ecological restoration among other multiple objectives including:

- Identification of immediate project needs;
- Provide general guidance for stream restoration;
- Identify ecological needs and benefits;
- Identify floodplain management strategies;
- Identify transportation improvements at Boulder Creek stream crossings;
- Identify concurrent recreation and open space access planning;
- Identify an improvement prioritization plan;
- Develop cost estimates for financial planning.

It is important to note that this master plan provides general guidance for restoration efforts, but it does not re-evaluate the current 100-year floodplain limits regulated by FEMA. Although the implementation of some proposed projects presented in this master plan will also improve the regulatory floodplain, the focus of this master plan is to provide a planning tool for stream and ecological restoration.

Within the City of Boulder, Boulder Creek resembles an urban stream corridor. This master plan does not comprehensively evaluate Boulder Creek through the City limits. Instead, the plan addresses specific areas of concern identified by the city staff and other interested parties. General guidance for Boulder Creek is also presented by the City's Greenway's Master Plan [Reference 4, City of Boulder].

1.4 Planning Process

Planning for this report began in December 2014. The consultant team collected information related to stream characteristics and existing infrastructure, as well as observations related to 2013 flood event. Data was collected from multiple sources, including the Federal Emergency Management Agency (FEMA), the Colorado Water Conservation Board (CWCB), the Urban Drainage and Flood Control District (UDFCD), and the Colorado Department of Transportation (CDOT), and local counties and municipalities.

Once background information was collected, the consultant team identified focal areas, and prepared geomorphic and riparian field assessments. This information was presented to the project team and interested stakeholders at monthly progress meetings.

Public Awareness/ Public Outreach

Public awareness of the master planning effort was developed through a combination of direct mailings to adjacent property owners and the development of a project website. The project website included interactive features allowing individuals to subscribe to a mailing list or to leave site specific comments through an interactive comment map.

Two public meetings were held in early March 2015. These meetings were held prior to the development of improvement alternatives, allowing attendee s to offer specific feedback on problems and concerns that they had along the creek corridor. Feedback was gathered through a priority assessment survey, comment cards, and direct discussions with the planning team and key agencies involved in the project. Feedback was incorporated in the development of alternatives and in selecting priority projects.

- Public Meeting #1; March 10, 2015, City of Boulder
- Public Meeting #2; March 18, 2015, Weld County

On September 16, 2015 FEMA held an Open House meeting to present the proposed updated floodplain maps for Boulder Creek from Boulder Canyon to approximately 61st St. While this study does not update any floodplain

mapping, this meeting was attended by the project team to raise awareness about this study and gather public input.

A final public meeting was held on September 29, 2015 to get public input on the recommended plan. At this meeting renderings of the recommended plan were presented to help visualize key elements in the recommended plan.

1.5 Mapping & Survey

Topographic mapping was provided by FEMA for use on this project. Light Detection and Ranging (LiDAR) elevation points were collected in November of 2013. This mapping was completed on the NAVD88 vertical datum and NAD83 State Plane Colorado Central horizontal datum. Additional field measurements were collected by ICON Engineering in February and March of 2015 in order to determine existing bridge dimensions and flood depths. The field survey was conducted on all major roadway crossings within Boulder and Weld County. The results of the approximate survey can be found in Table 9-2: Bridge Information and Replacement Locations.

1.6 Data Collection

Multiple data sources were collected from groups including CDOT, the CWCB, UDFCD, Boulder County, City of Boulder, Weld County, City of Longmont, and Town of Erie. These studies include:

- U.S. Army Corps of Engineers, Floodplain Information Report, FIR, 1969.
- URS Company, Phase B Preliminary Design Master Plan, City of Boulder and Boulder County, 1979.
- Sherry Oaks, Floods in Boulder County, Colorado, Boulder County, 1982.
- Muller Engineering Company, Lower Boulder Creek Flood Hazard Area Delineation, Boulder County, 1983.
- Muller Engineering Company, Boulder Creek Flood Hazard Area Delineation, City of Boulder, 1983.
- Simons, Li & Associates, Inc., Major Drainageway Planning Study, Boulder Creek - South Boulder Creek Confluence Area, 1984.
- Phyllis Smith, History of Floods and Flood Control in Boulder, Colorado, City of Boulder, 1987.
- Boulder County Comprehensive Plan, 2nd Edition, Subsequent Updates, Boulder County 1996.
- Anderson & Company, Lower Boulder Creek and Coal Creek Open Space Master Plan, Boulder County, 1998
- Colorado Department of Transportation, Final Hydraulics Report SH 52 at Boulder Creek, Boulder County, 2008
- Anderson Consulting Engineers, Inc., Hydrology Verification Report for Boulder Creek, City of Boulder, 2009
- Boulder Valley Comprehensive Plan, City of Boulder, Boulder County, 2010.
- Boulder County Parks and Open Space, Walden Ponds Habitat Management Plan, Boulder County, 2010.
- Greenway's Master Plan, City of Boulder, 2011
- U.S. Army Corps of Engineers, Lower Boulder Creek Aquatic Ecosystem Restoration Project, Detailed Project Report and Environmental Assessment, Boulder County, 2011.
- Federal Emergency Management Agency, Flood Insurance Study and Flood Insurance Rate Maps, Boulder County and Incorporated Areas, 2012
- Anderson Consulting Engineers, Inc., Boulder Creek Floodplain Mapping Study, City of Boulder, 2013
- City of Boulder, The Plan for Boulder's Civic Area, City of Boulder, 2013
- Oz Architecture, North of Boulder Creek Master Site Development Plan, Concept Report, University of Colorado, Boulder, 2014
- Michael Baker International, St. Vrain Creek Watershed Master Plan, St. Vrain Creek Coalition, 2014.
- CH2MHill, Draft Report for Boulder Creek Hydrologic Analysis: Phase 2: Boulder Creek above St. Vrain Creek, Colorado Department of Transportation, 2015
- City of Boulder Open Space and Mountain Parks, Grassland Ecosystem Management Plan, 2009

1.7 Acknowledgements

This report was prepared with groups including the UDFCD, City of Boulder, Boulder County, Weld County, City of Longmont, Town of Erie, ICON Engineering, DHM Design, Ecological Resource Consultants, Inc., CWCB, the Colorado Department of Transportation (CDOT), and the Federal Emergency Management Agency (FEMA). Project participants are listed below.

Table 1-1: Project Participants

Name	Representing
Craig D. Jacobson	ICON Engineering, Inc., Project Manager
Brian LeDoux	ICON Engineering, Inc., Project Engineer
Jeremy Deischer	ICON Engineering, Inc., Project Engineer
Eben Dennis	ICON Engineering, Inc., GIS Specialist
Troy Thompson	Ecological Resource Consultants, Inc.
David Blauch	Ecological Resource Consultants, Inc.
Diane Krzysztof	Ecological Resource Consultants, Inc.
Mark Wilcox	DHM Design
Shea Thomas	Urban Drainage and Flood Control District
Julie McKay	Boulder County Creek Recovery & Restoration Program Manager
Diane Malone	Boulder County IT Project Manager
Kristine Obendorf	Boulder County Transporation Engineer
Varda Blum	Boulder County Floodplain Manager
Yige Gao	Boulder County Floodplain Permitting Specialist
Jesse Rounds	Boulder County Parks and Open Space Planner
Claire DeLeo	Boulder County Parks and Open Space Senior Resource Specialist
Katie Knapp	City of Boulder
Annie Noble	City of Boulder
Marianne Giolitto	City of Boulder Open Space and Mountain Parks
Dan Wolford	City of Longmont
Jonathan Akins	University of Colorado
Naren Tayal	FEMA
Dan Marcucci	Colorado Department of Transportation
Scott Holwick	Lyons Gaddis - Attorneys & Counselors
Diana Aungst	Weld County
Steve Stanish	Town of Frederick

2.0 PROJECT BACKGROUND

2.1 Project Area

The Boulder Creek watershed has a drainage area of approximately 440 square miles, and is located within Boulder and Weld Counties. The majority of the watershed is located within Boulder County. The watershed is bounded to the west by the continental divide, to the north by the Saint Vrain Creek watershed, and to the south by the Clear Creek watershed. This study focuses on the main stem of Boulder Creek from the confluence with Fourmile Creek, approximately 2 miles west of the City of Boulder, to the confluence with Saint Vrain Creek, located within the City of Longmont. The study encumbers over 24 miles of channel length along Boulder Creek.

Boulder Creek is a perennial stream which generally flows from west to northeast. The study area generally lies within the South Central Semi-Arid Prairie ecoregion of the Great Plains; while a small portion of the upstream project reach occurs within the Northwestern Forested Mountain ecoregion of the Southern Rockies. The topographic elevation ranges from approximately 5,700 feet above mean sea level (AMSL) at the confluence with Fourmile Creek to approximately 4,800 feet AMSL at the downstream end of the project area.

West of the City of Boulder, Boulder Creek is confined within the steep canyon terrain of Boulder Canyon. Boulder Canyon generally shares the stream corridor with State Highway 119. East of Boulder Canyon, Boulder Creek enters the City of Boulder, where the stream reflects more of an urban waterway and greenway than a natural stream system. Although, through this reach, Boulder Creek does incorporate some degree of natural landscapes, the encroachment from urban development has occurred over many years. The channel is more confined and numerous bridges, diversions, and stabilization structures exist along its path. East of the city, within Boulder and Weld Counties and the City of Longmont, Boulder Creek resembles a plains stream with a broad floodplain. Although this stretch has fewer bridges than within the urban areas of the City of Boulder, over time, the stream also has experienced significant channel modifications as a result of farming, diversions, sand and gravel ponds, and aggregate mining. As a result, in many areas sinuosity has decreased and the stream lacks natural meanders and bends.

The predominant land cover type within the study area is cultivated cropland, which includes grazing, alfalfa and other crop production. As noted above, aggregate mining of sand and gravel since the mid 1950's has visibly shaped the project area landscape as open water ponds are scattered within the floodplain. Natural vegetation cover exists within the riparian zone and a variety of wetland habitats also exist. However, riparian and wetland habitat only occupies a small percentage of the project area. Other land uses include high and low density development within the City of Boulder, roadways and transportation infrastructure.

The Boulder Creek corridor contains a variety of wildlife, threatened or endangered species, and aquatic habitat. Both the City of Boulder Open Space and Mountain Parks and Boulder County Parks and Open Space maintain land restrictions or seasonal closures throughout the project area.

Finally, the floodplain areas along Boulder Creek are regulated by local floodplain administrators and the Federal Emergency Management Agency (FEMA) over the entirety of the study reach. Regulatory floodplain areas include a variety of flood zones for riverine and shallow flooding locations. Base Flood Elevations (BFEs), and shaded Zone X designating the 0.2%-annual-chance, or 500-year floodplain area has been identified within Boulder County. A regulatory floodway has also been designated along a portion of Boulder Creek from Valmont Road through 61st Street. Boulder County regulates floodway along Boulder Creek although a floodway designation is not shown on the FIRM. Within Weld County the regulatory floodplain consists of an approximate study designation. It should be noted that the City of Boulder is undergoing a floodplain remapping effort for the reach of Boulder Creek and Boulder Slough through the city limits. Although the City is still awaiting the formal adoption of the study on the FEMA FIRM maps, concurrence from FEMA has been given to the technical data, and these changes have therefore been considered with this master plan where applicable.

2.2 Flood History

Reports of flooding along Boulder Creek extend back to the 1840's, however the first documented flood may have occurred as early as June 1864, following a fifty hour rainfall event [Reference 5, Phyllis Smith]. The flood of record is reported to have occurred in 1894, where nearly three days of rainfall resulted in unprecedented damage within the City of Boulder, Boulder County, and surrounding communities. During this flood, Boulder Creek's swell destroyed numerous homes, businesses, and bridges, including the 4th Street Railroad Bridge and bridges at 6th, 9th, 12th, and 17th Streets. For five days, Boulder was essentially cut off from the world. Total damages were later estimated by the U.S. Army Corps of Engineers to be around $725,000 [in 1894 dollars, Reference 5, Phyllis Smith]. Damage to surrounding transportation networks in the County also hindered trade networks with nearby mountain towns [Reference 3, Sherry Oaks]. Peak discharges from the 1894 flood were estimated to be between 12,000 and 13,600 cfs [Reference 6, Metcalf and Eddy]. Over time, the 1894 flood has been synonymous with a 1%-annual-chance recurrence, or 100-year flood. Since 1894, and prior to 2013 (discussed below), five other notable floods occurred along Boulder Creek, including floods in 1897, 1914, 1921, 1938, and 1969.

Planning for floods within the City of Boulder and Boulder County initiated in the early 1900's. Over time, high profile architects, professors, and engineers were contracted to study and provide recommendations related to managing or mitigation Boulder Creek. Harvard-trained landscape architect, Frederick Law Olmstead, Jr. was among the first to offer an opinion. In 1910, he published his findings and lectured about floods and flood control on Boulder Creek [Reference 5, Phyllis Smith]. In his findings, he lectured:

> "The principal waterway in Boulder is Boulder Creek, and its principal function, from which there is no escaping is to carry off the storm-water which runs into it from the territory which it drains. If, lulled by the security of a few seasons of small storms, the community permits the channel to be encroached upon, it will inevitably pay the price in destructive floods." [Reference 7, Olmsted, Jr.]

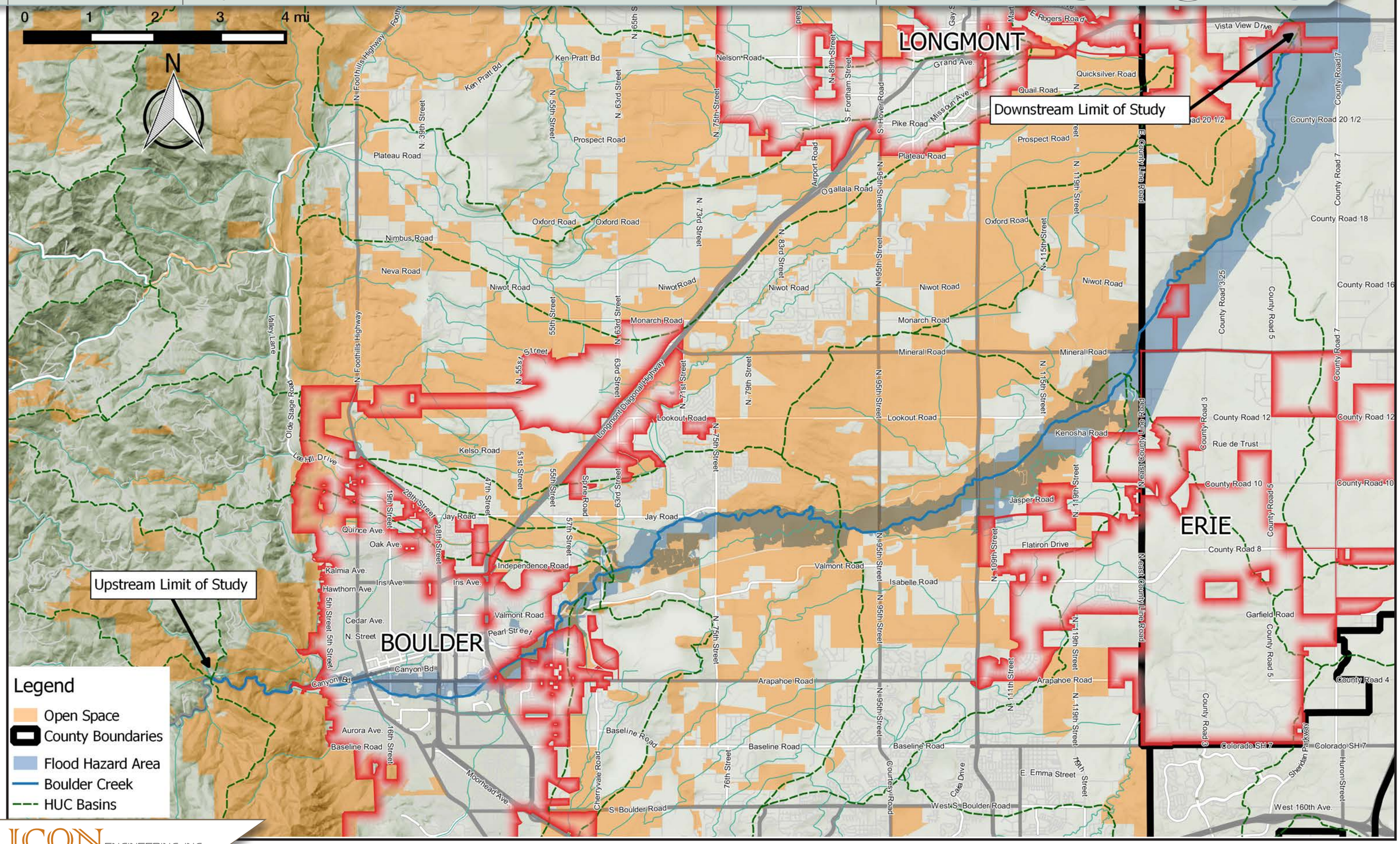
Since 1945 and 1973, the City of Boulder and Boulder County have commissioned over twenty flood studies. The studies recommend a varying degree of both structural and non-structural solutions for Boulder Creek in addition to recommendations related to surrounding land use and floodplain management. Prominent groups or individuals studying Boulder Creek have included the U.S. Army Corps of Engineers, Dr. Gilbert White (University of Colorado), and the Urban Drainage and Flood Control District, among others.

December 2015

Figure 2-1

Boulder Creek Master Plan

Project Overview



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2.3 September 2013 Flood Event

Between September 9 and September 15, 2013, a large rainfall event resulted in widespread flooding along the Colorado Front Range. Although damages along Boulder Creek were less severe than other locations along the Front Range, they were significant, none the less. Rainfall within the Boulder Creek watershed during the storm generally increased from west to east. Total rainfall between September 11th and 13th ranged from approximately 2.6 inches, west of the City of Boulder, to over 9.7 inches east of the City. Although the total volume of water greatly exceeded the 100-year regulatory design levels, the rainfall was spread out over the three days and did not translate to a 100-year degree of runoff. Peak discharges from the flood at various locations are shown in Table 2-1, as reported from Wright Water Engineers [Reference 8] and CH2MHill [Reference 1]. In general, the flood discharge was estimated to be on the order of a 25 year to 50 year flood event.

Table 2-1: 2013 Flood Discharge Observations

Location	Observed Discharge	Estimated Flood Frequency	Source
Boulder Creek at Broadway	Approx. 5,000 cfs	25-year	UCAR Estimate based on CDWR (Ref. 8)
Boulder Creek at 28th Street	Approx. 5,300 cfs	25-year	Colorado Water Conservation Board (Ref. 8)
Boulder Creek at 75th Street	Approx. 8,400 cfs	25-50 year	USGS Provisional Data (Ref. 8)
Boulder Creek at U.S. 287	Approx., 9,000 cfs	50-year	Estimated Peak Discharges - Phase 2 (URS per Ref. 1)

Damage from the September 2013 flood event along Boulder Creek was widespread. As noted previously, within the City of Boulder alone, damages were estimated to have exceeded $41 million [Reference 2, City of Boulder]; however, these damages were largely attributed to high groundwater and sewer backups. Within City of Boulder Open Space and Mountain Parks properties, unincorporated Boulder County, Weld County and the City of Longmont, stream banks overtopped and embankments along open space ponds and former aggregate pit sites failed. Roadway embankments breached, and stream diversion systems were damaged. Structural damage to homes also occurred in the vicinity of Kenosha Road and 115th Street. Within Boulder Canyon, avulsions and deposition changed the landscape of the riverine system. A partial list of flood related damages is described below, as well as discussed for each reach in Reach Descriptions.

City of Longmont (Confluence with the St. Vrain Creek):

- Areas of impact within the City of Longmont reflected avulsions of the St. Vrain Creek. During the flood, St. Vrain Creek diverted from its standard path, spilled through adjacent aggregate ponds, and defined a new confluence location with Boulder Creek, approximately 1,600 feet upstream of the historic confluence location. The newly defined confluence location will be kept going forward, shortening the overall channel length of Boulder Creek. Flood debris was prevalent through this reach, as was scour and deposition along the channel banks.

Weld County (20½ Road through County Line Road):

- Areas of impact with Weld County were identified along the County's roadway crossings with Boulder Creek, specifically at County Roads 20½ and 16½. At these locations, flooding resulted in scour around the bridge abutments and piers. The roadways were damaged where they overtopped, often a significant distance from the bridges.
- Boulder Creek through much of this reach is managed through irrigation diversions, sand and gravel ponds, and aggregate mining. Minor damage and breaches occurred at several ponds within Weld County. A significant bank cut developed adjacent to the Town of Erie's re-use pond downstream of County Line Road. This pond also experienced a deluge of flood waters from overtopping of adjacent ponds and roadways to the south. The bank cut is currently in process of repair by the Town of Erie.

Boulder County (County Line Road through 75th Street):

- A wide range of flood damages were experienced along Boulder Creek within Boulder County. Upstream of County Line Road, open space ponds breached and the stream bank failed along the Doniphan, Wittemeyer, and Bailey-Kenosha Pond open space properties. Similarly, the existing irrigation diversion and bridge connection, between the north and south properties at this location, were also damaged.
- Several residential properties and homes were damaged by flood water that overtopped Kenosha Road. Upstream of 109th Street, Boulder Creek diverted from its banks and washed out the 109th Street roadway approximately 600' north of the current bridge crossing. This roadway has since been repaired by Boulder County.
- Upstream of State Highway 287, within the Alexander Dawson Open Space, Boulder Creek diverted from its banks, short cutting recent channel and restoration features installed by Boulder County and the Urban Drainage and Flood Control District.
- Overtopping of 95th Street was significant and the roadway failed approximately 1,000 feet north of the current bridge location. Significant damage was also noted to downstream ponds and property. The overtopping of 95th Street was a result of channel avulsion upstream of the 95th Street bridge. This roadway has since been repaired by Boulder County.
- Within the Walden Pond Open Space, open space ponds breached at several locations. Boulder County is current in process of permanently breaching and making repairs to several of these ponds.

City of Boulder (75th Street to Boulder Canyon Mouth):

- Upstream of 61st Street, Boulder Creek's north bank breached in two locations, diverting floodwater and sediment into Pit D and the Cline Fish Ponds. The gravel pit south of the Fish Ponds, also breached to Boulder Creek. The City is currently in process of completing a design to restore this area.
- Downstream of 61st Street, Boulder Creek diverted its course and bypassed the Green Ditch diversion structure. The City is currently in the process of restoring the creek corridor in this area which will also re-establish the Green Ditch diversion point.
- Significant debris collected upstream of the Old Valmont Road Bridge. Flood debris also settled near the current Valmont Road location.

- Nearby, the Butte Mill Ditch breached at the crossing with South Boulder Creek, adjacent to where the flood washed out around the KOA Pond.
- Flooding was isolated in areas within the University of Colorado Campus (17th Street to Folsom) and was relatively minor. The 2013 flood destroyed an existing pedestrian bridge crossing near 19th Street.
- Damage to in-stream structures occurred along Boulder Creek within the Civic Center area. This damage has since been repaired by the City.

Boulder Canyon (City of Boulder to Fourmile Creek):

- Within Boulder Canyon, flood damage occurred to both Boulder Creek and State Highway 119. High velocities contributed to steam erosion, deposition and undermining of roadway infrastructure. Flows from inflow tributaries also overwhelmed infrastructure, resulting in damage to Highway 119, itself. Much of the immediate damage has since been repaired by the Colorado Department of Transportation (CDOT); however CDOT is currently planning for more permanent and flood resilient facilities in Boulder Canyon. Stream restoration needs are still prevalent within the master plan project reach, mostly along Boulder Creek Path upstream of Settler's Park trailhead.

2.4 Previous Studies

A comprehensive listing of past studies and information was previously described under Data Collection. Below are descriptions of key reports prepared concurrently with this master plan, which should be considered with the implementation of recommended improvements. Key studies are summarized below, organized by jurisdiction.

City of Longmont

- ***St. Vrain Creek Watershed Master Plan (Reference 9, 2014) –*** This plan was initiated following the 2013 flood event. The plan describes alternatives and restoration opportunities for the St. Vrain Creek and tributaries. Different restoration options were presented to restore the confluence location, between Boulder Creek and the St. Vrain River. The City of Longmont has since elected to maintain the confluence where the St. Vrain diverted from its bank, shortening the overall length of Boulder Creek by approximately 1,600 feet.

Boulder County

- ***Boulder Creek – South Boulder Creek Confluence Area (Reference 10, 1984) –*** This study provided preliminary design of drainageway improvements for the Boulder Creek / South Boulder Creek confluence area. The selected alternative from the plan includes: allowing the proposed Pearl Street roadway to be overtopped by 0.5 foot during the 100-year flood; removing the Union Pacific Railroad embankment; providing excavated floodway between 55th and Pearl Street; re-grading the Boulder Creek floodway north of the Union Pacific railroad crossing; removing the existing dike in the vicinity of 56th Street; examining if the existing Valmont bridge west of the Peal Street crossing should be removed; and investigating building a berm between 55th and Valmont. During the Phase B portion of the investigation it was determined that several changes to the selected alternative should be made including: elevating Pearl Street above the 100-year water surface elevation; remove the 61st Street roadway and bridge; provide a 100-year bridge for 55th Street. Several of the proposed improvements have been implemented from this study however; the proposed Pearl Street roadway was not constructed nor was 61st Street removed.

- ***Walden Ponds Management Plan (Reference 11, 2010) –*** This plan indicates that the Walden Pond area should continue to be managed as a high quality wildlife habitat with compatible and minimal-impact human uses.

- ***Lower Boulder Creek and Coal Creek Open Space Master Plan, Boulder County (Reference 12, 1998) –*** This plan developed a restoration master plan for the reach of Boulder Creek between the Alexander Dawson parcel, west of US 287, to the Boulder – Weld County line. This plan encumbered open space sites currently identified for repair following the 2013 flood, in addition to areas currently planned for restoration activities, including the U.S. Army Corps of Engineers, Lower Boulder Creek project described below. The confluence with Coal Creek was also evaluated. General project objectives included: re-establishing natural riverine function and self-sustaining ecosystems; restoring historic floodplain interaction; preserving, restoring, or creating diverse plant communities; enhancing pond and stream water quality; providing recreational opportunities; enhancing cultural and natural resources; and promoting sustainability along the project reach. This study evaluated a wide range of aspects related to Boulder and Coal Creeks, including: context; natural resources; channel morphology and stability; stream ecosystems; land planning; and implementation. Information from this report was reviewed to demonstrate compatibility with the planned improvements in this area.

- ***Lower Boulder Creek Aquatic Ecosystem Restoration Project, Detailed Project Report and Environmental Assessment, Boulder County (Reference 13, 2011)*** – This report was prepared by the U.S. Army Corps of Engineers (COE) and Boulder County to evaluate restoration opportunities and needs for Boulder Creek between 109th Street and Kenosha Road. This project is currently proceeding with a final design for the reach. Information from this report was reviewed to demonstrate compatibility with the planned (COE) improvements.

City of Boulder

- ***Civic Center Master Plan (Reference 14, 2013) –*** This draft plan includes redevelopment and improvements for the Civic Center area that extends from 13th Street on the east, 9th Street on the west, Arapahoe on the south, and Canyon Boulevard on the north. With regards to floodplain improvements, the proposed plan includes removal of several buildings and surface parking in an effort to increase floodplain capacity and reduce infrastructure in areas of high hazard designation. A potential underpass for the Boulder Creek Path below Arapahoe Road has been identified as a need; however improvement to the underpass also has potential for minor impacts to the floodplain in this area. With the Civic Center plan, Boulder Creek will continue to be a natural corridor with trees and creek-side vegetation. No specific proposed changes to the channel, ditch diversions, or to the existing crossing structures at 9th, Broadway, and Arapahoe Avenue were

identified. The master plan indicated that new or significantly altered buildings must be flood-proofed according to City of Boulder regulations.

- ***Civic Center Master Plan Flooding Evaluation (Reference 15, 2012) –*** This evaluation was completed by Anderson Consulting Engineers (ACE) in order to determine potential floodplain impacts for changes to the Civic Center area as a result of the Civic Center Master Plan (see above). This evaluation analyzed eleven flood mitigation scenarios using a hydraulic model. The scenarios included variations of the removal of the Park Central and New Britain buildings and increasing the opening of the Broadway and Arapahoe crossing structures. The evaluation determined that the base flood elevations upstream of Broadway could be reduced by removal of the buildings and increasing the opening area of the Broadway crossing, but the municipal building would remain within the 100-year floodplain. Additionally, it was noted that improvements have the potential to keep more water in the Boulder Creek channel area which would reduce discharges along the spill flow that follows Canyon Boulevard.

- ***Greenways Master Plan (Reference 4, 2011) –*** This master plan provides a planning tool for improvements along the Boulder Creek greenway and the 14 tributaries to Boulder Creek within the City. Along Boulder Creek the greenways plan calls for underpass improvements, over a mile of improved trail, and nearly 124 acres of habitat improvement and water quality improvements along Boulder Creek.

- **City of Boulder Open Space and Mountain Parks Grassland Ecosystem Management Plan (Reference 67, 2010) –** This grassland plan provides a framework for public policies, management actions, and land and water acquisition priorities to conserve the ecological values of Boulder's grasslands. The grassland plan focuses on 24,000 acres of OSMP lands where the Central High Plains meet the foothills of the Southern Rocky Mountains.

University of Colorado

- ***North of Boulder Creek Master Site Development Plan (Reference 16, 2014) –*** This plan identifies flood management strategies and infrastructure needs surrounding the North of Boulder Creek Campus, located between 17th Street and Folsom. Key goals and strategies include: maintaining flood water conveyance within open areas of athletic and recreation fields; maintaining existing roadway grades without further obstruction; elevating residential structures above flood elevations; and flood-proofing commercial infrastructure. Also noted as part of the North of Boulder Creek study was the need to improve existing bridge obstructions, and improve both pedestrian and emergency access to the stadium and campus south of Boulder Creek. A series of pedestrian bridge options have been considered to replace the existing access points over the creek.

3.0 HYDROLOGY AND HYDRAULICS

3.1 Hydrology

Baseline Hydrologic Information

Hydrologic information for the Boulder Creek Watershed has been documented from a variety of sources, initiating with the initial U.S. Army Corps of Engineers (COE) Floodplain Information Report in 1969 [Reference 17, U.S. Army Corps of Engineers], updates by the COE in 1977, more recent Flood Hazard Area Delineation (FHAD) reports [References 18 & 19, Muller Engineering Company] for the City of Boulder and Boulder County, and current FEMA Flood Insurance Studies (FIS) [Reference 20, FEMA]. In general, the current regulatory discharges are based on the 1977 COE findings.

In 2009, the City of Boulder initiated an update to the FEMA flood maps. As part of this study, an evaluation was completed to review and confirm previous hydrologic values [Reference 21, Anderson Consulting Engineers, Inc.]. This evaluation concluded that the regulatory discharges are reasonable.

For the purposes of this master plan, the current FEMA regulatory discharges were maintained for evaluating flood control aspects of each project alternative. These discharges are presented in Table 3-1, below. It should be noted that the regulatory discharges presented were confirmed within the referenced regulatory flood studies at each location.

Table 3-1: Summary of Boulder Creek Flood Discharges

Location	Drainage Area (sq. mi.)	10-Year (cfs)	25-Year (cfs)	50-Year (cfs)	100-Year (cfs)	500-Year (cfs)
Fourmile Creek Mouth[2]	129	2,050	--[1]	7,960	11,660	21,180
Boulder Creek Canyon Mouth[2]	130	2,050	--[1]	7,960	11,660	21,180
6th Street[3]	130 [5]	2,200	5,830	8,100	12,150	22,100
55th Street[3]	155 [5]	3,600	7,070	9,300	13,050	22,056
75th Street[4]	305	3,350	--[1]	9,600	13,800	28,800
U.S. Highway 287[4]	331	2,800	--[1]	8,600	12,700	27,600
County Line Road[4]	431	2,850	--[1]	9,150	13,750	31,700
County Road 16.5[6]	443	--[1]	--[1]	--[1]	13,750	--[1]
County Road 20.5[7]	446	--[1]	--[1]	--[1]	12,250	--[1]

[1] Data Not Avaliable

[2] Floodplain Information Report, Upper Boulder Creek & Fourmile Creek, Gingery Associates, 1981

[3] Boulder Creek Floodplain Mapping Study, Anderson Consulting Engineers, Inc., 2013

[4] Flood Hazard Area Delineation, Lower Boulder Creek, Muller Engineering Company, Inc. 1983

[5] Flood Hazard Area Delineation, Boulder Creek, Muller Engineering Company, Inc. 1983

[6] Letter of Map Revision 12-08-0198P at 16.5 Road, Weld County

[6] Letter of Map Revision 12-08-1047P at 20.5 Road, Weld County

CDOT Peak Flow Estimates

In June of 2015, the Colorado Department of Transportation completed a report regarding peak discharges along Boulder Creek, including the reaches within the Boulder Creek Restoration Master Plan project limits [Reference 1, CH2MHill]. CDOT's study confirmed peak flow estimates from the September 2013 flood, as previously presented, as well as conducted an independent review of flood discharges and frequencies. Primary tasks for CDOT's evaluation included:

- Estimating peak discharges that were believed to have occurred at key locations during the 2013 flood;
- Preparing rainfall-runoff models for the watershed;
- Calibrating results from the hydrologic models;
- Preparing updated flood frequency analyses using gage data;
- Utilizing the rainfall-runoff models to estimate predictive peak discharges along Boulder Creek.

CDOT's study also incorporated the effects of flood control storage on both Barker Reservoir (Middle Boulder Creek) and Gross Reservoir (South Boulder Creek).

CDOT's study recommended changes to peak discharges along Boulder Creek. Significant reductions in the 1%-annual-chance (100-year) discharge, on the order of 40%, have been recommended between Fourmile Creek and the confluence with South Boulder Creek. Downstream of 75th Street, CDOT's recommended flows gradually increase compared to the current regulatory discharges. At the confluence between Boulder and St. Vrain Creeks, increases in the 1%-annual-chance discharges are on the order of a 55% increase. It should be noted that the changes in discharges have not been ratified by project sponsors, local regulatory officials, or FEMA. For this reason, these changes in peak flows have not been incorporated into this master planning study. However, in the future, we would encourage users of this document to confirm any changes in regulatory discharges with local officials prior to implementing improvements recommended within this report. A comparison profile from CDOT's study has been provided in APPENDIX C.

3.2 Hydraulics

The focus of this study is stream restoration and ecological enhancement along Boulder Creek. The study does not re-evaluate the current 100-year floodplain limits as regulated by FEMA. For those reasons, a comprehensive floodplain model has not been generated for this study. However, hydraulic information was collected from a variety of sources. The hydraulic information utilized for this master plan is listed below:

- ***Boulder Canyon*** –From the confluence with Fourmile Creek to the western boundary of the City of Boulder, hydraulic information was obtained from the 1981 *Floodplain Information Report – Upper Boulder Creek and Fourmile Creek, prepared by Gingery Associates [Reference 23]*.
- ***City of Boulder*** – Within the City of Boulder and downstream to 61st Street, hydraulic information was obtained from the 2013 Boulder Creek Floodplain Mapping Study prepared by Anderson Consulting Engineers, Inc. [Reference 22].
- ***Boulder County*** – From 61st Street to the Boulder/Weld County line hydraulic information was obtained from the 1983 Lower Boulder Creek Flood Hazard Area Delineation (FHAD) report, prepared by Muller Engineering Company, Inc. [Reference 19].

- ***Weld County –*** Within Weld County hydraulic information was obtained from three separate FEMA Letter of Map Revisions (LOMRs) including:
    - **11-08-1090P** - Boulder / Weld County line to just downstream of the Town of Erie wastewater treatment facility;
    - **12-08-0198P** - from approximately 3,500 feet upstream of Weld County Road 16 ½, to approximately 6,500 feet downstream of Weld County Road 16 ½;
    - **12-08-1047P –** from approximately 3,900 feet upstream of Weld County Road 20 ½, to approximately 600 feet downstream of Weld County Road 20 ½;

  In addition, a floodplain modeling report for the bridge improvements at Mineral Road, at the Boulder-Weld County line was obtained through the Town of Erie. This report was prepared by CDOT in 2008 [Reference 24].

3.3 Climate Change and Uncertainty

Scientists are currently working to predict the future outlook with respect to climate change, uncertainty, and variability within watersheds across the United States. Boulder Creek is no exception and with its prolific flood history, would be considered susceptible to these changing elements. In a report titled *The Impact of Climate Change and Population Growth on the National Flood Insurance Program through 2100* [Reference 66, AECOM], AECOM notes that 1%-annual-chance (100-year) floodplains in the Unites States are expected to increase by around 45%, with significant regional variations. Some areas within the U.S. would increase more. No significant decreases in floodplain depth or flood area were anticipated for any region. The report also noted that for primary areas of interest for the National Flood Insurance Program (NFIP), 30% of the increases in flood discharges, floodplain area, and depth would be attributed to population growth. The remaining 70% of the increases would be attributed to the influence of climate change. The impact of population growth was more apparent in population centers compared to more rural areas. It should be noted that the AECOM study is based on national averages and is not intended to be interpreted locally.

Urban Drainage and Flood Control District (UDFCD) and Wright Water Engineers, Inc. (WWE) prepared a technical paper titled *Planning for Variability & Uncertainty: Climate Change and the UDFCD Urban Drainage System* to review climate change projections specifically for Colorado and the Front Range. The paper finds there is insufficient data to reliably forecast changes in the intensity-duration-frequency estimates especially for less-frequent events. However, the variability of wetter-than-normal and drought years is likely to increase.

Variations in temperature can also impact the stream corridor by impacting the vegetation along the stream banks. These future deviations in temperature can affect the vegetation's ability to thrive which is vital to protecting the stream corridor from future erosion. Climate change experts project an increase in average temperature making it imperative to account for the resiliency of the vegetation's ability to handle a variation in both temperature and precipitation.

The Colorado Water Conservation Board (CWCB) also released a paper titled *Climate Change in Colorado: A Synthesis to Support Water Resources Management and Adaptation.* The paper outlined statewide annual average temperatures have increased by 2.0^{o}F over the past 30 years and 2.5^{o}F over the past 50 years. All climate models project future warming statewide in Colorado. No long-term trends in average annual precipitation or heavy precipitation events have been detected. Climate models have a greater variability regarding future precipitation, not agreeing whether there will be an increase or decrease in future statewide annual precipitation. While total precipitation is not estimated to change significantly, the frequency of higher frequency storms is projected to increase.

WWE outlined the impact on Major Drainage Systems, quoted from their report below:

- Effects from increased temperatures would be expected to include stress on vegetation, greater potential evaporation and evapotranspiration, lower stream flow, and more frequent periods of precipitation as well as drought.
- Increased frequency in runoff from smaller storms would increase the potential for channel erosion and would increase the frequency of Stormwater flows in the major drainage system.
- Water quality may be affected by more frequent runoff and pollutant loading with increased runoff temperatures in summer.
- Current projections do not indicate a trend of increasing or decreasing flooding for large (e.g. 100-year and greater) events, and 100-yr floodplain limits would not be expected to change. In cases where floodplains that have been preserved and/or drainageways have been engineered with an adequate allowance for freeboard, the level of protection provided and flood risk would not be expected to change significantly based on projections from climate experts.
- Increased evapotranspiration would require additional water to maintain wetlands. If surface or groundwater levels decline, wetland vegetation will not be able to be sustained and wetlands may be displaced.
- Increases in precipitation may result in more frequent trail inundation, especially at crossings, resulting in a greater need for maintenance attention

Although recommendations presented in this master planning study are based on currently regulated discharges along Boulder Creek, users of this study are encouraged to consider future climate change estimates for any long term improvement that may be implemented.

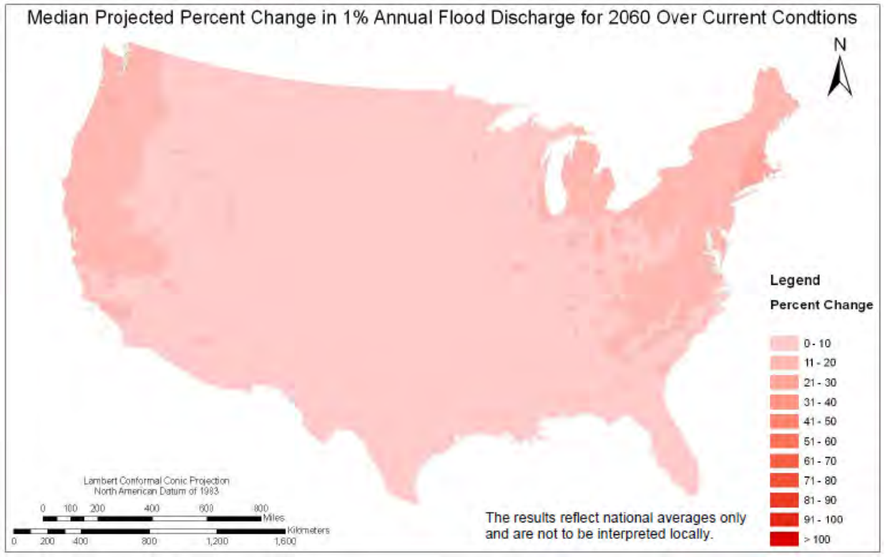


Figure 3-1: 1%-Annual Chance Projections for the United States, 2060 (AECOM, 2013)

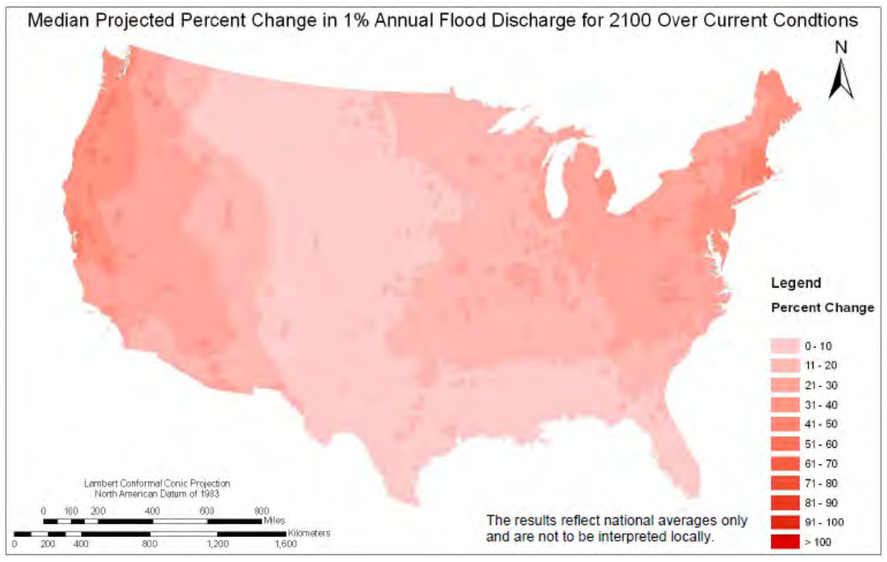


Figure 3-2: 1%-Annual-Chance Projections for the United States, 2100 (AECOM, 2013)

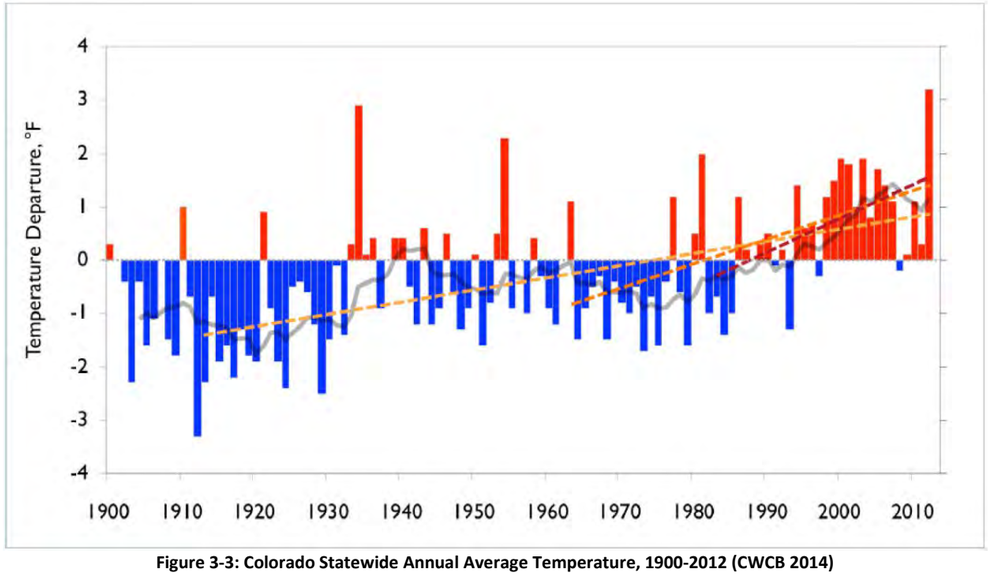


Figure 3-3: Colorado Statewide Annual Average Temperature, 1900-2012 (CWCB 2014)

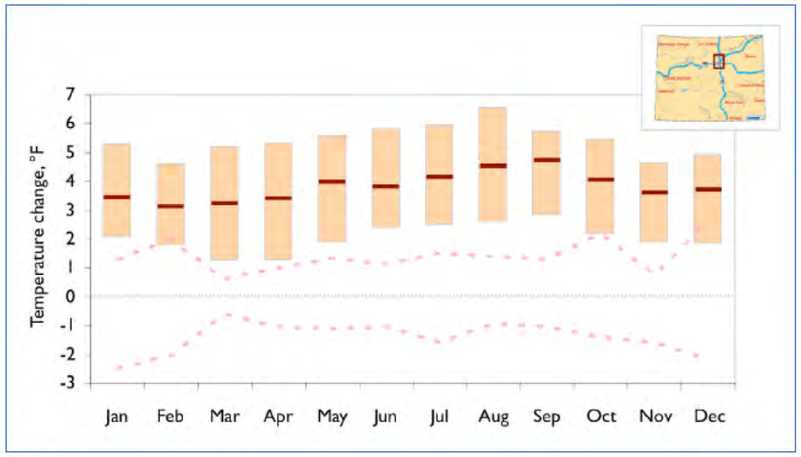


Figure 3-4: Projected Monthly Precipitation Change for Denver Metro Sub-region Low-moderate Emissions Scenario for 2035-2064 (Figure 5-9 CWCB 2014 from BCSD5 statistically downscaled CMIP5 projections, Reclamation 2013)

4.0 STREAM MORPHOLOGY AND EXISTING SITE CONDITIONS

4.1 Stream Classification

For the purposes of this master plan, Boulder Creek has been divided into ten separate reaches for description and planning purposes. Descriptions below discuss general observations along each stream reach, in addition to geomorphic classification based on Rosgen methodology. The Rosgen stream classification system is a widely used framework that defines stream types on the basis of geomorphic characteristics including channel slope, sinuosity, width/depth ratio, and entrenchment ratio. The classification system integrates geomorphic pattern with predominate bed material to identify different types of streams (Rosgen 1996). The Rosgen system defines eight Level I stream types on the basis of geomorphic characteristics including single thread or multiple channel condition, channel slope, sinuosity, width/depth ratio, and entrenchment ratio. Level I stream types are identified by letters, such as A, B, and C. The classification system integrates geomorphic pattern with predominate bed material to define 42 Level II stream types, identified by letters and numbers, such as B3, C3, C4, etc. (Rosgen and Silvey 1998). Numbers one through six are used to sequentially describe bedrock, boulders, cobble, gravel, sand, and silt and clay as the predominate bed material. A schematic showing the different Rosgen classification groupings based on observed and measured stream parameters is provided in Figure 4.1. Observation and stream types were determined based on aerial mapping, Google Earth (2013), and field assessments for the full length of Boulder Creek. In general, classification of Boulder Creek typically reflected a Type C stream. Rosgen Type C streams are typically characterized as being a "low gradient, meandering, point-bar, riffle/pool, alluvial channel with broad, well-defined floodplains" (Rosgen 1996). Type C streams have a sinuosity greater than 1.2, an average slope less than 0.02 feet per foot (ft/ft), and a meander width ratio (i.e., meander belt width divided by stream bankfull width) typically between 4 and 20 (Photo 1). These streams are slightly entrenched with well-defined meandering channels. In areas where Boulder Creek was more entrenched through encroachment, the stream was classified as a Type F stream. Finally, stream segments within the Boulder Canyon segment were classified as a Type B stream. Type B streams are defined as having "moderately entrenched, moderate gradient, riffle-dominated channels, with infrequently spaced pools". The plan, profile, and banks of Type B streams are all considered to be stable. The sinuosity of these stream types are greater than 1.2, with an average slope between 0.02 and 0.039 ft/ft, and a typical meander width ratio between 2 and 8. Type B streams are usually seen in narrower, steeper valleys than Type C streams, and contain colluvial deposition in the reach. Rapids and scour pools are characteristic of Type B streams. Photo 2 gives a representative example of a portion of a Type B channel that was observed in Boulder Canyon. Classifications assigned to individual stream segments are intended to describe their current physical characteristics; they are not intended to indicate information on the current stability of the channel or likely channel evolution.

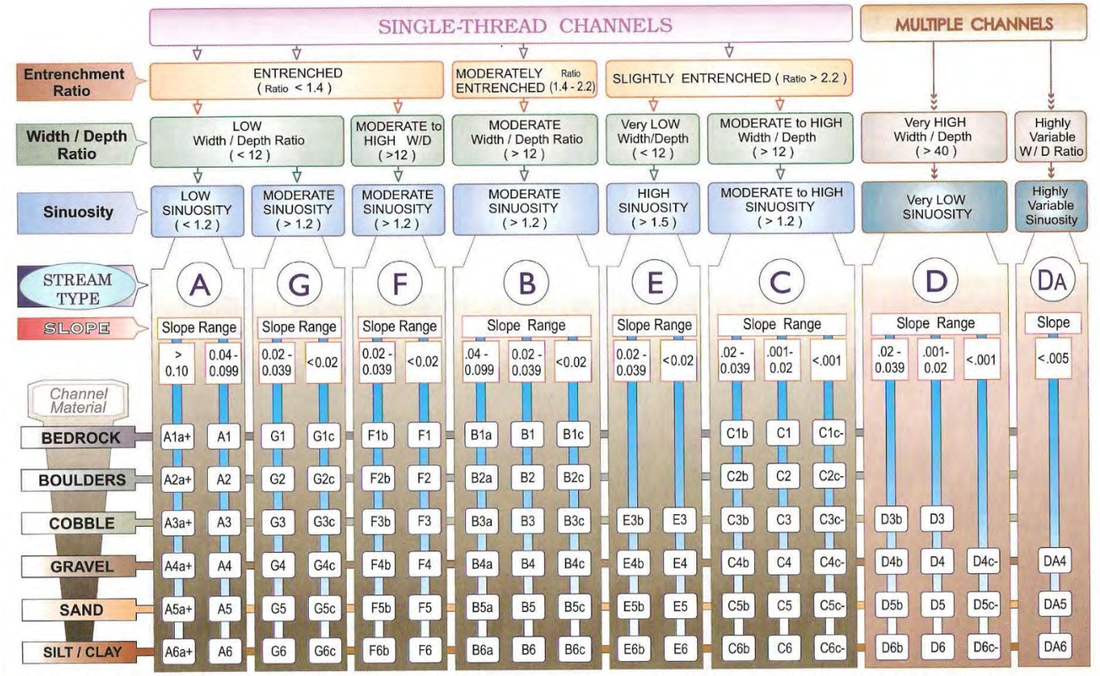


Figure 4-1: Rosgen Classification System System Schematic (from Rosgen 1996)



Photo 1: Typical riffle/pool sequence on Boulder Creek in Reach 1 (Type C classification)



Photo 2: Rapid and scour pools bedforms in Reach 10 (Type B classification)

4.2 Reach Descriptions

Ten stream reaches were defined for the purposed of this study. Reaches were separated based on a number of current stream characteristics including adjacent land uses, sinuosity, channel slope and geological transitions. As examples, the delineation point between the ends of Reach 1 and Reach 2 was selected based on stream sinuosity where Boulder Creek transitioned from a relatively laterally unconstrained system (Reach 1) to an area where gravel mining operations have channelized the stream (Reach 2). Reaches 6 and 7 were separated based on a physical feature (N. 75th Street) as well as an observed difference in stream characteristic while the limits of Reaches 9 and 10 were based on a change in valley type and slope. A combination of field investigations and review of mapping and channel slopes were utilized to assist in reach definition.

Reach 1 (Confluence with St. Vrain Creek to approximately 3,300 ft upstream of the City of Longmont)

Starting at the confluence with the Saint Vrain Creek, Reach 1 extends upstream along Boulder Creek for just over a mile of channel length. All of Reach 1 is contained within Weld County and the City of Longmont towards the downstream end. There are no channel crossings within this reach with the exception to a gravel pit conveyor crossing at the upstream end and several non-formalized low-water crossings for vehicles. This reach includes several gravel pits on either side of Boulder Creek that currently hold water. The riparian area within Reach 1 is approximately 700 feet wide near the confluence with Saint Vrain Creek and narrows to approximately 250 feet at the upstream end of Reach 1. Beyond the riparian area the floodplain overbanks generally consist of active and fallow farm lands. Sporadic residential and farm structures are also present within the overbanks along with several petroleum well pads.

From a channel morphology standpoint, the stream channel is in generally good condition and the riparian corridor is largely intact along the channel. Adjacent land development is limited throughout this reach. Channel sinuosity through Reach 1 is approximately 1.25 and average channel widths are on the order of 40 feet. The average slope through this reach is approximately 0.25%. Based on sinuosity, slope and observed bed material, Reach 1 classifies as a Type C4 stream using the Rosgen Stream Classification System. Some bank instability exists and there is evidence of past stabilization work.

Impacts within this corridor from the 2013 flood primarily reflect avulsions that developed from St. Vrain Creek. During the flood, St. Vrain Creek diverted from its standard path, flowed through adjacent aggregate ponds, and defined a new confluence location with Boulder Creek, approximately 1,600 feet upstream of the historic location. The new confluence location will be carried forward shortening the overall length of Boulder Creek. Although the Boulder Creek generally remained intact, flood debris in this reach still remains.



Photo 3: Flood debris along Boulder Creek (Reach 1)



Photo 4: New confluence between St. Vrain and Boulder Creeks (Reach 1)

Reach 2 (From approximately 3,300 ft upstream of the City of Longmont to CR 16½)

Reach 2 is approximately three miles long and includes bridge crossings at Weld County Roads 20½ and 16½. Although Reach 2 is located in Weld County, upstream locations are co-managed through Boulder County Conservation Easements. Two major diversion structures to Rural Ditch and Idaho Creek are located within this reach. The floodplain overbanks throughout Reach 2 generally consist of sand and gravel ponds, and aggregate mining operations. Disturbances from historic land use practices and other channel alterations are generally widespread. The channel within Reach 2 is relatively straight as a result of encroachment on both banks.

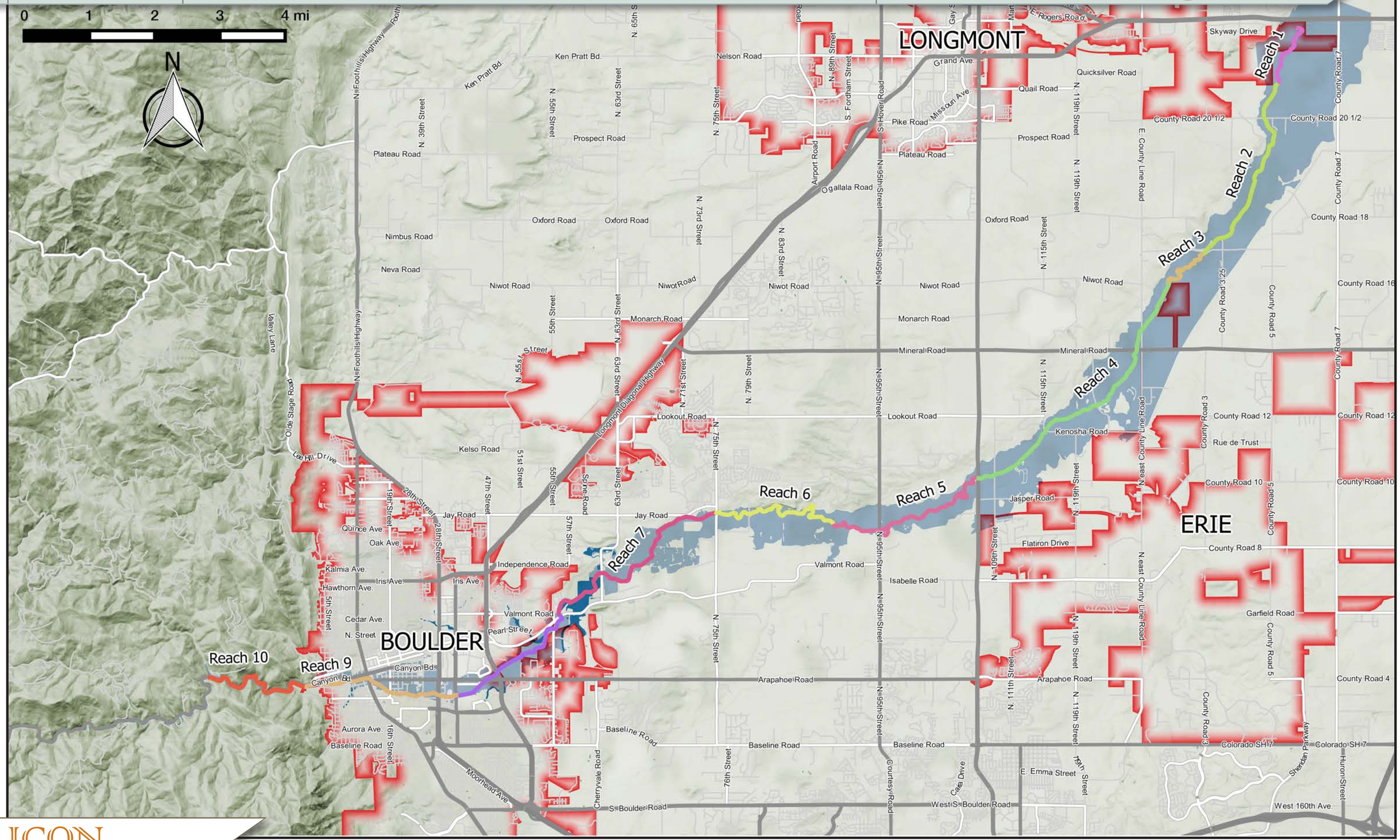
From a channel morphology standpoint, the significant past aggregate mining and other land use practices result in Reach 2 being very channelized. A narrow riparian fringe remains along the banks at some portions along Reach 2 while other sections of this reach have effectively no riparian vegetation. Sinuosity in Reach 2 is 1.04, which is the lowest of any stretch of Boulder Creek downstream from the City of Boulder. The average slope through this reach is approximately 0.28%. Based on sinuosity, slope, observed bed material and estimated entrenchment, Reach 2 is most similar to a Type F4 stream using the Rosgen Stream Classification System, although its sinuosity is lower and the natural stream type is very likely a C4. Encroachment and channelization have resulted in the unnatural F4 stream type. Bank instability and signs of past stabilization work exist at many locations along Reach 2. Through this reach the stream has an average width of approximately 30-40 feet.

December 2015

Figure 4-2

Boulder Creek Master Plan

Reach Overview



ICON ENGINEERING, INC.

Impacts within this corridor from the 2013 flood primary reflect damage along the County's roadway crossings with Boulder Creek, specifically at County Roads 20½ and 16½. At these locations, flooding resulted in scour around the bridge abutments and piers. The roadways were damaged where they overtopped.



Photo 5: Flood debris at 20½ Road (Reach 2)



Photo 6: Pier scour at 16½ Road (Reach 2)

Reach 3 (From CR 16½ to approximately 5,800 ft upstream)

Reach 3 lies completely within Weld County, although the majority of the property is managed through Boulder County Open Space Conservation Easement. This is a short reach with a stream length of 5,800 ft. but only spans a distance of 3,900 ft. The most significant, and ongoing, problem within Reach 3 occurs upstream of Weld County Road 16.5, where a breach in the Bryant Pond diverts flow from Boulder Creek east into the Williams Reservoir No. 1. This has led to overtopping of 16.5 Road well east of the bridge and has led to the continued cut through the south bank of Idaho Creek downstream of the Idaho Creek diversion structure thus bypassing the controlled diversion element at the confluence of Boulder Creek and Idaho Creek.

From a channel morphology standpoint, the remainder of Reach 3 appears to have not been significantly impacted by adjacent land use. Sinuosity through this reach was measured to be 1.49 and evidence of past stream meanders observed on aerial photos suggest that the current stream alignment has a sinuosity that is consistent with past channel alignments. These aerial photos can be found in APPENDIX D

The average slope through this reach is approximately 0.31%. Based on sinuosity, slope and observed bed material, Reach 3 classifies as a Type C4 stream using the Rosgen Stream Classification System. A riparian corridor exists adjacent to the channel throughout a majority of Reach 3, although there are locations along the channel where minimal vegetation remains. The channel takes on a meandering pattern with point bars and bend pools throughout this segment. Average stream widths are on the order of 30-40 feet. Bank instability exists but beyond the 16.5 Road corridor, are not a concern as there is an adequate riparian zone.

Reach 4 (From approximately 5,800 ft. upstream of CR 16½ to U.S. 287)

Reach 4 is the longest reach with a stream length of 4.5 miles. The downstream section is in Weld County and flanked by past aggregate mining activities, the Town of Erie's sanitary and re-use facility, and areas under active gravel operations. The overbanks include active and fallow farm lands and minimal residential development (including a small trailer park). Reach 4 is located in both Weld County and Boulder County with portions of the land owned or managed by Boulder County Parks and Open Space. There are six stream crossings that span Boulder Creek through Reach 4, some of which have the capacity exceeding the 100-year event. Others are more limited in capacity, dilapidated, or un-usable. Several diversion systems also exist within Reach 4. Finally, downstream of 109th Street, Boulder County is pursuing a stream restoration project with the U.S. Army Corps of Engineers. This project extends from 109th Street to Kenosha Road.

From a channel morphology standpoint, Reach 4 has been significantly impacted by adjacent land use as it is channelized along the full length of reach. Sinuosity through this reach was measured to be 1.05, which is essentially the same as Reach 2 and illustrates that the stream has been straightened. A narrow riparian fringe remains along the banks at some portions along Reach 4 while other sections of this reach have effectively no riparian vegetation. The average slope through this reach is approximately 0.34%. Based on sinuosity, slope, observed bed material and estimated entrenchment, Reach 4 classifies most closely to a Type F4 stream using the Rosgen Stream Classification System, although the natural stream type is very likely a C4. Encroachment and channelization have resulted in the unnatural F4 stream type. Bank instability and signs of past stabilization work exist at many locations along this reach. Through this reach the stream has an average width of approximately 30-40 feet.

During the September 2013 minor damage and breaches occurred of the adjacent ponds. A significant bank cut developed adjacent to the Town of Erie's re-use pond, downstream of County Line Road. This pond also experienced a deluge of flood waters from overtopping of adjacent ponds and roadways to the south. Following the flood, the south bank of Boulder Creek was reinforced with concrete rubble as a temporary stabilization measure. This bank should be repaired permanently. Upstream of County Line Road, open space ponds breached and the stream bank failed within the Doniphan, Wittemeyer, and Bailey-Kenosha Pond open space properties. Similarly, the bridge connection between the north and south properties in the open space, and existing irrigation diversion was damaged and in need of removal or repair. Damage to stream banks, sedimentation, and flooding of homes also occurred within the Wheeler Ranch property, located between Boulder County Open Space areas and County Line Road.

Further upstream. Residential properties were significantly damaged by flood water which overtopped Kenosha Road. Upstream of 109th Street, Boulder Creek diverted from its banks and washed out the 109th Street roadway approximately 600 ft. north of the current bridge crossing. This roadway has since been repaired by Boulder County.





Photo 7: Bank erosion at the Town of Erie Reuse Pond (Reach 4)



Photo 8: Failed bridge at Bailey-Kenosha Open Space (Reach 4)



Photo 9: Bank erosion near the Bailey-Kenosha Pond (Reach 4)



Photo 10: Flood damaged home near Kenosha Road (Reach 4)



Photo 11: Downstream County Line Road (Reach 4)

Photo 12: Downstream from U.S. 287 (Reach 4)

Reach 5 (From U.S. 287 to approximately 4,200 ft. upstream of 95th Street)

This reach is completely within Boulder County and has a stream length of approximately 3 miles. Within Reach 5, Boulder Creek crosses 95th Street, which washed out during the September 2013 flood event. Two diversion structures feed the Boulder and Weld County Ditch and the Lower Boulder Ditch. The overbanks generally consist of inactive gravel pit areas and both active and fallow farm fields. A vast majority of this reach is within property owned by Boulder County Parks and Open Space, including the Alexander Dawson Open Space, or conservation easements. Past stabilization efforts have been implemented in this reach, although damage was extensive following the flood.

From a channel morphology standpoint, Reach 5 appears to have been impacted somewhat by adjacent land use but still retains some of the characteristics of a natural stream. Sinuosity through this reach was measured to be 1.15, which is lower than would be expected from a natural stream in this setting. Aerial photos show that past alignments took on a more sinuous configuration. The average slope through this reach is approximately 0.34%. Based on sinuosity, slope, observed bed material and assumed entrenchment, Reach 5 classifies most closely as either a Type C4 or Type F4 stream using the Rosgen Stream Classification System. The natural stream type is very likely C4. A marginal riparian corridor exists adjacent to the channel throughout much of Reach 5, but the riparian zone has been largely impacted. The channel takes on a minimal meandering pattern with limited point bars and bend pools throughout this segment. Average stream widths are on the order of 30-40 feet. Bank instability exists in many locations in Reach 5.

During the September 2013 flood, Boulder Creek diverted from its banks upstream of US 287 and within the Alexander Dawson Open Space property. The diversion short-cut the preexisting channel and recent restoration features installed by Boulder County and the Urban Drainage and Flood Control District. Overtopping of 95th Street caused by creek avulsion upstream of 95th Street was also significant, and the roadway failed approximately 1,000 feet north of the current bridge location. Significant damage was also noted to downstream ponds and property. This roadway has since been repaired by Boulder County.



Photo 13: Braided flooding within the Alexander Dawson Open Space (Reach 5)



Photo 14: 95th Street flooding (Reach 5)
photo courtesy of David Mallory, UDFCD



Photo 15: Lower Boulder Ditch Diversion (Reach 5)



Photo 16: Upstream 95th Street (Reach 5)

Reach 6 (From approximately 4,200 ft. upstream of 95th Street to 75th Street)

Reach 6 is approximately 4.5 miles long and is completely contained within Boulder County. The stream corridor itself is contained within land managed by the City of Boulder's OSMP. This reach appears to be in a fairly natural state with little encroachments on either overbank. However, gravel mining operations on the south side of the creek have left several small gravel pits in the floodplain. Hydraulic drop structures exist both upstream and downstream of 75th Street and the diversion structure for the Leggett Ditch is centrally located.

From a channel morphology standpoint, Reach 6 appears to have not been significantly impacted by adjacent land use as the stream is only confined by one pond along its right (south) bank at its downstream end and by natural topography along much of its left bank. Sinuosity through this reach was measured to be 1.43 and evidence of past stream meanders observed on aerial photos suggests that the current stream alignment has a sinuosity that is slightly less yet generally consistent with past channel alignments. The average slope through this reach is approximately 0.40%. Based on sinuosity, slope and observed bed material, Reach 6 classifies as a Type C4 stream using the Rosgen Stream Classification System. A riparian corridor exists adjacent to the channel throughout a majority of Reach 6, although there are locations along the channel where minimal vegetation remains. The channel takes on a meandering pattern with point bars and bend pools throughout this segment. Average stream widths are on the order of 30-40 feet. Bank instability exists but is not a concern in areas with an adequate riparian zone.

Problems related to the September 2013 flood were minor relative to other reaches.



Photo 17: 75th Street Bridge (Reach 6)



Photo 18: Upstream 75th Street bridge (Reach 6)

Reach 7 (From 75th Street to Valmont Road)

This reach is approximately 3.5 miles in length and covers areas of both City of Boulder Open Space and Mountain Parks and Boulder County Parks and Open Space properties. Through this reach, the channel is nearly completely flanked by sand and gravel ponds, and mining operations. Most of these operations are no longer active and the excavated ponds remain full of water. A single large active gravel pit is located on the south bank of the creek approximately ½ mile downstream of 61st Street. The City of Boulder wastewater treatment plant is located just south of the creek, upstream of 75th Avenue. This wastewater treatment plant is protected from flooding by a ring levee. Private stream crossings, minor arterial (61st Street), bike path, and a major arterial (Valmont Road), are all located within Reach 7. The confluence of South Boulder Creek and Boulder Creek is located within Reach 7.

From a channel morphology standpoint, Reach 7 is impacted by adjacent land use but is the first segment downstream of high intensity development that starts to take on some of the characteristics of a natural stream. Sinuosity through this reach was measured to be 1.11, which is lower than would be expected from a natural stream in this setting and similar to Reach 5. The average slope through this reach is approximately 0.43%. Based on sinuosity, slope, observed bed material and assumed entrenchment, Reach 7 classifies most closely as a Type F4 stream using the Rosgen Stream Classification System. The natural stream type is very likely C4. The riparian corridor ranges from good to marginal at different locations within Reach 7, but it has been heavily impacted throughout by past land uses. There is a limited channel meander pattern. Average stream widths are on the order of 30-40 feet. Bank instability exists in many locations in Reach 7.

During the September 2013 flood, ponds within the Walden Pond Open Space breached in several locations. Boulder County is currently in the process of permanently breaching and repairing several of these ponds. The majority of flood damages within the City of Boulder occurred within open space locations. Upstream of 61st Street, Boulder Creek's north bank breached in two locations, diverting floodwater and sediment into Pit D, and the Cline Fish Ponds. The gravel pit south of Pit D also breached to Boulder Creek. Downstream of 61st Street, Boulder Creek breached its north bank, carving a new course through a former gravel pit and bypassing the existing Green Ditch diversion point. The City is currently developing design plans in preparation for future restoration of these areas, in addition to the reach immediately east of 61st Street. Within the confluence area of Boulder Creek and South Boulder Creek, the nearby Butte Mill Ditch breached at the crossing with South Boulder Creek and floodwater washed around the KOA Pond, also on South Boulder Creek. Finally, significant sedimentation and debris collected upstream of the Old Valmont Road Bridge. Flood debris also settled near the current Valmont Road location.



Photo 19: Downstream 61st Street (Reach 7)



Photo 20: Upstream 61st Street (Reach 7)



Photo 21: Boulder Creek breach to Pit D (Reach 7)



Photo 22: Old Valmont trail bridge (Reach 7)

Reach 8 (From Valmont Road to 30th Street)

This reach is approximately 2.3 miles in length and primarily within the City of Boulder. The channel characteristics generally include a combination of riparian habitat and roadway, or trail crossings. Wonderland and Goose Creeks enter Boulder Creek within Reach 7, and several small ponds are adjacent to the stream. For Boulder Creek, Reach 8 reflects the transition to an urban flood channel and for the most part, Boulder Creek has been locked in place through urbanization. The Burlington Northern and Santa Fe (BNSF) railroad embankment presents a significant obstacle for Boulder Creek and its connectivity with upstream and downstream floodplain areas. The BNSF crossing also has significantly less conveyance capacity than the larger span bridges within Boulder.

From a channel morphology standpoint, Reach 8 is heavily impacted by adjacent land use. Sinuosity through this reach was measured to be 1.07, which is extremely low and illustrates the channelization that has occurred. The average slope through this reach is approximately 0.68%. Based on sinuosity, slope, observed bed material and assumed entrenchment, Reach 8 classifies most closely as either a Type C4 or Type F4 stream using the Rosgen Stream Classification System, although the bed of the stream contains a fair amount of cobble. The natural stream type is very likely C4. There are small segments within Reach 8 where a healthy riparian corridor exists, however much of the riparian zone has been lost due to urbanization. Significant bank armoring exists within this reach. Average stream widths are on the order of 30-40 feet. Bank instability exists in many locations in Reach 8.

Problems within this reach during the 2013 flood event were not as significant as other locations. Principal problems related more to South Boulder Creek than Boulder Creek.



Photo 23: Upstream of Valmont Road (Reach 8)



Photo 24: Upstream of 55th Street (Reach 8)



Photo 25: BNSF Railroad Embankment (Reach 8)



Photo 26: BNSF Railroad Bridge (Reach 8)

Reach 9 (From 30th Street to City of Boulder Limits)

Reach 9 extends through downtown Boulder from 30th St. to upstream of the Arapahoe Avenue crossing. The reach includes the University of Colorado (CU) Campus, between 17th Street and Folsom. Many roadway crossings exist through this reach as well as Boulder Creek trail bridges. The Boulder Creek trail runs along the creek for the entire reach. Many buildings are located within the Boulder Creek floodplain. Both FEMA and the City of Boulder have designated additional regulatory zones to manage development and redevelopment. Strategic plans, including CU's North of Boulder Creek study review management strategies to reduce flood risk with future development. The City of Boulder is currently in process of planning for redevelopment surrounding the Civic Center area and are evaluating this plan with respect to flood management.

From a channel morphology standpoint, Reach 9 is heavily impacted by adjacent land use. Sinuosity through this reach was measured to be 1.02, which is extremely low and illustrates the channelization that has occurred. The average slope through this reach is approximately 1.11%, which is notably steeper than downstream segments and typical of a transitional segment between the mountains and the plains. Based on sinuosity, slope, observed bed material and assumed entrenchment, Reach 9 classifies most closely as either a Type C3 or a Type F3 stream using the Rosgen Stream Classification System. Near the upper ends of Reach 9 where slopes and median substrate material size increase the classification approaches B2 to B3 Type. A narrow riparian zone exists along the length of Reach 9, but in most cases it is surrounded by dense development. Significant bank and bed armoring exists within this reach. Average stream widths are on the order of 30-40 feet. Bank instability exists in many locations in Reach 9.

Problems within this reach during the 2013 flood event were not as significant as other locations. Flooding occurred within isolated areas of the University of Colorado Campus. The flooding was relatively minor and contained to landscape locations, although an existing pedestrian bridge crossing near 19th Street was washed out. Damage to in-stream structures also occurred along Boulder Creek within the Civic Center area. This damage has since been repaired by the City. The City of Boulder estimated that damages from Boulder Creek exceeded $41 million; however, these damages were largely attributed to high groundwater and sewer backups.



Photo 27: 19th Street Pedestrian Bridge (Reach 9)



Photo 28: Downstream 28th Street (Reach 9)



Photo 29: Downstream Broadway Bridge (Reach 9)



Photo 30: Boulder Creek at Civic Center Park (Reach 9)

Reach 10 (Boulder Canyon – City of Boulder to confluence with Fourmile Creek)

Reach 10 reflects the reach of Boulder Canyon between the City of Boulder and the confluence with Fourmile Creek. This reach has much steeper overbank slopes and narrower cross section than the reaches to the east. The reach length is approximately 2 miles and the riparian zone is narrow at less than 100 feet wide. Through the canyon, State Highway 119 parallels the creek, crossing it twice. The Boulder Creek trail also parallels Boulder Creek along the opposite bank of the highway. In general, the stream banks are steep and stable but armored with cobble, rock, and riprap. Boulder County is currently in process of repairing sections of the Boulder Creek trail and extending the path up to Fourmile Creek.

From a channel morphology standpoint, Reach 10 is heavily impacted by Highway 119. The highway abuts against the stream in many locations. While the stream alignment is largely defined by the geology of the canyon, the highway further constrains the stream. Sinuosity through this reach was measured to be 1.18, which is typical for this type of a canyon setting. The average slope through this reach is approximately 2.81%, which is notably steeper than downstream segments and controlled by the canyon. The channel substrate consists predominantly of cobbles, boulders and some bedrock. Based on sinuosity, slope and observed bed material, Reach 10 classifies as B1 to B3, depending on the specific substrate at a given location along the reach. The riparian zone is largely impacted by the highway. In areas where the stream and highway are immediately adjacent to one another, streamside vegetation is often completely absent. In a few locations where the highway and stream are separate, a narrow riparian corridor typical for this stream type was observed. Very significant bank and bed armoring exists within this reach. Average stream widths are on the order of 25-35 feet. Much of the armoring is associated with the highway but in other locations armoring appears to have occurred to protect other infrastructure. Bank instability exists in many locations in Reach 10.

Within Boulder Canyon, flood damage occurred to both Boulder Creek and State Highway 119. High velocities contributed to steam erosion, deposition and undermining of roadway infrastructure. Flows from inflow tributaries also overwhelmed infrastructure, resulting in damage to Highway 119. Much of the immediate damage has since been repaired by CDOT; however CDOT is currently planning for more permanent and flood resilient facilities in Boulder Canyon. Stream restoration needs are still prevalent, particularly along the Boulder Creek Path upstream of Settler's Park Trailhead.



Photo 31: Bank armoring in Boulder Canyon (Reach 10)



Photo 32: Depositional island in Boulder Canyon (Reach 10)



Photo 33: Deposition in Boulder Canyon (Reach 10)



Photo 34: Stable stream section near Fourmile Creek confluence (Reach 10)

Table 4-1: Existing Reach Properties

Reach	Length (ft)	Slope (%)	Sinuosity
1	5,970	0.25%	1.25
2	16,615	0.28%	1.04
3	5,815	0.31%	1.49
4	24,300	0.34%	1.05
5	15,210	0.34%	1.15
6	13,660	0.40%	1.43
7	18,450	0.43%	1.11
8	12,330	0.68%	1.07
9	13,100	1.11%	1.02
10	10,840	2.81%	1.18

4.3 Recreation and Public Access

Recreation and Public Access are an integral part of Boulder Creek. Extensive studies have been prepared that have reviewed recreation and its impact to the natural systems along Boulder Creek. These studies have been well vetted with the public over the years and have been founded on scientific and ecological principles. As part of this current study we have reviewed these previous studies and have incorporated their findings within the overall master plan. Previous studies include the Boulder County Comprehensive Plan, published May 27, 1999; the Lower Boulder Creek and Coal Creek Open Space Master Plan, published by Boulder County Parks and Open Space Department, 1997; the Boulder County Trail Plan published in 2003; the Weld County Trails Inventory Map 2010, and the City of Boulder Open Space and Mountain Parks Grassland Ecosystem Management Plan.

Boulder County Comprehensive Plan – Trails Guiding Principles

- ***OS 6.01*** Trails and trailheads shall be planned, designed, and constructed to avoid or minimize the degradation of natural and cultural resources, especially riparian areas and associated wildlife habitats. Riparian areas proposed for preservation but for which trail development is inappropriate include: 1) Boulder Creek between 55th Street and U.S. Highway 287, 2) St. Vrain Creek west of Airport Road, 3) Left Hand Creek west of State Highway 119, and 4) Rock Creek west of McCaslin Boulevard.
- ***OS 6.02*** Adverse effects on private lands shall be minimized insofar as possible by trail and trailhead placement, posting of rules and signs against trespassing, installation of containing fences where critical, and any other appropriate measures.
- ***OS 6.03*** The County shall acquire trail rights-of-way through purchase, lease, donation or dedication from any public or private entity. When appropriate and beneficial, existing roads and rights-of-way will be used.
- ***OS 6.04*** Trails shall provide for pedestrian, equestrian, bicycle, and/or other non-motorized uses, where each is warranted. Incompatible uses shall be appropriately separated.
- ***OS 6.05*** Special consideration shall be given to pedestrian, equestrian, bicycle, and/or other uses of road rights-of-way during the design and construction of road improvements.
- ***OS 6.06*** The County shall work through the Consortium of Cities to assure linkage of municipal and county trails and connections between communities.
- ***OS 6.07*** Where appropriate, trails should be incorporated into and provided by new development and linked to established trails, if possible.
- ***OS 6.08*** Trails constructed by the County Parks and Open Space Department shall be soft-surface except where necessary to prevent erosion and/or other resource damage.

Lower Boulder Creek and Coal Creek Open Space Master Plan:

Objectives

The foundation of this planning effort was the identification of specific project objectives to guide development of the Lower Boulder Creek and Coal Creek Open Space Master Plan.

- Re-establish successional river processes and restore self-sustaining riparian ecosystems
- Restore historic floodplain and associated features
- Preserve, restore, and create diverse, functional wetland communities
- Preserve, restore, and create a diversity of native plant communities and wildlife habitats throughout the stream corridor
- Enhance pond and stream water quality through natural processes
- Enhance aquatic habitat in surface waters
- Restore upland habitat
- Preserve and enhance viewsheds and open space in perpetuity
- Provide for a diversity of post-gravel mining land uses that complement the rural character of the region and promote a healthy stream corridor ecosystem
- Provide for recreational opportunities while preserving the integrity of the ecosystem
- Preserve and enhance cultural and agricultural resources
- Demonstrate the legacy of and Promote a sustainable future for the Boulder and Coal Creek systems

To sustain the function and value of native ecosystems in a landscape so affected by human activity both in and beyond the project boundaries requires that a delicate balance be maintained: a balance which is just beginning to be understood. The visible effects of past human activity on this property are, in fact, extensive.

Restoration is emphasized as a primary objective of this Master Plan; however restoration does not infer that the landscape is restored to a pristine state, or that human activity be precluded.

It is the conscious, careful synthesis of people and environment which creates sustainable community. This Master Plan addresses ecosystem function in the regional context. It also emphasizes restoring healthy, natural systems and preserving and enhancing biodiversity while accommodating compatible land uses such as agriculture, linear extraction, interpretation, and recreation within the project area. The principle goal of this planning effort is to preserve, restore, and enhance both ecosystem functions and cultural values.

Trails, Recreation, and Interpretation

Recreational features such as a regional trail, internal trails, fishing opportunities, and interpretive facilities are also recommended. These are located to minimize adverse environmental impacts and maximize the diversity, education, and enjoyment of the park user.

While preservation, ecological enhancement, and restoration are emphasized for much of the project area, the Master Plan recognizes that providing appropriate public access and recreation opportunities in open lands is essential to instilling a conservation ethic. It is recommended that a trailhead, and passive recreational/interpretive area be developed at the Kenosha parcel, herein referred to as Kenosha Ponds Park, situated near the Erie town limits. Numerous features of interest exist and are proposed for this site. Also, the Lower Boulder Creek and Coal Creek Master Plan is aimed at demonstrating ecosystem restoration and beneficial land management practices. Kenosha Ponds Park has the potential to be an invaluable educational center at the eastern gateway to Boulder County: one which demonstrates the County's philosophy and commitment to its environmental and cultural heritage.

General Planning and Management Recommendations

Maximizing species diversity and breeding bird population density on the property while protecting habitat for species of special concern is emphasized. The following recommendations are provided:

- Preserve mature riparian trees
- Encourage shrub growth along riparian corridors
- Preserve cattail marshes and exclude cattle from marsh (wetland #5) north of Boulder Creek
- Retain all standing dead trees along Boulder Creek and Coal Creek for cavity-nesting birds such as wood ducks
- Divert trails away from red-tailed hawk nest sites
- Divert trails away from Boulder Creek and some wetlands between the western study area boundary and Kenosha Road
- Generally locate future trails west of Kenosha Road a minimum of 10 meters from the creek and provide visual buffer from the creek bed for the protection of herons and cormorants

Trails

The Boulder County Comprehensive Plan (BCCP) designates a conceptual regional trail corridor along Boulder Creek from west of N. 95th St. to the Boulder County line. Although an exact alignment has not been determined for the linkage from this site west, a recommended trail alignment through the project area is proposed in this plan.

While access to streams and ditches provides an interesting park user experience, these waterways also provide the most diverse and valuable habitat zones onsite, and provide the critical function of wildlife movement corridors. It was determined, therefore, that the proposed trail should not follow the length of any waterway, but accesses them only intermittently. Other historic or natural points of interest are linked by trail to direct public use away from environmentally sensitive areas, including those scheduled for restoration.

A regional trail spur is proposed to access the Wise Museum, near 119th Street and Jasper Road, south of Boulder Creek. The lands east of 119th Street and south of Kenosha Road also have recently been annexed to the Town of Erie, and residential development has begun in this area.

In addition, an Erie neighborhood park is slated for construction here, accessed by an internal trail. Linkage to this privately developed trail system will provide valuable opportunities for the residents to access the open space lands, and will allow a regional trail connection to the eastern portion of the open space lands known as Kenosha without traversing the Boulder Creek corridor, An internal loop trail system and passive recreation I interpretive area is proposed at Kenosha Ponds Park.

Several equestrian facilities occur in the vicinity of the lower Boulder Creek/Coal Creek open space. It is recommended that the County consider allowing equestrian use on the regional trail, and provide hitching posts at trailheads. The internal trails proposed are best suited to pedestrian use only.

Kenosha Pond Park

The Kenosha parcel adjoins the town of Erie. Residential development has begun to occur in the area. Providing a passive recreational area in this vicinity to serve the citizens of Erie was an important consideration of the previous Master Plan efforts. Because the potential for stream restoration is limited in this reach, and a variety of interesting amenities exists, west Kenosha, herein referred to as Kenosha Ponds Park is a prime location for passive recreation, interpretation, and trailhead facilities at the eastern limit of the Boulder Creek regional trail corridor. Passive recreational activities recommended include hiking, fishing, wildlife viewing and picnicking. Programmed educational activities would also be appropriate. Phasing of park development in this area does not rely on sequential stream restoration phasing and can occur at any time according to Boulder County's priorities and budget.

Boulder County Regional Trail Program – Union Pacific Rail Trail

Boulder County has plans to pursue a resource inventory of the Union Pacific (UP) Rail Trail corridor. An inventory would identify environmental resources, trail opportunities, and alignment constraints along the UP rail line from the City of Boulder to the Town of Erie. This resource inventory would need to examine alternative trail alignments to protect wildlife resources.

The Union Pacific (UP) Trail (Figure 4-4) will run from the eastern boundary of the City of Boulder traversing nine miles to the Town of Erie along the Regional Transportation District (RTD) rail line when possible. Boulder County plans to pursue a technical report for the trail corridor that will identify trail alignment options, environmental resources, property ownership and any constraints. The trail could qualify as Rails-to-Trails project that may also accommodate a long-term Rails-with-Trail option.

The Weld County Trails Inventory Map 2010

The Weld County Trails Inventory Map highlights planned trail priorities based on a 2020 vision. The plan highlights the St Vrain Legacy Trail as a top priority.

City of Boulder Open Space and Mountain Parks Grassland Ecosystem Management Plan

The grasslands of the City of Boulder's Open Space and Mountain Parks (OSMP) land system are located where the Central High Plains meet the foothills of the Southern Rocky Mountains. These lands and waters have been acquired as part of a system designed to protect the agricultural, ecological, recreational, and scenic values of one of the most rapidly developing regions in North America.

The Grassland Ecosystem Management Plan (Grassland Plan) proposes specific on-the-ground management actions, public policies and lands & water acquisition priorities to conserve the ecological values of Open Space & Mountain Park's grasslands and ensure on-going agricultural production.

OSMP currently manages about 24,000 acres in the Grassland Ecosystem Management Plan project area. These areas conserve the species and natural communities that characterize the grasslands of the Boulder Valley. OSMP grasslands have been recognized by local, state and national agencies for their ecological values. They also support traditional agricultural uses such as livestock, hay and small grain production. Boulder's grasslands are popular destinations for outdoor recreation and see millions of visits annually.

Research and monitoring conducted on OSMP grasslands over time has revealed and emphasized the value of Boulder's native prairies as habitat for numerous rare and sensitive birds, mammals, insects, plants and other components of local prairie ecosystems. The ecological significance of Boulder's grasslands becomes increasingly important as urbanization spreads along the Front Range. Municipal open space is also important for the preservation of agriculture in Boulder County. Much of the land in agricultural use in the Boulder Valley is protected by ownership or partnership agreements by OSMP.

The Grassland Planning Area (GPA) is known to support more than 800 species of vascular plants, over 400 species of vertebrates and many more species in other, lesser-known groups (e.g., insects, mosses, algae). Rather than attempt to address each part of the grassland system individually, OSMP staff worked with partner agencies, biologists, ecologists, naturalists and other community members to identify the aspects of biological diversity that would best serve as the basis for setting objectives, taking action and measuring success.

These "conservation targets" include the Mixedgrass Prairie Mosaic and the Xeric Tallgrass Prairie—the two dominant cover types in the GPA.

The Agricultural Operations target addresses the long-term sustainability of agriculture on OSMP lands and the conservation of native species dependent upon agricultural operations.

The ecological system centered on the black-tailed prairie dog was also identified as a separate conservation target due to the distinctive ecological conditions and community of animals associated with prairie dogs. This target, Black-tailed Prairie Dogs and Associates, was also called out because of the unique challenges of managing a prairie dog-based system in a highly fragmented landscape.

OSMP also identified three targets dependent upon ground or surface water: Wetlands—including ponds, Riparian Areas—including creeks, and the Mesic Bluestem Prairie.

The White Rocks cliffs were identified as a target because they support a large number of rare species—well out of proportion to the small size of the area.

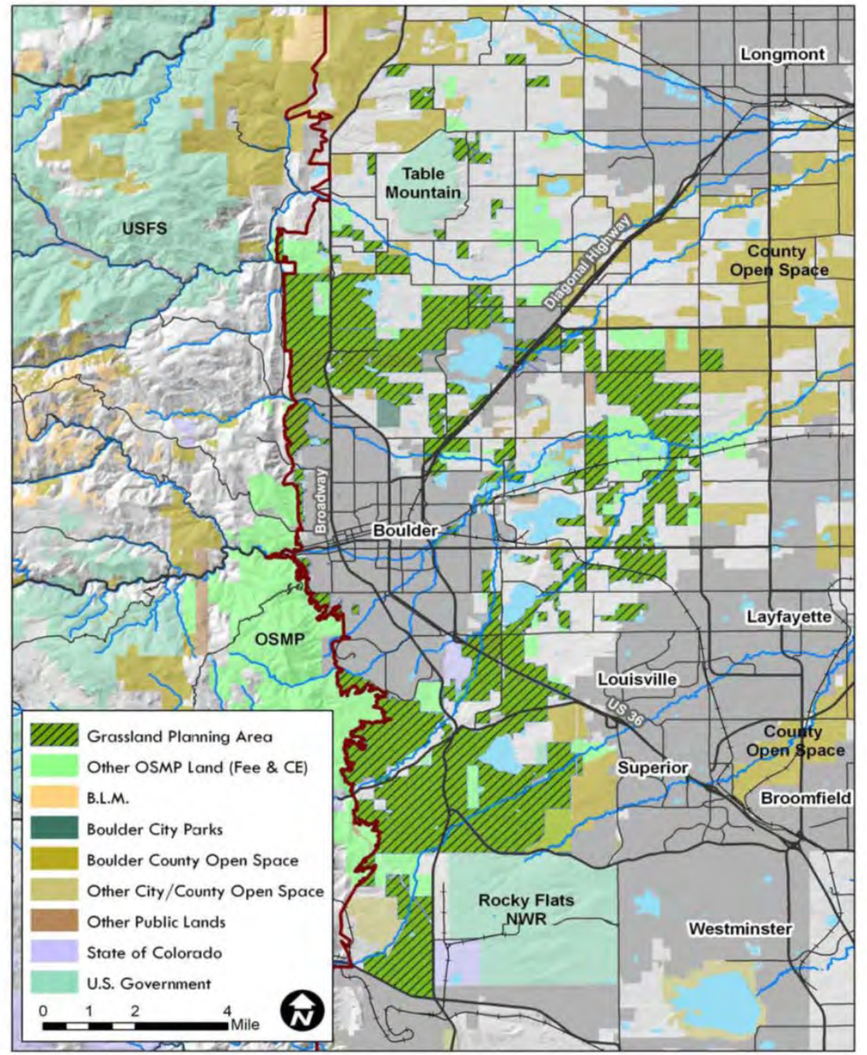


Figure 4-3: Grassland Planning Area

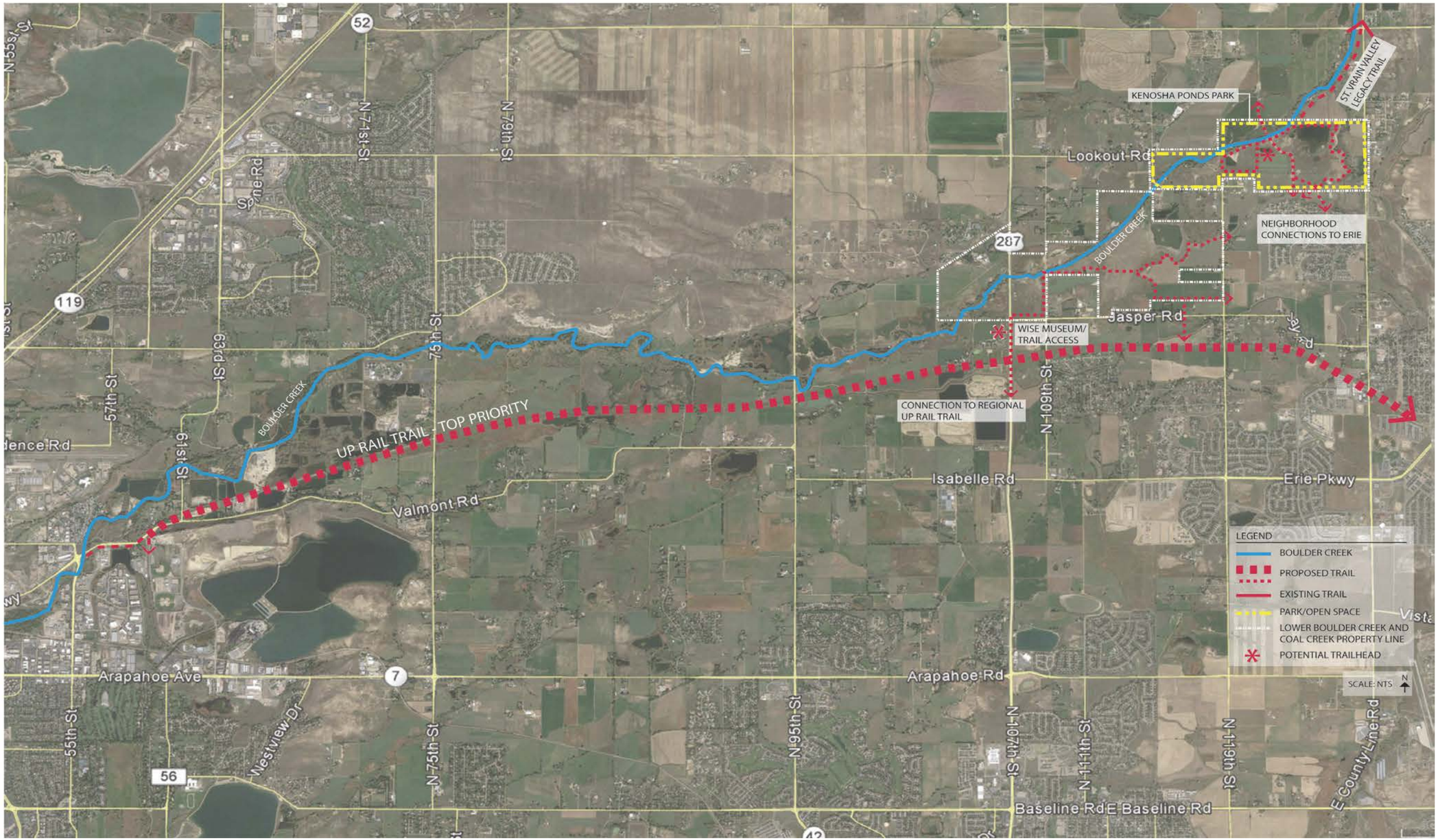


Figure 4-4: UP Rail Trail

5.0 HISTORIC STREAM EVALUATION

5.1 Background

As a way to understand alteration to the natural stream resulting from human impacts, historic mapping was used to evaluate historical stream alignments and how this data compares with current condition; confirm the gradual channelization of the stream which has led to a straighter alignments which lack natural meanders and bends; and to compare any noticeable changes in stream bank conditions.

To accomplish this, Boulder County supplied ERC with historic photographs showing a portion of Boulder Creek for years 1937, 1949, 1955, 1963, and 1969. In each of these years, aerial photos were only available for a relatively small portion of Boulder Creek. These historic photographs were inserted into the current Boulder Creek ACAD base map drawing and scaled by correlating known points from year to year. The entire study area includes Reach 1 through Reach 10, which accounts for approximately 25 miles (132,000 feet) of the current stream length. Historic aerial photographs overlays were available only for the southwest portion of Reach 4 and the northeast corner of Reach 5, with the specific extents of the photos varying by year. For each historic year, the creek alignment was traced in ACAD and changes were noted. The historic mapping for each year did not cover the same area from data year to data year; consequently the traced stream length for each data year varied in length. The minimum length covered of the existing stream was 18,120 feet (3.4 miles) and the maximum coverage was 32,610 feet (6.2 miles) based on 2015 stream conditions. For each data year, the length of traced stream was measured and the corresponding current (2015) length was recorded. The historic maps with the historic aerial overlays are included as attachments. The results of this evaluation are described in the following sections.

5.2 Channel Straightening

The results of the overlay and tracing exercise indicate that the creek has become straighter over time as is apparent when comparing the current stream length to the historic stream lengths for each data year. Every data year shows a decrease in length in comparison to the current stream length. The table and graph shown in Figure 5-1 show the historic length, the comparable 2015 length and the loss comparison, as a percentage, from the data year to the current year. Note that the extent of mapping for each of the different historic aerial imagery is different. As such, the historic stream lengths shown in the second column in Figure 5-1 represent the length of stream shown on the historic aerial. The 2015 length of stream presented in the third column indicates the current stream length for the individual historic aerial photographs. In order to compare data in Figure 5-1 across the different aerial images of 1937 to 1969, the right hand column showing percent change was added. This column indicates that the present decrease in stream length is greatest when comparing current conditions to 1937 and has decreased over time. This illustrates the continued trend of channel straightening over time.

Year	Historic Length (ft)	2015 Length (ft)	Length Change (ft)	Percent Change
1937	29,555	21,070	8,485	29%
1949	23,620	18,120	5,500	23%
1955	32,115	26,070	6,045	19%
1963	35,570	30,155	5,415	15%
1969	36,560	32,610	3,950	11%

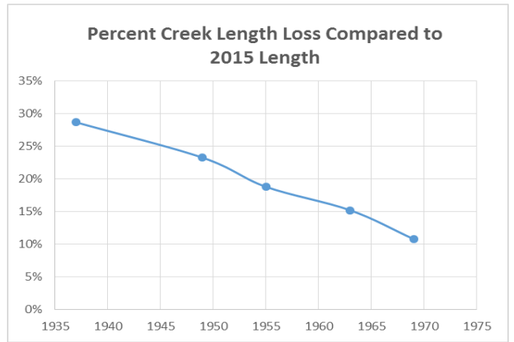


Figure 5-1: Loss of Stream Length over Time as a Percentage

An additional comparison was completed by taking the year with the least stream coverage (1949) and truncating the other historic year lengths to match the 1949 segment ends as a way of normalizing this segment. These values were recorded to see the reduction in the length over the same stream corridor section. As evident in the table below, this segment of channel has experienced channel straightening continually throughout the years. The table and graph below show the length loss when normalizing each year's length to the 1949 stream length. With the data years available, it appears the largest stream straightening occurred between 1949 and 1955.

Year	Historic Length (ft)	Length Change from Previous Data Year (ft)	Length Change Extrapolated on a per Year Basis (ft)
1937	25,250		
1949	23,620	1,630	136
1955	21,630	1,990	332
1963	20,735	895	112
1969	20,360	375	63
2015	18,120	2,240	49

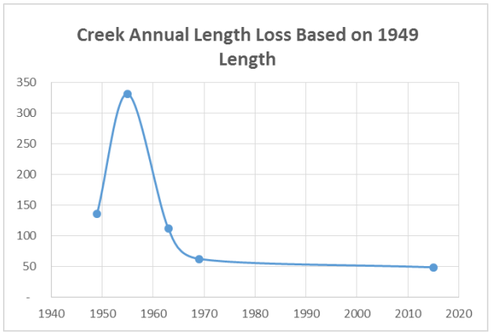
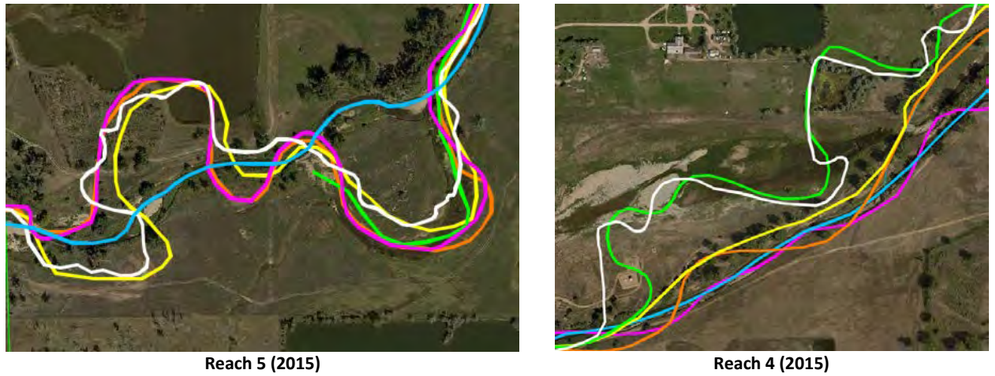


Figure 5-2: Loss of Stream Length

5.3 Sinuosity Changes

It is apparent from the stream length shortening that there is a corresponding change in the course of the river with the reduction of stream meanders. Below are two figures that show the historic creek pathways in comparison to the existing creek. The figure on the left, Reach 5, shows channel realignment occurring after 1969 and the figure on the right, Reach 4, shows channel realignment occurring between 1949 and 1955. The stream color coding is the following: 1937-White, 1949-Green, 1955-Yellow, 1963-Orange, 1969-Magenta, and 2015-Blue. In all cases the stream has straightened over time.



Reach 5 (2015) Reach 4 (2015)

Figure 5-3: Depiction of Modification to Channel Meanders

Channelization can be quantified by evaluating stream sinuosity. Sinuosity is the ratio of the length of a stream channel to the length of the valley. A sinuosity value of 1.0 indicates a straight channel whereas a sinuosity of 1.5 indicates that the length of the stream is 50% longer than the straight length of the valley. The higher the sinuosity of a channel, the more it meanders along its length. The figure below provides a graphic representation of a stream. Sinuosity is calculated as channel length (C_L) divided by Valley Length (V_L).

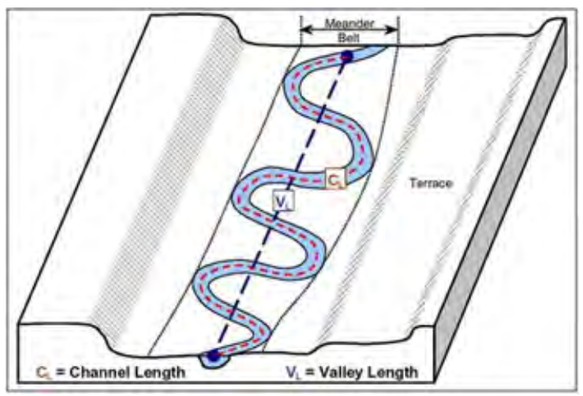


Figure 5-4: Stream Sinuosity

In order to quantify impacts of channelization on Boulder Creek, sinuosity was determined from historic mapping. These calculations were undertaken by measuring a valley length within the normalized section and comparing this value to the data year lengths. The results are shown below.

Year	Historic Length (ft)	Valley Length (ft)	Sinuosity
1937	25,250	17,060	1.480
1949	23,620	17,060	1.385
1955	21,630	17,060	1.268
1963	20,735	17,060	1.215
1969	20,360	17,060	1.193
2015	18,156	17,060	1.064

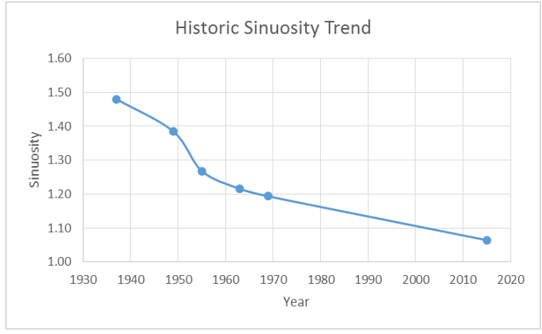


Figure 5-5: Change in Stream Sinuosity

5.4 Prior Stream Realignment

There is evidence of stream realignment occurring prior to 1949 when observing the 1949 photo overlay in Reach 5. There are distinct places where it is apparent that the creek followed a different alignment as is indicative of the curves and bends apparent in the 1949 natural ground surface photos below. Also it is apparent that stream straightening is more pronounced at road crossings as shown in the picture to the right below.

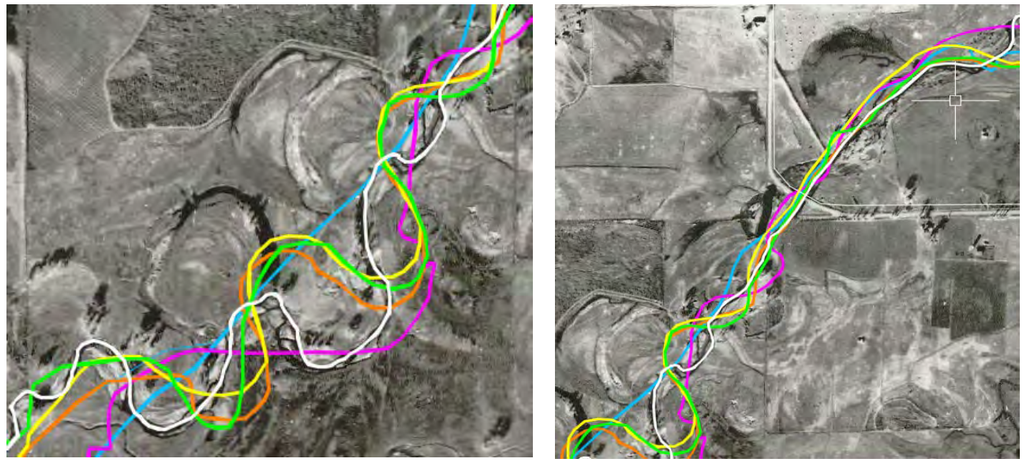


Figure 5-6: Straightening Trends in Reach 5

5.5 Conclusions

Historic aerial photographs dating from 1937 were available for a portion of reaches 4 and 5. Based on overlays of the available historic streams and comparison to the current stream alignment the following conclusions can be made:

- There has been an on-going trend of channelization.
- Land use practices have likely contributed heavily to the observed channelization.
- The channel has been straightened significantly by removing the natural sinuosity of the stream. This has led to steeper stream slopes and faster moving stream flows which negatively impact the entire biodiversity and health of the stream. Most likely the stream straightening has also resulted in a more uniform, shallow stream bed.
- Bank erosion is typically more prevalent in streams that have been straightened. Much of the bed and bank armoring that has been completed on Boulder Creek has likely occurred in response to channelization.

6.0 NATURAL RESTORATION OBJECTIVES

6.1 Background

Evaluation of current stream conditions identified impacts that past and current land use practices have on the condition of the stream. One of the objectives of the master plan is to define what a naturally occurring, unimpacted Boulder Creek would look like so that future restoration work can incorporate these types of stream characteristics. As part of the assessment, natural stream conditions that would likely exist for an unimpacted channel were defined. Potential alignments for a restored - unimpacted stream system, restored – confined stream system, or hybrid of the unimpacted and more confined stream system can be found in the appendix. It should be noted that there is not a singular correct solution in defining a restored stream alignment for Boulder Creek. The figures in the appendix are intended to provide an example for what a more natural system may look like. Final alignments would depend on many factors and should be further refined with individual project goals.

6.2 Characteristics of a Natural Channel

Observation of historic mapping indicates that the alignment and shape of the stream corridor has evolved in recent history in response to land use practices. Encroachment into the natural riparian corridor has caused channelization as is observed by the straightening of significant portions of the stream.

Some of the physical properties of natural channel conditions in Boulder Creek can be estimated based on flow, slope, geologic setting and an understanding of natural stream types. As part of this assessment, channel characteristics including stream bankfull width, stream depth, shape of the overbank and ideal sinuosity were estimated for the 10 individual stream reaches. In many instances it is not practical to implement these parameters due to land constraints and development, but these characteristics are intended to provide a template of what should be considered in areas where natural restoration is contemplated and sufficient land exists.

6.3 Typical Channel Geometries

Information on channel classification along with estimated flows were used to approximate natural channel geometries for the 10 individual stream reaches. One of the physical geomorphologic parameters of streams is bankfull flow. Bankfull flow is generally observed to be the flow rate at which the water exceeds the capacity of its active channel at starts to access its floodplain. Studies of typical stream geometry indicates that flood flows with a recurrence interval of approximately 1.5 to 2 years are the flows that exceed the bankfull level. Bankfull flows, which were approximated for this study using the 1.75-year flood flow, were used to help estimate the geometry of the active channel. Typical values of width to depth ratios (width of the stream at bankfull conditions divided by the bankfull stream depth) and entrenchment ratios (width of the stream channel for a depth that is twice the bankfull depth divided by the bankfull stream width) were used to help approximate natural channel geometry.

For each of these 10 reaches, the bankfull flows were used in combination with assumed natural channel types to define typical channel geometries. This information is provided in Table 6-1. Target bankfull channel widths, width/depth ratios, sinuosity and entrenchment ratios used to establish standard channel geometries are provided in Table 6-2. Target sinuosity values for reaches 1-8 were determined based on values from natural Type C streams, measured values in less disturbed areas and observation of historic meander patterns. Bankfull flows were calculated from gage records at the downstream end of Boulder Creek (Reach 1), at 75th Street (Reaches 6 and 7), in the City of Boulder (Reach 9) and in the canyon (Reach 10). Approximate bankfull flows in other reaches were interpolated. Bankfull widths were estimated based on observed areas where the current channel was found to be in good condition and was verified using bankfull flows and typical geomorphologic relationships between bankfull flow and width (Andrews 1984). Target entrenchment ratios were estimated based on stream type and typical values for the subgrade materials.

Table 6-1: Bankfull Flows and Stream Classifications at Locations with Estimated Flows

Reach	Bankfull Flow (cfs)	Target Bankfull Channel Width (ft)	Assumed Natural Stream Classification	Target Sinuosity
1	620	40	C4	>1.4
2	630	40	C4	>1.4
3	640	40	C4	>1.4
4	650	40	C4	>1.4
5	660	40	C4	>1.4
6	670	40	C4	>1.4
7	670	40	C4	>1.4
8	635	40	C4	>1.4
9	600	40	C3	>1.2
10	460	30	B3	>1.2

Table 6-2: Target Width/Depth Ratios, and Entrenchment Ratios for Each Stream Classification

Stream Classification	Width/Depth Ratio	Approximate Entrenchment Ratio
C4	>12	3.5
C3	>12	3.5
B3	>12	1.8

Approximate sizing for the bankfull channel and floodprone area adjacent to the active channel were defined. For this application the floodprone area describes the approximate width of the channel for a flow that is twice the bankfull channel depth. This is different than the floodplain and is intended to provide an indication of how quickly land adjacent to the channel slopes away from the channel. Given that changing the sinuosity of a reach would change its average slope, an approximate slope based on the desired sinuosity was assumed for these calculations.

A summary of recommended geometries for each reach is given in Table 6-3. This table can be used to define the approximate channel geometries throughout the basin. All channel sections are assumed to be generally trapezoidal with a bankfull width that is defined in the table.

These tabulated values provide average channel geometry information, but it is not the intent nor is it desired that the channel take on a uniform, defined cross section. Variability is inherent in any natural system and is desired for improvements along Boulder Creek.

Table 6-3: Geometries for Primary Stream Types at Each Flow Location

Reach	Assumed Sinuosity	Slope (%)	Bankfull Width (ft)	Bankfull Depth (ft)	Width at 2x Bankfull Depth (ft)
1	1.6	0.20%	40	3	140
2	1.6	0.19%	40	3	140
3	1.6	0.29%	40	3	140
4	1.6	0.22%	40	3	140
5	1.6	0.24%	40	3	140
6	1.6	0.36%	40	3	140
7	1.6	0.30%	40	3	140
8	1.6	0.46%	40	3	140
9	1.4	0.81%	40	2.5	140
10	1.3	2.60%	30	2	54

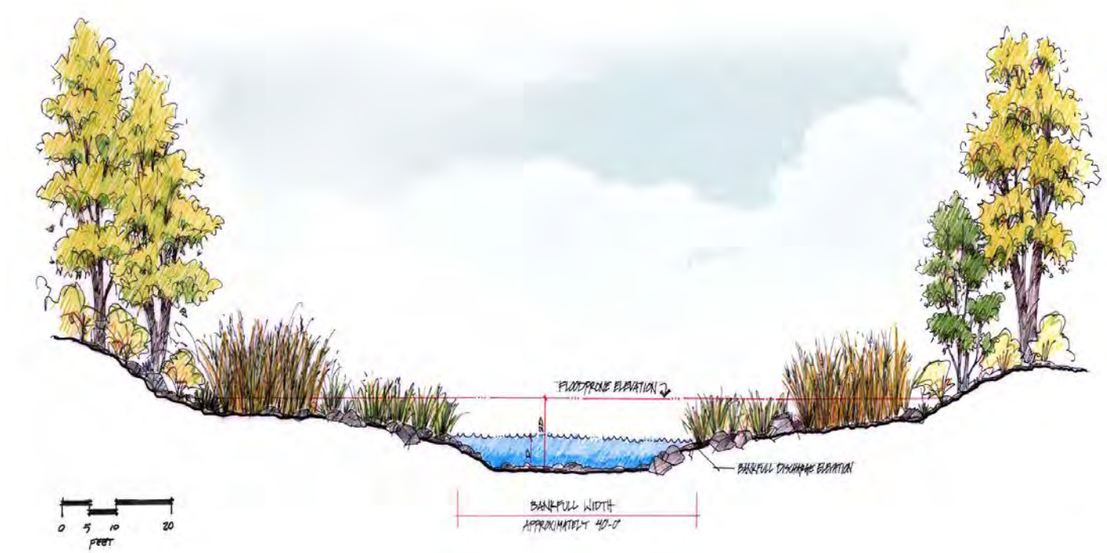
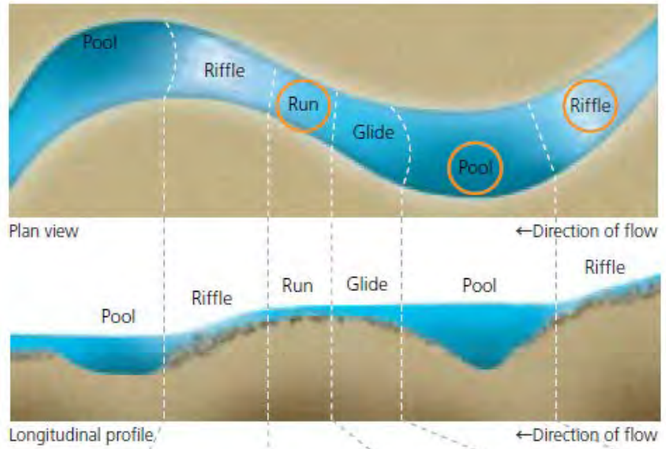


Figure 6-1: Typical Geomorphic Cross-section

In addition to variability in cross section, variability in channel slopes is a characteristic of natural channels. Features such as step pools, scour pools, rapids and riffles/pool sequences occur naturally and provide variety from both a habitat and aesthetic standpoint. Step pools, rapids and scour pools are bedform types that are typical of Type B stream that would be found in Reach 10. Riffle/pool sequences are alternating stretches of shallow, fast-moving sections (riffles) and deeper, slower pools, with glides or runs in between the end of a pool and beginning of the next riffle to allow for gradual bedform transformation. Riffle/pool sequences are typical bedforms seen in meandering, Type C streams such as Reaches 1-9. A schematic of a riffle/pool sequence, along with glides and runs is shown in Figure 6-2 (obtained from the Public Works Research Institute's Aquatic Restoration Research Center, 2004).



Zone	Riffle	Run	Glide	Pool
Water depth	Shallow	Shallow	Rather deep	Deep
Water surface	Whitecaps	Wrinkles	Calm	Calm
Current velocity	Very fast	Fast	Slow	Very Slow
River bed	Lying loosely on the top	Embedded	Sand and gravel	Sand and mud

Figure 6-2: Typical Riffle/Pool Schematic

7.0 BOULDER CREEK RIPARIAN ZONE

7.1 Background

During the September 2013 flood event, Boulder Creek experienced high peak flows for an extended duration which resulted in not only damages to infrastructure, but also widespread damages to the stream corridor. This section addresses the general condition of the existing riparian communities within the Boulder Creek corridor after the flooding and provides recommendations for re-establishment (or restoration) of the riparian zone within the project area.

During the initial flood recovery efforts, emergency stabilization measures focused more on hardened methods such as riprap, grout, boulders and infrastructure repair. As the focus shifts towards long-term recovery, measures must also consider restoration of critical natural riparian and aquatic ecosystem function.

The importance of a well-developed riparian corridor is well documented. Well vegetated riparian corridors provide important terrestrial wildlife habitat, provide instream aquatic habitat benefits, stabilize soils and reduce problems from erosion, flooding and excessive nutrients. A properly functioning riparian corridor protects the physical integrity of the aquatic environment.

A cursory baseline assessment of the existing post-flood riparian corridor was completed within the project area. The general condition of the existing riparian corridor was assessed including dominant vegetation community types remaining, species composition and primary vegetation strata that remain or that may have been damaged or lost. In addition, the assessment defined a typical "reference condition" riparian community or in other words the ideal natural riparian vegetation community that existed prior to the flood event and in an undisturbed state that should be the focus for riparian restoration during long-term recovery efforts.

The riparian corridor of the Boulder Creek project area also provides critical habitat that should be considered during flood recovery efforts. A cursory screening of potential federal and state threatened and endangered species that may occur on or immediately surrounding the project area was also completed. Included in this section is a summary of additional data reviewed for the project area including migratory birds, aquatic and macroinvertebrate data, wildlife closures and other important habitat management areas.

7.2 Importance of the Riparian Zone

A riparian corridor or "riparian zone" is defined as the transitional area or interface between upland terrestrial and aquatic habitats. A riparian zone is generally considered that portion of the landscape from the ordinary high water mark towards the adjoining uplands that affect or are affected by the presence of water (Figure 7-1). The riparian zone is often unique within a watershed containing notably different vegetation communities from the surrounding upland habitat. Properly functioning riparian zones of high ecological integrity contain an unfragmented, structurally diverse vegetation community, typically composed of three strata that includes trees, shrubs and grasses that are native to the region and that are adapted to the climatic, soil, and hydrologic conditions. The riparian zone has a variety of functions important to the stream or aquatic environment. Well vegetated riparian zones provide important terrestrial wildlife habitat, provide aquatic habitat benefits (shading, decreased water temperatures, biomass and instream cover), soil stabilization, and reduced problems from erosion, sedimentation and nutrients. Riparian vegetation also contributes to bank stability by dissipating the energy of moving water and reducing velocity, which is imperative during typical flood events. In an ideal situation, natural stream flows are able to access a broad floodplain. A properly functioning riparian zone protects not only water quality but also the physical integrity of the aquatic environment.

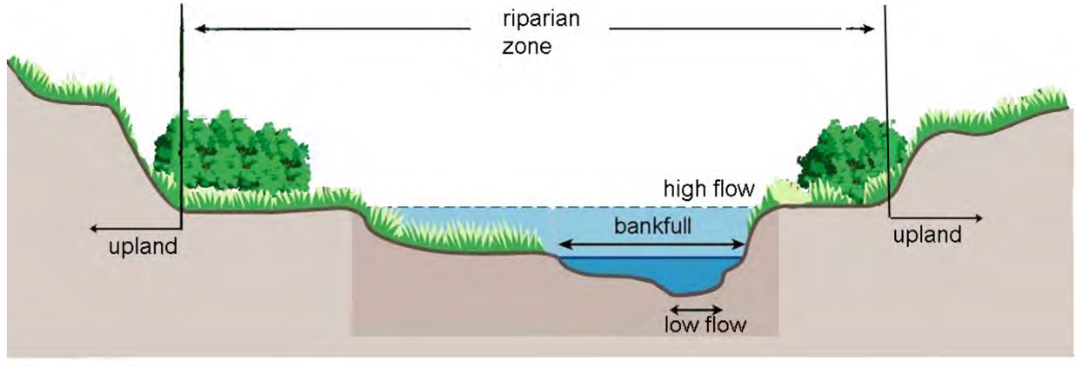


Figure 7-1: Components of a properly functioning riparian zone
(Image modified from FISRWG 1998.)

In general, the riparian zone width necessary to provide a particular level of function depends on the functions of the stream, the characteristics of the riparian zone, topography, intensity of adjacent land use, and overall watershed characteristics. The riparian zone is also often considered as a protective buffer to the aquatic system.

7.3 Land use and Vegetation Cover Types

Existing land use and vegetation cover types were evaluated within the project area using mapping from the US Geological Survey (USGS) Southwest Regional Gap Analysis Project (SWReGAP) (2001). The predominant land cover type of the project area is cultivated cropland (42% of land) which includes grazing, alfalfa and other crop production. Aggregate mining of sand and gravel since the mid 1950's has visibly shaped the project area landscape as open water ponds scatter the floodplain, occupying approximately 16% of project area. Natural vegetation cover types within the riparian zone occupy only 27% of the project area and are mainly classified as Western Great Plains Riparian Woodland and Shrubland and to a lesser degree Western Great Plains Floodplain. Other land mapped within the project includes high and low density developed areas (12%) such as land within the City of Boulder, larger paved roads and other miscellaneous developments.

7.4 Riparian Zone Vegetation Community and Reference Standard

Of the vegetation cover types identified within the project area (SWReGAP 2001), the primary natural riparian zone vegetation community type that occurs within the project area is the Western Great Plains Riparian Woodland and Shrubland. This vegetation community type is most characteristic of habitats within the project area thus would be considered the reference standard or ideal natural community.

The Western Great Plains Riparian Woodland and Shrubland community type is found widely in the Great Plains of Colorado and occurs in wide river corridors that have low-gradient and primarily sandy/gravelly beds (becoming cobbly with increasing gradients). The type is most often found proximal to perennial rivers on low sidebars and streambanks near stream bankfull levels (NatureServe 2004). Because of its low position, the type is flooded frequently (average recurrence interval is 5 years). Dominant communities within this streamside system range from floodplain forests to wet meadows where properly functioning systems are linked by underlying soils and the flooding regime (FGDC 2008).

Within the project area, this reference standard community would occur on low terraces and along the immediate streambanks of Boulder Creek through the riparian zone. The unconfined, active stream channel would frequently inundate vegetation through the riparian zone and active floodplain forming a complexity of habitats which support a variety of plant communities. Figure 7-3 depicts the components of a properly functioning and structurally diverse riparian community for Boulder Creek.

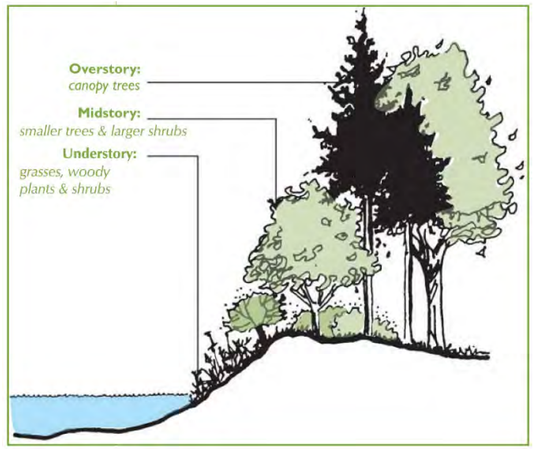


Figure 7-2: Components of a Riparian Community
(modified from: Montgomery county planning commission 2006).

Within the project area, the existing riparian vegetation community is also generally characteristic of the Western Great Plains Riparian Woodland and Shrubland community; however, the community is largely modified in vegetation structure, diversity and hydrologic regime from the ideal or reference standard community. The specific plant associations within the project area's riparian vegetation community can include drier species typically associated with upland forests and cultivated fields/pastures to mesic species associated with scrub-shrub fringe wetlands, wet meadows or emergent marshes. Some locations within the project area can also differ from the reference standard in the number of vegetation strata present, the amount of non-native species and overall percent cover.



Figure 7-3: Boulder Creek: Example Riparian Reference Standard
(dominated by cottonwood overstory with willow midstory and grass understory)

7.5 Riparian Zone Post Flood

The existing condition of the riparian zone both pre- and post- flood varies across the project area and is largely influenced by historic and current land use practices. In general, the overall extent and condition of riparian habitat and value has been impacted more from historic land use practices than direct impacts from the flood. Land use including riparian vegetation removal, urban development, grazing, mining, stream channelization and establishment of non-native invasive vegetation have significantly shaped the character and function of the riparian corridor. In addition, land leveling, stream channelization, water diversions and levees reduce the extent and frequency of floodplain inundation, which further diminishes the quality and quantity of riparian vegetation [Reference 29, Anderson & Company]. In these historically degraded areas, the riparian zone is narrow (<50 feet wide), fragmented and often dominated by non-native or weedy species.

Higher quality riparian areas typically occur within the project in areas less impacted by human land use. In these areas, Boulder Creek's riparian zone is wide, stable and densely vegetated extending well over 500 feet across the floodplain (Figure 7-4). The narrow riparian zone (left) is limited by land use and bisected by a railroad; the more naturalized downstream section (right) is wide and less confined.

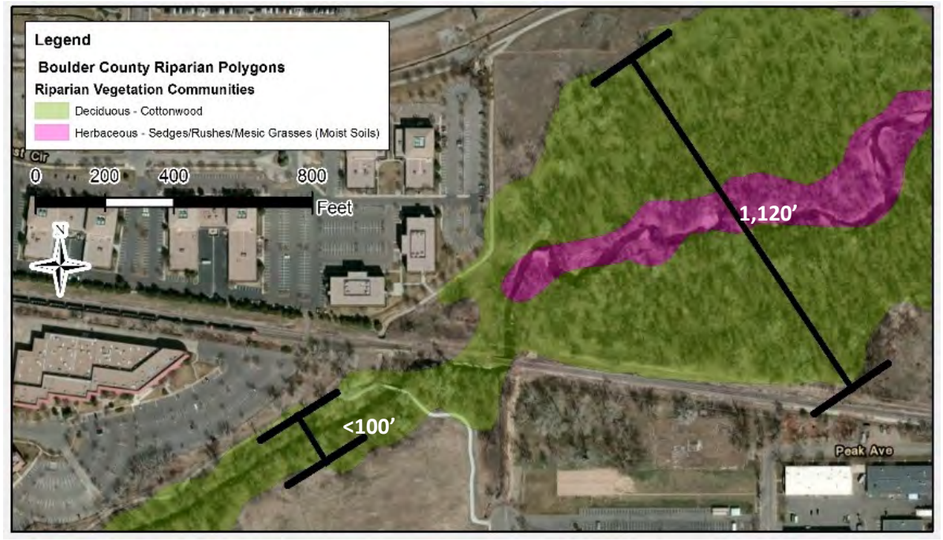


Figure 7-4: Example of varying riparian zone widths through the project area
The narrow riparian zone (left) is limited by land use and bisected by a railroad; the more naturalized downstream section (right) is wide and less confined. (Note: Example is provided for riparian width characteristics only - site specific vegetation communities and species may not represent an appropriate restoration target.)

The overall development and extent of the riparian zone through the project area is closely correlated with existing landforms, land use practices and geomorphic processes. Therefore the structure of the riparian zone (shape/width) within the project area varies across topographic gradients from the steep canyon slopes to the level landscape across the plains.

The existing (post-flood) riparian zone was evaluated within the project area reaches to determine the general overall effects from the September 2013 regional flood event. Overall, direct damage and loss to the riparian zone appears to be much less devastating than in other drainages affected by the flood event. For the most part, the riparian corridor of Boulder Creek remains intact and generally functioning with only relatively minor to moderate disturbance to the riparian zone.

Observed disturbance to the riparian zone varied throughout the project area reaches from minor or no impact within the more urban reaches which are designed to withstand higher peak flood flows; to more significant, moderate disturbances within downstream reaches which received higher volume of floodwater and debris flow from the upstream watershed. The effects included debris flows from the steep canyon reaches upstream that caused both bank erosion and sediment deposition in downstream riparian areas, along with conveyance and deposition of significant debris including boulders, trees, and household materials throughout the stream corridor. Within Boulder's city limits, significant maintenance was conducted post-flood to stabilize critically failing stream banks and to remove debris/sediment upstream and downstream of crossings; therefore these impacts appeared to be less severe through the project area.

The most significant impacts to the riparian zone observed in the project reaches are those areas where flood flows caused the stream to breach into nearby gravel ponds, completely abandoning the existing channel. This occurrence has altered the stream's connection to the original floodplain and riparian zone which will likely, over time, effect species diversity, abundance, structure, and functional characteristics of the riparian community. A summary of riparian zone post-flood conditions within the project area is presented as follows. More detail regarding each reach is provided in the appendix to this report.

Table 7-1: Post-flood Riparian Zone conditions

REACH	2013 REGIONAL FLOOD DAMAGE – RIPARIAN ZONE
Boulder Canyon	Low Disturbance • Stable armored stream banks. • Minor tree/shrub damage/loss. • Minor localized bank erosion and steep slope failure. • Debris accumulation. • Channel remains in original alignment and connected to riparian zone. • Limited existing riparian zone remains relatively intact.
City of Boulder	Low Disturbance • Stable armored stream banks. • Minor tree damage/loss. • Minor localized bank erosion. • Debris and sediment deposition removed by City of Boulder, CDOT, and UDFCD. • Channel remains in original alignment and connected to riparian zone. • Limited existing riparian zone remains relatively intact.
Foothills to N 107th Street	Low to Moderate Disturbance • Significant sediment deposition/vegetation burial. • Localized bank erosion. • Significant accumulation of debris from dead/downed trees. • Stream breach into gravel ponds – alteration of hydrology (channel and riparian zone abandoned). • Stream breach areas subject to potential long-term impacts to riparian species diversity, abundance, structure, and functional characteristics from alteration of hydrology.
N 107th Street to St. Vrain Creek	Low to Moderate Disturbance • Significant sediment deposition/vegetation burial. • Localized bank erosion. • Significant accumulation of debris from dead/downed trees. • Stream breach into gravel ponds – alteration of hydrology (channel and riparian zone abandon). • Stream breach area subject to potential long-term impacts to riparian species diversity, abundance, structure, and functional characteristics from alteration of hydrology.



Photo 35. Confluence with St. Vrain Creek. Example of reference standard riparian habitat which includes dense vegetation community with three strata, stable stream banks, a wide floodplain and little human disturbance. Flood flows resulted in minimal damage to the riparian corridor.



Photo 36. N 107th Street to St. Vrain Creek reach. Here flood flows resulted in abandonment of the pre-flood channel and riparian corridor. Herbaceous vegetation has begun to establish in the previous active channel bottom, indicative of an altered hydrologic regime.



Photo 37. Boulder Creek east from 61rd Street. Example of wide, well vegetated riparian zone with only moderate post-flood disturbance to the riparian zone. At this location, flood flows deposited significant amounts of cobble material within the existing overly wide stream channel which resulted in altered stream flow. The riparian zone is now disconnected from stream flow which can result in long-term habitat community shifts or complete loss of riparian species.



Photo 38. Boulder Creek near Valmont Road. Example of moderate post-flood disturbance to the riparian zone including: significant sediment deposition/vegetation burial, tree damage/loss and significant accumulation of debris from dead/downed trees. While moderate disturbance has occurred in this reach, a majority of the riparian vegetation remains intact and will continue to function.

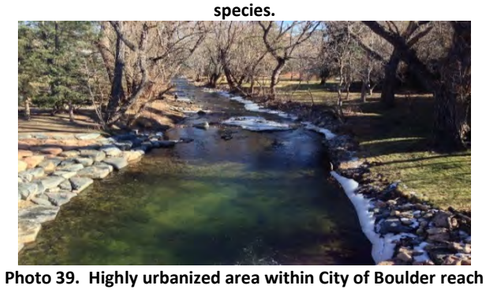


Photo 39. Highly urbanized area within City of Boulder reach characterized by overstory trees and armored stream banks. Through this reach, Boulder Creek overtopped its banks and inundated the existing riparian zone. After the flood event, the riparian zone remains relatively intact.



Photo 40. City of Boulder reach example of low-disturbance: debris accumulation and riparian zone tree damage (trunk damage and bark removal) as a result of the flood. For the most part, while damaged, a majority of the riparian vegetation community will persist and continue to function.



Photo 41. Boulder Canyon reach. The existing riparian zone is characterized by one vegetation strata including either trees or shrubs with no mid- or understory present. Flood damages to the riparian zone are low. Much of the riparian zone remains intact with little change the pre-flood condition.



Photo 42. Boulder Canyon reach example of low post-flood disturbances which includes only minor bank erosion and shrub damage.

7.6 Wetlands

A variety of wetland habitats do exist within the riparian zone of Boulder Creek. Wetlands and other waters of the US are regulated under Section 404 of the Clean Water Act (CWA). Future restoration and recovery efforts which result in disturbances to regulated areas may be subject to permitting and approval by the US Army Corps of Engineers (USACE), the US Environmental Protection Agency, and/or the US Fish and Wildlife Service (USFWS). A formal wetland delineation, by a qualified wetland consultant, and coordination with the USACE Denver Regulatory Office is recommended prior to implementation of any future restoration and recovery efforts to ensure CWA compliance. In addition, any future restoration and recovery efforts must comply with local wetland, stream and wildlife regulations.

7.7 Riparian Zone Restoration Guidelines

The framework for any successful riparian zone restoration effort is understanding the local (reference standard) community that is either present or known to have existed in the local area, in order to restore the functional integrity and biodiversity of the riparian zone. As stated in previous sections, the reference community or primary habitat type recommended for restoration within this project area which is locally native and appropriate for the environmental setting is the Western Great Plains Riparian Woodland and Shrubland. Replicating the natural characteristics of the local Western Great Plains Riparian Woodland and Shrubland habitat type including re-establishment of cottonwood tree overstory and a willow shrub mid-story with a mixed grassland understory that properly interacted with the channel flow should be the primary objective for natural restoration efforts. Successful riparian zone restoration is dependent on a thorough understanding of numerous environmental factors and site-specific conditions. Stream flow, soil moisture, groundwater table, soil chemistry and sun-orientation are all critical elements to consider. Any restoration efforts should carefully consider such factors which should generally be defined by an expert to ensure greater success. A number of references and guidance documents are available for restoration activities in Colorado and Boulder County. Further guidance is provided in the appendix of this report.

Riparian Zone Restoration shall generally follow the following guidelines:

- Natural riparian zone vegetation community type within the project area is characteristic of the *Western Great Plains Riparian Woodland and Shrubland;*
- A properly functioning riparian zone should have routine interaction with stream flows;
- In a more undisturbed condition, vegetation would be continuous along the entire corridor and occupy three strata (i.e., overstory, midstory and understory);
- Relatively dense native vegetation extending from the water's edge (bankfull) outward;
- Buffers that are wider, longer and more densely vegetated with herbaceous, shrub and tree layers provide more benefits. A minimum width should be at least 50 feet and extend upwards of 200 feet from the stream edge.

Overstory – Forest Canopy Establishment

Restoration or planting efforts should focus on re-establishing the overstory or forest canopy that has been lost. The plains cottonwood tree is one of the primary species of the forest canopy regionally as well as the largest tree reaching heights of up to 60 feet with trunk diameters of 2.5 feet. Cottonwoods are now primarily found along drainages and streams of the region. Cottonwood stands provide habitat for 82% of all bird species breeding in northeastern Colorado (Simonin 2001). This species establishes quickly under ideal conditions and is tolerant of frequent and prolonged flooding as well as seasonal low water conditions. Reproduction by seed is a primary means of cottonwood establishment (Hines 1999). The best conditions for establishment include moist, unvegetated mineral soils where the seedlings are not subject to significant erosion/deposition or prolonged flooding during the first growing season (Friedman et al., 1992) (Borman and Larson 2002) (Scott et al. 1997).

Many of the large mature cottonwoods of the project area appear to be relatively stable after the September 2013 flooding, however many have been damaged and populations may start to decline over time. The planting of second generation stands of cottonwood and other species during recovery efforts will ensure the continued existence of this valuable habitat type. Special care should be taken during restoration to protect cottonwood seedlings that are newly established on flood exposed flats or deposits.

Midstory - Shrubs Establishment

Shrubs are considered one of the most valuable strata in a natural riparian zone. Shrubs generally form dense thickets with extensive root systems immediately along the water's edge and can tolerate fluctuating flows.

Willows are a widely-distributed shrub species throughout lower montane habitats in the region. Species can range from 6.5 to 20 feet tall forming large colonies with up to 95% cover. Roots of willows are wide and spreading, forming an extensive root system, especially with the development of large clones. Willow can be both drought resistant and very tolerant of flooding. The ability to generate new roots on the original root or submerged stem is important to riparian restoration. Narrowleaf willow, particularly, colonizes rocky, gravelly, and sandy stream edges, moist, well-drained alluvial terraces, and recently deposited sand and gravel bars that are below the high-water mark, where it is subject to annual flooding, and associated scouring and deposition (Anderson 2006). Where cottonwoods are not present, other willows may become the climax vegetation as narrowleaf willow communities promote bank building and soil development, preparing hospitable sites for other species (Anderson 2006). Midstory shrub species not only provide bank stability but also increased biomass, structural habitat and complexity for wildlife.

Understory - Native HERBACEOUS

An established understory community provides numerous environmental benefits including soil stabilization, overland runoff filtration as well as forage and cover for wildlife. During restoration efforts native seeding should focus on quickly establishing a groundcover to stabilize soil, minimize establishment of invasive species and promote long-term successional development. In restoration areas, the ground surface should be seeded with specialized riparian seed mix that promotes species diversity, contains locally native species that germinate rapidly and provides complete groundcover over a wide variety of hydrologic conditions.

Table 7-2: Representative Native Riparian Zone Tree Species

Tree Species	
Scientific Name	Common Name
Acer glabrum	Rocky Mountain maple
Acer negundo	box elder
Alnus incana	thinleaf alder
Populus deltoides	plains cottonwood
Salix amygdaloides	peachleaf willow

Table 7-3: Representative Native Riparian Zone Shrub Species

Shrub Species	
Scientific Name	Common Name
Alnus incana	thinleaf alder
Amelanchier alnifolia	western serviceberry
Symphoricarpos occidentalis	western snowberry
Prunus americana	wild plum
Rosa woodsii	Woods' rose
Ribes aureum	golden currant
Salix exigua	narrowleaf willow

Table 7-4: Representative Native Riparian Zone Herbaceous Species

Seed Mix		
Scientific Name	Common Name	Comments
Achnatherum hymenoides	Indian ricegrass	Sandy, p/f, (FACU)
Sporobolus airoides	alkali sacaton	Damp, alkaline, p/f, (FAC)
Elymus canadensis	Canada wildrye	Disturbed sites, p/f, (FACU)
Panicum virgatum	switchgrass	Marshes, prairies, foothills, p/f, (FAC)
Pascopyrum smithii	western wheatgrass	Adaptable to variety of habitats, p,f, (FACU)

Notes:
Life Zones: p = Plains 4,000-6,000 feet; f = Foothills 6,000-8,000 feet;
USACE Wetland Indicator Status: (FAC) = Facultative; (FACU) = Facultative Upland

8.0 THREATENED AND ENDANGERED SPECIES, AND AQUATIC HABITAT ASSESSMENT

8.1 Background

A preliminary screening for federal and state threatened and endangered species was conducted within the project area. It will be important during long-term recovery and restoration efforts that protected species and habitats are considered. Close coordination with the agencies mentioned below is recommended.

Federal or state listed threatened and endangered species and/or habitat protected under the Endangered Species Act (ESA) or by the Colorado Parks and Wildlife (CPW) under Colorado Statute Title 33 are summarized below. Raptor nest sites are further protected by the US Fish and Wildlife Service (UFWS)/CPW under the Migratory Bird Treaty Act (MBTA) therefore the applicable regulatory requirements are also summarized subsequently.

Additionally, aquatic habitat data for the project area was also reviewed from the CPW and macroinvertebrate data from the City of Boulder: Boulder Habitat Assessment Report (CDM Smith 2014) City of Boulder. This information is also briefly summarized below.

Finally, the City of Boulder Open Space and Mountain Parks (OSMP) maintains land restrictions and seasonal wildlife closures throughout the project area pursuant to City Municipal Code, B.R.C. 1981. Additionally, Boulder County has identified important environmental resources and habitat areas that should be considered in land use decisions and preserved through management practices as summarized in the Boulder County Comprehensive Plan (BCCP) (Second Addition 1996, As Amended). These ecologically-significant areas are utilized by reference in the Boulder County Land Use Code are protected through administration of the Code and in conformance with applicable federal and state law.

8.2 Species Protected Under the Endangered Species Act of 1973

The ESA of 1973 was enacted by the United States to conserve endangered and threatened species and the ecosystems that they depend on. Under the ESA, species may be listed as either "endangered" or "threatened"; both designations are protected by law. The ESA is administered by the USFWS. The USFWS has developed project specific species lists, available online by request, identifying threatened, endangered, and proposed species, designated critical habitat, and candidate species protected under the ESA that may occur within the boundary of the proposed project and/or may be affected by the proposed project (USFWS 2014). Eleven species are identified to occur or historically occur within range of the project area in Boulder County (USFWS 2014). No USFWS critical habitat is present within or near the potential project areas. Further evaluation of the eleven species' distribution and habitat requirements indicates that three species potentially occur within range of the project area (Table 8-1). During restoration and recovery efforts coordination with the USFWS is recommended.

Table 8-1: Federal Threatened or Endangered Species

	Common Name	Scientific Name	*Status	Suitable habitat not present.
1	Canada-lynx	Lynx Canadensis	FT	Suitable habitat not present
2	Greenback cutthroat trout	Oncorhynchus clarki stomias	FT	Suitable habitat not present.
3	Mexican spotted owl	Strix occidentalis lucida	FT	Suitable habitat not present.
4	Interior Least tern	Sternula antillarium	FE	Water depletion species.
5	Pallid sturgeon	Scaphirhycchus albus	FE	Water depletion species.
6	Piping Plover	Charadrius melodus	FT	Water depletion species.
7	Western prairie fringed orchid	Platanthera praeclara	FT	Water depletion species.
8	Whooping crane	Grus americana	FE	Water depletion species.
9	Preble's Meadow Jumping Mouse	Zapus hudsonius preblei	FT	Suitable habitat may be present.
10	Ute Ladies'-tresses	Spiranthes diluvialis	FT	Suitable habitat may be present.
11	Colorado Butterfly Plant	Guara neomexicana spp.	FT	Suitable habitat may be present.

*Status:
FT - Federally Listed Threatened
FE - Federally Listed Endangered

Species identified as state threatened or endangered are protected by the CPW under Colorado Statute Title 33. State regulations prohibit "*any person to take, possess, transport, export, process, sell or offer for sale, or ship and for any common or contract carrier to knowingly transport or receive for shipment*" any species or subspecies listed as state endangered or threatened. State listed threatened and endangered species were screened as potential inhabitants of the project area based on general habitat requirements and CPW information (CPW 2014), *Colorado Listing of Endangered, Threatened, and Wildlife Species of Special Concern*. Seventeen species are identified to occur or historically occur within the project area [Reference 35, CPW 2014]. Further evaluation of the seventeen species' distribution and habitat requirements indicates that five species (PMJM, Ute ladies'-tresses, Colorado butterfly plant, burrowing owl and river otter) potentially occur within range of the project area.

8.3 Migratory Bird Treaty Act

Migratory birds are protected under the Migratory Bird Treaty Act (MBTA) (16 U.S.C. 730-712). The MBTA makes it illegal for anyone to take, possess, import, export, transport, sell, purchase barter, or offer for sale, purchase, or barter any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to Federal regulations. In Colorado, all birds except for the European starling (*Sturna vulgaris*), house sparrow (*Passer domesticus*), rock dove (*Columba livia*) and common grouse/pheasant species (*Order Galliformes*) are protected under the MBTA. A total of 523 migratory bird species are known to occur in the Mountain-Prairie Region (USFWS Region 6, Montana, Wyoming, Utah, North Dakota, South Dakota, Nebraska, Kansas and Colorado); 320 of the 523 migratory bird species are known to breed in USFWS Region 6.

Based upon literature review and an onsite assessment of the project area, it was determined that some migratory birds likely utilize the project area. These birds are protected under the MBTA, and killing or possession of these birds is prohibited. Future recovery and restoration efforts which remove vegetation should first ensure that active

nests are not disturbed. Generally, the active nesting season for most migratory birds in this region of Colorado occurs between April 1 and August 31.

Disturbance to raptor nest sites is further protected by the CPW. Within the project area, available CPW Species Activity Mapping (SAM) depicts known mapped buffer zones within the project area for bald eagle (*Haliaeetus leucocephalus*) and osprey (*Pandion haliaetus*) (NDIS 2013). Future recovery and restoration efforts should also be aware of any new raptor nest sites and consult with the CPW.

CPW SAM mapping also depicts great blue heron (*Ardea herodias*) nesting areas throughout the project area. The great blue heron is considered a Colorado species of special concern, protected under the MBTA. The rookery (nesting) areas are considered important habitat features for conservation within the project area.

8.4 Aquatic Life

Boulder Creek throughout the project area is classified as Water Supply Recreation 1A Agriculture Aquatic Life Warm 1 by CDPHE. Aquatic Life Warm 1 classification indicates the waters are currently capable of sustaining a wide variety of warm water biota, including sensitive species. Waters shall be considered capable of sustaining such biota where physical habitat and, water flows or levels and water quality conditions result in no substantial impairment of the abundance and diversity of species.

Informal discussions with local Colorado Parks and Wildlife (CPW) staff indicates that the project reach of Boulder Creek is a transitional zone between a cold water fishery (extending upstream of Boulder Canyon) dominated by trout to a warm water fishery (downstream of Boulder Canyon) dominated by native minnow species. Brown trout are present through the Canyon and City reaches, however east of 75th Street small bodied native fish become more dominate. CPW also indicated that future restoration efforts in the project reach and in particular east of 75th Street should focus on native small bodied native fish species and not typical trout habitat. CPW's most recent fish population survey (2014), identified the following dominant species: brown trout, common carp, creek chub, fathead minnows, green sunfish, largemouth bass, longnose dace, longnose sucker and white sucker. Of the 17 species collected, 9 species were non-native and 8 species were native to South Platte River basin.

CDM Smith completed a City of Boulder - Boulder Creek Habitat Data Review (Draft 2014) in anticipation of: a) the inclusion of habitat and biological data in future assessments and potential impairment determinations, and b) the importance of understanding habitat quality as part of the biological assessment process. The primary objective of the study was to organize the city's habitat data in a manner that supports meaningful evaluation of macroinvertebrate data that may be used to support aquatic life use attainment determinations in the Boulder Creek watershed. This study was also used to develop recommendations for streamlining future habitat characterization efforts so that in the future, monitoring resources are expended on the collection of the most useful habitat data. The Review study area begins in the canyon at the west end of the urban core and extends to the confluence of Boulder Creek and Coal Creek near the Boulder/Weld County line. The Review concluded that datasets show lower habitat quality through the City as seen in the habitat scores below the canyon through 28th Street. Associated biological indices also follow the general pattern of lower scores at 28th Street. Urban density begins to decrease east of Foothills Parkway and habitat scores and biological metrics generally improve as the area becomes more rural. Habitat subcategory scores show that the overall habitat results are driven by habitat scores related to riparian quality. Of particular note is habitat parameter 10, which scores vegetative riparian zone width. Scores are lower through the urban corridor where the riparian zone is most confined.

8.5 City of Boulder's Open Space & Mountain Parks (OSMP) Closures

The City of Boulder's Open Space & Mountain Parks land has been set aside for preservation and the protection of the natural environment. Within the project area, the Open Space and Mountain Parks (OSMP) division maintains the following closures:

- Bald Eagle Closures Nov. 1 - July 31. One area on OSMP within the project area is closed from Nov. 1 to July 31 every year to protect bald eagle nesting and roosting activity.
- New Zealand Mudsnail Closures Year Round. Portions of Boulder Creek downstream of Valmont Road are closed year round because of the non-native, invasive New Zealand Mudsnail.

9.0 PROJECT FOCAL AREAS / RESTORATION PROJECTS

9.1 Project Focus

As noted previously, the purpose of this master plan is to provide planning guidance to improve flooding resiliency along Boulder Creek. The focus is on general guidance for stream and ecological restoration; however consideration has also been given to other multi-purpose objectives along the corridor. Descriptions of different alternative categories are presented below.

The study reviews Boulder Creek, as a whole and the geomorphic and ecological principles described can be applied uniformly over the entire project reach. Restoration would most likely occur as property and funding become available. There is not a singular, correct solution in defining restored stream alignments for Boulder Creek. Alignments should be refined further through individual project goals, but keeping in mind compatibility with neighboring stream reaches.

Alternatives presented apply the stream restoration principles at locations with immediate restoration needs and a higher likelihood of implementation in the future. Larger restoration projects are generally focused in areas where property has already been acquired, such as public lands or locations where changes to private infrastructure could be more easily implemented.

It is important to note that although this master plan provides general guidance for restoration efforts, it does not re-evaluate the current 100-year floodplain limits regulated by FEMA. Although the implementation of some proposed projects presented in this master plan may also reduce the regulatory floodplain limits; the focus of this master plan is to provide a planning tool for stream and ecological restoration.

General guidance within the City of Boulder addresses specific areas of concern identified by city staff, and other public or interested stakeholders to the project. The master plan does not comprehensively evaluate and recommended changes to Boulder Creek through the City limits. Users are encouraged to reference standards presented in the City's Greenway's Master Plan for additional information along Boulder Creek.

Several projects within this reach of Boulder Creek are currently in process of design and/or construction. This includes the U.S. Army Corps of Engineers stream restoration project, east of 109th Street; restoration projects within the City of Boulder between 63rd Street and Valmont, improvements within Eben G. Fine Park, and bank stabilization at the Town of Erie's re-use facility. Improvements in these areas have been recognized by this master plan as in-progress. New alternatives and project costs estimates were not developed for the in-progress projeccts. Similarly, within the City of Boulder, this master plan completed a review of ongoing planning efforts for the Civic Center area and North of Boulder Creek. These studies were reviewed for compatibility with planning solutions and effectiveness on flood management. New alternatives were not developed or carried forward into this master plan.

9.2 Criteria and Constraints

Prior to construction, or commencing other work on private property or within the drainageways, it is recommended that individuals consult with the appropriate jurisdictions regarding the proposed changes and construction requirements, such as obtaining engineered plans, permitting requirements, erosion and sediment control, water quality and natural resource protection, easements or other items that may be required. If working within 100 feet of a ditch diversion, notify the ditch company early in the design. The following websites address specific requirements set forth by local jurisdictions:

1. City of Boulder: Flood Recovery Website: https://bouldercolorado.gov/flood
2. Boulder County: Flood Recovery Website: http://www.bouldercounty.org/flood/pages/default.aspx
3. Weld County: Flood Recovery Website: http://flood2013.weldgov.com/
4. City of Longmont: Flood Recovery Website: http://longmontcolorado.gov/departments/departments-n-z/public-information/flood-information
5. CDOT: Private Access Reconstruction Guide: http://jeffco.us/Disaster-Recovery/Documents/CDOT-Private-Access-Reconstruction-Guide-for-Residents/

Section 404 of the Clean Water Act (CWA) established a program to regulate the discharge of dredged or fill material into waters of the United States and wetland areas. Activities in waters of the United States regulated under this program include fill for development, water resource projects, infrastructure, and mining projects. Section 404 requires a permit before dredged or fill material may be discharged into waters of the United States. Proposed activities are regulated through a permit review process. An individual permit is required for potentially significant impacts. Individual permits are reviewed by the U.S. Army Corps of Engineers, which evaluates applications under a public interest review, as well as the environmental criteria set forth in the CWA Section 404(b)(1) Guidelines, regulations promulgated by EPA. General permits may also be suitable. General permits are issued on a nationwide, regional, or State basis for particular categories of activities. Local agencies, including the COE should be consulted and required permits should be obtained prior to filling or dredging material in streams or drainageways, on a both a permanent and temporary basis.

Rebuilding and new construction activities within the watershed should consider best practices to reduce the loss of human life and property from flood and storm damage, as managed through local floodplain administration. General guidance has also been provided to flood impacted communities by the Colorado Association of Stormwater and Floodplain Managers (CASFM), through a white paper distributed on October 4, 2013. This white paper is available at http://www.casfm.org/2013_Flood/CASFM_media_summary_statement_2013-10-04.pdf.

Boulder Creek is a regulated floodplain by FEMA, the City of Boulder, and Boulder and Weld Counties. Proper floodplain permitting through local jurisdictions will be required prior to commencing construction activities.

Future improvements along Boulder Creek shall give full consideration to policies presented in community planning documents, including the Boulder Valley Comprehensive Plan, City of Boulder's Greenways Master Plan and the Grassland Ecosystem Management Plan. These documents present multi-objective goals achievable with drainageway and open space improvements. Between Foothills Parkway and 95th Street, the Greenways' Master Plan and Grassland Ecosystem Management Plan present ancillary project goals which should be considered with any stream restoration project in this area.

Improvements to existing roadway crossings in Boulder and Weld Counties follow criteria set forth by each jurisdiction. As a minimum standard, both counties allow overtopping of the roadways during large flood events. However, county criteria require that the actual bridge structures, including the low chord, be elevated above the 100-year flood levels. This criterion was used as a minimum standard in evaluating transportation infrastructure.

For three other locations including: East County Line Road, 75th Street, and 61st Streets, Boulder County also requested that 100-year capacity bridge alternatives be evaluated.

9.3 Improvement Alternative Categories

Sediment Maintenance

Sediment buildup occurs at many locations along the Boulder Creek Path in the City of Boulder. Although restoration activities recommended with this master plan will alleviate several of these routine problem areas over time, ongoing maintenance, particularly with existing trail underpasses is still needed. Maintenance activities generally include removal of sediment on an annual basis.

Natural Stream / Channel Restoration

In order to allow Boulder Creek to return to a more natural state, channel restoration projects have been proposed along Boulder Creek. These projects consist of providing an appropriate channel width, bank full depth, stream sinuosity, overbank floodplain connection, and ecological / habitat enhancements. Alternatives presented apply the stream restoration principles at locations with immediate restoration needs and a higher likelihood of implementation in the future. These projects are generally focused in areas where property has already been acquired, such as public lands, or locations where changes to private infrastructure could be more easily implemented. However, the geomorphic and ecological principles presented can be applied uniformly for Boulder Creek, as property and funding become available.

Roadway Crossing Improvements

It is typical for roadway crossings of Boulder Creek, particularly east of the City of Boulder, to experience overtopping while the bridge structure, itself, remains perched over the main channel. As discussed above, per Boulder and Weld County criteria, new bridges are required to be elevated above the 100-year flood level. Overtopping is allowed elsewhere, often hundreds of feet from the bridge location. Per discussions with Boulder County transportation staff, it was determined that all bridges over Boulder Creek would need to meet this criteria, at a minimum. Boulder County also requested that additional alternatives be evaluated for 61st Street, 75th Street, 95th Street, and East County Line Road, which would convey the 100-year event without overtopping in order to provide emergency services during flooding. A summary of major roadway crossings along Boulder Creek is presented in Table 9-2: Bridge Information and Replacement Locations. This table compares the existing bridge elevations and estimated bridge deck thicknesses with FEMA's regulatory 100-year water surface elevations along Boulder Creek to determine if a bridge currently meets criteria. Bridges outside of criteria were selected to be replaced by this master plan.

In addition to comparing bridge elevations with current criteria, consideration was given to minimizing bridge obstructions on geomorphic channel boundaries. For this master plan, the project team recommended that standard bridges, within the plains stream region be sized: to convey a minimum of 60% of the 100-year discharge; to accommodate the stream and floodplain at twice the bank flow depth (as presented in Section 6.0); and to maintain less than a 6 ft./sec velocity through the bridge section at a maximum of depth of 10-feet. A 180-foot bridge opening width was used for this criterion, bridges with a smaller opening were recommended to be replaced.

For 100-year bridges alternatives at 61st Street, 75th Street, and County Line Road, a 220-foot bridge opening width was selected to closely match existing 100-year crossings at Mineral Road and Highway 287.

Bridge replacement recommendations focused on bridges outside of the City of Boulder, although general capacity observations in Table 9-2: Bridge Information and Replacement Locations included city roadways for informational purposes. Evaluating bridge changes within the City of Boulder was beyond the scope of this study due to the complexity of floodplain impacts; however the City's infrastructure was generally higher in capacity and more accommodating of both flood flows and geomorphic stream conditions. Improvement recommendations were made, however, at the Burlington, Northern, and Santa Fe Railroad Bridge, which has less flood capacity and a poor orientation with respect to the stream conditions.

Stream Stabilization and Ditch Diversions

Numerous water diversion points exist in Boulder Creek. Currently very few of the existing diversions structures also accommodate fish passage or macro-invertebrates common to the region. Improvements are recommended to retro-fit or rebuild diversions to satisfy this multi-objective need. Specifically these systems are proposed to be replaced with sloped drop faces and fish passage measures. Projects would need to ensure that private water rights are not negatively impacted by channel modifications and/or improvements. These conversions will allow the adjacent channel to exist in a more natural state while also providing the long term ability to divert water at the diversion point.

Plans to modify any diversion structure should be coordinated with the representative of the ditch company. The following diversion structures are proposed to be modified to allow for aquatic and habitat passage while maintaining the efficiency to divert water to the water rights holder.

Table 9-1: Alternative Ditch Diversion Structures

Ditch Name	Reach	Project ID
Rural Ditch	2	2C
Idaho Creek Diversion*	2	2D
Gooding A. and D. Plumb Ditch	4	4A
Howell Ditch	4	4G
Boulder Weld Ditch	5	5B
Lower Boulder Ditch	5	5E
Leggett Ditch	6	6A
Unknown Ditch	7	7C
Green Ditch	7	7D
Butte Mill Ditch	7	7G
Boulder Ditches	9	9E
Farmers' Ditch	10	10A

*Representative of 5 ditches in addition to the natural drainageway
(Delehant Ditch, Houck No. 2 Ditch, Carr & Tyler Ditch, Smith & Emmons Ditch, and Godding Ditch)

Drop structures, and other existing stabilization measures, which present obstruction to fish passage or macro-invertebrate habitat, have also been proposed to be replaced in a similar manner.



Photo 9.1 - Example of diversion structure and fish passage channel (ERC, East River)

Mining / Gravel Pond Spillways

Several aggregate mining or gravel pit ponds, located adjacent to Boulder Creek, experienced bank failures during the 2013 flooding event. These failures can cause surges in flood flows, imbalance in the stream's sediment transport, and diversion of stream flow, until repairs or restoration can be completed. Natural stream and floodplain restoration projects described previously are one means to address the challenges associated with floodplain mining or gravel pit ponds. However, this often leads to the elimination of the pond which is not always desired. Where eliminating the pond is not desired, retro fitting the mining or gravel pit ponds with spillways that will reduce the potential for bank failure is proposed. At a minimum, these spillways shall meet the guidelines set forth in the *Technical Review Guidelines for Gravel Mining and Water Storage Activities Within or Adjacent to 100-year Floodplains,* produced for the UDFCD [Reference 60, Wright Water Engineers, Inc.]. Per the UDFCD guidelines, ponds with a riverside berm length less than 1,300 feet long are proposed to be retro-fitted with a single spillway, while gravel pits with a riverside berm length greater than 1,300 feet are proposed to be retrofitted with two spillways. UDFCD also recommended that a minimum 100-feet of spillway width be provided. Most existing spillways within the watershed fall below this threshold and would also require a retro-fit.

Debris and Vegetation Removal

Debris along Boulder Creek is significant in some areas. In order to provide improved floodplain conveyance and to reduce the potential for debris related issues (such as debris clogging bridge openings or damaging diversion structures), removal of debris and/or vegetation has been proposed in some reaches of the project reach. This does not apply to areas in which vegetative flood debris (i.e. large woody debris not trash) provides important habitat and function in the creek and riparian systems. It is recommended that bridges be inspected and maintained clear of debris up to 200-feet upstream of each bridge crossing, at a minimum.

Bank Stabilization

Typical bank stabilization efforts have been proposed for areas of bank that have experienced damage due to flooding events. Bank stabilization is typically located in areas that would not otherwise be addressed through channel restoration or stream crossing improvements. This includes work near the City of Boulder sewage treatment interceptor, where stream stabilization and bank revetment has been proposed to address routine maintenance areas. When implementing bank stabilization, bio-engineered methods should be used when possible instead of traditional rip rap, grouted rock, etc. All bank stabilization projects should help restore the ecological function of the creek while repairing the integrity of the bank.

Other Project Alternatives

Other potential alternatives were evaluated and reviewed with project sponsors on a site specific level. In some cases, these additional alternatives demonstrated limited feasibility and were not carried forward further. Site specific alternatives are discussed below:

Property Acquisition: A review of flood prone properties was completed in select areas. Specifically, several properties along Kenosha Road in Boulder County, Cordry Court in the City of Boulder, and buildings that are part of the Millennium Harvest House property (south of the creek) were reviewed to determine if acquisition would be an effective flood management tool. For these locations, FEMA's Benefit-Cost-Analysis software [Reference 61, FEMA] was used to compare properties on an individual basis. No properties demonstrated a strong potential for acquisition. Staff from Boulder County also indicated that post-flood acquisition activities have been performed on a voluntary basis with property owners initiating discussions. Based on these conditions, property acquisition was not pursued further within this master plan.

Boulder Community Foothills Hospital Access: Access to the Boulder Community Foothills Hospital during flooding up to the 500-year event is required to meet the City's critical facilities ordinance. Currently, the intersection of 48th Street and Riverbend Road would be required to be elevated approximately 2 feet to provide access at the hospital's main entrance during the 500-year event. As an option, this master plan proposes to add a secondary paved emergency access location to the hospital's parking lot from 48th Street, north of the Arapahoe Avenue intersection. This would provide access to the hospital during the 500-year event and would be less costly than raising the intersection and entrance roadway.

Butte Mill Ditch (South Boulder Creek): The Butte Mill Ditch is originally diverted from Boulder Creek just upstream of Valmont Road, and then after approximately 400 feet, travels east to South Boulder Creek. In 2013 flooding in this area was exacerbated by the Butte Mill Ditch diversion on South Boulder Creek. Given that all the Butte Mill decreed flows originate from Boulder Creek, there are several needs for the ditch. At Boulder Creek, the ditch diversion is proposed to be retro-fitted to accommodate aquatic and habitat passage. At South Boulder Creek, the ditch is proposed to be improved to maintain separation from flows within the creek. This project includes an inverted siphon for the Butte Mill Ditch as it crosses South Boulder Creek, removal of the associated South Boulder Creek diversion structure, and channel restoration in the vicinity of the crossing along South Boulder Creek. Any modifications impacting the Butte Mill Ditch require written ditch company approval.

Old Valmont Trail Crossing: Significant amounts of debris collected between the Old Valmont trail crossing on Boulder Creek and Valmont Road. This trail crossing is proposed to be replaced with a bridge structure more accommodating of flood flow, geomorphic channel dimensions, and restoration needs.

***University of Colorado North of Boulder Creek*:** The University of Colorado planning study for North of Boulder Creek was completed in 2014. This plan identifies flood management strategies and infrastructure needs surrounding the North of Boulder Creek Campus, located between 17th Street and Folsom. Key goals and strategies

include: maintaining flood water conveyance within open areas of athletic and recreation fields; maintaining existing roadway grades without further obstruction; elevating residential structures above flood elevations; and flood-proofing commercial infrastructure. Also noted as part of the North of Boulder Creek study was the need to improve existing bridge obstructions, and improve both pedestrian and emergency access to the stadium and campus south of Boulder Creek. A series of pedestrian bridge options have been proposed with the Boulder Creek Master Plan alternatives to replace the existing access points over the creek.

High Hazard Mitigation at Cordry Court and Millennium Harvest House; Floodplain Reduction at Senior Housing Facility (Carillion): The City of Boulder regulates a high hazard zone along Boulder Creek in the vicinity of 28th Street. This high hazard zone encumbers property and structures adjacent to Cordry Court and the Millennium Harvest House. Hydraulic modeling was performed to verify if high hazard could be reduced, or removed on the Millennium Harvest House or Cordry Court properties through excavation within the Boulder Creek overbanks. For properties along Cordry Court, it was determined that channel bank grading between the existing residences and Boulder Creek would alleviate the High Hazard determination north of the homes. Bank grading and redevelopment concepts were explored for the property between the Millennium Harvest House and Carillion Senior Housing. It was determined that through overbank excavation (south bank between sections 24386 and 25267 and north bank around sections 25182), high hazard could be removed from abutting the Millennium Harvest House building, north of Boulder Creek, and the floodplain would be lowered by as much as 2-feet near the Carillion Senior Housing facility. However, accomplishing this would require many of the following projects:

- Modification or removal of the 7 court tennis complex, west of 28th Street;
- Removal of the three ancillary Harvest House buildings located South of Boulder Creek;
- Modification or removal of the western-half parking area north of the senior center;
- Modification or removal of the Millennium Harvest House basketball court, north of Boulder Creek;
- Excavation and expansion of the Boulder Creek channel and floodplain between 28th Street and Folsom;
- Adjustments to the Boulder Creek Trail.

With these changes, the split flow along Taft Drive that circumvents the Carillion Senior Housing development would also be eliminated, bringing the facility into compliance with the Boulder Critical Facilities Ordinance.

Cost estimates for projects along Cordry Court, the Millennium Harvest House, and Carillion Senior Housing facility have been provided; however it is anticipated that these improvements would occur with redevelopment. At this time, a more thorough evaluation of floodplain management aspects should be compared with land uses and site needs. As an alternative, non-residential buildings could be flood proofed as a mitigation option.

During evaluation of this alternative, it was noted, using FEMA's BCA software, that removal of the three 1,700 sf Harvest House buildings, south of Boulder Creek, alone, would yield over $570,000 in direct benefits. However, due to the nature of home and property values, the benefit versus cost ratio was only estimated at 0.6. This estimate was based on comparisons with nearby homes in the Cordry Court area, using a $100/sf estimate for building values, $26/sf estimate for property values (0.3 ac), and $40,000 estimate for demolition and disposal of each building.

Boulder Slough Mitigation: The slough currently originates as a diversion from Boulder Creek at the structure east of the Broadway Bridge, commonly known as the 12th Street diversion structure. Five ditches divert their respective water rights from this structure and waters co-mingle in Boulder Slough as it traverses the City. The five ditches are the Boulder & White Rock Ditch, Boulder & Left Hand Ditch, McCarty Ditch, Smith and Goss Ditch, and North Boulder Farmer's Ditch. Boulder Slough extends from Boulder Creek at Broadway downstream to Goose Creek, east of Foothills Parkway. In addition to carrying private irrigation ditch flows, Boulder Slough has the potential to also collect stormwater runoff derived from the area west of the slough and north of Boulder Creek. During the September 2013 flood, flows that entered the Boulder Slough spilled from its banks upstream and downstream of 15th Street and flooded residences within the Goss Grove neighborhood. An alternative has been proposed at 14th street to intercept flows beyond the ditch capacity and convey the overflow to Boulder Creek via a storm sewer. For the purposes of the analysis, the overflows were assumed to be approximately 110-cfs during the 100-year event, approximately half of the 100-year discharge at 18th Street, as referenced by the floodplain mapping study prepared by Anderson Consulting Engineers, Inc. (ACE) in 2014 [Reference 62]. A 48 inch RCP was assumed for the outfall. Any modifications impacting irrigation ditches require written ditch company approval.



Photo 9.2 – Boulder Slough Diversion at Broadway

City of Boulder Civic Center Area Plan: The City of Boulder is currently reviewing redevelopment and improvements options for the Civic Center between 13th Street and 9th Street. With regards to floodplain improvements, the proposed plan includes removal of several buildings and surface parking in an effort to increase floodplain capacity and reduce infrastructure in areas of high hazard designation. With the Civic Center plan, Boulder Creek will continue to be a natural corridor with trees and creek-side vegetation. No specific proposed changes to the channel, ditch diversions, or to the existing crossing structures at 9th, Broadway, and Arapahoe Avenue were identified. An evaluation of potential mitigation improvements was completed by ACE in 2012 [Reference 63]. This evaluation analyzed eleven flood mitigation scenarios using a hydraulic model. The scenarios included variations of the removal of the Park Central and New Britain buildings and increasing the opening of the Broadway and Arapahoe crossing structures. The evaluation determined that the base flood elevations upstream of Broadway could be reduced by removal of the buildings and increasing the opening area of the Broadway crossing, however the municipal building would remain within the 100-year floodplain. Additionally, it was noted that improvements have

the potential to keep more water in the Boulder Creek channel and reduce discharges along the spill flow that follows Canyon Boulevard. Future improvements should consider these potential affects.

No new alternatives have been presented for the Civic Center area in this master plan study; however changes to Boulder Creek at this location should consider the following scenarios presented by the City in a draft planning summary [Reference 64, City of Boulder]:

- *Removing the Park Central and New Britain buildings:* 100-year flood levels upstream of Broadway could be reduced slightly (less than 0.2 feet) by removing the Park Central and New Britain buildings though this action would eliminate two critical facilities from the 100-year floodplain, conveyance zone, and high hazard zone.
- *Adding conveyance capacity at the Broadway Bridge:* 100-year flood levels upstream of Broadway could be reduced by up to 0.70 feet by adding conveyance capacity at the Broadway Bridge. The bridge has been constructed in a manner that would facilitate conveyance capacity improvements. Based on the available topography, it appears that the 0.70-foot drop in flood level associated with increasing the bridges flow capacity would not remove the Municipal Building from the 100-year floodplain or conveyance zone, nor the Park Central and New Britain building from the conveyance and high hazard zones. This alternative would increase flows along Boulder Creek, while reducing flows on Canyon Boulevard.

Higher flows along the creek would persist downstream to west of 30th Street and cause higher 100-year flood levels that would need to be mitigated. However, increases in flood levels downstream of Arapahoe would be relatively small (less than 0.1 feet) and could likely be mitigated with one or more of the following: select grading of overbank areas, reducing the potential for debris obstruction at bridges, and/or increasing conveyance under road crossings.

Reduced flows on Canyon Boulevard (due to increased flows along the creek at Broadway) would likely not result in significant reductions in flood levels, or significant reductions in the footprint of either the conveyance zone or the high hazard zone, along Canyon Boulevard or the street system east of Broadway.

Reduced flows on Canyon Boulevard between Broadway and 13th Street could result in a slightly narrower footprint for the conveyance zone through the band shell area in the northern portion of Central Park. However, it would be unlikely that the conveyance zone could be confined to the street corridor in this area. Therefore, it appears the northern portion of Central Park would be available for building development assuming a significant building setback from Canyon Boulevard that avoids the conveyance zone.

- *Adding conveyance capacity at the Arapahoe Bridge:* Increasing the conveyance at Arapahoe would not significantly influence flood levels upstream of Arapahoe and does not make sense as a standalone project. Increasing the conveyance at Arapahoe would be required to mitigate increases in flood levels between Broadway and Arapahoe if conveyance capacity is added at Broadway.
- *Overbank grading of Boulder Creek between the Library and Broadway:* It is possible that lowering the grade adjacent to Boulder Creek between the Library and Broadway would reduce the footprint of the existing high hazard and conveyance zones on the north side of Arapahoe. This would possibly allow building construction along the north side of Arapahoe in a limited area. The grading would result in the removal of significant existing vegetation and parking.

Additional guidance for Flood Regulatory Considerations, Flood Policy Consideration, and Site Opportunities and Flood Constraints were provided for the Civic Area in June 2015. A summary of the guidance is provided below:

Flood Regulatory Consideration: Existing flood standards will be met or exceed, including avoiding placing new structures and parking in the HHZ. Existing regulations also include:

- No new buildings intended for human occupancy can be built within the HHZ.
- A building that is touched by the HHZ is regulated as if the entire structure is in the HHZ.
- An existing building in the HHZ cannot have additional space intended for occupancy built nor can the footprint be increased.
- An existing building cannot be improved by more than 50% of the value of the building.
- Any improvements that are within the conveyance zone require evaluation and certification of no impact.

Flood Policy Consideration: Consideration must be taken for public safety, but that does not prohibit all use of floodplain areas or HHZ. Uses that are outdoors and provide a safe and convenient evacuation route from the HHZ promotes a higher level of public safety compared to occupied buildings. Buildings occupied on a daily basis by the same people provide an opportunity for the occupants to be trained and aware of their risks when equated to assembly areas where occupants are not routinely in the building.

Site Opportunities and Flood Constraints: The west and east area of the Civic Area present different risks in flooding potential. The HHZ has a greater influence on the structures on the west end of the Civic Area. Although the HHZ designations are more confined on the east end, the structures are still inundated by the 100-year floodplain. Below grade parking structures should be avoided in the Civic Area due to the flood risk and groundwater challenges that below grade structures provide.



Figure 9-1: City of Boulder Civic Area Plan [Reference 65]

Table 9-2: Bridge Information and Replacement Locations

BRIDGE DATA							CRITERIA CONFIRMATION		GEOMORPHIC CONFIRMATION		REPLACEMENT	
Stream Reach	Bridge Location	Jurisdiction	Classification	Estimated Bridge Capacity	Estimated Roadway Elevation	Estimated 100-Year WSEL	Estimated Bridge Deck Thickness	Is Bridge Above 100-Year WSEL?	Existing Bridge Width	Does Bridge Meet Geomorphic Width Recommendations?	Does Bridge Require Replacement?	100-Year Emergency Access Considerations?
				(cfs, approx. freq)	(NAVD 1988)	(NAVD 1988)	(in)	(Yes/No)	(ft)	(Yes/No)	(Yes/No)	(Yes/No)
Reach 2	WC Road 20 1/2	Weld County	Collector	< 100-year	4884	4882	41	NO	132	NO	**YES**	NO
Reach 2	WC Road 16 1/2	Weld County	Local	1,000 cfs	4927	4920	51	YES	126	NO	**YES**	NO
Reach 4	East County Line Road	Boulder / Weld Counties	Collector	1,200 cfs	4957	4951	53	YES	124	NO	**YES**	**YES**
Reach 4	Mineral Road (SH 52)	CDOT	State Highway	> 100-year	4961	4958	26	YES	218	YES	NO	**YES**
Reach 4	Kenosha Road	Boulder County	Local	600 cfs	4996	4994	43	NO	92	NO	**YES**	NO
Reach 4	109th Street	Boulder County	Local	5,400 cfs	5016	5015	25	NO	77	NO	**YES**	NO
Reach 4	State Highway 287	CDOT	State Highway	> 100-year	5027	5021	66	YES	218	YES	NO	**YES**
Reach 5	95th Street	Boulder County	Arterial	3,300 cfs	5065	5059	56	YES	121	NO	**YES**	NO
Reach 6	75th Street	Boulder County	Arterial	6,200 cfs	5121	5117	46	YES	108	NO	**YES**	**YES**
Reach 7	61st Street	Boulder County	Arterial	8,300 cfs	5170	5171	30	NO	90	NO	**YES**	**YES**
Reach 7	Valmont Road	Boulder County	Arterial	> 100-yr	5199	5198	42	Yes	--	--	--	--
Reach 8	BNSF Railroad	BNSF Railroad	Railroad	1,000 cfs	5231	5228	30	YES	52	NO	**YES**	NO
Reach 8	55th Street	City of Boulder	Minor Arterial	> 100-yr	5214	5205	--	Yes	--	--	--	--
Reach 8	Foothills Parkway	City of Boulder	Principal Arterial	> 100-yr	5255	5244	--	Yes	--	--	--	--
Reach 8	Arapahoe Avenue	City of Boulder	Principal Arterial	> 100-yr	5254	5251	--	Yes	--	--	--	--
Reach 8	30th Street	City of Boulder	Minor Arterial	< 100-yr	5276	5275	--	Yes	--	--	--	--
Reach 9	28th Street	City of Boulder	Principal Arterial	< 100-yr	5291	5291	--	No	--	--	--	--
Reach 9	Folsom Street	City of Boulder	Minor Arterial	5,764 cfs	5304	5304	--	No	--	--	--	--
Reach 9	17th Street	City of Boulder	Collector	< 100-yr	5332	5329	--	Yes	--	--	--	--
Reach 9	Arapahoe Avenue	City of Boulder	Minor Arterial	6,800 cfs	5344	5345	--	No	--	--	--	--
Reach 9	Broadway Street	City of Boulder	Principal Arterial	5,272 cfs	5348	5350	--	No	--	--	--	--
Reach 9	9th Street	City of Boulder	Minor Arterial	> 100-yr	5366	5359	--	Yes	--	--	--	--
Reach 9	6th Street	City of Boulder	Local Street	11,078 cfs	5378	5380	--	No	--	--	--	--

9.4 Summary of Project Alternatives

A summary of project alternatives are presented in Table 9-3, below.

Table 9-3: Summary of Project Alternatives

Reach	ID	Description	Jurisdiction
1	A	Stream Restoration & Debris Removal City of Longmont Open Space	City of Longmont / Weld County
	B	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	City of Longmont / Weld County
2	A	CO Rd. 20.5 - Replace Bridge with 180 ft. Span Bridge	Weld County
	B	Replace Existing Grade Control for Aquatic and Habitat Passage	Weld County
	C	Modify Rural Ditch for Aquatic and Habitat Passage	Town of Frederick / Weld County
	D	Modify Idaho Creek Diversion for Aquatic and Habitat Passage	Weld County
	E	CO Rd. 16.5 - Replace Bridge with 180 ft. Span Bridge	Weld County
	F	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Town of Frederick / Weld County
	G	Stream Restoration Downstream of CO Rd. 16.5	Weld County
3	A	Stream Restoration Upstream of CO Rd. 16.5	Weld County
	B	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Weld County
4	A	Modify Godding A. and D. Plumb Ditch for Aquatic and Habitat Passage	Weld County
	B	East County Line Rd. - Replace Bridge with 180 ft. Span Bridge, Restore Channel Banks Option: Install 100-yr Crossing (220 ft. Span Bridge)	Weld County / Boulder County
	C	Protect Gravel Ponds / Town of Erie Reuse Pond / Wittemeyer Ponds Inlet & Outlet During Strom Flows, Typical.	Town of Erie / Weld County / Boulder County
	D	Stabilize Bank at Bailey-Kenosha Pond Outlet	Boulder County
	E	DS of Kenosha Rd. - Remove Washed Out Bridge	
	F	Stream Restoration Through Doniphan, Wittemeyer Ponds, Bailey-Kenosha Ponds, and Open Space	
	G	Stabilize Diversion System, Modify Diversion for Aquatic and Habitat Passage	
	H	Kenosha Rd. - Replace Bridge with 180 ft. Span Bridge	
	I	Replace Grade Control for Aquatic and Habitat Passage	
	J	109th St. - Replace Bridge with 180 ft. Span Bridge; Restore Adjacent Channel	
	K	Stream Restoration Through Wheeler Ranch	
5	A	Stream Restoration at Alexander Dawson Open Space	Boulder County
	B	Modify Boulder and Weld County Ditch for Aquatic and Habitat Passage	
	C	Protect Boulder Valley Ponds Inlet & Outlet During Storm Flows, Typical.	
	D	Modify Grade Control Structures for Aquatic and Habitat Passage	
	E	Modify Lower Boulder Ditch for Aquatic and Habitat Passage	
	F	Stream Restoration Downstream of 95th St.	
	G	95th St. - Replace Bridge with 180 ft. Span Bridge Option: Install 100-yr Crossing (220 ft. Span Bridge)	
	H	Stream Restoration from Upstream of 95th St. to White Rocks Trail	
6	A	Modify Leggett Ditch for Aquatic and Habitat Passage	Boulder County
	B	75th St. - Replace Bridge with 180 ft. Span Bridge; Option: Install 100-yr Crossing (220 ft. Span Bridge)	
7	A	Protect Walden Ponds Inlet & Outlet During Storm Flows, Typical	Boulder County
	B	Protect Ponds Inlet & Outlet During Storm Flows, Typical	
	C	Modify Diversion for Aquatic and Habitat Passage	
	D	Modify Green Ditch Diversion for Aquatic and Habitat Passage	
	E	61st St. - Replace Bridge with 180 ft. Span Bridge Option: Install 100-yr Crossing (220 ft. Span Bridge)	
	F	Replace Old Valmont Pedestrain Crossing with 180 ft. Span Bridge	
	G	Modify Butte Mill Ditch Crossing on South Boulder Creek	
	H	Protect Sanitary Interceptor Sewer	
	I	Stream Restoration from Valmont Rd to 61st St.	
8	A	Stream Restoration from 55th St. to Valmont Drive	City of Boulder
	B	Stream Restoration from BNSF RR to 55th St.	
	C	BNSF Railroad - Replace Bridge with 180 ft. Span Bridge	
	D	Stream Restoration from Foothills Pkwy to BNSF RR	
	E	Hospital Access Improvements for 500-yr Event	
	F	Sediment Maintenance along Boulder Creek Path	
9	A	Cordry Ct. - High Hazard & Flood Mitigation	City of Boulder
	B	Millenium Harvest House and Senior Housing - High Hazard Flood Mitigation	
	C	North of Boulder Creek Access Improvements	
	D	Boulder Slough Mitigation	
	E	Modify Boulder Ditches Diversion for Aquatic and Habitat Passage	
	F	Sediment Maintenance along Boulder Creek Path	
10	A	Modify Farmers' Ditch for Aquatic and Habitat Passage	Boulder County
	B	Boulder Canyon Stream Restoration	

9.5 Alternative Cost Estimates

Cost estimates for alternatives were developed using UDFCD's master planning cost estimating spreadsheet UD-MP COST, version 2.2. 2012 unit costs values were adjusted to present value using the current Colorado Construction Cost Index report. An inflation rate of 1.2166 was used to adjust unit costs to 2014 4th quarter costs. Effective interest rate was estimated to be 1.50%. This assumption was made based upon current discount rates from the Federal Reserve Discount Window and inflation rates published by the US government. Operation and Maintenance was also included within the UD-MP Cost worksheet. Bridge maintenance, channel maintenance and hydraulic structure maintenance were assumed to be performed once every five years. Sediment Maintenance removal costs were included for areas identified by the City of Boulder as frequent problem areas. Each sediment maintenance alternative was assumed to remove 200 cubic yards of sediment a year.

Regarding stream restoration and ecological enhancement costs, costs of recent stream and riparian restoration projects were used as the basis for costs in this master plan. Unit costs from these projects were generated and applied to the restoration quantities assumed for each of the Boulder Creek alternatives where restoration is recommended. Given the range of improvements, unit costs were developed for the following items:

1. Restoration of a stream where the work includes constructing a new channel alignment ($700,000 per mile)
2. Restoration of a stream where the work includes habitat enhancement and related improvements that are to occur within the existing channel ($400,000 per mile)
3. Restoration of the adjacent riparian corridor ($35,000 per acre)

When estimating restoration costs for alternative projects along Boulder Creek, unit restoration costs were combined with the quantity and type of work estimated to be required at each site. For all stream work downstream of the canyon, stream restoration was assumed to include realignment of the channel. Stream restoration within the canyon was assumed to occur within the existing channel with no realignment. The extents of stream restoration were selected to coincide with the alternatives presented in the plan.

Areas of riparian restoration were also estimated for each section. When generating costs for riparian restoration, a target riparian width of 25 feet on either side of the stream was used for the canyon section. The target riparian width was set at 200 feet on either side of the channel for all other segments. The actual amount of riparian restoration needed at each of the alternative sites accounted for the amount of room currently available and the condition of existing vegetation when estimating how much riparian work would be required at each location.

Other costs were calculated as a percent of Capital Improvement Costs, such as Engineering, Legal/Administrative, Contract Administration/Construction Management, and Contingency. No alterations to the default values provided by the UD-MP Cost spreadsheet were made to these items. Traffic Control and Utility Coordination/Relocation were assumed to be 2.5% of the Total Capital Improvements unless site conditions warranted otherwise. All projects assumed 1% of Total Capital Improvements for Dewatering.

Costs estimates assumed: bridge, culvert and storm sewer, channel maintenance for restoration reaches, and maintenance for hydraulic structures or other in-stream features would each occur once every five years.

Table 9-4: Minimum Improvement Alternative Costs (Reach 1 – 6)

Reach	ID	Description	Jurisdiction	Capital	Eng / Admin / Legal	Contingency	Total Capital Cost	50-yr O&M Cost
1	A	Stream Restoration & Debris Removal City of Longmont Open Space	City of Longmont / Weld County	$ 476,965	$ 143,090	$ 119,241	$ 739,296	$ 19,600
	B	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	City of Longmont / Weld County	$ 261,000	$ 78,300	$ 65,250	$ 404,550	$ 4,270
2	A	CO Rd. 20.5 - Replace Bridge with 180 ft. Span Bridge	Weld County	$ 1,792,200	$ 537,660	$ 448,050	$ 2,777,910	$ 420
	B	Replace Existing Grade Control for Aquatic and Habitat Passage	Weld County	$ 237,800	$ 71,340	$ 59,450	$ 368,590	$ 4,270
	C	Modify Rural Ditch for Aquatic and Habitat Passage	Town of Frederick / Weld County	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	D	Modify Idaho Creek Diversion for Aquatic and Habitat Passage	Weld County	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	E	CO Rd. 16.5 - Replace Bridge with 180 ft. Span Bridge	Weld County	$ 1,792,200	$ 537,660	$ 448,050	$ 2,777,910	$ 420
	F	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Town of Frederick / Weld County	$ 5,481,000	$ 1,644,300	$ 1,370,250	$ 8,495,550	$ 89,389
	G	Stream Restoration Downstream of CO Rd. 16.5	Weld County	$ 1,054,200	$ 316,260	$ 263,550	$ 1,634,010	$ 28,000
3	A	Stream Restoration Upstream of CO Rd. 16.5	Weld County	$ 1,058,840	$ 317,652	$ 264,710	$ 1,641,202	$ 28,000
	B	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Weld County	$ 261,000	$ 78,300	$ 65,250	$ 404,550	$ 4,270
4	A	Modify Godding A. and D. Plumb Ditch for Aquatic and Habitat Passage	Weld County	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	B	East County Line Rd. - Replace Bridge with 180 ft. Span Bridge Restore Channel Banks	Weld County / Boulder County	$ 2,384,281	$ 715,284	$ 596,070	$ 3,695,635	$ 560
	C	Protect Gravel Ponds / Town of Erie Reuse Pond / Wittemeyer Ponds Inlet & Outlet During Strom Flows, Typical.	Town of Erie / Weld County / Boulder County	$ 3,915,000	$ 1,174,500	$ 978,750	$ 6,068,250	$ 63,840
	D	Stabilize Bank at Bailey-Kenosha Pond Outlet	Boulder County	$ 17,088	$ 5,126	$ 4,272	$ 26,486	$ 3,220
	E	DS of Kenosha Rd. - Remove Washed Out Bridge		$ 69,600	$ 20,880	$ 17,400	$ 107,880	$ -
	F	Stream Restoration Through Doniphan, Wittemeyer Ponds, Bailey-Kenosha Ponds, and Open Space		$ 4,477,600	$ 1,343,280	$ 1,119,400	$ 6,940,280	$ 118,999
	G	Stabilize Howell Ditch Diversion System, Modify Diversion for Aquatic and Habitat Passage		$ 399,308	$ 119,792	$ 99,827	$ 618,927	$ 7,490
	H	Kenosha Rd. - Replace Bridge with 180 ft. Span Bridge		$ 2,296,800	$ 689,040	$ 574,200	$ 3,560,040	$ 560
	I	Replace Grade Control for Aquatic and Habitat Passage		$ 237,800	$ 71,340	$ 59,450	$ 368,590	$ 4,270
	J	109th St. - Replace Bridge with 180 ft. Span Bridge; Restore Adjacent Channel		$ 2,834,752	$ 850,426	$ 708,688	$ 4,393,866	$ 420
	K	Stream Restoration Through Wheeler Ranch		$ 2,424,657	$ 727,398	$ 606,164	$ 3,758,219	$ 64,399
5	A	Stream Restoration at Alexander Dawson Open Space	Boulder County	$ 2,378,000	$ 713,400	$ 594,500	$ 3,685,900	$ 62,999
	B	Modify Boulder and Weld County Ditch for Aquatic and Habitat Passage		$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	C	Protect Boulder Valley Ponds Inlet & Outlet During Storm Flows, Typ.		$ 1,305,000	$ 391,500	$ 326,250	$ 2,022,750	$ 21,280
	D	Modify Grade Control Structures for Aquatic and Habitat Passage		$ 237,800	$ 71,340	$ 59,450	$ 368,590	$ 4,270
	E	Modify Lower Boulder Ditch for Aquatic and Habitat Passage		$ 237,800	$ 71,340	$ 59,450	$ 368,590	$ 4,270
	F	Stream Restoration Downstream of 95th St.		$ 1,054,200	$ 316,260	$ 263,550	$ 1,634,010	$ 28,000
	G	95th St. - Replace Bridge with 180 ft. Span Bridge		$ 2,366,400	$ 709,920	$ 591,600	$ 3,667,920	$ 560
	H	Stream Restoration from Upstream of 95th St. to White Rocks Trail		$ 2,371,947	$ 711,584	$ 592,987	$ 3,676,518	$ 62,999
6	A	Modify Leggett Ditch for Aquatic and Habitat Passage	Boulder County	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	B	75th St. - Replace Bridge with 180 ft. Span Bridge		$ 2,343,200	$ 702,960	$ 585,800	$ 3,631,960	$ 560

Table 9-5: Minimum Improvements Alternative Costs (Reach 7 - 10)

Reach	ID	Description	Jurisdiction	Capital	Eng / Admin / Legal	Contingency	Total Capital Cost	50-yr O&M Cost
7	A	Protect Walden Ponds Inlet & Outlet During Storm Flows, Typical	Boulder County	$ 1,827,000	$ 548,100	$ 456,750	$ 2,831,850	$ 29,785
	B	Protect Ponds Inlet & Outlet During Storm Flows, Typical		$ 1,827,000	$ 548,100	$ 456,750	$ 2,831,850	$ 29,785
	C	Modify Diversion for Aquatic and Habitat Passage		$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	D	Modify Green Ditch Diversion for Aquatic and Habitat Passage		$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	E	61st Street - 100-yr Option: Replace Bridge with 220 ft. Span Bridge		$ 2,843,416	$ 853,025	$ 710,854	$ 4,407,295	$ 420
	F	Replace Old Valmont Pedestrain Crossing with 180 ft. Span Bridge		$ 1,117,813	$ 335,344	$ 279,453	$ 1,732,610	$ 210
	G	Modify Butte Mill Ditch Crossing on South Boulder Creek		$ 235,160	$ 70,548	$ 58,790	$ 364,498	$ 4,200
	H	Protect Sanitary Interceptor Sewer		$ 511,009	$ 153,302	$ 127,752	$ 792,063	$ 8,505
	I	Stream Restoration from Valmont Rd to 61st Street		$ 1,546,781	$ 464,034	$ 386,695	$ 2,397,510	$ 87,499
8	A	Stream Restoration from 55th St. to Valmont Drive	City of Boulder	$ 429,200	$ 128,760	$ 107,300	$ 665,260	$ 23,800
	B	Stream Restoration from BNSF RR to 55th St.		$ 1,194,800	$ 358,440	$ 298,700	$ 1,851,940	$ 67,199
	C	BNSF Railroad - Replace Bridge with 180 ft. Span Bridge		$ 2,697,000	$ 809,100	$ 674,250	$ 4,180,350	$ 280
	D	Stream Restoration from Foothills Pkwy to BNSF RR		$ 638,000	$ 191,400	$ 159,500	$ 988,900	$ 36,400
	E	Hospital Access Improvements for 500-yr Event		$ 46,932	$ 14,080	$ 11,733	$ 72,745	$ -
	F	Sediment Maintenance along Boulder Creek Path		$ -	$ -	$ -	$ -	$ 839,993
9	C	North of Boulder Creek Access Improvements	City of Boulder	$ 3,496,000	$ 1,048,800	$ 874,000	$ 5,418,800	$ -
	D	Boulder Slough Mitigation		$ 485,529	$ 145,658	$ 121,382	$ 752,569	$ 10,815
	E	Modify Boulder Ditches Diversion for Aquatic and Habitat Passage		$ 406,000	$ 121,800	$ 101,500	$ 629,300	$ 4,270
	F	Sediment Maintenance along Boulder Creek Path		$ -	$ -	$ -	$ -	$ 1,259,989
10	A	Modify Farmers' Ditch for Aquatic and Habitat Passage	Boulder County	$ 300,000	$ 90,000	$ 75,000	$ 465,000	$ 4,270
	B	Boulder Canyon Stream Restoration		$ 696,000	$ 208,800	$ 174,000	$ 1,078,800	$ 67,199
			Total Costs	$ 69,531,293	$ 20,859,388	$ 17,382,822	$ 107,773,503	$ 3,131,844

Table 9-6: 100-yr Crossing Improvements

Reach	ID	Description	Jurisdiction	Capital	Eng / Admin / Legal	Contingency	Total Capital Cost	50-yr O&M Cost
4	B	County Line Road - Install 100-yr Crossing Replace Bridge with 220 ft. Span Bridge	Boulder County	$ 3,655,196	$ 1,096,559	$ 913,799	$ 5,665,554	$ 560
5	F	95th Street - Install 100-yr Crossing Replace Bridge with 220 ft. Span Bridge	Boulder County	$ 3,778,680	$ 1,133,604	$ 944,670	$ 5,856,954	$ 560
6	B	75th Street - Install 100-yr Crossing Replace Bridge with 220 ft. Span Bridge	Boulder County	$ 3,097,220	$ 929,166	$ 774,305	$ 4,800,691	$ 560
7	E	61st Street - Install 100-yr Crossing Replace Bridge with 220 ft. Span Bridge	Boulder County	$ 2,843,416	$ 853,025	$ 710,854	$ 4,407,295	$ 420

9.6 Qualitative Evaluation Process

As discussed previously, the focus is on general guidance for stream and ecological restoration and does not re-evaluate the current 100-year floodplain limits regulated by FEMA. Alternatives generally apply the stream restoration principles at locations with immediate restoration needs and a higher likelihood of implementation, and in most cases, where property has already been acquired. As discussed, there is a wide range of options related to the implementation of the master plan and no singular, correct solution in defining restored stream alignments. Alignments should be refined further through individual project goals, but keeping in mind compatibility with neighboring stream reaches.

For these reasons, formal evaluations on direct project benefits, such as flood reduction, were not quantified with this study. Benefits from the alternatives presented would be ancillary, reflecting:

- Geomorphic resiliency for Boulder Creek for minor and major flood events;
- Improved ecological needs and function within the stream, riparian, and floodplain areas;
- Improved conveyance for roadway and public infrastructure (in some cases meeting 100-year levels);
- Improved safety and function of existing aggregate and natural resource ponds;
- Bank and stream stability;
- Promotion of fish passage and continuous habitat for in-stream organisms;
- Planning around trail and other multi-use functions.
- Emergency access to location susceptible to flooding;
- Reduction of High Hazard areas.

With exception to comparing bridge capacity at 61st Street, 75th Street, and County Line Road, alternatives presented were not comparable in nature. Ultimate alternative for inclusion in the conceptual design will be made through further discussions and rankings with project sponsors and other interested parties.

9.7 Water Quality Impacts

No formal regional water quality plan is proposed with these improvements. Eroding channel banks and stream instability leads to degradation in water quality throughout a watershed and challenges to habitat and aquatic species. Stream restoration, as recommended, will help improve water quality aspects through stabilizing channel slopes and banks, and improving adjacent riparian habitat. Any new development within the watershed is encouraged to handle water quality on a site specific basis.

December 2015

Figure 9-2

Boulder Creek Restoration Master Plan

Project Alternatives

Legend

- Hydraulic Feature
- 100-Year Floodplain
- Open Space
- Existing Stream Alignment

Alternate Centerline

- Reach 1
- Reach 2
- Reach 3

3A:
Stream Restoration
Upstream of CO Rd 16.5

2D:
Modify Idaho Creek Diversion for Aquatic and Habitat Passage

2G:
Stream Restoration
Downstream of CO Rd 16.5

2F (All ● Markers):
Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical.

2A:
Location: CO Rd 20.5
Replace Bridge With 180' Span Bridge
Q_{100}: 12,250 cfs

Downstream Limit of Study

1A:
Stream Restoration & Debris Removal
City of Longmont Open Space

3B (All ● Markers):
Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical.

2E:
Location: CO Rd 16.5
Replace Bridge With 180' Span Bridge
Q_{100}: 13,750 cfs

2C:
Modify Rural Ditch for Aquatic and Habitat Passage

2B:
Replace Existing Grade Control for Aquatic and Habitat Passage

1B (All ● Markers):
Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical.

Reach 1
Reach 2
Reach 3
Bridge
Diversion Structure
Bridge
Diversion Structure
Channel Bank Breach
County Road 18
County Road 20
County Road 20 1/2
Vista View Drive
Meadow View Drive
Idaho Creek Ditch
Rural Ditch
Rural ditch
Idaho Creek Ditch
Mineral Road
Louisville
Firestone
Frederick
0 0.25 0.5 0.75 1 mi

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Figure 9-3

Boulder Creek Restoration Master Plan

Project Alternatives

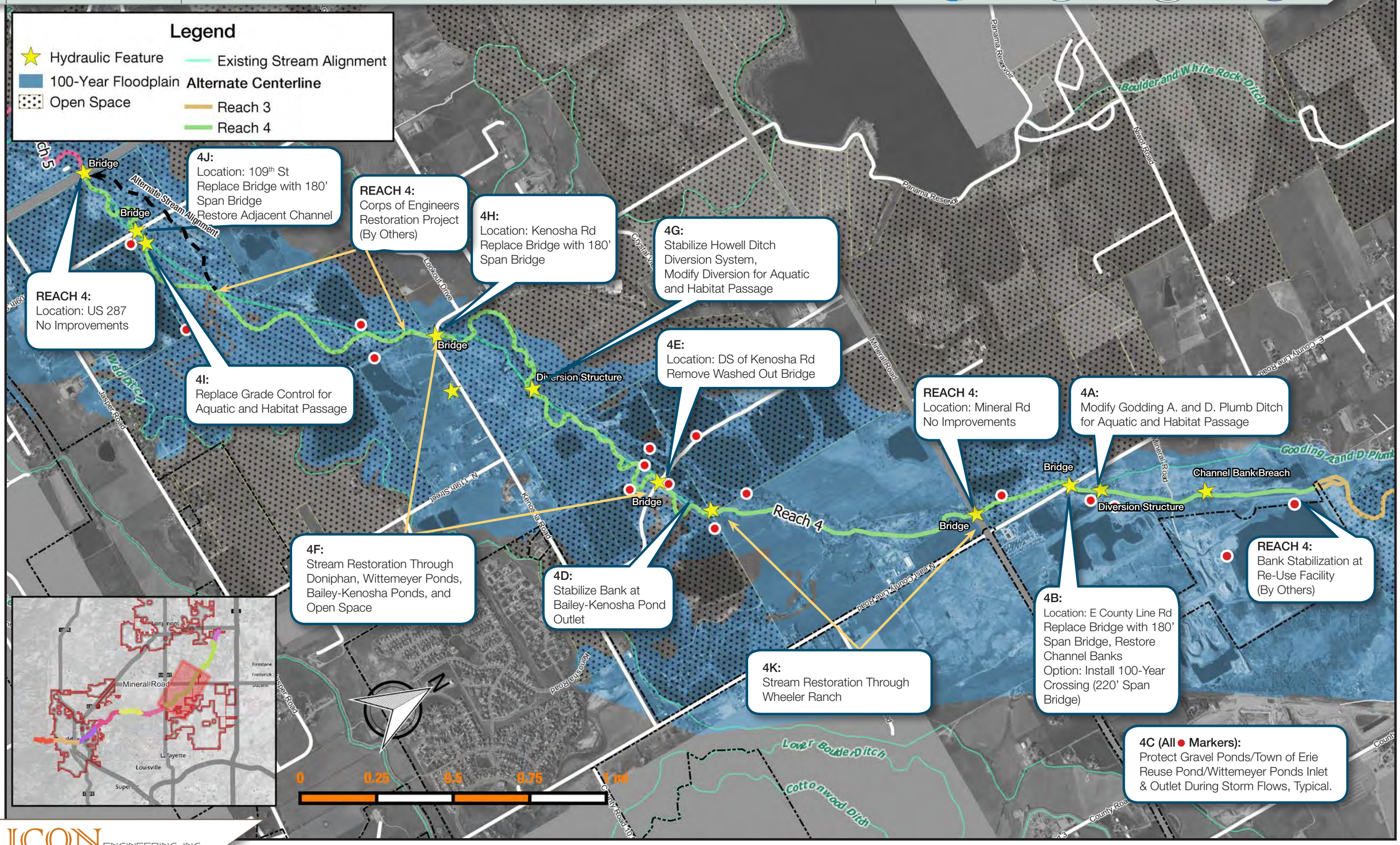

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Figure 9-4

Boulder Creek Restoration Master Plan

Project Alternatives

Legend
- Hydraulic Feature
- 100-Year Floodplain
- Open Space
- Existing Stream Alignment

Alternate Centerline
- Reach 4
- Reach 5
- Reach 6
- Reach 7

5A:
Stream Restoration at Alexander Dawson Open Space

5B:
Modify Boulder Weld Ditch for Aquatic and Habitat Passage

5F:
Stream Restoration Downstream of 95th Street

5G:
Location: 95th St
Replace Bridge with 180' Span Bridge
Option: Install 100-Year Crossing (220' Span Bridge)

6A:
Modify Leggett Ditch for Aquatic and Habitat Passage

6B:
Location: 75th St
Replace Bridge with 180' Span Bridge
Option: Install 100-Year Crossing (220' Span Bridge)

5H:
Stream Restoration from Upstream of 95th St. to White Rocks Trail

5E:
Modify Lower Boulder Ditch for Aquatic and Habitat Passage

5D:
Modify Grade Control Structures for Aquatic and Habitat Passage

5C (All ● Markers):
Protect Boulder Valley Ponds Inlet & Outlet During Storm Flows, Typical.

Bridge
Reach 4
Bridge
Diversion Structure
Boulder Weld Ditch
Drop Structure
Reach 5
Drop Structure
Goose Haven Drive
ERIE
Drop Structure
Diversion Structure
Lower Boulder Ditch
LAFAYETTE
Leyner Cottonwood Ditch
Isabelle Road
Leon A Wurl Parkway
Leyner Cottonwood Ditch
Diversion Structure
Leggett Ditch
Alternate Stream Alignment
Bridge
Private Bridge
Reach 6
Reach 7
Bridge
Jay Road
E. Boulder Trail
Gunbarrel Ridge Road
Phillips Road
N. 95th Street
N. 75th Street
N. 109th Street
Cambridge Street
Greylock Street
Hampshire Street
Harwich Street
Kincross Way
Kincross Drive
Heatherwood Drive
Ashfield Drive
Mineral Road
Valmont Road
Bassett Lane
E. Boulder Trail
0 0.25 0.5 0.75 1 mi
N

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Figure 9-5

Boulder Creek Restoration Master Plan

Project Alternatives

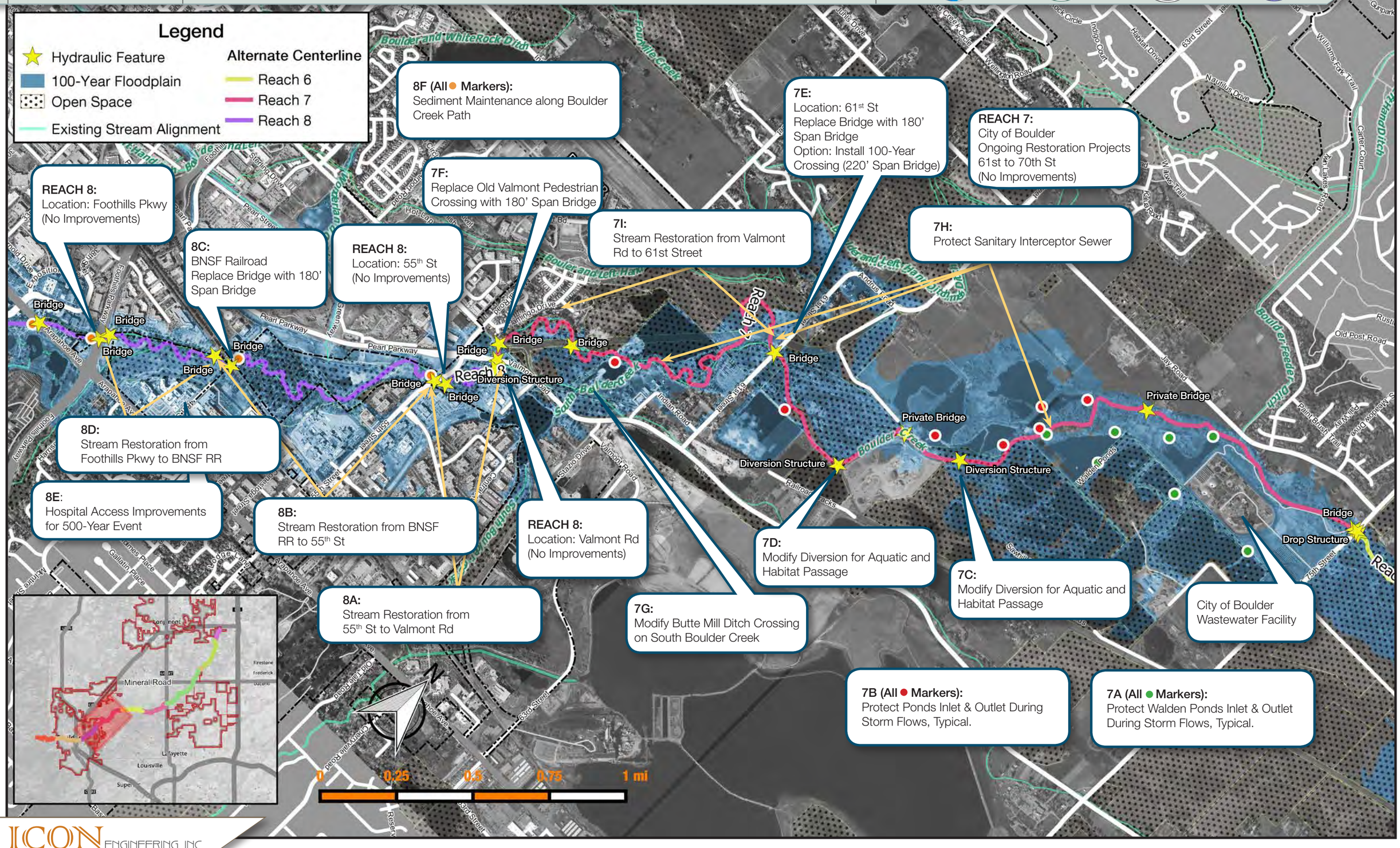

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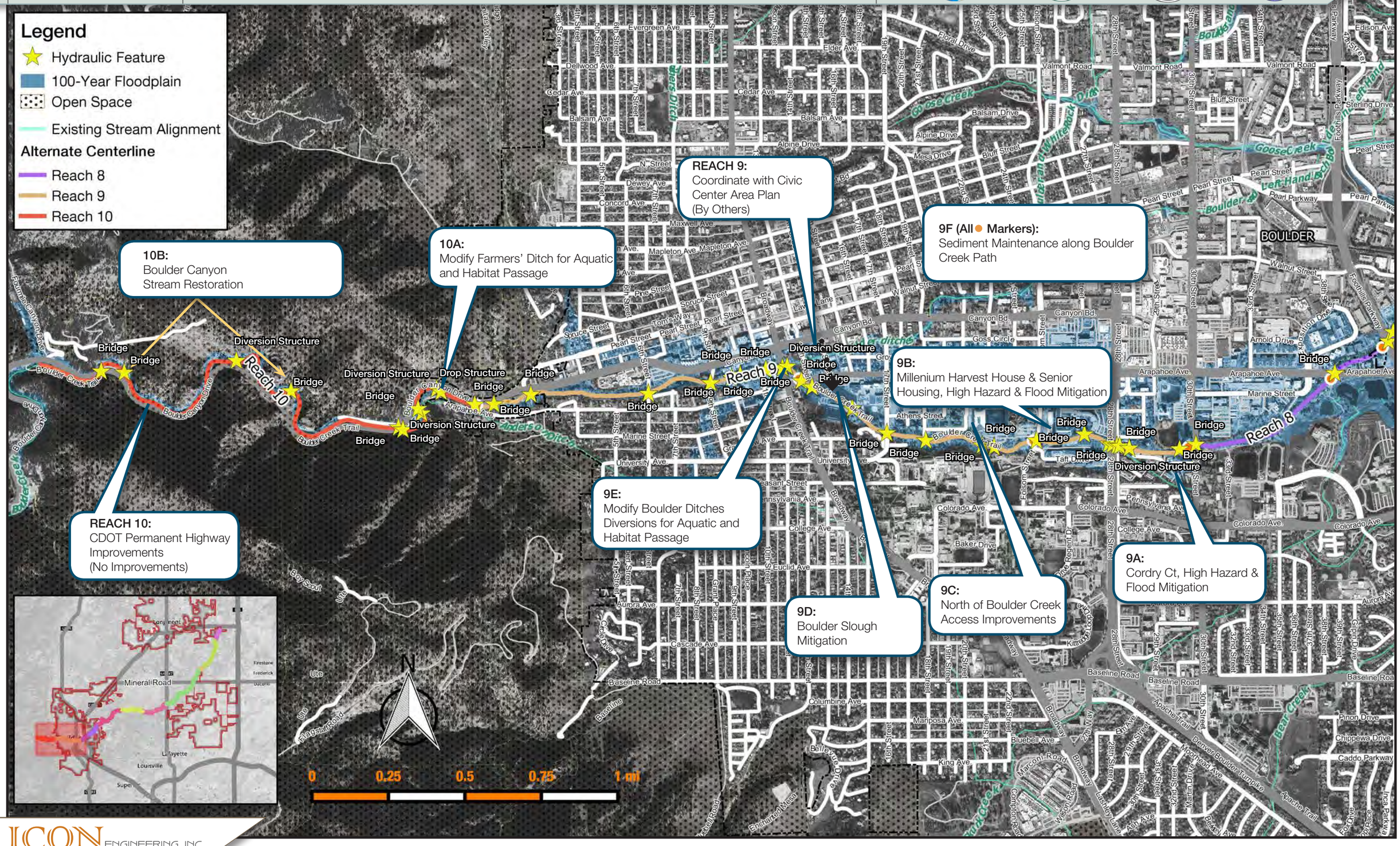
Figure 9-6

Boulder Creek Restoration Master Plan

Project Alternatives



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10.0 RECOMMENDED PLAN

The recommended plan is shown in Figure 10-1-10-5: Recommended Plan Maps. Project descriptions and summary of costs are provided in Table 10-1. In general, the recommended plan incorporates project alternatives discussed under Section 9.0, with exception to the following items:

1. 100-year stream crossings were recommended at 61st Street, 75th Street, 95th Street and County Line Road to maintain emergency access during flood events in the future.
2. High Hazard and floodplain mitigation for the Millennium Harvest House Property and Carillion Senior Housing Facility were not recommended in the master plan, as improvements in these areas would occur through future private redevelopment and planning.

Table 10-1 : Summary of Recommended Plan Project Alternatives (Reach 1-6)

Reach	ID	Description	Jurisdiction	Capital	Eng / Admin / Legal	Contingency	Total Capital Cost	50-yr O&M Cost
1	A	Stream Restoration & Debris Removal City of Longmont Open Space	City of Longmont / Weld County	$ 476,965	$ 143,090	$ 119,241	$ 739,296	$ 19,600
	B	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	City of Longmont / Weld County	$ 261,000	$ 78,300	$ 65,250	$ 404,550	$ 4,270
2	A	CO Rd. 20.5 - Replace Bridge with 180 ft. Span Bridge	Weld County	$ 1,792,200	$ 537,660	$ 448,050	$ 2,777,910	$ 420
	B	Replace Existing Grade Control for Aquatic and Habitat Passage	Weld County	$ 237,800	$ 71,340	$ 59,450	$ 368,590	$ 4,270
	C	Modify Rural Ditch for Aquatic and Habitat Passage	Town of Frederick / Weld County	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	D	Modify Idaho Creek Diversion for Aquatic and Habitat Passage	Weld County	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	E	CO Rd. 16.5 - Replace Bridge with 180 ft. Span Bridge	Weld County	$ 1,792,200	$ 537,660	$ 448,050	$ 2,777,910	$ 420
	F	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Town of Frederick / Weld County	$ 5,481,000	$ 1,644,300	$ 1,370,250	$ 8,495,550	$ 89,389
	G	Stream Restoration Downstream of CO Rd. 16.5	Weld County	$ 1,054,200	$ 316,260	$ 263,550	$ 1,634,010	$ 28,000
3	A	Stream Restoration Upstream of CO Rd. 16.5	Weld County	$ 1,058,840	$ 317,652	$ 264,710	$ 1,641,202	$ 28,000
	B	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Weld County	$ 261,000	$ 78,300	$ 65,250	$ 404,550	$ 4,270
4	A	Modify Godding A. and D. Plumb Ditch for Aquatic and Habitat Passage	Weld County	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	B	East County Line Road - 100-yr Option: Replace Bridge with 220 ft. Span Bridge	Boulder County	$ 3,655,196	$ 1,096,559	$ 913,799	$ 5,665,554	$ 560
	C	Protect Gravel Ponds / Town of Erie Reuse Pond / Wittemeyer Ponds Inlet & Outlet During Strom Flows, Typical.	Town of Erie / Weld County / Boulder County	$ 3,915,000	$ 1,174,500	$ 978,750	$ 6,068,250	$ 63,840
	D	Stabilize Bank at Bailey-Kenosha Pond Outlet	Boulder County	$ 17,088	$ 5,126	$ 4,272	$ 26,486	$ 3,220
	E	DS of Kenosha Rd. - Remove Washed Out Bridge		$ 69,600	$ 20,880	$ 17,400	$ 107,880	$ -
	F	Stream Restoration Through Doniphan, Wittemeyer Ponds, Bailey-Kenosha Ponds, and Open Space		$ 4,477,600	$ 1,343,280	$ 1,119,400	$ 6,940,280	$ 118,999
	G	Stabilize Howell Ditch Diversion System, Modify Diversion for Aquatic and Habitat Passage		$ 399,308	$ 119,792	$ 99,827	$ 618,927	$ 7,490
	H	Kenosha Rd. - Replace Bridge with 180 ft. Span Bridge		$ 2,296,800	$ 689,040	$ 574,200	$ 3,560,040	$ 560
	I	Replace Grade Control for Aquatic and Habitat Passage		$ 237,800	$ 71,340	$ 59,450	$ 368,590	$ 4,270
	J	109th St. - Replace Bridge with 180 ft. Span Bridge; Restore Adjacent Channel		$ 2,834,752	$ 850,426	$ 708,688	$ 4,393,866	$ 420
	K	Stream Restoration Through Wheeler Ranch		$ 2,424,657	$ 727,398	$ 606,164	$ 3,758,219	$ 64,399
5	A	Stream Restoration at Alexander Dawson Open Space	Boulder County	$ 2,378,000	$ 713,400	$ 594,500	$ 3,685,900	$ 62,999
	B	Modify Boulder and Weld County Ditch for Aquatic and Habitat Passage		$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	C	Protect Boulder Valley Ponds Inlet & Outlet During Storm Flows, Typical.		$ 1,305,000	$ 391,500	$ 326,250	$ 2,022,750	$ 21,280
	D	Modify Grade Control Structures for Aquatic and Habitat Passage		$ 237,800	$ 71,340	$ 59,450	$ 368,590	$ 4,270
	E	Modify Lower Boulder Ditch for Aquatic and Habitat Passage		$ 237,800	$ 71,340	$ 59,450	$ 368,590	$ 4,270
	F	Stream Restoration Downstream of 95th Street		$ 1,054,200	$ 316,260	$ 263,550	$ 1,634,010	$ 28,000
	G	95th St. - 100-yr Option: Replace Bridge with 220 ft. Span Bridge		$ 3,778,680	$ 1,133,604	$ 944,670	$ 5,856,954	$ 560
	H	Stream Restoration from Upstream of 95th St. to White Rocks Trail	City of Boulder	$ 2,371,947	$ 711,584	$ 592,987	$ 3,676,518	$ 62,999
6	A	Modify Leggett Ditch for Aquatic and Habitat Passage	Boulder County	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	B	75th Street - 100-yr Option: Replace Bridge with 220 ft. Span Bridge		$ 3,097,220	$ 929,166	$ 774,305	$ 4,800,691	$ 560

Table 10-2: Summary of Recommended Plan Project Alternatives (Reach 7 - 10)

Reach	ID	Description	Jurisdiction	Capital	Eng / Admin / Legal	Contingency	Total Capital Cost	50-yr O&M Cost
7	A	Protect Walden Ponds Inlet & Outlet During Storm Flows, Typical	Boulder County	$ 1,827,000	$ 548,100	$ 456,750	$ 2,831,850	$ 29,785
	B	Protect Ponds Inlet & Outlet During Storm Flows, Typical		$ 1,827,000	$ 548,100	$ 456,750	$ 2,831,850	$ 29,785
	C	Modify Diversion for Aquatic and Habitat Passage		$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	D	Modify Green Ditch Diversion for Aquatic and Habitat Passage		$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	E	61st Street - 100-yr Option: Replace Bridge with 220 ft. Span Bridge		$ 2,843,416	$ 853,025	$ 710,854	$ 4,407,295	$ 420
	F	Replace Old Valmont Pedestrain Crossing with 180 ft. Span Bridge		$ 1,117,813	$ 335,344	$ 279,453	$ 1,732,610	$ 210
	G	Modify Butte Mill Ditch Crossing on South Boulder Creek		$ 235,160	$ 70,548	$ 58,790	$ 364,498	$ 4,200
	H	Protect Sanitary Interceptor Sewer		$ 511,009	$ 153,302	$ 127,752	$ 792,063	$ 8,505
	I	Stream Restoration from Valmont Rd to 61st Street		$ 1,546,781	$ 464,034	$ 386,695	$ 2,397,510	$ 87,499
8	A	Stream Restoration from 55th St. to Valmont Drive	City of Boulder	$ 429,200	$ 128,760	$ 107,300	$ 665,260	$ 23,800
	B	Stream Restoration from BNSF RR to 55th St.		$ 1,194,800	$ 358,440	$ 298,700	$ 1,851,940	$ 67,199
	C	BNSF Railroad - Replace Bridge with 180 ft. Span Bridge		$ 2,697,000	$ 809,100	$ 674,250	$ 4,180,350	$ 280
	D	Stream Restoration from Foothills Pkwy to BNSF RR		$ 638,000	$ 191,400	$ 159,500	$ 988,900	$ 36,400
	E	Hospital Access Improvements for 500-yr Event		$ 46,932	$ 14,080	$ 11,733	$ 72,745	$ -
	F	Sediment Maintenance along Boulder Creek Path		$ -	$ -	$ -	$ -	$ 839,993
9	C	North of Boulder Creek Access Improvements	City of Boulder	$ 3,496,000	$ 1,048,800	$ 874,000	$ 5,418,800	$ -
	D	Boulder Slough Mitigation		$ 485,529	$ 145,658	$ 121,382	$ 752,569	$ 10,815
	E	Modify Boulder Ditches Diversion for Aquatic and Habitat Passage		$ 406,000	$ 121,800	$ 101,500	$ 629,300	$ 4,270
	F	Sediment Maintenance along Boulder Creek Path		$ -	$ -	$ -	$ -	$ 1,259,989
10	A	Modify Farmers' Ditch for Aquatic and Habitat Passage	Boulder County	$ 300,000	$ 90,000	$ 75,000	$ 465,000	$ 4,270
	B	Boulder Canyon Stream Restoration		$ 696,000	$ 208,800	$ 174,000	$ 1,078,800	$ 67,199
			Total Costs	$ 69,531,293	$ 20,859,388	$ 17,382,822	$ 107,773,503	$ 3,131,844

| | | | **Total Costs** | $ 69,531,293 | $ 20,859,388 | $ 17,382,822 | $ 107,773,503 | $ 3,131,844 |

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Figure 10-1

Boulder Creek Restoration Master Plan

Recommended Plan

Legend

- Hydraulic Feature
- 100-Year Floodplain
- Open Space
- Existing Stream Alignment

Alternate Centerline

- Reach 1
- Reach 2
- Reach 3

3A:
Stream Restoration
Upstream of CO Rd 16.5

2D:
Modify Idaho Creek Diversion for Aquatic and Habitat Passage

2G:
Stream Restoration
Downstream of CO Rd 16.5

2F (All ● Markers):
Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical.

2A:
Location: CO Rd 20.5
Replace Bridge With 180' Span Bridge
Q_{100}: 12,250 cfs

Downstream Limit of Study

1A:
Stream Restoration & Debris Removal
City of Longmont Open Space

1B (All ● Markers):
Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical.

2B:
Replace Existing Grade Control for Aquatic and Habitat Passage

2C:
Modify Rural Ditch for Aquatic and Habitat Passage

2E:
Location: CO Rd 16.5
Replace Bridge With 180' Span Bridge
Q_{100}: 13,750 cfs

3B (All ● Markers):
Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical.

Reach 1
Reach 2
Reach 3
Bridge
Diversion Structure
Bridge
Diversion Structure
Channel Bank Breach
County Road 20
County Road 20 1/2
County Road 18
Vista View Drive
Meadow View Drive
Harbor Drive
Idaho Creek Ditch
Rural Ditch
Rural ditch
Idaho Creek Ditch
Mineral Road
Louisville
Firestone
Frederick
0
0.25
0.5
0.75
1 mi

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Figure 10-2

Boulder Creek Restoration Master Plan

Recommended Plan

Legend

- Hydraulic Feature
- 100-Year Floodplain
- Open Space
- Existing Stream Alignment
- Alternate Centerline
- Reach 3
- Reach 4

4J:
Location: 109th St
Replace Bridge with 180' Span Bridge
Restore Adjacent Channel

REACH 4:
Corps of Engineers Restoration Project (By Others)

4H:
Location: Kenosha Rd
Replace Bridge with 180' Span Bridge

4G:
Stabilize Howell Ditch Diversion System,
Modify Diversion for Aquatic and Habitat Passage

4E:
Location: DS of Kenosha Rd
Remove Washed Out Bridge

4A:
Modify Godding A. and D. Plumb Ditch for Aquatic and Habitat Passage

4I:
Replace Grade Control for Aquatic and Habitat Passage

4F:
Stream Restoration Through Doniphan, Wittemeyer Ponds, Bailey-Kenosha Ponds, and Open Space

4D:
Stabilize Bank at Bailey-Kenosha Pond Outlet

4K:
Stream Restoration Through Wheeler Ranch

4B:
Location:
E County Line Rd
Replace Bridge with 220' Span Bridge (100-Year),
Restore Channel Banks

REACH 4:
Bank Stabilization at Re-Use Facility (By Others)

4C (All ● Markers):
Protect Gravel Ponds/Town of Erie Reuse Pond/Wittemeyer Ponds Inlet & Outlet During Storm Flows, Typical.

Ch 5
Bridge
Bridge
Alternate Stream Alignment
Lookout Drive
Bridge
Diversion Structure
Bridge
Bridge
Bridge
Reach 4
Diversion Structure
Channel Bank Breach
Panama Reservoir
Panama Reservoir
Boulder and White Rock Ditch
Nimrod Road
Mineral Road
E County Line Road
Gooding and D Plumb
Boulder Weld Ditch
Jasper Road
N 109th St
N 119th Street
Kenosha Road
Kenosha Road
Peoples Ditch
Lower Boulder Ditch
Cottonwood Ditch
County Road 6
County Road 10
Crystal Valley
Mineral Road
Firestone
Frederick
Dacono
Lafayette
Louisville
0 0.25 0.5 0.75 1 mi

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Figure 10-3

Boulder Creek Restoration Master Plan

Recommended Plan

Legend

- Hydraulic Feature
- 100-Year Floodplain
- Open Space
- Existing Stream Alignment

Alternate Centerline

- Reach 4
- Reach 5
- Reach 6
- Reach 7

5A:
Stream Restoration at Alexander Dawson Open Space

5B:
Modify Boulder and Weld County Ditch for Aquatic and Habitat Passage

5G:
Location: 95th St
Replace Bridge with 220' Span Bridge

6A:
Modify Leggett Ditch for Aquatic and Habitat Passage

5F:
Stream Restoration Downstream of 95th Street

6B:
Location: 75th St
Replace Bridge with 220' Span Bridge (100-Year)

5H:
Stream Restoration from upstream of 95th St to White Rocks Trail

5E:
Modify Lower Boulder Ditch for Aquatic and Habitat Passage

5D:
Modify Grade Control Structures for Aquatic and Habitat Passage

5C (All ● Markers):
Protect Boulder Valley Ponds Inlet & Outlet During Storm Flows, Typical.

Diversion Structure
Bridge
Reach 4
Reach 5
Reach 6
Reach 7
Drop Structure
Private Bridge
Alternate Stream Alignment
Boulder Weld Ditch
Leggett Ditch
Lower Boulder Ditch
Leyner Cottonwood Ditch
E. Boulder Trail
N. 75th Street
N. 95th Street
N. 109th Street
Jay Road
Valmont Road
Isabelle Road
Leon A Wurl Parkway
Gurtanel Ridge Road
West Phillips Road
Phillips Road
Goose Haven Drive
Heatherwood Drive
Kincross Way
Kincross Dr
Greylock Street
Hampshire Street
Harwich Street
Cambridge Street
Ashfield Drive
Mineral Road
Lake Lane
ERIE
LAFAYETTE

N

0 0.25 0.5 0.75 1 mi

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Figure 10-4

Boulder Creek Restoration Master Plan

Recommended Plan

Legend

- Hydraulic Feature
- 100-Year Floodplain
- Open Space
- Existing Stream Alignment

Alternate Centerline

- Reach 6
- Reach 7
- Reach 8

8F (All ● Markers):
Sediment Maintenance along Boulder Creek Path

7F:
Replace Old Valmont Pedestrian Crossing with 180' Span Bridge

7I:
Stream Restoration from Valmont Rd to 61st Street

7E:
Location: 61st St
Replace Bridge with 220' Span Bridge (100-Year)

8C:
BNSF Railroad
Replace Bridge with 180' Span Bridge

7H:
Protect Sanitary Interceptor Sewer

8D:
Stream Restoration from Foothills Pkwy to BNSF RR

8E:
Hospital Access Improvements for 500-Year Event

8B:
Stream Restoration from BNSF RR to 55th St

8A:
Stream Restoration from 55th St to Valmont Rd

7D:
Modify Green Ditch Diversion for Aquatic and Habitat Passage

7C:
Modify Diversion for Aquatic and Habitat Passage

7G:
Modify Butte Mill Ditch Crossing on South Boulder Creek

City of Boulder Wastewater Facility

7B (All ● Markers):
Protect Ponds Inlet & Outlet During Storm Flows, Typical.

7A (All ● Markers):
Protect Walden Ponds Inlet & Outlet During Storm Flows, Typical.

Bridge
Diversion Structure
Private Bridge
Drop Structure
Reach 3
Reach 7
Boulder Creek
South Boulder Creek
Boulder and WhiteRock Ditch
Boulder and Left Hand Ditch
Boulder Feeder Ditch
Green Ditch
Mineral Road
0 0.25 0.5 0.75 1 mi

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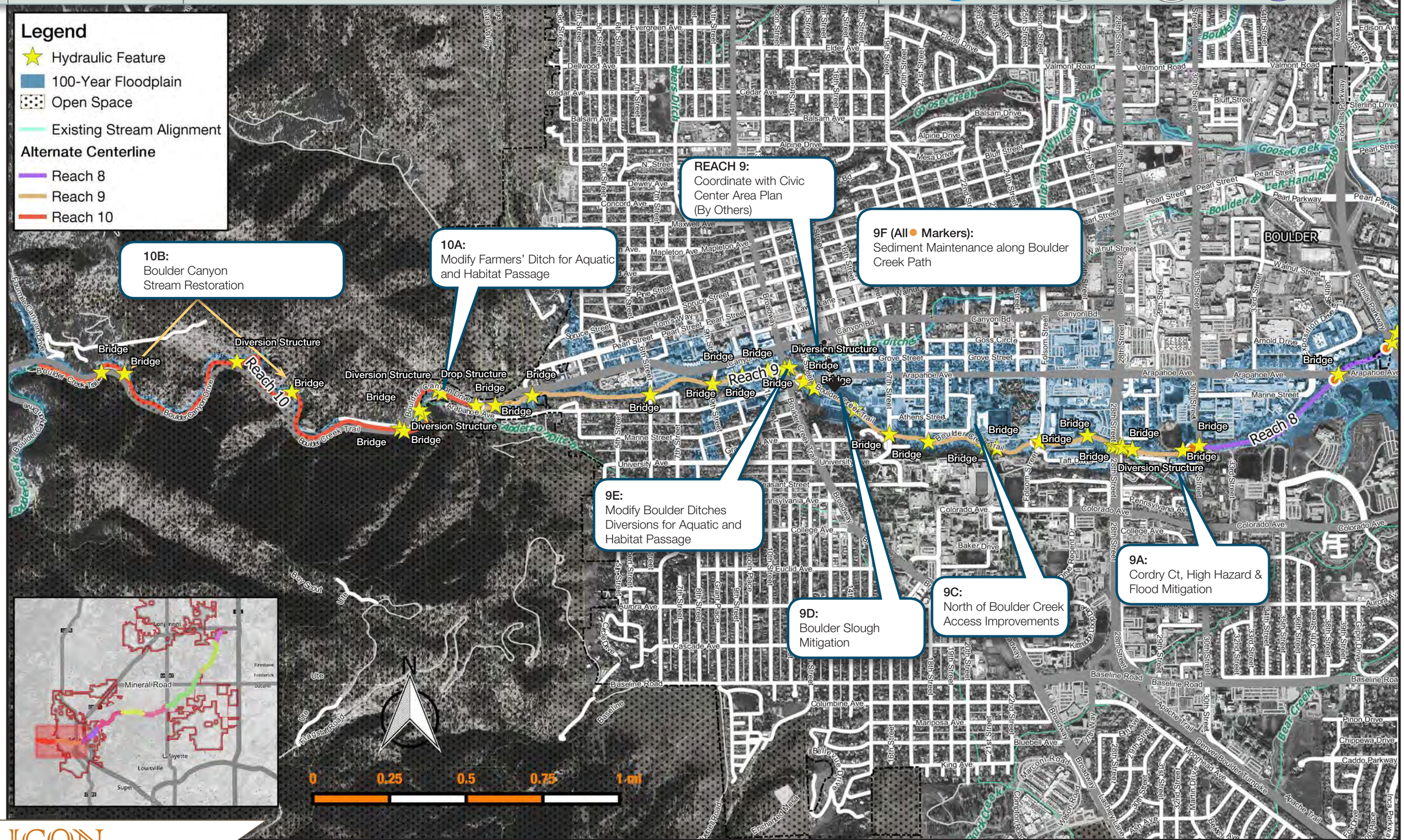
Figure 10-5

Boulder Creek Restoration Master Plan

Recommended Plan



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11.0 CONCEPTUAL DESIGN

11.1 Plan Development Overview

The Selected Plan letter was received from project sponsors on September 14, 2015 and can be found in APPENDIX B. The Conceptual Design follows the alternatives proposed in the recommended plan with the exception of three areas.

At the confluence with the St. Vrain River, Boulder Creek has breached along the north bank at a different location since the Alternative Analysis submittal. The project plan would reflect maintaining the current stream alignment with the Boulder Creek / St. Vrain Creek confluence remaining at its existing location. Given the stream segment and breach occurs on City of Longmont Open Space, improvements in this area will be more related to maintenance of the existing configuration and ecological enhancements.

Flooding events have become more common at 95th Street. At the request of Boulder County, an interim improvement was developed to help prevent overtopping of the roadway during these more frequent storms, while still maintaining the current bridge configurations and relation to downstream private property. This interim plan proposes changes to the roadway and integrates with stream restoration needs upstream of 95th Street on City of Boulder Open Space property. The interim condition is presented by the project rendering; however the master plan improvements and cost estimate will ultimately reflect a more long term solution.

At Cordry Court, improvements to the Boulder Creek Trail and grading between the trail and the Cordry Court residences have been added as a recommended improvement to eliminate the high hazard on the residences in the area. In accordance with City greenway's objectives, property acquisition in this area should be considered as a means to eliminate high flood hazard and improve overall public safety.

11.2 General Recommendations

Land-use changes to contributing watersheds affect the flood hazard nature (i.e., runoff rates, volumes and depths), the transport of sediment, and the water quality of the receiving natural waterways. To encourage the implementation of this master plan, it is recommended:

a. That the controlling jurisdictions take steps to stabilize all major waterways when their watershed urbanizes, rehabilitate existing degraded reaches of the waterways and their tributaries, and aggressively control erosion and sediment transport during construction activities.
b. That Sponsors and any other jurisdiction having land use control powers in this watershed require new land development and significant redevelopment and publicly funded projects to provide to the maximum extent practicable runoff volume control practices (i.e., minimize directly connected impervious areas and employ infiltrating permanent BMPs) whenever site conditions permit.
c. That the controlling jurisdictions take steps to require that all BMPs for all new development, redevelopment, and publicly funded projects provide to the maximum extent practicable a Water Quality Capture Volume (WQCV) as recommended in the Urban Storm Drainage Criteria Manual – Volume 3, after accounting for volume reductions achieved using volume control practices as recommended under item b above.
d. That all jurisdiction having land use control powers in this watershed continue to implement their floodplain management regulations, including regulation of the 100-year floodway and floodplain.
e. If not already done so, all jurisdictions should adopt a policy of preserving the defined floodplains as open spaces to the maximum extent possible and that at least 1-foot freeboard be provided for the lowest floor above the 100-year flood elevation shown on the latest flood hazard area delineation of FIRM maps for all human occupied structures built adjacent to, or within, the defined 100-year floodplains. NOTE: Freeboard requirements in Boulder County Land Use Code apply for structures that have some portion within the designated 100-year floodplain (no reference to adjacent).
f. That all jurisdiction having land use control powers in this watershed continue to participate in FEMA's flood insurance Community Rating System and public education programs.

Prior to construction, or commencing other work on private property or within the drainageways, it is recommended that individuals consult with the appropriate jurisdictions regarding the proposed changes and construction requirements, such as obtaining engineered plans, permitting requirements, erosion and sediment control, water quality and natural resource protection, easements or other items that may be required. The following websites address specific requirements set forth by local jurisdictions:

1. City of Boulder: Flood Recovery Website: https://bouldercolorado.gov/flood
2. Boulder County: Flood Recovery Website: http://www.bouldercounty.org/flood/pages/default.aspx
3. Weld County: Flood Recovery Website: http://flood2013.weldgov.com/
4. City of Longmont: Flood Recovery Website: http://longmontcolorado.gov/departments/departments-n-z/public-information/flood-information

Section 404 of the Clean Water Act (CWA) established a program to regulate the discharge of dredged or fill material into waters of the United States and wetland areas. Activities in waters of the United States regulated under this program include fill for development, water resource projects, infrastructure, and mining projects. Section 404 requires a permit before dredged or fill material may be discharged into waters of the United States. Proposed activities are regulated through a permit review process. An individual permit is required for potentially significant impacts. Individual permits are reviewed by the U.S. Army Corps of Engineers, which evaluates applications under a public interest review, as well as the environmental criteria set forth in the CWA Section 404(b)(1) Guidelines, regulations promulgated by EPA. General permits may also be suitable. General permits are issued on a nationwide, regional, or State basis for particular categories of activities. Local agencies, including the COE should be consulted and required permits should be obtained prior to filling or dredging material in streams or drainageways, on a both a permanent and temporary basis.

A variety of wetland habitats do exist within the riparian zone of Boulder Creek. Wetlands and other waters of the US are regulated under Section 404 of the Clean Water Act (CWA). Future restoration and recovery efforts which result in disturbances to regulated areas may be subject to permitting and approval by the US Army Corps of Engineers (USACE), the US Environmental Protection Agency, and/or the US Fish and Wildlife Service (USFWS). A formal wetland delineation, by a qualified wetland consultant, and coordination with the USACE Denver Regulatory Office is recommended prior to implementation of any future restoration and recovery efforts to ensure CWA

compliance. In addition, any future restoration and recovery efforts must comply with local wetland, stream and wildlife regulations.

Rebuilding and new construction activities within the watershed should consider best practices to reduce the loss of human life and property from flood and storm damage, as managed through local floodplain administration. General guidance has also been provided to flood impacted communities by the Colorado Association of Stormwater and Floodplain Managers (CASFM), through a white paper distributed on October 4, 2013. This white paper is available at http://www.casfm.org/2013_Flood/CASFM_media_summary_statement_2013-10-04.pdf.

Boulder Creek is a regulated floodplain by FEMA, the City of Boulder, Boulder and Weld Counties. Proper floodplain permitting through local jurisdictions will be required prior to commencing construction activities.

Future improvements along Boulder Creek shall give full consideration to policies presented in community planning documents, including the Boulder Valley Comprehensive Plan, City of Boulder's Greenways Master Plan and the Grassland Ecosystem Management Plan. These documents present multi-objective goals achievable with drainageway and open space improvements. Between Foothills Parkway and 95th Street, the Greenways' Master Plan and Grassland Ecosystem Management Plan present ancillary project goals which should be considered with any stream restoration project in this area.

Improvements to existing roadway crossings in Boulder and Weld Counties follow criteria set forth by each jurisdiction. As a minimum standard, both counties allow overtopping of the roadways during large flood events. However, both Weld and Boulder County criteria require that the actual bridge structures, including the low chord, be elevated above the 100-year flood levels. This criterion shall be used as a minimum standard in evaluating transportation infrastructure; however; for East County Line Road, 75th Street, 61st Street, and 95th Street, 100-year capacity should also be considered for emergency access.

11.3 Conceptual Design Cost Estimates

Cost estimates for alternatives were developed using UDFCD's master planning cost estimating spreadsheet UD-MP COST, version 2.2. 2012 unit costs values were adjusted to present value using the current Colorado Construction Cost Index report. An inflation rate of 1.2193 was used to adjust unit costs to 2015 2nd quarter costs. Effective interest rate was estimated to be 1.50%. This assumption was made based upon current discount rates from the Federal Reserve Discount Window and inflation rates published by the US government. Operation and Maintenance was also included within the UD-MP Cost worksheet. Channel maintenance and hydraulic structure maintenance were assumed to be performed once every five years. Maintenance to gravel pit spillways were assumed to occur once every 20 years, with bridge maintenance occurring once a year with a user defined cost of $800/year. Sediment Maintenance removal costs were included for areas identified by the City of Boulder as frequent problem areas. Each sediment maintenance alternative was assumed to remove 200 cubic yards of sediment a year.

Regarding stream restoration and ecological enhancement costs, costs of recent stream and riparian restoration projects were used as the basis for costs in this master plan. Unit costs from these projects were generated and applied to the restoration quantities assumed for each of the Boulder Creek alternatives where restoration is recommended. Given the range of improvements, unit costs were developed for the following items:

- Restoration of a stream where the work includes constructing a new channel alignment ($700,000 per mile)
- Restoration of a stream where the work includes habitat enhancement and related improvements that are to occur within the existing channel ($400,000 per mile)
- Restoration of the adjacent riparian corridor ($35,000 per acre)

When estimating restoration costs for alternative projects along Boulder Creek, unit restoration costs were combined with the quantity and type of work estimated to be required at each site. For all stream work downstream of the canyon, stream restoration was assumed to include realignment of the channel. Stream restoration within the canyon was assumed to occur within the existing channel with no realignment. The extents of stream restoration were selected to coincide with the alternatives presented in the plan.

Areas of riparian restoration were also estimated for each section. When generating costs for riparian restoration, a target riparian width of 25 feet on either side of the stream was used for the canyon section. The target riparian width was set at 200 feet on either side of the channel for all other segments. The actual amount of riparian restoration needed at each of the alternative sites accounted for the amount of room currently available and the condition of existing vegetation when estimating how much riparian work would be required at each location.

Other costs were calculated as a percent of Capital Improvement Costs, such as Engineering, Legal/Administrative, Contract Administration/Construction Management, and Contingency. No alterations to the default values provided by the UD-MP Cost spreadsheet were made to these items. Traffic Control and Utility Coordination/Relocation were assumed to be 2.5% of the Total Capital Improvements unless site conditions warranted otherwise. All projects assumed 1% of Total Capital Improvements for Dewatering.

11.4 Master Plan Description

The Conceptual Design for this master plan generally follows the alternatives proposed in the recommended plan with exception of three areas noted by sponsors in the Selected Plan Letter. Cost Estimates for the Selected Plan can be found in Table 11-5 and Table 11-6.

At the confluence with the St. Vrain Creek, Boulder Creek has breached along the north bank at a different location since the Alternative Analysis was submittal. The project plan would reflect maintaining the current stream alignment with the Boulder Creek / St. Vrain Creek confluence remaining at its existing location. Given the stream segment and breach occurs on City of Longmont Open Space, improvements in this area will be more related to maintenance of the existing stream configuration and ecological enhancements.

Flooding events have become more common at 95th Street. At the request of Boulder County, an interim improvement was developed to help prevent overtopping of the roadway during these more frequent storms, while still maintain the current bridge configurations and relation to downstream private property. This interim plan proposes changes to the roadway and integrates with stream restoration needs upstream of 95th Street on City of Boulder Open Space property. Although the interim condition is presented with the conceptual design, the master plan improvements and cost estimate reflect a more long term solution.

At Cordry Court, improvements to the Boulder Creek Trail and grading between the trail and the Cordry Court residences have been added as a recommended improvement to eliminate the high hazard on the residences. In accordance with City greenway's objectives, property acquisition in this area could be considered as a means to eliminate high flood hazard and improve overall public safety.

11.4.1 Reach 1 – Confluence with St. Vrain Creek to approximately 3,300 ft. upstream of the City of Longmont

Beginning at the confluence with the Saint Vrain Creek, Reach 1 extends upstream along Boulder Creek for just over a mile of channel length. All of Reach 1 is contained within Weld County and within City of Longmont Open Space towards the downstream end. There are no channel crossings within this reach with the exception to a gravel pit conveyor crossing and several non-formalized low-water crossings for vehicles. This reach includes gravel pit ponds on either side of Boulder Creek that currently hold water. The riparian area within Reach 1 is approximately 700 feet wide near the confluence with Saint Vrain Creek and narrows to approximately 250 feet at the upstream end. Beyond the riparian area the floodplain overbanks generally consist of active and fallow farm lands. Sporadic residential and farm structures are also present within the overbanks along with several petroleum well pads.

During the 2013 flood, the Saint Vrain Creek breached its banks, avulsing through nearby gravel pit ponds. A further breach of the pond bank between the Saint Vrain Creek and Boulder Creek redefined the confluence location of the two streams, moving it approximately 1,300 feet upstream of the original location. In 2015, following spring runoff, Boulder Creek also breached the same pond bank further west. This again modified the confluence. The streams continue to change over time. Given the changes are occurring on City of Longmont Open Space property, there is less risk to private property or infrastructure; therefore, the master plan recommendations reflect maintaining the creek in-place and providing additional ecological enhancements along the original stream alignment which can be seen in Figure 11-9. Gravel pond spillways have also been recommended for ponds adjacent to Boulder Creek.

11.4.2 Reach 2 – From approximately 3,300 ft. upstream of the City of Longmont to CR 16 ½

Reach 2 is approximately three miles long and includes bridge crossings at Weld County Roads 20½ and 16½. Although Reach 2 is located in Weld County, upstream locations are also co-managed through Boulder County Conservation Easements. Two major diversion structures to Rural Ditch and Idaho Creek are located within this reach. Disturbances from historic land use practices and channel alterations are widespread. Similarly, floodplain overbanks throughout Reach 2 generally consist of sand and gravel ponds, and aggregate mining operations. The channel within Reach 2 is relatively straight as a result of encroachment on both banks.

Master plan improvements through this reach include: replacement of the bridge crossing at Weld County Roads 20½ and 16½ with 180 foot span bridges compatible with baseline geomorphic conditions; retro-fit of the two ditch diversion structures to accommodate aquatic and habitat passage; modification of a grade control structure for aquatic and habitat passage; and the installation of gravel pond spillways to reduce the chance of failure during flood events. Downstream of CO Rd. 16 ½, general stream restoration is also recommended to repair bank erosion and revitalize Boulder Creek and the surrounding environment as seen in Figure 11-10. Through this reach Boulder Creek is more confined by adjacent land uses; therefore a more confined approach to stream restoration would be anticipated.

11.4.3 Reach 3 – From CR 16 ½ to approximately 5,800 ft. upstream

Reach 3 is located completely within Weld County with the majority of the property managed through Boulder County Open Space Conservation Easements. This is a short reach with a stream length of only 5,800 ft., spanning a distance of approximately 3,900 ft. The most significant, and ongoing, problem within Reach 3 occurs upstream of Weld County Road 16.5, where a breach in the Bryant Pond diverts flow from Boulder Creek east into the Williams Reservoir No. 1. This has led to overtopping of 16.5 Road well east of the bridge and has led to the continued cut through the south bank of Idaho Creek downstream of the Idaho Creek diversion structure thus bypassing the controlled diversion element at the confluence of Boulder Creek and Idaho Creek.

Master plan improvements in this reach focus on stream restoration and protection of the gravel pit pond from further failure. Stream restoration improvements propose a new alignment of Boulder Creek further west than its current location, reestablishing more historic stream alignment and providing additional buffer between the creek and reservoir as seen in Figure 11-10. Installation of gravel pond spillways will reduce the opportunity for failure of the reservoir embankment.

11.4.4 Reach 4 – From approximately 5,800 ft. upstream of CR 16 ½ to U.S. 287

Reach 4 is the longest reach with a stream length of 4.5 miles. Reach 4 is located in both Weld County and Boulder County with portions of the land owned or managed by Boulder County Parks and Open Space. The downstream most section is flanked by past aggregate mining activities; the Town of Erie's sanitary and Re-use facility; and areas under active gravel operations. The remaining overbanks include active and fallow farm lands and minimal residential development. There are six stream crossings that span Boulder Creek through Reach 4, some of which have capacity exceeding the 100-year event. Others are more limited in size, dilapidated, or un-usable. Several irrigation diversions also exist within Reach 4. Finally, downstream of 109th Street, Boulder County is pursuing a stream restoration project with the U.S. Army Corps of Engineers. This project extends from 109th Street to Kenosha Road.

Several different improvements are recommended through Reach 4 including: modifications to ditch diversions; improvements at roadway crossings; and stream restoration. At the downstream limits, an existing project is underway to stabilize channel banks adjacent to the Town of Erie's Re-use facility. Downstream of East County Line Road the conceptual design proposes to modify the Godding A. and D. Plumb Ditch to accommodate aquatic and habitat passage, in addition to installing gravel pond spillways at adjacent reservoirs. The East County Line Road Bridge is proposed to be improved to a 220 ft. span bridge, improving the crossing to a 100-year conveyance level consistent with the upstream Mineral Road Bridge. Bridge improvements at East County Line Road should also address stream restoration needs immediately downstream where concrete rubble has been used to stabilize stream banks. No improvements are proposed for the Mineral Road crossing as the existing crossing already meets the 100-year conveyance criteria.

Upstream of Mineral Road, stream restoration is proposed throughout the Wheeler Ranch property. Although a more unimpacted approach restoration can be performed in this area, the final restoration plan should consider constraints defined by the land owner and needs for the confluence with Coal Creek as seen in Figure 11-11. Upstream of the Wheeler Ranch property, channel banks have eroded and exposed the pipe outlet from the Bailey-Kenosha Pond. Stabilization is proposed along the east bank of Boulder Creek in this area. Upstream of the Bailey-Kenosha Pond, additional stream restoration is recommended downstream of the proposed U.S. Army Corps of Engineers project limits located upstream of Kenosha Road. The existing Howell Ditch Diversion, as well as local grade control, are also proposed to be modified for aquatic and habitat passage. Several gravel pond spillways have been proposed to reduce the chance of failure during flood events. At Kenosha Road and 109th Street, 180 ft. span bridges are proposed to increase the conveyance capacity and accommodate geomorphic channel conditions. The

Kenosha Road bridge should be evaluated to determine whether the structure could be removed in the future based on the transportation needs in the area before improving the roadway crossing.

Alternate stream alignments for restoration between U.S. 287 and 109th Street should be considered during final design to best balance the historic stream alignment, with current land uses and transition to the downstream U.S. Army Corps of Engineers project.

11.4.5 Reach 5 – From U.S. 287 to approximately 4,200 ft. upstream of 95th St.

This reach is located completely within Boulder County and has a stream length of approximately 3 miles. Within Reach 5, Boulder Creek crosses 95th Street, which washed out during the September 2013 flood event and nearly again in 2015. Diversion structures feed the Boulder and Weld County Ditch and the Lower Boulder Ditch. The overbanks generally consist of inactive gravel pit ponds and both active and fallow farm fields. A vast majority of this reach follows Boulder County Parks and Open Space, including the Alexander Dawson Open Space, or conservation easements. Past stabilization efforts have been implemented in this reach, although damage was extensive following recent floods.

Master plan improvements for Reach 5 consist of stream restoration, modifications to ditch diversions, and improving the roadway crossing at 95th Street. No improvements are proposed to the roadway crossing at U.S. 287 as the bridge crossing already exceeds the 100-year conveyance capacity.

Upstream of U.S. 287, stream restoration is proposed through Alexander Dawson Open Space, with aquatic and habitat passage improvements at the Boulder and Weld County Ditch diversion and upstream grade control. A more unimpacted approach to restoration is recommended through this area given the open space designation.

Upstream and downstream of 95th Street, stream restoration has been proposed to reestablish geomorphic channel geometry and improve riparian habitat. Similar to between U.S. 287 and 109th Street, several options for restoration may exist, including changes to both public and private property. Costs for the master plan improvements at this location generally reflect the restoration of Boulder Creek to the north of the current alignment, including: reestablishment of Boulder Creek through the 95th Street Pond (City of Boulder Open Space), new 100-year crossing of 95th Street at the roadway low point; construction of a new channel and easements across the Boulder Valley Farms property; and diversion to the current Lower Boulder Ditch at its current location. The master plan improvements represent a long term solution for the area.

Given the many entities involved and challenges of implementation for the long term solution, Boulder County requested that an interim solution be developed to address more frequent flooding problems at 95th Street. The interim solution will maintain the existing bridge, raise the roadway elevation to prevent frequent overtopping, and provide conveyance from the pond to the bridge through a vegetated spillway. This interim solution is depicted in Figure 11-13.

- Restoration of Boulder Creek: Stream restoration of Boulder Creek is proposed both upstream and downstream of 95th Street along the existing diversion and stream alignments. Stream restoration through this area will help reestablish baseline geomorphic conditions, increase channel sinuosity, and improve overall riparian vegetation and habitat.
- Reduce overtopping frequency for 95th Street: 95th Street is proposed to be raised at the low point by approximately two feet to help reduce overtopping frequency. Overflows to the 95th Street Pond are proposed to be redirected back to Boulder Creek upstream of the existing bridge crossing through a vegetated spillway section. Given the roadway will still overtop during significant storms, geo-fabric is proposed along the downstream embankment to prevent erosion.
- Maintain existing bridge: Given the 95th Street bridge is relatively new; the interim improvements accommodate the current location and size of the bridge.
- Aquatic and Habitat Passage: Changes to the Lower Boulder Ditch diversion have been proposed to accommodate fish and habitat passage.

Table 11-1: 95th Street Interim Conditions Improvements

Reach	ID	Description	Capital	Eng / Admin / Legal	Contingency	Total Capital Cost	50-yr O&M Cost
5	G	95th Street - Interim Conditions	$ 3,592,232	$ 1,077,670	$ 898,058	$ 5,577,645	$ 87,674

It should be noted that raising the elevation of 95th Street will potentially increase 100-year water surface elevations regulated by FEMA and Boulder County. The final design should give consideration to eliminating, or minimizing, floodplain impacts to public and private property, or adjacent insurable structures.

11.4.6 Reach 6 – From approximately 4,200 ft. upstream of 95th St. to 75th St.

Reach 6 is approximately 4.5 miles long and is completely contained within Boulder County. The stream corridor itself is located on land managed by the City of Boulder's Open Space and Mountain Parks Division. This reach appears to remain in a natural state with little encroachments on either overbank. Gravel mining operations on the south side of the creek have left several small gravel ponds in the floodplain. Hydraulic drop structures exist both upstream and downstream of 75th Street and the diversion structure for the Leggett Ditch is centrally located.

Master plan improvements for this reach include modifying Leggett Ditch for aquatic and habitat passage and improving the 75th Street crossing to a 220 ft. span bridge. Similar to the Kenosha Road bridge, the roadway crossing at 75th Street should be evaluated at a future time to determine whether the structure can be removed based on the transportation needs in the area.

11.4.7 Reach 7 – From 75th St. to Valmont Rd.

This reach is approximately 3.5 miles in length and covers areas of both City of Boulder Open Space and Mountain Parks and Boulder County Parks and Open Space properties. Through this reach, the channel is nearly completely flanked by sand and gravel ponds, and mining operations. Most of these operations are no longer active and the excavated ponds remain full of water. The City of Boulder wastewater treatment plant is located just south of the creek, upstream of 75th Street. The wastewater treatment plant is protected from flooding by a ring levee. Private stream crossings, minor arterial (61st Street), bike path, and a major arterial (Valmont Road) crossings, are all located within Reach 7. The confluence of South Boulder Creek and Boulder Creek is located within Reach 7.

Projects within Reach 7 include the installation of gravel pond spillways, protection of the City of Boulder's sanitary sewer trunk line, improved roadway crossings, stream restoration, and modification of existing diversion structures. Seven gravel pit spillways are proposed to protect Walden Ponds near the downstream limit of Reach 7. Several gravel pond spillways are proposed within the Walden Ponds Wildlife Habitat area and along private ponds within

Reach 7. Stream stabilization and bank protection is proposed to provide additional protection from erosion and degradation in the vicinity of the City of Boulder's central sanitary interceptor. These locations will be protected using grade control structures and bank stabilization.

The master plan improvements do not include stream restoration downstream of 61st Street, as this reach is currently being addressed by ongoing City of Boulder Open Space and Mountain Parks improvements; however general restoration guidance for this area is provided. Master plan improvement through this reach do, however, include modifying the two irrigation ditch diversion structures to accommodate aquatic and habitat passage.

The existing 61st Street bridge is proposed to be replaced with a 220 ft. span bridge to accommodate the 100-year event. Upstream of 61st Street to Valmont Road, stream restoration has been proposed to reestablish baseline geomorphic conditions, increase channel sinuosity, and improve overall riparian vegetation and habitat. This reach is also currently being evaluated by City of Boulder Open Space and Mountain Parks.

The existing trail crossing of Boulder Creek at Old Valmont Road is currently undersized. During the 2013 flood, the crossing was an obstruction to flow and a significant amount of blockage developed from debris and other items. This bridge is proposed to be replaced with a 180 ft. span pedestrian bridge to better convey flood flow, debris, and accommodate geomorphic channel conditions and habitat.

Finally, improvements through Reach 7 include improving the Butte Mill Ditch Crossing across South Boulder Creek. For this ditch, which originates from Boulder Creek, modifications include siphoning the canal flows underneath South Boulder Creek in a 54" RCP.

11.4.8 Reach 8 – From Valmont Rd. to 30th St.

This reach is approximately 2.3 miles in length and primarily located within the City of Boulder. The channel characteristics generally include a combination of riparian habitat, roadway, and trail crossings. Wonderland and Goose Creeks enter Boulder Creek within Reach 8, and several small ponds are located adjacent to the stream. For Boulder Creek, Reach 8 reflects the transition to an urban flood channel and for the most part, Boulder Creek has been locked in place through urbanization. The Burlington Northern and Santa Fe (BNSF) railroad embankment presents a significant obstacle for Boulder Creek and its connectivity with upstream and downstream floodplain areas. The BNSF crossing also has significantly less conveyance capacity than the larger span bridges within Boulder.

Master plan improvements within Reach 8 are comprised of stream restoration, improving the railroad crossing conveyance capacity, access to the Boulder Community Health Hospital, and management of accumulated sediment. Stream restoration is proposed from the downstream limit of Reach 8 at Valmont Road through Foothills Parkway. As described above, the BNSF railroad is a significant obstacle for Boulder Creek. The crossing is proposed to be increased to a 180 ft. span bridge to better convey flood flows and accommodate geomorphic channel conditions.

To ensure safe access to the hospital during major floods, up to the 500-year event, an alternate access point from 48th Street has been recommended. This access point would only serve emergency vehicles and would not provide routine access as seen in Figure 11-14.

Frequent sediment deposition has been observed throughout Reach 8 along Boulder Creek and pedestrian trail crossings. This sediment is believed to be conveyed downstream from into the City from Boulder Canyon where the manmade obstructions cause the sediment to collect around infrastructure. Maintenance level sediment removal projects (up to 200 cubic yards per year) have been incorporated into the master plan at various crossing locations.

11.4.9 Reach 9 – From 30th St. to City of Boulder Limits

Reach 9 extends through the City of Boulder from 30th St. to upstream of Arapahoe Avenue. This reach also includes the University of Colorado (CU) Campus, between 17th Street and Folsom. Many roadway crossings exist through this reach as well as Boulder Creek trail bridges. The Boulder Creek trail also follows the creek for the entire reach. Many buildings are located within the Boulder Creek floodplain. The City of Boulder has designated additional regulatory zones to manage existing development and redevelopment. Strategic plans, including CU's North of Boulder Creek study have also been developed to identify management strategies to reduce overall flood risk. Similarly, the City of Boulder is currently in the process of planning for redevelopment surrounding the Civic Center area, and is evaluating this plan with respect to flood management.

Master plan improvements within Reach 9 include mitigating flood hazards, improving access near Boulder Creek, modifying diversions, and sediment maintenance. Downstream of 28th Street, along Cordry Court, realignment of the Boulder Creek Trail is proposed to increase conveyance and mitigate the high hazard conditions near residences. In accordance with City greenway's objectives, property acquisition in this area should be considered as a means to eliminate high hazard designation and improve overall public safety. Near the CU campus, two new pedestrian bridges are proposed to improve access to the North of Boulder Creek campus. These bridges, or walkways, will provide emergency access to areas otherwise susceptible to isolation during flood events.

To mitigate flood hazards along the Boulder Slough, an overflow diversion structure is proposed at 14th Street. This diversion system will divert flows in excess of the conveyance capacity of the ditch back into Boulder Creek, reducing flood risk to adjacent properties and can be seen in Figure 11-14. A 48" RCP pipe underneath 14th Street is proposed to convey the flows from the diversion structure south to Boulder Creek.

Changes to the diversion structure at Broadway are also proposed to accommodate aquatic and habitat passage. The conceptual rendering of a typical diversion structure can be seen in Figure 11-17.

Similar to other locations, six areas have been identified for annual sediment removal (up to 200 cubic yards per year) in Reach 9.

No new alternatives have been developed for the Civic Center area in this master plan study; however changes to Boulder Creek at this location should consider implementing recommendations discussed in 9.3 Improvement Alternative Categories, including:

- Removing the Park Central and New Britain building from the 100-year floodplain, conveyance zone, and high hazard zone;
- Adding conveyance capacity at the Broadway Bridge;
- Overbank grading of Boulder Creek between the Library and Broadway to reduce high hazard and conveyance zones on the north side of Arapahoe.
- Consideration with respect to Flood Regulatory, Flood Policy, and Site Opportunities and Flood Constraints in accordance with the Civic Area Guiding Principles

It should be noted that with these changes, higher flows along the creek would persist downstream to west of 30th Street and cause higher 100-year flood levels that would need to be mitigated. Given that these increases in flood levels would be relatively small, they could likely be mitigated through: select grading of overbank areas, reducing the potential for debris obstruction at bridges, and/or increasing conveyance under road crossings.

11.4.10 Reach 10 – From City of Boulder Limits to Fourmile Creek

Reach 10 reflects the reach of Boulder Canyon between the City of Boulder and the confluence with Fourmile Creek. This reach has much steeper overbank slopes and narrower cross section than the reaches to the east. The reach length is approximately 2 miles and the riparian zone is narrow at less than 100 feet wide. Through the canyon, State Highway 119 parallels the creek, crossing it twice. The Boulder Creek trail also parallels Boulder Creek along the opposite bank of the highway. In general, the stream banks are steep and stable, and have been armored with cobble, rock, and riprap. Boulder County is currently in process of repairing sections of the Boulder Creek trail and extending the path up to Fourmile Creek.

Reach 10 improvements consist of modifying the Farmers' Ditch diversion for aquatic and habitat passage. Restoration of Boulder Creek has also been proposed in areas of disrepair following the 2013 flood event. Restoration locations have been depicted by the project conceptual design renderings seen in Figure 11-15.

11.5 Stream Restoration Recommendations

In 6.0 Natural Restoration Objectives, approximate sizing for the bankfull channel and floodprone areas adjacent to the active channel were defined. A summary of recommended geometries for each reach is given in Table 11-2. Cross-sections of typical restoration channels can be found in Figure 11-7.

In addition to variability in cross section, variability in channel slopes is a characteristic of natural channels. Features such as step pools, scour pools, rapids and riffles/pool sequences occur naturally and provide variety from both a habitat and aesthetic standpoint. Step pools, rapids and scour pools are bedform types that are typical of Type B stream that would be found in Reach 10. Riffle/pool sequences are alternating stretches of shallow, fast-moving sections (riffles) and deeper, slower pools, with glides or runs in between the end of a pool and beginning of the next riffle to allow for gradual bedform transformation. Riffle/pool sequences are typical bedforms seen in meandering, Type C streams such as Reaches 1-9.

This table can be used to define the approximate channel geometries throughout the basin. All channel sections are assumed to be generally trapezoidal with a bankfull width that is defined in the table. These tabulated values provide average channel geometry information, but it is not the intent nor is it desired that the channel take on a uniform, defined cross section. Variability is inherent in any natural system and is desired for improvements along Boulder Creek.

Table 11-2: Recommended Geometries for Primary Stream Types

Reach	Assumed Sinuosity	Slope (%)	Bankfull Width (ft)	Bankfull Depth (ft)	Width at 2x Bankfull Depth (ft)
1	1.6	0.20%	40	3	140
2	1.6	0.19%	40	3	140
3	1.6	0.29%	40	3	140
4	1.6	0.22%	40	3	140
5	1.6	0.24%	40	3	140
6	1.6	0.36%	40	3	140
7	1.6	0.30%	40	3	140
8	1.6	0.46%	40	3	140
9	1.4	0.81%	40	2.5	140
10	1.3	2.60%	30	2	54

11.6 Ecological Recommendations

A riparian corridor or "riparian zone" is defined as the transitional area or interface between upland terrestrial and aquatic habitats. A riparian zone is generally considered that portion of the landscape from the ordinary high water mark towards the adjoining uplands that affect or are affected by the presence of water. The riparian zone is often unique within a watershed containing notably different vegetation communities from the surrounding upland habitat.

The framework for any successful riparian zone restoration effort is understanding the local (reference standard) community that is either present or known to have existed in the local area, in order to restore the functional integrity and biodiversity of the riparian zone. As stated in previous sections, the reference community or primary habitat type recommended for restoration within this project area, which is locally native and appropriate for the environmental setting, is the Western Great Plains Riparian Woodland and Shrubland. Replicating the natural characteristics of the local Western Great Plains Riparian Woodland and Shrubland habitat type including re-establishment of cottonwood tree overstory and a willow shrub mid-story with a mixed grassland understory that properly interacted with the channel flow should be the primary objective for natural restoration efforts.

Successful riparian zone restoration is dependent on a thorough understanding of numerous environmental factors and site-specific conditions. Stream flow, soil moisture, groundwater table, soil chemistry and sun-orientation are all critical elements to consider. Any restoration efforts should carefully consider such factors which should generally be defined by an expert to ensure greater success. Further guidance is provided in the appendix of this report.

Riparian Zone Restoration shall generally follow the following guidelines:

- Natural riparian zone vegetation community type within the project area is characteristic of the *Western Great Plains Riparian Woodland and Shrubland;*
- A properly functioning riparian zone should have routine interaction with stream flows;

- In a more undisturbed condition, vegetation would be continuous along the entire corridor and occupy three strata (i.e., overstory, midstory and understory);
- Relatively dense native vegetation extending from the water's edge (bankfull) outward;
- Buffers that are wider, longer and more densely vegetated with herbaceous, shrub and tree layers provide more benefits. A minimum width should be at least 50 feet and extend upwards of 200 feet from the stream edge.

11.7 Recommended Bridge Improvements

A summary of existing major roadway crossings along Boulder Creek is presented in Table 9-2: Bridge Information and Replacement Locations. This table compares the existing bridge geometry with FEMA's regulatory 100-year water surface elevations along Boulder Creek to determine if a bridge currently meets criteria. Bridges outside of criteria were selected to be replaced by this master plan. The project team recommended that standard bridges, within the plains stream region be sized: to convey a minimum of 60% of the 100-year discharge; to accommodate the stream and floodplain at twice the bank flow depth; and to maintain less than a 6 ft./sec velocity through the bridge section at a maximum of depth of 10-feet. A 180-foot bridge opening width was used for this criterion, bridges with a smaller opening were recommended to be replaced. Renderings of typical bridge cross sections can be found in Figure 11-8.

Boulder County requested that additional alternatives be evaluated for 61st Street, 75th Street, 95th Street, and East County Line Road, which would convey the 100-year event without overtopping in order to provide emergency services during flooding. For 100-year bridges alternatives, a 220-foot bridge opening width was selected to closely match existing 100-year crossings at Mineral Road and Highway 287.

Table 11-3: Recommended Bridge Replacement

Stream Reach	Bridge Location	Jurisdiction	Estimated Existing Bridge Capacity (cfs, approx. freq)	Proposed Bridge Span (ft)
Reach 2	WC Road 20 1/2	Weld County	< 100-year	180
Reach 2	WC Road 16 1/2	Weld County	1,000 cfs	180
Reach 4	East County Line Road	Boulder / Weld Counties	1,200 cfs	220
Reach 4	Kenosha Road	Boulder County	600 cfs	180
Reach 4	109th Street	Boulder County	5,400 cfs	180
Reach 5	95th Street	Boulder County	3,300 cfs	220
Reach 6	75th Street	Boulder County	6,200 cfs	220
Reach 7	61st Street	Boulder County	8,300 cfs	220
Reach 8	BNSF Railroad	BNSF Railroad	1,000 cfs	180

11.8 Recreation

Recreation and Public Access are an integral part of Boulder Creek. Extensive studies have been prepared that have reviewed recreation and its impact to the natural systems along Boulder Creek. These studies have been well vetted with the public over the years and have been founded on scientific and ecological principles. Previous studies include: the Boulder County Comprehensive Plan, published May 27, 1999; the Lower Boulder Creek and Coal Creek Open Space Master Plan, published by Boulder County Parks and Open Space Department, 1997; the Boulder County Trail Plan published in 2003; the City of Boulder Open Space and Mountain Parks Grassland Ecosystem Management Plan, and the Weld County Trails Inventory Map 2010.

Section 4.3 discussed guiding principles from each plan and relationship to Boulder Creek and surrounding properties.

Table 11-4: Conceptual Design Cost Summary by Jurisdiction

Jurisdiction	Capital	Eng / Admin / Legal	Contingency	Total Capital Cost	50-yr O&M Cost
City of Longmont	$300,146	$90,044	$75,037	$465,227	$10,885
Weld County	$13,069,240	$3,920,772	$3,267,310	$20,257,322	$169,575
Boulder County	$43,973,780	$13,192,137	$10,993,445	$68,172,847	$1,563,718
City of Boulder	$12,054,634	$3,616,390	$3,013,658	$18,849,682	$1,578,171

Table 11-5: Conceptual Design Cost Estimate by Reach (1-6)

Reach	ID	Description	Jurisdiction	Reach Length (mi)	Capital	Eng / Admin / Legal	Contingency	Total Capital Cost	50-yr O&M Cost
1	A	Stream Maintenance and Ecological Enhancements City of Longmont Open Space	City of Longmont / Weld County	0.13	$ 39,146	$ 11,744	$ 9,787	$ 60,677	$ 9,800
	B	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	City of Longmont / Weld County	--	$ 261,000	$ 78,300	$ 65,250	$ 404,550	$ 1,085
		Reach 1 Total		**0.83**	**$ 300,146**	**$ 90,044**	**$ 75,037**	**$ 465,227**	**$ 10,885**
2	A	CO Rd. 20.5 - Replace Bridge with 180 ft. Span Bridge	Weld County	--	$ 1,792,200	$ 537,660	$ 448,050	$ 2,777,910	$ 35,420
	B	Replace Existing Grade Control for Aquatic and Habitat Passage	Weld County	--	$ 237,800	$ 71,340	$ 59,450	$ 368,590	$ 4,270
	C	Modify Rural Ditch for Aquatic and Habitat Passage	Town of Frederick / Weld County	--	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	D	Modify Idaho Creek Diversion for Aquatic and Habitat Passage	Weld County	--	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	E	CO Rd. 16.5 - Replace Bridge with 180 ft. Span Bridge	Weld County	--	$ 1,792,200	$ 537,660	$ 448,050	$ 2,777,910	$ 35,420
	F	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Town of Frederick / Weld County	--	$ 5,481,000	$ 1,644,300	$ 1,370,250	$ 8,495,550	$ 22,435
	G	Stream Restoration Downstream of CO Rd. 16.5	Weld County	0.38	$ 1,054,200	$ 316,260	$ 263,550	$ 1,634,010	$ 28,000
		Reach 2 Total		**3.14**	**$ 10,937,400**	**$ 3,281,220**	**$ 2,734,350**	**$ 16,952,970**	**$ 134,085**
3	A	Stream Restoration Upstream of CO Rd. 16.5	Weld County	0.38	$ 1,058,840	$ 317,652	$ 264,710	$ 1,641,202	$ 28,000
	B	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Weld County	--	$ 261,000	$ 78,300	$ 65,250	$ 404,550	$ 1,085
		Reach 3 Total		**1.03**	**$ 1,319,840**	**$ 395,952**	**$ 329,960**	**$ 2,045,752**	**$ 29,085**
4	A	Modify Godding A. and D. Plumb Ditch for Aquatic and Habitat Passage	Weld County	--	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	B	East County Line Road - 100-yr Option: Replace Bridge with 220 ft. Span Bridge	Boulder County	--	$ 3,655,197	$ 1,096,560	$ 913,799	$ 5,665,556	$ 28,560
	C	Protect Gravel Ponds / Town of Erie Reuse Pond / Wittemeyer Ponds Inlet & Outlet During Strom Flows, Typical.	Town of Erie / Weld County / Boulder County	--	$ 3,915,000	$ 1,174,500	$ 978,750	$ 6,068,250	$ 16,030
	D	Stabilize Bank at Bailey-Kenosha Pond Outlet	Boulder County		$ 17,089	$ 5,126	$ 4,272	$ 26,487	$ 3,220
	E	DS of Kenosha Rd. - Remove Washed Out Bridge		--	$ 69,600	$ 20,880	$ 17,400	$ 107,880	$ -
	F	Stream Restoration Through Doniphan, Wittemeyer Ponds, Bailey-Kenosha Ponds, and Open Space			$ 4,477,600	$ 1,343,280	$ 1,119,400	$ 6,940,280	$ 118,999
	G	Stabilize Howell Ditch Diversion System, Modify Diversion for Aquatic and Habitat Passage		--	$ 399,308	$ 119,792	$ 99,827	$ 618,927	$ 7,490
	H	Kenosha Rd. - Replace Bridge with 180 ft. Span Bridge		--	$ 2,296,800	$ 689,040	$ 574,200	$ 3,560,040	$ 28,560
	I	Replace Grade Control for Aquatic and Habitat Passage		--	$ 237,800	$ 71,340	$ 59,450	$ 368,590	$ 4,270
	J	109th St. - Replace Bridge with 180 ft. Span Bridge; Restore Adjacent Channel		--	$ 2,834,752	$ 850,426	$ 708,688	$ 4,393,866	$ 28,420
	K	Stream Restoration Through Wheeler Ranch		0.87	$ 2,424,657	$ 727,398	$ 606,164	$ 3,758,219	$ 64,399
		Reach 4 Total		**4.59**	**$ 20,617,803**	**$ 6,185,342**	**$ 5,154,450**	**$ 31,957,595**	**$ 304,218**
5	A	Stream Restoration at Alexander Dawson Open Space	Boulder County	0.85	$ 2,378,000	$ 713,400	$ 594,500	$ 3,685,900	$ 62,999
	B	Modify Boulder and Weld County Ditch for Aquatic and Habitat Passage		--	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	C	Protect Boulder Valley Ponds Inlet & Outlet During Storm Flows, Typical.		--	$ 1,305,000	$ 391,500	$ 326,250	$ 2,022,750	$ 5,355
	D	Modify Grade Control Structures for Aquatic and Habitat Passage		--	$ 237,800	$ 71,340	$ 59,450	$ 368,590	$ 4,270
	E	Modify Lower Boulder Ditch for Aquatic and Habitat Passage		--	$ 475,600	$ 142,680	$ 118,900	$ 737,180	$ 8,540
	F	Stream Restoration Downstream of 95th Street		0.38	$ 1,054,200	$ 316,260	$ 263,550	$ 1,647,495	$ 28,000
	G	95th St. - 100-yr Option: Replace Bridge with 220 ft. Span Bridge		--	$ 3,778,680	$ 1,133,604	$ 944,670	$ 5,856,954	$ 28,560
	H	Stream Restoration from Upstream of 95th St. to White Rocks Trail	City of Boulder	0.85	$ 2,371,947	$ 711,584	$ 592,987	$ 3,676,518	$ 62,999
		Reach 5 Total		**2.83**	**$ 11,891,227**	**$ 3,567,368**	**$ 2,972,807**	**$ 18,444,887**	**$ 204,993**
6	A	Modify Leggett Ditch for Aquatic and Habitat Passage	Boulder County	--	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	B	75th Street - 100-yr Option: Replace Bridge with 220 ft. Span Bridge		--	$ 3,097,220	$ 929,166	$ 774,305	$ 4,800,691	$ 28,560
		Reach 6 Total		**2.53**	**$ 3,387,220**	**$ 1,016,166**	**$ 846,805**	**$ 5,250,191**	**$ 32,830**

Table 11-6: Conceptual Design Cost Estimate by Reach (7-10)

Reach	ID	Description	Jurisdiction	Reach Length (mi)	Capital	Eng / Admin / Legal	Contingency	Total Capital Cost	50-yr O&M Cost
7	A	Protect Walden Ponds Inlet & Outlet During Storm Flows, Typical	Boulder County	--	$ 1,827,000	$ 548,100	$ 456,750	$ 2,831,850	$ 7,490
	B	Protect Ponds Inlet & Outlet During Storm Flows, Typical		--	$ 1,827,000	$ 548,100	$ 456,750	$ 2,831,850	$ 7,490
	C	Modify Diversion for Aquatic and Habitat Passage		--	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	D	Modify Green Ditch Diversion for Aquatic and Habitat Passage		--	$ 290,000	$ 87,000	$ 72,500	$ 449,500	$ 4,270
	E	61st Street - 100-yr Option: Replace Bridge with 220 ft. Span Bridge		--	$ 2,843,416	$ 853,025	$ 710,854	$ 4,407,295	$ 28,420
	F	Replace Old Valmont Pedestrain Crossing with 180 ft. Span Bridge		--	$ 1,117,813	$ 335,344	$ 279,453	$ 1,732,610	$ 28,210
	G	Modify Butte Mill Ditch Crossing on South Boulder Creek		--	$ 235,238	$ 70,572	$ 58,810	$ 364,620	$ 4,200
	H	Protect Sanitary Interceptor Sewer		--	$ 511,010	$ 153,304	$ 127,753	$ 792,067	$ 8,540
	I	Stream Restoration from Valmont Rd to 61st Street	City of Boulder	1.18	$ 1,546,781	$ 464,034	$ 386,695	$ 2,397,510	$ 87,499
		Reach 7 Total		**3.51**	**$ 10,488,258**	**$ 3,146,479**	**$ 2,622,065**	**$ 16,256,802**	**$ 180,389**
8	A	Stream Restoration from 55th St. to Valmont Drive	City of Boulder	0.32	$ 429,200	$ 128,760	$ 107,300	$ 665,260	$ 23,800
	B	Stream Restoration from BNSF RR to 55th St.		0.91	$ 1,194,800	$ 358,440	$ 298,700	$ 1,851,940	$ 67,199
	C	BNSF Railroad - Replace Bridge with 180 ft. Span Bridge		--	$ 2,697,000	$ 809,100	$ 674,250	$ 4,180,350	$ 28,280
	D	Stream Restoration from Foothills Pkwy to BNSF RR		0.49	$ 638,000	$ 191,400	$ 159,500	$ 988,900	$ 36,400
	E	Hospital Access Improvements for 500-yr Event		--	$ 46,932	$ 14,080	$ 11,733	$ 72,745	$ -
	F	Sediment Maintenance along Boulder Creek Path		--	$ -	$ -	$ -	$ -	$ 839,993
		Reach 8 Total		**2.3**	**$ 5,005,932**	**$ 1,501,780**	**$ 1,251,483**	**$ 7,759,195**	**$ 995,672**
9	A	Cordry Ct, High Hazard & Flood Mitigation	City of Boulder	0.06	$ 65,589	$ 19,676	$ 16,397	$ 266,662	$ 13,650
	C	North of Boulder Creek Access Improvements		--	$ 3,496,000	$ 1,048,800	$ 874,000	$ 5,418,800	$ 69,999
	D	Boulder Slough Mitigation		--	$ 486,385	$ 145,916	$ 121,596	$ 753,897	$ 10,815
	E	Modify Boulder Ditches Diversion for Aquatic and Habitat Passage		--	$ 406,000	$ 121,800	$ 101,500	$ 629,300	$ 4,270
	F	Sediment Maintenance along Boulder Creek Path		--	$ -	$ -	$ -	$ -	$ 1,259,989
		Reach 9 Total		**2.87**	**$ 4,453,974**	**$ 1,336,192**	**$ 1,113,493**	**$ 7,068,659**	**$ 1,358,723**
10	A	Modify Farmers' Ditch for Aquatic and Habitat Passage	Boulder County	--	$ 300,000	$ 90,000	$ 75,000	$ 465,000	$ 4,270
	B	Boulder Canyon Stream Restoration		0.91	$ 696,000	$ 208,800	$ 174,000	$ 1,078,800	$ 67,199
		Reach 10 Total		**1.64**	**$ 996,000**	**$ 298,800**	**$ 249,000**	**$ 1,543,800**	**$ 71,469**
		Total Costs		**25.27**	**$ 69,397,800**	**$ 20,819,343**	**$ 17,349,450**	**$ 107,745,078**	**$ 3,322,349**

Boulder Creek Master Plan
Conceptual Design Interactive Map

Open detailed sheets in new window:

Conceptual Design Alternatives	Reach 1 - 3
Stream Restoration Alternatives	Reach 4
Bridge Replacement Alternatives	Reach 5 - 6
Public Safety Alternatives	Reach 7 - 8
Maintenance Alternatives	Reach 9 - 10

City Boundaries - ON or OFF

100-yr Floodplain - ON or OFF

Open Space - ON or OFF

This drawing is for master planning purposes and represents preliminary and conceptual engineering. Alternatives will be considered by local agencies and the Urban Drainage and Flood Control District provided the alternative offers an equivalent intent of the plan, including hydraulic capacity, water quality, stream stability, and natural waterway features. The alternative must comply with all requirements of the local jurisdiction and the Urban Drainage and Flood Control District. In addition, there may be State and Federal requirements that will need to be considered and met. This drawing does not provide a final design and shall not be used for construction purposes.

Many activities that occur in or affect ditches, drainages, creeks, ponds or wetlands require a Section 404 Permit Authorization from the US Army Corps of Engineers. During preliminary design, and prior to final design or starting work, contact the Corps' Denver Regulatory Office at 303-979-4120 for appropriate permit authority to avoid compromising and delaying the completion of the project.

N

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Centennial, CO 80112
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0 — 1.25 — 2.5 — 5 Miles

Legend

- Sediment Alternatives
- Gravel Pit Spillway
- Walden Pond
- Hydraulic Features
- Reach 1
- Reach 2
- Reach 3
- Reach 4
- Reach 5
- Reach 6
- Reach 7
- Reach 8
- Reach 9
- Reach 10
- High Priority
- Medium Priority
- Low Priority
- County Border
- City Boundaries
- 100-yr Floodplain
- Open Space

LONGMONT

BOULDER

ERIE

Boulder County

Weld County

Upstream Limit of Study

Downstream Limit of Study

Coordinate with Civic Center Plan (by others)

Reach 4- Bank Stabilization at Re-Use Facility (By Others)

Reach 4- Corps of Engineers Restoration Project (By Others)

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Figure 11-2

Boulder Creek Restoration Master Plan

Conceptual Design

Legend

- Hydraulic Feature
- 100-Year Floodplain
- Open Space
- Existing Stream Alignment

Alternate Centerline

- Reach 1
- Reach 2
- Reach 3

High Priority

Medium Priority

Low Priority

3A:
Stream Restoration
Upstream of CO Rd 16.5

2D:
Modify Idaho Creek Diversion for Aquatic and Habitat Passage

2G:
Stream Restoration
Downstream of CO Rd 16.5

2F (All ● Markers):
Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical.

2A:
Location: CO Rd 20.5
Replace Bridge With 180' Span Bridge
Q_{100}: 12,250 cfs

Downstream Limit of Study

Reach 1

Reach 3

Reach 2

Bridge

Diversion Structure

Bridge

Diversion Structure

Channel Bank Breach

1A:
Stream Restoration & Debris Removal
City of Longmont Open Space

3B (All ● Markers):
Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical.

2E:
Location: CO Rd 16.5
Replace Bridge With 180' Span Bridge
Q_{100}: 13,750 cfs

2C:
Modify Rural Ditch for Aquatic and Habitat Passage

2B:
Replace Existing Grade Control for Aquatic and Habitat Passage

1B (All ● Markers):
Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical.

Idaho Creek Ditch

Rural Ditch

Idaho Creek Ditch

Rural ditch

County Road 20 1/2

County Road 18

County Road 20

County Road 20 1/2

Harbor Drive

Mineral Road

Louisville

Firestone

Frederick

0 0.25 0.5 0.75 1 mi

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Figure 11-3

Boulder Creek Restoration Master Plan

Conceptual Design

Legend

- Hydraulic Feature
- 100-Year Floodplain
- Open Space
- Existing Stream Alignment
- Alternate Centerline
- Reach 3
- Reach 4

High Priority

Medium Priority

Low Priority

4J:
Location: 109th St
Replace Bridge with 180' Span Bridge
Restore Adjacent Channel

REACH 4:
Corps of Engineers Restoration Project (By Others)

4H:
Location: Kenosha Rd
Replace Bridge with 180' Span Bridge

4G:
Stabilize Howell Ditch Diversion System,
Modify Diversion for Aquatic and Habitat Passage

4E:
Location: DS of Kenosha Rd
Remove Washed Out Bridge

4A:
Modify Godding A. and D. Plumb Ditch for Aquatic and Habitat Passage

4I:
Replace Grade Control for Aquatic and Habitat Passage

4F:
Stream Restoration Through Doniphan, Wittemeyer Ponds, Bailey-Kenosha Ponds, and Open Space

4D:
Stabilize Bank at Bailey-Kenosha Pond Outlet

4K:
Stream Restoration Through Wheeler Ranch

4B:
Location:
E County Line Rd
Replace Bridge with 220' Span Bridge (100-Year),
Restore Channel Banks

4C (All ● Markers):
Protect Gravel Ponds/Town of Erie Reuse Pond/Wittemeyer Ponds Inlet & Outlet During Storm Flows, Typical.

REACH 4:
Bank Stabilization at Re-Use Facility
(By Others)

Ch 5
Bridge
Alternate Stream Alignment
Bridge
Bridge
Diversion Structure
Bridge
Bridge
Reach 4
Diversion Structure
Channel Bank Breach
Panama Reservoir
Panama Reservoir
Boulder and White Rock Ditch
Nimrod Road
Lookout Drive
Boulder Feed Ditch
Jasper Road
N. 109th St
N. Main Street
Kenosha Road
Kenosha Road
Mineral Road
Mineral Road
E. County Line Road
Gooding and D. Plumb
Peoples Ditch
Lower Boulder Ditch
Cottonwood Ditch
County Road 8
County Road 10
Mineral Road
Firestone
Frederick
Louisville
Lafayette

0 0.25 0.5 0.75 1 mi

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Figure 11-4

Boulder Creek Restoration Master Plan

Conceptual Design

Legend
- Hydraulic Feature
- 100-Year Floodplain
- Open Space
- Existing Stream Alignment

Alternate Centerline
- Reach 4
- Reach 5
- Reach 6
- Reach 7

High Priority

Medium Priority

Low Priority

5A:
Stream Restoration at Alexander Dawson Open Space

5B:
Modify Boulder and Weld County Ditch for Aquatic and Habitat Passage

5G:
Location: 95th St
Replace Bridge with 220' Span Bridge

6A:
Modify Leggett Ditch for Aquatic and Habitat Passage

5F:
Stream Restoration Downstream of 95th Street

6B:
Location: 75th St
Replace Bridge with 220' Span Bridge (100-Year)

5H:
Stream Restoration from upstream of 95th St to White Rocks Trail

5E:
Modify Lower Boulder Ditch for Aquatic and Habitat Passage

5D:
Modify Grade Control Structures for Aquatic and Habitat Passage

5C (All ● Markers):
Protect Boulder Valley Ponds Inlet & Outlet During Storm Flows, Typical.

Bridge
Reach 4
Bridge
Diversion Structure
Boulder Weld Ditch
Drop Structure
Reach 5
Drop Structure
Drop Structure
Diversion Structure
Alternate Stream Alignment
Leggett Ditch
Bridge
Reach 6
Private Bridge
Bridge
Reach 7
Lower Boulder Ditch
Leyner Cottonwood Ditch
Leyner Cottonwood Ditch
E. Boulder Trail
Gunbarrel Ridge Road
West Phillips Road
Phillips Road
Goose Haven Drive
Isabelle Road
Leon A Wurl Parkway
Valmont Road
Mineral Road
Jay Road
Heatherwood Drive
Kincross Way
Kincross Dr
Greylock Street
Hampshire Street
Harwich Street
Cambridge Street
Ashfield Drive
N. 75th Street
N. 95th Street
N. 100th Street
ERIE
LAFAYETTE

N

0 0.25 0.5 0.75 1 mi

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Figure 11-5

Boulder Creek Restoration Master Plan

Conceptual Design

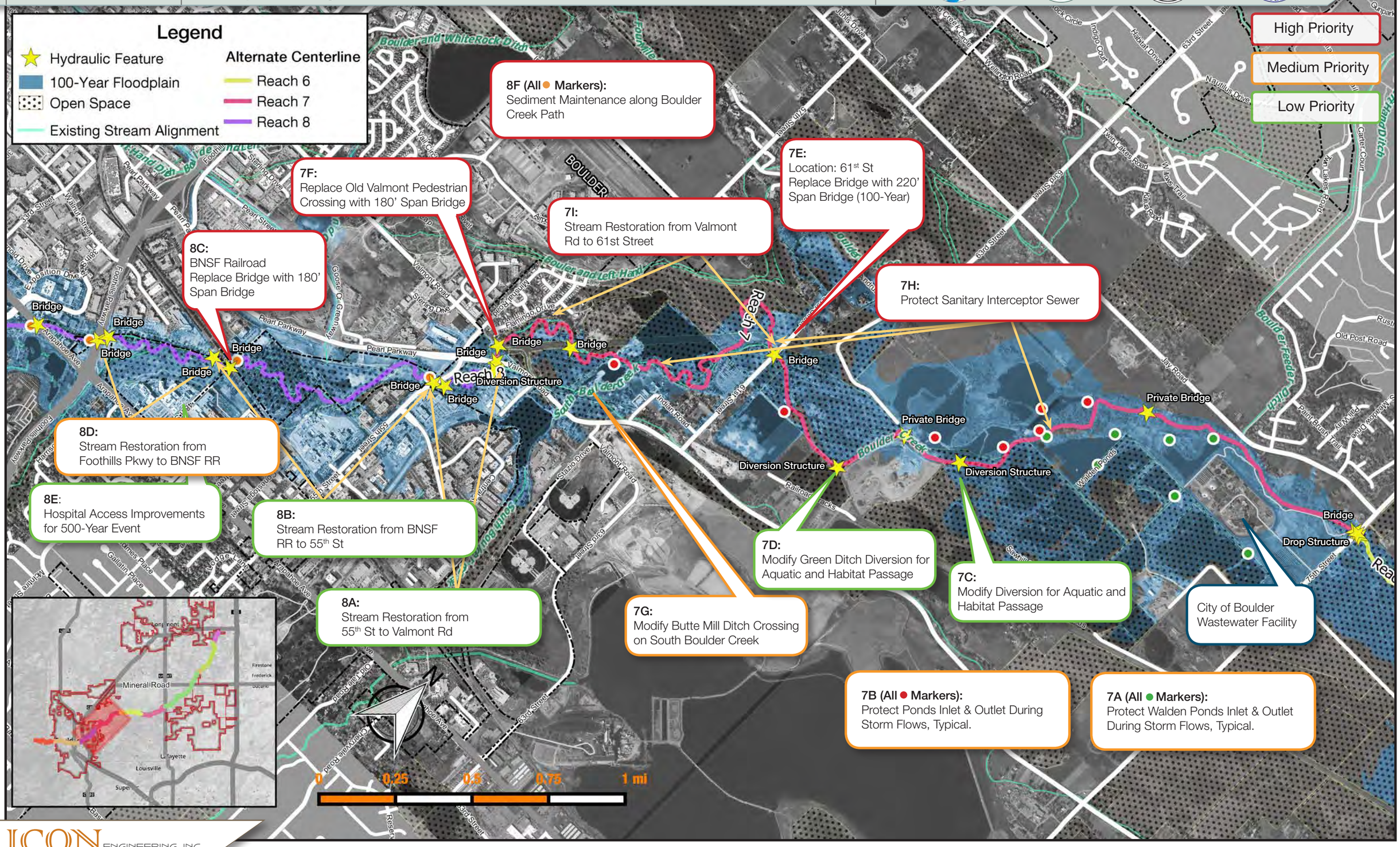

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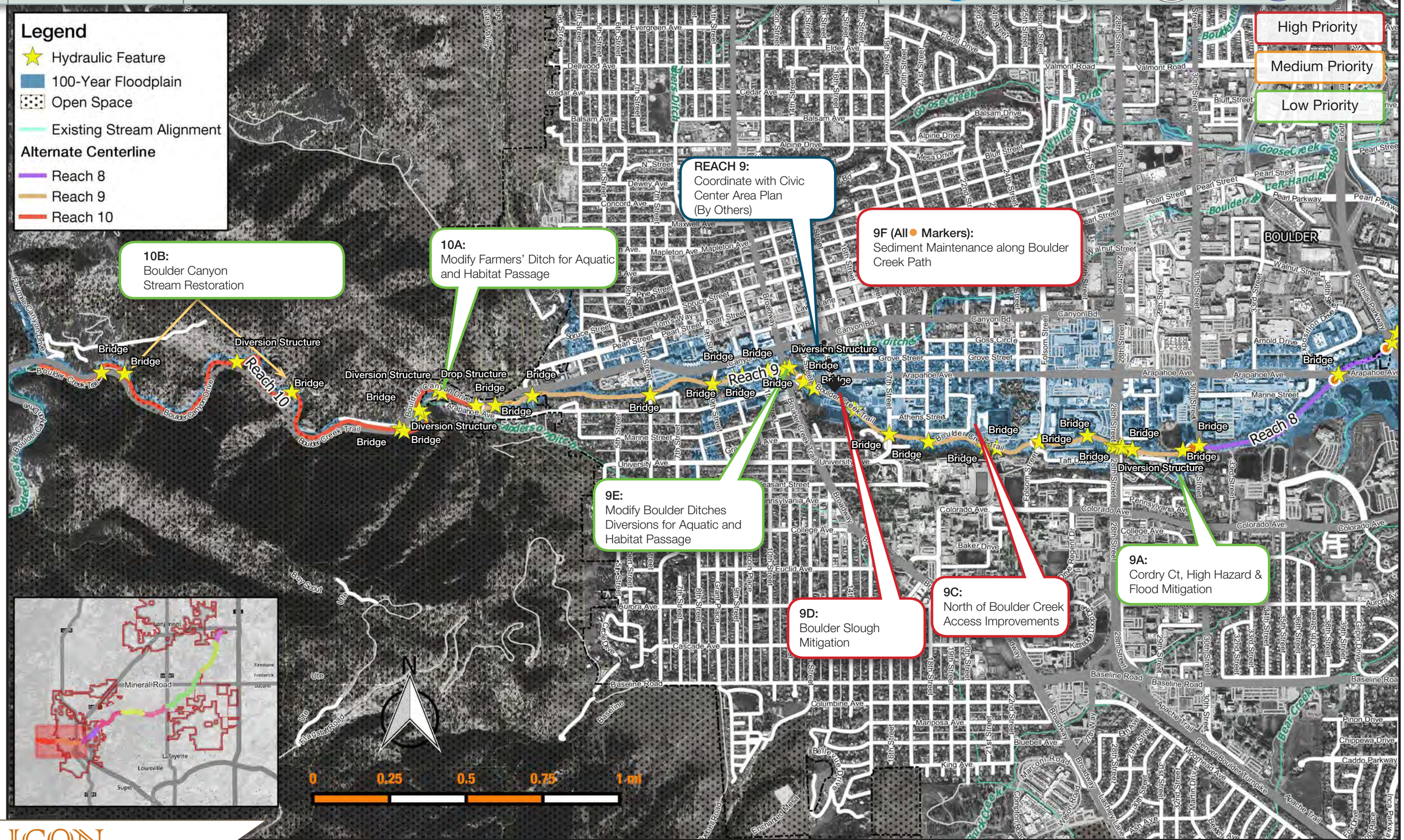
Figure 11-6

Boulder Creek Restoration Master Plan

Conceptual Design



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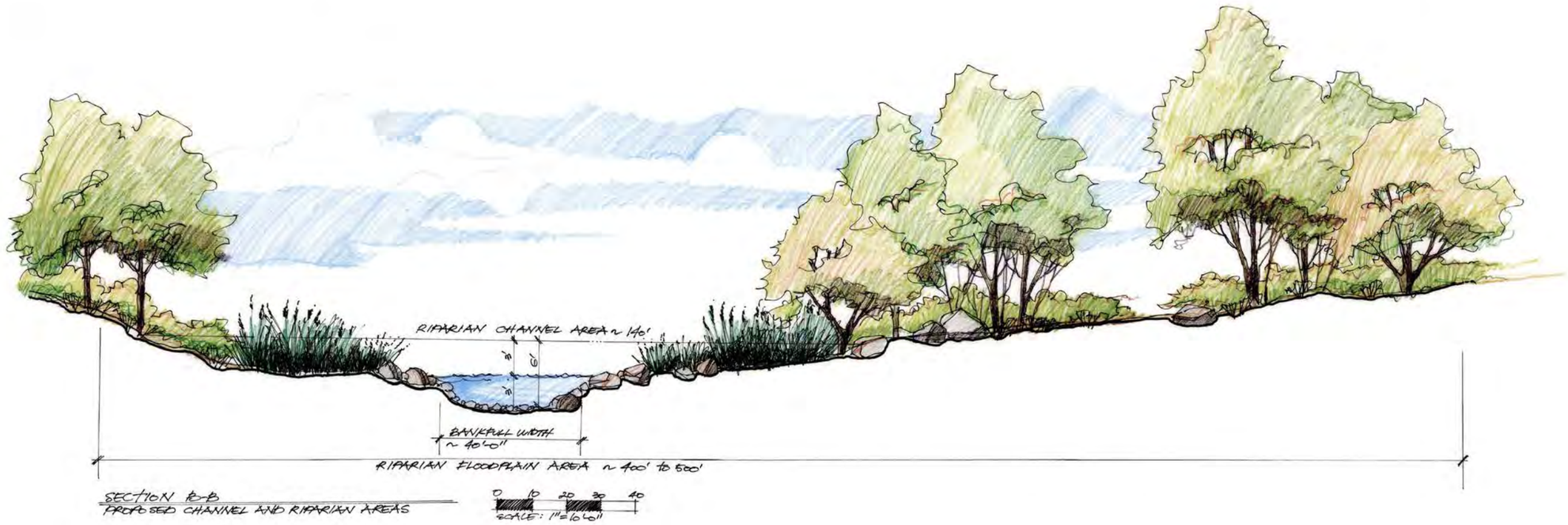
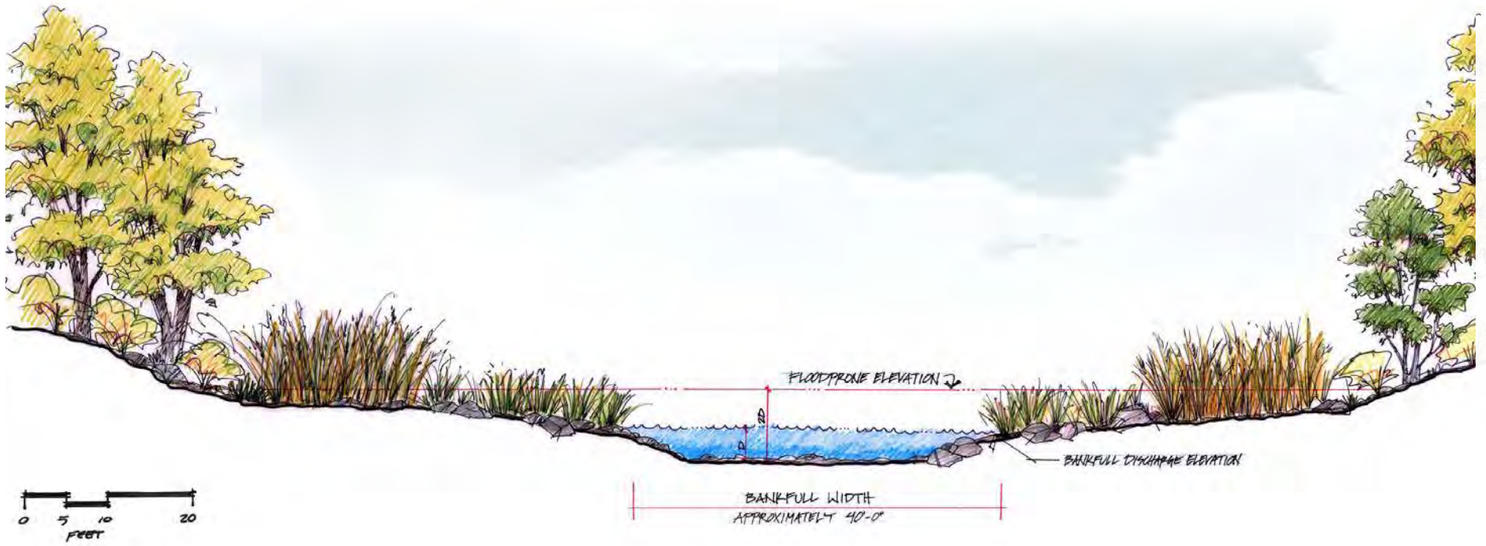
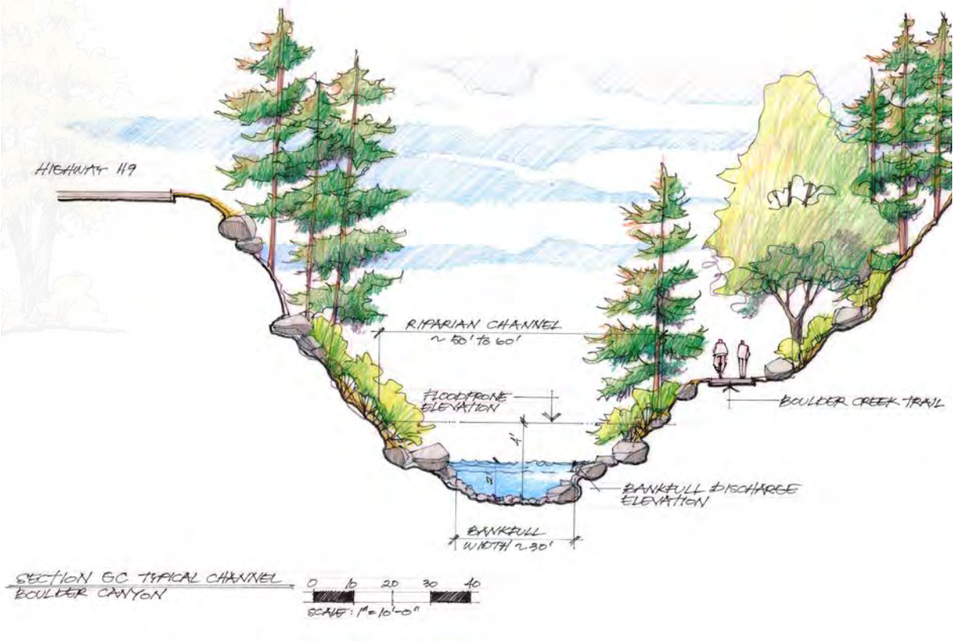
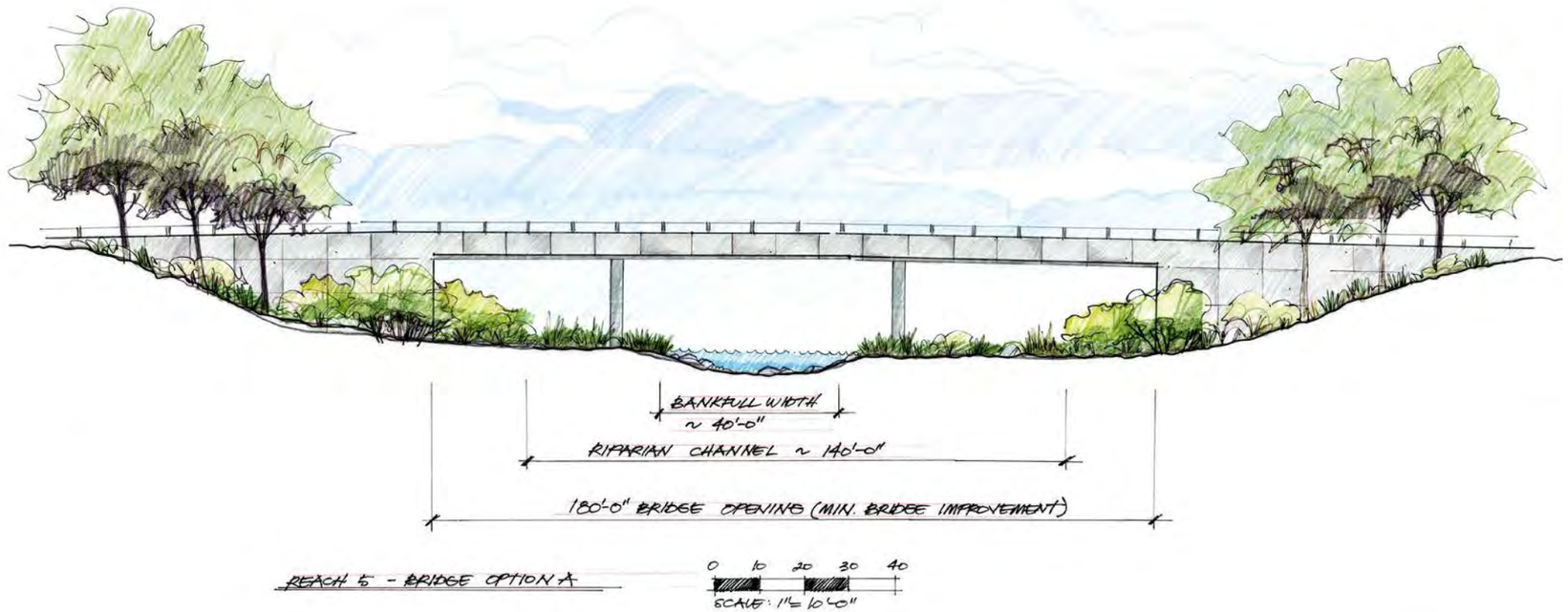
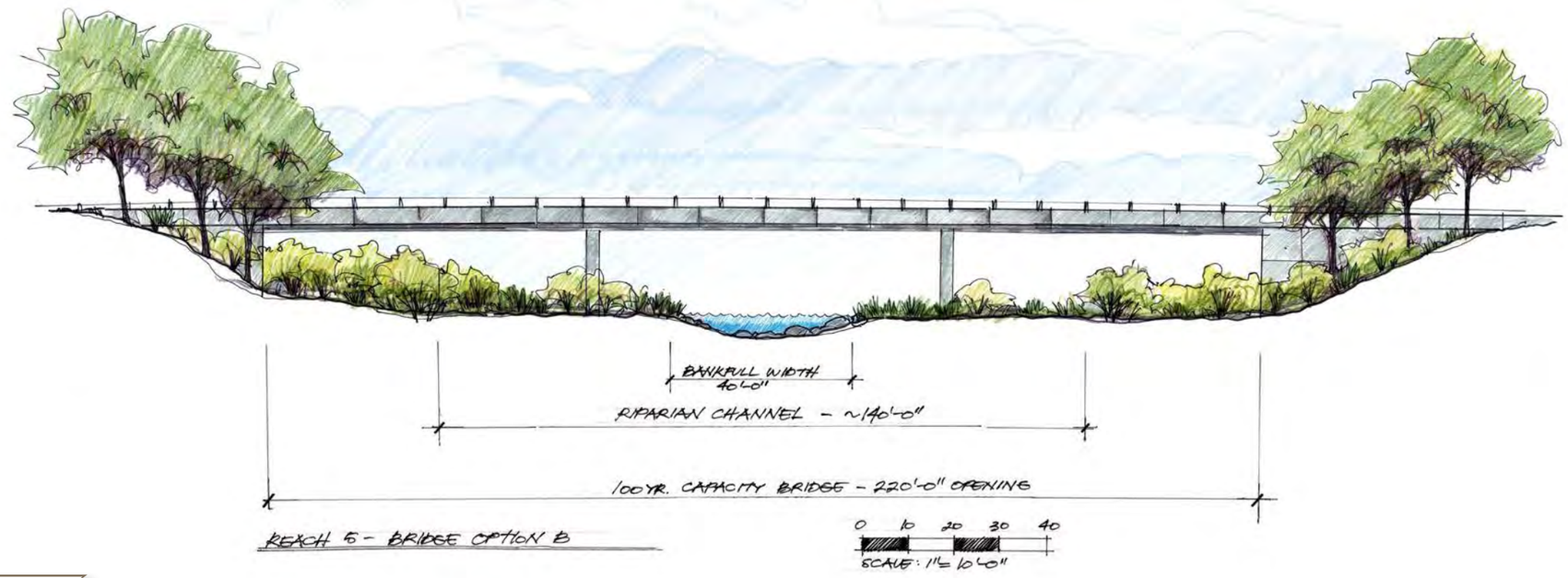
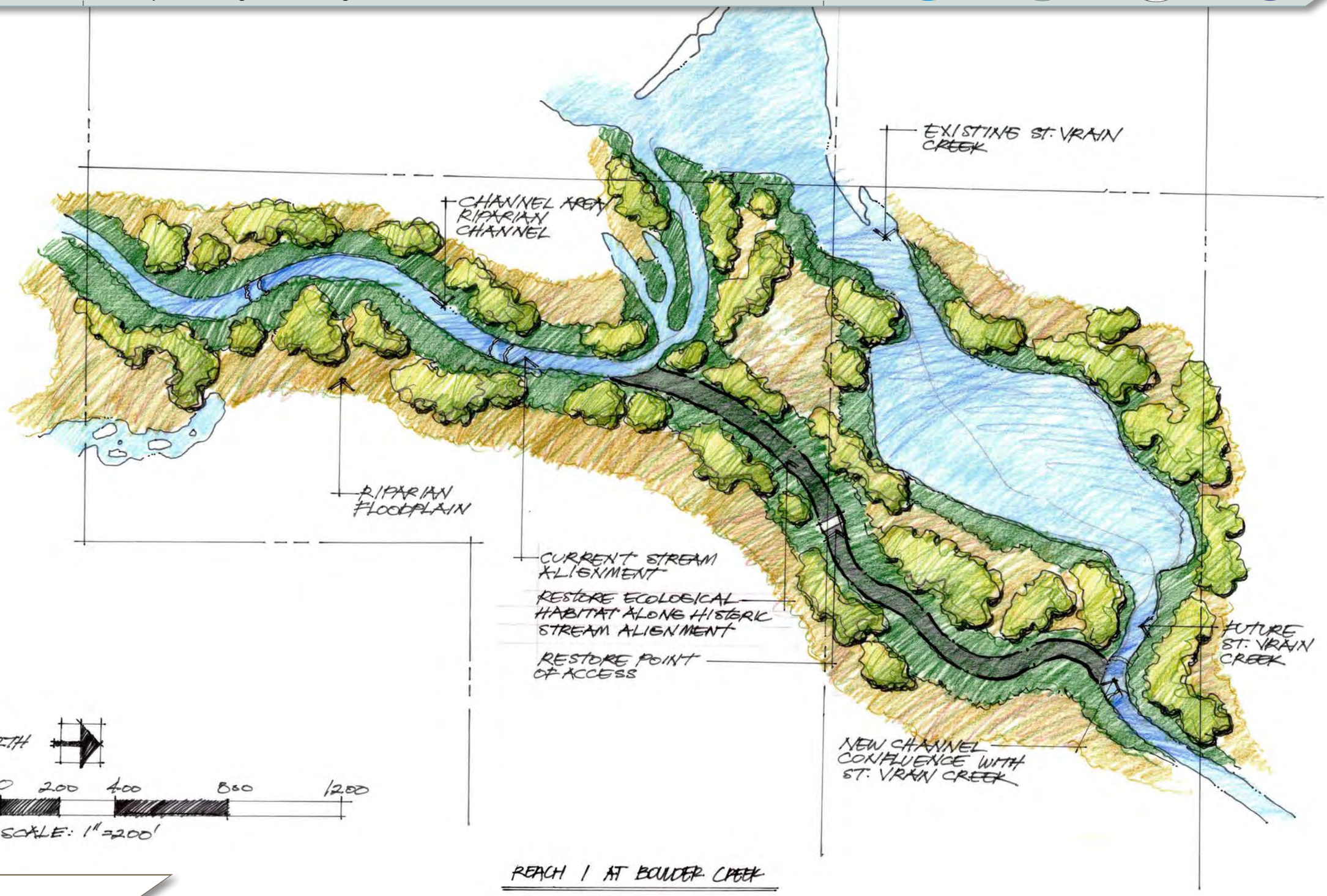

RIPARIAN CHANNEL AREA ~ 140'
BANKFULL WIDTH
~ 40'-0"
RIPARIAN FLOODPLAIN AREA ~ 400' TO 500'
SECTION B-B
PROPOSED CHANNEL AND RIPARIAN AREAS
0 10 20 30 40
SCALE: 1"=10'-0"


FLOODPRONE ELEVATION
BANKFULL DISCHARGE ELEVATION
BANKFULL WIDTH
APPROXIMATELY 40'-0"
0 5 10 20
FEET

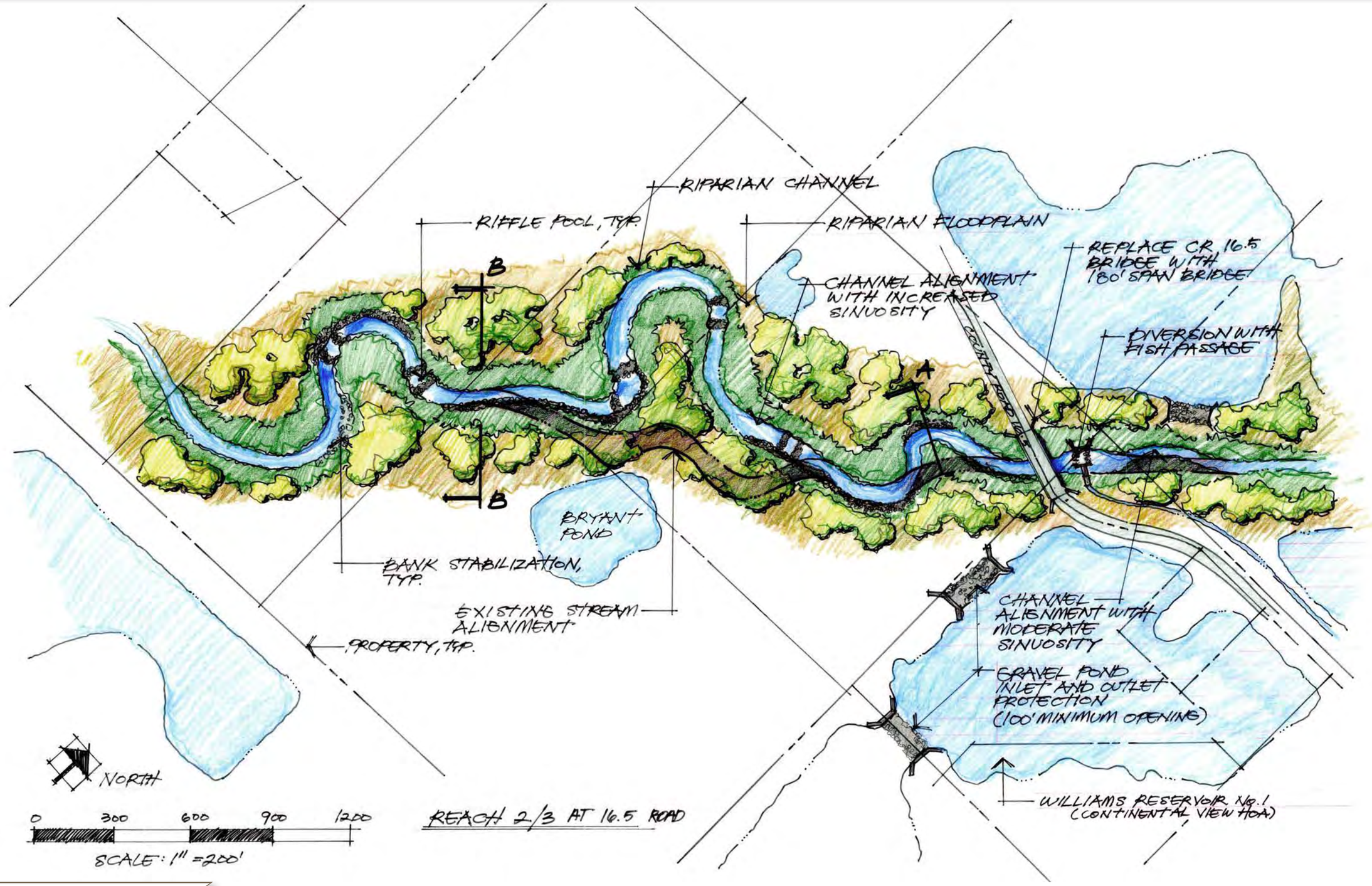

HIGHWAY 119
RIPARIAN CHANNEL
~ 50' TO 60'
FLOODPRONE ELEVATION
BOULDER CREEK TRAIL
BANKFULL DISCHARGE ELEVATION
BANKFULL WIDTH ~ 30'
SECTION GC TYPICAL CHANNEL
BOULDER CANYON
0 10 20 30 40
SCALE: 1"=10'-0"

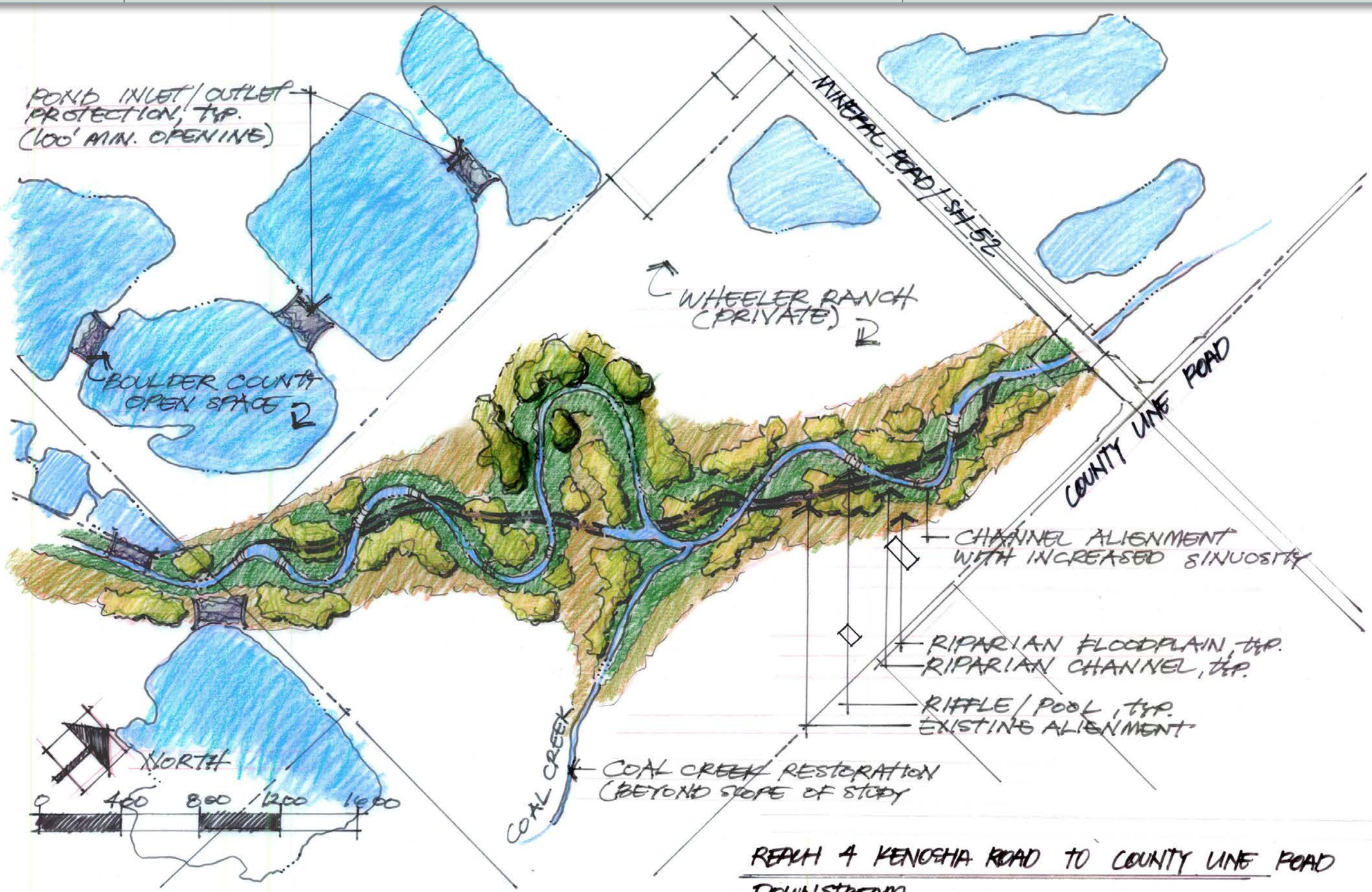

BANKFULL WIDTH
~ 40'-0"
RIPARIAN CHANNEL ~ 140'-0"
180'-0" BRIDGE OPENING (MIN. BRIDGE IMPROVEMENT)
REACH 5 - BRIDGE OPTION A
0 10 20 30 40
SCALE: 1"= 10'-0"

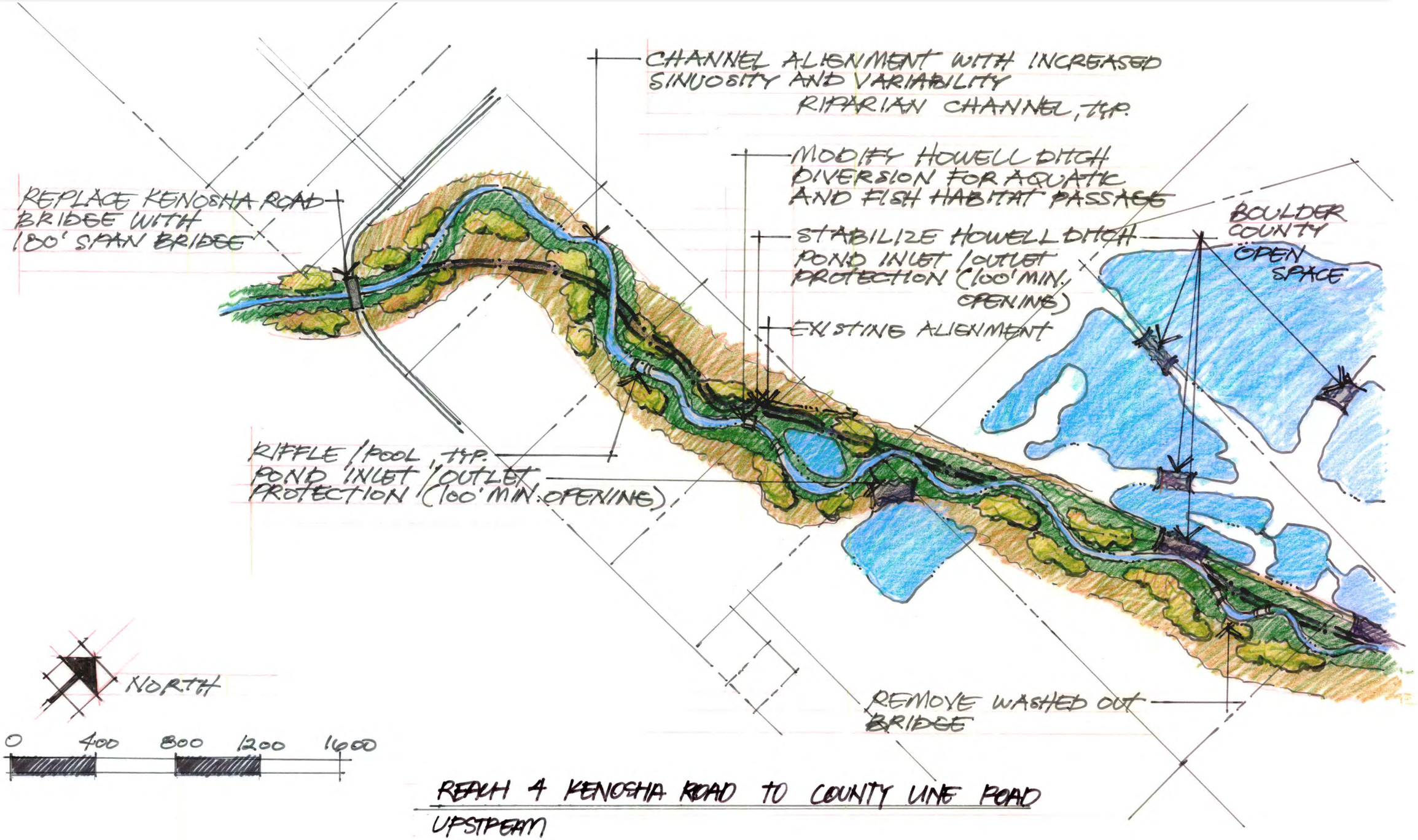

BANKFULL WIDTH
40'-0"
RIPARIAN CHANNEL - ~140'-0"
100 YR. CAPACITY BRIDGE - 220'-0" OPENING
REACH 5 - BRIDGE OPTION B
0 10 20 30 40
SCALE: 1"= 10'-0"



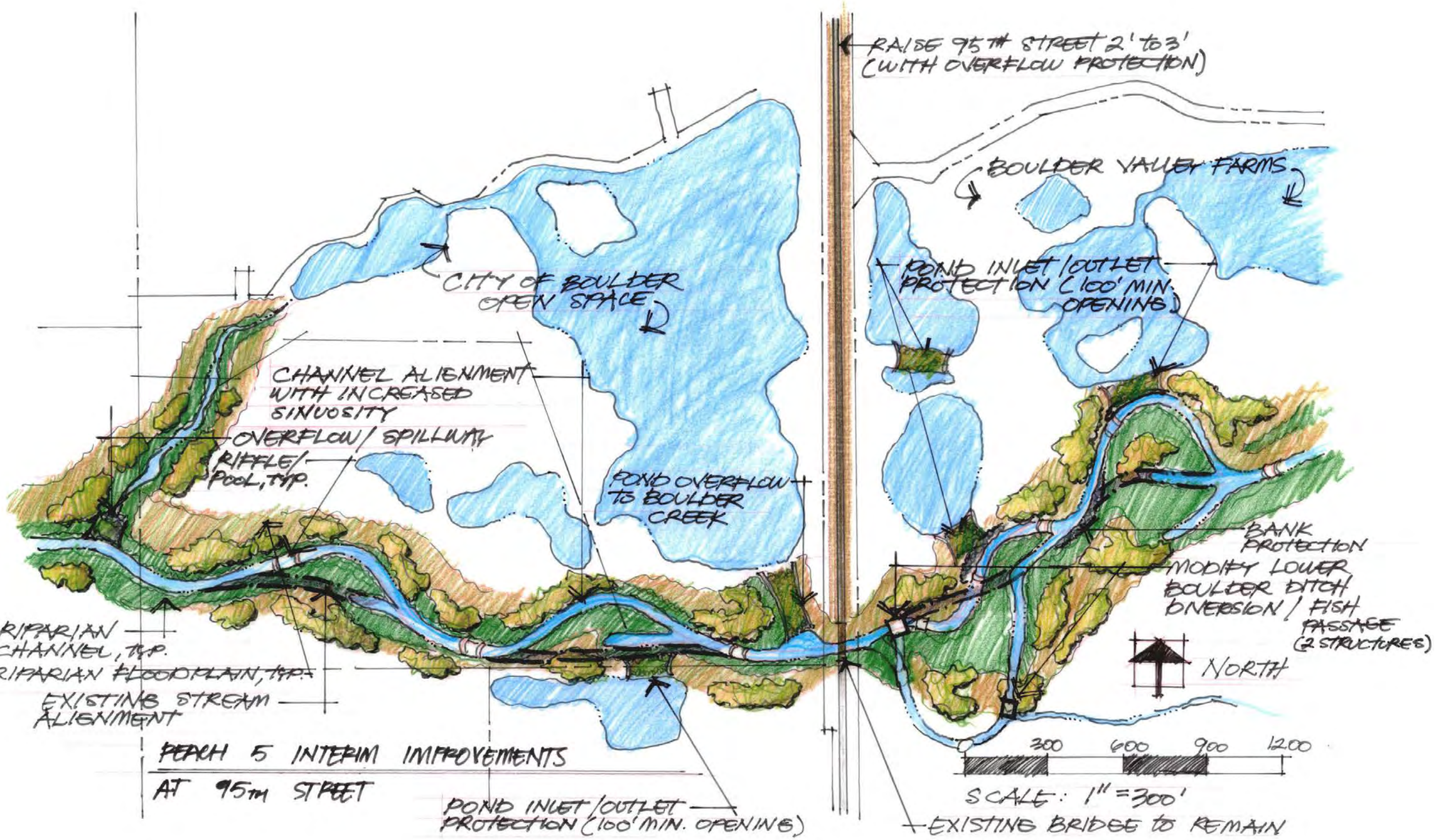
REACH 1 AT BOULDER CREEK

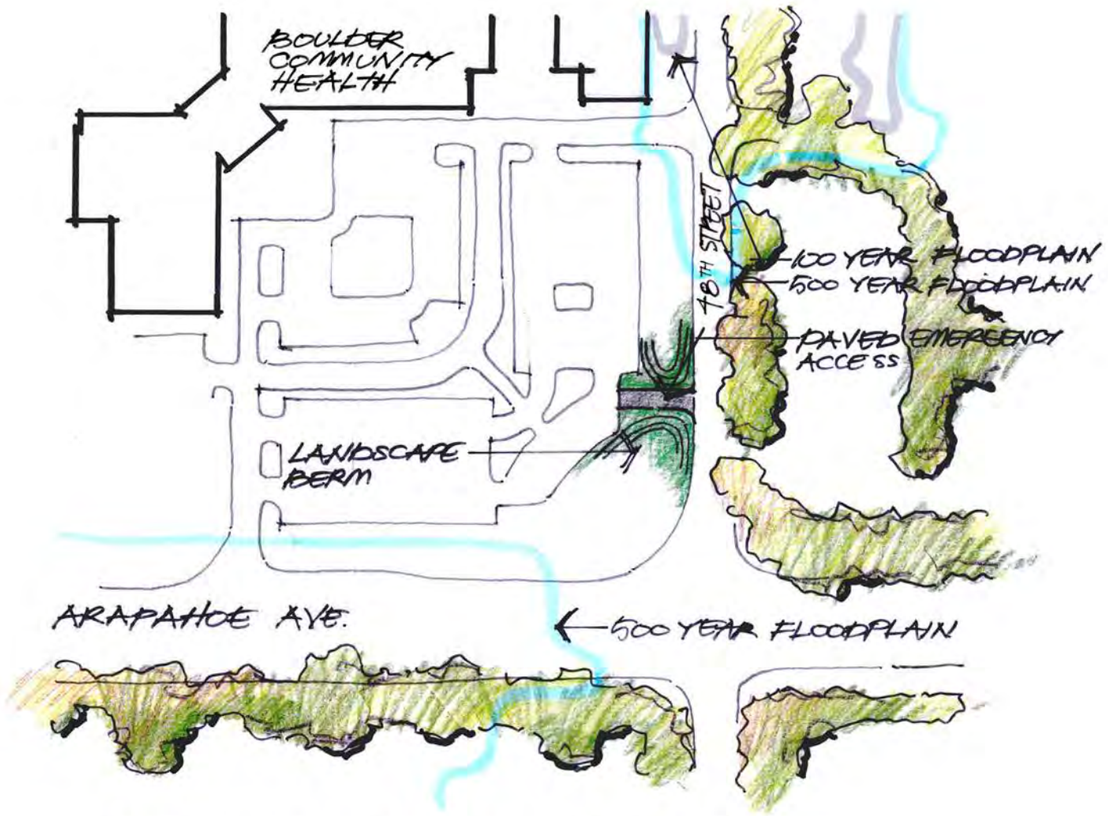

RIPARIAN CHANNEL
RIFFLE POOL, TYP.
RIPARIAN FLOODPLAIN
REPLACE CR. 16.5 BRIDGE WITH 180' SPAN BRIDGE
CHANNEL ALIGNMENT WITH INCREASED SINUOSITY
DIVERSION WITH FISH PASSAGE
B
A
B
BRYANT POND
BANK STABILIZATION, TYP.
EXISTING STREAM ALIGNMENT
PROPERTY, TYP.
CHANNEL ALIGNMENT WITH MODERATE SINUOSITY
GRAVEL POND INLET AND OUTLET PROTECTION (100' MINIMUM OPENING)
WILLIAMS RESERVOIR NO. 1 (CONTINENTAL VIEW HOA)
NORTH
0 300 600 900 1200
SCALE: 1" = 200'
REACH 2/3 AT 16.5 ROAD


POND INLET/OUTLET PROTECTION, TYP. (100' MIN. OPENING)
BOULDER COUNTY OPEN SPACE
WHEELER RANCH (PRIVATE)
NATIONAL ROAD / SH-52
COUNTY LINE ROAD
CHANNEL ALIGNMENT WITH INCREASED SINUOSITY
RIPARIAN FLOODPLAIN, TYP.
RIPARIAN CHANNEL, TYP.
RIFFLE / POOL, TYP.
EXISTING ALIGNMENT
COAL CREEK
COAL CREEK RESTORATION (BEYOND SCOPE OF STUDY)
NORTH
0 400 800 1200 1600
REACH 4 KENOSHA ROAD TO COUNTY LINE ROAD
DOWNSTREAM

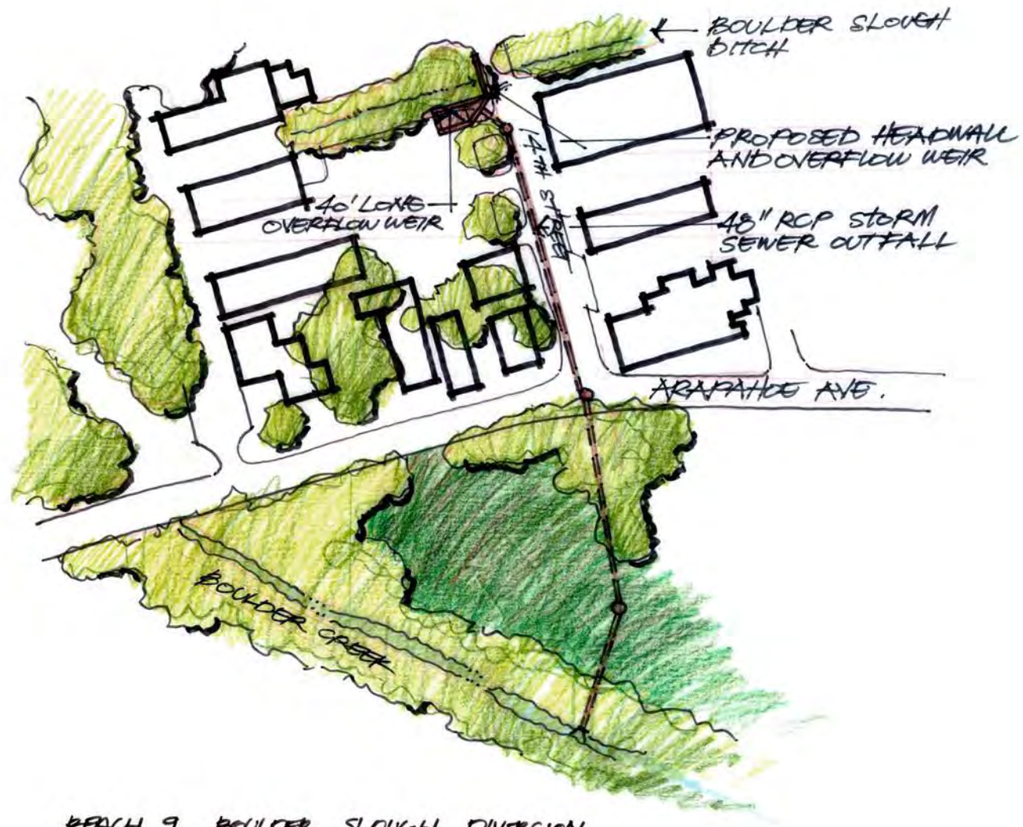


REACH 4 KENOSHA ROAD TO COUNTY LINE ROAD
UPSTREAM

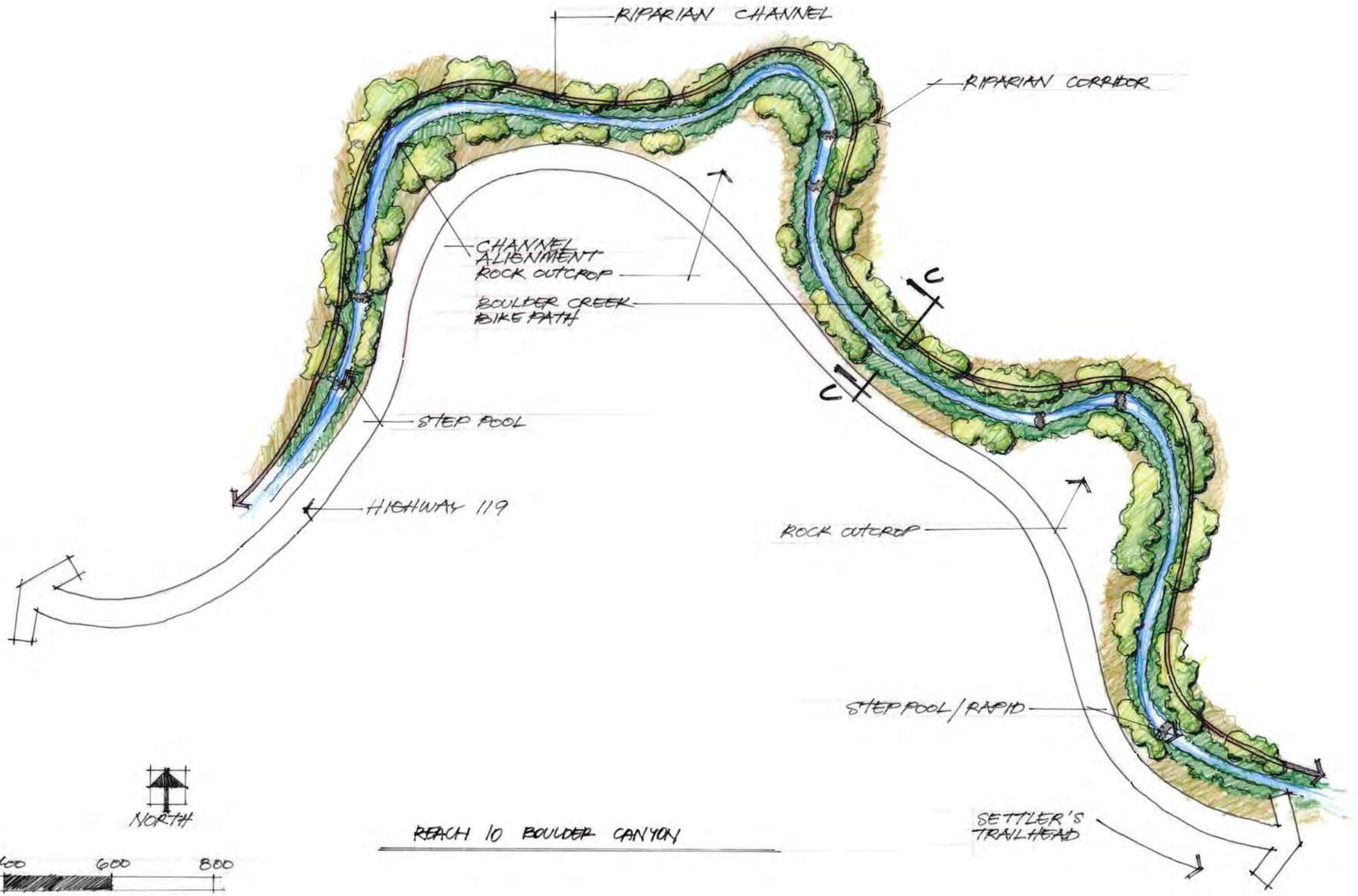

RAISE 95TH STREET 2' TO 3' (WITH OVERFLOW PROTECTION)
BOULDER VALLEY FARMS
CITY OF BOULDER OPEN SPACE
POND INLET/OUTLET PROTECTION (100' MIN. OPENING)
CHANNEL ALIGNMENT WITH INCREASED SINUOSITY
OVERFLOW/SPILLWAY
RIFFLE/POOL, TYP.
POND OVERFLOW TO BOULDER CREEK
BANK PROTECTION
MODIFY LOWER BOULDER DITCH DIVERSION/FISH PASSAGE (2 STRUCTURES)
NORTH
RIPARIAN CHANNEL, TYP.
RIPARIAN FLOODPLAIN, TYP.
EXISTING STREAM ALIGNMENT
REACH 5 INTERIM IMPROVEMENTS
AT 95TH STREET
POND INLET/OUTLET PROTECTION (100' MIN. OPENING)
EXISTING BRIDGE TO REMAIN
300 600 900 1200
SCALE: 1" = 300'



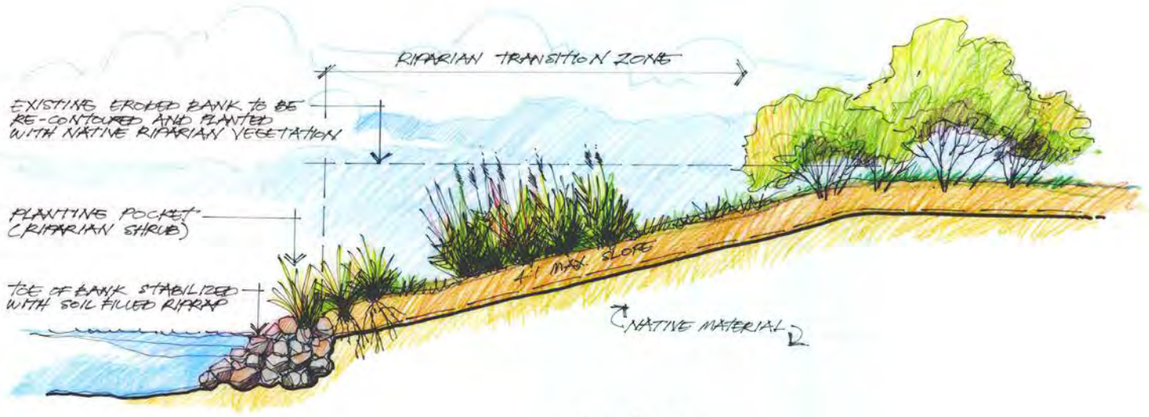
REACH 8 BOULDER COMMUNITY HEALTH
500 YEAR ACCESS



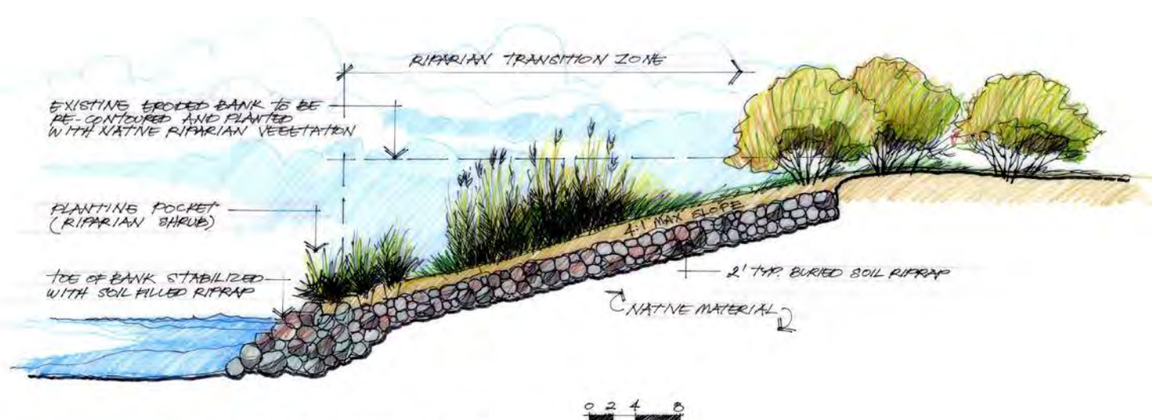
REACH 9 BOULDER SLOUGH DIVERSION



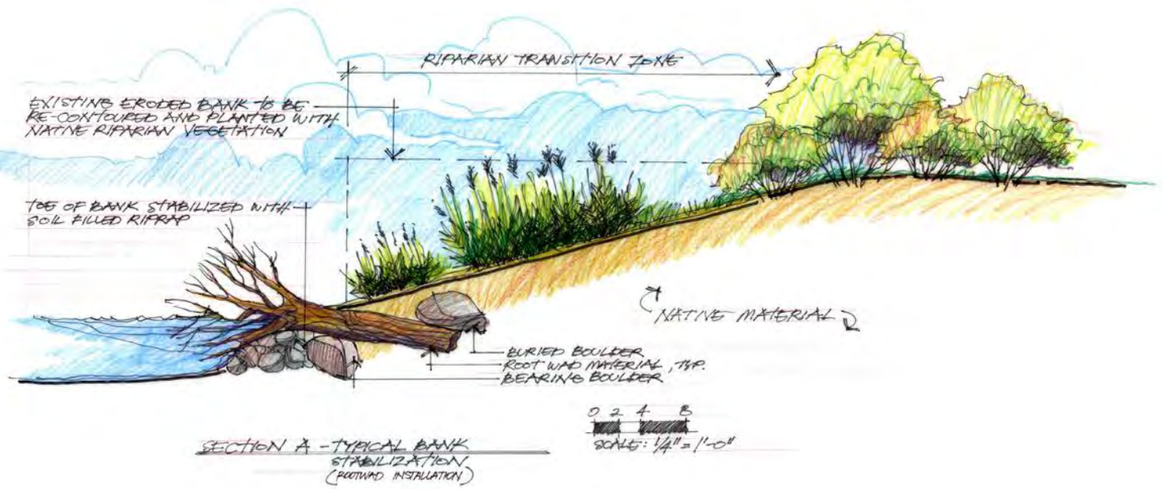
REACH 10 BOULDER CANYON



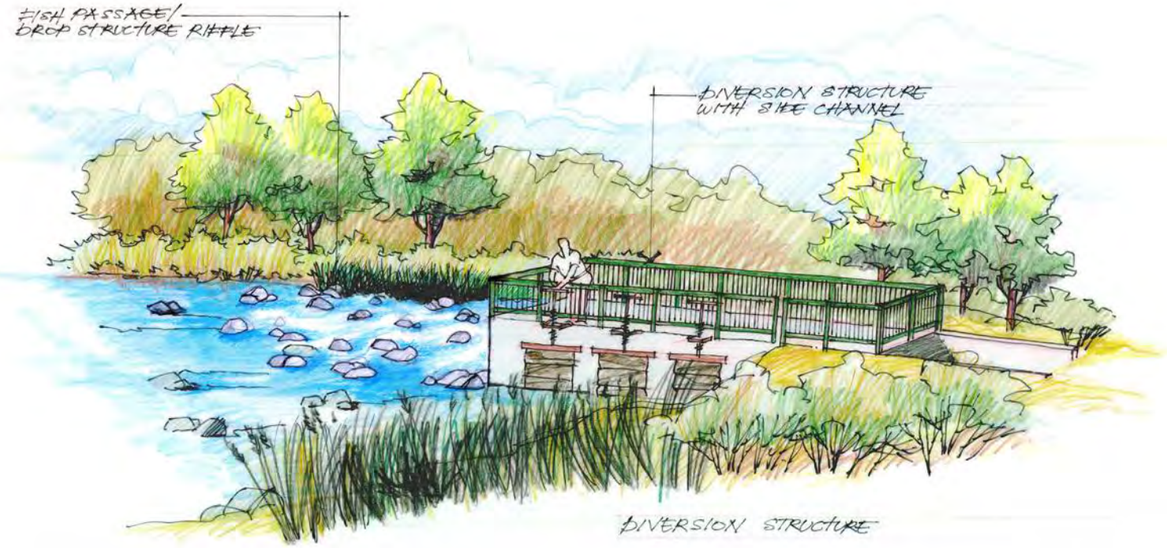
SECTION A - TYPICAL BANK STABILIZATION



SECTION A - TYPICAL BANK STABILIZATION (RIP RAP INSTALLATION)



SECTION A - TYPICAL BANK STABILIZATION (ROOTWAD INSTALLATION)



DIVERSION STRUCTURE

12.0 PRIORITIZATION

In general, projects presented by this master plan are isolated in nature and can be implemented in any order without affecting adjacent projects upstream and downstream. Stream restoration and ecological enhancement will be most affected when Boulder Creek has been restored in a consistent manner across the entirety of the study length.

Since many of the alternatives in this study are not directly comparable, each recommended alternative has been grouped into a distinguishing category for prioritization. The four categories reflect: stream and Ecological Restoration, Bridge Replacement & Emergency Access; Public Safety; and Stream Maintenance. Within each category, projects were ranked in terms of a high, medium, or low priority. Top priority was given to project which serviced an immediate need; high level of stakeholder interest or collaboration; and presented higher levels of feasibility for implementation. Lower priority was assigned to locations posing less immediate threat to public safety, or integrated more long term planning goals.

12.1 Stream and Ecological Restoration

Prioritization of stream and ecological restoration projects are presented below. Examples of higher priority projects include restoration upstream and downstream of County Road 16.5 in Weld County, where erosion continues to threaten adjacent infrastructure and property. Similar prioritization was made within the City of Boulder Open Space, where stream restoration is also an integral component to implementing roadway improvements in the area. Lower priority was given to project more isolated by open space areas with less immediate threat to public safety, such as near the confluence with the Saint Vrain Creek, or Alexander Dawson Open Space. In general, modification to grade control and irrigation diversion structures were generally given lower priority, except in cases where the changes were also an integral part of the restoration activities.

12.2 Bridge Replacement & Emergency Access

Prioritization for bridge replacements considered: the need to provide emergency access; age of structure (if known); existing bridge capacity; and current bridge size with respect to geomorphic recommendations. As shown by Table 12-2: Bridge Replacement & Emergency Access Prioritization Summary, most bridge replacements were classified as higher priorities for the watershed. The County Road 20.5 and 75th Street bridges were generally ranked as a medium priority based on existing capacity and size. The 95th Street bridge replacement was also ranked as a medium priority due to the newer age of the structure. However, interim improvements at 95th Street, as discussed previously, would be considered a high priority to reduce the frequency of overtopping.

12.3 Public Safety

Public safety oriented improvements are shown below. Prioritization considered the current overall threat to public safety; frequency of concern; and implementation. Higher priority was given to protection of the City of Boulder's sanitary interceptor line and Boulder Slough mitigation, where significant flooding occurred during 2013. High priority was also given to providing inflow and outflow protection for the Bryant Pond in addition to the Williams Reservoir No. 1, in Weld County, which has incurred damage since 2013. Medium priority was given to the remaining gravel pond locations. Low priority was applied to the Boulder Community Health Hospital Access and Cordry Court high hazard mitigation projects, where public safety issues would develop less frequently.

12.4 Maintenance

Maintenance oriented improvements are shown below. Prioritization considered the immediate impact to public and private facilities, trail access, and potential effects on the floodplain elevations.

Table 12-1: Stream Restoration Prioritization Summary

Reach	ID	Stream Restoration Prioritization	Jurisdiction	Priority
		HIGH PRIORITY PROJECTS		
2	G	Stream Restoration Downstream of CO Rd. 16.5	Weld County	High
3	A	Stream Restoration Upstream of CO Rd. 16.5	Weld County	High
4	F	Stream Restoration Through Doniphan, Wittemeyer Ponds, Bailey-Kenosha Ponds, and Open Space	Boulder County	High
4	G	Stabilize Howell Ditch Diversion System, Modify Diversion for Aquatic and Habitat Passage	Boulder County	High
4	K	Stream Restoration Through Wheeler Ranch	Boulder County	High
7	I	Stream Restoration from Valmont Rd to 61st Street	City of Boulder	High
		MEDIUM PRIORITY PROJECTS		
4	D	Stabilize Bank at Bailey-Kenosha Pond Outlet	Boulder County	Medium
5	F	Stream Restoration Downstream of 95th Street	Boulder County	Medium
5	H	Stream Restoration from Upstream of 95th St. to White Rocks Trail	City of Boulder*	Medium
8	D	Stream Restoration from Foothills Pkwy to BNSF RR	City of Boulder	Medium
		LOW PRIORITY PROJECTS		
1	A	Stream Maintenance and Ecological Enhancements City of Longmont Open Space	City of Longmont / Weld County	Low
2	B	Replace Existing Grade Control for Aquatic and Habitat Passage	Weld County	Low
2	C	Modify Rural Ditch for Aquatic and Habitat Passage	Town of Frederick / Weld County	Low
2	D	Modify Idaho Creek Diversion for Aquatic and Habitat Passage	Weld County	Low
4	A	Modify Godding A. and D. Plumb Ditch for Aquatic and Habitat Passage	Weld County	Low
4	I	Replace Grade Control for Aquatic and Habitat Passage	Boulder County	Low
5	A	Stream Restoration at Alexander Dawson Open Space	Boulder County	Low
5	B	Modify Boulder and Weld County Ditch for Aquatic and Habitat Passage	Boulder County	Low
5	D	Modify Grade Control Structures for Aquatic and Habitat Passage	Boulder County	Low
5	E	Modify Lower Boulder Ditch for Aquatic and Habitat Passage	Boulder County	Low
6	A	Modify Leggett Ditch for Aquatic and Habitat Passage	Boulder County	Low
7	C	Modify Diversion for Aquatic and Habitat Passage	Boulder County	Low
7	D	Modify Green Ditch Diversion for Aquatic and Habitat Passage	Boulder County	Low
8	A	Stream Restoration from 55th St. to Valmont Drive	City of Boulder	Low
8	B	Stream Restoration from BNSF RR to 55th St.	City of Boulder	Low
9	E	Modify Boulder Ditches Diversion for Aquatic and Habitat Passage	City of Boulder	Low
10	A	Modify Farmers' Ditch for Aquatic and Habitat Passage	Boulder County	Low
10	B	Boulder Canyon Stream Restoration	Boulder County	Low

* Although located in Boulder County this project is City of Boulder Open Space and Mountain Park managed land and has classified as City of Boulder jurisdiction

Table 12-2: Bridge Replacement & Emergency Access Prioritization Summary

Reach	ID	Bridge Replacement & Emergency Access Prioritization	Jurisdiction	Priority
		HIGH PRIORITY PROJECTS		
2	E	CO Rd. 16.5 - Replace Bridge with 180 ft. Span Bridge	Weld County	High
4	B	East County Line Road - 100-yr Option: Replace Bridge with 220 ft. Span Bridge	Boulder County	High
4	H	Kenosha Rd. - Replace Bridge with 180 ft. Span Bridge	Boulder County	High
4	J	109th St. - Replace Bridge with 180 ft. Span Bridge; Restore Adjacent Channel	Boulder County	High
7	E	61st Street - 100-yr Option: Replace Bridge with 220 ft. Span Bridge	Boulder County	High
7	F	Replace Old Valmont Pedestrain Crossing with 180 ft. Span Bridge	Boulder County	High
8	C	BNSF Railroad - Replace Bridge with 180 ft. Span Bridge	City of Boulder	High
9	C	North of Boulder Creek Access Improvements	City of Boulder	High
		MEDIUM PRIORITY PROJECTS		
2	A	CO Rd. 20.5 - Replace Bridge with 180 ft. Span Bridge	Weld County	Medium
5	G	95th St. - 100-yr Option: Replace Bridge with 220 ft. Span Bridge	Boulder County	Medium
6	B	75th Street - 100-yr Option: Replace Bridge with 220 ft. Span Bridge	Boulder County	Medium

Table 12-3: Public Safety Prioritization Summary

Reach	ID	Public Safety Prioritization	Jurisdiction	Priority
		HIGH PRIORITY PROJECTS		
3	B	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Weld County	High
7	H	Protect Sanitary Interceptor Sewer	Boulder County	High
9	D	Boulder Slough Mitigation	City of Boulder	High
		MEDIUM PRIORITY PROJECTS		
1	B	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	City of Longmont / Weld County	Medium
2	F	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Town of Frederick / Weld County	Medium
4	C	Protect Gravel Ponds / Town of Erie Reuse Pond / Wittemeyer Ponds Inlet & Outlet During Strom Flows, Typical.	Town of Erie / Weld County / Boulder County	Medium
5	C	Protect Boulder Valley Ponds Inlet & Outlet During Storm Flows, Typical.	Boulder County	Medium
7	A	Protect Walden Ponds Inlet & Outlet During Storm Flows, Typical	Boulder County	Medium
7	B	Protect Ponds Inlet & Outlet During Storm Flows, Typical	Boulder County	Medium
		LOW PRIORITY PROJECTS		
8	E	Hospital Access Improvements for 500-yr Event	City of Boulder	Low
9	A	Cordry Ct, High Hazard & Flood Mitigation	City of Boulder	Low

Table 12-4: Maintenance Prioritization Summary

Reach	ID	Maintenance Prioritization	Jurisdiction	Priority
		HIGH PRIORITY PROJECTS		
8	F	Sediment Maintenance along Boulder Creek Path	City of Boulder	High
9	F	Sediment Maintenance along Boulder Creek Path	City of Boulder	High
		MEDIUM PRIORITY PROJECTS		
7	G	Modify Butte Mill Ditch Crossing on South Boulder Creek	Boulder County	Medium
		LOW PRIORITY PROJECTS		
4	E	DS of Kenosha Rd. - Remove Washed Out Bridge	Boulder County	Low

12.5 Prioritization by Jurisdiction

Prioritization by jurisdiction is presented below. Overall prioritization in terms of high, medium, or low priorities have also been depicted on the master plan exhibits shown previously.

Table 12-5: Prioritization Summary by Jurisdiction

Reach	ID	Juristictional Prioritization	Jurisdiction	Priority
4	B	East County Line Road - 100-yr Option: Replace Bridge with 220 ft. Span Bridge	Boulder County	High
4	D	Stabilize Bank at Bailey-Kenosha Pond Outlet		High
4	F	Stream Restoration Through Doniphan, Wittemeyer Ponds, Bailey-Kenosha Ponds, and Open Space		High
4	G	Stabilize Howell Ditch Diversion System, Modify Diversion for Aquatic and Habitat Passage		High
4	H	Kenosha Rd. - Replace Bridge with 180 ft. Span Bridge		High
4	J	109th St. - Replace Bridge with 180 ft. Span Bridge; Restore Adjacent Channel		High
4	K	Stream Restoration Through Wheeler Ranch		High
5	C	Protect Boulder Valley Ponds Inlet & Outlet During Storm Flows, Typical.		High
5	F	Stream Restoration Downstream of 95th Street		High
5	G	95th St. - 100-yr Option: Replace Bridge with 220 ft. Span Bridge		Medium
6	B	75th Street - 100-yr Option: Replace Bridge with 220 ft. Span Bridge		Medium
7	A	Protect Walden Ponds Inlet & Outlet During Storm Flows, Typical		Medium
7	B	Protect Ponds Inlet & Outlet During Storm Flows, Typical		Medium
7	E	61st Street - 100-yr Option: Replace Bridge with 220 ft. Span Bridge		Medium
7	F	Replace Old Valmont Pedestrain Crossing with 180 ft. Span Bridge		Medium
7	G	Modify Butte Mill Ditch Crossing on South Boulder Creek		Medium
7	H	Protect Sanitary Interceptor Sewer		Medium
4	E	DS of Kenosha Rd. - Remove Washed Out Bridge		Low
4	I	Replace Grade Control for Aquatic and Habitat Passage		Low
5	A	Stream Restoration at Alexander Dawson Open Space		Low
5	B	Modify Boulder and Weld County Ditch for Aquatic and Habitat Passage		Low
5	D	Modify Grade Control Structures for Aquatic and Habitat Passage		Low
5	E	Modify Lower Boulder Ditch for Aquatic and Habitat Passage		Low
6	A	Modify Leggett Ditch for Aquatic and Habitat Passage		Low
7	C	Modify Diversion for Aquatic and Habitat Passage		Low
7	D	Modify Green Ditch Diversion for Aquatic and Habitat Passage		Low
10	A	Modify Farmers' Ditch for Aquatic and Habitat Passage		Low
10	B	Boulder Canyon Stream Restoration		Low
7	I	Stream Restoration from Valmont Rd to 61st Street	City of Boulder	High
8	C	BNSF Railroad - Replace Bridge with 180 ft. Span Bridge		High
8	F	Sediment Maintenance along Boulder Creek Path		High
9	C	North of Boulder Creek Access Improvements		High
9	D	Boulder Slough Mitigation		High
9	F	Sediment Maintenance along Boulder Creek Path		High
5	H	Stream Restoration from Upstream of 95th St. to White Rocks Trail		Medium
8	D	Stream Restoration from Foothills Pkwy to BNSF RR		Medium
8	A	Stream Restoration from 55th St. to Valmont Drive		Low
8	B	Stream Restoration from BNSF RR to 55th St.		Low
8	E	Hospital Access Improvements for 500-yr Event		Low
9	A	Cordry Ct, High Hazard & Flood Mitigation		Low
9	E	Modify Boulder Ditches Diversion for Aquatic and Habitat Passage		Low
1	B	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	City of Longmont / Weld County	Medium
1	A	Stream Maintenance and Ecological Enhancements City of Longmont Open Space		Low
4	C	Protect Gravel Ponds / Town of Erie Reuse Pond / Wittemeyer Ponds Inlet & Outlet During Strom Flows, Typical.	Town of Erie / Weld County / Boulder County	Medium
2	F	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Town of Frederick / Weld County	Medium
2	C	Modify Rural Ditch for Aquatic and Habitat Passage		Low
2	E	CO Rd. 16.5 - Replace Bridge with 180 ft. Span Bridge	Weld County	High
2	G	Stream Restoration Downstream of CO Rd. 16.5		High
3	A	Stream Restoration Upstream of CO Rd. 16.5		High
3	B	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical		High
2	A	CO Rd. 20.5 - Replace Bridge with 180 ft. Span Bridge		Medium
2	B	Replace Existing Grade Control for Aquatic and Habitat Passage		Low
2	D	Modify Idaho Creek Diversion for Aquatic and Habitat Passage		Low
4	A	Modify Godding A. and D. Plumb Ditch for Aquatic and Habitat Passage		Low

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Photo Credits (not provided by planning team)
Photo 14: 95th Street flooding, photo courtesy of David Mallory, UDFCD

APPENDIX A

LEGAL OPINION

Edward J. Krisor
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January 19, 1998

Mr. Ben Urbonas, P.E.
Chief, Master Planning Program
Urban Drainage And Flood Control District
2480 West 26th Avenue, Suite 156 B
Denver, Colorado 80211

BY HAND DELIVERY

Re: Legal opinion in regard to alternative and planned drainage facilities in general as contained in alternatives development and evaluation reports

Dear Ben:

You have asked me to provide you with a legal opinion that you may use to initially evaluate in general all alternatives development and evaluation reports for compliance with the law of the State of Colorado applicable to drainage. What follows is such an opinion which will need to be supplemented by a short legal opinion in regard to each report to either indicate that no further comment is necessary or that certain other factors, other than those noted herein, will need to be considered before proceeding to the selection and construction of drainage improvements contained in that specific report.

In order to properly evaluate these reports you first must take note of the following comments in regard to the law of drainage in Colorado:

I. GENERAL LEGAL DRAINAGE PRINCIPLES

Natural drainage conditions may be altered by an upper (dominant) owner provided the water is not sent down in a manner or quantity to do more harm than formerly to the lower

(servient) owner, Hankins v. Borland, 163 Colo. 575, 431 P.2d 1007 (1967). Colorado follows the "rule of reasonableness" as related to drainage matters and in each drainage situation, the court will look at the relationship of the parties and at who is doing what to whom in order to determine "what is reasonable under the circumstances". Prior to the Hankins case, the Colorado Supreme Court ruled in Ambrosio v. Perl-Mack, 143 Colo. 49, 317 P.2d 803 (1960), that downstream owners had to accept additional runoff from an upstream developer.

As the engineering technology has become more precise in drainage matters, it is possible to determine from the actual development and from land use decisions that will determine future development what the additional (more than natural) runoff will be because landowners make their land impermeable.

The Colorado Legislature in 1973 recognized this and adopted Sec. 30-28-113(4)(b) which requires developers in unincorporated areas to detain greater than historical flows. As a matter of drainage practice, cities as well as counties and the Urban Drainage District work to identify with precision "who is doing what" to whom so that the cost of drainage solutions to problems created by future development can be placed on those who would change the use of land from permeable to impermeable. Runoff from existing development is also computed and the need, if any, to solve existing drainage problems can be determined and costs of solutions estimated.

Drainage matters historically were resolved between or among property owners. However, as urbanization (multiple property owners) has taken place, governments have become involved for several reasons. In some cases, the government itself helped create additional runoff by making improvements. In other cases, government approved land use changes without regard to the problems of additional runoff. In still other situations, government got involved because constituents (owners) wanted government help in the difficult and expensive field of determining (identifying) where the additional runoff was coming from and the paying of costs of solutions. For whatever the reason, whenever government gets involved, it can be expected to be treated like a private party. 2 Farnham, Water and Water Rights, pp. 975 and 977, adopted by the Colorado Supreme Court in City of Boulder v. Boulder and White Rock Ditch Co., 73 Colo. 426, 216 P. 553 (1923). A municipality can be held to its negligence. It can also determine whether to become involved at all, if it did not create the problem.

An update of these legal principles has yielded the conclusion that the law of drainage as set forth above has not really changed to any substantially degree over the years. Both the Hankins and Ambrosio cases continue to be cited by the Colorado courts when dealing with the law of drainage. In the case of Metro Docheff v. City of Broomfield, 623 P. 2d 69 (Colo. App.

1980) the Colorado Court of Appeals held that: "Although we recognize the right of the owner of higher land to a drainage easement over the lower land of others, . . . the discharge of water will be enjoined as a continuing trespass if the drain sends the water down 'in a manner or quantity to do more harm than formerly.'" In the case of Hoff v. Ehrlich, 511 P. 2d 523 (Colo. App. 1973) the Colorado Court of Appeals was faced with the question of the propriety of a servient owner blocking drainage from a dominant estate in order to protect the servient owner's land. The Court held that: "The owner of the dominant estate has a legal and natural easement or servitude in the lower or servient estate for the drainage of surface water flowing in its natural course and manner . . . When an interruption in the natural flow or passage of surface waters is caused by the servient owner to the detriment or injury of the estate of the dominant owner, the court should issue a mandatory injunction for the opening of the easement which has been blocked . . . [the servient owner] may not act to the extent that damage is caused thereby to the dominant landowner . . . in order for the owner of the servient estate to be afforded a remedy, it must be evident that the water was sent down in a manner or quantity causing more harm than it formerly had done."

If a government permits the development which in turn causes "more harm than formerly", then the government, as well as the developers, may be held liable. (Cases consistently move toward governmental, as well as developers' liability.) See Metro Docheff, *supra*, which held as follows: "The trial court found that the city had accepted the streets and storm drains for maintenance and control and, therefore, had exclusive control over the water collected in the subdivision. It determined that by approving the subdivision and drainage plan and accepting control, the city interfered with the natural conditions and thereby caused surface water to be collected and discharged upon plaintiff's land 'in a greater quantity or in different manner than had previously occurred under natural conditions."

Recently, governmental entities have raised in their defense of drainage cases the Governmental Immunity Act. In two recent cases, that defense has not been successful. In Burnworth v. Adams County, 826 P. 2d 368 (Colo. App. 1991) the Colorado Court of Appeals held that actions ". . . against public entities arising from the maintenance of a sewer, a storm sewer, or a storm drainage system." were not prohibited by the Governmental Immunity Act. In the case of Scott v. City of Greeley, 931 P. 2d 525 (Colo. App. 1996), the Colorado Court of Appeals again denied protection under the Governmental Immunity Act to a public entity when it argued that the damage complained of was the result of a design flaw rather than from the operation of a facility. The facts were that the City designed and constructed a new storm water line which was 42" and connected it to a line which was only 15". This caused the water to back up, or surcharge, through the storm drains and manhole covers, overtopping the curb and flooding adjacent property. In addition to the denial of protection to the entity under the

Governmental Immunity Act, the Court also rejected the City's defense that the connection to the smaller pipe was only temporary.

Any improvements upstream must be made taking into consideration the outlet capability downstream. (Long line of case law.) See Hankins, *supra*, which states: "The trial court has found that the water which these defendants have sent into the Borland drain is in greater quantity and more rapid in time — a finding fully justified by the evidence. Under such circumstances it is the court's duty to determine what the dominant owners must do in order to prevent their increased waste water from damaging the servient owner."

Colorado generally imposes strict liability on owners of dams (regional detention ponds). (Long line of cases.)

Interfering with natural drainageways or channels is generally looked upon with disfavor by Colorado Courts. However, builders of irrigation canals, railroads, and highways in other times were not aware or were unconcerned with the problems they might be creating in the future by artificially blocking natural drainageways. Sometimes the very passage of time (at least eighteen years) provides an argument that the blockage should be allowed to be continued because parties have relied and should be able to continue to rely on this "protection". Generally, the laws of nature prevail in these situations and artificial structures such as canals, railroads and highways do not rise to the status of permanent dams which require spillways and other features under the jurisdiction in the State of Colorado of the State Engineer.

With the enactment of federal environmental (including water quality) provisions, the quality of the runoff may also have an effect, as well as on other ecological matters.

Natural waters are subject to the doctrine of prior appropriation in Colorado and what may have become a water right must also be considered with any plan for the "handling" of surface runoff in natural waterways.

Finally, any drainage, "facility" built by a government must be maintained. "If you're not going to maintain it, then don't build it!" is the theme of a long line of cases.

II. GENERAL COMMENTS ON COMMONLY PROPOSED FACILITIES AND CONSTRUCTION TECHNIQUES

1. It is my understanding that the purpose of all reports in regard to this subject is to

examine alternatives which will, if implemented, improve upon and/or formalize the drainage that is within the study area.

2. In general, consideration must be given to any potential adverse effects of the selected alternative on properties within the study area and downstream of the study area.

3. If any selected facilities would increase or materially change the direction of the flows across downstream property in a study area, the downstream property has a right to claim damages and/or protection from such a material increase or change in flow. Thus, care should be taken to make sure that increased flows from upstream facilities are accommodated by sufficiently increasing the size of the downstream channels and conduits. If in final design, the selected alternative still has the effect of placing water on the residents and land owners in the area that they either never had or in a quantity larger than what they have had previously, the same must be revised to eliminate that result or the selected alternative must not be constructed.

4. If re-alignment of a channel is the selected alternative, careful consideration should be given to the channel's geometry, alignment and ability to carry flood flows so as not to create additional potential damages to surrounding landowners.

5. If the selected alternative is the collection of overland flows from a specific area and returning those flows to a drainage structure of some kind, care should be taken not to adversely impact landowners in the area.

6. If a selected alternative involves the redirection of flows from their historic path, prior to its finalization in the design process, caution should be taken that this redirection will not cause any increase in damage to those adjacent or downstream of the proposed redirection.

7. If any selected alternative, when it is finalized in the design process, is changed to include a plan for the diversion of runoff from one watershed to another; extreme caution should be used in implementing that portion of the selected alternative since the participants may be faced with the imposition of strict liability for any damage that occurs from any size storm event if it can be shown that the same would not have been suffered if the diversion had not occurred.

8. If the construction of crossing structures over irrigation canals are part of the selected alternative for the project, caution must be taken in regard to the capacity of those crossing structures. The structures, when designed for the design event, should not cause any more water than presently exists to flow into those canals.

9. The intentional routing, as opposed to inadvertent inflows, of flood flows into an irrigation ditch should be eliminated from any plan if at all possible unless a written agreement from the owner of the irrigation ditch is obtained permitting the use of the ditch to carry those flood flows. The participants have no control over the available capacity of the ditch at the time it would be necessary to carry flood flows so the ditch cannot realistically be used to control the flows downstream.

10. If an alternative is being selected that relies upon inadvertent detention and the participants do not intend to formalize such detention by written agreement, it is my opinion that the effect of that non-formalized inadvertent detention cannot be taken into consideration in the final design.

11. If a selected alternative includes the formalization of inadvertent detention it will be necessary for at least one of the participants to formalize that detention by entering into a written agreement with the owner of the facility causing the detention. The agreement must prohibit the owner from operating or modifying the facility in a way that would have the effect of lessening the inadvertent detention of the facility necessary to implement the selected alternative. Further, the owner must either agree to maintain the facility so that the same does not lose its current inadvertent detention or agree to permit at least one of the participants to maintain the facility.

12. If the owner of the facility will not agree to maintain the inadvertent detention facility, at least one of the participants should confirm in writing to all of the participants that the participant is committed to maintaining the inadvertent detention facility in a manner that assures the necessary inadvertent detention to implement the alternative. This should be done prior to the implementation of any of the alternatives involving inadvertent detention. The level of maintenance must at least permit the facility to function as relied upon in flooding events and not fail structurally during the design and larger events.

13. Any formalized detention facilities that are utilized in the final design of a project will need to be the subject of a written agreement between the owner and at least one participant that the facility will be maintained in a manner that assures the necessary flood storage to implement the design and that adequate maintenance will be performed by either the owner or the participant so that the facility will function as designed in flooding events and that it will not fail structurally during the design and larger events.

The participating entities must agree amongst themselves, in writing, that any one of the participants may enforce the terms of the agreement with the owner of the facility if the responsible participant does not. This agreement must include the maintenance of no more than

a certain level of water in the facility at any one time and that any one of the participants may, at their sole cost and expense, maintain the facility so that its effectiveness in the selected alternative will be continued in perpetuity.

14. The embankments of all detention facilities should be designed so that they will not fail during a design event.

15. If a potential wetland is involved in a design alternative, it will be necessary that a Section 404 Permit from the United States Army Corps of Engineers be applied for and obtained, if necessary. Such a Permit should be obtained before any construction is done on the recommended alternative.

16. During construction of the selected facilities, care should be taken in constructing those facilities so that downstream property is not adversely affected temporarily by such construction. Usually, with the exception of the construction of detention facilities, the best method to avoid that problem is construction from the downstream limit of the project in an upstream direction which would then have the effect of having the downstream facilities ready to accept any increased flows as a result of the project.

If you have any questions in regard to my comments and opinions contained in this letter, please feel free to telephone me to discuss the same.

Very truly yours,

Edward J. Krisor

Edward J. Krisor

APPENDIX B

MEETING MINUTES AND PRESENTATIONS

MINUTES

1) Attendees:

- Craig Jacobson, ICON Engineering, Inc.
- Brian LeDoux, ICON Engineering, Inc.
- Mark Wilcox, DHM Design
- Dave Blanch, Ecological Resource Consultants, Inc.
- Shea Thomas, Urban Drainage and Flood Control District
- Diane Malone, Boulder County
- Julie McKay, Boulder County
- Katie Knapp, City of Boulder
- Ward Bauscher, City of Boulder
- Marianne Giolitto, City of Boulder Open Space and Mountain Parks
- Dan Wolford, City of Longmont
- Clair DeLeo, Boulder County Parks and Open Space

2) INTRODUCTIONS

The project team consists of ICON Engineering Inc. as the lead consultant with assistance from DHM Design and Ecological Resource Consultants (ERC).

The project sponsors include the UDFCD, City of Boulder, Boulder County, and City of Longmont.

The notice to proceed for the project will be set as December 8th 2014.

Communication will primarily be by email. Shea will set up a dropbox folder to be used for file transfers.

Monthly progress meetings will be held at the County offices (approximately every 3rd meeting may be moved to a Longmont location). There will be approximately 8 meetings over the course of the project. The next meeting is scheduled for Tuesday January 13th, 2015 at 1:00pm.

Additional stakeholders were identified and may include:

- Colorado Water Conservation Board (CWCB)
- Federal Emergency Management Agency (FEMA)
- University of Colorado Boulder (CU)
- Weld County
- Town of Erie
- Colorado Department of Transportation (CDOT)
- Irrigation ditches and associated water users
- General public

Weld County, Town of Erie, and CDOT will be invited to the next progress meeting. Shea will contact Wendy and the Town of Erie and Steven (with Muller) at CDOT. Craig also mentioned that he had been working with Steve Harelson at CDOT from the Coal Creek project. His contact information is stephen.harelson@state.co.us, (720) 497-6913, if needed. Dianna Wink is the Weld County contact.

3) PROJECT SCOPE:

Baseline hydrology and hydraulics information has been requested from FEMA. The City of Boulder indicated that the pending Boulder Creek Study by Anderson Consulting Engineers is the preferred study to use within the City of Boulder limits. The City of Boulder will provide additional data that is relevant. The County will check with Dave Watson on availability of additional data within the County. The City of Longmont does not have any additional data to provide. ICON will compile all provided hydrology and hydraulic information and provide a list of the areas where information is not available.

ERC will compile all aquatic and habitat data that is available. The City of Boulder's habitat assessment is in progress and will be provided upon completion.

Additional review of recreation, open space, and transportation plans will be completed as information availability allows. It was noted that the City of Boulder is starting projects at the Eben G. Fine Park and at Arapahoe and 13th (pedestrian underpass) which may be incorporated into the master plan.

Mapping for the project will utilize the 2014 USGS LiDAR data.

Field work will be started soon. Access to County and City of Boulder Open Space and Mountain Parks (OSMP) properties will be reviewed separately with corresponding staff. It was noted that New Zealand mud snails are present in Boulder Creek from approximately 55th Street and downstream. Basic decontamination efforts are needed for personal or equipment that encounters the creek in this area. Between 75th and 95th there is a nesting bald eagle that restricts access in this area. Longmont also has bald eagles. Field visits will be coordinated with City of Boulder OSMP, City of Longmont, and Boulder County Parks and Open Space and likely be scheduled the first week in January

4) PROJECT Schedule:

The following project schedule was presented to the group. It was noted that the City of Boulder plans to present the draft alternatives analysis to their Water Resources Advisory Board (WRAB) in May. It was noted that this schedule is acceptable with potential grant scheduling including watershed resilience grants (mid March - $300K max) and watershed only grants (November 2015 - $1-$3M)

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ITEM	WEEKS	DATE
Submit Baseline Information	8	Jan30
Submit Draft Alternatives Analysis – Boulder County	6	Mar13
Submit Draft Alternatives Analysis – Other	4	Apr10
Review Draft Alternatives Analysis	3	May1
Correct Draft Alternatives Analysis	3	May22
Select Best Alternative Plan	3	June12
Submit Draft Master Plan Report	8	Aug7
Review Draft Master Plan Report	3	Aug28
Submit Final Master Plan Report	3	Sept18
TOTAL	41	

5) STAKEHOLDER INPUT (PROBLEM AREA REVIEW)

Due to time constraints this item was not addressed. It was noted however that Boulder County desires improvements to include 100-year roadway crossings (the County's floodplain manager and transportation group will confirm).

6) PUBLIC ENGAGEMENT PLAN

The approach to the public engagement plan was discussed. Options were presented, including up-front mailings to ask for interest in meeting attendance (for the January 13th meeting). Shea will develop a map and corresponding mailing list depicting how many properties may be involved. The group will discuss this more at the next progresses meeting.

7) PROJECT WEBSITE

The project website was reviewed. An interactive comment form is forthcoming. A single main point of contact will be advertised in addition to the general comment form. Team members will be left on for public reference, however only email contact information will be shown.

8) ACTION ITEMS

ICON Engineering Inc.
- ✓ Assemble floodplain information and provide list of information gaps
- ✓ Coordinate field visits
- ✓ Send out recurring meeting invitations.
- ✓ Coordinate with CU Boulder as a stakeholder.
- ✓ Coordinate collection data from City of Boulder and Boulder County

DHM Design
- ✓ Brainstorm format for a public engagement mailer

KICK-OFF MEETING
BOULDER CREEK MASTER PLAN
UDFCD, BOULDER COUNTY, CITIES OF BOULDER & LONGMONT
DECEMBER 9, 2014 AT 3:00 PM

MINUTES

Ecological Resource Consultants
- ✓ Compile aquatic, habitat, and geomorphic data

UDFCD
- ✓ Finalize contract paperwork and notice to proceed
- ✓ Develop public engagement map and mailing list
- ✓ Contact Erie, Weld County and CDOT

City of Boulder, City of Longmont, Boulder County
- ✓ Provide applicable data as available

- END OF MEETING--

Minutes prepared by: Brian LeDoux, P.E., CFM
ICON ENGINEERING, INC.

2014-12-12
Date

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1) ATTENDEES

- Craig Jacobson, ICON Engineering, Inc.
- Brian LeDoux, ICON Engineering, Inc.
- Mark Wilcox, DHM Design
- Troy Thompson, Ecological Resource Consultants, Inc.
- Shea Thomas, Urban Drainage and Flood Control District
- Naren Tayal, Federal Emergency Management Agency
- Diane Malone, Boulder County
- Katie Knapp, City of Boulder
- Annie Noble, City of Boulder
- Marianne Giolitto, City of Boulder Open Space and Mountain Parks
- Dan Wolford, City of Longmont
- Clair DeLeo, Boulder County Parks and Open Space
- Jonathan Akins, CU Boulder
- Kristine Obendorf, Boulder County Transportation (by phone)

2) INTRODUCTIONS

Brief introductions were completed by everyone in attendance.

3) PROJECT MANAGEMENT

Website: The project website was reviewed. No issues were noted; however ICON will add the following items:

- Form to assemble a mailing list;
- Ticker to track site usage.

Schedule: The project schedule was reviewed. No issues or requests for changes were noted. See attached copy of the proposed project schedule.

Meeting Dates: The standing progress meeting was chosen to occur on the 3rd Wednesday of each month from 10am until noon. The next meeting will be held on **February 18th at the City of Longmont Natural Resources / Parks facility (7 So Sunset St.)**. The previous recurring meeting invitation will be canceled and an update Outlook meeting invitation will be provided. Shea requested a list of meeting invitees for review.

4) ACTION ITEMS FROM PAST MEETING:

Floodplain Information: ICON has obtained various sources of floodplain information including workmaps and HEC-2 (hard copy) and HEC-RAS (electronic) hydraulic models.

Field Visit Coordination: Initial field visits were completed on January 12th, 2015. Additional field visits will be completed on an as-needed basis.

Additional Stakeholders including CU, CDOT, Town of Erie, and Weld County have been contacted and invited to the recurring progress meetings.

Data Collection from City of Boulder / Boulder County is in progress.

5) FLOODPLAIN SUMMARY

PROGRESS MEETING
BOULDER CREEK MASTER PLAN
UDFCD, BOULDER COUNTY, CITIES OF BOULDER & LONGMONT
JANUARY 13, 2015 AT 1:00 PM

MINUTES

A summary of the hydrologic information gathered to date was reviewed (see attached figure). It was noted that the recent CDOT "Boulder Creek Hydrologic Analysis" provided discharge values on Boulder Creek just downstream of the confluence with Fourmile Creek. These discharges are notably less than the FEMA effective discharges (approximately 60% of the effective values). This master plan project will not revise discharges and will use FEMA effective discharge values for all hydraulic analysis.

Sources for effective floodplain delineation and modeling include the following:

- 1981 Upper Boulder Creek and Fourmile Creek Floodplain Information Report (HEC-2)
- 2013 Boulder Creek Floodplain Mapping Study (HEC-RAS)
- 1983 Flood Hazard Area Delineation (HEC-2)
- Letter of Map Revision Case No. 11-08-1090P (HEC-RAS)
- Letter of Map Revision Case No. 12-08-0198P (HEC-RAS)
- Letter of Map Revision Case No. 12-08-1047P (HEC-RAS)

A comprehensive hydraulic modeling will not be developed, the source models will be utilized and recreated as needed on a site specific basis to evaluate alternatives.

Several stream gage facilities exist throughout the project reach (see attached figure). No additional gage analysis will be completed for flood discharge purposes. However, gage information may be used to determine more frequent return interval storm discharges for geomorphology analysis and design purposes.

6) DATA COLLECTION

ICON has obtained background data from the following list of sources:

<u>Hydrology and Hydraulics</u>

- Upper Boulder Creek and Fourmile Creek, Gingery Associates 1981
- Fourmile Mouth to Boulder Canyon Mouth
- Anderson Study
- Boulder Canyon Mouth to 61st St.
- Lower Boulder Creek, Flood Hazard Area Delineation, Muller Engineering Co. 1983
- 55th St. to Weld County
- LOMR 11-081090P
- LOMR 12-08-0198P
- LOMR 12-08-1047P

<u>Master Planning Information</u>

City of Boulder:

- Justice Center LOMR
- Boulder Slough
- Eben G. Fine Park
- Civic Area Master Plan
- Arapahoe Avenue Underpass
- North of Boulder Creek (See University of Colorado Master Plan)
- Open Space Restoration Projects From 55th to downstream of 61st

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Boulder County

- Boulder County Transportation Master Plan
- Lower Boulder Creek Restoration (COE)
- 109th St. to Kenosha Rd.
- The Boulder Valley Comprehensive Plan
- Boulder County Trail Plan

City of Longmont

- St. Vrain Master Plan

A listing of data collected by ERC and approach to their Habitat, Ecological, Geomorphic work is attached.

The following sources of data were noted by the project team as applicable to the Boulder Creek master planning efforts. ICON will obtain the following reports:

- Boulder County: Parks and Open Space Plan
- Boulder County: Transportation Master Plan
- City of Boulder: Transportation Master Plan
- City of Longmont: St. Vrain Trails Master Plan (for confluence area)
- CU Boulder: North of Boulder Creek Redevelopment Master Plan
- CU Boulder: Research Park Redevelopment Master Plan (in progress)

7) GEOMORPHOLOGIC & HABITAT ASSESSMENTS

Troy Thompson reviewed ERC's preliminary geomorphologic and habitat assessment work. See attached figures from the power point presentation.

The aerial imaging provided by the City of Boulder was noted to not be georeferenced. Katie will review this issue and see if it can be rectified. For historic channel alignment review previous USGS topographic mapping was used. Marianne noted that the City of Boulder Parks department has georeferenced aerials that date back to 1937 as well and will see what format they could be provided in.

The potential for completing channel restoration in a piecemeal approach was discussed in light of the patchwork of land ownership and exiting land uses adjacent to the channel. Troy noted that piecemeal restoration can be done but there can be issues with sediment transport where the creek transitions between existing conditions and restoration reaches. Given that approximately 75% of Boulder Creek downstream of the City of Boulder is publicly owned there are many options for restoration alignments, the project team indicated that restoration should be viewed from a big picture and long range approach.

8) OUTREACH

Mailing: The project team indicated that public engagement should occur early in the process. Shea noted that the initial mailing list based on the channel alignment with an additional buffer included 830 properties in Boulder County and 75 properties in Weld County. Shea will send out an email asking for any additional entities to be included in the mailing list. A post-card

ICON ENGINEERING, INC.
PROGRESS MEETING
BOULDER CREEK MASTER PLAN
UDFCD, BOULDER COUNTY, CITIES OF BOULDER & LONGMONT
JANUARY 13, 2015 AT 1:00 PM
MINUTES

type mailing will then be sent out providing an address for the project website and indicating that there will be future public meetings. A second mailing will be sent out approximately 10 days prior to the initial public meeting.

Social Media: The City of Boulder and Boulder County will review use of its facebook/social media account for announcing this project and future public meetings.

Email List: All public meeting attendees and those who use the interactive website comment form will be complied into a project email list for future news distribution. ICON was asked to add a form for people to sing up on the mailing list.

Web Statistics: The statistics for the project website will be reviewed following the initial mailing in order to gage the public interest and expected engagement.

Public Meeting: After lengthy discussion it was determined that two locations will be used for the initial public meeting (one in the City of Boulder, the other in the Weld County Annex). The meeting will likely be an open house style of format; however a short presentation may be made at the start (and also produced as a webex). The first meeting will be on or around March 1st. Shea will set up a doodle poll for an ideal date and time.

9) NEXT MEETING

The next progress meeting will be on February 18th at the City of Longmont Natural Resources / Parks facility conference room (7 So Sunset St., Longmont CO 80501)

10) ACTION ITEMS

ICON Engineering Inc.

- ✓ Send out invitations for recurring progress meeting; cancel previous Outlook invitations; sent invitee list to Shea
- ✓ Provide Shea with list of ditch/canal contacts along project reach

UDFCD

- ✓ Incorporate other mailing list entities provided by others and send out initial mailing.
- ✓ Set up doodle poll for the initial public meetings.

- END OF MEETING--

Minutes prepared by: Brian LeDoux, P.E., CFM
ICON ENGINEERING, INC.

2015-01-14
Date

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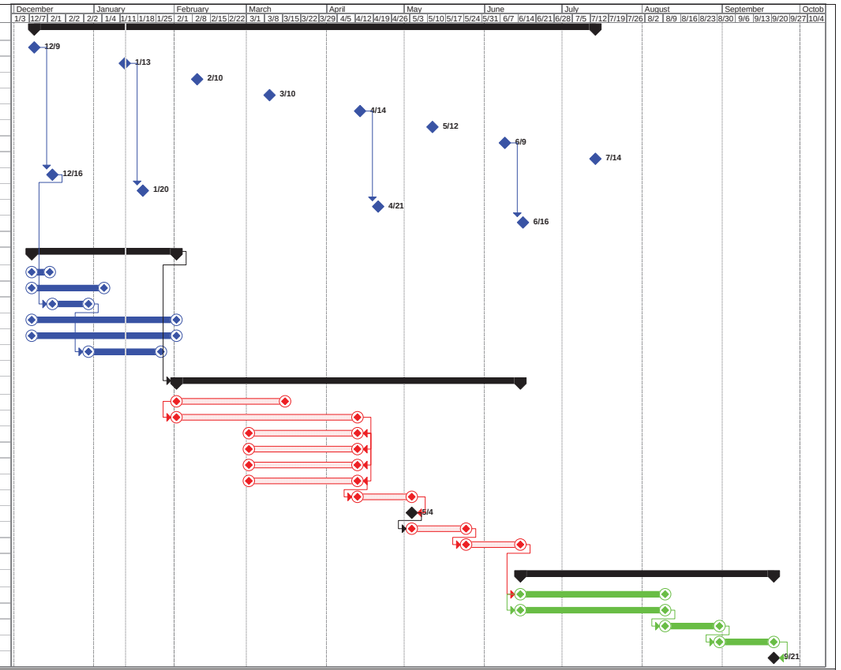
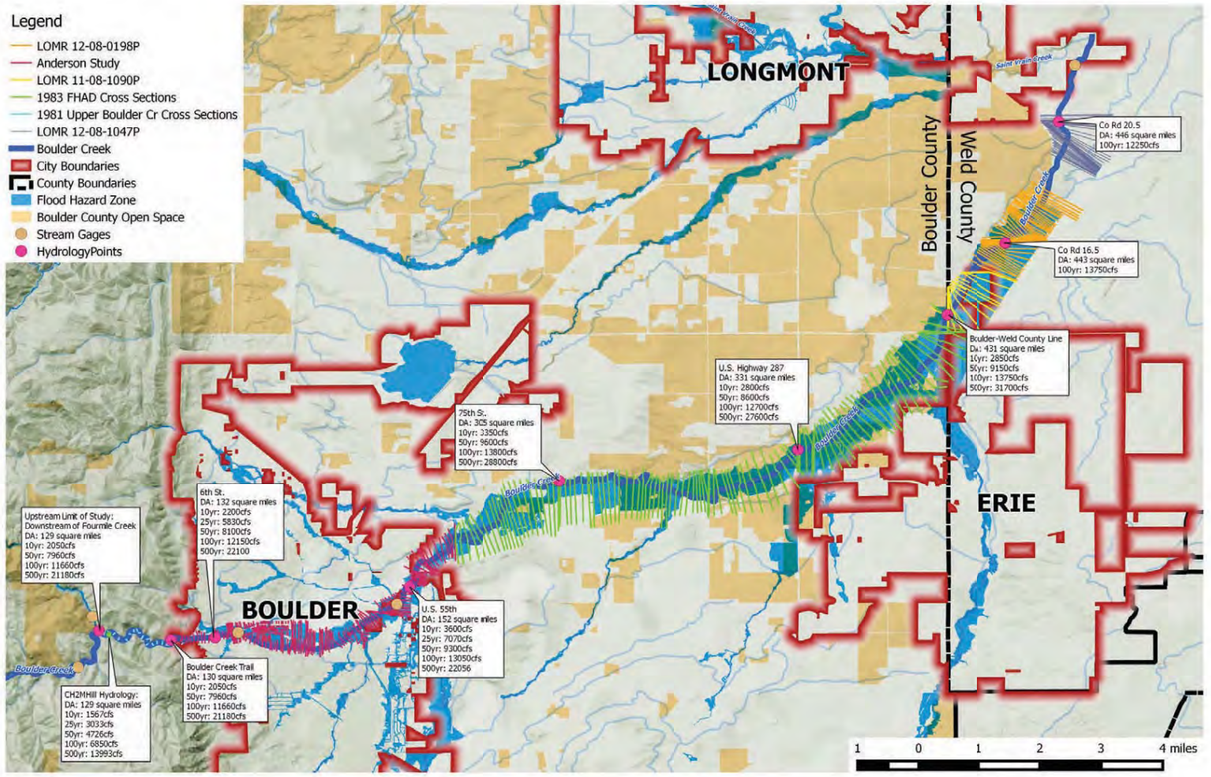
ID	Task Name
1	**Task 3A – Meetings & Coordination**
2	Kickoff Meeting
3	Progress Meeting - 2
4	Progress Meeting - 3
5	Progress Meeting - 4
6	Progress Meeting - 5
7	Progress Meeting - 6
8	Progress Meeting - 7
9	Progress Meeting - 8
10	Individual Stakeholder Meetings - 1
11	Individual Stakeholder Meetings - 2
12	Individual Stakeholder Meetings - 3
13	Individual Stakeholder Meetings - 4
14	
15	**Task 3B – Baseline Information**
16	Collect FEMA Hydrology
17	Collect and Assemble FEMA Floodplain Information
18	Collect & Review Past Master Plans and Other Data
19	Geomorphic Analysis
20	Ecological, Riparian, Aquatic Assessments
21	Stakeholder Recreation Plans and Open Space Objectives
22	
23	**Task 3C – Alternatives Analysis**
24	Boulder County, City of Longmont, Town of Erie, Weld County
25	City of Boulder
26	Master Planning Process (Decision Making)
27	Operation, Restoration, Maintenance
28	Benefit-cost-analysis
29	DRAFT Alternatives Report
30	Review Alternatives Report
31	Public Stakeholder Meetings
32	Final Alternatives Report
33	Select Alternative Plan
34	
35	**Task 3D – Conceptual Design**
36	Prepare Conceptual Design Detailing and Renderings
37	Master Plan Report
38	Review Master Plan Report
39	Final Master Plan Report
40	Technical Information



Project: Boulder Creek MP Schedule.r
Date: Tue 1/13/15

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone



Boulder Creek Restoration Master Plan
ERC Project Status for Ecological, Riparian and Aquatic Habitat Planning
January 12, 2015

Riparian Habitat - Background Data Review

- Compiled City/County/State ecological GIS base mapping including: riparian vegetation communities, wetlands, and overall vegetation communities.
- Coverage exists across the entire project area.
- Next step includes spatial analysis to determinate acreage and habitat types within the project area.
- Define reference standard for riparian habitat community types.
- Results will be summarized in the existing conditions evaluation. Shapefiles are available to ICON as needed.

Aquatic Data Review

- Define target aquatic species.
- Fish population data: ERC formally requested fish population data from CPW. ERC is awaiting receipt of this data.
- Macroinvertebrate data: ERC contacted City of Boulder Public Works Dept. regarding acquisition of macroinvertebrate data. ERC is awaiting receipt of this data.

Riparian Habitat Restoration Potential

Boulder County Comprehensive Plan – Environmental Conservation Areas

- Compiled the following County shapefiles: Environmental Conservation Areas, Critical Wildlife Habitat and Migration Corridors, Significant Riparian Corridors, Natural Landmark Natural Area, Natural Lands, Natural Communities, Rare Plants, High Biodiversity Areas.
- All coverage includes Boulder County; only High Biodiversity Areas includes Weld County.
- Upon further review of this mapping, the GIS shapefiles available for download on the County website *Comprehensive Plan* (http://www.bouldercounty.org/gov/data/pages/gisdldata.aspx) differ from the *Boulder County Comprehensive Plan Update* "Maps Approved by Planning Commission (12/18/2013)" which are available on the County website (http://www.bouldercounty.org/property/build/pages/bccpupdate.aspx).
- Specifically, the downloaded GIS mapping is not consistent with the following 12/18/2013 PDF maps:
    - Critical Wildlife Habitats & Wildlife Migration Corridors,
    - Rare Plant Areas & Significant Natural Communities
    - Natural Landmarks and Natural Areas
- ERC will follow up with Claire DeLeo to confirm appropriate current files- we would like to verify which mapping (GIS or 12/18/2013 PDF maps) is most appropriate for use in the master plan.
- Claire to provide Boulder County Flood Mapping Shapefiles, possible historic imagery, post flood studies and any available current restoration designs for Boulder Creek

OSMP Mapping and Closures

- Compiled applicable shapefiles to show closures and other sensitive lands including: wildlife closure areas – New Zealand mud snail, nest sites, other closure areas, OSMP lands and OSMP closures.
- Shapefiles are available to ICON as needed.

Wildlife and Regulated Species Screening

- Identified State/Federal Threatened and Endangered Species known in project area
- Species to be screened for likelihood of presence/absence and included in master plan as a summary table.

Geomorphology Assessment - Evaluation of Imagery

- Currently historic data from available USGS topographic maps and imagery will be used:
    - 1904-USGS Topo
    - 1950 USGS Topo
    - 1960 USGS Topo
    - 2004-Aerial and USGS Topo
    - 2010-Aerial and USGS Topo
    - 2013 Aerial and USGS Topo
    - 2014 LiDar and 1' Contours

City of Boulder Provided Data (from Katie)

- Acquired extensive historical aerial imagery from City of Boulder.
- Sparse coverage from years 1937, 1938, 1940, 1958, 1966, 1971, 1972, 1976, 1979, 1982, 1984, 1993.
- Imagery is not georeferenced therefore cannot be easily overlaid on project base mapping for spatial analysis and measurement. For example, the year 1966 has 300 images
- Based on the appearance of the file names (ex., S10W07_1971) each year contains random coverage for various USGS 'Sections'.
- Complete coverage for the project area is unlikely from any one year.
- It is possible based on the section numbering, that aerial coverage may exist for portions of the project area however further analysis would be required.

Available Aerial Imagery and Historic USGS Topographic Map Analysis

- Compiled historic USGS mapping and available aerial imagery for geomorphology assessment.
- Georeferenced USGS topos for entire project area covering years 1904, 1950, 1960.
- Aerial photo evaluation of free imagery included 2004, 2010, 2013 pre-flood and 2014 (Lidar) post flood.
- More detailed evaluation of sinuosity to follow.

Historic Imagery – Purchase through Mapmart

- Received cost for one of three years requested.
- 1949 would require 11 frames and cost $4,650 for georeferenced coverage of entire project area.
- Image searches for years 1939 and 1963 are still pending.

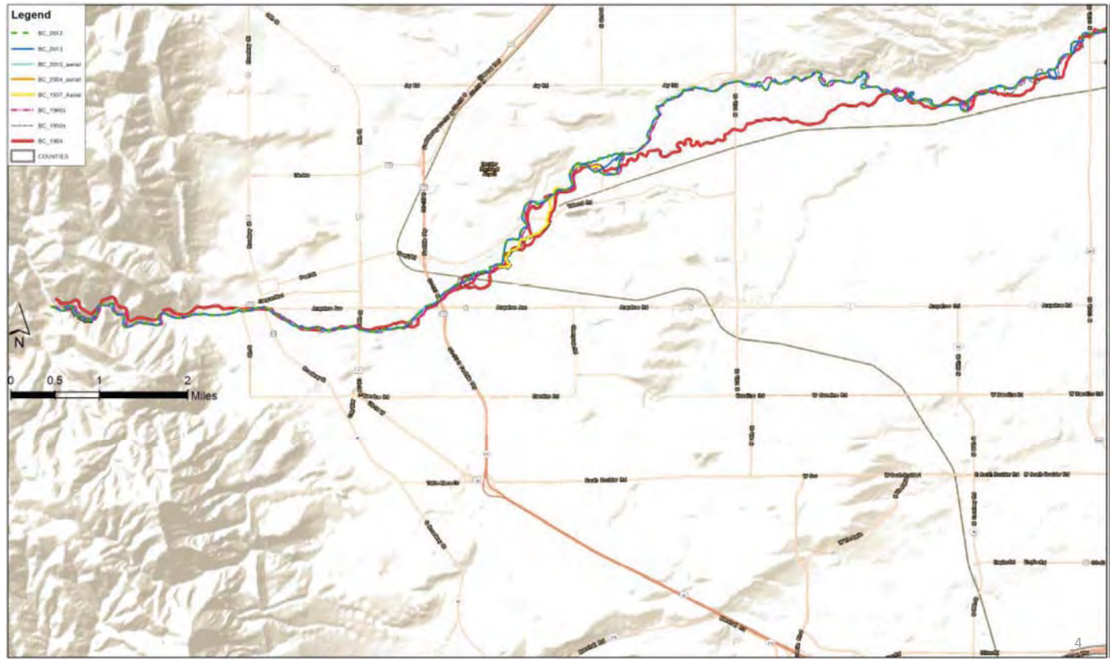
Boulder Creek Master Plan
Initial Geomorphic Assessment

January 13, 2015

Objective of Initial Geomorphology Evaluation

- Evaluate evolution of channel through recent times
- Quantify changes in alignment and planform
- Identify natural channel form to aid in restoration objectives

Changes to Historic Alignment



Comparison of Historic Planform and Stream Widths (USGS Maps and Current Topo)

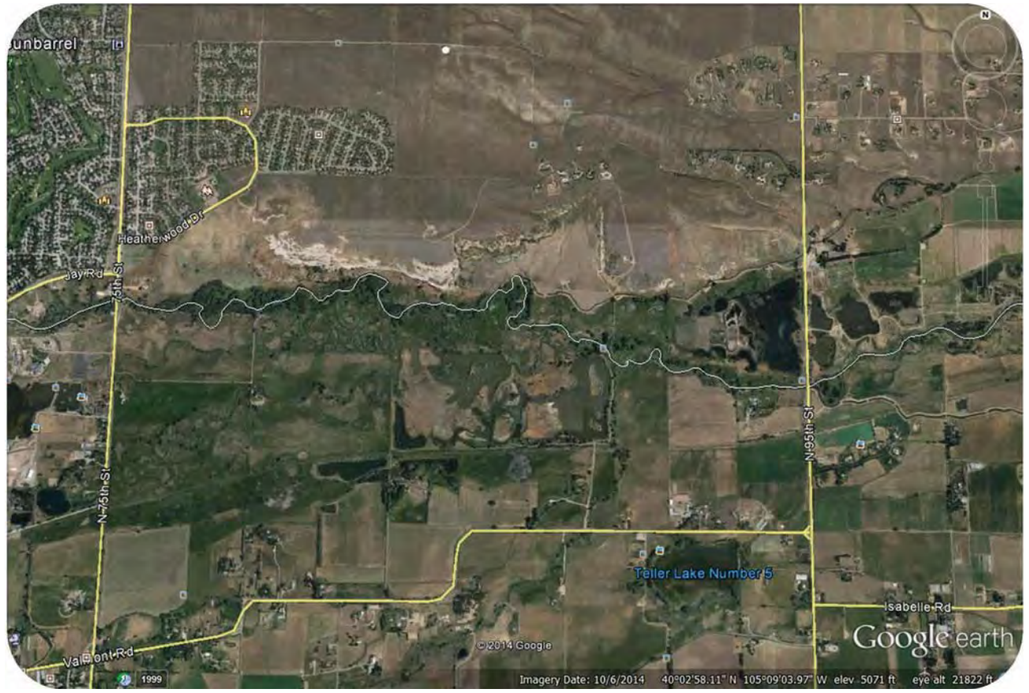
Reach ID and Description	1904		1950		1960		2004		2013		2014		Greatest Observed Changes	
All widths are feet:	Width	Sinuosity	Width	Sinuosity	Width	Sinuosity	Width	Sinuosity	Width	Sinuosity	Width	Sinuosity	Width	Sinuosity
REACH 1: Fourmile Creek Confl. to Broadway	None	1.22	45**	1.25	None	1.29	30	1.27	30	1.28	35	1.28	-10	0.05
REACH 2: Broadway to Foothills Parkway	None	1.16	45**	1.15	None	1.12	25	1.12	25	1.12	25	1.12	-20	-0.04
REACH 3: Foothills Parkway to Valmont	None	1.30	30*	1.26	None	1.12	20	1.22	20	1.22	20	1.20	-10	-0.09
REACH 4: Valmont Road to N 75th St.	None	1.36	85	1.28	85	1.25	60	1.26	30	1.29	40	1.29	-45	-0.07
REACH 5: N 75th St. to Hwy 287	None	1.24	60	1.44	60	1.26	40	1.38	40	1.37	40	1.37	-20	-0.07
REACH 6: Hwy 287 to CO-52	None	1.32	60	1.42	70	1.08	40	1.10	40	1.11	40	1.11	-30	-0.31
REACH 7: CO-52 to CO-119	None	1.27	100	1.41	100	1.34	100	1.18	50	1.19	50	1.19	-50	-0.23

Observations from Historic Characteristics

- Stream through the canyon and developed City had historically lower sinuosity that areas downstream from the developed City
- Sinuosity downstream from the City historically was in the 1.25 to 1.45 range
- Sinuosity has decreased fairly significantly in several locations over time
- Areas with limited development or encroachment exist and should form the basis for idealized restoration reaches
- Active stream width have decreased, with largest decreases observed towards the downstream end of the project
  - This may at least in part be a response to diversions and decreased flows

What is the natural state of the stream?

Area downstream of N. 75th Street is likely a good example of Boulder Creek functioning in its natural geomorphic state



More detailed evaluation of 2014 conditions

Upstream ID	Upstream El. (ft)	Downstream El	Segment Length (ft)	Valley Length (ft)	Slope (%)	Sinuosity
Fourmile Confluence to Mouth of Canyon	5733	5400	11,839	9,128	2.81%	1.30
Mouth of Canyon to 28th Street	5400	5289	10,748	10,279	1.03%	1.05
28th Sreet to Valmont	5289	5189	13,790	12,551	0.73%	1.10
Valmont to N. 75th Street	5189	5109	18,448	16,730	0.43%	1.10
N. 75th Street to N. 95th Street	5109	5054	18,419	13,267	0.30%	1.39
N. 95th Street to 107th	5054	5014	10,447	9,107	0.38%	1.15
107th to Upstream End of Gravel Pits	5014	4932	24,303	24,024	0.34%	1.01
Upstream to Downstream End of Gravel Pits	4932	4914	5,815	3,906	0.31%	1.49
Downstream End of Gravel Pits to St. Vrain Confluence	4914	4853	22,585	20,635	0.27%	1.09

Non-Channelized Sections

Constraints on Current Alignment

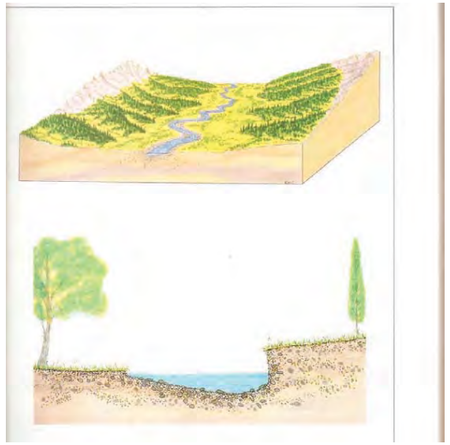


Stream Classification (Rosgen) Based on Slope for Comparison with Natural Sinuosity

Upstream ID	Segment Length (ft)	Slope (%)	Rosgen Classification Based on Slope and Thread	Current Sinuosity	Expected Sinuosity Based on Classification
Fourmile Confluence to Mouth of Canyon	11,839	2.81%	B	1.30	>1.2
Mouth of Canyon to 28th Street	10,748	1.03%	C, E or F	1.05	>1.2
28th Sreet to Valmont	13,790	0.73%	C, E or F	1.10	>1.2
Valmont to N. 75th Street	18,448	0.43%	C, E or F	1.10	>1.2
N. 75th Street to N. 95th Street	18,419	0.30%	C, E or F	1.39	>1.2
N. 95th Street to 107th	10,447	0.38%	C, E or F	1.15	>1.2
107th to Upstream End of Gravel Pits	24,303	0.34%	C, E or F	1.01	>1.2
Upstream to Downstream End of Gravel Pits	5,815	0.31%	C, E or F	1.49	>1.2
Downstream End of Gravel Pits to St. Vrain Confluence	22,585	0.27%	C, E or F	1.09	>1.2

Exhibits natural sinuosity

Most Probable Natural Rosgen Stream Type for Valley Sections



- Type C Stream
- Broad valley with terraces, connected to floodplain; riffle/pool morphology
  - Slope < 2%
  - Entrenchment Ratio >2.2
  - Width/Depth Ratio >12
  - Sinuosity >1.2
    - (avg sinuosity 1.4 for C3 and 1.9 for C4 types)

Challenges for Restoration

- Land practices have significantly impacted Boulder Creek
- True geomorphologic restoration would put the stream back to a meandering stream system with sinuosity on the order of 1.4 and allow the stream to access its broad floodplain most years
- Land constraints may make this impractical or economically infeasible
- Objectives of natural restoration associated with this project will need to consider these constraints

1) ATTENDEES

- Craig Jacobson, ICON Engineering, Inc.
- Brian LeDoux, ICON Engineering, Inc.
- Mark Wilcox, DHM Design
- Troy Thompson, Ecological Resource Consultants, Inc.
- Shea Thomas, Urban Drainage and Flood Control District
- Yige Gao, Boulder County
- Varda Blum, Boulder County
- Kristine Obendorf, Boulder County Transportation
- Julie McKay, Boulder County
- Dan Wolford, City of Longmont
- Clair DeLeo, Boulder County Parks and Open Space
- Scott Holwick, LGKH Law / Boulder County Planning Commission
- Dan Marcucci, CDOT

2) INTRODUCTIONS

Brief introductions were completed by everyone in attendance. It was noted that representatives from the Town of Erie and Weld County were not in attendance.

3) WEBSITE ACTIVITY

Following the post card mailing by the UDFCD, the project website traffic was documented and a graph showing unique visitors over the previous few weeks was shown. Additionally, several comments have been received via the interactive comment form. The form to add an email address to the project mailing list was placed on the project website and the current mailing list was shown to the project team. This email list will be used to provide notifications for the upcoming public meetings in addition to a 2nd post card mailing by the UDFCD.

4) ACTION ITEMS FROM PAST MEETING:

Ditch / Canal Contacts – The UDFCD incorporated ditch and canal contact information into the post card mailing list. Scott Holwick represents several Boulder Creek diverters and will provide additional contact information for subsequent mailing efforts.

Initial information mailings – these have been sent out by the UDFCD.

Public meeting mailings - Subsequent mailings will be sent out by the UDFCD for the upcoming public meetings to be held on March 10th and March 18th. The public meeting on March 10th will be held in the City of Boulder, and the meeting on March 18th will be held at the Weld County Annex. Shea will send out the mailing list for project team review and possible additions.

5) UPCOMING PUBLIC MEETINGS

The upcoming public meetings will be held on March 10th (City of Boulder) and March 18th (Weld County Annex). No alternatives will be presented, rather, the initial meeting will be to gather public input and present initial findings. A survey card will be developed for use at the public meetings. The public meetings will stress that this master plan effort is focused on restoration of Boulder Creek and is not specifically looking at flooding mitigation efforts. The public meetings will follow the general UDFCD format of a short presentation at the start of the meeting followed by an open house type meeting where attendees can ask specific questions of project representatives

PROGRESS MEETING
BOULDER CREEK MASTER PLAN
UDFCD, BOULDER COUNTY, CITIES OF BOULDER & LONGMONT
FEBRUARY 18, 2015 AT 10:00 AM

MINUTES

and review and mark up maps of the project area. Maps to be used at the public meetings will be developed by ICON and provided to the project team. If time allows, after review by the stakeholders, these maps will be available on the project website prior to the public meetings.

6) ALTERNATIVES ANLAYSES – REVIEW PROJECT FOCAL AREAS

The draft project focal area maps were reviewed and additional discussion items for each reach are noted below. See attached maps. Boulder County will review the problem ID maps and provide any needed revisions prior to the public meetings.

Reach 1 – The alternatives for the confluence area adjacent to the St. Vrain River will rely on the St. Vrain River master plan that is currently in progress. Once the St. Vrain plan is further refined, the recommended plan for Boulder Creek will incorporate the proposed St. Vrain improvements. Dan confirmed that the St. Vrain work was still in the initial stages. He will coordinate with ICON when more information is available.

Reach 2 – For Weld County bridges, the project team would like to discuss the County's criteria for roadway improvements, and the County's general tolerance for roadway washout in areas that are not immediately adjacent to bridge structures. Diversions in reach 2 will be proposed to be modified for aquatic and habitat passage. Scott noted that a Boulder Creek bank breach near the Idaho diversion occurred prior to the September 2013 flooding but remains a significant issue in this area. (bank breach is located on property owned by Helen Bryant).

Reach 3 – Mineral Road was recently re-built by CDOT.

Reach 4 – It is anticipated that the washed-out bridge on Boulder County Open Space will be removed. This was confirmed with the County at the meeting.

The Kenosha Road area including the potential to remove the bridge over Boulder Creek and to acquire flood impacted properties was discussed at length. It was noted that the Kenosha Road bridge structure was not damaged in September 2013 and for transportation purposes is expected to remain in place for the foreseeable future. Due to the eastern sloping gradient of the roadway, providing 100-year conveyance would likely not be achievable under the current condition. Craig asked if this level of capacity was needed at this location, as with the others. Shea noted that alternatives to raise Kenosha Road would focus is on restoration not necessarily flood impact mitigation. Craig also suggested the potential to abandon the roadway crossing with traffic using the ancillary roadways east and west to cross Boulder Creek. The County will review the needs at this location. For now, it was agreed to consider more of the channel needs for restoration as opposed to flood control at this location.

ICON explained that a cursory review of acquisition was made at Kenosha Road using FEMA's benefit-cost software. The benefit values (per the FEMA BCA software) for acquisition of structures adjacent to Kenosha Road were reviewed. With a single exception, benefit values were low relative to the expected fair market value of the properties. Although the actual acquisition costs are still unknown, this would likely resultin a low benefit vs. cost ratio. . It was noted that these draft benefit values were based on elevations taken from USGS LiDAR mapping with an assumption of a finished floor at 1.0 foot above average adjacent grade. It was noted that at least one structure (11664 Kenosha Road) has been removed following the September 2013 flood. However, several adjacent properties are in the process of rebuilding. The County is working on some acquisition efforts in the area and the timing for additional proposed acquisition would be

good, however, as noted the estimated benefits are low and acquisition will likely not be a recommended alternative in this master plan effort. The County will provide information on properties that are in the process of rebuilding which may be able to be coordinated with further analysis.

The US Army Corps of Engineers project in Reach 4 has a final design completed but construction has not started begun. The master plan will review the design to determine if recommendations are compatible.

US Highway 287 does have 100-year capacity. The potential to abandon 109th Avenue was discussed as the stream crossings did not provide additional access to the residences.

Reach 5 – Previous restoration work has been completed in Reach 5; however much of this work has since been flanked by the flood event. The channel will require restoration and drop structures in Reach 5 will be proposed to be modified for aquatic and habitat passage. The diversion at 95th Street was damaged in September 2013.

Reach 6 – This reach includes several private bridges but is also an ideal restoration reach.

Reach 7 – City of Boulder open space projects are in progress. The master plan will note these projects and proposed alternatives will be compatible with the City's improvements.

Reach 8 – This reach includes a notable capacity issue at the railroad crossing. The Boulder Slough and 2 ditches are also issues within this reach. CDOT is going to construction with a wetland mitigation project in the summer of 2015. CDOT will provide plans to the project team. The hospital and its need for access during the 500-year event will be reviewed for alternatives in Reach 8. Additionally, planning for the CU east campus will also be incorporated into any alternatives in this reach. Additional project focal areas included reviewing acquisition for homes along Cordry Court located in the proposed high hazard areas, Boulder Slough, Civic Center, and CU north of Boulder Creek.

Reach 10 - The Boulder Creek trail extension and roadway repair project is just now beginning. CDOT noted that the road repair design is likely 1 year out and should generally consist of pushing the road off of fill and onto bedrock, where feasible, and the road will likely have 6 foot shoulders. CDOT will provide ICON with the damage report for CO Highway 119. Damage photographs can be obtained from www.cdotfloods.org. For the master plan, ICON will identify ongoing efforts from CDOT and provide specific restoration needs for the canyon area which can be incorporated into CDOT's approach.

7) GEOMORPHIC DESIGN PRESENTATION

Troy Thompson presented a review of the initial geomorphic investigation and conceptual restoration parameters that would satisfy sinuosity and riparian sizing for typical restoration design. It is important to note that the channel orientation depicted by the presentation was not reflective of actual recommendations; only what a natural stream system may look like. No consideration was given to defining an actual stream location at this time.

8) INITIAL BOULDER COUNTY ALTERNATIVES–

See individual reach discussions in item 6 above. A typical roadway crossing improvement alternative was presented that illustrated overbank culverts in flood prone areas outside of the main channel. This approach reduces the contraction and expansion required for the floodplain to be passed through a typical single opening roadway crossing and will allow for additional overbank floodplain capacity below the roadway grade. These additional culverts can reduce or eliminate roadway washouts caused by overtopping flows and will increase habitat connectivity. The details of this type of roadway crossing alternative will not be presented at the public open houses.

9) INITIAL CITY OF BOULDER ALTERNATIVES

Cordry Court Acquisition – draft benefit values were calculated for structures adjacent to the proposed high hazard zone along Cordry Court east of 28th Street and the three large apartment buildings south of Boulder Creek and east of 28th Street. Similar to at Kenosha Road, draft benefit values for acquisitions were estimated to be much lower than and anticipated market value and would not likely present a viable alternative. City staff was not in attendance during the meeting.

10) NEXT STEPS

a) Refinement of stream channel location / restoration philosophy
b) Mitigation costs for Boulder County reaches
c) Continuation of City of Boulder alternatives development
d) Weld County & City of Longmont alternative strategies (input needed)

11) SCHEDULE & NEXT MEETING

The March meeting will be canceled in light of the March 18th public meeting. The draft alternatives report will be submitted 2 weeks after the March 18th meeting such that the project team will have 2 weeks to review prior to the April progress meeting.

12) ACTION ITEMS

All

- ✓ Review Focal Area maps prior to public meetings. Please provide ICON comments by March 2nd such that the maps can be uploaded to the website prior to the meetings.

ICON Engineering Inc.

- ✓ Develop mitigation costs for Boulder County reaches
- ✓ Continue to develop City of Boulder alternatives
- ✓ Confirm with Weld County desired roadway crossing criteria

ERC

- ✓ Refinement of stream channel location / restoration plan

UDFCD

- ✓ Provide project team with contact mailing list
- ✓ Send out public meeting mailings

Boulder County

- ✓
- ✓ Provide information on which Kenosha Road properties are being rebuilt
- ✓ Set up a meeting with Transportation to discuss roadway conveyance approach

CDOT

- ✓ Provide wetland mitigation project design drawings

PROGRESS MEETING
BOULDER CREEK MASTER PLAN
UDFCD, BOULDER COUNTY, CITIES OF BOULDER & LONGMONT
FEBRUARY 18, 2015 AT 10:00 AM

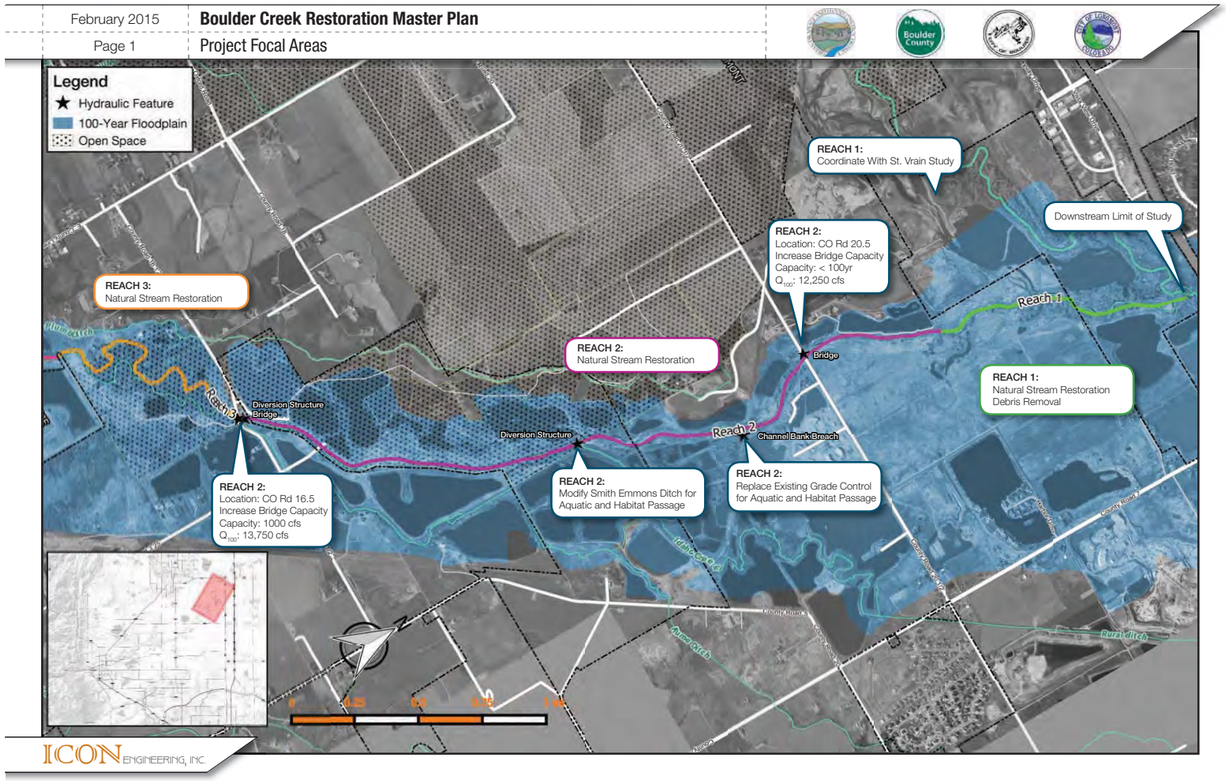
MINUTES

- ✓ Provide Highway 119 damage report
- ✓ Inform design team of upcoming improvements with the canyon area.

- END OF MEETING--

Minutes prepared by: Brian LeDoux, P.E., CFM
ICON ENGINEERING, INC.

2015-02-19
Date



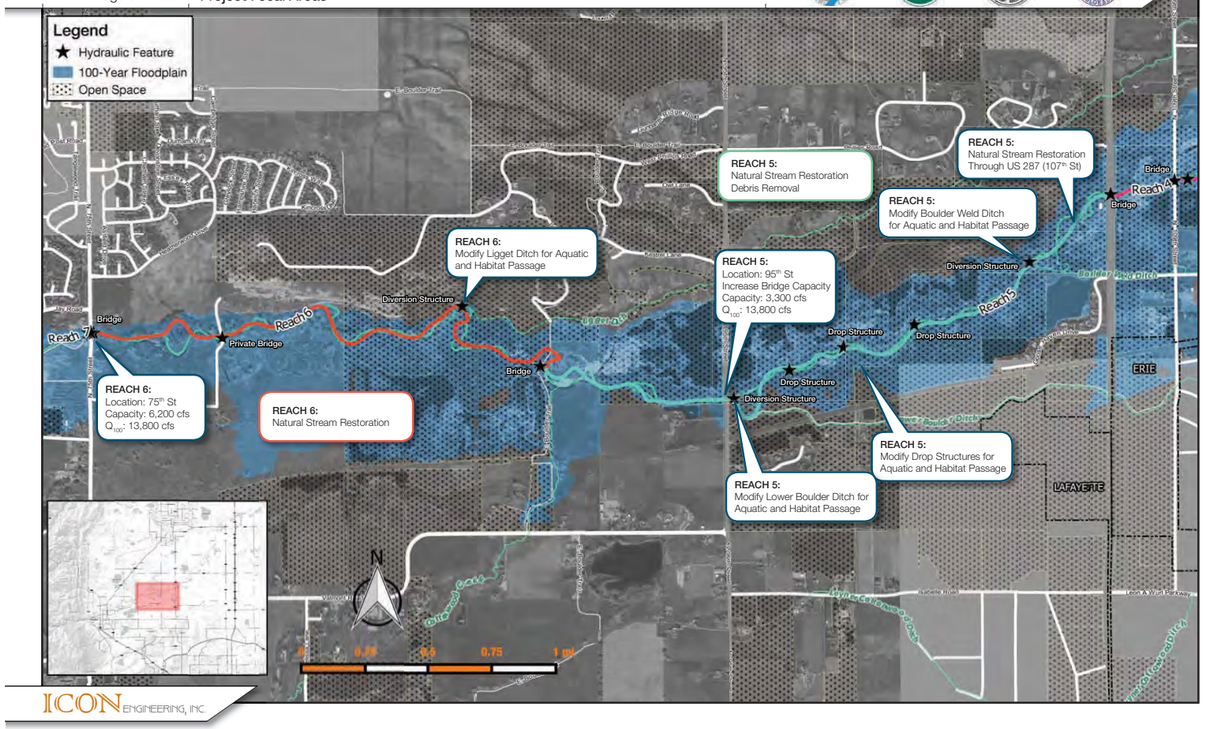
Boulder Creek Restoration Master Plan

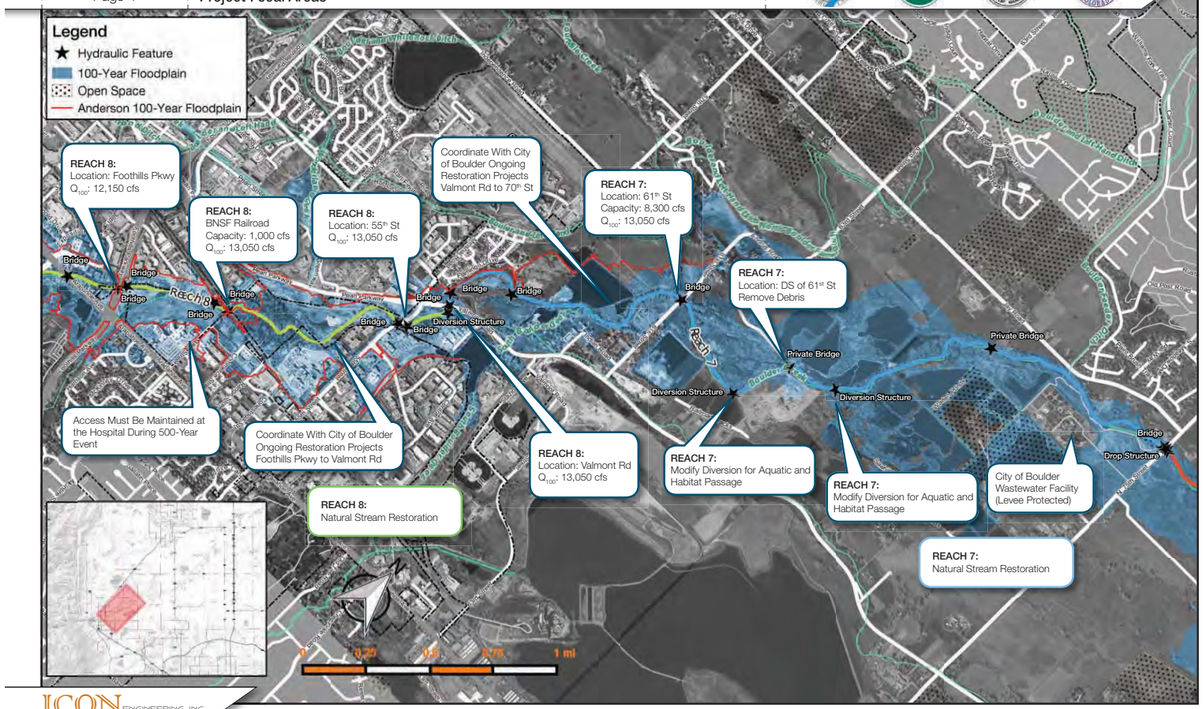
Project Focal Areas



Boulder Creek Restoration Master Plan

Project Focal Areas





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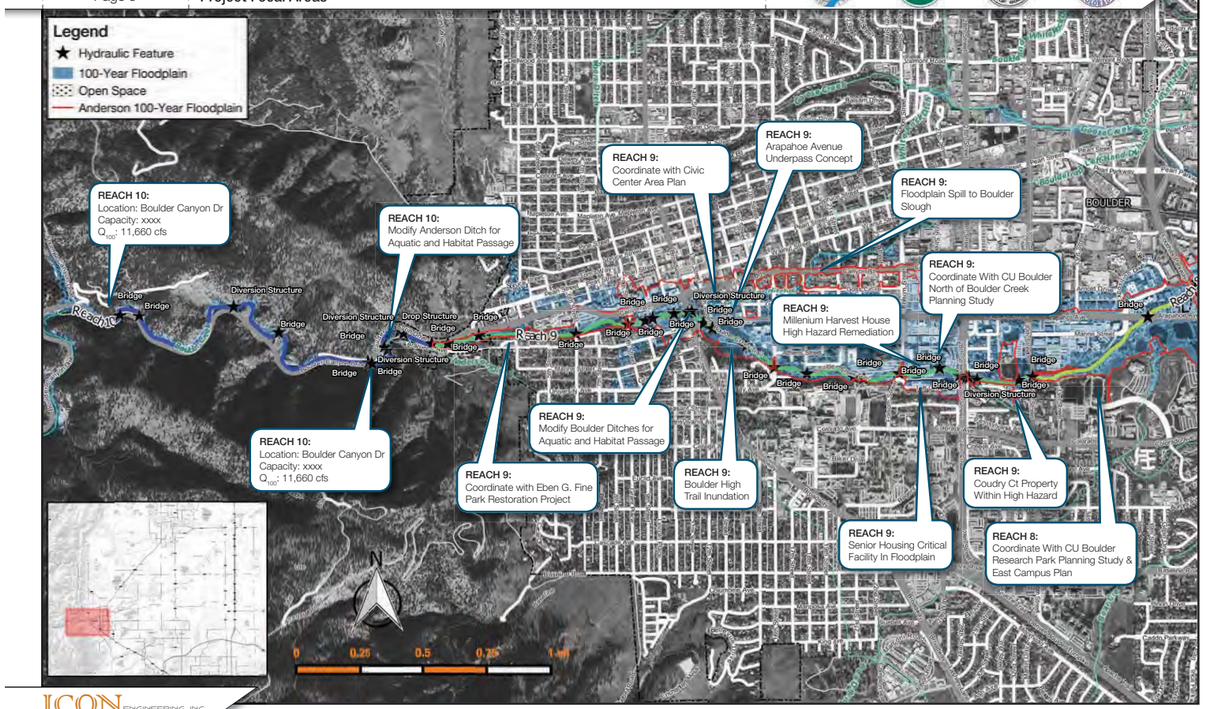

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Boulder Creek Master Plan
Conceptual Channel Realignment and Riparian Area

February 18, 2015

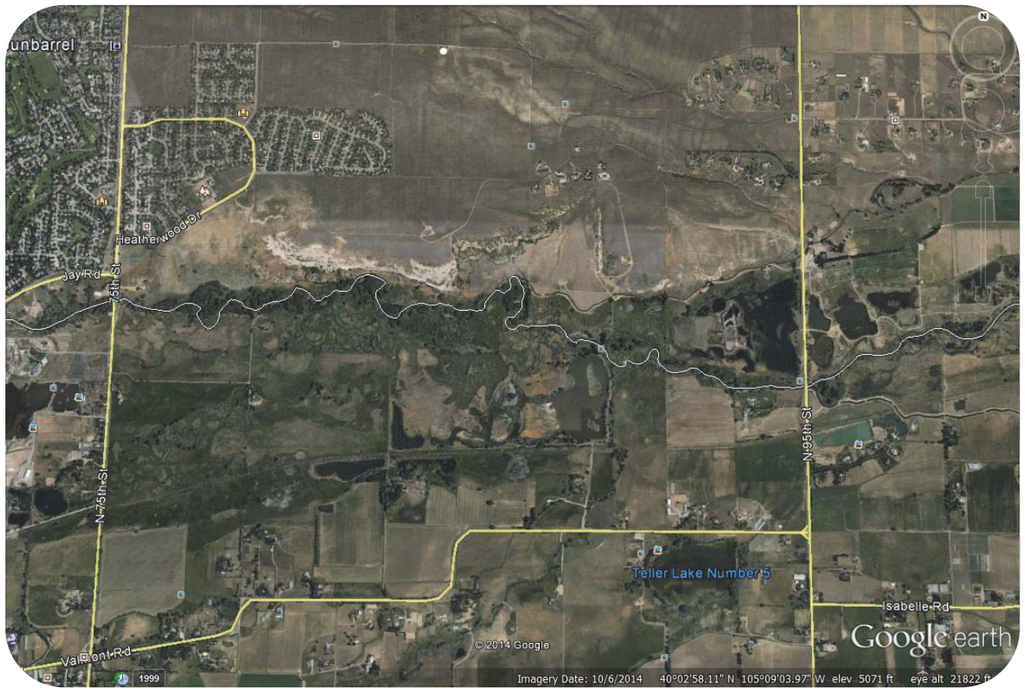
Review from January 13th Meeting

Observations from Historic Characteristics

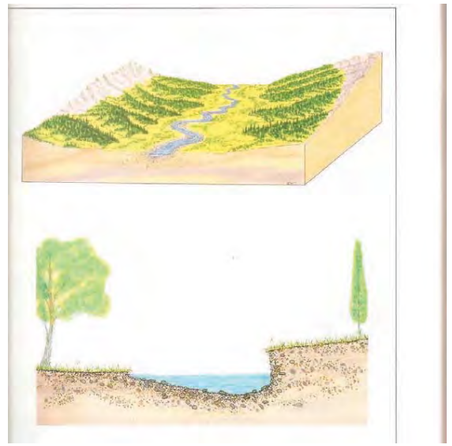
- Stream through the canyon and developed City had historically lower sinuosity that areas downstream from the developed City
- Sinuosity downstream from the City historically was in the 1.25 to 1.45 range
- Sinuosity has decreased fairly significantly in several locations over time
- Areas with limited development or encroachment exist and should form the basis for idealized restoration reaches
- Active stream width have decreased, with largest decreases observed towards the downstream end of the project
  - This may at least in part be a response to diversions and decreased flows

What is the natural state of the stream?

Area downstream of N. 75th Street is likely a good example of Boulder Creek functioning in its natural geomorphic state

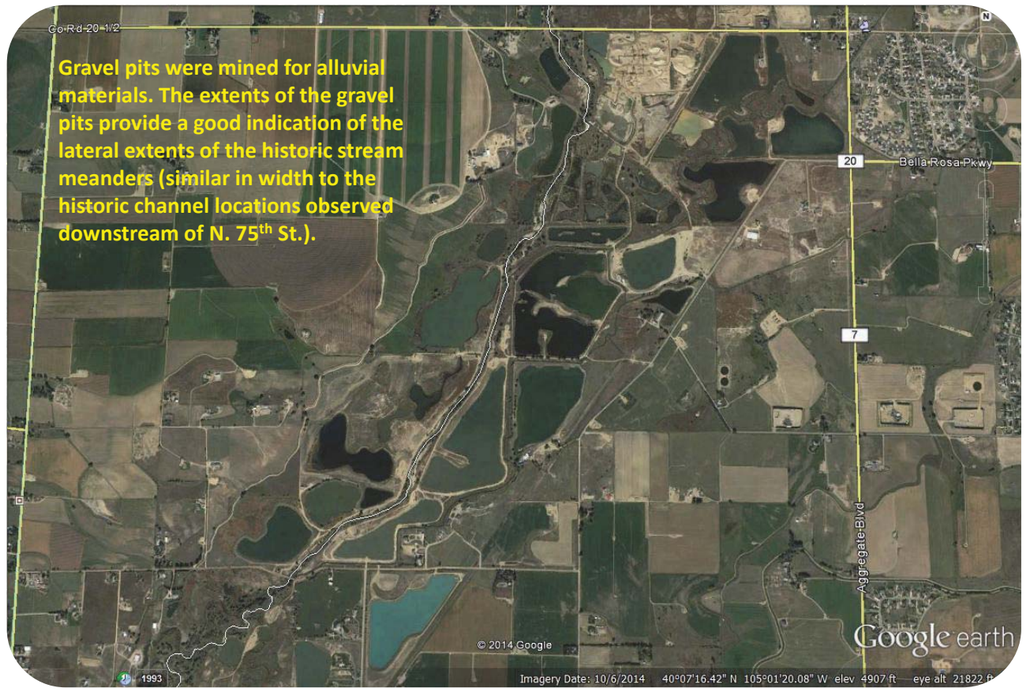


Most Probable Natural Rosgen Stream Type for Valley Sections



- Type C Stream
- Broad valley with terraces, connected to floodplain; riffle/pool morphology
  - Slope < 2%
  - Entrenchment Ratio >2.2
  - Width/Depth Ratio >12
  - Sinuosity >1.2
    - (avg sinuosity 1.4 for C3 and 1.9 for C4 types)

Constraints on Current Alignment

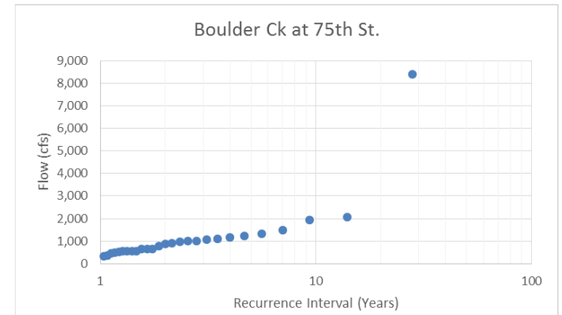


Ideal Restoration Objectives

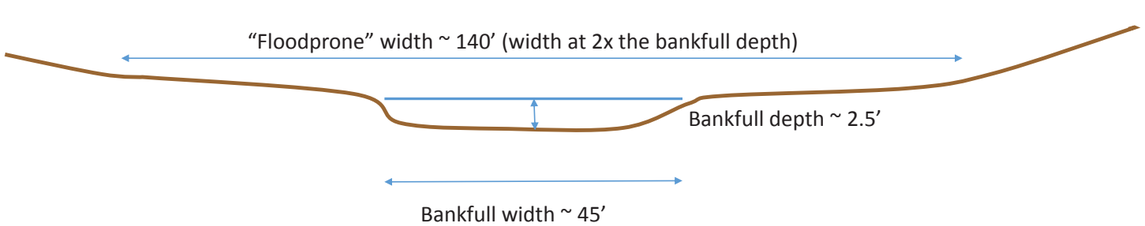
- Allow the stream to replicate natural conditions
- No single “correct” alignment as the stream has migrated across a wide valley in response to flow and sediment load as is evident by aerial photos and recent gravel operations
- Create a bankfull channel cross section to contain flows during normal conditions
- Allow the stream to access its floodplain approximately every other year
- Provide a riparian zone that is protective of the stream and provides ecological benefits of an undisturbed natural corridor

Bankfull Flow Estimates

- Estimated as the flood flow with an approximately 1.5 – 2 year recurrence interval
  - 460 cfs at Orodell
  - 600 cfs at Boulder gage
  - 670 cfs at 75th Street
  - 620 cft at Mouth near Longmont

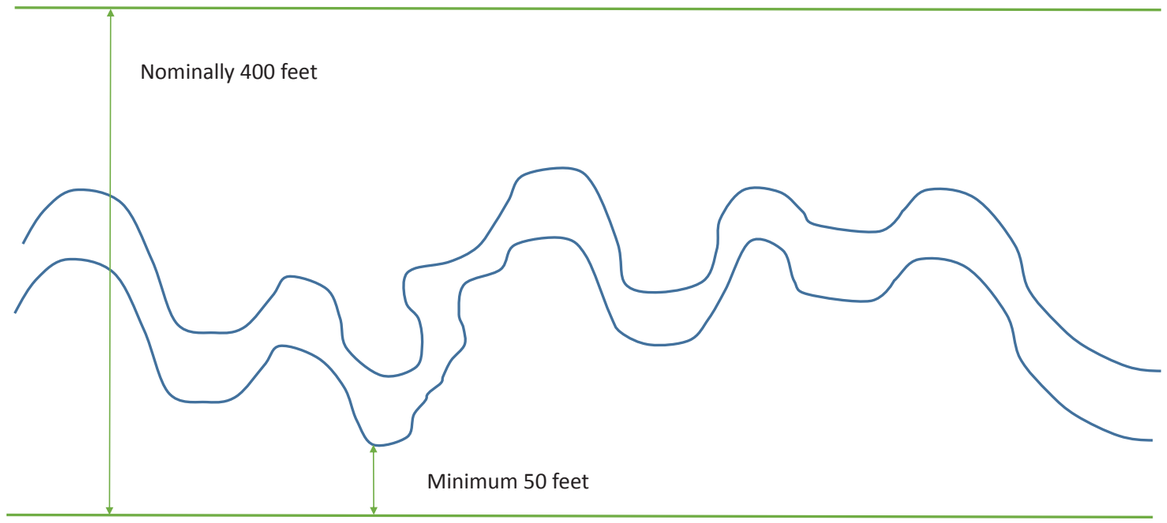


Typical Channel Geometry for Bankfull Flows and Rosgen Type C Stream Type

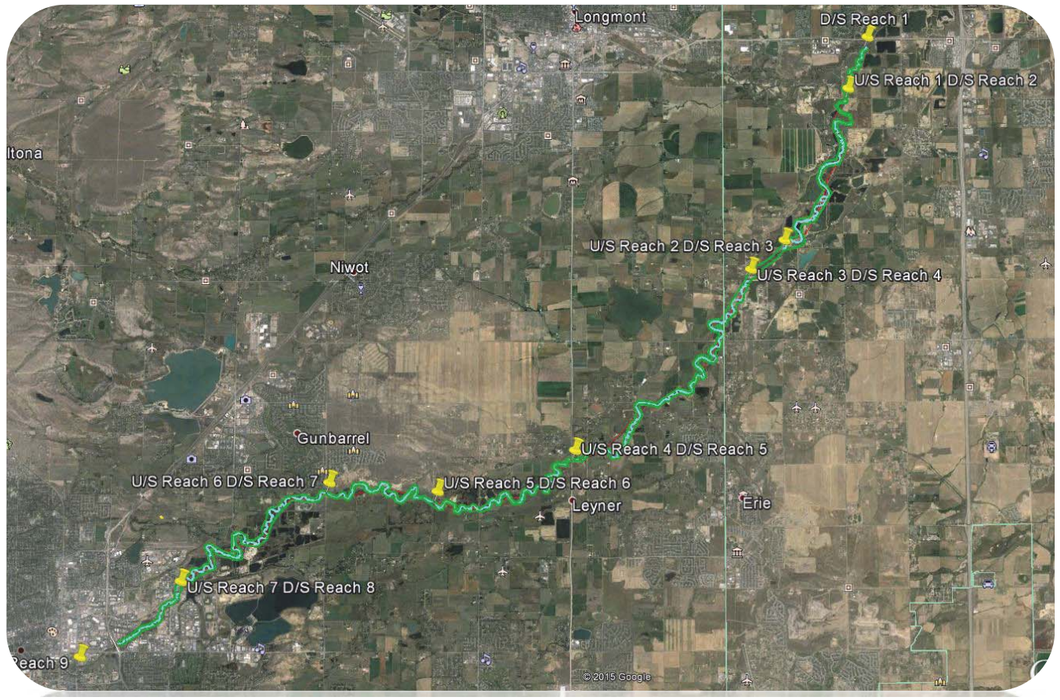


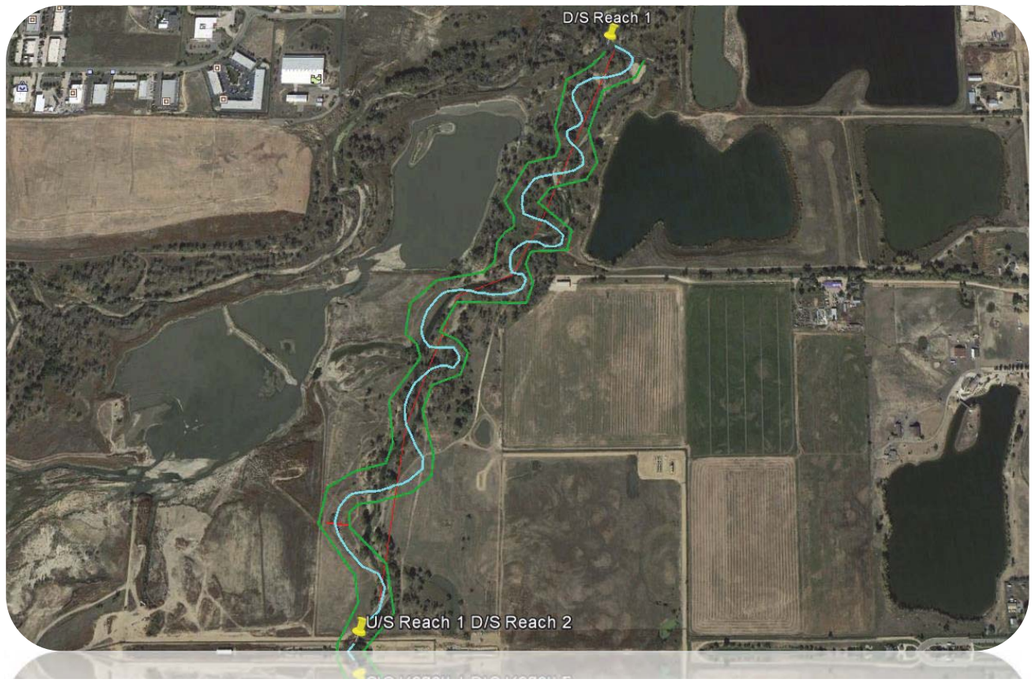
Riparian Corridor Sizing

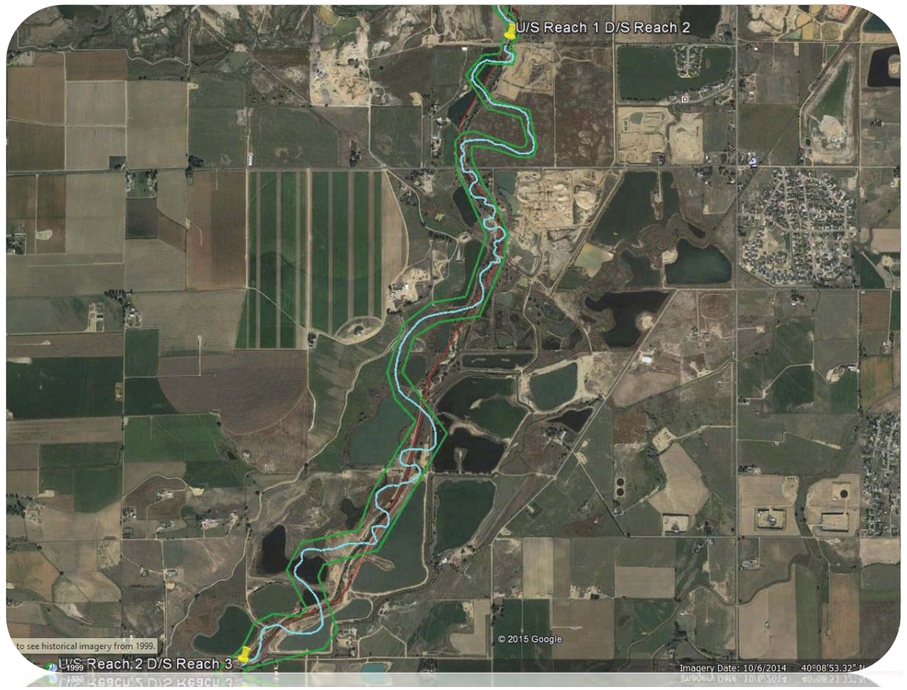
- Not a significant amount of research on "ideal" riparian corridor sizing
- Typical width for water quality buffering protection is 50' – 200' from uplands
- EPA generally defines "ideal buffering capabilities" as greater than 50'
- Within the current project area, wider existing riparian areas are on the order of 200' on either side (this equates to roughly 450 feet total corridor)
- ERC's initial thought is for an approximately 400 foot corridor

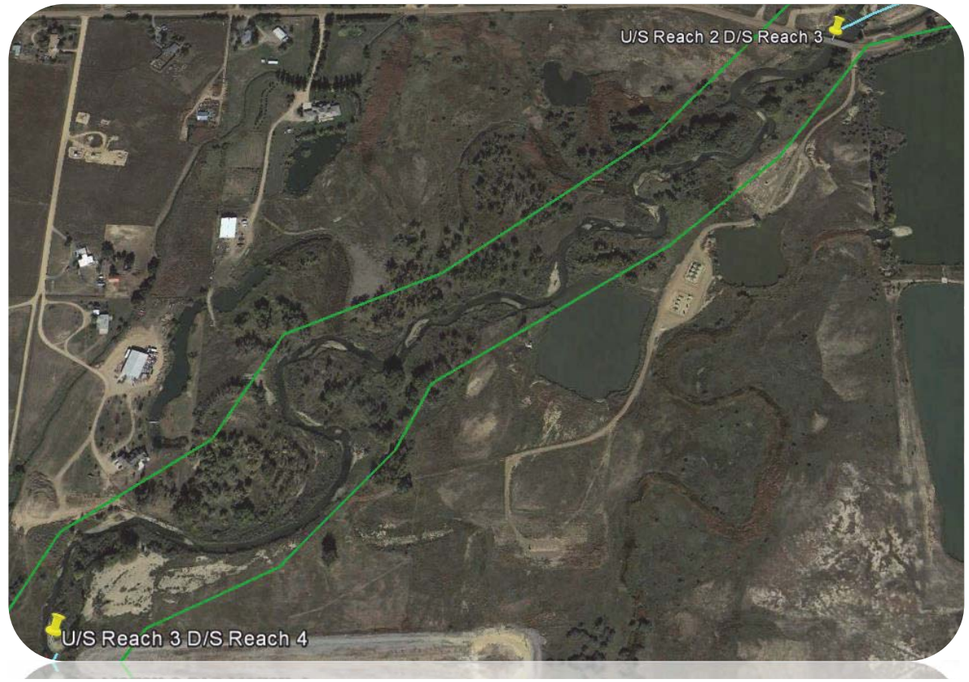


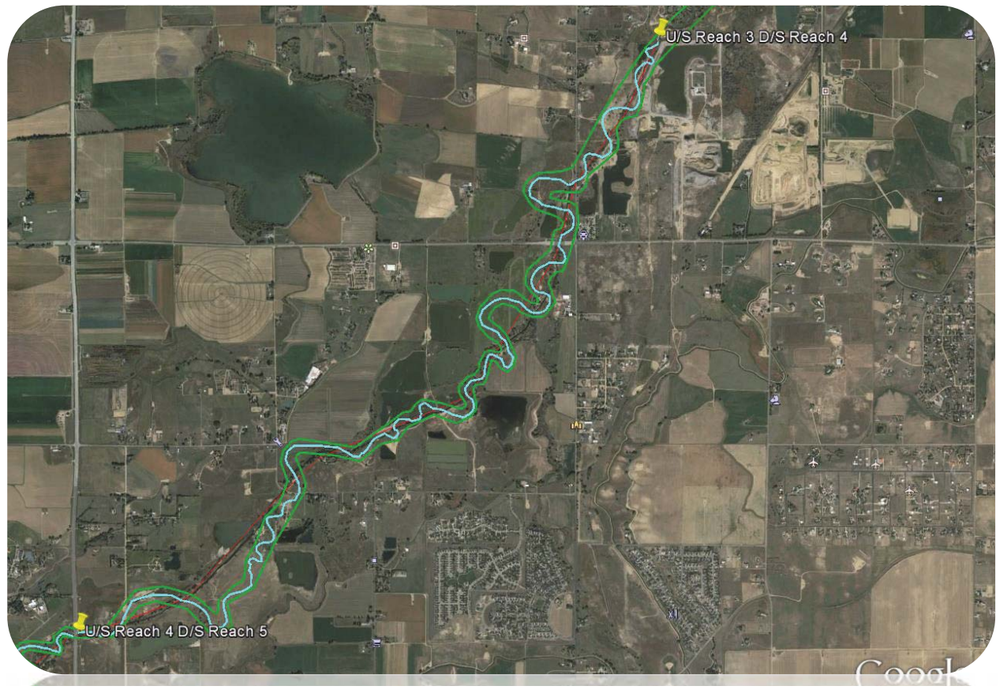
What does this look like from a conceptual level downstream of developed areas within the City?

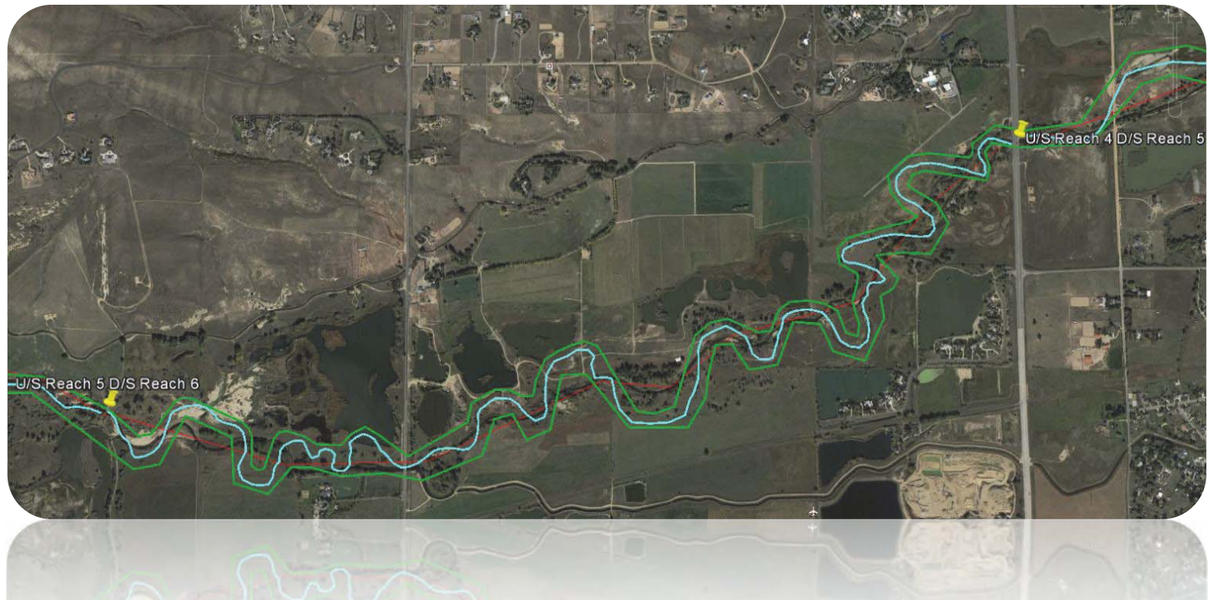

Longmont
D/S Reach 1
U/S Reach 1 D/S Reach 2
U/S Reach 2 D/S Reach 3
U/S Reach 3 D/S Reach 4
Niwot
Gunbarrel
U/S Reach 4 D/S Reach 5
U/S Reach 6 D/S Reach 7
U/S Reach 5 D/S Reach 6
Leyner
Erie
U/S Reach 7 D/S Reach 8
©2015 Google

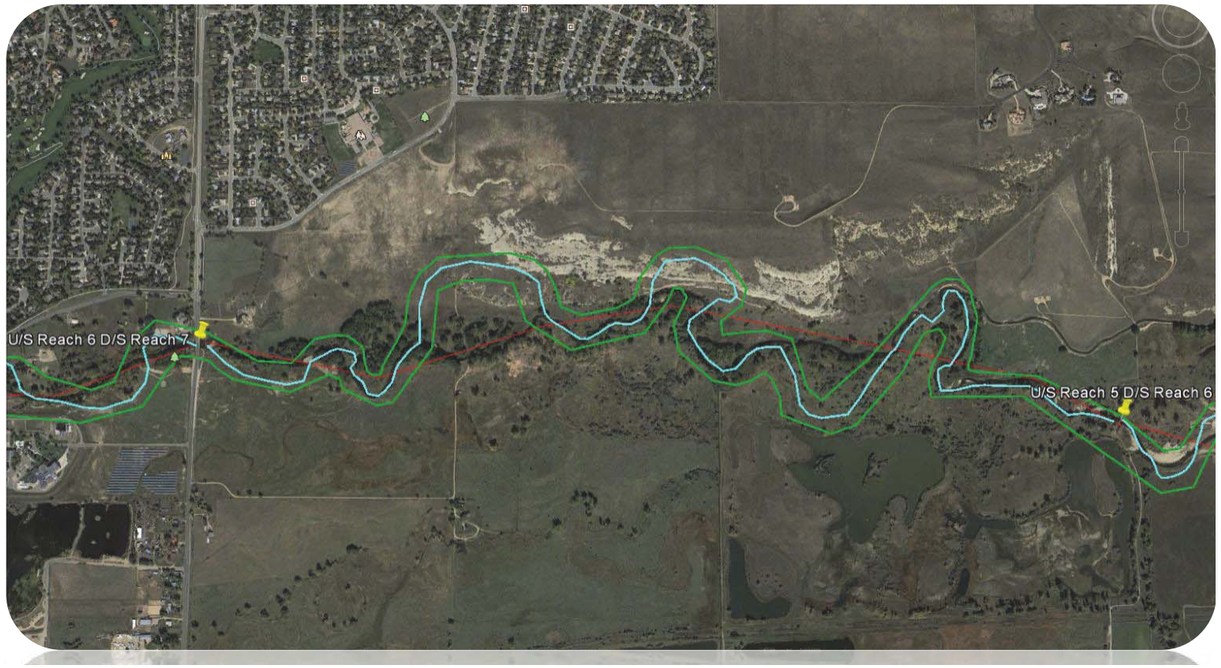

D/S Reach 1
U/S Reach 1 D/S Reach 2

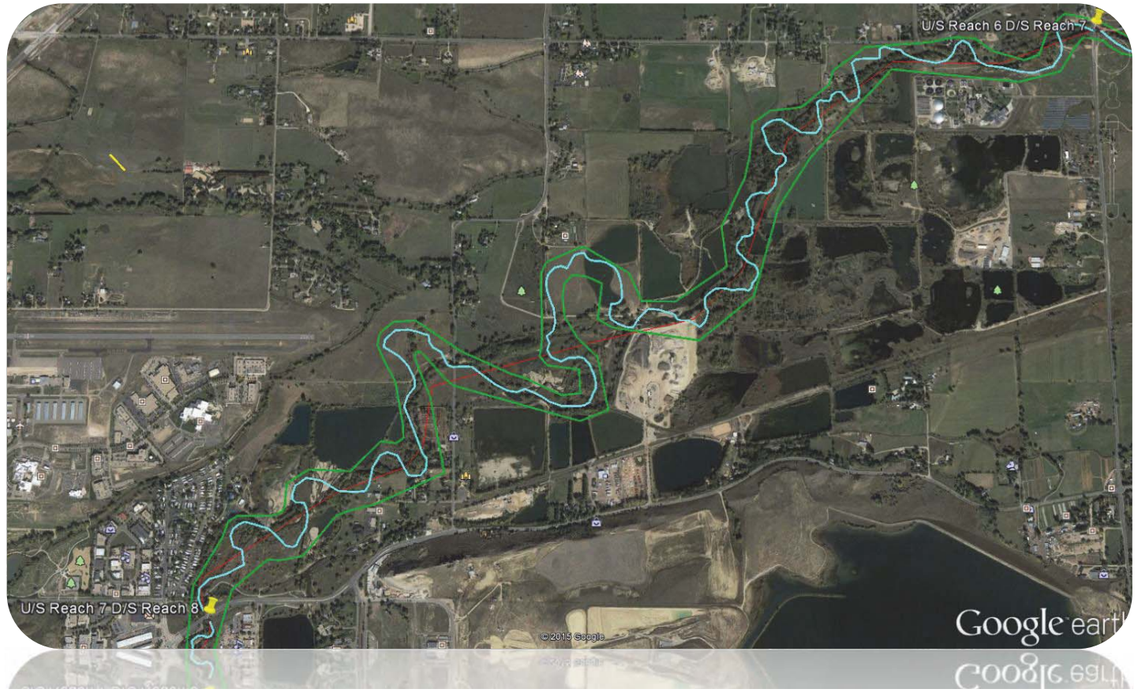

U/S Reach 1 D/S Reach 2
U/S Reach 2 D/S Reach 3
to see historical imagery from 1999.
© 2015 Google
Imagery Date: 10/6/2014

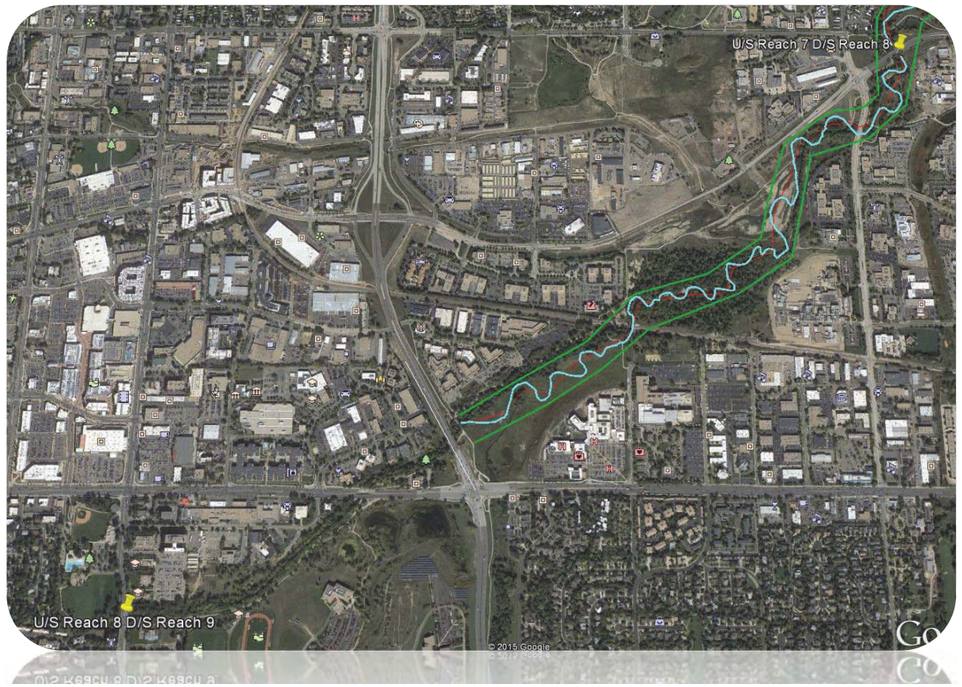

U/S Reach 2 D/S Reach 3
U/S Reach 3 D/S Reach 4


U/S Reach 3 D/S Reach 4
U/S Reach 4 D/S Reach 5


U/S Reach 4 D/S Reach 5
U/S Reach 5 D/S Reach 6


U/S Reach 6 D/S Reach 7
U/S Reach 5 D/S Reach 6


U/S Reach 6 D/S Reach 7
U/S Reach 7 D/S Reach 8
Google earth



PROGRESS MEETING – BOULDER COUNTY TRANSPORTATION
BOULDER CREEK MASTER PLAN
UDFCD, BOULDER COUNTY, CITIES OF BOULDER & LONGMONT
MARCH 3, 2015 AT 10:00 AM

MINUTES

1) Attendees

- Craig Jacobson, ICON Engineering, Inc.
- Brian LeDoux, ICON Engineering, Inc.
- Matt Wempe, Boulder County Transportation – Regional Trails Planner
- Anne Pagano, Boulder County Transportation – Project Implementation Manager
- Julie McKay, Boulder County Transportation – Planning Division Manager
- Kristine Obendorf, Boulder County Transportation – Project Engineer
- Tim Swope, Boulder County Transportation – Capital Improvements Coordinator
- Mike Thomas, Boulder County Engineer
- George Gerstle, Boulder County Transportation - Director

2) Introductions and Background

Brief introductions were completed by everyone in attendance. Julie provided an overview of the Boulder Creek Master Plan project and approach. This meeting with the Boulder County Transportation department was set up to gather input on potential improvement and restoration alternatives from the group. Other master planning efforts within Boulder County would include the potential for property acquisition along Kenosha Road and coordination with other entities that are completing or planning for improvements along Boulder Creek (i.e. USACE, Town of Erie)

Craig noted that the City of Boulder portion of the master planning effort is for site specific issues, but the Boulder County portion would develop a big picture conceptual plan that would identify immediate needs.

3) Focal Areas

The focal areas within Boulder County pertaining to the transportation group include:

- General channel restoration (optimal channel size and sinuosity)
- 61st Street (Boulder County)
- 75th Street (Boulder County)
- 95th Street (Boulder County)
- US HWY 287 / 107th (CDOT)
- 109th Street (Boulder County)
- Kenosha Road (Boulder County)
- CO HWY 52 / Mineral Road (CDOT)
- East County Line Road / Weld County Road 1 (Boulder / Weld County)

It was noted that CO HWY 52 / Mineral Road was recently reconstructed by CDOT and has close to the 100-year discharge capacity. US HWY 287 has 100-year capacity and needs to be open for emergency services during a 100-year event.

4) County Bridge and Roadway Criteria

All new Boulder County bridge structures must be able to convey the 100-year discharge. However, the adjacent roadways must be able to accommodate the 100-year event which can include overtopping to a specified depth. The roadway classification dictates the allowable overtopping depth, if allowed at all. ICON will review classifications for all County roads and determine the roadway accommodation requirements for each crossing.

P:\P\14040BCM\Meetings\2015-03-04 Progress Meeting (Boulder County Transportation)\Boulder Creek Progress Meeting 2015_03_04_Minutes.docx

George noted that the criteria for all new bridges to convey the 100-year discharge may not be reasonable given the perched nature of several of the County's crossings (i.e. not all of the 100-year discharge will make it to the bridge structure given that the floodplain will overtop the roadway at another location). This will be considered for each crossing, however, if a roadway is proposed to remain open throughout the 100-year event (i.e. raise the adjacent road grade above the base flood elevation), then the bridge structure(s) would be proposed to convey the full 100-year discharge.

5) Initial Roadway Improvement Concept

The initial roadway improvement concept of a major bridge crossing along with secondary overbank culverts was presented to the group. The secondary overbank culverts would allow the flood waters in the overbank areas to pass through the roadway without contracting to fit through the bridge structure and then expanding downstream of the bridge to return to the extent of the floodplain. This will reduce discharges and scour adjacent to the bridge crossing and allow for better overbank hydrology and habitat connectivity.

The initial concept would have approximately 60% of the peak discharge passing through the major bridge structure and 40% of the discharge passing through the secondary overbank culverts. The improvement concept would not negatively impact the base flood elevations and would be anticipated to have a maximum velocity of 6 ft/s in the main bridge and 2-4 feet in the overbank culverts. The group was receptive to this conceptual improvement approach.

It was noted that at 95th Street the multiple opening approach is likely to be problematic due to property owners on the downstream side of 95th. It is expected that any channelization or concentration of flows as a result of the secondary overbank culverts would be met with opposition by the property owners. Damage to 95th Street in 2013 was approximately $120K, but time that the crossing was out of operation was excessive.

A prioritization matrix will be developed for proposed roadway improvements. This matrix will include data such as traffic volume data, emergency access needs, existing bridge capacity, existing roadway overtopping depths, county criteria, improvement costs, restoration benefit, and existing bridge condition. This matrix will be used to develop a priority list for all proposed roadway improvements as presented in the master plan.

It was noted that the County may want some roads to be improved above and beyond the County's criteria. An initial discussion indicated that 61st, 75th, and East County Line Road (Weld County Road 1) would be likely candidates for exceeding the criteria. Julie will email ICON results of additional internal discussion on which roadways are desired to remain passable throughout a 100-year event.

6) Roadway Removal Concept

The concept of removing (or more likely the concept of not replacing when significantly damaged or deemed no longer in usable condition) crossing structures such as Kenosha Road and 109th Street was discussed. The general consensus was that existing crossing structures should **not** be proposed to be removed (or not replaced). It was noted that both Kenosha Road and 109th Street are close to other crossing structures and serve a low number of properties. For these reasons removal would be expected to have a relatively small impact on traffic use patterns. It was noted that bridge removal and any associated roadway reclamation would be beneficial to channel restoration efforts. Regardless, based on feedback the concept of roadway removal will not be included in the list of master planning alternatives. Dependent on channel restoration design, new locations for bridge structures may be proposed in order to facilitate future restoration efforts and channel behavior.

ICON ENGINEERING, INC.
PROGRESS MEETING – BOULDER COUNTY TRANSPORTATION
BOULDER CREEK MASTER PLAN
UDFCD, BOULDER COUNTY, CITIES OF BOULDER & LONGMONT
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7) Town of Erie

George noted that the Town of Erie has substantial land use plans for development in the areas near the current boundaries of the Town of Erie. These planning efforts likely include 109th Street and Kenosha Road. ICON and the UDFCD will contact Gary at the Town of Erie to discuss their land use plans and how they may potentially affect restoration and crossing improvements.

8) CWCB Hydrology Update

It was noted that the CWCB is in the process of completing the Phase 2 hydrology updates that would include this reach of Boulder Creek. This information has not yet been made public. Regardless, the master planning effort will not address changes in hydrology. However, selected projects will ultimately have the option to review any new hydrology that is available at the time of the project design work.

9) CO Highway 119

No Boulder County roads exist between Fourmile Creek and the City of Boulder along Boulder Creek. It was noted that CDOT is in the process of designing improvements to make CO HWY 119 more resilient within the canyon area.

- END OF MEETING--

Minutes prepared by: Brian LeDoux, P.E., CFM
ICON ENGINEERING, INC.

2015-03-05
Date

P:\P\14040BCM\Meetings\2015-03-04 Progress Meeting (Boulder County Transportation)\Boulder Creek Progress Meeting 2015_03_04_Minutes.docx

1) Attendees

- Craig Jacobson, ICON Engineering, Inc.
- Brian LeDoux, ICON Engineering, Inc.
- Diane Malone, Boulder County
- Naren Tayal, FEMA
- Katie Knapp, City of Boulder
- Dan Wolford, City of Longmont
- Yge Gao, Boulder County
- Shea Thomas, UDFCD
- Randy Ray, CCWCD
- Mohammed Said, Frederick
- Kristine Obendorf, Boulder County Transportation – Project Engineer

2) Weld County

Contact had been made with Weld County regarding their participation in the master plan process. The County indicated that since much of the proposed improvements would be located on private property that the County will not be involved much in the project. It was noted that the County has provided roadway criteria information.

3) Website Activity

Updated meeting minutes and the initial public meeting presentation has been posted on the project web site. Comments from the interactive comment map have slowed down considerably. The mailing list continues to grow per web site submissions of email addresses.

4) Public Meeting Feedback and Public Outreach

Attendance at both public meetings was very low. Several citizens did provide input via speaking with project team members or submitting the comment cards. Input included concerns about flooding along South Boulder Creek (near the confluence with Boulder Creek), a recycled asphalt/concrete operation in close proximity to the channel, and general concerns about diversions and water right implications.

Randy with CCWCD indicated that he is interested in the project for water supply and water quality aspects.

Shea noted that the goals for this proposed in this master plan is in line with previous restoration efforts and would not have an impact on the ability to continue diversions from Boulder Creek.

The next public meeting will be scheduled following the submittal of the alternatives analysis report. This will likely be in late May. It was suggested that an open house style of meeting be pursued.

5) Stakeholder Meetings

Several stakeholder meetings have been completed and the ultimate direction of the master plan has been influenced by the stakeholder desires.

Boulder County Transportation provided direction that not all crossings would need to have 100-year capacity, and instead overtopping of the roadway (outside of the bridge structure) would be acceptable. 61st, 75th, and County Line Road were identified as needing a 100-year capacity (with

PROGRESS MEETING
BOULDER CREEK MASTER PLAN
UDFCD, BOULDER COUNTY, CITIES OF BOULDER & LONGMONT
APRIL 15, 2015 AT 10:00 AM

MINUTES

no overtopping) alternative. The overbank culverts were recommended to be removed and not pursued given the criteria allowing overtopping to occur. Additionally, it was noted that overbank culverts may lead to concentrated flows and result in additional erosion during flood events.

Boulder County Open Space provided direction that a full length restoration effort would be a lengthy process and may not be realistic and recommended that specific projects be identified for restoration in terms of completion in the next 5-25 years.

The City of Boulder has been contacted and specific projects within the City were discussed. Katie noted that bridge crossing within the City should also be analyzed in similar fashion to the bridges in Boulder County, but no bridge replacement projects will be identified.

6) Stream Restoration Approach

The initial stream restoration approaches were reviewed – full restoration; realistic restoration; and a hybrid of the realistic restoration that includes many of the large oxbow areas from the full restoration approach. Following discussions it was recommended that the master plan present the three initial stream restorations but provide recommended projects. Costs will be developed for the recommended projects and those costs will be extrapolated to the full length in order to document the costs of unmet needs along Boulder Creek for County and FEMA budgeting and grant purposes. Restoration projects that are currently in progress will be noted within the master plan (both channel and gravel pit spillways).

7) Project Alternatives

The project alternative maps were reviewed with the project team (see attached maps). The proposed projects were reviewed and the following was noted:

- For the Civic Center / Arapahoe Underpass the projects can be referenced but not further addressed as they are in their own design phase.
- The Boulder Slough project will likely involve a box culver to deliver flows south to Boulder Creek where minor impacts due to increased discharge will need to be addressed. Water right issues and other constraints will be addressed.
- No projects will be presented for bridge crossings within the City of Boulder, however, the City would like to have general data for each bridge crossing similar to what has been developed for Boulder and Weld County bridge crossings.

8) CWCB Hydrology

The CWCB hydrology report for Boulder Creek was reviewed. The project team concluded that discharges presented in the CWCB report should not be used for the alternatives phase of the project but that any selected plan and conceptual design could consider the revised discharge values where higher than the current values.

9) Next Steps

Given the general agreement with the alternatives approach, a draft alternatives report will be produced. Given the current timing of the project, the alternatives report will combine the Weld County, Boulder County, and City of Boulder projects into a single report. Once this report is reviewed and alternatives have been selected, the conceptual design phase will begin.

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PROGRESS MEETING
BOULDER CREEK MASTER PLAN
UDFCD, BOULDER COUNTY, CITIES OF BOULDER & LONGMONT
APRIL 15, 2015 AT 10:00 AM

MINUTES

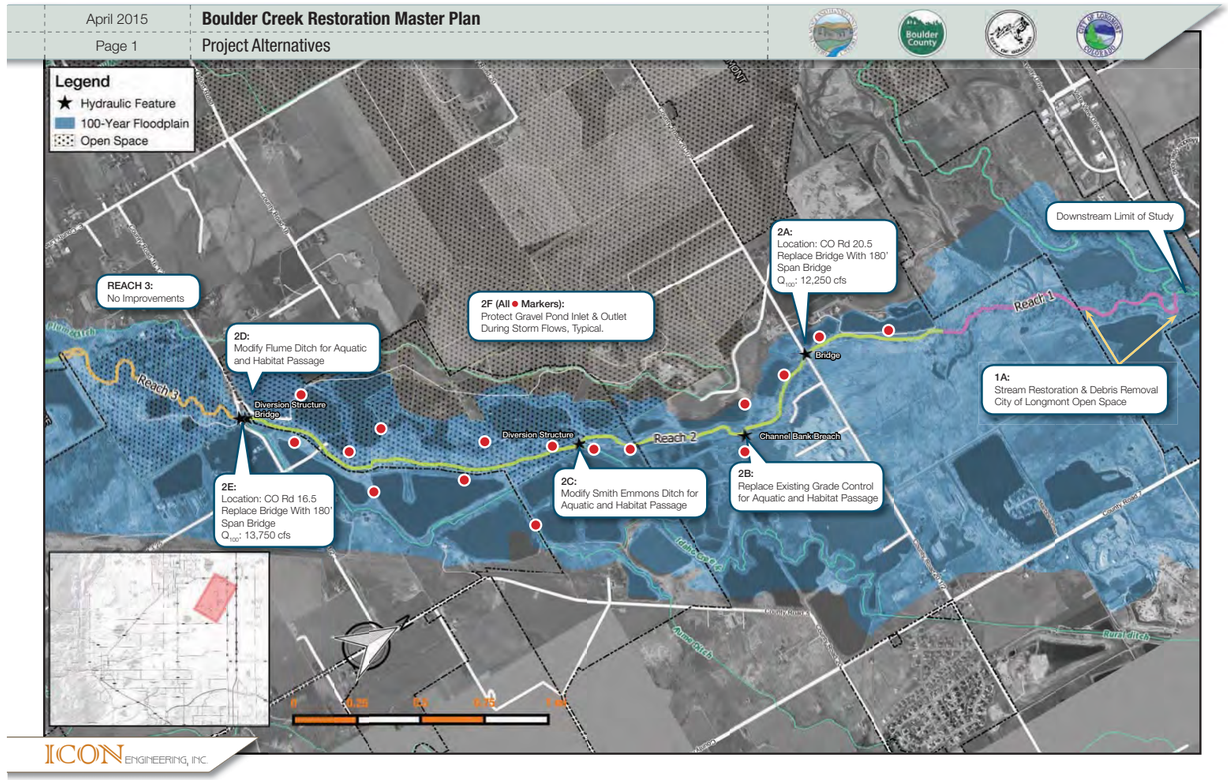
10) Schedule and Next Meeting

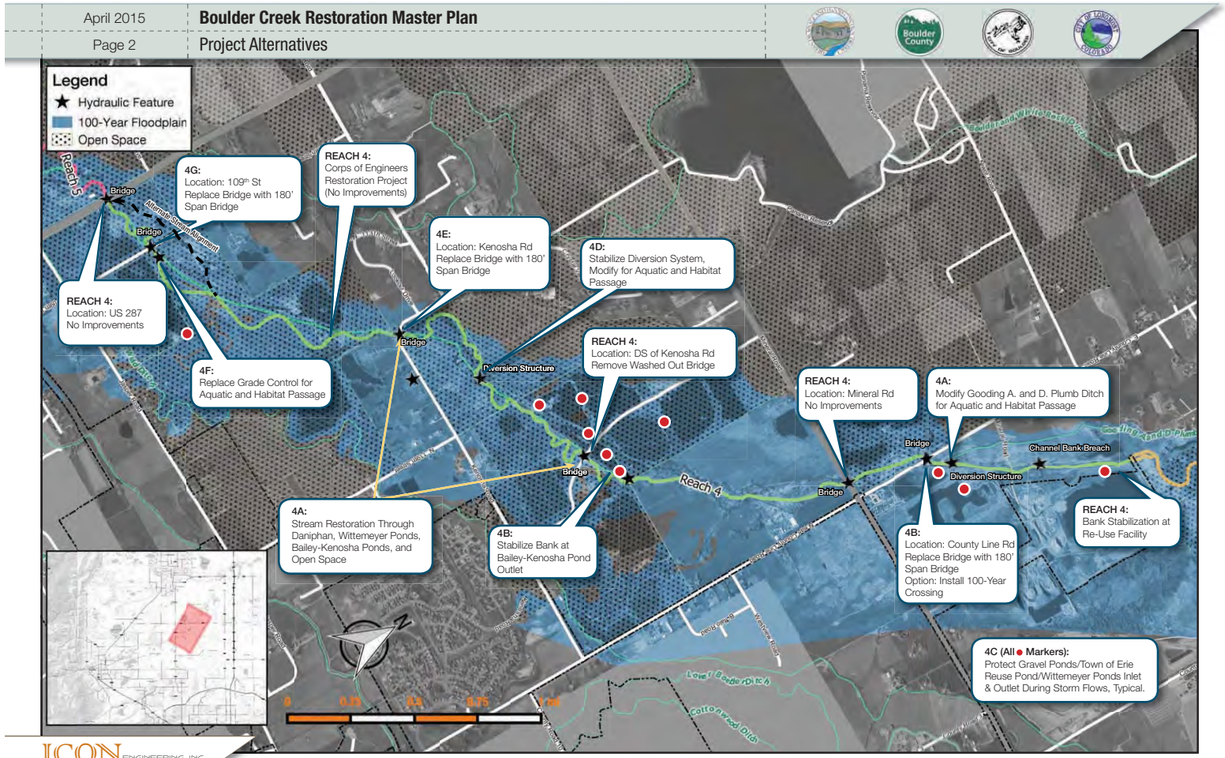
The draft alternatives plan will be completed in approximately 4 weeks. The next progress meeting will be scheduled for after the draft alternatives analysis report is submitted.

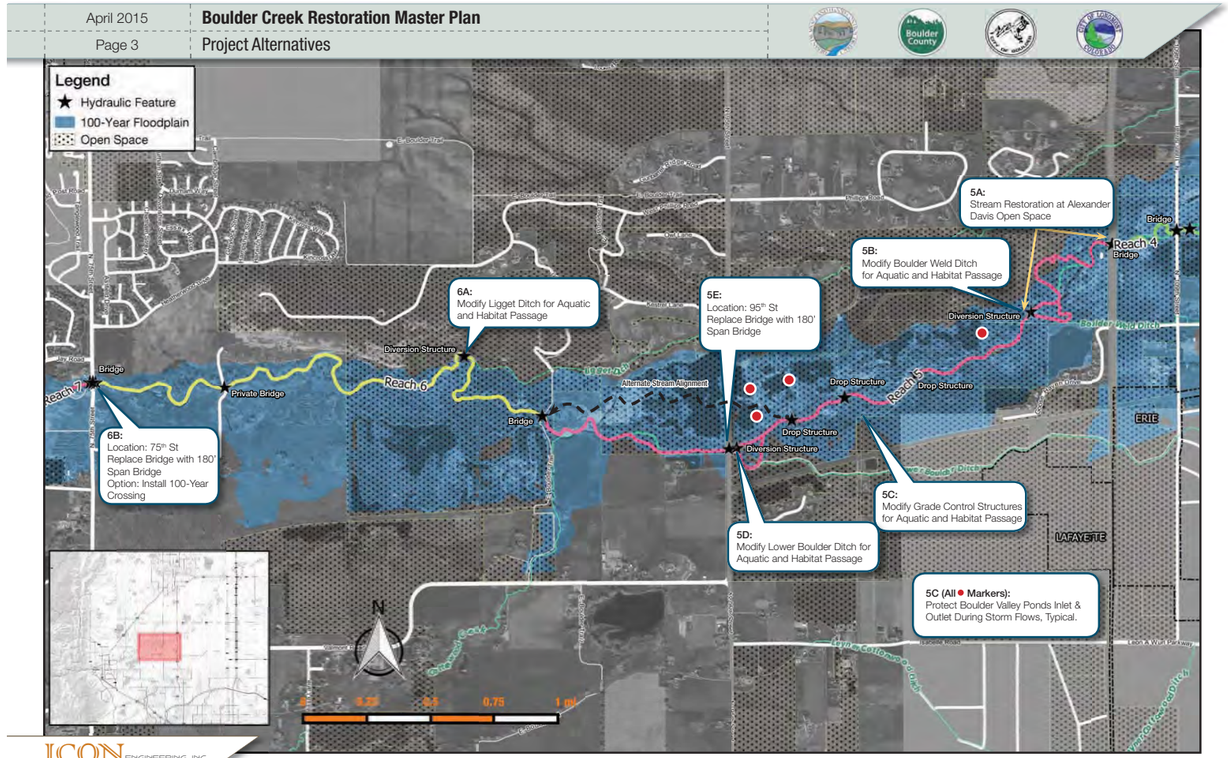
- END OF MEETING--

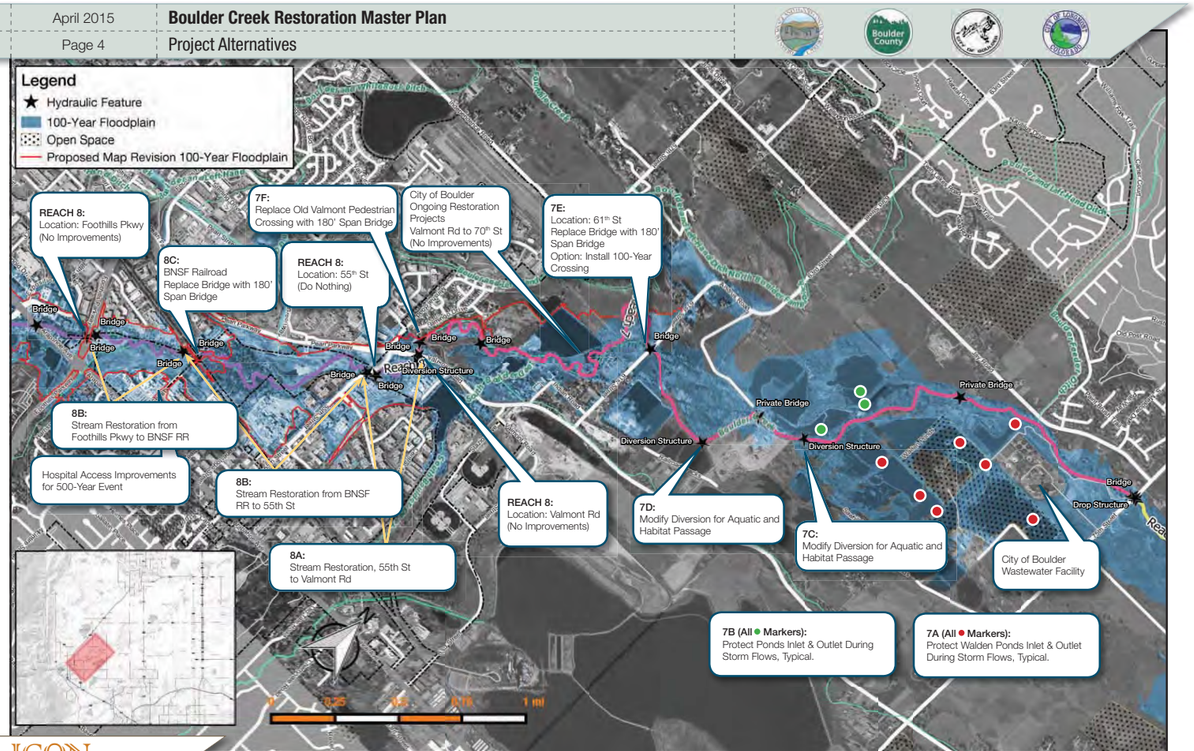
Minutes prepared by: Brian LeDoux, P.E., CFM
ICON ENGINEERING, INC.

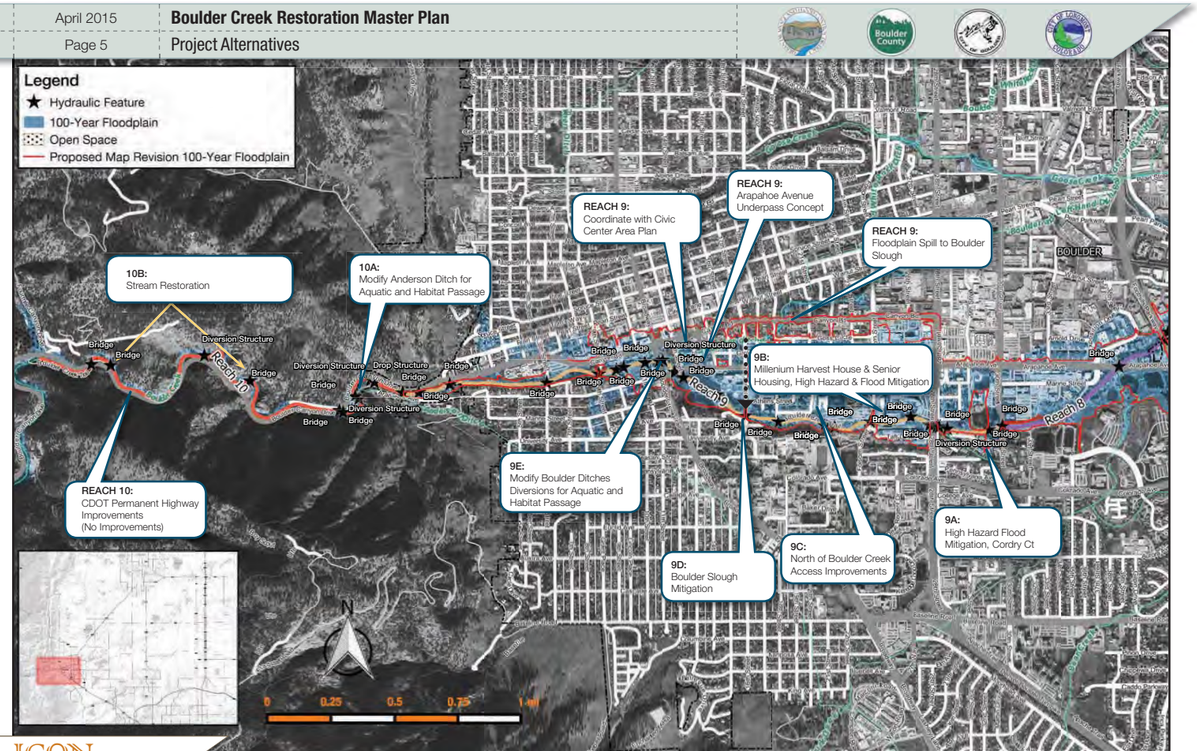
2015-04-22
Date




Legend
Hydraulic Feature
100-Year Floodplain
Open Space
4G: Location: 109th St Replace Bridge with 180' Span Bridge
REACH 4: Corps of Engineers Restoration Project (No Improvements)
4E: Location: Kenosha Rd Replace Bridge with 180' Span Bridge
4D: Stabilize Diversion System, Modify for Aquatic and Habitat Passage
REACH 4: Location: US 287 No Improvements
4F: Replace Grade Control for Aquatic and Habitat Passage
REACH 4: Location: DS of Kenosha Rd Remove Washed Out Bridge
REACH 4: Location: Mineral Rd No Improvements
4A: Modify Gooding A. and D. Plumb Ditch for Aquatic and Habitat Passage
4A: Stream Restoration Through Daniphan, Wittemeyer Ponds, Bailey-Kenosha Ponds, and Open Space
4B: Stabilize Bank at Bailey-Kenosha Pond Outlet
4B: Location: County Line Rd Replace Bridge with 180' Span Bridge Option: Install 100-Year Crossing
REACH 4: Bank Stabilization at Re-Use Facility
4C (All ● Markers): Protect Gravel Ponds/Town of Erie Reuse Pond/Wittemeyer Ponds Inlet & Outlet During Storm Flows, Typical.
Reach 5
Reach 4
Bridge
Diversion Structure
Channel Bank Breach
Alternate Stream Alignment
Boulder Weld Ditch
Lower Boulder Ditch
Cottonwood Ditch
0 0.25 0.5 0.75 1 mi


Legend
Hydraulic Feature
100-Year Floodplain
Open Space
5A: Stream Restoration at Alexander Davis Open Space
5B: Modify Boulder Weld Ditch for Aquatic and Habitat Passage
6A: Modify Ligget Ditch for Aquatic and Habitat Passage
5E: Location: 95th St Replace Bridge with 180' Span Bridge
6B: Location: 75th St Replace Bridge with 180' Span Bridge Option: Install 100-Year Crossing
5C: Modify Grade Control Structures for Aquatic and Habitat Passage
5D: Modify Lower Boulder Ditch for Aquatic and Habitat Passage
5C (All ● Markers): Protect Boulder Valley Ponds Inlet & Outlet During Storm Flows, Typical.
Reach 7
Reach 6
Reach 5
Reach 4
Bridge
Private Bridge
Diversion Structure
Drop Structure
Alternate Stream Alignment
Boulder Weld Ditch
ERIE
LAFAYETTE
0 0.25 0.5 0.75 1 mi


Legend
Hydraulic Feature
100-Year Floodplain
Open Space
Proposed Map Revision 100-Year Floodplain
REACH 8: Location: Foothills Pkwy (No Improvements)
7F: Replace Old Valmont Pedestrian Crossing with 180' Span Bridge
City of Boulder Ongoing Restoration Projects Valmont Rd to 70th St (No Improvements)
7E: Location: 61st St Replace Bridge with 180' Span Bridge Option: Install 100-Year Crossing
8C: BNSF Railroad Replace Bridge with 180' Span Bridge
REACH 8: Location: 55th St (Do Nothing)
8B: Stream Restoration from Foothills Pkwy to BNSF RR
Hospital Access Improvements for 500-Year Event
8B: Stream Restoration from BNSF RR to 55th St
8A: Stream Restoration, 55th St to Valmont Rd
REACH 8: Location: Valmont Rd (No Improvements)
7D: Modify Diversion for Aquatic and Habitat Passage
7C: Modify Diversion for Aquatic and Habitat Passage
City of Boulder Wastewater Facility
7B (All Markers): Protect Ponds Inlet & Outlet During Storm Flows, Typical.
7A (All Markers): Protect Walden Ponds Inlet & Outlet During Storm Flows, Typical.
Bridge
Diversion Structure
Drop Structure
Private Bridge
Reach 8
0 0.25 0.5 0.75 1 mi


Legend
Hydraulic Feature
100-Year Floodplain
Open Space
Proposed Map Revision 100-Year Floodplain
10B: Stream Restoration
10A: Modify Anderson Ditch for Aquatic and Habitat Passage
REACH 9: Coordinate with Civic Center Area Plan
REACH 9: Arapahoe Avenue Underpass Concept
REACH 9: Floodplain Spill to Boulder Slough
9B: Millenium Harvest House & Senior Housing, High Hazard & Flood Mitigation
REACH 10: CDOT Permanent Highway Improvements (No Improvements)
9E: Modify Boulder Ditches Diversions for Aquatic and Habitat Passage
9D: Boulder Slough Mitigation
9C: North of Boulder Creek Access Improvements
9A: High Hazard Flood Mitigation, Cordry Ct
BOULDER
Bridge
Diversion Structure
Drop Structure
Reach 10
Reach 9
Reach 8
0 0.25 0.5 0.75 1 mi

BRIDGE DATA							CRITERIA CONFIRMATION		GEOMORPHIC CONFIRMATION		REPLACEMENT	
Stream Reach	Bridge Location	Jurisdiction	Classification	Estimated Bridge Capacity (cfs, approx. freq)	Estimated Roadway Elevation (NAVD 1988)	Estimated 100-Year WSEL (NAVD 1988)	Estimated Bridge Deck Thickness (in)	Is Bridge Above 100 Year WSEL? (Yes/No)	Existing Bridge Width (ft)	Does Bridge Meet Geomorphic Width Recommendations? (Yes/No)	Does Bridge Require Replacement? (Yes/No)	100-Year Emergency Access Considerations? (Yes/No)
Reach 2	WC Road 20 1/2	Weld County	Collector	< 100-year	4884	4882	41	NO	132	NO	**YES**	NO
	WC Road 16 1/2	Weld County	Local	1,000 cfs	4927	4920	51	YES	126	NO	**YES**	NO
Reach 4	County Line Road	Boulder / Weld Counties	Collector	1,200 cfs	4957	4951	53	YES	124	NO	**YES**	**YES**
	Mineral Road (SH 52)	CDOT	State Highway	> 100-year	4961	4958	26	YES	218	YES	NO	**YES**
	Kenosha Road	Boulder County	Local	600 cfs	4996	4994	43	NO	92	NO	**YES**	NO
	109th Street	Boulder County	Local	5,400 cfs	5016	5015	25	NO	77	NO	**YES**	NO
	State Highway 287	CDOT	State Highway	> 100-year	5027	5021	66	YES	218	YES	NO	**YES**
Reach 5	95th Street	Boulder County	Arterial	3,300 cfs	5065	5059	56	YES	121	NO	**YES**	NO
Reach 6	75th Street	Boulder County	Arterial	6,200 cfs	5121	5117	46	YES	108	NO	**YES**	**YES**
Reach 7	61st Street	Boulder County	Arterial	8,300 cfs	5170	5171	30	NO	90	NO	**YES**	**YES**
Reach 8	BNSF Railroad	BNSF Railroad	Railroad	1,000 cfs	5231	5228	30	YES	52	NO	**YES**	NO

Reach	ID	Description	Jurisdiction
1	A	Stream Restoration & Debris Removal	City of Longmont / Weld County
2	A	CO Rd. 20.5 - Replace Bridge with 180 ft. Span Bridge	Weld County
	B	Replace Existing Grade Control for Aquatic and Habitat Passage	Weld County
	C	Modify Smith Emmons Ditch for Aquatic and Habitat Passage	Town of Frederick / Weld County
	D	Modify Flume Ditch for Aquatic and Habitat Passage	Weld County
	E	CO Rd. 16.5 - Replace Bridge with 180 ft. Span Bridge	Weld County
	F	Protect Gravel Pond Inlet & Outlet During Storm Flows, Typical	Town of Frederick / Weld County
3		No Improvements	Weld County
4	A	Modify Gooding A. and D. Plumb Ditch for Aquatic and Habitat Passage	Weld County
	B	County Line Rd. - Replace Bridge with 180 ft. Span Bridge	Weld County / Boulder County
	C	Protect Gravel Ponds / Town of Erie Reuse Pond / Wittemeyer Ponds Inlet & Outlet During Strom Flows, Typical.	Town of Erie / Weld County / Boulder County
	D	Stabilize Bank at Bailey-Kenosha Pond Outlet	Boulder County
	E	DS of Kenosha Rd. - Remove Washed Out Bridge	
	F	Stream Restoration Through Daniphan, Wittemeyer Ponds, Bailey-Kenosha Ponds, and Open Space	
	G	Stabilize Diversion System, Modify for Aquatic and Habitat Passage	
	H	Kenosha Rd. - Replace Bridge with 180 ft. Span Bridge	
	I	Replace Grade Control for Aquatic and Habitat Passage	
	J	109th St. - Replace Bridge with 180 ft. Span Bridge	
5	A	Stream Restoration at Alexander Davis Open Space	Boulder County
	B	Modify Boulder Weld Ditch for Aquatic and Habitat Passage	
	C	Protect Boulder Valley Ponds Inlet & Outlet During Storm Flows, Typical.	
	D	Modify Grade Control Structures for Aquatic and Habitat Passage	
	E	Modify Lower Boulder Ditch for Aquatic and Habitat Passage	
	F	95th St. - Replace Bridge with 180 ft. Span Bridge	
6	A	Modify Ligget Ditch for Aquatic and Habitat Passage	Boulder County
	B	75th St. - Replace Bridge with 180 ft. Span Bridge	
7	A	Protect Walden Ponds Inlet & Outlet During Storm Flows, Typical	Boulder County
	B	Protect Ponds Inlet & Outlet During Storm Flows, Typical	
	C	Modify Diversion for Aquatic and Habitat Passage	
	D	Modify Diversion for Aquatic and Habitat Passage	
	E	61st St. - Replace Bridge with 180 ft. Span Bridge	
	F	Replace Old Valmont Pedestrain Crossing with 180 ft. Span Bridge	
	G	Modify Butte Mill Ditch Crossing on South Boulder Creek	
8	A	Stream Restoration from 55th St. to Valmont Drive	Boulder County
	B	Stream Restoration from BNSF RR to 55th St.	
	C	BNSF Railroad - Replace Bridge with 180 ft. Span Bridge	
	D	Stream Restoration from Foothills Pkwy to BNSF RR	
9	B	Millenium Harvest House and Senior Housing - High Hazard Flood Mitigation	City of Boulder
	C	North of Boulder Creek Access Improvements	
	D	Boulder Slough Mitigation	
	F	Modify Boulder Ditches Diversion for Aquatic and Habitat Passage	
10	A	Modify Anderson Ditch for Aquatic and Habitat Passage	Boulder County
	B	Stream Restoration	

BOULDER CREEK MDP
SIGN-IN SHEET

Date: March 10, 2015

NAME	Address	Contact Information	Would you like to be added to Mailing List? (Yes/No)
John McIntosh	2802 Sundown #202 Boulder, CO 80303	Phone: 303 443 9072 E-mail: john@urticator.net	no ~~none~~
~~Bob Iehl~~	~~501 Independence Rd Boulder 80301~~	Phone: ~~3-359-8284~~ E-mail:	OK
Don Rogers	5973 Indian Road 80301	Phone: E-mail: drrogers51@Gmail.com	Yes
Robert Carlson	St of Colorado Water Comm Db	Phone: E-mail: bob.carlson@state.co.us	
Mohammed Said	401 Locust St Frederick, CO	Phone: 720 382-5603 E-mail: msaid@frederickco.gov	Yes
Joanna Bloom	1739 Broadway PO Box 791 Boulder 80302	Phone: 303-441-4251 E-mail: bloomj@bouldercolorado.gov	yes
Bob Vonkesch	3227 61st Boulder Co	Phone: 303-668-7620 E-mail: bolderbob54@Gmail	yes
Naren Tayal	FEMA, Lakewood, CO	Phone: 720-415-5976 E-mail:	1 copy
Katie Knapp	COB	Phone: 303-441-4077 E-mail: Knappk@bouldercolorado.gov	
		Phone: E-mail:	
		Phone: E-mail:	

BOULDER CREEK MDP
SIGN-IN SHEET

Date: March 18, 2015

NAME	Address	Contact Information	Would you like to be added to Mailing List? (Yes/No)
Scott Struck	1455 Dixon Ave Lafayette, CO	Phone: 303-586-8194 E-mail: SStruck@Geosyntec.com	Y
Scott Holwick	515 Kimbark Longmont	Phone: 317 776 9900 E-mail: sholwick@lgklaw.com	Y
DAVE SMOOTZ	556 CR 16.5 Longmont 80504	Phone: 303 588 6700 E-mail: DS261X@GMAIL.CO	Y
Connie Davis	PO Box 337231 Greeley CO 80633	Phone: 970-396-5252 E-mail: Connie.davis@aggregate-us.com	Y
Judy Hefner	370 CR 16 1/2 Longmont CO 80504	Phone: 720-220-6059 E-mail: hefnerjudy@msn.com	Y
AVERY ELLIS	12912 HILLCREST CONGMONT CO	Phone: 908-692-7878 E-mail: ABOODAHBJA@GMAIL.com	Y
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	

BOULDER CREEK MASTER PLAN

~~Mar~~ch 18, 2015



1908 – Haines Photo. Looking east from Boulder Canyon mouth

ICON ENGINEERING, INC.

Consultant Team:

ICON ENGINEERING, INC.

Craig D. Jacobson, P.E., CFM
Principal, Project Manager

Troy Thompson, P.E.
President, Sr. Water Resource Engineer

Ecological Resource Consultants, Inc.

Mark Wilcox, RLA, ASLA
Principal

DHM DESIGN

Brian Bledsoe, PhD, PE
CSU

Partnerships and Project Stakeholders:

Boulder County Parks & Open Space

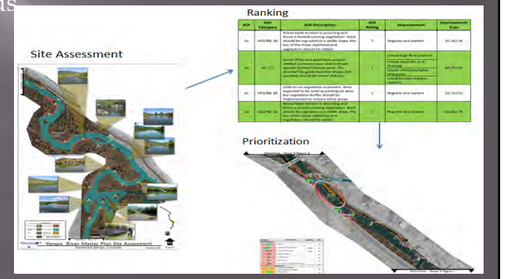
University of Colorado Boulder

FEMA

DOT

Purpose of Master Plan

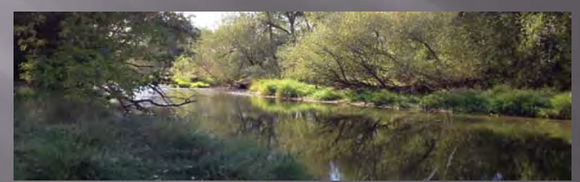
- Plan for Resiliency for Boulder Creek:
- Multiple Objectives Including:
  - Stream & ecological restoration
  - Immediate impacts and needs
  - Floodplain management
  - Transportation
  - Recreation
  - Public safety
- Collaborative Effort
- Prioritization and Funding



ICON ENGINEERING, INC.

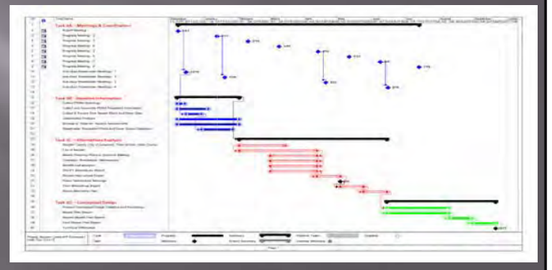
Purpose of Master Plan

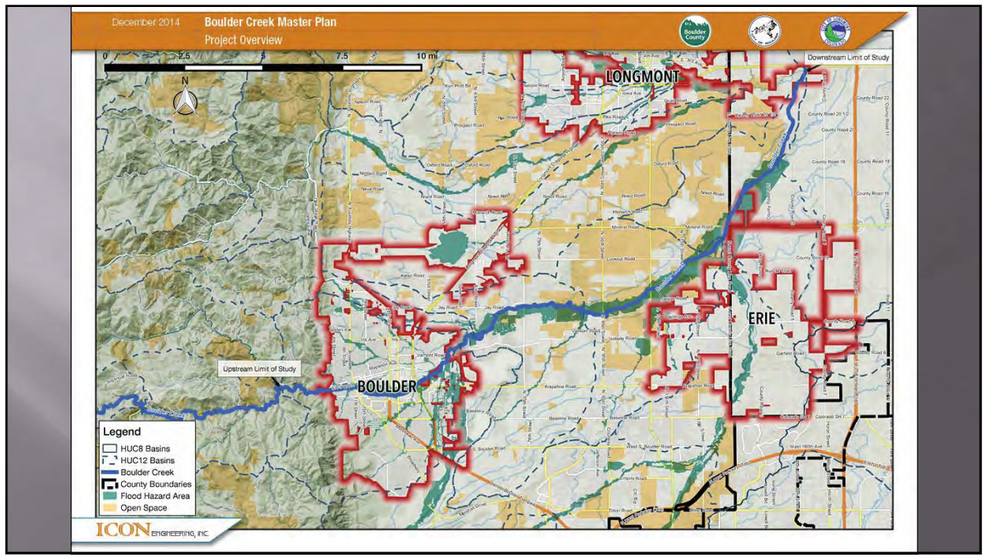
- This master plan will provide general guidance for stream and ecological restoration;
- This study will not re-evaluate the 100-year floodplain limits



Schedule and Process

- Project Kickoff
  - (Dec 2014)
- Baseline Data
  - (Jan/Feb 2015)
- Alternative Analysis
  - (Mar – May 2015)
- Conceptual Design
  - (June – Sept 2015)
- Project Completion
  - (Oct 2015)





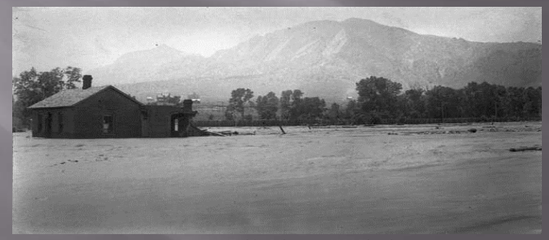
Boulder Creek Watershed[1]

- 440 square miles
- Continental Divide to confluence with St. Vrain Creek
- Boulder Canyon
  - Steep Mountain Stream
- City of Boulder
  - Urban Waterway
- Downstream of City Limits
  - Plains Stream with broad floodplain

1- *A September To Remember*, UDFCD 2014

Historic Flooding[1]

- Since 1864 – 6 major floods including September 2013
  - 1894 - Produced peak flow rates on main stem of Boulder Creek that exceeded September 2013



Denver Public Library – 1894 Flood

1- *A September To Remember*, UDFCD 2014

September 2013 – Boulder Canyon

- Mountain Stream confined to narrow canyon
- High velocities caused bank erosion undermining roads in number of locations



AP Photo (Brennan Linsley)

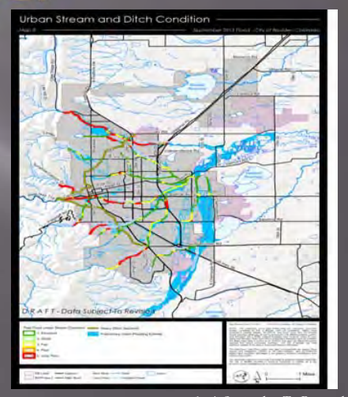
September 2013 – Boulder County[1]

- Primarily City and County Open Space
  - Restricts future development
- Lack of development prevented substantial flood damages
- Primary problems related to road crossings
- Gravel ponds didn't provided adequate outlet
  - 95th Street – Overtopping occurred 1,000 feet north of the creek bridge
  - 109th Street – Boulder Creek cut a course through ponds

1- *A September To Remember*, UDFCD 2014

September 2013 – City of Boulder[1]

- Sewer backups from high groundwater and saturated soils caused extensive damage
- City of Boulder Survey ~ $41.3 million in damages from Boulder Creek[2]



1- *A September To Remember*, UDFCD 2014
2-City of Boulder Utilities Division

95th Street Overtopping



95th Street Overtopping – David Mallory, UDFCD 2013

September 2013 – Weld County & Longmont

- Primary problems related to road crossings
- Reclamation & Gravel ponds didn't provided adequate outlet
  - 16.5 Road - Overtopping
  - 20.5 Road – Flood flanked bridge through ponds
- Saint Vrain Creek
  - Confluence Shifted

1- *A September To Remember*, UDFCD 2014

2013 Discharge Frequency

- Although rainfall exceeded 100-yr storm for some areas, peak flows didn't exceed 50-yr flows.
- Didn't produce peak flows in the same magnitude of rainfall frequencies due to temporal and spatial distribution

Table 11 – September 2013 Peak Flow Estimates for Boulder Creek and Major Tributaries West of City

Location	Peak Flow Estimate (cfs)	Comments and Source of Data	Estimated Runoff Return Period (year)	Q_{100} (cfs)
Middle Boulder Creek at Nederland	409	CDWR	< 10	825
North Boulder Creek d/s CO Hwy 72 nr Nederland	340	Jarrett	----	----
North Boulder Creek u/s Boulder Creek and CO Hwy 119 nr Orodell	740	Jarrett—Canyon rockfall risk; poor estimate	----	----
Boulder Creek u/s Keystone Gulch nr Orodell	1,560	Jarrett	----	----
Boulder Creek @ Orodell (above Fourmile)	2,020	CDWR—Peak on Sept. 12 23:30	10 - 15	7,080
Fourmile Creek u/s burned area	490	Jarrett	----	----
Fourmile Creek d/s Poorman Rd u/s #1267 Fourmile Cr Rd nr Orodell	2,300	Jarrett—USGS gage nr mouth (not much d/s inflow)	~20	5,570
Boulder Creek @ Broadway	~5,000	UCAR estimate based on CDWR	25	12,000
Boulder Creek @ 28th Street	5,300	CWCB	25	~11,500
Boulder Creek at 75th St in Boulder	8,400	USGS—Provisional Data	25-50	~13,000

Rainfall-Runoff Analysis for September 2013 Flood in the City of Boulder, Colorado, Wright Water Engineers 2014

September 2013 – Weld County & Longmont



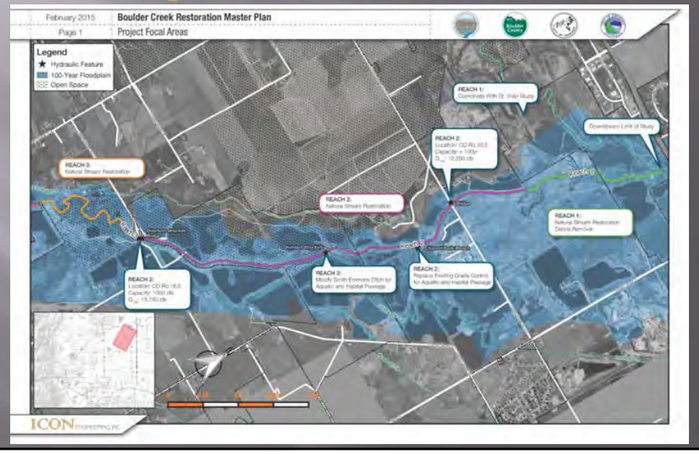


Saint Vrain Creek Confluence

Project Focal Areas

- Project Reaches
  - Canyon Reach
    - Define Restoration needs and Coordinate with CDOT
  - City of Boulder
    - Catalyst for future work
    - Specific locations to evaluate and coordinate
  - City of Boulder through 61st Street
    - Stream restoration & open space
  - 61st Street through East County Line Road
    - Stream restoration & open space
    - Transportation
    - Inclusion of access and recreation needs
  - East County Line Road through St. Vrain Creek
    - Stream restoration & open space
    - Transportation
    - Saint Vrain Creek confluence

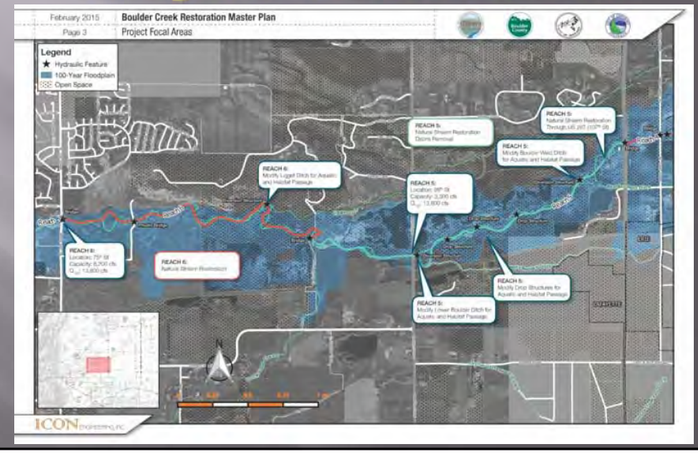
Project Focal Areas



Project Focal Areas



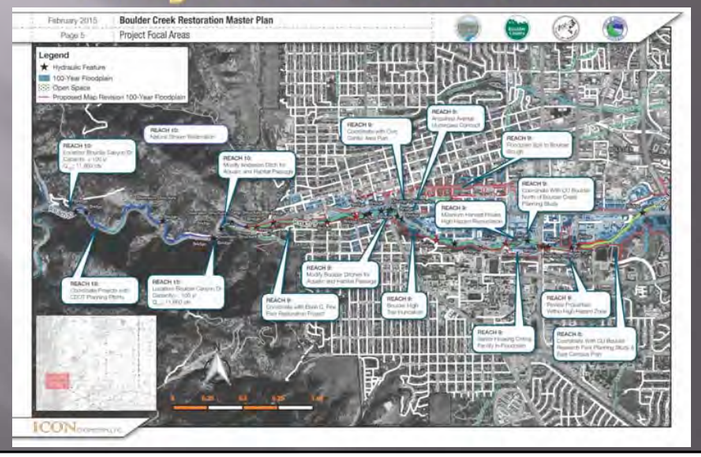
Project Focal Areas



Project Focal Areas



Project Focal Areas



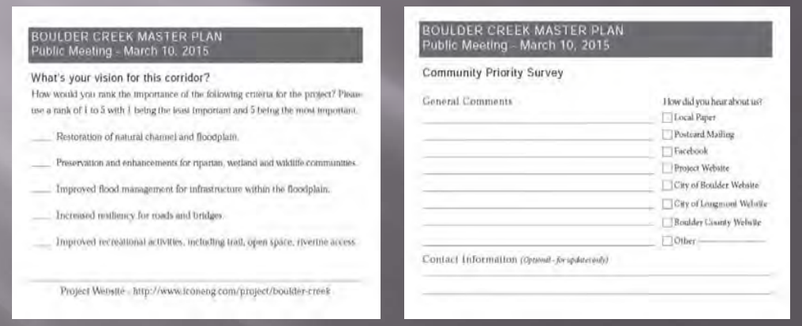
Outreach

- Community involved within planning process:
  - Website Updates
  - Informational Mailing List
- Opportunity for comment and feedback:
  - Interactive Comment Map
    - Accessible through UDFCD or ICON website
    - www.iconeng.com/project/boulder-creek
  - Email: contact.boulder.creek@gmail.com

Interactive Comment Map



Meeting Comment Card



BOULDER CREEK MASTER PLAN
Public Meeting – March 10, 2015

What's your vision for this corridor?

How would you rank the importance of the following criteria for the project? Please use a rank of 1 to 5 with 1 being the least important and 5 being the most important.

___ Restoration of natural channel and floodplain.

___ Preservation and enhancements for riparian, wetland and wildlife communities.

___ Improved flood management for infrastructure within the floodplain.

___ Increased resiliency for roads and bridges.

___ Improved recreational activities, including trail, open space, riverine access.

Project Website - http://www.iconeng.com/project/boulder-creek

BOULDER CREEK MASTER PLAN
Public Meeting – March 10, 2015

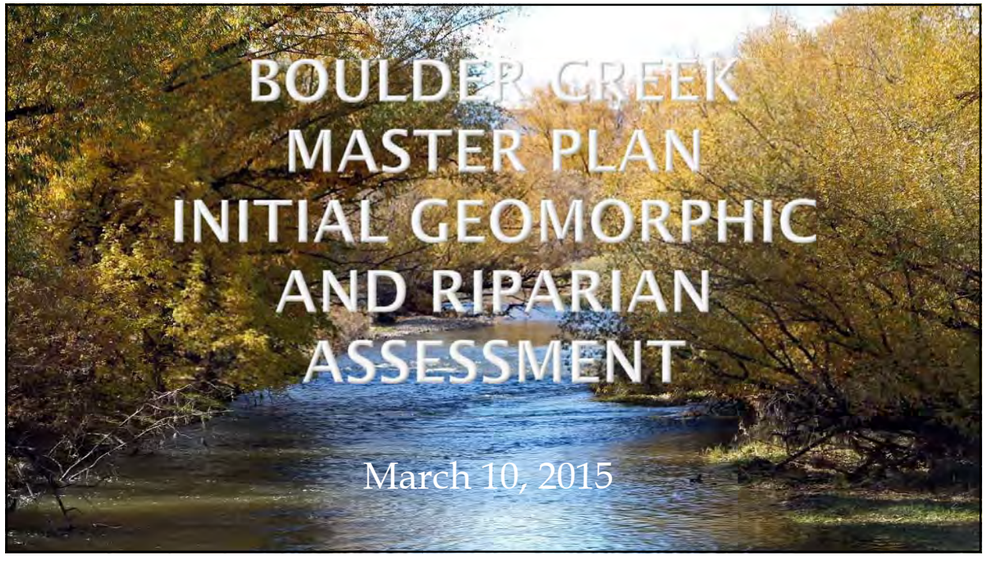
Community Priority Survey

General Comments

How did you hear about us?

- ☐ Local Paper
- ☐ Postcard Mailing
- ☐ Facebook
- ☐ Project Website
- ☐ City of Boulder Website
- ☐ City of Longmont Website
- ☐ Boulder County Website
- ☐ Other _____

Contact Information *(Optional - for updates only)*



Changes to Historic Alignment



Objective of Initial Geomorphology and Riparian Assessments

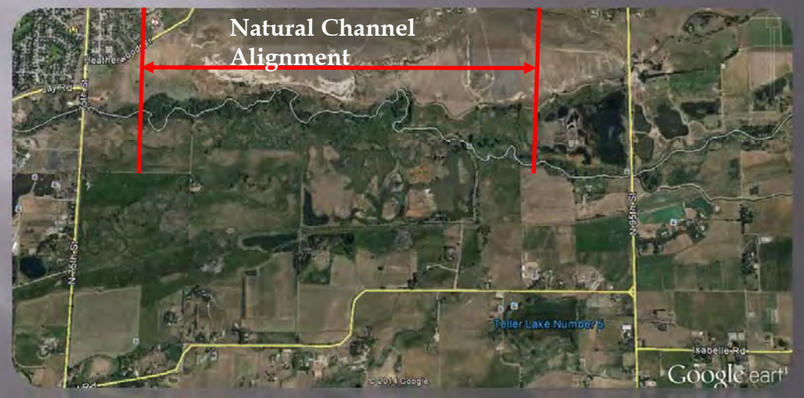
1. Evaluate evolution of channel through recent times
2. Quantify changes in alignment and planform
3. Identify natural channel form to aid in restoration objectives
4. Identify ideal or reference riparian community

Observations from Historic Characteristics

- Stream through the canyon and developed City had historically lower sinuosity that areas downstream from the developed City
- Sinuosity downstream from the City historically was in the range of 1.25 to 1.45 or greater
- Sinuosity has decreased fairly significantly in several locations over time
- Areas with limited development or encroachment exist and should form the basis for idealized restoration reaches
- Active stream width have decreased, with largest decreases observed towards the downstream end of the project. *(This may at least in part be a response to diversions and decreased flows)*

What is the natural state of the stream?

(Area downstream of N. 75th Street is likely a good example of Boulder Creek functioning in its natural geomorphic state)



Most Probable Natural Rosgen Stream Type for Valley Sections



- Type C Stream
- Broad valley with terraces, connected to floodplain; riffle/pool morphology
  - Slope < 2%
  - Entrenchment Ratio >2.2
  - Width/Depth Ratio >12
  - Sinuosity >1.2 (1.4 to 1.9)

Riparian Zone

- defined as the transitional area or interface between upland terrestrial and aquatic habitats
- generally considered that portion of the landscape from the ordinary high water mark towards the adjoining uplands that interacts with stream flow
- contains unique and diverse vegetation communities
- integral in stream health and function

Runoff Filtering	Aquatic Biomass	Wildlife Habitat
Bank Stabilization	Aquatic Habitat	Wildlife Movement Corridors
Flood Water Storage	Flood Water Filtering	Shading

Riparian Zone–Boulder Creek Reference Condition

"Western Great Plains Riparian Woodland and Shrubland"

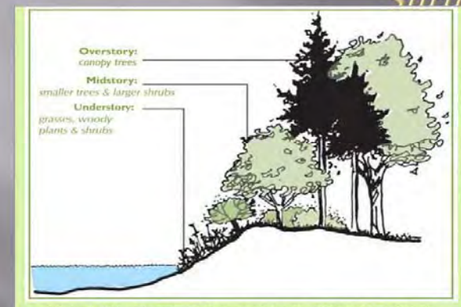
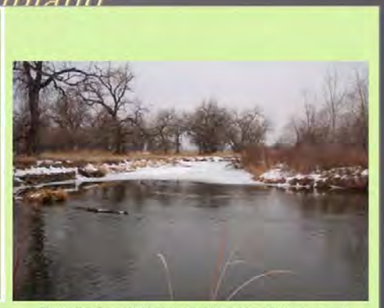
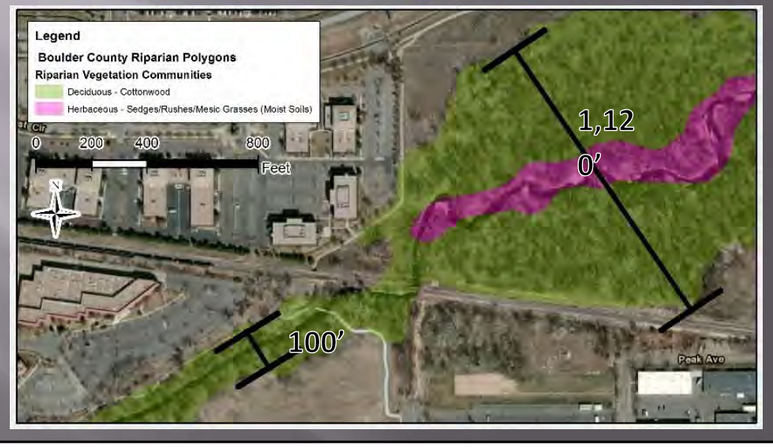


FIGURE 1. NATURAL RIPARIAN CORRIDORS OF HIGH ECOLOGICAL INTEGRITY TYPICALLY CONTAIN THREE DISTINCT LAYERS OF VEGETATION – OVERSTORY FOREST CANOPY OF TREES, MIDSTORY OF SHRUBS AND AN UNDERSTORY OF GRASSES. (MODIFIED FROM: MONTGOMERY COUNTY PLANNING COMMISSION 2006).



BOULDER CREEK: EXAMPLE OF HIGH ECOLOGICAL INTEGRITY RIPARIAN FOREST HABITAT – DOMINATED BY COTTONWOOD OVERSTORY WITH WILLOW MIDSTORY AND GRASS UNDERSTORY.

Boulder Creek– Examples of Existing Riparian Width



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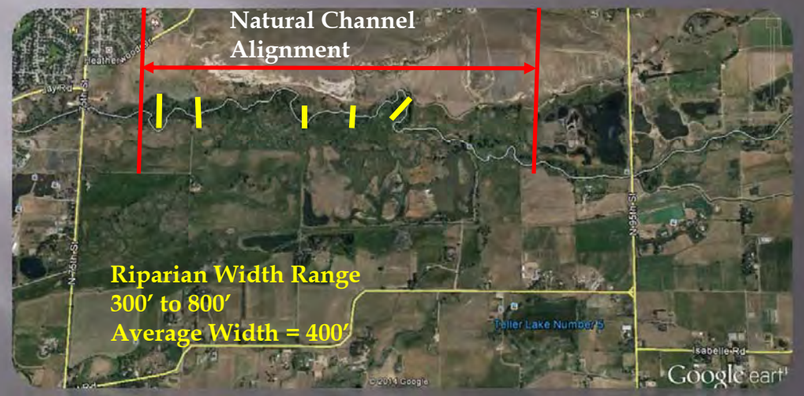
(Area downstream of N. 75th Street is likely a good example of Boulder Creek functioning in its natural geomorphic state)



Ideal Restoration Objectives

- Allow the stream to replicate natural conditions
- No single "correct" alignment as the stream has migrated across a wide valley in response to flow and sediment load as is evident by aerial photos and recent gravel operations
- Create a bankfull channel cross section to contain flows during normal conditions
- Allow the stream to access its floodplain approximately every other year
- Provide a riparian zone that is protective of the stream and provides ecological benefits of an undisturbed natural corridor

Next Steps

- Development of Initial Alternatives
  - March – April 2015
  - Draft Reports Posted Online
- 1st Public Meeting

  Wednesday, March 18, 2015, 6:30 pm
  SW Weld County Annex
  4209 County Road 24.5
  Longmont, CO
- More Public Meetings with Subsequent Phases



ICONENGINEERING, INC.

Boulder Creek Master Plan
Progress Meeting
June 17, 2015 2 PM

City of Longmont Office
Meeting Minutes

Attendees:		
	Marianne Giolitto	*City of Boulder OSMP*
	Dan Wolford	*City of Longmont*
	Julie McKay	*Boulder County*
	Diane Malone	*Boulder County*
	Shea Thomas	*Urban Drainage and Flood Control District*
	Diana Aungst	*Weld County*
	Kristine Obendorf	*Boulder County*
	Varda Blum	*Boulder County*
	Katie Knapp	*City of Boulder*
	Steve Holwick	*Lyons Gaddis*
	Jesse Rounds	*Boulder County POS*
	Steve Stanish	*Town of Frederick*
	Mark Wilcox	*DHM Design*
	Craig Jacobson	*ICON Engineering, Inc.*
	Jeremy Deischer	*ICON Engineering, Inc.*

The Draft Alternatives Report Feedback items were discussed:

2A: Typos & Text Additions

- ICON is in the process of editing the report and addressing all comments. There was great input from the sponsors on the report.

2B/C: Ditch identification and names / Acknowledgment of ditch diversions, goal to maintain them

- Scott will work with ICON to identify the irrigation canals within each reach, which will be included in the report. ICON will provide a listing within the report and need to coordinate future projects with the canal companies.

2D: Acknowledgements of project participants

- The group discussed the inconsistencies for each of the project participants when listing their titles and departments. Julie will provide ICON the correct departments for the participants within Boulder County
- Shea noted the need to stay consistent with professional designations (P.E., CFM, etc.) whether they are listed for everyone or for no one.
- If anyone would like their professional designation changed from what appeared on the report, they will contact ICON and the report will be updated.

2E: City of Boulder OSMP – Grassland and Ecosystem Management Plan

- Marianne noted ICON should add the Ecosystem plan as a reference to the report

2F: Weld County involvement:

- Shea noted Weld County did review the draft alternatives report. Diana was present at this meeting.

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2I: Geomorphic questions / tables:

- ERC was not present at the meeting but Craig explained has spoken to them about the question relating to some of the items. Particularly, the stream loss over time table was intended to be read horizontally and not comparing the same reach for every time period. The table will be updated to avoid confusion.
- Shea asked for the aerial photos used in the comparisons to be included in the appendix and referenced in the text.

2K: Additional restoration alternatives

- Existing planned projects, which were not involved in the alternative analysis, will be included in the masterplan to assist with grant funding.

The team transitioned to discussing additional areas of focused:

3A: Referencing water users

- Water users were not specifically identified in the report. ICON will create a list of known irrigation canals in each reach for Scott to review. ICON will also add text to the report about the right to divert water along Boulder Creek.
- Scott noted that not all diverters are companies so there might not be individual points of contacts

3B: Map of breach areas

- Marianne will provide ICON with a map on the breach areas to include in the flood history of Boulder Creek.

3C: Climate change and uncertainty

- Shea noted that if climate change is discussed in the report, the UDFCD 2015 Climate Change White Paper should be referenced since it is more focused on the rocky mountain region than the FEMA study. Shea gave a brief summary stating the report found very little change to the 100-year storm but the likelihood of more frequent storms of lesser intensity.
- ICON will incorporate the UDFCD White Paper findings into the report as soon as the document becomes available.

3D: WCR 16.5 Restoration

- Scott detailed the problem area near WCR 16.5 where flow is being diverted to the northeast away from the Boulder Creek flowpath through a breach in the embankment. There have been repairs to the culvert underneath WCR 16.5 since it is not adequately sized to handle the diverted flows. Scott noted that the bridge at 16.5 did not contribute to the flooding but the low point east of the stream crossing was leading the roadway overtopping.
- Craig discussed this could be an area that a formalized inflow/outflow spillway could be applicable protecting the embankment. There is also the possibility of stream realignment, moving the bridge from its existing alignment to the low point where flows are overtopping the road, although it isn't the most feasible to implement in the future.
- Scott pointed out that downstream of WCR 16.5 the diversion structure at the Idaho Ditch, which impacts several other ditches, would have to be relocated if the stream alignment was changed. Scott outlined several parties are impacted by the flooding are interested in restoring the area, including the president of the water users group, and the home owners association.
- Craig explained how this could be the best area for restoration within Weld County besides the confluence with the St. Vrain Creek.
- After discussion of the 95th Street area it was decided to apply the same concept with the most feasible alternative in this area. This included restoration through the area including channel work to prevent future breaches but maintaining the existing bridge alignment.

3E/F: 95th St. Restoration

- Craig gave an overview of the area, outlining the perched bridge with the low point along occurring through the pond north of the existing alignment. The alternative report outlined two different possibilities for the area, keeping the existing alignment (with restoration) or realigning Boulder Creek to flow through the pond. Previously 95th Street was not identified as a location for a 100-year bridge alternative to be developed.
- Julie noted there may be a desire for a 100-year alternative to be developed for the 95th Street bridge.
- Craig noted the bridge is relatively new so prioritization for any alternative at 95th Street would be low relative to other areas.
- While the property east of 95th Street was flooded, Marianne did not believe any of their residential structures were impacted by the flooding.
- Shea questioned whether the recommended plan should focus on what is obtainable now by maintaining the existing bridge or allowing the stream to cross at the low point of 95th Street. She noted that even though the area is currently private property, that may not always be the case so it might benefit designing this alternative.
- Marianne asked whether there could be a third alternative where restoration to the creek around the pond is designed but the existing bridge is maintained.
- Shea stated the more feasible design, maintaining the existing bridge alignment, should be carried forward. ICON will investigate restoration opportunities in the area, while maintaining the bridge alignment.

3G: St. Vrain Confluence

- Dan outlined how the confluence of Boulder Creek and the St. Vrain Creek will occur future upstream on Boulder Creek. The confluence will now occur where flows breached the embankment during the September 2013 flood, shortening the overall length of Boulder Creek.

3H: Additional restoration from 61st to Valmont

- Craig described how general restoration costs will be added to this reach for grant funding.

3I: Keep or Remove Pond Protection on City of Boulder – Open Space

- The group discussed formalizing the inflow/outflow spillway structure proposed in the alternatives. Marianne states that the City of Boulder Open Space charter is only in favor of restoration, which may include taking down the gravel pit embankment and creating a floodplain terrace in the vicinity of the gravel pits. The spillways will be removed from City of Boulder Open Space and replaced with general stream restoration instead.

- The spillways are still applicable for gravel pits residing within Boulder County.

3J: Property owners near South Boulder Creek Confluence

- Craig detailed how an owner on South Boulder Creek would be an interested party to collaborate on a future projct. The property owner is interested in dredging the pond on his property and providing an overflow to protect the embankment.
- Craig noted another property owner that had reached out expressing interest in alternatives for Boulder Creek. This property owner was concerned about the floodway associated with the City of Boulder floodplain mapping update residing on his property. While not directly involved in this masterplan since it would only mitigate hazards to the floodway, Craig wanted to inform the sponsors about the interest and determine if an alternative was needed for this area.
- Shea described how there was an existing masterplan for the Boulder Creek and South Boulder Creek confluence. No alternative was needed at this time.

3M: Plan layout – orientation

- The project team discussed the orientation of the alternative maps if there was any confusion or a better way to identify alternatives
- The project team informed ICON the plan layout was straightforward and did not need any revision.

3N: Anything else

- The recent storms have led to frequent flooding of pedestrian underpasses in the City of Boulder. Katie will pass along the map identifying these areas for general problem ID maps. Craig and Shea explained the best way to treat sediment treating the source or including maintenance for the channel if the longitudinal slope can't be adjusted.
- Scott inquired about the Civic Center Masterplan and its relationship to this study. Katie noted that it was a separate entity from this masterplan. Craig noted that it was referenced in this report to direct anyone looking for information about the area to that masterplan.

4A: Phasing and Schedule for Public Meeting

- Shea described the schedule for the project. ICON will address all comments received from the draft alternative analysis report and submit the final alternative analysis to the sponsors. UDFCD and the sponsors then will create a selected plan for ICON to refine in the Conceptual Design phase noting any differences from the recommended plan.
- The group discussed whether the next public meeting should be held before or after the selected plan was issued. It was decided some of the alternative areas would be drafted by DHM prior to the public meeting to help the public visualize the selected plan.
- Mark described to the project team some of the media channels he has used to get great public involvement in past public meetings. He mentioned social media, sponsors websites, posters in key locations in addition to the mailers. The project team would further discuss strategies to gather public interest for the public meeting at the next progress meeting.

- The public meeting was estimated to be held in 8 weeks.

4B: Report Corrections / Formalize Selected Plan

- ICON will correct the alternative draft report and submit the final alternative analysis prior to the next progress meeting. Conceptual Design sketches will be developed after the next progress meeting, before the public meeting. After the public meeting is held the Conceptual Design Draft Report will be submitted.

4C: Conceptual Design Approach & Focal Locations

- The focal locations will be identified at the next progress meeting.

4D: Prioritization of Alternatives

- Craig described the process of prioritizing the projects that was very success on the Coal Creek Watershed Restoration Masterplan. Each project will be given individual ratings in several different categories creating a weighted average for ease of comparison. Craig will bring an example of the spreadsheet to the next meeting to review with the project team.

- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein. Failure to do so will constitute acceptance of these minutes as statements of fact in which you concur.

Minutes prepared by: Jeremy Deischer

Jeremy Deischer
ICON Engineering, Inc.

Date

Boulder Creek Master Plan
Progress Meeting
August 31, 2015

Boulder County Rembrandt Room
Meeting Minutes

Attendees:	Julie McKay,	Boulder County
	Diane Malone,	Boulder County
	Annie Noble,	City of Boulder
	Dan Wolford,	City of Longmont
	Kristine Obendorf,	Boulder County
	Scott Holwick,	Lyons Gaddis
	Mark Monger,	Lower Boulder Ditch
	Marianne Giolitto,	City of Boulder OSMP
	Shea Thomas,	UDFCD
	Mark Wilcox,	DHM Design
	Craig Jacobson,	ICON Engineering
	Jeremy Deischer,	ICON Engineering

1) INTRODUCTIONS

- Mark Monger introduced himself to the project team. He contacted Craig recently and represents the Lower Boulder Ditch as well as the Wheeler Ranch property.

2) ALTERNATIVES REPORT

- ICON has updated the DRAFT Alternative Analysis report since the prior meeting and has submitted a revised version to project stakeholders. There were three areas remaining to discuss:
- 95th Street:
  - Julie informed the project team that 95th Street overtopped during a storm in late May 2015. A 100-year crossing structure alternative at 95th was not a priority when speaking to the Boulder County Transportation group in the past because the overtopping, originally witnessed in September 2013, seemed to be infrequent. Julie passed along a series of emails to ICON and Shea to update them of the conversation between the transportation department and Dave Skuodas of UDFCD, as this conclusion may have changed and a 100-year crossing alternative may be of interest at this location.
  - Craig summarized the alternatives that had been proposed for 95th Street. At the previous progress meeting the project team discussed maintaining the current bridge alignment since the existing bridge is in good condition which would lead to a low prioritization ranking. Restoration could be implemented upstream of 95th Street to convey flows from the sump location, located north of the bridge, to the existing bridge location. Another alternative could be developed to add additional conveyance at the existing sump conveying flood flows underneath 95th Street with base flows continuing along the existing stream alignment. This alternative would require restoration downstream of 95th Street including property easements or acquisition to convey these flood flows back to the existing alignment.
  - Mark Monger informed the project team that keeping the existing bridge alignment should be a high priority as the existing diversion structure just downstream of 95th Street is very expensive and a high priority for the Lower Boulder Ditch Company. Scott Holwick pointed that while the base flow of Boulder Creek would still be intercepted by the Lower Boulder Ditch, the flood floods would bypass the diversion structure and could be a loss of water opportunity to water rights users downstream. Shea pointed out these flood flows would be conveyed underneath 95th Street instead of overtopping the roadway, and no flows would be diverted from the Lower Boulder Ditch.
  - Craig inquired about developing parallel conceptual designs for this area to better visualize the proposed alternatives and provide an opportunity of two alternate plans which to be carried forward after the completion of the master plan. Shea expressed concern of having two conceptual designs in the final master plan with the possibility of multiple entities implementing different aspects of the design.
  - ICON will meet with the Boulder County Transportation Department to clarify what is being proposed in the recommended plan. Any changes to the proposed plan that are developed in this meeting will be reported to the team at the next project meeting.
- Cordry Court
  - When selecting the recommended plan Cordry Court was linked to the Harvest House alternative. The Cordry Court alternative could be implemented separately from the Harvest House with grading of the Boulder Creek overbanks and trail realignment to eliminate the High Hazard Flood Zone located along Cordry Court. Property acquisition was evaluated but not included in the recommended plan due to a low BCA ratio.
  - Annie noted that the City generally has interest in acquisition for properties within the High Hazard Zone as a safety measure above and beyond the BCA computations. She confirmed the need to add conveyance by moving the trail away from the creek and that acquisition may help address both restoration in addition to eliminating the High Hazard Zone.
  - Craig suggested including the minimum improvement to eliminate the High Hazard along Cordry Court in the Selected Plan but to elaborate in the report that consideration could also be given to property acquisition in the high hazard location to address a life and public safety condition.
  - Annie asked for a brief explanation of what was being proposed for the Harvest House alternative
    - Craig detailed the alternative focused on removing the spill flow from Taft Drive by expanding the creek through relocation of the tennis courts and housing structures located along the south bank. Craig explained this alternative could be more easily implemented with the redevelopment of the area rather than a singular restoration alternative. The three structures located along the south bank west of the tennis courts had a relatively high BCA but they were contained within the Harvest House parcel so they were not separated into their own alternative.
  - Annie reiterated the safety issue concerning structures within a High Hazard Zone not taken into account when using the FEMA BCA Analysis tool.

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- Weld County / St. Vrain
    - Dan detailed the recent developments of Boulder Creek eroding the left bank further upstream diverting flows into the gravel ponds. Two alternatives were being developed for the St. Vrain / Boulder Creek confluence area. The first alternative would allow Boulder Creek to breach the banks and create a wetland area confluence where the two ponds currently exist. The second alternative would be to restore the eroding banks along Boulder Creek and maintain the existing confluence area. Craig showed the project team a preliminary rendering of the Boulder Creek restoration, which would restore the eroding channel banks in Reach 1. Dan noted his preference is what the rendering showed, by repairing the eroded banks.
    - Shea asked for the existing alignment to be added to the exhibits to see the differences in sinuosity between existing and proposed conditions. Dan will keep the project team informed of any decisions made about the area.

3) CONCEPTUAL DESIGN

- Craig outlined the seven areas chosen to represent the watershed in the Conceptual Design phase. The existing alignment will be shown on each of the renderings to differentiate between existing and proposed alignment and sinuosity. Shea pointed out these areas may not be the top prioritization for the master plan; they just represent the variety of the projects possible throughout the watershed.

4) PLAN FOR PUBLIC MEETING

- The team decided the Recommended Plan would be used in the public meeting allowing input from the public before developing the Conceptual Design.
- The team discussed the Boulder Creek FEMA PMR Open House meeting being held on September 16, 2015. Since this is strictly a floodplain meeting this was a good opportunity to raise awareness for the master plan public meeting, but this meeting would not be used in lieu of the public meeting.
- The public meeting will be scheduled as soon as possible to allow time for the mailing list to be sent out in advance of the meeting. The seven renderings representing the variety of projects throughout the watershed will be prepared for the public meeting.
- Shea will schedule the public meeting once a meeting place is agreed upon and notify the project team, tentatively scheduled for the week of September 28th – October 2nd.

5) PRIORTIZATION

- Craig described the prioritization process based on a weighted grading scale for each project. The weighted categories will differ between each reach to accommodate the priorities for each area throughout the watershed.
- Annie questioned whether prioritization was necessary given the differences in the proposed alternatives and the multiple entities that would be implementing different aspects of the plan. Shea asked for each prioritization to be separated by community within the report. The prioritization process will be a qualitative assessment between the different alternatives rather than the strict quantitative assessment, such as the one ICON completed on Coal Creek.
- Kristine suggested the alternatives be grouped into tiers to allow flexibility when choosing the order the implementation order.

- The group requested the ICON take a first stab at prioritization and the group could comment from that point forward.

6) NEXT STEPS

- Annie mentioned an upcoming WRAB meeting. Craig noted that he anticipated that the Draft Conceptual Design Report will be finalized before the Water Resources Advisory Board (WRAB) meeting on October 19 by approximately one week. He noted this may not give time to provide the completed draft document to WRAB in an information packet, usually due a few weeks prior. The schedule for WRAB will be discussed further with the City following this meeting.

- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein. Failure to do so will constitute acceptance of these minutes as statements of fact in which you concur.

Minutes prepared by: Jeremy Deischer

Jeremy Deischer September 3, 2015
ICON Engineering, Inc.

Selected Plan for the Boulder Creek Restoration Master Plan

September 14, 2015

The *Selected Plan* for Boulder Creek agreed upon by Boulder County (*Boulder Co*), City of Boulder (*Boulder*), City of Longmont (*Longmont*) and the Urban Drainage and Flood Control District (*UDFCD*) (hereinafter *Boulder Co, Boulder, Longmont and UDFCD* shall jointly be referred to as "*Sponsors*") to be shown by ICON Engineering, Inc. (*ICON)* in the final *Boulder Creek Restoration Master Plan* report (hereinafter called "*Final Report*") is described in general and specific terms below.

SELECTED PLAN AND DIRECTLY RELATED ISSUES

Unless specifically directed otherwise below, this *Selected Plan* to be shown in the *Final Report* essentially follows the recommendations made by *ICON* in the *Boulder Creek Restoration Master Plan Alternatives Report* dated July 2015 (hereinafter called "*Alternatives*") based on the primary goal of improving resiliency along Boulder Creek.

ICON is asked to address all items that are specified to be addressed in the *Final Report* as described in the agreement between *UDFCD* and *ICON* for this project, which includes developing, describing and showing a conceptual design based on the Recommended Plan in the *Alternatives*, with the following exceptions:

1. Recommended alternatives for Reaches 5(F) and 5(G) at 95th Street, pending project discussion between ICON and Boulder County engineering staff. Boulder County would like a comprehensive explanation of current conditions, analysis conducted during master planning, and reasons for recommendations (refer to original draft alternatives analysis comments/questions submitted).
2. Evaluate the new alignment of Boulder Creek in Longmont after the May 2015 storm event and adjust the plan accordingly.
3. Recommend alternatives for reach adjacent to Cordry Court pending project discussion between ICON and City of Boulder staff.

Also show and describe all recommended facilities, costs and actions on a reach-by-reach of the drainageway. In general, the *Final Report* shall provide, show, and recommend the following:

1. Under a section in the *Final Report* titled "General Recommendations", recommend:
   a) That the controlling jurisdictions take steps to stabilize all major waterways when their watershed urbanizes, rehabilitate existing degraded reaches of the waterways and their tributaries, and aggressively control erosion and sediment transport during construction activities.
   b) That Sponsors and any other jurisdiction having land use control powers in this watershed require new land development and significant redevelopment and publicly funded projects to provide to the maximum extent practicable runoff volume control practices (i.e., minimize directly connected impervious areas and employ infiltrating permanent BMPs) whenever site conditions permit.

   c) That the controlling jurisdictions take steps to require that permanent BMPs for all new development, redevelopment, and publicly funded projects provide to the maximum extent practicable a Water Quality Capture Volume (*WQCV*) as recommended in the Urban Storm Drainage Criteria Manual – Volume 3, after accounting for volume reductions achieved using volume control practices as recommended under Item 1.b above.
   d) That jurisdictions having land use control powers in this watershed continue to implement their floodplain management regulations, including regulation of the 100-year floodway and floodplain.

      Recommend that these jurisdictions adopt a policy, if not already done so, of preserving the defined floodplains as open spaces to the maximum extent possible and that at least 1-foot freeboard be provided for the lowest floor above the 100-year flood elevation shown on the latest flood hazard area delineation or FIRM maps for all human occupied structures built adjacent to, or within, the defined 100-year floodplains. NOTE: Freeboard requirements in Boulder County Land Use Code apply for structures that have some portion within the designated 100-year floodplain (no reference to adjacent).
   e) That all jurisdiction having land use control powers in this watershed continue to participate in FEMA's flood insurance Community Rating System and public education programs.
2. List on the plan view and profile sheet of the conceptual design, where appropriate, the recommended wetland mitigations that will be needed to implement recommended improvements, if any.
3. Using input from stakeholders and the public, work with *Sponsors* and other affected local jurisdictions to prioritize the recommended facilities and actions that are listed in the *Final Report* and clearly articulate them in that document.
4. Describe the recommended type and schedule of maintenance activities for all improved facilities recommended in the *Final Report*.
5. Consider the various functions of all natural waterways in the study watersheds and their floodplain, including flood conveyance, riparian habitat, open space, aesthetics, recreation, urban development, water quality, utility crossing, transportation and other features.
6. Acknowledge in the *Final Report*, that land-use changes to the contributing watersheds affect the flood hazard nature (i.e., runoff rates, volumes and depths), the transport of sediment, and the water quality of the receiving natural waterways.

EXECUTIVE SUMMARY

Include an Executive Summary in the *Final Report* written in plain, non-technical language, which is directed primarily at the general public and elected officials. This summary should, at the minimum, contain the following as well as other items listed in *UDFCD's* checklist for preparation of the final major drainageway plan conceptual design report:

1. A brief summary of the planning process including numbers of progress and public meetings.
2. A brief description of the decisions made by project sponsors during this project.
3. A brief summary of all design criteria specifically developed for this plan.

4. A brief summary of the following sections of the *Final Report*: Purpose and Scope, Study Area Description, Alternative Evaluation, Recommended Plan, and Conceptual Design.
5. A map showing the area and all recommended improvements.
6. Tabular and narrative summaries of costs showing costs for capital improvements, engineering/administrative/contingencies, and land values, all sorted by drainageway, reach, tributary, and by jurisdiction. The reach length (miles), tributary catchment area (square miles), and their totals should also be included in the table.

Incorporate the following notes on each drawing:

"*This drawing is for master planning purposes and represents preliminary and conceptual engineering. Alternatives will be considered by local agencies and the Urban Drainage and Flood Control District provided the alternative offers an equivalent intent of the plan, including hydraulic capacity, water quality, stream stability and natural waterway features. The alternative must comply with all requirements of the local jurisdiction and the Urban Drainage and Flood Control District. In addition, there may be State and Federal requirements that will need to be considered and met. This drawing does not provide a final design and shall not be used for construction purposes.*"

"*Many activities that occur in or affect ditches, drainages, creeks, ponds or wetlands require a Section 404 Permit Authorization from the US Army Corps of Engineers. During preliminary design, and prior to final design or starting work, contact the Corps' Denver Regulatory Office at 303-979-4120 for appropriate permit authority to avoid compromising and delaying the completion of the project.*"

ADDITIONAL DIRECTION

1. Unit costs should be updated to reflect the most current costs available using the UD-MP Cost worksheet.
2. Include an Acknowledgements section listing all participants and stakeholders in this study. Include in the list their name, organization and function in the planning process.
3. Show all maintenance access routes along all reaches. To the extent feasible, the alignment of these routes shall be coordinated with existing and planned recreational trails identified using input provided by Sponsors, special districts and other local stakeholders.
4. Summarize cost estimates of improvements by jurisdiction where those improvements are located, by the reach in which the improvements are located and overall project totals.
5. Report estimated costs for maintenance of all facilities, including detention ponds, storm sewer outfall points, grade control structures, etc. reported in the *Final Report.*

Boulder Creek Master Plan
95th Street Meeting – Boulder County
September 15, 2015

Meeting Minutes

Attendees:	Julie McKay,	Boulder County
	Varda Blum,	Boulder County
	Anne Pagano,	Boulder County
	Dave Webster,	Boulder County
	George Gerstle,	Boulder County
	Shea Thomas (phone),	UDFCD
	Craig Jacobson,	ICON Engineering

1) INTRODUCTIONS

- Introductions of the attendees were made.
- Shea Thomas joined the meeting by phone.

2) 95th Street

- Craig provided an overview discussion for the 95th Street crossing of Boulder Creek.
- Craig discussed the geometry of the 95th Street crossing and flooding aspects experienced in 2013 and for larger storm events. He explained how the existing bridge was perched and due to the low points in the roadway, the bridge itself only passed a small percentage of the 100-year discharge (3,000 cfs of 13,000 cfs).
- Craig noted that the original direction received from the County was that 95th Street did not require 100-year conveyance capacity from a transportation perspective. Subsequently, the County requested that ICON review 100-year alternatives for the area.
- Craig explained that ICON's current concept alternative incorporated: raising the roadway elevation above the 100-year level; adding a new 100-year bridge crossing; and providing stream restoration both upstream and downstream of 95th Street.
- Stream restoration would follow the topography of the area, extending through the 95th Street pond and across Boulder Valley Farms property where property may be needed.
- With this plan, the irrigation diversion would still follow the current alignment upstream of 95th Street, and flow through the existing bridge.
- At the last progress meeting, Julie noted that the roadway had also nearly overtopped earlier in 2015. Although the master plan does provide a recommendation for an ultimate solution in the area, the County was concerned with more regular flooding that may occur prior. She also noted that implementation of the master plan improvements would take time, given the need for additional property downstream of 95th; coordination with City of Boulder Open Space upstream of 95th, and the fact that the existing bridge was still relatively new.

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- It was suggested that an interim solution be developed that could address more frequent flooding at 95th, with objectives to maintain the current bridge and reduce the need for property acquisition.
- The group discussed options to raise the roadway by a more moderate level (approximately 2'). This would still allow overtopping, but reduce the frequency of occurrence.
- The group also discussed how water upstream of the roadway, in the 95th Street pond, could be redirected back to the main channel by installing an opening in the north bank upstream of the existing bridge.
- Finally, it was discussed that with this plan; the upstream channel sections would still be restored through City of Boulder Open Space property.
- Craig noted that with the roadway changes, flood elevation may increase upstream of 95th, the design would need to ensure that no impacts occur to upstream insurable structures. It was discussed that the stream restoration through City open space may also help mitigate flood impacts. The County would need to consider a combined project with the City.

3) CONCEPTUAL DESIGN

- The group discussed how to present this interim plan for 95th Street in the overall master plan.
- Shea suggested that the conceptual design reflect the interim solution, as that is what is most likely to be implemented by Boulder County. However, the master plan discussion and costs should still reflect more of an ultimate solution. With that said, ICON should still note the difference in cost for interim plan alone in the text.

- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein. Failure to do so will constitute acceptance of these minutes as statements of fact in which you concur.

Minutes prepared by:

Craig D. Jacobson — September 20, 2015
ICON Engineering, Inc.

Boulder Creek Master Plan
Progress Meeting
November 18, 2015

Boulder County Parks and Open Space Offices
Meeting Minutes

Attendees:	*Katie Knapp*	*City of Boulder*
	Julie McKay	*Boulder County*
	Shea Thomas	*Urban Drainage and Flood Control District*
	Marianne Giolitto	*City of Boulder OSMP*
	Claire DeLeo	*Boulder County*
	Dan Wolford	*City of Longmont*
	Mark Wilcox	*DHM Design*
	Craig Jacobson	*ICON Engineering*
	Jeremy Deischer	*ICON Engineering*

- Craig informed the project team the Water Resources Advisory Board (WRAB) meeting was held last night in the City of Boulder. The board unanimously recommended taking the study to council and for the council to approve pending including City comments.

Conceptual Design Report Feedback:

1A: Saint Vrain Confluence

- The group discussed the two comments received on the St. Vrain Creek Confluence Rendering. The report will be clarified that the confluence location will be on City of Longmont Open Space. The rendering will be updated to remove the property call out to avoid confusion.

2D: Modify Idaho Creek Ditch

- Scott Holwick, who was unable to attend the meeting, commented on the naming convention of the Idaho Creek Ditch. Scott notes the diversion structure at the confluence of Idaho Creek and Boulder Creek diverts water for five ditches that is conveyed through Idaho Creek but there is no Idaho Creek Ditch. The report references to Idaho Creek Ditch will be clarified and the team will coordinate with Scott before the final report is delivered.

3A: Stream Restoration Upstream of CO Rd. 16.5

- Scott Holwick provided a comment about the stream restoration and proposed spillway protection of the pond upstream of CO 16.5. Scott's comment clarified the breach is occurring is not occurring in the Williams Reservoir No.1, but an unnamed reservoir. Craig noted this would be revised in the report and protection would be included for the breeched reservoir.

4G: Stabilize Howell Ditch Diversion

- The team discussion a comment from Boulder County about lumping alternative 4G with alternative 4H for funding purposes. The team decided while the projects could be combined when applying for funding and implemented concurrently, for the purposes of this study the projects would remain as separate alternatives.

4F: Stream Restoration Though Doniphan, Wittemeyer Ponds, etc.

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- The priority of project 4H (Stream restoration through Doniphan, Wittemeyer Ponds, Bailey-Kenosha Ponds, and Open Space) will be raised to high priority due to the highly erosive slopes in the area.

4H: Kenosha Road Bridge

- The priority of Kenosha Road Bridge alternative was discussed. This structure was assigned a high priority by ICON due to the small existing bridge width providing minimal conveyance capacity compared to other roadway crossings. After discussion with the project team, the high priority will be maintained for consistency.

4J: 109th Street

- The Boulder County comment asking about removal of the bridge entirely was discussed. The team discussed how the crossing at 109th wasn't a high priority for access in the area. Craig explained previous discussions with Boulder County led the project team to believe there wasn't a desire to remove the structure entirely. Shea recommended including text in the report to evaluate the removal of the bridge in the future but maintaining the alternative of improving the bridge structure. The same note about evaluating whether to remove the bridge will be included at the Kenosha Road Bridge alternative.

4K: Stream Restoration through Wheeler Ranch

- The team discussed a comment asking to consider making the confluence of Boulder and Coal Creek plans compatible. Craig did not believe the Lower Boulder and Coal Creek Master plan included any recommendations for the confluence of Boulder Creek and Coal Creek. Although improvements to Coal Creek are outside of the scope of this study the project team will review the previous master plans for Coal Creek to verify whether any recommendations were provided for the confluence area.

5A: Alexander Dawson Open Space

- ICON will revise the stream alignment on the exhibits to eliminate the meander from going outside of the floodplain limits.
- Claire explained to the project team Boulder County has plans to restore a segment of the stream in Alexander Dawson Open Space that suffered damage

5G: 95th Street

- The team discussed a comment from Boulder County about the alternate alignment proposed upstream of 95th Street bisecting the pond. Craig described how the full restoration to a natural channel would remove the pond. Marianne added she was in favor of filling the pond to restore the natural floodplain with the alternate alignment. The report does not include a conceptual design for the alternate stream alignment but does include the 100-year bridge crossing as well as a cost estimate for the interim condition design.

5H: Stream Restoration from Upstream of 95th St. to White Rocks Trail

- This project will be changed from high priority to medium.

6B: 75th Street

- A comment was received from Boulder County questioning the replacement of the bridge. The team discussed the comment and decided to stay consistent with other roadway crossings and not suggest adding any culverts. Increasing the roadway elevation in conjunction with the bridge improvement would remove the low spot in the roadway that currently exists away from the bridge crossing.

7I: Stream Restoration from Valmont to 61st St.

- This project will be raised in priority from medium to high priority.

9E: Boulder Slough Diversion

- The comment about the Boulder Slough was from Scott Holwick explaining the different ditches that convey flow through the Boulder Slough. ICON will coordinate with Scott after the Boulder Slough has been further explained in the report.

9F: Sediment Maintenance along Boulder Creek

- Shea's comment was wondering if the source of sediment to be removed in project 9F was known. Craig explained his belief was the sediment was carried into the City of Boulder from the canyon as he did not know of any significant bank erosion within the City of Boulder. Katie agreed the source was most likely from the canyon as well as tributary's entering Boulder Creek as the creek moved downstream towards the city limits. Shea suggested clarifying in the report where the sediment was coming from.

Misc Comments:

UP Rail Trail Alignment

- Marianne and Boulder County provided revisions to the description of the UP Rail Trail as well as comments on the figure that will be revised.

Debris Removal around infrastructure guidelines

- Boulder County commented if there was a suggested standard or guideline as to distance to infrastructure for a removal zone. Craig explained he didn't believe there was a good guideline to include in the report as any specified distance wouldn't account for debris that would be carried downstream into this threshold. Craig noted clarification would be added to the report about the need to inspect these areas for debris around infrastructure.

Stream Centerline Alignment on renderings

- Scott provided a comment about the existing stream centerline not being an accurate depiction. The team will coordinate with Scott to clarify and address this comment.

Gravel Pit Spillway Report Clarification

- Marianne provided a comment to the clarify the report text that the City of Boulder Open Space and Mountain Parks charter requires the department to restore ecological systems to a natural system. The gravel pit spillways proposed, while alleviating flooding concerns, do not restore the natural floodplain. A section will be added to the report addressing restoration of the floodplain gravel pits is an option although not always desirable since it often requires eliminating the pond.

Description of Previous Reports

- Mark Wilcox will add descriptions of the other reports referenced in Section 4.3.

Stream Alignment

- Shea asked for clarification regarding the text description of relocating Boulder Creek further west in Reach 3. Craig explained the intent is to add separation between the creek and reservoir by returning the creek to a more historic alignment through the use of an oxbow. The report will be clarified to better explain what is being proposed.

Next Steps:

- ICON will revise the report to incorporate the comments received in the next few weeks. Shea noted she planned to present this report for adoption to the UDFCD board on December 19th.

- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein. Failure to do so will constitute acceptance of these minutes as statements of fact in which you concur.

Minutes prepared by: Jeremy Deischer

Jeremy Deischer
ICON Engineering, Inc.

November 19, 2015

BOULDER CREEK MDP
SIGN-IN SHEET

Date: September 16, 2015

NAME	Address	Contact Information	Would you like to be added to Mailing List? (Yes/No)
Dan Prince Need 9th St storm drain into Boulder Creek & 16th St	1605 17th St	Phone: 512 297 7787 E-mail: danofboulder@yahoo.com	Yes
TERRY SIVERLY	Box 5004 Vail, Co. 81658	Phone: 303-443-0077 E-mail: N224@me.com	
Robert Soden	636 Arapahoe Ave #10 Boulder 80302	Phone: 202-330-3006 E-mail: robert.soden@gmail.com	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	

ICON ENGINEERING, INC.

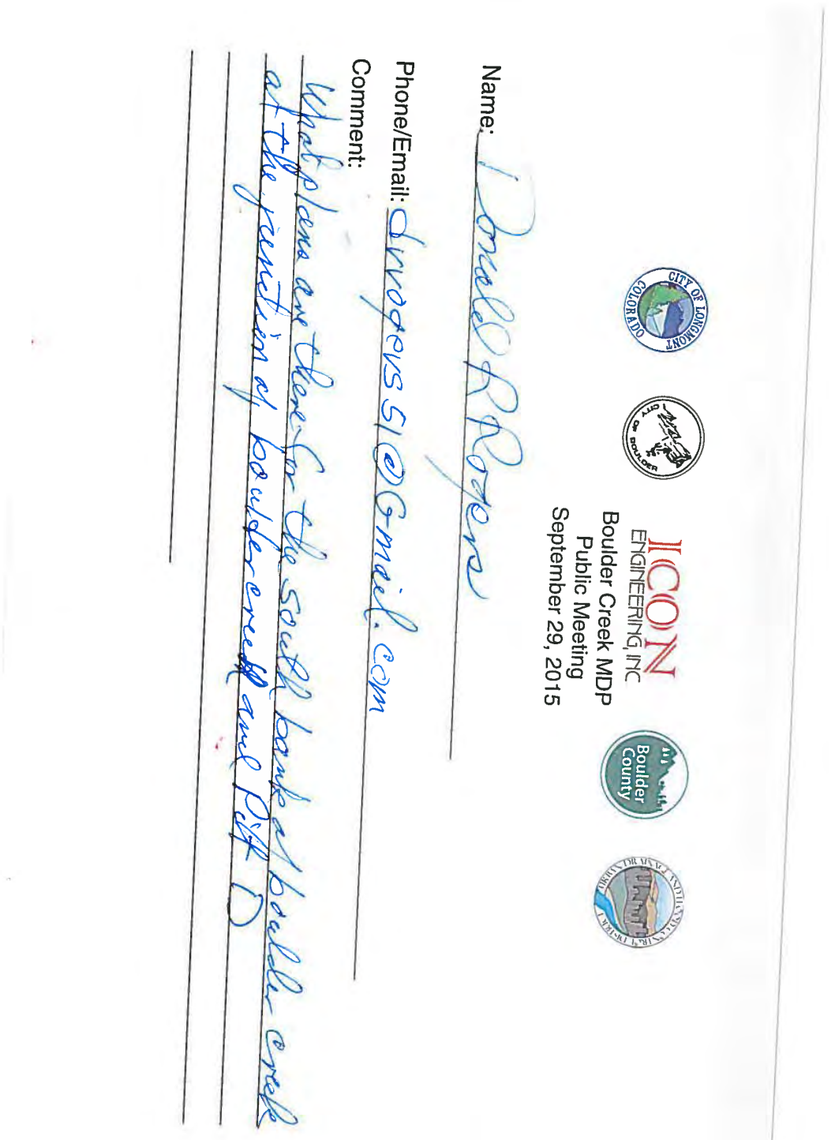
BOULDER CREEK MDP
SIGN-IN SHEET
Date: September 29, 2015

NAME	Address	Contact Information	Would you like to be added to Mailing List? (Yes/No)
Janice Lopitz	3842 Wonderland Hill Boulder CO 80304	Phone: E-mail: buzpitz@aol.com	Already on
Mike	1209 Illinois St. Golden CO 80401	Phone: 501 231-9035 E-mail: rmhanley47@gmail.com	
Les Williams	8876 Rogers Rd Longmont CO 80503	Phone: 720-684-8924 E-mail: coljwilliams@Gmail.com	
Don Rogers	5973 Indian Rd Boulder, CO 80302	Phone: 303-579-4519 E-mail: DRROGERS51@GMail.com	
TERRY SIVERLY	1750 30th ST 77F BOULDER, CO. 80301	Phone: 303-443-0077 E-mail: terrysiverly@mac.com.	Y
Dee Jay Smith	5909 NE Co Line Rd Erie, Co 80516	Phone: 303-652-2729 E-mail: rodeodj@g.com	Y
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	

ICON ENGINEERING, INC.

BOULDER CREEK MDP
SIGN-IN SHEET
Date: September 29, 2015

NAME	Address	Contact Information	Would you like to be added to Mailing List? (Yes/No)
G. Taylor	PO Box 20601 Boulder, CO 80308	Phone: 303.530.0858 E-mail: TaylorTaylor106@gmail.com	Yes
Mark Monger	5911 NE County Line Rd	Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	
		Phone: E-mail:	



Boulder Creek Website Email Distribution List (10/20/15)

Timestamp	Name	Email
2/3/2015 11:06:03	Shawn Roberts	robersh@yahoo.com
2/4/2015 7:29:49	Alan Bueltel	acbueltel@msn.com
2/4/2015 9:29:57	Erik Hartronft	erik@hapcdesign.com
2/4/2015 9:35:04	Don Rogers	drrogers51@gmail.com
2/5/2015 10:24:32	rob mccormack	troutrobert@gmail.com
2/14/2015 4:29:43	Tricia Olson	olynmawr@msn.com
2/17/2015 12:45:48	Don Rogers	drrogers51@gmail.com
2/17/2015 12:46:21	Scott E. Holwick	sholwick@lgkhlaw.com
2/17/2015 16:55:19	Burton Lee	4bslee@gmail.com
2/21/2015 15:22:30	Arthur Hacker	arthacker4@yahoo.com
2/26/2015 12:23:41	Dave Smoljan	ds261x@gmail.com
2/27/2015 13:53:16	g	gxxid@yahoo.com
3/3/2015 13:32:52	JM Seiler	jms569@msn.com
3/3/2015 14:47:37	Kim Hutton	huttonk@bouldercolorado.gov
3/6/2015 6:37:37	Dave Smoljan	ds261x@gmail.com
3/6/2015 8:09:05	Katie Knapp	knappk@bouldercolorado.gov
3/6/2015 14:32:09	Chuck Howe	Charles.Howe@Colorado.edu
3/9/2015 1:11:16	Avery	Aboodahbja@gmail.com
3/9/2015 9:10:40	Kim Cattau	kim.cattau@surroundarchitecture.com
3/9/2015 9:37:18	Dash	ash@scottcox.com
3/10/2015 10:41:40	Bret Linenfelser	linenfelserb@bouldercolorado.gov
3/10/2015 21:31:05	Jennifer Stanley	rolinj@yahoo.com
3/16/2015 13:21:33	taylor	sajama67@yahoo.com
3/17/2015 12:53:54	Mark Jordahl	mark@conservationconcepts.net
3/18/2015 23:47:35	Avery	Aboodahbja@gmail.com
3/21/2015 7:57:24	sue	baylor2000@comcast.net
3/23/2015 15:06:33	Brad Dallam	bradd@cityoflafayette.com
3/24/2015 19:55:05	Randy Ray	rray@ccwcd.org
4/6/2015 15:07:46	david rausch	dmr247@gmail.com
4/6/2015 15:55:42	Robert Queen	robert.queen@aecom.com
5/3/2015 9:43:23	Susan Iott	sei_rsp87@hotmail.com
5/14/2015 9:49:30	Garrett Varra	Gvarra@varracompanies.com
5/29/2015 8:00:54	David Rose	david@rosewoodconstruction.com
5/29/2015 12:06:01	Chad Pettrone	Chadpettrone@yahoo.com
7/28/2015 11:38:00	Jim Cowart, PE	jimcowartpe@gmail.com
9/14/2015 8:57:34	David Davia	d.davia@comcast.net
	John Mansell	tex2891@aol.com
	Alan Bueltel	acbueltel@msn.com
	Western Disposal Services	kbowar@westerndisposal.com
	Mark Fuller	mark_fuller@centurylink.net
	Bill Jancosko	bjancosko@timepiececapital.com
	David Rose	david@rosewoodconstruction.com
	Curt Parker	cparker@flatsurv.com
	Todd	toddmakescoffee@gmail.com
	Jeremiah Brodal	jbrodal@transwest.com
	Dan Prince	danofboulder@yahoo.com
	Terry Siverly	n224@me.com
	Robert Soden	rober.soden@gmail.com

Craig Jacobson <contact.boulder.creek@gmail.com>

Boulder Creek Project

2 messages

J. Erik Hartronft, AIA <erik@hapcdesign.com> Sun, Feb 1, 2015 at 5:01 PM
Reply-To: erik@hapcdesign.com
To: contact.boulder.creek@gmail.com

We own property adjacent to the Boulder Creek open space near the intersection of Kenosha Road and 115th Street, just northwest of Erie. I tried to use the interactive map, (Google Chrome browser) but no map or interactive tools were available on the link. Please keep my email on the list for updates. Thanks.

J. Erik Hartronft, AIA, LEED® AP

HARTRONFT ASSOCIATES, P.C.

Architecture - Planning - Interiors

950 Spruce Street, Suite 1A

Louisville, CO 80027

p. 303.673.9304

f. 303.673.9319

erik@hapcdesign.com

www.hapcdesign.com

Craig Jacobson <contact.boulder.creek@gmail.com> Wed, Feb 4, 2015 at 9:30 AM
To: erik@hapcdesign.com

Mr. Hartronft,
Thank you for your interest in the Master Plan. I am sorry the interactive map did not work. Maybe give it another try at a later point. I will add you to the contact list for further updates on the project. Thank you.

Craig D. Jacobson, P.E., CFM

Associate Principal

Craig Jacobson <contact.boulder.creek@gmail.com>

Lower boulder creek master plan

2 messages

Don Rogers <drrogers51@gmail.com> Sat, Jan 31, 2015 at 3:52 PM
To: contact.boulder.creek@gmail.com

Are you going to take in any public input before you present the drafts of your master plan? If there is to be public input, at what point is that going to occur?

Thank you.

Donald Rogers

Craig Jacobson <contact.boulder.creek@gmail.com> Wed, Feb 4, 2015 at 9:35 AM
To: Don Rogers <drrogers51@gmail.com>

Hello Don,
Yes w will be soliciting public input as part of the Master Plan process. We are in process of selecting dates for initial information meetings (likely in early March), and follow up meeting in the months after that. I will add you to the mailing list for when dates and new information is available. Please let me know if there are more questions. Thank you.

Craig D. Jacobson, P.E., CFM

Associate Principal

ICON ENGINEERING, INC.

8100 S. Akron Street | Suite 300 | Centennial, CO 80112

Office | 303-221-0802 | Website | www.iconeng.com

[Quoted text hidden]

Craig Jacobson <contact.boulder.creek@gmail.com>

Boulder Creek Master Plan Comment Response

1 message

Craig Jacobson <contact.boulder.creek@gmail.com> Fri, Feb 6, 2015 at 11:31 AM
To: tex2891@aol.com
Cc: vblum@bouldercounty.org

Hello John Mansell.
Thank you for your comment related to the Boulder Creek Master Plan study. Your comment regarding the home elevation is noted and will be passed on to the County. Please note that the 100-year floodplain represented on the exhibit map was derived from the current FEMA flood insurance study. This master plan study will consider flooding potential, but is not the mechanism to modify current floodplain limits shown on FEMA's mapping. I would suggest contacting Boulder County's floodplain administrator, Varda Blum, vblum@bouldercounty.org with question you may have regarding how you property relates to the current FEMA flood limits. Please let me know if you have further questions. I will add you to the list for additional communication regarding the Master Plan Study. Thank you.



--

Craig D. Jacobson, P.E., CFM

Associate Principal

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8100 S. Akron Street | Suite 300 | Centennial, CO 80112

Craig Jacobson <contact.boulder.creek@gmail.com>

Boulder Creek Master Plan Comment Response

2 messages

Craig Jacobson <contact.boulder.creek@gmail.com> Fri, Feb 6, 2015 at 11:38 AM
To: acbueltel@msn.com
Cc: KnappK@bouldercolorado.gov

Hello Alan Bueltel
Thank you for your comment related to the Boulder Creek Master Plan study. Your comment regarding the fallen tree will be passed on to the City of Boulder Staff. Please let me know if you have further questions. I will add you to the list for additional communication regarding the Master Plan Study. Thank you.



--

Craig D. Jacobson, P.E., CFM

Associate Principal

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Knapp, Katie <KnappK@bouldercolorado.gov> Fri, Feb 6, 2015 at 11:44 AM
To: Craig Jacobson <contact.boulder.creek@gmail.com>

Thanks, Craig.

Gmail by Google

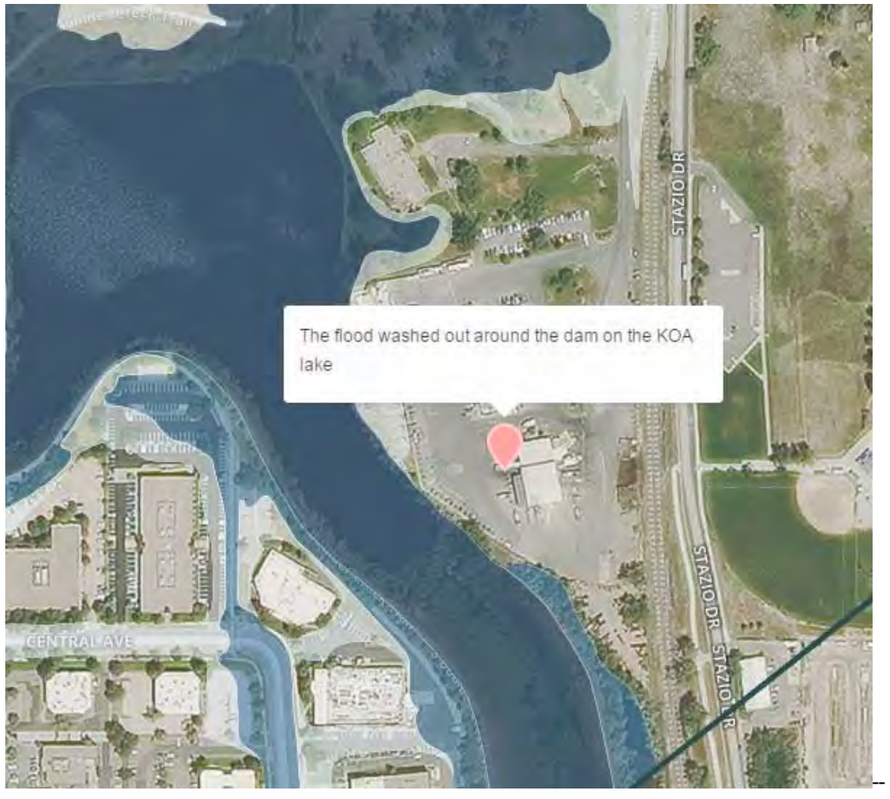
Craig Jacobson <contact.boulder.creek@gmail.com>

Boulder Creek Master Plan Comment Response

1 message

Craig Jacobson <contact.boulder.creek@gmail.com> Fri, Feb 6, 2015 at 11:44 AM
To: kbowar@westerndisposal.com

Hello Western Disposal Services.
Thank you for your comment related to the Boulder Creek Master Plan study. Your comment regarding the flooding is noted and we will let you know if we need more information. Please contact me if you have further questions. I will add you to the list for additional communication regarding the Master Plan Study. Thank you.



--

Craig D. Jacobson, P.E., CFM

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Gmail by Google

Craig Jacobson <contact.boulder.creek@gmail.com>

Boulder Creek Master Plan Comment Response

1 message

Craig Jacobson <contact.boulder.creek@gmail.com> Fri, Feb 6, 2015 at 12:15 PM
To: mark_fuller@centurylink.net

Hello Mark Fuller.
Thank you for your interest and comment related to the Boulder Creek Master Plan study. The purpose of the study is to provide technical and planning guidance to improve the resiliency of Boulder Creek. This master plan will provide general guidance for stream and ecological restoration along with conveyance improvements to crossing structures. This study will not re-evaluate the 100-year floodplain limits.

Given you proximity to the Creek, we welcome your participation and input regarding future planning activities. The master plan may consider future needs an changes to the riverine system as well as adjacent infrastructure such as 75th Street. I will add you to the list for additional communication regarding the Master Plan Study. Thank you.



--

Craig D. Jacobson, P.E., CFM

Associate Principal

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Office | 303-221-0802 | Website | www.iconeng.com

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Craig Jacobson <contact.boulder.creek@gmail.com>

Boulder Creek Master Plan Comment Response

1 message

Craig Jacobson <contact.boulder.creek@gmail.com> Fri, Feb 6, 2015 at 12:28 PM
To: bjancosko@timepiececapital.com
Cc: jmckay@bouldercounty.org

Hello Bill Jancosko,

Thank you for your comment related to the Boulder Creek Master Plan study. The purpose of the study is primarily to provide planning guidance for Boulder Creek, itself. However, your comment regarding the tributary creek is important and will be passed on to the County. I would suggest contacting Julie McKay, jmckay@bouldercounty.org with further question. I will add you to the list for additional communication regarding the Master Plan Study. Thank you.

--

Craig D. Jacobson, P.E., CFM

Associate Principal

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Craig Jacobson <contact.boulder.creek@gmail.com>

Boulder Creek Master Plan Update

Craig Jacobson <contact.boulder.creek@gmail.com> Thu, Mar 5, 2015 at 9:40 PM
To: contact.boulder.creek@gmail.com
Bcc: robersh@yahoo.com, acbueltel@msn.com, erik@hapcdesign.com, Donald Rogers <drrogers51@gmail.com>, troutrobert@gmail.com, olynmawr@msn.com, sholwick@lgkhlaw.com, 4bslee@gmail.com, arthacker4@yahoo.com, ds261x@gmail.com, gxxid@yahoo.com, jms569@msn.com, huttonk@bouldercolorado.gov, tex2891@aol.com, Kevin Bowar <kbowar@westerndisposal.com>, Mark Fuller <mark_fuller@centurylink.net>, bjancosko@timepiececapital.com, david@rosewoodconstruction.com, cparker@flatsurv.com

Hello Everybody.
Thank you for your interest and feedback regarding the ongoing Boulder Creek Master Plan Project. Beginning next week, project sponsors will be hosting a series of public information meetings. Details regarding the meetings are shown below, as well as on the project website at:

http://www.iconeng.com/project/boulder-creek/

Events

Boulder Creek Master Plan Public Information Meeting

Tuesday, March 10, 2015	Wednesday, March 18, 2015
6:30 pm	6:30 pm
City Municipal Services Center	SW Weld County Annex
5050 Pearl Street	4209 County Road 24.5
Boulder, Colorado	Longmont, Colorado

Join project sponsors to learn about a major drainageway planning study for Boulder Creek from Fourmile Creek to St. Vrain Creek. This master plan will provide general guidance for stream and ecological restoration along with conveyance improvements to crossing structures. This study will not re-evaluate the 100-year floodplain limits.

We look forward to seeing you you there. Thank you.

Craig D. Jacobson, P.E., CFM

Associate Principal

ICON ENGINEERING, INC.

8100 S. Akron Street | Suite 300 | Centennial, CO 80112

Office | 303-221-0802 | Website | www.iconeng.com

Craig Jacobson <contact.boulder.creek@gmail.com>

Comments on interactive map

2 messages

Susan Iott <sei_rsp87@hotmail.com> Sun, May 3, 2015 at 10:58 AM
To: "contact.boulder.creek@gmail.com" <contact.boulder.creek@gmail.com>

I just tried to add some comments to the map and they didn't save, so I'm sending them by email:

Broadway, Central Park in Boulder: The Boulder Whiterock/Lefthand ditch is also the start of Boulder Slough. Its gates were closed during the flood, but the creek flowed up the pedestrian path, around the gates, and back into the ditch. The ditch thus carried a lot more floodwater into the Goss-Grove neighborhood and was acting as a flood conveyance. That means the ditch, culverts, and bridges in the neighborhood should be improved to carry floodwater. Or there should be improvements made at the irrigation gates to keep the creek from flooding the ditch.

The city says the Boulder Creek flood was about a 25-year flood. At some point on Thursday night, at the peak of the flood, the news was filming off the Broadway bridge with the Gilbert White flood marker in the background. The water was higher than the 25-year mark--pretty close to the 50-year mark.

Your map shows floodwater covering almost all the area of 13th through 18th streets as covered by water. If this is the actual flood water, then most of the floodwater stayed in the streets/conveyance zones. Some of it came up into peoples' yards, but the area around 17th street was not covered by floodwater--the water camp up onto the sidewalk, but not further.

Boulder Slough/Whiterock/Lefthand ditch and 17th streets: There is a condominium on the edge of the ditch on the northeast corner. It has porches facing the slough/ditch and the building wall/porch wall is the same as the ditch wall. The water in the slough/ditch was higher than the floor of the first floor porches during the flood. If the flood had been higher, the water would have flowed into those units and potentially harmed the occupants. Boulder's floodmapping does not identify this as a high hazard unit, which seems improbable given the actual flood conditions.

Boulder Slough/Whiterock/Lefthand ditch and 19th-21st street: The slough/ditch takes a tight curve to go under Canyon St. at this point. The water flowed straight out of the ditch at this point, according to neighbors, and down the alley. There is a small house at this point that seems like it should be a high hazard house, but I don't believe it is identified by the city's floodmapping as high hazard.

Overall, Boulder doesn't have detailed floodmapping of the slough from Central Park to Canyon Boulevard--it just mapped the area after the flood and amended the Boulder Creek floodmap to add information from the neighborhood. The slough/ditch functions as a branch of Boulder Creek during floods. So some attention needs to be paid to how the slough/ditch functions as a conveyance zone and what will happen during higher floods.

Thanks for the opportunity to comment. I'm very interested in the study and the plan--I've been out of town for work over the last two months and am just getting a chance to catch up with what you're doing. If you have any information sessions coming up, I'd be interested in attending. I've signed up for email updates.

Susan Iott
1711 Grove St.
Boulder
(303) 572-7383 (work)
(303) 440-7058 (home)

Sent from my iPad

Craig Jacobson <contact.boulder.creek@gmail.com> Thu, May 28, 2015 at 11:15 AM

To: Susan Iott <sei_rsp87@hotmail.com>, KnappK@bouldercolorado.gov

Hello Susan.
Thank you for you email. I'm sorry the interactive map did not save for you. We have not had other public meetings other than the initial meetings. I anticipate that another round of meetings will be forthcoming after the project sponsors have an opportunity to review the current DRAFT report. The DRAFT Alternatives report is now available on the project website: http://www.iconeng.com/project/boulder-creek/ in the deliverable section. We did incorporate an alternative for the slough in the vicinity of 14th Street, to address the flooding that occurred in 2013. I believe this may relate to your concerns below.

Please let us know if you have other thoughts or questions. I have also relayed this email to Katie Knapp with the City of Boulder. Please look for additional information regarding upcoming meetings or activities via the mailing list.

Craig D. Jacobson, PE, CFM

Principal

ICON ENGINEERING, INC.

[Quoted text hidden]
--

Craig D. Jacobson, PE, CFM

Principal

ICON ENGINEERING, INC.

WE HAVE MOVED TO...

7000 S. Yosemite Street I Suite 120 I Centennial CO 80112

Ofc I 303-221-0802 I Web I www.iconeng.com I Email I cjacobson@iconeng.com

Gmail by Google

Craig Jacobson <contact.boulder.creek@gmail.com>

Boulder Creek Master Plan - Draft Alternatives Analysis

2 messages

Craig Jacobson <contact.boulder.creek@gmail.com> Thu, May 28, 2015 at 11:26 AM
To: robersh@yahoo.com, acbueltel@msn.com, erik@hapcdesign.com, Donald Rogers <drrogers51@gmail.com>, Robert McCormack <troutrobert@gmail.com>, olynmawr@msn.com, sholwick@lgkhlaw.com, Burton Lee <4bslee@gmail.com>, Arthur Hacker <arthacker4@yahoo.com>, Dave S <ds261x@gmail.com>, gxxid@yahoo.com, jms569@msn.com, "Farmers Ditch Co." <huttonk@bouldercolorado.gov>, knappk@bouldercolorado.gov, Charles.Howe@colorado.edu, Avery Ellis <Aboodahbja@gmail.com>, kim.cattau@surroundarchitecture.com, ash@scottcox.com, linenfelserb@bouldercolorado.gov, rolinj@yahoo.com, sajama67@yahoo.com, Mark Jordahl <mark@conservationconcepts.net>, baylor2000@comcast.net, bradd@cityoflafayette.com, rray@ccwcd.org, dmr247@gmail.com, robert.queen@aecom.com, Susan Iott <sei_rsp87@hotmail.com>, Gvarra@varracompanies.com, tex2891@aol.com, Kevin Bowar <kbowar@westerndisposal.com>, Mark Fuller <mark_fuller@centurylink.net>, bjancosko@timepiececapital.com, David Rose <david@rosewoodconstruction.com>, cparker@flatsurv.com, toddmakescoffee@gmail.com

Hello Again.
Thank you for your past interest and participation in the Boulder Creek Master Plan. We are pleased to announce that a DRAFT Alternatives Analysis Plan is available for review on the project website at:

http://www.iconeng.com/project/boulder-creek/

Please let us know if you have comments. We will continue to communicate with you regarding any upcoming public meetings for the project.

Thank you.
--

Craig D. Jacobson, PE, CFM

Principal

ICON ENGINEERING, INC.

WE HAVE MOVED TO...

7000 S. Yosemite Street I Suite 120 I Centennial CO 80112

Ofc I 303-221-0802 I Web I www.iconeng.com I Email I cjacobson@iconeng.com

Craig Jacobson <contact.boulder.creek@gmail.com> Thu, May 28, 2015 at 11:34 AM
To: Shea Thomas <sthomas@udfcd.org>, jmckay@bouldercounty.org, KnappK@bouldercolorado.gov, Dan.Wolford@ci.longmont.co.us

Just FYI, I did send this out to our contact list for the master plan, in case anyone gets questions on it, or you wish to forward it on to anyone else.
Thanks

Gmail by Google

Craig Jacobson <contact.boulder.creek@gmail.com>

Boulder Creek Mitigation

4 messages

Katherine Clifford <katie.clifford@colorado.edu> Mon, Jun 29, 2015 at 10:59 AM
Reply-To: katie.clifford@colorado.edu
To: contact.boulder.creek@gmail.com

Hi,

I am teaching a hazards class this summer at CU and was hoping to do a "scavenger hunt" of flood mitigation strategies. I was planning on having them look for"
-caution or information signs
-mitigated roads
-mitigated pedestrian bridges
-raised buildings
-flood walls
-protective berms
-flood water spillways and retention plans
-building relation
-warning sirens

I was wondering if there was a document that detailed all the different CURRENT mitigation actions on Boulder Creek? I have found documents about new proposed improvements, but less outlining the current ones that could be seen by someone today. Any help of suggestions for this project would be great.

Thanks,

--
Katie Clifford
Ph.D. Student
Department of Geography
University of Colorado
katie.clifford@colorado.edu

Craig Jacobson <contact.boulder.creek@gmail.com> Wed, Jul 1, 2015 at 7:34 AM
To: katie.clifford@colorado.edu

Hi Katie.
Thank you for the email, I will pass this on to some of our agencies working with us on the project and see if they have suggestions that come to mind. Interesting project and learning experience!

Craig

Craig D. Jacobson, PE, CFM

Principal

ICON ENGINEERING, INC.

WE HAVE MOVED TO...

7000 S. Yosemite Street I Suite 120 I Centennial CO 80112

Ofc I 303-221-0802 I Web I www.iconeng.com I Email I cjacobson@iconeng.com

[Quoted text hidden]
--

Craig D. Jacobson, PE, CFM

Principal

ICON ENGINEERING, INC.

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Ofc I 303-221-0802 I Web I www.iconeng.com I Email I cjacobson@iconeng.com

Craig Jacobson <contact.boulder.creek@gmail.com> Wed, Jul 1, 2015 at 7:36 AM
To: jmckay@bouldercounty.org, KnappK@bouldercolorado.gov, Shea Thomas <sthomas@udfcd.org>

Interesting email that came through this week. Any thoughts on what may help her out? Sounds like a fun scavenger hunt.....for engineers at least.

Craig
[Quoted text hidden]

Knapp, Katie <KnappK@bouldercolorado.gov> Tue, Jul 7, 2015 at 10:43 AM
To: Craig Jacobson <contact.boulder.creek@gmail.com>
Cc: External-McKay-Julie <jmckay@bouldercounty.org>, Shea Thomas <sthomas@udfcd.org>

I don't know of a map with this info, but I will contact her to let her know what we have.

From: Craig Jacobson [mailto:contact.boulder.creek@gmail.com]
Sent: Wednesday, July 01, 2015 7:37 AM
To: External-McKay-Julie; Knapp, Katie; Shea Thomas
Subject: Fwd: Boulder Creek Mitigation

[Quoted text hidden]

Gmail by Google

Craig Jacobson <contact.boulder.creek@gmail.com>

Boulder Creek Master Plan Update

Craig Jacobson <contact.boulder.creek@gmail.com> Thu, Sep 10, 2015 at 5:04 PM
To: robersh@yahoo.com, acbueltel@msn.com, erik@hapcdesign.com, Donald Rogers <drrogers51@gmail.com>, Robert McCormack <troutrobert@gmail.com>, olynmawr@msn.com, sholwick@lgkhlaw.com, Burton Lee <4bslee@gmail.com>, Arthur Hacker <arthacker4@yahoo.com>, Dave S <ds261x@gmail.com>, gxxid@yahoo.com, jms569@msn.com, "Farmers Ditch Co." <huttonk@bouldercolorado.gov>, knappk@bouldercolorado.gov, Charles.Howe@colorado.edu, Avery Ellis <Aboodahbja@gmail.com>, kim.cattau@surroundarchitecture.com, ash@scottcox.com, linenfelserb@bouldercolorado.gov, rolinj@yahoo.com, sajama67@yahoo.com, Mark Jordahl <mark@conservationconcepts.net>, baylor2000@comcast.net, bradd@cityoflafayette.com, Randy Ray <rray@ccwcd.org>, Rausch Eng <dmr247@gmail.com>, robert.queen@aecom.com, Susan Iott <sei_rsp87@hotmail.com>, Gvarra@varracompanies.com, David Rose <david@rosewoodconstruction.com>, Chadpettrone@yahoo.com, jimcowartpe@gmail.com, tex2891@aol.com, Kevin Bowar <kbowar@westerndisposal.com>, Mark Fuller <mark_fuller@centurylink.net>, bjancosko@timepiececapital.com, cparker@flatsurv.com, Todd Straughan <toddmakescoffee@gmail.com>, jbrodal@transwest.com
Bcc: Shea Thomas <sthomas@udfcd.org>, KnappK@bouldercolorado.gov, jmckay@bouldercounty.org, Dan.Wolford@ci.longmont.co.us, daungst@co.weld.co.us, Craig Jacobson <cjacobson@iconeng.com>

Hello.
Thank you for your interest and feedback regarding the ongoing Boulder Creek Master Plan Project. We wanted to inform you of an upcoming public information meeting on September 29th. Details regarding the meeting are shown below, as well as on the project website at:

http://www.iconeng.com/project/boulder-creek/

Events

Boulder Creek Watershed Master Plan Public Information Meeting
Tuesday, September 29, 2015
6:30 pm
City Municipal Services Center
5050 Pearl Street
Boulder, Colorado

Join project sponsors to learn about recommended alternatives for Boulder Creek from Fourmile Creek to St. Vrain Creek. This master plan will provide general guidance for stream and ecological restoration along with conveyance improvements to crossing structures. This study will not re-evaluate the 100-year floodplain limits.

Project Sponsors:
Urban Drainage and Flood Control District
Boulder County
City of Boulder
City of Longmont

We look forward to seeing you there. Thank you.

Craig D. Jacobson, PE, CFM

Principal

ICON ENGINEERING, INC.

7000 S. Yosemite Street I Suite 120 I Centennial CO 80112

INTERACTIVE MAP COMMENTS (AS OF 10/20/2015)

COMMENT 1
"Response" : "Email sent 2-6, copied Julie McKay",

"description" : "This feeder creek flooded to within 10 feet of our house. The sewers backed up into all our basements all the way down to the creek. The entire lower end of the golf course turned into one big lake. Will there be any help on this? ",
"email" : "bjancosko@timepiececapital.com",
"name" : "Bill Jancosko",
"phone" : "303-931-1025"

COMMENT 2
"Response" : "None Required",
"email" : "",
"name" : "",
"phone" : "",
"title" : ""

COMMENT 3
"Response" : "Email 2-6 Thank you",
"description" : "To what degree does this affect us?",
"email" : "mark_fuller@centurylink.net",
"name" : "Mark Fuller",
"phone" : "303.579.3238"

COMMENT 4
"Response" : "Email Response on 2-6, Copied Varda",

"description" : "This house is outside the 100y flood zone according to USGA. During the flood, water the water on this side of the creek rose about 12 feet but would have needed an additional 12+ vertical feet.to reach this home. ",
"email" : "tex2891@aol.com",
"name" : "John Mansell",
"phone" : "3034441237"

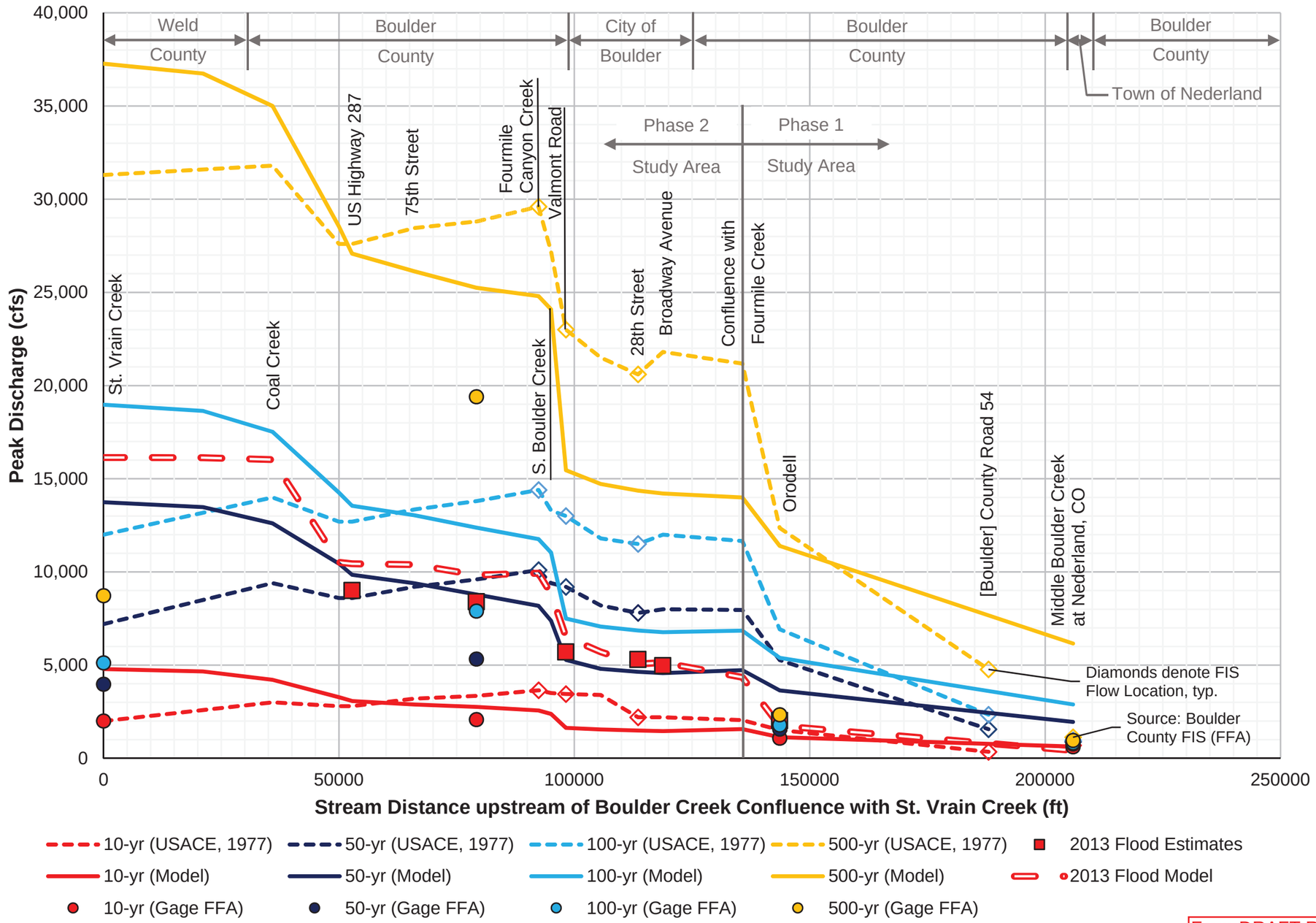
COMMENT 5
"Response" : "Email 2-6, Thank you",
"description" : "The flood washed out around the dam on the KOA lake",
"email" : "kbowar@westerndisposal.com",
"marker-color" : "#FFA6A6",
"name" : "Western Disposal Services",
"phone" : "303-210-0972"

COMMENT 6

APPENDIX C

DRAFT CDOT HYDROLOGY PROFILE

Figure ES-2 - Boulder Creek Peak Discharge Profiles

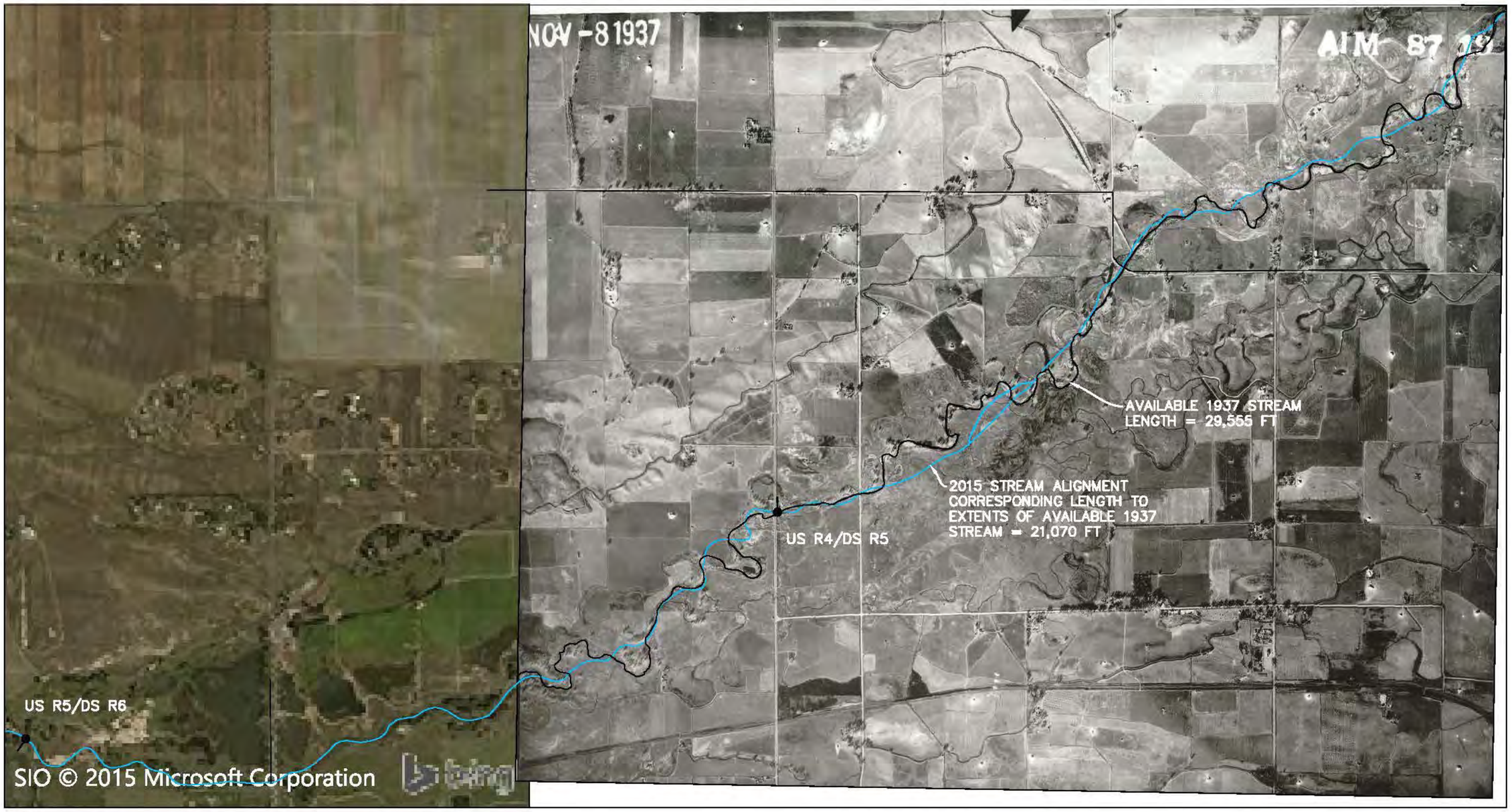


Note: FIS values derived from USACE, 1977 study, unless noted otherwise.

From DRAFT REPORT - Boulder Creek Hydrologic Analysis, Phase 2: Boulder Creek above St. Vrain Creek, Colorado Department of Transportation, CH2MHill, April 2015

APPENDIX D

HISTORIC INVESTIGATION & ALTERNATE RESTORATION ALIGNMENTS



REV	DATE	DESCRIPTION
A	07/07/15	ISSUED FOR INTERNAL REVIEW

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ECOLOGICAL RESOURCES CONSULTANTS, INC
35715 US HIGHWAY 40, SUITE D204
EVERGREEN, CO 80439

CLIENT
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D - 1

PROJECT
BOULDER CREEK RESTORATION
MASTER PLAN ALTERNATIVES
ANALYSIS

TITLE
1937 STREAM
ALIGNMENT

SHEET NO
1

C:\Users\Lisa\Dropbox (ERC Colorado)\ERC\01 PROJECTS\1005 Icon Engineering - Evergreen Files\1402 Boulder Creek Master Plan\CAD\PRODUCTION DWGS\01-1937-Boulder Creek_Historic_Routes.dwg, 7/6/2015 3:47:18 PM



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PROJECT
BOULDER CREEK RESTORATION
MASTER PLAN ALTERNATIVES
ANALYSIS

TITLE
1949 STREAM
ALIGNMENT

SHEET NO
2

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PROJECT
BOULDER CREEK RESTORATION
MASTER PLAN ALTERNATIVES
ANALYSIS

TITLE
1955 STREAM
ALIGNMENT

SHEET NO
3

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PROJECT
BOULDER CREEK RESTORATION MASTER PLAN ALTERNATIVES ANALYSIS

TITLE
1963 STREAM ALIGNMENT

SHEET NO
4

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BOULDER CREEK RESTORATION
MASTER PLAN ALTERNATIVES
ANALYSIS

TITLE
1969 STREAM
ALIGNMENT

SHEET NO
5

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PROJECT
BOULDER CREEK RESTORATION
MASTER PLAN ALTERNATIVES
ANALYSIS

TITLE
HISTORIC STREAM LENGTHS NORMALIZED
PER 1949 STREAM ALIGNMENT LENGTH

SHEET NO
6

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D - 7

PROJECT
BOULDER CREEK RESTORATION
MASTER PLAN ALTERNATIVES
ANALYSIS

TITLE
BOULDER CREEK EXISTING
ROUTING AND REACHES
SHEET 1 OF 7

SHEET NO
7

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PROJECT
BOULDER CREEK RESTORATION
MASTER PLAN ALTERNATIVES
ANALYSIS

TITLE
BOULDER CREEK EXISTING
ROUTING AND REACHES
SHEET 2 OF 7

SHEET NO
8

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PROJECT
BOULDER CREEK RESTORATION
MASTER PLAN ALTERNATIVES
ANALYSIS

TITLE
BOULDER CREEK EXISTING
ROUTING AND REACHES
SHEET 3 OF 7

SHEET NO
9

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PROJECT
BOULDER CREEK RESTORATION
MASTER PLAN ALTERNATIVES
ANALYSIS

TITLE
BOULDER CREEK EXISTING
ROUTING AND REACHES
SHEET 4 OF 7

SHEET NO
10

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REV	DATE	DESCRIPTION
A	07/07/15	ISSUED FOR REVIEW

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PROJECT
BOULDER CREEK RESTORATION
MASTER PLAN ALTERNATIVES
ANALYSIS

TITLE
BOULDER CREEK EXISTING
ROUTING AND REACHES
SHEET 5 OF 7

SHEET NO
11

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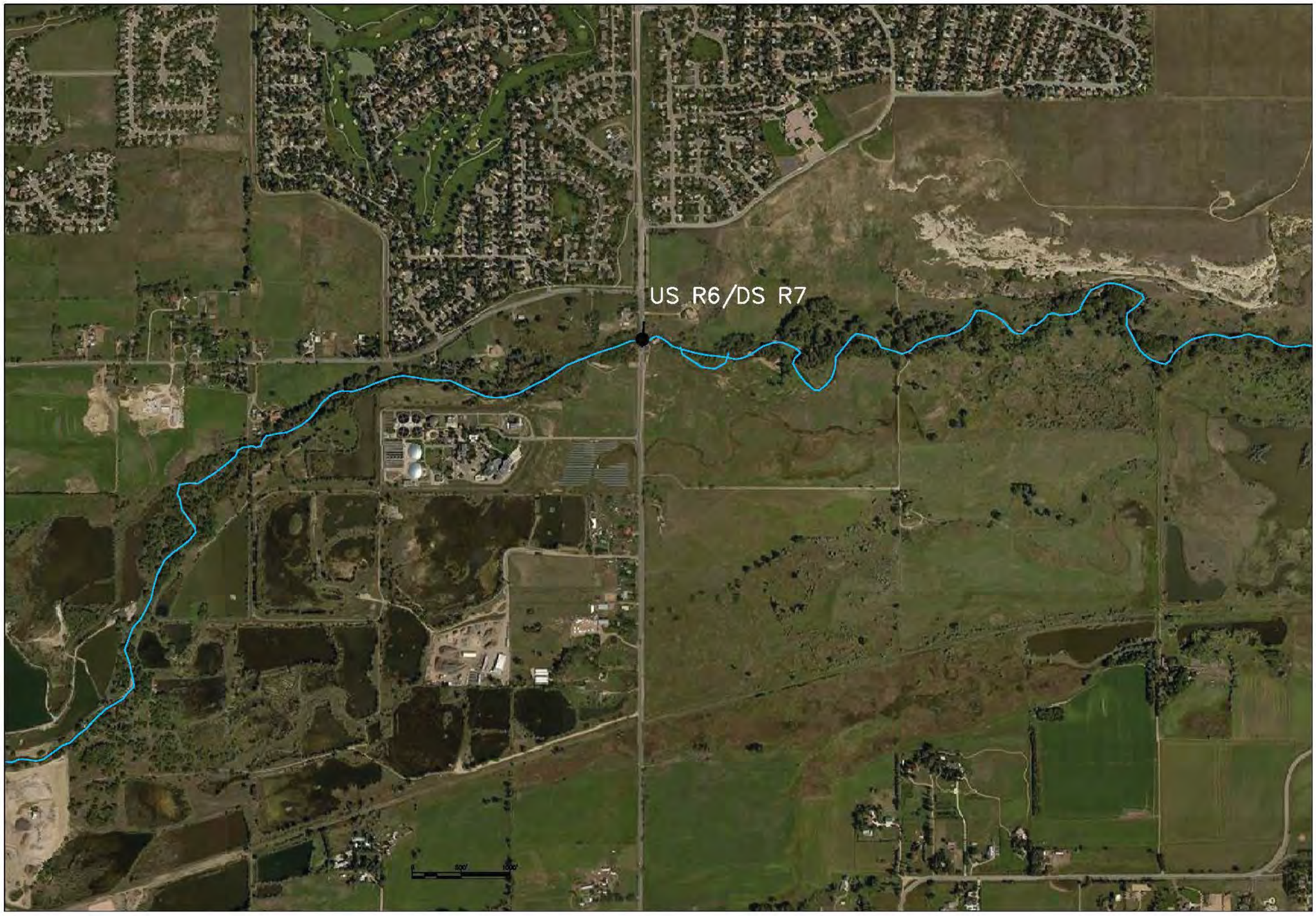

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A	07/07/15	ISSUED FOR REVIEW

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EVERGREEN, CO 80439

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PROJECT
BOULDER CREEK RESTORATION
MASTER PLAN ALTERNATIVES
ANALYSIS

TITLE
BOULDER CREEK EXISTING
ROUTING AND REACHES
SHEET 6 OF 7

SHEET NO
12

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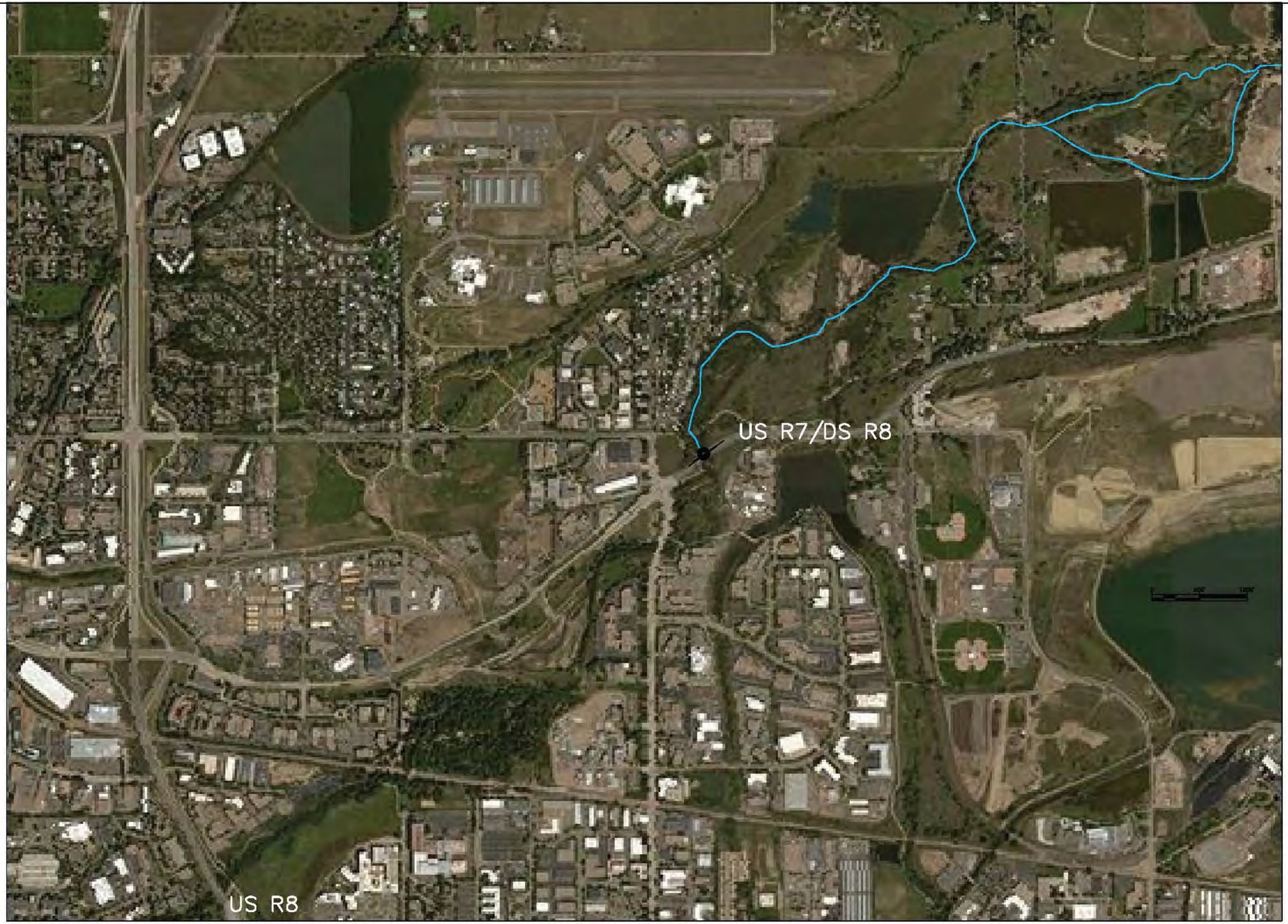

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PROJECT
BOULDER CREEK RESTORATION
MASTER PLAN ALTERNATIVES
ANALYSIS

TITLE
BOULDER CREEK EXISTING
ROUTING AND REACHES
SHEET 7 OF 7

SHEET NO
13

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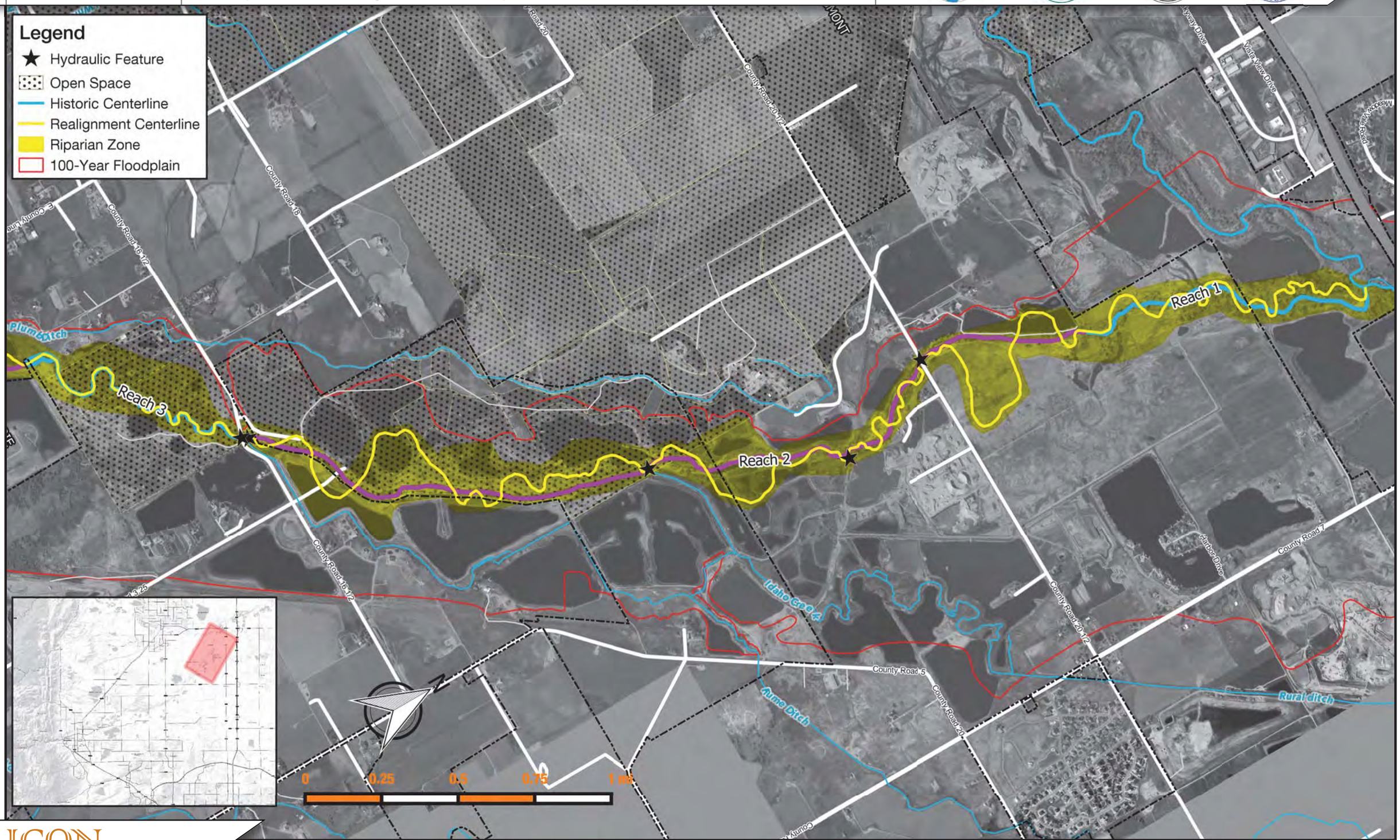
May 2015

Exhibit D-A(1)

Boulder Creek Restoration Master Plan

Conceptual Stream Alignments - Unimpacted Stream System



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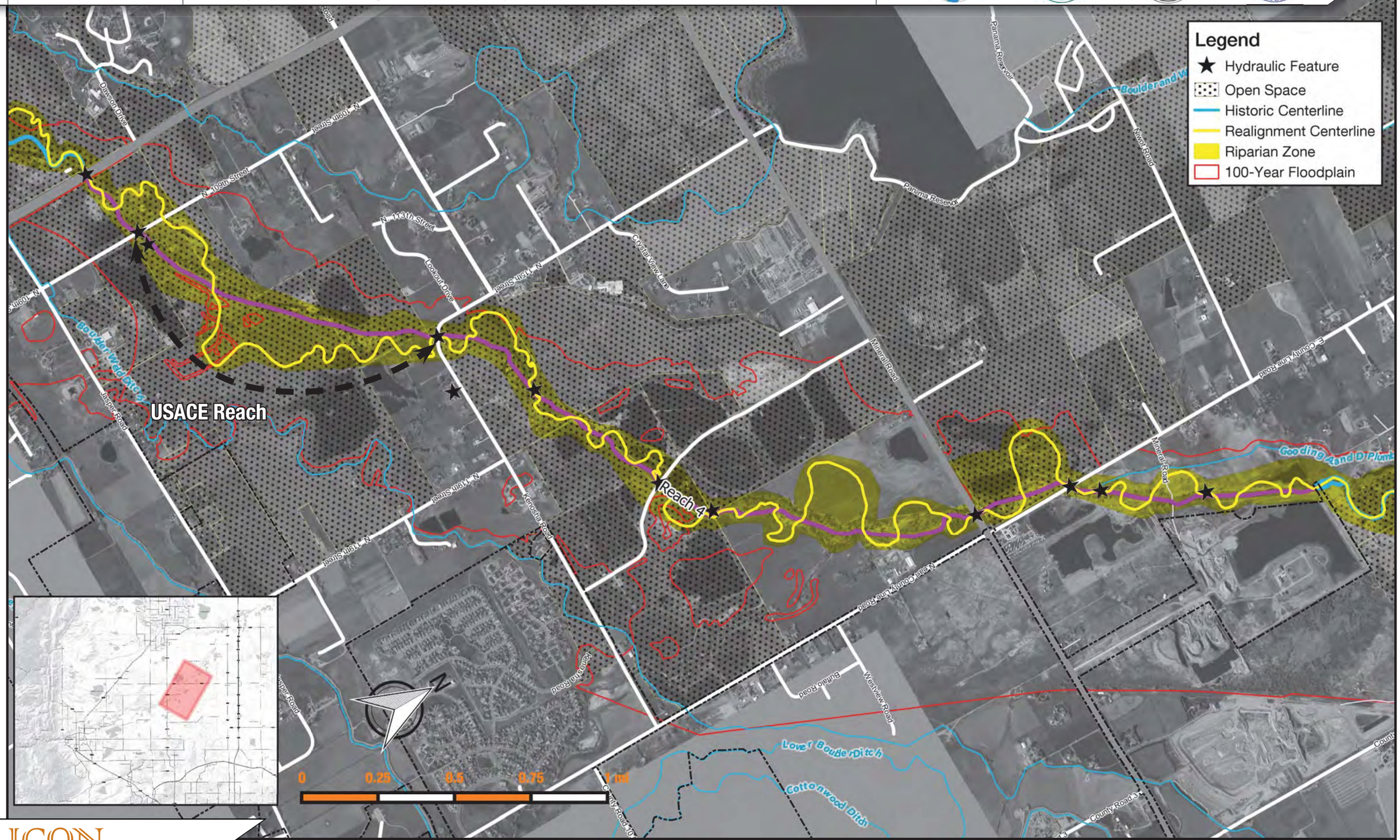
May 2015

Exhibit D-A(2)

Boulder Creek Restoration Master Plan

Conceptual Stream Alignments - Unimpacted Stream System

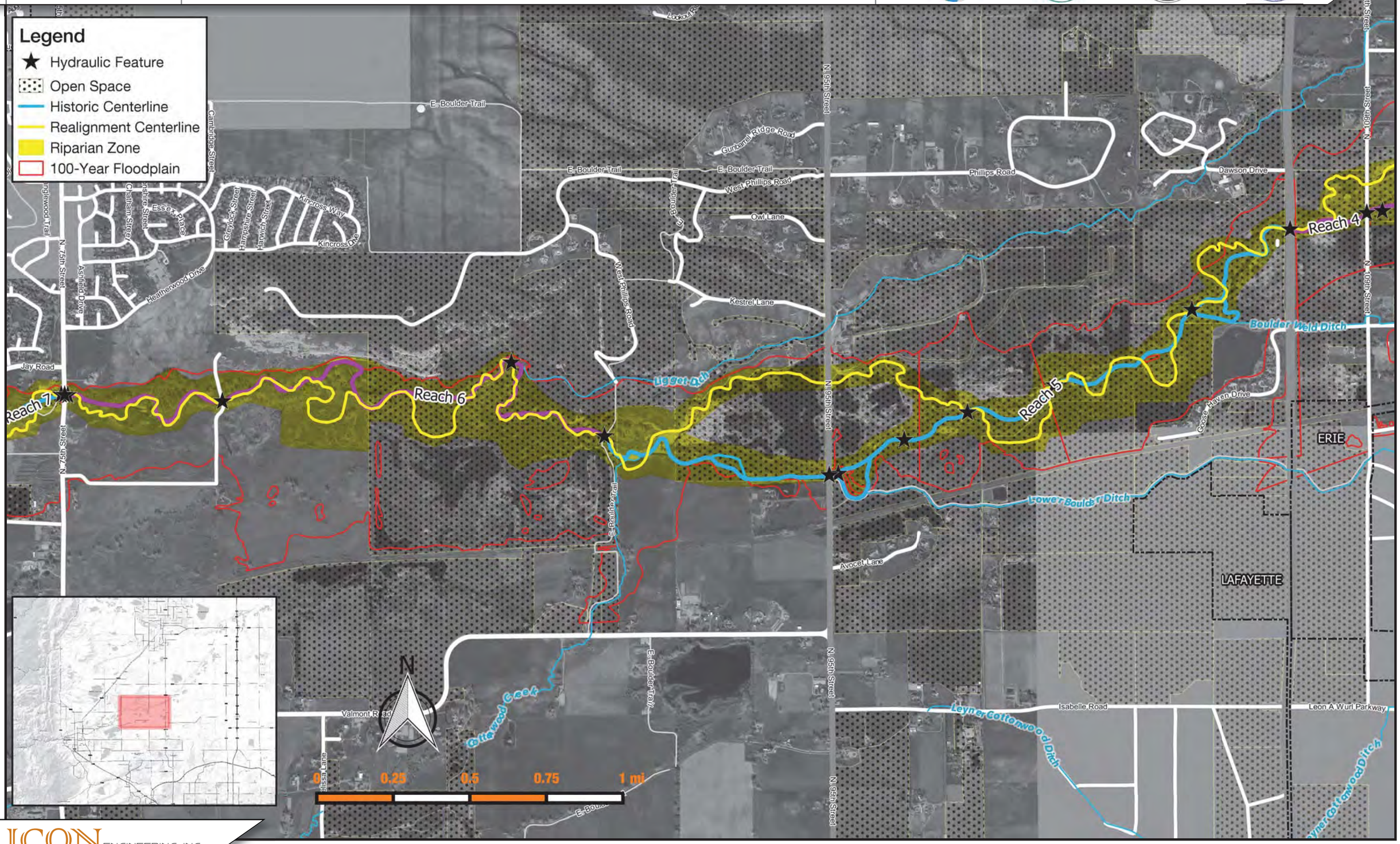


May 2015

Exhibit D-A(3)

Boulder Creek Restoration Master Plan

Conceptual Stream Alignments - Unimpacted Stream System

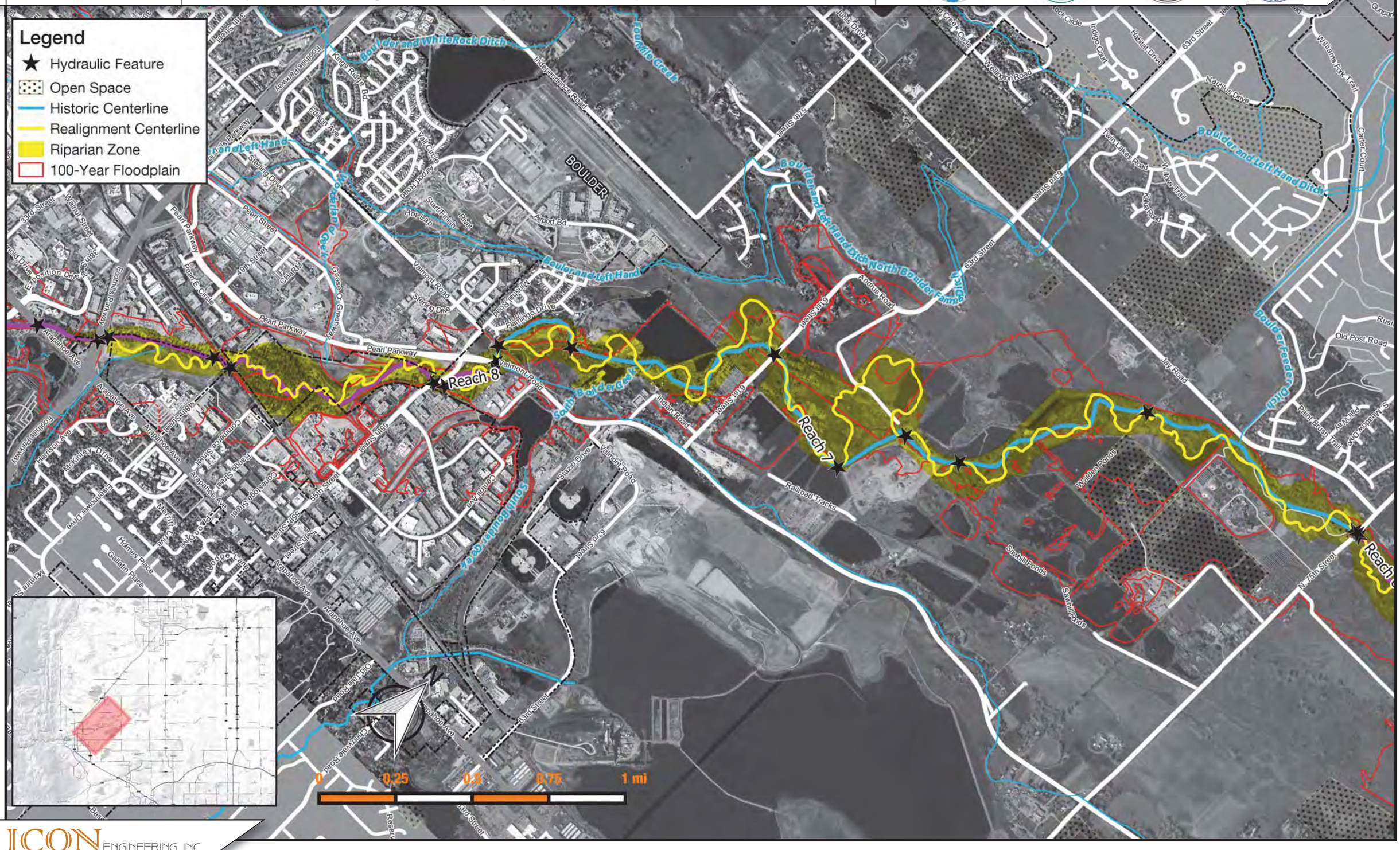


May 2015

Exhibit D-A(4)

Boulder Creek Restoration Master Plan

Conceptual Stream Alignments - Unimpacted Stream System

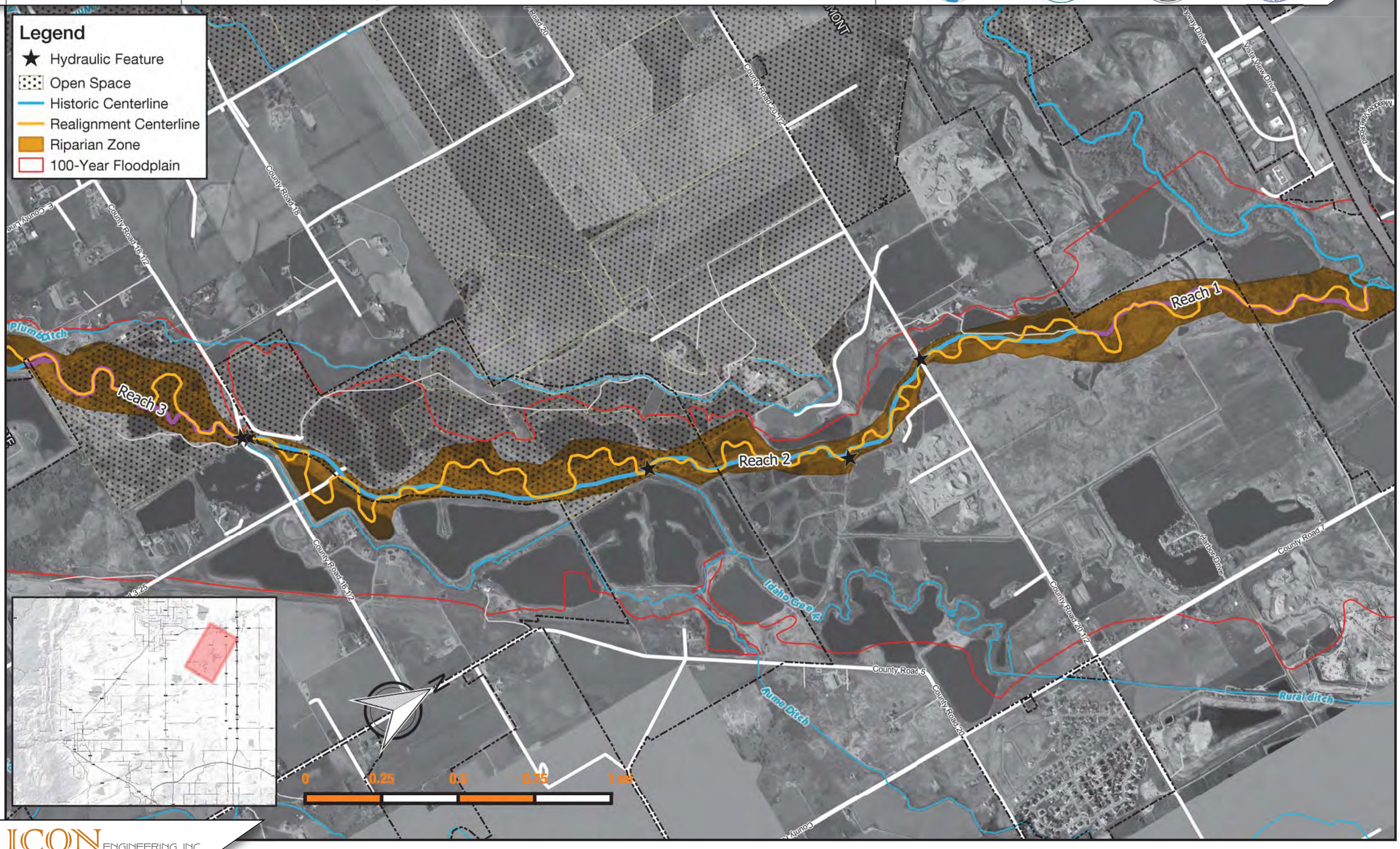


May 2015

Exhibit D-B(1)

Boulder Creek Restoration Master Plan

Conceptual Stream Alignments - Confined Stream System



ICON ENGINEERING, INC.

May 2015

Exhibit D-B(2)

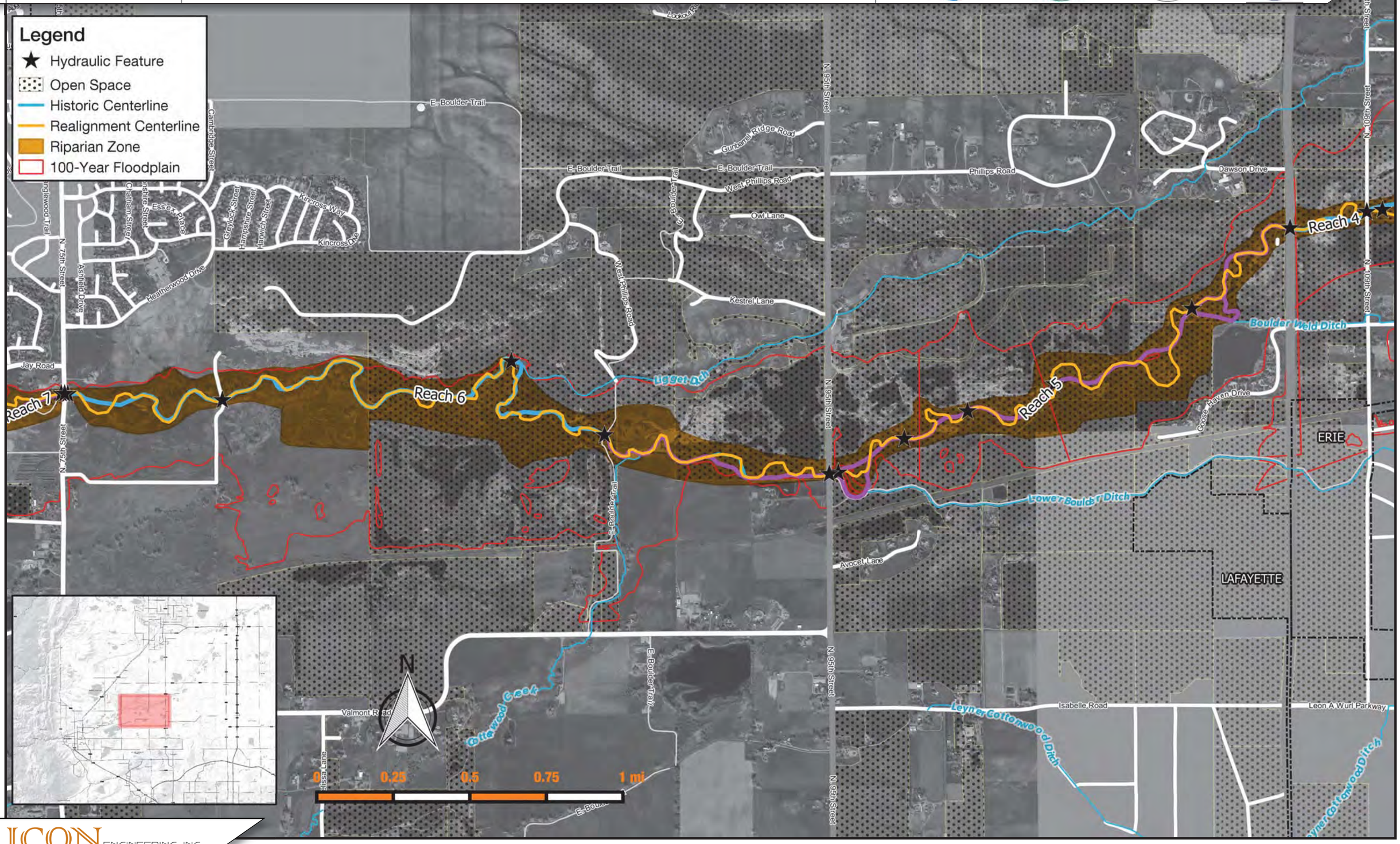
Boulder Creek Restoration Master Plan

Conceptual Stream Alignments - Confined Stream System



Boulder Creek Restoration Master Plan

Conceptual Stream Alignments - Confined Stream System

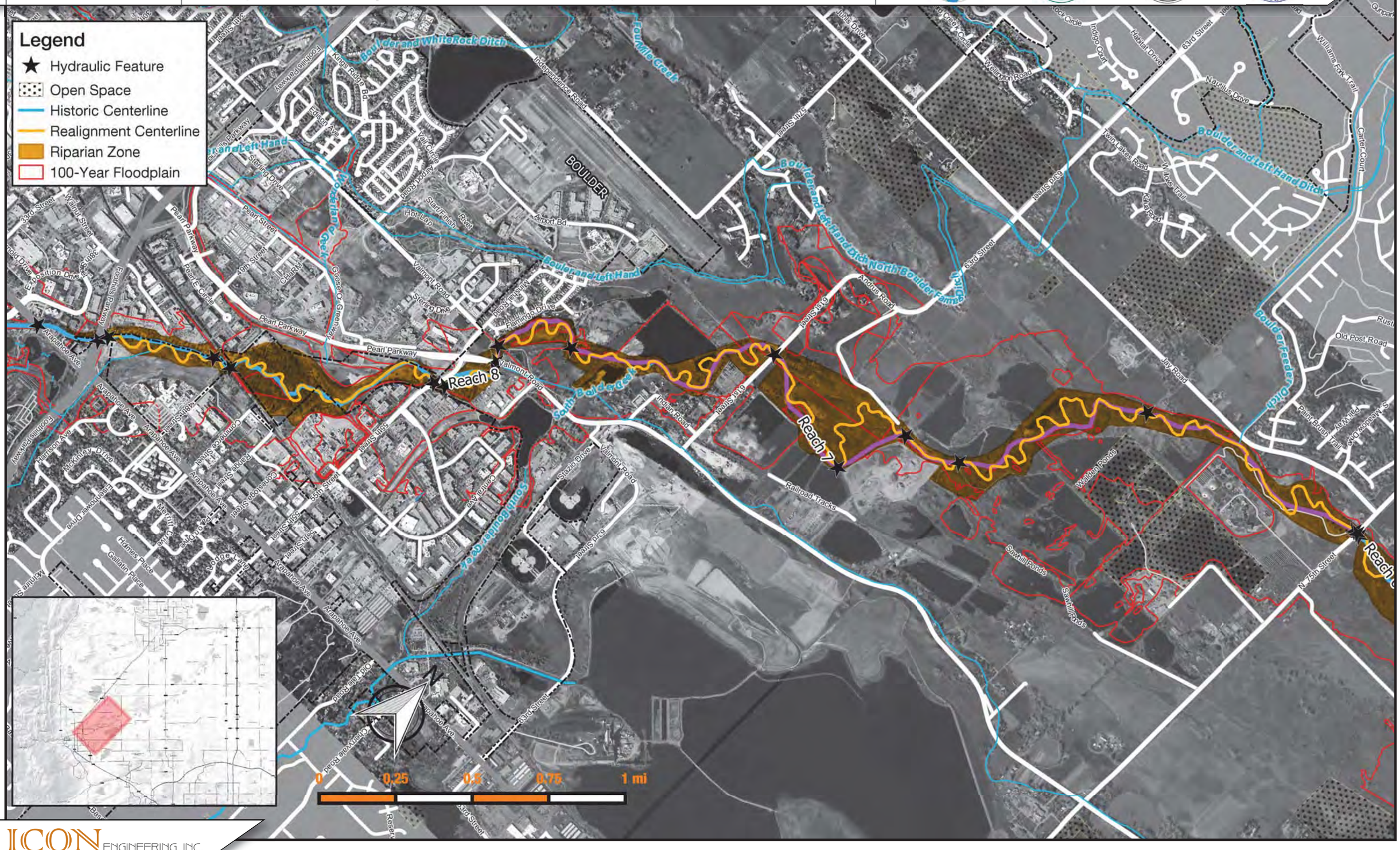


May 2015

Exhibit D-B(4)

Boulder Creek Restoration Master Plan

Conceptual Stream Alignments - Confined Stream System



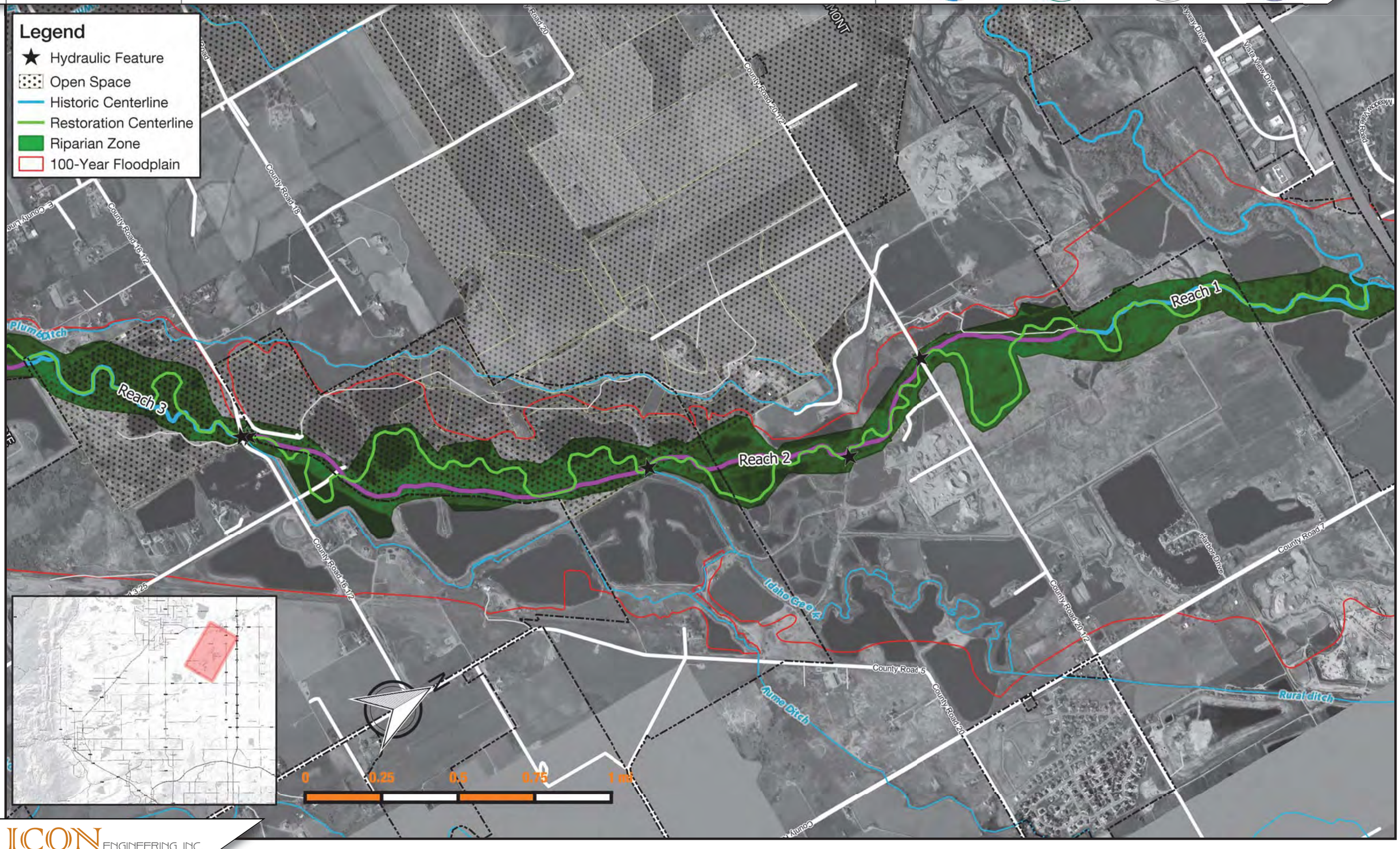
ICON ENGINEERING, INC.

May 2015

Exhibit D-C(1)

Boulder Creek Restoration Master Plan

Conceptual Stream Alignments - Hybrid Stream System



ICON ENGINEERING, INC.

May 2015

Exhibit D-C(2)

Boulder Creek Restoration Master Plan

Conceptual Stream Alignments - Hybrid Stream System

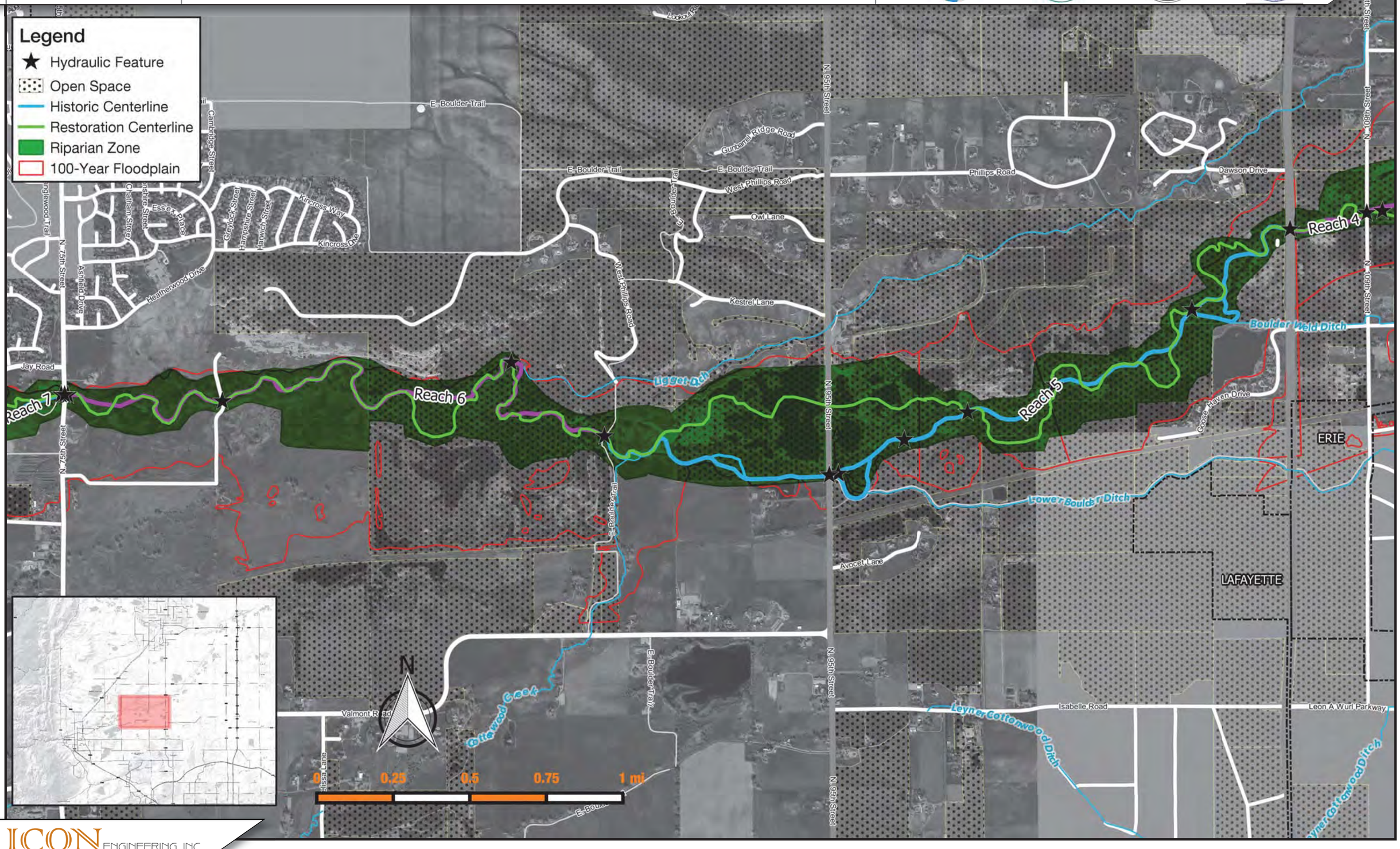


May 2015

Exhibit D-C(3)

Boulder Creek Restoration Master Plan

Conceptual Stream Alignments - Hybrid Stream System

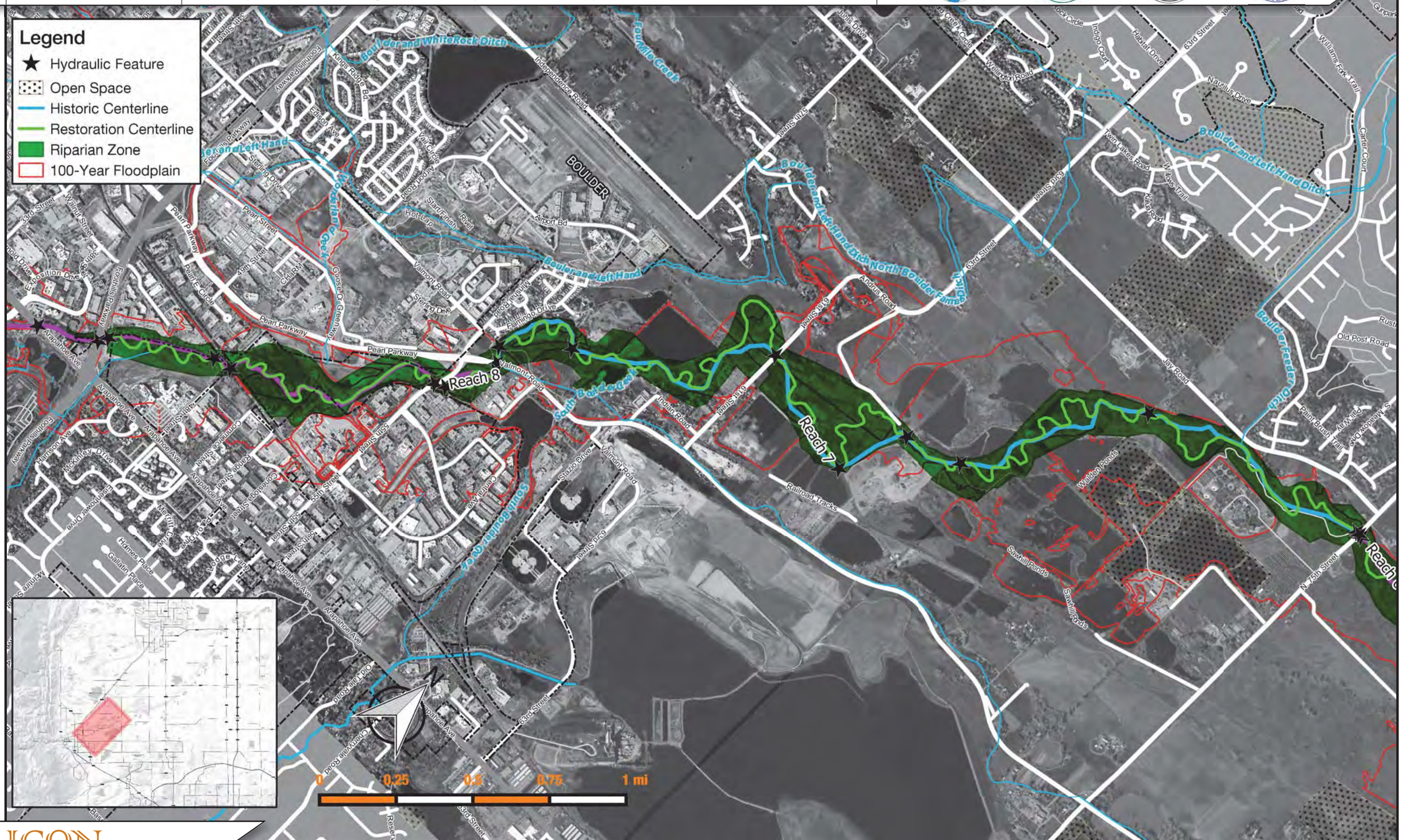


May 2015

Exhibit D-C(4)

Boulder Creek Restoration Master Plan

Conceptual Stream Alignments - Hybrid Stream System



APPENDIX E

ALTERNATIVE COST SUMMARIES

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 1
DRAINAGEWAY :	Boulder Creek
REACH :	1A
JURISDICTION :	City of Longmont
REACH ID:	BCM-Reach1A

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Estimated New Stream	<----User Defined Items	1400	L.F.	$133.00	$186,200.00	
ERC Estimated Riparian Restoration	<----User Defined Items	6	AC	$35,000.00	$224,977.00	100 ft. each side of river

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$411,177.00
Subtotal Capital Improvement Costs				**$411,177.00**
Additional Capital Improvement Costs				
Dewatering	$4,111.77	L.S.		$4,112.00
Mobilization	5%			$20,559.00
Traffic Control	$10,279.43	L.S.		$10,279.00
Utility Coordination/Relocation	$10,279.43	L.S.		$10,279.00
Stormwater Management/Erosion Control	5%			$20,559.00
Subtotal Additional Capital Improvement Costs				**$65,788.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$71,545.00
Legal/Administrative	5%			$23,848.00
Contract Admin/Construction Management	10%			$47,697.00
Contingency	25%			$119,241.00
Subtotal Other Costs				**$262,331.00**
Total Capital Improvement Costs				**$739,296.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	1400	L.F.	$2.00	$560.00
Total Annual Operation and Maintenance Cost				**$560.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$19,600.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 1
DRAINAGEWAY :	Boulder Creek
REACH :	1B
JURISDICTION :	City of Longmont
REACH ID:	BCM-Reach1B

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverside Spillway	<----User Defined Items	1	L.S.	$225,000.00	$225,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$225,000.00
Subtotal Capital Improvement Costs				**$225,000.00**
Additional Capital Improvement Costs				
Dewatering	$2,250.00	L.S.		$2,250.00
Mobilization	5%			$11,250.00
Traffic Control	$5,625.00	L.S.		$5,625.00
Utility Coordination/Relocation	$5,625.00	L.S.		$5,625.00
Stormwater Management/Erosion Control	5%			$11,250.00
Subtotal Additional Capital Improvement Costs				**$36,000.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$39,150.00
Legal/Administrative	5%			$13,050.00
Contract Admin/Construction Management	10%			$26,100.00
Contingency	25%			$65,250.00
Subtotal Other Costs				**$143,550.00**
Total Capital Improvement Costs				**$404,550.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00
Total Annual Operation and Maintenance Cost				**$122.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 2
DRAINAGEWAY : Boulder Creek
REACH : 2A
JURISDICTION : Weld County
REACH ID: BCM-Reach2A Jeremy Deischer DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
180 ft. span bridge at CO Rd 20.5	<----User Defined Items	5400	SF	$250.00	$1,350,000.00	30 ft width bridge
Removal of old bridge	<----User Defined Items	3900	SF	$50.00	$195,000.00	130 ft x 30 ft

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$1,545,000.00
Subtotal Capital Improvement Costs				**$1,545,000.00**
Additional Capital Improvement Costs				
Dewatering	$15,450.00	L.S.		$15,450.00
Mobilization	5%			$77,250.00
Traffic Control	$38,625.00	L.S.		$38,625.00
Utility Coordination/Relocation	$38,625.00	L.S.		$38,625.00
Stormwater Management/Erosion Control	5%			$77,250.00
Subtotal Additional Capital Improvement Costs				**$247,200.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$268,830.00
Legal/Administrative	5%			$89,610.00
Contract Admin/Construction Management	10%			$179,220.00
Contingency	25%			$448,050.00
Subtotal Other Costs				**$985,710.00**
Total Capital Improvement Costs				**$2,777,910.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	30	L.F.	$2.00	$12.00
Total Annual Operation and Maintenance Cost				**$12.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$420.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 2
DRAINAGEWAY : Boulder Creek
REACH : 2B
JURISDICTION : Weld County
REACH ID: BCM-Reach2B Jeremy Deischer DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Diversion for Aquatic Passage	<----User Defined Items	1	L.S.	$205,000.00	$205,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$205,000.00
Subtotal Capital Improvement Costs				**$205,000.00**
Additional Capital Improvement Costs				
Dewatering	$2,050.00	L.S.		$2,050.00
Mobilization	5%			$10,250.00
Traffic Control	$5,125.00	L.S.		$5,125.00
Utility Coordination/Relocation	$5,125.00	L.S.		$5,125.00
Stormwater Management/Erosion Control	5%			$10,250.00
Subtotal Additional Capital Improvement Costs				**$32,800.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$35,670.00
Legal/Administrative	5%			$11,890.00
Contract Admin/Construction Management	10%			$23,780.00
Contingency	25%			$59,450.00
Subtotal Other Costs				**$130,790.00**
Total Capital Improvement Costs				**$368,590.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00
Total Annual Operation and Maintenance Cost				**$122.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 2
DRAINAGEWAY :	Boulder Creek
REACH :	2C
JURISDICTION :	Weld County
REACH ID:	BCM-Reach2C
	Jeremy Deischer
DATE :	2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$250,000.00	
Subtotal Capital Improvement Costs					**$250,000.00**	
Additional Capital Improvement Costs						
Dewatering		$2,500.00	L.S.		$2,500.00	
Mobilization		5%			$12,500.00	
Traffic Control		$6,250.00	L.S.		$6,250.00	
Utility Coordination/Relocation		$6,250.00	L.S.		$6,250.00	
Stormwater Management/Erosion Control		5%			$12,500.00	
Subtotal Additional Capital Improvement Costs					**$40,000.00**	
Land / Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$43,500.00	
Legal/Administrative		5%			$14,500.00	
Contract Admin/Construction Management		10%			$29,000.00	
Contingency		25%			$72,500.00	
Subtotal Other Costs					**$159,500.00**	
Total Capital Improvement Costs					**$449,500.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00	
Total Annual Operation and Maintenance Cost				**$122.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 2
DRAINAGEWAY :	Boulder Creek
REACH :	2D
JURISDICTION :	Weld County
REACH ID:	BCM-Reach2D
	Jeremy Deischer
DATE :	2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$250,000.00	
Subtotal Capital Improvement Costs					**$250,000.00**	
Additional Capital Improvement Costs						
Dewatering		$2,500.00	L.S.		$2,500.00	
Mobilization		5%			$12,500.00	
Traffic Control		$6,250.00	L.S.		$6,250.00	
Utility Coordination/Relocation		$6,250.00	L.S.		$6,250.00	
Stormwater Management/Erosion Control		5%			$12,500.00	
Subtotal Additional Capital Improvement Costs					**$40,000.00**	
Land / Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$43,500.00	
Legal/Administrative		5%			$14,500.00	
Contract Admin/Construction Management		10%			$29,000.00	
Contingency		25%			$72,500.00	
Subtotal Other Costs					**$159,500.00**	
Total Capital Improvement Costs					**$449,500.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00	
Total Annual Operation and Maintenance Cost				**$122.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 2
DRAINAGEWAY :	Boulder Creek
REACH :	2E
JURISDICTION :	Weld County
REACH ID:	BCM-Reach2E

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
180 ft span bridge	<----User Defined Items	5400	SF	$250.00	$1,350,000.00	30 ft width bridge
Removal of old bridge	<----User Defined Items	3900	SF	$50.00	$195,000.00	130 ft x 30 ft

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$1,545,000.00
Subtotal Capital Improvement Costs					**$1,545,000.00**
Additional Capital Improvement Costs					
Dewatering		$15,450.00	L.S.		$15,450.00
Mobilization		5%			$77,250.00
Traffic Control		$38,625.00	L.S.		$38,625.00
Utility Coordination/Relocation		$38,625.00	L.S.		$38,625.00
Stormwater Management/Erosion Control		5%			$77,250.00
Subtotal Additional Capital Improvement Costs					**$247,200.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$268,830.00
Legal/Administrative		5%			$89,610.00
Contract Admin/Construction Management		10%			$179,220.00
Contingency		25%			$448,050.00
Subtotal Other Costs					**$985,710.00**
Total Capital Improvement Costs					**$2,777,910.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	30	L.F.	$2.00	$12.00
Total Annual Operation and Maintenance Cost				**$12.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$420.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 2
DRAINAGEWAY :	Boulder Creek
REACH :	2F
JURISDICTION :	Weld County
REACH ID:	BCM-Reach2F

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverbank Spillway	<----User Defined Items	20	L.S.	$225,000.00	$4,500,000.00	
Lateral Spillway	<----User Defined Items	1	L.S.	$225,000.00	$225,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$4,725,000.00
Subtotal Capital Improvement Costs					**$4,725,000.00**
Additional Capital Improvement Costs					
Dewatering		$47,250.00	L.S.		$47,250.00
Mobilization		5%			$236,250.00
Traffic Control		$118,125.00	L.S.		$118,125.00
Utility Coordination/Relocation		$118,125.00	L.S.		$118,125.00
Stormwater Management/Erosion Control		5%			$236,250.00
Subtotal Additional Capital Improvement Costs					**$756,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$822,150.00
Legal/Administrative		5%			$274,050.00
Contract Admin/Construction Management		10%			$548,100.00
Contingency		25%			$1,370,250.00
Subtotal Other Costs					**$3,014,550.00**
Total Capital Improvement Costs					**$8,495,550.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	21	EA	$608.00	$2,554.00
Total Annual Operation and Maintenance Cost				**$2,554.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$89,389.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 2
DRAINAGEWAY : Boulder Creek
REACH : 2G
JURISDICTION : Weld County
REACH ID: BCM-Reach2G Jeremy Deischer DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Stream Restoration	<-----User Defined Items	2000	L.F.	$133.00	$266,000.00	
ERC Riparian Restoration	<-----User Defined Items	18	AC	$35,000.00	$642,792.00	200 ft. on each side of river

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$908,792.00
Subtotal Capital Improvement Costs					**$908,792.00**
Additional Capital Improvement Costs					
Dewatering		$9,087.92	L.S.		$9,088.00
Mobilization		5%			$45,440.00
Traffic Control		$22,719.80	L.S.		$22,720.00
Utility Coordination/Relocation		$22,719.80	L.S.		$22,720.00
Stormwater Management/Erosion Control		5%			$45,440.00
Subtotal Additional Capital Improvement Costs					**$145,408.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$158,130.00
Legal/Administrative		5%			$52,710.00
Contract Admin/Construction Management		10%			$105,420.00
Contingency		25%			$263,550.00
Subtotal Other Costs					**$579,810.00**
Total Capital Improvement Costs					**$1,634,010.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	2000	L.F.	$2.00	$800.00
Total Annual Operation and Maintenance Cost				**$800.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$28,000.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 3
DRAINAGEWAY : Boulder Creek
REACH : 3A
JURISDICTION : Weld County
REACH ID: BCM-Reach3A Jeremy Deischer DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Stream Restoration	<-----User Defined Items	2000	L.F.	$135.00	$270,000.00	
ERC Riparian Restoration	<-----User Defined Items	18	AC	$35,000.00	$642,792.00	200 ft. on each side of stream

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$912,792.00
Subtotal Capital Improvement Costs					**$912,792.00**
Additional Capital Improvement Costs					
Dewatering		$9,127.92	L.S.		$9,128.00
Mobilization		5%			$45,640.00
Traffic Control		$22,819.80	L.S.		$22,820.00
Utility Coordination/Relocation		$22,819.80	L.S.		$22,820.00
Stormwater Management/Erosion Control		5%			$45,640.00
Subtotal Additional Capital Improvement Costs					**$146,048.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$158,826.00
Legal/Administrative		5%			$52,942.00
Contract Admin/Construction Management		10%			$105,884.00
Contingency		25%			$264,710.00
Subtotal Other Costs					**$582,362.00**
Total Capital Improvement Costs					**$1,641,202.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	2000	L.F.	$2.00	$800.00
Total Annual Operation and Maintenance Cost				**$800.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$28,000.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 3
DRAINAGEWAY :	Boulder Creek
REACH :	3B
JURISDICTION :	Weld County
REACH ID:	BCM-Reach3B

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverside Spillway	<----User Defined Items	1	EA	$225,000.00	$225,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$225,000.00	
Subtotal Capital Improvement Costs					**$225,000.00**	
Additional Capital Improvement Costs						
Dewatering		$2,250.00	L.S.		$2,250.00	
Mobilization		5%			$11,250.00	
Traffic Control		$5,625.00	L.S.		$5,625.00	
Utility Coordination/Relocation		$5,625.00	L.S.		$5,625.00	
Stormwater Management/Erosion Control		5%			$11,250.00	
Subtotal Additional Capital Improvement Costs					**$36,000.00**	
Land / Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$39,150.00	
Legal/Administrative		5%			$13,050.00	
Contract Admin/Construction Management		10%			$26,100.00	
Contingency		25%			$65,250.00	
Subtotal Other Costs					**$143,550.00**	
Total Capital Improvement Costs					**$404,550.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00	
Total Annual Operation and Maintenance Cost				**$122.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4A
JURISDICTION :	Weld County
REACH ID:	BCM-Reach4A

Jeremy Deischer | DATE : 04-22-2015

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$250,000.00	
Subtotal Capital Improvement Costs					**$250,000.00**	
Additional Capital Improvement Costs						
Dewatering		$2,500.00	L.S.		$2,500.00	
Mobilization		5%			$12,500.00	
Traffic Control		$6,250.00	L.S.		$6,250.00	
Utility Coordination/Relocation		$6,250.00	L.S.		$6,250.00	
Stormwater Management/Erosion Control		5%			$12,500.00	
Subtotal Additional Capital Improvement Costs					**$40,000.00**	
Land / Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$43,500.00	
Legal/Administrative		5%			$14,500.00	
Contract Admin/Construction Management		10%			$29,000.00	
Contingency		25%			$72,500.00	
Subtotal Other Costs					**$159,500.00**	
Total Capital Improvement Costs					**$449,500.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00	
Total Annual Operation and Maintenance Cost				**$122.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4B
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4B

Jeremy Deischer | DATE : 04-22-2015

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Soil Riprap, Type M		178	C.Y.	$85.00	$15,111.00	400 L.F. of Right Bank stabilization
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		0	ACRE	$1,217.00	$304.00	
Special Items (User Defined)						
180 ft. span bridge at County Line road	<----User Defined Items	7200	S.F.	$250.00	$1,800,000.00	40 ft width
Old bridge removal	<----User Defined Items	4800	S.F.	$50.00	$240,000.00	120 ft x 40 ft.

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$15,111.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$304.00
Special Items (User Defined)				$2,040,000.00
Subtotal Capital Improvement Costs				**$2,055,415.00**
Additional Capital Improvement Costs				
Dewatering	$20,554.15	L.S.		$20,554.00
Mobilization	5%			$102,771.00
Traffic Control	$51,385.38	L.S.		$51,385.00
Utility Coordination/Relocation	$51,385.38	L.S.		$51,385.00
Stormwater Management/Erosion Control	5%			$102,771.00
Subtotal Additional Capital Improvement Costs				**$328,866.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$357,642.00
Legal/Administrative	5%			$119,214.00
Contract Admin/Construction Management	10%			$238,428.00
Contingency	25%			$596,070.00
Subtotal Other Costs				**$1,311,354.00**
Total Capital Improvement Costs				**$3,695,635.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	40	L.F.	$2.00	$16.00
Total Annual Operation and Maintenance Cost				**$16.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$560.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4B-100yr
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4B-100yr

Jeremy Deischer | DATE : 04-22-2015

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		9458	C.Y.	$29.00	$274,282.00	Fill required to raise roadway
Soil Riprap, Type M		178	C.Y.	$85.00	$15,111.00	400 L.F. RB Stabilization
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		0	ACRE	$1,217.00	$304.00	
Special Items (User Defined)						
220 ft span bridge at County Line Road	<----User Defined Items	8800	S.F.	$250.00	$2,200,000.00	40 ft. width
Asphalt for roadway	<----User Defined Items	7022	S.Y.	$60.00	$421,333.00	1580 ft. of roadway construction (N side)
Old bridge removal	<----User Defined Items	4800	S.F.	$50.00	$240,000.00	120 ft. x 40 ft.

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$289,393.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$304.00
Special Items (User Defined)				$2,861,333.00
Subtotal Capital Improvement Costs				**$3,151,030.00**
Additional Capital Improvement Costs				
Dewatering	$31,510.30	L.S.		$31,510.00
Mobilization	5%			$157,552.00
Traffic Control	$78,775.75	L.S.		$78,776.00
Utility Coordination/Relocation	$78,775.75	L.S.		$78,776.00
Stormwater Management/Erosion Control	5%			$157,552.00
Subtotal Additional Capital Improvement Costs				**$504,166.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$548,279.00
Legal/Administrative	5%			$182,760.00
Contract Admin/Construction Management	10%			$365,520.00
Contingency	25%			$913,799.00
Subtotal Other Costs				**$2,010,358.00**
Total Capital Improvement Costs				**$5,665,554.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	40	L.F.	$2.00	$16.00
Total Annual Operation and Maintenance Cost				**$16.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$560.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4C-Boulder
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4C-Boulder

Jeremy Deischer | DATE : 04-22-2015

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverbank Spillway	<----User Defined Items	11	L.S.	$225,000.00	$2,475,000.00	
Lateral Spillway	<----User Defined Items	2	L.S.	$225,000.00	$450,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$2,925,000.00
Subtotal Capital Improvement Costs					**$2,925,000.00**
Additional Capital Improvement Costs					
Dewatering		$29,250.00	L.S.		$29,250.00
Mobilization		5%			$146,250.00
Traffic Control		$73,125.00	L.S.		$73,125.00
Utility Coordination/Relocation		$73,125.00	L.S.		$73,125.00
Stormwater Management/Erosion Control		5%			$146,250.00
Subtotal Additional Capital Improvement Costs					**$468,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$508,950.00
Legal/Administrative		5%			$169,650.00
Contract Admin/Construction Management		10%			$339,300.00
Contingency		25%			$848,250.00
Subtotal Other Costs					**$1,866,150.00**
Total Capital Improvement Costs					**$5,259,150.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	13	EA	$608.00	$1,581.00
Total Annual Operation and Maintenance Cost				**$1,581.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$55,335.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4C-Weld
JURISDICTION :	Weld County
REACH ID:	BCM-Reach4C-Weld

Jeremy Deischer | DATE : 04-22-2015

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverbank spillway	<----User Defined Items	2	L.S.	$225,000.00	$450,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$450,000.00
Subtotal Capital Improvement Costs					**$450,000.00**
Additional Capital Improvement Costs					
Dewatering		$4,500.00	L.S.		$4,500.00
Mobilization		5%			$22,500.00
Traffic Control		$11,250.00	L.S.		$11,250.00
Utility Coordination/Relocation		$11,250.00	L.S.		$11,250.00
Stormwater Management/Erosion Control		5%			$22,500.00
Subtotal Additional Capital Improvement Costs					**$72,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$78,300.00
Legal/Administrative		5%			$26,100.00
Contract Admin/Construction Management		10%			$52,200.00
Contingency		25%			$130,500.00
Subtotal Other Costs					**$287,100.00**
Total Capital Improvement Costs					**$809,100.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	2	EA	$608.00	$243.00
Total Annual Operation and Maintenance Cost				**$243.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$8,505.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 4
DRAINAGEWAY : Boulder Creek
REACH : 4D
JURISDICTION : Boulder County
REACH ID: BCM-Reach4D Jeremy Deischer DATE : 04-22-2015

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Soil Riprap, Type M		102	C.Y.	$85.00	$8,670.00	230 ft. x 6 ft. x 2 ft.
Excavation, Mid Range		188	C.Y.	$29.00	$5,452.00	Fill required in addition to soil riprap
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		1	ACRE	$1,217.00	$609.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$14,122.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$609.00
Special Items (User Defined)					$0.00
Subtotal Capital Improvement Costs					**$14,731.00**
Additional Capital Improvement Costs					
Dewatering		$147.31	L.S.		$147.00
Mobilization		5%			$737.00
Traffic Control		$368.28	L.S.		$368.00
Utility Coordination/Relocation		$368.28	L.S.		$368.00
Stormwater Management/Erosion Control		5%			$737.00
Subtotal Additional Capital Improvement Costs					**$2,357.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$2,563.00
Legal/Administrative		5%			$854.00
Contract Admin/Construction Management		10%			$1,709.00
Contingency		25%			$4,272.00
Subtotal Other Costs					**$9,398.00**
Total Capital Improvement Costs					**$26,486.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	230	L.F.	$2.00	$92.00
Total Annual Operation and Maintenance Cost				**$92.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$3,220.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 4
DRAINAGEWAY : Boulder Creek
REACH : 4E
JURISDICTION : Boulder County
REACH ID: BCM-Reach4E Jeremy Deischer DATE : 04-22-2015

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Remove washed out bridge	<----User Defined Items	1200	S.F.	$50.00	$60,000.00	15 ft. x 80 ft.

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$60,000.00
Subtotal Capital Improvement Costs					**$60,000.00**
Additional Capital Improvement Costs					
Dewatering		$600.00	L.S.		$600.00
Mobilization		5%			$3,000.00
Traffic Control		$1,500.00	L.S.		$1,500.00
Utility Coordination/Relocation		$1,500.00	L.S.		$1,500.00
Stormwater Management/Erosion Control		5%			$3,000.00
Subtotal Additional Capital Improvement Costs					**$9,600.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$10,440.00
Legal/Administrative		5%			$3,480.00
Contract Admin/Construction Management		10%			$6,960.00
Contingency		25%			$17,400.00
Subtotal Other Costs					**$38,280.00**
Total Capital Improvement Costs					**$107,880.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4F
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4F

Jeremy Deischer | DATE : 04-22-2015

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Estimate - New Stream	<----User Defined Items	1	L.S.	$1,130,000.00	$1,130,000.00	
ERC Estimate - Riparian Restoration	<----User Defined Items	1	L.S.	$2,730,000.00	$2,730,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$3,860,000.00
Subtotal Capital Improvement Costs					**$3,860,000.00**
Additional Capital Improvement Costs					
Dewatering		$38,600.00	L.S.		$38,600.00
Mobilization		5%			$193,000.00
Traffic Control		$96,500.00	L.S.		$96,500.00
Utility Coordination/Relocation		$96,500.00	L.S.		$96,500.00
Stormwater Management/Erosion Control		5%			$193,000.00
Subtotal Additional Capital Improvement Costs					**$617,600.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$671,640.00
Legal/Administrative		5%			$223,880.00
Contract Admin/Construction Management		10%			$447,760.00
Contingency		25%			$1,119,400.00
Subtotal Other Costs					**$2,462,680.00**
Total Capital Improvement Costs					**$6,940,280.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	8500	L.F.	$2.00	$3,400.00
Total Annual Operation and Maintenance Cost				**$3,400.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$118,999.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4G
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4G

Jeremy Deischer | DATE : 04-22-2015

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		804	C.Y.	$29.00	$23,316.00	Cut & Haul
Excavation, Low Range		368	C.Y.	$13.00	$4,784.00	Cut & Fill Onsite
Soil Riprap, Type M		778	C.Y.	$85.00	$66,130.00	1050 ft. x 2 ft. x 5 ft.
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$94,230.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$250,000.00
Subtotal Capital Improvement Costs					**$344,230.00**
Additional Capital Improvement Costs					
Dewatering		$3,442.30	L.S.		$3,442.00
Mobilization		5%			$17,212.00
Traffic Control		$8,605.75	L.S.		$8,606.00
Utility Coordination/Relocation		$8,605.75	L.S.		$8,606.00
Stormwater Management/Erosion Control		5%			$17,212.00
Subtotal Additional Capital Improvement Costs					**$55,078.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$59,896.00
Legal/Administrative		5%			$19,965.00
Contract Admin/Construction Management		10%			$39,931.00
Contingency		25%			$99,827.00
Subtotal Other Costs					**$219,619.00**
Total Capital Improvement Costs					**$618,927.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	230	L.F.	$2.00	$92.00
Total Annual Operation and Maintenance Cost				**$214.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$7,490.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4H
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4H

Jeremy Deischer | DATE : 04-22-2015

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
180 ft. span bridge at Kenosha Road	<----User Defined Items	7200	S.F.	$250.00	$1,800,000.00	40 ft. Bridge width
Old bridge removal	<----User Defined Items	3600	S.F.	$50.00	$180,000.00	90 ft. x 40 ft.

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$1,980,000.00
Subtotal Capital Improvement Costs					**$1,980,000.00**
Additional Capital Improvement Costs					
Dewatering		$19,800.00	L.S.		$19,800.00
Mobilization		5%			$99,000.00
Traffic Control		$49,500.00	L.S.		$49,500.00
Utility Coordination/Relocation		$49,500.00	L.S.		$49,500.00
Stormwater Management/Erosion Control		5%			$99,000.00
Subtotal Additional Capital Improvement Costs					**$316,800.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$344,520.00
Legal/Administrative		5%			$114,840.00
Contract Admin/Construction Management		10%			$229,680.00
Contingency		25%			$574,200.00
Subtotal Other Costs					**$1,263,240.00**
Total Capital Improvement Costs					**$3,560,040.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	40	L.F.	$2.00	$16.00
Total Annual Operation and Maintenance Cost				**$16.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$560.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4I
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4I

Jeremy Deischer | DATE : 04-22-2015

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Grade Control for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$205,000.00	$205,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$205,000.00
Subtotal Capital Improvement Costs					**$205,000.00**
Additional Capital Improvement Costs					
Dewatering		$2,050.00	L.S.		$2,050.00
Mobilization		5%			$10,250.00
Traffic Control		$5,125.00	L.S.		$5,125.00
Utility Coordination/Relocation		$5,125.00	L.S.		$5,125.00
Stormwater Management/Erosion Control		5%			$10,250.00
Subtotal Additional Capital Improvement Costs					**$32,800.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$35,670.00
Legal/Administrative		5%			$11,890.00
Contract Admin/Construction Management		10%			$23,780.00
Contingency		25%			$59,450.00
Subtotal Other Costs					**$130,790.00**
Total Capital Improvement Costs					**$368,590.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00
Total Annual Operation and Maintenance Cost				**$122.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4J
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4J — Jeremy Deischer — DATE : 04-22-2015

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
180 ft. span bridge at 109th St.	<----User Defined Items	5400	S.F.	$250.00	$1,350,000.00	30 ft. bridge width
Old bridge removal	<----User Defined Items	2400	S.F.	$50.00	$120,000.00	80 ft. x 30 ft.
Stream Restoration	<----User Defined Items	1	Mile	$575,000.00	$350,750.00	Average of New and Existing Stream Restoration
Riparian Restoration	<----User Defined Items	18	ACRE	$35,000.00	$623,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$2,443,750.00
Subtotal Capital Improvement Costs				**$2,443,750.00**
Additional Capital Improvement Costs				
Dewatering	$24,437.50	L.S.		$24,438.00
Mobilization	5%			$122,188.00
Traffic Control	$61,093.75	L.S.		$61,094.00
Utility Coordination/Relocation	$61,093.75	L.S.		$61,094.00
Stormwater Management/Erosion Control	5%			$122,188.00
Subtotal Additional Capital Improvement Costs				**$391,002.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$425,213.00
Legal/Administrative	5%			$141,738.00
Contract Admin/Construction Management	10%			$283,475.00
Contingency	25%			$708,688.00
Subtotal Other Costs				**$1,559,114.00**
Total Capital Improvement Costs				**$4,393,866.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	30	L.F.	$2.00	$12.00
Total Annual Operation and Maintenance Cost				**$12.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$420.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4K
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4K — Jeremy Deischer — DATE : 04-22-2015

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Stream Restoration	<----User Defined Items	4600	L.F.	$133.00	$611,800.00	
ERC Riparian Restoration	<----User Defined Items	42	AC	$35,000.00	$1,478,421.00	200 ft on each side of stream

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$2,090,221.00
Subtotal Capital Improvement Costs				**$2,090,221.00**
Additional Capital Improvement Costs				
Dewatering	$20,902.21	L.S.		$20,902.00
Mobilization	5%			$104,511.00
Traffic Control	$52,255.53	L.S.		$52,256.00
Utility Coordination/Relocation	$52,255.53	L.S.		$52,256.00
Stormwater Management/Erosion Control	5%			$104,511.00
Subtotal Additional Capital Improvement Costs				**$334,436.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$363,699.00
Legal/Administrative	5%			$121,233.00
Contract Admin/Construction Management	10%			$242,466.00
Contingency	25%			$606,164.00
Subtotal Other Costs				**$1,333,562.00**
Total Capital Improvement Costs				**$3,758,219.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	4600	L.F.	$2.00	$1,840.00
Total Annual Operation and Maintenance Cost				**$1,840.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$64,399.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 5
DRAINAGEWAY : Boulder Creek
REACH : 5A
JURISDICTION : Boulder County
REACH ID: BCM-Reach5A Jeremy Deischer DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Estimated New Stream	<----User Defined Items	1	L.S.	$600,000.00	$600,000.00	
ERC Estimated Riparian Restoration	<----User Defined Items	1	L.S.	$1,450,000.00	$1,450,000.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$2,050,000.00
Subtotal Capital Improvement Costs					**$2,050,000.00**
Additional Capital Improvement Costs					
Dewatering		$20,500.00	L.S.		$20,500.00
Mobilization		5%			$102,500.00
Traffic Control		$51,250.00	L.S.		$51,250.00
Utility Coordination/Relocation		$51,250.00	L.S.		$51,250.00
Stormwater Management/Erosion Control		5%			$102,500.00
Subtotal Additional Capital Improvement Costs					**$328,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$356,700.00
Legal/Administrative		5%			$118,900.00
Contract Admin/Construction Management		10%			$237,800.00
Contingency		25%			$594,500.00
Subtotal Other Costs					**$1,307,900.00**
Total Capital Improvement Costs					**$3,685,900.00**

Master Plan Operation and Maintenance Cost Summary					
Description		**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)		4500	L.F.	$2.00	$1,800.00
Total Annual Operation and Maintenance Cost					**$1,800.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$62,999.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 5
DRAINAGEWAY : Boulder Creek
REACH : 5B
JURISDICTION : Boulder County
REACH ID: BCM-Reach5B Jeremy Deischer DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$250,000.00
Subtotal Capital Improvement Costs					**$250,000.00**
Additional Capital Improvement Costs					
Dewatering		$2,500.00	L.S.		$2,500.00
Mobilization		5%			$12,500.00
Traffic Control		$6,250.00	L.S.		$6,250.00
Utility Coordination/Relocation		$6,250.00	L.S.		$6,250.00
Stormwater Management/Erosion Control		5%			$12,500.00
Subtotal Additional Capital Improvement Costs					**$40,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$43,500.00
Legal/Administrative		5%			$14,500.00
Contract Admin/Construction Management		10%			$29,000.00
Contingency		25%			$72,500.00
Subtotal Other Costs					**$159,500.00**
Total Capital Improvement Costs					**$449,500.00**

Master Plan Operation and Maintenance Cost Summary					
Description		**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)		1	EA	$608.00	$122.00
Total Annual Operation and Maintenance Cost					**$122.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$4,270.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5C
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach5C

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverbank spillway	<----User Defined Items	5	L.S.	$225,000.00	$1,125,000.00	
Lateral spillway	<----User Defined Items	0	L.S.	$225,000.00	$0.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs		
Pipe Culverts and Storm Drains	$0.00	
Concrete Box Culverts	$0.00	
Hydraulic Structures	$0.00	
Channel Improvements	$0.00	
Detention/Water Quality Facilities	$0.00	
Removals	$0.00	
Landscaping and Maintenance Improvements	$0.00	
Special Items (User Defined)	$1,125,000.00	
Subtotal Capital Improvement Costs	**$1,125,000.00**	
Additional Capital Improvement Costs		
Dewatering	$11,250.00	
Mobilization	$56,250.00	
Traffic Control	$28,125.00	
Utility Coordination/Relocation	$28,125.00	
Stormwater Management/Erosion Control	$56,250.00	
Subtotal Additional Capital Improvement Costs	**$180,000.00**	
Land Acquisition Costs		
ROW/Easements	$0.00	
Subtotal Land Acquisition Costs	**$0.00**	
Other Costs (percentage of Capital Improvement Costs)		
Engineering	$195,750.00	
Legal/Administrative	$65,250.00	
Contract Admin/Construction Management	$130,500.00	
Contingency	$326,250.00	
Subtotal Other Costs	**$717,750.00**	
Total Capital Improvement Costs	**$2,022,750.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	5	EA	$608.00	$608.00	
Total Annual Operation and Maintenance Cost				**$608.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$21,280.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5D
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach5D

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Grade Control for Acquatic & Habitat Passage	<----User Defined Items	1	L.S.	$205,000.00	$205,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$0.00
Hydraulic Structures			$0.00
Channel Improvements			$0.00
Detention/Water Quality Facilities			$0.00
Removals			$0.00
Landscaping and Maintenance Improvements			$0.00
Special Items (User Defined)			$205,000.00
Subtotal Capital Improvement Costs			**$205,000.00**
Additional Capital Improvement Costs			
Dewatering	$2,050.00	L.S.	$2,050.00
Mobilization	5%		$10,250.00
Traffic Control	$5,125.00	L.S.	$5,125.00
Utility Coordination/Relocation	$5,125.00	L.S.	$5,125.00
Stormwater Management/Erosion Control	5%		$10,250.00
Subtotal Additional Capital Improvement Costs			**$32,800.00**
Land Acquisition Costs			
ROW/Easements			$0.00
Subtotal Land Acquisition Costs			**$0.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$35,670.00
Legal/Administrative	5%		$11,890.00
Contract Admin/Construction Management	10%		$23,780.00
Contingency	25%		$59,450.00
Subtotal Other Costs			**$130,790.00**
Total Capital Improvement Costs			**$368,590.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00
Total Annual Operation and Maintenance Cost				**$122.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5E
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach5E

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Grade Control for Acquatic & Habitat Passage	<----User Defined Items	1	L.S.	$205,000.00	$205,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$205,000.00	
Subtotal Capital Improvement Costs					**$205,000.00**	
Additional Capital Improvement Costs						
Dewatering		$2,050.00	L.S.		$2,050.00	
Mobilization		5%			$10,250.00	
Traffic Control		$5,125.00	L.S.		$5,125.00	
Utility Coordination/Relocation		$5,125.00	L.S.		$5,125.00	
Stormwater Management/Erosion Control		5%			$10,250.00	
Subtotal Additional Capital Improvement Costs					**$32,800.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$35,670.00	
Legal/Administrative		5%			$11,890.00	
Contract Admin/Construction Management		10%			$23,780.00	
Contingency		25%			$59,450.00	
Subtotal Other Costs					**$130,790.00**	
Total Capital Improvement Costs					**$368,590.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00	
Total Annual Operation and Maintenance Cost				**$122.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5F
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach5F

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC New Stream Restoration	<----User Defined Items	2000	L.F.	$133.00	$266,000.00	
ERC Riparian Restoration	<----User Defined Items	18	Acre	$35,000.00	$642,792.00	200 ft on each side of stream

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$908,792.00	
Subtotal Capital Improvement Costs					**$908,792.00**	
Additional Capital Improvement Costs						
Dewatering		$9,087.92	L.S.		$9,088.00	
Mobilization		5%			$45,440.00	
Traffic Control		$22,719.80	L.S.		$22,720.00	
Utility Coordination/Relocation		$22,719.80	L.S.		$22,720.00	
Stormwater Management/Erosion Control		5%			$45,440.00	
Subtotal Additional Capital Improvement Costs					**$145,408.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$158,130.00	
Legal/Administrative		5%			$52,710.00	
Contract Admin/Construction Management		10%			$105,420.00	
Contingency		25%			$263,550.00	
Subtotal Other Costs					**$579,810.00**	
Total Capital Improvement Costs					**$1,634,010.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	2000	L.F.	$2.00	$800.00	
Total Annual Operation and Maintenance Cost				**$800.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$28,000.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5G
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach5G — Jeremy Deischer — DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Old bridge removal	<----User Defined Items	4800	S.F.	$50.00	$240,000.00	120 ft. x 40 ft.
180 ft. span bridge	<----User Defined Items	7200	S.F.	$250.00	$1,800,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$2,040,000.00
Subtotal Capital Improvement Costs				**$2,040,000.00**
Additional Capital Improvement Costs				
Dewatering	$20,400.00	L.S.		$20,400.00
Mobilization	5%			$102,000.00
Traffic Control	$51,000.00	L.S.		$51,000.00
Utility Coordination/Relocation	$51,000.00	L.S.		$51,000.00
Stormwater Management/Erosion Control	5%			$102,000.00
Subtotal Additional Capital Improvement Costs				**$326,400.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$354,960.00
Legal/Administrative	5%			$118,320.00
Contract Admin/Construction Management	10%			$236,640.00
Contingency	25%			$591,600.00
Subtotal Other Costs				**$1,301,520.00**
Total Capital Improvement Costs				**$3,667,920.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	40	L.F.	$2.00	$16.00
Total Annual Operation and Maintenance Cost				**$16.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$560.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5G-100yr
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach5G-100yr — Jeremy Deischer — DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		14304	C.Y.	$29.00	$414,816.00	Fill Required for roadway reconstruction
Special Items (User Defined)						
Removal of old 120 ft. bridge	<----User Defined Items	4800	S.F.	$50.00	$240,000.00	40 ft. width
220' span bridge	<----User Defined Items	8800	S.F.	$250.00	$2,200,000.00	40 ft. width
Asphalt Remove and Replace	<----User Defined Items	6711	S.Y.	$60.00	$402,667.00	1510 ft. of roadway reconstruction

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$414,816.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$2,842,667.00
Subtotal Capital Improvement Costs				**$3,257,483.00**
Additional Capital Improvement Costs				
Dewatering	$32,574.83	L.S.		$32,575.00
Mobilization	5%			$162,874.00
Traffic Control	$81,437.08	L.S.		$81,437.00
Utility Coordination/Relocation	$81,437.08	L.S.		$81,437.00
Stormwater Management/Erosion Control	5%			$162,874.00
Subtotal Additional Capital Improvement Costs				**$521,197.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$566,802.00
Legal/Administrative	5%			$188,934.00
Contract Admin/Construction Management	10%			$377,868.00
Contingency	25%			$944,670.00
Subtotal Other Costs				**$2,078,274.00**
Total Capital Improvement Costs				**$5,856,954.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	40	L.F.	$2.00	$16.00
Total Annual Operation and Maintenance Cost				**$16.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$560.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5H
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach5H

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Stream Restoration	<----User Defined Items	4500	L.F.	$133.00	$598,500.00	
ERC Riparian Restoration	<----User Defined Items	41	AC	$35,000.00	$1,446,281.00	200 ft. on each side of stream

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$2,044,781.00
Subtotal Capital Improvement Costs					**$2,044,781.00**
Additional Capital Improvement Costs					
Dewatering		$20,447.81	L.S.		$20,448.00
Mobilization		5%			$102,239.00
Traffic Control		$51,119.53	L.S.		$51,120.00
Utility Coordination/Relocation		$51,119.53	L.S.		$51,120.00
Stormwater Management/Erosion Control		5%			$102,239.00
Subtotal Additional Capital Improvement Costs					**$327,166.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$355,792.00
Legal/Administrative		5%			$118,597.00
Contract Admin/Construction Management		10%			$237,195.00
Contingency		25%			$592,987.00
Subtotal Other Costs					**$1,304,571.00**
Total Capital Improvement Costs					**$3,676,518.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	4500	L.F.	$2.00	$1,800.00
Total Annual Operation and Maintenance Cost				**$1,800.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$62,999.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 6
DRAINAGEWAY :	Boulder Creek
REACH :	6A
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach6A

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$250,000.00
Subtotal Capital Improvement Costs					**$250,000.00**
Additional Capital Improvement Costs					
Dewatering		$2,500.00	L.S.		$2,500.00
Mobilization		5%			$12,500.00
Traffic Control		$6,250.00	L.S.		$6,250.00
Utility Coordination/Relocation		$6,250.00	L.S.		$6,250.00
Stormwater Management/Erosion Control		5%			$12,500.00
Subtotal Additional Capital Improvement Costs					**$40,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$43,500.00
Legal/Administrative		5%			$14,500.00
Contract Admin/Construction Management		10%			$29,000.00
Contingency		25%			$72,500.00
Subtotal Other Costs					**$159,500.00**
Total Capital Improvement Costs					**$449,500.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00
Total Annual Operation and Maintenance Cost				**$122.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 6
DRAINAGEWAY :	Boulder Creek
REACH :	6B
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach6B — Jeremy Deischer — DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
180 ft. span bridge at 75th St.	<----User Defined Items	7200	S.F.	$250.00	$1,800,000.00	40 ft width at 75th St.
Old bridge removal	<----User Defined Items	4400	S.F.	$50.00	$220,000.00	110 x 40 ft

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$2,020,000.00
Subtotal Capital Improvement Costs				**$2,020,000.00**
Additional Capital Improvement Costs				
Dewatering	$20,200.00	L.S.		$20,200.00
Mobilization	5%			$101,000.00
Traffic Control	$50,500.00	L.S.		$50,500.00
Utility Coordination/Relocation	$50,500.00	L.S.		$50,500.00
Stormwater Management/Erosion Control	5%			$101,000.00
Subtotal Additional Capital Improvement Costs				**$323,200.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$351,480.00
Legal/Administrative	5%			$117,160.00
Contract Admin/Construction Management	10%			$234,320.00
Contingency	25%			$585,800.00
Subtotal Other Costs				**$1,288,760.00**
Total Capital Improvement Costs				**$3,631,960.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	40	L.F.	$2.00	$16.00
Total Annual Operation and Maintenance Cost				**$16.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$560.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 6
DRAINAGEWAY :	Boulder Creek
REACH :	6B-100yr
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach6B-100yr — Jeremy Deischer — DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		7242	C.Y.	$29.00	$210,018.00	Fill required for roadway improvement
Special Items (User Defined)						
180 ft span bridge at 75th St.	<----User Defined Items	7200	S.F.	$250.00	$1,800,000.00	40 ft. width at 75th
Remove and Replace Asphalt	<----User Defined Items	7333	S.Y.	$60.00	$440,000.00	1650 feet of roadway reconstruction (South Side)
Old bridge removal	<----User Defined Items	4400	S.F.	$50.00	$220,000.00	110 ft x 40 ft

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$210,018.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$2,460,000.00
Subtotal Capital Improvement Costs				**$2,670,018.00**
Additional Capital Improvement Costs				
Dewatering	$26,700.18	L.S.		$26,700.00
Mobilization	5%			$133,501.00
Traffic Control	$66,750.45	L.S.		$66,750.00
Utility Coordination/Relocation	$66,750.45	L.S.		$66,750.00
Stormwater Management/Erosion Control	5%			$133,501.00
Subtotal Additional Capital Improvement Costs				**$427,202.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$464,583.00
Legal/Administrative	5%			$154,861.00
Contract Admin/Construction Management	10%			$309,722.00
Contingency	25%			$774,305.00
Subtotal Other Costs				**$1,703,471.00**
Total Capital Improvement Costs				**$4,800,691.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	40	L.F.	$2.00	$16.00
Total Annual Operation and Maintenance Cost				**$16.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$560.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 6
DRAINAGEWAY :	Boulder Creek
REACH :	6C
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach6C
Jeremy Deischer	DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverside spillway	<----User Defined Items	4	L.S.	$225,000.00	$900,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$900,000.00
Subtotal Capital Improvement Costs					**$900,000.00**
Additional Capital Improvement Costs					
Dewatering		$9,000.00	L.S.		$9,000.00
Mobilization		5%			$45,000.00
Traffic Control		$22,500.00	L.S.		$22,500.00
Utility Coordination/Relocation		$22,500.00	L.S.		$22,500.00
Stormwater Management/Erosion Control		5%			$45,000.00
Subtotal Additional Capital Improvement Costs					**$144,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$156,600.00
Legal/Administrative		5%			$52,200.00
Contract Admin/Construction Management		10%			$104,400.00
Contingency		25%			$261,000.00
Subtotal Other Costs					**$574,200.00**
Total Capital Improvement Costs					**$1,618,200.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	4	EA	$608.00	$486.00
Total Annual Operation and Maintenance Cost				**$486.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$17,010.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 7
DRAINAGEWAY :	Boulder Creek
REACH :	7A
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach7A
Jeremy Deischer	DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverside Spillway	<----User Defined Items	4	LS	$225,000.00	$900,000.00	
Lateral Spillway	<----User Defined Items	3	LS	$225,000.00	$675,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$1,575,000.00
Subtotal Capital Improvement Costs					**$1,575,000.00**
Additional Capital Improvement Costs					
Dewatering		$15,750.00	L.S.		$15,750.00
Mobilization		5%			$78,750.00
Traffic Control		$39,375.00	L.S.		$39,375.00
Utility Coordination/Relocation		$39,375.00	L.S.		$39,375.00
Stormwater Management/Erosion Control		5%			$78,750.00
Subtotal Additional Capital Improvement Costs					**$252,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$274,050.00
Legal/Administrative		5%			$91,350.00
Contract Admin/Construction Management		10%			$182,700.00
Contingency		25%			$456,750.00
Subtotal Other Costs					**$1,004,850.00**
Total Capital Improvement Costs					**$2,831,850.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	7	EA	$608.00	$851.00
Total Annual Operation and Maintenance Cost				**$851.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$29,785.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 7
DRAINAGEWAY :	Boulder Creek
REACH :	7B
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach7B
Jeremy Deischer	DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverside Spillway	<----User Defined Items	5	LS	$225,000.00	$1,125,000.00	
Lateral Spillway	<----User Defined Items	2	LS	$225,000.00	$450,000.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$1,575,000.00
Subtotal Capital Improvement Costs					**$1,575,000.00**
Additional Capital Improvement Costs					
Dewatering		$15,750.00	L.S.		$15,750.00
Mobilization		5%			$78,750.00
Traffic Control		$39,375.00	L.S.		$39,375.00
Utility Coordination/Relocation		$39,375.00	L.S.		$39,375.00
Stormwater Management/Erosion Control		5%			$78,750.00
Subtotal Additional Capital Improvement Costs					**$252,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$274,050.00
Legal/Administrative		5%			$91,350.00
Contract Admin/Construction Management		10%			$182,700.00
Contingency		25%			$456,750.00
Subtotal Other Costs					**$1,004,850.00**
Total Capital Improvement Costs					**$2,831,850.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	7	EA	$608.00	$851.00
Total Annual Operation and Maintenance Cost				**$851.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$29,785.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 7
DRAINAGEWAY :	Boulder Creek
REACH :	7C
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach7C
Jeremy Deischer	DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$250,000.00
Subtotal Capital Improvement Costs				**$250,000.00**
Additional Capital Improvement Costs				
Dewatering	$2,500.00	L.S.		$2,500.00
Mobilization	5%			$12,500.00
Traffic Control	$6,250.00	L.S.		$6,250.00
Utility Coordination/Relocation	$6,250.00	L.S.		$6,250.00
Stormwater Management/Erosion Control	5%			$12,500.00
Subtotal Additional Capital Improvement Costs				**$40,000.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$43,500.00
Legal/Administrative	5%			$14,500.00
Contract Admin/Construction Management	10%			$29,000.00
Contingency	25%			$72,500.00
Subtotal Other Costs				**$159,500.00**
Total Capital Improvement Costs				**$449,500.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00
Total Annual Operation and Maintenance Cost				**$122.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 7
DRAINAGEWAY :	Boulder Creek
REACH :	7D
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach7D

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$250,000.00	
Subtotal Capital Improvement Costs					**$250,000.00**	
Additional Capital Improvement Costs						
Dewatering		$2,500.00	L.S.		$2,500.00	
Mobilization		5%			$12,500.00	
Traffic Control		$6,250.00	L.S.		$6,250.00	
Utility Coordination/Relocation		$6,250.00	L.S.		$6,250.00	
Stormwater Management/Erosion Control		5%			$12,500.00	
Subtotal Additional Capital Improvement Costs					**$40,000.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$43,500.00	
Legal/Administrative		5%			$14,500.00	
Contract Admin/Construction Management		10%			$29,000.00	
Contingency		25%			$72,500.00	
Subtotal Other Costs					**$159,500.00**	
Total Capital Improvement Costs					**$449,500.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00	
Total Annual Operation and Maintenance Cost				**$122.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 7
DRAINAGEWAY :	Boulder Creek
REACH :	7E
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach7E

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
180 ft. span bridge at 61st St.	<----User Defined Items	5400	S.F.	$250.00	$1,350,000.00	30 ft width bridge at 61st St.
Old bridge removal	<----User Defined Items	2700	S.F.	$50.00	$135,000.00	90 ft x 30 ft

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$1,485,000.00	
Subtotal Capital Improvement Costs					**$1,485,000.00**	
Additional Capital Improvement Costs						
Dewatering		$14,850.00	L.S.		$14,850.00	
Mobilization		5%			$74,250.00	
Traffic Control		$37,125.00	L.S.		$37,125.00	
Utility Coordination/Relocation		$37,125.00	L.S.		$37,125.00	
Stormwater Management/Erosion Control		5%			$74,250.00	
Subtotal Additional Capital Improvement Costs					**$237,600.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$258,390.00	
Legal/Administrative		5%			$86,130.00	
Contract Admin/Construction Management		10%			$172,260.00	
Contingency		25%			$430,650.00	
Subtotal Other Costs					**$947,430.00**	
Total Capital Improvement Costs					**$2,670,030.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	30	L.F.	$2.00	$12.00	
Total Annual Operation and Maintenance Cost				**$12.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$420.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 7
DRAINAGEWAY :	Boulder Creek
REACH :	7E-100yr
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach7E-100yr

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		9180	C.Y.	$29.00	$266,220.00	Fill required for roadway reconstruction
Special Items (User Defined)						
220 ft. span bridge	<----User Defined Items	6600	S.F.	$250.00	$1,650,000.00	30 ft width bridge at 61st St.
Remove and replace asphalt	<----User Defined Items	6667	S.Y.	$60.00	$400,000.00	2000 ft of roadway reconstruction (N and S Side)
Old bridge removal	<----User Defined Items	2700	S.F.	$50.00	$135,000.00	90 ft x 30 ft

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$266,220.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$2,185,000.00
Subtotal Capital Improvement Costs				**$2,451,220.00**
Additional Capital Improvement Costs				
Dewatering	$24,512.20	L.S.		$24,512.00
Mobilization	5%			$122,561.00
Traffic Control	$61,280.50	L.S.		$61,281.00
Utility Coordination/Relocation	$61,280.50	L.S.		$61,281.00
Stormwater Management/Erosion Control	5%			$122,561.00
Subtotal Additional Capital Improvement Costs				**$392,196.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$426,512.00
Legal/Administrative	5%			$142,171.00
Contract Admin/Construction Management	10%			$284,342.00
Contingency	25%			$710,854.00
Subtotal Other Costs				**$1,563,879.00**
Total Capital Improvement Costs				**$4,407,295.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	30	L.F.	$2.00	$12.00
Total Annual Operation and Maintenance Cost				**$12.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$420.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 7
DRAINAGEWAY :	Boulder Creek
REACH :	7F
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach7F

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Remove pedestrian bridge	<----User Defined Items	2250	S.F.	$50.00	$112,500.00	Existing 75ft x 30 ft
180 ft span pedestrain bridge	<----User Defined Items	2700	S.F.	$300.00	$810,000.00	180 ft x 15 ft

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$922,500.00
Subtotal Capital Improvement Costs				**$922,500.00**
Additional Capital Improvement Costs				
Dewatering	$9,225.00	L.S.		$9,225.00
Mobilization	5%			$46,125.00
Traffic Control	$13,837.50	L.S.		$13,838.00
Utility Coordination/Relocation	$80,000.00	L.S.		$80,000.00
Stormwater Management/Erosion Control	5%			$46,125.00
Subtotal Additional Capital Improvement Costs				**$195,313.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$167,672.00
Legal/Administrative	5%			$55,891.00
Contract Admin/Construction Management	10%			$111,781.00
Contingency	25%			$279,453.00
Subtotal Other Costs				**$614,797.00**
Total Capital Improvement Costs				**$1,732,610.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	15	L.F.	$2.00	$6.00
Total Annual Operation and Maintenance Cost				**$6.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$210.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 7
DRAINAGEWAY : Boulder Creek
REACH : 7G
JURISDICTION : Boulder County
REACH ID: BCM-Reach7G Jeremy Deischer DATE : 2015-04-22

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
54-inch	600	1	600	L.F.	$263.00	$157,800.00	
Headwalls							
Diameter (in)	Applicable	No. of Barrels					
54-inch	Yes	1	2	EA	$1,756.60	$3,513.00	
Wingwalls (includes concrete apron)							
Diameter (in)		No. of Barrels					
54-inch		1	2	EA	$10,706.24	$21,412.00	
Special Items (User Defined)							
Remove existing diversion structure	<----User Defined Items		1	L.S.	$20,000.00	$20,000.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains					$182,725.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$20,000.00
Subtotal Capital Improvement Costs					**$202,725.00**
Additional Capital Improvement Costs					
Dewatering			$2,027.25	L.S.	$2,027.00
Mobilization			5%		$10,136.00
Traffic Control			$5,068.13	L.S.	$5,068.00
Utility Coordination/Relocation			$5,068.13	L.S.	$5,068.00
Stormwater Management/Erosion Control			5%		$10,136.00
Subtotal Additional Capital Improvement Costs					**$32,435.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering			15%		$35,274.00
Legal/Administrative			5%		$11,758.00
Contract Admin/Construction Management			10%		$23,516.00
Contingency			25%		$58,790.00
Subtotal Other Costs					**$129,338.00**
Total Capital Improvement Costs					**$364,498.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs,	600	L.F.	$1.00	$120.00
Total Annual Operation and Maintenance Cost				**$120.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$4,200.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 7
DRAINAGEWAY : Boulder Creek
REACH : 7H
JURISDICTION : Boulder County
REACH ID: BCM-Reach7H Jeremy Deischer DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Soil Riprap, Type M		356	C.Y.	$85.00	$30,222.00	Protection for Sanitary near Boulder Creek (400 LF)
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		0	ACRE	$1,217.00	$304.00	
Special Items (User Defined)						
Grade Control Structure to Protect Sanitary	<----User Defined Items	2	L.S.	$205,000.00	$410,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$30,222.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$304.00
Special Items (User Defined)				$410,000.00
Subtotal Capital Improvement Costs				**$440,526.00**
Additional Capital Improvement Costs				
Dewatering	$4,405.26	L.S.		$4,405.00
Mobilization	5%			$22,026.00
Traffic Control	$11,013.15	L.S.		$11,013.00
Utility Coordination/Relocation	$11,013.15	L.S.		$11,013.00
Stormwater Management/Erosion Control	5%			$22,026.00
Subtotal Additional Capital Improvement Costs				**$70,483.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$76,651.00
Legal/Administrative	5%			$25,550.00
Contract Admin/Construction Management	10%			$51,101.00
Contingency	25%			$127,752.00
Subtotal Other Costs				**$281,054.00**
Total Capital Improvement Costs				**$792,063.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	2	EA	$608.00	$243.00
Total Annual Operation and Maintenance Cost				**$243.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$8,505.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 7
DRAINAGEWAY : Boulder Creek
REACH : 7I
JURISDICTION : Boulder County
REACH ID: BCM-Reach7I Jeremy Deischer DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Stream Restoration	<-----User Defined Items	6250	L.F.	$133.00	$831,250.00	
ERC Riparian Restoration	<-----User Defined Items	14	AC	$35,000.00	$502,181.00	50 ft on each side of stream

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$1,333,431.00
Subtotal Capital Improvement Costs				**$1,333,431.00**
Additional Capital Improvement Costs				
Dewatering	$13,334.31	L.S.		$13,334.00
Mobilization	5%			$66,672.00
Traffic Control	$33,335.78	L.S.		$33,336.00
Utility Coordination/Relocation	$33,335.78	L.S.		$33,336.00
Stormwater Management/Erosion Control	5%			$66,672.00
Subtotal Additional Capital Improvement Costs				**$213,350.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$232,017.00
Legal/Administrative	5%			$77,339.00
Contract Admin/Construction Management	10%			$154,678.00
Contingency	25%			$386,695.00
Subtotal Other Costs				**$850,729.00**
Total Capital Improvement Costs				**$2,397,510.00**

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	6250	L.F.	$2.00	$2,500.00	
Total Annual Operation and Maintenance Cost				**$2,500.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$87,499.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 8
DRAINAGEWAY : Boulder Creek
REACH : 8A
JURISDICTION : Boulder County
REACH ID: BCM-Reach8A Jeremy Deischer DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Estimate New Stream	<-----User Defined Items	1	L.S.	$230,000.00	$230,000.00	
ERC Estimate Riparian Restoration	<-----User Defined Items	1	L.S.	$140,000.00	$140,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$370,000.00
Subtotal Capital Improvement Costs				**$370,000.00**
Additional Capital Improvement Costs				
Dewatering	$3,700.00	L.S.		$3,700.00
Mobilization	5%			$18,500.00
Traffic Control	$9,250.00	L.S.		$9,250.00
Utility Coordination/Relocation	$9,250.00	L.S.		$9,250.00
Stormwater Management/Erosion Control	5%			$18,500.00
Subtotal Additional Capital Improvement Costs				**$59,200.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$64,380.00
Legal/Administrative	5%			$21,460.00
Contract Admin/Construction Management	10%			$42,920.00
Contingency	25%			$107,300.00
Subtotal Other Costs				**$236,060.00**
Total Capital Improvement Costs				**$665,260.00**

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	1700	L.F.	$2.00	$680.00	
Total Annual Operation and Maintenance Cost				**$680.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$23,800.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 8
DRAINAGEWAY :	Boulder Creek
REACH :	8B
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach8B

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Estimate New Stream	<----User Defined Items	1	L.S.	$640,000.00	$640,000.00	
ERC Estimate Riparian Restoration	<----User Defined Items	1	L.S.	$390,000.00	$390,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$1,030,000.00
Subtotal Capital Improvement Costs					**$1,030,000.00**
Additional Capital Improvement Costs					
Dewatering		$10,300.00	L.S.		$10,300.00
Mobilization		5%			$51,500.00
Traffic Control		$25,750.00	L.S.		$25,750.00
Utility Coordination/Relocation		$25,750.00	L.S.		$25,750.00
Stormwater Management/Erosion Control		5%			$51,500.00
Subtotal Additional Capital Improvement Costs					**$164,800.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$179,220.00
Legal/Administrative		5%			$59,740.00
Contract Admin/Construction Management		10%			$119,480.00
Contingency		25%			$298,700.00
Subtotal Other Costs					**$657,140.00**
Total Capital Improvement Costs					**$1,851,940.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	4800	L.F.	$2.00	$1,920.00
Total Annual Operation and Maintenance Cost				**$1,920.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$67,199.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 8
DRAINAGEWAY :	Boulder Creek
REACH :	8C
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach8C

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
220 ft railroad replacement	<----User Defined Items	4000	S.F.	$450.00	$1,800,000.00	20 ft width
Temp Bridge	<----User Defined Items	1500	S.F.	$350.00	$525,000.00	75 ft x 50 ft

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$2,325,000.00
Subtotal Capital Improvement Costs					**$2,325,000.00**
Additional Capital Improvement Costs					
Dewatering		$23,250.00	L.S.		$23,250.00
Mobilization		5%			$116,250.00
Traffic Control		$58,125.00	L.S.		$58,125.00
Utility Coordination/Relocation		$58,125.00	L.S.		$58,125.00
Stormwater Management/Erosion Control		5%			$116,250.00
Subtotal Additional Capital Improvement Costs					**$372,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$404,550.00
Legal/Administrative		5%			$134,850.00
Contract Admin/Construction Management		10%			$269,700.00
Contingency		25%			$674,250.00
Subtotal Other Costs					**$1,483,350.00**
Total Capital Improvement Costs					**$4,180,350.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	20	L.F.	$2.00	$8.00
Total Annual Operation and Maintenance Cost				**$8.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$280.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 8
DRAINAGEWAY :	Boulder Creek
REACH :	8D
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach8D

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Estimate New Stream	<----User Defined Items	1	L.S.	$340,000.00	$340,000.00	
ERC Estimate Stream Restoration	<----User Defined Items	1	L.S.	$210,000.00	$210,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$550,000.00
Subtotal Capital Improvement Costs					**$550,000.00**
Additional Capital Improvement Costs					
Dewatering		$5,500.00	L.S.		$5,500.00
Mobilization		5%			$27,500.00
Traffic Control		$13,750.00	L.S.		$13,750.00
Utility Coordination/Relocation		$13,750.00	L.S.		$13,750.00
Stormwater Management/Erosion Control		5%			$27,500.00
Subtotal Additional Capital Improvement Costs					**$88,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$95,700.00
Legal/Administrative		5%			$31,900.00
Contract Admin/Construction Management		10%			$63,800.00
Contingency		25%			$159,500.00
Subtotal Other Costs					**$350,900.00**
Total Capital Improvement Costs					**$988,900.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	2600	L.F.	$2.00	$1,040.00
Total Annual Operation and Maintenance Cost				**$1,040.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$36,400.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 8
DRAINAGEWAY :	Boulder Creek
REACH :	8E
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach8E

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		133	C.Y.	$29.00	$3,867.00	30 ft x 40 ft x 3 ft
Special Items (User Defined)						
Roadway Surface (Concrete)	<----User Defined Items	43	C.Y.	$730.00	$31,543.00	25 ft x 70 ft x 8 in
Landscaping	<----User Defined Items	700	S.F.	$2.00	$1,400.00	2 of 70 ft x 5 ft
Trees	<----User Defined Items	2	EA	$500.00	$1,000.00	
Signage / Barriers	<----User Defined Items	2	EA	$1,500.00	$3,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$3,867.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$36,943.00
Subtotal Capital Improvement Costs					**$40,810.00**
Additional Capital Improvement Costs					
Dewatering			L.S.		$0.00
Mobilization		5%			$2,041.00
Traffic Control		$1,020.25	L.S.		$1,020.00
Utility Coordination/Relocation		$1,020.25	L.S.		$1,020.00
Stormwater Management/Erosion Control		5%			$2,041.00
Subtotal Additional Capital Improvement Costs					**$6,122.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$7,040.00
Legal/Administrative		5%			$2,347.00
Contract Admin/Construction Management		10%			$4,693.00
Contingency		25%			$11,733.00
Subtotal Other Costs					**$25,813.00**
Total Capital Improvement Costs					**$72,745.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 8
DRAINAGEWAY : Boulder Creek
REACH : 8F
JURISDICTION : Boulder County
REACH ID: BCM-Reach8F Jeremy Deischer DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Master Plan Capital Improvement Cost Summary						
Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$0.00	
Subtotal Capital Improvement Costs					**$0.00**	
Additional Capital Improvement Costs						
Dewatering		$0.00	L.S.		$0.00	
Mobilization		5%			$0.00	
Traffic Control		$0.00	L.S.		$0.00	
Utility Coordination/Relocation		$0.00	L.S.		$0.00	
Stormwater Management/Erosion Control		5%			$0.00	
Subtotal Additional Capital Improvement Costs					**$0.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$0.00	
Legal/Administrative		5%			$0.00	
Contract Admin/Construction Management		10%			$0.00	
Contingency		25%			$0.00	
Subtotal Other Costs					**$0.00**	
Total Capital Improvement Costs					**$0.00**	

Master Plan Operation and Maintenance Cost Summary					
Description		**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Sediment Removal (4 locations 1x annually)	<----User Defined Items	800	C.Y.	$30.00	$24,000.00
Total Annual Operation and Maintenance Cost					**$24,000.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$839,993.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 9
DRAINAGEWAY : Boulder Creek
REACH : 9A
JURISDICTION : City of Boulder
REACH ID: BCM-Reach9A Jeremy Deischer DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		1303	C.Y.	$29.00	$37,773.00	Estimated cut
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		1	ACRE	$1,219.00	$1,219.00	
Trail/Path, Concrete (10' Width)		325	L.F.	$54.00	$17,550.00	
Land Acquisition						
Easement/ROW Acquisition		0.30	ACRE	$550,000.00	$165,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains			$0.00	
Concrete Box Culverts			$0.00	
Hydraulic Structures			$0.00	
Channel Improvements			$37,773.00	
Detention/Water Quality Facilities			$0.00	
Removals			$0.00	
Landscaping and Maintenance Improvements			$18,769.00	
Special Items (User Defined)			$0.00	
Subtotal Capital Improvement Costs			**$56,542.00**	
Additional Capital Improvement Costs				
Dewatering	$565.42	L.S.	$565.00	
Mobilization	5%		$2,827.00	
Traffic Control	$1,413.55	L.S.	$1,414.00	
Utility Coordination/Relocation	$1,413.55	L.S.	$1,414.00	
Stormwater Management/Erosion Control	5%		$2,827.00	
Subtotal Additional Capital Improvement Costs			**$9,047.00**	
Land Acquisition Costs				
ROW/Easements			$165,000.00	
Subtotal Land Acquisition Costs			**$165,000.00**	
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%		$9,838.00	
Legal/Administrative	5%		$3,279.00	
Contract Admin/Construction Management	10%		$6,559.00	
Contingency	25%		$16,397.00	
Subtotal Other Costs			**$36,073.00**	
Total Capital Improvement Costs			**$266,662.00**	

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	325	L.F.	$6.00	$390.00
Total Annual Operation and Maintenance Cost				**$390.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$13,650.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 9
DRAINAGEWAY :	Boulder Creek
REACH :	9B
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach9B

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		21201	C.Y.	$29.00	$614,829.00	Cut required
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		7	ACRE	$1,217.00	$8,519.00	
Trail/Path, Concrete (10' W/dth)		250	L.F.	$54.00	$13,500.00	
Special Items (User Defined)						
Tennis Court Reconstruction	<----User Defined Items	7	EA	$65,000.00	$455,000.00	
Basketball Court Relocation	<----User Defined Items	1	EA	$30,000.00	$30,000.00	
Acquisition of Homes (3)	<----User Defined Items	5594	S.F.	$100.00	$559,400.00	
Removal of Homes (3)	<----User Defined Items	3	EA	$40,000.00	$120,000.00	
Asphalt Remove and Replace	<----User Defined Items	5640	S.Y.	$60.00	$338,400.00	
Land Acquisition						
Easement/ROW Acquisition		7.00	ACRE	$1,132,560.00	$7,927,920.00	$26 per S.F.

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$614,829.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$22,019.00
Special Items (User Defined)				$1,502,800.00
Subtotal Capital Improvement Costs				**$2,139,648.00**
Additional Capital Improvement Costs				
Dewatering	$21,396.48	L.S.		$21,396.00
Mobilization	5%			$106,982.00
Traffic Control	$53,491.20	L.S.		$53,491.00
Utility Coordination/Relocation	$53,491.20	L.S.		$53,491.00
Stormwater Management/Erosion Control	5%			$106,982.00
Subtotal Additional Capital Improvement Costs				**$342,342.00**
Land Acquisition Costs				
ROW/Easements				$7,927,920.00
Subtotal Land Acquisition Costs				**$7,927,920.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$372,299.00
Legal/Administrative	5%			$124,100.00
Contract Admin/Construction Management	10%			$248,199.00
Contingency	25%			$620,498.00
Subtotal Other Costs				**$1,365,096.00**
Total Capital Improvement Costs				**$11,775,006.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 9
DRAINAGEWAY :	Boulder Creek
REACH :	9C
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach9C

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Boulder Creek Pedestrian Bridges	<----User Defined Items	2	EA	$1,520,000.00	$3,040,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$3,040,000.00
Subtotal Capital Improvement Costs				**$3,040,000.00**
Additional Capital Improvement Costs				
Dewatering	$30,400.00	L.S.		$30,400.00
Mobilization	5%			$152,000.00
Traffic Control	$45,600.00	L.S.		$45,600.00
Utility Coordination/Relocation	$76,000.00	L.S.		$76,000.00
Stormwater Management/Erosion Control	5%			$152,000.00
Subtotal Additional Capital Improvement Costs				**$456,000.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$524,400.00
Legal/Administrative	5%			$174,800.00
Contract Admin/Construction Management	10%			$349,600.00
Contingency	25%			$874,000.00
Subtotal Other Costs				**$1,922,800.00**
Total Capital Improvement Costs				**$5,418,800.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 9
DRAINAGEWAY :	Boulder Creek
REACH :	9D
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach9D

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
48-inch	750	1	750	L.F.	$175.00	$131,250.00	
Flare End Sections							
Diameter (in)	Applicable	No. of Barrels					
48-inch	Yes	1	1	EA	$2,506.00	$2,506.00	
Channel Improvements							
Excavation, Low Range			2010	C.Y.	$13.00	$26,130.00	Earthwork
Special Items (User Defined)							
Asphalt Remove and Replace	<----User Defined Items		2060	S.Y.	$60.00	$123,600.00	14th Street
Manhole Box Base	<----User Defined Items		3	EA	$7,000.00	$21,000.00	
Concrete for Weir Diversion	<----User Defined Items		48	CY	$730.00	$35,186.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$133,756.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$26,130.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$179,786.00
Subtotal Capital Improvement Costs				**$339,672.00**
Additional Capital Improvement Costs				
Dewatering		$3,396.72	L.S.	$3,397.00
Mobilization		5%		$16,984.00
Traffic Control		$8,491.80	L.S.	$8,492.00
Utility Coordination/Relocation		$100,000.00	L.S.	$100,000.00
Stormwater Management/Erosion Control		5%		$16,984.00
Subtotal Additional Capital Improvement Costs				**$145,857.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering		15%		$72,829.00
Legal/Administrative		5%		$24,276.00
Contract Admin/Construction Management		10%		$48,553.00
Contingency		25%		$121,382.00
Subtotal Other Costs				**$267,040.00**
Total Capital Improvement Costs				**$752,569.00**

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, e	750	L.F.	$1.00	$150.00	
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	3	EA	$61.00	$37.00	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00	
Total Annual Operation and Maintenance Cost				**$309.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$10,815.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 9
DRAINAGEWAY :	Boulder Creek
REACH :	9E
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach9E

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	
Additional Improvements	<----User Defined Items	1	L.S.	$100,000.00	$100,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$350,000.00
Subtotal Capital Improvement Costs				**$350,000.00**
Additional Capital Improvement Costs				
Dewatering		$3,500.00	L.S.	$3,500.00
Mobilization		5%		$17,500.00
Traffic Control		$8,750.00	L.S.	$8,750.00
Utility Coordination/Relocation		$8,750.00	L.S.	$8,750.00
Stormwater Management/Erosion Control		5%		$17,500.00
Subtotal Additional Capital Improvement Costs				**$56,000.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering		15%		$60,900.00
Legal/Administrative		5%		$20,300.00
Contract Admin/Construction Management		10%		$40,600.00
Contingency		25%		$101,500.00
Subtotal Other Costs				**$223,300.00**
Total Capital Improvement Costs				**$629,300.00**

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00	
Total Annual Operation and Maintenance Cost				**$122.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 9
DRAINAGEWAY :	Boulder Creek
REACH :	9F
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach9F

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Master Plan Capital Improvement Cost Summary						
Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$0.00	
Subtotal Capital Improvement Costs					**$0.00**	
Additional Capital Improvement Costs						
Dewatering		$0.00	L.S.		$0.00	
Mobilization		5%			$0.00	
Traffic Control		$0.00	L.S.		$0.00	
Utility Coordination/Relocation		$0.00	L.S.		$0.00	
Stormwater Management/Erosion Control		5%			$0.00	
Subtotal Additional Capital Improvement Costs					**$0.00**	
Land / Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$0.00	
Legal/Administrative		5%			$0.00	
Contract Admin/Construction Management		10%			$0.00	
Contingency		25%			$0.00	
Subtotal Other Costs					**$0.00**	
Total Capital Improvement Costs					**$0.00**	

Master Plan Operation and Maintenance Cost Summary					
Description		**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Sediment Removal (6 locations - 1x annually)	<----User Defined Items	1200	C.Y.	$30.00	$36,000.00
Total Annual Operation and Maintenance Cost					**$36,000.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$1,259,989.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 10
DRAINAGEWAY :	Boulder Creek
REACH :	10A
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach10A

Jeremy Deischer | DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	
Master Plan Capital Improvement Cost Summary						
Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$250,000.00	
Subtotal Capital Improvement Costs					**$250,000.00**	
Additional Capital Improvement Costs						
Dewatering		$12,500.00	L.S.		$12,500.00	
Mobilization		5%			$12,500.00	
Traffic Control		$6,250.00	L.S.		$6,250.00	
Utility Coordination/Relocation		$6,250.00	L.S.		$6,250.00	
Stormwater Management/Erosion Control		5%			$12,500.00	
Subtotal Additional Capital Improvement Costs					**$50,000.00**	
Land / Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$45,000.00	
Legal/Administrative		5%			$15,000.00	
Contract Admin/Construction Management		10%			$30,000.00	
Contingency		25%			$75,000.00	
Subtotal Other Costs					**$165,000.00**	
Total Capital Improvement Costs					**$465,000.00**	

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00
Total Annual Operation and Maintenance Cost				**$122.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 10
DRAINAGEWAY : Boulder Creek
REACH : 10B
JURISDICTION : Boulder County
REACH ID: BCM-Reach10B Jeremy Deischer DATE : 2015-04-22

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Estimate Enhanced Stream	<----User Defined Items	1	L.S.	$410,000.00	$410,000.00	
ERC Estimate Riparian Restoration	<----User Defined Items	1	L.S.	$190,000.00	$190,000.00	

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains		$0.00	
Concrete Box Culverts		$0.00	
Hydraulic Structures		$0.00	
Channel Improvements		$0.00	
Detention/Water Quality Facilities		$0.00	
Removals		$0.00	
Landscaping and Maintenance Improvements		$0.00	
Special Items (User Defined)		$600,000.00	
Subtotal Capital Improvement Costs		**$600,000.00**	
Additional Capital Improvement Costs			
Dewatering	$6,000.00 L.S.	$6,000.00	
Mobilization	5%	$30,000.00	
Traffic Control	$15,000.00 L.S.	$15,000.00	
Utility Coordination/Relocation	$15,000.00 L.S.	$15,000.00	
Stormwater Management/Erosion Control	5%	$30,000.00	
Subtotal Additional Capital Improvement Costs		**$96,000.00**	
Land Acquisition Costs			
ROW/Easements		$0.00	
Subtotal Land Acquisition Costs		**$0.00**	
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%	$104,400.00	
Legal/Administrative	5%	$34,800.00	
Contract Admin/Construction Management	10%	$69,600.00	
Contingency	25%	$174,000.00	
Subtotal Other Costs		**$382,800.00**	
Total Capital Improvement Costs		**$1,078,800.00**	

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	4800	L.F.	$2.00	$1,920.00
Total Annual Operation and Maintenance Cost				**$1,920.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$67,199.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek - Modify Ditch Diversion for Aquatic and Habitat Passage
DRAINAGEWAY : Boulder Creek
REACH : DitchForAquatic
JURISDICTION : Weld County
REACH ID: BCM-ReachDitchForAquatic Jeremy Deischer DATE : 2015-04-27

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Grouted Boulders, 36"		763	S.Y.	$231.00	$176,253.00	
12-inch Riprap, Type M		37	C.Y.	$73.00	$2,682.00	
Excavation, Low Range		821	C.Y.	$13.00	$10,673.00	
Special Items (User Defined)						
Concrete Seepage Cutoff Wall	<----User Defined Items	21	CY	$730.00	$15,009.00	
Improvements to Diversion Structure	<----User Defined Items	1	L.S.	$45,000.00	$45,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains			$0.00	
Concrete Box Culverts			$0.00	
Hydraulic Structures			$0.00	
Channel Improvements			$189,608.00	
Detention/Water Quality Facilities			$0.00	
Removals			$0.00	
Landscaping and Maintenance Improvements			$0.00	
Special Items (User Defined)			$60,009.00	
Subtotal Capital Improvement Costs			**$249,617.00**	
Additional Capital Improvement Costs				
Dewatering		L.S.	$0.00	
Mobilization	5%		$12,481.00	
Traffic Control		L.S.	$0.00	
Utility Coordination/Relocation		L.S.	$0.00	
Stormwater Management/Erosion Control	5%		$12,481.00	
Subtotal Additional Capital Improvement Costs			**$24,962.00**	
Land Acquisition Costs				
ROW/Easements			$0.00	
Subtotal Land Acquisition Costs			**$0.00**	
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%		$41,187.00	
Legal/Administrative	5%		$13,729.00	
Contract Admin/Construction Management	10%		$27,458.00	
Contingency	25%		$68,645.00	
Subtotal Other Costs			**$151,019.00**	
Total Capital Improvement Costs			**$425,598.00**	

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$608.00	$122.00
Total Annual Operation and Maintenance Cost				**$122.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek - Modify Ditch Diversion for Aquatic and Habitat Passage
DRAINAGEWAY : Boulder Creek
REACH : GradeControl
JURISDICTION : Weld County
REACH ID: BCM-ReachGradeControl Jeremy Deischer DATE : 2015-04-27

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Grouted Boulders, 36"		763	S.Y.	$231.00	$176,253.00	
12-Inch Riprap, Type M		37	C.Y.	$73.00	$2,682.00	
Excavation, Low Range		821	C.Y.	$13.00	$10,673.00	
Special Items (User Defined)						
Concrete Seepage Cutoff	<----User Defined Items	21	CY	$730.00	$15,330.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains			$0.00	
Concrete Box Culverts			$0.00	
Hydraulic Structures			$0.00	
Channel Improvements			$189,608.00	
Detention/Water Quality Facilities			$0.00	
Removals			$0.00	
Landscaping and Maintenance Improvements			$0.00	
Special Items (User Defined)			$15,330.00	
Subtotal Capital Improvement Costs			**$204,938.00**	
Additional Capital Improvement Costs				
Dewatering		L.S.	$0.00	
Mobilization	5%		$10,247.00	
Traffic Control		L.S.	$0.00	
Utility Coordination/Relocation		L.S.	$0.00	
Stormwater Management/Erosion Control	5%		$10,247.00	
Subtotal Additional Capital Improvement Costs			**$20,494.00**	
Land Acquisition Costs				
ROW/Easements			$0.00	
Subtotal Land Acquisition Costs			**$0.00**	
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%		$33,815.00	
Legal/Administrative	5%		$11,272.00	
Contract Admin/Construction Management	10%		$22,543.00	
Contingency	25%		$56,358.00	
Subtotal Other Costs			**$123,988.00**	
Total Capital Improvement Costs			**$349,420.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek Gravel Spillway
DRAINAGEWAY : Boulder Creek
REACH : MineralRd
JURISDICTION : Boulder County
REACH ID: BCM-ReachMineralRd JKD DATE : 2015-03-23

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Grouted Boulders, 36"		540	S.Y.	$231.00	$124,740.00	
Excavation, Mid Range		880	C.Y.	$29.00	$25,532.00	Haul Required (Autocad Estimate)
Soil Riprap, Type M		289	C.Y.	$85.00	$24,557.00	
Excavation, Low Range		712	C.Y.	$13.00	$9,256.00	Excavate and Backfill (CAD Estimate)
Special Items (User Defined)						
Concrete for Cutoff Walls	<----User Defined Items	56	CY	$730.00	$40,588.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains			$0.00	
Concrete Box Culverts			$0.00	
Hydraulic Structures			$0.00	
Channel Improvements			$184,085.00	
Detention/Water Quality Facilities			$0.00	
Removals			$0.00	
Landscaping and Maintenance Improvements			$0.00	
Special Items (User Defined)			$40,588.00	
Subtotal Capital Improvement Costs			**$224,673.00**	
Additional Capital Improvement Costs				
Dewatering		L.S.	$0.00	
Mobilization	5%		$11,234.00	
Traffic Control		L.S.	$0.00	
Utility Coordination/Relocation		L.S.	$0.00	
Stormwater Management/Erosion Control	5%		$11,234.00	
Subtotal Additional Capital Improvement Costs			**$22,468.00**	
Land Acquisition Costs				
ROW/Easements			$0.00	
Subtotal Land Acquisition Costs			**$0.00**	
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%		$37,071.00	
Legal/Administrative	5%		$12,357.00	
Contract Admin/Construction Management	10%		$24,714.00	
Contingency	25%		$61,785.00	
Subtotal Other Costs			**$135,927.00**	
Total Capital Improvement Costs			**$383,068.00**	

APPENDIX F

RIPARIAN ZONE AND THREATENED AND ENDANGERED SPECIES SUMMARY

Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204 ~ Evergreen, CO ~ 80439 ~ (303) 679-4820

Technical Memorandum

Date: July 14, 2015

To: ICON Engineering

From: Dave Blauch, Diane Krzysztof (Ecological Resource Consultants, Inc.)

Re: **Boulder Creek Watershed Master Plan**
Riparian Zone and Threatened and Endangered Species Summary

During the historic regional flood event in September 2013, Boulder Creek experienced high peak flows for an extended duration which resulted in not only damages to infrastructure, but also widespread damages to the stream corridor. Roads and bridges overtopped, channel avulsions occurred, and questions arose regarding the best approach to rebuild infrastructure and restore Boulder Creek.

This memo, as part of the Boulder Creek Master Plan, specifically addresses the general condition of the existing riparian communities within the Boulder Creek corridor after the flooding and provides recommendations for re-establishment (or restoration) of the riparian zone as flood recovery efforts continue within the project area.

During the initial flood recovery efforts, emergency stabilization measures focused more on hardened methods such as riprap, grout, boulders and infrastructure repair. As the focus shifts towards long-term recovery, measures must also consider restoration of critical natural riparian and aquatic ecosystem function.

The importance of a well-developed riparian corridor is well documented. Well vegetated riparian corridors provide important terrestrial wildlife habitat, provide instream aquatic habitat benefits, stabilize soils and reduce problems from erosion, flooding and excessive nutrients. A properly functioning riparian corridor protects the physical integrity of the aquatic environment.

As part of ICON's team, ERC completed a cursory baseline assessment of the existing post-flood riparian corridor within the project area. The general condition of the existing riparian corridor was assessed including dominant vegetation community types remaining, species composition and primary vegetation strata that remain or that may have been damaged or lost. In addition, the assessment defined a typical "reference condition" riparian community or in other words the ideal natural riparian vegetation community that existed prior to the flood event and in an undisturbed state that should be the focus for

riparian restoration during long-term recovery efforts. **Section 1.0** of this memo summarizes the riparian corridor existing conditions and long-term recovery recommendations.

The riparian corridor of the Boulder Creek project area also provides critical habitat that should be considered during flood recovery efforts. **Section 2.0** of this memo includes a cursory screening of potential federal and state threatened and endangered species that may occur on or immediately surrounding the project area. Also included in this section is a summary of additional data reviewed for the project area including migratory birds, aquatic and macroinvertebrate data, wildlife closures and other important habitat management areas. This data is provided for reference, as-needed.

SECTION 1.0 RIPARIAN ZONE ASSESSMENT

1.1 IMPORTANCE OF THE RIPARIAN ZONE

A riparian corridor or "riparian zone" is defined as the transitional area or interface between upland terrestrial and aquatic habitats. A riparian zone is generally considered that portion of the landscape from the ordinary high water mark towards the adjoining uplands that affect or are affected by the presence of water (**Figure 1**). The riparian zone is often unique within a watershed containing notably different vegetation communities from the surrounding upland habitat. Properly functioning riparian zones of high ecological integrity contain an unfragmented, structurally diverse vegetation community, typically composed of three strata that includes trees, shrubs and grasses that are native to the region and that are adapted to the climatic, soil, and hydrologic conditions. The riparian zone has a variety of functions important to the stream or aquatic environment. Well vegetated riparian zones provide important terrestrial wildlife habitat, provide aquatic habitat benefits (shading, decreased water temperatures, biomass and instream cover), soil stabilization, and reduced problems from erosion, sedimentation and nutrients. Riparian vegetation also contributes to bank stability by dissipating the energy of moving water and reducing velocity, which is imperative during typical flood events. In an ideal situation, natural stream flows are able to access a broad floodplain. A properly functioning riparian zone protects not only water quality but also the physical integrity of the aquatic environment.

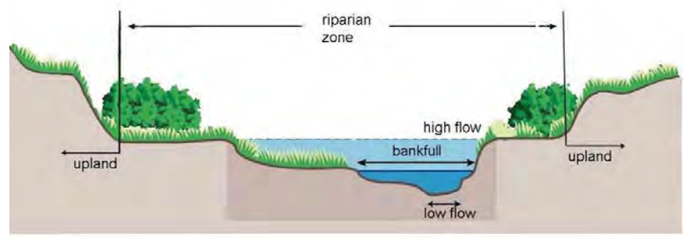


FIGURE 1. COMPONENTS OF A PROPERLY FUNCTIONING RIPARIAN ZONE.
(IMAGE MODIFIED FROM FISRWG 1998.)

In general, the riparian zone width necessary to provide a particular level of function depends on the functions of the stream, the characteristics of the riparian zone, topography, intensity of adjacent land use, and overall watershed characteristics. The riparian zone is also often considered as a protective buffer to the aquatic system.

The City of Boulder prepared a report entitled *Wetland and Stream Buffers: A review of the Science and Regulatory Approaches to Protection* (April 2007) which summarizes that riparian zone or stream buffers adjacent to active stream channels provide important hydrological and ecological "rights-of-ways." Stream buffers maintain lateral connectivity between the streams and adjacent floodplains and uplands, as well as longitudinal connectivity up and down stream. The buffer width, length and vegetation composition are key features essential to establishing and maintaining health aquatic systems. Generally buffers that are wider, longer and more densely vegetated with herbaceous, shrub and tree layers provide more benefits than buffers that are narrower, shorter and sparsely vegetated with only herbaceous species. The report provides a summary of buffer widths recommended by the USEPA for various functions which indicates a minimum width should be at least 50 feet and extend upwards of 200 feet from the stream edge. Error! Reference source not found. illustrates riparian buffer widths correlated to ecological function. Other scientific research has specifically evaluated the size of a riparian zone or buffer needed to adequately remove specific sediments, phosphorous, nitrogen, and other pollutants as well as provide effective wildlife protection (Environmental Law Institute 2008). Riparian zone widths for wildlife protection are typically the broadest and are based on how far individuals range from the waterbody for breeding or other life-cycle needs which can range from 33 feet to 5,000 feet, depending on the species (Environmental Law Institute 2003, Fischer 2000).

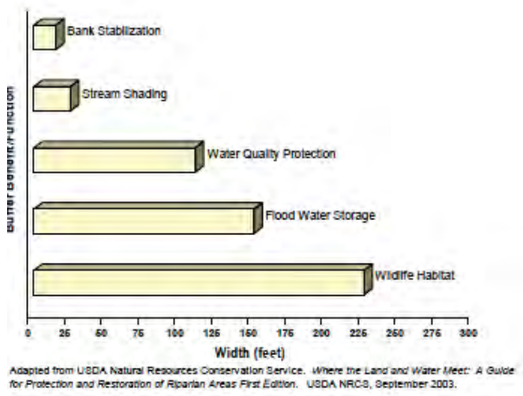


FIGURE 2. RIPARIAN BUFFER WIDTH CORRELATED TO ECOLOGICAL FUNCTION (FROM CITY OF BOULDER 2007).

1.2 PROJECT AREA SETTING

The project area comprises nearly 24 miles along Boulder Creek, extending from the confluence with Fourmile Creek, located within Boulder Canyon upstream of the City of Boulder, downstream to the confluence with the St. Vrain River, in the City of Longmont. The project area encompasses Boulder Creek and its adjacent floodplain through Boulder and Weld Counties.

The Boulder Creek project area generally lies within the South Central Semi-Arid Prairie ecoregion of the Great Plains; while a small portion of the upstream project reach occurs within the Northwestern Forested Mountain ecoregion of the Southern Rockies (USEPA Level III Ecoregions). The topographic elevation

ranges from approximately 5,700 feet above mean sea level (AMSL) at the confluence with Four Mile Creek within Boulder Canyon to approximately 4,800 feet AMSL at the downstream (east) end of the project area.

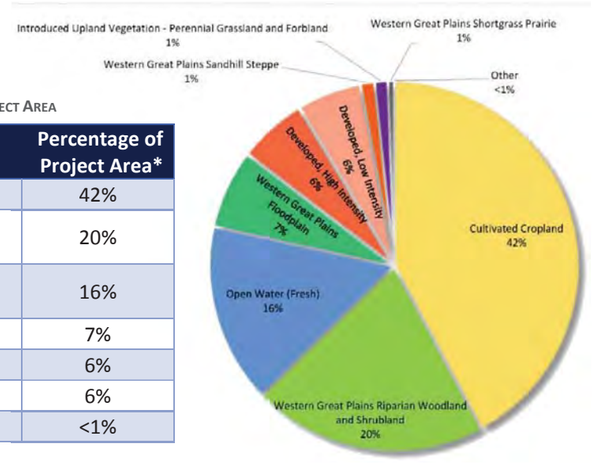
1.2.1 LAND USE AND VEGETATION COVER TYPES

Boulder Creek is a perennial stream which generally flows from west to northeast through the project area. The FEMA mapped 100-year floodplain has been used to generally define the project area boundary, which varies in width from approximately 150 feet wide at the upstream end to approximately 6,500 feet wide at the downstream confluence with the Saint Vrain River.

Existing land use and vegetation cover types were evaluated within the project area using mapping from the US Geological Survey (USGS) Southwest Regional Gap Analysis Project (SWReGAP) (2001). The predominant land cover type of the project area is cultivated cropland (42% of land) which includes grazing, alfalfa and other crop production. Aggregate mining of sand and gravel since the mid 1950's has visibly shaped the project area landscape as open water ponds scatter the floodplain, occupying approximately 16% of project area. Natural vegetation cover types within the riparian zone occupy only 27% of the project area and are mainly classified as Western Great Plains Riparian Woodland and Shrubland and to a lesser degree Western Great Plains Floodplain. Other land mapped within the project includes high and low density developed areas (12%) such as land within the City of Boulder, larger paved roads and other miscellaneous developments. **Table 1** summarizes all land use types and vegetation communities mapped within the project area.

TABLE 1-LANDCOVER TYPES MAPPED WITHIN THE PROJECT AREA

Land cover Types	Percentage of Project Area*
Cultivated Cropland	42%
Western Great Plains Riparian Woodland and Shrubland	20%
Open Water (Fresh) *(i.e., abandoned gravel ponds)*	16%
Western Great Plains Floodplain	7%
Developed, High Intensity	6%
Developed, Low Intensity	6%
Other	<1%



Source: SWReGAP 2001

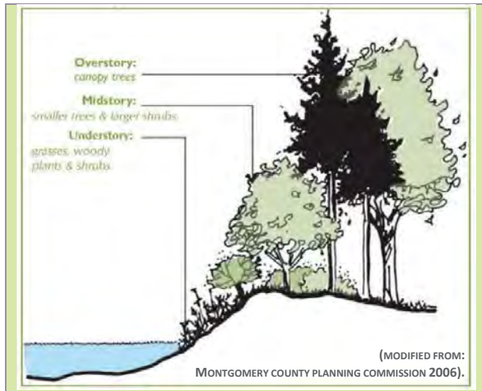
*Project Area defined by FEMA 100-year floodplain.

1.2.2 RIPARIAN ZONE VEGETATION COMMUNITY AND REFERENCE STANDARD

Of the vegetation cover types identified within the project area (SWReGAP 2001), the primary natural riparian zone vegetation community type that occurs within the project area is the Western Great Plains Riparian Woodland and Shrubland. This vegetation community type is most characteristic of habitats within the project area thus would be considered the reference standard or ideal natural community.

The Western Great Plains Riparian Woodland and Shrubland community type is found widely in the Great Plains of Colorado and occurs in wide river corridors that have low-gradient and primarily sandy/gravelly beds (becoming cobbly with increasing gradients). The type is most often found proximal to perennial rivers on low sidebars and streambanks near stream bankfull levels (NatureServe 2004). Because of its low position, the type is flooded frequently (average recurrence interval is 5 years). Dominant communities within this streamside system range from floodplain forests to wet meadows where properly functioning systems are linked by underlying soils and the flooding regime (FGDC 2008).

Within the project area, this reference standard community would occur on low terraces and along the immediate streambanks of Boulder Creek through the riparian zone. The unconfined, active stream channel would frequently inundate vegetation through the riparian zone and active floodplain forming a complexity of habitats which support a variety of plant communities. In a more undisturbed condition, vegetation would be continuous along the entire corridor and occupy three strata (i.e., overstory, midstory and understory). The riparian zone vegetation community would be dominated by open to moderately open tree canopy of plains cottonwood (25-50% cover) with thickets of narrowleaf willow in the mid-story. A dense herbaceous understory layer comprised of graminoids would be present along portions the streambanks above the ordinary high water mark. The overall herbaceous diversity would be high and predominantly native in composition. Subirrigated areas may support tallgrass meadow understory. The presence of narrowleaf willow indicates that the water table is relatively high and the community floods at least occasionally (E. Muldavin et al. 2006). **Figure 3** depicts the components of a properly functioning and structurally diverse riparian community for Boulder Creek.



(MODIFIED FROM: MONTGOMERY COUNTY PLANNING COMMISSION 2006).

FIGURE 3. NATURAL RIPARIAN CORRIDORS OF HIGH ECOLOGICAL INTEGRITY TYPICALLY CONTAIN THREE DISTINCT LAYERS OF VEGETATION – OVERSTORY FOREST CANOPY OF TREES, MIDSTORY SHRUBS AND AN UNDERSTORY OF GRASSES.



BOULDER CREEK: EXAMPLE OF REFERENCE STANDARD RIPARIAN FOREST HABITAT – DOMINATED BY COTTONWOOD OVERSTORY WITH WILLOW MIDSTORY AND GRASS UNDERSTORY.

1.2.3 PROJECT AREA VEGETATION

Within the project area, the existing riparian vegetation community is generally characteristic of the Western Great Plains Riparian Woodland and Shrubland community; however, the community is largely modified in vegetation structure, diversity and hydrologic regime from the ideal or reference standard community. The specific plant associations within the project area's riparian vegetation community can include dryer species typically associated with upland forests and cultivated fields/pastures to mesic species associated with scrub-shrub fringe wetlands, wet meadows or emergent marshes. Some locations within the project area can also differ from the reference standard in the number of vegetation strata present, the amount of non-native species and overall percent cover.

The riparian vegetation community of the project area is generally dominated by plains cottonwood (*Populous deltoides*) in the overstory layer, narrowleaf willow (*Salix exigua*) in the midstory layer and mixed mesic graminoids form the understory layer. In some areas, scattered shrubs such as snowberry (*Symphoricarpos occidentalis*), chokecherry (*Prunus virginiana*) or golden currant (*Ribes aureum*) can also found in the midstory. The herbaceous stratum is variable. Native grasses such as needle-and-thread grass (*Stipa comata*), wild licorice (*Glycyrrhiza lepidota*) occur in dryer areas, while sedge (*Carex spp.*) and rushes species (*Juncus spp.*) can occupy the understory near the immediate streambank. Introduced prairie grasses such as smooth brome (*Bromus inermis*), orchard grass (*Dactylis glomerata*) and meadow fescue (*Festuca pratensis*) are common in the project area. Non-native or weedy plants are common within the project area include Russian olive (*Elaeagnus angustifolia*), crackwillow (*Salix fragilis*), crested wheatgrass (*Agropyron cristatum*), reed canarygrass (*Phalaris arundinacea*) and cheatgrass (*Bromus tectorum*).

1.2.4 PROJECT AREA WETLANDS

A variety of wetland habitats do exist within the riparian zone of Boulder Creek. Wetlands and other waters of the US are regulated under Section 404 of the Clean Water Act (CWA). Future restoration and recovery efforts which result in disturbances to regulated areas may be subject to permitting and approval by the US Army Corps of Engineers (USACE), the US Environmental Protection Agency, and/or the US Fish and Wildlife Service (USFWS). A formal wetland delineation, by a qualified wetland consultant, and coordination with the USACE Denver Regulatory Office is recommended prior to implementation of any future restoration and recovery efforts to ensure CWA compliance. In addition, any future restoration and recovery efforts must comply with local wetland, stream and wildlife regulations.

1.3 RIPARIAN ZONE POST-FLOOD

The existing condition of the riparian zone both pre- and post- flood varies across the project area and is largely influenced by historic and current land use practices. In general, the overall extent and condition of riparian habitat and value has been impacted more from historic land use practices than direct impacts from the flood. Land use including riparian vegetation removal, urban development, grazing, mining, stream channelization and establishment of non-native invasive vegetation have significantly shaped the character of the riparian corridor. In addition, land leveling, stream channelization, water diversions and levees reduce the extent and frequency of floodplain inundation, which further diminishes the quality and quantity of riparian vegetation (Anderson & Company Consulting Team 1998).

In these historically degraded areas, the riparian zone is narrow (<50 feet wide), fragmented and often dominated by non-native or weedy species. Higher quality riparian areas typically occur within the project in areas less impacted by human land use. In these areas, Boulder Creek's riparian zone is wide, stable and densely vegetated extending well over 500 feet across the floodplain. Refer to **Figure 4.** Example of varying riparian zone widths through the project area. The narrow riparian zone (left) is limited by land use and bisected by a railroad; the more naturalized downstream section (right) is wide and less confined.



FIGURE 4. EXAMPLE OF VARYING RIPARIAN ZONE WIDTHS THROUGH THE PROJECT AREA. THE NARROW RIPARIAN ZONE (LEFT) IS LIMITED BY LAND USE AND BISECTED BY A RAILROAD; THE MORE NATURALIZED DOWNSTREAM SECTION (RIGHT) IS WIDE AND LESS CONFINED. (NOTE: EXAMPLE IS PROVIDED FOR RIPARIAN WIDTH CHARACTERISTICS ONLY - SITE SPECIFIC VEGETATION COMMUNITIES AND SPECIES MAY NOT REPRESENT AN APPROPRIATE RESTORATION TARGET.)

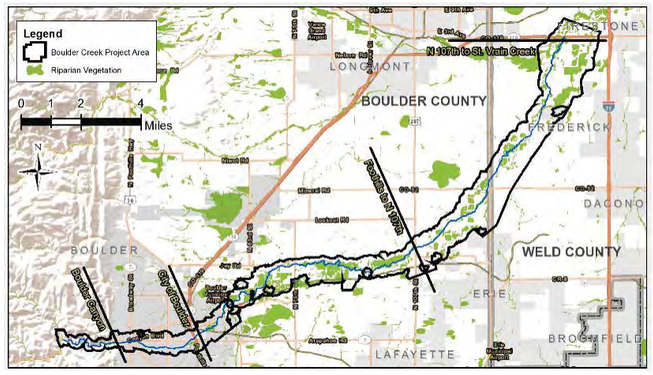


FIGURE 5. PROJECT AREA REACHES.

The overall development and extent of the riparian zone through the project area is closely correlated with existing landforms, land use practices and geomorphic processes. Therefore the structure of the riparian zone (shape/width) within the project area varies across topographic gradients from the steep canyon slopes to the level landscape across the plains. The Boulder Creek riparian zone through the project area is characterized by four distinct reaches: Boulder Canyon, City of Boulder, Foothills to N 107th Street and N 107th Street to Saint Vrain Creek (**Figure 5**).

1.3.1 DISTURBANCES TO THE RIPARIAN ZONE

Riparian zones by nature require regular flooding cycles to maintain their function. Certain vegetation species such as plains cottonwoods rely on regular flooding cycles for regeneration. However, extreme flood events can result in significant changes.

Floods can interact with vegetation in complex ways, both influencing and influenced by the structure and composition of the riparian zone (Johnson et al. 1999). The intensity of vegetation disturbance can be variable and influenced by factors such as pre-flood site conditions (i.e., type of vegetation present and channel constraints) and the interaction with flood dynamics (i.e., magnitude of flow and delivery of wood/sediment to a channel). Flood damage to riparian zone vegetation can occur by sediment and debris impact, scour or erosion of substrate or long-lasting change of hydrological conditions caused by changes in floodplain morphology and channel displacement. A less evident negative impact is a general decrease in plant vigor associated with post-stress reaction of plants to erosion (Toda et al. 2005). Flooding can damage trees indirectly by modifying soil characteristics. Extreme stream flows can wash away soil, exposing roots or deposit soil around a tree, smothering the roots. Generally, most trees and riparian vegetation damaged from flooding can recover in as little as one growing season; however, in other situations there may be no recovery at all. In addition, stressed trees can become more susceptible to secondary problems such as insect infestation or windthrow from the damaged root and trunk systems.

In several drainages effected by the 2013 flood event, the riparian zone was completely lost with removal of all soils and vegetation down to the underlying substrate. For example, the Little Thompson River, as described in the Little Thompson Watershed Restoration Master Plan (December 2014), exhibited some of the highest flow per square mile resulting in areas with almost total riparian zone loss. **Figure 6** below depicts an example of nearly complete riparian zone loss on the Little Thompson River as a result of the 2013 flood event.



FIGURE 6. EXAMPLE OF NEARLY COMPLETE RIPARIAN ZONE LOSS: *FROM* LITTLE THOMPSON WATERSHED RESTORATION MASTER PLAN (DECEMBER 2014) [*FIGURE 1.2 LITTLE THOMPSON RIVER AT BLUE MOUNTAIN NEIGHBORHOOD (FORMERLY X-BAR 7) BEFORE AND AFTER THE SEPTEMBER 2013 FLOOD.*]

1.3.2 PROJECT AREA DISTURBANCES

The existing (post-flood) riparian zone was evaluated within the project area reaches to determine the general overall effects from the September 2013 regional flood event. Overall, direct damage and loss to the riparian zone appears to be much less devastating than in other drainages affected by the flood event. For the most part, the riparian corridor of Boulder Creek remains intact and generally functioning with only relatively minor to moderate disturbance to the riparian zone.

Observed disturbance to the riparian zone varied throughout the project area reaches from minor or no impact within the more urban reaches which are designed to withstand higher peak flood flows; to more significant, moderate disturbances within downstream reaches which received higher volume of floodwater and debris flow from the upstream watershed. The effects included debris flows from the steep canyon reaches upstream that caused both bank erosion and sediment deposition in downstream riparian areas, along with conveyance and deposition of significant debris including boulders, trees, and household materials throughout the stream corridor. Within Boulder's city limits, significant maintenance was conducted post-flood to stabilize critically failing stream banks and to remove debris/sediment therefore these impacts appeared to be less severe through the project area.

The most significant impacts to the riparian zone observed in the project reaches are those areas where flood flows caused the stream to breach into nearby gravel ponds, completely abandoning the existing channel. This occurrence has altered the stream's connection to the original floodplain and riparian zone which will likely, over time, effect species diversity, abundance, structure, and functional characteristics of the riparian community.

Because the riparian zone is characterized by a distinct vegetation community that is physiologically adapted to a greater amount of available water (soil moisture, base flows, seasonal high flows and groundwater) than upland species, in areas where the available water has been altered, the reduced available water will eventually cause riparian succession to a dryer, more xeric (upland) plant community. Species composition can change dramatically over a gradient of available water frequency and depths: existing vegetation along the stream channel that is adapted to wetter conditions can be replaced by species that are tolerant of drier conditions causing habitat community shifts and in some cases complete loss of riparian species (Stomberg et al. 1996) (**Figure 7**).

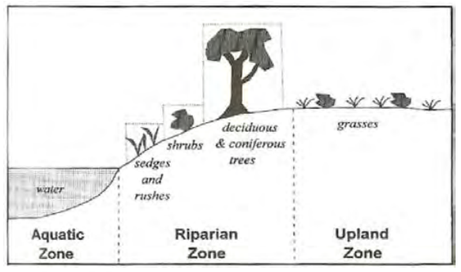


FIGURE 7. EXAMPLE OF SPECIES COMPOSITION THROUGH THE RIPARIAN ZONE.

Specifically within the project area, the Western Great Plains Riparian Woodland and Shrubland community is both propagated by and maintained by, periodic flooding (Drake and Rolfsmeier 1995). Cottonwood trees which dominate the existing riparian zone are particularly dependent on shallow alluvial groundwater and stream flows and exhibit a range of drought-stress responses including morphological responses, die-back and in severe cases, mortality occurs (Rood et al. 2003, Williams and Cooper 2005). Studies suggest

that without frequent flood events, this riparian community type would likely transition into a grassland community type within 30 years post-flood, as the cottonwood and willow species would not regenerate (Bellah and Hulbert 1974). Conversely, in areas where the active channel may be re-aligned, existing vegetation which is accustomed to less available water (xeric conditions) may transition to species more tolerant of increased available water.

Under both scenarios, even slight changes in the channel alignment or flow patterns can alter the composition and quality of both riparian and upland vegetation communities. During restoration and recovery efforts special consideration should be taken to thoroughly understand the interaction and dependence of vegetation communities on any proposed changes to the channel alignment and flow patterns.

A summary of riparian zone post-flood conditions within the project area is presented as follows by reach.

Boulder Canyon Reach

In this reach, the riparian zone is narrow (<100 feet wide) and confined between steep canyon walls and the adjacent Boulder Canyon Drive (Hwy 119) (**Figure 8**). Vegetation is largely comprised of one strata of trees or shrubs in the overstory with little or no understory vegetation present. The stream banks are steep and stable but armored with cobble/rock/riprap therefore lack mid- and understory strata.



FIGURE 8. BOULDER CANYON REACH OVERVIEW.

Through the Boulder Canyon reach, fast moving floodwaters inundated the narrow but armored riparian zone which resulted in only low disturbances including tree/shrub damage/loss, localized bank erosion and steep slope failure and debris accumulation. The original channel retains a relatively stable (armored) stream bank. Overall, the limited existing riparian zone remains intact and functioning. Characteristics of the Boulder Canyon reach are shown in **Photos 1-2**.



Photo 1. Boulder Canyon reach. The existing riparian zone is characterized by one vegetation strata including either trees or shrubs with no mid- or understory present. Flood damages to the riparian zone are low. Much of the riparian zone remains intact with little change the pre-flood condition.



Photo 2. Boulder Canyon reach example of low post-flood disturbances which includes only minor bank erosion and shrub damage.

City of Boulder Reach

This reach extends through the City of Boulder from approximately 5th Avenue to Foothills Parkway (**Figure 9**). High recreational use and an urban landscape setting characterize this reach, which limits the overall existing riparian habitat. The riparian zone varies in width from approximately 50-100 feet and is confined on both the north and south sides by commercial and residential development. Vegetation is typical of an urban corridor and is largely comprised of mixed deciduous overstory trees with little or no understory vegetation present. Turf grass is common along portions of this reach. Stream access structures constructed of grouted riprap are present and reinforced cobble banks are common through this reach. For the most part Boulder Creek has been channelized and "locked in place" from urbanization.



FIGURE 9. CITY OF BOULDER REACH OVERVIEW.

Through this reach, Boulder Creek overtopped its banks and inundated the existing riparian zone. Disturbances to the riparian zone are generally low and include minor tree damage/loss, minor localized bank erosion and relatively moderate sediment and debris deposition. Much of the deposition has been removed through City of Boulder flood recovery efforts and therefore is less pronounced at this time. Post-flood the riparian zone remains intact with little change the pre-flood condition therefore is anticipated to continue to function properly with little long-term adverse effects. Characteristics of the City of Boulder reach are shown in **Photos 3-4**.

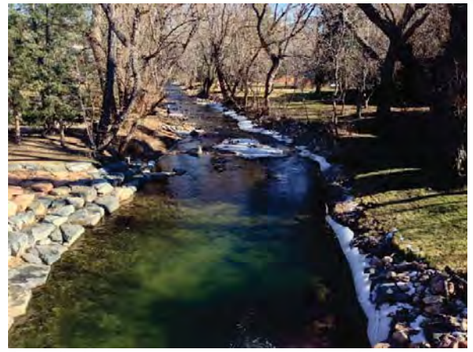


Photo 3. Highly urbanized area within City of Boulder reach characterized by overstory trees and armored stream banks. Through this reach, Boulder Creek overtopped its banks and inundated the existing riparian zone. After the flood event, the riparian zone remains relatively intact with little change from the pre-flood condition.



Photo 4. City of Boulder reach example of low-disturbance: debris accumulation and riparian zone tree damage (trunk damage and bark removal) as a result of the flood. For the most part, while damaged, a majority of the riparian vegetation community will persist and continue to function.

Foothills to N 107th Street

This reach is comprised of mixed land ownership including private, City of Boulder and Boulder County. The majority of land within this reach is City and County designated open space including conservation easement lands. Abandoned gravel ponds characterize the landscape within this reach which historically altered the channel alignment and riparian corridor. Overall, the riparian corridor is less confined and wider than the canyon and City of Boulder reaches (extending 100 feet to over 1,000 feet across the floodplain), but existing conditions vary widely throughout this reach (**Figure 10**).

The overall extent and quality of riparian habitat through this reach varies greatly with the degree of historic land use disturbance, specifically stream channelization. Likewise, the amount of flood disturbance to the riparian zone also ranges from low to moderate through this reach based on the degree of floodplain connectivity associated with historic stream channelization.

In less disturbed sections of this reach where the stream channel is not confined and able to access the active floodplain, the riparian zone is well developed and comprised of cottonwood trees in the overstory with willow species in the midstory and a mixed herbaceous understory. In these areas, the stream was able to access the floodplain and riparian zone dissipating flood energy and lowering erosion potential; therefore,

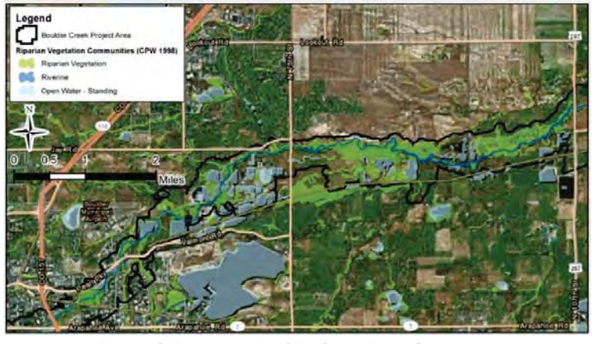


FIGURE 10. FOOTHILLS TO N 107TH STREET REACH OVERVIEW.

the post-flood disturbance to the riparian zone is low and includes only localized stream bank erosion/failure and/or tree damage/loss. In these low disturbance areas, the existing riparian zone remains intact and functioning.

In other areas where the stream is slightly modified (entrenched) but still able to access the bankfull stage, low terraces are present and dominated by one strata of trees/shrubs or herbaceous sedges/rushes/mesic grasses. In these sections of this reach, higher streamflows caused moderate disturbances including significant sediment deposition/vegetation burial, localized bank erosion, tree damage/loss and significant accumulation of debris from dead/downed trees through the riparian zone. For the most part, a majority of the riparian vegetation community remains intact and, while damaged, will persist and continue to function.

More degraded portions of this reach, which are confined by steep levees or significantly entrenched banks with no access to the active floodplain, are characterized by non-vegetated channel only with sparse overstory trees and upland herbaceous species present along the stream banks. In several locations, flood flows breached the original pre-flood channel and riparian zone resulting in new channel creation and flood flows through gravel ponds. In a few localized areas, specifically where the flood flows had eroded and breached the stream banks, the riparian vegetation is completely lost. In addition to the immediate disturbance to localized riparian vegetation, potential long-term impacts may occur within the abandoned channel and within overal associated riparian zone from alteration of stream flow which may result in vegetation community shifts or complete loss of riparian species. Characteristics of the Foothills to N 107th Street reach are shown in **Photos 5-6**.



Photo 5. Boulder Creek east from 61rd Street. Example of wide, well vegetated riparian zone with only moderate post-flood disturbance to the riparian zone. At this location, flood flows deposited significant amounts of cobble material within the existing overly wide stream channel which resulted in altered stream flow. The riparian zone is now disconnected from stream flow which can result in long-term habitat community shifts or complete loss of riparian species.



Photo 6. Boulder Creek near Valmont Road. Example of moderate post-flood disturbance to the riparian zone including: significant sediment deposition/vegetation burial, tree damage/loss and significant accumulation of debris from dead/downed trees. While moderate disturbance has occurred in this reach, a majority of the riparian vegetation remains intact and will continue to function.

ERC
Boulder Creek Master Plan
Riparian Zone and Threatened and Endangered Species Summary

N 107th Street to St. Vrain Creek Reach

This reach extends from N 107th Street in Boulder County to the confluence with St. Vrain Creek in Weld County (**Figure 11**). Within Boulder County (N 107th Street to County Line Road), land ownership is predominantly Boulder County open space including conservation easement lands. Land use throughout the reach is largely cultivated cropland with some abandoned gravel ponds throughout. Existing conditions vary throughout this reach however disturbance from historic land use practices and other channel alterations is generally widespread.

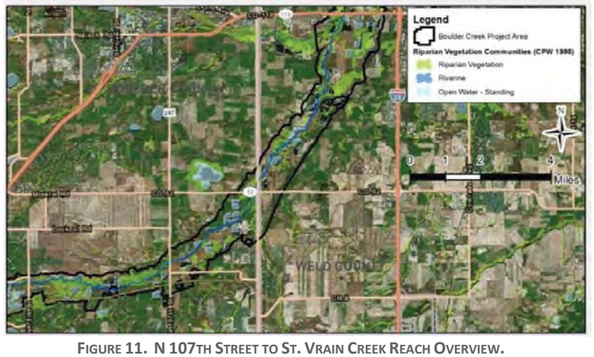


FIGURE 11. N 107TH STREET TO ST. VRAIN CREEK REACH OVERVIEW.

Throughout most of the reach, the riparian corridor is narrow, less than 50 feet wide and confined between upland leveed berms with limited floodplain connection. Riparian vegetation occurs along a narrow stream bench and is comprised of midstory shrubs and herbaceous sedges/rushes/mesic grasses in the understory. Sparse clusters of cottonwood trees occur sporadically along the riparian corridor. Non-native or invasive species are common in these channelized areas. In other areas where the stream is less confined, the reach is characterized by a meandering stream channel, wide floodplain and a dense riparian community dominated by overstory cottonwood trees, midstory willow species and an understory of herbaceous sedges/rushes/mesic grasses. The downstream portion of this reach near the confluence with Saint Vrain Creek exhibits these characteristics of high quality habitat or the reference standard comprised of a dense vegetation community with three strata, stable stream banks, a wide floodplain and little human disturbance thus was considered to be a more typical reference standard habitat for the project.

Disturbance to the riparian zone varies widely through this reach. Overall, areas where the stream is less confined, well vegetated and able to access the floodplain exhibited less disturbance to the riparian zone. In these areas, the riparian zone remains intact and functioning. In more confined sections of this reach, impacts are moderate and include significant sediment deposition/vegetation burial, localized bank erosion, tree damage/loss and significant accumulation of debris from dead/downed trees through the riparian zone. For the most part, while moderate disturbances to the riparian zone occurred, a majority of the riparian vegetation community will persist and continue to function.

Additional disturbances associated with stream channel breaches that occurred through more confined sections of this reach as a result of extreme flood flows. In several locations, Boulder Creek breached its original pre-flood channel and riparian zone and now flows through gravel ponds. In the far downstream portion of this reach, Saint Vrain Creek also breached it's existing pre-flood channel resulting in flow alteration into gravel ponds and flow back into Boulder Creek, abandoning the historic channel. Where the breaches occured, immediate post-flood disturbance to the riparian zone includes localized riparian

vegetation loss. In addition, potential long-term impacts may occur within the abandoned channel or even within other adjacent riparian areas from alteration of hydrology (increase or decrease in available water) which may result in vegetation community shifts or complete loss of riparian species. Characteristics of the N 107th Street to St. Vrain Creek reach are shown in **Photos 7-8**.



Photo 7. Confluence with St. Vrain Creek. Example of reference standard riparian habitat which includes dense vegetation community with three strata, stable stream banks, a wide floodplain and little human disturbance. Here flood flows resulted in minimal damage to the riparian corridor.



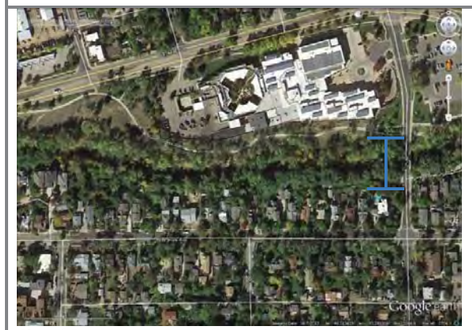
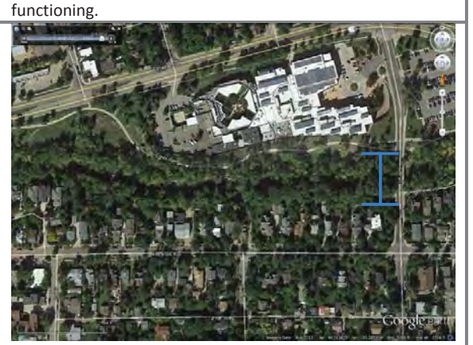
Photo 8. N 107th Street to St. Vrain Creek reach. Here flood flows resulted in abandonment of the pre-flood channel and riparian corridor. Herbaceous vegetation has begun to establish in the previous active channel bottom, indicative of an altered hydrologic regime.

1.3.3 SUMMARY RIPARIAN ZONE POST-FLOOD

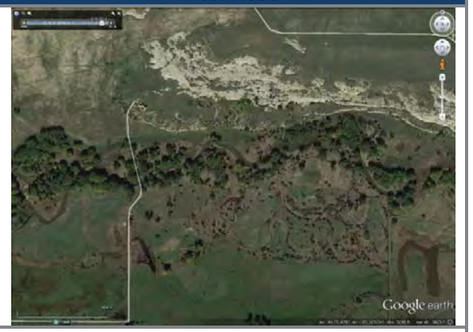
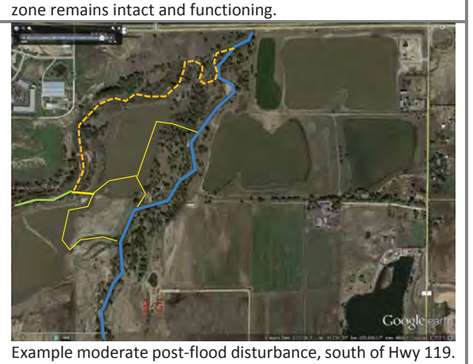
Specific impacts to the riparian zone reaches through the project area include:

REACH	2013 REGIONAL FLOOD DAMAGE – RIPARIAN ZONE
Boulder Canyon	*Low Disturbance* • Stable armored stream banks. • Minor tree/shrub damage/loss. • Minor localized bank erosion and steep slope failure. • Debris accumulation. • Channel remains in original alignment and connected to riparian zone. • Limited existing riparian zone remains relatively intact.
City of Boulder	*Low Disturbance* • Stable armored stream banks. • Minor tree damage/loss. • Minor localized bank erosion. • Debris and sediment deposition removed by City of Boulder, CDOT and UDFCD. • Channel remains in original alignment and connected to riparian zone. • Limited existing riparian zone remains relatively intact.
Foothills to N 107th Street	*Low to Moderate Disturbance* • Significant sediment deposition/vegetation burial. • Localized bank erosion. • Significant accumulation of debris from dead/downed trees. • Stream breach into gravel ponds – alteration of hydrology (channel and riparian zone abandoned). • Stream breach areas subject to potential long-term impacts to riparian species diversity, abundance, structure, and functional characteristics from alteration of hydrology.
N 107th Street to St. Vrain Creek	*Low to Moderate Disturbance* • Significant sediment deposition/vegetation burial. • Localized bank erosion. • Significant accumulation of debris from dead/downed trees. • Stream breach into gravel ponds – alteration of hydrology (channel and riparian zone abandon). • Stream breach area subject to potential long-term impacts to riparian species diversity, abundance, structure, and functional characteristics from alteration of hydrology.

Following are examples of pre- and post-flood conditions through the project area with examples of disturbances to the riparian zone.

Pre-Flood	Post-Flood
	
Boulder Canyon reach pre-flood: narrow riparian zone confined between steep canyon walls and Boulder Canyon Drive (Hwy 119).	Example of low post-flood disturbance. In this area, localized stream bank erosion/slope failure occurred due to the narrow and confined riparian zone. A relatively small portion of the riparian corridor has been damaged while other portions remain intact. Overall, the riparian zone remains intact and functioning.
	
City of Boulder reach pre-flood: riparian zone is confined on both the north and south sides by commercial and residential development. The stream channel is connected to the riparian zone which is vegetated by deciduous, riparian trees.	Example post-flood: This photo shows no significant change to the riparian zone post-flood, through a highly urbanized section through downtown Boulder. The stream was able to access the floodplain; armored stream banks and riparian tree root system functioned to withstand extreme flood flows limiting significant disturbances. The limited existing riparian zone remains relatively intact.

Pre-Flood	Post-Flood
	
Foothills to N 107th Street reach. Pre-flood conditions west of 61st Street. The blue line indicates the approximate pre-flood flow path of Boulder Creek. Through this section, the narrow riparian zone is confined by existing gravel ponds on either side.	Example moderate post-flood disturbance, west of 61st Street. As a result of the flood, this section of Boulder Creek breached (yellow line) into an existing gravel pond. The historic riparian corridor is now disconnected from stream flow which can result in long-term habitat community shifts or complete loss of riparian species.
	
Foothills to N 107th Street reach. Pre-flood conditions east of 61st Street. The blue line indicates the approximate pre-flood flow path of Boulder Creek.	Example moderate post-flood disturbance, east of 61st Street. Extreme flood flows resulted in altered stream hydrology including a channel breach through an existing pond (yellow line) and abandoned side channel (blue arrow). Alterations in stream flow can result in long-term habitat community shifts or complete loss of riparian species.

Pre-Flood	Post-Flood
	
Foothills to N 107th Street reach. Pre-flood conditions east of 75th Street. In this less disturbed section of the reach, Boulder Creek is not confined, the riparian zone is well developed and able to access the active floodplain.	Example low post-flood disturbance, east of 75th Street. In this section, the riparian zone had functioned properly by allowing flood flows to dissipate on the floodplain; therefore, the post-flood disturbance to the riparian zone is low and includes only localized stream bank erosion/failure and/or tree damage/loss. In these low disturbance areas, the riparian zone remains intact and functioning.
	
N 107th Street to St. Vrain Creek reach. Pre-flood conditions south of Hwy 119. Variable conditions along Boulder Creek (right, blue line). Saint Vrain Creek is shown on the left (green line). Portions of this reach are well vegetated and able to access the floodplain, while other areas are narrow and more confined as a result of historic gravel mining.	Example moderate post-flood disturbance, south of Hwy 119. Extreme flood flows through historically confined sections of Boulder Creek resulted in channel breach through existing gravel ponds (yellow line). A breach also occurred on Saint Vrain Creek (left, green line) which resulted in channel abandonment (orange line). As a result of the flood, the existing well vegetated riparian zone through this reach is threatened from altered stream flow which can result in long-term habitat community shifts or complete loss of riparian species.

1.4 RIPARIAN ZONE RESTORATION GUIDELINES

The framework for any successful riparian zone restoration effort is understanding the local (reference standard) community that is either present or known to have existed in the local area, in order to restore the functional integrity and biodiversity of the riparian zone. As stated in the previous section, the reference community or primary habitat type recommended for restoration within this project area which is locally native and appropriate for the environmental setting is the Western Great Plains Riparian Woodland and Shrubland.

Replicating the natural characteristics of the local Western Great Plains Riparian Woodland and Shrubland habitat type including re-establishment of cottonwood tree overstory and a willow shrub mid-story with a mixed grassland understory that properly interacted with the channel flow should be the primary objective for natural restoration efforts.

Successful riparian zone restoration is dependent on a thorough understanding of numerous environmental factors and site-specific conditions. Stream flow, soil moisture, groundwater table, soil chemistry and sun-orientation are all critical elements to consider. Any restoration efforts should carefully consider such factors which should generally be defined by an expert to ensure greater success.

A number of references and guidance documents are available for restoration activities in Colorado and Boulder County. Please refer to the following for further guidance on riparian zone restoration and suggested native plants for revegetation within the project area:

Suggested Native Plants for Horticultural Use on the Front Range of Colorado. Boulder County Land Use Department Publications.
http://www.bouldercounty.org/doc/landuse/p11nativeplants.pdf

City of Boulder Wetlands Protection Program Best Management Practices.
City of Boulder Planning Department. May, 1995. Rule Adopted July, 1995.
https://www-static.bouldercolorado.gov/docs/wetlands-proptection-program-best-management-practices-1-201308011515.pdf

Native Seed Mixes.
Boulder County Land Use Department Publications.
http://www.bouldercounty.org/doc/landuse/p18nativeseedmix.pdf

Revegetation. Boulder County Land Use Department Publications.
http://www.bouldercounty.org/doc/landuse/revegetationpacket.pdf

Native Plant Revegetation Guide for Colorado.
Colorado Natural Areas Program; Colorado State Parks, Colorado Department of Natural Resources. October 1998.
https://cpw.state.co.us/Documents/CNAP/RevegetationGuide.pdf

Site-specific restoration plans can be developed which specify planting locations, soil amendments and appropriate species types. While site specific plans should be developed by experts, the following provides some generalized guidelines for restoration of the riparian zone within the project area.

Riparian Zone Restoration Guideline Summary

- Natural riparian zone vegetation community type within the project area is characteristic of the *Western Great Plains Riparian Woodland and Shrubland;*
- A properly functioning riparian zone should have routine interaction with stream flows;
- In a more undisturbed condition, vegetation would be continuous along the entire corridor and occupy three strata (i.e., overstory, midstory and understory);
- Relatively dense native vegetation extending from the water's edge (bankfull) outward;
- Buffers that are wider, longer and more densely vegetated with herbaceous, shrub and tree layers provide more benefits. A minimum width should be at least 50 feet and extend upwards of 200 feet from the stream edge.

OVERSTORY – FOREST CANOPY ESTABLISHMENT

Restoration or planting efforts should focus on re-establishing the overstory or forest canopy that has been lost. The plains cottonwood tree is one of the primary species of the forest canopy regionally as well as the largest tree reaching heights of up to 60 feet with trunk diameters of 2.5 feet. Cottonwoods are now primarily found along drainages and streams of the region. Cottonwood stands provide habitat for 82% of all bird species breeding in northeastern Colorado (Simonin 2001). This species establishes quickly under ideal conditions and is tolerant of frequent and prolonged flooding as well as seasonal low water conditions. Reproduction by seed is a primary means of cottonwood establishment (Hines 1999). The best conditions for establishment include moist, unvegetated mineral soils where the seedlings are not subject to significant erosion/deposition or prolonged flooding during the first growing season (Friedman et al., 1992) (Borman and Larson 2002) (Scott et al. 1997).

Other trees species that are appropriate in conjunction with cottonwoods may include those species listed in **Table 2** below. The re-establishment of the forest canopy will provide significant bank stabilization benefits due to binding of soil with their roots and can also block or deflect high flow stream currents. Many of the large mature cottonwoods of the project area appear to be relatively stable after the September 2013 flooding, however many have been damaged and populations may start to decline over time. The planting of second generation stands of cottonwood and other species during recovery efforts will ensure the continued existence of this valuable habitat type. Special care should be taken during restoration to protect cottonwood seedlings that are newly established on flood exposed flats or deposits.

TABLE 2. REPRESENTATIVE NATIVE RIPARIAN ZONE TREE SPECIES.

Tree Species	
Scientific Name	**Common Name**
Acer glabrum	Rocky Mountain maple
Acer negundo	box elder
Alnus incana	thinleaf alder
Populus deltoides	plains cottonwood
Salix amygdaloides	peachleaf willow

*All tree species should only be planted above the ordinary high water mark where moist soil conditions are present during a majority of the growing season.

Tree species are generally obtained from a commercial nursery as potted containers or balled and burlapped and are ideally planted during the latter part of the dormant season between February 1 and April 1, one to two weeks before budding stage. Tree planting efforts should also consider a monitoring and maintenance program that includes temporary irrigation, weed management and herbivory prevention.

MIDSTORY - SHRUBS ESTABLISHMENT

Shrubs are considered one of the most valuable strata in a natural riparian zone. Shrubs generally form dense thickets with extensive root systems immediately along the water's edge and can tolerate fluctuating flows.

Willows are a widely-distributed shrub species throughout lower montane habitats in the region. Species can range from 6.5 to 20 feet tall forming large colonies with up to 95% cover. Roots of willows are wide and spreading, forming and extensive root system, especially with the development of large clones. Willow can be both drought resistant and very tolerant of flooding. The ability to generate new roots on the original root or submerged stem is important to riparian restoration. Narrowleaf willow, particularly, colonizes rocky, gravelly, and sandy stream edges, moist, well-drained alluvial terraces, and recently deposited sand and gravel bars that are below the high-water mark, where it is subject to annual flooding, and associated scouring and deposition (Anderson 2006). Where cottonwoods are not present, other willows may become the climax vegetation as narrowleaf willow communities promote bank building and soil development, preparing hospitable sites for other species (Anderson 2006). Midstory shrub species not only provide bank stability but also increased biomass, structural habitat and complexity for wildlife. Shrub species that are considered appropriate for native riparian zone restoration are listed in **Table 3** below.

TABLE 3. REPRESENTATIVE NATIVE RIPARIAN ZONE SHRUB SPECIES.

Shrub Species	
Scientific Name	**Common Name**
Alnus incana	thinleaf alder
Amelanchier alnifolia	western serviceberry
Symphoricarpos occidentalis	western snowberry
Prunus americana	wild plum

Shrub Species	
Scientific Name	**Common Name**
Rosa woodsii	Woods' rose
Ribes aureum	golden currant
Salix exigua	narrowleaf willow

*All shrub species should be planted above the ordinary high water mark where moist soil conditions are present during a majority of the growing season.

Shrub species are generally obtained from a commercial nursery in varying pot sizes from 1-quart to 5-gallons and ideally planted during the latter part of the dormant season between February 1 and April 1, one to two weeks before budding stage. Shrub planting efforts should also consider a monitoring and maintenance program that includes temporary irrigation, weed management and herbivory prevention.

Willows species also have a unique ability to be harvested from onsite sources and installed as live stakes. Willow live staking consists of harvesting a cutting or single stem of a willow shrub. The stake is then inserted into the ground then will naturally root and develop above ground shoots.

UNDERSTORY - NATIVE HERBACEOUS

An established understory community provides numerous environmental benefits including soil stabilization, overland runoff filtration as well as forage and cover for wildlife. During restoration efforts native seeding should focus on quickly establishing a groundcover to stabilize soil, minimize establishment of invasive species and promote long-term successional development. In restoration areas, the ground surface should be seeded with specialized riparian seed mix that promotes species diversity, contains locally native species that germinate rapidly and provides complete groundcover over a wide variety of hydrologic conditions. Generally in areas to be seeded, a minimum of 3 to 6 inches of suitable topsoil is recommended.

Refer to the following references for examples of native seed mixes.

Native grass seed mix specs from Boulder County NRCS - for loamy to clayey soils:
http://www.coopext.colostate.edu/boulder/sam/pdf/BCLOAMY1.pdf

Native grass seed mix specs from Boulder County NRCS - for sandy soils:
http://www.coopext.colostate.edu/boulder/sam/pdf/BCSANDY1.pdf

Native Seed Mixes. Samples for Boulder County:
http://www.bouldercounty.org/doc/landuse/p18nativeseedmix.pdf

TABLE 4. REPRESENTATIVE NATIVE RIPARIAN ZONE HERBACEOUS SPECIES.

Seed Mix		
Scientific Name	**Common Name**	**Comments**
Achnatherum hymenoides	Indian ricegrass	Sandy, p/f, (FACU)
Sporobolus airoides	alkali sacaton	Damp, alkaline, p/f, (FAC)
Elymus canadensis	Canada wildrye	Disturbed sites, p/f, (FACU)
Panicum virgatum	switchgrass	Marshes, prairies, foothills, p/f, (FAC)
Pascopyrum smithii	western wheatgrass	Adaptable to variety of habitats, p,f, (FACU)

Notes:
Life Zones: p = Plains 4,000-6,000 feet; f = Foothills 6,000-8,000 feet;
USACE Wetland Indicator Status: (FAC) = Facultative; (FACU) = Facultative Upland

1.5 NATIVE PLANT STOCK NURSERIES AND SEED SUPPLIER

Following is a list of native riparian zone plant stock nurseries and seed suppliers considered appropriate for the project area. This list is not inclusive of all regionally available native plant suppliers.

A list of Colorado plant vendors can also be found on the Colorado Native Plant Society web page: http://conps.org/horticulture_and_restoration.html.

North Fork Native Plants
1499 S 6000 W
Rexburg, ID 83440
Phone: (208) 354-3691
http://www.northforknativeplants.com/

Conservation Seeding & Restoration, Inc. dba Rocky Mountain Native Plants
3780 County Rd. 233
Rifle, CO 81650-8740
Phone: (208) 423-4835
Toll-Free: (877) 423-4835
http://www.csr-inc.com/

Little Valley Wholesale Nursery
13022 E 136th Ave
Brighton, CO 80601
Phone: (303) 659-6708
https://www.lvwn.com/

Arkansas Valley Seed
4333 Hwy 68
Longmont, CO 80504
Phone: (877) 907-3337
www.avseeos.com

Pawnee Buttes Seed
805 25th Street
Greeley, CO 80632
Phone: (970) 782-5947
www.pawneebuttesseed.com

Western Native Seed
P.O. Box 188
Coaldale, CO 81222
Phone: (719) 942-3935
www.westernnativesed.com

SECTION 2.0 THREATENED AND ENDANGERED SPECIES

ERC conducted a preliminary screening for federal and state threatened and endangered species within the project area. It will be important during long-term recovery and restoration efforts that protected species and habitats are considered. Close coordination with the agencies mentioned below is recommended.

Federal or state listed threatened and endangered species and/or habitat protected under the Endangered Species Act (ESA) or by the Colorado Parks and Wildlife (CPW) under Colorado Statute Title 33 are summarized as follows. Raptor nest sites are further protected by the US Fish and Wildlife Service (UFWS)/CPW under the Migratory Bird Treaty Act (MBTA) therefore the applicable regulatory requirements are also summarized subsequently.

Additionally, ERC review aquatic habitat data for the project area from the CPW and macroinvertebrate data from the City of Boulder: Boulder Habitat Assessment Report (CDM Smith 2014) City of Boulder which are briefly summarized in the following section.

The City of Boulder Open Space and Mountain Parks (OSMP) maintains land restrictions and seasonal wildlife closures throughout the project area pursuant to City Municipal Code, B.R.C. 1981. Additionally, Boulder County has identified important environmental resources and habitat areas that should be considered in land use decisions and preserved through management practices as summarized in the Boulder County Comprehensive Plan (BCCP) (Second Addition 1996, As Amended). These ecologically-significant areas are utilized by reference in the Boulder County Land Use Code are protected through administration of the Code and in conformance with applicable federal and state law. A summary of these areas follows.

2.1 SPECIES PROTECTED UNDER THE ENDANGERED SPECIES ACT (ESA) OF 1973

The ESA of 1973 was enacted by the United States to conserve endangered and threatened species and the ecosystems that they depend on. Under the ESA, species may be listed as either “endangered” or “threatened”; both designations are protected by law. The ESA is administered by the USFWS. The USFWS has developed project specific species lists, available online by request, identifying threatened, endangered, and proposed species, designated critical habitat, and candidate species protected under the ESA that may occur within the boundary of the proposed project and/or may be affected by the proposed project (USFWS 2014). Eleven species are identified to occur or historically occur within range of the project area in Boulder County (USFWS 2014). No USFWS critical habitat is present within or near the potential project areas. Further evaluation of the eleven species’ distribution and habitat requirements indicates that three species potentially occur within range of the project area (**Table 5**). During restoration and recovery efforts coordination with the USFWS is recommended.

US Fish and Wildlife Service – Ecological Services Field Office
P.O. Box 25486
Denver Federal Center (MS 65412)
Denver, Colorado 80225

Telephone: (303) 236-4773
Colorado Field Supervisor: Susan Linner
Email: Susan_Linner@fws.gov
http://www.fws.gov/coloradoes/

TABLE 5. FEDERAL THREATENED OR ENDANGERED SPECIES.

Common Name	Scientific Name	*Status	Occurrence
Canada lynx	*Lynx canadensis*	FT	Suitable habitat not present.
Greenback cutthroat trout	*Oncorhynchus clarki stomias*	FT	Suitable habitat not present.
Mexican spotted owl	*Strix occidentalis lucida*	FT	Suitable habitat not present.
Interior Least tern	*Sternula antillarium*	FE	Water depletion species.
Pallid sturgeon	*Scaphirhycchus albus*	FE	Water depletion species.
Piping Plover	*Charadrius melodus*	FT	Water depletion species.
Western prairie fringed orchid	*Platanthera praeclara*	FT	Water depletion species.
Whooping crane	*Grus americana*	FE	Water depletion species.
Preble’s Meadow Jumping Mouse	*Zapus hudsonius preblei*	FT	Suitable habitat may be present.
Ute Ladies’-tresses	*Spiranthes diluvialis*	FT	Suitable habitat may be present.
Colorado Butterfly Plant	*Guara neomexicana spp.*	FT	Suitable habitat may be present.

*Status:
FT - Federally Listed Threatened
FE - Federally Listed Endangered

Suitable habitat not present. These federally listed threatened and endangered species are identified to occur within the Boulder/Weld Counties. However, these species are not known to exist within the specific vicinity of the project area and/or have specific habitat requirements (i.e., elevation range) that are not common in the vicinity of the project area. The species are not likely to occur within the project area and therefore, restoration and recovery efforts would not likely adversely affect the continued existence or available habitat of the species.

Water depletion species. The USFWS under the ESA has determined that water depletions in the South Platte River Basin are considered an adverse effect to these species. The project area is considered to be located within the South Platte River Basin; therefore, coordination with the USFWS would be necessary to determine whether a project would fall under a water-related activity/use.

Suitable habitat may be present. Within the project area along Boulder Creek, potential suitable habitat may be present for these species. Potential habitat includes well-developed riparian vegetation along Boulder Creek. The project area is not designated as Critical Habitat by the USFWS (CPW 2013).

PMJM: The project area does not occur within the PMJM Block Clearance Zone. PMJM are not known to occur within the project area (UDFCD 2010) and the nearest known population of PMJM occurs to the south of the project area on South Boulder Creek; however, the riparian corridor of the project area may provide suitable habitat for this species.

Colorado Butterfly Plant: This plant species is a short-lived, perennial herb endemic to moist soils in mesic or wet meadows of floodplain areas in southeastern Wyoming, north central Colorado, and extreme western Nebraska. Potential habitat for this species exists along the Boulder Creek stream channel and in the mesic or wet meadow floodplain areas.

Ute Ladies'-tresses: The Ute ladies-tresses occurs in seasonally moist soils and wet meadows near springs, lakes, or perennial streams and their associated floodplains below 6,500 feet in elevation in certain areas of Utah, Colorado, Idaho, Wyoming, and Nevada. Potential habitat for this species exists along the riparian corridor of Boulder Creek.

It is recommended that before a project is commenced, site specific surveys and more detailed analysis are conducted to determine the existence of potential habitat for the species.

In support of flood recovery efforts, the USFWS recommends implementation of conservation measures from the Recommended Conservation Measures to Avoid and Minimize Impacts to the Preble's Meadow Jumping Mouse, the Ute Ladies'-tresses, and the Colorado butterfly plant from Emergency Flood Response Activities Along Streams, Rivers, or Transportation Corridors. Information can be found online at: http://www.fws.gov/endangered/esa-library/index.html#consultations.

STATE THREATENED AND ENDANGERED SPECIES

Species identified as state threatened or endangered are protected by the CPW under Colorado Statute Title 33. State regulations prohibit "*any person to take, possess, transport, export, process, sell or offer for sale, or ship and for any common or contract carrier to knowingly transport or receive for shipment*" any species or subspecies listed as state endangered or threatened. State listed threatened and endangered species were screened as potential inhabitants of the project area based on general habitat requirements and CPW information (CPW 2014), *Colorado Listing of Endangered, Threatened, and Wildlife Species of Special Concern*. Seventeen species are identified to occur or historically occur within the project area (CPW 2014). Further evaluation of the seventeen species' distribution and habitat requirements indicates that five species (PMJM, Ute ladies'-tresses, Colorado butterfly plant, burrowing owl and river otter) potentially occur within range of the project area. Three of these species are also federally listed by the USFWS therefore are summarized in the previous section (**Table 5**). State listed species which also occur on the USFWS federal list, as screened above, were not duplicated below.

Colorado Parks and Wildlife – Northeast Region Office
6060 Broadway
Denver, Colorado 80216
Telephone: (303) 291-7227

http://cpw.state.co.us/aboutus/Pages/ContactUs.aspx

Table 6. State Threatened or Endangered Species.

Common Name	Scientific Name	*Status	Occurrence
Boreal Toad	*Bufo boreas*	SE	Suitable habitat not present.
Burrowing owl	*Athene cunicularia*	ST	Suitable habitat may be present.
Southwestern willow flycatcher	*Empidonax traillii extimus*	SE	Suitable habitat not present.
Lesser prairie-chicken	*Tympanuchus pallidicinctus*	ST	Suitable habitat not present.
Plains sharp-tailed grouse	*Tympanuchus phasianellus jamesii*	SE	Suitable habitat not present.
Arkansas darter	*Etheostoma cragini*	ST	Suitable habitat not present.
Bonytail	*Gila elegans*	SE	Suitable habitat not present.
Brassy minnow	*Hybognathus hankinsoni*	ST	Suitable habitat not present.
Colorado pikeminnow	*Ptychocheilus lucius*	ST	Suitable habitat not present.
Common shiner	*Luxilus cornutus*	ST	Suitable habitat not present.
Greenback cutthroat trout	*Oncorhynchus clarki stomias*	ST	Suitable habitat not present.
Humpback chub	*Gila cypha*	ST	Suitable habitat not present.
Lake chub	*Couesius plumbeus*	SE	Suitable habitat not present.
Northern redbelly dace	*Phoxinus eos*	SE	Suitable habitat not present.
Plains minnow	*Hybognathus placitus*	SE	Suitable habitat not present.
Razorback sucker	*Xyrauchen texanus*	SE	Suitable habitat not present.
Rio grande sucker	*Catostomus plebeius*	SE	Suitable habitat not present.
Southern redbelly dace	*Phoxinus erythrogaster*	SE	Suitable habitat not present.
Suckermouth minnow	*Phenacobius mirabilis*	SE	Suitable habitat not present.
Black-footed ferret	*Mustela nigripes*	SE	Suitable habitat not present.
Gray wolf	*Canis lupus*	SE	Suitable habitat not present.
Grizzly bear	*Ursus arctos*	SE	Suitable habitat not present.
Kit fox	*Vulpes macrotis*	SE	Suitable habitat not present.
Lynx	*Lynx canadensis*	SE	Suitable habitat not present.
River otter	*Lontra canadensis*	ST	Suitable habitat may be present.
Wolverine	*Gulo gulo*	SE	Suitable habitat not present.

*Status:
ST - State Listed Threatened
SE - State Listed Endangered

Suitable habitat not present. These state listed threatened and endangered species are identified to occur within the state. However, these species are not known to exist within the specific vicinity of the project area and/or have specific habitat requirements (i.e., elevation range) that are not common in the vicinity of the project area. The species are not likely to occur within the project area and therefore, restoration and recovery efforts would not likely adversely affect the continued existence or available habitat of the species.

Suitable habitat may be present. Within the project area along Boulder Creek, potential suitable habitat may be present for these species.

Burrowing owl: The burrowing owl is a breeding species across the plains of eastern Colorado. Potential nesting habitat for the burrowing owl includes abandoned burrows, especially prairie dog colonies, located in grassland or agricultural lands from late March through October. The presence of prairie dog colonies (although active) within the project area exhibits general characteristics that are considered potential burrowing owl habitat. Any land use changes that disturb prairie dog colonies from March 1st through October 31st should ensure burrowing owls are not adversely affected.

River otter: Otters live in riparian habitat. Populations of this species have been historically rare in Colorado however since the 1970's, the CPW has focused on reintroduction efforts. Within the project area, the first river otter in approximately 100 years was documented on Boulder Creek, east of downtown Boulder on March 7, 2014. Therefore, segments of Boulder Creek maybe considered potential habitat for the otter. During restoration and recovery efforts coordination with the CPW is recommended.

2.1 MIGRATORY BIRD TREATY ACT

Migratory birds are protected under the Migratory Bird Treaty Act (MBTA) (16 U.S.C. 730-712). The MBTA makes it illegal for anyone to take, possess, import, export, transport, sell, purchase barter, or offer for sale, purchase, or barter any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to Federal regulations. In Colorado, all birds except for the European starling (*Sturna vulgaris*), house sparrow (*Passer domesticus*), rock dove (*Columba livia*) and common grouse/pheasant species (*Order Galliformes*) are protected under the MBTA. A total of 523 migratory bird species are known to occur in the Mountain-Prairie Region (USFWS Region 6, Montana, Wyoming, Utah, North Dakota, South Dakota, Nebraska, Kansas and Colorado); 320 of the 523 migratory bird species are known to breed in USFWS Region 6.

- Based upon literature review and an onsite assessment of the project area, ERC has determined that some migratory birds likely utilize the project area. These birds are protected under the MBTA, and killing or possession of these birds is prohibited. Future recovery and restoration efforts which remove vegetation should first ensure that active nests are not disturbed. Generally, the active nesting season for most migratory birds in this region of Colorado occurs between April 1 and August 31.

- In addition, disturbance to raptor nest sites is further protected by the CPW. The CPW guidance document (Recommended Buffer Zones and Seasonal Restrictions for Colorado Raptors) provides recommended tolerance limits or buffer zones for various species of raptors in addition to seasonal restrictions in response to human activity. Within the project area, available CPW Species Activity Mapping (SAM) depicts known mapped buffer zones within the project area for bald eagle (*Haliaeetus leucocephalus*) and osprey (*Pandion haliaetus*) (NDIS 2013). Seasonal restrictions for these species can be obtained from the CPW (2008) guidance document: https://cpw.state.co.us/Documents/WildlifeSpecies/LivingWithWildlife/RaptorBufferGuidelines2008.pdf. Future recovery and restoration efforts should also be aware of any new raptor nest sites and consult with the CPW.

- CPW SAM mapping depicts great blue heron (*Ardea herodias*) nesting areas throughout the project area. The great blue heron is considered a Colorado species of special concern, protected under the MBTA. The rookery (nesting) areas are considered important habitat features for conservation within the project area.

- Refer to **Figure 12** in Section 2.4 for a map which depicts CPW nest sites within vicinity of the project area.

2.2 AQUATIC LIFE

Boulder Creek throughout the project area is classified as Water Supply Recreation 1A Agriculture Aquatic Life Warm 1 by CDPHE. Aquatic Life Warm 1 classification indicates the waters are currently capable of sustaining a wide variety of warm water biota, including sensitive species. Waters shall be considered capable of sustaining such biota where physical habitat and, water flows or levels and water quality conditions result in no substantial impairment of the abundance and diversity of species.

Informal discussions with local Colorado Parks and Wildlife (CPW) staff indicates that the project reach of Boulder Creek is a transitional zone between a cold water fishery (extending upstream of Boulder Canyon) dominated by trout to a warm water fishery (downstream of Boulder Canyon) dominated by native minnow species. Brown trout are present through the Canyon and City reaches, however east of 75th Street small bodied native fish become more dominate. CPW also indicated that future restoration efforts in the project reach and in particular east of 75th Street should focus on native small bodied native fish species and not typical trout habitat. CPW's most recent fish population survey (2014), identified the following dominant species: brown trout, common carp, creek chub, fathead minnows, green sunfish, largemouth bass, longnose dace, longnose sucker and white sucker. Of the 17 species collected, 9 species were non-native and 8 species were native to South Platte River basin.

CDM Smith completed a City of Boulder - Boulder Creek Habitat Data Review (Draft 2014) in anticipation of: a) the inclusion of habitat and biological data in future assessments and potential impairment determinations, and b) the importance of understanding habitat quality as part of the biological assessment process. The primary objective of the study was to organize the city's habitat data in a manner that supports meaningful evaluation of macroinvertebrate data that may be used to support aquatic life

use attainment determinations in the Boulder Creek watershed. This study was also used to develop recommendations for streamlining future habitat characterization efforts so that in the future, monitoring resources are expended on the collection of the most useful habitat data. The Review study area begins in the canyon at the west end of the urban core and extends to the confluence of Boulder Creek and Coal Creek near the Boulder/Weld County line. The Review concluded that datasets show lower habitat quality through the City as seen in the habitat scores below the canyon through 28th Street. Associated biological indices also follow the general pattern of lower scores at 28th Street. Urban density begins to decrease east of Foothills Parkway and habitat scores and biological metrics generally improve as the area becomes more rural. Habitat subcategory scores show that the overall habitat results are driven by habitat scores related to riparian quality. Of particular note is habitat parameter 10, which scores vegetative riparian zone width. Scores are lower through the urban corridor where the riparian zone is most confined.

2.4 CITY OF BOULDER'S OPEN SPACE & MOUNTAIN PARKS (OSMP) CLOSURES

The City of Boulder's Open Space & Mountain Parks land has been set aside for preservation and the protection of the natural environment. Within the project area, the Open Space and Mountain Parks (OSMP) division maintains the following closures (**Figure 12**).

- Bald Eagle Closures Nov. 1 - July 31. One area on OSMP land is closed from Nov. 1 to July 31 every year to protect bald eagle nesting and roosting activity.
- New Zealand Mudsnail Closures Year Round. Portions of Boulder Creek downstream of Valmont Road are closed year round because of the non-native, invasive New Zealand Mudsnail.

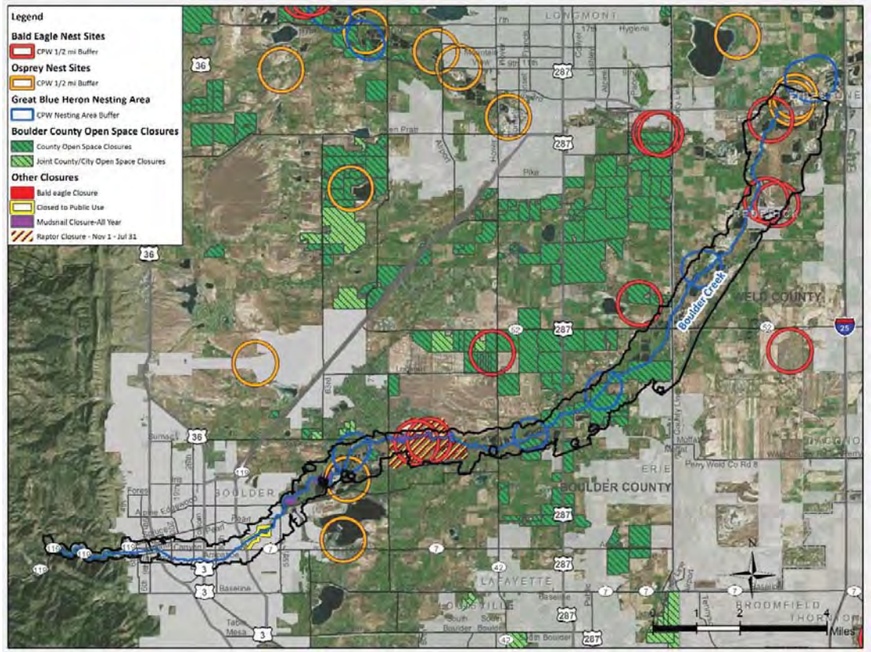


FIGURE 12. CPW NEST SITES AND OTHER CLOSURES.

2.5 BOULDER COUNTY OPEN SPACE (BCPOS) COMPREHENSIVE PLAN

The Boulder County Comprehensive Plan (BCCP) identifies important environmental resources and habitat areas that should be considered in land use decisions and preserved through management practices (Second Addition 1996, As Amended). The designated areas include areas: environmental conservation areas, wetlands, critical wildlife habitat, rare plant areas, habitat connectors and natural areas/landmarks. A map depicting key habitat areas from the BCCP update is provided below as **Figure 13**. These ecologically-significant areas are referenced in the Boulder County Land Use Code and should be considered in future project planning. The BCCP Update can be accessed online:
http://www.bouldercounty.org/property/build/pages/bccpupdate.aspx

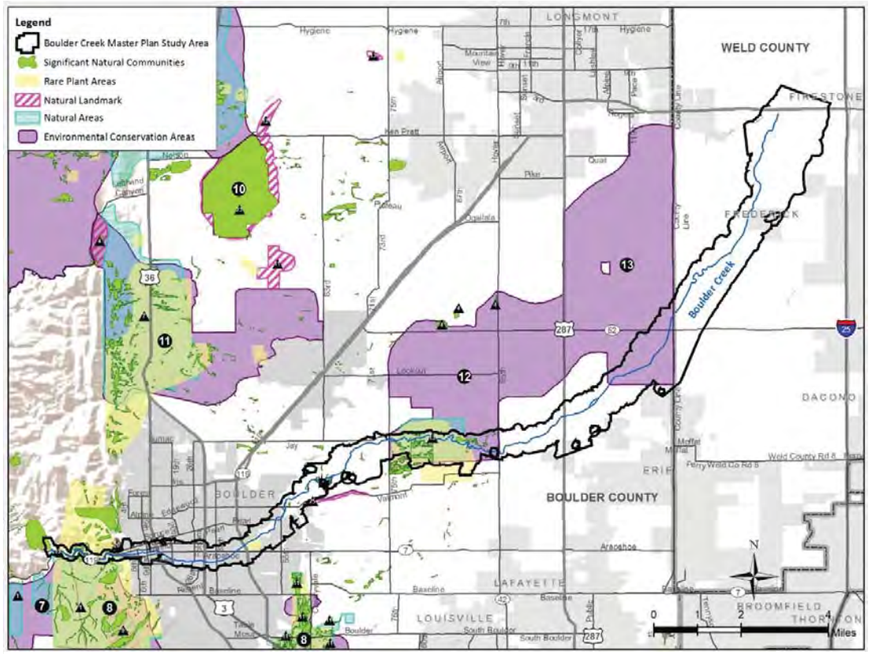


FIGURE 13. BOULDER COUNTY COMPREHENSIVE PLAN UPDATE - KEY HABITAT AREAS.

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APPENDIX G

CONCEPTUAL DESIGN INFORMATION

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 1
DRAINAGEWAY :	Boulder Creek
REACH :	1A
JURISDICTION :	City of Longmont
REACH ID:	BCM-Reach1A
	Jeremy Deischer
DATE :	2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Estimated Riparian Restoration	<----User Defined Items	1	AC	$35,000.00	$33,747.00	700 ft. of 30 ft each side of channel

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$33,747.00	
Subtotal Capital Improvement Costs					**$33,747.00**	
Additional Capital Improvement Costs						
Dewatering		$337.47	L.S.		$337.00	
Mobilization		5%			$1,687.00	
Traffic Control		$843.68	L.S.		$844.00	
Utility Coordination/Relocation		$843.68	L.S.		$844.00	
Stormwater Management/Erosion Control		5%			$1,687.00	
Subtotal Additional Capital Improvement Costs					**$5,399.00**	
Land / Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$5,872.00	
Legal/Administrative		5%			$1,957.00	
Contract Admin/Construction Management		10%			$3,915.00	
Contingency		25%			$9,787.00	
Subtotal Other Costs					**$21,531.00**	
Total Capital Improvement Costs					**$60,677.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	700	L.F.	$2.00	$280.00	
Total Annual Operation and Maintenance Cost				**$280.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$9,800.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 1
DRAINAGEWAY :	Boulder Creek
REACH :	1B
JURISDICTION :	City of Longmont
REACH ID:	BCM-Reach1B
	Jeremy Deischer
DATE :	2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverside Spillway	<----User Defined Items	1	L.S.	$225,000.00	$225,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$225,000.00	
Subtotal Capital Improvement Costs					**$225,000.00**	
Additional Capital Improvement Costs						
Dewatering		$2,250.00	L.S.		$2,250.00	
Mobilization		5%			$11,250.00	
Traffic Control		$5,625.00	L.S.		$5,625.00	
Utility Coordination/Relocation		$5,625.00	L.S.		$5,625.00	
Stormwater Management/Erosion Control		5%			$11,250.00	
Subtotal Additional Capital Improvement Costs					**$36,000.00**	
Land / Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$39,150.00	
Legal/Administrative		5%			$13,050.00	
Contract Admin/Construction Management		10%			$26,100.00	
Contingency		25%			$65,250.00	
Subtotal Other Costs					**$143,550.00**	
Total Capital Improvement Costs					**$404,550.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$610.00	$31.00	
Total Annual Operation and Maintenance Cost				**$31.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$1,085.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 2
DRAINAGEWAY :	Boulder Creek
REACH :	2A
JURISDICTION :	Weld County
REACH ID:	BCM-Reach2A

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
180 ft. span bridge at CO Rd 20.5	<----User Defined Items	5400	SF	$250.00	$1,350,000.00	30 ft width bridge
Removal of old bridge	<----User Defined Items	3900	SF	$50.00	$195,000.00	130 ft x 30 ft

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$1,545,000.00
Subtotal Capital Improvement Costs					**$1,545,000.00**
Additional Capital Improvement Costs					
Dewatering		$15,450.00	L.S.		$15,450.00
Mobilization		5%			$77,250.00
Traffic Control		$38,625.00	L.S.		$38,625.00
Utility Coordination/Relocation		$38,625.00	L.S.		$38,625.00
Stormwater Management/Erosion Control		5%			$77,250.00
Subtotal Additional Capital Improvement Costs					**$247,200.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$268,830.00
Legal/Administrative		5%			$89,610.00
Contract Admin/Construction Management		10%			$179,220.00
Contingency		25%			$448,050.00
Subtotal Other Costs					**$985,710.00**
Total Capital Improvement Costs					**$2,777,910.00**

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)		30	L.F.	$2.00	$12.00
Bridge Maintenance	<----User Defined Items	1	EA	$1,000.00	$1,000.00
Total Annual Operation and Maintenance Cost					**$1,012.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$35,420.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 2
DRAINAGEWAY :	Boulder Creek
REACH :	2B
JURISDICTION :	Weld County
REACH ID:	BCM-Reach2B

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Diversion for Aquatic Passage	<----User Defined Items	1	L.S.	$205,000.00	$205,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$205,000.00
Subtotal Capital Improvement Costs					**$205,000.00**
Additional Capital Improvement Costs					
Dewatering		$2,050.00	L.S.		$2,050.00
Mobilization		5%			$10,250.00
Traffic Control		$5,125.00	L.S.		$5,125.00
Utility Coordination/Relocation		$5,125.00	L.S.		$5,125.00
Stormwater Management/Erosion Control		5%			$10,250.00
Subtotal Additional Capital Improvement Costs					**$32,800.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$35,670.00
Legal/Administrative		5%			$11,890.00
Contract Admin/Construction Management		10%			$23,780.00
Contingency		25%			$59,450.00
Subtotal Other Costs					**$130,790.00**
Total Capital Improvement Costs					**$368,590.00**

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)		1	EA	$610.00	$122.00
Total Annual Operation and Maintenance Cost					**$122.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$4,270.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 2
DRAINAGEWAY :	Boulder Creek
REACH :	2C
JURISDICTION :	Weld County
REACH ID:	BCM-Reach2C

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$250,000.00	
Subtotal Capital Improvement Costs					**$250,000.00**	
Additional Capital Improvement Costs						
Dewatering		$2,500.00	L.S.		$2,500.00	
Mobilization		5%			$12,500.00	
Traffic Control		$6,250.00	L.S.		$6,250.00	
Utility Coordination/Relocation		$6,250.00	L.S.		$6,250.00	
Stormwater Management/Erosion Control		5%			$12,500.00	
Subtotal Additional Capital Improvement Costs					**$40,000.00**	
Land / Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$43,500.00	
Legal/Administrative		5%			$14,500.00	
Contract Admin/Construction Management		10%			$29,000.00	
Contingency		25%			$72,500.00	
Subtotal Other Costs					**$159,500.00**	
Total Capital Improvement Costs					**$449,500.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$610.00	$122.00	
Total Annual Operation and Maintenance Cost				**$122.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 2
DRAINAGEWAY :	Boulder Creek
REACH :	2D
JURISDICTION :	Weld County
REACH ID:	BCM-Reach2D

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$250,000.00	
Subtotal Capital Improvement Costs					**$250,000.00**	
Additional Capital Improvement Costs						
Dewatering		$2,500.00	L.S.		$2,500.00	
Mobilization		5%			$12,500.00	
Traffic Control		$6,250.00	L.S.		$6,250.00	
Utility Coordination/Relocation		$6,250.00	L.S.		$6,250.00	
Stormwater Management/Erosion Control		5%			$12,500.00	
Subtotal Additional Capital Improvement Costs					**$40,000.00**	
Land / Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$43,500.00	
Legal/Administrative		5%			$14,500.00	
Contract Admin/Construction Management		10%			$29,000.00	
Contingency		25%			$72,500.00	
Subtotal Other Costs					**$159,500.00**	
Total Capital Improvement Costs					**$449,500.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$610.00	$122.00	
Total Annual Operation and Maintenance Cost				**$122.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 2
DRAINAGEWAY :	Boulder Creek
REACH :	2E
JURISDICTION :	Weld County
REACH ID:	BCM-Reach2E

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
180 ft span bridge	<----User Defined Items	5400	SF	$250.00	$1,350,000.00	30 ft width bridge
Removal of old bridge	<----User Defined Items	3900	SF	$50.00	$195,000.00	130 ft x 30 ft

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$1,545,000.00
Subtotal Capital Improvement Costs					**$1,545,000.00**
Additional Capital Improvement Costs					
Dewatering		$15,450.00	L.S.		$15,450.00
Mobilization		5%			$77,250.00
Traffic Control		$38,625.00	L.S.		$38,625.00
Utility Coordination/Relocation		$38,625.00	L.S.		$38,625.00
Stormwater Management/Erosion Control		5%			$77,250.00
Subtotal Additional Capital Improvement Costs					**$247,200.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$268,830.00
Legal/Administrative		5%			$89,610.00
Contract Admin/Construction Management		10%			$179,220.00
Contingency		25%			$448,050.00
Subtotal Other Costs					**$985,710.00**
Total Capital Improvement Costs					**$2,777,910.00**

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)		30	L.F.	$2.00	$12.00
Bridge Maintenance	<----User Defined Items	1	EA	$1,000.00	$1,000.00
Total Annual Operation and Maintenance Cost					**$1,012.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$35,420.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 2
DRAINAGEWAY :	Boulder Creek
REACH :	2F
JURISDICTION :	Weld County
REACH ID:	BCM-Reach2F

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverbank Spillway	<----User Defined Items	20	L.S.	$225,000.00	$4,500,000.00	
Lateral Spillway	<----User Defined Items	1	L.S.	$225,000.00	$225,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$4,725,000.00
Subtotal Capital Improvement Costs					**$4,725,000.00**
Additional Capital Improvement Costs					
Dewatering		$47,250.00	L.S.		$47,250.00
Mobilization		5%			$236,250.00
Traffic Control		$118,125.00	L.S.		$118,125.00
Utility Coordination/Relocation		$118,125.00	L.S.		$118,125.00
Stormwater Management/Erosion Control		5%			$236,250.00
Subtotal Additional Capital Improvement Costs					**$756,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$822,150.00
Legal/Administrative		5%			$274,050.00
Contract Admin/Construction Management		10%			$548,100.00
Contingency		25%			$1,370,250.00
Subtotal Other Costs					**$3,014,550.00**
Total Capital Improvement Costs					**$8,495,550.00**

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)		21	EA	$610.00	$641.00
Total Annual Operation and Maintenance Cost					**$641.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$22,435.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 2
DRAINAGEWAY :	Boulder Creek
REACH :	2G
JURISDICTION :	Weld County
REACH ID:	BCM-Reach2G

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Stream Restoration	<-----User Defined Items	2000	L.F.	$133.00	$266,000.00	
ERC Riparian Restoration	<-----User Defined Items	18	AC	$35,000.00	$642,792.00	200 ft. on each side of river

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$908,792.00
Subtotal Capital Improvement Costs					**$908,792.00**
Additional Capital Improvement Costs					
Dewatering		$9,087.92	L.S.		$9,088.00
Mobilization		5%			$45,440.00
Traffic Control		$22,719.80	L.S.		$22,720.00
Utility Coordination/Relocation		$22,719.80	L.S.		$22,720.00
Stormwater Management/Erosion Control		5%			$45,440.00
Subtotal Additional Capital Improvement Costs					**$145,408.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$158,130.00
Legal/Administrative		5%			$52,710.00
Contract Admin/Construction Management		10%			$105,420.00
Contingency		25%			$263,550.00
Subtotal Other Costs					**$579,810.00**
Total Capital Improvement Costs					**$1,634,010.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	2000	L.F.	$2.00	$800.00
Total Annual Operation and Maintenance Cost				**$800.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$28,000.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 3
DRAINAGEWAY :	Boulder Creek
REACH :	3A
JURISDICTION :	Weld County
REACH ID:	BCM-Reach3A

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Stream Restoration	<-----User Defined Items	2000	L.F.	$135.00	$270,000.00	
ERC Riparian Restoration	<-----User Defined Items	18	AC	$35,000.00	$642,792.00	200 ft. on each side of stream

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$912,792.00
Subtotal Capital Improvement Costs					**$912,792.00**
Additional Capital Improvement Costs					
Dewatering		$9,127.92	L.S.		$9,128.00
Mobilization		5%			$45,640.00
Traffic Control		$22,819.80	L.S.		$22,820.00
Utility Coordination/Relocation		$22,819.80	L.S.		$22,820.00
Stormwater Management/Erosion Control		5%			$45,640.00
Subtotal Additional Capital Improvement Costs					**$146,048.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$158,826.00
Legal/Administrative		5%			$52,942.00
Contract Admin/Construction Management		10%			$105,884.00
Contingency		25%			$264,710.00
Subtotal Other Costs					**$582,362.00**
Total Capital Improvement Costs					**$1,641,202.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	2000	L.F.	$2.00	$800.00
Total Annual Operation and Maintenance Cost				**$800.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$28,000.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 3
DRAINAGEWAY :	Boulder Creek
REACH :	3B
JURISDICTION :	Weld County
REACH ID:	BCM-Reach3B

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverside Spillway	<----User Defined Items	1	EA	$225,000.00	$225,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$225,000.00	
Subtotal Capital Improvement Costs					**$225,000.00**	
Additional Capital Improvement Costs						
Dewatering		$2,250.00	L.S.		$2,250.00	
Mobilization		5%			$11,250.00	
Traffic Control		$5,625.00	L.S.		$5,625.00	
Utility Coordination/Relocation		$5,625.00	L.S.		$5,625.00	
Stormwater Management/Erosion Control		5%			$11,250.00	
Subtotal Additional Capital Improvement Costs					**$36,000.00**	
Land / Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$39,150.00	
Legal/Administrative		5%			$13,050.00	
Contract Admin/Construction Management		10%			$26,100.00	
Contingency		25%			$65,250.00	
Subtotal Other Costs					**$143,550.00**	
Total Capital Improvement Costs					**$404,550.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$610.00	$31.00	
Total Annual Operation and Maintenance Cost				**$31.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$1,085.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4A
JURISDICTION :	Weld County
REACH ID:	BCM-Reach4A

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$250,000.00	
Subtotal Capital Improvement Costs					**$250,000.00**	
Additional Capital Improvement Costs						
Dewatering		$2,500.00	L.S.		$2,500.00	
Mobilization		5%			$12,500.00	
Traffic Control		$6,250.00	L.S.		$6,250.00	
Utility Coordination/Relocation		$6,250.00	L.S.		$6,250.00	
Stormwater Management/Erosion Control		5%			$12,500.00	
Subtotal Additional Capital Improvement Costs					**$40,000.00**	
Land / Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$43,500.00	
Legal/Administrative		5%			$14,500.00	
Contract Admin/Construction Management		10%			$29,000.00	
Contingency		25%			$72,500.00	
Subtotal Other Costs					**$159,500.00**	
Total Capital Improvement Costs					**$449,500.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$610.00	$122.00	
Total Annual Operation and Maintenance Cost				**$122.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4B
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4B — Jeremy Deischer — DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Soil Riprap, Type M		178	C.Y.	$85.00	$15,111.00	400 L.F. of Right Bank stabilization
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		0	ACRE	$1,219.00	$305.00	
Special Items (User Defined)						
180 ft. span bridge at County Line road	<----User Defined Items	7200	S.F.	$250.00	$1,800,000.00	40 ft width
Old bridge removal	<----User Defined Items	4800	S.F.	$50.00	$240,000.00	120 ft x 40 ft.

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$15,111.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$305.00
Special Items (User Defined)				$2,040,000.00
Subtotal Capital Improvement Costs				**$2,055,416.00**
Additional Capital Improvement Costs				
Dewatering		$20,554.16	L.S.	$20,554.00
Mobilization		5%		$102,771.00
Traffic Control		$51,385.40	L.S.	$51,385.00
Utility Coordination/Relocation		$51,385.40	L.S.	$51,385.00
Stormwater Management/Erosion Control		5%		$102,771.00
Subtotal Additional Capital Improvement Costs				**$328,866.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering		15%		$357,642.00
Legal/Administrative		5%		$119,214.00
Contract Admin/Construction Management		10%		$238,428.00
Contingency		25%		$596,071.00
Subtotal Other Costs				**$1,311,355.00**
Total Capital Improvement Costs				**$3,695,637.00**

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)		40	L.F.	$2.00	$16.00
Bridge Maintenance	<----User Defined Items	1	EA	$800.00	$800.00
Total Annual Operation and Maintenance Cost					**$816.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$28,560.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4B-100yr
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4B-100yr — Jeremy Deischer — DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		9458	C.Y.	$29.00	$274,282.00	Fill required to raise roadway
Soil Riprap, Type M		178	C.Y.	$85.00	$15,111.00	400 L.F. RB Stabilization
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		0	ACRE	$1,219.00	$305.00	
Special Items (User Defined)						
220 ft span bridge at County Line Road	<----User Defined Items	8800	S.F.	$250.00	$2,200,000.00	40 ft. width
Asphalt for roadway	<----User Defined Items	7022	S.Y.	$60.00	$421,333.00	1580 ft. of roadway construction (N side)
Old bridge removal	<----User Defined Items	4800	S.F.	$50.00	$240,000.00	120 ft. x 40 ft.

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$289,393.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$305.00
Special Items (User Defined)				$2,861,333.00
Subtotal Capital Improvement Costs				**$3,151,031.00**
Additional Capital Improvement Costs				
Dewatering		$31,510.31	L.S.	$31,510.00
Mobilization		5%		$157,552.00
Traffic Control		$78,775.78	L.S.	$78,776.00
Utility Coordination/Relocation		$78,775.78	L.S.	$78,776.00
Stormwater Management/Erosion Control		5%		$157,552.00
Subtotal Additional Capital Improvement Costs				**$504,166.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering		15%		$548,280.00
Legal/Administrative		5%		$182,760.00
Contract Admin/Construction Management		10%		$365,520.00
Contingency		25%		$913,799.00
Subtotal Other Costs				**$2,010,359.00**
Total Capital Improvement Costs				**$5,665,556.00**

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)		40	L.F.	$2.00	$16.00
Bridge Maintenance	<----User Defined Items	1	EA	$800.00	$800.00
Total Annual Operation and Maintenance Cost					**$816.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$28,560.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4C-Boulder
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4C-Boulder

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverbank Spillway	<----User Defined Items	11	L.S.	$225,000.00	$2,475,000.00	
Lateral Spillway	<----User Defined Items	2	L.S.	$225,000.00	$450,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$2,925,000.00	
Subtotal Capital Improvement Costs					**$2,925,000.00**	
Additional Capital Improvement Costs						
Dewatering		$29,250.00	L.S.		$29,250.00	
Mobilization		5%			$146,250.00	
Traffic Control		$73,125.00	L.S.		$73,125.00	
Utility Coordination/Relocation		$73,125.00	L.S.		$73,125.00	
Stormwater Management/Erosion Control		5%			$146,250.00	
Subtotal Additional Capital Improvement Costs					**$468,000.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$508,950.00	
Legal/Administrative		5%			$169,650.00	
Contract Admin/Construction Management		10%			$339,300.00	
Contingency		25%			$848,250.00	
Subtotal Other Costs					**$1,866,150.00**	
Total Capital Improvement Costs					**$5,259,150.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	13	EA	$610.00	$397.00
Total Annual Operation and Maintenance Cost				**$397.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$13,895.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4C-Weld
JURISDICTION :	Weld County
REACH ID:	BCM-Reach4C-Weld

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverbank spillway	<----User Defined Items	2	L.S.	$225,000.00	$450,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$450,000.00	
Subtotal Capital Improvement Costs					**$450,000.00**	
Additional Capital Improvement Costs						
Dewatering		$4,500.00	L.S.		$4,500.00	
Mobilization		5%			$22,500.00	
Traffic Control		$11,250.00	L.S.		$11,250.00	
Utility Coordination/Relocation		$11,250.00	L.S.		$11,250.00	
Stormwater Management/Erosion Control		5%			$22,500.00	
Subtotal Additional Capital Improvement Costs					**$72,000.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$78,300.00	
Legal/Administrative		5%			$26,100.00	
Contract Admin/Construction Management		10%			$52,200.00	
Contingency		25%			$130,500.00	
Subtotal Other Costs					**$287,100.00**	
Total Capital Improvement Costs					**$809,100.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	2	EA	$610.00	$61.00
Total Annual Operation and Maintenance Cost				**$61.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$2,135.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4D
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4D
Jeremy Deischer	DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Soil Riprap, Type M		102	C.Y.	$85.00	$8,670.00	230 ft. x 6 ft. x 2 ft.
Excavation, Mid Range		188	C.Y.	$29.00	$5,452.00	Fill required in addition to soil riprap
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		1	ACRE	$1,219.00	$610.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$14,122.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$610.00
Special Items (User Defined)				$0.00
Subtotal Capital Improvement Costs				**$14,732.00**
Additional Capital Improvement Costs				
Dewatering	$147.32	L.S.		$147.00
Mobilization	5%			$737.00
Traffic Control	$368.30	L.S.		$368.00
Utility Coordination/Relocation	$368.30	L.S.		$368.00
Stormwater Management/Erosion Control	5%			$737.00
Subtotal Additional Capital Improvement Costs				**$2,357.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$2,563.00
Legal/Administrative	5%			$854.00
Contract Admin/Construction Management	10%			$1,709.00
Contingency	25%			$4,272.00
Subtotal Other Costs				**$9,398.00**
Total Capital Improvement Costs				**$26,487.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	230	L.F.	$2.00	$92.00
Total Annual Operation and Maintenance Cost				**$92.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$3,220.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4E
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4E
Jeremy Deischer	DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Remove washed out bridge	<----User Defined Items	1200	S.F.	$50.00	$60,000.00	15 ft. x 80 ft.

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$60,000.00
Subtotal Capital Improvement Costs				**$60,000.00**
Additional Capital Improvement Costs				
Dewatering	$600.00	L.S.		$600.00
Mobilization	5%			$3,000.00
Traffic Control	$1,500.00	L.S.		$1,500.00
Utility Coordination/Relocation	$1,500.00	L.S.		$1,500.00
Stormwater Management/Erosion Control	5%			$3,000.00
Subtotal Additional Capital Improvement Costs				**$9,600.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$10,440.00
Legal/Administrative	5%			$3,480.00
Contract Admin/Construction Management	10%			$6,960.00
Contingency	25%			$17,400.00
Subtotal Other Costs				**$38,280.00**
Total Capital Improvement Costs				**$107,880.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 4
DRAINAGEWAY : Boulder Creek
REACH : 4F
JURISDICTION : Boulder County
REACH ID: BCM-Reach4F Jeremy Deischer DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Estimate - New Stream	<----User Defined Items	1	L.S.	$1,130,000.00	$1,130,000.00	
ERC Estimate - Riparian Restoration	<----User Defined Items	1	L.S.	$2,730,000.00	$2,730,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$3,860,000.00
Subtotal Capital Improvement Costs					**$3,860,000.00**
Additional Capital Improvement Costs					
Dewatering		$38,600.00	L.S.		$38,600.00
Mobilization		5%			$193,000.00
Traffic Control		$96,500.00	L.S.		$96,500.00
Utility Coordination/Relocation		$96,500.00	L.S.		$96,500.00
Stormwater Management/Erosion Control		5%			$193,000.00
Subtotal Additional Capital Improvement Costs					**$617,600.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$671,640.00
Legal/Administrative		5%			$223,880.00
Contract Admin/Construction Management		10%			$447,760.00
Contingency		25%			$1,119,400.00
Subtotal Other Costs					**$2,462,680.00**
Total Capital Improvement Costs					**$6,940,280.00**

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)		8500	L.F.	$2.00	$3,400.00
Total Annual Operation and Maintenance Cost					**$3,400.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$118,999.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 4
DRAINAGEWAY : Boulder Creek
REACH : 4G
JURISDICTION : Boulder County
REACH ID: BCM-Reach4G Jeremy Deischer DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		804	C.Y.	$29.00	$23,316.00	Cut & Haul
Excavation, Low Range		368	C.Y.	$13.00	$4,784.00	Cut & Fill Onsite
Soil Riprap, Type M		778	C.Y.	$85.00	$66,130.00	1050 ft. x 2 ft. x 5 ft.
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$94,230.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$250,000.00
Subtotal Capital Improvement Costs					**$344,230.00**
Additional Capital Improvement Costs					
Dewatering		$3,442.30	L.S.		$3,442.00
Mobilization		5%			$17,212.00
Traffic Control		$8,605.75	L.S.		$8,606.00
Utility Coordination/Relocation		$8,605.75	L.S.		$8,606.00
Stormwater Management/Erosion Control		5%			$17,212.00
Subtotal Additional Capital Improvement Costs					**$55,078.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$59,896.00
Legal/Administrative		5%			$19,965.00
Contract Admin/Construction Management		10%			$39,931.00
Contingency		25%			$99,827.00
Subtotal Other Costs					**$219,619.00**
Total Capital Improvement Costs					**$618,927.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$610.00	$122.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	230	L.F.	$2.00	$92.00
Total Annual Operation and Maintenance Cost				**$214.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$7,490.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4H
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4H

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
180 ft. span bridge at Kenosha Road	<----User Defined Items	7200	S.F.	$250.00	$1,800,000.00	40 ft. Bridge width
Old bridge removal	<----User Defined Items	3600	S.F.	$50.00	$180,000.00	90 ft. x 40 ft.

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$1,980,000.00
Subtotal Capital Improvement Costs					**$1,980,000.00**
Additional Capital Improvement Costs					
Dewatering		$19,800.00	L.S.		$19,800.00
Mobilization		5%			$99,000.00
Traffic Control		$49,500.00	L.S.		$49,500.00
Utility Coordination/Relocation		$49,500.00	L.S.		$49,500.00
Stormwater Management/Erosion Control		5%			$99,000.00
Subtotal Additional Capital Improvement Costs					**$316,800.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$344,520.00
Legal/Administrative		5%			$114,840.00
Contract Admin/Construction Management		10%			$229,680.00
Contingency		25%			$574,200.00
Subtotal Other Costs					**$1,263,240.00**
Total Capital Improvement Costs					**$3,560,040.00**

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)		40	L.F.	$2.00	$16.00
Bridge Maintenance	<----User Defined Items	1	EA	$800.00	$800.00
Total Annual Operation and Maintenance Cost					**$816.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$28,560.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4I
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4I

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Grade Control for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$205,000.00	$205,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$205,000.00
Subtotal Capital Improvement Costs					**$205,000.00**
Additional Capital Improvement Costs					
Dewatering		$2,050.00	L.S.		$2,050.00
Mobilization		5%			$10,250.00
Traffic Control		$5,125.00	L.S.		$5,125.00
Utility Coordination/Relocation		$5,125.00	L.S.		$5,125.00
Stormwater Management/Erosion Control		5%			$10,250.00
Subtotal Additional Capital Improvement Costs					**$32,800.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$35,670.00
Legal/Administrative		5%			$11,890.00
Contract Admin/Construction Management		10%			$23,780.00
Contingency		25%			$59,450.00
Subtotal Other Costs					**$130,790.00**
Total Capital Improvement Costs					**$368,590.00**

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)		1	EA	$610.00	$122.00
Total Annual Operation and Maintenance Cost					**$122.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$4,270.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4J
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4J — Jeremy Deischer — DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
180 ft. span bridge at 109th St.	<----User Defined Items	5400	S.F.	$250.00	$1,350,000.00	30 ft. bridge width
Old bridge removal	<----User Defined Items	2400	S.F.	$50.00	$120,000.00	80 ft. x 30 ft.
Stream Restoration	<----User Defined Items	1	Mile	$575,000.00	$350,750.00	Average of New and Existing Stream Restoration
Riparian Restoration	<----User Defined Items	18	ACRE	$35,000.00	$623,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$2,443,750.00
Subtotal Capital Improvement Costs				**$2,443,750.00**
Additional Capital Improvement Costs				
Dewatering	$24,437.50	L.S.		$24,438.00
Mobilization	5%			$122,188.00
Traffic Control	$61,093.75	L.S.		$61,094.00
Utility Coordination/Relocation	$61,093.75	L.S.		$61,094.00
Stormwater Management/Erosion Control	5%			$122,188.00
Subtotal Additional Capital Improvement Costs				**$391,002.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$425,213.00
Legal/Administrative	5%			$141,738.00
Contract Admin/Construction Management	10%			$283,475.00
Contingency	25%			$708,688.00
Subtotal Other Costs				**$1,559,114.00**
Total Capital Improvement Costs				**$4,393,866.00**

Master Plan Operation and Maintenance Cost Summary					
Description		**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)		30	L.F.	$2.00	$12.00
Bridge Maintenance	<----User Defined Items	1	EA	$800.00	$800.00
Total Annual Operation and Maintenance Cost					**$812.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$28,420.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 4
DRAINAGEWAY :	Boulder Creek
REACH :	4K
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach4K — Jeremy Deischer — DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Stream Restoration	<----User Defined Items	4600	L.F.	$133.00	$611,800.00	
ERC Riparian Restoration	<----User Defined Items	42	AC	$35,000.00	$1,478,421.00	200 ft on each side of stream

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$2,090,221.00
Subtotal Capital Improvement Costs				**$2,090,221.00**
Additional Capital Improvement Costs				
Dewatering	$20,902.21	L.S.		$20,902.00
Mobilization	5%			$104,511.00
Traffic Control	$52,255.53	L.S.		$52,256.00
Utility Coordination/Relocation	$52,255.53	L.S.		$52,256.00
Stormwater Management/Erosion Control	5%			$104,511.00
Subtotal Additional Capital Improvement Costs				**$334,436.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$363,699.00
Legal/Administrative	5%			$121,233.00
Contract Admin/Construction Management	10%			$242,466.00
Contingency	25%			$606,164.00
Subtotal Other Costs				**$1,333,562.00**
Total Capital Improvement Costs				**$3,758,219.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	4600	L.F.	$2.00	$1,840.00
Total Annual Operation and Maintenance Cost				**$1,840.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$64,399.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5A
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach5A

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Estimated New Stream	<----User Defined Items	1	L.S.	$600,000.00	$600,000.00	
ERC Estimated Riparian Restoration	<----User Defined Items	1	L.S.	$1,450,000.00	$1,450,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$2,050,000.00
Subtotal Capital Improvement Costs					**$2,050,000.00**
Additional Capital Improvement Costs					
Dewatering		$20,500.00	L.S.		$20,500.00
Mobilization		5%			$102,500.00
Traffic Control		$51,250.00	L.S.		$51,250.00
Utility Coordination/Relocation		$51,250.00	L.S.		$51,250.00
Stormwater Management/Erosion Control		5%			$102,500.00
Subtotal Additional Capital Improvement Costs					**$328,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$356,700.00
Legal/Administrative		5%			$118,900.00
Contract Admin/Construction Management		10%			$237,800.00
Contingency		25%			$594,500.00
Subtotal Other Costs					**$1,307,900.00**
Total Capital Improvement Costs					**$3,685,900.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	4500	L.F.	$2.00	$1,800.00
Total Annual Operation and Maintenance Cost				**$1,800.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$62,999.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5B
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach5B

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$250,000.00
Subtotal Capital Improvement Costs					**$250,000.00**
Additional Capital Improvement Costs					
Dewatering		$2,500.00	L.S.		$2,500.00
Mobilization		5%			$12,500.00
Traffic Control		$6,250.00	L.S.		$6,250.00
Utility Coordination/Relocation		$6,250.00	L.S.		$6,250.00
Stormwater Management/Erosion Control		5%			$12,500.00
Subtotal Additional Capital Improvement Costs					**$40,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$43,500.00
Legal/Administrative		5%			$14,500.00
Contract Admin/Construction Management		10%			$29,000.00
Contingency		25%			$72,500.00
Subtotal Other Costs					**$159,500.00**
Total Capital Improvement Costs					**$449,500.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$610.00	$122.00
Total Annual Operation and Maintenance Cost				**$122.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5C
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach5C

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverbank spillway	<----User Defined Items	5	L.S.	$225,000.00	$1,125,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$1,125,000.00	
Subtotal Capital Improvement Costs					**$1,125,000.00**	
Additional Capital Improvement Costs						
Dewatering		$11,250.00	L.S.		$11,250.00	
Mobilization		5%			$56,250.00	
Traffic Control		$28,125.00	L.S.		$28,125.00	
Utility Coordination/Relocation		$28,125.00	L.S.		$28,125.00	
Stormwater Management/Erosion Control		5%			$56,250.00	
Subtotal Additional Capital Improvement Costs					**$180,000.00**	
Land / Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$195,750.00	
Legal/Administrative		5%			$65,250.00	
Contract Admin/Construction Management		10%			$130,500.00	
Contingency		25%			$326,250.00	
Subtotal Other Costs					**$717,750.00**	
Total Capital Improvement Costs					**$2,022,750.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	5	EA	$610.00	$153.00	
Total Annual Operation and Maintenance Cost				**$153.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$5,355.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5D
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach5D

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Grade Control for Acquatic & Habitat Passage	<----User Defined Items	1	L.S.	$205,000.00	$205,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$205,000.00	
Subtotal Capital Improvement Costs					**$205,000.00**	
Additional Capital Improvement Costs						
Dewatering		$2,050.00	L.S.		$2,050.00	
Mobilization		5%			$10,250.00	
Traffic Control		$5,125.00	L.S.		$5,125.00	
Utility Coordination/Relocation		$5,125.00	L.S.		$5,125.00	
Stormwater Management/Erosion Control		5%			$10,250.00	
Subtotal Additional Capital Improvement Costs					**$32,800.00**	
Land / Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$35,670.00	
Legal/Administrative		5%			$11,890.00	
Contract Admin/Construction Management		10%			$23,780.00	
Contingency		25%			$59,450.00	
Subtotal Other Costs					**$130,790.00**	
Total Capital Improvement Costs					**$368,590.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$610.00	$122.00	
Total Annual Operation and Maintenance Cost				**$122.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5E
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach5E
	Jeremy Deischer
DATE :	2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Grade Control for Acquatic & Habitat Passage	<----User Defined Items	2	L.S.	$205,000.00	$410,000.00	Two diversions DS of 95th St.

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$410,000.00
Subtotal Capital Improvement Costs					**$410,000.00**
Additional Capital Improvement Costs					
Dewatering		$4,100.00	L.S.		$4,100.00
Mobilization		5%			$20,500.00
Traffic Control		$10,250.00	L.S.		$10,250.00
Utility Coordination/Relocation		$10,250.00	L.S.		$10,250.00
Stormwater Management/Erosion Control		5%			$20,500.00
Subtotal Additional Capital Improvement Costs					**$65,600.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$71,340.00
Legal/Administrative		5%			$23,780.00
Contract Admin/Construction Management		10%			$47,560.00
Contingency		25%			$118,900.00
Subtotal Other Costs					**$261,580.00**
Total Capital Improvement Costs					**$737,180.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	2	EA	$610.00	$244.00
Total Annual Operation and Maintenance Cost				**$244.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$8,540.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5F
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach5F
	Jeremy Deischer
DATE :	2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC New Stream Restoration	<----User Defined Items	2000	L.F.	$133.00	$266,000.00	
ERC Riparian Restoration	<----User Defined Items	18	Acre	$35,000.00	$642,792.00	200 ft on each side of stream
Land Acquisition						
Easement/ROW Acquisition		23.67	ACRE	$569.71	$13,485.00	Parcel: 146516010001 (6.7% Easement of Parcel Required)

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$908,792.00
Subtotal Capital Improvement Costs					**$908,792.00**
Additional Capital Improvement Costs					
Dewatering		$9,087.92	L.S.		$9,088.00
Mobilization		5%			$45,440.00
Traffic Control		$22,719.80	L.S.		$22,720.00
Utility Coordination/Relocation		$22,719.80	L.S.		$22,720.00
Stormwater Management/Erosion Control		5%			$45,440.00
Subtotal Additional Capital Improvement Costs					**$145,408.00**
Land Acquisition Costs					
ROW/Easements					$13,485.00
Subtotal Land Acquisition Costs					**$13,485.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$158,130.00
Legal/Administrative		5%			$52,710.00
Contract Admin/Construction Management		10%			$105,420.00
Contingency		25%			$263,550.00
Subtotal Other Costs					**$579,810.00**
Total Capital Improvement Costs					**$1,647,495.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	2000	L.F.	$2.00	$800.00
Total Annual Operation and Maintenance Cost				**$800.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$28,000.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5G
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach5G
	Jeremy Deischer
DATE :	2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Old bridge removal	<----User Defined Items	4800	S.F.	$50.00	$240,000.00	120 ft. x 40 ft.
180 ft. span bridge	<----User Defined Items	7200	S.F.	$250.00	$1,800,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$2,040,000.00
Subtotal Capital Improvement Costs				**$2,040,000.00**
Additional Capital Improvement Costs				
Dewatering		$20,400.00	L.S.	$20,400.00
Mobilization		5%		$102,000.00
Traffic Control		$51,000.00	L.S.	$51,000.00
Utility Coordination/Relocation		$51,000.00	L.S.	$51,000.00
Stormwater Management/Erosion Control		5%		$102,000.00
Subtotal Additional Capital Improvement Costs				**$326,400.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering		15%		$354,960.00
Legal/Administrative		5%		$118,320.00
Contract Admin/Construction Management		10%		$236,640.00
Contingency		25%		$591,600.00
Subtotal Other Costs				**$1,301,520.00**
Total Capital Improvement Costs				**$3,667,920.00**

Master Plan Operation and Maintenance Cost Summary					
Description		Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)		40	L.F.	$2.00	$16.00
Bridge Maintenance	<----User Defined Items	1	EA	$800.00	$800.00
Total Annual Operation and Maintenance Cost					**$816.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$28,560.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5G-100yr
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach5G-100yr
	Jeremy Deischer
DATE :	2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		14304	C.Y.	$29.00	$414,816.00	Fill Required for roadway reconstruction
Special Items (User Defined)						
Removal of old 120 ft. bridge	<----User Defined Items	4800	S.F.	$50.00	$240,000.00	40 ft. width
220' span bridge	<----User Defined Items	8800	S.F.	$250.00	$2,200,000.00	40 ft. width
Asphalt Remove and Replace	<----User Defined Items	6711	S.Y.	$60.00	$402,667.00	1510 ft. of roadway reconstruction

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$414,816.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$2,842,667.00
Subtotal Capital Improvement Costs				**$3,257,483.00**
Additional Capital Improvement Costs				
Dewatering		$32,574.83	L.S.	$32,575.00
Mobilization		5%		$162,874.00
Traffic Control		$81,437.08	L.S.	$81,437.00
Utility Coordination/Relocation		$81,437.08	L.S.	$81,437.00
Stormwater Management/Erosion Control		5%		$162,874.00
Subtotal Additional Capital Improvement Costs				**$521,197.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering		15%		$566,802.00
Legal/Administrative		5%		$188,934.00
Contract Admin/Construction Management		10%		$377,868.00
Contingency		25%		$944,670.00
Subtotal Other Costs				**$2,078,274.00**
Total Capital Improvement Costs				**$5,856,954.00**

Master Plan Operation and Maintenance Cost Summary					
Description		Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)		40	L.F.	$2.00	$16.00
Bridge Maintenance	<----User Defined Items	1	EA	$800.00	$800.00
Total Annual Operation and Maintenance Cost					**$816.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$28,560.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5G-Interim
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach5G-Interim
	Jeremy Deischer
DATE :	2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		3290	C.Y.	$29.00	$95,410.00	Fill required for roadway reconstruction raising roadway 2 ft.
Special Items (User Defined)						
Asphalt Remove and Replace	<----User Defined Items	4511	S.Y.	$60.00	$270,667.00	1015 ft (40 ft width)
Geo-Fabric roadway protection	<----User Defined Items	4511	S.Y.	$17.00	$76,689.00	Turf Reinforcement Mat (TRM) US and DS side of 95th St.
(2) Vegetated spillways 95th St. Pond	<----User Defined Items	2	L.S.	$225,000.00	$450,000.00	Upstream of 95th Street
Lower Boulder Ditch Modification (2 structures)	<----User Defined Items	2	L.S.	$250,000.00	$500,000.00	2 structures DS of 95th adjusted for aquatic and habitat passage
Stream Restoration DS of 95th St.	<----User Defined Items	750	L.F.	$133.00	$99,750.00	
Riparian Restoration DS of 95th St.	<----User Defined Items	7	AC	$35,000.00	$241,047.00	
Stream Restoration US of 95th St.	<----User Defined Items	3000	L.F.	$133.00	$399,000.00	
Riparian Restoration US of 95th St.	<----User Defined Items	28	AC	$35,000.00	$964,187.00	
Land Acquisition						
Easement/ROW Acquisition		17.00	ACRE	$569.73	$9,685.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$95,410.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$3,001,340.00
Subtotal Capital Improvement Costs				**$3,096,750.00**
Additional Capital Improvement Costs				
Dewatering	$30,967.50	L.S.		$30,968.00
Mobilization	5%			$154,838.00
Traffic Control	$77,418.75	L.S.		$77,419.00
Utility Coordination/Relocation	$77,418.75	L.S.		$77,419.00
Stormwater Management/Erosion Control	5%			$154,838.00
Subtotal Additional Capital Improvement Costs				**$495,482.00**
Land Acquisition Costs				
ROW/Easements				$9,685.00
Subtotal Land Acquisition Costs				**$9,685.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$538,835.00
Legal/Administrative	5%			$179,612.00
Contract Admin/Construction Management	10%			$359,223.00
Contingency	25%			$898,058.00
Subtotal Other Costs				**$1,975,728.00**
Total Capital Improvement Costs				**$5,577,645.00**

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	2	EA	$610.00	$244.00	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	5500	L.F.	$2.00	$2,200.00	
Gravel Pit Spillway Maintenance <----User Defined Items	2	EA	$610.00	$61.00	
Total Annual Operation and Maintenance Cost				**$2,505.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$87,674.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 5
DRAINAGEWAY :	Boulder Creek
REACH :	5H
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach5H
	Jeremy Deischer
DATE :	2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Stream Restoration	<----User Defined Items	4500	L.F.	$133.00	$598,500.00	
ERC Riparian Restoration	<----User Defined Items	41	AC	$35,000.00	$1,446,281.00	200 ft. riparian restoration each side of stream

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$2,044,781.00
Subtotal Capital Improvement Costs				**$2,044,781.00**
Additional Capital Improvement Costs				
Dewatering	$20,447.81	L.S.		$20,448.00
Mobilization	5%			$102,239.00
Traffic Control	$51,119.53	L.S.		$51,120.00
Utility Coordination/Relocation	$51,119.53	L.S.		$51,120.00
Stormwater Management/Erosion Control	5%			$102,239.00
Subtotal Additional Capital Improvement Costs				**$327,166.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$355,792.00
Legal/Administrative	5%			$118,597.00
Contract Admin/Construction Management	10%			$237,195.00
Contingency	25%			$592,987.00
Subtotal Other Costs				**$1,304,571.00**
Total Capital Improvement Costs				**$3,676,518.00**

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	4500	L.F.	$2.00	$1,800.00	
Total Annual Operation and Maintenance Cost				**$1,800.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$62,999.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 6
DRAINAGEWAY :	Boulder Creek
REACH :	6A
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach6A

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$250,000.00	
Subtotal Capital Improvement Costs					**$250,000.00**	
Additional Capital Improvement Costs						
Dewatering		$2,500.00	L.S.		$2,500.00	
Mobilization		5%			$12,500.00	
Traffic Control		$6,250.00	L.S.		$6,250.00	
Utility Coordination/Relocation		$6,250.00	L.S.		$6,250.00	
Stormwater Management/Erosion Control		5%			$12,500.00	
Subtotal Additional Capital Improvement Costs					**$40,000.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$43,500.00	
Legal/Administrative		5%			$14,500.00	
Contract Admin/Construction Management		10%			$29,000.00	
Contingency		25%			$72,500.00	
Subtotal Other Costs					**$159,500.00**	
Total Capital Improvement Costs					**$449,500.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$610.00	$122.00	
Total Annual Operation and Maintenance Cost				**$122.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 6
DRAINAGEWAY :	Boulder Creek
REACH :	6B
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach6B

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
180 ft. span bridge at 75th St.	<----User Defined Items	7200	S.F.	$250.00	$1,800,000.00	40 ft width at 75th St.
Old bridge removal	<----User Defined Items	4400	S.F.	$50.00	$220,000.00	110 x 40 ft

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$2,020,000.00	
Subtotal Capital Improvement Costs					**$2,020,000.00**	
Additional Capital Improvement Costs						
Dewatering		$20,200.00	L.S.		$20,200.00	
Mobilization		5%			$101,000.00	
Traffic Control		$50,500.00	L.S.		$50,500.00	
Utility Coordination/Relocation		$50,500.00	L.S.		$50,500.00	
Stormwater Management/Erosion Control		5%			$101,000.00	
Subtotal Additional Capital Improvement Costs					**$323,200.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$351,480.00	
Legal/Administrative		5%			$117,160.00	
Contract Admin/Construction Management		10%			$234,320.00	
Contingency		25%			$585,800.00	
Subtotal Other Costs					**$1,288,760.00**	
Total Capital Improvement Costs					**$3,631,960.00**	

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)		40	L.F.	$2.00	$16.00	
Bridge Maintenance	<----User Defined Items	1	EA	$800.00	$800.00	
Total Annual Operation and Maintenance Cost					**$816.00**	
Effective Interest Rate					1.50%	
Total Operation and Maintenance Costs Over 50 Years					**$28,560.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 6
DRAINAGEWAY : Boulder Creek
REACH : 6B-100yr
JURISDICTION : Boulder County
REACH ID: BCM-Reach6B-100yr Jeremy Deischer DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		7242	C.Y.	$29.00	$210,018.00	Fill required for roadway improvement
Special Items (User Defined)						
180 ft span bridge at 75th St.	<----User Defined Items	7200	S.F.	$250.00	$1,800,000.00	40 ft. width at 75th
Remove and Replace Asphalt	<----User Defined Items	7333	S.Y.	$60.00	$440,000.00	1650 feet of roadway reconstruction (South Side)
Old bridge removal	<----User Defined Items	4400	S.F.	$50.00	$220,000.00	110 ft x 40 ft

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$210,018.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$2,460,000.00
Subtotal Capital Improvement Costs					**$2,670,018.00**
Additional Capital Improvement Costs					
Dewatering		$26,700.18	L.S.		$26,700.00
Mobilization		5%			$133,501.00
Traffic Control		$66,750.45	L.S.		$66,750.00
Utility Coordination/Relocation		$66,750.45	L.S.		$66,750.00
Stormwater Management/Erosion Control		5%			$133,501.00
Subtotal Additional Capital Improvement Costs					**$427,202.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$464,583.00
Legal/Administrative		5%			$154,861.00
Contract Admin/Construction Management		10%			$309,722.00
Contingency		25%			$774,305.00
Subtotal Other Costs					**$1,703,471.00**
Total Capital Improvement Costs					**$4,800,691.00**

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)		40	L.F.	$2.00	$16.00
Bridge Maintenance	<----User Defined Items	1	EA	$800.00	$800.00
Total Annual Operation and Maintenance Cost					**$816.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$28,560.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 7
DRAINAGEWAY : Boulder Creek
REACH : 7A
JURISDICTION : Boulder County
REACH ID: BCM-Reach7A Jeremy Deischer DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverside Spillway	<----User Defined Items	4	LS	$225,000.00	$900,000.00	
Lateral Spillway	<----User Defined Items	3	LS	$225,000.00	$675,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$1,575,000.00
Subtotal Capital Improvement Costs					**$1,575,000.00**
Additional Capital Improvement Costs					
Dewatering		$15,750.00	L.S.		$15,750.00
Mobilization		5%			$78,750.00
Traffic Control		$39,375.00	L.S.		$39,375.00
Utility Coordination/Relocation		$39,375.00	L.S.		$39,375.00
Stormwater Management/Erosion Control		5%			$78,750.00
Subtotal Additional Capital Improvement Costs					**$252,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$274,050.00
Legal/Administrative		5%			$91,350.00
Contract Admin/Construction Management		10%			$182,700.00
Contingency		25%			$456,750.00
Subtotal Other Costs					**$1,004,850.00**
Total Capital Improvement Costs					**$2,831,850.00**

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)		7	EA	$610.00	$214.00
Total Annual Operation and Maintenance Cost					**$214.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$7,490.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 7
DRAINAGEWAY :	Boulder Creek
REACH :	7B
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach7B
	Jeremy Deischer
DATE :	2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Riverside Spillway	<----User Defined Items	5	LS	$225,000.00	$1,125,000.00	
Lateral Spillway	<----User Defined Items	2	LS	$225,000.00	$450,000.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$1,575,000.00
Subtotal Capital Improvement Costs					**$1,575,000.00**
Additional Capital Improvement Costs					
Dewatering		$15,750.00	L.S.		$15,750.00
Mobilization		5%			$78,750.00
Traffic Control		$39,375.00	L.S.		$39,375.00
Utility Coordination/Relocation		$39,375.00	L.S.		$39,375.00
Stormwater Management/Erosion Control		5%			$78,750.00
Subtotal Additional Capital Improvement Costs					**$252,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$274,050.00
Legal/Administrative		5%			$91,350.00
Contract Admin/Construction Management		10%			$182,700.00
Contingency		25%			$456,750.00
Subtotal Other Costs					**$1,004,850.00**
Total Capital Improvement Costs					**$2,831,850.00**

Master Plan Operation and Maintenance Cost Summary					
Description		**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)		7	EA	$610.00	$214.00
Total Annual Operation and Maintenance Cost					**$214.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$7,490.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 7
DRAINAGEWAY :	Boulder Creek
REACH :	7C
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach7C
	Jeremy Deischer
DATE :	2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$250,000.00
Subtotal Capital Improvement Costs				**$250,000.00**
Additional Capital Improvement Costs				
Dewatering	$2,500.00	L.S.		$2,500.00
Mobilization	5%			$12,500.00
Traffic Control	$6,250.00	L.S.		$6,250.00
Utility Coordination/Relocation	$6,250.00	L.S.		$6,250.00
Stormwater Management/Erosion Control	5%			$12,500.00
Subtotal Additional Capital Improvement Costs				**$40,000.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$43,500.00
Legal/Administrative	5%			$14,500.00
Contract Admin/Construction Management	10%			$29,000.00
Contingency	25%			$72,500.00
Subtotal Other Costs				**$159,500.00**
Total Capital Improvement Costs				**$449,500.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$610.00	$122.00
Total Annual Operation and Maintenance Cost				**$122.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 7
DRAINAGEWAY :	Boulder Creek
REACH :	7D
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach7D

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$250,000.00	
Subtotal Capital Improvement Costs					**$250,000.00**	
Additional Capital Improvement Costs						
Dewatering		$2,500.00	L.S.		$2,500.00	
Mobilization		5%			$12,500.00	
Traffic Control		$6,250.00	L.S.		$6,250.00	
Utility Coordination/Relocation		$6,250.00	L.S.		$6,250.00	
Stormwater Management/Erosion Control		5%			$12,500.00	
Subtotal Additional Capital Improvement Costs					**$40,000.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$43,500.00	
Legal/Administrative		5%			$14,500.00	
Contract Admin/Construction Management		10%			$29,000.00	
Contingency		25%			$72,500.00	
Subtotal Other Costs					**$159,500.00**	
Total Capital Improvement Costs					**$449,500.00**	

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)		1	EA	$610.00	$122.00	
Total Annual Operation and Maintenance Cost					**$122.00**	
Effective Interest Rate					1.50%	
Total Operation and Maintenance Costs Over 50 Years					**$4,270.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 7
DRAINAGEWAY :	Boulder Creek
REACH :	7E
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach7E

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
180 ft. span bridge at 61st St.	<----User Defined Items	5400	S.F.	$250.00	$1,350,000.00	30 ft width bridge at 61st St.
Old bridge removal	<----User Defined Items	2700	S.F.	$50.00	$135,000.00	90 ft x 30 ft

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$1,485,000.00	
Subtotal Capital Improvement Costs					**$1,485,000.00**	
Additional Capital Improvement Costs						
Dewatering		$14,850.00	L.S.		$14,850.00	
Mobilization		5%			$74,250.00	
Traffic Control		$37,125.00	L.S.		$37,125.00	
Utility Coordination/Relocation		$37,125.00	L.S.		$37,125.00	
Stormwater Management/Erosion Control		5%			$74,250.00	
Subtotal Additional Capital Improvement Costs					**$237,600.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$258,390.00	
Legal/Administrative		5%			$86,130.00	
Contract Admin/Construction Management		10%			$172,260.00	
Contingency		25%			$430,650.00	
Subtotal Other Costs					**$947,430.00**	
Total Capital Improvement Costs					**$2,670,030.00**	

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)		30	L.F.	$2.00	$12.00	
Bridge Maintenance	<----User Defined Items	1	EA	$800.00	$800.00	
Total Annual Operation and Maintenance Cost					**$812.00**	
Effective Interest Rate					1.50%	
Total Operation and Maintenance Costs Over 50 Years					**$28,420.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 7
DRAINAGEWAY :	Boulder Creek
REACH :	7E-100yr
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach7E-100yr
Jeremy Deischer	DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		9180	C.Y.	$29.00	$266,220.00	Fill required for roadway reconstruction
Special Items (User Defined)						
220 ft. span bridge	<----User Defined Items	6600	S.F.	$250.00	$1,650,000.00	30 ft width bridge at 61st St.
Remove and replace asphalt	<----User Defined Items	6667	S.Y.	$60.00	$400,000.00	2000 ft of roadway reconstruction (N and S Side)
Old bridge remoual	<----User Defined Items	2700	S.F.	$50.00	$135,000.00	90 ft x 30 ft

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$266,220.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$2,185,000.00
Subtotal Capital Improvement Costs					**$2,451,220.00**
Additional Capital Improvement Costs					
Dewatering		$24,512.20	L.S.		$24,512.00
Mobilization		5%			$122,561.00
Traffic Control		$61,280.50	L.S.		$61,281.00
Utility Coordination/Relocation		$61,280.50	L.S.		$61,281.00
Stormwater Management/Erosion Control		5%			$122,561.00
Subtotal Additional Capital Improvement Costs					**$392,196.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$426,512.00
Legal/Administrative		5%			$142,171.00
Contract Admin/Construction Management		10%			$284,342.00
Contingency		25%			$710,854.00
Subtotal Other Costs					**$1,563,879.00**
Total Capital Improvement Costs					**$4,407,295.00**

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)		30	L.F.	$2.00	$12.00
Bridge Maintenance	<----User Defined Items	1	EA	$800.00	$800.00
Total Annual Operation and Maintenance Cost					**$812.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$28,420.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 7
DRAINAGEWAY :	Boulder Creek
REACH :	7F
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach7F
Jeremy Deischer	DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Remove pedestrian bridge	<----User Defined Items	2250	S.F.	$50.00	$112,500.00	Existing 75ft x 30 ft
180 ft span pedestrain bridge	<----User Defined Items	2700	S.F.	$300.00	$810,000.00	180 ft x 15 ft

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$922,500.00
Subtotal Capital Improvement Costs					**$922,500.00**
Additional Capital Improvement Costs					
Dewatering		$9,225.00	L.S.		$9,225.00
Mobilization		5%			$46,125.00
Traffic Control		$13,837.50	L.S.		$13,838.00
Utility Coordination/Relocation		$80,000.00	L.S.		$80,000.00
Stormwater Management/Erosion Control		5%			$46,125.00
Subtotal Additional Capital Improvement Costs					**$195,313.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$167,672.00
Legal/Administrative		5%			$55,891.00
Contract Admin/Construction Management		10%			$111,781.00
Contingency		25%			$279,453.00
Subtotal Other Costs					**$614,797.00**
Total Capital Improvement Costs					**$1,732,610.00**

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)		15	L.F.	$2.00	$6.00
Bridge Maintenance	<----User Defined Items	1	EA	$800.00	$800.00
Total Annual Operation and Maintenance Cost					**$806.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$28,210.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 7
DRAINAGEWAY : Boulder Creek
REACH : 7G
JURISDICTION : Boulder County
REACH ID: BCM-Reach7G | Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
54-inch	600	1	600	L.F.	$263.00	$157,800.00	
Headwalls							
Diameter (in)	Applicable	No. of Barrels					
54-inch	Yes	1	2	EA	$1,760.84	$3,522.00	
Wingwalls (includes concrete apron)							
Diameter (in)		No. of Barrels					
54-inch		1	2	EA	$10,733.84	$21,468.00	
Special Items (User Defined)							
Remove existing diversion structure	<----User Defined Items		1	L.S.	$20,000.00	$20,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs						
Pipe Culverts and Storm Drains						$182,790.00
Concrete Box Culverts						$0.00
Hydraulic Structures						$0.00
Channel Improvements						$0.00
Detention/Water Quality Facilities						$0.00
Removals						$0.00
Landscaping and Maintenance Improvements						$0.00
Special Items (User Defined)						$20,000.00
Subtotal Capital Improvement Costs						**$202,790.00**
Additional Capital Improvement Costs						
Dewatering			$2,027.90	L.S.		$2,028.00
Mobilization			5%			$10,140.00
Traffic Control			$5,069.75	L.S.		$5,070.00
Utility Coordination/Relocation			$5,069.75	L.S.		$5,070.00
Stormwater Management/Erosion Control			5%			$10,140.00
Subtotal Additional Capital Improvement Costs						**$32,448.00**
Land Acquisition Costs						
ROW/Easements						$0.00
Subtotal Land Acquisition Costs						**$0.00**
Other Costs (percentage of Capital Improvement Costs)						
Engineering			15%			$35,286.00
Legal/Administrative			5%			$11,762.00
Contract Admin/Construction Management			10%			$23,524.00
Contingency			25%			$58,810.00
Subtotal Other Costs						**$129,382.00**
Total Capital Improvement Costs						**$364,620.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs,	600	L.F.	$1.00	$120.00
Total Annual Operation and Maintenance Cost				**$120.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$4,200.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 7
DRAINAGEWAY : Boulder Creek
REACH : 7H
JURISDICTION : Boulder County
REACH ID: BCM-Reach7H | Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Soil Riprap, Type M		356	C.Y.	$85.00	$30,222.00	Protection for Sanitary near Boulder Creek (400 LF)
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		0	ACRE	$1,219.00	$305.00	
Special Items (User Defined)						
Grade Control Structure to Protect Sanitary	<----User Defined Items	2	L.S.	$205,000.00	$410,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$30,222.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$305.00
Special Items (User Defined)				$410,000.00
Subtotal Capital Improvement Costs				**$440,527.00**
Additional Capital Improvement Costs				
Dewatering	$4,405.27	L.S.		$4,405.00
Mobilization	5%			$22,026.00
Traffic Control	$11,013.18	L.S.		$11,013.00
Utility Coordination/Relocation	$11,013.18	L.S.		$11,013.00
Stormwater Management/Erosion Control	5%			$22,026.00
Subtotal Additional Capital Improvement Costs				**$70,483.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$76,652.00
Legal/Administrative	5%			$25,551.00
Contract Admin/Construction Management	10%			$51,101.00
Contingency	25%			$127,753.00
Subtotal Other Costs				**$281,057.00**
Total Capital Improvement Costs				**$792,067.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	2	EA	$610.00	$244.00
Total Annual Operation and Maintenance Cost				**$244.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$8,540.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 7
DRAINAGEWAY :	Boulder Creek
REACH :	7I
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach7I
Jeremy Deischer	DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Stream Restoration	<----User Defined Items	6250	L.F.	$133.00	$831,250.00	
ERC Riparian Restoration	<----User Defined Items	14	A.C.	$35,000.00	$502,181.00	50 ft each side

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$1,333,431.00
Subtotal Capital Improvement Costs				**$1,333,431.00**
Additional Capital Improvement Costs				
Dewatering	$13,334.31	L.S.		$13,334.00
Mobilization	5%			$66,672.00
Traffic Control	$33,335.78	L.S.		$33,336.00
Utility Coordination/Relocation	$33,335.78	L.S.		$33,336.00
Stormwater Management/Erosion Control	5%			$66,672.00
Subtotal Additional Capital Improvement Costs				**$213,350.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$232,017.00
Legal/Administrative	5%			$77,339.00
Contract Admin/Construction Management	10%			$154,678.00
Contingency	25%			$386,695.00
Subtotal Other Costs				**$850,729.00**
Total Capital Improvement Costs				**$2,397,510.00**

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	6250	L.F.	$2.00	$2,500.00	
Total Annual Operation and Maintenance Cost				**$2,500.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$87,499.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 8
DRAINAGEWAY :	Boulder Creek
REACH :	8A
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach8A
Jeremy Deischer	DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Estimate New Stream	<----User Defined Items	1	L.S.	$230,000.00	$230,000.00	
ERC Estimate Riparian Restoration	<----User Defined Items	1	L.S.	$140,000.00	$140,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$370,000.00
Subtotal Capital Improvement Costs				**$370,000.00**
Additional Capital Improvement Costs				
Dewatering	$3,700.00	L.S.		$3,700.00
Mobilization	5%			$18,500.00
Traffic Control	$9,250.00	L.S.		$9,250.00
Utility Coordination/Relocation	$9,250.00	L.S.		$9,250.00
Stormwater Management/Erosion Control	5%			$18,500.00
Subtotal Additional Capital Improvement Costs				**$59,200.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$64,380.00
Legal/Administrative	5%			$21,460.00
Contract Admin/Construction Management	10%			$42,920.00
Contingency	25%			$107,300.00
Subtotal Other Costs				**$236,060.00**
Total Capital Improvement Costs				**$665,260.00**

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	1700	L.F.	$2.00	$680.00	
Total Annual Operation and Maintenance Cost				**$680.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$23,800.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 8
DRAINAGEWAY :	Boulder Creek
REACH :	8B
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach8B
Jeremy Deischer	DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Estimate New Stream	<----User Defined Items	1	L.S.	$640,000.00	$640,000.00	
ERC Estimate Riparian Restoration	<----User Defined Items	1	L.S.	$390,000.00	$390,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$1,030,000.00
Subtotal Capital Improvement Costs				**$1,030,000.00**
Additional Capital Improvement Costs				
Dewatering	$10,300.00	L.S.		$10,300.00
Mobilization	5%			$51,500.00
Traffic Control	$25,750.00	L.S.		$25,750.00
Utility Coordination/Relocation	$25,750.00	L.S.		$25,750.00
Stormwater Management/Erosion Control	5%			$51,500.00
Subtotal Additional Capital Improvement Costs				**$164,800.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$179,220.00
Legal/Administrative	5%			$59,740.00
Contract Admin/Construction Management	10%			$119,480.00
Contingency	25%			$298,700.00
Subtotal Other Costs				**$657,140.00**
Total Capital Improvement Costs				**$1,851,940.00**

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	4800	L.F.	$2.00	$1,920.00	
Total Annual Operation and Maintenance Cost				**$1,920.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$67,199.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 8
DRAINAGEWAY :	Boulder Creek
REACH :	8C
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach8C
Jeremy Deischer	DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
220 ft railroad replacement	<----User Defined Items	4000	S.F.	$450.00	$1,800,000.00	20 ft width
Temp Bridge	<----User Defined Items	1500	S.F.	$350.00	$525,000.00	75 ft x 50 ft

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$2,325,000.00
Subtotal Capital Improvement Costs				**$2,325,000.00**
Additional Capital Improvement Costs				
Dewatering	$23,250.00	L.S.		$23,250.00
Mobilization	5%			$116,250.00
Traffic Control	$58,125.00	L.S.		$58,125.00
Utility Coordination/Relocation	$58,125.00	L.S.		$58,125.00
Stormwater Management/Erosion Control	5%			$116,250.00
Subtotal Additional Capital Improvement Costs				**$372,000.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$404,550.00
Legal/Administrative	5%			$134,850.00
Contract Admin/Construction Management	10%			$269,700.00
Contingency	25%			$674,250.00
Subtotal Other Costs				**$1,483,350.00**
Total Capital Improvement Costs				**$4,180,350.00**

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	20	L.F.	$2.00	$8.00	
Bridge Maintenance <----User Defined Items	1	EA	$800.00	$800.00	
Total Annual Operation and Maintenance Cost				**$808.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$28,280.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 8
DRAINAGEWAY :	Boulder Creek
REACH :	8D
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach8D

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Estimate New Stream	<----User Defined Items	1	L.S.	$340,000.00	$340,000.00	
ERC Estimate Stream Restoration	<----User Defined Items	1	L.S.	$210,000.00	$210,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains			$0.00	
Concrete Box Culverts			$0.00	
Hydraulic Structures			$0.00	
Channel Improvements			$0.00	
Detention/Water Quality Facilities			$0.00	
Removals			$0.00	
Landscaping and Maintenance Improvements			$0.00	
Special Items (User Defined)			$550,000.00	
Subtotal Capital Improvement Costs			**$550,000.00**	
Additional Capital Improvement Costs				
Dewatering	$5,500.00	L.S.	$5,500.00	
Mobilization	5%		$27,500.00	
Traffic Control	$13,750.00	L.S.	$13,750.00	
Utility Coordination/Relocation	$13,750.00	L.S.	$13,750.00	
Stormwater Management/Erosion Control	5%		$27,500.00	
Subtotal Additional Capital Improvement Costs			**$88,000.00**	
Land Acquisition Costs				
ROW/Easements			$0.00	
Subtotal Land Acquisition Costs			**$0.00**	
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%		$95,700.00	
Legal/Administrative	5%		$31,900.00	
Contract Admin/Construction Management	10%		$63,800.00	
Contingency	25%		$159,500.00	
Subtotal Other Costs			**$350,900.00**	
Total Capital Improvement Costs			**$988,900.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	2600	L.F.	$2.00	$1,040.00
Total Annual Operation and Maintenance Cost				**$1,040.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$36,400.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 8
DRAINAGEWAY :	Boulder Creek
REACH :	8E
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach8E

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		133	C.Y.	$29.00	$3,867.00	30 ft x 40 ft x 3 ft
Special Items (User Defined)						
Roadway Surface (Concrete)	<----User Defined Items	43	C.Y.	$730.00	$31,543.00	25 ft x 70 ft x 8 in
Landscaping	<----User Defined Items	700	S.F.	$2.00	$1,400.00	2 of 70 ft x 5 ft
Trees	<----User Defined Items	2	EA	$500.00	$1,000.00	
Signage / Barriers	<----User Defined Items	2	EA	$1,500.00	$3,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains			$0.00	
Concrete Box Culverts			$0.00	
Hydraulic Structures			$0.00	
Channel Improvements			$3,867.00	
Detention/Water Quality Facilities			$0.00	
Removals			$0.00	
Landscaping and Maintenance Improvements			$0.00	
Special Items (User Defined)			$36,943.00	
Subtotal Capital Improvement Costs			**$40,810.00**	
Additional Capital Improvement Costs				
Dewatering		L.S.	$0.00	
Mobilization	5%		$2,041.00	
Traffic Control	$1,020.25	L.S.	$1,020.00	
Utility Coordination/Relocation	$1,020.25	L.S.	$1,020.00	
Stormwater Management/Erosion Control	5%		$2,041.00	
Subtotal Additional Capital Improvement Costs			**$6,122.00**	
Land Acquisition Costs				
ROW/Easements			$0.00	
Subtotal Land Acquisition Costs			**$0.00**	
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%		$7,040.00	
Legal/Administrative	5%		$2,347.00	
Contract Admin/Construction Management	10%		$4,693.00	
Contingency	25%		$11,733.00	
Subtotal Other Costs			**$25,813.00**	
Total Capital Improvement Costs			**$72,745.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 8
DRAINAGEWAY : Boulder Creek
REACH : 8F
JURISDICTION : Boulder County
REACH ID: BCM-Reach8F Jeremy Deischer DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Master Plan Capital Improvement Cost Summary						
Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$0.00	
Subtotal Capital Improvement Costs					**$0.00**	
Additional Capital Improvement Costs						
Dewatering		$0.00	L.S.		$0.00	
Mobilization		5%			$0.00	
Traffic Control		$0.00	L.S.		$0.00	
Utility Coordination/Relocation		$0.00	L.S.		$0.00	
Stormwater Management/Erosion Control		5%			$0.00	
Subtotal Additional Capital Improvement Costs					**$0.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$0.00	
Legal/Administrative		5%			$0.00	
Contract Admin/Construction Management		10%			$0.00	
Contingency		25%			$0.00	
Subtotal Other Costs					**$0.00**	
Total Capital Improvement Costs					**$0.00**	

Master Plan Operation and Maintenance Cost Summary						
Description		**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Sediment Removal (4 locations 1x annually)	<----User Defined Items	800	C.Y.	$30.00	$24,000.00	
Total Annual Operation and Maintenance Cost					**$24,000.00**	
Effective Interest Rate					1.50%	
Total Operation and Maintenance Costs Over 50 Years					**$839,993.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Boulder Creek MDP - Reach 9
DRAINAGEWAY : Boulder Creek
REACH : 9A
JURISDICTION : City of Boulder
REACH ID: BCM-Reach9A Jeremy Deischer DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		1303	C.Y.	$29.00	$37,773.00	Estimated cut
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		1	ACRE	$1,219.00	$1,219.00	
Trail/Path, Concrete (10' Width)		325	L.F.	$54.00	$17,550.00	
Land Acquisition						
Easement/ROW Acquisition		0.30	ACRE	$550,000.00	$165,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains			$0.00	
Concrete Box Culverts			$0.00	
Hydraulic Structures			$0.00	
Channel Improvements			$37,773.00	
Detention/Water Quality Facilities			$0.00	
Removals			$0.00	
Landscaping and Maintenance Improvements			$18,769.00	
Special Items (User Defined)			$0.00	
Subtotal Capital Improvement Costs			**$56,542.00**	
Additional Capital Improvement Costs				
Dewatering	$565.42	L.S.	$565.00	
Mobilization	5%		$2,827.00	
Traffic Control	$1,413.55	L.S.	$1,414.00	
Utility Coordination/Relocation	$1,413.55	L.S.	$1,414.00	
Stormwater Management/Erosion Control	5%		$2,827.00	
Subtotal Additional Capital Improvement Costs			**$9,047.00**	
Land Acquisition Costs				
ROW/Easements			$165,000.00	
Subtotal Land Acquisition Costs			**$165,000.00**	
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%		$9,838.00	
Legal/Administrative	5%		$3,279.00	
Contract Admin/Construction Management	10%		$6,559.00	
Contingency	25%		$16,397.00	
Subtotal Other Costs			**$36,073.00**	
Total Capital Improvement Costs			**$266,662.00**	

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	325	L.F.	$6.00	$390.00
Total Annual Operation and Maintenance Cost				**$390.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$13,650.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 9
DRAINAGEWAY :	Boulder Creek
REACH :	9B
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach9B

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		21201	C.Y.	$29.00	$614,829.00	Cut required
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		7	ACRE	$1,219.00	$8,533.00	
Trail/Path, Concrete (10' W/dth)		250	L.F.	$54.00	$13,500.00	
Special Items (User Defined)						
Tennis Court Reconstruction	<----User Defined Items	7	EA	$65,000.00	$455,000.00	
Basketball Court Relocation	<----User Defined Items	1	EA	$30,000.00	$30,000.00	
Acquisition of Homes (3)	<----User Defined Items	5594	S.F.	$100.00	$559,400.00	
Removal of Homes (3)	<----User Defined Items	3	EA	$40,000.00	$120,000.00	
Asphalt Remove and Replace	<----User Defined Items	5640	S.Y.	$60.00	$338,400.00	
Land Acquisition						
Easement/ROW Acquisition		7.00	ACRE	$1,132,560.00	$7,927,920.00	$26 per S.F.

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$614,829.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$22,033.00
Special Items (User Defined)					$1,502,800.00
Subtotal Capital Improvement Costs					**$2,139,662.00**
Additional Capital Improvement Costs					
Dewatering		$21,396.62	L.S.		$21,397.00
Mobilization		5%			$106,983.00
Traffic Control		$53,491.55	L.S.		$53,492.00
Utility Coordination/Relocation		$53,491.55	L.S.		$53,492.00
Stormwater Management/Erosion Control		5%			$106,983.00
Subtotal Additional Capital Improvement Costs					**$342,347.00**
Land Acquisition Costs					
ROW/Easements					$7,927,920.00
Subtotal Land Acquisition Costs					**$7,927,920.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$372,301.00
Legal/Administrative		5%			$124,100.00
Contract Admin/Construction Management		10%			$248,201.00
Contingency		25%			$620,502.00
Subtotal Other Costs					**$1,365,104.00**
Total Capital Improvement Costs					**$11,775,033.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 9
DRAINAGEWAY :	Boulder Creek
REACH :	9C
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach9C

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Boulder Creek Pedestrian Bridges	<----User Defined Items	2	EA	$1,520,000.00	$3,040,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$0.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$0.00
Special Items (User Defined)					$3,040,000.00
Subtotal Capital Improvement Costs					**$3,040,000.00**
Additional Capital Improvement Costs					
Dewatering		$30,400.00	L.S.		$30,400.00
Mobilization		5%			$152,000.00
Traffic Control		$45,600.00	L.S.		$45,600.00
Utility Coordination/Relocation		$76,000.00	L.S.		$76,000.00
Stormwater Management/Erosion Control		5%			$152,000.00
Subtotal Additional Capital Improvement Costs					**$456,000.00**
Land Acquisition Costs					
ROW/Easements					$0.00
Subtotal Land Acquisition Costs					**$0.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$524,400.00
Legal/Administrative		5%			$174,800.00
Contract Admin/Construction Management		10%			$349,600.00
Contingency		25%			$874,000.00
Subtotal Other Costs					**$1,922,800.00**
Total Capital Improvement Costs					**$5,418,800.00**

Master Plan Operation and Maintenance Cost Summary

Description		Quantity	Unit	Unit Cost	Total Annual Cost
Bridge Maintenance	<----User Defined Items	2	EA	$1,000.00	$2,000.00
Total Annual Operation and Maintenance Cost					**$2,000.00**
Effective Interest Rate					1.50%
Total Operation and Maintenance Costs Over 50 Years					**$69,999.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 9
DRAINAGEWAY :	Boulder Creek
REACH :	9D
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach9D

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
48-inch	750	1	750	L.F.	$176.00	$132,000.00	
Flare End Sections							
Diameter (in)	Applicable	No. of Barrels					
48-inch	Yes	1	1	EA	$2,512.00	$2,512.00	
Channel Improvements							
Excavation, Low Range			2010	C.Y.	$13.00	$26,130.00	Earthwork
Special Items (User Defined)							
Asphalt Remove and Replace	<----User Defined Items		2060	S.Y.	$60.00	$123,600.00	14th Street
Manhole Box Base	<----User Defined Items		3	EA	$7,000.00	$21,000.00	
Concrete for Weir Diversion	<----User Defined Items		48	CY	$730.00	$35,186.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$134,512.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$26,130.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$179,786.00
Subtotal Capital Improvement Costs				**$340,428.00**
Additional Capital Improvement Costs				
Dewatering		$3,404.28	L.S.	$3,404.00
Mobilization		5%		$17,021.00
Traffic Control		$8,510.70	L.S.	$8,511.00
Utility Coordination/Relocation		$100,000.00	L.S.	$100,000.00
Stormwater Management/Erosion Control		5%		$17,021.00
Subtotal Additional Capital Improvement Costs				**$145,957.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering		15%		$72,958.00
Legal/Administrative		5%		$24,319.00
Contract Admin/Construction Management		10%		$48,639.00
Contingency		25%		$121,596.00
Subtotal Other Costs				**$267,512.00**
Total Capital Improvement Costs				**$753,897.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, e	750	L.F.	$1.00	$150.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	3	EA	$61.00	$37.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$610.00	$122.00
Total Annual Operation and Maintenance Cost				**$309.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$10,815.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 9
DRAINAGEWAY :	Boulder Creek
REACH :	9E
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach9E

Jeremy Deischer | DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	
Additional Improvements	<----User Defined Items	1	L.S.	$100,000.00	$100,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$350,000.00
Subtotal Capital Improvement Costs				**$350,000.00**
Additional Capital Improvement Costs				
Dewatering		$3,500.00	L.S.	$3,500.00
Mobilization		5%		$17,500.00
Traffic Control		$8,750.00	L.S.	$8,750.00
Utility Coordination/Relocation		$8,750.00	L.S.	$8,750.00
Stormwater Management/Erosion Control		5%		$17,500.00
Subtotal Additional Capital Improvement Costs				**$56,000.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering		15%		$60,900.00
Legal/Administrative		5%		$20,300.00
Contract Admin/Construction Management		10%		$40,600.00
Contingency		25%		$101,500.00
Subtotal Other Costs				**$223,300.00**
Total Capital Improvement Costs				**$629,300.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$610.00	$122.00
Total Annual Operation and Maintenance Cost				**$122.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 9
DRAINAGEWAY :	Boulder Creek
REACH :	9F
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach9F
	Jeremy Deischer
DATE :	2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Master Plan Capital Improvement Cost Summary						
Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$0.00	
Subtotal Capital Improvement Costs					**$0.00**	
Additional Capital Improvement Costs						
Dewatering		$0.00	L.S.		$0.00	
Mobilization		5%			$0.00	
Traffic Control		$0.00	L.S.		$0.00	
Utility Coordination/Relocation		$0.00	L.S.		$0.00	
Stormwater Management/Erosion Control		5%			$0.00	
Subtotal Additional Capital Improvement Costs					**$0.00**	
Land / Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$0.00	
Legal/Administrative		5%			$0.00	
Contract Admin/Construction Management		10%			$0.00	
Contingency		25%			$0.00	
Subtotal Other Costs					**$0.00**	
Total Capital Improvement Costs					**$0.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Sediment Removal (6 locations - 1x annually) <----User Defined Items	1200	C.Y.	$30.00	$36,000.00	
Total Annual Operation and Maintenance Cost				**$36,000.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$1,259,989.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 10
DRAINAGEWAY :	Boulder Creek
REACH :	10A
JURISDICTION :	City of Boulder
REACH ID:	BCM-Reach10A
	Jeremy Deischer
DATE :	2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
Modify Ditch for Aquatic & Habitat Passage	<----User Defined Items	1	L.S.	$250,000.00	$250,000.00	
Master Plan Capital Improvement Cost Summary						
Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$250,000.00	
Subtotal Capital Improvement Costs					**$250,000.00**	
Additional Capital Improvement Costs						
Dewatering		$12,500.00	L.S.		$12,500.00	
Mobilization		5%			$12,500.00	
Traffic Control		$6,250.00	L.S.		$6,250.00	
Utility Coordination/Relocation		$6,250.00	L.S.		$6,250.00	
Stormwater Management/Erosion Control		5%			$12,500.00	
Subtotal Additional Capital Improvement Costs					**$50,000.00**	
Land / Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$45,000.00	
Legal/Administrative		5%			$15,000.00	
Contract Admin/Construction Management		10%			$30,000.00	
Contingency		25%			$75,000.00	
Subtotal Other Costs					**$165,000.00**	
Total Capital Improvement Costs					**$465,000.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$610.00	$122.00	
Total Annual Operation and Maintenance Cost				**$122.00**	
Effective Interest Rate				1.50%	
Total Operation and Maintenance Costs Over 50 Years				**$4,270.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Boulder Creek MDP - Reach 10
DRAINAGEWAY :	Boulder Creek
REACH :	10B
JURISDICTION :	Boulder County
REACH ID:	BCM-Reach10B Jeremy Deischer DATE : 2015-10-05

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Special Items (User Defined)						
ERC Estimate Enhanced Stream	<-----User Defined Items	1	L.S.	$410,000.00	$410,000.00	
ERC Estimate Riparian Restoration	<-----User Defined Items	1	L.S.	$190,000.00	$190,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$600,000.00
Subtotal Capital Improvement Costs				**$600,000.00**
Additional Capital Improvement Costs				
Dewatering	$6,000.00	L.S.		$6,000.00
Mobilization	5%			$30,000.00
Traffic Control	$15,000.00	L.S.		$15,000.00
Utility Coordination/Relocation	$15,000.00	L.S.		$15,000.00
Stormwater Management/Erosion Control	5%			$30,000.00
Subtotal Additional Capital Improvement Costs				**$96,000.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$104,400.00
Legal/Administrative	5%			$34,800.00
Contract Admin/Construction Management	10%			$69,600.00
Contingency	25%			$174,000.00
Subtotal Other Costs				**$382,800.00**
Total Capital Improvement Costs				**$1,078,800.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	4800	L.F.	$2.00	$1,920.00
Total Annual Operation and Maintenance Cost				**$1,920.00**
Effective Interest Rate				1.50%
Total Operation and Maintenance Costs Over 50 Years				**$67,199.00**