FINAL

Post-Construction Project Report: Meadow and South Ledge Diversion Reconstruction and Fish Passage Demonstration Project

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Prepared for:

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1.0 INTRODUCTION

In September 2013, extremely heavy and sustained rainfall along the Front Range of the Colorado Rocky Mountains resulted in catastrophic flooding over a large area. The flood destroyed or damaged dozens of irrigation diversion structures throughout the St. Vrain Valley and surrounding watersheds. Both the Meadow and South Ledge Ditch Companies received significant damage to their systems.

The *Meadow and South Ledge Ditch Diversion Reconstruction and Fish Passage Demonstration Project*, completed in May 2015, rebuilt and consolidated both irrigation diversions into one diversion, while eliminating impediments to native fish passage and delivering a full decree of irrigation water to the ditch company shareholders. This project was designed as a demonstration project for other ditch companies, to showcase how fish passage can be constructed in a way that maximizes the efficiency of the diversion while minimizing its associated costs.

The engineering strategy to successfully achieve this objective is referred to as “chasing grade upstream.” In other words, the point of diversion is moved far enough upstream to deliver water to the existing ditch via gravity, without having to construct a cross-channel diversion structure in the river.

Changing the point of diversion, and moving it upgradient, is an important design component of this engineering strategy. In 2014, the Colorado General Assembly allowed that when the channel of a stream changes due to natural events such as flooding, rendering a headgate inoperable, the ditch owner may move the headgate upstream without filing a change of water right application – as long as the relocation does not interfere with the use or enjoyment of any decreed or absolute conditional water right.

In non-flood scenarios, the point of diversion could also be changed using form *JDF 241W - Application for Simple Change in Surface Point of Diversion*, which can be obtained on the Colorado Judicial Branch web site under “forms.” This process need not involve going to water court, or hiring an attorney, as long as the conditions of non-injury can be met.

Following the catastrophic floods of September 2013, in the rush to rebuild local irrigation and diversion structures, options to support the aquatic environment could not always be granted full consideration. Both the South Ledge and the Meadow ditches are small-scale operations with limited resources primarily irrigating family farms. However, both companies committed to suspending 2014 irrigation operations in order to reconstruct in the most environmentally sustainable manner possible.

This post-construction project report describes the project in more detail; provides watershed background information for context; details the hydrology and hydraulics information used as a basis for the project design; lists permits required and associated costs; reviews the project through pre- and post-construction narrative descriptions, data, and photographs; outlines the project budget; describes outreach and educational activities and materials; and provides recommendations for maintenance of this project and construction of similar projects in the future.

2.0 PROJECT DESCRIPTION

The Meadow and South Ledge Ditch Companies' diversions are located on South St. Vrain Creek in Boulder County, Colorado near the Town of Lyons. The project site is located in Section 18 (Meadow Ditch) and Section 19 (South Ledge Ditch), Township 3 North, Range 70 West. The Meadow and South Ledge diversions were located within a few hundred feet of each other on the south side of South St. Vrain Creek in an area just east of Hall Meadows. The diversions are accessed off of Old South St. Vrain Road less than one mile southwest of the Town of Lyons (Figure 1). The two ditches irrigate agricultural lands south and east of Lyons. The South Ledge Ditch also provides agricultural storage water on the grounds of the CEMEX cement plant east of Lyons.

This project aims to serve as a successful demonstration project to illustrate how permanent and sustainable irrigation diversion structures can be constructed to efficiently and cost-effectively deliver a full decree of water while still promoting a healthy riparian and aquatic community. The project additionally supports the St. Vrain Creek Watershed Master Plan objectives, promoting natural channel design, sediment transport, and fish passage (SVCC 2014). Reconstruction of the Meadow and South Ledge diversion structures with consideration for the aquatic environment is supported by a number of diverse stakeholders, including: Boulder County Parks and Open Space, City of Longmont, St. Vrain Creek Coalition, St. Vrain Chapter of Trout Unlimited, Colorado Department of Parks and Wildlife, US Fish and Wildlife Service, CEMEX Lyons Cement Plant, and Colorado Water Conservation Board (CWCB).

The primary objectives of the project were as follows:

- Reconstruct and consolidate the Meadow and South Ledge diversion structures to provide a full decree of agricultural irrigation water to select family farms in the St. Vrain watershed;

- Support the St. Vrain Creek Watershed Master Plan objectives, promoting overall watershed health by incorporating natural channel design, improved sediment transport, and fish passage;

- Provide long-term, sustainable infrastructure improvements in a critical Recreational Focus Area as defined by the South Platte Non-Consumptive Needs Assessment (CWCB 2009); and

- Serve as a Statewide demonstration project to showcase economical and effective construction of a diversion that supports fish passage.

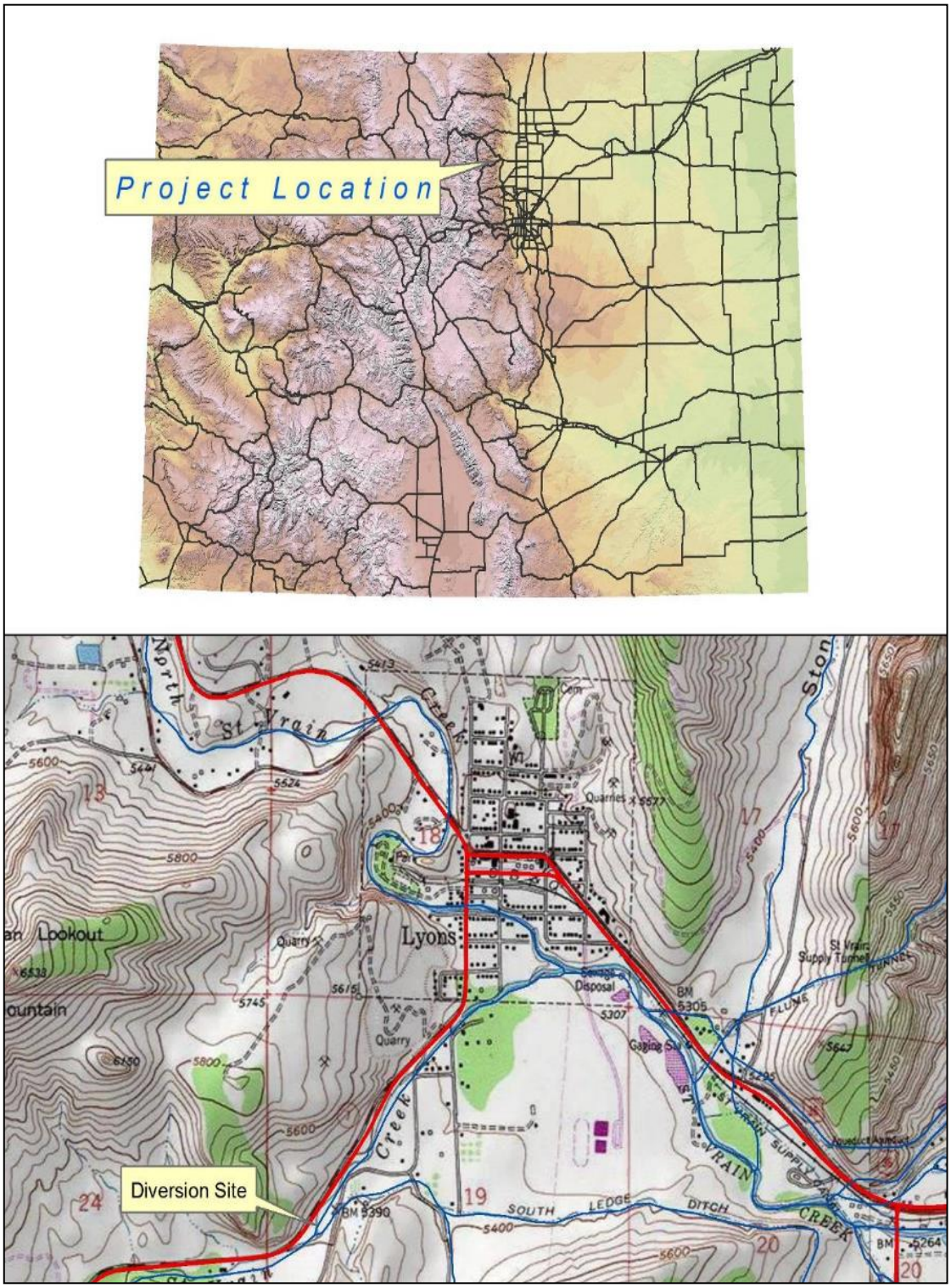

Figure 1. Project location map

Adequate fish passage along this reach of South St. Vrain Creek is important to the future survival of native species. Restoring connectivity in the upper reaches of this transitional zone may facilitate natural seasonal movement patterns of predatory fish populations in the St. Vrain

watershed in such a way that predation pressure on the small native plains fishes in the lower reaches may be temporarily alleviated. This reconstruction project will provide an opportunity to test this hypothesis and restore important life processes for predatory fish in the system. Restoring connectivity in these upper reaches will also likely promote diversity in the sport fishery by allowing trout to fulfill their life histories.

3.0 WATERSHED BACKGROUND

The South Ledge and Meadow Ditches are located on South St. Vrain Creek southwest of the Town of Lyons, approximately two miles upstream of its confluence with North St. Vrain Creek (Figure 1) North and South St. Vrain Creek's confluence just outside of Lyons to form St. Vrain Creek. St. Vrain Creek is a tributary of the South Platte River, and is approximately 32.2 miles (51.8 km) long.

South St. Vrain basin topography transitions from forested mountain terrain in the west to alluvial valley floors near the confluence of North and South St. Vrain Creeks. The total drainage area at Lyons on South St. Vrain Creek is 94 square miles (FEMA 2012).

The climate of the study area is classified as semiarid. Average annual precipitation is 18.3 inches, which includes an average annual snowfall of 83 inches (NOAA 1973). The location of the project area relative to the foothills west of the City of Boulder has a slight influence on total precipitation depth; those areas east of the foothills, including the Ditch locations, receive more precipitation (a few tenths of an inch per event) than areas adjacent to the foothills. Most of the rainfall is concentrated in May, and thunderstorms occur irregularly throughout the summer months (FEMA 2012).

Flooding in Boulder County is due primarily to snowmelt combined with heavy rainfall, although heavy rainfall alone, especially in the form of cloudbursts, is capable of causing severe flooding. Floods caused by rainstorms can peak within a few hours of the rainfall, leaving little time for evacuation. Much of the floodplain is used for agriculture; thus, flood damage is typically inflicted on crops, irrigation equipment, roads, and bridges (FEMA 2012). The project area is an alluvial valley bottom where the 2013 flood caused several channel avulsions, severe erosion, and large sediment deposits.

Early records of floods in the study reach are fragmented and lacking in detail. Flooding occurred on St. Vrain Creek in 1864, 1876, 1894, 1919, 1941, 1949, 1951, 1957, and 1969. The floods of June 1864 and May 1876 were severe and a significant portion of valley farmland was flooded. The flood of May 1894 inundated the entire lower part of Lyons, washing away 20 homes. This flood had an estimated peak discharge of 9,800 cfs, mainly from South St. Vrain Creek. The largest peak discharge on record prior to the September 2013 flood was 10,500 cfs in June 1941. This flood originated mainly on South St. Vrain Creek, and the creek peaked very rapidly with floodwaters receding quickly. It is assumed that an extremely localized cloudburst occurring over South St. Vrain Creek a short distance upstream of Lyons caused this event (FEMA 2012). The preliminary peak discharge estimated on St. Vrain Creek downstream of Lyons as a result of the September 2013 flood is 23,000 cfs (CDOT 2014).

4.0 DESIGN BASIS

The following sections describe the hydrology information used and the hydraulic modeling effort completed for the *Meadow and South Ledge Ditch Diversion Reconstruction and Fish Passage Demonstration Project*. The hydraulic modeling compared both existing and proposed conditions based on the 100-year peak discharge from two different sets of hydrological information to determine whether water surface elevations (WSE) would rise as a result of the proposed project and associated grading plan. The hydraulic analyses indicated "no-rise" in the base flood elevation from existing post-flood (March 2015) conditions to proposed conditions with the restored irrigation diversion structure.

4.1 HYDROLOGY

This section identifies the source of the discharge information used for the hydraulic analyses. Hydrologic analyses and modeling were conducted based on two different hydrology sources: the 2012 Flood Insurance Study (FIS) (FEMA 2012) and the Colorado Department of Transportation (CDOT) post-flood hydrologic evaluation entitled "Hydrologic Evaluation of the St. Vrain Watershed: Post September 2013 Flood Event" (CDOT 2014) used by the CWCB.

The effective regulatory flow rates derived in 1977 and 1978 and documented by the Federal Emergency Management Agency (FEMA) in the 2012 FIS were developed as part of two different studies. The effective peak discharges were developed based on a combination of flood frequency analysis for stream gage records and regression equations (CDOT 2014). In particular, the 2012 FIS includes information from a 1977 analysis performed by Howard, Needles, Tammen, and Bergendorff. The discharge-frequency relationships in this analysis were based on data generated for the June 1972 and September 1972 Floodplain Information Reports of Lower and Upper St. Vrain Creek by the USACE and on an updated statistical analysis of the stream gaging records of St. Vrain Creek at Lyons. Synthetic unit hydrographs were developed for St. Vrain Creek to help define the flow characteristics within the basin (CDOT 2014).

The second study incorporated into the 2012 FIS is flood information report for South St. Vrain Creek and Middle St. Vrain Creek upstream of Lyons performed in 1978 by Camp, Dresser, and McKee, Inc. (CWCB 1978). The flood flow frequency-discharge relationships in this analysis were based on regional relationships for statistical parameters of a log-Pearson Type III distribution using the streamflow records at ten USGS gaging stations located in the upper St. Vrain Creek and Big Thompson River basins. These relationships were used to develop peak flows at numerous locations along Middle St. Vrain Creek and South St. Vrain Creek (CWCB 1978). Table 1 lists select peak discharge values from the 2012 FIS for South St. Vrain Creek at its confluence with St. Vrain Creek and North St. Vrain Creek, just downstream of the project area.

Table 1. South St. Vrain Creek* Peak Discharge Values from Various Sources

Data Source	Drainage Area (sq. mi.)	Peak Discharge (cfs)				
		10-yr	25-yr	50-yr	100-yr	500-yr
FIS (FEMA 2012)	92	1,400	-	3,750	5,430	11,900
Hydrologic Evaluation (CDOT 2014)	91	1,605	3,168	4,933	7,234	14,748

*South St. Vrain Creek at its confluence with St. Vrain Creek and North St. Vrain Creek

The CDOT post-flood hydrologic evaluation used by the CWCB estimated peak discharges based on a predictive rainfall-runoff model. The September 2013 flood event was modeled using the US Army Corps of Engineers (USACE) Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) Version 3.5 to calculate peak runoff experienced during the flood within St. Vrain, North St. Vrain, South St. Vrain, and Middle St. Vrain Creeks. Within HEC-HMS, watershed hydrologic response was simulated using the Curve Number method for infiltration losses, the Snyder Unit Hydrograph method for transformations, and the Muskingum-Cunge method with an 8-point cross-section for channel routing. HEC-GeoHMS was used for its GIS interface (CDOT 2014).

After initial working models were developed, the models were calibrated to the peak discharge estimates derived from field investigations of high water marks. Once the rainfall-runoff model was calibrated to represent the September 2013 rainfall and peak runoff, the model was used to predict peak discharges based on NOAA rainfall for a number of return periods (CDOT 2014). The results from this calibrated predictive model for the NOAA 24-hour Type II distribution storms (i.e., depth-area adjusted NOAA design storms) are presented in Table 1.

On South St. Vrain Creek, predictive storms appear to have produced peak discharge values approximately 4 percent to 33 percent larger than the effective FIS discharge values. At the confluence with North St. Vrain Creek in Lyons near the project site, the 100-year peak discharge was 33 percent higher than the effective FIS value (CDOT 2014).

4.2 HYDRAULICS

Hydraulic modeling was conducted to compare existing conditions to proposed conditions to determine potential project impacts to the water surface elevation. The existing conditions (March 2015) model was created using survey data, proposed contours for the adjacent area currently under construction, and remote sensing topographic data in areas that experienced no change, as necessary. The proposed conditions model was created using the proposed grading plan for the Meadow and South Ledge Diversion Reconstruction and Fish Passage Demonstration Project.

4.2.1 Hydraulic Modeling Software

The CWCB 100-year flow and the FIS 100-year flow were inputted into both models and water surface profiles were generated using HEC-RAS Version 4.1.0.

The model was set up using the HEC-GeoRAS extension in ArcMap 10.1. The stream centerline was delineated based on the pre-flood, low-flow channel condition. The existing channel has been returned to the approximate pre-flood alignment, after avulsing to the east during the flood event. The channel banks were delineated based on the survey data, aerial photography, and LiDAR produced topography. Once imported into the model, they were

adjusted within each cross-section to better reflect the topographic top of bank. Other major model components are described in the remainder of this section.

4.2.2 Cross-Sectional Geometry

Standard cross-sectional spacing in 1-D hydraulic models can range from 3-6 mean bankfull channel widths (USGS 2014) to 7-11 bankfull channel widths (Kondolf 2007), depending on site-specific conditions. The St. Vrain Master Plan defines the bankfull channel width at 50 feet for this reach (SVCC 2014); therefore, estimated cross-sectional spacing could range from approximately 150-300 feet to 350-550 feet. For comparison, the approximate spacing for St. Vrain Creek below the confluence is 500 feet in the 2012 FIS. (There are no cross-sections specifically defined on South St. Vrain Creek.) The cross-sectional spacing in the HEC-RAS model for this project ranges from 145 to 318 feet, measured along the low-flow channel's centerline. Because this model was constructed to represent a large flood event, cross-sections were oriented perpendicular to the valley bottom to capture the overall direction of high flows.

The cross-sections through the project area (XS 1955.4 to XS 3081.5) were cut through the existing contours developed for the project area from survey data and supplemented with additional survey- and LiDAR-derived points at the valley walls and boundaries. The cross-sections representing the 1,000 feet upstream of the project (XS 3290.3 to XS 4230.3) were defined by GPS survey data and were surveyed for the express purpose of this FDP. The cross-sections representing the 1,000 feet downstream of the project (XS 715.5 to XS 1664.2) were cut through the proposed contours of the City of Longmont diversion project which was currently under construction while designing this project, rendering field survey potentially unsafe and immediately obsolete. The 2013 LiDAR data supplemented this reach's topographic data near the southeastern valley margins only where there was minimal change in the pre-flood to post-flood topography and no visible signs of ground-disturbing work.

As most of this project is installed below grade, the only modifications to existing cross-section geometry occur in two discrete locations within the project area: XS 3081.5, which is placed directly through the diversion structure, and XS 2370.9, at the location of the destroyed South Ledge Ditch Diversion structure that will be removed. These two cross sections are included as Figures 2 and 3.

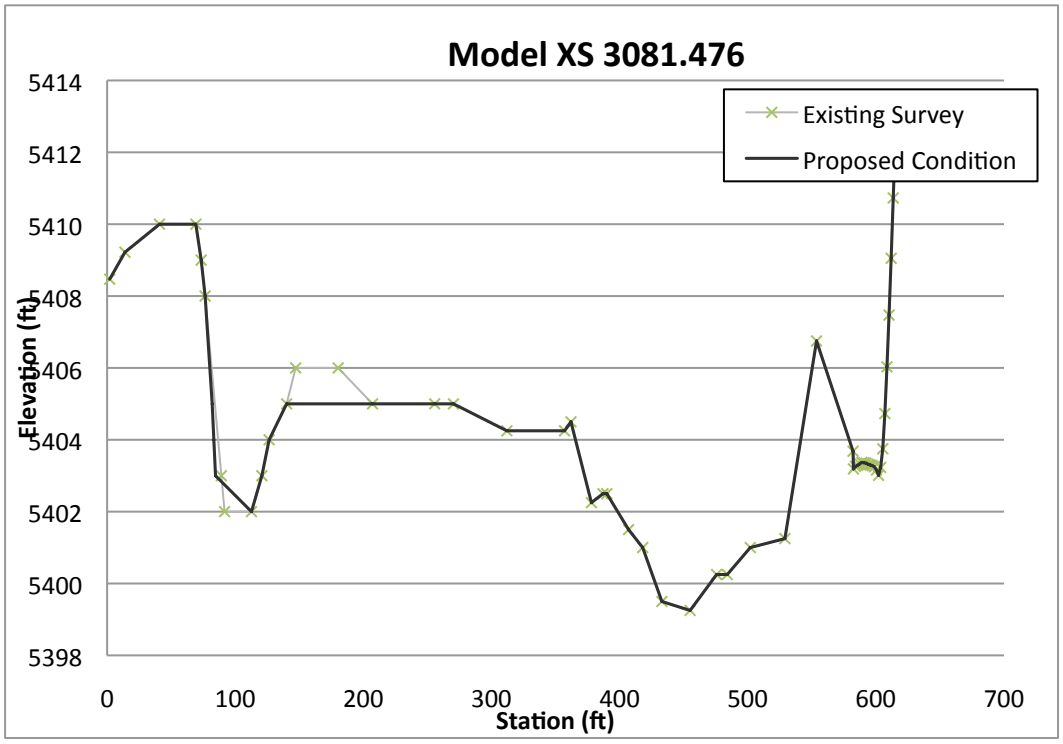

Figure 2. Model cross-section 3081.5, representing the area at the proposed diversion structure

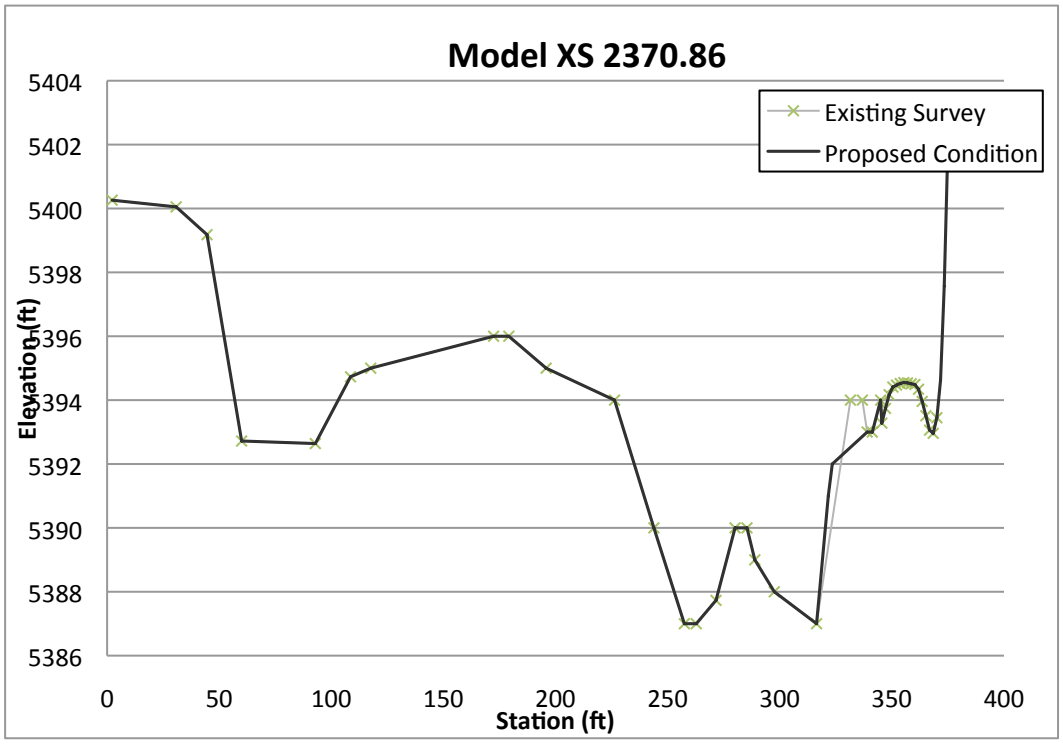

Figure 3. Model cross-section 2370.9, representing the area at the damaged South Ledge Diversion Structure

4.2.3 Roughness Coefficients

Manning's "n" values, or roughness coefficients, were assigned based on field inspection of the floodplain areas within the project footprint (Figure 4). Standard roughness coefficient values for the main channels and overbank areas range from 0.030 to 0.040 and 0.040 to 0.060, respectively (FEMA 2012; ODOT 2014). The values used in this study are shown in Table 2. In addition to the modified cross-sectional geometry at the diversion structure, the installed rootwads and riffle hardening in the main channel are reflected in the model as increased roughness within the main channel of XS 3081.5.

Figure 4. Typical channel and floodplain conditions

Table 2. South St. Vrain Creek Manning's n values

Channel Section	Manning's n	Description
Main Channel	0.035	Coarse gravel, cobble, and small boulder channel bed.
Main Channel	0.04	Coarse gravel, cobble, and small boulder channel bed with installed rootwads and hardened riffles.
Right and Left Overbanks	0.06	Woody vegetation at channel bank; open meadow with intermittent trees, shrubs, and short grasses.

4.2.4 Hydraulic Model Flow Rates and Boundary Conditions

A 100-year flow rate of 5,430 cfs was applied to model the FEMA effective flow and a 100-year flow rate of 7,234 cfs was applied to model the CWCB/CDOT flow. Both flows were run within subcritical flow regimes.

A normal depth boundary condition of 0.018 was set at XS 715.476 for both the existing and proposed condition models.

4.2.5 Hydraulic Model Results

The existing conditions HEC-RAS model results were compared to the proposed condition HEC-RAS model results run. These results are shown in Table 3. The proposed conditions resulted in slight decreases to 100-year water surface elevations (WSE) in the immediate vicinities of the work that is being proposed. These changes do not propagate upstream or downstream, nor do they result in any predicted changes to base flood elevations 1,000 feet upstream or 1,000 feet downstream of the project area.

Table 3. Modeled 100-year Water Surface Elevations for Existing (March 2015) and Proposed Conditions

River Station	Regulatory Flow (5430 cfs)			CWCB Flow (7234 cfs)		
	Existing WSE (ft)	Proposed WSE (ft)	Change in WSE (ft)	Existing WSE (ft)	Proposed WSE (ft)	Change in WSE (ft)
4230.3	5421.50	5421.50	0.00	5422.29	5422.29	0.00
3879.4	5418.19	5418.19	0.00	5418.24	5418.24	0.00
3636.6	5413.56	5413.56	0.00	5415.13	5415.13	0.00
3436.2	5412.19	5412.19	0.00	5412.83	5412.83	0.00
3290.3	5409.33	5409.33	0.00	5409.81	5409.81	0.00
3081.5	5404.37	5404.40	-0.03	5404.83	5404.89	-0.06
2763.1	5401.53	5401.53	0.00	5404.42	5404.42	0.00
2602.8	5395.36	5395.36	0.00	5395.36	5395.36	0.00
2370.9	5394.40	5394.48	-0.08	5395.10	5395.21	-0.11
2207.0	5394.30	5394.30	0.00	5395.20	5395.20	0.00
1955.4	5391.83	5391.83	0.00	5392.75	5392.75	0.00
1664.2	5388.25	5388.25	0.00	5388.89	5388.89	0.00
1396.2	5383.72	5383.72	0.00	5384.16	5384.16	0.00
1209.2	5378.56	5378.56	0.00	5378.95	5378.95	0.00
909.5	5374.52	5374.52	0.00	5374.88	5374.88	0.00
715.4	5370.95	5370.95	0.00	5371.50	5371.50	0.00

NOTE: This numbers in green indicate that there is no rise, and the water surface elevation is being reduced, not increased.

The hydraulic modeling indicates that the proposed project consisting of an at-grade diversion structure and below-grade conveyance system will incur a small increase in floodplain capacity in the immediate vicinity of the proposed intake and removed damaged structure. The proposed project also provides an irrigation diversion structure that has the capability to allow sediment and fish passage through the reach rather than a straight dam face which impedes a free-flowing channel.

Hydraulic modeling indicates “no-rise” in the base flood elevation from existing (March 2015) conditions to proposed conditions with the restored irrigation diversion structure, as is consistent with Boulder County and FEMA regulations.

5.0 RESTORATION PROJECT REVIEW

This section presents a detailed review of pre-project and post-project conditions related to the Meadow and South Ledge diversion structures themselves, the riparian area and floodplain vegetation in the vicinity of the diversion structures, the geomorphology of the main stem and side channel of South St. Vrain Creek, and the adjacent roadway (Old South St. Vrain Road).

5.1 Pre-Project Site Conditions

The entire project area was significantly impacted by, and recovering from, the September 2013 flood event prior to any construction activities conducted at the site. Pre-project conditions were marked by destroyed diversion structures and associated features; a recovering riparian zone with both native and non-native existing vegetation and root stock that survived the flood; a flood-impacted stream corridor with areas of erosion and deposition throughout; and a damaged adjacent roadway. The following sections describe pre-project site conditions in more detail.

5.1.1 Diversion Conditions

The 2013 flood impacted both the Meadow and South Ledge diversion structures. Details regarding the extent of the damage to these diversion structures are provided in the District 5 Ditch and Reservoir Flood Damage and Recovery Report last updated in September 2014 (SVLHWCD 2014) and summarized here.

Figure 6a. South Ledge ditch prior to construction

The Meadow diversion and head gate structures were completely destroyed, and the measurement gauge was buried by sediment. The head gate concrete was still intact, but the head gate itself was found suspended in a tree following the flood. The conveyance ditch was filled with debris, silt, and sediment, and the culverts sustained significant damage as well. The creek's banks were largely eroded and in need of stabilization (SVLHWCD 2014).

The South Ledge diversion structure was also destroyed as a result of the flood (Figure 5). Although most of the head gate remained intact following the flood, it was undermined on the uphill side and one wall had collapsed into the river. The ditch also sustained severe damage with approximately 1,500 feet of failed ditch (Figure 6). As in the case of the Meadow diversion, bank stabilization was necessary as well (SVLHWCD 2014).

Figure 6b. South Ledge ditch prior to construction

5.1.2 Vegetation Conditions

The diversion reconstruction project occurred on South St. Vrain Creek just south of Lyons in an area known as Hall Meadows. This area was significantly impacted by the September 2013 flood event. The flood transported a tremendous amount of sediment and cobble to the previously vegetated area (Figure 7). Banks were scoured, in some cases all the way to bedrock, along both the main channel and the side channels of South St. Vrain Creek. After the flood, extensive deposits of coarse alluvium, ranging in size from sand to cobble and boulders, were deposited throughout the floodplain (Figure 8).

Figure 7. South St. Vrain riparian floodplain deposition and riparian vegetation cover

The plains riparian community that was once relatively healthy and diverse was denuded by the floodwaters. Since the flood, some of the understory had returned, although much of the area was still bare ground covered with sand and cobble. Intermittent surviving vegetation, particularly forbs and grasses, was present, along with fairly extensive non-native weeds and grasses that began to colonize many of the sand-deposited areas and became more established in the growing season since the flood.

Figure 8. Example of sand and cobble windrow on South St. Vrain floodplain

The post-flood vegetation community at Hall Meadows is characterized by a sparse narrowleaf cottonwood and peach-leaved willow overstory, along with several forest remnant ponderosa pines, and a denser understory dominated by non-native grasses and forbs such as smooth brome, alfalfa, and kochia (Backus and Sherrod 2014). Native sunflowers and blazingstar forbs are also common. Some native shrubs are present as well, including snowberry, chokecherry, wood's rose, plum, currant, and coyote willow.

5.1.3 Stream Conditions

river left

As a result of the flood, the main channel and side channels of South St. Vrain Creek experienced significant channel and bank erosion (Figure 9), as well as extensive areas of sediment and debris deposits throughout the project area. Unstable banks characterized much of the creek, and in some cases banks were even scoured to bedrock. Mid-channel gravel bars were evident in some areas as well.

South St Vrain Creek splits approximately one half mile upstream of the project site. The main channel occupies the left branch, while the side channel at the construction site receives flows from the right branch. Following the flood, Boulder County Parks and Open Space staff installed large boulders in the right channel to maintain the left channel as the primary. Although Boulder County Parks and Open Space staff would have preferred to wait to study channel morphology, sediment transport, and the riparian ecosystem in Hall Meadows upstream of the project, the ditch companies had already postponed diverting water for a full year in an effort to raise funds and build a resilient project. Coordination between the ditch companies, funders and the staff was a primary concern in identifying the appropriate location for the diversion. As a result, a decision was jointly made by the ditch companies and staff to locate the project in the existing primary channel.

Pre-construction cross-sections throughout the project area are provided in Appendix A (also refer to Figures 2 and 3).

5.1.4 Roadway Conditions

Figure 10. Example of damage to Old South St. Vrain Road east of South St. Vrain Creek side channel

The project site is bordered by Highway 7 to the west and Old South St. Vrain Road to the east. Portions of Old South St. Vrain Road were damaged as a result of the flood, particularly in the vicinity of the new underground pipeline (Figure 10). The project is located in an area where the South St. Vrain Creek side channel is close to the road (less than 5 feet from the edge of the road in some locations). The flood overtopped the road and washed out large sections of asphalt in several locations adjacent to the project. It was also determined that the asphalt was laid on little to no road base, which may have contributed to the failure of the road.

The Colorado Highway 7 right-of-way at mile marker 32 also experienced bank erosion across from the diversion location but did not impact the roadway. Vertical bank erosion on river left was measured up to approximately 10 feet from the top of the bank to the toe of the slope and the channel cut approximately 8 feet into the right-of-way.

5.2 Post-Project Site Conditions

The diversion reconstruction project had ranging impacts on the Meadow and South Ledge diversion structures, floodplain riparian vegetation, stream geomorphology, and the adjacent roadway. Post-project conditions at the site are described in the sections that follow.

5.2.1 Diversion Conditions

A schematic aerial photograph of the site and project design is presented in Figure 11, and the project design is described in this section. A complete set of construction drawings and project plans is provided in Appendix C.

Figure 11. Schematic aerial photograph of project site and design

The new point of diversion for the combined Meadow and South Ledge ditch is located adjacent to mile marker 32 on Colorado State Highway 7 approximately 800 feet upstream from where the South Ledge Ditch diverted water pre-flood. The success of this demonstration project relies on the ability to "chase grade" upstream, allowing diverted water to flow underground by gravity to the existing ditch without the construction of a cross-channel dam.

The original Meadow Ditch diversion was just 600 feet downstream of the South Ledge diversion so consolidating the two diversions into one made both ecological and economic sense. To facilitate water delivery, the diversion site was located at an existing natural pool. The top of the proposed 36-inch inlet pipe was designed at an elevation just below the bottom of the natural pool. This allowed for a full head of water into the pipe at low-flow channel conditions without constructing any in-channel diversion structures.

Figure 12. New intake structure and head gate on South St. Vrain Creek (river right)

To prevent the entire channel from being diverted into the pipe, a flow control gate was installed at the diversion point that can be controlled by the water commissioner (Figure 12). The tail water of the existing pool is naturally controlled by the head of the adjoining downstream riffle. Large boulders were installed into the channel bed at the head of that riffle and at the same pre-construction elevation to maintain the pool depth and the natural morphology of the post-flood channel. This will allow for continued in-stream flows, sediment transport, fish passage, and recreational boater passage through the pool.

A concrete inlet structure was constructed on the right streambank to facilitate the diversion of the irrigation water (Figure 12). It serves as a flow-controlling headwall for the subsurface irrigation pipeline, a sediment sluice during high-flow conditions and a trash rack for debris. The structure was designed and aligned in a manner that would encourage sediment to pass through the sediment sluice during high flows. It will not keep all sediment out of the inlet pipe but will divert the majority of it back to the stream. A slide gate installed at the sluice structure can be closed at low flow conditions to maintain water flow into the irrigation pipeline. A galvanized trash rack installed in front of the pipe inlet will prevent large debris from entering the pipeline and will require routine maintenance.

From the intake structure, a 36-inch HDPE pipe was installed below grade for approximately 500 feet across the right bank floodplain, under the side channel adjacent to Old South St. Vrain Road, to a manhole installed under the north side of the road (Figure 11). In order to maintain floodplain capacity and not block the side channel, the pipe needed to traverse under the side channel and rise 3 feet in the manhole before continuing east to the splitter box. As a result, the manhole acts as an inverted syphon. The pipe then continues to run under the roadway, parallel to the edge of the pavement, for approximately 400 feet to the concrete splitter box near the location of the old South Ledge diversion structure (Figure 13). At the splitter box, the flows are divided between the two irrigation diversions and controlled by the water commissioner. A 30-inch HDPE pipe passes under the road to service the South

Figure 13. Splitter box that diverts water to Meadow and South Ledge ditches

Ledge Ditch and an 18-inch pipe continues east along the road for approximately 600 feet until it reaches the existing Meadow Ditch.

Ditch flows are monitored by two Parshall flumes (one for each diversion) located downstream from the splitter box (Figure 14).

Figure 14. South Ledge diversion Parshall flume

5.2.2 Vegetation Conditions

An important component of the project involved seeding the entire disturbed area with a native seed mix immediately following the completion of construction activities. At the end of May 2015, all temporarily disturbed areas were reseeded with the Boulder County-approved native seed mix that is certified weed free, and then mulched and mechanically crimped with 1.5 tons per acre of weed-free straw and applied with mulch tackifier. The seed mix used for this project was composed of live seeds of the following species:

- Blue grama (Bouteloua gracilis)
- Western wheatgrass (Pascopyrum smithii)
- Sideoats grama (Bouteloua curtipendula)
- Little bluestem (Schizachyrium scoparium)
- Green needlegrass (Stipa viridula)
- Switchgrass (Panicum virgatum)
- Junegrass (Koeleria macrantha)
- Sand dropseed (Sporobolus cryptandrus)
- Inland saltgrass (Distichlis spicata)
- Coneflower (Ratibida columnaris)
- Gaillardia (Gaillardia aristrata)
- Oats (Avena sativa)

Figure 15. Post-project revegetation conditions approximately 6 weeks after seeding.

In less than two months since reseeding activities, the previously disturbed area is revegetating well, with extensive growth including an abundance of green needlegrass, some coyote willow, and native sunflowers (Figure 15). In addition, less than two months after root wad installation with coyote willow poles, the willows are already leafing out and establishing themselves in the bank.

5.2.3 Stream Conditions

Minor adjustments to the channel alignment upstream of the structure moved the channel slightly to the south toward the right bank (up to 20') and away from the highway to encourage flows along the outside bend of the right (south) streambank. The adjustments also help to reduce shear stress and erosion along the left (north) streambank where bank erosion following the flood

Figure16. South St. Vrain Creek looking downstream at eroded bank on river left prior to bank stabilization and root wad installation activities.

had jeopardized the integrity of the highway right-of-way and a utility pole.

Bioengineered bank stabilization and habitat enhancement treatments utilizing root wads, strategically placed boulders, willow plantings and native backfill material were installed along the left bank adjacent to and downstream of the intake structure and along the right bank upstream of the structure. Figure 15 shows a detailed photograph of the bank-stabilizing root wads installed on river right, along with coyote willow poles planted in the bank. For comparison, Figure 16 shows a photograph of this same bank (taken from the opposite bank) before the project was completed and prior to bank stabilization activities. The root wads (large trees with a 20 foot to 30 foot trunk attached) were buried into the bank with the root wad facing upstream at approximately 30 degrees to the streambank. The installation of the large woody debris is intended to add complexity to the streambank and provide fish cover during medium to high flow events. The 12 root wads used in this project were donated and delivered by Boulder County Parks and Open Space.

Following the flood, a mid-channel bar formed in the center of the channel downstream of the intake structure (Figure 17). This mid-channel bar was removed, the width of the channel was reduced by approximately 15 to 20 feet, and large woody debris were installed on river left to conform to the natural channel morphology upstream and downstream of the reach below the intake structure. Several boulder clusters were also installed both upstream and downstream of the intake structure to provide additional aquatic habitat.

Figure 15. South St. Vrain Creek looking upstream at water supply pool. Note bank stabilizing root wads and coyote willow poles planted at the bank.

5.2.4 Roadway Conditions

Following construction, crews repaired the portions of Old South St. Vrain Road that were damaged as a result of the underground pipeline construction (Figure 18). As required, the entire length of the roadway in the vicinity of the project area was much improved compared to post-flood, pre-project conditions.

Figure 17. Pre-construction (left) and post-construction (right) photographs from Highway 7 mile marker 32 looking downstream. Note the removal of the mid-channel berm, the bank stabilization using root wads, and addition of boulder clusters and riffle complexity.

Figure 18. Road repair on Old South St. Vrain Road at manhole location.

6.0 PERMITTING

The permitting requirements for irrigation diversion reconstruction projects such as this can vary from location to location, however they generally involve Federal, State and local (county) permitting processes. The purpose of this section is to identify the permits required, as well as to assess the associated costs of permit fees and related expenses, in order to better plan for future projects.

During the initial grant application process in June 2014 to the US Fish and Wildlife Service and the Colorado Water Conservation Board, the level of permitting required for this project was under-estimated. This created unanticipated additional costs. The majority of the additional costs was associated with county permits and related engineering studies and construction plans required.

All permits required for this project are summarized below and in Table 6.0.

FEDERAL PERMITS

- **US Army Corps Section 404 of the Clean Water Act Permit** – The US Army Corps of Engineers regulates the discharge of dredge and fill material and certain excavation activities in waters of the United States. Waters of the US include ephemeral, intermittent and perennial streams, their surface connected wetlands and adjacent wetlands and certain lakes, ponds, drainage ditches and irrigation ditches that have a nexus to interstate commerce. After reviewing the proposed project the Corps concluded that this project was eligible for an agricultural exemption and issued an exemption letter on December 14, 2014 less than 30 days after submitting preliminary plans. Costs to the project were insignificant.
- **US Fish & Wildlife Service (USFWS) Intra Service Section 7 of the Endangered Species Act** – The USFWS found on March 17, 2015 that the proposed project may affect the Prebles meadow jumping mouse and that a formal consultation would be required for this project. On March 30th the USFWS issued a biological opinion with 14 conservation measures designed to minimize impacts to riparian and upland habitats. Costs to the project were insignificant.

STATE PERMITS

- **Colorado Department of Transportation State Highway Access Permit** – This project proposed accessing the site from two locations: one from Old South St Vrain Road and one from Colorado Highway 7. A temporary access permit off of Highway 7 was required. The permit was issued on March 4th approximately one week after submitting the application to the State. There was no cost.
- **Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Division Stormwater Management Plan and General Permit for Construction Activities** - A storm water discharge permit is required for construction activity including clearing, grading, and excavating activities except: operations that result in the disturbance of less than one acre of total land area which are not part of a larger common plan development or sale. Total disturbed area of this project was 1.9

acres. The permit was free and easy to obtain in a matter of one day but the Stormwater Management Plan took a few days to develop. Cost was approximately $2,000.

- **CDPHE Water Quality Control Division Construction Dewatering Permit** – If there is a need to dewater the site a Construction Dewatering permit and permission to discharge to the storm sewer, if applicable, is required.
- **History Colorado Permit** – An investigation of historical sites was required. Boulder County coordinated and paid for this effort.

COUNTY PERMITS

For this specific project, the Boulder County Commissioners capped total permit fees at $750 for local agricultural projects for all the projects below. This was a one-time variance, but may be an option for future projects. The Commissioners also waived a $2,000 fee from Boulder County for "plan review" by landuse planners.

- **Boulder County Building Permit** – A building permit was required to build the new concrete diversion structure. In addition, the left streambank adjacent to CO Highway 7 and across from the diversion structure received severe erosion during the flood. The plan called for rip rapping that bank at a 1:1 slope to stabilize the bank and protect both the highway right-of-way and a power pole. Boulder County required an engineered retaining wall and a building permit for that bank stabilization. The engineering for the retaining wall cost $2,000. Building permit fees are based on the value of the project and a deposit is required. However, the Building Department will not review or submit a permit until the Commissioners have approved the permit.
- **Boulder County Grading Permit** – A grading permit was required by the Boulder County Building Department for the installation of the water transfer pipeline.
- **Boulder County Access Permit** - An access permit was required to access the site on Old South St Vrain Road. As part of the access permit the County required soil borings along the alignment of the pipeline to determine depth to bedrock. The borings and associated geotechnical report cost $1,200. A road sweeping plan was also required for the Access permit.
- **Boulder County Utility Construction Permit** – The irrigation pipeline was proposed to be installed in the right-of-way of Old South St Vrain Road. This permit required trenching and compaction details and a traffic control plan. Because Old South St Vrain Road only had two residents on it beyond the project site, it was anticipated that traffic control signs would suffice. However, the Transportation Department required flaggers during any work in the right-of-way and that cost an additional $7,370. It should be noted that permits are only good for 45 days.
- **Boulder County Floodplain Development Permit** – A floodplain development permit was required to prove there would be a zero rise in the water surface elevation during the 100-year flood event due to the proposed project. That required a HEC-RAS hydrologic model 1,000 feet up and downstream of the project developed by a Professional Engineer with multiple cross sections surveyed by a Professional Land Surveyor. The cost of surveying and engineering involved in obtaining this permit was $10,415.
- **Boulder County Oversized/Overweight Permit** – This permit was required to transport construction equipment to the site.

- **Boulder County Parks and Open Space Permanent Non-Exclusive Easement** – A permanent easement for the ditch companies was required and a legal description by a Professional Land Surveyor was necessary. The cost for the surveyor was $2,530.
- **Boulder County Parks and Open Space Temporary License (Access) Agreement** – This is required for any construction on and access to County land. This also required legal descriptions but was generally covered in the permanent easement agreement.

The total cost of the permitting fees, associated engineering studies, and related costs of the permitting requirements was **$26,265.**

Table 6.0 Summary of Permitting Requirements, Fees and Related Costs

Permit	Agency/Department	Associated Studies or Engineering Required	Permit Fees	Estimated Cost of Engineering Studies, and Permitting Requirements
FEDERAL PERMITS				
Section 404 of the Clean Water Act Permit	US Army Corps of Engineers	Corps concluded that this project was eligible for an agricultural exemption and issued an exemption letter on December 14, 2014	$0	Minimal
Intra Service Section 7 of the Endangered Species Act	US Fish & Wildlife Service	USFWS found that the proposed project may affect the Prebles meadow jumping mouse, formal Section 7 consultation was required	Paid for by the USFWS as project partner	Minimal
STATE PERMITS				
State Highway Access Permit	Colorado Department of Transportation	None	$0	Minimal
Stormwater Management Plan and General Permit for Construction Activities	Colorado Department of Public Health and Environment / Water Quality Control Division	Stormwater Management Plan	$0	$2,000
Construction Dewatering Permit	Colorado Department of Public Health and Environment / Water Quality Control Division	None	$0	none
History Colorado Permit	Office of the State Archeologist	None	$0	None
COUNTY PERMITS				
Building Permit	Boulder County Building Department	Included engineering design for retaining wall	$750, total for all permitting fees	$2,000

Permit	Agency/Department	Associated Studies or Engineering Required	Permit Fees	Estimated Cost of Engineering Studies, and Permitting Requirements
Grading Permit	Boulder County Building Department	None	$0	none
Access Permit	Boulder County Building Department	Soil Borings Road Sweeping Plan	$0	$1,200
Utility Construction Permit	Boulder County Transportation Dept	Traffic Control Plan Flaggers	$0	$7,370
Floodplain Development Permit	Boulder County Transportation Dept/Floodplain Development Office	HEC-RAS hydrologic model Multiple cross sections by a Professional Land Surveyor	$0	$10,415
Oversized/Overweight Permit	Boulder County Transportation Dept	None	$0	none
Permanent Non-Exclusive Easement	Boulder County Parks and Open Space	Legal description by a Professional Land Surveyor	$0	$2,530
Temporary License Agreement	Boulder County Parks and Open Space	Legal descriptions	$0	minimal
		subtotal	**$750**	**$25,515**
		TOTAL		**$26,265**

7.0 BUDGET

The estimated total cost of this project was $329,000 including in-kind donations. This included some $299,000 in cash contributions, and $30,000 in inkind match.

The final cost of the project was $364,588, some $64,657 more than initial cost estimates. These cost overruns were generally associated with permitting expenses and construction costs. Permitting costs were initially underestimated and additional work such as engineered retaining walls and the inverted siphon were not anticipated at the time of the grant request to the Water Supply Reserve Account and the US Fish & Wildlife Service.

The US Fish and Wildlife Service committed $120,000 in cash to ensure the passage of local native fish. Trout Unlimited was the fiscal agent for this grant. CEMEX, as a shareholder in the South Ledge Ditch, contributed some $22,518 to cover cost overruns. A grant from Northern Water to the Meadow Ditch contributed $10,000 to address the costs of construction. Boulder County also paid some $14,523 to cover the cost of road repairs to Old South St. Vrain Road and for the delivery of root wads to the project site. This project component was requested as part of permitting, and was not budgeted for in the original cost of the project. The Boulder County Commissioners also capped their permitting fees at $750 which saved another several thousand to the project. The Saint Vrain Chapter of Trout Unlimited contributed $2,500 to cover the cost of outreach.

As an in-kind donation, the ditch companies each transported and stockpiled more than 300 cubic yards of large rock with an approximate total value of $30,000 ($50/cubic yard).

The Colorado Water Conservation Board's Water Supply Reserve Account granted $170,000 to engineer and build the consolidated irrigation diversion structure for the two ditch companies. The match from the USFWS and other sources exceeds the minimum 25% match requirement for the Water Supply Reserve Account grant.

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Table 7.0 Balance Sheet: Meadow and South Ledge Diversion Reconstruction and Fish Passage Project

INCOME	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**	**Task 6**	**Task 7**	**TOTAL**
	Data Collection	Permitting	Engineering	Construction	Outreach	Mngt/Monitor	Admin	
South Ledge Ditch				$22,518.57				$22,518.57
Northern Water				$10,000.00				$10,000.00
CEMEX				$25,016.00				$25,016.00
SV Trout Unlimited					$2,500.00			$2,500.00
USFWS	$4,608.00	$26,265.00	$8,614.25	$75,677.50	$1,121.25		$3,714.00	$120,000.00
CWCB- WSRA			$1,964.00	$162,110.00		$4,140.00	$1,786.00	$170,000.00
Boulder County				$14,523.50				$14,523.50
Total Income	$4,608.00	$26,265.00	$10,578.25	$309,845.57	$3,621.25	$4,140.00	$5,500.00	**$364,558.07**
EXPENSES	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**	**Task 6**	**Task 7**	**TOTAL**
	Data Collection	Permitting	Engineering	Construction	Outreach	Mngt/Monitor	Admin	
Crane Associates	$4,608.00	$26,265.00	$10,578.25		$1,121.25	$4,140.00	$3,000.00	$49,712.50
Frontier				$309,845.57				$309,845.57
Trout Unlimited							$2,500.00	$2,500.00
PR Company					$2,500.00			
Total Expenses	$4,608.00	$26,265.00	$10,578.25	$309,845.57	$3,621.25	$4,140.00	$5,500.00	**$364,558.07**
							Difference (Income -Expenses)	***$-***
BUDGETED								
Cash	$7,400.00	$5,000.00	$15,250.00	$244,475.00	$6,000.00	$13,415.00	$8,361.00	$299,901.00
							TOTAL	**$299,901.00**
							Difference (Cash Budget-Actual)	**-$64,657.07**

8.0 EDUCATION AND OUTREACH

Outreach and education efforts were aimed at sharing the project design and successes, as well as helping this project serve as a viable model for other diversion reconstruction projects. The Saint Vrain Chapter of Trout Unlimited provided $2,500 to assist with the cost of outreach.

As the intent of this project was to demonstrate the ability of a diversion to be reconstructed while allowing for fish passage, outreach was targeted toward other ditch companies through associations such as the Ditch and Reservoir Company Alliance (DARCA) and other local and state non-profit educational and professional organizations. The target audience for outreach and education activities also includes the Saint Vrain Creek Coalition, local county commissioners, municipal employees (engineers), local ditch companies, DARCA, and consultants.

Outreach focused on the following activities:

- Web site
- Press releases
- Tours
- Presentations

Web Site
A web site www.fishpassageproject.org was developed to provide easily accessible information about the Project. It offers a platform for Tour RSVPs, publication of reports, before and after photos, sponsor thank yous, and other technical and summary information.

On-site Tour(s)
September 16, 2015, an on-site tour of the project was conducted as part of the larger Saint Vrain Creek Coalition Advisory Council tour. Some 42 people attended the tour. Gary Gorman from the Meadow Ditch and a representative from USFWS, presented to the tour attendees.

Additional tours are planned, likely in conjunction with other water-related tours conducted by Boulder County, the Saint Vrain Lefthand Water Conservancy District or others.

Press Release
As part of project completion, The PR Company prepared a press release and distributed it to local newspapers, the CSU *Water News* magazine, and the *Irrigation Leader* magazine (the *Irrigation Leader* is distributed to irrigation district managers and boards of directors in the 17 western states, Bureau of Reclamation officials, members of Congress and committee staff, and advertising sponsors).

Technical Presentation

A technical presentations covering the project (PowerPoint) was created for presentation to the tours, CWCB, Ditch and Reservoir Company Alliance (DARCA) and other organizations as needed. This includes photos taken before and at all stages of construction.

9.0 CONCLUSIONS AND RECOMMENDATIONS

The consolidation of two diversions into one significantly reduces the environmental impact on the aquatic ecosystem and generates substantial savings in construction and maintenance costs. The Meadow and South Ledge ditch companies were able to pool their limited resources and successfully apply for grants by working together while maintaining their individual water rights and ditch infrastructure. The joint diversion structure, piping, and splitter box will be managed by the water commissioner and therefore reduce any potential for conflict.

The ability to move the diversion upstream may be the most important component of this project. By "chasing grade" upstream, the ditch companies are able to divert their water without an instream structure that impedes aquatic movement, and move water by gravity to their respective ditches. By constructing an off-channel intake structure below the existing grade of the stream bed, water can be diverted and controlled at the point of diversion without impacting the aquatic environment.

The biggest challenge with this concept is obtaining easements from landowners and constructing the project in an unobtrusive manner that does not impact the existing use of the land. In the case of this project, the landowner is Boulder County Parks and Open Space. The primary use of the land is natural habitat in a riparian floodplain. Care was taken in the design and construction to maintain that natural environment by installing the infrastructure underground and restoring the surface to the appropriate natural state.

Changing the point of diversion, and moving it upgradient, is an important design component of this engineering strategy. In 2014, the Colorado General Assembly allowed that when the channel of a stream changes due to natural events such as flooding, rendering a headgate inoperable, the ditch owner may move the headgate upstream without filing a change of water right application – as long as the relocation does not interfere with the use or enjoyment of any decreed or absolute conditional water right.

In non-flood scenarios, the point of diversion could also be changed using form *JDF 241W - Application for Simple Change in Surface Point of Diversion*, which can be obtained on the Colorado Judicial Branch web site under "forms." This process need not involve going to water court, or hiring an attorney, as long as the conditions of non-injury can be met.

The split flow upstream in Hall Meadow should be re-graded in a manner that maintains the north channel as the primary channel and the south channel as an overflow channel. As part of this project, boulders were buried in the bed of the south channel to make it slightly higher than the north channel while still allowing water to enter the channel. However, the south channel is at a somewhat lower grade than the north channel, and an opportunity exists to develop a single thread channel on the south and increase sinuosity in this location while directing flow back to the existing north channel. This type of change would improve resiliency and future flood attenuation.

A monitoring plan was developed but not implemented due to cost over-runs. If funding can be raised it is recommended that cross section measurements, photo points and vegetative analysis be performed to further evaluate the project over time.

Another goal of this project is to use it as a demonstration for other diversion projects and build on the concept constructed here. It is possible, and even cost-effective, to build an irrigation diversion that meets the needs of multiple stakeholders, including recreational and environmental interests, while providing for a full decree of reliable water to agricultural interests.

10.0 REFERENCES

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APPENDIX A

USFWS BIOLOGICAL OPINION

INTRA-SERVICE SECTION 7 CONSULTATION ON THE MEADOW/SOUTH LEDGE DITCH DIVERSION AND FISH PASSAGE PROJECT ON SOUTH ST VRAIN RIVER

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Colorado Field Office
P.O. Box 25486, DFC (65412)
Denver, Colorado 80225-0486

IN REPLY REFER TO:
TAILS: 06E24000-2015-F-0327

MAR 3 0 2015

MEMORANDUM

To: Pam Sponholz, Project Leader, Colorado Fish and Wildlife Conservation Office, U.S. Fish and Wildlife Service, Lakewood, Colorado

From: ACTING FOR Leslie Ellwood
Charles A. Pelizza, Acting Field Supervisor, Colorado Ecological Services Field Office, Lakewood, Colorado

Subject: Intra-Service Section 7 Consultation on the Meadow/South Ledge Ditch Diversion and Fish Passage Project on South St. Vrain River

This memorandum transmits the U.S. Fish and Wildlife Service's (Service) biological opinion concerning the Service's proposed Meadow/South Ledge Ditch Diversion and Fish Passage Project on the South St. Vrain River in Boulder County, Colorado in accordance with section 7 of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 et seq.).

In this biological opinion, the Colorado Ecological Services Field Office (CFO) finds that the proposed action may affect the Preble's meadow jumping mouse (*Zapus hudsonius preblei*) (Preble's) and that these Service-initiated actions carried out pursuant to the Intra-Service Section 7 Biological Evaluation provided by the Colorado Fish and Wildlife Conservation Office (FWCO) for this project are not likely to jeopardize the continuing existence of the species. We also find that other federally listed species that exist near the project site, including Ute ladies' tresses orchid (*Spiranthes diluvialis*) and the Colorado butterfly plant (*Gaura neomexicana var. coloradensis*) may be affected by the proposed action but will not be adversely affected. Critical habitat has not been designated in the project area; therefore, none will be affected.

We base this biological opinion on the the Intra-Service Section 7 Biological Evaluation, dated March 13, 2015, as well as any subsequent clarifying correspondence.

This action meets the conditions of an agricultural exemption under Section 404(f) of the Clean Water Act found at 33 C.F. R. Part 323.4(a)(3) for maintenance of farm/stock ponds or drainage ditches (COE Action No. NWO-2014-02764-DEN, dated December 20, 2014).

CONSULTATION HISTORY

On January 22, 2015, our CFO received the request for informal intra-service consultation from the Service's FWCO.

On March 5, 2015, our CFO requested additional project information from the Service's FWCO regarding anticipated impacts to Preble's habitat.

On March 13, 2015, our CFO received additional project information regarding project impacts.

On March 17, 2015, our CFO spoke with Jeff Crane of Crane and Associates, project contractor, regarding project impacts and determined that formal consultation is necessary for this project. We provided email messages to the project contractor and the Service's FWCO with notification of the need for formal consultation.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The September 2013 destroyed two ditch diversion structures and headgates (Meadows Ditch and South Ledge Ditch) on the South St. Vrain River. The Meadows and the South Ledge ditch diversions are located less than 1 mile west of Lyons and are within a few hundred feet of each other on the south side of the South St. Vrain River. The ditches irrigate agricultural lands south and east of Lyons.

The goal of this project is to rebuild and combine the original two ditches into a single structure in a manner that will facilitate fish passage of native fish species in the area while continuing to provide the full decree of irrigation water. In addition, the new structure will allow for more water to remain in the channel longer to support growth of riparian vegetation.

Following the September 2013 flood, both ditch companies voluntarily suspended the diversion of agricultural water for the 2014 irrigation season to allow a coalition of interests to design and build an innovative diversion structure that can be a model for other ditch companies. Those interests include Boulder County Parks and Open Space, the St. Vrain Chapter of Trout Unlimited, Colorado Parks and Wildlife, the U.S. Fish & Wildlife Service, and the Colorado Water Conservation Board. This coalition has coordinated to fund and build this project for the mutual benefit of the family farms that use the water, the fishing and recreational community in Lyons, and the fish in the South St. Vrain River.

The instream diversion structure and concrete headgate have been designed and engineered to allow for a full decree of irrigation water while providing for upstream migration of native fish. The construction of a low-head diversion structure within the stream will utilize large native rock provided by ditch companies. The headgates will allow for management of ditch water at the point of diversion and will maximize the water left in the stream. Grade control at the diversion site will be provided by 3' to 6' diameter boulders buried at the head of the riffle. Water will be conveyed through a below-grade concrete intake structure located on the right side of the river channel and

then through a buried pipeline to the ditch located along the Old South St. Vrain road. The project will compile and process field data, including horizontal and vertical topographic survey data, bed and bank composition, stream hydrology, and existing ditch grades and dimensions into the project design.

The project will disturb approximately 1.9 acres of instream, riparian and upland areas combined, all of which are within the 100-year floodplain. Instream work will affect an area of approximately 50 feet x 50 feet at the site of the diversion structure. Approximately 1,000 feet of pipeline will be installed, 500 feet across the floodplain and 500 feet along Old South St. Vrain Road. Impacts to Preble's habitat are considered temporary as structures generally will be buried below grade. Bank stabilization will include installation of root wads, riprap buried by 4 inches of native soil, and willow cuttings installed below water line.

Revegetation and weed management will follow Colorado Department of Transportation's (CDOT) specifications. The landscape plan and final seed mix will be reviewed and approved by CDOT. Revegetation and weed monitoring will be conducted by FWCO and Crane and Associates and will occur in August or September for three growing seasons. Monitoring will be accomplished using visual estimates of percent cover.

The project monitoring and evaluation plan will utilize multiple cross sections established during the field survey with permanent end points that can accurately be resurveyed pre-construction, post-construction, post runoff and subsequent flow events. The structure will be monitored closely for changes in vertical elevation or channel alignment. Velocity calculations will be taken at the structure at different flows to ensure minimum velocity for fish passage. Work will occur primarily during April 2015; work that occurs after May 1 will primarily be revegetation and will not result in new disturbances of vegetation.

Conservation Measures

Conservation measures are actions outlined in the project description that the project proponent will implement in order to reduce the environmental impacts of the action or promote the recovery of threatened and endangered species. The Service considers the beneficial effects of these conservation measures during the jeopardy and adverse modification analyses. Conservation measures are part of the proposed action and their implementation is required under the terms of this consultation.

- Project will be designed to avoid and minimize permanent and temporary impacts to riparian and adjacent upland habitats.

- Project will minimize the amount of concrete, riprap, bridge footings, and other "hard," impermeable engineering features within the stream channel and riparian or adjacent upland habitats. If riprap is used, it will be buried, then planted with native riparian vegetation where technically feasible.

- Project will use bioengineering techniques, where technically feasible, to stabilize stream banks.

- Project will minimize the number and footprint of access routes, staging areas, and work areas.

- Project site disturbance, including access routes and staging areas, will be limited to areas devoid of vegetation resulting from disaster-related scouring and erosion, or deposition of flood-transported debris such as silt, sand, cobble, or large rocks.

- Project will locate access routes, staging areas, and work areas within previously disturbed or modified non-habitat areas. Heavy access equipment and vehicle access to site is via previously disturbed areas, or uses a route that avoids destruction to live or dormant vegetation.

- Project will install limits of work fencing (e.g., orange barrier netting or silt fencing), signage, or other visible markers to delineate access routes and the project area from habitats. This fencing will be used to enforce no-entry zones.

- Project Leader will hold a preconstruction briefing for onsite personnel to explain the limits of work and other conservation measures.

- Project will follow regional stormwater guidelines and design best management practices (BMPs) to control contamination, erosion, and sedimentation, such as silt fences, silt basins, gravel bags, and other controls needed to stabilize soils in denuded or graded areas, during and after construction.

- Project will develop and implement a habitat restoration plan that addresses site preparation, planting techniques, control of non-native weeds, native seed mixtures, and post-construction monitoring.

- Project Leader will contact the Service immediately by telephone at (303) 236–4773 if a Preble's is found alive, dead, injured, or hibernating within the project area. Service will also be contacted if any Ute ladies' tresses orchids or Colorado butterfly plants are found within the project area.

- Project will, to the maximum extent practicable, limit disturbing (e.g., crushing, trampling) or removing (e.g., cutting, clearing) of vegetation, such as willows, trees, shrubs, and grasses within riparian and adjacent upland habitats.

    - Restrict the temporary or permanent removal of vegetation to the footprint of the project area.

    - Minimize the use of heavy machinery and use smaller equipment when possible.

    - Soil compaction: Temporarily line access routes with geotextiles or other materials, especially in wet, unstable soils to protect roots and the seed bank.

- Project will locate, store, stage, operate, and refuel equipment outside of riparian or adjacent upland habitats.

- During the Preble's active season (May 1 through October 31), work only during daylight hours to avoid disrupting Preble's nocturnal activities.

- Project site manager will promptly remove waste to minimize site disturbance and avoid attracting predators.

- Project will use best management practices (BMPs) to limit construction-related disturbance, such as soil compaction, erosion, and sedimentation, and to prevent the spread of invasive weeds;

    - Soil compaction: Establish one access route for workers, vehicles, and machinery, preferably along a previously disturbed surface or route.

    - Soil compaction: Temporarily line access routes with geotextiles or other materials, especially in wet, unstable soils.

    - Weed control: Wash and inspect vehicles and equipment before entering or leaving the project area so that they are free of noxious weed seeds and plant parts.

    - Weed control: Use only weed free certified materials, including gravel, sand, top soil, seed, and mulch.

- Project will, upon completion, revegetate all disturbed areas with native shrubs, trees, and grasses. Only weed free material and native seed mixtures recommended by the CDOT will be used.

ACTION AREA

The action area includes the immediate area involved in the action and also includes all areas to be affected directly or indirectly by the Federal action (50 CFR § 402.02). The action area contains the most far-reaching potential effects of the Federal and non-Federal actions on the species being discussed. The action area is defined by measurable or detectable changes in land, air, and water or to other measurable factors that will result from the proposed action. In other words, the action area is not limited to the "footprint" of the action, but rather encompasses the biotic, chemical, and physical impacts to the environment resulting directly or indirectly from the action.

The project area is bordered by the South St. Vrain Road (Highway 7) to the north and the old South St. Vrain River Road to the south. The project area includes the instream area of the South St. Vrain, where a low-head diversion structure will be placed, as well as the south river bank where the pipeline will be placed.

We describe the action area as including not only the project area, which is defined by the limits of the project's disturbance, but also downstream reaches of the South St. Vrain River and St. Vrain River for approximately 3 miles because this is the approximate maximum recorded dispersal distance for the Preble's meadow jumping mouse. We include downstream reaches in order to evaluate the proposed project's potential secondary impacts from erosion, sedimentation, pollution, hydrologic changes, and fragmentation.

STATUS OF THE PREBLE'S MEADOW JUMPING MOUSE

The Service added the Preble's meadow jumping mouse to the List of Endangered and Threatened Wildlife in 50 CFR 17.11 as a threatened species on May 13, 1998 (63 FR 26517). As discussed in more detail under the Environmental Baseline section, previous trapping surveys and habitat evaluations confirm that the species occupies the action area.

Taxonomy

The Preble's meadow jumping mouse is a member of the family Dipodidae (jumping mice) with four living genera, two of which, *Zapus* and *Napaeozapus*, are found in North America (Hall 1981). The three living species within the genus *Zapus* are *Z. hudsonius* (the meadow jumping mouse), *Z. princeps* (the western jumping mouse), and *Z. trinotatus* (the Pacific jumping mouse). Edward A. Preble (1899) first documented the meadow jumping mouse from Colorado. Krutzsch (1954) described the Preble's as a separate subspecies of meadow jumping mouse limited to Colorado and Wyoming. Taxonomic authorities recognize the Preble's subspecies of meadow jumping as 1 of 12 subspecies of meadow jumping mouse (Hafner *et al.* 1981).

A September 2013 publication in *Molecular Ecology* further evaluated the genetic relationship between jumping mice, including the Preble's (Malaney and Cook, 2013). This study broadly evaluated the entire *Zapus* genus, including all 12 subspecies of meadow jumping mice (*Z. hudsonius*) and confirmed that the Preble's is distinct from neighboring subspecies that were previously proposed to be taxonomically synonymized (*Z. h. campestris* and *Z. h. intermedius*) (Malaney and Cook, 2013, pp. 8, 10). However, the study concludes that Preble's is closely related to two meadow jumping mouse subspecies that are found in Alaska and Canada (*Z. h. tenellus* and *Z. h. alascensis*), which the study refers to as the "northern lineage" of meadow jumping mice (Malaney and Cook 2013, p. 8, 10).

Although the study suggests that the Preble's meadow jumping mouse is genetically similar to two subspecies of jumping mice found in Alaska and Canada, it does not propose to revise the formal taxonomy of Preble's or any of the other subspecies of jumping mice (Malaney and Cook 2013, p. 10). Specifically, the study concludes, "additional tests will be required before hypotheses of infraspecific taxonomic synonymy can be implemented… [and that] a revised taxonomy of the group is needed but is outside the context of this study" (Malaney and Cook, p. 10).

Although the Preble's may be genetically similar to two other subspecies found more than 800 miles away in Alaska and Canada, the study confirms that the Preble's is genetically isolated from its nearest neighbors found in Wyoming and New Mexico (Malaney and Cook 2013, p. 10). Therefore, even if the Preble's were to be taxonomically synonymized into a "northern lineage," the Preble's appears to be both (1) distinct, due to the significant geographic separation from the two other subspecies of the "northern lineage" and (2) significant, because the loss of this southernmost population along the Front Range would represent a range retraction of more than seven latitudinal degrees to the north, likely resulting in a significant gap in the range of the taxon. Therefore, the best available information continues to indicate that the Preble's is a valid subspecies of meadow jumping mice (SEI 2006a, p. 44).

Physical Description

The Preble's is a small mouse with an extremely long tail, large hind feet, and long hind legs, which enable jumping mice to make prodigious leaps (Figure 3). The long tail is bicolored, lightly furred, and twice as long as the body. The large hind feet are three times as large as those of other mice of similar body size. Preble's have a distinct, dark, broad stripe on its back that runs from head to tail and is bordered on either side by grey to rusty, orange-brown fur. The hair on the back of all jumping mice appears coarse compared to other mice. White hairs on the underside are finer.

Figure 3. The Preble's meadow jumping mouse, or Preble's, has an extremely long tail, large hind feet, and a distinctive dark stripe running along its back. Unlike deer mice or voles, the Preble's makes incredible jumps to escape predators. Left photo: The Preble's is in "torpor," or cold-induced hibernation/sleep. (USFWS)

Adult Preble's are approximately 7 to 10 inches (18 to 25 centimeters) long and the tail is 4 to 6 inches (10 to 15 centimeters) long (Krutzsch 1954; Fitzgerald *et. al.* 1994; Fitzgerald *et al.* 2011). The average weight of 120 adult Preble's captured early in their active season prior to June 18 was 0.6 ounces (17 grams); included were 10 pregnant females weighing more than 0.8 ounces (20 grams) (Meaney *et al.*, 2002).

Preble's meadow jumping mouse Life History

Habitat

Preble's meadow jumping mice live in well-developed, plains riparian vegetation with adjacent, relatively undisturbed grassland communities and a nearby water source (Figure 4). The well-developed, plains riparian vegetation typically includes a dense combination of grasses, forbs, and shrubs; a taller shrub and tree canopy may be present (Bakeman 1997). When a taller canopy is present, the shrub canopy is often willow (*Salix* spp.), although other shrub species, including snowberry (*Symphoricarpos* spp.), chokecherry (*Prunus virginiana*), hawthorn (*Crataegus* spp.), Gambel's oak (*Quercus gambelli*), alder (*Alnus incana*), river birch (*Betula fontinalis*), skunkbrush *(Rhus trilobata*), wild plum (*Prunus americana*), lead plant (*Amorpha fruticosa*), dogwood *(Cornus sericea*) and others may also occur (Bakeman 1997, Shenk and Eussen 1998).

Figure 4. Preble's habitats feature dense riparian vegetation, such as willows and cottonwoods, and adjacent grassy uplands within 300 feet of the 100-year floodplain, with an open water source nearby. (USFWS)

Preble's have rarely been trapped in uplands adjacent to riparian areas (Dharman 2001; Hansen 2006). However, Preble's feed and rest in adjacent uplands (Shenk and Sivert 1999b; Schorr 2001) as far out as 328 feet (100 meters) beyond the 100-year floodplain (Ryon 1999; Tanya Shenk-Colorado Division of Wildlife, 2002). Adjacent uplands used by the Preble's are extremely variable ranging from open grasslands to ponderosa pine (*Pinus ponderosa*) woodlands (Corn *et al.* 1995; Pague and Grunau 2000).

Riparian shrub cover, tree cover, and the amount of open water nearby are good predictors of Preble's densities (White and Shenk 2000). Based on habitat quality, estimates of Preble's abundance range from 6 to 110 mice per mile with an average of 53 mice per mile of stream (White and Shenk 2000). A comparison of habitats at capture locations on the Department of Energy's Rocky Flats Site in Jefferson County, Colorado, and the U.S. Air Force Academy (Academy) in El Paso County, Colorado, revealed that Academy sites had lower plant species richness at capture locations but considerably greater numbers of Preble's (Schorr 2001). However, the Academy sites also had higher densities of both grasses and shrubs. Preble's abundance is likely driven by the density of riparian vegetation rather than the diversity of plant species.

During the active season, Preble's construct day nests composed of grasses, forbs, sedges, rushes, and other available plant material. Day nests may be globular in shape or simply raised mats of litter, and are most commonly above ground but may also be below ground. Day nests are typically located under debris at the base of shrubs and trees, or in open grasslands (Ryon 2001). Mice may have multiple day nests in both riparian and grassland communities (Shenk and Sivert 1999a), and may abandon a nest after approximately one week of use (Ryon 2001).

Hydrologic regimes that support Preble's habitat range from large perennial rivers such as the South Platte River to small ephemeral drainages only 3 to 10 feet wide, as at Rocky Flats and in montane habitats at higher elevations. Flooding is a common and natural event in the riparian systems along the Front Range of Colorado. This periodic flooding helps create a dense vegetative community by stimulating sprouting from willow shrubs and the growth of herbs and grasses in freshly deposited soil.

Hibernation:

Preble's is a true hibernator, usually entering hibernation in September or October and emerging the following May, after a long hibernation period of seven to eight months. Adults enter hibernation first before than young of the year because they accumulate the necessary fat stores more quickly. Similar to other subspecies of meadow jumping mouse, Preble's do not store food for hibernation. Instead, while hibernating, the Preble's persists on fat stores accumulated prior to hibernation (Whitaker 1963).

Hibernacula (hibernation nests) of Preble's have been located both within and outside of the 100-year floodplain of streams (Shenk and Sivert 1999a; Ryon 2001; Schorr 2001). Those hibernating outside of the 100-year floodplain would likely be less vulnerable to flood-related mortality. Fifteen apparent Preble's hibernacula have been located through radio telemetry, all within 260 feet of a perennial streambed or intermittent tributary (Bakeman and Deans 1997; Shenk and Sivert 1999a; Schorr 2001).

Hibernacula have been located under willow, chokecherry, snowberry, skunkbrush, sumac (*Rhus* spp.), clematis (*Clematis* spp.), cottonwoods (*Populus* spp.), Gamble's oak, thistle (*Cirsium* spp.), and alyssum (*Alyssum* spp.) (Shenk and Sivert 1999a). At the Air Force Academy near Colorado Springs, 4 of 6 likely hibernacula found by radio-telemetry were located in close proximity to coyote willow (*Salix exigua*) (Schorr 2001). The one excavated hibernaculum at

Rocky Flats south of Boulder, was found 30 feet above the streambed, in a dense patch of chokecherry and snowberry (Bakeman and Deans 1997). The nest was constructed of leaf litter 12 inches below the surface in coarse textured soil.

Movements and Home Range:

Radio telemetry and mark-recapture data provide insight into the Preble's home ranges and dispersal capabilities. At Plum Creek in Douglas County, Colorado, the Preble's home ranges averaged 1.24 acres (0.50 hectares) based on radio-telemetry (Trainor *et al.* 2012, p. 432). In the Pike National Forest of Colorado, travel distances averaged 1,357 feet (413.9 meters) with an approximate home range size of 1.02 acres (Hansen 2006, p. 158). At the Air Force Academy in El Paso County, Colorado, home ranges were between 0.42 to 9.49 acres (0.17 to 3.84 hectares), with an average home range of 3.48 acres (1.41 hectares) (Schorr 2003, p. 9). During this study, the farthest distance moved by individual Preble's ranged from 43 to 3,176 feet (13 to 968 meters), with an average maximum travel distance of 1,188 feet (362 meters) (Schorr 2003, p. 9). An earlier study documented a Preble's moving as far as 1.1 kilometers (0.7 mile) in 24 hours (Ryon 1999, p. 12). However, compared to radio telemetry data, mark-recapture data suggest that the Preble's may have longer dispersal capabilities. Mark-recapture data between active seasons identified mice traveling more than 4 kilometers (2.3 miles) along a linear riparian system (Schorr 2003, p. 10; Schorr 2012b, pp. 1274, 1278).

Reproduction and Lifespan:

Preble's have two litters per year, but may have up to three litters per year. An average of five young is born, but the size of a litter can range from two to eight young (Quimby 1951; Whitaker 1963). Preble's are long-lived for a small mammal, surviving up to three years, in comparison with many species of mice and voles that seldom live a full year. Along South Boulder Creek, Boulder County, Colorado, seven individuals originally captured as adults were still alive two years later, having attained at least three years of age (*Meaney et al.*, 2002).

Although Preble's are long-lived compared to other small rodents, the annual survival rate is low. Preble's survival rates appear to be lower over the summer than over the winter. Over-summer survival rates ranged from 22 to 78 percent and over-winter survival rates ranged from 56 to 97 percent (Shenk and Sivert 1999b; Schorr 2001; Meaney *et al.* 2002). Higher overwintering survival rates indicate that predation or other factors impact Preble's during the active season.

Predation:

Known predators of the Preble's include garter snakes (*Thamnophis* spp.), prairie rattlesnake (*Crotalus viridus*), bullfrog (*Rana catesbiana*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), house cat (*Felis catus*), long-tailed weasel (*Mustela frenata*), and red-tailed hawk (*Buteo jamaicensis*) (Shenk and Sivert 1999a; Schorr 2001). Drowning and vehicle collisions also kill Preble's (Schorr 2001; Shenk and Sivert 1999a). Other causes of death include starvation, exposure, disease, and insufficient fat stores for hibernation (Whitaker 1963).

Diet:

Although fecal analyses provide the best data on Preble's diet, they overestimate the components of the diet that are less digestible. Preble's diets shift seasonally, consisting primarily of insects and fungi after emerging from hibernation, and shifting to fungi, moss, seeds, and pollen during mid-summer (July through August), with insects again added in September (Shenk and Sivert 1999a). The shift in diet along with shifts in mouse movements suggests that Preble's may require specific seasonal diets, perhaps related to the physiological constraints imposed by hibernation (Shenk and Sivert 1999a).

Preble's Abundance and Trends

Due to the difficulty of implementing long-term trapping studies needed to assess population sizes, quantitative studies designed to estimate Preble's populations have occurred at only a few sites in Colorado. As a result, we lack a reliable regional, Statewide, or rangewide population estimate for the Preble's. Without long-term trapping studies, our understanding of population densities is limited for the Preble's in Wyoming (WGFD 2005, p. 36; WGFD 2010, p. IV-2-66). In Colorado, we have several population estimates, but little trend information for Preble's populations. In addition, because jumping mouse population sizes in a given area vary significantly from year to year (Quimby 1951, pp. 91–93; Whitaker 1972, p. 4), short-term studies may not accurately characterize abundance. In one ongoing trapping study, population highs of 24 and 69 Preble's per site were estimated for two control sites in 1999; subsequent trapping in 2002, during regional drought conditions, found no Preble's at either site (Bakeman 2006, p. 11). Over 4 years, Preble's populations varied widely and were absent at certain sites during some seasons, suggesting that 10 or more years of study might be necessary to assess the full extent of variation in Preble's populations (Meaney *et al.* 2003, p. 620).

Because the Preble's occupies linear riparian communities, researchers estimate abundance as the number of mice per kilometer (or mile) of riparian corridor. Estimates of linear abundance range widely, from 2 to 67 mice per kilometer (3 to 107 mice per mile) with a mean of approximately 27 mice per kilometer (44 mice per mile) (Shenk 2004). These above abundance estimates, coupled with sufficient knowledge of occupied stream miles, may provide a rough indicator of Preble's numbers within a stream reach or drainage, but may overestimate actual population size (Hayward 2002). The Recovery Team used the 27 mice per km (44 mice per mi) population estimate (Shenk 2004) to approximate the number of stream miles required to support varying sized populations of the Preble's (USFWS 2003, p. 25).

As with abundance estimates, the difficulty of implementing long-term trapping studies limits the availability of population trend data for the Preble's. Since 1998, there have been few attempts to characterize changes in Preble's populations over time. One long-term study at the Air Force Academy (Academy) in El Paso County, Colorado, provides the most thorough estimate of population trends for the subspecies. Mark-recapture data over 7 years at the Academy suggested that populations were declining (Schorr 2012b, p. 1277).

Preble's Status and Distribution

The Preble's lives along the foothills in southeastern Wyoming, southward along the eastern edge of the Front Range of Colorado to Colorado Springs, El Paso County (Hall 1981; Clark and Stromberg 1987; Fitzgerald *et al.* 1994; Fitzgerald *et al.* 2011). Knowledge about the current distribution of the Preble's comes from collected specimens, and live-trapping locations from both rangewide survey efforts and numerous site-specific survey efforts conducted in Wyoming and Colorado since the mid-1990s. The Denver Museum of Nature and Science (DMNS) houses recently collected specimens. Trappers file survey reports with the Service's Field Offices in Colorado and Wyoming.

In Wyoming, capture locations of mice confirmed as the Preble's, and locations of mice identified in the field as Preble's and released, extend in a band from the town of Douglas southward along the Laramie Range to the Colorado border, with captures east to eastern Platte County and Cheyenne, Laramie County. The Preble's does not likely extend west past the crest of the Laramie Range in Wyoming (Bowe and Beauvais 2012). In Colorado, the distribution of the Preble's forms a band along the Front Range from Wyoming southward to Colorado Springs, El Paso County, with eastern marginal captures in western Weld County, western Elbert County, and north-central El Paso County.

The Preble's is likely an Ice Age relict (Hafner *et al.* 1981; Fitzgerald *et al.* 1994; Fitzgerald *et al.* 2011). Once the glaciers receded from the Front Range of Colorado and the foothills of Wyoming and the climate became drier, the Preble's was confined to the riparian (river) systems where moisture was more plentiful. The semi-arid climate in southeastern Wyoming and eastern Colorado limits the eastern extent of riparian corridors and restricts the range of the Preble's. The Preble's has not been found east of Cheyenne in Wyoming or on the extreme eastern plains in Colorado. The dry shortgrass prairie defines the eastern boundary for the subspecies and may present a barrier to eastward expansion (Beauvais 2001).

Higher elevations along the Laramie Range and the Front Range likely impose the western boundary of the Preble's. The Service has used 2,300 meters (7,600 feet) in elevation as the general upward limit of Preble's habitat in Colorado (USFWS 1998). Recent morphological examination of specimens has confirmed Preble's to an elevation of approximately 7,600 feet in Colorado (Meaney *et al.* 2001) and to 7,750 feet in southeastern Wyoming (DMNS, 2001). In a modeling study of habitat associations in Wyoming, Keinath (2001) found suitable habitat predicted in the Laramie Basin and Snowy Range Mountains (west of known Preble's captures) but very little suitable habitat predicted on the plains of Goshen, Niobrara, and eastern Laramie counties (east of known Preble's captures).

The Preble's is closely associated with riparian ecosystems that are linear in nature and represent a small percentage of the landscape. If Preble's habitat is destroyed or modified, populations in those areas may decline or be extirpated. The main factor threatening the subspecies is the decline in the extent and quality of Preble's habitat (USFWS 1998; Hafner *et al.* 1998; Shenk 1998). Habitat alteration, degradation, loss, and fragmentation resulting from urban development, flood control, water development, intensive agricultural activities, and other human land uses have adversely affected Preble's populations. Habitat destruction may impact

individual Preble's directly or by destroying nest sites, food resources, and hibernation sites, by disrupting behavior, fragmenting habitats, or by creating a barrier to movement.

Although there is little information on historic distribution and abundance of the Preble's, surveys identified various locations where the subspecies was historically present but is now absent (Ryon 1996). Despite numerous surveys, the Preble's has not recently been found in the Denver or Colorado Springs metropolitan areas and is believed to be extirpated from these areas because of extensive urban development. Since at least 1991, the Preble's has not been found in Denver, Adams, or Arapahoe Counties in Colorado. Its absence in these counties is likely due to urban development, which has altered, reduced, or eliminated riparian habitat (Compton and Hugie 1993; Ryon 1996).

Preble's Occupied Range in Colorado:

A map layer, "Preble's occupied range," developed by Colorado Parks and Wildlife (CPW 2007) estimates the acres of habitats occupied by the Preble's in Colorado. CPW developed this occupied range layer by drawing habitat polygons around points where trappers have captured Preble's. Based on the trapping records, CPW estimated that Colorado supports approximately 89,771.7 acres (36,329.3 hectares) of occupied Preble's habitats.

However, CPW's mapping effort underestimates the actual acres of potentially occupied habitats in Colorado because it incorporates only trapped habitats. The point data used to draw the *occupied range* polygons records only Preble's captures, but trappers have not trapped all the potential or likely occupied Preble's habitats in Colorado. Although CPW's occupied range map is an estimate, it is the best available estimate of acres of occupied habitat for the Preble's in Colorado. The layer overestimates potential habitats elsewhere, by including areas of non-habitat.

Threats to the Preble's

Below we summarize threats to the Preble's. Our most recent 12-month status review for the Preble's published in the **Federal Register** on May 23, 2013, provides more detail and analysis regarding threats (78 FR 31679; https://federalregister.gov/a/2013-12387).

Agricultural Land Conversions:

Conversion of native riparian ecosystems to commercial croplands and grazed rangelands was identified as the major threat to the Preble's in Wyoming (Clark and Stromberg 1987; Compton and Hugie 1993). Certain grazing and haying management scenarios maintain what appears to be good habitat for the Preble's. However, intensive grazing and haying operations may negatively impact Preble's by removing food and shelter. While some Preble's populations coexist with livestock operations, overgrazing can decimate riparian communities on which the subspecies depends. Similarly, haying operations and the associated water development that allow significant riparian vegetation to remain in place appear to be compatible with persistence of Preble's populations. In fact, large populations of Preble's occur in grazed and hayed areas along Cottonwood Creek, Chugwater Creek, and Horse Creek in Wyoming.

Recreational Trails:

Recreational trail systems frequently parallel or intersect riparian communities and thus are common throughout Preble's. Trail development can alter natural communities and may impact the Preble's meadow jumping mouse by: Modifying nest sites, food resources, and hibernation sites; fragmenting habitat; and increasing predation. Humans and pets using these trails may alter behavior patterns of Preble's and cause a decrease in survival and reproductive success.

Habitat Fragmentation:

Habitat fragmentation limits the range and abundance of the Preble's. In general, as animal populations become more fragmented and isolated, it becomes more difficult for them to persist. Small, isolated patches of habitat are unable to support as many Preble's as larger patches of habitat. When threats to persistence are similar, larger populations are more secure from extirpation than smaller ones.

Hydrologic Changes:

Hydrology of a waterway influences the structure and function of the corresponding riparian ecosystems. Water development and management may facilitate development of lush riparian vegetation by maintaining more moisture in the riparian areas for longer periods, particularly during drought. However, changes in timing and abundance of water may also alter the channel structure, riparian vegetation, and the adjacent floodplain, which may be detrimental to the persistence of Preble's. Increased development and impervious surface within a drainage can result in more frequent and severe flood events and prevent the maintenance of riparian communities. Bank stabilization, channelization, and other measures to address flooding and storm water runoff have increased the rate of stream flow, straightened riparian channels, and narrowed riparian areas (Pague and Grunau 2000). Riprap and other stabilization structures designed to reduce erosion can destroy riparian vegetation, while preventing or prolonging its reestablishment. Erosion control measures can adversely alter the hydrologic processes and riparian plant communities such that Preble's populations can no longer persist.

Aggregate mining:

Alluvial aggregate extraction may produce long-term changes to Preble's habitat by altering hydrology and removing riparian vegetation. Extraction removes and often precludes reestablishment of habitat components required by the Preble's, such as vegetation for feeding and sheltering and deposits of alluvial sands and gravels that may be important hibernation locations for hibernation.

Transportation Corridors:

Transportation and utility corridors frequently cross Preble's meadow jumping mouse habitat and may negatively affect populations. Road construction and maintenance degrades, destroys, and fragments Preble's habitats. Roads and bridges also may act as barriers to dispersal.

Accidents within or near riparian areas may spill chemicals, fuels and other substances into wetlands and waterways that may impact the Preble's and its habitat. Sewer, water, communications, gas, and electric lines cross Preble's and contribute to habitat disturbance and fragmentation through new construction and periodic maintenance. Impacts related to construction are often temporary if adequate rehabilitation and reclamation actions are implemented.

Noxious weeds:

Invasive, noxious plants can encroach upon a landscape and displace native plant species. This change reduces the abundance and diversity of native plants, and may negatively impact cover and food sources for Preble's. The control of noxious weeds may also impact Preble's where large-scale removal of vegetation occurs through chemical treatments and mechanical mowing operations.

Pesticides and Herbicides:

Pesticides and herbicides are used within the range of the Preble's. Inappropriate use of these chemicals may harm the Preble's directly or when ingested with food or water. Overall, an integrated pest management approach (use of biological, chemical, and mechanical control) may help reduce the threat of chemicals, but allow for the control of target species.

Floods:

Floods occur throughout the Preble's range in the Wyoming and Colorado foothills and plains. Preble's and their streamside habitats evolved under historic flood regimes, so populations and habitats naturally respond to floods. While floods may affect Preble's populations by killing individuals and destroying riparian and adjacent upland habitats, the effects to vegetation are usually temporary. Vegetation typically reestablishes quickly after floods, although larger floods may delay recovery. Routine flooding may help maintain the vegetative communities that provide suitable habitat for the Preble's. Preble's that hibernate outside the 100-year floodplain are less likely to drown in a flood.

However, manmade increases in impervious surfaces and the loss of vegetation caused by human activities or catastrophic wildfire can result in an increased frequency and severity of flood events. Flooding is often a byproduct of wildfires and may act synergistically to alter the composition and structure of riparian ecosystems for many years (Ellis 2001, p. 159). Therefore, extreme floods may prevent the re-establishment of the Preble's favored riparian vegetation, forcing mice to disperse until habitats recover. Although an extreme flood can eliminate an entire Preble's population in an affected stream reach, floods are less likely to eliminate the Preble's from an entire drainage system if populations extend into side tributaries or headwaters unaffected by the flood. Therefore, maintaining the connectivity of riparian habitats between stream reaches is crucial to maintaining the security of Preble's populations faced with an increased incidence of flooding.

In September 2013, heavy rains in Colorado flooded streams and inundated many riparian and upland habitats occupied by the Preble's in Larimer, El Paso, Boulder, and Weld Counties. By drowning Preble's, scouring vegetation, removing topsoil, and depositing debris, early estimates suggest that the flood disaster affected approximately 60 percent of the Preble's occupied range and approximately 70 percent of its designated critical habitat in Colorado.

Many Preble's may have drowned where the flash floods were large, unpredictable, or destructive. Throughout the flood disaster zone, especially in more mountainous (montane) habitats of the Front Range foothills, the flash floods completely inundated the Preble's habitats, with the fast moving floodwaters often extending far beyond the limits of the floodplain. Many Preble's in these high intensity flash flood areas may not have been able to escape the floodwaters and washed downstream or drowned. Preble's densities were low before the flood disaster, especially in the montane habitats at the westernmost extent of the Preble's range, so the floods may have significantly reduced rangewide population numbers.

Trapping surveys, habitat evaluations, and remote imagery will be necessary to gauge the full effect of the flood disaster on the Preble's. Although population and habitat losses were likely significant across approximately 60 percent of the Preble's occupied range, some Preble's may have survived. Survivors will be critical to the Preble's recovery in the flood disaster zone.

Wildfire:

Fire, particularly catastrophic fires, can alter habitat dramatically and change the structure and composition of the vegetation communities such that the Preble's may no longer persist. In addition, precipitation falling in a burned area may degrade Preble's habitat by causing greater levels of erosion and sedimentation. Controlled use of fire may be one method to maintain appropriate riparian, floodplain, and upland vegetation within Preble's habitat. However, over the past several decades, as human presence has increased throughout the Preble's range, significant effort has been made to suppress fires. Long periods of fire suppression may result in a build-up of fuel and result in a catastrophic fire that significantly impacts Preble's habitats by burning vegetation or increasing catastrophic floods.

Predation:

The increasing presence of humans near Preble's habitats may result in increased level of predation that may pose a threat to the mouse. The striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), red fox, and the domestic and feral cat are found in greater densities in and around areas of human activity; all four of these species feed opportunistically on small mammals. Introduction of species such as the bullfrog into waters within the Preble's range may result in additional predation. The fact that summer mortality is higher than overwinter mortality underscores the impact that predators can have on Preble's.

Climate Change:

Climate change may negatively affect the Preble's meadow jumping mouse and its habitat, primarily by causing changes in stream flows resulting in reduced quality and quantity of

riparian habitats. Trends of warming in the mountains of western North America could decrease snowpack, hasten spring runoff, and reduce summer flows (IPCC 2007a). While fewer cold days and nights could result in increased plant biomass yield in colder environments, increased summer heat may increase the frequency and intensity of wildfires, decrease the productivity of riparian vegetation, and increase the frequency and duration of droughts (IPCC 2007a). Stream-flow reductions or seasonal changes in flow due to climate change will probably cause a greater disruption in those watersheds with a high level of human development (Hurd *et al.* 1999) where human demands for water resources are greatest.

Preble's meadow jumping mouse Critical Habitat

The Service designated critical habitat for the Preble's meadow jumping mouse in 50 CFR 17.68 on June 23, 2003 (68 FR 37275; https://federalregister.gov/a/03-14490) and revised critical habitat for the subspecies on December 15, 2010 (74 FR 52066; https://federalregister.gov/a/2010-30571). Critical habitat for the Preble's mouse includes approximately 411 miles of rivers and streams and 34,935 acres (14,138 hectares) of lands in Colorado (75 FR 78450). Lands designated as critical habitat are under Federal, State, local government, and private ownership. No lands designated as critical habitat are under Tribal ownership.

This biological opinion does not rely on the regulatory definition of destruction or adverse modification of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statute and the August 6, 2004, Ninth Circuit Court of Appeals decision in *Gifford Pinchot Task Force v. U.S. Fish and Wildlife Service* (No. 03-35279) to complete our analysis with respect to critical habitat.

Primary constituent elements are physical and biological features essential to the conservation of the species and that may require special management considerations and protection. Primary constituent elements for the Preble's include those habitat components essential for the biological needs of reproducing, rearing of young, foraging, sheltering, hibernation, dispersal, and genetic exchange are:

(1) Riparian corridors: formed and maintained by normal, dynamic, geomorphological, and hydrological processes that create and maintain river and stream channels, floodplains, and floodplain benches and that promote patterns of vegetation favorable to the Preble's; containing dense, riparian vegetation consisting of grasses, forbs, or shrubs, or any combination thereof, in areas along rivers and streams that normally provide open water through the Preble's active season; and including specific movement corridors that provide connectivity between and within populations. This may include river and stream reaches with minimal vegetative cover or that are armored for erosion control; travel ways beneath bridges, through culverts, along canals and ditches; and other areas that have experienced substantial human alteration or disturbance.

(2) Additional adjacent floodplain and upland habitat with limited human disturbance (including hayed fields, grazed pasture, other agricultural lands that are not plowed or

disked regularly, areas that have been restored after past aggregate extraction, areas supporting recreational trails, and urban–wildland interfaces).

Existing human-created features and structures within the boundaries of the mapped critical habitat units, such as buildings, roads, parking lots, other paved areas, manicured lawns, other urban and suburban landscaped areas, regularly plowed or disked agricultural areas, and other features not containing any of the PCEs that support the Preble's are not considered critical habitat.

Designated critical habitat units include only river and stream reaches, and adjacent floodplains and uplands that are within the known geographic and elevational range of the Preble's, and have at least one of the primary constituent elements present, and, based on the best scientific data available, are believed to currently support the Preble's.

We considered several qualitative criteria to judge the current status and probable persistence of Preble's populations in the selection and designation of specific areas as critical habitat. These include:

- The quality, continuity, and extent of habitat components present;
- The state of natural hydrological processes that maintain and rejuvenate suitable habitat components;
- The presence of lands devoted to conservation, either public lands such as parks, wildlife management areas, and dedicated open space, or private lands under conservation easements; and
- The landscape context of the site, including the overall degree of current human disturbance and presence, and likelihood of future development based on local planning and zoning.

Activities with the potential to alter the primary constituent elements are those that result in development or alteration of the landscape within a unit, including land clearing activities associated with construction for urban and industrial development; some agricultural activities; activities resulting in changes in the hydrology of a unit; activities that detrimentally alter natural processes in a unit, and; activities that could lead to the introduction, expansion, or increased density of exotic plant or animal species detrimental to Preble's and its habitat.

We used the Preliminary Draft Recovery Plan (Draft Plan) for the Preble's (USFWS 2003) and its concepts as a source of the best scientific and commercial data available on the Preble's, and as a catalyst to identify areas that are essential for the conservation of Preble's. To recover Preble's to the point where it can be delisted, the Draft Plan identifies the need for a specified number, size, and distribution of wild, self-sustaining Preble's populations across its known range.

The Draft Plan identifies recovery criteria for two Recovery Units where the Preble's occurs: The North Recovery Unit and the South Recovery Unit. The Denver metropolitan area roughly separates the two recovery units. The Draft Plan uses 8-digit HUC boundaries to define

subdrainages, and identifies 13 HUCs as occupied or potentially occupied. Of these, six are located in the North Recovery Unit, and seven are located in the South Recovery Unit. Furthermore, the Draft Plan defines large populations as maintaining 2,500 mice and usually including at least 50 miles of rivers and streams. Medium populations maintain 500 mice over at least 10 miles of rivers and streams, and small populations maintain 150 mice over 3 miles of stream. In addition, the Draft Plan calls for one large and two medium populations in three separate HUCs, as well as three small populations within each of the remaining three HUCs within the North Recovery Unit, and one large population and two medium populations in three separate HUCs, as well as three small populations in each of the remaining four HUCs within the South Recovery Unit. We are currently in the process of updating the Draft Plan.

ENVIRONMENTAL BASELINE

The environmental baseline is the past and present effects of all Federal, State, or private actions and other human activities in the action area, the anticipated effects of all proposed Federal actions in the action area that have already undergone formal or early section 7 consultation, and the effects of State or private actions that are contemporaneous with the consultation in progress.

Status of the Preble's meadow jumping mouse within the Proposed Project and Action Areas

Pre-flood surveys confirmed the presence of Preble's in 2005 within the project area as well as downstream in the vicinity of the Town of Lyons (surveys conducted from 1997 to 1999). We recognize that habitat along the creeks was lost or damaged during the flooding, and that Preble's meadow jumping mouse populations likely suffered. The species is, however, adapted to a flood regime and so we also assume that some individuals were able to survive the flood, find suitable hibernation habitat, and emerge in spring. Post-flood surveys have not been conducted within the project site; however, post-flood trapping identified a Preble's mouse approximately 5 miles downstream on the St. Vrain River during the summer of 2014.

The stream and river banks in the project area were heavily scoured and eroded by the September 2013 flood, which left a combination of silt, sand, cobble, large rocks and flood-transported debris in the project area. Much of the riparian vegetation in the area was removed by the flood. Since that time, vegetation has started to return in the form of grasses and small shrubs. Based on the post-flood observation of a Preble's mouse downstream and the regrowth of vegetation in the project area, we consider the project area to be occupied.

At this time, we lack a concise population estimate (mice per acre or mice per stream mile) for the Preble's meadow jumping mouse in the project area. In the Draft Plan (2012), we estimated that good habitat located within a broad floodplain could support a maximum of 50 mice per stream mile. Given that the proposed project will occur within a degraded riparian system with a narrow floodplain containing only moderate or low quality habitat, we assume that the area is capable of supporting a maximum of 10 mice per stream mile. Based on this population estimate, the 1000'-foot reach of South St. Vrain River within the project area may support up to two (2) Preble's mouse.

Regulatory Actions under the ESA Completed by the Service for the Preble's meadow jumping mouse

Since listing the Preble's meadow jumping mouse in May 1998, we have conducted 170 formal consultations pursuant to section 7 of the ESA and issued 22 incidental take permits pursuant to section 10(a)(1)(B) of the ESA for the Preble's in Colorado. In Wyoming, we have completed 13 formal consultations under section 7 of the ESA, but have not issued any incidental take permits under section 10(a)(1)(B) of the ESA.

Table 1 below summarizes the total acres of habitat loss exempted or incidental take permitted by the Service through these actions in Colorado and Wyoming. Throughout the Preble's range, we have permitted take of approximately 3.4 percent of CPW's occupied range for Colorado (Table 1). We provided this take to a variety of projects, including residential and commercial developments, transportation projects, recreational facilities, and water supply projects.

Table 1. Total acres of permanent and temporary Preble's habitat loss exempted or incidental take permitted by the Service under the ESA between May 1998 and March 2015, in Colorado and Wyoming.

Regulatory Authority of the ESA	Number of Exemptions or Permits		Permanent Take (acres)		Temporary Take‡ (acres)	
	Colorado	Wyoming	Colorado	Wyoming	Colorado	Wyoming
Section 7 (Federal consultations)	170	13	835.01	70.97	1,392.27	42.69
Section 10 (non-Federal consultations)	22	0	426.3 *	0	270*	0
STATE TOTALS =	192	13	1,261.31*	70.97	1,662.27*	42.69
RANGEWIDE TOTAL =	205		1,332.28*		1,704.96*	
Percent of Preble's Occupied Range (CPW layer†) in Colorado			1.48%		1.90%	
			3.4%			

* The total acres of permanent and temporary take exempted under section 10 does not include the Livermore Habitat Conservation Plan (HCP) in Larimer County, Colorado, completed in January 2004, which exempts up to 3,357 acres of permanent habitat loss. As of March 2015, there are no enrollments in the Livermore HCP and we have not completed any section 10 consultations in Wyoming.

† Colorado Parks and Wildlife (CPW) created their occupied range data layer for Preble's by buffering upstream and downstream habitats around positive capture locations, thereby estimating that there are 89,771.7 acres of occupied Preble's range in Colorado. We lack a similar estimate for Wyoming, so we use the estimate for Colorado as a conservative rangewide estimate.

‡ Project proponents completely restore, and often enhance, habitats that they temporarily impact.

Factors Affecting the Environment of the Preble's meadow jumping mouse within the Action Area

The landscape surrounding the project corridor has been affected by human activities such as houses, outbuildings, and grazing that have likely degraded and fragmented habitat along the South St. Vrain River. The September 2013 flood scoured much of the project area and removed many of the areas providing Preble's habitat. Grasses and small shrubs are starting to grow back in the project area.

Status of Preble's meadow jumping mouse Critical Habitat within the Action Area

Critical habitat has not been designated in the project area; therefore, none will be affected.

EFFECTS OF THE ACTION

The project corridor is considered habitat for the Preble's meadow jumping mouse and its presence in the vicinity has been confirmed. The proposed project will temporarily affect 1.9 acres of Preble's meadow jumping mouse habitat along 0.18 miles of stream. These impacts will be due to the temporal loss of habitat caused by excavation, construction, back filling, and revegetation activities on the stream bank and along the Old South St. Vrain Road.

Effects to the Preble's meadow jumping mouse

Direct effects of the project could include disruption of normal behavior, and injury or mortality to mice due to excavation or crushing by construction equipment or workers. Noise associated with heavy equipment may also disrupt normal behaviors. Habitat quality will be reduced following construction and post-restoration activities, but these effects will be temporary, and the species' use of this habitat is expected to resume once the habitat recovers.

During and after construction, opportunistic weeds may colonize disturbed soils, degrading habitat and hindering the establishment of native species. However, monitoring and weed management should minimize any habitat loss associated with invasive plants. Furthermore, revegetation and monitoring of temporarily disturbed areas will ensure that habitats are of similar or better quality than those present before construction.

Because of the short duration of the proposed project, we do not think that climate change will affect the species.

Using the methodology provided above in the ***Status of the Preble's meadow jumping mouse within the Proposed Project and Action Areas*** section, we anticipate that up to two (2) Preble's meadow jumping mouse could be taken by completion of the project. Given the amount and condition of the habitat, we believe that this is a reasonable estimate.

Although the project will result in temporary impacts to Preble's meadow jumping mouse habitat, we expect that after restoration is complete, habitat should be as good as or better than before project construction.

Cumulative Effects

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Completion of the proposed project will not increase access to currently undeveloped lands, nor will it result in an increase in predators such as skunks, raccoons, or domestic cats. We also do not anticipate a long-term increase in weeds due to the project.

Future development, transportation, recreation, or water supply projects could impact the Preble's meadow jumping mouse and its habitats within the action area. However, these projects would more than likely require Federal review. We are not aware of any future State, local, or private actions expected to occur within the action area that would not require some type of Federal permitting or review due to potential impacts to waterways, wetlands, or the habitats of federally listed species. Therefore, at this time, we have not identified specific projects that meet the criteria for cumulative effects within the action area.

CONCLUSION

The Service defines "jeopardize the continued existence of" as to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR § 402.02).

Recovery calls for improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria identified in section 4(a)(1) of the ESA (50 CFR § 402.02).

After reviewing the current status of the affected species, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the Preble's. We base our conclusion on the following:

- The action area constitutes a small portion of the species' entire range. Although take of Preble's meadow jumping mouse from project implementation is possible, the anticipated level is small in proportion to the size of the population as a whole. These actions would not preclude recovery.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to 4(d) of the ESA prohibit the take of endangered and threatened animals, respectively, without special exemption. Take is to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. The Service further defines "harm" to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering. The Service defines "harass" as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavioral patterns, which include but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the FWCO so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The FWCO has a continuing duty to regulate the activity covered by this incidental take statement. If the FWCO and the other partners (1) fail to assume and implement the terms and conditions, or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the applicant must report the progress of the action and its impact on the species or subspecies to the Service as specified in the incidental take statement. [50 CFR § 402.14(i)(3)]

AMOUNT OR EXTENT OF TAKE:

The Service anticipates that the proposed project will result in incidental take of 1.9 acres of Preble's habitat on approximately 1.8 miles of stream and the incidental take of no more than two (2) individual mice. This take will be difficult to detect because of the species' small size, solitary nature, and hibernation underground. However, we estimate the amount of take by considering the loss of food, cover, other essential habitat elements, and disturbance. Because the project will make an effort to avoid remaining riparian vegetation, where possible, we conclude that the potential take of two Preble's mice represents a conservative and maximum number that may result from construction of the proposed project.

In the above biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species. Critical habitat has not been designated in the project area; therefore, none will be affected.

Reasonable and Prudent Measures

The reasonable and prudent measures, and implementing terms and conditions, minimize the effects of incidental take that might otherwise result from the action. In addition to the

Conservation Measures already proposed as part of the project description, the Service believes that the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of the Preble's meadow jumping mouse:

1. The FWCO and Crane and Associates will monitor the extent of habitat impacted to ensure that it does not exceed the authorized area or the authorized take limits.

2. The FWCO will monitor all aspects of restoration to assure project completion and success.

3. The FWCO and Crane and Associates will ensure that best management practices and conservation measures designed to minimize take are implemented and successful.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, FWCO must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring. These terms and conditions are non-discretionary.

The following terms and conditions implement reasonable and prudent measures:

1. FWCO shall ensure that proposed conservation measures (outlined above and in the biological assessment) are formally adopted and implemented, including burying and revegetating riprap. During construction, project compliance monitoring will be provided by Crane Associates.

2. FWCO and Crane and Associates shall monitor the revegetation of all temporarily disturbed areas, enhanced areas, and restored areas for at least three (3) growing seasons following habitat restoration and enhancement activities, or until such time that the FWCO and the Service determine that success has been achieved. FWCO shall monitor for presence of weeds. Weed management will be provided by Crane and Associates.

   Success criteria is defined as:

   a. Grass and forb cover at revegetated sites is 80 percent of cover at adjacent areas (i.e., undisturbed by project activities).
   b. Survival rate of willow stakes is 65 percent.
   c. Percentage of weed cover in project site is no more than 5 percent of adjacent areas.

3. Monitoring reports will be provided annually to the Service by December 1.

4. In the unlikely event that a Preble's meadow jumping mouse is encountered (dead, injured, or hibernating), the Colorado Field Office of the Service shall be contacted immediately at (303) 236–4773.

The Service believes that the proposed action will adversely affect no more than 1.9 acres of Preble's meadow jumping mouse habitat on 1.8 miles of stream, resulting in incidental take of no more than two (2) Preble's meadow jumping mouse. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action.

If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. FWCO must immediately provide an explanation of the causes of the increased level of taking and review with the Service the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS:

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

We have no conservation recommendations at this time.

REINITIATION NOTICE:

This concludes formal consultation on Meadows/South Ledge Ditch Diversion on South St. Vrain River, Boulder County, Colorado. As required by 50 CFR § 402.16, reinitiation of formal consultation is required if:

1. The amount or extent of incidental take is exceeded;

2. New information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion;

3. The agency action is subsequently modified in a manner that causes an adverse effect to the listed species or critical habitat that was not considered in this opinion; or

4. A new species is listed or critical habitat designated that may be affected by the action.

At any time, if incidental take exceeds the take authorized by this biological opinion, any operations causing such take must cease pending reinitiation.

If the Service can be of any additional assistance, please contact Leslie Ellwood of the Colorado Field Office by telephone at (303) 236–4747 or by email to leslie_ellwood@fws.gov.

ec: Ellwood

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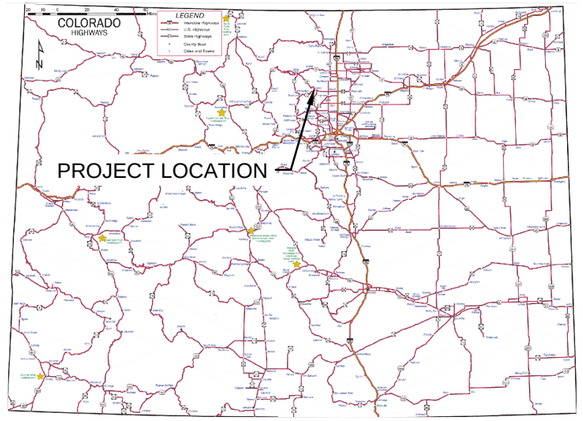
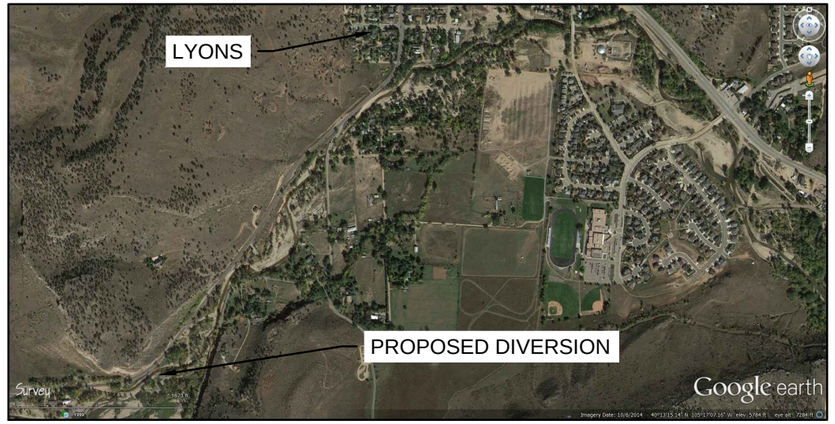
APPENDIX B
PROJECT PLAN SET

MEADOWS & SOUTH LEDGE DITCHES FINAL RECONSTRUCTION PLAN
SOUTH ST. VRAIN CREEK

TABLE OF CONTENTS



COLORADO STATE MAP



PROJECT VICINITY MAP

UTILITY NOTIFICATION

NOTICE TO COOPERATOR AND CONTRACTOR

NO REPRESENTATION IS MADE BY THE NATURAL RESOURCES CONSERVATION SERVICE AS TO THE EXISTENCE OR NONEXISTENCE OF UNDERGROUND UTILITIES. CALL 2 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES. CALL THE UTILITY NOTIFICATION CENTER OF COLORADO AT 1-800-922-1987 OR 811. IN THE DENVER METRO AREA CALL 303-232-0491 OR 811.

UNCC TICKET NUMBER: _____

COLORADO REGISTERED DAVID E. MOORE 22495 PROFESSIONAL ENGINEER

Symbol | Description | Date Approved

CRANE ASSOCIATES

Designed by: JEFF CRANE | Drawn by: JAR | Checked by: JC | Reviewed by: | Submitted by:

Date: MAR 31, 2015 | Rev:
Design file no:
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File name:
Plot date:
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SOUTH ST. VRAIN CREEK
MEADOWS & SOUTH LEDGE DITCHES
FINAL RECONSTRUCTION PLAN

COVER

Sheet reference number: C

UPDATE

LEGEND

THALWEG

CONSTRUCTION LIMITS (BOUNDER COUNTY)

PARCEL BOUNDARY

PROPOSED CONTOURS

EXISTING COUNTOURS

N

SCALE: 1" = 60'

0 60'

EXISTING MEADOWS DITCH HEADGATE

5384.78 EX GATE INV

5382.00 TW

5385.72 CL

16+00

5383.07 CL

5382.49 CL

16+10

CL MEADOWS DITCH

15+00

WB

TS

SF

DITCH COMPANY RESPONSIBLE TO CLEAN DITCH TO PRE FLOOD INVERTS

CURVED 18" HDPE Pipe
LENGTH = 168.9
N27° 57' 03.37"E

5384

SOUTH ST. VRAIN CREEK

5390.03 EOA

Sta=15+17
18" FLARED CULVERT END SECTION AND 48" X 10' ROCK APRON

STAGING AREA

14+00

CP CA1 MAG
N:1320526.541
E:3062000.762
EL:5390.88

5385

5390.82 EOA

5390

OLD ST. VRAIN ROAD

13+00

5385

5391.68 EOA

12+00

5392.46 EOA

5390

18" HDPE Pipe
LENGTH = 390.5
N13° 44' 21.42"E

CITY OF LONGMONT
BOULDER COUNTY PARKS & OPEN SPACE

CP CA2 60D
N:1320214.091
E:3061943.083
EL:5393.48

11+00

1+55

DITCH COMPANY RESPONSIBLE TO CLEAN DITCH TO PRE FLOOD INVERTS

CENTERLINE SOUTH LEDGE DITCH

5385.00 TW

ALL CONSTRUCTION DEBRIS TO BE SWEPT FROM ROADWAY FOLLOWING CONSTRUCTION

1+00

30 CFS PARSHALL FLUME

10 CFS PARSHALL FLUME

5388.90 EX INV

3" THICK ASPHALT PATCH, AREA = 230 SF

5394.32 EOA

10+00

36" HDPE Pipe
LENGTH = 71.2
N38° 01' 56.67"E

20' PIPE SECTION

9+00

Sta=9+55.1
SPLITTER BOX 2

COLORADO REGISTERED
DAVID E. MOORE
22495
PROFESSIONAL ENGINEER

CRANE ASSOCIATES

Rev: | Description | Date Approved | Symbol

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SOUTH ST. VRAIN CREEK
MEADOWS & SOUTH LEDGE DITCHES
FINAL RECONSTRUCTION PLAN
BOULDER COUNTY, COLORADO

PLAN VIEW – NORTH

Sheet reference number: 1

UPDATE

LEGEND

THALWEG

CONSTRUCTION LIMITS (BOULDER COUNTY)

PARCEL BOUNDARY

PROPOSED CONTOURS

EXISTING COUNTOURS

COLORADO REGISTERED DAVID E. MOORE 22495 PROFESSIONAL ENGINEER

N

SCALE: 1" = 60'

0 60'

NOTE:
1. DELINEATE LIMITS OF CONSTRUCTION WITH ORANGE CONSTRUCTION FENCING OR SILT FENCE.
2. FENCE SELECT TREES WITHIN THE CONSTRUCTION LIMITS AT DRIP LINE.

ALL CONSTRUCTION DEBRIS TO BE SWEPT FROM ROADWAY FOLLOWING CONSTRUCTION

10 CFS PARSHALL FLUME

3" THICK ASPHALT PATCH, AREA = 230 SF

20' PIPE SECTION

EXISTING 48" CMP. ASSUMED INV. ELEV. - 5390.3

EXISTING DAMAGED SOUTH LEDGE DITCH HEADGATE. TO BE REMOVED.

EDGE OF ASPHALT

STAGING AREA

16' WIDE STABILIZED STONE CONSTRUCTION ENTRANCE PER SECTION 5-5 OF THE BOULDER COUNTY MULTIMODAL TRANSPORTATION STANDARDS

200 LF/20' OC ROOT WAD REVETMENT

MILE-MARKER POST 32

COLO ST. HWY 7

SOUTH ST. VRAIN CREEK

5402.71 TW

Sta=0+35

Sta=0+75

CONC INTAKE STRUCTURE (see details)

EX. GUY WIRES

36" HDPE Pipe
LENGTH = 475.6
N88° 56' 52.44"E

STAGING AREA

SILT FENCE

ALL CONSTRUCTION DEBRIS TO BE SWEPT FROM ROADWAY FOLLOWING CONSTRUCTION

3" THICK ASPHALT PATCH AREA = 400 SF

5385.00 TW

30 CFS PARSHALL FLUME

5388.90 EX INV

5394.32 EOA

36" HDPE Pipe
LENGTH = 71.2
N38° 01' 56.67"E

Sta=9+55.1
SPLITTER BOX 2
RIM ELEV. = 5394.4

5390.30 EX INV

PROPOSED GRADING

Sta=8+64

5388.00 TW

NEW TRIB. CHANNEL

OLD ST. VRAIN ROAD

CP CA3 MAG
N:1319949.956
E:3061850.732
EL:5396.27

5396.50 EOA

36" HDPE Pipe
LENGTH = 396.1
N16° 17' 13.92"E

5390.00 TW

SILT FENCE

ONE LANE OF OLD ST. VRAIN ROAD TO BE USED FOR EQUIPMENT STORAGE AND FUEL STAGING

16' WIDE STABILIZED STONE CONSTRUCTION ENTRANCE W/ TEMPORARY 48" CULVERT PER SECTION 5-5 OF THE BOULDER COUNTY MULTIMODAL TRANSPORTATION STANDARDS

SECTION 5+70

WATER TIGHT MANHOLE 1
WITH SEALED LID
5+53.1
RIM ELEV = 5398.90

SECTION 5+53.1

5392.65 TW

5399.03 EOA

CHANNEL ARMORING SEE DETAILS. ARMORING TO EXTEND 10' DOWNSTREAM OF PIPE. ALL ROCK TO BE AT OR BELOW THE BOTTOM OF THE EXISTING DITCH.

SECTION 5+26

CP CA4 MAG
N:1319668.945
E:3061755.090
EL:5399.96

Description | Date Approved | Symbol

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Date: MAR 31, 2015 | Rev:
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SOUTH ST. VRAIN CREEK MEADOWS & SOUTH LEDGE DITCHES FINAL RECONSTRUCTION PLAN
BOULDER COUNTY, COLORADO
PLAN VIEW – SOUTH

Sheet reference number: 2

UPDATE

LEGEND

THALWEG

PROPOSED CONTOURS

EXISTING COUNTOURS

N

SCALE: 1" = 20'

0 20'

GRAVITY RETAINING WALL
SEE DETAILS

5410

5405

5400

0+00

MILE-MARKER
POST 32

200 LF/20' OC ROOT WAD REVETMENT

3' TO 6' DIA BOULDERS BURIED AT THE
HEAD OF EX RIFFLE FOR GRADE CONTROL

COLO ST. HWY 7

5405

0+00

1+00

5410

Sta=0+35

EX EDGE OF
SOUTH ST VRAIN
CREEK

5405

5405

1+00

Sta=0+75

CONC INTAKE
STRUCTURE (see
details)

EX. GUY WIRES

150 LF OF ROCK & ROOT WAD
REVETMENT TO STABILIZE BANK &
PROTECT POWER POLE GUY WIRES

PROP EDGE OF CREEK

COLORADO REGISTERED
DAVID E. MOORE
22495
PROFESSIONAL ENGINEER

Symbol	Description	Date Approved

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SOUTH ST. VRAIN CREEK
MEADOWS & SOUTH LEDGE DITCHES
FINAL RECONSTRUCTION PLAN
BOULDER COUNTY, COLORADO

INTAKE STRUCTURE PLAN VIEW

Sheet reference number: 3

UPDATE

LEGEND

THALWEG

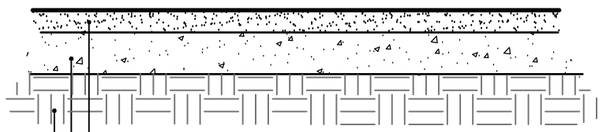
PROPOSED CONTOURS

EXISTING COUNTOURS

N

SCALE: 1" = 20'

0 20'



3" PLANT MIX BITUMINOUS PAVEMENT, TYPE II–B
6" CRUSHED GRAVEL BASE COURSE
6" COMPACTED SUBGRADE PREP, 95% STANDARD PROCTOR

ASPHALT PATCHING SECTION

NOT TO SCALE

NOTE: CULVERT AND ALL FILL IN CHANNEL TO BE REMOVED UPON COMPLETION. CHANNEL TO BE RESTORED TO PRE-CONSTRUCTION CONDITIONS

ALL CONSTRUCTION DEBRIS TO BE SWEPT FROM ROADWAY FOLLOWING CONSTRUCTION

3" THICK ASPHALT PATCH AREA = 400 SF

48" CULVERT TO BE REMOVED FOLLOWING COMPLETION OF CONSTRUCTION

16' WIDE CONSTRUCTION ENTRANCE

SECTION 5+70

WATER TIGHT MANHOLE 1 WITH SEALED LID
5+53.1
RIM ELEV = 5398.90

SECTION 5+53.1

5392.65 TW

5399.03 EOA

CHANNEL ARMORING SEE DETAILS. ARMORING TO EXTEND 10' DOWNSTREAM OF PIPE. ALL ROCK TO BE AT OR BELOW THE BOTTOM OF THE EXISTING DITCH.

SECTION 5+26

R15.00

R5.00

63°

3'-0"

5400

5395

4+00

5+00

6+00

10+00

11+00

11+43

COLORADO REGISTERED PROFESSIONAL ENGINEER
DAVID E. MOORE
22495

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CRANE ASSOCIATES

Date: MAR 31, 2015 | Rev:
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File name:
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Plot scale:
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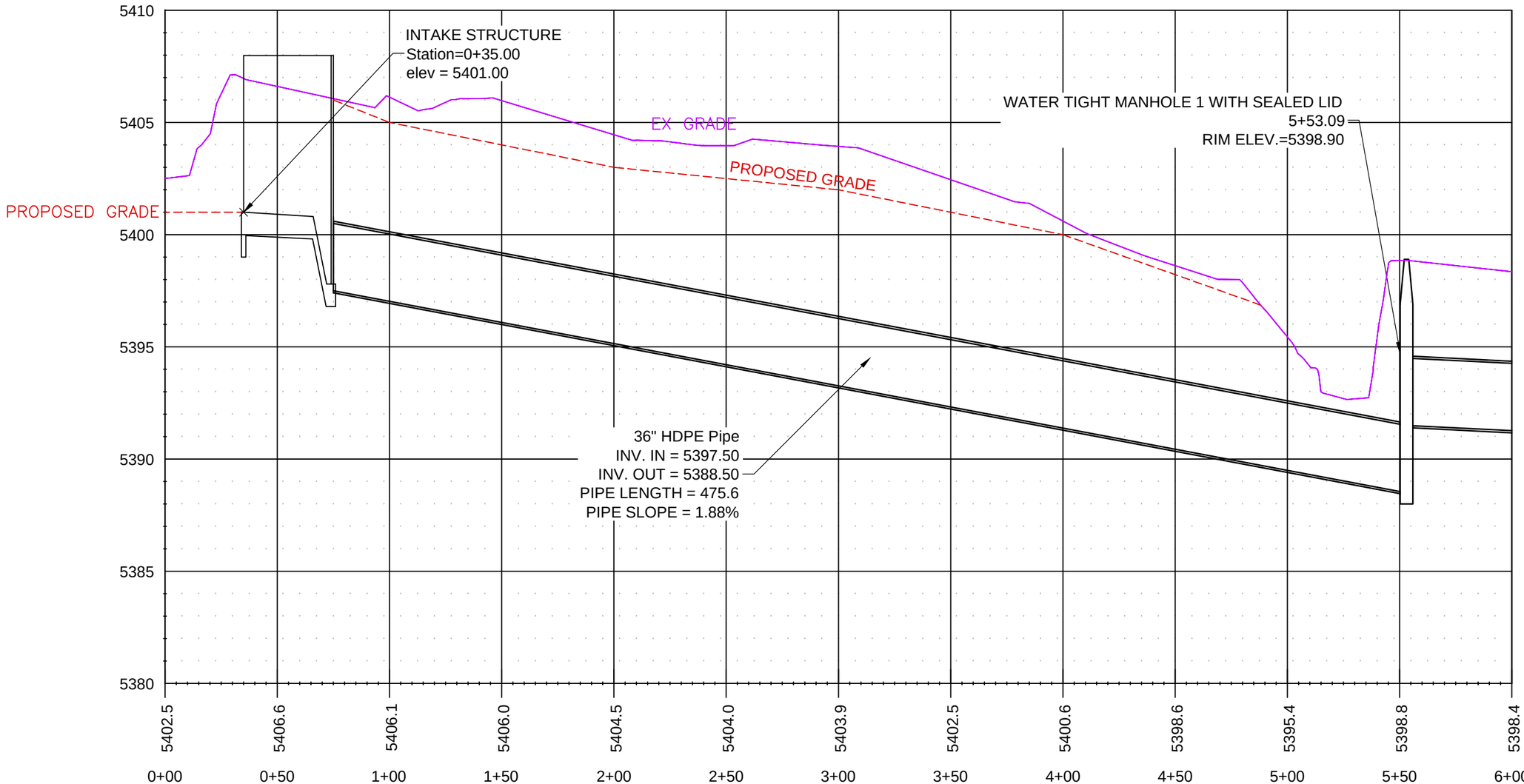
SOUTH ST. VRAIN CREEK
MEADOWS & SOUTH LEDGE DITCHES
FINAL RECONSTRUCTION PLAN
BOULDER COUNTY, COLORADO
MANHOLE AND CONSTRUCTION ENTRANCE PLAN VIEW

Sheet reference number: 4

UPDATE

SCALE: 1" = 50'

0 50'



MEADOWS AND SOUTH LEDGE DIVERSION PROFILE
HORIZONTAL SCALE 1"=50'
VERTICAL SCALE 1"=5'

COLORADO REGISTERED
DAVID E. MOORE
22495
PROFESSIONAL ENGINEER

Symbol | Description | Date | Approved

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Date: MAR 31, 2015 | Rev:
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SOUTH ST. VRAIN CREEK
MEADOWS & SOUTH LEDGE DITCHES
FINAL RECONSTRUCTION PLAN
BOULDER COUNTY, COLORADO

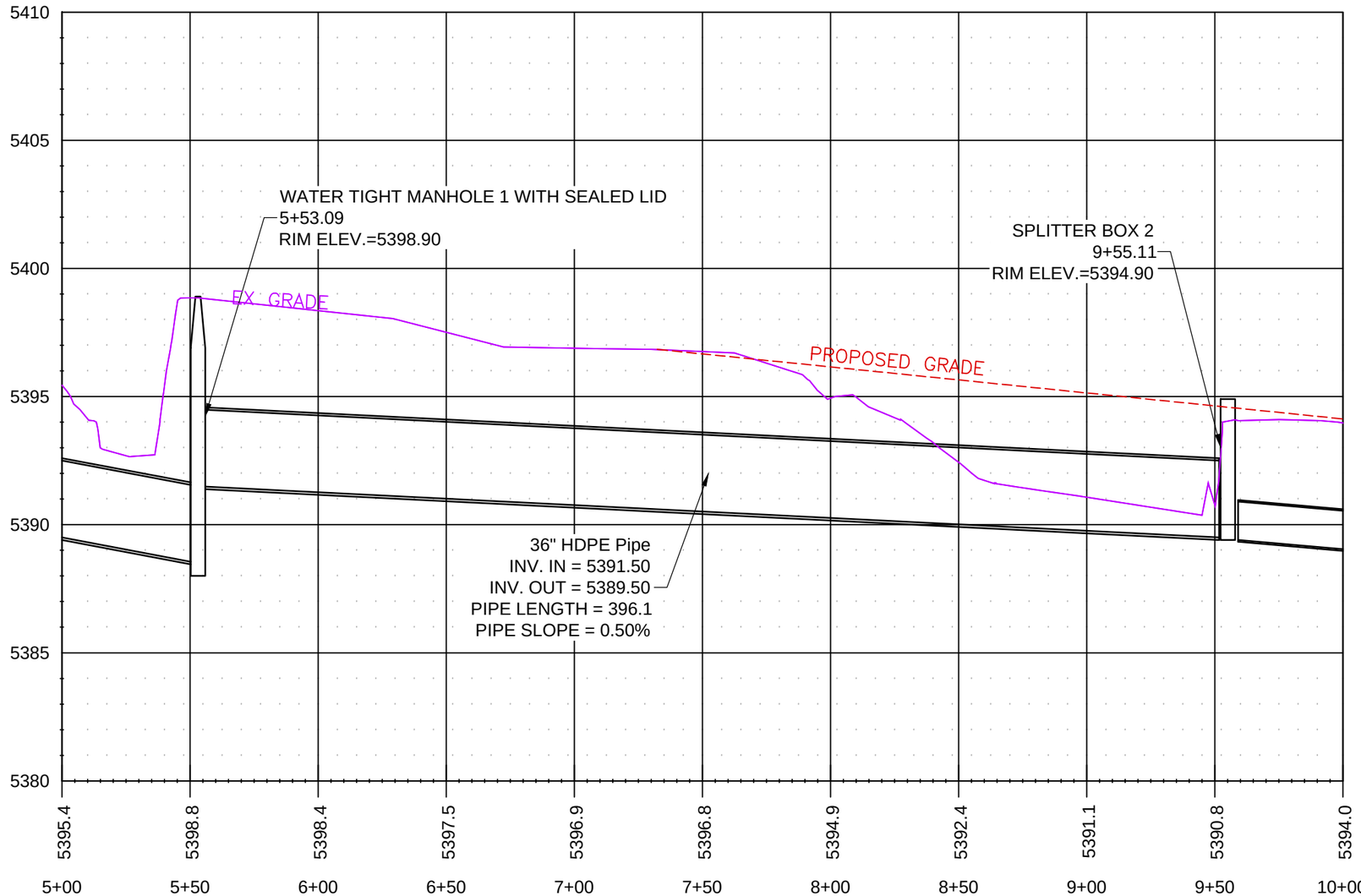
DIVERSION PROFILE

Sheet reference number: 5

UPDATE

SCALE: 1" = 50'

0 50'



MEADOWS AND SOUTH LEDGE DIVERSION PROFILE
HORIZONTAL SCALE 1"=50'
VERTICAL SCALE 1"=5'

COLORADO REGISTERED PROFESSIONAL ENGINEER
DAVID E MOORE
22495

Symbol	Description	Date	Approved

CRANE ASSOCIATES

Designed by: JEFF CRANE | Date: MAR 31, 2015 | Rev:
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Reviewed by: JPC | Ckd by: | Drawing Code:
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SOUTH ST. VRAIN CREEK
MEADOWS & SOUTH LEDGE DITCHES
FINAL RECONSTRUCTION PLAN
BOULDER COUNTY, COLORADO

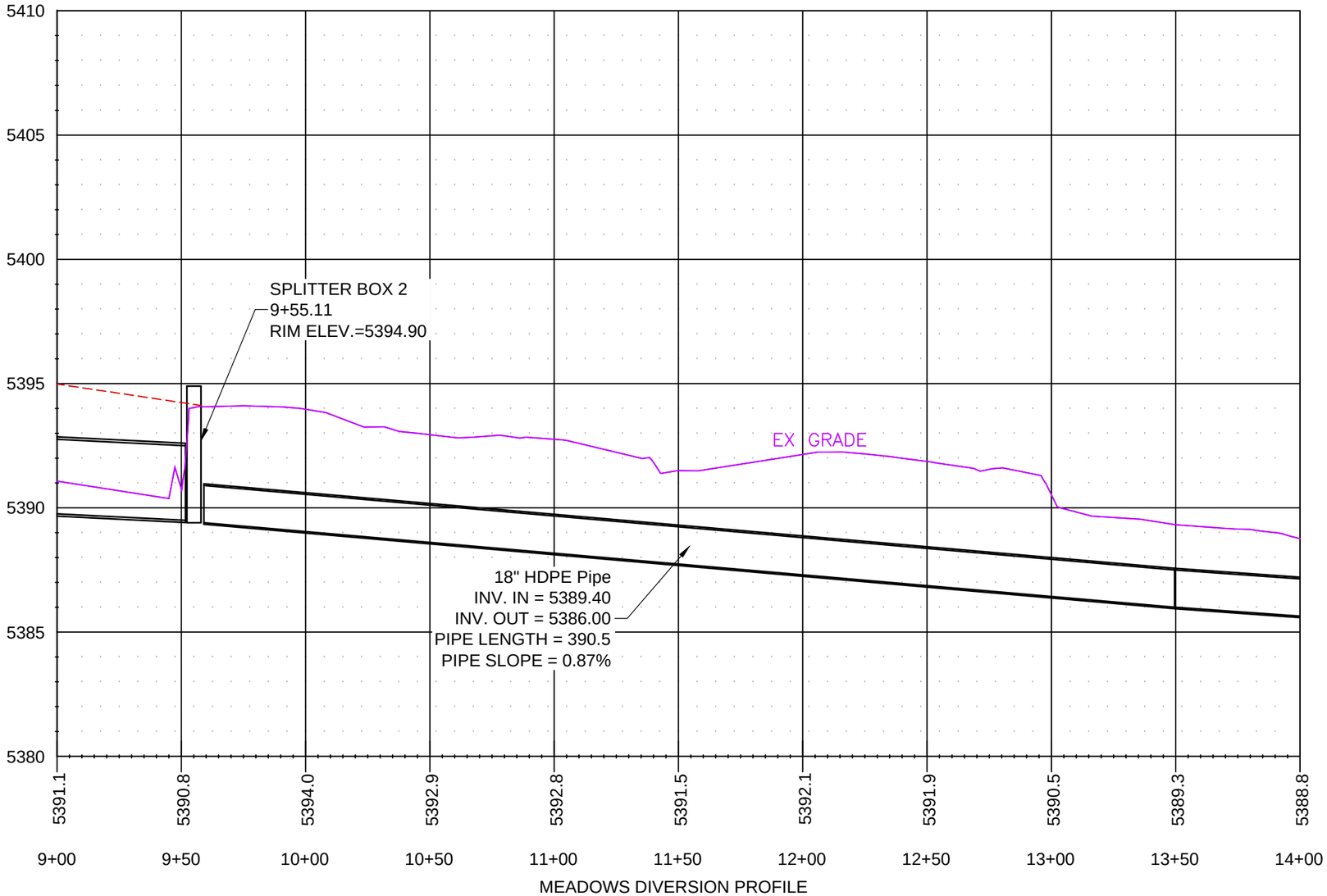
DIVERSION PROFILE

Sheet reference number: 6

UPDATE

SCALE: 1" = 50'

0 50'



MEADOWS DIVERSION PROFILE
HORIZONTAL SCALE 1"=50'
VERTICAL SCALE 1"=5'

COLORADO REGISTERED
DAVID E MOORE
22495
PROFESSIONAL ENGINEER

Symbol	Description	Date	Approved

CRANE ASSOCIATES

Date: MAR 31, 2015
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SOUTH ST. VRAIN CREEK
MEADOWS & SOUTH LEDGE DITCHES
FINAL RECONSTRUCTION PLAN
BOULDER COUNTY, COLORADO

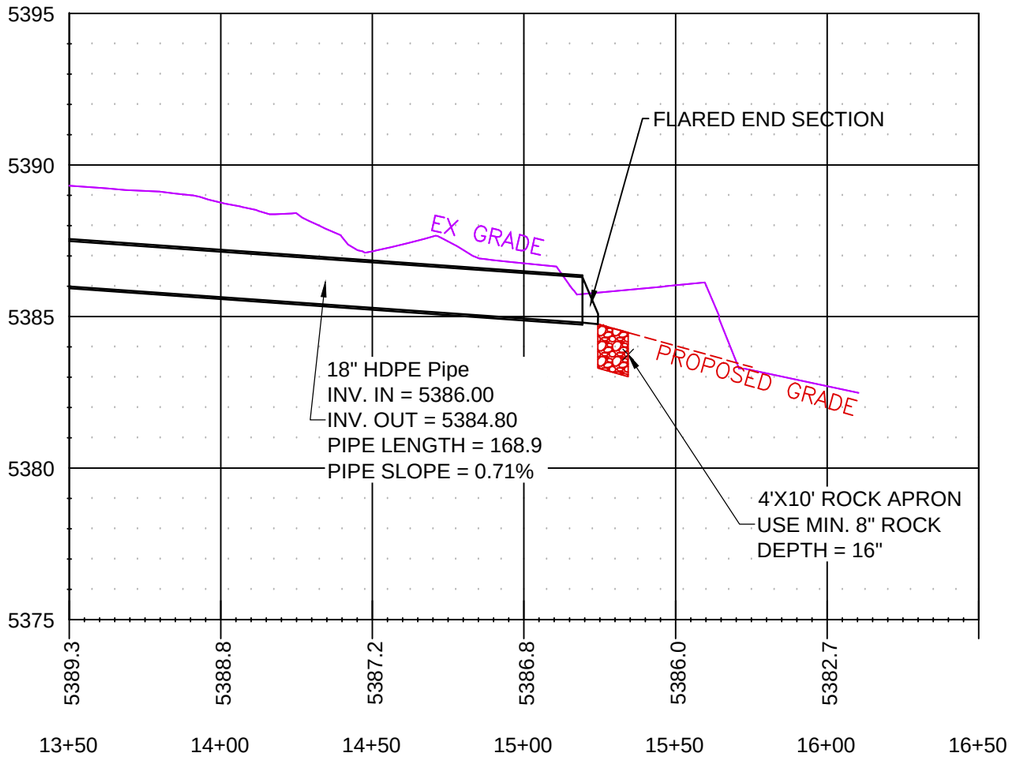
DIVERSION PROFILE

Sheet reference number: 7

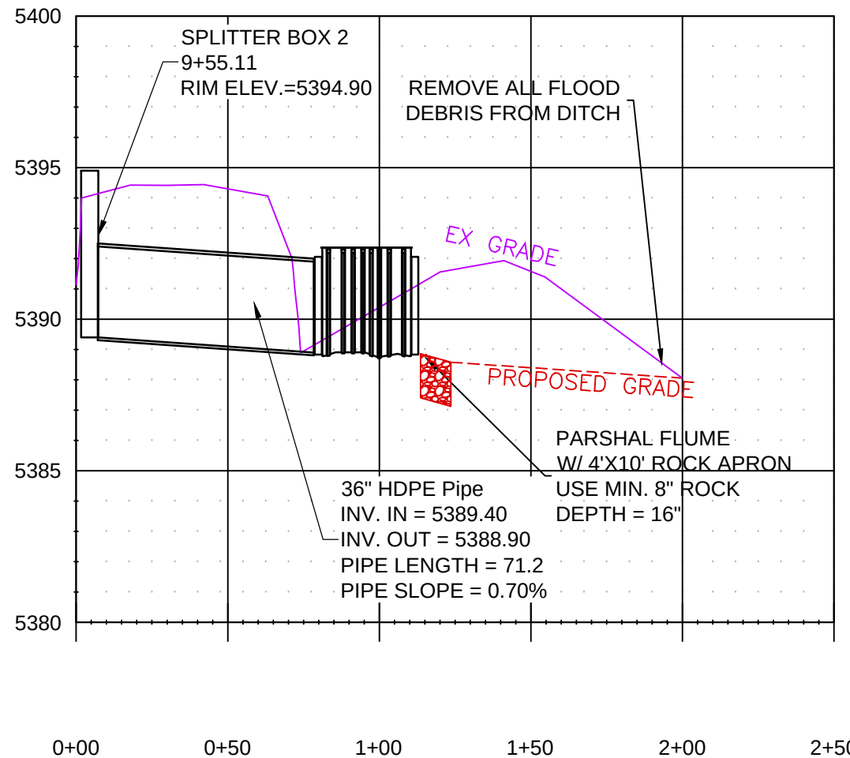
UPDATE

SCALE: 1" = 50'

0 50'



MEADOWS DIVERSION PROFILE
HORIZONTAL SCALE 1"=50'
VERTICAL SCALE 1"=5'



SOUTH LEDGE DIVERSION PROFILE
HORIZONTAL SCALE 1"=50'
VERTICAL SCALE 1"=5'

COLORADO REGISTERED
DAVID E. MOORE
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PROFESSIONAL ENGINEER

Symbol	Description	Date	Approved

CRANE ASSOCIATES

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SOUTH ST. VRAIN CREEK
MEADOWS & SOUTH LEDGE DITCHES
FINAL RECONSTRUCTION PLAN
BOULDER COUNTY, COLORADO

DIVERSION PROFILE

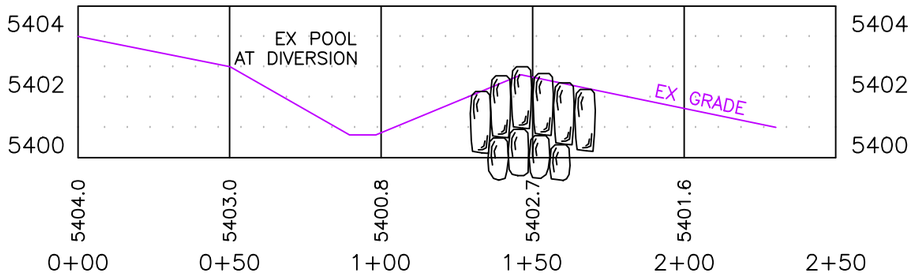
Sheet reference number: 8

UPDATE

SCALE: 1" = 50'

0 50'

ARMOR EX HEAD OF RIFFLE
WITH 3' TO 6' DIA BOULDERS
MAINTAIN APPROX EX GRADE
IN AND OUT OF RIFFLE

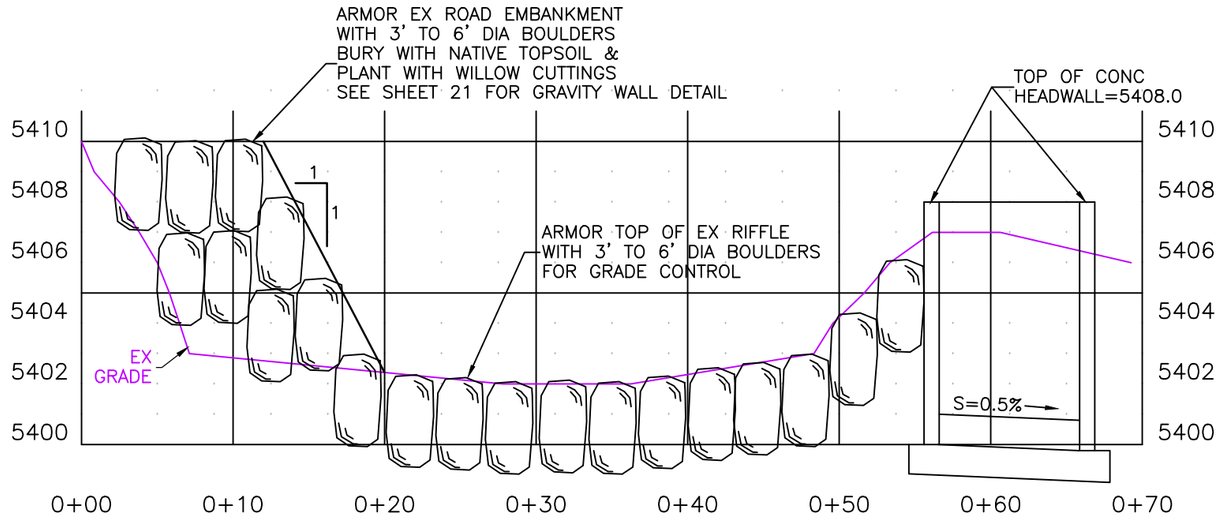


DIVERSION STRUCTURE PROFILE

HORIZONAL SCALE:1"=50'
VERTICAL SCALE: 1"=5'

SCALE: 1" = 10'

0 10'



DIVERSION CROSS SECTION

HORIZONTAL SCALE:1"=10'
VERTICAL SCALE:1"=5'

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DAVID E. MOORE
22495
PROFESSIONAL ENGINEER

Rev:	
Date: MAR 31, 2015	
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SOUTH ST. VRAIN CREEK
MEADOWS & SOUTH LEDGE DITCHES
FINAL RECONSTRUCTION PLAN
BOULDER COUNTY, COLORADO

PROFILE AND CROSS SECTION

Sheet reference number: 9

UPDATE

Symbol	Description	Date Approved

SCALE: 1" = 5'

0 5'

(ALTERNATE) FRESNO SLIDE GATE
MODEL: FABRICATED 48"W x 36"H STAINLESS

INV. OUT 5400.5

4"X6" SIDE BLOCKOUT
FOR GATE INSTALLATION
BOTH SIDES

4'

4'

5'

10'

S=2.0%

6'6"

3'-4"

INCLUDE 48"W X 4"LX3"D BLOCKOUT
BELOW GATE

FRESNO SLIDE GATE
MODEL: 6600 101C - 36"
INTAKE ALSO DESIGNED TO ACCEPT A
RUBICON FGB 6-2.3 FLUME GATE

24'-4$\frac{1}{2}$"

6'-2$\frac{1}{4}$"

16'-9"

INV. OUT 5401.0

5'-6"

5'-6"

10'

36" CMP

INV. OUT 5397.5

A

A

42'4"

9'

12"(typ)

PLAN VIEW
SCALE:1"=5'

S=0.5%

FABRICATED TRASH GUARD
STEEL BARS AT 4" SPACING
ANGLED 45° TO DIRECTION
OF FLOW

INCLUDE BLOCKOUT
BELOW GATE AS DIRECTED

FRESNO SLIDE GATE
MODEL: 6600 101C - 36"
INTAKE ALSO DESIGNED TO ACCEPT A
RUBICON FGB 6-2.3 FLUME GATE

43'4"

8'

#5 @ 12" VERTICAL
18" HORIZONTAL
BOTH FACES (see
CDOT M-601-10)

12" (typ)

TOP OF WALL=5408.0

7'

2"
ALL AROUND

7' X 1.5' ORIFICE
INV=5400.8

EL=5401.0

S=0.5%

12"

2

1

10'-5$\frac{3}{4}$"

2'

SEE CDOT M-601-10 & 20
FOR FOOTER BAR DETAILS
INTO FLOOR AND HEADWALL

33'-4$\frac{1}{2}$"

36" CMP
INV IN=5397.5

SECTION A-A
SCALE:1"=5'

POUR CONC FOOTER ON A 4"
LEVEL BED OF PEA GRAVEL

2'

2'

12"

CONCRETE INTAKE STRUCTURE (STA 0+35)

COLORADO REGISTERED
DAVID E. MOORE
22495
PROFESSIONAL ENGINEER

Date Approved | Description | Symbol

CRANE ASSOCIATES

Date: MAR 31, 2015 | Rev.
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File name:
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Plot scale:
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SOUTH ST. VRAIN CREEK
MEADOWS & SOUTH LEDGE DITCHES
FINAL RECONSTRUCTION PLAN
BOULDER COUNTY, COLORADO

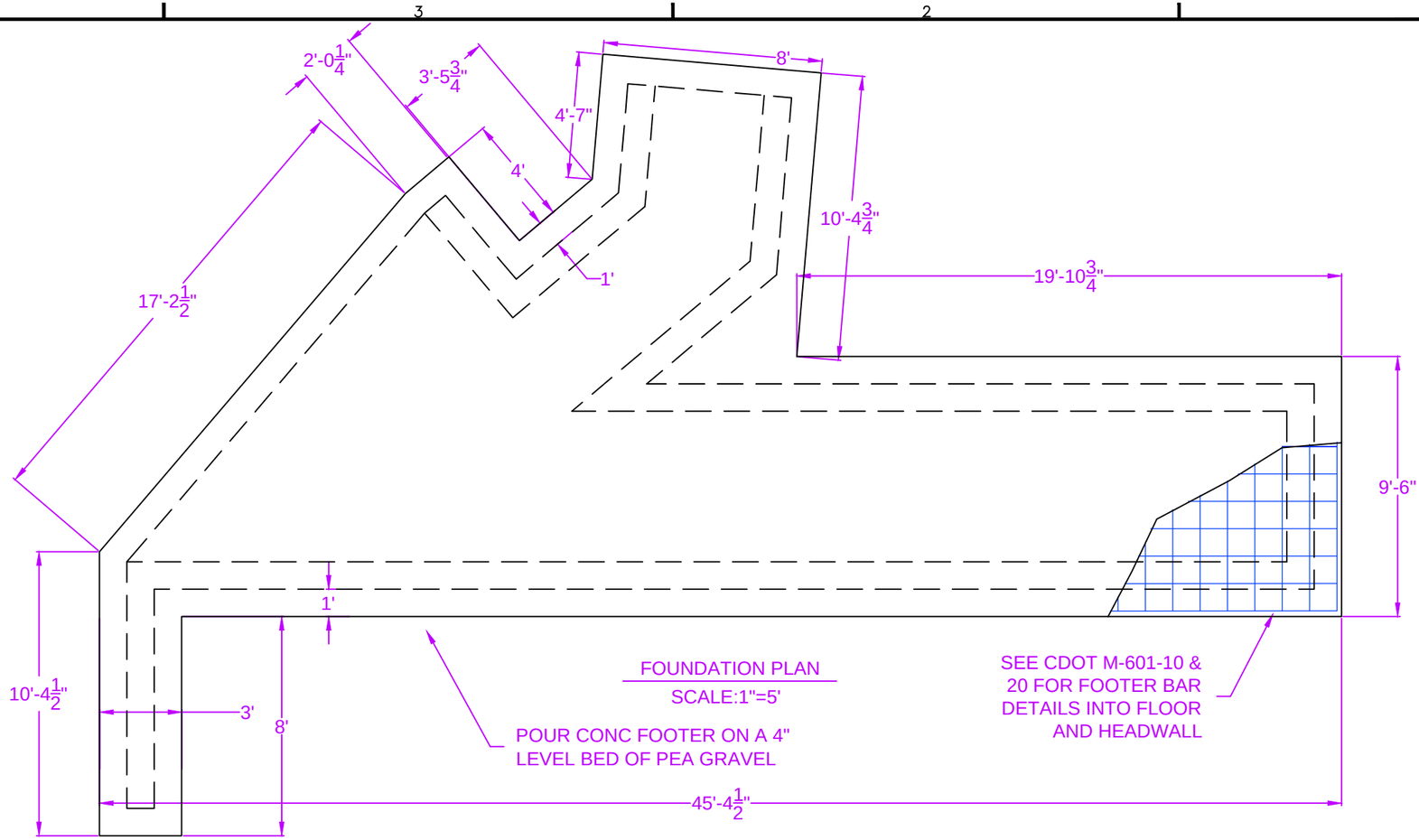
INTAKE STRUCTURE DETAILS

Sheet reference number: 10

UPDATE

SCALE: 1" = 5'

0 5'

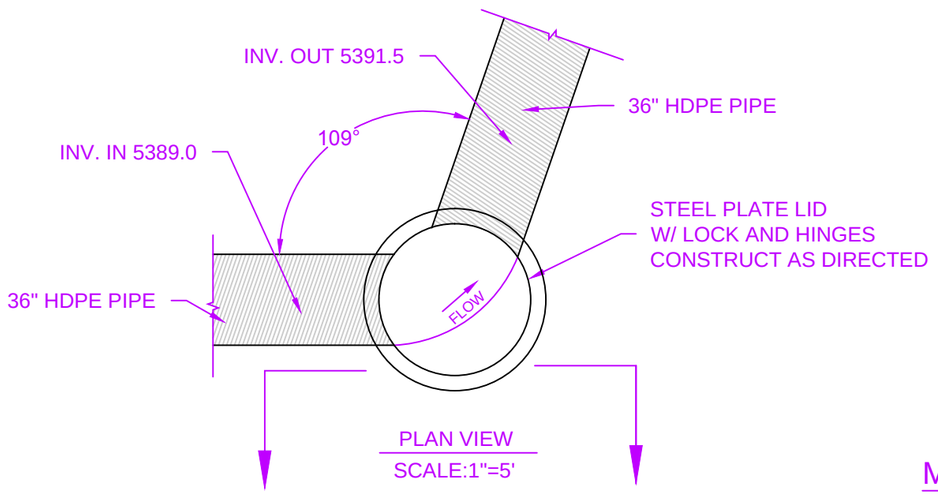


FOUNDATION PLAN
SCALE:1"=5'

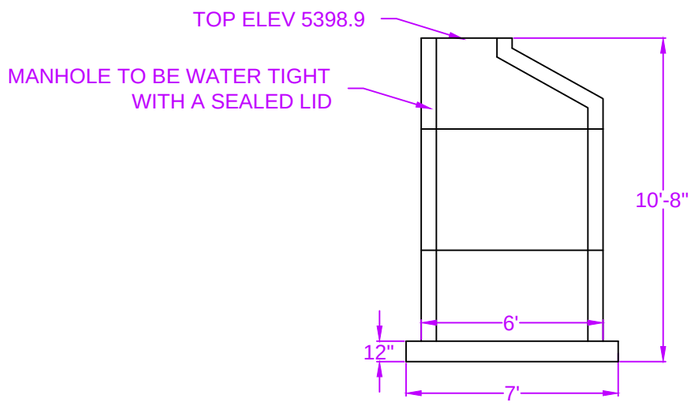
POUR CONC FOOTER ON A 4" LEVEL BED OF PEA GRAVEL

SEE CDOT M-601-10 & 20 FOR FOOTER BAR DETAILS INTO FLOOR AND HEADWALL

CONCRETE INTAKE STRUCTURE (STA 0+35)



PLAN VIEW
SCALE:1"=5'



SECTION A-A
SCALE:1"=5'

MANHOLE 1 (STA 5+53)

COLORADO REGISTERED DAVID E. MOORE 22495 PROFESSIONAL ENGINEER

Date Approved | Description | Symbol

CRANE ASSOCIATES

Rev:
Date: MAR 31, 2015
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:
Designed by: JEFF CRANE
Drn by:
Ckd by:
Reviewed by: JPC
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SOUTH ST. VRAIN CREEK
MEADOWS & SOUTH LEDGE DITCHES
FINAL RECONSTRUCTION PLAN
BOULDER COUNTY, COLORADO

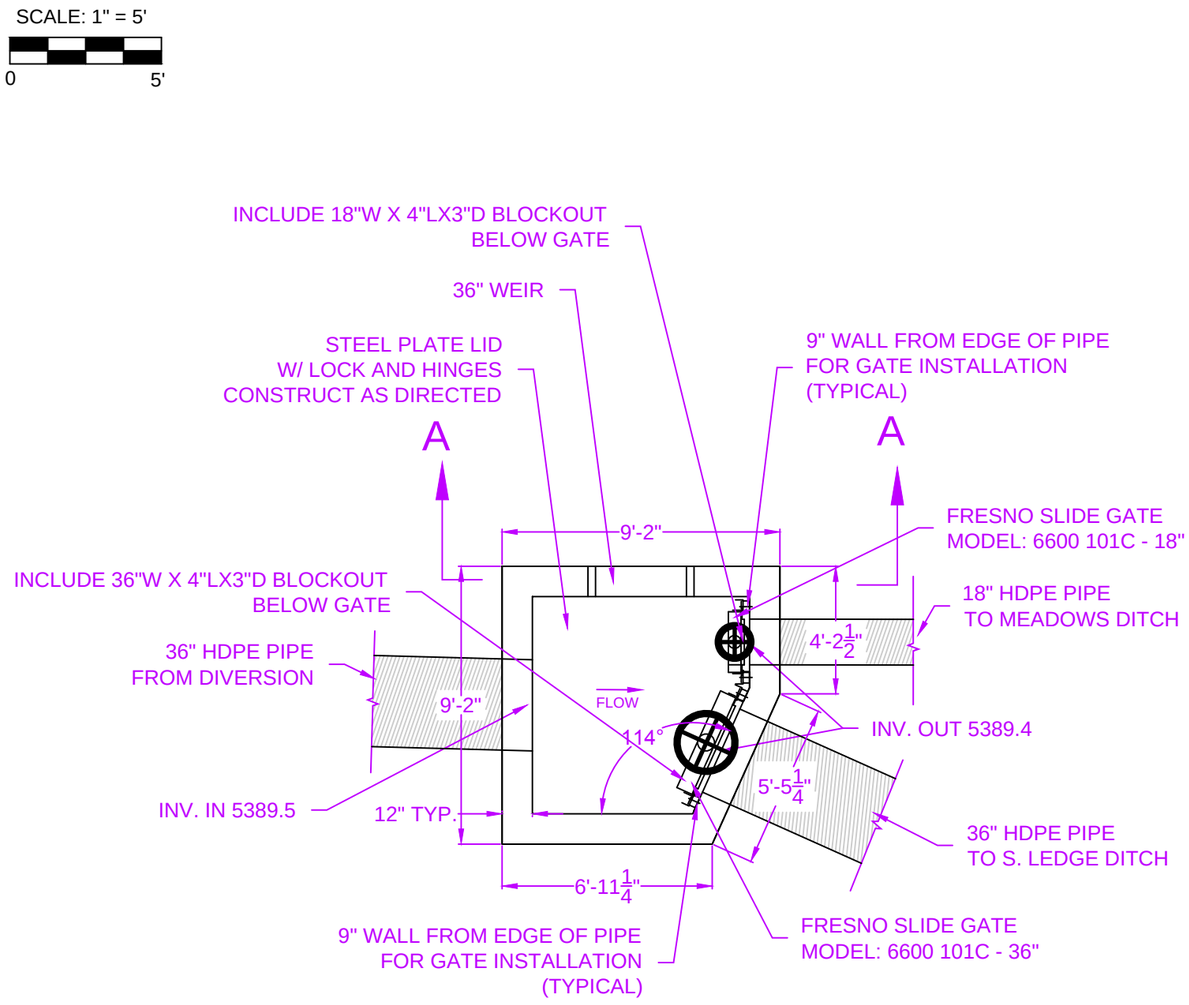
FOUNDATION & MANHOLE DETAILS

Sheet reference number: 11

UPDATE

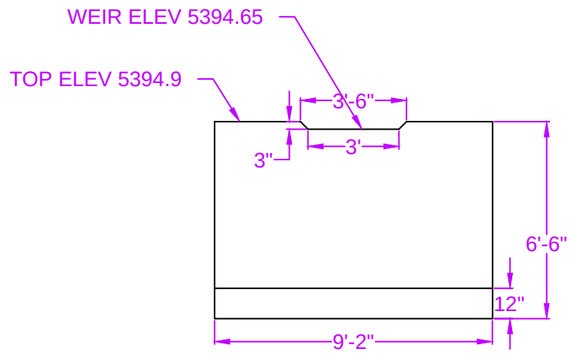
SCALE: 1" = 5'

0 5'



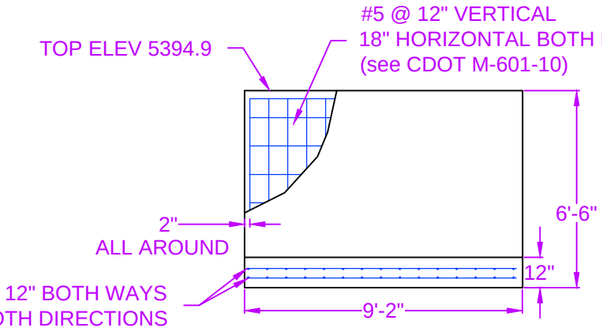
PLAN VIEW

SCALE:1"=5'



WEIR DIMENSIONS

SCALE:1"=5'



SECTION A-A

SCALE:1"=5'

SPLITTER BOX 2 (STA 9+55)

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Date: MAR 31, 2015 | Rev:
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Drawn by: | Ckd by:
Reviewed by: JPC | Drawing Code:
Submitted by: | File name: | Plot date: | Plot scale:

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BOULDER COUNTY, COLORADO

SPLITTER BOX DETAILS

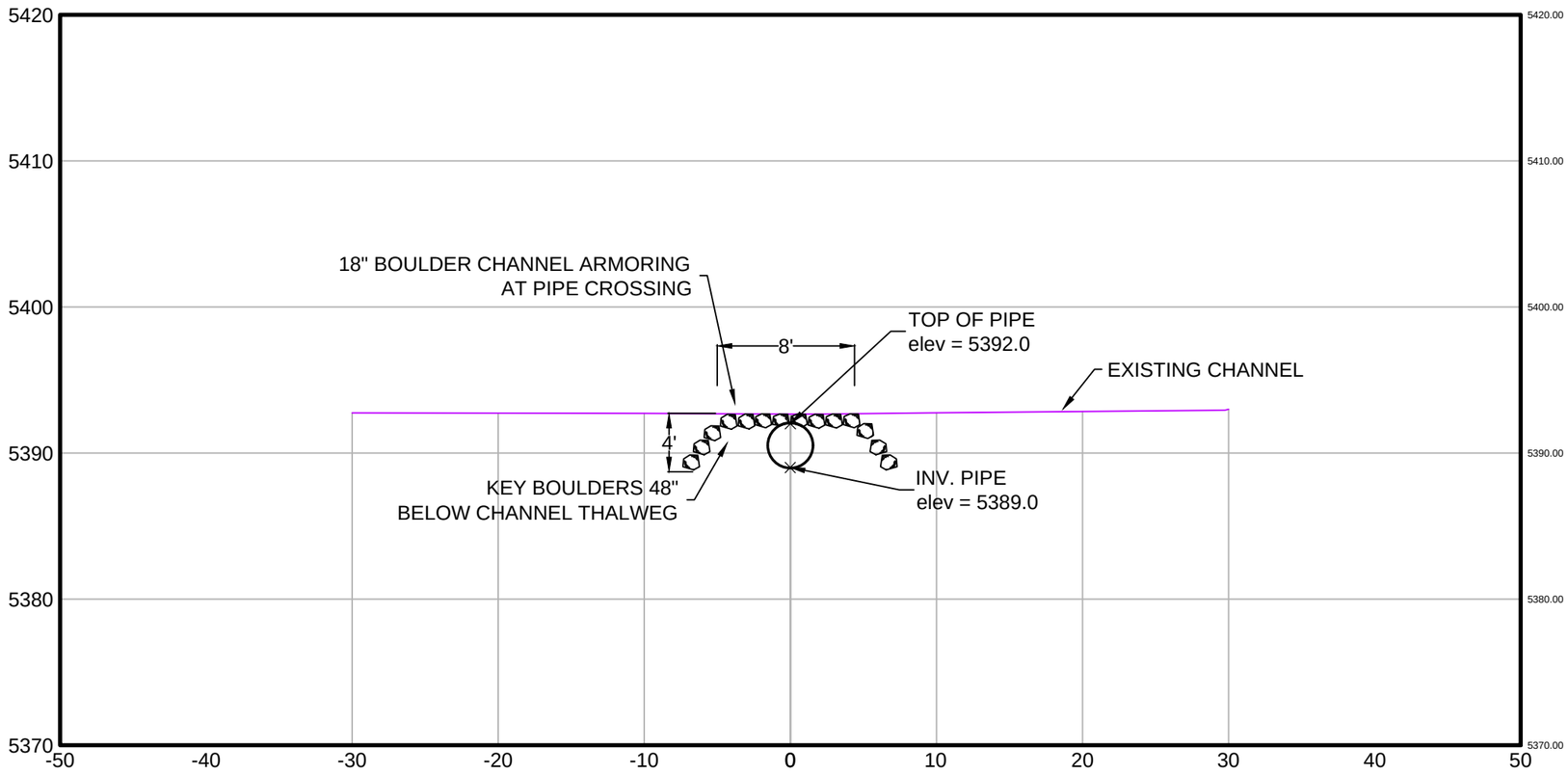
Sheet reference number: 12

UPDATE

SCALE: 1" = 5'

0 5'

SECTION 5+26.00



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SOUTH ST. VRAIN CREEK
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BOULDER COUNTY, COLORADO

DIVERSION SECTION

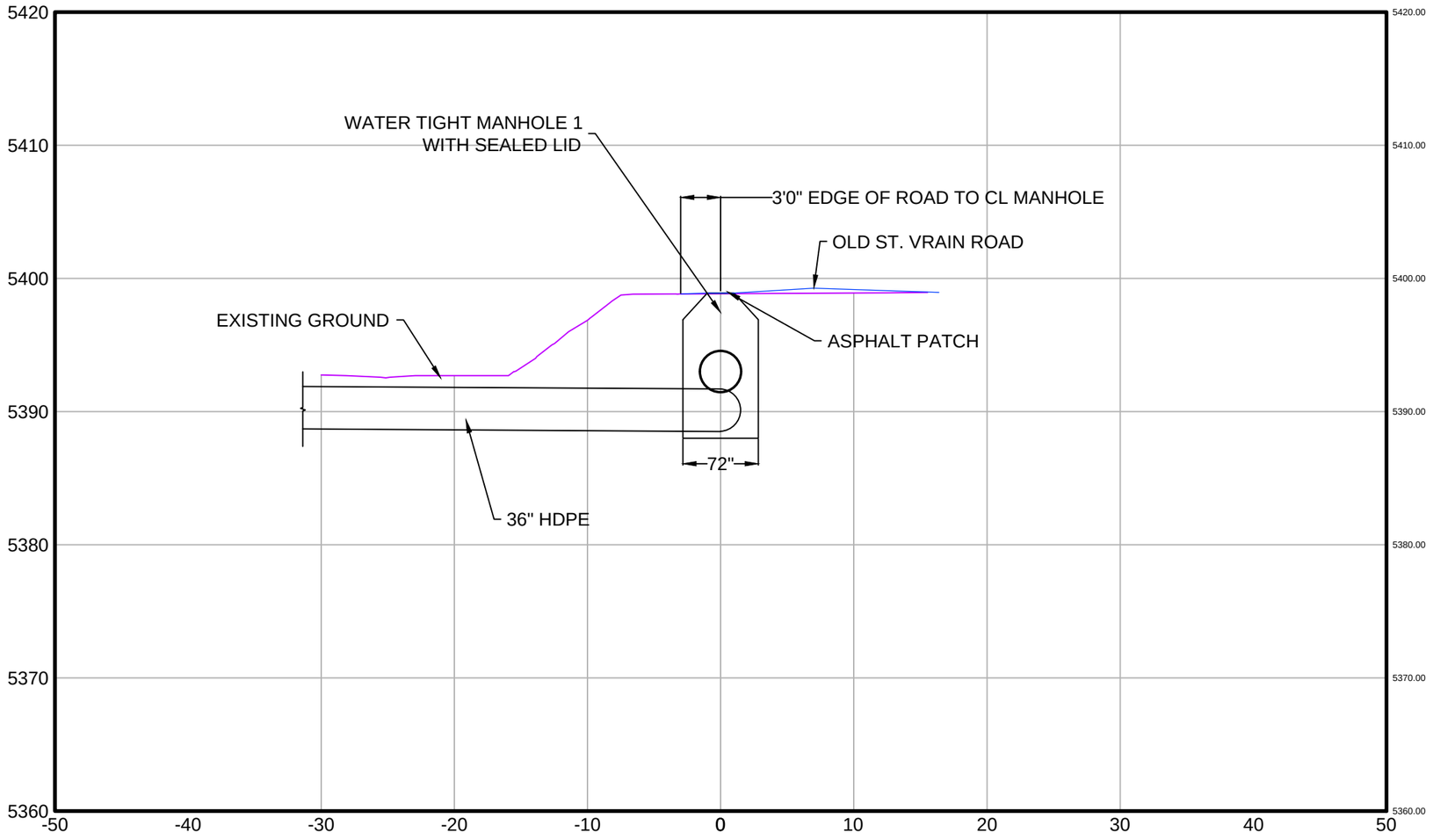
Sheet reference number: 13

UPDATE

SCALE: 1" = 5'

0 5'

SECTION 5+53.10



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SOUTH ST. VRAIN CREEK
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BOULDER COUNTY, COLORADO

MANHOLE SECTION

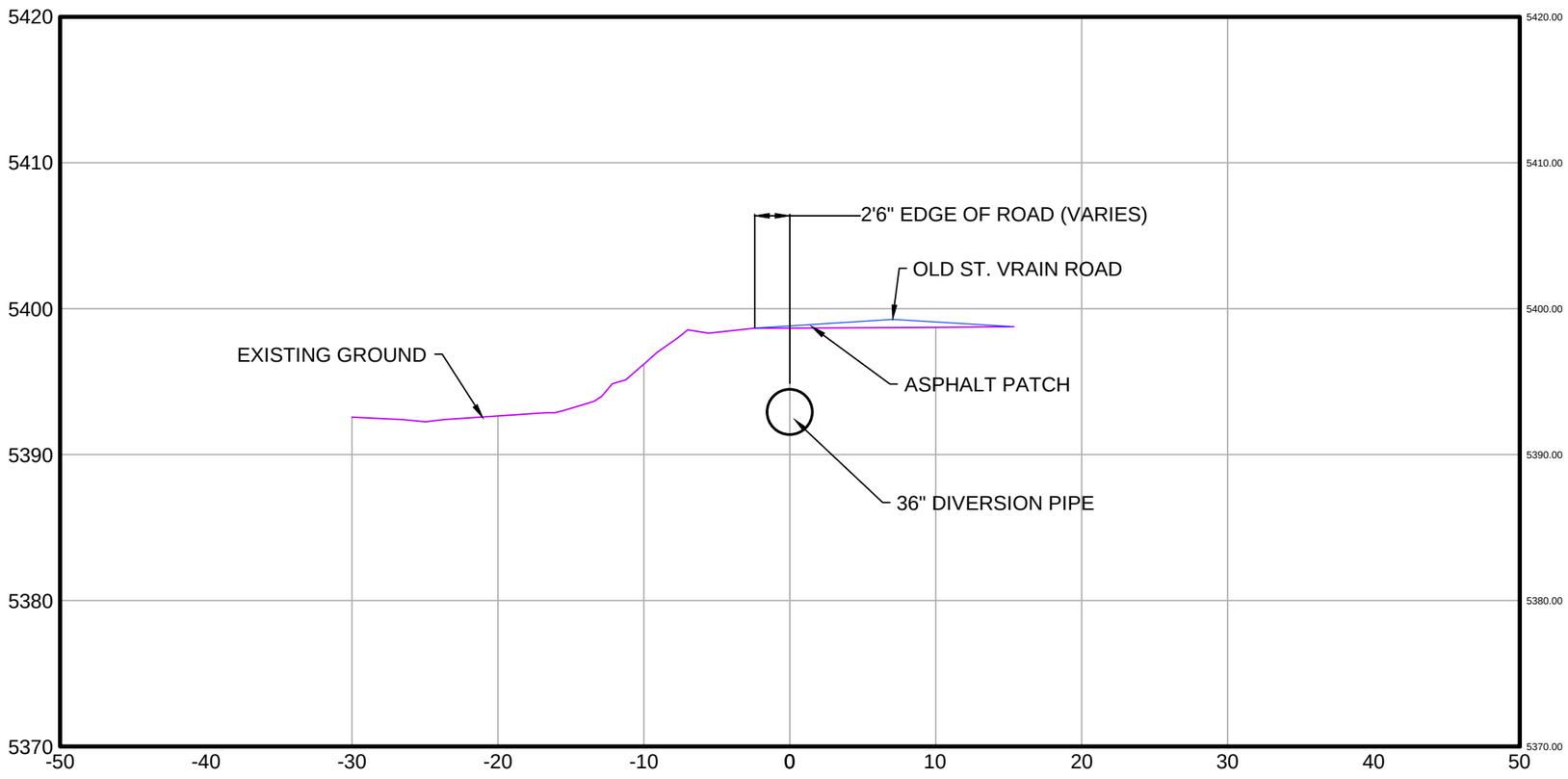
Sheet reference number: 14

UPDATE

SCALE: 1" = 5'

0 5'

SECTION 5+70.00



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SOUTH ST. VRAIN CREEK
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BOULDER COUNTY, COLORADO

DIVERSION SECTION

Sheet reference number: 15

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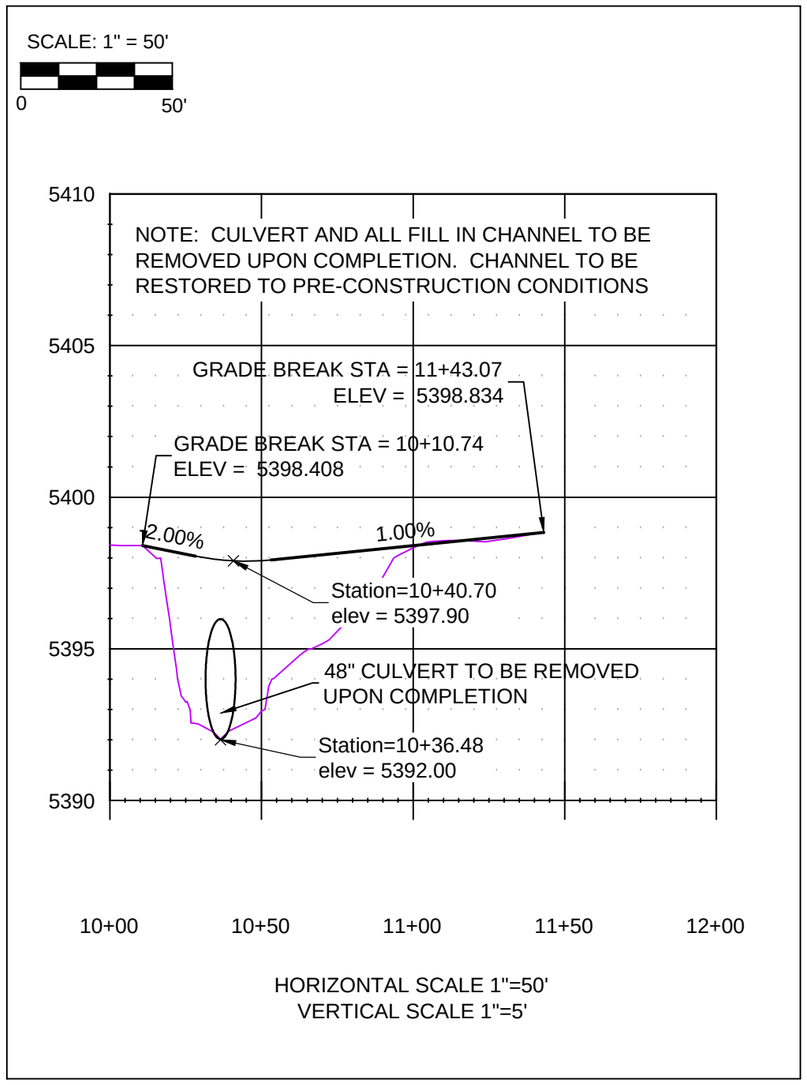
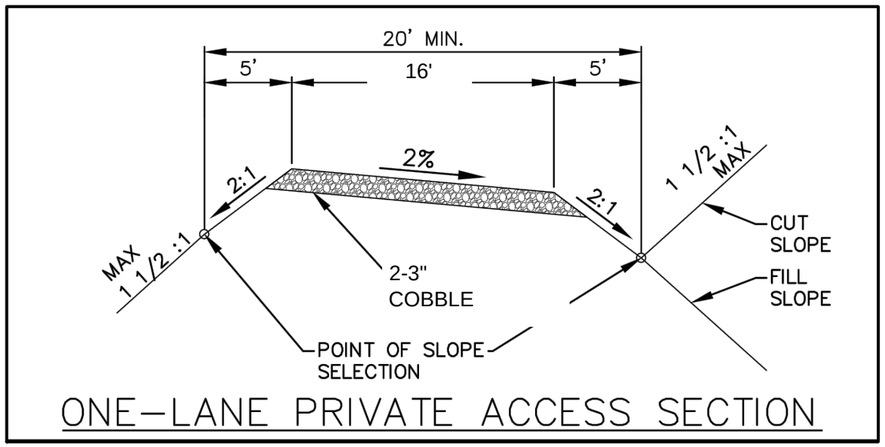
UPDATE





ONE–LANE PRIVATE ACCESS SECTION

COLORADO REGISTERED
DAVID E. MOORE
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SOUTH ST. VRAIN CREEK
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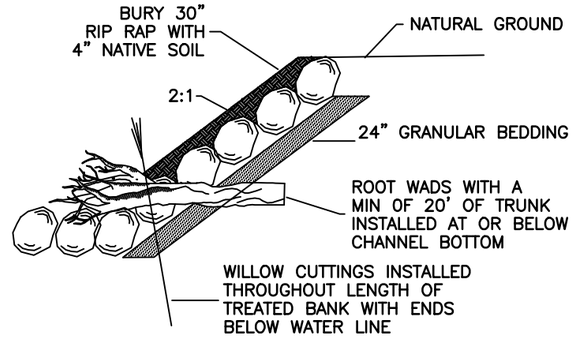
BOULDER COUNTY, COLORADO

CONSTRUCTION ENTRANCE PROFILE

Sheet reference number: 16

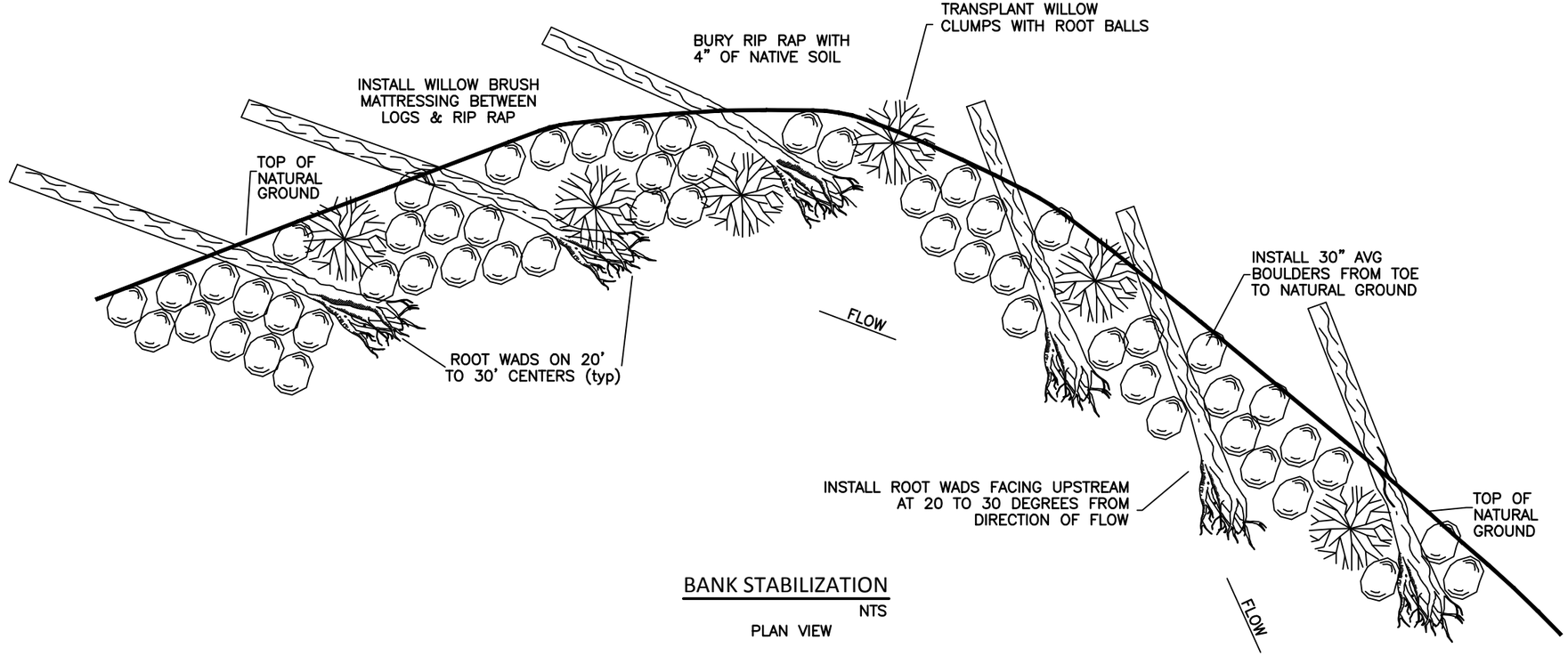
UPDATE



BANK STABILIZATION

NTS

CROSS SECTION



BANK STABILIZATION

NTS

PLAN VIEW

COLORADO REGISTERED PROFESSIONAL ENGINEER
DAVID E. MOORE
22495

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SOUTH ST. VRAIN CREEK
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BOULDER COUNTY, COLORADO

ROOT WAD DETAILS

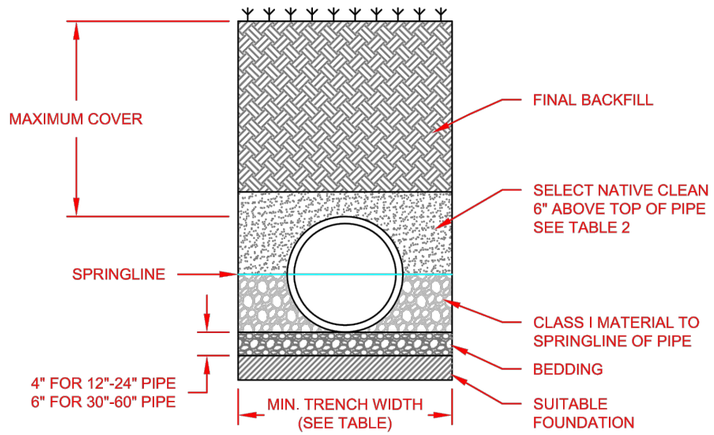
Sheet reference number: 17

UPDATE

N-12 HP STORM TRENCH INSTALLATION DETAIL (ALTERNATE)

TABLE 1, RECOMMENDED MINIMUM TRENCH WIDTHS

PIPE DIAM.	MIN TRENCH WIDTH
12" (300mm)	30" (750mm)
15" (375mm)	34" (860mm)
18" (450mm)	39" (990mm)
24" (600mm)	48" (1200mm)
30" (750mm)	56" (1420mm)
36" (900mm)	64" (1620mm)
42" (1050mm)	72" (1800mm)
48" (1200mm)	80" (2030mm)
60" (1500mm)	96" (2440mm)



NOTES:

1. MEASURES SHOULD BE TAKEN TO PREVENT MIGRATION OF NATIVE FINES INTO BACKFILL MATERIAL, WHEN REQUIRED.

2. SOIL CLASSIFICATIONS ARE PER THE LATEST VERSION OF ASTM D2321. CLASS IVB MATERIALS (MH, CH) AS DEFINED IN PREVIOUS VERSIONS OF ASTM D2321 ARE NOT APPROPRIATE BACKFILL MATERIALS.

3. FOUNDATION: WHERE THE TRENCH BOTTOM IS UNSTABLE, THE CONTRACTOR SHALL EXCAVATE TO A DEPTH REQUIRED BY THE ENGINEER AND REPLACE WITH SUITABLE MATERIAL AS SPECIFIED BY THE ENGINEER. AS AN ALTERNATIVE AND AT THE DISCRETION OF THE DESIGN ENGINEER, THE TRENCH BOTTOM MAY BE STABILIZED USING A GEOTEXTILE MATERIAL.

4. BEDDING: SUITABLE MATERIAL SHALL BE CLASS I. THE CONTRACTOR SHALL PROVIDE DOCUMENTATION FOR MATERIAL SPECIFICATION TO ENGINEER. UNLESS OTHERWISE NOTED BY THE ENGINEER, MINIMUM BEDDING THICKNESS SHALL BE 4" (100mm) FOR 4"-24" (100mm-600mm); 6" (150mm) FOR 30"-60" (750mm-900mm).

5. BACKFILL: FOR PIPES OUTSIDE OF PAVEMENT CLASS I MATERIAL TO BE USED FOR BACKFILL UP TO THE SPRINGLINE OF PIPE. THE CONTRACTOR SHALL PROVIDE DOCUMENTATION FOR MATERIAL SPECIFICATION TO ENGINEER. UNLESS OTHERWISE NOTED BY THE ENGINEER. CLASS I MATERIAL MUST BE COMPACTED IN 6" (200mm) LIFTS TO 95% STANDARD PROCTOR DENSITY.

6. MINIMUM COVER: MINIMUM COVER, H, IN NON-TRAFFIC APPLICATIONS (GRASS OR LANDSCAPE AREAS IS 12" (300mm) FROM THE TOP OF PIPE TO GROUND SURFACE. ADDITIONAL COVER MAY BE REQUIRED TO PREVENT FLOTATION.

7. SELECT NATIVE CLEAN BACKFILL SHALL BE WELL PLACED, MODERATELY COMPACTED (85% SPD) CLASS IV OR BETTER PER ASTM D2321 WITH NO FOREIGN DEBRIS INCLUDING ROCKS, LARGE CLUMPS ORGANIC MATERIAL, OR FROZEN MATERIAL.

8. N-12 HP ALTERNATE STORM TRENCH DETAIL MUST BE APPROVED BY DESIGN ENGINEER. DETAIL DOES NOT SUPERSEDE ADS STANDARD DETAIL STD-108.

TABLE 2, MAXIMUM COVER FOR ADS N-12 HP PIPE, ALTERNATE INSTALLATION, ft (γ_s=120)

	SELECT NATIVE CLEAN MATERIAL CLASSIFICATION		
PIPE DIAM.	CLASS II	CLASS III	CLASS IV
12" (300mm)	17 (5.2m)	14 (4.3m)	11 (3.4m)
15" (375mm)	17 (5.2m)	14 (4.3m)	10 (3.0m)
18" (450mm)	16 (4.9m)	13 (4.0m)	10 (3.0m)
24" (600mm)	14 (4.3m)	12 (3.7m)	9 (2.7m)
30" (750mm)	13 (4.0m)	12 (3.7m)	8 (2.4m)
36" (900mm)	11 (3.4m)	11 (3.4m)	7 (2.1m)
42" (1050mm)	11 (3.4m)	11 (3.4m)	7 (2.1m)
48" (1200mm)	11 (3.4m)	10 (3.0m)	6 (1.8m)
60" (1500mm)	11 (3.4m)	10 (3.0m)	6 (1.8m)

FILL HEIGHT TABLE GENERATED ASSUMING DRY CONDITIONS, OUTSIDE OF WATER TABLE. FOR INSTALLATION WITHIN THE WATER TABLE, CONTACT APPLICATIONS ENGINEERING.

REV.	DESCRIPTION	BY	MM/DD/YY	CHK'D
2	UPDATED INFORMATION PER TN 2.04	NDB	01/09/2013	

ALTERNATE STORM TRENCH DETAIL N-12 HP OUTSIDE OF PAVEMENT

DRAWING NUMBER: STD-109

ADS
ADVANCED DRAINAGE SYSTEMS, INC.
4640 TRUEMAN BLVD
HILLIARD, OHIO 43026

DRAWN BY: JAB
DATE: 01/29/09
CHK'D BY:
SCALE: NTS
SHEET 1 OF 1

COLORADO REGISTERED
DAVID E. MOORE
22495
PROFESSIONAL ENGINEER

Description | Date Approved | Symbol

CRANE ASSOCIATES

Date: MAR 31, 2015 | Rev.
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Plot scale:
Designed by: JEFF CRANE
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Reviewed by: JPC
Submitted by:

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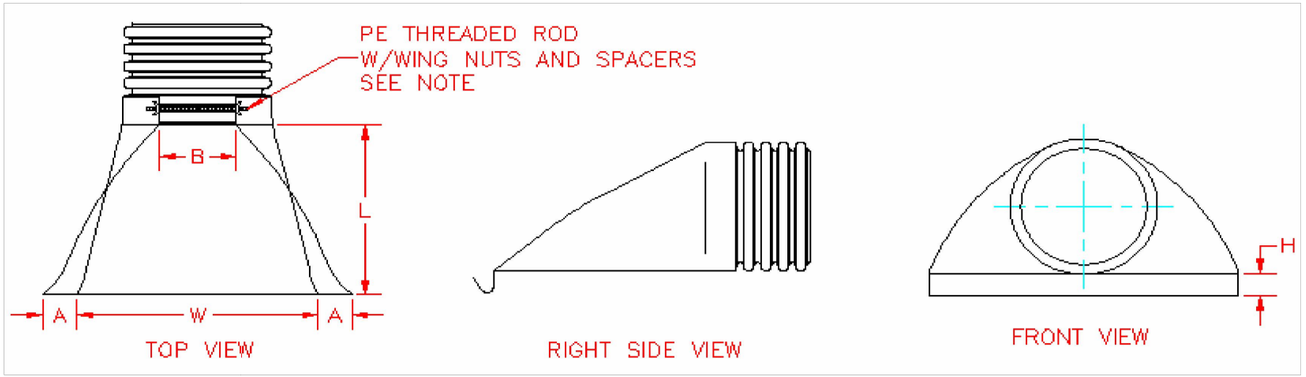
SOUTH ST. VRAIN CREEK
MEADOWS & SOUTH LEDGE DITCHES
FINAL RECONSTRUCTION PLAN
BOULDER COUNTY, COLORADO

PIPE BEDDING DETAILS

Sheet reference number: 18

UPDATE

FLARED END SECTIONS



PART #	PIPE SIZE	A	B(MAX)	H	L	W
1210NP	12 in (300 mm)	6.5 in (165 mm)	10.0 in (254 mm)	6.5 in (165 mm)	25.0 in (635 mm)	29.0 in (737 mm)
1510NP	15 in (375 mm)	6.5 in (165 mm)	10.0 in (254 mm)	6.5 in (165 mm)	25.0 in (635 mm)	29.0 in (737 mm)
1810NP	18 in (450 mm)	7.5 in (191 mm)	15.0 in (381 mm)	6.5 in (165 mm)	32.0 in (813 mm)	35.0 in (889 mm)
2410NP	24 in (600 mm)	7.5 in (191 mm)	18.0 in (457 mm)	6.5 in (165 mm)	36.0 in (914 mm)	45.0 in (1143 mm)
3015NP	30 in (750 mm)	7.5 in (191 mm)	12.0 in (305 mm)	8.6 in (218 mm)	58.0 in (1473 mm)	63.0 in (1600 mm)
3615NP	36 in (900 mm)	7.5 in (191 mm)	25.0 in (635 mm)	8.6 in (218 mm)	58.0 in (1473 mm)	63.0 in (1600 mm)

NOTE: ALL DIMENSIONS ARE NOMINAL

ADS ADVANCED DRAINAGE SYSTEMS, INC.

DRAWING #:	6070	
DRAWN BY:	JCB	01.17.07
APPROVED BY:	JCB	06.28.07
REVISIONS:	NJP	06.20.07

COLORADO REGISTERED PROFESSIONAL ENGINEER
DAVID E. MOORE
22495

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SOUTH ST. VRAIN CREEK
MEADOWS & SOUTH LEDGE DITCHES
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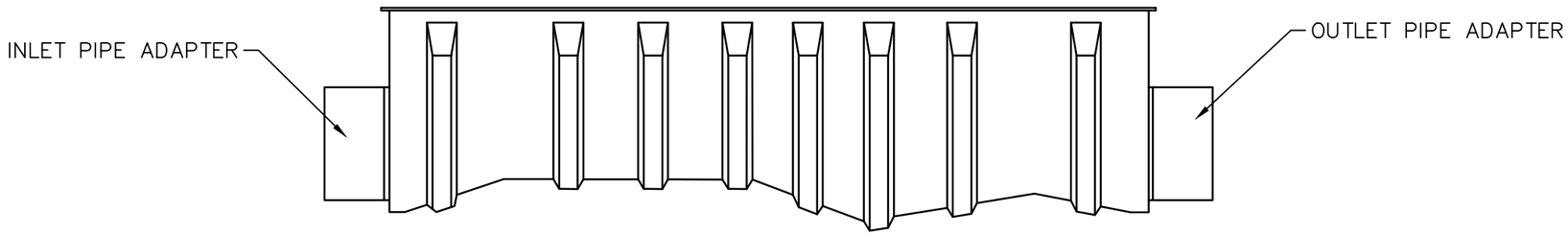
BOULDER COUNTY, COLORADO
PIPE END SECTION DETAILS

Sheet reference number: 19

UPDATE



TYPICAL FLUME PROFILE

PLASTI-FAB FLUMES FLUME INSTALLATION NOTES, SEE http://www.plasti-fab.com/ FOR MORE INFORAMTION:

1. FLUMES SHALL BE INSTALLED LEVEL END-TO-END AND SIDE-TO-SIDE BY USING A LEVEL ON THE FLOOR.
2. FLUME MUST BE REINFORCED BY WOOD ON THE INSIDE IN ORDER TO KEEP THE SIDEWALLS STRAIGHT AND MAINTAIN THE DIMENSIONAL INTEGRITY OF THE FLUME. THE THROAT IS THE MOST CRITICAL PORTION OF THE FLUME TO PROTECT.
3. THE TOP CROSS BRACES SHIPPED ON THE FLUME SHOULD BE LEFT ON THE FLUME UNTIL IT HAS BEEN INSTALLED.
4. USE BEAMS THAT RUN FROM ONE SIDE OF THE CHANNEL TO THE OTHER TO LEVEL THE FLUME, PREVENT FLOATING AND TO LIMIT SHIFTING OF THE FLUME DURING THE PROCESS OF GROUTING THE FLUME INTO THE CHANNEL. THESE CROSS BEAMS WILL SPAN THE CHANNEL AND ATTACH TO EACH OF THE SIDE CHANNEL WALLS. DRILL THROUGH THE TOP FLANGE OF THE FLUME AND BOLT TO THESE BEAMS. DOUBLE NUT OR SHIM TO GET THE FLUME SET LEVEL BOTH DIRECTIONS. OTHER CROSS BRACING MAY BE REQUIRED TO PREVENT SHIFTING. IT MAY BE DESIRABLE TO DO CROSS BRACING NEAR OR AT THE BOTTOM OF THE FLUME.
5. PLASTI-FAB FLUMES ARE DESIGNED TO BE FREE STANDING, AND REQUIRE NO ADDITIONAL EXTERNAL SUPPORT IN ORDER TO MAINTAIN THEIR DIMENSIONAL INTEGRITY DURING OPERATION. HOWEVER THE BOTTOM MUST BE ADEQUATELY SUPPORTED TO BE KEEP THE FLUME LEVEL.
6. THE FLUME IS COMMONLY GROUTED INTO AN EXISTING CONCRETE CHANNEL. THIS ALLOWS FOR THE CROSSBEAMS (SEE # 4 ABOVE) TO BE USED. GROUTING INTO AN EXISTING CHANNEL IS THE PREFERRED METHOD OF INSTALLATION. POURING THE CONCRETE OR GROUT AROUND THE FLUME TOO FAST CAN DEFORM THE SIDES/FLOOR OF THE FLUME, FORCE IT TO SHIFT OUT OF ALIGNMENT OR MAKE IT OUT OF LEVEL. GREAT CARE MUST BE TAKEN IF A VIBRATOR IS USED. IT CAN ALSO CAUSE DISTORTION. PROPER BRACING/CRIBBING IS IMPORTANT (SEE #2 ABOVE).
7. WHEN INSTALLING A FLUME WE RECOMMEND THAT CONCRETE OR GROUT BE POURED IN LAYERS OF NO MORE THAN 6"- 10" AT A TIME AND EACH LAYER BE ALLOWED TO SET BEFORE THE NEXT IS ADDED.
8. ALL FLUMES WITH BOLT ON ADAPTERS, CAULKING COLLARS OR TRANSITION SECTIONS MUST BE SEALED BETWEEN JOINTS. WE SUGGEST APPLYING TWO CONTINUOUS BEAD(S) OF SILICONE ON ALL SEATING SURFACES BETWEEN FLANGED JOINTS BEFORE BOLTING TOGETHER.
9. AN INLET ADAPTER SHOULD HAVE A RAMPED FLOOR FOR TRANSITIONING FLOWS UP TO THE FLOOR OF THE FLUME. THIS WILL HELP TRANSITION SOLIDS AND HELP FACILITATE A NON-TURBULENT FLOW INTO THE FLUME. SOME OF OUR ADAPTERS HAVE A BUILT IN RAMP FROM THE FLOOR OF THE ADAPTER TO THE FLOOR OF THE FLUME.

COLORADO REGISTERED DAVID E. MOORE 22495 PROFESSIONAL ENGINEER

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SOUTH ST. VRAIN CREEK
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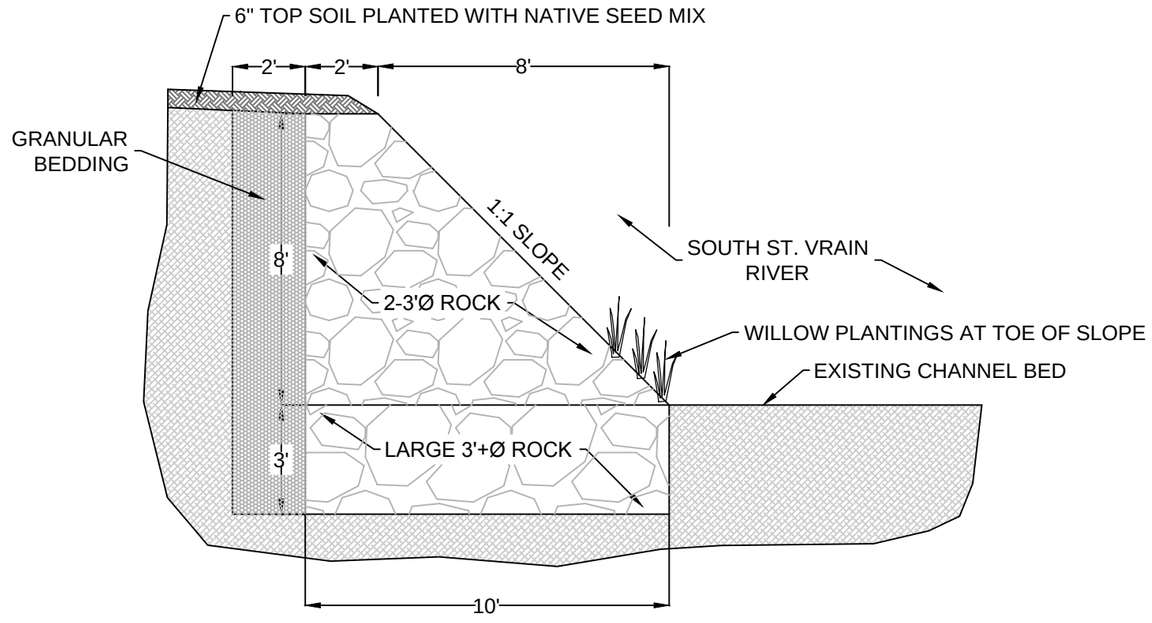
BOULDER COUNTY, COLORADO

FLUME DETAILS AND NOTES

Sheet reference number: 20

UPDATE



GRAVITY RETAINING WALL DETAIL

NOTES:
1) THE GRAVITY RETAINING WALL SHALL BE CONSTRUCTED WITH LARGE 2-3'Ø ROCK.
2) THE WALL SHALL BE CONSTRUCTED IN LAYERS. VOIDS BETWEEN ROCKS SHALL BE FILLED WITH A WELL GRADED MIXTURE OF SOIL AND COBBLE.
3) BACKFILL BEHIND THE WALL SHALL BE A GRANULAR BEDDING A MINIMUM OF 2' IN THICKNESS. NATIVE SOIL MAY BE USED BEHIND THE GRANULAR BEDDING.
4) THE 1:1 FACE OF THE SLOPED WALL CAN BE COVERED AND PLANTED WITH VEGETATIVE PLANTINGS.

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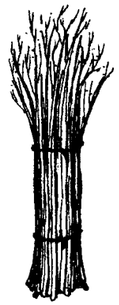
BOULDER COUNTY, COLORADO
GRAVITY RETAINING WALL DETAIL

Sheet reference number: 21

UPDATE

Procedure for Brush Trench

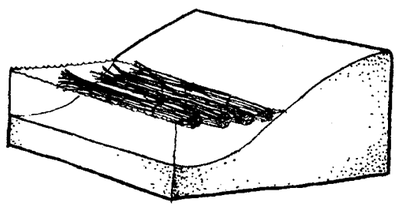
Step One: **Harvest Willow Cuttings**



Tie cuttings into bundles using 2 pieces of twine for ease of transportation.

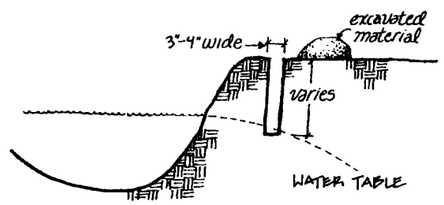
Step Two: Willow Bundles

Soak bundles for 5 to 7 days. Remove them from water before roots emerge.



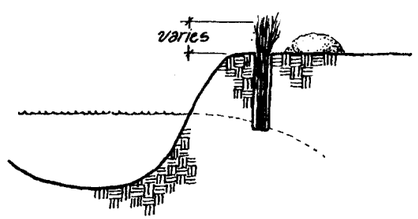
Step Three: Soak Willow Bundles

Make sure the bottom of the trench reaches the capillary fringe of the permanent water table.



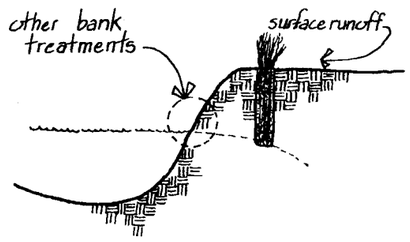
Step Four: Excavate Trench

Cut twine and place the cuttings in trench. Spread cuttings for desired thickness.



Step Five: Cutting Placement

Backfill soil and water into the trench to remove air pockets.



Step Six: Backfill

COLORADO REGISTERED PROFESSIONAL ENGINEER
DAVID E. MOORE
22495

CRANE ASSOCIATES

Designed by: JEFF CRANE
Drawn by:
Cksd by:
Reviewed by: JPC
Submitted by:
Date: MAR 31, 2015
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:
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SOUTH ST. VRAIN CREEK
MEADOWS & SOUTH LEDGE DITCHES
FINAL RECONSTRUCTION PLAN
BOULDER COUNTY, COLORADO
MISCELLANEOUS DETAILS

Sheet reference number: 22

UPDATE

KEY

SF	SILT FENCE
SW	STRAW WADDLE
DS	DRAINAGE SWALE
ST	SEDIMENT TRAP
CE	STABILIZED CONSTRUCTION ENTRANCE
CWS	CONCRETE WASH STATION
VT	VEHICLE TRACKING
WB	WASTE BORROW
CB	CROSS GRADE BERM
FD	FILL DIRT STOCKPILE
ES	EQUIPMENT STORAGE
TS	TOP SOIL STOCKPILE
FS	FUEL STORAGE

NOTE: ALL SYMBOLS MAY NOT BE USED

EROSION CONTROL NOTES

1. MINOR CHANGES MAY BE MADE BY CRANE AND ASSOCIATES.
2. A CRANE AND ASSOCIATES REPRESENTATIVE SHALL BE PRESENT DURING CONSTRUCTION OF KEY PORTIONS OF THE PROJECT.
3. ANY TS, FD, WB OR OTHER STORAGE ITEMS SHOULD BE CONTAINED WITH THE APPROPRIATE BMP'S AND LOCATED AWAY FROM CONCENTRATED WATERWAYS.
4. THE CONTRACTOR SHALL LOCATE AND MARK ALL UTILITIES WITHIN THE PROJECT AREA PRIOR TO CONSTRUCTION AND SHALL NOT RELY SOLELY ON THESE CONSTRUCTION PLANS FOR UTILITY LOCATIONS. CONTRACTOR MUST COMPLETE ALL UTILITY LOCATES PRIOR TO CONSTRUCTION. FOR UTILITY LOCATES CONTACT UTILITY NOTIFICATION CENTER OF COLORADO (UNCC) 800-922-1987 . DAMAGE TO ANY EXISTING UTILITIES IS THE RESPONSIBILITY OF THE CONTRACTOR.
5. ALL EROSION CONTROL BEST MANAGEMENT PRACTICES (BMP'S) RECOMMENDED BY CRANE AND ASSOCIATES ARE FOR GUIDANCE AND SHOULD PROVIDE THE FOUNDATION FOR THE FINAL BMP'S USED ON-SITE. THE CONTRACTOR IS ULTIMATELY RESPONSIBLE FOR THE BMP'S USED, THEIR EFFECTIVENESS, AND COMPLIANCE WITH THE COLORADO WATER QUALITY CONTROL DIVISION (CWQCD) COLORADO DISCHARGE PERMIT SYSTEM (CDPS). THE EROSION CONTROL SUPERVISOR (ECS) SHOULD BE DESIGNATED BY THE CONTRACTOR AND WILL BE RESPONSIBLE FOR THE IMPLEMENTATION, MANAGEMENT, MAINTENANCE, AND CARE OF THE STORMWATER POLLUTION PREVENTION PLAN (SWPPP) AND THE ASSOCIATED BMP'S.
6. AS AN ADDITIONAL RESOURCE, SEE WWW.UDFCD.ORG URBAN STORM DRAINAGE, CRITERIA MANUAL VOLUME 3, BEST MANAGEMENT PRACTICES.

EROSION CONTROL WORK SEQUENCE

1. INSTALL STABILIZED CONSTRUCTION ENTRANCE.
2. CLEAR AND GRUB FOR SILT FENCE AND/OR STRAW WATTLES.
3. INSTALL ALL SEDIMENT CONTROL DEVICES.
4. ROUGH GRADE ALL ACCESS AND STAGING AREAS
5. FOLLOWING COMPLETION OF ALL CONSTRUCTION, ALL DISTURBED AREAS TO BE RESEEDED WITH MULCH TACKIFIER.
6. AFTER ALL AREAS ARE STABILIZED USING SEED MIX AND MULCH TACKIFIER, REMOVE ALL SEDIMENT CONTROL DEVICES.

COLORADO REGISTERED DAVID E. MOORE 22495 PROFESSIONAL ENGINEER

Symbol	Description	Date Approved

CRANE ASSOCIATES

Date: MAR 31, 2015 | Rev.:
Designed by: JEFF CRANE | Design file no:
Drawn by: | Chkd by:
Reviewed by: JPC | Drawing Code:
Submitted by: | File name: Plot date: Plot scale:

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SOUTH ST. VRAIN CREEK MEADOWS & SOUTH LEDGE DITCHES
FINAL RECONSTRUCTION PLAN
BOULDER COUNTY, COLORADO

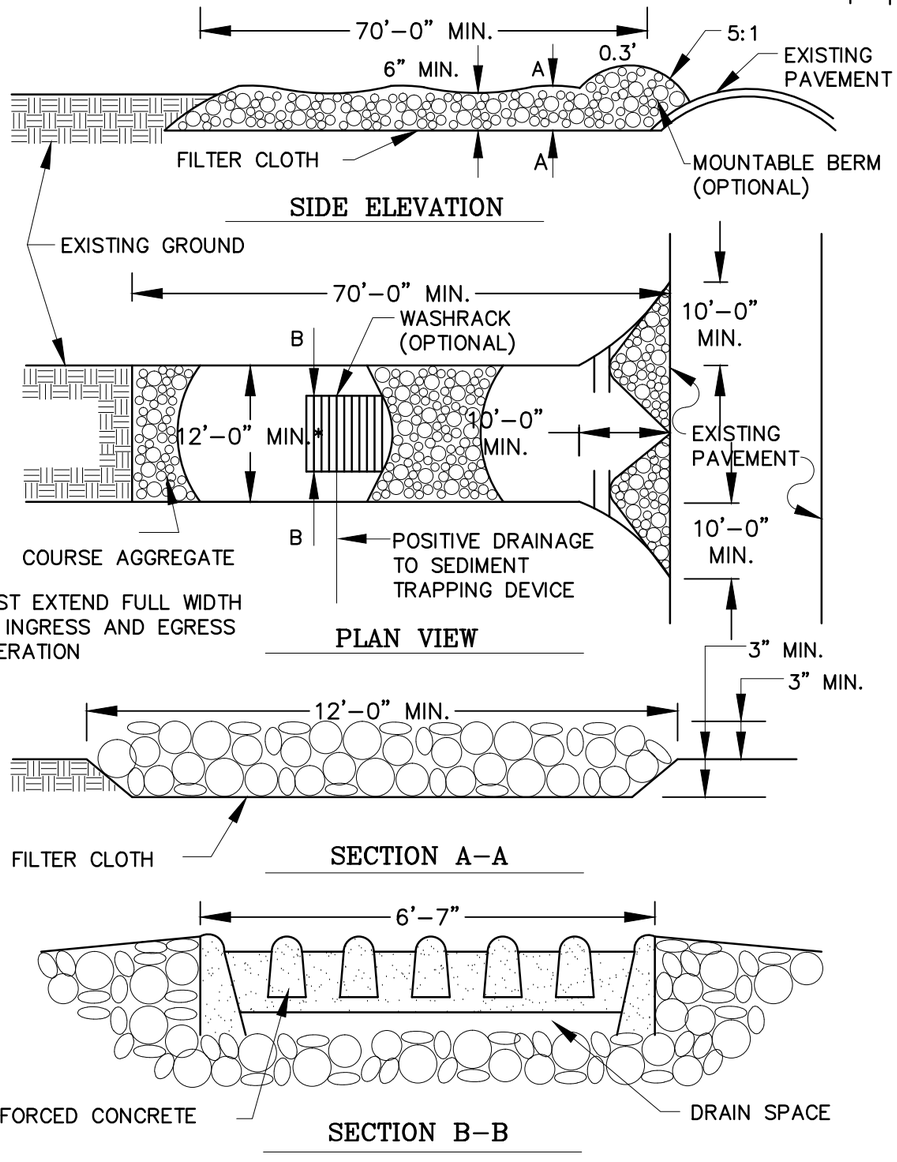
EROSION CONTROL NOTES

Sheet reference number: 23

UPDATE

TEMPORARY STONE CONSTRUCTION ENTRANCE

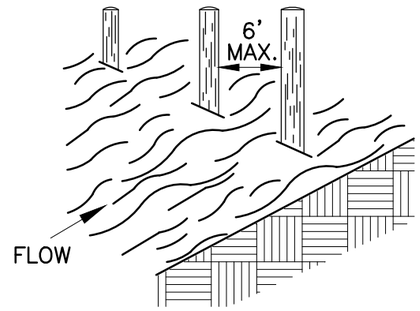
CE



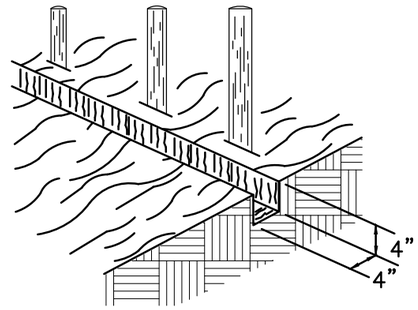
SILT FENCE (WITHOUT WIRE SUPPORT)

SF — SF — SF —

1. SET THE STAKES.

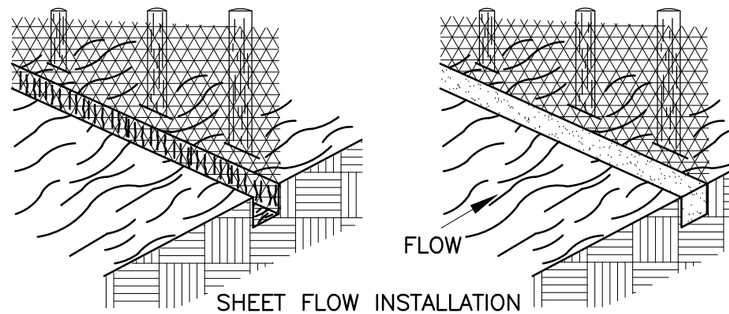


2. EXCAVATE A 4" X 4" TRENCH UPSLOPE ALONG THE LINE OF STAKES.

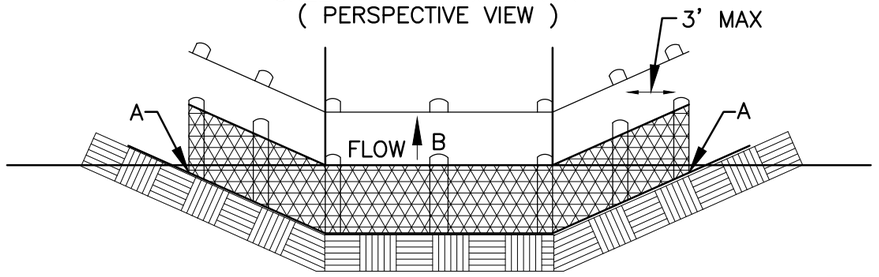


3. STAPLE FILTER MATERIAL TO STAKES AND EXTEND IT INTO THE TRENCH.

4. BACKFILL AND COMPACT THE EXCAVATED SOIL.



SHEET FLOW INSTALLATION
(PERSPECTIVE VIEW)



POINTS A SHOULD BE HIGHER THAN POINT B.
DRAINAGEWAY INSTALLATION
(FRONT ELEVATION)

COLORADO REGISTERED
DAVID E. MOORE
22495
PROFESSIONAL ENGINEER

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Ckd by:
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Submitted by:

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SOUTH ST. VRAIN CREEK
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BOULDER COUNTY, COLORADO

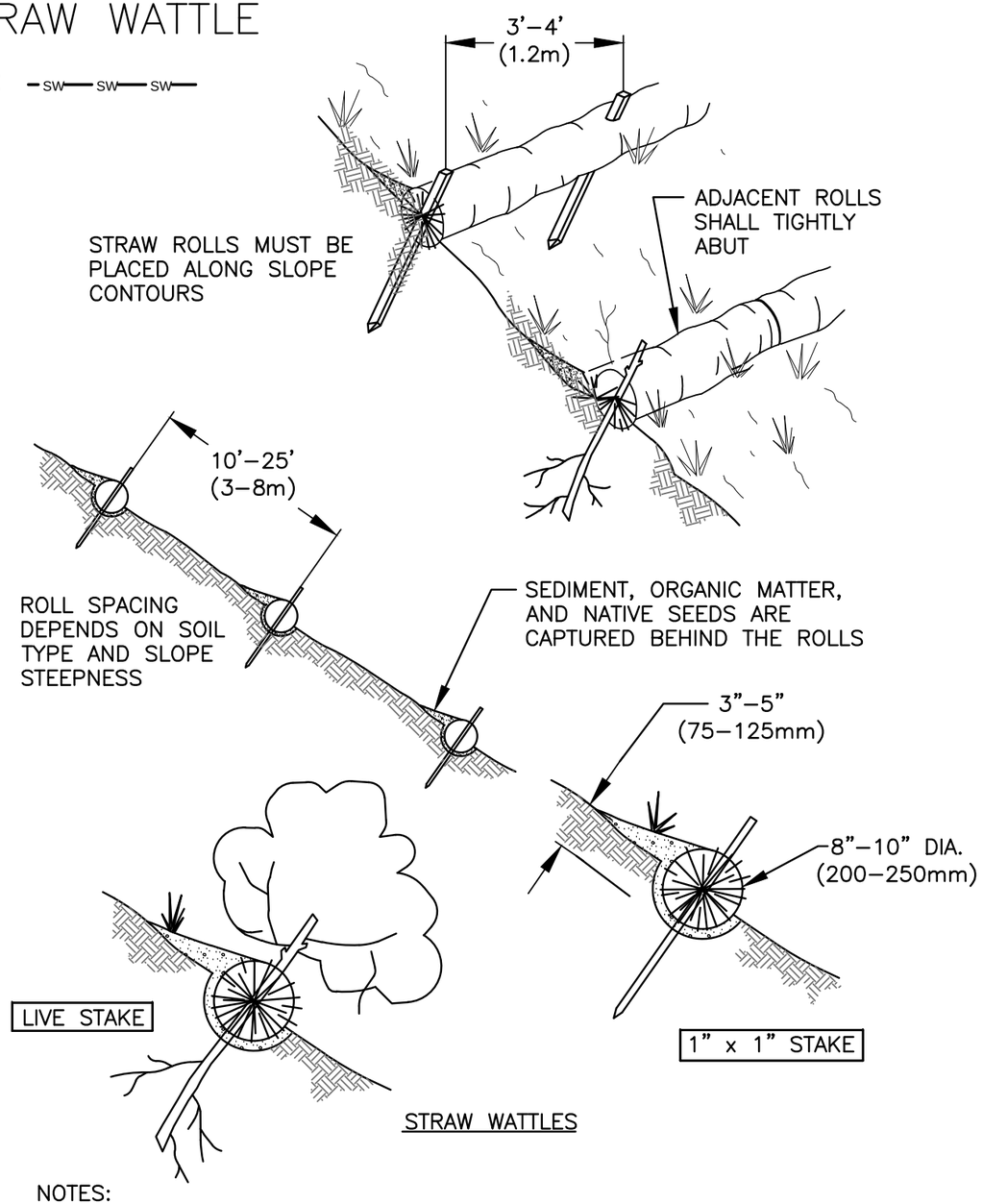
EROSION CONTROL DETAILS

Sheet reference number: 24

UPDATE

STRAW WATTLE

SW — SW — SW — SW



STRAW WATTLES

NOTES:

1. STRAW ROLL INSTALLATION REQUIRES THE PLACEMENT AND SECURE STAKING OF THE ROLL IN A TRENCH, 3" x 5" (75–125mm) DEEP, DUG ON CONTOUR. RUNOFF MUST NOT BE ALLOWED TO RUN UNDER OR AROUND ROLL.

SEEDING SPECIFICATIONS

SEEDING SPECIFICATIONS AND THE PLANT MIX SHOWN BELOW ARE FOR REVIEW AND BIDDING ONLY. A FINAL LANDSCAPE PLAN AND SEED MIX TO BE SUBMITTED BY THE CONTRACTOR FOR REVIEW BY THE PROJECT OWNER AND PROJECT ENGINEER. PRIOR TO CONSTRUCTION THE LANDSCAPE PLAN AND FINAL SEED MIX IS TO BE REVIEWED AND APPROVED BY BOULDER COUNTY.

AREAS TO BE PERMANENTLY STABILIZED AFTER COMPLETION SHALL FOLLOW THE REQUIREMENTS OF THE 2011 CDOT STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, SECTIONS 101, 107, AND 208, 213, AND 620 WATER QUALITY CONTROL, 213 MULCHING SPECIFICATIONS, AND OTHER REFERENCED MATERIAL.

REMOVAL OF ADJACENT ROADSIDE VEGETATION SHALL BE MINIMIZED WHERE POSSIBLE

ALL TEMPORARY DISTURBED AREAS NOT WITHIN THE WORK AREA WILL BE RETURNED TO PRECONSTRUCTION ELEVATION AND CONTOURS AND RESEEDED WITH THE BOULDER COUNTY APPROVED NATIVE SEED MIX THAT IS CERTIFIED WEED FREE

ALL NATIVE SEEDING AREAS WITH SLOPES 3:1 OR FLATTER SHALL BE MULCHED AND MECHANICALLY CRIMPED WITH 1.5 TONS PER ACRE OF WEED FREE STRAW AND APPLIED WITH MULCH TACKIFIER.

ALL OTHER SLOPES SHALL HAVE SOIL RETENTION BLANKET FOR SLOPES STEEPER THAN 3:1. IF SOIL RETENTION BLANKET IS USED, MULCH AND TACKIFIER ARE NOT REQUIRED.

COMMON NAME	BOTANICAL NAME	POUNDS PLS/ACRE
BLUE GRAMA	BOUTELOUA GRACILIS V. HACHITA	2
WESTERN WHEATGRASS	PASCOPYRUM SMITHII V ARRIBA	6
SIDEOATS GRAMA	BOUTELOUA CURTIPENDULA V. VAUGHN	3
LITTLE BLUESTEM	SCHIZACHYRIUM SCOPARIUM PASTURA'	3
GREEN NEEDLEGRASS	STIPA VIRIDULA V. LORDOM	3
SWITCHGRASS	PANICUM VIRGATUM DACOTAH	4
JUNEGRASS	KOELERIA MACRANTHA	0.2
SAND DROPSEED	SPOROBOLUS CRYPTANDRUS	0.1
INLAND SALTGRASS	DISTICHLIS SPICATA STRICTA	1
CONEFLOWER	RATIBIDA COLUMNARIS	0.5
GAILLARDIA	GAILLARDIA ARISTATA	1
OATS	AVENA SATIVA	3
TOTAL		31.8

THE CONTRACTOR SHALL USE CDOT'S STANDARD PROTOCOL FOR WEED MANAGEMENT, INCLUDING THE DEVELOPMENT OF AN INTEGRATED NOXIOUS WEED MANAGEMENT PLAN (INWMP) TO MITIGATE THE POTENTIAL ADVERSE EFFECTS OF EARTH DISTURBANCE.

COLORADO REGISTERED DAVID E. MOORE 22495 PROFESSIONAL ENGINEER

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SOUTH ST. VRAIN CREEK MEADOWS & SOUTH LEDGE DITCHES FINAL RECONSTRUCTION PLAN
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UPDATE